

**TENDER DOCUMENT**

for

**THE ADVANCE WORKS**

for

**THE PROPOSED SHOOTING RANGE**

at

**PILLAR POINT VALLEY LANDFILL, TAP SHEK KOK,  
TUEN MUN, HONG KONG**

for

**THE HONG KONG SHOOTING ASSOCIATION**

**DECEMBER 2010**

**HONG KONG SHOOTING ASSOCIATION**  
Employer

**THOMAS CHOW ARCHITECTS LIMITED**  
Architect

**OVE ARUP & PARTNERS HONG KONG LIMITED**  
Geotechnical and Structural Engineer

**OVE ARUP & PARTNERS HONG KONG LIMITED**  
Building Services Engineer

**ENVIRON HONG KONG LIMITED**  
Environmental Consultant

**RIDER LEVETT BUCKNALL LIMITED**  
Quantity Surveyor

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SPECIFICATION	
SECTION 1 - PRELIMINARIES	1/1 - 1/49 1.S/1 - 1.S/8
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ARCHITECTURAL SPECIFICATION	TOTAL 18 PAGES
STRUCTURAL SPECIFICATION	TOTAL 239 PAGES (INCLUDES 65 PAGES PRINTED ON DOUBLE SIDES)
ENVIRONMENTAL PRECAUTIONARY MEASURES	TOTAL 5 PAGES
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**CONDITIONS OF TENDERING**

1. The tender documents issued consist of :
  - (a) A booklet and containing :
    - (i) Conditions of Tendering
    - (ii) Form of Tender
    - (iii) Special Conditions of Contract
    - (iv) Preambles
    - (v) Specification
    - (vi) Summary of Tender
    - (vii) Schedule of Drawings
  - (b) One set of tender drawings as listed in the Schedule of Drawings.
2. The tender is to consist of :
  - (a) Three hard copies of the bounded booklet referred to in 1(a) above with the following sections completed :
    - (i) The Form of Tender completed, signed, witnessed and dated. (The sum shown in the Form of Tender must agree with the total of the Summary of Tender as 1(a)(vi) above)
    - (ii) Section 1 of the Specification fully priced in ink, extended, cast and totalled. The sums shown in the Summary of Tender must agree with the total of the relevant sections of the Specification.
    - (iii) The Schedules of Quantities and Rates as required under Specification, Section 1 - Preliminaries, clause 7.03 fully priced in ink, extended, cast and totaled. The sums shown in the Summary of Tender must agree with the total of the relevant sections of the Schedules of Quantities and Rates.

2. (Cont'd)

(a) (Cont'd)

- (iv) The Summary of Tender fully priced in ink, extended, cast and totaled.

(b) Six hard copies of the following submissions:-

- (i) An organization chart together with the name, qualification and experience of key staff to be responsible for this Contract.
- (ii) An outline construction programme for the work showing all crucial construction activities. All construction programmes and time schedules will be used for tender evaluation only and will not form part of the Contract.
- (iii) A Method Statement describing the Tenderer's planned approach to the construction of the Works together with the proposed major plant to be used and its location on the site, type of formwork systems, scaffolding and method, locations and area for loading and unloading materials within the site boundary etc.
- (iv) Proposed site layout showing location of site office, access route, etc.
- (v) Proof of being an Approved Contractor on the List of Public Works in Group A, B or C.
- (vi) Site supervision plan.
- (vii) Technical information, specification, catalogues, brochures, data sheets indicating details of the equipment offered.
- (viii) Job references of similar nature in the past 5 years.
- (ix) Brief introduction and background of the Company.
- (x) Any other details and information as required by the Tender Documents.

(c) Six disk copy each containing the soft copy of all items as listed in items 2(a) and 2(b) above in PDF format.



2. (Cont'd)

The contents of the hard copy and the disc copy of the tender referred above must be identical in all aspects. In the event of discrepancies, the hard copy shall take precedence and form the basis of the tender. The disc copy serves to facilitate the tendering and tender assessment processes and shall be discarded after award of the Contract.

3. The tender is to be enclosed in a sealed envelope which is to be labelled "Tender for the Advance Works for the Proposed Shooting Range at Pillar Point Valley Landfill, Tap Shek Kok, Tuen Mun, Hong Kong" and deposited at the time and place set out in the invitation to tender.

4. Any other drawings required by the Tenderer for tendering will be supplied on request at the Architect's discretion.

5. No unauthorised alteration or erasure to the text of the tender documents will be permitted. Any tender containing such alteration or erasure may not be considered.

6. The Tenderer shall be deemed to be in possession of a valid business registration certificate and be registered with the relevant Authority authorising him to carry out construction works of the category of this project.

7. The Tenderer shall be required to check the numbers of the pages of the tender booklet against the page numbers given in the Content page and should he find any missing, in duplicate, or indistinct, he must inform the Quantity Surveyor at once and have the same rectified.

8. Should the Tenderer for any reason whatsoever be in doubt as to the precise meaning of any item or figure, he must inform the Quantity Surveyor in order that the correct meaning can be clarified before the date for submission of tenders.

9. No liability will be admitted, nor claim allowed, in respect of errors in the tender due to mistakes in the tender documents which should have been rectified in the manner described above.

10. Any qualification of tender or of the tender document may cause the tender to be disqualified.

11. All drawings issued are to be returned to the Architect at or before the time set for receipt of tenders.

12. The Tenderer shall be deemed to have made allowance in his prices generally to cover items of Preliminaries, expense in connection with Prime Cost, Provisional and other items if these have not been priced against the respective items.

13. In the event of a Tenderer discovering a genuine error in his tender after it has been deposited, attention in writing may be drawn to the error and an amendment submitted which, provided that the amendment shall have been deposited on or before the time fixed for receipt of tenders, may be accepted.

14. The tendered sum will not be amended for errors found in the examination of tenders. The following errors should they occur in the tendered priced Schedule of Quantities and Rates will be rectified and altered in red ink :

- (a) The rate amended to agree with the quantity and the extension in the cash column or the extension to agree with the quantity and the rate.
- (b) Errors in casting of cash columns.
- (c) Errors in carrying forward totals to collections or summaries.

The total error will be calculated as a plus or minus percentage of the corrected tendered sum minus the correct totals of preliminary items and provisional and P.C. Sums (but not profit and attendance thereon) and prime cost elements within tendered rates based on prime cost rates and will be applied to the tendered rates for the purposes of pricing variations. If the percentage error is less than 0.50% no adjustment will be made.

For the purpose of clarification, where a tendered rate is based on a prime cost rate (e.g. tiling where a prime cost rate is specified), the percentage error calculated in the manner described above shall only be applied to that portion of the rate remaining after the deduction of the prime cost rate.

15. Should examination of a tender reveal errors of such magnitude as in the opinion of the Architect would involve the Contractor in serious loss then the nature and amount of such errors will be communicated to the Tenderer and he will be asked to confirm in writing that he is prepared to abide by his tender.

16. The Architect on behalf of the Employer is not bound to accept the lowest or any tender he may receive.

17. All tenders shall be in Hong Kong dollars and no adjustment will be made for fluctuations in exchange rates of currencies.

FORM OF TENDER  
for  
THE ADVANCE WORKS  
for  
THE PROPOSED SHOOTING RANGE  
at  
PILLAR POINT VALLEY LANDFILL, TAP SHEK KOK, TUEN MUN, HONG KONG  
for  
THE HONG KONG SHOOTING ASSOCIATION

To : HONG KONG SHOOTING ASSOCIATION

1. Having inspected the Site and examined the drawings, Conditions of Contract and Specification for the above named Works, I/we offer to carry out, complete and maintain the whole of the said Works in conformity with the said drawings, Conditions of Contract and Specification for the sum of Hong Kong Dollars

.....

..... (HK\$ )  
or such sum as may be ascertained in accordance with the Conditions of Contract.

2. I/We undertake if my/our tender is accepted to complete the whole of the Works comprised in this Contract within the period of time set out in the Preliminaries Section of the Specification.

3. I/We agree to abide by this tender for a period of three months from the date fixed for receiving the same and it shall remain binding upon me/us and may be accepted at any time before the expiry of that period.

4. Unless and until a formal agreement is prepared and executed this tender together with the written acceptance thereof by the Architect on behalf of the Employer subject to the provisions of Clause 3 hereof shall constitute a binding Contract.

5. I/We understand that the Employer (or the Architect on his behalf) is not bound to accept the lowest or any tender which he may receive.

6. I/We are aware of and accept the amendments to the Standard Conditions of Contract as set out in the Special Conditions of Contract.

7. I/We agree that I/we shall provide a Bond in the amount specified in the Appendix to the Conditions of Contract for the due performance of the Contract in a form as shown in Schedule 1 of the Standard Conditions of Contract.

Signature .....

in the capacity of .....

duly authorised to sign tenders for and on behalf of \*.....

.....

Registered address of firm .....

.....

Date .....

Name and signature of witness .....

Address of witness.....

If a tender is being made by a partnership or an unincorporated body, the names and residential addresses of all partners shall be given in the spaces provided below.

Names of Partners	Residential Addresses of Partners

\* In the case of a limited Company, insert the name of the Company.

**SPECIAL CONDITIONS OF CONTRACT**

**SPECIAL CONDITIONS OF CONTRACT**

Any cost effects resulting from the Special Conditions of Contract hereunder shall be taken into account in the pricing of the Specification - Section 1 - Preliminaries.

These Special Conditions of Contract are to be read in conjunction with "The Standard Conditions of Contract".

"The Standard Conditions of Contract" means the Agreement & Schedule of Conditions of Building Contract for use in the Hong Kong Special Administrative Region, Private Edition - Without Quantities together with its Appendix and Schedules 2006 Edition issued under the sanction of the Hong Kong Institute of Architect, the Hong Kong Institute of Construction Managers and the Hong Kong Institute of Surveyors.

Where applicable the provisions of these Special Conditions of Contract shall prevail over those of the Standard Conditions of Contract.

The Contract shall be signed by the parties as a simple contract on the "Attestation" paper of the Standard Conditions of Contract.

"The Conditions of Contract" means the Standard Conditions of Contract and these Special Conditions of Contract.

The Contractor should study the Standard Conditions of Contract in conjunction with the particulars to be inserted in the Appendix as detailed in the Specification - Section 1 - Preliminaries together with the Special Conditions of Contract.

Index of the Special Conditions of Contract :

SCC 1	Not used
SCC 2	Not used
SCC 3	Not used
SCC 4	Not used
SCC 5	Documents forming the Contract and other documents
SCC 6	Not used
SCC 7	Not used
SCC 8	Materials, goods, workmanship and work
SCC 9	Not used
SCC 10	Not used
SCC 11	Not used

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SCC 12	Not used
SCC 13	Not used
SCC 14	Not used
SCC 15	Not used
SCC 16	Not used
SCC 17	Substantial Completion and defects liability
SCC 18	Not used
SCC 19	Not used
SCC 20	Not used
SCC 21	Insurance against injury to persons or property
SCC 22	Not used
SCC 22A	Not used
SCC 22B	Not used
SCC 22C	Not used
SCC 23	Possession, commencement and completion
SCC 24	Damages for non-completion
SCC 25	Extension of time
SCC 26	Delay recovery measures
SCC 27	Not used
SCC 28	Not used
SCC 29	Nominated Sub-Contractors and Nominated Suppliers
SCC 30	Not used
SCC 31	Not used
SCC 32	Certificates and payments
SCC 33	Surety bond
SCC 34	Not used
SCC 35	Not used
SCC 36	Not used
SCC 37	Not used
SCC 38	Fluctuation
SCC 39	Not used
SCC 40	Recovery of money due to the Employer
SCC 41	Not used

Schedule 1 Form of Surety bond to be given by the Contractor to the Employer

SCC 5 - Documents forming the Contract and other documents

Replace the whole of sub-clause 5.1(2) of the Standard Conditions of Contract by the following:

(2) Where there are discrepancies between the various documents forming the Contract, the more onerous requirements shall take precedence.

SCC 8 - Materials, goods, workmanship and work

Add the following clause after sub-clause 8.2(3) of the Standard Conditions of Contract:

(4) The Contractor shall notify the Architect in writing before work is covered up and give him at least two full days notice to inspect it. Unless the Contractor does so, no charge shall be incurred by the Employer for opening up, testing and making good nor will any extension of time be granted in this respect.

Add the following in sub-clause 8.3 of the Standard Conditions of Contract :

The words", in his opinion," between the words "work" and "are".

SCC 17 - Substantial Completion and defects liability

Add the following sub-clause 17.3(6) of the Standard Conditions of Contract:

(6) If in the opinion of the Architect it is more suitable and beneficial that unfinished items of work or remedial work in rectifying defects remaining after the issuance of the Substantial Completion Certificate is carried out by others, the Contractor shall undertake to reimburse the Employer the cost of carrying out such outstanding or remedial work by others or the Employer has the right to deduct such cost from payments due to the Contractor.

SCC 21 - Insurance against injury to persons or property

Replace the following in sub-clause 21.1(1) of the Standard Conditions of Contract :

The words "the employees of Contractor or of sub-contracts of all tiers" replaced by the words "the employees of the Contractor or of any sub-contractor of all tiers".

Replace the following in sub-clause 21.2(1)(b)(ii) of the Standard Conditions of Contract :

The words ";and" replaced by the words"; or"



SCC 23 - Possession, commencement and completion

Add the following sub-clause 23.4 to the Standard Conditions of Contract :

23.4 The Architect, or the Architect's representative with the express delegation of authority from the Architect may issue instructions suspending or stopping all work or any part of the Works for such time or times and in such manner as they may consider necessary, by reason of :

- a) weather conditions affecting the safety or quality of the Works or any part thereof;
- b) default on the part of the Contractor in not complying with the Contract Specification, Drawings and Architect's Instructions, and/or statutory or relevant Government Authorities' requirements;
- c) the carrying out of the Works by the Contractor and/or his Sub-Contractors which in the opinion of the Architect endangers or undermines the safety of adjoining or other buildings, streets or structures, either totally or partially; or
- d) insufficient measures being taken by the Contractor to abate noise pollution during the carrying out of the Works so as to avoid unreasonable nuisance to the occupants of neighbouring and adjoining buildings.

The Contractor shall upon such written instruction suspend and/or stop the progress of the Works or any part thereof for such time and in the manner as contained in such instruction, and shall during such suspension or stoppage properly protect and secure the Works to the Architect's reasonable satisfaction.

All costs incurred in connection with the suspension or stoppage shall be borne by the Contractor and no extension of time will be granted in this respect unless provided for elsewhere in the Contract. No claim for loss/expenses will be entertained in connection with such suspension or stop work instruction.

SCC 24 - Damages for non-completion

It is expressly agreed that the words "between the Completion Date and the Date of Substantial Completion" in the last line of clause 24.2(1) shall be deleted and replaced by the words "during which the Works shall so remain or have remained not substantially complete".

SCC 25 - Extension of time

It is expressly agreed that sub-clause 25.1(3)(b) of the Standard Conditions of Contract is deleted and replaced by the following:

- (b) inclement weather conditions, being rainfall in excess of fifty millimetres in a twenty-four hour period (midnight to midnight) as recorded by the Hong Kong Observatory station nearest to the Site, affecting the progress of the Works but not the subsequent effects thereof;

It is expressly agreed that sub-clause 25.1(3)(c) of the Standard Conditions of Contract is deleted and replaced by the following :

- (c) the hoisting of tropical cyclone warning signal No. 8 or above or the announcement of a Black Rainstorm Warning but not the subsequent effects thereof;

It is expressly agreed that sub-clauses 25.1(3)(t) and (u) of the Standard Conditions of Contract are deleted.

SCC 26 - Delay recovery measures

It is expressly agreed that sub-clause 26.3(2) of the Standard Conditions of Contract is deleted.

SCC 29 - Nominated Sub-Contractors and Nominated Suppliers

Replace the following in sub-clause 29.7(2) of the Standard Conditions of Contract :

The words "payment from the Employer" replaced by the words "payment or the accounting of payment from the Employer, as the case may be".

Replace the following in sub-clause 29.12(2) of the Standard Conditions of Contract :

The words "payment from the Employer" replaced by the words "payment or the accounting of payment from the Employer, as the case may be".

SCC 32 - Certificates and payments

Add the following at the end of sub-clause 32.3 of the Standard Conditions of Contract :

Provided that :-

- (1) Such materials or goods are intended for inclusion in the Works;
- (2) Such materials or goods are in accordance with this Contract;
- (3) The Contractor furnishes to the Architect reasonable proof that the premises where the materials or goods have been assembled or stored are owned or leased by the Contractor;
- (4) Such materials or goods have been and are set apart at the premises where they have been assembled or stored, and have been clearly and visibly marked, individually or in sets, so as to indentify :
  - (a) the person to whose order they are held, and
  - (b) their destination as being the Works;
- (5) The Contractor furnishes to the Architect evidence that such materials or goods are insured against the perils set out in clause 22 as applicable, of these Conditions;
- (6) The Contractor furnishes to the Architect reasonable proof that the property in such materials or goods is in the Contractor and that the conditions set out in paragraphs (1) to (5) of this sub-clause have been complied with.

Add the following after sub-clause 32.7(3)(e) of the Standard Conditions of Contract :

Provided further for the circumstances that if the Contractor's tender sum for work provided for by a Prime Cost Sum as included in the Schedule of Quantities and Rates has been added to the Contract Sum under clause 32.7(3)(b), the sum payable for attendance shall be the price entered in the Schedule of Quantities and Rates as a separate item whether or not the Contractor's tender sum is greater or less than the Prime Cost Sum.

SCC 33 - Surety bond

Replace the following in sub-clause 33.2 of the Standard Conditions of Contract :

The words "Substantial Completion Certificate" replaced by the words "Defects Rectification Certificate".

Add the following in sub-clause 33.3 of the Standard Conditions of Contract :

The words "or the issue of the Defects Rectification Certificate for the whole of the Works" between the words "Employer" and ", at".

The words "or the issue of the Defects Rectification Certificate as appropriate" between the words "delivery of the bond" and ".".

Add the following at the end of sub-clause 33.3 of the Standard Conditions of Contract :

The amount so withheld shall be held upon trust by the Employer for the Contractor (without obligation to invest) subject to the rights of the Employer to have recourse to it for payment of any amount which he is entitled to under the Contract or at law or to deduct from it any sum owed to him by the Contractor, provided that the Employer gives notice to the Contractor in accordance with clause 32.1(6).

SCC 38 - Fluctuations

The whole clause 38 of the Standard Conditions of Contract shall not be applicable.

SCC 40 - Recovery of money due to the Employer

Replace the following in sub-clause 40(2) of the Standard Conditions of Contract:

The words "clause 40.1(1)" replaced by "clause 40(1)".

Schedule 1 - Form of surety bond to be given by the Contractor to the Employer

Replace the following in line 3 on page 91 of the Schedule 1 to the Standard Conditions of Contract :

The words "Defects Rectification Certificate" replaced by the words "Substantial Completion Certificate for the Works".

Replace the following in clause 5 of Schedule 1 to the Standard Conditions of Contract :

The words "Substantial Completion Certificate/Defects Rectification Certificate\*" replaced by the words "Defects Rectification Certificate".

Delete the following after Clause 6 of Schedule 1 to the Standard Conditions of Contract :

The words "\* Delete as appropriate".

(End of Amendments to the Standard Conditions of Contract)

## **PREAMBLES**

PREAMBLESPREAMBLES APPLICABLE TO ALL TRADESGenerally

- A This Schedules of Quantities and Rates is for reference only. The tenderer is deemed to have visited the site, studied the tender documents and assessed for himself the actual scope of works.

The Tenderer may propose in parallel under the Item - "Allow for all other items of works which have been described in the Specification or shown on the drawings or which are necessary for the satisfactory completion of the Works." in each Schedule, any alterations, omission or addition to the items, descriptions or quantities in the Schedule of Quantities and Rates according to his own interpretation and/or measurements.

Pricing

- B The Preambles and Specification shall not be priced. They shall be regarded as part of the descriptions of the measured items in the Schedule of Quantities and Rates which shall be read in conjunction with the Preambles and Specification and priced accordingly.

Allow

- C Whenever the word "allow" occurs in these Schedule of Quantities and Rates the cost of the items shall be at the risk of the Contractor and no adjustment will be made at the settlement of accounts unless the work described in an item is not required, in which case the relevant sum will be omitted. In the absence of any price against such items, the cost shall be deemed to be included in the rates contained in the Schedules of Quantities and Rates hereinafter following.

Adjustment of P.C. Rates

- D Where prime cost (P.C.) rates are included in the descriptions of items in the Schedule of Quantities and Rates they are either for the material cost of items or are for the supply and installation or application of items.

P.C. rates for materials are for the supply of materials to site only and the Contractor shall allow in addition for taking delivery from the supplier at street level, unloading or assisting in unloading, storing, distributing to required positions, returning packing cases etc. to the supplier (including paying transportation charges and obtaining credits for the packing cases etc), all waste, fixing, all ancillary materials required for fixing such as mortar for bedding and jointing and all other similar items of a like nature, for any finance charges arising from the terms of payment agreed between the supplier and the Contractor and for profit. P.C. rates included in the descriptions for the supply and installation or supply and application of items such as specialist suspended ceilings or finishes shall include any finance charges arising from the terms of payment agreed between the specialist and the Contractor and for the Contractor's allowance for profit and attendance on the specialists carrying out the works.

**PREAMBLES APPLICABLE TO ALL TRADES** (Cont'd)**Adjustment of P.C. Rates** (Cont'd)

The Contract rate will be adjusted by the nett difference between the prime cost rate and the actual price and will be applied to the nett quantity of the items fixed, installed or applied in position and measured in accordance with the Preambles.

**Making good**

- A The term "making good" shall be understood as including all labours and materials necessary to bring the disturbed area to the same face, colour, texture etc., in the same materials as the surrounding work, and shall include for painting, colouring and/or varnishing any new work to match the surrounding existing work to the entire satisfaction of the Architect.

**As described**

- B The term "as described" included in descriptions contained in the Schedules of Quantities and Rates refers to the materials and workmanship described in the relevant Specification Clauses and in the Preambles.

**As before described**

- C Descriptions which contain the term "as before described" are abbreviated descriptions of items which have occurred previously in the Schedules of Quantities and Rates.

**Approval**

- D Terms such as "approved by", "to approval", "as directed" and the like, refer to approval or directions given by the Architect. The phrase "or equal approved" is deemed to be included in the description whenever proprietary brands are named and the tendered rates are deemed to include for the provision of the specified proprietary brand item but the Architect will consider alternative materials and methods that the Contractor may propose. The Contractor shall submit full details to the Architect of any proposed alternative products or material together with supporting information on the price of the alternative products or materials and of the specified proprietary brand of products or materials. No such alternatives shall be adopted without the prior approval of the Architect. Approved alternative materials or work will not qualify for additional costs unless such additional costs are sanctioned before approval is given. Under no circumstances shall approval relieve the Contractor of his responsibilities as set out in the Conditions of Contract. No approval will be binding until given in writing.



**PREAMBLES APPLICABLE TO ALL TRADES** (Cont'd)**Allowance for laps**

- A No allowances for laps have been made in the quantities. Materials such as fabric reinforcement, flexible sheet underlays and the like shall be lapped to the extent required and the prices shall include for this.

**Preambles applicable throughout Schedule of Quantities and Rates**

- B Preambles are applicable to all items in the Schedules of Quantities and Rates irrespective of the trade section under which they are billed.

**Metric/imperial sizes**

- C In the event of any current Standard being imperial and the articles in the Schedules of Quantities and Rates not being available in metric sizes stated, the Contractor is deemed to have allowed in his rates for substitution of the nearest higher imperial size for the metric size stated.

**Extra over or extra for**

- D Throughout the Schedules of Quantities and Rates are descriptions commencing with the words "Extra over" or "Extra for" or under headings commencing with either "Extra over or Extra for".
- E The volume, area, length or number of these items has been included in the measurements of the quantities in which they occur and the prices for these items are to be extra only over the prices of the items in which they occur.

**Warranty/Guarantee**

- F The costs of provision of warranties/guarantees in respect of any materials or works as required in the Specification are deemed to be included in the rates for the relevant materials or works unless items for such purpose have been otherwise identified in the Schedules of Quantities and Rates for pricing.

**DEMOLITIONS AND ALTERATIONS****Demolitions****Generally**

- A The tenderer is directed to visit the Site and assess for himself the scope of the demolition work and take his own measurements and notes as necessary in order to price each item.
- B All materials, debris and other items arising from demolitions shall become the property of the Contractor unless specifically stated otherwise.

**Rates to include**

- C The rates for all demolition work shall include for :
- (a) Giving due notice of proposed demolition to Government Departments and to any Utility Company if their installations will be affected, and for the disconnection of services.
  - (b) Carrying out the work in such a way as to ensure the safety of, and cause as little inconvenience as possible to, adjoining properties and occupants, the public in general, passing vehicles and workmen.
  - (c) Provision of all shoring, scaffolding, needling, strutting or other supports incidental to demolitions and necessary for the protection and safety of and upholding all portions of the building affected by the works including all necessary cutting away and making good after removal.
  - (d) Wedging and pinning up, cutting to line remaining portions, making good any walling which collapses or is pulled down in excess of requirement, and preparing surfaces of floor slabs under, ceiling over, and abutting surfaces of columns or side walls to receive new finishes, facing up or flushing up existing surfaces after cutting to match the surrounding work and cutting back old plaster and pavings etc. for joints with new.

**DEMOLITIONS AND ALTERATIONS** (Cont'd)**Demolitions** (Cont'd)**Rates to include** (Cont'd)

- (e) Removing all old materials, debris and other arisings off Site to a store or to an approved dump to be provided by the Contractor.
- (f) Covering up and protecting the works from damage by dust, sun, rain and similar hazards and protecting the occupants and the general public from dust nuisance, falling rubbish and the like.
- (g) All other work necessary or implied to complete the demolitions in a proper and workmanlike manner in accordance with the Specification and Drawings.

A The rates for the removal of asbestos, toxic or dangerous materials or materials containing asbestos or other noxious materials shall include for :

- (a) Provision and subsequent removal of protective screens and enclosures, unless separately measured and the provision of protective measures for workmen, the public and adjoining property.
- (b) Depositing in a dump site approved for the purpose.

B The rates for shoring shall include for obtaining licences and paying fees and providing all necessary rails, wedges, cramps and bolts.

**DEMOLITIONS AND ALTERATIONS** (Cont'd)**Alterations****Take down and clear away and credit**

- A The term "take down" or "take up" or "take out" and "clear away" shall mean the execution complete by the Contractor of the work of taking down, taking up or taking out of an existing article, fitting or material either in whole or in part and removing from site and disposing of same and the rates shall be held to include for all or any of the following :
- (a) Taking down, taking up or taking out of the article, fitting, or material, either in whole or part complete with plugs, holdfasts, lugs, brackets and other fixings including all cutting out and clearing the whole debris away from site.
  - (b) Making good to all work disturbed at fixings and any damage to surrounding surfaces including filling all mortices, holes, etc., or alternatively leaving same open and clean ready to receive new article, fitting or material.
  - (c) Preparing edges, ends, or surfaces of remaining material to receive junction with new.
- B The article, fitting, or material taken down shall become the property of the Contractor and due allowance for credit should be made.

**Take down and set aside for re-use**

- C The term "take down" or "take up" or "take out and set aside for re-use" shall mean the execution complete by the Contractor of the work of taking down or taking up, or taking out an existing article, fitting, or material, and setting same aside on site for subsequent re-use and the rates shall be held to include for all or any of the following :
- (a) Carefully taking down, taking up or taking out of the article, fitting or material complete with plugs, holdfasts, lugs, brackets and other fixings including dismantling if necessary and all cutting out.
  - (b) Thoroughly cleaning, oiling and adjusting the article, fitting or material ready for re-use including dismantling and re-assembling again as necessary and moving and stacking or putting into store on site.

**DEMOLITIONS AND ALTERATIONS** (Cont'd)**Alterations** (Cont'd)**Take down and set aside for re-use** (Cont'd)

- (c) Making good to all work disturbed at fixings and any damage to surrounding surfaces including filling all mortices, holes, etc., or alternatively leaving same open and clean ready to receive new article, fitting or material.
  - (d) Preparing edges, ends, or surfaces of remaining material to receive junction with new.
  - (e) Repairing any damage to the article, fitting, or material caused during taking down, etc.
- A Any repairs required to the article, fitting or material apart from cleaning, oiling and adjusting or making good damage caused during taking down, etc., and re-fixing in new positions, will be measured and paid for separately.

**Re-fix or Re-hang**

- B The term "re-fix" or "re-hang" shall mean the carrying out complete by the Contractor of the work of re-fixing and jointing an article, fitting or material available from the demolitions, and the rates shall be held to include for any or all of the following :
- (a) Taking the article, fitting or material from store on site, sorting, cutting and fitting, fabricating, assembling, moving, hoisting, fixing, laying or setting and jointing in new or existing work, opening or position.
  - (b) Providing all fixing and jointing materials such as nails, bolts, nuts, washers, screws, mastic, adhesive and mortar.
  - (c) Carrying out all plugging and screwing, jointing, cutting all mortices and grouting same, cutting, fitting, easing or adapting necessary to the article, fitting or material or to the position in which same is to be fixed, and oiling and leaving in working order.
  - (d) Making good any damage caused to the article, fitting or material, and to surrounding surfaces.
- C The prior taking down of the existing article, fitting, or material has been measured separately.

**DEMOLITIONS AND ALTERATIONS** (Cont'd)**Alterations** (Cont'd)**Making out**

- A The term "making out" shall be understood as including all labour and materials necessary in providing new work to match existing in bare areas caused by demolitions or alterations.
- B The "making out" shall be carried out to bring the bare areas to the same face, colour and texture in the same materials as the surrounding work and shall include for painting, colouring etc. to match the existing work.

**Ease and adjust wooden doors or windows**

- C The term "ease and adjust" doors or windows shall include for re-securing, tightening existing or providing new screws to hinges, pivots, sliding gear etc., cleaning and oiling same, and planing, sanding, and painting one coat of hard gloss paint or polishing edges as required.

**Examine and repair**

- D The term "examine and repair" shall mean the carrying out complete by the Contractor of the work of putting into repair an article, fitting or material complete in its existing position when no prior complete taking down (or taking up or taking out) of the article, fitting or material is involved and the rates shall include for tightening all existing fixings, the provision and use of new fixing materials required such as plugs, nails, screws, mastic and mortar, and drilling new holes, etc. and making good, and easing, oiling and adjusting the item as necessary.

**Prepare to receive new finish**

- E The term "prepare to receive new finish" means raking out joints of existing brickwork or hacking surfaces of existing concrete, thoroughly cleaning down and watering as necessary and appropriate to receive new finish, including washing over with cement grout if ordered by the Architect.

**DEMOLITIONS AND ALTERATIONS** (Cont'd)**Alterations** (Cont'd)**Internal plaster and external plaster**

- A All patches and repairs to internal plaster and external plaster are measured nett as completed.
- B No provision will be made for large or small quantities, narrow widths, easy or difficult locations or any other exceptional circumstances.

**Demolishing or cutting into concrete or brickwork**

- C Rates for cutting into and taking down concrete or brickwork etc. including cutting chases, sinkings, grooves, holes and similar items shall be held to include for removal of debris, and all material arising from these operations shall become the property of the Contractor.
- D Rates for demolition of brick or concrete walls shall be held to include all finishings and dados both sides, brackets and small items built in and for making good all work disturbed including cutting back reinforcement or cutting out cramps where abutting concrete columns, cleaning and preparing the floor and ceiling abutments for new finishings. (Facing up of brick walls has been measured separately).

**Cut new openings or enlarge existing openings**

- E The rates for cutting new openings or enlarging existing openings shall be held to include for levelling for sills, cutting toothings and providing and bonding in any new bricks required, and preparing jambs and head ready to receive new plaster or other finish, cutting and pinning in ends of new sills, lintols, fixing lugs, cramps, bolts, etc. and clearing away all debris.
- F Openings are measured nett size including allowance for lintol and sill but excluding pockets for lintols, lugs, cramps, bolts, etc.
- G New lintols and sills are measured separately.

**DEMOLITIONS AND ALTERATIONS** (Cont'd)**Alterations** (Cont'd)**Take down timber doors**

- A Timber doors shall be taken out complete with all ironmongery, frames, linings, sills, architraves, grounds, cramps, dowels, etc. where so described. Where timber doors occur in glazed screens, a separate item is given for removal of the door from the screen.

**Remove ironmongery**

- B The rates for "removing" all ironmongery shall be held to include for "piecing out" and filling all old sinkings, housings, screw holes, mortices or similar in the timber or other surfaces to which the article of ironmongery was fixed, and preparing surface to receive new decoration.

**Take down steel doors**

- C The rates for taking down steel doors shall be held to include for taking down frames and thresholds and cutting out lugs, cramps etc. and for removing all control gear and ancillary items such as hooks, stops, etc.

**Taking down pipework**

- D The rates for taking down pipework shall be held to include for hacking floors, walls and ceilings as necessary to allow withdrawal, cutting out pipe brackets and other fixings, removing sleeves, making good all disused holes through floors and walls, all chases or other damage to surfaces of floors, walls, ceilings and all other work disturbed. If extraction of tubing, gullies etc. is unnecessary or impossible, ends are to be sealed off in position and the rates shall be held to include for this. Removing pipework from or within walls, partitions, floors, etc. and joinery fittings to be demolished or removed has not been measured separately and the cost shall be included within the cost of the demolition or removal of these items.

**Sanitary fittings**

- E The rates for taking down all sanitary fittings shall be held to include for disconnecting all service, overflow, waste and anti-siphonage pipes. A separate item has been measured for taking out all service pipework beyond the taps or fittings, and for all waste pipes beyond the traps.



**EXCAVATION****Nature of excavation**

- A The Tenderer is directed to visit the Site and satisfy himself as to the nature of the Site and the ground to be excavated prior to tendering.
- B The onus is on the Tenderer to judge the nature of the ground to be excavated and to estimate the percentage of rock to be removed. This estimate is at the Tenderer's own risk and will not be subject to any adjustment.
- C The Site (or Part of the Site) was previously occupied by buildings which have been demolished under a previous contract.

**Blasting**

- D Blasting will not be permitted.

**Site investigation reports**

- E Any site investigation reports which may be made available are given in good faith as a guide to Tenderers but no responsibility can be taken for their accuracy or applicability over the whole site.
- F Any additional preliminary investigation may be carried out by the Contractor at his own expense.

**Rates to include**

- G The rates for all excavations shall include for :
- (a) Excavating in any type of level or sloping ground whatsoever including boulders and solid rock and for the use of compressed air plant, wedges or other plant and appliances if required.
  - (b) Excavating by hand or taking such other precautions as are necessary to avoid damage to tops of foundations or other works already constructed on Site by a previous Contractor.
  - (c) Additional excavation to provide working space where required for the erection of formwork and/or carrying out of work which requires workmen to operate from the outside and subsequent backfilling of working space as required.
  - (d) Excavating in stages if directed or required.

**EXCAVATION** (Cont'd)**Rates to include** (Cont'd)

- (e) Grubbing up roots and similar and removing disused electrical and mechanical works, manholes, tanks, drains and sealing connections.
- (f) Getting out excavated material by any means necessary.
- (g) Increase in bulk of excavated material.
- (h) All multi-handling after excavation including provision of temporary off site storage of excavated materials to be used for backfilling or filling to make up levels, as necessary or as required by site conditions or restrictions or to suit the construction sequence and for transportation to the temporary storage site.
- (i) Trimming, levelling or grading, and ramming bottoms.
- (j) Trimming sides.
- (k) Planking and strutting to all faces of excavations, unless measured or itemised in the Schedules of Quantities and Rates, including any additional excavation, backfilling and/or disposal occasioned thereby.
- (l) Temporarily supporting existing services, drain pipes, cables, and similar during excavation and making good any damage caused to same.
- (m) Filling with concrete where excavations have been executed deeper or wider than instructed, or concrete placed in lieu of trimming rock bottoms to exact levels.
- (n) Protecting all works from inclement weather and for making good any subsidence, slip or denudation.

A The rates for reduce level excavation shall be held to include for any additional excavation and return filling to form face of excavation to temporary slopes and/or all necessary shoring and planking and strutting to uphold the face of the excavation behind retaining walls.

B The rates for trenches for curbs, service pipes, cables, multiple pipes and cables and the like given run and for excavating enumerated post holes shall include for part backfilling and compacting of excavated material and for removal of surplus.

**EXCAVATION** (Cont'd)**Rates to include** (Cont'd)

- A The rates or allowances for temporary supports to faces of excavations measured or itemised in the Schedules of Quantities and Rates shall include for any additional excavation, backfilling and/or disposal occasioned thereby.
- B The rates for backfilling, filling, soil and hardcore shall include for :
- (a) Additional material required to allow for consolidation.
  - (b) All multi-handling, on or off the Site including transportation back to the Site of any materials to be used for backfilling or filling to make up levels which have been temporarily removed to off Site storage.
  - (c) Spreading and levelling, watering as required, filling in layers and compacting as specified.
  - (d) Temporary retaining boards to edges and slopes and any necessary handpacking at steppings, thickening under slabs, behind walls and similar positions.
  - (e) Compaction testing including determining on site maximum dry density, optimum moisture content, insitu field density and moisture content and keeping records of all tests and results all as specified.
- C The rates for backfilling around the foundations or filling to make up levels are to include for provision of approved quality material imported from the Contractor's own source to substitute for any excavated material that may be found unsuitable for filling and for carting away unsuitable materials from Site. The onus is on the Tenderer to determine, before submission of his tender, the nature of the soil to be encountered and its suitability for filling. Imported filling shall be measured only when the measured amount of filling exceeds the measured amount of excavation.
- D The rates for removal of excavated material and debris from Site shall be held to include for transporting to an authorised dump site arranged by the Contractor and paying all charges in connection therewith. No claim will be considered if the Contractor is compelled to change the place of dumping.

**EXCAVATION** (Cont'd)**Rates to include** (Cont'd)

- A Rates for removal of excavated material or importation of filling or hardcore which have to be transported along public roads shall include for conforming with all Police Regulations for carting, loading and unloading of these materials and for taking the following precautions to prevent the material being deposited on these roads during haulage :
- (a) All lorries must have tightly fitting and adequately secured side and tail boards.
  - (b) Earth or hardcore shall not be loaded into the lorry to a level higher than the tail or side boards. Rock shall be carefully and securely stacked on the vehicle to prevent any dislodging and falling onto the road during haulage.
  - (c) During the period covered by the excavation works the Contractor shall provide and employ at the works site, borrow site and dump site such unskilled labour as is necessary or as directed by the Architect for the purpose of keeping the wheels and undersides of lorries clean and free from earth prior to leaving the works site, borrow site or dump site and, after dumping, for sweeping out all loose material remaining in the vehicle. At the discretion of the Architect such labour shall be employed also in keeping clean the approach roads to works site, borrow site or dump site.
- B The rates for "Excavation" items will be applied to all work within the boundary of the site including variations for changes in depth and positions of excavations and for extra work.

CONCRETE WORKSRates to include

- A The rates for all concrete work are to include for :
- (a) Mixing, sampling and testing requirements prior to construction including trial mixes and provision and submission of test cubes for testing.
  - (b) Conveying, hoisting or lowering, placing in position, complying with temperature control requirements, curing and protection.
  - (c) Additional thickness for tolerances stated in the Specification.
  - (d) Forming all construction joints at pouring breaks including the provision of approved waterstops, movement joints, backer rods, sealant and the like.
  - (e) Laying slabs level or to falls in alternate bays including temporary formwork to edges between bays and finishing surfaces level or to falls, currents, cambers and pre-cambers as required, and to receive pavings unless otherwise specifically stated.
  - (f) Forming or cutting all grooves (other than in fair faced concrete to form ornamental feature), chases, rebates, mortices, holes for pipes, and ducts, openings and recesses, notches, grouting in lugs, dowels, bolts, cramps, baluster ends and the like with cement mortar and making good.
  - (g) Forming angles, ends, intersections, outlets and similar labours to channels and other items measured run.
  - (h) Casting kickers monolithically with base slab where these are required at base of walls and columns.
  - (i) Carrying out in-situ core tests to verify the quality of the concrete structure all in accordance with the Building Departments requirements or as and when instructed by the Architect.
- B The rates for all reinforced concrete shall further include for :
- (a) Tamping around reinforcement.
  - (b) Consolidating with vibrators.

**CONCRETE WORKS** (Cont'd)**Rates to include** (Cont'd)

- A The rates for thickening under concrete beds under walls, partitions, channels and the like shall include for any extra excavation, disposal, hardcore, forming trenches in or handpacking hardcore and formwork.
- B The rates for concrete described as poured (or partly poured) against face of excavation shall include for any additional concrete to fill the interstices in the face of the excavation.
- C The rates for suspended slabs shall include for the additional cost of higher strength concrete in shoulders or haunchings at abutment with columns or walls or over beams and for formwork or permanent mesh separation barriers to form the shoulders or haunchings.
- D The rates for beams shall include for the additional cost of higher strength concrete in shoulders or haunchings at abutment with columns or walls and for formwork or permanent mesh separation barriers to form the shoulders or haunchings.
- E The rates for reinforcement shall include for :
  - (a) Cutting to length, bending (including cranks and hooked ends), hoisting, fixing and securely supporting in position and tying with wire.
  - (b) Annealed iron tying wire.
  - (c) Precast concrete or approved proprietary spacer blocks or chairs and supports (other than spacers, chairs and supports designed by the Engineer which have been measured) and ordinary spacer rods.
  - (d) Allowance for rolling margin.
  - (e) Allowance for couplers and for threading ends of bars for same where required. (Couplers included in the Engineer's design have been measured).
  - (f) Allowance for extra material in laps in fabric reinforcement.
  - (g) Bending fabric reinforcement and notching around obstructions.
  - (h) Provision and submission of reinforcement for testing and provision of test certificates.
  - (i) Carrying out testing as described on the drawings.

**CONCRETE WORKS** (Cont'd)**Rates to include** (Cont'd)

- A The total weights of bar reinforcement have been calculated at the following weights per linear metre. These unit weights will be used for the purposes of measurement and valuation of variations and remeasurements.

<u>Diameter</u>	<u>Kg/m</u>	<u>Diameter</u>	<u>Kg/m</u>
4 mm	0.099	20 mm	2.466
6 mm	0.222	22 mm	2.984
8 mm	0.395	25 mm	3.854
9.5 mm	0.557	28 mm	4.834
10 mm	0.616	30 mm	5.549
12 mm	0.888	32 mm	6.313
13 mm	1.042	36 mm	7.991
14 mm	1.208	40 mm	9.864
16 mm	1.579	50 mm	15.413
18 mm	1.998		

The total weight of any provisionally measured bar reinforcement will also be calculated from the weights per metre set out in the above table.

- B No claim will be considered for any difference between the standard weights per metre stated above and the weights of steel reinforcement delivered to site.
- C Where reinforcement detailing is supplied in the form of computer print out schedules, rates shall include for any extra cost and expense in co-ordinating between drawings, standard details and computer printout schedules as to the exact number, lengths, type, size, spacing, shape, location and bending dimensions of the reinforcement to be used including the production of any working drawings the Contractor may consider necessary. (Note : Samples of the computer printout schedules may be inspected at the Architect's Office during normal office hours. The Contractor shall be deemed to have inspected the computer printout prior to submission of his tender).

**CONCRETE WORKS** (Cont'd)**Rates to include** (Cont'd)

- A The rates for formwork shall include for designing, all falsework erecting, making allowance in setting out for all cambers and pre-cambers required on beams and slabs, etc., splayed edges, notchings, allowance for overlaps and passings at angles, battens, fillets for chases, grooves (other than on wrought formwork to form ornamental features), recesses, rebates, chamfered edges, drips and similar, splayed angles, strutting, bolting, wedging, easing, coating surfaces in contact with concrete with an approved release agent and for striking and removal and for re-propping as required.
- B The rates for formwork to soffits shall include being suitable to support the weight of whatever thickness concrete slab is being cast upon it and for any strutting heights.
- C The rates for formwork to sides and soffits of beams shall include formwork to sides and soffits of beams of any depth.
- D Wherever formwork is described as "Wrought" a fair face concrete finish is required. If plywood is used the rates are to include for boards to be close jointed to produce a smooth finished appearance in the concrete surfaces, free from board marks, voids, holes, and other imperfections and any such marks are to be carefully rubbed down and any holes filled with hard filler.
- E The rates for formwork shall include for shuttering simultaneously as many floors as may be necessary for the continuous and expeditious progress of the Works to the satisfaction of the Architect.
- F Formwork has been measured to concrete surfaces which are to be bush hammered and the rates for bush hammering are deemed to include for any extra costs in forming true and even surfaces suitable for bush hammering.
- G The rates for precast concrete items shall include for all moulds, finished faces, all reinforcement detailed, hoisting, steel angles with all necessary fixings and painting, setting, building in position and bedding in mortar and for all additional reinforcement not specified but deemed by the Contractor as necessary for handling purposes and for all temporary supports.



**CONCRETE WORKS** (Cont'd)**Rates to include** (Cont'd)

- A     The rates for ducts in prestressed works are to include for ducts of any length as necessary, for extra lengths due to being laid to curves in the longitudinal vertical plane, for the provision of supports to the material used in the formation of the ducts and for forming and grouting air holes.
- B     The rates for supplying steel strands for tendons shall include for extra lengths required at ends for tensioning and for curves in the longitudinal vertical plane.
- C     The rates for fixing tendons in prestressed works are to include for degreasing, straightening, cutting to lengths and assembling.
- D     The rates for tensioning tendons are to include for tensioning tendons of lengths shown on the drawings and for cutting off ends of tendons.

**BRICKWORK AND BLOCKWORK****Rates to include**

- A The rates for all brickwork, blockwork and facings shall include for :
- (a) Leaving loose bricks or blocks for and cleaning out cavities.
  - (b) Forming cavities between skins of hollow or cavity walls.
  - (c) Rough and fair cutting and bonding at angles and intersections.
  - (d) Oversailing and receding courses, and forming square or rebated reveals.
  - (e) Rough relieving and discharging arches.
  - (f) Wedging and pinning, and eaves filling.
  - (g) Raking out joints to form key.
  - (h) Raking out and enlarging joints if necessary for, and pointing to turn-ins of flashings and similar items.
  - (i) Bedding and pointing frames, plates and similar items.
  - (j) Ties between concrete and brick or block walls.
  - (k) Reinforcement in brickwork or block including concrete or steel supporting structure if so required.
  - (l) Building in sundry items.
  - (m) Plumbing angles.
  - (n) Cut squints, birdsmouths, splays, chamfers and similar items.
  - (o) Cutting or leaving chases, grooves, notches, holes, mortices and similar and grouting in ends, pipes and the like and making good.
  - (p) Cutting and pinning ends and building in sundry items and making good.
  - (q) Air bricks.

**BRICKWORK AND BLOCKWORK** (Cont'd)**Rates to include** (Cont'd)

- (r) Providing and building in fixing blocks where required for fixing joinery.
  - (s) Woven, expanded or welded metal mesh wall reinforcement.
  - (t) Standard and special wall ties or dowels.
  - (u) Control joints, filling, movement joints including joint filler, backing material and sealant.
  - (v) Centering.
  - (w) Sundry items of like nature to any of the above.
  - (x) Providing all necessary galvanized mild steel angles, plates, channels, 'z' sections, etc. to the top, bottom and inside of blockwork or brickwork as required by the drawings or Specification.
- A The rates for faced brickwork are to include for keeping the work perfectly clean during progress of the works.
- B The rates for brick or tile steps, cills, cornices, plinth cappings, copings and similar shall include for all angles, fair edges and ends notched and fitted returned ends and the like.
- C The rates for all block walling are also to include for building in isolated positions in pipe ducts and the like, free ends, intersections, top edges, openings, etc. and for all necessary fractional size blocks and for solid blocks or filling cores solid with cement mortar at ends, jambs or intersections.

**BRICKWORK AND BLOCKWORK** (Cont'd)**Rates to include** (Cont'd)

- A The rates for brick and block pavings and steps shall include for :
- (a) Fair joints.
  - (b) Working over and around obstructions.
  - (c) Cutting.
  - (d) Bedding mortars.
  - (e) Grouting.
- B The rates for blockwork or brickwork partitions shall include strengthening measures as approved by the Architect in accordance with the Specification.

IRONMONGERYRates to include

- A The rates for fixing ironmongery, toilet paper holders, paper towel holders and other fittings shall include for :
- (a) Fixing to any type of timber or building board unless some other surface is specifically mentioned.
  - (b) Provision of all necessary screws to match the ironmongery, and any bolts, nuts, washers, nails, pins or similar items required.
  - (c) All fitting, cutting, housing, sinking, boring, morticing, drilling and similar labours to the material to which the article is being fixed.
  - (d) All drilling and plugging of concrete, brick, stone or other materials.
  - (e) Oiling, easing and adjusting ironmongery and leaving in working order.
- B The rates for fixing locks shall further include for fixing staples or striking plates, escutcheons when required, stamping lock face with number and supplying and fixing identification discs, engraved with lock or room number, to the two keys and for the provision of a key board at handover.

## STEEL AND METAL WORKS

### Generally

#### Rates to include

- A The rates for all internal and external accessible exposed metalwork shall be held to include for the provision of a screw hole or other suitable connection point for the purposes of connection, by the Electrical Installation Contractor, of equipotential bonding conductors as required by the I.E.E. Wiring Regulations.
- B The rates for galvanised metal work shall include for treating welds, cut edges and ends of galvanised sections with two coats of primer as specified.
- C The rates for all non-galvanised ferrous metal (except structural steel) items shall allow for painting with one coat of rust inhibitor and one coat of primer as specified at the manufacturer's workshop or on site.
- D The rates for stainless steel and non-ferrous metal works shall include for grinding and fine smooth polished finish on all exposed surfaces, joints and edges.
- E Isolating dissimilar metals and between metals and concrete, plaster, mortar, brickwork or blockwork or similar materials with sealant or separator.

### Structural Steel

#### Rates to include

- F The rates for structural steelwork shall include for :
  - (a) Shop and site rivets.
  - (b) Cutting, notching and drilling including drilling for fixing of timber etc. to steelwork by others.
  - (c) Bolts in connections including black bolts, special bolts or fasteners including high strength, turned and friction bolts, chemical anchor bolts and expansion bolts (Holding down bolts or assemblies have been measured).
  - (d) Welding including provision of welding materials and temporary run-on and run-off plates.

**STEEL AND METALWORKS** (Cont'd)**Structural Steel** (Cont'd)**Rates to include** (Cont'd)

- (e) Provision, welding on and removal of temporary erection cleats etc. and any making good.
- (f) The weight of galvanised coatings where steelwork is described as galvanised.
- (g) Welding tests including X-rays.
- (h) Performance tests.
- (i) Wedging and grouting under base plates.

- A The rate for items which have been abbreviated to "Steelwork in loose and attached connections etc." under each elemental classification of steelwork shall include for steelwork in loose and attached connections, including cleats, brackets, packing pieces, cap and base plates stiffeners and the like and shall also include for any contractor design or redesign requirement in respect of such items.
- B The rates for surface preparation and surface treatments shall allow for the preparation and treatment of the steelwork which has been abbreviated to "Steelwork in loose and attached connections etc." in the Schedules.
- C The rates for structural steel plates fixed to concrete structure shall further include for non-shrink grouting to fill void all around.

**Linings, Coverings and Claddings****Rates to include**

- D The rates for work to ceilings and beams shall allow for working at any heights above floor level.
- E The rates for sheet linings shall include for bending to shape, adhesives, screwing, cutting, notching holes, angles, joints and the like.

**STEEL AND METALWORKS** (Cont'd)**Roofing and Flashings etc.****Rates to include**

- A The rates for work under this sub-section (c) shall include for :
- (a) Wedging into grooves, solder for lead work or brazing for copper work and all labours connected with the item, including dressing into outlets.
  - (b) Provision and use of tead lacks or copper clips or cleats.
  - (c) All extra material required for passings, welted and double welted seams and laps and welted edges.
  - (d) Nailing.
- B The work to gutters, flashings, aprons, valleys, ridges and hips and the like shall include all ends, angles and intersections, outlets and the like.

**Doors, Gates, Shutters, Grilles****Rates to include**

- C The rates for doors shall include for fitting and hanging,
- D The rates for all items shall include for :
- (a) Ironmongery and accessories, except work stated to have been measured separately.
  - (b) Operating equipment.
  - (c) Fixings and fastenings.
  - (d) Bedding and pointing frames.
  - (e) Pressure grouting with cement mortar to fill void all around frames.



**STEEL AND METALWORKS** (Cont'd)**Doors, Gates, Shutters, Grilles** (Cont'd)**Rates to include** (Cont'd)

- A The rates for aluminium windows, doors, louvres and cladding shall further include for :
- (a) Protecting with approved masking tape or covering with a thick layer of polythene before delivery and for stripping and cleaning on completion.
  - (b) All necessary shop drawings, submitting samples, testing, obtaining approved test certificates and providing guarantees.
  - (c) Coating surfaces of concrete, mortar, plaster or similar materials in contact with approved bituminous waterproofing paint.
- B The rates for fire rated windows, doors and louvers shall further include for :
- (a) Designing the whole construction to suit the required fire rating and as described.
  - (b) Providing test certificates from an approved independent laboratory certifying that the whole construction meets with the fire rating requirements.
  - (c) Obtaining FSD fire resisting certificates and approvals from relevant authorities.
  - (d) All additional testing that may be required by FSD and relevant authorities.
  - (e) Providing intumescent strip to top and long edges and at meeting stiles of door frames with matching colour/pattern as required.

**STEEL AND METALWORKS** (Cont'd)**Framed Work, Stairs, Handrails and Balustrades****Rates to include**

- A The rates for all each item shall include for cutting to correct lengths, splay cut ends and all drilling and countersinking.
- B The rates for framed work, brackets, core rails handrails, glazed metal balustrades etc. shall include for :
  - (a) Welded, brazed or tap screwed connections.
  - (b) Pointed, forged or fanged ends and the like.
  - (c) Bends, forged bends and the like and jointing.
  - (d) Bolts in connections, plugs and screws and expansion bolts or chemical anchor bolts in fixing to the structure including drilling concrete, brickwork or blockwork and masonry.
  - (e) Ironmongery to work made to open.
- C The rates for balustrades, railings, core rails and handrails shall include for joints in the running lengths, bends, mitres, angles, guardrants, ramps, wreaths, junctions, capped ends, flange plates and the like.
- D The rates for balustrades comprising metal handrail, glass panels and metal and other fixings shall include for all component parts including glass and glazing.
- E Frames to floor channels shall include for fixing lugs.
- F The cutting and pinning of ends of lugs, balusters, core rails etc. are covered in the "Rates to include" sections of "Concrete" and "Brickwork and Blockwork" and the making good of finishing in the "Rates to include" section of "Plastering and Paving".

**STEEL AND METALWORKS** (Cont'd)**Fencing and Gates****Rates to include**

- A The rates for fencing shall include for :
- (a) Excavating holes for supports, special supports and independent gate posts in any ground met with, including breaking up and removing any obstructions.
  - (b) Backfilling and disposal of surplus materials.
  - (c) Earthwork support.
  - (d) Supports.
  - (e) Making good existing hard pavings.
- B The rates for gates shall include gate stops, gate catches and independent gate stays and their associated works.

**Minor Buildings and Structures mainly of metal construction****Rates to include**

- C The rates for the works in this sub-section shall include for obtaining permission/licenses, payment of rates, fees and charges relating thereto.

**Sundries****Rates to include**

- D The rates for gratings and frames to gratings shall include for angles, ends and the like.
- E The rates for manhole covers and frames and covers and frames to watertanks and the like shall include for bedding and haunching frames and setting covers in grease or fine sand and grease.
- F The rates for pressed, folded or extrudes metal skirtings or rails shall include for joints in the running lengths, mitres, ends and the like.

**STEEL AND METALWORKS** (Cont'd)**Raised Access Floors****Rates to include**

- A The rates for access floors shall include for :
- (a) Panels, supporting structures, adhesives, bearing pads and the like.
  - (b) Cutting and notching and extra supports.
- B The rates for skirtings and perimeter edge trims shall include for joints in the running lengths, mitres, ends and the like.

**Metal Profiled Sheet Roof Coverings and Wall Claddings****Rates to include**

- C The rates for coverings and claddings shall include for
- (a) Work in forming voids.
  - (b) Holes for pipes, standards and the like.
  - (c) Integral underlay.
- D The rates for boundary work shall include for bedding, pointing, ends, angles and intersections.
- E The rates for all works shall include for raking and curved cutting.

**Fixed Partitions and Demountable Partitions****Rates to include**

- F The rates for partitions shall include for :
- (a) All integral components, holes, etc. preformed at factory.
  - (b) Cutting and fittings around obstructions etc. and holes for services.
  - (c) Head and cill fixings.
  - (d) All angles, intersections, ends and abutments etc.

**STEEL AND METALWORKS** (Cont'd)**Fixed Partitions and Demountable Partitions** (Cont'd)**Rates to include** (Cont'd)

- A The rates for openings shall include for :
- (a) Additional integral components.
  - (b) Ironmongery, glass, linings or the like but excluding trim.
- B The rates for fixings for heavy fittings shall include additional supports and any cutting of cladding, trim or jointing.

**Toilet Cubicle Partitions and Office Cubicle Partitions and Fittings****Rates to include**

- C The rates for cubicle partitions shall include for :
- (a) All integral components, holes, etc. preformed at factory.
  - (b) Connecting and fixing devices.
  - (c) Supporting legs and brackets.
  - (d) Cutting and fitting around obstructions etc. and holes for services.

**Suspended Ceilings****Rates to include**

- D The rates for suspended ceilings and upstands or bulkheads shall include for :
- (a) Working at any heights above floor level.
  - (b) Metal tiled, panelled or strip ceilings complete with the whole of the suspension system (i.e. suspension framing, edge and angle trims, hangers to suit any height from structure to underside of ceiling) and expansion joints.
  - (c) All cutting to ceiling for narrow widths, around pipes, conduits, power points, sleeves, sprinkler and detector heads, forming openings for grilles, registers, light fittings, diffusers, speakers, access panels and the like including extra hangers, supports, trimmers, and edge and angle trims for same.

**STEEL AND METALWORKS** (Cont'd)**Suspended Ceilings** (Cont'd)**Rates to include** (Cont'd)

- (d) Additional framing, hangers and supports etc. to support fittings or to bridge services trunking, ducts etc. in the ceiling space where these obstruct the standard grids.
- A The rates for upstands or bulkheads shall include for strengthening the ceiling suspension system as necessary and for providing and fixing runners for the lining.
- B The rates for fire barriers within the ceiling space and elsewhere shall include for all scribing, angles, ends and supports.

**Windows and Glazed Doors****Rates to include**

- C Unless specifically measured or included within the descriptions the rates for metal windows, doors and louvres shall be held to include for :
  - (a) Openings lights of size and type detailed.
  - (b) Fitting and hanging.
  - (c) All ancillary items including screws, bolts, shot fired fixings, lugs, anchors, sealants, gaskets, water bars, weather strips, ironmongery, fittings and glazing beads as necessary.
  - (d) Morticing ends of transoms and mullions and/or strengtheners for same.
  - (e) Assembling composite units including supply of coupling mullions and transoms, galvanised steel strengtheners within same and jointing and pointing in mastic.
  - (f) Sealing all joints, bedding frames in waterproof cement mortar and pointing all round externally with sealant as specified.
  - (g) Easing all opening sashes and oiling all fittings.
- D The rates for aluminium windows and doors shall further include for protecting with approved masking tape or covering with a thick layer of polythene before delivery and for striping and cleaning on completion.

**STEEL AND METALWORKS** (Cont'd)**Shop Fronts****Rates to include**

- A The rates for shop fronts shall include for :
- (a) All integral components, holes etc. preformed at factory, but exclude trims.
  - (b) All screws and bolt fixings, shot fired fixings and fixing lugs.
  - (c) Glass and linings or solid panels.
  - (d) Cutting and fitting around obstructions etc. and holes for services.
  - (e) Sealing all joints and bedding and pointing.
  - (f) Protecting with approved masking tape and/or thick polythene before delivery and for stripping and cleaning on completion.
- B The rates for enumerated shop fronts shall include for :
- (a) Head and cill fixings.
  - (b) All angles, intersections, ends and abutments etc.
- C The rates for shop fronts measure linear shall include for head and cill fixings.
- D The rates for openings shall include for :
- (a) Additional integral components.
  - (b) Ironmongery, linings or the like but excluding trim.
- E The rates for doors (which are to be included in the rates for forming door openings) shall include for easing and adjusting and oiling fittings.

**STEEL AND METALWORKS** (Cont'd)**Curtain Walling****Rates to include**

- A The rates for curtain walling shall include for :
- (a) All framing, sub-framing, strengtheners, struts, cladding, flashings, surface treatments, fire stops, closers, insulation including insulation to spandrel and other panels, cleats, brackets, shims, spacers, setting blocks, bushings, tapes, seals, gaskets, bedding, all bolts, fixings, fasteners, joint fillers, sealants, pointing including backing rods and accessories.
  - (b) Additional costs at raking or circular edges at perimeters or at intersections.
- B The extra over rates for vision, spandrel and other infill panelling, louvres, opening lights and doors shall include for framing, gaskets and sealants not allowed for in the base curtain walling prices.
- C The extra over rates for openings lights and doors shall in addition include for architraves, trims and the like, all hardware and ironmongery and for glass and glazing. Rates for automatic sliding doors shall include for sliding door gear, activating and operating mechanism including electric motor, sensors, etc.

**Furniture, Fittings, Shelving, Racks, Playground Equipment etc.****Rates to include**

- D The rates for items provided by the Employer shall include for accepting delivery on site, storing and handling.



**PLASTERING AND PAVING****Lathing and Plaster Board****Rates to include**

- A The rates for all items shall include for :
- (a) Narrow widths and small quantities.
  - (b) All holes notchings and other sundry items of a like nature.
  - (c) Work in any position and at any height above floor.
  - (d) Stop beads, angle beads and casing beads.
- B The rates for metal lathing and plasterboard fixed to wood framing shall allow for provision of additional timber framing to support ends as required.
- C The rates for plasterboard lining shall be held to include for all fixings, preparation of cut edges and forming scrimmed joints all in accordance with the manufacturer's recommendations.
- D The rates for suspended ceilings and upstands or bulkheads within the ceilings shall include for :
- (a) Working at any heights above floor level.
  - (b) Metal lathing, plasterboard, fibreboard or acoustic tile and the like ceilings complete with the whole of the suspension system (i.e. suspension framing, edge and angle trims, hangers to suit any height from structure to underside of ceiling) and expansion joints.
  - (c) Cutting or forming holes for sprinkler and detector heads, grilles, registers, light fittings, diffusers, speakers, access panels and the like including extra hangers, supports, trimmers and edge and angle trims for same.
  - (d) Additional framing, hangers and supports to support fittings or to bridge services trunking, ducts etc. within the ceiling space where these obstruct the standard grids.
- E The rates for upstands or bulkheads shall include for strenthening the ceiling suspension system as necessary and for providing and fixing runners for the lining.
- F The rates for fire barriers within the ceiling space and elsewhere shall include for all scribing, angles, ends and supports.

**PLASTERING AND PAVING** (Cont'd)**General Rates Applicable to Plastering and Paving****Rates to include**

- A     The rates for all items shall include for :
- (a) Proper preparation of backgrounds.
  - (b) Narrow widths and small quantities.
  - (c) Temporary formwork and rules.
  - (d) Laying or carrying out work in bays or between division or panel strips.
  - (e) Joints between different types of work and between new and old work, recess joints, angles, joint foam, sealant and the like at joints.
  - (f) Intersections of curved surfaces.
  - (g) Carrying out works in any position, at any level and at any height.
  - (h) All making good.
  - (i) Working up to or cutting and fitting up to frames and metalwork and around pipes, brackets and the like and dishing to outlets.
  - (j) Equal margins.
- B     The rates for work to floors shall include for laying or finishing to slopes, falls and/or crossfalls, currents and for intersections in slopes and falls.

**PLASTERING AND PAVING** (Cont'd)**In-Site Surface Finishes and Screeds or Backings****Rates to include**

- A The rates for screeds, rendering, plastering, granolithic and terrazzo work and any other in-situ finish shall include for (as appropriate) :
- (a) Cleaning off and wetting surfaces of concrete slabs and washing with cement grout if the concrete has hardened.
  - (b) Forming key for applied finishes as required including but not limited to raking out mortar joints to brickwork or blockwork, hacking off projections and fins, removing efflorescence, laitance and any loose material by thoroughly dry brushing, washing to remove release agent and applying spatterdash, bonding agent and the like.
  - (c) "Dubbing out" of irregularities in the surface being covered and to form coves, splays and similar.
  - (d) A strip of approved metal lathing/wire netting/meshing at junctions of different backgrounds, angles, junctions between walls and ceilings/beams and over pipe chases; over all chases for concealed conduits and at angles, junctions between slabs at different levels, slabs and walls/upstands/curbs, walls and ceilings and the like as required.
  - (e) Internal angles, arrises, throats, drips and the like.
  - (f) Coves, grooves, rounded external angles, metal corner beads and plaster stops to all plastering and rendering corner and edges.
  - (g) Angles, stops, intersections, fair ends, junctions, wreathed corners and the like on coves, skirtings, channels, strings, curbs and the like.
  - (h) Division strips.

**PLASTERING AND PAVING** (Cont'd)**In-Site Surface Finishes and Screeds or Backings** (Cont'd)**Rates to include** (Cont'd)

- A The rates for screeds and pavings shall include for additional thicknesses as necessary over the minimum thicknesses stated to provide the falls and/or crossfalls required.
- B The rates for reinforced screeds shall include for reinforcement as described.
- C The rates for terrazzo pavings and wall linings shall be held to include for a strip of mesh reinforcement at all coves etc., and for polishing all terrazzo prior to the building being handed over.

**Tile and Slab Finishes****Rates to include**

- D The rates shall include for division strips, internal angles and arrises.
- E The rates for mouldings, coves, skirtings, gutters, channels, strings, curbs and similar shall include for stops, intersections, fair ends, junctions, wreathed corners and the like except where special tiles or fittings are required.
- F The rates for tiling shall further include for bedding mortar to be up to 10 mm thick and for laying in colours and patterns and with joint widths all as required and approved by the Architect.
- G The rates for coloured tiles etc. are deemed to be for tiles from the standard colour range unless otherwise described.
- H The rates for mosaic pavings shall be held to include for setting the edge tiles at junctions with walls at an angle including all necessary dubbing out.
- I The rates for nosings shall include for working finishes thereto.
- J The rates for nosings, cover strips and dividing strips at junction of different finishes shall include for regular and irregular mitred angles.

**PLASTERING AND PAVING** (Cont'd)**Rubber and Plastic Sheet or Carpet Sheet/Tile Finishes and the like****Rates to include**

- A The rates for all items shall include for :
- (a) Rounded internal and external angles.
  - (b) Seams and fair joints.
  - (c) Fixing at perimeter.
  - (d) Laying into shallow channels without the need for cutting.
  - (e) Division strips.
- B The rates for strings and aprons shall include for ends, angles, ramped and wreathed corners.
- C The rates for skirtings and kerbs shall include for rounded, beaded and moulded ends, coved junctions, ends, angles and ramps.
- D The rates for nosings shall include for working finishes thereto and regular and irregular mitred angles.
- E The rates for stonework/granite shall include for :
- (a) All labours, and stops and returns to all labours.
  - (b) Hoisting, setting and jointing the work in any position and all joggles, templates and the like.
  - (c) Rough and fair cutting and bonding at angles, intersections and the like.
  - (d) Oversailing and receding courses, and rough relieving and discharging arches.
  - (e) Angles, intersections, shoulders to architraves, stoppings, returned ends, sunk joints, stoolings and the like on cills, copings and other stonework measured run.
  - (f) Raking out joints for and pointing flashings.
  - (g) Bedding and pointing frames, plates and the like.

**PLASTERING AND PAVING** (Cont'd)**Rubber and Plastic Sheet or Carpet Sheet/Tile Finishes and the like**  
(Cont'd)**Rates to include** (Cont'd)

- A The rates for stonework/granite shall include for : (Cont'd)
- (a) Plumbing angles, forming returns and reveals and similar labours.
  - (b) Casing or protecting work with slurry and cleaning off and rubbing down on completion if required.
  - (c) Design, construction and installation of a suitable steel frame to support the cladding together with all necessary anchoring fixings
- B The rates for stone/granite slabs shall include for :
- (a) Smooth polished face (or other finish as required)
  - (b) All cutting including cutting for narrow widths, equal margins and angles
  - (c) Polishing exposed edges and slightly rounding arrises
  - (d) Hoisting, setting, fixing, bedding, jointing and pointing the work in any position
  - (e) Protecting, cleaning and stopping as necessary

**PAINTING****General Clauses Applicable to Painting****Painting and Similar Work****Rates to include**

- A The rates for painting shall include for :
- (a) All preliminary preparatory work.
  - (b) Touching up workshop or site primed ferrous metalwork prior to undercoating.
  - (c) Rubbing down between coats.
  - (d) All multi-colour work and cutting to line.
  - (e) Removing all articles of ironmongery, hardware and similar, before painting and replacing after painting is complete.
  - (f) Painting on beads, hinges, and other fittings, brackets, bolts, lugs, and the like and attached pipework and conduits painted at the same time and in the same material as the surface to which they are attached.
- B The rates for work to ceilings and beams shall allow for working at any heights above floor level.
- C The rates for painting grilles, louvres and the like shall include for finish to all surfaces.
- D The rates for painting glazed metal windows, louvres, doors, screens, and the like shall include for opening edges and all surfaces of frames, mullions, transomes, cills and the like.
- E The rates for painting glazed wood sashes, casements, screens and the like shall include for opening edges and all surfaces of integral frames, mullions, transomes, cills and the like.
- F The rates for painting on pipes and conduits shall include for painting on pipe clips, holders, hangers, conduit boxes and the like.

**PAINTING** (Cont'd)**Painting on off-form concrete surfaces**

- A "Off-form" concrete surfaces shall mean concrete surfaces left after removal of formwork. The rates for painting on off-form concrete surfaces shall include for cleaning the exposed concrete surfaces of cement latiance, removing all loose materials by wire brush or scraper, removing any ribs or projections and for rubbing down where these ribs or projections have been removed, filling all voids with neat cement grout to bring the entire surfaces to reasonably smooth even planes.

**Signwriting****Rates to include**

- B The rates for all items shall include for the proper preparation of backgrounds.

**Paperhanging, including sheet plastic or fabric linings****Rates to include**

- C The rates for all items shall include for :
- (a) Proper preparation of backgrounds.
  - (b) Cutting to profile.
  - (c) Matching patterns.
  - (d) Cutting and fitting around pipes, switches, brackets and the like.
- D The rates for border strips shall include for mitres and intersections.



## **SPECIFICATION**

**SPECIFICATION**

**SECTION 1 -**

**PRELIMINARIES**

**SPECIFICATION**

**PRELIMINARIES**

**1.0 GENERALLY**

The preliminary items included hereunder apply to the whole of the Works contained in this Contract and the rates and/or amounts inserted by the Contractor shall be deemed to apply to the whole of the Works carried out under this Contract including all Variations to the Contract.

The Contractor shall be deemed to have allowed in his tender for all costs in respect of all items described in this Preliminaries Section.

In the absence of any sum against any item or items, any monetary cost attributable thereto shall be deemed to be included elsewhere in this Preliminaries Section or in the unit rates for the work.

Any price entered for this Preliminaries Section shall be at the risk of the Contractor and no adjustment will be made at the settlement of accounts.

The documents forming the Contract are to be taken as mutually explanatory and the tendered sum shall be deemed to cover the complete requirements of the Conditions of Contract (as defined in the Special Conditions), Specification and Contract Drawings.

In the event of a lump sum only being inserted in respect of this Preliminaries Section, the Contractor will be required to provide an itemised breakdown of the amount so included.

In the event of the amount inserted against an item of this Preliminaries Section for which whole payment or substantially whole payment would normally be made at the outset of the Contract (e.g. insurances) being higher than the amount which the Contractor can substantiate, payment for the excess amount will be effected over the period of the Contract.

Payments for amounts inserted against time related items in this Preliminaries Section such as overtime, plant, construction manager watching, etc. will be effected over the period of the Contract in the same proportion as the value of the Contractor's work carried out is to the total value of the Contractor's work (excluding Preliminaries).

In the event of no amount being inserted by the Contractor in respect of this Preliminaries Section, no relative payment whatsoever will be included in interim payments.

2.0     DEFINITIONS

2.01     Employer

Hong Kong Shooting Association

2.02     Architect

Thomas Chow Architects Limited

2.03     Geotechnical and Structural Engineer

Ove Arup & Partners Hong Kong Limited

2.04     Building Services Engineer

Ove Arup & Partners Hong Kong Limited

2.05     Environmental Consultant

ENVIRON Hong Kong Limited

2.06     Quantity Surveyor

Rider Levett Bucknall Limited

2.07     Contractor/Main Contractor

The Contractor appointed to carry out the Works.

2.08     Architect's representative

Such representative of the Architect on the Site as may be appointed.

2.09     The Authority/Authorities

The Authority/Authorities shall mean the Building Authority or any Government Department or Public Utility or Statutory Undertaker having jurisdiction with regard to the Works or with whose system are or will be connected.

3.0      DESCRIPTION OF THE WORKS

3.01      Generally

The descriptions of the scope of the Works and description of the Works given hereunder must not be considered as being completed.

The tenderer is deemed to have read other related documents, Specification - Technical, etc. and in particular to have studied the tender drawings and to have visited the Site to be fully aware of the full extent of the Works.

3.02      Scope of the Works

The Works to be carried out under this Contract are the Advance Works for the proposed shooting range and are fully detailed on the drawings, but briefly described as follows :

- (1)      Erection of new hoarding (including chain link fence and gantries), carrying out alteration and relocation as necessary, including maintenance and painting as directed by the Architect and to satisfaction of the Architect and Building Authorities. The hoarding shall be handed over to the Employer upon completion of the Works.

The Contractor's attention is drawn to that there are temporary lighting requirements for hoarding. The Contractor shall include the price for arrangement and obtaining the power provision for these temporary lighting despite there is no power supply provisions at the Site or near the Site.

- (2)      Modification of existing and construction of new EVA including the footpath outside site boundary from existing access road to the shooting range.
- (3)      Carrying out environmental precautionary measures.

The Contractor shall be responsible for arranging, co-ordinating and applying through the Architect for all services connections, if any, inspections, operation permits, excavation permit, certificates of compliance and the like in connection with the Works.

3.0 DESCRIPTION OF THE WORKS (Cont'd)

3.03 Works to be carried out by separate Specialist Contractors

The Contractor shall allow any Specialist Contractor, as may be employed by the Employer from time to time, access to their working areas, provisions of storage area, including allowing and facilitating these Specialist Contractors to pass through the Contractor's own working areas as and when necessary for the purpose of carrying out their works.

The Contractor shall closely liaise and co-ordinate with the Specialist Contractors in respect of the working areas, access within the Site, sequence of works, etc. and afford all reasonable opportunities to these contractors for the carrying out their works as directed by the Architect.

The Contractor shall provide all materials, equipment, tools, instruments and labour to ensure the satisfactory operation at the interface of the installation and the proper sequencing of the works for which he is responsible. During all stages of the work, the interfaces shall be discussed, co-ordinated and agreed with the separate Specialist Contractors.

No claim for extension of time and any other additional costs and/or any abortive works involved will be considered for the lack of co-ordination in this respect.

The Contractor is deemed to have inspected all drawings, documents and other information available at the time of tendering regarding the works to be carried out by the Specialist Contractors employed direct by the Employer and to have allowed in his tender for all costs in connection therewith. No claim whatsoever will be entertained for any additional costs incurred nor time allowed in respect of the works of these Specialist Contractors.

4.0 SITE AND INSPECTION

4.01 Location

The Site of the Works is at Pillar Point Valley Land Fill, Tap Shek Kok, Tuen Mun, Hong Kong.

4.02 Access and restrictions

The Contractor shall make every endeavour to cause the minimum nuisance, noise, dust or any other disturbance or inconvenience to the neighbouring properties, occupants, pedestrians or traffic.

The Contractor shall also conform with the regulations and restrictions imposed by the Police or other government authorities with regard to traffic arrangement, usage of road, loading and unloading, temporary traffic controls, etc. The Contractor shall allow in his tender any extra costs incurred in complying with such regulations and restrictions which may be imposed or altered from time to time including the payment of fees and the application for permit required.

The Contractor shall provide traffic directions to all vehicles entering or leaving the site and efficient warning to the public and persons on site of the traffic at site exit.

The Contractor shall be responsible for cleaning all vehicles and plant (regardless of ownership) before they leave the Site to ensure that no earth, mud, debris, etc. is deposited by them. For this purpose, the Contractor shall install a wheel washing facility at exit from the Site, to the Architect's satisfaction, and remove and make good works disturbed before completion of the Works.

The Contractor is responsible for ensuring that all vehicles (regardless of ownership) leaving the Site are safely loaded and sheeted to prevent any spillage or loss of materials during transit.

4.0 SITE AND INSPECTION (Cont'd)

4.03 Site visit

Tenderers are advised to visit the Site of the Works and make themselves thoroughly acquainted with the location, general site conditions, type of ground to be excavated, accessibility, storage space, restrictions for loading and off-loading materials, etc., and any other conditions which may affect their tender.

No claim for extra payment or extension of the contract period will be allowed on the grounds of ignorance of the conditions under which the work is to be carried out.

The Contractor shall accept the Site as found on the Date for Possession of the Site and at his own expense clear the Site of any debris, etc., which may have been left on the Site.

4.04 Sub-soil conditions

Tenderers are advised that the Site is located mainly within a platform formed as part of the Pillar Point Valley Landfill (PPVL) waste area. The platform formed is mainly bareground and partly covered with grass. The following restoration measures/facilities have been installed at the landfill :

- (a) Platform capping system. Platform capping system includes a proprietary "Barrierdrain" layer which serve dual functions as a drainage layer at the top and a low permeability layer at bottom. It comprises a geotextile layer bonded over the protruding dimples of a 1 mm thick linear low density polyethylene (LLDPE) geomembrane. A general cover layer of not less than 850 mm is provided on top and covered with hydroseeding.
- (b) Slope capping system. It consists of a soil cover of not less than 2 m thick and suitably landscaped with vegetation.
- (c) Leachate treatment plant. It collects leachate from the landfill and treat it to meet the required discharge standards before discharging into public foul sewer.



4.0 SITE AND INSPECTION (Cont'd)

4.04 Sub-soil conditions (Cont'd)

- (d) Landfill gas collection system. It is provided to collect landfill gas for energy recovery to generate heat for the leachate treatment plant. A generator consuming landfill gas as fuel to supply electricity for the site in case there is surplus landfill gas is also provided. A flare plant burns excess landfill gas.

There is a aftercare contractor who is responsible for operation and maintenance of the above restoration facilities for 30 years under his Contract with EPD. During the aftercare period, continuous environmental monitoring on leachate, landfill gas, groundwater, surface water and nuisances will be carried out.

The Contractor shall take every reasonable precaution possible to maintain the above restoration facilities not affected by the Works. Any damage to the above restoration facilities shall be repaired by the Contractor at his own expenses.

4.05 Work Area

The working areas of the works are as shown on the drawings.

The Contractor's attention is drawn to the fact that most of the works will be carried out outside the site boundaries.

The Contractor shall ensure that his operations outside the site boundaries do not obstruct existing accesses to adjacent properties and are properly protected as not to endanger the safety of pedestrians or vehicles. The Contractor shall maintain at all times traffic and pedestrian flows by means of traffic diversions which may be required or approved by the Architect. The Contractor is responsible for making arrangement with, application to and obtaining all necessary agreement, permits and consent from the relevant parties/adjoining landowners/authorities for carrying out works outside site boundary and for traffic diversion. The Contractor shall also provide all necessary screens to avoid nuisance caused by dust, water, noise, etc.

**4.0      SITE AND INSPECTION (Cont'd)**

**4.05      Work area (Cont'd)**

The Contractor shall ensure that existing utilities and property are not damaged by the execution of the works and shall be responsible for any necessary diversion and reinstatement works.

The Contractor shall note that the programme of his work outside the site boundaries is subject to the approval of the Architect.

The Contractor shall submit a work schedule to the Architect for his approval prior to the commencement of work outside the site boundaries. He shall also comply with any other requirements of the Architect or the Employer from time to time during the progress of the Works.

The Tenderer shall allow for all extra costs arising from the above requirements. No claim for extra payment or extension of time shall be entertained in this respect.

The Contractor must keep his workmen, plant, materials, etc. within the working areas unless otherwise approved by the Architect.

All working/storage areas shall be properly fenced off, guarded or locked up at all times.

The Contractor is deemed to have allowed in his tender for efficient planning of works and any off-site fabrication and storage that may be required.

Storage of inflammable goods on site are not allowed.

**5.0      POSSESSION, COMMENCEMENT AND COMPLETION**

**5.01      Possession of Site**

The Contractor shall take over the site as set out in the Contract. The tentative Date for Possession of the Site is December 2010 / January 2011.

5.0 POSSESSION, COMMENCEMENT AND COMPLETION (Cont'd)

5.01 Possession of Site (Cont'd)

Immediately upon taking possession of the site, the Contractor is to check and satisfy himself as to the correctness of the setting out, levels, etc., of the works already carried out on site before he commences his work. He shall immediately inform the Architect of any discrepancies or faults found in such works otherwise no claim will be considered for costs incurred and/or extensions of time in respect of such discrepancies or faults. In the event of the Contractor failing to observe this requirement, any work under this Contract which is incorrectly constructed as a result of such discrepancies or faults shall, if so required by the Architect, be pulled down and re-erected at the Contractor's expense.

5.02 Commencement

The Contractor shall commence the Works as set out in the Contract. The tentative Commencement Date of the Works is December 2010 / January 2011.

The Contractor is to particularly note that the above tentative Date for commencement and Date for Possession of the Site given above are to be confirmed by the Architect and may not materialize. The actual dates may be advanced or delayed. The Contractor is deemed to have allowed in his tender for flexibility in the above dates. The Contractor shall not be entitled to additional payment nor claimed that time for completion of the Works has been placed at large as a result of such flexibility in the Date for Commencement and Date for Possession of the Site.

5.03 Completion

The Works are to be completed within the time set out in the Contract including Sundays and public holidays.

It is essential that the Contractor completes the works on or before the Completion Date.

5.0     **POSSESSION, COMMENCEMENT AND COMPLETION** (Cont'd)

5.03     Completion (Cont'd)

For the avoidance of doubt, the Contract Period mentioned above shall include also the following times, which are all at the Contractor's own risk, and the Contractor shall not be entitled to any extension of time nor any extra payment on the grounds of any of the times being longer than allowed :

- (a)     The waiting time for the Buildings Department to process and issue acknowledgement of Form BA14.
- (b)     Any other times in connection with the statutory procedures leading up to and until the issue of acknowledgement of Form BA14 by the Buildings Department, which procedures include preparation and submission of statutory forms, test certificates, as-build records, etc.

Without limiting the Architect's absolute authority in determining the state of Substantial Completion of the Works, in accordance with clause 17 of the Conditions of Contract, fulfillment of the following obligations, as appropriate, by the Contractor are the minimum criteria, which are not exhaustive, for the Architect to certify Substantial Completion of the Works :

- (a)     Obtaining of acknowledgement of Form BA14.
- (b)     Completion of the Works with each part thereof fit for the purpose which it is respectively intended for.
- (c)     Obtaining the Architect's approval of all guarantees, maintenance instructions, as-built records and other documents as required under the Contract, and submission of the same as approved.

Should any designs or submissions for which the Contractor is responsible, or any testings or other works carried out by the Contractor be found unsatisfactory to the Building Authority or other authorities having jurisdiction over the Works, the Contractor shall carry out any additional designs, submissions, testings or other additional or remedial works as required at no extra time or cost to the Contract.

5.0     POSSESSION, COMMENCEMENT AND COMPLETION (Cont'd)

5.03     Completion (Cont'd)

In granting any extension of time pursuant to clause 25 of the Conditions of Contract, consideration will be given to the time saved due to any omission of the original scope of the Works.

The Contractor shall be fully responsible for any suspension of work ordered by the Architect and/or Authorities due to excavation disturbance, nuisance, excessive smoke of machinery, etc. during execution of work. No claim for any extra expense, overhead charges or time loss arising from the suspension of work will be allowed.

The Contractor's attention is drawn to the fact that he shall be responsible for any delay, loss, damages or claim whatsoever arising due to the failure of his part to proceed regularly and diligently with the statutory submissions and resubmission where necessary.

If it becomes apparent that there is any likelihood of the completion date not being met, the Architect may issue instructions to the Contractor directing any revision to the sequence of works, etc. to enable the works to be completed on time. The Contractor shall comply with such instructions at no extra cost.

The Contractor should allow in his tender for all extra costs for overtime, provision of extra labour and all other provisions considered necessary for the timely completion of the Works.

5.04     Substantial Completion

When the Contractor considers he has reached Substantial Completion of the Works he shall notify the Architect to report completion. The Contractor shall be responsible for making good / completing any outstanding works to the satisfaction of the Architect, the Structural Engineer and the Buildings Authority during subsequent inspection after issuance of such notification.

**6.0      CONDITIONS OF CONTRACT**

**6.01      Form of Contract**

The Conditions of Contract are as defined in the Special Conditions of Contract included with and forming part of these Tender Documents.

The following is a list of the Standard Conditions of Contract clause headings and where these have been amended or added to by the Special Conditions of Contract they have the words "amended" or "additional" in parentheses at the end of the clause. The Contractor should allow here or in his rates for complying with any of the Conditions of Contract which are not described more fully elsewhere.

The allowances shall take into account any cost effects resulting from the Special Conditions of Contract.

- Clause No. 1. Interpretation and definitions  
2. Contractor's obligations  
3. Master programme  
4. Architect's instructions  
5. Documents forming the Contract and other documents (amended)  
6. Statutory obligations  
7. Setting out the Works  
8. Materials, goods, workmanship and work (amended)  
9. Intellectual property rights  
10. Contractor's site management team  
11. Access for Architect to the Works  
12. Architect's representative  
13. Variations, Provisional Quantities, Provisional Items and Provisional Sums  
14. (Not used)  
15. Contract Sum  
16. Materials and goods on or off-site  
17. Substantial Completion and defects liability (amended)  
18. Partial possession by Employer  
19. Assignment and sub-letting  
20. Injury to persons and property and indemnity to Employer  
21. Insurance against injury to persons or property (amended)

6.0      CONDITIONS OF CONTRACT (Cont'd)

6.01      Form of Contract (Cont'd)

- Clause No. 22. Insurance of the Works
- 22A. Insurance of the Works by the Contractor
  - 22B. Insurance of the Works by the Employer
  - 22C. Insurance of existing building and insurance of the Works by the Employer
  - 23. Possession, commencement and completion (amended)
  - 24. Damages for non-completion (amended)
  - 25. Extension of time (amended)
  - 26. Delay recovery measures (amended)
  - 27. Direct loss and/or expense
  - 28. Notice of claims for additional payment
  - 29. Nominated Sub-Contractors and Nominated Suppliers (amended)
  - 30. Persons engaged by Employer
  - 31. Facilities for statutory undertakers and utility companies
  - 32. Certificates and payments (amended)
  - 33. Surety bond (amended)
  - 34. Antiquities
  - 35. Determination by Employer
  - 36. Determination by Contractor
  - 37. Determination by Employer or Contractor
  - 38. Fluctuations (Not used)
  - 39. Notices, certificates and other communications
  - 40. Recovery of money due to the Employer (amended)
  - 41. Settlement of disputes
- Schedule 1    Form of surety bond to be given by the Contractor to the Employer (amended)

6.0 CONDITIONS OF CONTRACT (Cont'd)

6.02 Appendix to the Standard Conditions of Contract

The following particulars will be inserted in the Appendix to the Standard Conditions of Contract :

	Clause	
Time for submission of master programme	3.1	Within seven days after the acceptance of the Contractor's tender
Defects Liability Period	17.3	Twelve months from the Date of Substantial Completion of the Works, a Section or a Relevant Part
Limit of indemnity to third party liability insurance against injury or death to any person	21.2	HK\$30,000,000.00
Limit of indemnity to third party liability insurance against injury or damage to real or personal property	21.2	HK\$30,000,000.00
Insurance of the Works	22.1	Clause 22A applies
Percentage to cover professional fees	22.2	4%
Date for Possession of the Site	23.1	Within seven days of the Architect's written Instructions
Commencement Date	23.2	Within seven days of the Architect's written Instructions



6.0      CONDITIONS OF CONTRACT (Cont'd)

6.02      Appendix to the Standard Conditions of Contract (Cont'd)

	Clause	
Completion Date	23.2	90 Calendar days from the Date for Possession including Sundays and Public Holidays
Liquidated and ascertained damages	24.2	HK\$1,500.00 per calendar day
Period of Interim Certificates	32.1	One month
Period for payment of certificates	32.1	One month from the date of the certificate
Retention Percentage	32.4	Ten per cent of the certified value of the Contractor's own work
Limit of Retention	32.4	Five per cent of the Contract Sum (to the nearest one thousand dollars)
Period for completion of the final account	32.6	Twelve months from Substantial Completion of the whole of the Works
Amount of Surety bond	33.1	Ten per cent of the Contract Sum (to the nearest one thousand dollars)
Release of insurance company or bank	33.2	Clause 33.2B applies
Fluctuations	38	Not applicable

7.0     TENDER, DRAWINGS AND SPECIFICATION

7.01     Tender

The tender shall be for the carrying out of the whole of the Works in conformity with the Contract Drawings, Conditions and Specification.

7.02     No adjustment for rises or falls in cost of labour and materials

There will be no adjustment to the Contract Sum for rises or falls in the cost of labour and materials or exchange rates of currencies.

7.03     Schedule of Quantities and Rates

The Tenderer shall submit with his tender the Schedule of Quantities and Rates on which his tender has been based, showing the rates for supplying and fixing the various materials, fittings, etc. involved, including labour charges, overheads, etc. The use of 'lump sums' in the Schedule of Rates is to be avoided wherever possible. The total of the extensions of the quantities multiplied by the unit rates together with any monetary allowances included by the Tenderer shall equal the respective item in the Summary of Tender and the Tender Sum. The unit rates will be used for the purpose of ascertaining the price of Variations and calculating the amounts of interim payments.

The quantities in the Schedule of Quantities and Rates to be submitted are to be nett as fixed in position and the rates shall include for material and fabrication costs, conveyance and delivery to the Site, unloading, storing, hoisting, lowering and all labour in setting, fitting and fixing in position, all cutting and waste, return of packings, use of plant and tools, establishment charges, overhead charges and profit.

The descriptions in the Schedule of Quantities and Rates to be submitted are not comprehensive and for identification purpose only. The Contractor is deemed to have referred to the drawings and Specification to acquaint himself as to the full requirements, added items of work which he deemed necessary and priced accordingly.

7.0     TENDER, DRAWINGS AND SPECIFICATION (Cont'd)

7.03     Schedule of Quantities and Rates (Cont'd)

The quantities in the Schedule of Quantities and Rates or other statement as to quantities submitted by the tenderer are at his sole risk and do not form part of the Contract.

In the absence of any items in the Schedule of Quantities and Rates to be submitted for works shown on the Contract Drawings or described in the Specification, any monetary cost attributable thereto shall be deemed to have been included elsewhere in the tendered sum.

The Tender Sum shall be deemed to have included all costs for carrying out and completing the Works in accordance with the Conditions of Contract, Drawings and Specification.

The unit rates inserted by the Contractor in the Schedule of Quantities and Rates shall be used for the purpose of ascertaining the prices of Variations and calculating the amounts of interim payments. The pricing of Variations will be strictly based on the unit rates submitted and accepted.

Any lump sum prices inserted by the Contractor against items of works in the Schedules of Quantities and Rates to be submitted shall be at the sole risk of the Contractor and no adjustment to such lump sum prices shall be made in connection with pricing of Variations. However, if any of the lump sum priced items of works is instructed by the Architect to be deleted from the Contract, then the lump sum price against that particular item shall be omitted entirely from the Contract Sum.

If so required by the Architect the Contractor shall submit further breakdown of the Schedule of Quantities and Rates showing the build-up of any "lump sums" included in the Schedule of Quantities and Rates.

7.0     TENDER, DRAWINGS AND SPECIFICATION (Cont'd)

7.04     (Not used)

7.05     Ordering materials, etc. from Contract Drawings and/or Specification

The Contractor should note that he should not order materials or commence work based only on quantities or sizes stated on the Contract Drawings and/or in the Specification(s) without reference to site measurements, and there shall be no liability for any expense incurred by the Contractor in connection with wrong items or abortive work which would have been apparent had the site measurements been checked.

The Contractor shall be responsible for the correct ordering of materials and goods including those supplied by the Nominated Suppliers.

7.06     Drawings forming part of the Tender Documents

The drawings listed in the "Schedule of Drawings" form part of the Tender Documents.

7.07     Drawings, etc. at Site

A complete set of the Contract Drawings and Specification together with copies of all variation orders and additional drawings issued after the Commencement Date shall be available on the Site at all times for reference by the Architect.

The drawings shall be stored in a neat and orderly manner.

7.08     Shop drawings

Shop drawings, as may be required, shall be furnished by the Contractor well before the work proceeds and in any case within one week of the Architect's written request. The Architect may reject, approve or amend such shop drawings. No claim will be accepted for disapprovals or amendments required by the Architect.

The approval by the Architect of any such drawings shall not relieve the Contractor of his duties and responsibilities under the Contract.

7.0      **TENDER, DRAWINGS AND SPECIFICATION** (Cont'd)

7.09      Dimensions

Figured dimensions are to be taken in preference to scaled in all cases. Before commencing any work or ordering any materials the Contractor must verify all measurements. If any discrepancies are found they must be brought to the notice of the Architect immediately.

In the event of the Contractor failing to verify measurements before commencing work or ordering materials as required, any work or material under this Contract which is incorrectly constructed or rendered abortive as a result of discrepancies between dimensions on drawings and the actual site measurements shall, if so required by the Architect, be pulled down and re-erected at the Contractor's expense and time.

7.10      Specification

The Contractor is directed to examine the Specification - Technical (referred to hereinafter as "T.S.") bound into and forming part of the tender documentation.

The Contractor should allow here or in his rates for complying with the requirements of the T.S.

7.11      Discrepancies

Where there are discrepancies between the various tender documents including but not limited to drawings, specifications, conditions of contract, etc., the more onerous requirements shall take precedence, and all time and expense in this connection shall be deemed to be included in the Tender submitted.

**8.0      MATERIALS AND WORKMANSHIP**

**8.01      Compliance with regulations**

Materials, workmanship and the works as a whole shall conform to or be of a higher standard than the minima required by the latest edition of the Buildings Ordinance, Chapter 123 of the Laws of the Hong Kong Special Administrative Region.

The Works and the execution thereof shall also conform to any other Ordinances, Regulations or Codes of Practice issued by relevant authorities, which have jurisdiction over the works, or govern the design or testing of the Works, or serve to enhance good practice or standard of Workmanship, in so far as they are applicable to the Works.

**8.02      Samples**

The quality of materials and articles supplied for any purpose are to be approved by the Architect prior to their use in the Works. Wherever practicable samples are to be submitted for approval before bulk supplies are delivered to the Site. Approved samples are to be kept on the Site to serve as standards for the materials or goods represented by the samples. Samples, and any packing for same, are to be provided free of charge by the Contractor.

Should any material or article be rejected it shall be removed from the Site at the Contractor's expense.

The Contractor shall provide samples of workmanship for all trades and obtain the Architect's approval prior to commencement of each trade.

All subsequent workmanship shall be to the standard of the approved samples.

**8.03      Safe custody of materials**

The Contractor shall be responsible for the safe custody of all materials delivered on to the Site including those for the separate Specialist Contractors. He will be required to reinstate at his own expense any such materials that may be lost or stolen.

He will also be required to reinstate at his own expense any material or article damaged by careless handling or storage or as a result of inferior workmanship by his workmen either in the original fixing or in the subsequent taking down and refixing thereof.

**8.0      MATERIALS AND WORKMANSHIP (Cont'd)**

**8.04      Loading and unloading of materials**

The Contractor shall take every care in the loading and off-loading of materials for the work, ensure that the street, roads and footpaths are not obstructed or the traffic impeded and conform with the police regulations therewith.

**9.0      INSTRUCTIONS, VARIATIONS AND METHODS OF MEASURING AND VALUING**

**9.01      Site instructions**

The Contractor shall maintain an efficient organisation so that all instructions issued by the Architect are communicated immediately to the Site and he shall take instructions only from the Architect or persons authorised by the Architect in writing to give them.

The Contractor shall enter all site instructions given to him or his construction manager by the Architect or such other persons as are authorised as noted above in a special diary recording a description of such work ordered and shall obtain against each entry the initials of the Architect or such other authorised person on the day that such instructions are given.

The Contractor shall allow such diary to be inspected at all reasonable times when required by the Architect, the Quantity Surveyor and the Architect's representative.

**9.02      Stop work instructions**

The Architect's representative or the Site Engineer is empowered to stop all work or any part of the Works and advise the Architect immediately, if such work is not in accordance with the Architect's Specifications, Drawings and Instructions.

**9.03      Quotation for Variation**

If required by the Architect or the Quantity Surveyor, the Contractor shall within fourteen (14) days of his written request submit a detailed estimate of the value of any Variation instructed by the Architect.

9.0      INSTRUCTIONS, VARIATIONS AND METHODS OF MEASURING AND VALUING  
(Cont'd)

9.03      Quotation for Variation (Cont'd)

If required by the Architect or the Quantity Surveyor, the Contractor shall within fourteen (14) days of his written request submit a detailed estimate of the cost and time effects of any proposed Variation or work which is carried out at the expense of a Provisional Sum. The issue of a subsequent instruction by the Architect formally ordering the execution of the proposed Variation or the work shall not be construed as acceptance of the Contractor's estimate. The acceptance of the Contractor's estimate shall not be a prerequisite to the Contractor's execution of the proposed Variation or the work.

9.04      Contractor's claims for extras for verbal instructions

The Contractor shall submit to the Architect (copied to the Quantity Surveyor) any claims (giving full and detailed particulars of the amount claimed) for extra and additional work contained in the Architect's verbal instructions which have been confirmed in accordance with Clause 4.2 of the Standard Conditions of Contract within one months after the event and no claim for such extra and additional work will be considered if submitted later than required herein.

9.05      Measurement of Variations

The units of billing measured omissions and additions for Variations or additions of remeasurements where the unit is either metre cube or metre super the quantities shall be billed to the nearest 0.10 of a whole unit and where the unit is either metre run or kilogram the quantities shall be billed to the nearest whole.

9.06      Invoices, receipts, etc.

The Contractor shall produce all original invoices, vouchers or receipted accounts for any materials or sub-contract labour charges when called upon to do so by the Architect or by the Quantity Surveyor. Upon making photocopies of the invoices, receipts, etc., the originals shall be returned to the Contractor.



**9.0      INSTRUCTIONS, VARIATIONS AND METHODS OF MEASURING AND VALUING**  
(Cont'd)

**9.07      Contractor's expenses in connection with Variations and settlement of accounts**

The Contractor shall be responsible for making or procuring at his own expense such additional copies of the Architect's instructions and any specifications, schedules, drawings and details issued therewith as are necessary for distribution within his own organization and to the Nominated Sub-Contractors as required.

The Employer will not be liable for any expense incurred by the Contractor in connection with the measurement of Variations or the adjustment and settlement of accounts.

**9.08      Supportive documentation for a fair Valuation**

Where it becomes necessary for a fair Valuation to be made, as required under Clause 13.4(1) of the Standard Conditions of Contract, the Contractor shall provide all supportive documentation as may reasonably be required by the Quantity Surveyor to make such fair Valuation, and this shall be provided by the Contractor within one month of the Quantity Surveyor's formal request.

**10.0      PROGRAMME AND REPORTS**

**10.01      Weekly reports**

Submit to the Architect at weekly intervals reports on the general progress of the Works detailing any information required, extension of contract period claimed, etc.

The format of the report shall be submitted to the Architect for approval before commencement of work on the Site.

The submission of the above does not relieve the Contractor from his obligations, in accordance with the Conditions of Contract, to give written notice of delays to the progress of the Works.

10.0     **PROGRAMME AND REPORTS** (Cont'd)

10.02     Site meetings

Site meetings will normally be held every two weeks. The Contractor shall attend site meetings at time and place as required by the Architect and shall inform his sub-contractors when their presence are required.

10.03     Daily reports

The Contractor shall submit to the Architect each day throughout the contract period a report showing records of the labour employed on the Site under each trade, materials delivered to the Site, plant and equipment on the Site and the weather throughout the day.

The format of the daily report shall be submitted to the Architect for approval before commencement of work on the Site.

In all cases where an Architect's representative is employed upon the Works the daily reports shall be submitted for checking and signing by the Architect's representative.

10.04     Progress photographs

The Contractor shall provide progress photographs of the Works when directed by the Architect.

The Contractor shall be required to take photographs of surrounding areas including the trees and retaining walls and nearby buildings to record their status before the work commences.

The Contractor shall provide 3 sets of 6 nos. (minimum) coloured photographs of 5R size and with date stamped to show progress of the works at weekly intervals at location as directed by the Architect.

The Contractor shall also provide progress photo of the works as and when directed by the Architect.

Such photographs shall be sufficient number and location to record the progress of the Works.

A label shall be provided to each photograph in the album clearly indicating the project title, the point from which the photograph is taken and the part of the Works it shows.

10.0 PROGRAMME AND REPORTS (Cont'd)

10.05 Programme of Works

The Tenderer shall at the time of returning his tender provide a time related bar chart as stated in Clause 2 of the Conditions of Tender showing his intended method, sequence, stages and order of proceeding in which he proposes to carry out the Works.

The Contractor shall immediately after the award of the Contract prepare and submit to the Architect a comprehensive critical path programme showing how he intends to organise and carry out the Works within the time fixed for completion.

The Architect reserves the right to examine, enquire and check the practical feasibility of the critical path programme and, if necessary, make suggestions to it.

In order that the programme may be maintained or amended where necessary it is incumbent upon the Contractor to notify the Architect whenever there is the likelihood of a delay occurring in his own work or material supplies or in those of any of his Sub-Contractors. The Contractor must with the utmost diligence endeavour to retrieve lost time.

In the event of the Contractor becoming liable to pay Liquidated Damages to the Employer, the critical path programme may be used by the Architect as a basis for certifying the period of delay which has been caused by the Contractor.

If during the course of the Contract special circumstances should arise which in the opinion of the Architect warrant or necessitate a revision or departure from the order of procedure as shown in the approved programme, then the Contractor shall accordingly so revise his programme as the Architect may require.

The submission to and approval by the Architect of such programme (and revisions if applicable) shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

**11.0     PERSONS ENGAGED BY EMPLOYER (See also Standard Conditions of Contract Clause 30)**

The Contractor shall permit the execution of works by persons who are not the Nominated Sub-Contractors and who may be engaged by the Employer.

The Contractor shall afford all reasonable opportunities to persons employed direct by the Employer for the carrying out of their work. Such facilities shall include the reasonable use by others of any scaffolding or staging erected by the Contractor for his own use but the Contractor shall not be required to maintain any such scaffolding or staging longer than is necessary for his own use or to erect any special scaffolding or staging for the use of others.

**12.0     (NOT USED)**

**13.0     (NOT USED)**

**14.0     STATUTORY OBLIGATIONS**

**14.01     Regulations**

The Contractor shall comply with any ordinances, regulations and requirements of the Government of the Hong Kong Special Administrative Region or statutory undertaker or utility company applicable to the Works, subject to Clause 6 of the Standard Conditions of Contract.

The Contractor shall comply with and accept the risk of any impending Ordinances, Regulations, requirements and legislation or other conditions which alter any obligations or impose new obligations.

The whole of the Works shall comply with all applicable Codes and Regulations.

The Contractor shall be responsible for obtaining permits required under the noted ordinances and for complying with any restrictions that may be imposed by the various Government authorities from time to time during the Contract Period.

No claim for extension of time, loss and/or expense from the Contractor due to failure to observe these requirements will be entertained.

**14.0     STATUTORY OBLIGATIONS (Cont'd)**

**14.02     Notices, fees and charges (See also Standard Conditions of Contract Clause 6)**

The Contractor shall comply with Clause 6 of the Standard Conditions of Contract relative to notices, fees and charges in respect of the Works.

The Contractor shall specifically note that a new Construction Waste Disposal Charging Scheme has come into effect. The Contractor shall comply with any requirements and allow in their tender prices and rates for any charges required by the Scheme.

**14.03     Working hours, rates of wages, etc.**

The Contractor shall comply with any current legislation or regulations regarding working conditions, working hours, or rates of payment to employees and accept the risk of any impending legislation or other conditions which alters any obligations or imposes new obligations.

**14.04     Safety supervision plan and safety precautions**

The Contractor shall, if not already previously submitted, immediately upon award of the Contract complete and submit to the Architect the appropriate parts for compiling a fully co-ordinated and documented Supervision Plan for the Works in accordance with the requirements under the Technical Memorandum for Supervision Plans 2005 issued by the then Secretary for Housing, Planning and Lands under section 39A of the Buildings Ordinance (Cap. 123) for approval by the Building Authority, and shall comply with such throughout the construction period.

The Contractor shall note that the Supervision Plan is a pre-requisite document for application for consent to the commencement of the Works. If the issue of consent is delayed (notwithstanding solely or partly) due to fault by the Contractor in the preparation of the Supervision Plan, no extension of time shall be granted and the Contractor shall be responsible for the consequences of the full delay.

**14.0     STATUTORY OBLIGATIONS (Cont'd)**

**14.04     Safety supervision plan and safety precautions (Cont'd)**

The review and approval by the Architect of the Contractor's Supervision Plan shall not reduce the Contractor's liability as specified above.

The Contractor shall provide sufficient safety helmets for the use of the consultants and other authorised persons visiting the Site.

The Contractor shall display during the hours of daylight, such flags, signals and markings and during the hours of darkness such lights for the safety of aircraft or the public as required by the regulations for the time being in force in the Hong Kong Special Administrative Region.

The Contractor is fully responsible for the safety of all persons engaged in the execution of the Works and shall comply with any Ordinances and Regulations governing safety on work sites.

The Contractor shall ensure that all persons carrying out construction work on site, whether in the employment of the Contractor or any sub-contractors, must have completed the mandatory basis safety training course for the construction industry under the Factories and Industrial Undertakings (Amendment) Ordinance 1999 and possessed the relevant valid certificate.

All workman or other person whether in the employment of the Contractor or any sub-Contractor, who enter the site, must possess the valid "Green Card" issued by the Construction Industrial Training Authority and the Valid "Construction Works Registration Card" issued by Construction Workers Registration Authority. Otherwise, the entry of such workman to the site will be denied.

The Contractor shall provide sufficient safety helmets, safety boots, eye goggles, ear protectors and other personnel protection equipment as necessary for all personnel working on site and shall enforce the wearing thereof.

**14.0     STATUTORY OBLIGATIONS (Cont'd)**

**14.05     Statutory levies**

The Contractor shall pay all statutory levies applicable to his own works including, but not limited to, the Construction Industry, Pneumoconiosis and Mesothelioma, and levy under Construction Workers Registration Ordinance, etc.

**14.06     Noise control**

The Contractor's particular attention is drawn to the Noise Control Ordinance 1988 which from mid 1989 or thereabout imposes new restrictions on noisy activities and the requirement imposed by the Environmental Protection Department from time to time and which may affect the carrying out of the Works. No claim for extension of time or additional loss and expense in this respect shall be entertained.

**14.07     Illegal immigrants**

The Contractor shall familiarise himself with the statutory provisions concerning ILLEGAL IMMIGRANTS on construction sites as set out in the Immigration Ordinance Cap. 115 ("the Ordinance") as amended by the Immigration Amendment Ordinance particularly those criminal offences dealing with the employment of Illegal Immigrants (section 17 I of the Ordinance) or the presence of Illegal Immigrants upon a construction site (section 38A of the Ordinance). It shall be the responsibility of the Contractor to observe and keep in force the following practices at all times whilst the Works are being carried out :-

- (a)     The Contractor will take all practicable steps to determine that all employees employed either by the Contractor or by any subcontractors are lawfully employed.
- (b)     The Contractor shall take all practicable steps to prevent illegal immigrants from entering the site.

14.0     **STATUTORY OBLIGATIONS** (Cont'd)

14.07     Illegal immigrants (Cont'd)

Without derogation from the generality of sub-clause above the Contractor shall ensure that his employees comply with the following terms :-

- (a)     all employees will produce a valid Hong Kong identity card upon commencement of employment;
- (b)     all employees will carry and produce upon demand their Hong Kong identity card. No one is allowed to remain on the site if they refuse to produce their Hong Kong identity card;
- (c)     notices in writing are prominently posted upon the site at the commencement of the Contract and maintained throughout the Contract written in both Chinese and English warning that any illegal immigrants found upon the site will be reported to the police;
- (d)     any illegal immigrant found upon the site is forthwith reported to the police;
- (e)     the local crime prevention officer attends the site at the commencement of the Contract to advise upon site security;
- (f)     all Contractors' site security and supervisory staff are instructed upon these and any other measures to be or subsequently to be adopted by the Contractor;
- (g)     all sub-contractors keep a full and current list of all those persons and employees upon the site with details of their Hong Kong identity card number, such list to be produced to the Contractors' office weekly;



**14.0     STATUTORY OBLIGATIONS (Cont'd)**

**14.07    Illegal immigrants (Cont'd)**

- (h)    the site is secured at night;
- (i)    no persons, except for the watchman, are allowed to sleep upon the site.

The Sub-Contractors shall be deemed to observe and allow for complying with the above requirements and all arrangements of the Contractor in this respect. The Sub-Contractors shall be responsible for all claims arising from failure of his part to comply with the above requirement.

**15.0     PROTECTION OF PUBLIC PROPERTY, ETC.**

**15.01    Protection of public**

The Contractor is to take every precaution necessary to protect the public from injury or death during the course of the Works.

**15.02    Protection of public property**

The Contractor shall maintain and protect all public property and roads and property of the utility companies and bear all costs incurred in making good any damage caused thereto.

**15.03    Protection of adjoining property**

The Contractor shall take every precaution necessary to protect adjoining property from damage and shall bear all costs incurred in remedying damage caused through lack of proper care on his part.

15.0     PROTECTION OF PUBLIC PROPERTY, ETC. (Cont'd)

15.04     Protection and maintenance of existing slopes

Any existing slopes within and around the Site are under the care of the Contractor.

Provide, maintain and remove on completion all necessary temporary surface water drainage to protect all slopes, roads and paths from landslips, subsidence, etc.

Phase the works as necessary to maintain the stability of all existing slopes and to prevent landslips. The Contractor is to comply with all reasonable directions of the Architect and Building Authority in this respect and his tender is deemed to include for any extra cost involved.

All landslips, subsidence, etc. caused by any negligence, omission or default of the Contractor, shall be made good by the Contractor at his own expense.

15.05     Maintenance of existing roads, footpaths, steps, etc.

Maintain all existing roads, footpaths, steps, etc. and reinstate any damage caused by any reason whatsoever during the progress of the Works.

It will be the Contractor's responsibility to ensure that the roads leading to and around the Site are kept free from obstruction brought about by the work on the Site and in no way shall he cause any hindrance to traffic or ancillary works either by his own vehicles, or by his workpeople, materials, etc.

The Contractor shall be responsible for repairing damage to private streets and access roads if deterioration occurs during the Contract Period.

15.06     Maintenance of existing trees and shrubs

Take every reasonable precaution possible to preserve all trees and shrubs not affected by the Works. No tree or shrub within the boundary lines shall be cut down without the prior approval of the Architect.

15.0 PROTECTION OF PUBLIC PROPERTY, ETC. (Cont'd)

15.07 Maintenance of existing services

The Contractor shall ensure that any existing services such as electric power, telephone, water, gas or drainage to adjacent properties and buildings which pass through the Site are maintained during the course of the Works.

The Contractor shall arrange with statutory undertakers or utility companies for any necessary disconnection or diversion of drains or other services.

If any existing services are damaged during the execution of the Works, the Contractor shall immediately notify the Architect, the Employer and relevant Authorities or Utility Companies as necessary. The Contractor shall bear all the costs of making good the damages and the costs of provision of any temporary services as may be required by the Employer for its continuing operation.

Any services that the Contractor requires to be diverted to suit his method of construction shall be diverted by the relevant authority and/or adjacent owners and the Contractor shall bear all costs and charges in respect thereof.

Where alterations to services are necessitated by the Works, no adjacent work shall commence until the alterations have been made.

If, in the Architect's opinion, damage may be caused by the operation of mechanical plant over or adjacent to services, the Contractor shall be required to excavate by hand in their vicinity. The Contractor shall be responsible for any damage, accidental or otherwise, and shall make good such damage as required at his own expense.

Before excavations are carried out near utility services by means of mechanical plant, the Contractor shall carry out full and adequate preliminary investigations to locate utility services by means of hand-dug trial holes. The Contractor shall allow for making such enquiries and investigations as are necessary to check and confirm the positions of all utility services before commencing work.

15.0     PROTECTION OF PUBLIC PROPERTY, ETC. (Cont'd)

15.08     Construction of foundations, etc. close to buildings, roads and other structures

Care must be taken in constructing foundations, etc. near buildings, roads and other structures and the Contractor shall bear all costs incurred in remedying any damage caused through lack of proper care on his part.

Provide all necessary additional planking, strutting and shoring to the sides of excavations adjacent to buildings, roads and other structures and take special care to prevent subsidence or other damage.

15.09     Restrict nuisance of dust and noise

The Contractor shall comply with all Regulations concerning the prevention of nuisance arising from noise, water, smoke, dust, accumulation of rubbish, mosquito breeding and all other causes.

The Contractor is to take all necessary steps to restrict the nuisance of dust and noise. Pneumatic drills shall be fitted with silencers. Compressors shall be in good order to run as quietly as possible and shall be placed in position as far away as possible from adjoining premises. The Contractor shall take care to abate the nuisance caused by dust and shall sprinkle dusty areas with water frequently.

15.10     Suppressors

All mechanical plant shall be fitted with radio and T.V. interference suppressors.

**16.0     INSURANCE AND SURETY (See also Standard Conditions of Contract  
Clauses 20, 21, 22, 22A and 33)**

**16.01     Employees' Compensation Insurance**

Refer to Clause 14.01 herein.

The Contractor is solely responsible for liability for accidents or injuries to his workpeople. The attention of the Contractor is particularly drawn to his obligations in respect of the Employees' Compensation Ordinance which requires the insurance against his liability to pay compensation to his employees injured in the course of or caused by the carrying out of the works.

The Employer shall not be liable for or in respect of any damages for compensation under the Employees' Compensation Ordinance, the Fatal Accidents Ordinance and any revision or amendment thereof or at common law by or in consequence of any accident or injury to any employee or other person whether in the employment of the Contractor or any of his sub-contractors of every tier and the Contractor shall indemnify and keep indemnified the Employer against all claims, demands, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

The Contractor shall effect and maintain on behalf of himself and his sub-contractors of every tier such insurances as are necessary to cover all liability of the Contractor arising under any statute or at common law in respect of personal injury to or death of any employee and other person who may be employed on the Works or anywhere in Hong Kong whilst engaged in business connected with the Works.

The policies shall be extended to cover the Employer's liability under any statute or ordinance or at common law. For this purpose, the policies shall be issued on a "joint names" basis, i.e. in the names of the Employer, the Contractor and of all his sub-contractors whilst engaged in business connected with the Works.

16.0     INSURANCE AND SURETY (Cont'd)

16.01    Employees' Compensation Insurance (Cont'd)

The policies shall be effected with a minimum cover of at least \$200 million (or \$100 million if the number of employees in relation to whom the policy is in force is less than 200) for any one event in respect of claims arising out of the Employees' Compensation Ordinance, the Fatal Accidents Ordinance and any revision or amendment thereof and at common law.

Should the Contractor opt to incorporate the above requirements by means of effecting endorsement to cover the Employer's liability as Principal using W338 for their Employees' Compensation Insurance Policy, the Contractor is hereby informed that proviso (1) of the said endorsement will not be acceptable for the purpose of this Contract and must therefore be deleted.

Should the Contractor fail to effect and keep in force the aforementioned insurance or any other insurances which he may be obliged to effect under the terms of the Main Contract then the Employer may effect and keep in force those insurances and pay such premium or premiums as may be necessary for such purpose and all costs incurred in connection shall be recoverable from the Contractor by the Employer as a debt or may be deducted by him from any monies due or become due to the Contractor.

16.02    Third party insurance

The Contractor shall effect and maintain the third party liability insurance.

The excess payable by the Contractor under the insurance in respect of each and every occurrence of loss or damage shall not be higher than the following :

\$25,000 or 20% of the loss whichever is the greater for loss or damage arising from subsidence, collapse, vibration, the weakening or removal of support or water damage

16.0     INSURANCE AND SURETY (Cont'd)

16.02    Third party insurance (Cont'd)

\$20,000 or 20% of the loss whichever is the greater for loss or damage to underground services, oil filled cables or fibre optic cables

\$15,000 in respect of all other loss or damage

If the Contractor considers the limit of indemnity for any one accident to be inadequate to cover his contractual obligations he is at liberty to take out a policy with an increased limit of indemnity but any additional premium or differential in premium shall be at his own expense.

16.03    Contractors' All Risks Insurance

The Contractor shall effect and maintain the Contractors' All Risks Insurance.

There shall be an escalation clause in the policy for an amount equal to 10% of the work insured.

The excess payable by the Contractor under the insurance in respect of each and every occurrence of loss or damage shall not be higher than the following :

\$150,000 for loss or damage arising out of water, storm, tempest, earthquake, subsidence, collapse, vibration or the weakening or removal of support, theft, burglary and robbery

\$10,000 or 50% of the loss whichever is greater in respect of damage to scaffolding, shuttering, formwork, timbering, screens and hoardings

\$20,000 in respect of all other loss or damage

**16.0     INSURANCE AND SURETY (Cont'd)**

**16.04     Surety bond**

The Contractor shall obtain the guarantee of a Bank or Insurance Company, approved by the Architect, to be bound to the Employer in a sum as stated in the Appendix to the Standard Conditions of Contract for the due performance of this Contract.

The Architect will not approve the nomination of any bank or Insurance Company having associated company connections with the Contractor. The Contractor may be required to furnish evidence that no such association exists.

**17.0     GENERAL OBLIGATIONS**

**17.01     Overtime**

Should the Contractor consider that it may become necessary to cause overtime to be worked in order to complete the Works by the Completion Date, he must allow for such a contingency in his tender price. No claim for any extra in this connection will be considered.

The Contractor shall apply to the relevant government departments for approval and also give the Architect written notice of his intention to work overtime.

**17.02     Labour**

The Contractor and Sub-Contractor shall provide and employ on the Site in connection with the execution and maintenance of the work :

- (a) Only such technical assistants as are skilled and experienced in their respective callings and such sub-agents, foremen and leading hands as are competent to give proper supervision to the work they are required to supervise; and
- (b) Such skilled, semi-skilled and unskilled labour as is necessary for the proper and timely execution and maintenance of the Works.



17.0     GENERAL OBLIGATIONS (Cont'd)

17.02     Labour (Cont'd)

The Architect shall be at liberty to object to and require the Contractor and any Sub-Contractor to remove forthwith from the Works any person employed by the Contractor or by a Sub-Contractor who in the opinion of the Architect misconducts himself or is incompetent or negligent in the proper performance of his duties or whose employment is otherwise considered by the Architect to be undesirable and such person shall not be again employed upon the Works without the written permission of the Architect.

Any person so removed from the Works shall be replaced as soon as possible by a competent substitute approved by the Architect.

17.03     Construction Manager/Contractor's site management team (See also Standard Conditions of Contract Clause 10)

The Contractor shall constantly keep upon the Works a site management and supervisory team.

The site management and supervisory team shall be headed by a construction manager who shall be dedicated full time to the Works. The appointment of the construction manager shall have been consented to in writing by the Architect prior to the commencement of the Works and the Contractor shall not remove or replace him and key management personnel without the Architect's written consent.

A services engineer shall be a member of the team and will act as a co-ordinator for all building services installations carried out by the Contractor, Specialist Contractors and utility companies.

The co-ordination of services shall be deemed to include :

- (1) The acquisition and checking of all design drawings from the Architect and those to be provided under any sub-contract or contract for specialist work for the compatible integration of all the work, including recommending to the Architect, for his approval, design solutions to eliminate any conflict between the positioning of any work, and to provide adequate space for the routing of all such work and for subsequent maintenance of the various installations in accordance with good practice.

17.0     GENERAL OBLIGATIONS (Cont'd)

17.03     Construction Manager/Contractor's site management team  
(Cont'd)

- (2)     In conjunction with the sub-contractors, the production and provision of finalised master co-ordination drawings and/or combined services drawings incorporating all design solutions approved by the Architect and showing the integration of all services to be carried out by the Contractor and his sub-contractors.
- (3)     The establishment of a detailed sequence of work to enable the expeditious completion of the Works and all Specialist Works and works carried out by utility companies.
- (4)     The co-ordination of all building services sub-contractors for the timely completion of all testing/commissioning works, submission of manuals and as-fitted drawings, including the completion of all outstanding works and rectification of defects during the Defects Liability Period.

17.04     Visitors

The Contractor shall not allow any unauthorised visitors on the Site. He shall keep a visitors book for persons authorised to visit the Site and provide safety helmets for such visitors.

17.05     Workmen living on Site

Unless the Architect gives written permission no workmen will be allowed to live on the Site apart from the necessary number of watchmen.

17.06     Watching

Keep efficient watchmen on the Works day and night and provide all necessary lighting, guards, barriers and all safeguards for the prevention of fire, accidents and losses.

The Contractor shall be solely responsible for the safety from damage or theft of all materials, plant, machinery, tools and scaffolding and also for all Specialist Contractors' fixed and unfixed materials, goods, etc. delivered to the Site.

The Contractor shall not be responsible for the Specialist Contractors' plant, tools, equipment and the like.

17.0     GENERAL OBLIGATIONS (Cont'd)

17.07     Protection and cleaning of all trades

The Contractor is to amply protect all finished Works including electrical and sanitary fittings, built-in fixtures, metal work, glass, tiles and other wall and floor finishes, and will be responsible for any damage caused by carelessness and negligence in this respect.

At the completion of the Works, clean up after all trades and remove all marks, stains, finger prints and other soil or dirt from all finished surfaces, ease and adjust all doors, windows, drawers, etc., check and oil all hardware, cut out cracks in plastering and make good, clean all wall linings, floors and glass inside and out, touch up all painted and polished work and clean out all gutters and channels.

Clear away from the Site all plant, surplus building materials, earth and rubbish and leave the premises clean and fit for occupation to the entire satisfaction of the Architect.

17.08     Fire protection

The Works shall be kept free from fire hazard and the Contractor shall take all possible precautions and provide all necessary fire fighting equipment and properly trained staff.

17.09     Clearing away rubbish during progress of the Works

The Contractor shall remove all rubbish, crates, wrappings, surplus materials, etc. from the Site as soon as is possible and at frequent intervals during the progress of the Works so as to maintain unhindered access to and easy inspection of all work.

17.0     GENERAL OBLIGATIONS (Cont'd)

17.09     Clearing away rubbish during progress of the Works (Cont'd)

If, in the Architect's opinion, the Contractor fails to provide proper bulk bins or remove rubbish from the Site after reasonable notice in writing has been given by the Architect or notice received from the relevant authority the Employer reserves the right to employ outside labour to remove rubbish and deduct all costs and expenses incurred therefor from any money due or to become due to the Contractor.

Burning of rubbish on the Site will not be permitted.

17.10     Removal of water

Keep the Site and the Works including all excavations free from water by pumping or otherwise. Allowance shall be made for removal of all water and this shall be deemed to include rain, storm, spring, percolating or running water.

To prevent mosquitoes breeding no accumulation of water is to be permitted at any time.

17.11     Setting out (See also Standard Conditions of Contract Clause 7)

Set out the Works and provide all instruments, etc. and labour required by the Architect for checking any work.

The Contractor shall verify all dimensions and ground levels shown before commencing work.

17.12     Preparation for Substantial Completion

The Contractor shall carry out all necessary preparatory work well in advance of the Substantial Completion.

17.13     Blasting

Blasting will not be permitted.

17.0 GENERAL OBLIGATIONS (Cont'd)

17.14 Treasure trove, coins, etc.

Any treasure trove, coins or objects of antiquity shall become the property of the Employer and shall be carefully removed by the Contractor and handed to the Architect.

17.15 Prevention of mosquito-breeding

The Contractor shall treat all standing water on the Site with an approved mosquito-larvae abatement oil at least once a week. The Contractor shall also comply with all Government rulings and requirements with respect to the control of mosquitoes and similar health hazards.

18.0 TEMPORARY WORKS

18.01 Plant, tools, etc. and scaffolding

Provide and maintain in good working order all mechanical equipment, plant, tools, implements, ladders, tarpaulins and the like necessary for the proper and timely execution and protection of the Works.

Provide, erect, alter if necessary and maintain all necessary scaffolding to the satisfaction of the Architect and remove on completion and make good all work disturbed.

The Contractor will not be permitted to take support from windows for erecting scaffolding or plant. The method of securing the scaffolding and plant shall be to the Architect's approval.

The maintenance of all plant shall be undertaken outside normal working hours and the Contractor shall provide sufficient reserve plant of all kinds to ensure that the work is not interrupted by breakdown of plant.

Erect and maintain suitable and safe ladders and gangways for the Architect, the Architect's representative, etc. to thoroughly inspect any portion of the Works, with complete safety.

18.0     TEMPORARY WORKS (Cont'd)

18.02     Hoardings, screens, etc.

Provide, erect, alter if necessary and maintain all necessary hoardings, screens, gates, covered walkways, footways, gangways, fans, gantries, temporary enclosures, barriers, etc., to the satisfaction of the Architect.

The Contractor shall be responsible for the design of hoardings, screens, covered walkway, fencing, etc. where such designs are not provided by the Architect. The Contractor's design shall be to the satisfaction of the Architect and Building Authority. The Contractor shall be responsible for preparing all calculations, drawings and submissions to the Building Authority in order to obtain the necessary permit from the Building Authority for carrying out such work.

All hoardings, covered walkways, fencing, etc. shall be erected BEFORE any excavation commences.

Provide all lighting to hoardings, covered walkways, fencing, etc. as may be required by the authorities.

All surfaces are to be prepared and painted with two coats of synthetic paint in colours to be selected by the Architect.

All hoardings, covered walkways, fencing, etc. are to be handed over to the Employer on completion.

18.03     Contractor's storage sheds, workshops and offices

The Contractor shall provide for his own use all necessary workshops, mess rooms, offices and sheds of suitable construction for the storage of materials, maintain them in good order to the satisfaction of the Architect, remove on completion of the Works and make good the Site.

Materials may be stored in completed sections of the Works provided that no section of the structure is loaded in excess of the design loading and no hindrance is caused to the progress of the Works or access thereto or to partial completion of Works where this is required.

18.0     TEMPORARY WORKS (Cont'd)

18.03     Contractor's storage sheds, workshops and offices (Cont'd)

All materials on the Site and in the building shall be stored in a neat and orderly manner.

Separate inflammable goods storage sheds must be provided in an approved location. No inflammable goods such as oil based paints, kerosene, thinners, cellulose lacquers, bitumen or bitumen based products, etc. will be permitted to be stored in the building under construction.

18.04     Office for Architect and Architect's representative

Provide and maintain a suitable weathertight site office for the Architect and the Architect's representative. The office shall have a minimum total floor area of 50 m<sup>2</sup>, be of sufficient strength and adequately braced and anchored to resist tropical cyclones and of a quality to meet the approval of the Architect.

The office must be fitted with 'L' shaped desks having 1800 x 900 mm and 1500 x 750 mm tops, tables, chairs, A4 filing cabinets, AO drawing racks plus clips, fridges, AO drawing boards, bookshelves (1800 x 900 mm), waste paper bins, fire extinguishers and with toilet accommodation. The toilet accommodation shall consist of European type W.C. suite and with an adequate number of wash hand basins together with running water and a supply of soap and towels. The office shall be properly decorated and the floor shall be covered with heavy quality linoleum or similar approved finish. The office shall also be equipped with air-conditioners, electric lights, power points, telephone line, an approved answering machine, approved facsimile machine and photocopying machine for A4 and A3 paper together with an adequate supply of paper. Provide all necessary shelving, storage racks, computer facilities with licensed Microsoft Office 2000 "Word" and "Excel" programme and broadband internet provision, office equipment and stationary.

Telephone and internet connections are to be made available on commencement of the Works. In addition mobile phone shall be provided for use by the Architect and the Architect's representative for the duration of the Contract.

18.0     TEMPORARY WORKS (Cont'd)

18.05     Temporary latrines

Provide and maintain efficient and sanitary latrine accommodation for the use of male and female labour employed on the Works and keep the whole of the Site and buildings in a clean and sanitary condition to the satisfaction of the Architect and of the Director of Food and Health and remove on completion.

18.06     Positions of all site offices, temporary latrines, sheds, hoists and the like

Submit to the Architect for approval proposals for the positions of all site offices, temporary latrines, sheds, hoists and the like. After receiving approval from the Architect, submit the proposals with the required form to the Building Authority for approval.

18.07     Temporary supports

Provide all necessary temporary supports including, but not limited to, shoring, propping, strutting, planking and strutting, sheet piling, etc. whether for the support of excavation, new work under construction or of existing buildings and existing slopes. All such temporary supports shall be designed by the Contractor to the approval of the Architect and the Building Authority. The Contractor shall be responsible for its safety throughout the period of the Works and no indication of approval or disapproval of such temporary supports by the Architect shall be interpreted as in any way reducing the Contractor's responsibility in this respect. Should the Architect in lieu of the Contractor subsequently undertake to provide drawings detailing the requirements for temporary supports and should the Architect obtain the approval of the Building Authority to these proposals, then the Contractor shall construct the temporary supports in accordance with such drawings at no extra cost, as if they were his own design.

18.08     Telephones

Provide telephones on the Site for use also by the Architect, etc. and others legitimately employed on the Site including paying all charges and removing on completion.



18.0     TEMPORARY WORKS (Cont'd)

18.09     Water for the Works

Provide and distribute all necessary water at the Site for the carrying out of the Works, including the works of the Specialist Contractors employed direct by the Employer, statutory undertakers and utility companies including the erection and removal of temporary plumbing and storage and the payment of all fees and charges.

The Contractor shall provide and distribute water free of charge to the Specialist Contractors employed direct by the Employer, statutory undertakers and utility companies.

Should the Contractor intend to use water from the government mains he shall arrange for a temporary water supply at an early stage of the mobilization period. No extension of time will be granted for any delay in obtaining a temporary water supply.

18.10     Lighting and power

Provide all necessary electric lighting and power at the Site for the carrying out of the Works including the works of the Specialist Contractors employed direct by the Employer, statutory undertakers and utility companies and including all electric power to enable all Specialist Contractors to check, test and commission their installations to meet the requirements of the Architect and all others having jurisdiction.

The Contractor shall be responsible for all site works in distributing electricity including, but not limited to, provision, installation and subsequent removal of temporary main switch board, distribution boards, cables, wiring, junction boxes, transformers, lights and all other accessories.

The whole installation is to comply with the latest edition of the IEE Wiring Regulations produced by the Institution of Engineering and Technology, and all requirements of the electricity supply company.

18.0     TEMPORARY WORKS (Cont'd)

18.10    Lighting and power (Cont'd)

The Contractor shall provide and distribute electricity free of charge to the Specialist Contractors employed direct by the Employer, statutory undertakers and utility companies.

Should the Contractor intend to use electricity from the mains he shall arrange for a temporary electricity supply at an early stage of the mobilization period. No extension of time will be granted for any delay in obtaining a temporary electricity supply.

18.11    Temporary roads

Form and maintain all necessary temporary roads and paths to provide adequate access to and within the Site and reinstate the Site and all works damaged or disturbed upon completion of the Contract to the satisfaction of the Architect.

The layout of the proposed temporary roads and paths must be submitted to the Architect for his approval. The Architect may issue instructions to the Contractor regarding the layout and method of forming temporary roads and paths and the Contractor shall comply with these instructions at no extra cost.

18.12    Restriction of advertising

No advertising, other than that given by the name board specified will be permitted on the Site, except with permission in writing from the Architect. The Architect may instruct the Contractor to remove advertisements, etc., from the Works, whether erected by the Contractor or not.

Publicity releases relating to this project should be first submitted to the Employer and the Architect for approval.

18.0 TEMPORARY WORKS (Cont'd)

18.13 Name board

Provide and erect a name board complete with the names of the project, Employer, Consultants, etc. all to the approval of the Architect. The lettering is to be carried out by a competent sign writer.

The Contractor will be required to carry out all necessary re-painting and re-writing that may be necessary during the progress of the Works. No notice other than that approved by the Architect will be permitted on the Site.

The Contractor shall remove the name board on completion and make good all works disturbed.

18.14 Other temporary works

Provide all other necessary temporary works not specifically mentioned herein.

Ref. 编号	Item 项目	Total 总额
	<p style="text-align: center;"><b><u>SPECIFICATION</u></b></p> <p style="text-align: center;"><b><u>SECTION 1 - PRELIMINARIES</u></b></p> <p style="text-align: center;"><b><u>SUMMARY</u></b></p>	
1.0	<b><u>GENERALLY</u></b>	
2.0	<b><u>DEFINITIONS</u></b>	
2.01	Employer	
2.02	Architect	
2.03	Geotechnical and Structural Engineer	
2.04	Building Services Engineer	
2.05	Environmental Consultant	
2.06	Quantity Surveyor	
2.07	Contractor/Main Contractor	
2.08	Architect's representative	
2.09	The Authority/Authorities	
3.0	<b><u>DESCRIPTION OF THE WORKS</u></b>	
3.01	Generally	
3.02	Scope of the Works	
3.03	Works to be carried out by separate Specialist Contractors	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$

Ref. 编号	Item 项目	Total 总额
4.0	<b><u>SITE AND INSPECTION</u></b>	
4.01	Location	
4.02	Access and restrictions	
4.03	Site visit	
4.04	Sub-soil conditions	
4.05	Working area	
5.0	<b><u>POSSESSION, COMMENCEMENT AND COMPLETION</u></b>	
5.01	Possession of Site	
5.02	Commencement	
5.03	Completion	
5.04	Substantial Completion	
6.0	<b><u>CONDITIONS OF CONTRACT</u></b>	
6.01	Form of Contract	
6.02	Appendix to the Standard Conditions of Contract	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$

Ref. 编号	Item 项目	Total 总额
7.0	<b><u>TENDER, DRAWINGS AND SPECIFICATION</u></b>	
7.01	Tender	
7.02	No adjustment for rises or falls in cost of labour and materials	
7.03	Schedule of Quantities and Rates	
7.04	(Not used)	
7.05	Ordering materials, etc. from Contract Drawings and/or Specification	
7.06	Drawings forming part of the Tender Documents	
7.07	Drawings, etc. at Site	
7.08	Shop drawings	
7.09	Dimensions	
7.10	Specification	
7.11	Discrepancies	
8.0	<b><u>MATERIALS AND WORKMANSHIP</u></b>	
8.01	Compliance with regulations	
8.02	Samples	
8.03	Safe custody of materials	
8.04	Loading and unloading of materials	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$

Ref. 编号	Item 项目	Total 总额
9.0	<b><u>INSTRUCTIONS, VARIATIONS AND METHODS OF MEASURING AND VAL</u></b>	
9.01	Site instructions	
9.02	Stop work instructions	
9.03	Quotations for Variations	
9.04	Contractor's claims for extras for verbal instructions	
9.05	Measurement of Variations	
9.06	Invoices, receipts, etc.	
9.07	Contractor's expenses in connection with Variations and settlement of accounts	
9.08	Supportive documentation for a fair Valuation	
10.0	<b><u>PROGRAMME AND REPORTS</u></b>	
10.01	Weekly reports	
10.02	Site meetings	
10.03	Daily reports	
10.04	Progress photographs	
10.05	Programme of Works	
11.0	<b><u>PERSONS ENGAGED BY EMPLOYER</u></b>	
12.0	<b><u>(NOT USED)</u></b>	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$

Ref. 编号	Item 项目	Total 总额
13.0	<u>(NOT USED)</u>	
14.0	<u>STATUTORY OBLIGATIONS</u>	
14.01	Regulations	
14.02	Notices, fees and charges	
14.03	Working hours, rates of wages, etc.	
14.04	Safety supervision plan and safety precautions	
14.05	Statutory levies	
14.06	Noise control	
14.07	Illegal immigrants	
15.0	<u>PROTECTION OF PUBLIC PROPERTY, ETC.</u>	
15.01	Protection of public	
15.02	Protection of public property	
15.03	Protection of adjoining property	
15.04	Protection and maintenance of existing slopes	
15.05	Maintenance of existing roads, footpaths, steps, etc.	
15.06	Maintenance of existing trees and shrubs	
15.07	Maintenance of existing services	
15.08	Construction of foundations, etc. close to buildings, roads and other structures	
15.09	Restrict nuisance of dust and noise	
15.10	Suppressors	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$



Ref. 编号	Item 项目	Total 总额
16.0	<b><u>INSURANCE AND SURETY</u></b>	
16.01	Employees' Compensation Insurance	
16.02	Third party insurance	
16.03	Contractors' All Risks Insurance	
16.04	Surety bond	
17.0	<b><u>GENERAL OBLIGATIONS</u></b>	
17.01	Overtime	
17.02	Labour	
17.03	Construction manager/Contractor's site management team	
17.04	Visitors	
17.05	Workmen living on Site	
17.06	Watching	
17.07	Protection and cleaning of all trades	
17.08	Fire protection	
17.09	Clearing away rubbish during progress of the Works	
17.10	Removal of water	
17.11	Setting out	
17.12	Preparation for Substantial Completion	
17.13	Blasting	
17.14	Treasure trove, coins, etc.	
17.15	Prevention of mosquito-breeding	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$

Ref. 编号	Item 项目	Total 总额
18.0	<b><u>TEMPORARY WORKS</u></b>	
18.01	Plant, tools, etc. and scaffolding	
18.02	Hoardings, screens, etc.	
18.03	Contractor's storage sheds, workshops and offices	
18.04	Office for Architect and Architect's representative	
18.05	Temporary latrines	
18.06	Positions of all site offices, temporary latrines, sheds, hoists and the like	
18.07	Temporary supports	
18.08	Telephones	
18.09	Water for the Works	
18.10	Lighting and power	
18.11	Temporary roads	
18.12	Restriction of advertising	
18.13	Name board	
18.14	Other temporary works	
SHOOTING RANGE AT PILLAR POINT ADVANCE WORKS H:/6206.3		Carried to Collection \$

Ref. 编号	Item 项目	Total 总额
	<p style="text-align: center;"><u>SPECIFICATION</u></p> <p style="text-align: center;"><u>SECTION 1 - PRELIMINARIES</u></p> <p style="text-align: center;"><u>SUMMARY</u></p> <p style="text-align: center;"><u>COLLECTION</u></p> <p>Brought forward from page 1.S/1</p> <p>" " " " 1.S/2</p> <p>" " " " 1.S/3</p> <p>" " " " 1.S/4</p> <p>" " " " 1.S/5</p> <p>" " " " 1.S/6</p> <p>" " " " 1.S/7</p>	
	<p style="text-align: right;"><u>TOTAL - SECTION 1</u></p> <p>Carried to Summary of Tender \$</p>	

SHOOTING RANGE AT PILLAR POINT  
 ADVANCE WORKS  
 H:/6206.3

1.S/8

**SPECIFICATION**

**SECTION 2 -**

**TECHNICAL**

**SPECIFICATION**

**SECTION 2 - TECHNICAL**

**General Notes :**

1. The Contractor is to note that apart from the Specification bound herein this section of the tender documents, the latest Hong Kong Government Specifications by Architectural Services Department shall also be applicable to the Works, subject nevertheless to that the "Preliminaries" section of the Hong Kong Government Specifications shall be superseded by the Preliminaries Section of this Contract and therefore shall not be applicable.
2. Should there be any discrepancy between the Specification bound into the tender document and the latest Hong Kong Government Specifications, the more onerous requirements shall take precedence.

**SPECIFICATION - SECTION 2 - TECHNICAL**  
**ARCHITECTURAL SPECIFICATION**

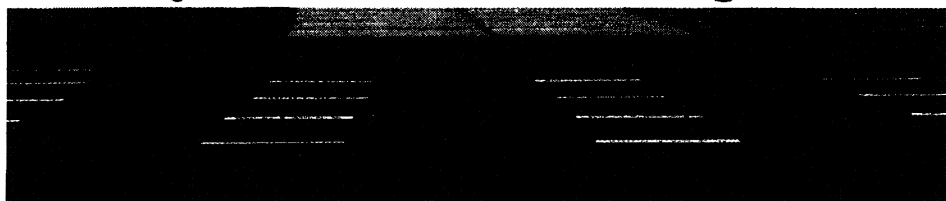
TCAI email 29.11.10 (IBP)

Paving Block

# TIOSTONE

Waste Recycling • Pollution Control

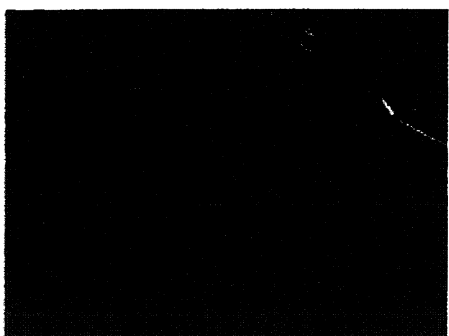
**Recycled Concrete Paving Block**



**Public recreation playground**



**Local Institute**



**Private properties**



**Local Institute**

**An Effective Way to improve**

**The Environment in Hong Kong**

**Exclusive Agent**



**GREENWAY**  
BUILDING MATERIALS LIMITED  
**綠威建材有限公司**



21/F., Shun Kwong Commercial Building, 8 Des Voeux Road West Hong Kong

Tel: 2545-7272

Fax: 2547-3075


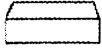

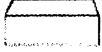



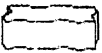

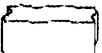


# TIOSTONE Paving Blocks Series

**Recycled Aggregate Concrete Pavers**

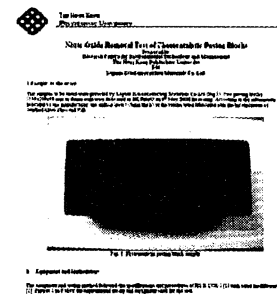
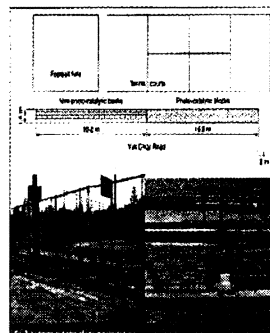
**ECO-Glass Concrete Pavers**

**APR (Air Pollutants Removal) Concrete Pavers**

Paving		
		200 x 100 x 50 mm
		200 x 100 x 60 mm
		200 x 100 x 80 mm
		225 x 112.5 x 60 mm
		225 x 112.5 x 80 mm

Paving	
<b>Compressive strength:</b>	
> 30 MPa (footpath or cycle track)	
> 45 MPa (vehicular access)	
<b>Skid resistance:</b>	
> 45	

## 測試報告



## 生產設備



## 生產TIOSTONE的材料：廢棄玻璃瓶



九龍區巴士有限公司

SWIRE

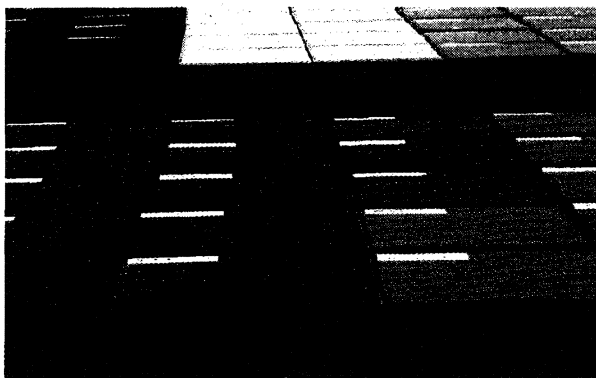
HSBC

九龍區巴士有限公司



## Recycled Aggregates Concrete Pavers

**TIOSTONE Recycled Aggregates Concrete Paver** is a concrete paver contains recycled aggregates, river sand and cement which can reduce construction wastes to landfills in Hong Kong. **TIOSTONE Recycled Aggregates Concrete Paver** was invented by the research team led by Prof.C.S. Poon of the Hong Kong Polytechnic University. The technology, patented in Hong Kong, effectively uses recycled aggregates as a major constituent in the production of concrete pavers. As more than 6,000 tonnes of construction wastes are generated daily in Hong Kong, this invention reduces the disposal of construction wastes as well as preserving the use of natural materials.



**Suitable area :**

Pedestrian footpath, Car Park, Emergency Vehicular Access and also Square.

**Applicable Standard :**

BS6717:2001, AS/NZS4456.14:1997, BS6677:1986

HKHA Specification Library 2004 Edition EXT3.T130.4 to T150.4

**Performance Properties :**

Compressive Strength >30 Mpa (60mm thick for walkway),

> 45 Mpa (80mm thick for driveway).

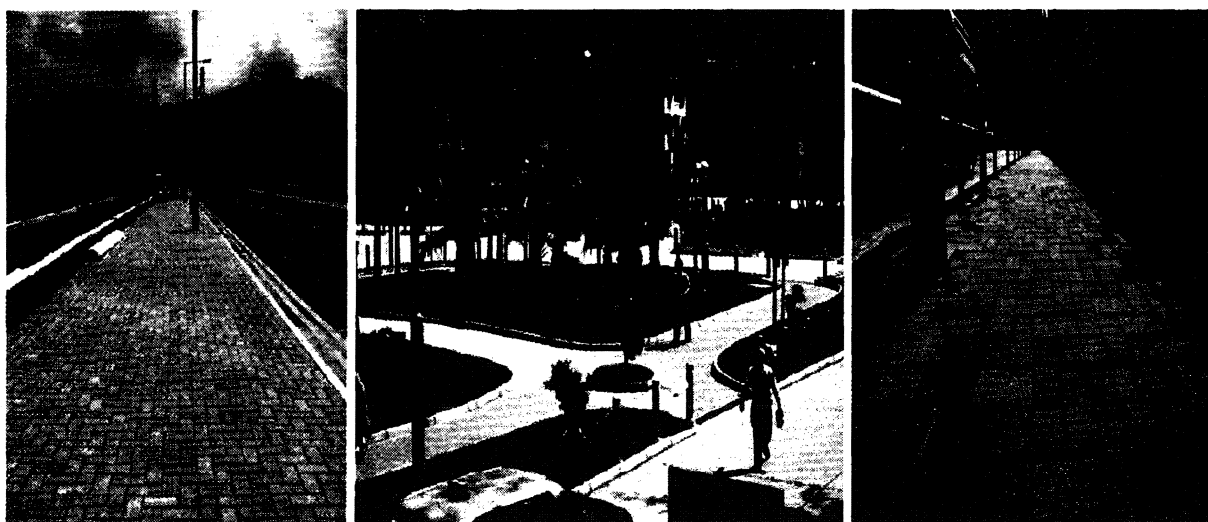
Degree of abrasion resistance: < 23mm

Unpolished Skid Resistance Value (USRV) : > 45

Water Absorption : < 6%

### Advantages of TIOSTONE Recycled Aggregates Concrete Paver

- 1) Use **recycled materials** to reduce construction wastes to landfills. (also reduce mining)
- 2) Unlike Clay Pavers, **NO Green House Gas** is generated during production.
- 3) Modern face-mix (double-layer) design to eliminate the discoloration of pavers. (Traditional homogeneous color is also available upon request.)
- 4) Iron oxide color pigment is used to ensure sharp and stable color
- 5) Our Recycled Aggregates Concrete Pavers are made by fully automatic German MASA concrete block making machine to ensure the excellent quality of goods.
- 6) Made in Hong Kong with a reliable production lead time and economic transportation cost.
- 7) Reduce Heat Island Effect
- 8) Using of our Recycled Aggregates Concrete Paver is subject to the HK-BEAM and LEED credit points.



#### Sizes:

Classic Series (Basic) 200 x 100 x 60mm, 200 x 100 x 80mm

225 x 112.5 x 60mm & 225 x 112.5 x 80mm

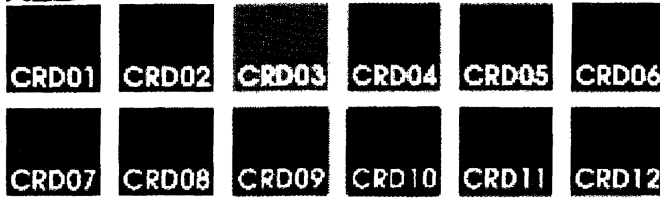
Custom-made sizes are upon request depending on the quantity.

All relevant references of the product are available upon request.

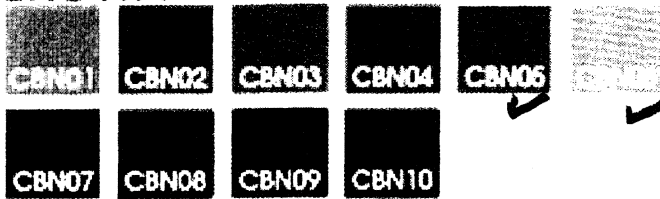
# TIOSTONE

天興石

## RED



## BROWN



## GREEN



## BLUE



## BLACK & GRAY



## COLORS

Due to printing limitations, colors shown may vary from that of actual TIOSTONE. Customers are advised to make final selection from actual samples.



Local Institute



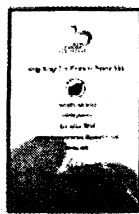
Local Institute



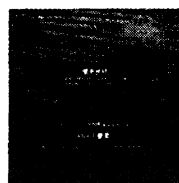
Public School - Green Roof



Public properties



Notable Mention  
ECO-Products Award 2006



Merit Award  
Green Building Award 2006

## Environmental Innovations Paving Blocks



TEST CERTIFICATE  
DETERMINATION OF SHAPE AND DIMENSIONS OF PAVING BLOCK  
( BS 6717 : 2001, Annex B )

Date of issue: 24-11-2008

Page 1 of 1 page

Castco LRN: HC281121-1

Details as supplied by client

Client: Laputa Eco-construction Material Co. Ltd.

Client's ref. no.: -

Contract no.: -

Job title: -

Work dimension: 200 x 100 x 60 mm

Type: Paving Block

Laboratory Test Result

Date received: 21-11-2008

Date tested: 22-11-2008

Specimen no.		1	2	3	4	5	6	7	8
<b>Overall dimensions</b>									
Length	L1	200	200	200	200	200	200	200	200
	L2	200	200	201	200	200	200	200	200
Width	W1	100	100	100	100	100	100	100	100
	W2 (mm)	100	100	100	101	101	101	100	100
Thickness	Average	61	61	61	60	61	61	61	60
	Max - Min (mm)	1	0	0	0	0	1	1	1
<b>Flatness and Bow</b>									
Convex	Diagonal 1	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.1
	2	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.1
Concave	Diagonal 1	0.2	0.0	0.1	0.1	0.1	0.1	0.1	0.1
	2 (mm)	0.1	0.1	0.1	0.1	0.0	0.0	0.2	0.2
<b>Chamfer</b>									
Vertical chamfer length									
	Average (mm)	3	3	3	3	3	3	3	3
Horizontal chamfer length									
	Average (mm)	5	5	5	5	5	5	5	5
<b>Thickness of facing layer</b>									
<b>( Split sample )</b>									
Minimum thickness on the split face									
	(mm)								

## Remarks:

1. Test results are related to the specimens tested only.
2. Test results comply to BS 6717:2001, Cl.5.2.1 & Cl.5.2.4.

Checked by:

M. L. LAM

Certified by:

CHOI TZE WING  
C. Eng., MBE, MICE  
Quality Manager



佳力高試驗中心有限公司  
CASTCO TESTING CENTRE LTD.

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香港粉嶺安全街29A號 29A, On Chuen Street, Fanling, Hong Kong. Fax: 2677 0351  
E-mail: castco@netvigator.com Website: www.castco.com.hk



HOKLAS 032

Test Certificate

Determination of Characteristic Compressive Strength of Paving Blocks  
[General Specification for Civil Engineering Works 2006 Edition Appendix 11.1]

Date of issue: 31-01-2008

Page 1 of 1 page

Castco LRN: HC280128-1

Details as supplied by client

Client: Laputa Eco - Const. Material Co. Ltd.

Client's Ref. No.: --

Job Title: Construction of Aldrich Bay Phase 5

Contract No.: 20040062

Sample Description: Paving Block

Shape: Rectangular

Sample Nominal Size (Length x Width x Height): 200 x 100 x 60 mm

Type: --

Source & Manufacturer: --

Date of Manufacture: --

Identification Marks: 1 to 8

Laboratory Test Result

Date Received: 28-01-2008

Date Tested: 30-01-2008

Age: -- days

Identification mark		1	2	3	4	5	6	7	8
Lesser dimension of the two plan (L) (mm)		98	98	98	98	98	98	98	98
Nominal height (H) (mm)		59	59	59	59	59	59	59	60
Nominal gross plan area (A) (mm <sup>2</sup> )		19400	19400	19500	19600	19400	19400	19400	19400
Breaking Load (P) (kN)		1022	915	1049	1143	970	929	1102	1191
Compressive Strength $C = \frac{1000 P}{A} \times \frac{2.5}{1.5 + L/H}$ (MPa)		42	37	43	46	40	38	45	49
Square of Compressive Strength $C^2$ (MPa <sup>2</sup> )		1738.9	1391.3	1806.5	2125.2	1560.3	1436.4	2016.0	2401.0
The Sum of Square of Compressive Strength $\Sigma C^2$ (MPa <sup>2</sup> )		14475.4							
Average of Compressive Strength $C_m$ (MPa)		42							
Unbiased Standard Deviation $s = \frac{\sqrt{\Sigma C^2 - n (C_m)^2}}{n - 1}$ (MPa)		2							
The Characteristic Strength of the Batch $C_0 = C_m - 1.65s$ (MPa)		40							
Compliance (Appendix 11.85(4))		30MPa for blocks in footways and cycle tracks							

- Remark 1. Test result relates to the specimen tested only.  
2. Test result meets the compliance stated above.

M. L. LAM

Checked by:

Certified by:

CHOI TZE WING  
C.Eng., MHKIE MICE  
Laboratory Engineer

Form No. TDN B1.X\_GS2004 T & 04/05/2107

Hong Kong Accreditation Service (HKAS) has accredited this laboratory under the Hong Kong Laboratory Accreditation Scheme (HOKLAS) for specific laboratory activities as listed in the HOKLAS Directory of Accredited Laboratories. The results shown in this report were determined by this laboratory in accordance with its terms of accreditation. This report shall not be reproduced unless with prior written approval from this laboratory.

## Test Certificate

Measuring Abrasion Resistance of Precast, Unreinforced Concrete Paving Blocks  
(Tested to BS 6717 : 2001 Annex F)

Date of issue : 08-12-2006

Page 1 of 1 page

Castco LRN : HC261204-2

Details as supplied by client

Client : Laputa Eco-Const. Material Co. Ltd.

Client's Ref. No. : --

Job Title : --

Contract No. : --

Sample Description : Paving Block

Type : --

Nominal Size (Length x Width x Thickness) : 200 x 100 x 60 mm

Laboratory test results

Date sample received : 04-12-2006

Date of test : 04-12-2006

Specimen no.	1	2	3
Specimen size (Length x Width x Thickness) (mm)	199 x 100 x 60 mm	200 x 100 x 59 mm	200 x 100 x 59 mm
Maximum convex (mm)	0.1 0.2	0.2 0.3	0.1 0.2
Maximum concave (mm)	0.2 0.1	0.2 0.2	0.3 0.1
Max. convex after ground (if necessary) (mm)	--	--	--
Max. concave after ground (if necessary) (mm)	--	--	--
Width of groove (mm)	70.3	70.4	70.5
Length of groove (L) (mm)	18.5	19.0	18.7
Calibration factor (c) (mm)	20.3		
Degree of abrasion (mm)	18.0	18.5	18.5

## Remark :

1. Test results relate only to the specimens tested.

Checked by :

M. L. LAM

Certified by :

CHOITZE WING  
C.Eng., M.HKIE, M.CE  
Laboratory Engineer

**Test Certificate**

**Unpolished Skid Resistance Value (USRV) of Concrete Paving Blocks**  
(Tested to BS 6717 : 2001 Annex G)

Date of issue : 12-06-2006

Page 1 of 1 page

Castco LRN : HC260606-2

**Details as supplied by client**

Client : Laputa Eco-Construction Material Co. Ltd.

Client's Ref. No. : --

Job Title : --

Contract No. : --

Sample Description : Paving block

Type : --

Nominal Size (Length x Width x Thickness) : 200 x 100 x 60 mm

**Laboratory test results**

Date sample received : 06-06-2006

Date of test : 07-06-2006

Ambient temp. : 20 °C

Specimen no.	Recorded individual readings at 0°					Mean of last three readings	Recorded individual readings at 180°					Mean of last three readings	Unpolished skid resistance value
1	81	81	80	81	79	80	83	81	79	76	79	78	79
2	83	87	85	84	84	84	87	85	85	83	83	84	84
3	87	90	89	87	84	87	85	85	83	82	80	82	85
4	87	88	85	88	87	87	85	84	82	81	81	81	84
Average unpolished skid resistance value													83

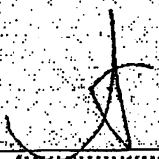
**Remarks:**

1. Test results relate only to the specimens tested.

Checked by :

  
M. L. LAM

Certified by :

  
KEITH CHOI  
C.Eng., MFKIE MICE  
Laboratory Engineer





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CASTCO TESTING CENTRE LTD.

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香港粉嶺安全街29A號 29A, On Chuen Street, Fanling, Hong Kong. Fax: 2677 0351  
E-mail: castco@netvigator.com Website: www.castco.com.hk



Test Certificate

Determination of Water Absorption Properties of Masonry Units and Segmental Pavers  
(AS/NZS 4456.14 : 1997)

Date of issue: 22-09-2008

Page 1 of 1 page

Castco LRN: HC280909-1

Details as supplied by client

Client: Laputa Eco-Construction Material Co. Ltd.

Client's Ref. No.: -

Contract No.: -

Job Title: -

Sample Type: Paving Block

Date cast: -

Sample Size: 200 mm x 100 mm x 60 mm

Source: -

Location of Sampling: -

Date of Sampling: -

Laboratory Test Results

Date Received: 09-09-2008

Date Tested: 12-09-2008

Specimen no:	1	2	3	4	5	6	7	8	9	10
Cold water immersion										
water absorption (%)	5.7	5.9	4.4	5.9	5.1	5.9	4.8	5.8	4.3	5.0
Average cold water immersion										
water absorption (%)	5.3									
Boiling water absorption										
(%)										
Average boiling water absorption										
(%)										

Remark:

1. Test result relate to the specimen tested only.
2. Only cold water immersion test was performed on test specimens as requested by client.

Checked by :

M. L. LAM

Certified by :

CHOI TZE WING  
C. Eng., MHKIE, MICE  
Quality Manager

Form No. 31, CON AS4456, T1.d0 15/10/2007



佳力高試驗中心有限公司  
CASTCO TESTING CENTRE LTD.

TEST CERTIFICATE  
DETERMINATION OF SHAPE AND DIMENSIONS OF PAVING BLOCK  
(BS 6717 : 2001, Annex B)

Date of issue: 24-11-2008

Page 1 of 1 page

Castco LRN: HC281120-3

Details as supplied by client

Client: Laputa Eco-construction Material Co. Ltd.

Client's ref. no.: --

Contract no.: --

Job title: --

Work dimension: 200 x 100 x 80 mm

Type: Paving Block

Laboratory Test Result

Date received: 20-11-2008

Date tested: 21-11-2008

Specimen no.		1	2	3	4	5	6	7	8
<u>Overall dimensions</u>									
Length	L1	199	200	200	200	200	200	200	200
	L2	200	200	200	200	200	200	200	200
Width	W1	100	100	100	100	100	100	100	100
	W2 (mm)	101	100	101	100	100	100	100	101
Thickness	Average	81	80	81	80	80	81	80	80
	Max - Min (mm)	0	0	0	1	1	1	0	0
<u>Flatness and Bow</u>									
Convex	Diagonal 1	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.0
	2	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.1
Concave	Diagonal 1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
	2 (mm)	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1
<u>Chamfer</u>									
Vertical chamfer length									
Average (mm)		3	4	3	4	3	3	3	3
Horizontal chamfer length									
Average (mm)		5	5	5	5	5	5	5	4
<u>Thickness of facing layer</u> (Split sample)									
Minimum thickness on the split face (mm)									

Remarks:

1. Test results are related to the specimens tested only.
2. Test results comply to BS 6717:2001, Cl.5.2.1 & Cl.5.2.4.

Checked by:

M. L. LAM

Certified by:

CHOI TZE WING  
C. Eng., M. E. M. E.  
Quality Manager



佳力高試驗中心有限公司  
CASTCO TESTING CENTRE LTD.

TEST CERTIFICATE  
DETERMINATION OF SHAPE AND DIMENSIONS OF PAVING BLOCK  
( BS 6717 : 2001, Annex B )

Date of issue: 24-11-2008

Page 1 of 1 page

Castco LRN: HC281120-3

Details as supplied by client

Client: Laputa Eco-construction Material Co. Ltd.

Client's ref. no.: --

Contract no.: --

Job title: --

Work dimension: 200 x 100 x 80 mm

Type : Paving Block

Laboratory Test Result

Date received: 20-11-2008

Date tested: 21-11-2008

Specimen no.	1	2	3	4	5	6	7	8
<b>Overall dimensions</b>								
Length L1	199	200	200	200	200	200	200	200
	200	200	200	200	200	200	200	200
Width W1	100	100	100	100	100	100	100	100
	101	100	101	100	100	100	100	101
Thickness Average	81	80	81	80	80	81	80	80
	0	0	0	1	1	1	0	0
<b>Flatness and Bow</b>								
Convex Diagonal 1	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.0
	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.1
Concave Diagonal 1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.1
<b>Chamfer</b>								
<b>Vertical chamfer length</b>								
Average (mm)	3	4	3	4	3	3	3	3
<b>Horizontal chamfer length</b>								
Average (mm)	5	5	5	5	5	5	5	4
<b>Thickness of facing layer (Split sample)</b>								
Minimum thickness on the split face (mm)								

Remarks:

1. Test results are related to the specimens tested only.
2. Test results comply to BS 6717:2001, Cl.5.2.1 & Cl.5.2.4.

Checked by:

M. L. LAM

Certified by:

CHOI TZE WING  
C. Eng., M.H.K.R., M.C.E.  
Quality Manager

Form No. CASTCO-SP0671-1-01 07/11/2002

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香港粉嶺安全街29A號 29A, On Chuen Street, Fanling, Hong Kong. Fax: 2677 0351  
E-mail: castco@netvigator.com Website: www.castco.com.hk



HOKLAS 032

Test Certificate

Determination of Characteristic Compressive Strength of Paving Blocks  
[General Specification for Civil Engineering Works 2006 Edition Appendix 11.1]

Date of issue: 31-01-2008

Page 1 of 1 page

Castco LRN: HC280128-2

Details as supplied by client

Client: Laputa Eco - Const. Material Co. Ltd.

Client's Ref. No.: --

Job Title: Construction of Aldrich Bay Phase 5

Contract No.: 20040062

Sample Description: Paving Block

Shape: Rectangular

Sample Nominal Size (Length x Width x Height): 200 x 100 x 80 mm

Type: --

Source & Manufacturer: --

Date of Manufacture: --

Identification Marks: 1 to 8

Laboratory Test Result

Date Received: 28-01-2008

Date Tested: 30-01-2008

Age: -- days

Identification mark	1	2	3	4	5	6	7	8
Lesser dimension of the two plan (L) (mm)	98	98	98	98	98	99	98	98
Nominal height (H) (mm)	81	81	81	81	81	81	81	81
Nominal gross plan area (A) (mm <sup>2</sup> )	19400	19400	19400	19500	19400	19600	19500	19500
Breaking Load (P) (kN)	1355	1521	1423	1421	1429	1409	1586	1420
Compressive Strength $C = \frac{1000 P}{A} \times \frac{2.5}{1.5 + L/H}$ (MPa)	64	72	68	67	68	66	75	67
Square of Compressive Strength -- $C^2$ (MPa <sup>2</sup> )	4147.4	5227.3	4583.3	4515.8	4569.8	4356.0	5580.1	4515.8
The Sum of Square of Compressive Strength $\sum C^2$ (MPa <sup>2</sup> )	37495.5							
Average of Compressive Strength $C_m$ (MPa)	68							
Unbiased Standard Deviation $s = \frac{\sqrt{\sum C^2 - n(C_m)^2}}{n-1}$ (MPa)	1							
The Characteristic Strength of the Batch $C_k = C_m - 1.65s$ (MPa)	66							
Compliance (Appendix 11.85(4))	45MPa for blocks in carriageways and paved areas to which vehicles will have access							

Remark: 1. Test result relates to the specimen tested only.  
2. Test result meets the compliance stated above.

Checked by:

M. L. LAM

Certified by:

CHOI TZE WING  
C.Eng., MHKIE MICE  
Laboratory Engineer

Form No. CON HK\_GS2006 T-01 (04/15/2017)

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佳力高試驗中心有限公司  
CASTCO TESTING CENTRE LTD.

Test Certificate  
Measuring Abrasion Resistance of Precast, Unreinforced Concrete Paving Blocks  
(Tested to BS 6717 : 2001 Annex F)

Date of issue: 17-11-2008

Page 1 of 1 page

Castco LRN: HC281112-2

Details as supplied by client

Client: Laputa Eco-Const. Material Co. Ltd.

Client's Ref. No.: --

Job Title: --

Contract No.: --

Sample Description: Paving Block

Type: --

Nominal Size (Length x Width x Thickness): 200 x 100 x 80 mm

Laboratory test results

Date sample received: 12-11-2008

Date of test: 14-11-2008

Specimen no.	1	2	3
Specimen size (Length x Width x Thickness) (mm)	200 x 100 x 52	200 x 100 x 50	199 x 100 x 52
Maximum convex (mm)	0.2 0.1	0.0 0.3	0.1 0.2
Maximum concave (mm)	0.2 0.1	0.2 0.2	0.1 0.1
Max. convex after ground (if necessary) (mm)	--	--	--
Max. concave after ground (if necessary) (mm)	--	--	--
Width of groove (mm)	70.3	70.3	70.4
Length of groove (L) (mm)	16.0	16.8	15.6
Calibration factor (c) (mm)	20.4		
Degree of abrasion (mm)	15.5	16.5	15.0

Remark:

1. Test results relate only to the specimens tested.
2. Specimens were sawn to suitable thickness to fit the machine holder.

Checked by:

M. L. LAM

Certified by:

CHOI TZE WING  
C. Eng., M.H.K.E., M.C.E.  
Quality Manager

Form no.: BCS\_6717-2001A\_1.dwg 25/06/2007



佳力高試驗中心有限公司  
CASTCO TESTING CENTRE LTD.

Test Certificate:

Unpolished Skid Resistance Value (USRV) of Concrete Paving Blocks  
(Tested to BS 6717 : 2001 Annex G)

Date of issue : 17-11-2008

Page 1 of 1 page

Castco LRN : HC281112-1

Details as supplied by client

Client : Laputa Eco-Const. Material Co. Ltd.

Client's Ref. No. : -

Job Title : -

Contract No. : -

Sample Description : Paving Block

Type : -

Nominal Size (Length x Width x Thickness) : 200 x 100 x 80 mm

Laboratory test results

Date sample received : 12-11-2008

Date of test : 13-11-2008

Ambient temp. : 23 °C

Specimen no.	Recorded individual readings at 0°					Mean of last three readings	Recorded individual readings at 180°					Mean of last three readings	Unpolished skid resistance value
1	73	71	72	72	72	72	70	70	68	69	68	68	70
2	70	70	70	70	69	70	68	66	68	66	67	67	69
3	68	66	67	68	67	67	69	70	71	69	68	69	68
Average unpolished skid resistance value													69

Remarks :

1. Test results relate only to the specimens tested.

Checked by :

M. L. LAM

Certified by :

CHOI TZE WING  
C. Eng., MBE, MICE  
Quality Manager

Form No. R&D USRV\_T4J (5/11/2003)

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E-mail: castco@netvigator.com Website: www.castco.com.hk



Test Certificate

Determination of Water Absorption Properties of Masonry Units and Segmental Pavers  
(AS/NZS 4456.14 : 1997)

Date of issue: 25-10-2007

Page 1 of 1 page

Castco LRN: HC271016-2

Details as supplied by client

Client: Laputa Eco-Const Material Co. Ltd.

Client's Ref. No.: --

Contract No.: --

Job Title: --

Sample type: Precast Concrete Paving Block

Date Cast: --

Sample Size: 200 mm x 100 mm x 80 mm

Source: --

Location of Sampling: --

Date of Sampling: --

Laboratory Test Result

Date Received: 16-10-2007

Date Tested: 20-10-2007

Specimen no.	1	2	3	4	5	6	7	8	9	10
Cold water immersion water absorption (%)	5.2	5.1	5.3	5.3	5.1	5.2	5.1	5.2	5.0	5.3
Average cold water immersion water absorption (%)	5.2									
Boiling water absorption (%)										
Average boiling water absorption (%)										

Remark:

1. Test result relate to the specimen tested only.
2. Only cold water immersion test was performed on test specimens as requested by client.

Checked by:

M. L. LAM

Certified by:

CHOI TZE WING  
C.Eng., MHKIE MICB  
Laboratory Engineer

Form No. 41 CDN AS4456\_T1 dt 27/06/2002



佳力高試驗中心有限公司  
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E-mail: castco@netvigator.com Website: www.castco.com.hk



HOKLAS 032

Test Certificate

Compressive Strength of Precast Concrete Paving Blocks  
(Based on BS6717 : Part 1 : 1993, Cl. 11, Appendix A & B)

Date of issue: 26-09-2008

Page 1 of 1 page

Castco LRN: HC280923-1

Details as supplied by client

Client: Laputa Eco - Const. Material Co. Ltd.

Job Title: --

Sample Description / Size : 200 x 100 x 80 mm Precast Concrete Paving Block

Date cast: --

Client's Ref. No.: --

Contract No.: --

Shape: R Block

Type: Chamfered

Laboratory Test Result

Date Received: 23-09-2008

Date Tested : 25-09-2008

Specimen No.	Measured Dimension			Squareness	Chamfer		Plan Area (mm <sup>2</sup> )	Maximum Load (kN)	Crushing Strength (MPa)	Compressive Strength (MPa)
	Length Mean (mm)	Width Mean (mm)	Thickness Mean (mm)	Maximum discrepancy (mm)	Maximum width (mm)	Maximum depth (mm)				
1	200	100	78	0.6	5	3	20000	1313	77.5	85.7
2	200	100	79	0.5	5	3	20000	1436	84.7	
3	200	100	80	0.6	5	3	20000	1418	83.7	
4	200	100	79	0.5	5	3	20000	1282	75.6	
5	200	100	78	0.6	5	3	20000	1520	89.7	
6	200	100	79	0.5	5	3	20000	1334	78.7	
7	200	100	79	0.7	5	3	20000	1599	94.3	
8	200	100	78	0.5	5	3	20000	1251	73.8	
9	200	100	79	0.6	5	3	20000	1589	93.8	
10	200	100	78	0.6	5	3	20000	1539	90.8	
11	200	100	79	0.6	5	3	20000	1546	91.3	
12	200	100	79	0.6	5	3	20000	1354	79.9	
13	200	100	78	0.7	5	3	20000	1431	84.4	
14	200	100	79	0.6	5	3	20000	1464	86.4	
15	200	100	79	0.7	5	3	20000	1613	95.2	
16	200	100	78	0.4	5	3	20000	1559	92.0	

- Remark:
1. Test result relates only to the specimen tested.
  2. Chamfered block correction factor = 1.18.
  3. Test result meets the requirement of BS6717 : Part 1 : 1993 Clause 10 & Clause 11.1.
  4. Compliance of the test results to the specification is an opinion of the laboratory and is not covered under the HOKLAS accreditation.

Checker:

M. L. LAM

Certified by:

CHOI TZE WING  
C. Eng., MHKIE, MICE  
Quality Manager

Form No. CON PAV\_24T ed 05/01/2002

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**SPECIFICATION - SECTION 2 - TECHNICAL  
STRUCTURAL SPECIFICATION**

## **1.0 General Requirements**

1. All works shall be carried out in accordance with the BD approved plans and satisfy the approval condition as stated in the approval letter from the BD.
2. The Contractor shall provide full time site supervision at site by an experienced site agent/foreman according to the submitted safety site supervision plan with competent persons.
3. The Contractor shall submit the mill's certificate for the structural steelworks and re-bar reinforcement which shall be specified the standard/properties as follows (but not limited to):
  - a. Relevant BS and HK Standards
  - b. Chemical composition
  - c. Tensile strength (elastic and yield)
  - d. Elongations
  - e. Origin of Production
  - f. Delivery notes

## **2.0 Structural Steelworks Design**

4. The particular requirements for the steelworks are as follows:-
  - a. The Contractor shall submit the welding procedure and the electrode for all the structural steel works for the Architects/Engineers' approval before the commencement of works;
  - b. All welding including the butt weld shall be carried out the non-destructive welding test according to the minimum rate stated in the general notes of the BD approval drawings.
  - c. The proposed welders shall carry out the welding test by an HKOLAS laboratory and by follow the welding procedure;
  - d. Tensile test for the drill-in anchor bolts shall be carried out by an HKOLAS laboratory according to section 12.7 and Appendix B of the Specifications for Structural Steelwork which shall be found satisfactory by the Architects/Engineers;

## **3.0 Temporary Works Design**

5. The Contractor shall responsible for all the temporary works including the hoarding with the endorsement by an independent ICE (with min. qualification of RPE) of the shop drawings and calculations prior to the commencement of the works.
6. The role of the RE/ARE for inspection of the temporary works will be on spot checking on the design and works and will advise any improvement of the temporary works.

**4.0 The EVA/Footway Paving Works**

7. The Contractor shall responsible for the design of all necessary joints during the construction EVA/footway paving works including the contraction joint, isolation joint, expansion joint, longitudinal joint etc. with the endorsement by an independent ICE (with min. qualification of RPE) of the shop drawings and calculations prior to the commencement of the works.

**5.0 Provision of the Utility for the Full Time Resident Engineer / Assistance Resident Engineer at the Site Works**

The Contractor shall responsible for provision of the furniture and Equipment Items utility for the full time resident engineer / assistance resident engineer at the site including the followings:

- |      |   |  |
|------|---|--|
| (1)  | Desk, with lockable drawers   | 1 nos.   |
| (2)  | Chair   | 1 nos.   |
| (3)  | Book shelf  | 1 no.  |
| (4)  | File tray   | 2 nos.   |
| (5)  | Desktop Computer with Monitor and Keyboard<br>(software: including (but not limited to)<br>Windows XP, Internet Explore (shall be function<br>and workable), Words 2007, Excel 2007 etc.) | 1 no.  |
| (6)  | Safety rubber boots/shoes   | 1 pair (basic) and<br>as required for<br>renewal |
| (7)  | Safety helmet   | 1 no.(basic) and<br>as required for<br>renewal   |
| (8)  | Stationery  | 1 set (basic) and<br>as required for<br>renewal  |
| (9)  | Drinking water machine, photocopying machine,<br>facsimile machine, etc.  | Share with the<br>Contractor                     |
| (10) | camera  | 1 set (basic)                                    |

Hong Kong Shooting  
Association

---

**Proposed Shooting  
Range at Pillar Point**

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Standard Specification  
for Structural Concrete

ARUP

DAP's T 29.11.10 (55p)

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# 1 GENERAL

## 1.1 Abbreviations

Abbreviations used in this Specification for Structural Concrete shall have the following meanings:

AAR	Alkali-aggregate Reaction
ASTM	American Society for Testing and Materials
BD	Buildings Department
BS	British Standard
BS EN and BS EN ISO	European Standard adopted as British Standard
HKCC	Hong Kong Code of Practice for Structural Use of Concrete 2004
CS1	Hong Kong Construction Standards CS1 – Testing Concrete
CS2	Hong Kong Construction Standards CS2 – Carbon Steel Bars for the Reinforcement of Concrete
GGBS	Ground Granulated Blastfurnace Slag
GRP	Glass-reinforced Plastic
HKB(C)R	Hong Kong Building (Construction) Regulations
HKQAA	Hong Kong Quality Assurance Agency
HOKLAS	Hong Kong Laboratory Accreditation Scheme
ICE	Independent Checking Engineer
IRSE	Independent Registered Structural Engineer appointed by the Contractor and approved by the Architect
ISO	International Organization for Standardization
PC	Portland Cement – CEM I cement to BS EN 197-1
PFA	Pulverised Fuel Ash
PNAP	Practice Notes for Authorized Persons and Registered Structural Engineers
PPFAC	Portland Pulverised Fuel Ash Cement – CEM II/A-V, CEM II/A-W, CEM II/B-V and CEM II/B-W cement to BS EN 197-1
QSPSC	Quality Scheme for the Production and Supply of Concrete
RILEM	Reunion Internationale des Laboratoires et Experts des Matériaux, Systèmes de Construction et Ouvrages (International Union of Laboratories and Experts in Construction Materials, Systems, and Structure)
RSE	Registered Structural Engineer
SCM	Secondary Cementitious Materials
TCP	Technical Competent Person
TFV	Ten percent Fines Value

## 1.2 Definitions

### 1.2.1 Designed Mixes

"Designed mixes" shall mean any concrete mix where the specified constituents are individually proportioned and purposely combined to achieve the design compressive strength or to satisfy other specified requirements of the concrete.

### 1.2.2 Prescribed Mixes

"Prescribed mixes" shall mean a concrete mix as defined in Regulation 60 of the HKB(C)R.

### **1.2.3 Concrete Grade**

For designed mixes, the concrete grade shall mean the design compressive strength of the concrete as determined by Regulations 58 and 59 of the HKB(C)R when tested to CS1. In certain cases, the grades may be suffixed alphabetically to differentiate between similar grades but for different uses.

For prescribed mixes, the concrete grade designation will denote concrete as defined in Regulation 60 of the HKB(C)R and will be used only for minor structures or non-structural works.

### **1.2.4 Building Regulations and Standards**

Unless stated otherwise, all undated references to Building Regulations and various standards cited in this Specification refer to the editions (including any amendments) current at the time of Tender. For dated references, only the edition cited applies. Reference to a Code or Standard shall be deemed to include all other Codes and Standards referred to in the specified Code or Standard.

### **1.2.5 Falsework**

The temporary structure used to support a permanent structure until it is self supporting.

### **1.2.6 Formwork**

The part of the falsework used to give the required shape, finish and support to the poured concrete.

## **1.3 Hong Kong Building Regulations and Code of Practice**

This Specification shall be read in conjunction with the HKCC, PNAP(s) and Practice Notes for Registered Contractors which cover the implementation of the Hong Kong Building Regulations. In cases of conflict, the more onerous requirement shall prevail.

In this Specification, Hong Kong Building Regulations include the current editions of the Building Ordinance, Building (Administration) Regulations, Building (Planning) Regulations and Building (Construction) Regulations.

## **1.4 General Description of Concrete Works**

The reinforced concrete works of the Contract are designed in accordance with current edition of the HKB(C)R, relevant PNAP(s) and HKCC.

The Works shall include all the concrete works shown or described in the Tender Documents, and as modified or added during the Contract. The works may consist of different grades and usage of concrete including concrete for water-resisting construction. These usages will be shown on the Architectural or Structural Drawings.

Read this Specification in conjunction with the General Contract Preliminaries and all other Contract Documents.

## **1.5 Co-ordination of Works**

The Contractor shall be fully conversant with all the drawings and other information on the Works including mechanical, electrical and utility drawings and specifications to be carried out by Sub-contractors and Specialist Contractors.

The Contractor shall coordinate and make necessary provisions for any holes, cast-in items and embedded pipes or conduits etc. by all Sub-contractors and Specialist Contractors. The location and routing of such which would affect the structures shall be subject to Architect's approval.



## 2 MATERIALS

### 2.1 General

---

#### 2.1.1 Quality of Materials

All materials used in the structure shall be new and shall be of the quality and grades comply with this Specification and current versions of standards referred to therein. The Architect may specify samples for testing and the Contractor shall arrange for such samples to be supplied, identified, stored and tested and the results delivered to the Architect in accordance with the relevant HKB(C)R and BS.

#### 2.1.2 Materials to be Approved

Where this Specification and the Drawings allow the Contractor a choice of materials to be used in the Works, the materials chosen and their proposed sources of supply shall be subject to approval in writing by the Architect.

The proposed sources of supply shall be accompanied by test certificates from the supplier showing that the materials comply with the specified requirements. Any change of sources shall be subject to approval in writing by the Architect.

The fact that the Contractor has used materials to the approval of the Architect shall in no way relieve him from his responsibility of producing a concrete of the required characteristics as stipulated in this Specification such as grade strength, workability and etc. for the purpose to which it is placed.

#### 2.1.3 Materials to Comply With Relevant Standards

Where a Hong Kong or International Standard is applicable, the materials used for the Works shall comply with the relevant standard. In general, the Standard adopted by the manufacturer of a material shall be considered, unless the Engineer's design is based on a particular Standard, in which case that Standard shall be used for assessment of the material.

A copy of all relevant standards shall be provided by the Contractor and kept on site at all times.

### 2.2 Cement

---

Cement used for making concrete shall be PC or blended PPFAC containing PFA at a nominal content of 25% by weight. Other cements shall only be used when approved by the Architect.

When required by the Architect, the Contractor shall submit for approval the technical data of the cement including the mix proportion before cement grinding (the percentage of clinker, gypsum and underground materials) and the results of composition analysis. The composition analysis shall at least include CaO, MgO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, SO<sub>3</sub>, alkalis as K<sub>2</sub>O and Na<sub>2</sub>O, free lime as CaO, acid insoluble residue, loss of ignition and the calculated mineral phase constituents (by Bogue).

All cement to be used on the Works shall be supplied from the same source unless alternate sources are approved by the Architect.

All cement to be used on the Works shall be delivered in the original sealed and branded bags of the manufacturer or in bulk containers approved by the Architect.

### 2.3 Secondary Cementitious Materials (SCM)

---

Subject to approval from the BD and the Architect, SCM, including PFA, GGBS and microsilica (silica fume), or any combination of two, may be used with PC in concrete.

PFA shall comply with BS 3892-1: 1997, except that the criterion for maximum water requirement may not apply. GGBS shall comply with BS 6699 (BS EN 15167-1 may be

used to replace BS 6699). Microsilica shall comply with Canadian Standard CAN/CSA-A23.5-98 or ASTM C1240-05.

The use of such SCM shall comply with the requirements in HKB(C)R and PNAP.

## **2.4 Aggregates**

### **2.4.1 General**

The Contractor shall submit to the Architect for approval details of his proposed source of supply of aggregates giving the aggregate group classification and typical physical and chemical properties complying with BS EN 12620 unless otherwise specified in this Specification. The Contractor may, in special circumstances, propose variations from the grading shown in BS EN 12620; such proposals shall be subject to approval in writing by the Architect.

The grading of aggregates should be such as to produce a dense concrete of the specified proportions which will work readily into position without segregation. The grading should be controlled throughout the work so that it conforms closely to that used for the preliminary tests.

The definition and particle size distribution of fine aggregate and coarse aggregate shall comply with BS EN 12620 and BS 812-103.1 (BS EN 933-1 may be used to replace BS 812-103.1).

### **2.4.2 Uniformity**

The Contractor shall obtain an undertaking from the suppliers of both fine and coarse aggregates of the quality and type selected that sufficient supplies are available to complete the Contract, and that the aggregates come from a single source. This source shall be subject to approval in writing by the Architect. The Architect shall be notified prior to any change in the source of supply of aggregate.

### **2.4.3 Shape, Strength and Porosity**

Coarse aggregate shall have a flakiness index not exceeding 30% when tested by the sieve method of BS 812-105.1.

Coarse aggregate shall have an elongation index not exceeding 35% when tested in accordance with BS 812-105.2.

The ten percent fines values shall be at least 100kN when tested in accordance with BS 812-111.

The water absorption of coarse aggregates shall not exceed 2.5% by weight, unless evidence is produced to show that such materials are not available.

### **2.4.4 Marine Aggregates**

Marine aggregates shall not be used without prior approval by the Architect.

### **2.4.5 Salts**

The total amount of soluble salts and chloride contents in the aggregates shall not exceed the limits in Table 2.1 when tested to BS 812-117:

**Table 2.1**

Type of Aggregate	Sodium Chloride Content as % by Weight of the Dry Aggregate
Fine	0.08
Coarse	0.04

### **2.4.6 Control of Aggregate Alkali-Reactivity**

The Contractor shall carry out tests on all aggregate for potential alkali-reactivity by an independent laboratory approved by the Architect using the 'Accelerated Mortar Bar Test' to RILEM AAR-2. The aggregate shall be considered acceptable if the average expansion

result at 16 days is less than 0.15%. Each aggregate shall be tested initially, prior to supply, and then at a minimum frequency of twice per year. At the discretion of the Architect, the aggregate shall be examined petrographically with respect to alkali aggregate reactivity and other deleterious substance by a qualified geologist.

## **2.5 Water**

Potable water which complies with BS 3148 shall be used for mixing and curing concrete. If suitable potable water is not available (i.e. non-compliance to BS 3148) then the alternative source or mix design with corresponding inhibitors (e.g. corrosion inhibitors) shall be proposed and is to be approved in writing by the Architect.

When so directed, the Contractor shall arrange for tests of the water to be carried out in accordance with BS 3148.

The water used for flaked ice for the control of concrete mixing temperature should also be tested in accordance with BS 3148 if it comes from a non-potable source.

BS EN 1008 may be used to replace BS 3148.

## **2.6 Admixtures**

Admixtures may be permitted in designed mixes at the Architect's discretion, after satisfactory details of the admixtures and the associated mix design and trial results have been submitted by the Contractor.

Admixtures will not be permitted in prescribed mixes unless otherwise approved by the Architect.

Admixtures containing calcium chloride will not be permitted.

All admixtures shall comply with BS EN 480 and BS EN 934 and shall be accompanied by manufacturer's performance and uniformity tests certificates. Admixtures shall be used in accordance with the manufacturer's instructions.

The Contractor should also refer to the Architect's specifications and drawings for details of the water-resisting additives proposed for the various elements.

The Contractor's attention is particularly drawn to Clause 3.15 on water-resisting construction responsibilities and recommendations.

## **2.7 Curing Compound**

Where used, curing compounds for concrete shall have a minimum efficiency index of at least 80%. The Contractor shall provide the test certificates prepared by an approved laboratory to show that the compound will provide the required curing efficiency.

Curing compound shall not react chemically with the concrete to be cured and shall not crack, peel or disintegrate during the curing period of at least seven days. The curing compound shall degrade completely within three weeks after application and the concrete surface so treated shall not impair the bonding of applied finishes, otherwise, the Contractor shall justify with confirmation from the manufacturer the compatibility with the surface finishes to the satisfaction of the Architect.

Curing compound for use on concrete surface against which potable or fresh water will be stored or conveyed shall be non-toxic and shall not impart a taste to the water.

## **2.8 Concrete**

### **2.8.1 General**

Concrete shall be made with cementitious material, coarse and fine aggregates and water. No other ingredients shall be used by the Contractor or Concrete Supplier without

demonstrating compliance of such ingredients and the concrete mix with the requirements of the BD, as well as the Architect's approval.

Unless otherwise approved by the Architect, ready-mixed concrete used for the Works shall only come from an approved concrete supplier. No change of supplier shall be allowed without approval from the Architect.

The Contractor shall also refer to Section 5 for High Strength Concretes (Grade 60-100 MPa).

### 2.8.2 Designed Mix Concrete

Designed mixes, with proportions calculated by the Contractor (guidelines given in Table 2.2), shall be used for each concrete grade as specified on the Drawings. Complete details shall be submitted for approval of the Architect and, if necessary, of the BD before commencement of concreting work.

As far as possible, PFA could be used in structural concrete in complying with Clause 4.2.5.5 of HKCC. All structural concrete of Grade 40 to Grades below 60 for structural elements with thickness of 2m and above, and of Grade 60 and above shall contain a nominal PFA content of 25% by weight of total cementitious material unless evidence can be produced to show that PFA or PPFAC is not available. PFA shall not be used separately as a SCM together with PPFAC.

This Specification shall take precedence over the mix limitations specified in Part XII (Structural Use of Concrete) of the HKB(C)R.

**Table 2.2: Designed Mixes**

Grade	28-Day Works Strength (N/mm <sup>2</sup> )	Maximum Coarse Aggregate Size (mm)	Maximum Water/ Cementitious Ratio	Minimum Cementitious Content (kg/m <sup>3</sup> )	Maximum Cementitious Content (kg/m <sup>3</sup> )	Other Requirement
20D	20	20	0.55	290	360	-
25D	25	20	0.50	290	360	-
30D	30	20	0.50	290	360	-
40D	40	20	0.45	340	450	-
45D	45	20	0.45	340	450	See Notes
50D	50	20	0.40	380	500	See Notes
30D(W)	30	20	0.45	360	400	Water-resisting Construction
40D(W)	40	20	0.45	360	420	Water-resisting Construction
45D(W)	45	20	0.42	360	440	Water-resisting Construction
50D(W)	50	20	0.40	400	520	Water-resisting Construction
<p>Notes: The mix should be designed using a Standard Deviation of not less than 7 MPa.</p> <p>The Contractor shall satisfy himself that the mix proportions specified for use in water-resisting construction are suitable for the aggregate available.</p> <p>Under normal circumstances, the cement content shall be limited to not more than 450 kg/m<sup>3</sup>.</p> <p>Concrete of Grade 45 to Grades below 60 shall use coarse aggregate having a 10% fines value of not less than 150kN when tested dry.</p>						

When using a maximum aggregate size of 10mm and 14mm, the minimum cementitious contents specified in Table 2.2 shall be increased by 40 kg/m<sup>3</sup> and 20 kg/m<sup>3</sup> respectively.

In certain circumstance, coarse aggregate of a maximum size up to 40mm may be used providing the Contractor has obtained the written agreement from the Architect beforehand. When using a maximum aggregate size of 40mm, the minimum cementitious contents specified in Table 2.2 shall be decreased by 30 kg/m<sup>3</sup>.

Concrete used for Water-resisting Construction (W) shall use coarse aggregates having combined indices for flakiness and elongation not exceeding 50% and the flakiness index shall not exceed 25%.

Pumped mix concrete shall have a minimum slump of 150mm. High Flow Concrete shall achieve a minimum slump-flow value of 600mm within one minute and without evidence of segregation. Self Compacting Concrete shall achieve a minimum slump-flow value of 700mm within two minutes without segregation and a flow to 500mm in 15 seconds. The concrete shall retain this slump-flow performance for a minimum period of 2 hours after mixing. See also Clause 4.6.6.

Regardless of the limitations of the proportions in Table 2.2, at any time during the progress of the Works the Architect shall have the right to make such changes in the materials or proportions or both as he may consider necessary to meet the requirements of the structure.

### **2.8.3 Prescribed Mix Concrete**

Prescribed mix concrete shall be in accordance with Regulation 60 of the HKB(C)R.

All materials for concrete shall be measured by weight. The workability of the mix shall be determined by the Contractor and shall have a slump not less than 75mm.

### **2.8.4 Trial Mixes**

Preliminary tests shall be done in accordance with BS 8500 and BS EN 206-1.

Results of all preliminary tests shall be sent to the Architect as soon as they are available and at least 35 days before concrete work starts on site.

The Architect may not accept the results of tests on trial mixes produced in a laboratory if he is not satisfied that they are representative of the quality of concrete produced for the Works.

Plant trials shall be carried out, at the Architect's discretion, using the same equipment and at the same plant intended for supply of the concrete. Each plant trial mix shall be carried out on three separate days and the minimum size of each batch shall be 60% of the mixer's nominal capacity or 1m<sup>3</sup> whichever is the bigger.

Two 150mm test cubes shall be made for 3, 7 and 28 days compressive strength test in accordance with CS1 for each batch of concrete. The 28 days results shall comply with the following criteria for acceptance of the trial mix:

- (a) The mean strength of the 28 days results shall exceed the characteristic strength plus 10 MPa for plant trial or 12 MPa for laboratory trial.
- (b) No single result shall fall below the characteristic strength plus 5 MPa.

Two slump or compacting factor tests shall be carried out in each batch of the trial. For slump with design value < 100mm, the tolerance shall be within  $\pm 20$ mm or  $\pm 25\%$  of the design value whichever is more stringent. For slump with design value  $\geq 100$ mm, the tolerance shall be within  $\pm 40$ mm or  $\pm 25\%$  of the design value whichever is more stringent. The average of the slump value shall be within  $\pm 20$ mm, and the range of the slump value for each batch of concrete shall not exceed 20% of the average slump value for that batch. The acceptance criterion of the compacting factor shall be the design compacting factor  $\pm 0.03$ .

No concrete shall be placed in the permanent Works until the concrete mix and trial mix results have been reviewed and accepted by the Architect.

### **2.8.5 Ready-Mixed Concrete**

The onus is on the Contractor to ensure that all concrete is strictly in accordance with the requirement of this Specification. The Contractor shall arrange for the Architect to inspect the supplier's plant if required before and/or during the period of supply.

Concrete suppliers shall operate a quality assurance scheme meeting the requirements of the QSPSC of the HKQAA or BS 8500. The scheme shall cover all aspects of material supply, quality, batching, mixing transportation, and properties of the concrete. The

Contractor shall provide copies of the plant certificate with each mix submission. The Contractor shall advise any change of status of the plant(s) during the progress of the Works. The contractor shall be responsible for the performance of the Ready-mix Supplier. The Architect shall have the right to instruct the Contractor to change the supplier or to stop further use of ready-mixed concrete during the progress of the Works if the concrete has failed to comply with any of the requirements specified in the Specification.

Ready-mixed concrete shall comply with this Specification. All concrete shall be supplied and transported to the point of discharge from the mixer/agitator truck in accordance with the requirements of BS 8500-2: 2002 Section 12. Delivery tickets shall contain information in line with the particulars as required in Clause 3.8.12 and shall be completed and available before discharging concrete into the structure. Manually prepared records of batch composition are not acceptable. Where a ticket is marked 'non-conforming' a copy shall be passed to both the Contractor and the Architect within 24 hours of placing the concrete. All delivery tickets shall be retained by the Contractor for inspection throughout the duration of the contract.

All the constituents of each mix shall be measured and mixed at the manufacturer's depot. No extra water or other material shall be added after the concrete leaves the depot.

Contingency plans shall be in place before starting work in the event of supplies being interrupted during a pour due to a plant breakdown. Details of a suitable back-up plant/supplier should be submitted to the Architect for agreement.

#### **2.8.6 Salts**

The total amount of soluble chloride content in the concrete from the aggregates, water and any admixtures when tested to CS1 shall not exceed the values stated in Table 2.3 for the type of concrete involved.

**Table 2.3**

<b>Type of Concrete</b>	<b>Maximum Total Chloride Content Expressed as Percentage of Chloride Ion by Weight of Cement</b>
Prestressed Concrete. Steam-cured Structural Concrete	0.1
Concrete made with Sulphate Resisting Portland Cement	0.2
Reinforced Concrete	0.35
Un-reinforced Concrete	3.00

The total sulphate content of the concrete mix, expressed as  $\text{SO}_3$ , shall not exceed 2.5% by mass of the binder (cement + SCM) in the mix unless it can be shown to the satisfaction of the Architect, with the nature of the concrete mix concerned in relation to the project to be applied, that a higher sulphate content (up to 4%) will not be detrimental to performance of the concrete. Concrete with sulphate content over 4% shall only be allowed to use for special purposes. The sulphate content shall be calculated as the total from the various constituents of the mix. The Contractor shall provide confirmation of compliance before any concrete is supplied to the Works.

Preliminary or routine testing may be required dependent on the choice of aggregate or admixture.

#### **2.8.7 Alkali-Aggregate Reaction**

Measures to control the occurrence of alkali-aggregate reaction (AAR) in concrete shall be submitted to the Architect for approval. In the absence of alternative proposals, such control shall be achieved by limiting the reactive alkali content of the concrete as described in Clause 2.8.8 below unless, in the opinion of the Architect, the concrete element will not be

subjected to moisture ingress throughout its design life. Attention is also drawn to PNAP 180.

The following particulars of the concrete mix shall be submitted by the Contractor to the Architect:

- (a) HOKLAS-endorsed test certificates not older than six months giving the results of test required in Clause 2.8.8: (a) to (f).
- (b) Calculation of the reactive alkali of the proposed mix; and
- (c) new HOKLAS-endorsed test certificates giving the results of tests required in Clause 2.8.8: (a) to (f) to be submitted at quarterly intervals together with any necessary further calculations to demonstrate that the mix continues to comply with the limit on reactive alkali.

### **2.8.8 Limit on Reactive Alkali**

The reactive alkali of concrete expressed as the equivalent sodium oxide shall not exceed 3.0 kg per cubic metre of concrete. The equivalent sodium oxide content of the concrete shall be determined in accordance with the following steps:

- (a) The equivalent  $\text{Na}_2\text{O}$  shall be calculated by the expression  

$$\text{Equivalent Na}_2\text{O} = A + B + C, \text{ where}$$

A is the sum of the acid-soluble alkalis (expressed as equivalent  $\text{Na}_2\text{O}$ ) of cement, admixtures and water;

B is equal to 1/6 the total alkalis of PFA (expressed as equivalent  $\text{Na}_2\text{O}$ ); and

C is equal to 0.76 times the chloride ion ( $\text{Cl}^-$ ) of the aggregate.
- (b) The acid-soluble alkali content of the cement shall be determined in accordance with BS EN 196-2 and BS EN 196-5 and shall be taken as the average of the latest 25 daily determinations of equivalent sodium oxide plus twice the standard deviation of the results.
- (c) The acid-soluble alkali content of admixtures shall be determined in accordance with BS 1881: Part 124.
- (d) The acid-soluble alkali content of water shall be determined in accordance with American Public Health Association - *Standard Methods for the Examination of Water and Wastewater*, Sections 3500-K and 3500-Na.
- (e) The total alkali of the PFA shall be determined in accordance with BS EN 196-2 and BS EN 196-5 and shall be taken as the average of the latest 25 weekly determinations of equivalent sodium oxide plus twice the standard deviation of the results.
- (f) The equivalent sodium oxide content of the coarse and fine aggregates shall be calculated from the quantity of chloride ion present which shall be measured in accordance with BS 812-117.

## **2.9 Steel Reinforcement**

### **2.9.1 General**

Each bundle of bent bars shall be clearly tagged with their schedule and mark numbers. Reinforcement should be free from mechanical damage.

### **2.9.2 Mill Certificates and Certificate of Origin**

Every batch of steel reinforcement bars and fabric reinforcement delivered to the site shall be accompanied by certificate of origin and mill certificates that verify the mass and properties in accordance with CS2 and in compliance with the requirements stated in this Specification.

The Contractor shall satisfy the requirements of the BD by submitting the mill certificates and all relevant test reports, which shall be carried out by HOKLAS accredited laboratories, to the RSE for onward submission to the BD. These shall be accompanied by details of the manufacturer's identification marks rolled into each brand of bars supplied. For welded fabric reinforcement, the certificate shall also include the results of weld test.

### 2.9.3 Type of Reinforcement

#### (a) Bar reinforcement

When mild steel reinforcement is specified, such reinforcement shall be hot rolled plain bars with a characteristic strength of 250 MPa. When high yield deformed reinforcement is specified, such reinforcement shall be hot rolled deformed bars with a characteristic strength of 460 MPa. Both mild steel and high yield deformed reinforcement shall comply with BS 4449 and CS2.

#### (b) Fabric Reinforcement

Steel fabric for the reinforcement of concrete shall comply with BS 4483 and shall be factory-made machine-welded sheets manufactured from ribbed bars conforming to BS 4449 and CS2, or manufactured from wire conforming to BS 4482 for wrapping fabrics D49 and D98.

Steel fabric shall be delivered to Site in flat sheets.

Steel mesh for fire protection, which is required as per the Hong Kong Code of Practice for Fire Resisting Construction, to be included in reinforced concrete to reduce the risk of spalling shall be hot dip galvanized in accordance with BS EN ISO 1461 or stainless steel Grade 304.

### 2.9.4 Reinforcement Couplers

Where reinforcement couplers are used, the Contractor shall supply a type which is approved by the BD. Reinforcement couplers shall be used strictly in accordance with the manufacturer's written instructions. Samples of each type/diameter of couplers shall be tested in accordance with the requirements of the BD where specified or as directed by the Architect prior to the use in the Works. For bars in compression, the concrete cover to the sleeve shall not be less than that specified for normal reinforcement. For bars in tension, the mechanical coupler shall satisfy the following criteria (see also Clause 4.7.4):

- (a) when a representative gauge length assembly comprising reinforcement of the diameter, grade and profile to be used, and a coupler of precise type to be used, is tested in tension, the permanent elongation after loading to  $0.6f_t$ , shall not exceed 0.1mm; and
- (b) the coupled bar assembly tensile strength shall exceed  $287.5 \text{ N/mm}^2$  for grade 250 bars, and  $483 \text{ N/mm}^2$  for grade 460 bars.

Details of the selected couplers, including the source and suppliers, shall be submitted to the Architect for approval.

The Contractor shall provide suitable equipment on site for the Architect or his representative to inspect the installation workmanship of the couplers.

### 2.9.5 Spacers

Where spacers are required to maintain the concrete cover to the reinforcement these shall be of concrete or plastic and shall be as small as possible consistent with their purpose. The Contractor shall detail, supply and fix all spacers. The materials and workmanship shall be in accordance with Clause 7.3 of BS 8110: Part 1: 1985, and BS 7973 Parts 1 and 2. The Contractor shall ensure that the spacers have the required performance characteristics.

Where spacers have to carry heavy loads the Architect may require that plastic spacers shall not be used. The Contractor shall submit samples of concrete and plastic spacers to the Architect and obtain the Architect's approval in writing before starting steel fixing.

Concrete spacers shall contain maximum 10mm aggregate size and be of strength and durability equal to that of the concrete in which they are to be embedded. Where spacers require the use of tying wires to be fixed to reinforcement bars the wires shall be designed not to be exposed to the external unless they are made of stainless steel. Concrete spacer blocks shall not be used until they have an age of at least seven days.



Where concrete spacer blocks are required in visually exposed concrete they shall be made from materials matching those used in the surrounding concrete. The Contractor shall obtain the Architect's approval for the use of the spacer blocks.

Except otherwise specified in the Drawings, spacer bars shall be provided for multiple layers of reinforcement. For main bars of 25mm diameter or less, spacer bars shall be at 1m centres. For main bars greater than 25mm diameter spacer bars shall be at 2m centres. Spacer bars shall be of equal diameter to the largest bar in the layers being separated and in any case not less than 25mm diameter.

#### **2.9.6 Tying Wire**

Tying wire for fixing reinforcement shall be black annealed 16-gauge mild steel wire or equivalent. Tying wire for water-retaining structures, fair faced concrete and concrete exposed to the atmosphere shall be 18-gauge stainless steel wires.

#### **2.9.7 Continuity Strips**

Proprietary continuity strips can be used subject to agreement by the Architect.

### **2.10 Miscellaneous Materials**

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#### **2.10.1 General**

The Contractor shall submit full details of his proposed alternatives to the materials shown on the Drawings to the Architect for approval. Such alternatives shall be those that have already obtained approval from the BD, where applicable, unless the Contractor undertakes to apply for the necessary approval from the BD. Generally, such applications have to be undertaken by the Contractor without claims for costs and extension of time unless otherwise approved by the Architect.

Proprietary products shall be approved by the Architect in writing and used in accordance with the manufacturers' written instructions.

#### **2.10.2 Waterstops**

Waterstops (Waterbars) shall comply with Clause 4.1.10 and Section 4 of BS 8102: 1990.

Waterstops, where used, shall be as shown in the Drawings or as determined by the Contractor and approved by the Architect. They shall be jointed with purpose-made junction pieces. The Contractor shall submit shop drawings showing the sizes, types, isometric layout, jointing and support of all waterstops and obtain approval by the Architect in writing before starting installation. Intersection and change of direction waterstops shall be shop fabricated.

Hydrophilic waterstops shall be of a compound of polymer modified chloroprene rubber type. Hydrophilic strips of bentonite based material shall not be used unless otherwise approved by the Architect. The Contractor shall submit the technical data including its properties for the Architect's approval.

Hydrophilic strips shall be a minimum of 20mm x 10mm size and shall be coated with a "delay" coating to temporary protect from inclement weather and inhibit initial expansion due to moisture present in the fresh concrete.

See also Clause 3.15.4.

#### **2.10.3 Cast-in and Drill-in Items for Other Trades**

The Contractor shall submit details of all cast-in and drill-in items for other trades or Sub-contractors to the Architect for approval. The cast-in items should be shown on the Main Contractor's Combined Builder's Work Drawings, together with loading data & additional spreader reinforcement where necessary. Expansion or chemical anchors shall not be used except otherwise approved by the Architect. All cast-in and drill-in items shall be co-ordinated such that they do not clash with any reinforcing steel bars of the concrete structure.

Where approval from the BD is required for the use of such cast-in and drill-in items, e.g. fixings for curtain wall or cladding, the Contractor shall be responsible for the approval to be obtained in a timely manner to facilitate the cast-in and/or drill-in work. The cost and delay due to removal of any work without BD approval, or due to any remedial work required as a result of non-approved work shall be borne by the Contractor.

#### **2.10.4 Bearings**

Bearings and bearing strips shall be as specified on the Engineer's Drawings or of a similar approved type.

The Contractor shall submit the type, performance criteria, bearing detail data and test reports together with the design calculations to the Architect for approval in writing prior to any procurement.

#### **2.10.5 Joint Fillers**

Joint fillers shall be a proprietary type as specified in the Drawings or equivalent approved by the Architect and shall be placed strictly in accordance with the manufacturer's written instructions. Joint filler shall be firm, compressible, single-thickness, non-rotting and resistant to pests. Joint filler for joints in water retaining structures and water-resisting structures shall be non-absorbent.

Left in place joint filler in buildings shall comply with the specified fire rating.

#### **2.10.6 Joint Sealants**

Joint sealants shall be a proprietary type as specified in the Drawings or equivalent approved by the Architect and shall be used strictly in accordance with the manufacturer's written instructions. Primers must be compatible with the sealant to be used.

Poured joint sealing compound shall be hot poured rubber bitumen compound complying with BS EN 14188-1.

#### **2.10.7 Permanent Steel Formwork**

Permanent steel formwork may be used if approved by the Architect. The profiled steel sheeting shall be a proprietary product. It must be designed and used strictly in accordance with the manufacturer's written instructions.

#### **2.10.8 Materials for Joints in Water Retaining Structures**

Materials for joints in water retaining structures for sewage shall be resistant to aerobic and anaerobic bacteriological attack and attack by petrol, diesel oil, dilute acids and alkalis.

Materials for joints in water retaining structures for potable and fresh water shall be non-toxic and shall not impart taste and colour to the water.

### **2.11 Storage of Materials**

#### **2.11.1 General**

All materials shall be stored in a manner which is not detrimental to their use in the Works.

#### **2.11.2 Reinforcement**

Reinforcement bars shall be stored clear of the ground in designated safe load areas. The stored material should be protected from rain, water, corrosive materials and other materials that may be detrimental to their performance.

Different types and sizes of reinforcement shall be stored separately. Fabric reinforcement shall be stored horizontally.

#### **2.11.3 Cement**

All cements shall be stored in weatherproof structures having a raised dry floor or in a suitable silo.

Cement shall be used in the order that it is received on site. If for any reason the cement is not used for a considerable period, it shall be inspected before use. Any cement which,

upon inspection, is considered by the Architect to have been in any way affected by dampness or hydration or otherwise unsuitable for use will be condemned without further tests and shall be removed from the site.

Cement of different types shall not be mixed together.

The loading, unloading, transfer, handling or storage of bulk cement or dry PFA during or after the debagging process must be done in a totally enclosed system or facility. Any vent or exhaust shall be fitted with fabric filter or equivalent air pollution control system/equipment.

#### **2.11.4 Aggregate**

Aggregates shall be stored on hard paved self-draining areas or in approved hoppers or containers. Aggregate shall not be handled or stored in a manner which will result in mixing of the different types and sizes or in segregation or contamination of the aggregates.

#### **2.11.5 Admixtures, Curing Compounds and Materials for Joints**

Admixtures, curing compounds and materials for joints shall be stored in watertight weatherproof and sealed containers or stores clearly marked to show the contents. All materials shall be stored in accordance with the manufacturers' written recommendations and shall not be used after the recommended shelf life has been expired.

### **2.12 Rejected Materials**

All materials which are un-identifiable or do not comply with this Specification shall be removed from the site immediately at the Contractor's expense.

## **3 WORKMANSHIP AND CONSTRUCTION**

### **3.1 Standard of Workmanship**

The standard of workmanship shall be in accordance with this Specification, the relevant clauses of BS 8110 and all statutory requirements. Wherever differences occur, the more onerous requirement shall prevail.

### **3.2 Construction Loads and Contractor's Plant Effects to the Permanent Structures**

During construction the Contractor shall ensure that the structure is not subjected to loads which will cause short-term or long-term distress and shall take account of the maturity of the concrete at the time of loading.

No loading in excess of the design loading shall be placed on any portion of the structure without the written permission of the Architect. If such permission is granted, all structural elements which are subjected to such loading other than the design load shall be strengthened and supported to the satisfaction of the Architect and any extra cost so incurred shall be borne by the Contractor.

Where the Contractor proposes to use the climbing tower cranes, or any type of plant which places any load on the structures, he must furnish full details and calculations of such plant with justification to the Architect for agreement before its erection and use. When required, the Contractor shall appoint an IRSE to prepare the calculations and detail method statements of the plant in working conditions, during raising and during dismantling operations.

The Contractor shall be responsible for making good and/or repair to the satisfaction of the Architect of any damages to the permanent structure which are caused by the erection/operation/dismantling of the plant and/or the excess construction loads.

If the Contractor desires to leave permanently any embeds in the structure for any purpose, he must furnish in writing the exact details of his proposals and such supports shall be subject to the agreement of the Architect.

Any temporary works that will have effects to the permanent works shall be designed and checked and certified by the Contractor's IRSE.

### **3.3 Construction and Preparation of Formwork**

#### **3.3.1 General**

Design and construction of falsework and formwork shall be in accordance with BS 5975 and BS 8110: Part 1 where applicable.

Before construction of the formwork begins, the Contractor shall submit details of the formwork systems he proposes to use for all major structural works to the Architect and obtain the Architect's approval in writing before starting erection.

Formwork materials shall suit the method of construction to be used and the surface finish required for the final work where specified by the Architect.

The formwork shall be sufficiently tight to prevent loss of grout or mortar from the concrete. Formwork and falsework should be sufficiently rigid to ensure the final concrete structure complies with the specified tolerances.

The responsibility for the design, supply, construction, removal and safety of all falsework and formwork system (including but not limited to the falsework/formwork itself, stability of falsework during construction, checking the existing structure to support the falsework, back propping, removal of formwork and falsework etc) shall rest with the Contractor. The Contractor shall appoint an IRSE to check and certify the design prior to submission to the Architect. The qualification of the IRSE shall be subject to the approval by the Architect. The implementation of the actual arrangement on site against the design should be checked by TCP employed by the Contractor. The qualification of the TCP shall be subject to the approval by the Architect.

#### **3.3.2 Holes, Inserts and Fixings**

Approval for the size, type and position of any holes, cast-in inserts or fixings required by the Contractor or any Sub-Contractor (See Clause 2.10.3) shall be obtained before work proceeds.

Unless otherwise specified or approved, all holes through structural members shall be formed and all inserts and fixings cast in the concrete works at the time of concreting. No part of the concrete works shall be drilled or cut away without prior approval of the Architect.

Fixing lugs, lewis bolts, timber or breeze plugs or pads, floor clips and all other fixtures must comply with the architectural requirements and must be of a type and size to avoid any weakening of the structural concrete and/or chemical contamination thereof.

Any fixture to be inserted into the structural concrete by means of explosive is not allowed.

Any clashes between holes, cast-in items and reinforcement shall be resolved before any concrete is placed. Reinforcement bars in the main structure should not be dislocated to make way for cast-in items unless approved by the Architect.

The Contractor shall clear out block out items after concreting.

#### **3.3.3 Release Agents**

Release agents shall be materials marketed as such and shall be of one of the following types approved by the Architect:

- (a) cream emulsion
- (b) neat oil with surfactant added
- (c) chemical release agent

All release agents used shall be non-staining, non-injurious to the finished concrete and shall not be adversely affected by the weather.

Release agents shall be stored and used strictly in accordance with the manufacturer's written instructions. Architect's approval shall be obtained for the compatibility of the release agent with the surface finishes.

#### **3.3.4 Formwork Ties**

Through-ties may be used to support vertical faces of formwork other than in water-resisting construction or as agreed with the Architect.

No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

The Contractor shall make good any holes left exposed to view in the faces of the concrete to the agreement of the Architect.

In water-resisting construction, methods of fixing formwork which result in holes through the concrete section when formwork is removed shall not be used.

In water-resisting construction, ties used shall be of a type to maintain water resistance of the construction.

#### **3.3.5 Cleaning of Forms**

All rubbish shall be removed from the interior of the forms before concrete is placed. The formwork in contact with the concrete should be cleaned and treated with an approved release agent. In the case of deep sections a temporary opening shall be left at the base to enable such cleansing to be adequately completed and avoid ponding prior to concreting.

#### **3.3.6 Pre-Cambers**

All formwork for suspended beams and slabs shall be constructed so that the upward cambers as shown on the Drawings exist immediately before striking. If camber is not specified on the Drawings, the following guidelines are provided:

- (a) 0.15% of span length at the centre of span, for span length up to 10m.
- (b) The sum of 0.15% of the first 10m plus 0.30% of the rest of span length for span length over 10m.
- (c) 0.35% of span length at the free end of a cantilever span.

The Contractor shall check the prescribed precambers are compatible with his chosen method of construction and time to striking of formwork and falsework. It shall remain the Contractor's responsibility to ensure the complete structure is within specified tolerances, and suitable to receive the work of following trades and Sub-contractors.

#### **3.3.7 Stiffness of Formwork Panels**

Formwork panels shall be stiff enough to prevent damage to the concrete surface caused by excessive movements of the panel during vibration of the concrete.

#### **3.3.8 Repair of Formwork**

Damaged formwork shall not be re-used if in the opinion of the Architect that the making good would impair the surface appearance of the concrete.

#### **3.3.9 Design of Formwork to Suit Striking Method**

The side formwork should be so designed and arranged that it can be removed while the soffit form can be retained in position, properly supported on props, until the concrete has achieved the required maturity.

The Contractor shall submit to the Architect for approval their method statement for removal of formwork.

#### **3.3.10 Sealers on Timber Surfaces**

Where their use has been specified or approved, sealers shall be applied to surfaces which are dry and free from dirt, grease or other impurities. Before a surface is sealed, it shall be

sanded to remove any protrusions or to smooth any rough areas. Any holes or indentations shall be stopped with waterproof filler. The manufacturer's instructions regarding the method of applying the sealer shall be followed exactly and the work shall be done by a skilled painter.

Whether or not the surface of the formwork in contact with the concrete is sealed all edges and joints to plywood or other timber, including the edges of any holes drilled through it, shall be sealed.

### **3.3.11 Sloping Forms**

When concrete is to be placed to an angle steeper than 15° from the horizontal top forms shall be used to enable the concrete to be properly compacted.

### **3.3.12 Curved or Domed Concrete Surfaces**

Where curved or domed surfaces are specified, the formwork shall be curved or domed accordingly. The alternative of replacing a curved or domed concrete surface with a series of small connecting planar surfaces will not be permitted unless the concrete exposed surface will be covered by tiles and the Contractor has demonstrated to the satisfaction of the Architect that the irregularities on the concrete surfaces due to such alternative will not affect the final smoothness of the tiled surface, and the Architect's written approval is given.

## **3.4 Falsework**

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### **3.4.1 General**

The Contractor shall be responsible for the design, supply, construction, removal and safety of the falsework. See also Clause 3.3.1.

The falsework shall have sufficient stiffness to prevent excessive deformation, to support the formwork, cast elements, and any imposed loads before the poured concrete reaches the required strength. Not less than 3 weeks before construction of the falsework begins, the Contractor shall submit method statements, calculations and details of the falsework systems he proposes to use for all main structural construction to the Architect and obtain the Architect's approval in writing before starting falsework erection. The method statements shall include layout drawings of formwork and falsework, details of the props, e.g. their load capacities, connection and bracing details, assumed rates of concreting, and removal sequence.

Where structural concrete relies on permanent or temporary support from the existing structure or ground, the Contractor shall ensure that the support is adequate for such purposes.

### **3.4.2 Formwork Props**

Formwork props are part of the falsework required for the support of the formwork cast elements, and imposed loads. The props shall remain in place for the minimum striking period established under Clause 3.10.

In calculating the load capacities of the props, the Contractor shall take account of their slenderness.

All formwork props shall have base plates for safely spreading their load to the supporting member without damage.

### **3.4.3 Stability of Falsework during Construction**

The Contractor shall be responsible for the stability of all the falsework systems, and shall provide adequate lateral supports and bracings to assist the falsework in resisting all concrete and imposed loads during construction.

No bracing of the falsework system shall be removed prior to the minimum striking period established under Clause 3.10.

### 3.4.4 Safe Access for Concreting

The Contractor shall include in his method statement details of his proposed access to, and working platforms at concreting work faces where the height of the platform exceeds 2m above the local general level.

### 3.4.5 Back Propping

The Contractor shall check that the maximum loads taken by the falsework system can be safely carried by the supporting structure. If back propping is required to distribute the loads between two or more consecutive floors, the Contractor shall obtain the Architect's prior approval in writing to his proposals for back prop layout, and sequence for installation and removal.

### 3.4.6 Removal of Formwork and Falsework

The Contractor shall be responsible for the safe timing, sequence and manner of removal of any falsework or formwork.

## 3.5 Construction Joints

### 3.5.1 General

Where construction joints are not shown on the Drawings the Contractor shall submit his proposed construction joint positions with method statement of the joint preparation and concreting sequence to the Architect for approval before work starts.

### 3.5.2 Preparation of Construction Joints

Prior to the Works commencing on site, the Contractor shall obtain the Architect's approval for proposals of forming and preparing construction joints.

All construction joints other than horizontal joints shall be formed with proper stop-boards which shall be fixed vertically unless otherwise directed.

At construction joints, all laitance and honeycombed concrete shall be removed from the contact face to expose the coarse aggregate before the adjacent section is concreted. Where difficulty of access makes the removal of laitance impossible, the means of producing a roughened joint face of properly compacted concrete shall be approved.

When work is resumed at a construction joint the contact face shall be clean and saturated with water but with no free water present at the surface. The fresh concrete shall be placed directly against it. No grout or mortar shall be used.

The use of surface concrete retarders and bonding agents at construction joints shall be subject to approval in writing of the Architect.

### 3.5.3 Spacing of Construction Joints

The spacing of construction joints other than those in water-resisting construction shall comply with the requirements stated in Table 3.1 unless otherwise shown on the Drawings or approved:

Table 3.1

Construction	Maximum Area (m <sup>2</sup> )	Maximum Length (m)
Slabs with major restraint at both ends	100	13
Slabs with major restraint at one end only	250	20
Slabs with little restraint in any direction	500	30
Walls	40	10

The Contractor shall propose the joint layout with design justification for the additional anti-crack reinforcement required if the above requirement is exceeded. Attention shall

be drawn to the possible thermal/shrinkage induced cracking due to massive pour. For areas of water-resisting construction, refer to Clause 3.15.

#### **3.5.4 Shrinkage Strip**

Where shrinkage strip is specified on the Drawings, construction joints shall be properly formed with stop-boards. All reinforcement across the shrinkage strip should be discontinued and lapped with full bond length. Prior to commencement of concreting the infill area, the joint faces shall be properly cleaned and roughened.

The Contractor shall programme his work to allow for the specified shrinkage strip, and follow the sequence and timing for infilling the shrinkage strip area as directed in the Drawings or by the Architect.

Where shrinkage strip is required in external environment, waterstop shall be provided in accordance with Clause 3.15.4.

#### **3.5.5 Construction of Cantilevered Reinforced Concrete Structures**

All cantilevered structures should be cast monolithically with the direct supporting members. Construction joints should not be located along the external edge of the supporting members. In case this is inevitable, an alternative construction method must be submitted to the Architect for approval prior to the commencement of Works.

### **3.6 Movement Joints**

Concrete shall not be placed on both sides of a movement joint at the same time unless otherwise approved. Joint filler forming the gap at a movement joint should be firmly fixed to the first-placed concrete. If more than one strip is used, the ends should be butted closely together and taped to prevent grout leakage thus preventing the closure of the joint.

A method statement for forming movement joints shall be submitted to the Architect for approval. Details of placing the joint material and bearing pads, if applicable, shall be included in the method statement.

The permanent sealing of joints shall be carried out as late as practical and preferably in cool weather. Excess joint sealant shall be removed by using a purpose made finishing tool such that the finish surface of the sealant is between 4mm and 6mm set back from the face of the concrete.

If required by the Architect, samples of joint filler shall be tested to determine the disintegration and shrinkage, the recovery value and reduction in mass and the extrusion.

Unless otherwise specified in the drawings, dowel bars shall be 25mm diameter Grade 250 plain round steel bars complying with CS2 at 300mm spacing. Dowel bars shall be straight and sawn square at both ends with all burrs removed. The bar length shall be 650mm long. 300mm cast in one side and the other sides slotted into a preformed PVC tight fitting dowel sleeve with a nominal wall thickness not exceeding 1.5 mm.

### **3.7 Reinforcement Handling**

#### **3.7.1 Reinforcement Cutting and Bending**

The Contractor shall prepare his own bending schedule for cutting and bending reinforcement bars in accordance with the reinforcement detail Drawings.

All reinforcement shall be bent only to the details shown on the Drawings and in compliance with BS 8666 and BS 8110: Part 1: 1985, Clause 7.2 unless otherwise stated or approved by the Architect in writing. Tolerance on cutting and bending reinforcement shall comply with BS 8666.

Reinforcement should not be bent or straightened in a manner which will damage the material. Grade 460 bars should not be re-bent or straightened without the Architect's approval. Reinforcement shall not be heated.



Where not specifically detailed in the Drawings, the laps of reinforcement shall be staggered so that laps do not occur in a band.

Each bundle of bars shall be clearly tagged with their schedule and mark numbers.

### **3.7.2 Reinforcement Fixing**

Reinforcement fixing shall not start until satisfactory testing of representative batches has been completed. Attention is drawn to PNAP 122 and 221 in this regard.

All reinforcement shall be fixed in position in accordance with the reinforcement detail Drawings and reinforcement schedules. Any alterations to the reinforcement shall be carried out only with the agreement of the Architect.

Steel reinforcement shall be clean and free from corrosive pitting, paint, oil, grease, spilt concrete or grout, adhering earth or loose rust, rust scale, loose mill scale etc. at the time of fixing in position and concreting.

All laps of fabric and all intersections of bars shall be securely connected with tying wire or by an alternative method approved by the Architect.

Welding of reinforcement is not permitted without the Architect's agreement in writing. Where welding is allowed, it should be carried out in compliance with Clause 10.4.6 of the HKCC and BS 7123. Welding procedures and welder qualifications shall be subject to the agreement of the Architect.

Except otherwise specified the concrete cover to reinforcement shall be the minimum recommended in Table 4.2 of the HKCC, and the tolerances for fixing reinforcement should be as follows:

- actual concrete cover not less than the specified covers minus 5 mm.

For reinforcement located relative to only one face of a member, the actual concrete cover must not exceed the specified cover plus:

- 5 mm on bars up to and including 12 mm diameter;
- 10 mm on bars over 12 mm up to and including 25 mm diameter; or
- 15 mm on bars over 25 mm diameter.

With the exception of using stainless steel wires in spacer blocks, no metal part of any device used for connecting reinforcement bars or for maintaining reinforcement in the correct position shall be remained within the specified minimum concrete cover to the reinforcement.

The Contractor shall supply and fix all chairs required to maintain reinforcement bars in the correct positions. The Contractor shall obtain agreement to the type, size and spacing of chairs in advance of commencing the area of work.

See Clause 3.8.5 for attendance by steel fixer during concreting.

### **3.7.3 Rust Staining**

Concrete surfaces which will be exposed to view in the finished works shall be protected from staining due to rusting of projecting reinforcement either by coating the reinforcement with cement grout or by another method approved in writing by the Architect.

### **3.7.4 Safe Access for Steel fixing**

The Contractor shall include in his method statement details of his proposed access to, and working platforms at, steel-fixing work faces where the height of the platform exceeds 2m above the local general level.

### **3.7.5 Projecting Reinforcement**

All reinforcement ends left projecting from cast concrete shall be free of release agents and shall be protected against damage and corrosion by polythene sleeves tied to the bars or coating the bars with cement slurry.

### **3.8 Concreting**

#### **3.8.1 Method Statement**

The Contractor shall submit a method statement for concreting operations of the Contract to the Architect for approval. The method statement shall cover comprehensively all the different arrangements of concreting at different locations. Details of each arrangement shall include the following:

- (a) volume of concrete delivered and placed per hour;
- (b) tools and equipment utilized;
- (c) mode of placing, e.g. by skip, or pumping etc;
- (d) number of persons in the concreting team;
- (e) means of safe working at height; and
- (f) contingency plans for unexpected situations, e.g. rain, disruption of concrete supply, accidents, etc.

If pumping concrete is to be used, the method statement shall also include:

- (g) general arrangement and methods of supporting pipelines; and
- (h) procedure for charging and emptying of pipelines.

If pumping concrete is to be used, the inside diameter of the pipes and hoses shall not be less than three times the maximum size of the aggregate. Aluminium pipes shall not be used. Extra strong couplings shall be used on vertical runs and on sections which are not easily accessible.

Concrete pumps shall be operated and maintained in accordance with the manufacturer's written recommendations and shall produce a continuous stream of concrete without air pockets. The pumps and pipelines shall be maintained in a clean condition. Pipelines shall be lubricated by passing cement grout through the pipeline before the Permanent Works concrete is pumped. This initial lubricating grout shall not be placed in the Permanent Works.

#### **3.8.2 Notice of Concreting**

Before each concrete pour, the Contractor shall give an advance notice of at least one day to the Architect so that an inspection of the concreting may be made at his discretion. Such notice shall provide details of the concreting operation including:

- (a) the date and time for the Architect or his representative to inspect the formwork and fixed reinforcement;
- (b) the location of concreting;
- (c) the elements to be concreted;
- (d) the volume of concrete to be poured;
- (e) grade of concrete to be poured; and
- (f) date and starting time and expected completion time of the operation.

No concreting shall be commenced until the Architect or his representative has had an opportunity to inspect the formwork and any fixed reinforcement and given his written approval to concreting.

#### **3.8.3 Attendance at Concrete Unloading Area**

During each delivery of concrete to site, a suitably trained concrete technician employed by the Contractor shall stand by at the unloading area for the concrete trucks and attend to the following:

- (a) to take concrete temperature;
- (b) to carry out slump test;

- (c) to decide on the acceptability of the concrete, record the concrete volume arrived (both accepted and rejected), collect the delivery tickets if accepted; and
- (d) to do sampling and concrete cubes.

The technician shall be familiar with the acceptance criteria for (a) to (d) above. The technician in charge shall be given the authority to reject unacceptable concrete and report to the Contractor's site agent any anomaly regarding the concrete or delivery and he shall also be responsible for collecting and keeping all the above records and test reports.

Concrete temperature shall be taken with approved thermometers prior to unloading of the concrete on site, at least once every hour or as directed. Temperature of the concrete at placing shall not exceed 30°C.

All delivery record slips for ready-mixed concrete shall be retained by the Contractor for inspection throughout the duration of the Contract.

### **3.8.4 Transporting Concrete On Site**

Runs or gangways for concrete transports and main runs for foot traffic shall not be supported or allowed to bear on the fixed reinforcement for permanent works. Concrete shall be deposited as near to its final position as practical to minimize re-handling or flowing.

Concrete shall be transported from the concrete unloading area to the place of concreting as quickly as possible by methods which will prevent segregation or loss of ingredients including water.

### **3.8.5 Placing Concrete**

Concrete shall be placed continuously up to construction joints while it is still sufficiently plastic for adequate compaction. Concrete shall be rejected if its workability test result fails to comply with the specified requirements in this Specification when tested according to either Clauses 4.6.1 and 4.6.2 or Clause 4.6.6 or Clauses 5.4.8(a) and (b) subject to the concrete mix, or if it is not placed within two hours of the introduction of water to the cement and aggregate.

Concrete shall be compacted in layers not exceeding 0.6m thick during placement and compaction of each layer shall be completed before the next layer is placed. Care should be taken to ensure that successive layers are well worked together.

At all times when concrete is being placed, a competent steel fixer shall be in continuous attendance. He shall inspect the reinforcement in advance of the concreting movement, and adjust or correct the position of any reinforcement which may have been displaced or found to be loose.

Concrete shall not be allowed to fall freely for more than 2m. Chutes should be used instead.

Where permanent formwork is incorporated in the structure extra care is required, as full compaction of the concrete cannot be checked after the formwork is removed.

Arrangements for premature stoppage of a pour shall be agreed and in place before work starts. Should premature stoppage of a pour occurred, the Contractor shall agree with the Architect the extent and timing of any necessary remedial work before resumption of placing. Should this happen during concrete placing, it should be recorded by the Contractor and the Architect should be notified. Coring test may be required as directed by the Architect, to verify the quality of the concrete bonding interface.

Concrete shall not be placed under heavy rainfall unless adequate tented protection is provided or otherwise agreed by the Architect. Any concrete that has been damaged, contaminated or diluted by rainfall shall be removed from the Works.

### **3.8.6 Placing Concrete on Rock**

Rock surface upon which structural concrete is to be placed shall be free from oil, mud, standing water (except concrete is placed by tremie) and any kind of foreign matters. Loose, shattered or unsound rock fragments shall be removed. The surface shall be inspected and

approved by the Architect before blinding concrete is placed. Except otherwise specified in the Drawings the blinding concrete shall be of Grade 10P and 50mm thick minimum and shall be cast in bays with vertical joints properly formed. Immediately before placing the blinding concrete, the rock surface shall be thoroughly wetted so that water is not absorbed from the blinding concrete.

### **3.8.7 Placing Concrete for Formed Finish**

Concrete shall be placed in one continuous operation rising uniformly in the formwork at a rate not less than 2m per hour. The concrete shall not be handled in any manner that may cause segregation or cold joints.

Concrete shall not be placed directly against a vertical form face but shall be caused to flow to this surface during the compaction process. Care shall be taken to avoid the form face being splashed with mortar during the placing operation.

### **3.8.8 Compaction**

All structural concrete except self compacting shall be fully compacted by mechanical vibrators of an appropriate type and size to avoid cold joints and honeycombing and to minimize segregation, excessive blemishes or other defects in the hardened concrete. Concrete shall be thoroughly compacted in its final position within 30 minutes of discharge from the mixer.

The Contractor shall submit details of the type, size and number of vibrators to be used in the Works. Whenever concrete is being vibrated, at least one spare vibrator of each type in use shall be available in case of breakdown.

Compaction shall start as soon as there is sufficient concrete within the formwork to immerse the vibrator and vibration shall continue during the placing operation so that at no time shall there be a large volume of un-compacted concrete in the formwork. Immersion vibrators shall be fully inserted into the concrete at points of application and not exceeding 0.5m apart and shall be withdrawn slowly to prevent the formation of voids. Immersion vibrators shall avoid contact with the formwork, the reinforcement or any embedded fixtures.

Over vibration, causing segregation, surface laitance or leakage through formwork, shall be avoided.

Kicker sections of walls, columns etc. shall be cast monolithically with the base slab and compacted in such a way that their strength and other characteristics are at least equal to those specified for the whole member.

At areas with very congested reinforcement, trial panel may be required as directed by the Architect to ensure that the quality of hardened concrete can be attained.

### **3.8.9 Re-vibration**

Where for any reasons, concreting cannot be carried out without interruption, care shall be taken that vibration of new concrete, in contact with that vibrated before the break, is done within 30 minutes of the stoppage unless in the opinion of the Architect, the concrete already placed is sufficiently workable and responds to the action of internal vibrator. If this cannot be arranged, the old concrete must be left to harden and undisturbed for at least 24 hours before the new concrete is poured, and the joint treated as a normal construction joint, as specified. The cost of any additional works caused by these stoppages shall be borne by the Contractor.

### **3.8.10 External Vibrators**

External vibrators shall not be used without the approval of the Architect in writing.

### **3.8.11 Cleaning**

All equipment used for mixing, transporting, placing and compacting concrete shall be thoroughly cleaned before changing from one type of aggregate or cement to another, and when the respective operation using the equipment is completed or before the grout/concrete attached to the equipment hardens.

**3.8.12 Records of Placing**

The Contractor shall submit weekly to the Architect a complete record of the concrete placing done showing the time and date of concreting, the locations and types of structural member cast.

The Contractor shall keep on site a record containing the following particulars:

- (a) Date and time of arrival of the concrete trucks;
- (b) Time of batching and quantity of water added at Site if any;
- (c) Registration number of each truck and name of depot, serial number of delivery ticket;
- (d) Time when concrete was placed;
- (e) Grade of concrete and quantity;
- (f) Temperature of concrete when placed;
- (g) Accurate description of the location of concrete placement;
- (h) Reference marks of any test cubes taken from this delivery;
- (i) The slump; and
- (j) Type, name and quantity of admixture if used.

The record book shall be available for inspection by the Architect or his representative at all times.

**3.8.13 Curing**

All surfaces of structural concrete shall be protected from loss of moisture by suitable curing process immediately after compaction and the curing period which, for concrete using PC only, shall be at a minimum the first four days after casting. The minimum curing period of six days is required for concrete containing PFA. Formwork left in position can be regarded as protection for the surfaces with which it is in contact.

For finished concrete other than water-resisting construction, the curing shall be provided by one of the following means:

- (a) A membrane, formed by an approved proprietary liquid curing compound by using a mechanical sprayer with low-pressure spray at the rate recommended by the manufacturer, on the horizontal surfaces immediately after finishing the concrete and on vertical surfaces immediately after removing the formwork until a continuous visible covering is achieved.
- (b) Cover the finished concrete completely, after thoroughly wetting, with 0.125mm thick impermeable polyethylene sheeting raised approximately 50mm over the surface.
- (c) Cover the finished concrete completely with a layer of fine aggregate at least 25mm thick or Hessian, sacking, canvas or similar absorbent material. Such covering layer shall be kept constantly wet during the curing period.

For water-resisting structures, the curing shall be provided by one of the following means:

- (d) Upon completion of the finishing process, all exposed surfaces shall be covered with 0.125mm thick impermeable polyethylene sheeting until such time as the concrete has hardened sufficiently to permit water curing. Water curing shall be effected whenever possible by the continuous spraying of cool water or by ponding immediately after the sheeting is removed for a period of two days. Particular care shall be taken to avoid thermal shock at the surface of the concrete caused by the intermittent application of large quantities of cool water. Thereafter, spraying of cool water shall continue or be substituted by the aforesaid method (b) until the concrete has reached the age of seven days.
- (e) Formwork to vertical elements shall be kept moistened by water sprays as soon as the concrete has hardened sufficiently and until the formwork is removed, then the aforesaid curing method (b) shall be adopted until the concrete has reached the age of seven days.

All the covering materials shall be lapped and securely held in position in such a manner that the concrete under curing will not be damaged.

Before commencing concreting the Contractor shall obtain prior approval of his proposals for concrete curing.

#### **3.8.14 Temporary Protection for Fresh Concrete**

After the compaction, the fresh concrete should be protected from vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

#### **3.8.15 Pouring of Concrete against Walls of Adjoining Building**

Concrete can only be poured against adjoining building walls on the condition, complying with PNAP 81, that the process will not cause damage to the property and injury to person subject to the written approval of the Architect.

Independent shuttering shall be provided for pouring concrete against the wall of the adjoining building to avert excessive wet concrete and tamping load so imposed.

### **3.9 Special Requirements Regarding Concrete Temperature**

#### **3.9.1 General**

Under an ambient temperature above 25°C, any formwork made of metal, concrete or other material of high thermal capacity shall be cooled with water before concrete is placed.

The concrete temperature at the time of placing shall not be more than 30°C. The Contractor shall have an approved thermometer at the concreting location for checking the concrete temperature at any time.

The Contractor shall employ effective means such as pre-cooling of aggregate and mixing water, as necessary, to maintain the temperature of the concrete below 30°C prior to placing. The Contractor shall liaise with the batching plant to control the concrete temperature prior to and during the concreting operation.

#### **3.9.2 Concreting in Hot Weather or High Wind**

For exposed concrete surfaces in high sun temperature or strong drying wind conditions the Contractor shall provide shield to the fresh concrete during the curing period, and this shield shall be placed in position no later than half an hour after final tamping. If the surface exhibits cracking while the concrete is still plastic, it shall be re-tamped to close the cracks.

#### **3.9.3 Heat of Hydration**

The peak temperature of the concrete shall not exceed 70°C at any point of a cast section, unless it can be shown to and approved by the Architect that with the nature of the construction and the concrete mix concerned, a higher temperature will not be detrimental to the concrete performance. In this case, this limit may be relaxed up to 85°C. When the concrete temperature exceeds 70°C, the Contractor shall inform the Architect and investigate the case.

The temperature difference between any two points within 1m apart in a cast section shall not exceed 25°C. Cooling and/or insulation of the concrete shall be carried out as necessary to maintain the above conditions.

Before casting sections greater than 1.5m thick, or concrete is to be placed in a large volume pour, and if a rich concrete is used, consideration shall be given to the concrete temperature rise above ambient and to reduce the risk of early thermal cracking. The Contractor shall demonstrate by means of thermocouples in representative trial panels that the specified peak temperature and temperature difference are not exceeded. The Contractor shall propose the size and layout of the representative panel, the mix design, and number and arrangement of thermocouples for the approval of the Architect in writing before the demonstration.

Where a risk of thermal cracking is identified, the location of temperature monitoring apparatus and interpretation of the temperatures recorded shall be agreed with the Architect prior to installation.

### **3.9.4 Concreting in Cold Weather**

When the ambient temperature is 5°C or below, or is likely to drop in that direction, the Contractor shall not carry out any concreting without prior approval from the Architect.

If concreting at ambient temperature below 5°C is anticipated, the Contractor shall submit a method statement for concreting in cold weather to the Architect for approval. Details of the method statement shall include the following:

- (a) insulating the concreted works from the ambience to keep the minimum temperature at any point of the concrete section above 5°C;
- (b) maintaining the temperature of formwork to a minimum of 5°C prior to start of concreting;
- (c) temperature monitoring measures for the minimum and maximum temperatures in the poured concrete;
- (d) measures to keep the difference between maximum and minimum temperatures within 25°C; and
- (e) remedial work proposal for non-compliance of the above requirements.

## **3.10 Striking of Formwork**

### **3.10.1 General**

Before any formwork is removed the Contractor shall ensure that the concrete has attained sufficient strength to support its own weight and any construction loads, without short-term or long-term distress. The structure shall not be distorted, damaged or overloaded in any way by the removal of the formwork.

The Contractor shall be responsible for the safe timing, sequences and manner of removal of any falsework or formwork. Formwork shall be removed carefully to avoid damaging the concrete surface. Any damage so caused shall be made good by the Contractor to the acceptance of the Architect.

### **3.10.2 Method Statement**

The Contractor shall submit method statements for removing formwork and falsework to the Architect for approval. These method statements shall be compatible with the requirements of the designs and method statements for the formwork and falsework.

### **3.10.3 Minimum Striking Period**

The minimum time before removing formwork shall be determined from either (A) or (B) below unless otherwise specified. The Architect may approve earlier striking of forms (but not props) if the Contractor can show that this can be done without damage to the concrete.

When SCM are used and the surface temperature is less than 16°C the minimum striking time shall be determined by (B).

- (A) The minimum striking times shall be as listed in Table 3.2 (for concrete without SCM) and Table 3.3 (for concrete with SCM and having the surface temperature  $\geq 16^{\circ}\text{C}$ ). The Contractor's method of measuring the surface temperature of the concrete shall obtain prior approval from the Architect.

The periods specified for striking of soffit formwork and props at 7°C shall be increased by half a day for each day on which the minimum concrete temperature is between 2°C and 7°C. Any day on which the minimum concrete temperature falls below 2°C shall not be counted.

**Table 3.2: For Concrete without SCM**

Location	Minimum Striking Time	
	Surface Temperature of Concrete T	
	T ≥ 16°C	16°C > T ≥ 7°C
Beam sides, walls and columns	12 hours	12 hours
Slab soffits (formwork props undisturbed)	4 days	7 days
Formwork props to slabs	10 days	14 days
Beams soffits (formwork props undisturbed)	7 days	14 days
Formwork props to beams (Except cantilever)	14 days	21 days
Formwork props to cantilever, hanger walls and transfer structures	28 days	28 days

**Table 3.3: For Concrete with SCM and having the surface temperature ≥ 16°C**

Location	Minimum Striking Time
Beam sides, walls and columns	15 hours
Slab soffits (formwork props undisturbed)	5 days
Formwork props to slabs	11 Days
Beams soffits (formwork props undisturbed)	8 days
Formwork props to beams (Except cantilever)	15 days
Formwork props to cantilever, hanger walls and transfer structures	29 days

- (B) The Contractor may determine the striking time from the strength of the concrete. The forms and/or formwork props to a structural member may be removed when the strengths of two concrete cubes made from a batch used in the member and cured and stored under the same conditions as the member both exceed 10 N/mm<sup>2</sup> or twice the stress to which the concrete will be subjected, whichever is the greater, provided that such earlier striking will not result in unacceptable deflections due to shrinkage, creep, etc.

Permission to carry out this procedure will be withdrawn if the Architect is not satisfied that the strength of the cubes is representative of the strength of the poured concrete.

Notwithstanding the above, formwork props shall remain in position for at least 3 days.

### **3.11 Treatment of Cast Concrete**

Unless shown in the Drawings or directed by the Architect, no treatment of any kind other than that required for curing shall be applied to the concrete after removal of the forms until it has been inspected by the Architect.



## 3.12 Concrete Finishes

### 3.12.1 General

Where no finish is indicated on the Drawings a smooth dense surface free of voids and honeycombing is required.

The Contractor shall check and follow the Architectural specification and drawings for the type/quality of surface finish required for various elements. The Contractor shall pay particular attention, where fair face concrete, rendering, painting or other surface applications are required by the Architect.

Where a particular type of finish is required on specific concrete surfaces it will be indicated on the Drawings. The reference to finishes shall have the meanings described in Clauses 3.12.2 and 3.12.3.

### 3.12.2 Formed Concrete Finishes

#### Type 1F

Form material shall be good quality plywood or similar and shall have uniform panels and fixings arranged in a regular pattern.

Small surface blemishes caused by entrapped air or water may be expected, but the surface shall be free from voids, honeycombing or other large blemishes. The concrete surface shall be the finish except that, if required by the Architect, defects such as fins and other minor blemishes shall be made good by an approved method.

#### Type 2F

Form faces shall be of an impervious material such as plastic-laminate-faced plywood, GRP or steel. Form panels shall be as large as practicable and arranged in an approved regular pattern. The finish shall be smooth without significant blemishes or discolouration. No making good will be permitted except with approval. Internal form ties and spacers for maintaining concrete cover will not normally be permitted.

#### Type 3F

Formwork type 3F is to be generally as specified for 2F but extra care shall be taken to ensure that the concrete surface has no blemishes or discolouration and meets with the Architect's requirement.

The surface of each prefabricated formwork panel is to be inspected for marks, indentation, holes or blemishes, which are either to be made good to the Architect's satisfaction, or the panel shall be withdrawn from use as 3F formwork.

When concrete is placed, the surfaces of the panels are not to be splashed with concrete or grout and the formwork joints shall be grout tight.

### 3.12.3 Unformed Concrete Finishes

**Type 1U** The concrete shall be uniformly levelled and tamped.

**Type 2U** The concrete shall be uniformly levelled and tamped, and subsequently wood floated by hand to produce a uniform surface.

**Type 3U** The concrete shall be uniformly levelled, tamped and floated. When sufficiently hard it shall be steel floated by hand or machine to produce a dense, smooth, uniform surface free from tool marks.

**Type 4U** Except otherwise shown on the Drawings, the finish for vehicular ramps shall be of Type 2U finish on an extra concrete layer of 15mm thick and same grade of the slab on top of the ramp cast monolithically with the slab with anti-skid grooves of 10mm (W) x 15mm (D) at 100mm centres formed evenly across the slab in one direction at right angles to the longitudinal axis of the vehicular ramps.

### 3.13 Quality of Exposed Concrete Surface

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#### 3.13.1 Appearance

Any finished work which the Architect judges to be inferior in any respect to a standard, or to be unacceptably different in appearance from other parts of the works already constructed, or which is subsequently stained or damaged, will be classed as defective work.

#### 3.13.2 Protection

Surfaces which will be exposed to view without rendering in the finished works shall be protected from spillage, stains, discoloration and any other damage at all time.

### 3.14 Trial Panels

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In order to ensure that the specified formed finishes can be achieved by the method of construction and formwork proposed, and to provide a standard by which the finishes in the Works can be assessed, trial panels shall be cast on site as directed by the Architect. These panels shall be approved before similar construction is started for the Works.

The trial panels shall be cast with concrete using the materials, plant, and concrete mix and methods of placing and compaction proposed for the Works. They shall be at least of storey height and 1m wide.

They shall be of similar thickness and similarly reinforced as the elements they represent, and shall incorporate all features which may contribute to their final appearance, i.e.:

- horizontal and vertical construction joints;
- horizontal and vertical panel joints;
- arises and chamfers;
- tie bolts or other fixing devices;
- means of maintaining concrete cover to reinforcement;
- release agent; and
- any other features.

### 3.15 Water-resisting Construction

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#### 3.15.1 Responsibility

The structural elements that would be in direct contact with soil or water have been designed in accordance with the HKCC, and have been checked such that the maximum crack widths should not be more than the values as stated in Table 7.1 of the HKCC. To achieve water-resisting construction, due considerations shall be made in respect of construction method, concrete mix, inserts and false work through the structure, joints and method of curing etc. The Contractor should refer to the Architects drawings and specification for the areas of water-resisting construction and the performance requirements.

The Contractor is responsible for planning, detailing and controlling the construction works, so that they achieve the water-resisting performance required by the contract. If a warranty is required in the Contract, the Contractor shall prepare and submit to the Architect a) the drawings and method statements to show the details of all construction joints, pouring sequence, curing methods etc.; and b) the quality plan ensuring the provision of adequate quality control measures. The Contractor shall check and confirm to the Architect in writing, before commencing a particular area of the Works, that they are satisfied with such proposal that the elements will achieve the water-resistance requirement. The Contractor's particular attention is drawn to the recommendations described in BS 8007 and BS 8102 for monolithic structural protection.

The Contractors' engineering and QC staff shall check and supervise the steel fixers, paying particular attention to good detailing practices and staggering of laps to prevent local stress

concentrations which may cause cracking. The Contractor shall also submit to the Architect before starting work written confirmation from the waterproofing system supplier that the proposed concrete mix, placing methods, release agents, curing compounds, movement joint details, surface finishes, reinforcement support methods and loads will not adversely affect the performance of the waterproofing system.

The Contractor shall closely liaise with his concrete supplier, to ensure that a consistent concrete supply is maintained during concreting to reduce risks of cold joints being formed, thus weakening the element and increasing risk of future leakage.

The Contractor shall submit to the Architect, a specific detailed method statement for water-resisting construction. This shall address the major issues such as proposed concrete mix, construction joint locations, sequence and timing of pours, waterstops, quality control and checking procedures, key personnel and key sub-contractors details.

The Contractor shall take care to protect the freshly cast or cured concrete from early damage due to, early depropping, early loading or construction vibration (generators, walkways or driveways), which may cause early and excessive cracking.

The Contractor should consider the practice of re-vibration of the concrete elements at the appropriate time to eliminate plastic settlement cracks; this would be particularly beneficial in the suspended slab areas. The Contractor should note however that it shall be their decision/responsibility if they use this method.

### **3.15.2 General Recommendations**

Methods of fixing formwork resulting in holes through the concrete section when the formwork is removed shall not be used.

Wall ties shall have water baffles. Pipes and sleeves shall have integral puddle flanges.

Except otherwise specified in the Drawings, all walls shall have kickers of minimum 150mm high cast monolithically with the base slab or pile caps. Supports for kicker formwork shall not penetrate through any water-resisting elements.

All pipes, sleeves, inserts, fixing etc shall be cast-in with the concrete. Coring and post-drilled fixing will not be permitted (See Clause 3.3.2).

Other applicable clauses in the Specification include but not limited to Clauses 2.8.1 and 2.8.2.

### **3.15.3 Position of Construction Joints**

It is the Contractor's responsibility to decide where they locate the construction joints to achieve the necessary water-resisting construction. However, the following may be used for guidance. The maximum dimension of pours should not exceed:

- In slabs, more than 10m in any direction;
- In walls, maximum length 5m and maximum area 25m<sup>2</sup> unless as specified in the Drawings.

If the Contractor wishes to use significantly larger lengths, they should address curing and temperature control of the sections in their method statements together with design justification of the shrinkage effect.

The use of Hyrib type construction joints will not be permitted in areas of water-resisting construction as it is considered deleterious to the joint integrity.

### **3.15.4 Waterstops**

Whether or not shown on the Drawings and notwithstanding the provision of external membranes, waterstops shall be provided in all construction joints and movement joints. The waterstops shall be of an approved type and fixed in accordance with the manufacturer's written instructions. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Exposed waterstops shall be protected during

application of form release agents to avoid being coated. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued. All site splices shall be done by a competent person using proper equipment and procedures.

Where waterstops within the concrete section are proposed, the Contractor shall submit to the Architect for agreement details of the methods to be used to a) maintain the waterstops in their correct positions and to prevent damage while the concrete is being placed and during and after removal of the formwork; and b) ensure that the concrete around the waterstops is thoroughly compacted so that there is dense concrete adjacent to the waterstops. See also Clause 2.10.2.

Hydrophilic strips shall be fully enclosed in the concrete section and shall not be positioned in the concrete cover zone and shall be a minimum of 50mm clear distance from the nearest reinforcement face. Hydrophilic strip shall be continuously glued by an approved epoxy cement into a formed recess in the previous pour. Recesses shall be of similar width and half the depth of the strip. Ends to be joined shall be miter cut with sharp knife or shears. The ends shall be adhered with cyanoacrylate (super glue) adhesive. Once installed, adequate measures should be taken to prevent exposure to rain water, ground water, etc. before the joint is covered with concrete.

Hydrophilic waterstop strips shall not be used in movement joints or in any internal or above-ground construction joints, which are not permanently damp, for water-resisting application unless otherwise approved by the Architect.

### **3.16 Mortar**

#### **3.16.1 Cement Mortar**

Cement mortar for structural work shall be mixed in the proportions of 1 part cement to 3 parts sand by volume. The sand shall be of natural sand or crushed natural stone or a combination of both complying with BS EN 13139.

Mortar shall be mixed thoroughly either by hand or mechanically until its colour and consistency are uniform. The constituent materials shall be accurately gauged, allowance being made for bulking of sand. Mortar shall be made in small quantities only as and when required. Mortar starting to set or having been mixed for more than one hour shall be discarded.

#### **3.16.2 Dry Pack**

Dry pack shall be a (1:1) stiff cement mortar composed of PC and fine aggregate which shall be thoroughly mixed with water to obtain a strength when rammed in standard cube moulds of not less than 30 N/mm<sup>2</sup> at 28 days. The mix shall have minimum water content compatible with achieving a consistency suitable for ramming into place using caulking tools.

#### **3.16.3 Epoxy**

Epoxy mortar shall comprise not more than 6.5 parts by weight of a suitable fine aggregate such as silica sand to one part by weight of approved epoxy mortar. The concrete surface shall be skilfully hammered to remove all laitance immediately before applying epoxy resin tack coat. The epoxy mortar shall then be laid and cured, all in accordance with the manufacturer's written instructions.

#### **3.16.4 Cement Mortar and Grout for Drill-in Bars and Bearings**

Cement mortar for bedding and construction of un-reinforced plinths for bearings shall be a proprietary non-shrink type approved by the Architect having a grade strength of at least 50MPa except otherwise stated in the Drawing.

Grout for grouting drill-in bars, base plates and holding down bolts shall be a proprietary non-shrink cementitious type approved by the Architect having a grade strength of at least 50MPa. The grout shall be flowable and shall not bleed or segregate. The suitability of the

grout shall be demonstrated by site trials to the approval of the Architect. Chemical-resin based grout shall not be used.

### **3.16.5 Cubes for Strength Tests**

Where mortar is employed for structural work, cubes shall be made and tested to verify the strength of the mortar. Sampling shall be proposed by the Contractor.

## **3.17 Filling Openings for Services Penetrations**

Where openings have been left through floors and walls to allow building services to penetrate through one compartment to another, the openings shall be filled after installation of the services.

Large openings such as pipe ducts shall be filled with the same grade of concrete as the adjacent structure. Small openings less than 100mm diameter such as sleeves for individual pipes shall be filled with 1:3 cement-sand dry packed mortar well rammed in. Before filling, the pipes or trunking shall be painted with bituminous paint or wrapped with anticorrosive tape. Where it is necessary to allow for expansion of the pipes, they shall be wrapped with compressible and fireproofing linings after painting.

## **3.18 Quality Assurance**

### **3.18.1 Material Testing - Concrete and Reinforcement**

Sampling of concrete and reinforcement, and testing of concrete cubes and reinforcement samples shall comply with the requirements of the HKB(C)R, PNAPs, CS1, & CS2 and the relevant approval letters for the Works from the BD.

For each consignment of cement or reinforcement, the Contractor shall obtain and keep on site a copy of the Manufacturer's certificate of tests (including for reinforcement bars, the rebend test) carried out in accordance with this specification.

Testing of concrete cubes and reinforcement shall be carried out by a laboratory approved for such tests through HOKLAS. The Contractor shall submit to the Architect for approval such details as the HOKLAS certificate, types of test approved through HOKLAS and job references etc of the laboratory selected.

The Contractor shall be responsible for observing requirements of the BD for testing of any material, and requirements for materials to be approved by BD before being used for the Works. The Contractor shall be familiar with such requirements that may be stated in the Building Regulations, PNAPs and BD approval letters for structural submissions and material submissions.

Apart from the above, the Contractor shall carry out any tests as necessary or as required by the Architect to ensure acceptable level of quality and performance of the Works.

### **3.18.2 Workmanship**

The Contractor shall only employ persons or companies properly qualified to carry out special work or tests. Where applicable, the Contractor shall submit to the Architect certificates of proficiency of the persons and certificate of accreditation of the companies to be delegated or employed for doing the work or tests.

If the Architect is in doubt of the workmanship and quality of work done by any person employed by the Contractor, the Architect may request the Contractor to send that person to take relevant proficiency tests at the Contractor's cost.

### **3.18.3 Management**

The Contractor shall operate an agreed quality management system to BS EN ISO 9000 and BS EN ISO 9001 unless otherwise agreed with the Architect, which shall be accessible for audit. All documentation shall be available for inspection during the contract period.

The Contractor shall submit to the Architect the names, curriculum vitae and job reference of the following personnel delegated to complete the Contract or carry out the Works:

- Director responsible for the Contract
- Contracts Manager responsible for the Contract
- Project Manager responsible for the Contract
- Programme planner
- Quantity surveyor
- ICE for formwork and falsework design and other temporary works including checking effects on permanent structures
- ICE for the Contractor design and build items
- Technical competent person for temporary works checking on site
- Site Agent
- Concreting foreman in charge
- Steel fixing foreman in charge
- Formwork foreman in charge
- Setting out foreman in charge
- Excavation foreman in charge
- Structural engineer
- Quality engineer whose duties include preparation of documents to be submitted to the BD

#### **3.18.4 Quality Control**

The minimum quality control measures for design and construction of the concrete works by the Contractor should comply with Section 11 of HKCC.

#### **3.19 Defective Concrete**

The Contractor's methods of making good any defects shall be submitted to the Architect for approval prior to start of remedial work. See also Clause 4.10.

## **4 PERFORMANCE AND TESTS**

### **4.1 General**

All tests, inspections and checks shall be carried out in the presence of or as directed by the Architect. The Contractor shall be responsible for carrying out all tests and inspections required by this Specification or called for by the Architect and shall arrange for copies of test results and inspection reports to be supplied to the Architect immediately when they are available.

A competent person shall be employed to supervise all stages, including preparation work, of testing of concrete and reinforcement. They shall also supervise all tests on materials and maintenance and calibration of all mixing and measuring equipment. For monitoring, controlling and taking samples of concrete, the Contractor shall employ a technician holding a Certificate in Concrete Technology (Level 2) from the Materials Division of the HKIE or a Certificate from the CITA Certification Course for Construction Materials Samplers.

### **4.2 Testing**

#### **4.2.1 General**

Before commencement of the Works, the Contractor shall engage suitably qualified staff, to the Architect's approval, for carrying out tests required by this Specification. He shall submit

for the approval of the Architect the name and project reference of the HOKLAS certified testing laboratory he proposes to employ to carry out the tests. Unless noted otherwise they shall maintain on site the following pieces of apparatus which shall be kept in good condition throughout the Contract and shall remain the property of the Contractor:

- (a) Apparatus for assessing workability in accordance with CS1:1990, Construction Standard Testing Concrete Vol. 1 and 2.
- (b) Apparatus for making, curing, and weighing the concrete test cubes required by this Specification, all in accordance with CS1:1990.
- (c) A calibrated thermometer(s) to be kept on site close to the Works for measuring and record daily maximum and minimum atmospheric shade temperatures.
- (d) A soil thermometer for measuring concrete and ground temperature.
- (e) Temperature-controlled curing tanks for concrete cubes.
- (f) Rebound hammer (Schmidt) for testing concrete hardness. Calibrated by independent laboratory.

#### **4.2.2 Water Tests**

Water tests shall be carried out to all water tanks, pools and aqueous containing chambers etc., in accordance with BS 8007, or as directed by the Architect.

#### **4.2.3 Test Nonconformity**

- (a) Any test results which do not meet the specified criteria shall be reported to the Architect. In the light of this nonconformity, the Contractor shall propose a course of action to the Architect for agreement, within one week of reporting the results. The material to which the test nonconformity applies shall be deemed to be unacceptable unless further testing or analysis proves otherwise and all associated costs shall be borne by the Contractor. Any remedial work shall be at the Contractor's expense.
- (b) A course of action shall be agreed within a further week.

### **4.3 Testing of Cement and SCM**

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Cement and SCM shall be tested in accordance with relevant standards and the test frequencies shall comply with QSPSC Part 2 - Technical Regulations (Issue 6) published by HKQAA.

### **4.4 Testing of Aggregate**

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#### **4.4.1 General**

The Contractor shall be responsible for the application of the following clauses and tests to aggregate for structural concrete to be mixed on site, and for such application by the concrete supplier if ready-mixed concrete is used for the Works.

Where ready-mixed concrete is used, the Contractor shall obtain from the concrete supplier the test results to submit to the Architect for approval before commencement of the concrete works.

All sampling and testing of aggregate shall be carried out in accordance with BS 812.

#### **4.4.2 Preliminary Tests**

A HOKLAS approved laboratory shall carry out the following tests for the aggregate used:

- (a) Sieve analyses;
- (b) Tests for clay, silt and dust content;
- (c) Tests for organic impurities; and
- (d) Tests for salt content.

Tests (a) and (b), with tests for the moisture content of each aggregate, shall also be carried out on the samples used for each trial mix.

Test (c) shall comply with BS EN 12620 and BS EN 1744-1.

The Contractor shall submit to the Architect for approval certificates of recent tests giving the following information about the aggregate:

- Specific gravity
- Water absorption
- Ten percent fines value
- Flakiness and Elongation

#### **4.4.3 Works Tests**

The Contractor shall either take it upon himself or instruct the Concrete Supplier to carry out the above tests on the aggregate, from each size and from each source, as are necessary for the production of the specified concrete.

The minimum frequency of testing shall be as follows:

- (a) Sieve analysis – Once a day for each of the first ten days on delivery, and thereafter once a week or as required by the Architect.
- (b) Tests for clay, silt and dust – Once a day, until the Architect is satisfied with the results of the tests and their uniformity. Thereafter once a week or as required by the Architect.
- (c) Moisture content of coarse and fine aggregate – daily.
- (d) Specific gravity – twice per year.
- (e) Water absorption – twice per year.
- (f) Ten percent fines value – once per month.
- (g) Flakiness and Elongation – twice per year.
- (h) Potential Alkali Reactivity – see Clause 2.4.6.

Any aggregate delivered during the progress of the work which shows a variation in grading outside the range specified in BS EN 12620 shall be rejected.

The Contractor shall provide the Architect with a certificate for his record at such regular intervals as the Architect may prescribe from time to time showing that all aggregates have been tested since the date of the last such certificate and showing that all aggregates being used continue to comply with the requirements of this Specification.

### **4.5 Testing of Admixtures**

The performance and uniformity tests of the admixtures in use shall be carried out in accordance with BS EN 480 and BS EN 934 for each product each month, provided always that the manufacturer's production quality control and quality system records according to BS EN ISO 9001 are available to support the claim of no change within the specified acceptance tolerances and such records are accepted by the Architect.

### **4.6 Testing of Concrete**

#### **4.6.1 General**

The sampling of works concrete shall be in accordance with Regulation 58 and Table 7 of the HKB(C)R except that samples shall be taken at the mixer or at the point of placing or as directed, and that samples shall be taken on eight occasions on each of the first five days of using a mix. The batches from which samples are taken shall be chosen by the Architect or Engineer.

From each sample a minimum of two 150mm test cubes, made and cured in accordance with CS1, shall be taken for testing at 28 days.

All records of works concrete tests shall indicate clearly which part of the structure each sample of concrete represents.



**Table 4.1: Sampling Rate Extracted from Table 7 of HKB(C)R**

Type or Part of Building, Building Works or Street Works	Quantity of Concrete to be Represented by Each Sample
Cantilevers, columns, shear walls, prestressed and other critical elements	10 m <sup>3</sup> or 10 batches whichever is the smaller volume
Solid rafts, pile caps, caisson caps and mass concrete	100 m <sup>3</sup> or 100 batches whichever is the smaller volume
All other types or parts	25 m <sup>3</sup> or 25 batches whichever is the smaller volume

The workability of each sample shall be checked. Unless otherwise directed, the slump shall be within the following limits from the value determined for the trial mix:

For slump value below 100mm,  $\pm 25\text{mm}$  or  $\pm$  one third of the design value, whichever is more stringent.

For slump value  $\geq 100\text{mm}$ ,  $\pm 50\text{mm}$  or  $\pm$  one third of the design value, whichever is more stringent.

If at any time the Architect is not satisfied that the ready-mixed concrete complies with this Specification they may alter the frequency of the sampling.

#### **4.6.2 Sampling and Testing of Ready-mixed Concrete**

Samples and tests shall be carried out to meet the requirements of the BD. Samples of concrete shall be taken in accordance with the requirements of this Specification at the point and time of delivery.

Each concrete mix shall be sampled and tested in accordance with Clause 5.4.1 of BS EN 206-1: 2000 for consistence at least once a day for the first five days on which the mix is delivered to site, and thereafter as directed.

In accordance with Clause 8.2.1 of BS EN 206-1: 2000 samples of each mix shall be taken at the mixer at least once each day when concrete of that mix is delivered. For each sample, **workability tests** shall be carried out and two cubes shall be made, one for test at 7 days and the other for test at 28 days. The results of these tests shall be submitted to the Architect within a week of the tests, with copies of the manufacturer's certificates for each type of cement used.

A slump test shall be carried out in accordance with CS1 or directed by the Architect on each batch of concrete delivered to site. The whole batch of concrete shall not be placed in the permanent works if the result of any test for workability, carried out on a sample taken from the batch, does not comply with the requirements for workability as specified in this Specification.

#### **4.6.3 Statistical Analyses of Cube Test Results**

The Contractor shall prepare statistical analyses and other calculations of cube results in accordance with HKB(C)R requirements and submit them to the Architect for information and record.

#### **4.6.4 Schmidt Hammer Test**

The Contractor shall carry out Schmidt Hammer Test as required by the BD and/or directed by the Architect to supplement the cube test and core test results to the grade strength of the in-situ concrete works.

#### **4.6.5 Salts**

Tests for salt content of hardened concrete specimens shall be made in accordance with CS1 as directed by the Architect.

#### **4.6.6 Slump-flow Testing**

Slump-flow testing shall be used to replace slump testing as a workability acceptance test for Self Compacting Concrete and High Flow Concrete. Slump-flow testing of concrete shall be carried out to ISO 1920-2: 2005. Where appropriate the slump equipment described in CS1 shall be used instead of that referenced in the ISO document.

#### **4.6.7 Test Failure of Works Concrete**

Notwithstanding the recommendations in Regulation 59 of the HKB(C)R, the Architect will assess the effect of any cube results falling below the designed strength of the concrete in relation to the location of the sampled batch, and may reject or call for further investigation by means of non-destructive tests and/or, if applicable, taking and testing of cores in accordance with CS1 to demonstrate the adequacy of that part of the structure. The coring test requirements shall comply with Clause 5.2.10. If such investigation reveals that the grade strength of the in-situ concrete is not attained, that part of work shall be condemned and replaced as directed by the Architect at the Contractor's expense. The Contractor may be required to stop concreting in other parts of the structure until the rectification work is completed to the satisfaction of the Architect.

#### **4.6.8 Measuring Equipment for Concrete Mixing**

The accuracy of the measuring equipment shall be within  $\pm 2.5\%$  of the quantity of cement, water or total aggregate being measured and within  $\pm 5\%$  of the quantity of any admixture being used. All measuring equipment shall be maintained in a clean, serviceable and accurate condition. The accuracy of each scale shall be checked daily at its zero. Re-calibration of the weighing equipment by the manufacturer or his agent shall be undertaken at intervals of not more than 3 months.

### **4.7 Testing of Reinforcement**

#### **4.7.1 General**

Testing of reinforcement shall be carried out by a laboratory approved through HOKLAS for such tests. The Contractor shall submit to the Architect for approval the details, such as the HOKLAS certificate, types of test approved by HOKLAS and job references etc of the selected laboratory.

Should any test specimens fail to comply with this Specification, the Architect may require further tests all at the Contractor's expense, or reject the whole or part of the particular consignment, which must be immediately removed from the site.

Test reports in compliance with the BD requirements shall be furnished to the Architect and RSE.

#### **4.7.2 Sampling and Testing of Steel Reinforcement Bars**

Every batch of steel reinforcement bars delivered to the site shall be sampled and tested in accordance with PNAP 122 or CS2 and the relevant approval letters for the Works from the BD.

The Contractor shall ensure that the tests are in compliance with the current edition of PNAP 122 or CS2, which may be revised by the BD throughout the duration of the Contract.

#### **4.7.3 Fabric Reinforcement**

Every batch of welded fabric reinforcement delivered to the site shall be sampled and tested in accordance with BS 4483 and BS EN ISO 15630 Part 1 and Part 2.

#### **4.7.4 Testing of Reinforcement Couplers**

Where an approved type of reinforcement coupler is used and there is no BD requirement for tests of the type, the Contractor shall carry out tensile tests for three samples of each diameter of couplers to be used for the Works in three months interval or one sample per batch of less than 100 in number or at 1% of the quantity used for the whole Works whichever is the greater as directed by the Architect.

The test shall demonstrate the compliance to BS 4449 and the following requirements:

- (a) The preferred failure mode of the couplers is a bar-break failure, defined as a failure occurring away from the coupler, at a distance of at least 2 bar diameters.
- (b) If bar break is not achieved, then the connection shall reach at least 95% of the actual tensile strength of the bar, measured on a control bar from the same batch, and shall have a ductility of at least 5% measured as the elongation at maximum load ( $A_{gt}$ ).
- (c) The permanent elongation after loading to 60% yield strength ( $f_y$ ) shall not exceed 0.1mm.

The test results shall be submitted to the Architect for record.

#### **4.8 Testing of Cast-in and Drill-in Items**

The Contractor shall carry out loading test of the structural cast-in and drill-in items as may be required by the BD at his own cost and time.

The Architect subject to his discretion may instruct the Contractor to carry out loading test of the structural cast-in and drill-in items to prove the capacity. The test load shall be 1.5 times the recommended working load in the direction of application of the design load. The cost and time incurred shall be borne by the Employer if the test result is found satisfactory to the Architect, otherwise by the Contractor.

See also Annex A for Drill-in Anchors.

#### **4.9 Setting out and Tolerances**

##### **4.9.1 General**

The permitted deviations specified in this section are **NOT** cumulative. Permitted deviations are of individual components and where it is necessary to combine permitted deviations to establish the acceptability of the position of the structural work, the deviations shall be combined using the root sum square method as recommended in Clause 9.4 of BS 5606.

The Contractor shall carry out regular checks on the structure. If an accumulation of tolerances results in a position which is out of the permissible deviations as specified in this Specification, BS 5606 and Clause 10.2 of the HKCC, whichever is more stringent, the Contractor shall propose remedial measures for agreement with the Architect prior to carry out any rectification works. The Contractor shall liaise with all Sub-Contractors and advise the Architect on more stringent requirements in related to the acceptable structural tolerances prior to commencement of Works.

When required by the Architect, the contractor shall furnish all necessary instruments and labour all at his own cost for the use of the Architect for checking the finished concrete.

##### **4.9.2 Datum References**

At commencement of the Contract, the Contractor shall agree with the Architect the government bench marks as datum levels and for the purpose of setting out the gridlines for the Works.

The Contractor shall obtain the setting out dimensions from the Architect to set out the gridlines, and shall be responsible for the accuracy of his work. Figured dimensions shown on the Drawings shall be taken and the Contractor shall verify all such dimensions and levels before commencement of execution of the Works. The checking of any setting-out or of any line or level by the Architect or his representatives shall not in any way relieve the Contractor of his responsibility for the accuracy.

At every structural level, the Contractor shall establish both a datum level and a horizontal reference grid which shall be related back to the approved base bench mark and base reference grid in the forms agreed by the Architect.

##### **4.9.3 Structural Members**

Unless otherwise directed structural members shall be set out from the reference grids and datum levels, and constructed such that the dimension between any two points on different

constructed structural members, or between any two points on the same constructed structural member, or between any point on a constructed structural member and any reference grid or datum level, or the formed elements shall agree with the required dimension, whether shown on or calculable from the Drawings, within the degree of accuracy as stipulated in Clause 4.9.1.

#### **4.9.4 Cast-In Fixings and Starter Bars**

All cast-in fixings and starter bars shall be located within 10mm of the specified location. The Contractor shall liaise with the Nominated Sub-Contractors and advise the Architect if a more stringent tolerance is required.

#### **4.9.5 Vertical Shafts**

The maximum deviation in plumb for any vertical shaft used by hoists or lifts shall not be in excess of the permissible tolerances given in BS 5655-6 or in Clause 4.9.1 of this Specification whichever is the lesser.

The Contractor shall liaise with the Architect on the acceptable tolerances in advance of concreting.

#### **4.9.6 Measuring Equipment**

Tapes used for setting out the Works shall comply with BS 4035 and BS 4484-1. A reference tape shall be kept to check the accuracy of all working tapes. The Contractor shall ensure that all other setting out and measuring equipment is adequate to achieve the accuracies required by this Specification.

#### **4.9.7 Dimensions of Completed Work**

The Contractor shall keep records in an approved form of the dimensions of all work as constructed.

These records shall be available for inspection at any time and shall be submitted to the Architect as an as-built record plan immediately after completion of each section.

### **4.10 Defective Work**

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#### **4.10.1 General**

If any of the finished works, materials, tests or workmanship in any part of the Works fails to comply with this Specification, that part of the works will be classed as defective.

All works classed as defective shall be rectified without due delay. The Contractor shall submit a remedial work proposal to the Architect for approval prior to execution of the remedial work, unless the Architect provides direction to the Contractor for the remedial work or tests to demonstrate acceptability of the work. The Architect may order testing and if found defective, order the defective works to be cut out and properly reconstructed. Such cutting out shall extend to a position suitable, in the opinion of the Architect, for a construction joint.

If the works are proved defective, the Contractor shall bear all the costs and effects on programme incurred by investigation and remedial work for defective work.

#### **4.10.2 Surface Cracking**

The Contractor shall take all reasonable actions to minimise surface cracking. Cracking that will allow corrosion of reinforcement, unsightliness, unacceptable water leakage, impair durability or reduce structural adequacy shall be rectified by the Contractor as agreed with the Architect.

#### **4.10.3 Water-resisting Construction**

In construction specified on the Drawings as water-resisting, any leaks or damp patches shall be repaired in accordance with a method statement proposed by the Contractor and approved by the Architect.

#### 4.10.4 Testing to Establish Acceptability of Work

Where the Works fail to comply with this Specification or the works concrete cubes fail to reach the required strength, the Architect will not necessarily accept the results of any tests proposed by the Contractor as proof of adequate material quality or workmanship.

#### 4.10.5 Defective Appearance

Where the concreting of a part of the works is interrupted before the approved position of a construction joint is reached and the intended appearance of the concrete is thereby spoilt, that part of the works will be treated as defective work.

Any surface which is marred by rubbish left in the formwork, and (when using smooth-surfaced formwork) any surface which is discoloured by leakage of water or grout will be treated as defective works.

### 4.11 Load Tests

Where the works is constructed with dubious material or workmanship, the Architect may require load tests be carried out on the dubious works and the expenses so incurred shall be borne by the Contractor if the work is proved defective.

Test criteria and standards of acceptance shall be in accordance with Section 13 of the HKCC except otherwise specified by the Architect to satisfy the design intent. In normal case, the following test loads and sequence will be applicable:

- (a) The test load including self weight of the structure shall be the greater of: (i) the sum of the characteristic dead load and 1.25 times the characteristic imposed load; or (ii) 1.125 times the sum of the characteristic dead and imposed load.
- (b) Test loads shall be applied and removed in 25% increments, and allowing at least five minutes after a load increment is applied before recording deformation measurements.
- (c) The maximum test load shall be maintained for a period of 24 hours before removal.

Assessment of results shall be made by the Architect with due regard to the material strength, stress or other characteristics in the as-built structures, and with regard to the comparison of the measured performance with that expected on the basis of design calculation. In normal case, the structure under test shall be deemed to be satisfactory if all the following criteria are met:

- (a) no structure defects, signs of weakness or faulty construction are observed;
- (b) the maximum deflection of a member during the test does not exceed  $1/360$  of its span or, for cantilevered members,  $1/180$  of its span; and
- (c) within 24 hours after removal of the test load, the recovery of deformation is at least 75% of the maximum deformation during test.

If the recovery of deformation is less than 75% but is not less than 50%, a retest may be carried out adopting the same test load and sequences. The structure shall be deemed to be satisfactory if in this retest all the above three criteria are met.

The contractor shall submit the method statement and carry out all proper precautions during the load test.

Where results of such tests indicate that any part of the works does not comply with this Specification that part of the works will be classified as defective work.

## 5 HIGH STRENGTH CONCRETES (GRADE 60-100 MPA)

### 5.1 General

#### 5.1.1 Application

The provisions of Sections 1 to 4 of this Specification shall apply; the following additional requirements shall apply to Grade 60-100 MPa concretes only. In the event of any conflict, the requirements of this section shall supersede and take precedence over the other sections.

#### 5.1.2 Special Requirements

The Contractor's attention is drawn to the following special requirements for Grade 60-100 concretes [items (h) to (j) apply to Grade 100 concrete only]:

##### (a) Quality Assurance

All High Strength Concretes shall be subject to a comprehensive quality assurance programme extending from the supply of materials for the concrete to the final curing procedures on site. Details of the proposed scheme shall be submitted at least 8 weeks prior to elements being required. The scheme will be operated by the Contractor with checks by the Architect. The scheme shall cover the items listed in Clause 5.5.

##### (b) Temperature Control

The peak in-situ temperature specified in Clause 3.9.3 may be relaxed to 85°C, provided that:

- the concrete shall contain a minimum of 25% PFA or 50% GGBS by weight of cementitious material; and
- the PC shall have an  $\text{SO}_3^-$  content of less than 2.5%; and
- the total alkali content of the concrete is less than 3kg/m<sup>3</sup> when determined as in PNAP 180; and
- the water / cement ratio of the concrete is less than 0.40; and
- temperature and strength monitoring of the concrete is conducted.

The Contractor is advised that the peak temperature of high strength concrete is likely to exceed 85°C in Hong Kong unless appropriate measures are taken to reduce it, such as adjusting the mix design, insulating formwork, reducing the delivery temperature (by using liquid nitrogen cooling if necessary), or even internal cooling measures such as those achieved by introducing cooling pipes. The Contractor should explore measures of controlling temperatures and temperature gradient and shall submit a temperature control proposal not less than 8 weeks prior to first scheduled pouring of High Strength Concrete.

##### (c) Demonstration Elements

For concretes higher than Grade 60, for each construction method proposed by the Contractor for each mix, the Contractor is required to build one demonstration element on site to demonstrate his methods of construction and temperature control to the satisfaction of the Architect, prior to the commencement of elements construction in the building. These demonstration elements shall represent the elements in which concrete higher than Grade 60 is used and shall be subject to monitoring and testing as described in Clause 5.3.

##### (d) Compliance Testing

The Contractor is advised that an increase in the number of tests is required and that special provisions are necessary for compliance with testing of concrete to ensure validity of results and as described in Clauses 5.2 and 5.4.

**(e) Coring**

The Contractor is required to extract and test 100mm diameter cores for compressive strength from the structure which are to be used as final compliance check for the concrete as described in Clauses 5.2.10 and 5.4.8(q).

**(f) Submissions**

The following submissions are required at least two weeks before casting of any demonstration column:

- i) Mix design
- ii) Temperature control proposals
- iii) Curing
- iv) Quality assurance procedures
- v) Strength compliance

**(g) Control of Alkali Silica Reactivity**

The Contractor shall carry out tests on all aggregate for potential alkali reactivity by an independent laboratory approved by the Architect using the 'Accelerated Mortar Bar Test' to RILEM AAR-2. The aggregate shall be considered acceptable if the average expansion result at 16 days is less than 0.15%. Each type of aggregate shall be tested initially, prior to supply, and then at a minimum frequency of twice per year. If any aggregate is likely to exceed the limit, Contractor shall seek prior approval from the Architect and carry out an accelerated mortar bar test on the actual mix design to RILEM AAR-2 (grading the aggregates to achieve the specified grading) with expansion less than 0.15% at 16 days.

**(h) Control of Thermal Cracking**

The Contractor shall propose suitable methods of protecting the cast concrete in order to ensure that the risk of cracking, from water loss, peak temperature and temperature differential, is minimised and that peak temperature and temperature differential are retained within the maximum allowable temperature. The Contractor shall demonstrate by means of calculations and trials that the proposed concrete mix and method of concreting is adequate to control cracking. The Contractor shall make allowance to conduct stress analysis by a computer program approved by the Architect and in-situ stress measurement of trial element in order to assess the risk of cracking.

**(i) Concrete Creep and Shrinkage**

The long-term deformation effect of concrete by creep and shrinkage shall be evaluated by laboratory tests in an approved body. The shortening effect shall be comparable to normal graded concrete. The following tests are required:

- Concrete creep test to ASTM C512-02 using 100x200mm concrete cylinders instead of 150x300mm. 3 specimens shall be prepared for each mix.
- Shrinkage measured in parallel with the creep specimens (i.e. same curing and environmental exposure conditions throughout the testing) on unloaded specimens. 2 specimens shall be prepared for each mix.
- 2 nos. of standard 150mm cube strength tests and 150mm cylinder elastic modulus test to CS1 at 28 days shall be conducted.
- The creep specimens shall be loaded at an age of 7 days with a loading of 0.3 times the cube strength at 7 days and the loading is adjusted to 0.3 times the work strength of the specified concrete grade at 28 days.
- Creep and Shrinkage to be taken at the following times:
  - Immediately before first creep measurement
  - 3 hours after first creep measurement
  - Daily for first week

- Weekly for next 12 weeks
- Monthly for next 3 months

**(j) Pumping Trial**

Pumping tests shall be conducted by the contractor to satisfy the requirements for placing the concrete and achieving the workability without significant loss of properties. Slump/Slump flow test shall be conducted at the point of placement of the concrete after pumping as necessary to demonstrate that this is being achieved to the satisfaction of the Architect.

**(k) Fire Performance**

The Contractor shall ensure the proposed design mix complies with Clause 4.3 of HKCC and all applicable requirements in the Code of Practice for Fire Resisting Construction 1996. Relevant factors that could minimize spalling of concrete should be considered in the high strength concrete including type of aggregate used, control of silica fume content, moisture content, permeability of concrete and possible heating rate etc. The Contractor shall demonstrate (by local experience, specialist literature review or by testing) that practical means of control is taken in place to reduce risk of spalling that may occur under fire exposure.

## **5.2 Materials**

### **5.2.1 Types of Cement**

The cement shall be PC and supplied from one stated source.

PPFAC and Portland blastfurnace slag cement complying with BS 146: 2002 (BS EN 197-4: 2004 may be used to replace BS 146: 2002) may only be used where approved by the Architect. The level of PFA or GGBS in the cement used throughout the works shall remain constant and be approved by the Architect.

All the cements shall achieve a strength guaranteed to within  $\pm 5$  N/mm<sup>2</sup> when concrete cubes are tested at 28 days to BS 4550: Part 3: Section 3.4: 1978 (amended 1988).

No mixtures of cements of different type will be permitted.

### **5.2.2 Silica Fume (Microsilica)**

Silica fume mineral admixture, also known as microsilica, shall conform to Canadian Standard CAN/CSA-A23.5-98 or ASTM C1240-05. All silica fumes shall come from the same single, proprietary source. Microsilica may be used with any cement specified in Clause 5.2.1.

### **5.2.3 PFA**

PFA shall only be used with PC. Mixtures of PFA with any blended cement will not be permitted. All PFA shall come from the same single, proprietary source. PFA content, which complies with Clause 4.2.5.5 of the HKCC, shall be a minimum of 25% by mass of the total cementitious content of the concrete.

### **5.2.4 Ground Granulated Blastfurnace Slag (GGBS)**

GGBS shall only be used with PC. Mixtures of GGBS with any blended cement will not be permitted. All GGBS shall come from the same single, proprietary source. The maximum GGBS content, by mass of the total cementitious content of the concrete, shall not exceed 50%. For large sections that require to control the heat of hydration or for sulphate resisting concrete, the GGBS content may be increased to 70% subject to the approval of the Architect.



### 5.2.5 Aggregates

Aggregates shall achieve a minimum TFV of 150kN for concrete grade inferior to 70MPa and 170kN for concrete grade 70MPa and above using BS 812-111, and shall comply with all other requirements of BS 812.

In addition to the requirements for flakiness and elongation in this Standard Specification, the combined indices for flakiness and elongation for coarse aggregates used for high strength concrete shall not exceed 50%.

### 5.2.6 Designed Concrete Mixes

High Strength Concretes shall comply with the mix requirements stated in Table 5.1 (NR means no requirements).

No additional water is permitted to adjust slump. All slump adjustment is to be made using admixtures.

**Table 5.1**

Requirements	Max	Min
Total Cementitious content (kg/m <sup>3</sup> ) (See Notes)	600	300
Water/total cementitious content ratio	0.4	NR
Nominal coarse aggregate size (mm)	20	10
Slump at site (mm)	NR	100
Temperature of wet concrete at time of placing °C	25	NR
Notes: 1. For Grade 60 concrete, the total cementitious content shall not in excess of 550kg/m <sup>3</sup> . 2. The cement content should be limited to not more than 450kg/m <sup>3</sup> .		

### 5.2.7 Trial Mixes

Five trial plant mixes shall be carried out using the same equipment and at the same plant intended for supply of the concrete. Each trial mix shall be carried out on a separate day and shall consist of a 3m<sup>3</sup> (minimum size) batch from which the following tests and sample shall be taken from the beginning, middle and end of each batch; after due allowance is made for the time between mixing and placing.

- Temperature
- Slump
- 6 no. cubes

The cubes shall be tested for the 7, 14 and 28 day compressive strength to the requirements of this Specification at an independent HOKLAS approved laboratory and the 28 days results obtained from the 100mm cubes shall comply with the following criteria for acceptance of the trial mix:

- The mean strength of the 28 days results shall exceed the characteristic strength plus 12 MPa.
- No single strength result shall fall below the characteristic strength plus 5 MPa.

In addition to tests on trial mixes to verify compliance with strength requirements, trial mixes shall also be utilised to investigate workability, setting times, and slump loss changes for the mix proposed using various dosages of admixture and different ambient and concrete temperatures.

### 5.2.8 Concrete Production

Concrete suppliers shall operate a quality assurance scheme meeting the requirements of the QSPSC of the HKQAA or BS 8500 and BS EN 206-1; and shall cover all aspects of material supply, quality, batching, mixing, transportation, and properties of the concrete. Provision shall be made for the actual quantities of materials contained in each batch of

concrete to be recorded automatically and the method by which this is to be documented shall be subject to endorsement by the Architect.

The adjustment of slump by dosing admixtures into the concrete should take place not more than two times and each adjustment must be followed with remixing for at least 5 minutes.

If necessary facilities should be set up on site for dispensing admixtures into ready mix concrete for the purposes of controlling slump and setting time. This facility shall be provided and operated by the ready mix concrete supplier.

The ready mix supplier shall provide qualified concrete technicians on site to determine and control the amount of admixture required to be added on site. The technician shall hold a certificate in Concrete Technology (Level 2) from the Materials Division of the Hong Kong Institute of Engineers, or an approved equivalent certification.

### 5.2.9 Cube Testing Compliance Criteria

The cube testing compliance criteria shall be in accordance with the HKB(C)R requirements using 150mm cube specimens. Specimens of 100mm cube complying with the acceptable criteria stated in Table 5.2 may be used subject to the acceptance by BD.

If 100mm control cubes is to be used the Contractor shall make proposal to the Architect in writing, at least 3 months before the commencement of concrete Works, in order to obtain BD's approval for the exemption of Regulation 58 of the HKB(C)R.

**Table 5.2**

Compliance Criteria for 100mm Cube	Column A	Column B
	Average of any four consecutive test results shall exceed the specified grade strength by at least	Any individual test result shall not be less than the specified grade strength minus
C1	7 MPa	2 MPa
C2	5 MPa	2 MPa
Note: Compliance criteria C2 shall apply if in the opinion of the Architect there is sufficient evidence that the standard of quality control using similar materials and plant is such that the standard deviation for at least 40 test results will not exceed 5.5 MPa.		

### 5.2.10 Core Testing Requirements

Concrete cores shall not show evidence of segregation or honeycombing which in the opinion of the Architect is excessive.

Concrete cores shall be capped with sulphur compound with a compressive strength of not less than the core. The thickness of the cap shall not exceed 5mm and made of the same material for all cores.

The test results for compressive strength of concrete cores shall be interpreted in accordance with BS 6089. Adjustments to the measured strength in respect of the age of the core when tested shall not be made unless permitted by the Architect. The estimated equivalent cube strength of each core specimen shall be calculated in accordance with CS1. For any set of cores representing a test location, the average estimated equivalent cube strength shall be at least 85% of the specified grade strength, and each individual estimated equivalent cube strength shall be at least 75% of the specified grade strength.

### 5.2.11 Formwork

The formwork to be adopted for the high strength concrete shall be of the type and design appropriate for the concrete properties including higher fluidity, longer setting time and higher heat content than conventional concrete. Formwork shall be impermeable to prevent moisture loss from the newly poured concrete before stripping of formwork and commencement of curing.

## **5.3 Workmanship and Construction**

### **5.3.1 Demonstration**

#### **(a) General**

Where required, one demonstration element to represent the element sizes being used on site shall be poured at least 40 days prior to commencement of concrete placing to demonstrate the Contractor's method of construction and temperature control. The demonstration elements shall contain the full reinforcement condition of the typical columns to be used in the permanent works. These columns will be used to check and agree with the following:

- site QA procedures, slump adjustment and monitoring procedures, setting times and HKB(C)R strength requirements;
- adequacy of steel fixing and reinforcement spacing;
- adequacy of formwork for grout tightness, rigidity, alignment, and surface finish;
- curing proposals including measures complying with Clause 3.9.2;
- strength of concrete by coring (12 nos. per trial column);
- coring methods;
- rate of gain of strength using matched curing;
- non-destructive testing as directed by the Architect.

Should any demonstration element fail to demonstrate the adequacy of the Contractor's proposals to meet the requirements of this Specification, then the Contractor shall undertake such extra demonstrations as are necessary to demonstrate the adequacy of his proposals.

#### **(b) Heat of Hydration**

The Contractor shall make proposals for achieving the requirements of Clauses 3.9.1, 3.9.2, 3.9.3 and 5.1.2(b) in respect of the effect on heat of hydration. The demonstration elements as stated above shall demonstrate the adequacy of these proposals to meet the requirements of the specification in respect of temperature control. They shall be fully instrumented to record temperatures at 20 locations at 15 minutes intervals for at least 72 hours, as directed by the Architect. Provision shall be made for testing of the concrete as indicated above.

### **5.3.2 Placing and Compaction**

#### **(a) Placing**

High Strength Concrete shall not be placed in any part of the Works until approval has been given. All placing and compacting should be carried out under suitable supervision and as soon after mixing as is practicable. Transporting, placing and compaction of a batch shall be completed within 45 minutes after arrival on site. Delays in placing may be permitted provided that the concrete can still be placed and fully compacted without the addition of further water or admixtures. Protection to exposed concrete surfaces from direct sunlight shall be in place 30 minutes after compaction.

Concrete shall be placed continuously up to construction joints while it is still sufficiently plastic for adequate compaction.

#### **(b) Compaction**

Internal vibrators shall operate at not less than 10,000 cycles per minute. For compacting the test cubes and cylinders a vibrating table operating at not less than 3,000 cycles per minute shall be used.

### 5.3.3 Curing

Immediately upon removing the column formwork, the sections shall be wrapped in 2000 gauge polythene with the polythene edges overlapped by at least 400mm and fully sealed all the way around the edge by 100mm wide PVC tape. Curing shall be maintained for a period of at least 10 days. Other measures of curing protection may be allowed with the approval of the Architect.

### 5.3.4 Making Good

No structural making good of high strength concrete will be permitted except to repair core holes where the strength and durability of the concrete should remain unimpaired.

## 5.4 Performance and Tests

### 5.4.1 General

The tests shall be conducted for materials from each size (where applicable) and from each source; and "each batch" cited in these clauses shall be any quantity of the material of the same type, manufactured or produced at the same time in the same place, covered by the same certificates and delivered to the Site, or stored at the ready-mixed concrete plant, at any one time.

### 5.4.2 Cement

One set of full physical tests shall be carried out in accordance with BS 4550 and BS EN 196 on each batch of cement used; and thereafter twice per week on the same batch.

One set of full chemical analysis tests shall be carried out in accordance with BS EN 196 on each batch of cement used; and thereafter once a year for concrete grade inferior to 70MPa and once a month for concrete grade 70MPa and above on the same batch.

### 5.4.3 Silica Fume (Microsilica)

The Contractor shall certify that all silica fume used complies fully with Canadian Standard CAN/CSA-A23.5-98 or ASTM C1240-05.

Each batch of silica fume delivered shall be tested by an approved independent testing laboratory for compliance with Canadian Standard CAN/CSA-A23.5-98 or ASTM C1240-05 and for the following chemical and physical requirements:

#### (a) Chemical Requirements

Silicon dioxide (SiO <sub>2</sub> ), minimum, percent	85.0
Sulphur trioxide (SO <sub>3</sub> ), maximum, percent	3.0
Loss on ignition, maximum, percent	7.0

#### (b) Physical Requirements

Fineness: Amount retained when wet sieved, on 45µm sieve, percent	0
Pozzolanic Activity Index: With PC, determined at 7 days and 28 days, minimum percent of control	100

### 5.4.4 Pulverised Fuel Ash

**Acceptance upon delivery:** Each delivery of PFA shall be accompanied by a certificate of compliance with BS 3892-1: 1997 stating the chemical compositions, the moisture content, loss on ignition and fineness (45µm sieve).

**Sampling and testing:** a) Physical Test – From each batch used, sample shall be taken once per week or every 1000m<sup>3</sup> concrete production by the concrete supplier; and b) Chemical Test – From each batch used, sample shall be taken once per year by the concrete supplier. The samples will be delivered to the concrete supplier's quality control laboratory and tested in accordance with BS 3892-1:1997.

**Regular tests carried out by an independent laboratory:** Every month a sample shall be taken from the batching plant to be delivered to an independent HOKLAS approved

laboratory to carry out all the chemical analysis and the physical tests required in the BS 3892-1: 1997.

#### **5.4.5 Ground Granulated Blastfurnace Slag (GGBS)**

**Acceptance upon delivery:** Each delivery of GGBS shall be accompanied by a certificate of compliance with BS 6699 stating the chemical compositions, the moisture content, loss on ignition and fineness (80µm sieve).

**Sampling and testing:** a) Physical Test – From each batch used, sample shall be taken once per week or every 1000m<sup>3</sup> concrete production by the concrete supplier; and b) Chemical Test – From each batch used, sample shall be taken twice per year by the concrete supplier. The samples will be delivered to the concrete supplier's quality control laboratory and tested in accordance with BS 6699.

**Regular tests carried out by an independent laboratory:** Every month a sample shall be taken from the batching plant to be delivered to an independent HOKLAS approved laboratory to carry out all the chemical analysis and the physical tests required in the BS 6699.

#### **5.4.6 Aggregates**

The tests described in Clause 4.4.3 shall be carried out except the test frequencies specified otherwise as follows:

- Sieve analysis shall be carried out once per day for concrete grade 70MPa and above.
- Tests for clay, silt and dust shall be carried out once per day.

In addition, tests for TFV, elongation and flakiness indices shall be carried out on each new batch delivered; and the test for potential alkali reactivity shall comply with Clause 2.4.6.

#### **5.4.7 Admixtures**

In addition to Clause 4.5, each batch of admixture shall be tested to BS EN 480 and BS EN 934 and shall be accompanied by a certificate of testing which includes the test results.

#### **5.4.8 Testing of Concrete**

##### **Consistency Test**

- (a) Slump or slump flow tests shall be performed for each batch of concrete delivered to site. Slump tests shall achieve  $\pm 50\text{mm}$  or  $\pm$  one third of the agreed design value, whichever is more stringent, subject to the minimum figure in Clause 5.2.6. Slump flow values and testing criteria shall refer to Clauses 2.8.2 and 4.6.6 respectively.
- (b) Slump/consistency tests shall be carried out both prior to and after the addition of admixture on site to achieve the required workability. Where necessary, workability measurements should be made at the placement location of the concrete.
- (c) A secure, air conditioned lockable facility shall be set up on site by the Contractor under the control of the quality control engineer to provide site testing requirements.

##### **Concrete Cube Test**

- (d) Concrete cubes as required shall be taken for each batch of concrete delivered to site. Only approved concrete test moulds complying with the relevant standards shall be used.
- (e) Concrete cubes should in general be taken after the final adjustment of workability by admixtures has been made, but two additional 150mm cubes and two additional 100mm cubes should be taken before adjustment in one out of every five batches of concrete.
- (f) All cubes made on site shall be compacted using a vibrating table.
- (g) The surface of samples shall be steel-trowelled smooth after the application of an approved polymer latex solution. The latex solution shall be diluted in the proportion of 1 part of latex to 2 parts of water.

- (h) Samples shall only be marked by wax crayon or ink. The concrete shall not be "scribed" or marked in any manner on surfaces intended to be placed in a test machine.
- (i) Concrete cubes shall be cured at an off site HOKLAS certified laboratory.
- (j) For each truckload of concrete, 150mm concrete cubes shall be tested for compressive strength, two at 28 days and two at 7 days if proof of early age strength is required. The testing laboratory should be made aware of the possible high strength at 28 days and they should make arrangement to use a fully accredited and calibrated compression testing machine having the necessary loading capacity.
- (k) All cubes shall be water cured in a temperature controlled tank (at  $27\pm 3^{\circ}\text{C}$ ) containing clean, circulating water for a period of not less than three days after demoulding.
- (l) All testing shall be carried by laboratories holding current HOKLAS approval for conducting the relevant tests.
- (m) For 100MPa concrete, a test machine shall be dedicated to the project and shall be calibrated each month by the approved test laboratory. Any effects of compression impact failure loads shall be immediately reported, and if necessary, the machine shall be mounted on an energy absorption base.  
  
The test machine must have smooth, clean and dry platens to ensure a constant coefficient of friction between the platens and the sample.  
  
The test machine should not be operated at more than 75% of the calibrated machine capacity.
- (n) The cubes should be centrally placed in the test machine. Cubes showing evidence of platen markings shall be rejected.
- (o) The rate of loading applied by the machine to the cube shall be in accordance with CS1.  
  
The machine shall be adjustable to apply a rapid rate of loading to crush the cube to failure and to exhibit the concrete failure mode once the maximum test cube load is exceeded.
- (p) After failure, each concrete test cube shall be examined for proof of concentric loading and concentric concrete reaction by measuring the eccentricity of the load circle relative to the geometric centre of each of the compression faces. Cubes having an eccentricity of more than 25mm and/or an abnormal mode of failure shall be rejected.

#### **Concrete Core Test**

- (q) The Contractor shall make allowance for taking two 100mm diameter concrete cores from each of the elements on each floor at an age of 28-35 days. The core ends should be capped with high strength sulphur capping compound. The cores shall be tested for the compressive strength at an age not greater than 40 days. The Contractor shall make good the voids remaining after coring with a material having a strength not less than the surrounding concrete. Locations of cores shall be agreed in advance and steel reinforcement shall be placed to compensate for the loss of section.

### **5.5 Quality Assurance**

A fully qualified quality control engineer shall be present on site during the construction of concrete work and be responsible for the quality of the concrete as defined above and the implementation of the quality assurance scheme.

## **Annex A: Construction, Performance and Test of Drill-in Anchors**

### **A1 Construction and Performance**

The drill-in anchors shall comply with Clauses 2.10.3 and 4.8 of this Specification and the following requirements:

- (a) Qualified site supervision of the drilled-in anchor works by an experienced and competent person should be provided to ensure that the works are carried out in accordance with the plans approved by BD and that the required standards are complied with.
- (b) Strength tests on a representative number of the drilled-in anchors, as directed by the Architect, are required to be carried out in accordance with the test criteria specified in paragraph A2 below and should be carried out by a recognized laboratory independent of the Contractor.
- (c) A method statement on the anchor tests mentioned under item (b) above is required to be submitted to the Architect for BD submission prior to the application for consent to the commencement of the drill-in works.
- (d) Upon completion of the works, a report is required to be submitted to the Architect, which should include:
  - (i) All results of the strength tests of the drilled-in anchors.
  - (ii) A discussion on any problems encountered during the installation of the anchor bolts and how they were overcome.
  - (iii) A statement signed by the Contractor's structural engineer to confirm that all drilled-in anchors have been installed in accordance with the manufacturer's recommendations.

### **A2 Testing**

Strength tests of the drilled-in anchors should satisfy the following criteria:

- (a) Sampling rate should be i) at least 5% of anchors acting in shear and 10% of anchors acting in tension or 5 numbers each, whichever is more, of each type and size of the anchors installed; or ii) as required by BD whichever is more stringent.
- (b) Each representative anchor should be tested for tensile load by pullout test or shear load by shear load test as appropriate.
- (c) Test load should not be less than 1.5 times the recommended working load of the anchor as specified by the anchor manufacturer.
- (d) Upon the maximum test load is reached, the load should be maintained for at least one hour, and the readings of load and deformation should be taken at the beginning and end of this period to establish whether the tested anchor is subject to creep and relaxation of load under this maximum test load.
- (e) Recovery of the deformation after removal of all loads should be at least 80% of the total deformation at the maximum test load, and the tested anchor should not show any signs of separation, plastic deformation or deleterious effect.

Reference may be made to BS 5080 Parts 1 & 2 for the testing procedures for drilled-in anchors including apparatus set-up, load application and results presentation.

## **Annex B: List of International Standards**

<b>British Standards</b>	<b>Title</b>
BS 146:2002	Specification for blastfurnace cements with strength properties outside the scope of BS EN 197-1
BS 812-103.1	Testing aggregates. Method for determination of particle size distribution. Sieve tests
BS 812-105.1:1989 (Replace BS 812:Section 105.1)	Testing aggregates. Methods for determination of particle shape. Flakiness index
BS 812-105.2	Testing aggregates. Methods for determination of particle shape. Elongation index of coarse aggregate
BS 812-110 (Replace BS 812:Part 3)	Testing aggregates. Methods for determination of aggregate crushing value (ACV)
BS 812-111 (Replace BS 812:Part 3)	Testing aggregates. Methods for determination of ten per cent fines value (TFV)
BS 812-112 (Replace BS 812:Part 3)	Testing aggregates. Method for determination of aggregate impact value (AIV)
BS 812-113 (Replace BS 812:Part 3)	Testing aggregates. Method for determination of aggregate abrasion value (AAV)
BS 812-114 (Replace BS 812:Part 3)	Testing aggregates. Method for determination of the polished-stone value
BS 812-117 (Replace BS 812:Part 4)	Testing aggregates. Method for determination of water-soluble chloride salts
BS 1881:Part 124	Testing concrete. Methods for analysis of hardened concrete
BS 1881-131:1998 (Partially replace BS 4550-3.4)	Testing concrete. Methods for testing cement in a reference concrete
BS 3148	Methods of test for water for making concrete (including notes on the suitability of the water)
BS 3892-1:1997 (Replace BS 3892:Part 1:1982*)	Pulverised-fuel ash. Specification for pulverised-fuel ash for use with Portland cement
BS 4035	Specification for linear measuring instruments for use on building and civil engineering constructional works. Steel measuring tapes, steel bands and retractable steel pocket rules
BS 4449	Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification
BS 4482	Steel wire for the reinforcement of concrete products. Specification
BS 4483	Steel fabric for the reinforcement of concrete. Specification
BS 4484-1	Specification for measuring instruments for constructional works. Metric graduation and figuring of instruments for linear measurement
BS 4550-3.1	Methods of testing cement. Physical tests. Introduction
BS 4550-3.4 (BS 4550:Part 3:Section 3.4:1978)	Methods of testing cement. Physical tests. Strength tests
BS 4550-3.8	Methods of testing cement. Physical tests. Test for heat of hydration
BS 5080-1	Structural fixings in concrete and masonry. Method of test for tensile loading
BS 5080-2	Structural fixings in concrete and masonry. Method for determination of resistance to loading in shear
BS 5606	Guide to accuracy in building
BS 5655-6 (Replace BS 5655:Part 6)	Lifts and service lifts. Code of practice for the selection and installation of new lifts
BS 5975	Code of practice for falsework



BS 6089	Guide to assessment of concrete strength in existing structures
BS 6699	Specification for ground granulated blastfurnace slag for use with Portland cement
BS 7123	Specification for metal arc welding of steel for concrete reinforcement
BS 7973-1	Spacers and chairs for steel reinforcement and their specification. Product performance requirements
BS 7973-2	Spacers and chairs for steel reinforcement and their specification. Fixing and application of spacers and chairs and tying of reinforcement
BS 8007	Code of practice for design of concrete structures for retaining aqueous liquids
BS 8102:1990	Code of practice for protection of structures against water from the ground
BS 8110:Part 1:1985	Structural use of concrete: Code of practice for design and construction
BS 8500-1 (Replace BS 1926 & 5328)	Concrete. Complementary British Standard to BS EN 206-1. Method of specifying and guidance for the specifier
BS 8500-2:2002 (Replace BS 1926 & 5328)	Concrete. Complementary British Standard to BS EN 206-1. Specification for constituent materials and concrete
BS 8666	Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. Specification
BS EN 196-1 (Partially replace BS 4550-3.4)	Methods of testing cement. Determination of strength
BS EN 196-2 (Replace BS 4550:Part 2)	Methods of testing cement. Chemical analysis of cement
BS EN 196-3 (Replace BS 4550-3.5, 3.6 & 3.7)	Methods of testing cement. Determination of setting time and soundness
BS EN 196-5 (Replace BS 4550:Part 2)	Methods of testing cement. Pozzolanicity test for pozzolanic cements
BS EN 196-6 (Replace BS 4550-3.2 & 3.3)	Methods of testing cement. Determination of fineness
BS EN 196-7 (Replace BS 4550:Part 1)	Methods of testing cement. Methods of taking and preparing samples of cement
BS EN 197-1 (Replace BS 12*, 6588 & 7583)	Cement. Composition, specifications and conformity criteria for low heat common cements
BS EN 197-4:2004 (Replace BS 146:2002)	Cement. Composition, specifications and conformity criteria for low early strength blastfurnace cements
BS EN 206-1:2000 (Replace BS 1926 & 5328)	Concrete. Specification, performance, production and conformity
BS EN 480-1 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Reference concrete and reference mortar for testing
BS EN 480-2 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of setting time
BS EN 480-4 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of bleeding of concrete
BS EN 480-5 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of capillary absorption
BS EN 480-6 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Infrared analysis
BS EN 480-8 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of the conventional dry material content
BS EN 480-10 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of water soluble chloride content
BS EN 480-11 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of air void characteristics in hardened concrete

BS EN 480-12 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Test methods. Determination of the alkali content of admixtures
BS EN 933-1 (Replace BS 812-103.1)	Tests for geometrical properties of aggregates. Determination of particle size distribution. Sieving method
BS EN 934-2 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Concrete admixtures. Definitions, requirements, conformity, marking and labelling
BS EN 934-6 (Replace BS 5075*)	Admixtures for concrete, mortar and grout. Sampling, conformity control and evaluation of conformity
BS EN 1008 (Replace BS 3148*)	Mixing water for concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
BS EN 12350-2 (Replace BS 1881-102)	Testing fresh concrete. Slump test
BS EN 12620 (Replace BS 882*)	Aggregates for concrete
BS EN 13139 (Replace BS 1199 and 1200)	Aggregates for mortar
BS EN 14188-1 (Replace BS 2499-1)	Joint fillers and sealants. Specifications for hot applied sealants
BS EN 15167-1	Ground granulated blast furnace slag for use in concrete, mortar and grout. Definitions, specifications and conformity criteria
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
BS EN ISO 9000	Quality management systems. Fundamentals and vocabulary
BS EN ISO 9001	Quality management systems. Requirements
BS EN ISO 15630-1	Steel for the reinforcement and prestressing of concrete - Test methods - Part 1: Reinforcing bars, wire rod and wires
BS EN ISO 15630-2	Steel for the reinforcement and prestressing of concrete - Test methods - Part 2: Welded fabric
<b>International Organization for Standardization</b>	<b>Title</b>
ISO 1920-2:2005	Testing of concrete - Part 2: Properties of fresh concrete
<b>Canadian Standards</b>	<b>Title</b>
CAN/CSA-A23.5-98	Supplementary Cementing Materials
<b>American Standards</b>	<b>Title</b>
ASTM C1240-05	Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C512-02	Standard Test Method for Creep of Concrete in Compression
American Public Health Association (APHA)	Standard Methods for the Examination of Water and Wastewater, Sections 3500-K and 3500-Na
<b>RILEM Standards</b>	<b>Title</b>
RILEM AAR-2	Accelerated test for the alkali-reactivity potential of concrete aggregates - The ultra-accelerated mortar-bar test

Note: The withdrawn BS marked with asterisk \* denotes which remains acceptable by Buildings Department according to the Code of Practice for Structural Use of Concrete 2004.

Hong Kong Shooting  
Association

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**Proposed Shooting  
Range at Pillar Point**

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Specifications for  
Structural Steelwork

ARUP

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# 1 GENERAL

## 1.1 Description of the Structural Works

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The Architect's Drawings show the layout, principal dimensions and arrangement of the structure, the requirements of which are amplified in the following paragraphs.

### 1.1.1 Project Information

In addition to the requirements stipulated in this Specification, the Structural Steelwork (Works) shall be carried out in accordance with the requirements stipulated in all other Contract documents and Drawings which contain general information about the project.

### 1.1.2 Drawings

Tender Drawings, as listed in Bills of Quantities, show the layout, principal dimensions and arrangement of the steelwork. Unless noted otherwise on the Drawings, the Works are designed for the permanent condition only. The Contractor should assess the effects of his/her construction sequence on the design of the structure prior to commencement of the Works

## 1.2 Design

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### 1.2.1 Design

The Works shown on the Drawings and described in this Specification has been designed to the Hong Kong Code of Practice for the Structural Use of Steel 2005 and BS 5950.

### 1.2.2 Slip Factor

Unless noted otherwise, a slip factor of 0.45 has been used in the design of friction grip joints.

### 1.2.3 Building Regulations and Standards

Unless stated otherwise, all undated references to Building Regulations and various standards cited in this Specification refer to the editions (including any amendments) current at the time of Tender. For dated references, only the edition cited applies. Reference to a Code or Standard shall be deemed to include all other Codes and Standards referred to in the specified Code or Standard.

This Specification shall be deemed to be supplementary to the Hong Kong Building (Construction) Regulations. Wherever differences occur then the more onerous requirement is to prevail.

## 1.3 Definitions

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### 1.3.1 Shop Drawings

Drawings showing all necessary information to fabricate the Works.

### 1.3.2 Erection Drawings

Drawings showing the dimension layout of the steel structure from which Shop Drawings are made and which correlate the piece markings with the location in the structure.

### 1.3.3 Independent Inspection Authority

A competent independent person or a HOKLAS accredited association that verifies compliance with this Specification.

### 1.3.4 Examiner/Examining Body

An independent person or a HOKLAS accredited association whose competence to verify compliance of welder tests to BE EN 287-1 or welding procedure tests to BS EN ISO 15614-1 has been accepted by the Architect.



### 1.3.5 Welds

For the purpose of inspection, the weld shall be defined as the weld and the adjacent material.

#### 1.3.5.1 Full Strength Butt Weld (FSBW)

A weld that is not full penetration but is designed to develop full strength of the connection and may have an un-fused land in the centre.

#### 1.3.5.2 Full Penetration Butt Weld (FPBW)

A weld that is fully fused for the full thickness of the material.

#### 1.3.5.3 Partial Penetration Butt Weld (PPBW)

A weld that is similar to a FSBW but is **not** designed to develop the full strength of the connection and will have an un-fused land.

#### 1.3.5.4 Fillet Weld (FW)

A weld that is normally between two plates at right angles. It can also apply to plates lapped (lap weld).

## 1.4 Abbreviations

---

ASTM	American Society for Testing and Materials
BA	Building Authority of Hong Kong
BD	Hong Kong Buildings Department
BS	British Standard
BS EN and BS EN ISO	European Standard adopted as British Standard
CSWIP	Certification Scheme for Welding and Inspection Personnel
DAC	Distance-amplitude-curve
ETAG	European Technical Approval Guideline
HKSC	Hong Kong Code of Practice for the Structural Use of Steel 2005
HOKLAS	Hong Kong Laboratory Accreditation Scheme
IRSE	Independent Registered Structural Engineer appointed by the Contractor and approved by the Architect
NDT	Non-destructive testing
PNAP	Practice Notes for Authorized Persons and Registered Structural Engineers
WPAR	Welding Procedure Approval Record
WPQR	Welding Procedure Qualification Record
WPS	Welding Procedure Specification

## 1.5 Contractor's Drawings and Design Calculations

The Contractor shall produce detailed shop drawings, erection drawings and relevant design calculations. Approval by the Architect of drawings and design calculations prepared by the Contractor does not relieve the Contractor of the responsibility for accuracy of the calculations, detail dimensions on drawings, nor for the general fit-up of parts to be assembled on site.

## **2 GENERAL REQUIREMENTS**

### **2.1 Hong Kong Building Regulations and Code of Practice**

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This Specification shall be read in conjunction with the HKSC, PNAPs and Practice Notes for Registered Contractors which cover the implementation of the Hong Kong Building Regulations. In cases of conflict, the more onerous requirement shall prevail.

In this Specification, Hong Kong Building Regulations include the current editions of the Building Ordinance, Building (Administration) Regulations, Building (Planning) Regulations and Building (Construction) Regulations.

### **2.2 Connection Details**

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If required by the Architect, the Contractor shall design and detail the connections to satisfy the loads shown on the Drawings. All details are to be substantiated by full calculations unless agreed otherwise by the Architect.

The requirements of BS EN 1011-2 and HKSC in avoiding lamellar tearing when designing connections should be considered.

### **2.3 Temporary Works**

---

#### **2.3.1 Responsibility**

The Contractor shall be responsible for the design, fabrication, erection and removal of all temporary works. The design and details of temporary works shall be checked and endorsed by an approved IRSE before fabrication and erection. Upon completion of erection and prior to operation, the temporary works shall be inspected and certified by the IRSE that they are erected in compliance with the endorsed details.

#### **2.3.2 Stability**

The Contractor shall design and provide temporary bracing or restraints to incomplete structure to suit its own sequence and method of working. Alternatively the Contractor shall provide calculations to show that part of the erected structure at its temporary state subjected to relevant loads is still adequate. Any fixing to the permanent structure shall be agreed with the Architect before construction.

Where temporary restraints are used during erection which do not substitute for permanent features, they may be removed after the structure has been lined, levelled and plumbed provided that sufficient steelwork and/or permanent bracing has been erected to ensure the stability of the structure under the worst expected conditions of dead, imposed and wind loading.

### **2.4 Construction Information**

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#### **2.4.1 Fabrication**

The Contractor shall provide the following information to the Architect for review, at least 5 weeks before commencing fabrication (or as otherwise stated in the Contract Documents) and allow another 60 days for submission to BD for approval if necessary:

- (i) Complete and coordinated Shop and Erection Drawings.
- (ii) Calculations and details for connections designed by the Contractor which are required to obtain approval and consent from BD for commencement of the construction works.
- (iii) Detailed method statements for fabrication and corrosion protection application.

- (iv) Details of welding procedures in accordance with BS EN 1011 and approved to BS EN ISO 15614-1 for all welds, including tack and sealing welds.
- (v) Details of proposed shop inspection system, Independent Inspection Authority and Examiner/Examining Body.

The Contractor is entirely at his own risk to commence fabrication works before obtaining approval from the BD.

#### **2.4.2 Erection**

The Contractor shall provide the following information to the Architect for review, at least 4 weeks before commencing erection (or as otherwise stated in the Contract Documents) and allow another 60 days for submission to BD for approval if necessary:

- (i) Detailed method statement for erection, taking account of all information provided by the Architect on design, erection and programme.
- (ii) Detailed drawings and calculations for all temporary works, which are to be checked and endorsed by an approved IRSE.
- (iii) Details of proposed site inspection system.

Erection shall not commence until the method statement has been accepted by the Architect. Any such acceptance means that the Architect's design concept for safe erection has not been invalidated.

#### **2.4.3 Holes, Chases, Inserts and Fixings**

The Contractor shall obtain Architect's approval for the size and position of any hole, chase, insert or fixing required, including those required by any Sub-contractor, before the related work begins. Unless otherwise specified or approved all holes and chases shall be formed and any inserts or fixings shall be built in at the time of construction. Do not cut or drill any part of the Works without Architect's written approval.

#### **2.4.4 Record Drawings**

The Contractor shall provide Record Drawings which show the works as finally fabricated and erected and shall clearly show the location, orientation and level of the erected steel within 4 weeks after completion of each level of the structural steel works or as otherwise stated in the Contract Document.

### **2.5 Programme**

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#### **2.5.1 Programme**

The Contractor shall provide a detailed programme prior to commencement of any Works to show the planned timing of the various items of work to be done, including:

- (i) Preparation and submission of construction information.
- (ii) Sample testing, order and delivery of materials.
- (iii) Fabrication.
- (iv) Application of protective coatings.
- (v) Transport to site.
- (vi) Erection of temporary works.
- (vii) Erection.

#### **2.5.2 Inspection and Testing**

Include in the programme the necessary time for BD's approval and consent as required, all procedural trials, inspection and testing, and trial assemblies.

**2.5.3 Progress**

Arrange the programme so that actual progress can be monitored against each item.

**2.6 Quality Control****2.6.1 Management**

The Contractor shall operate an agreed quality management system to BS EN ISO 9001 and BS EN ISO 3834-3 unless otherwise agreed with the Architect, which shall be accessible for audit. All documentation shall be available for inspection during the contract period.

A quality plan shall be prepared by the Contractor which includes his general standards of workmanship. A method statement shall be provided for each stage of the work. The Contractor shall show that he will be able to achieve the specified quality level at each stage and that the procedures for design, detailing, purchasing, fabrication, erection and protective treatment of steel components and structures can provide a completed steelwork that conforms to the requirements of this specification

Unless otherwise agreed, the Contractor shall provide the Architect with extracts of all execution and supervision standards given in his quality manual that are relevant to the Specification.

**2.6.2 Inspection System**

The Contractor shall operate an inspection system agreed by the Architect to verify that all materials, workmanship and completed Works comply with the specified requirements.

**2.6.3 Tests, Procedural Trials, Trial Assemblies**

The Contractor shall carry out or arrange to carry out all tests on operatives, procedural trials, tests on materials and workmanship and trial assemblies.

All tests are to be conducted by an approved Inspection Authority.

**2.6.4 Personnel**

The Contractor shall ensure that all personnel performing inspections and tests have appropriate qualifications, experience or training.

**2.6.5 Inspection Status**

The Contractor shall operate a system agreed by the Architect for identifying the inspection status at all stages of fabrication and erection.

**2.6.6 Records**

The Contractor shall keep records on site of all tests on operatives, procedural trials and tests on materials and workmanship. All steelwork delivered to site shall be accompanied by relevant mill certificates and delivery records which are to be cross referenced to the approved fabrication and/or erection drawings. Make records available to the Architect for examination.

**2.6.7 Period of Notice**

Agree a period of notice with the Architect for all tests and before commencing any trial assembly.

**2.6.8 Function of the Independent Inspection Authority**

The functions of the Independent Inspection Authority (IIA) shall include, but not limited to the following:

- Review of the Fabricators quality system in relation to the works being carried out.
- Review of the chemical and mechanical properties of materials to be used in the works for conformity.

- Review of all welding procedures proposed (in conjunction with the Architect).
- Checking that personnel have required qualifications and approvals.
- Inspection of fit-up, weld preparations, flame cutting, bending, machining, tack welding, welding pre-heats, completed welding and dimensional conformity as required.
- Witnessing and occasional random verification of NDT carried out by the Fabricator's inspectors.
- Overview of destructive testing programme.
- Witnessing of trial erection.
- Inspection of blast cleaning, application of protective treatments including drying time, overcoating times, stripe coats, minimum coating thickness and quality of surface finish.
- Installation and removal of temporary attachments.
- Any other task that the IIA sees fit to ensure quality at the approval of the Engineer.

### **3 MATERIALS – SECTIONS, PLATES and BARS**

#### **3.1 Hot Rolled Sections, Plates and Bars**

Unless otherwise stated all steel material shall conform to BS EN 10025 or BS EN 10210. Quality grades as noted on the Drawings. Steel must be certified to either BS EN 10025 or BS EN 10210.

#### **3.2 Cold Formed Sections**

##### **3.2.1 Cold Formed Sections**

Steel shall conform to BS 5950-7. Quality grades as noted on the Drawings.

##### **3.2.2 Cold Formed Hollow Sections**

Steel shall conform to BS EN 10219-1 and BS EN 10219-2. Quality grades as noted on the Drawings.

##### **3.2.3 Pre-galvanized Steel Sheet**

Shall conform to BS EN 10143, BS EN 10326 and BS EN 10327. Quality grades and coating types as noted on the Drawings.

#### **3.3 Thin Materials**

Steel plate, sheet and strip under 3mm thickness shall conform to BS 1449-1.1, BS EN 10111, BS EN 10209 and BS EN 1993-1-3. Quality grades as noted on the Drawings.

#### **3.4 Through Thickness Properties**

Shall conform to Clause 3.1.5 of HKSC. See also Clause 12.2.1 of this Specification for through-thickness tensile tests.

#### **3.5 Dimensions and Tolerances**

##### **3.5.1 Plates**

Shall conform to BS EN 10029.

**3.5.2 Structural Steel I and H Sections**

Shall conform to BS 4-1 and BS EN 10034.

**3.5.3 Angles**

Shall conform to BS EN 10056-1 and BS EN 10056-2.

**3.5.4 Hot Finished Hollow Sections**

Shall conform to BS EN 10210-2.

**3.5.5 Hot Rolled Sections**

All other Hot Rolled sections not referred to above shall conform to the relevant BS in Table 1 of BS 5950-2.

**3.5.6 Cold Rolled Sections**

Shall conform to BS EN 10162.

**3.5.7 Cold Formed Hollow Sections**

Shall conform to BS EN 10219-2.

**3.6 Condition of Steel**

---

Steel for fabrication is not to be more heavily pitted or rusted than Grade C of Swedish Standard SIS 05 59 00.

Rectify surface defects in hot rolled sections, plates and wide flats revealed during surface preparation which are not in accordance with the requirements of BS EN 10163.

Rectify surface defects in hot finished hollow sections revealed during surface preparation which are not in accordance with the requirements of BS EN 10210-1

Rectify surface defects in cold formed hollow sections revealed during surface preparation which are not in accordance with the requirements of BS EN 10219-1.

**3.7 Steel Castings and Forgings**

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Shall conform to Clause 9.5 of HKSC.

**3.8 Inspection and Testing**

---

Structural steels shall comply with the requirements of BS 5950-2 and any additional requirements given in Contract documents and on Drawings or as required by BD.

**4 MATERIALS – STRUCTURAL FASTENERS****4.1 Ordinary Bolts and Nuts**

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Shall conform to BS 3692 or BS 4190 as appropriate.

**4.2 Countersunk Bolts**

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Shall conform to BS 4933.

**4.3 High Strength Friction Grip (HSFG) Fasteners**

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Shall conform to BS 4395: Part 1, General Grade.

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#### **4.4 Holding Down Bolts**

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Shall conform to BS 7419.

#### **4.5 Washers**

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Plain and tapered steel washers for use with ordinary bolts shall conform to BS 4320. High strength washers for use with HSFG bolts shall conform to BS 4395 Part 1.

#### **4.6 Spring Washers**

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Shall conform to BS 4464.

#### **4.7 Load Indicating Devices**

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Where load indicating devices are required, use 'Coronet' load indicating washers manufactured by 'Cooper and Turner' conforming to BS 4395 or Torshear type bolts conforming to JSS II-09 or equivalent subject to the approval of the Architect and BD in friction grip joints.

#### **4.8 Surface Finish**

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##### **4.8.1 Galvanized**

Bolt assemblies are to be galvanized in accordance with BS 7371-6.

##### **4.8.2 Sherardized**

Bolt assemblies are to be sherardized in accordance with BS 7371-8 and BS 4921, Class 1.

#### **4.9 Shear Studs**

---

All shear studs to be used in the Works to be proprietary headed studs complying with BS EN ISO 13918 and Clause 10.1.4.1 of HKSC. Diameter and nominal length as noted on the Drawings.

#### **4.10 Stainless Steel Bolts, Nuts and Washers**

---

Bolts and nuts shall conform to BS EN ISO 3506 Parts 1, 2 and 3. Washers should be of stainless steel and should conform to BS EN ISO 7089 or BS EN ISO 7090 as appropriate. The corrosion resistance of the bolts should be equivalent to, or better than, the corrosion resistance of the material to be fastened.

For fasteners with nominal diameters larger than M24 for property classes 70 and 80, the mechanical properties must be agreed between the Contractor and manufacturer and approved by the Architect.

High strength bolts made of stainless steel should not be used as preloaded bolts designed for a specific slip resistance, unless the Contractor can demonstrate, to the satisfaction of the Architect, their acceptability in a particular application from test results.

#### **4.11 Drill-in Anchors**

---

Expansion or chemical anchors shall not be used except otherwise approved by the Architect.

The Contractor shall submit details of all proposed drill-in anchors to be used for the Works to the Architect for approval prior to commencement of the works.

Where approval from the BD is required for the use of such drill-in anchors, the Contractor shall be responsible for the approval to be obtained in a timely manner to facilitate the drill-in work. The cost and delay due to removal of any work without BD approval, or due to any remedial work required as a result of non-approved work shall be borne by the Contractor.

## **5 MATERIALS – WELDING CONSUMABLES**

### **5.1 Welding Consumables**

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All welding consumables used for the arc welding of metallic materials are to comply with BS EN ISO 2560, BS EN 440, BS EN 756 or BS EN 758 as appropriate.

### **5.2 Mechanical Properties**

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Welding consumables and procedures used in the welding of structural works are to achieve mechanical properties for the deposited weld metal not less than the minima specified for the parent metal.

## **6 MATERIALS – GROUT**

### **6.1 Grout**

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Unless otherwise stated on the Drawings, grout around foundation bolts and under column base plates is to be of non-shrink cementitious grout and have a minimum compressive strength at 28 days of 50 N/mm<sup>2</sup> except otherwise specified on the Drawings and is to be of the following form:-

A fluid Portland cement based grout comprising Portland cement and fine natural aggregate mixed in the ratio 1:1 by volume including the use of approved expanding additives to avoid shrinkage. Sufficient water is to be added to provide a viscosity suitable for the voids to be filled without bleeding or segregation of the fresh grout mix.

Salts and chemical requirements for grouts shall comply with the criteria for concrete as stipulated in the **Standard Specification for Structural Concrete**.

### **6.2 Trial Mix**

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For pressure grouting narrow gaps where access is difficult for normal gravity grouting, a trial mix for grout shall be made and tested to demonstrate that the proposed materials, grout mix and method of production will produce grout which complies with the specified requirements on bleeding, free expansion, flow cone efflux time and crushing strength.

If the result of any test does not comply with the specified requirements for the grout, any proposed changes to the materials, grout mix or methods of production shall be submitted to the Architect for review. Further trial mixes shall be made until the result of every test complies with the specified requirements for the grout.

### **6.3 Sampling and Testing**

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### **6.3.1 Bleeding and Free Expansion**

For each grout mix, one sample shall be taken from the grout produced in a day. The sample shall be divided into three specimens and each specimen shall be tested within one hour after the grout has been mixed to determine the amount of bleeding and free expansion of the grout. Samples shall be protected from moisture content changes before the tests are carried out.

Bleeding and free expansion of grout shall be tested in accordance with ASTM C940-98a. The bleeding tests shall be completed immediately prior to each application in a day or as directed by the Architect. The amount of bleeding shall not exceed 2% in the first 3 hours and shall not exceed 4% in total. The water shall be reabsorbed by the grout within 24 hours after mixing.

Free expansion of grout shall not exceed 10% at the ambient temperature.

If the result of any test for amount of bleeding or free expansion of grout does not comply with the specified requirements the grout shall be rejected.

### **6.3.2 Flow Cone Efflux Time**

For each grout mix, one sample shall be taken from each batch of grout and tested to determine the flow cone efflux time of the grout. The method of testing shall be in accordance with ASTM C939-02.

Grout having a flow cone efflux time of less than 15 seconds shall be rejected.

### **6.3.3 Crushing Strength**

The sampling, testing and acceptable criteria for the compressive strength for each grout mix, including the trial mix, shall comply with the requirements for designed mix concrete as stipulated in the **Standard Specification for Structural Concrete** except that the size of test cubes shall be 100mm.

## **6.4 Proprietary Grouts**

Use where specified on the Drawings. The proprietary grout shall conform to HKSC. Resin based grout shall only be used where the fire resistance of material is not required.

Provide written confirmation that proprietary grouts used in the Works do not contain high alumina cement.

## **7 WORKMANSHIP – IDENTIFICATION, STORAGE and HANDLING**

### **7.1 Identification**

#### **7.1.1 Marking**

The Contractor shall mark and document all materials, components, assemblies and sub assemblies delivered to site, to ensure that they are used as specified, and in the locations as shown in the approved drawings.

#### **7.1.2 Additional Paint Marking**

Where appropriate, steel is to have the additional paint marking for identification of steel grade conforming to BS EN 10025-1.

#### **7.1.3 Location of Marks**

Piece markings are to be in positions which are not masked by other material after erection.

**7.1.4 Hardstamping**

No steel is to be hardstamped. Tag-mark steel which is to be blast-cleaned, acid-pickled, metal-sprayed or galvanized.

**7.2 Storage**

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**7.2.1 Holding Areas**

Lay out steelwork in separate holding areas and keep clean.

**7.2.2 Support**

Steelwork is to be adequately supported clear of the ground. Individual piece markings are to be visible when members are stacked.

**7.2.3 Consumables**

Consumables in the Contractor's works and on the Site shall be stored and handled in the manner described in BS EN 1011-1 and in accordance with the relevant standard (See Clause 5.1) and the manufacturer's instructions. Any additional drying or baking of consumables before issue shall be carried out in accordance with the manufacturer's recommendations.

**7.3 Handling**

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Plan and carry out bundling, packing, handling and transport in a manner designed to prevent damage to the steelwork and any protective coating.

Restore any steelwork damaged during off-loading, transportation, storage or erection to conform to the standards of manufacture as given in this specification.

**8 WORKMANSHIP – GENERAL****8.1 Cutting**

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**8.1.1 Process**

Cut steel by an automatic or semi-automatic process.

**8.1.2 Hand Flame Cutting**

Use only where it is impractical to use machine flame cutting and is not to be used without prior approval by the Architect.

**8.2 Dressing**

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**8.2.1 Dressing**

Dress the edges of all plate cut by flame to remove slag, scale, irregularities and excessive hardening. The hardness value after dressing for flame cut surfaces of all grades of steel is not to exceed 350HV when tested to BS EN ISO 6507-1 with 10kgf.

**8.2.2 Grinding**

Remove burrs, sharp arrises and ragged edges by grinding.

**8.3 Bearing**

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### **8.3.1 Compression Joints**

Joints that depend on contact bearing are to have the bearing surfaces prepared to a common plane by milling, sawing or other suitable means to the accuracy given in Clause 8.7.6. The bearing surfaces are to be at right angles to the nominal axis of the member or such other angle noted on the drawings.

No work need be carried out on a bearing surface which is to be grouted direct to a foundation.

### **8.3.2 Stiffeners**

Cut and grind bearing stiffeners to ensure a tight bearing along edges in contact with flanges.

## **8.4 Curving and Straightening**

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### **8.4.1 Properties**

No curving or straightening is to be carried out which may result in material properties that do not conform to the specified requirements for the as-supplied material.

### **8.4.2 Methods**

Shall conform to Clause 14.2.7 of HKSC.

### **8.4.3 Procedures**

Provide curving or straightening procedures to the Architect for review and approval before commencement of the Works.

## **8.5 Heating**

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### **8.5.1 Properties**

No heating is to be carried out to materials that would result in changes of material properties. This applies to normalised steel, controlled rolled steel and quench and tempered steels.

### **8.5.2 Procedures**

Provide heating procedures to the Architect for review and approval before commencement of the Works.

## **8.6 Temporary Attachments to facilitate Erection**

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Details of holes and fittings in components necessary for safety or to provide lifting and erection aids shall be included. Unless specified otherwise in the Drawings, such holes and fittings may remain on the permanent structure.

Account shall be taken of Clause 9.5.5 when detailing the welding of temporary attachments.

When removal of attachments is necessary, they shall be flame cut or gouged at a point not closer than 3mm from the surface of the parent material. The residual material may be ground flush and the affected area visually inspected. When the base material thickness exceeds 20mm (or carbon equivalent > 0.43%) it shall also be checked by magnetic particle inspection. Acceptance criteria are as set out in Clause 12.4. Attachments shall not be removed by hammering.

## **8.7 Accuracy of Fabrication**

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### **8.7.1 General**

Fabricate steelwork to an accuracy that will enable erection within the specified limits to take place without inducing excessive stresses, deflection or distortion into the structure. The

accuracy of fabrication shall comply with this Specification and Section 15 of HKSC whichever is more stringent. Unless specified otherwise permitted deviations refer to the unstressed condition.

Notwithstanding the permitted deviations given in the following clauses in this section, the steelwork shall be fabricated such that it can be erected within the tolerances given in Clause 11.13 of this Specification.

#### **8.7.2 Built-up Members**

Tolerances on built-up members, including castellated beams, are to comply with BS 5950-2:2001.

#### **8.7.3 Length**

Members with both ends prepared for contact bearing are not to deviate from the detailed length by more than 1mm.

Members without ends prepared for contact bearing, which are to be framed to other steel parts of the structure, are not to deviate from the detailed length by more than 2mm for members 10m or less in length, and 4mm for members greater than 10m in length.

#### **8.7.4 Straightness**

The deviation of a member from a straight line drawn between adjacent points of subsequent effective lateral restraint is not to exceed the greater of 3mm or 0.1% of the distance between restraints unless noted otherwise on the Drawings.

#### **8.7.5 Camber**

The deviation from specified or proposed camber is not to exceed the greater of 12mm or 0.1% of the length of the member.

#### **8.7.6 Compression Joints**

Gaps in joints that depend on contact bearing when assembled during fabrication are to comply with Clause 15.4.5 of HKSC.

## **9 WORKMANSHIP – WELDING**

### **9.1 General**

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#### **9.1.1 Arc Welding**

Arc welding of metallic material is to comply with BS EN 1011-1 and BS EN 1011-2 as appropriate, together with clauses contained in this Section.

#### **9.1.2 Welding Technologist**

Welding is to be carried out under the direction of a certified International Welding Technologist (IWT) with appropriate qualifications, experience or training as described in BS EN ISO 3834-5. The tasks and responsibilities of such persons shall be clearly defined.

#### **9.1.3 Quality requirements**

The Steelwork Contractor's system for the management of welding shall comply with BS EN ISO 3834-3.

All welding documentation (welder qualification certificates, welding-procedure qualification records, welding procedure specifications and associated work instructions) shall be reviewed for applicability by the person responsible for welding coordination (welding coordinator).

The manufacturer and Steelwork Contractor shall have at their disposal sufficient and competent personnel for the planning, performing and supervising of the welding production according to specified requirements.

## **9.2 Welding Procedures**

### **9.2.1 Approval of Welding Procedures**

Welding procedure trials and the qualification records according to BS EN ISO 15614-1 shall be witnessed and endorsed by an Examiner/Examining Body.

Witnessing of procedures shall be undertaken by approved inspectors to BS EN 473 as a minimum and approval by an approved certified IWT as a minimum.

Previous welding procedure approvals to BS EN 288-3:1992 or former national standards may be considered at contract stage and agreed between the contracting parties, providing that the intent of the technical requirements is satisfied and the previous procedure approvals are relevant to the application and production work on which they are to be employed. Where applicable the WPS(s) shall be submitted for review by the Architect at least 2 weeks prior to the start of production.

Documents required to support a WPQR(s) are as follows:

- WPAR(s)
- Complete mechanical test results
- Complete non-destructive test results
- Original material certificates (which should have either a full chemical analysis or the carbon equivalent)
- Consumable certificates (if available)

Summary documents are not acceptable.

Notified fillet welds, partial penetration welds, full strength butt welds and tee butt welds subject to tensile loads  $> 0.5 Y_s$ , tests shall be completed by additional cruciform test performed in accordance with BS EN ISO 9018.

### **9.2.2 Preparation of Welding Procedure Specifications**

Written welding procedure specifications (WPSs) shall be available in accordance with BS EN ISO 15609-1. They shall comply with the guidance of BS EN 1011-2, Annex C, Method A for the avoidance of hydrogen cracking. Consideration shall be made to the requirements in Annex D of BS EN 1011-2 to ensure that there is adequate toughness in the heat-affected zone (HAZ) of the weld. HAZ toughness shall be as a minimum be equivalent to the parent steel specification.

WPS shall ensure that the range of qualification is within the requirements of Section 8, BS EN ISO 15614-1. In addition to Section 8 of BS EN ISO 15614-1, carbon equivalent is considered an essential variable <sup>(Note)</sup>. Any change in the carbon equivalent from that given in the WPQR  $> + 0.01\%$  and the production material and the procedure will require additional approval. Reduction in the recorded carbon equivalent level for production when compared to the recorded carbon equivalent in the WPQR will not require additional approval.

All WPS shall be reviewed and approved by the IWT before being used in production.

Where WPS(s) are based on previously approved WPQR(s) they shall be submitted to the Examiner/Examining Body for verification of compliance with BS EN ISO 15614-1 and BS EN 1011-2.

(Note: The suitability of WPS for the steel to be welded includes the consideration of the actual Carbon Equivalent (CE) of the steel if this differs from the CE value recorded in the WPQR.)

### **9.2.3 Charpy V-notch Impact Test**

Shall be included, either to BS EN 10045-1 or as instructed by the Architect.

### **9.2.4 Application of Welding Procedure Specifications**

Appropriate work instructions shall be produced from the WPQR(s) under the authority of the welding coordinator. The work instructions shall be either WPS(s) or contain all the relevant information required from the WPS in other formats suitable to the Steelwork Contractor's system. They shall be provided to the welder or welding operator prior to the commencement of welding and shall be made available to the Architect, Employer or Inspection Authority on request and shall include a cross-reference to the WPS upon which they are based. Simple work instructions with minimal information are not acceptable.

## **9.3 Welder Qualification**

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### **9.3.1 Testing**

Welders shall be tested to meet the requirements as given in BS EN 287-1.

### **9.3.2 Certification**

Welder testing shall be witnessed and certificates approved/endorsed by an Independent Inspection Authority or Examiner/Examining Body.

### **9.3.3 Period of Validity**

The period of validity of the welder's qualification shall comply with Section 9 of BS EN 287-1.

### **9.3.4 Limitations**

Welders shall work within the stipulated limitations as given in BS EN 287-1 at all times. Welds completed by welders found to be working outside stated limitations may be required to be removed.

## **9.4 Welding Consumables**

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Shall be used in accordance with the manufacturer's recommendations.

## **9.5 Assembly**

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### **9.5.1 Fit-up**

Joints shall be prepared in accordance with BS EN ISO 9692, Parts 1 and 2 and fitted up to the dimensional accuracy required by the WPS, depending on the process to be used, to ensure that the quality in BS EN ISO 5817, level B is satisfied. Precautions shall be taken to ensure cleanliness of the connection prior to welding.

### **9.5.2 Jigs**

Fabrications assembled in jigs may be completely welded in the jig, or may be removed from the jig after tack welding. It is the responsibility of the Steelwork Contractor to ensure the welds used before removal are adequate.

### **9.5.3 Tack Welding**

Tack welds complying with BS EN 1011-1 and BS EN 1011-2 may be used provided:

- (i) they are laid in an area to be welded and are thoroughly removed by grinding or gouging such that the subsequent welding is unaffected; or
- (ii) they are undertaken by a welder qualified as in Clause 9.3 as short length normal welds of a length at least four times the thickness of the thicker part being joined, or

50mm whichever is the greater. The welding procedure shall comply with Clause 9.2; or

- (iii) they are undertaken by a welder qualified as in Clause 9.3 and the welding procedure complies with Clause 9.2, and the tack is fully re-melted during subsequent welding (this will need to be substantiated by a welding procedure); or
- (iv) they are located away from zones where subsequent welding is to take place and in a zone where only compressive forces are present in service.

#### **9.5.4 Distortion**

Welding procedures and sequence of fabrication are to be such that distortion is controlled and reduced to a minimum. But in any case, distortion shall not exceed the tolerances set out in Clause 8.7 of this Specification unless otherwise agreed with the Architect.

#### **9.5.5 Temporary Attachments**

Welding of temporary attachments required for fabrication or erection shall comply with BS EN 1011-1 and BS EN 1011-2 and shall be made in accordance with the requirements for a permanent weld and inspected.

#### **9.5.6 Run-on and Run-off Plates**

Where possible, use run-on and run-off plates in making butt welds to ensure full throat thickness at the ends. They are to comply with the following requirements:

- (i) The Specification for the plates is to be identical to that for the material being welded.
- (ii) The plates, having a sufficient length to prevent craters due to the stoppage of the weld, are to be prepared in the same profile as the parts being joined.
- (iii) After completion of welding, the plates are to be removed by cutting. The surfaces where they were attached are to be ground smooth and inspected for cracks.

#### **9.5.7 Castellated Beams**

Welding is to comply with this Specification.

#### **9.5.8 Production Test Plates**

Where production test plates are specified for test purposes they shall be clamped in-line with the joint. The grade and quality of material, carbon equivalent and rolling direction shall match the parent plate, but need not be cut from the same plate or cast.

The production test plates shall meet the requirements of BS EN ISO 15614-1 for tensile, impacts and hardness unless otherwise agreed with the Architect.

### **9.6 Shear Stud Welding**

#### **9.6.1 Method**

Fix shear studs in accordance with the manufacturer's recommendations for materials, procedures and equipment. Adequate return earth connections shall be made local to the area being stud welded. The local area around where the stud is to be welded shall be free of standing water before commencement of welding. The welding shall comply with BS EN ISO 14555.

If the studs are to be welded by other than drawn arc and this has not been indicated on the Drawings, the Architect shall be notified. Unless agreed otherwise by the Architect, the size of fillet weld shall be chosen such that the full tension capacity of the stud can be developed.

#### **9.6.2 Trial Welding**

Before commencement of the Works, carry out trial welding of studs to demonstrate the suitability of the proposed welding system and equipment. The trials shall be made using the

proposed procedures and on samples of materials representative of those to be used in the work (carbon equivalent, grade and thickness). Test a minimum of ten studs in the trial.

During the work, at the start of each shift, a minimum of two trial welds are to be undertaken by each welder. If either of these trial studs fails a bend test in accordance with Clause 9.10.4, then further trials shall be conducted until satisfactory performance is established.

#### **9.6.3 Visual Inspection**

Visually inspect trial welded studs. They are to exhibit full 360 degree 'flash'. See also Clause 12.6.1.

#### **9.6.4 Bend Test**

Subject trial welded studs to a 15-degree bend test according to Clause 12.6.2.

### **9.7 Removal of Slag**

Remove slag by light hammering, wire brushing or other methods that do not deform the surface of the weld.

## **10 WORKMANSHIP – BOLTING**

### **10.1 Holes**

#### **10.1.1 Forming and Tolerance**

Unless agreed otherwise by the Architect, the forming of holes and the tolerance of hole diameters shall conform to Clause 14.2.5 of HKSC.

Holes for close-tolerance bolts shall be drilled to a diameter equal to the nominal diameter of the shank subject to a tolerance of +0.15 mm and -0 mm.

#### **10.1.2 Size**

Holes for ordinary bolts are to be of diameter not more than 2mm greater than the diameter of the bolt for bolts up to 24mm diameter, and not more than 3mm greater than the diameter of the bolt for bolts over 24mm diameter, except in steel base plates and where noted on the Drawings.

Holding down bolt details shall include provision of loose cover plates or washers with hole diameter 3mm greater than the holding down bolts.

#### **10.1.3 HSFG Fasteners**

Holes to comply with BS 4604.

#### **10.1.4 Drifting**

Drifting to align holes shall not enlarge the holes and must not cause damage or distortion to the final assembly.

#### **10.1.5 Reaming**

Where parts cannot be brought together by drifting without distorting the steelwork, rectification may be made by reaming, provided that the design of the connection will allow the use of larger diameter holes and bolts and approved by the Architect.

Calculations shall be made to demonstrate that the connection remains adequate for the forces in the connection if using pre-loaded bolt assemblies.



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## **10.2 Holes in Hollow Sections**

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Seal bolt holes and vent holes in hollow sections to prevent the ingress of moisture. If not specified on the Drawings, the Contractor shall show the proposed method on the Shop Drawings.

## **10.3 Make-up of Bolt Assemblies**

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For all bolt assemblies the strength grade combination of bolt/nuts/washers is to be as prescribed or recommended in BS 5950-2.

## **10.4 Condition of Bolts**

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Bolt assemblies are to be in such condition immediately before installation that the nut turns freely on the bolt. Any bolt assemblies which seize when being tightened shall be replaced.

## **10.5 Galvanized Nuts**

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Nuts shall be checked after being galvanized for free running on the bolt and re-tapped if necessary to ensure a satisfactory tightening performance.

## **10.6 Washers**

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### **10.6.1 Washers**

Each bolt assembly is to contain at least one washer placed under the part being rotated.

If full bearing capacity is required when connecting thin-gauge sections of 4mm or less to each other, washers shall be used under both the bolt head and the nut.

A heavy duty washer shall be used under the head and nut if bolts are used to assemble components with oversize or slotted holes.

### **10.6.2 Taper Washers**

Taper washer shall be placed under bolt head and nut bearing on surfaces sloping 3° or more from a plane at right angles to the bolt axis.

## **10.7 Installation of Spring Washers**

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Tighten bolt assemblies containing spring washers until the spring washer is completely flattened.

## **10.8 Locking of Nuts**

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Secure nuts shall be used in connections subject to vibration or reversal of stresses to prevent loosening. If not specified on the Drawings, the Contractor shall include the proposed method in the erection details.

## **10.9 Limits to Length**

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For Grade 8.8 bolts, the bolt length shall be chosen such that at least one complete thread in addition to the thread run-out that shall remain clear between the nut and the unthreaded shank of the bolt after tightening. For higher grades, at least five clear threads shall remain.

For normal grade HSFG bolts, the bolt length shall be chosen such that at least three complete threads in addition to the thread run-out that shall remain clear between the nut and the unthreaded shank of the bolt after tightening. For higher grade, at least five clear threads shall remain.

The length of bolts in all cases is to be such that at least one clear thread shows above the nut after tightening, and at least one thread plus the thread run out is clear between the nut and the unthreaded shank of the bolt.

## **10.10 Bolt Tightening**

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Bolt and nut assemblies shall be tightened to BS 5950-2.

## **10.11 Fitted Bolts**

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Precision bolts to BS 3692 may be used as fitted bolts if holes are drilled or reamed after assembly so that the clearance in the hole is not more than 0.3mm.

## **10.12 Fit-up**

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Connected parts shall be firmly drawn together (Connected parts intended to transfer force in friction shall be firmly drawn together with all bolts partially tightened). The joint shall then be examined and if there is any remaining gap which may affect the integrity of the joint, it shall be taken apart and a pack inserted before recommencing the tightening procedure.

## **10.13 Movement Connections**

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### **10.13.1 Slotted Holes**

Where slotted holes are provided for movement connections, the joint is to be free to move.

### **10.13.2 Method**

Make bolted movement connections in the following manner:

- (i) The slotted hole is to be wider than the unslotted hole.
- (ii) A shouldered bolt is to be used, with a spring washer under the head and the shoulder bearing on the faying surface of the unslotted member.
- (iii) A flat washer is to be provided under the nut and the nut tightened onto the unslotted member.

## **10.14 High Strength Friction Grip Fasteners**

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### **10.14.1 Tightening**

The use of high strength friction grip bolts shall comply with BS 4604 Part 1 or Part 2.

### **10.14.2 Tightening Method**

Tightening which complies with BS 4604-1 may be by the torque-control method or load indicating device (see Clause 4.7) used according to the manufacturer's recommendations.

### **10.14.3 Calibration of Tightening Equipment**

The tightening equipment, whatever its type or pattern, shall have a calibration check at least once per shift, and shall be re-calibrated if required by the Architect in accordance with BS 4604.

### **10.14.4 Discarded Bolt Assemblies**

If, after complete tightening, a bolt or nut is slackened off for any reason the whole bolt assembly is to be discarded and not re-used in the Works.

## **10.15 Faying Surfaces for HSFG Fasteners**

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### **10.15.1 Mill-scale**

Remove all mill-scale from the faying surfaces of friction grip joints.

**10.15.2 Surface Condition**

The faying surfaces of friction grip joints are to be free of distortion, deformities or contaminants which may reduce the slip factor below the design value.

**10.15.3 Deformed Surfaces**

Machine flat. Carry out tests to BS 4604 to determine the slip factor after machining.

**11 WORKMANSHIP – ERECTION****11.1 General**

The Contractor shall check before erection of any steelwork that work abutting the steelwork to be erected has been correctly placed in position and level. Any discrepancies shall be reported immediately to the Architect. Checks shall be made in a timely manner which enables connections and modifications to be performed without delay to the erection.

The erection of structural frames shall comply with this Specification, the requirements given in BS 5950-2 and BS 5531. The Contractor shall ensure that appropriate safe systems of work are provided, installed and properly maintained to discharge the duties under current safety legislation.

**11.2 Foundation Bolts****11.2.1 Setting-in**

Hold foundation bolts firmly in position during all setting-in operations.

**11.2.2 Damage**

Protect bolts, threads and nuts against damage, corrosion and contamination at all stages of construction.

**11.2.3 Pockets**

Keep pockets formed around foundation bolts clean and free from all extraneous matter.

**11.3 Drill-in Anchors****11.3.1 General**

All drill-in anchors in the concrete structure shall be demonstrated to have sufficient strength and shall be adequately embedded in such a manner that the load is sufficiently distributed to avoid over stressing of the concrete. The location of fixings shall meet the tolerances required for installation of the fitting-out system. Anchors shall be co-ordinated such that they do not clash with any reinforcing steel bars of the concrete structure. See also Annex B for further requirements of drill-in anchors.

**11.3.2 Installation**

Installation of anchor bolts must strictly follow the manufacturer's specifications. Any installation procedures or details that deviate from the manufacturer's specifications should be appended by a written statement from the manufacturer to confirm strength of the anchors.

**11.3.3 Tolerances on Placement**

Any deviation from the correct position of anchor bolt should be reported, appended with justification calculation to prove the capacity of the anchor, to the Architect prior to the installation of the fitting-out items. Minimum edge distance and spacing of anchor bolts should strictly comply with the manufacturer's specification.

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## **11.4 Erection Stresses and Erection Loads**

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The stress limits given in BS 5950 during handling and erection, shall not be exceeded.

The Contractor shall ensure that no part of the structure is permanently distorted by stacking of materials or temporary erection loads during the erection process.

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## **11.5 Temporary Works**

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### **11.5.1 Loadings**

Ensure that the steelwork is adequately braced or restrained to withstand all loadings liable to be encountered during construction without inducing excessive stresses, deflection or distortion in the structure.

The Contractor shall ensure that the load spread under cranes and lifting plant is commensurate with the strength of firm standing provided by the supporting structure.

### **11.5.2 Removal**

Temporary works are to remain in position until such time as construction is sufficiently advanced to allow its safe removal.

### **11.5.3 Connections**

Any connections for temporary works are not to weaken the permanent structure or impair serviceability.

### **11.5.4 Effect on Permanent Works**

The Contractor is responsible for justifying the impact of any temporary works on the permanent structure.

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## **11.6 Alignment**

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Align each part of the structure as soon as practicable after it has been erected. Do not make permanent connections between members until sufficient of the structure has been aligned, levelled, plumbed and temporarily connected to ensure that members will not be displaced during the subsequent erection or alignment of the remainder of the structure.

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## **11.7 Temperature Adjustments**

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Take due account of the effects of temperature on the structure and measuring equipment when measurements are made for setting-out and erection, and for dimensional checks carried out subsequently.

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## **11.8 Packings**

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### **11.8.1 Packs and Wedges**

Plumb and level columns using steel packs and wedges of adequate strength and stiffness and these packs and wedges are not to be larger than necessary for the purpose and of adequate strength and stiffness.

### **11.8.2 Position**

Where packings are to be left in position and subsequently grouted, they are to be placed such that they are totally enclosed by the grout and would not prevent subsequent grouting to completely fill all spaces directly under the base plates.

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## **11.9 Grouting**

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### **11.9.1 Grouting**

Do not carry out grouting under column base plates until a sufficient portion of the structure has been aligned, levelled, plumbed and adequately braced by other structural components which have been levelled and are securely held by their permanent connections.

As directed by the Architect, the Contractor shall submit detailed method statements for grouting narrow gaps or gaps where the grout materials could not be placed by gravity.

### **11.9.2 Space Under Base Plate**

Immediately before grouting, the space under column base plates is to be clean and free of all extraneous matter.

### **11.9.3 Proprietary Grout**

Prepare, mix and place in strict accordance with the manufacturer's instructions and recommendations.

## **11.10 Sliding Surfaces**

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Treat the sliding surfaces of uncoated expansion joints with molybdenum disulphide grease before making the connection.

## **11.11 Thermal Cutting**

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Do not use thermal cutting equipment on site unless agreed otherwise by the Architect for specific applications.

## **11.12 Site Welding**

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Where site welding is required, provide suitable staging, platforms and weather protection for welding operations. Site welding shall comply with all the requirements given in Section 9.0.

## **11.13 Accuracy of Construction**

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### **11.13.1 General**

Except otherwise stated on the Drawings and other Contract documents, the Contractor shall erect steelwork within the limits specified in this Specification and make all necessary allowances and adjustments to achieve this accuracy, taking account of the following:

- (i) All measurements be taken in calm weather, and due note is to be taken of temperature effects on the structure.
- (ii) The deviations shown for I sections apply also to box and tubular sections.
- (iii) Where deviations are shown relative to nominal centrelines of the section, the permitted deviation on cross-section and straightness may be added.
- (iv) Inspect for position and level not less than seven days before the planned start of steelwork erection.
- (v) Notify the Architect of any discrepancies found.
- (vi) Ensure that structures by others, including cast-in components and fixings, to which steelwork attaches, are constructed within the anticipated permitted deviations before commencing steelwork erection.

The permitted deviations specified in this section are **NOT** cumulative. Permitted deviations are of individual components and where it is necessary to combine permitted deviations to establish the acceptability of the position of the steelwork, the deviations shall be combined using the root sum square method as recommended in Clause 9.4 of BS 5606.

The Contractor shall carry out regular checks on the steelworks. If an accumulation of tolerances results in a position which is out of the permissible deviations as specified in this Specification or other Contract documents and Section 15 of HKSC, whichever is more stringent, the Contractor shall propose remedial measures for agreement with the Architect prior to carry out any repair works.

The Contractor shall liaise with all Sub-Contractors and advise the Architect on more stringent requirements in related to the acceptable structural tolerances prior to commencement of Works.

When required by the Architect, the Contractor shall furnish all necessary instruments and labour all at his own cost for the use of the Architect for checking the finished steelworks.

#### **11.13.2 Datum References**

At commencement of the Contract, the Contractor shall agree with the Architect the government bench marks as datum levels and for the purpose of setting out the gridlines for the Works.

The Contractor shall obtain the setting out dimensions from the Architect to set out the gridlines, and shall be responsible for the accuracy of his work. Figured dimensions shown on the Drawings shall be taken and the Contractor shall verify all such dimensions and levels before commencement of execution of the Works. The checking of any setting-out or of any line or level by the Architect or his representatives shall not in any way relieve the Contractor of his responsibility for the accuracy.

At every structural level, the Contractor shall establish both a datum level and a horizontal reference grid which shall be related back to the approved base bench mark and base reference grid in the forms agreed by the Architect.

#### **11.13.3 Structural Members**

Unless otherwise directed structural members shall be set out from the reference grids and datum levels, and constructed such that the dimension between any two points on different constructed structural members, or between any two points on the same constructed structural member, or between any point on a constructed structural member and any reference grid or datum level, or the formed elements shall agree with the required dimension, whether shown on or calculable from the Drawings, within the degree of accuracy as stipulated in Clause 11.13.1.

The butting surfaces of column sections which are one metre and over in width or depth and are to be in direct bearing shall be specially prepared so that after erection both the permitted deviation in plumb in Clause 15.12.4 of HKSC and the permitted gap in Clause 15.12.7 of HKSC are not exceeded except that the second diagram in Clause 15.12.7 of HKSC shall not apply.

#### **11.13.4 Pre-camber**

The Contractor shall determine the exact pre-cambers required according to his proposed construction sequence and method statements for the construction of concrete floor slabs and/or glass/metal features etc., such that the specified level of the slab and/or feature is achieved within the specified tolerances. The Contractor shall allow for carrying out a trial, prior to pre-cambering of the steel, to show that the typical secondary floor beams when supported using the connection details determined by the Contractor, exhibit the predicted deflection characteristics when subjected to loads equivalent to the weight of the concrete slab or glass/metal feature.

The first level of each typical floor being constructed on site will be designated as trial floor to assess the construction tolerances both before and after construction of the floor slabs. The Contractor shall conduct a detailed survey of all the beams on the floor to assess their levels and deflections prior to and after construction of the floor slabs. The findings from this

study will be reviewed against the predicted deflections of beams and the Contractor shall make necessary pre-camber adjustments prior to construction of the next level of floor.

Except otherwise agreed by the Architect, the concrete encasement of the columns will be carried out at the same time as the concreting of the floor slab at the level immediately above and the Contractor should not rely on the composite action of the columns when assessing the pre-camber or propping strategy of the floor beams when casting the floor slab.

## **12 QUALITY CONTROL**

### **12.1 Materials Test Certificates**

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#### **12.1.1 Steels**

Provide test certificates to demonstrate that steels used in the Works conform to the requirements of this Specification and BS 5950-2.

#### **12.1.2 Bolts**

Provide test certificates to demonstrate that bolts used in the Works conform to the requirements of this Specification and BS 5950-2.

#### **12.1.3 Welding Consumables**

All welding consumables used in the Works need to have certificates to demonstrate that they comply with the requirements of this Specification and BS 5950-2.

#### **12.1.4 Verification**

All test certificates are to be verified by an approved Independent Inspection Authority.

### **12.2 Additional Tests on Steels**

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#### **12.2.1 Additional Tests**

In the areas noted on the Drawings, the material is to be subject to the following additional tests:

- (i) Ultrasonic tests for laminations to the specified acceptance level in accordance with BS EN 10160, Class S2 and E2.
- (ii) Through-thickness tensile tests for through thickness properties to quality class Z25 in accordance with BS EN 10164.

Tests are to be conducted either by the steel manufacturer or by an approved independent HOKLAS accredited laboratory on supplied materials.

#### **12.2.2 Test and Inspection Records**

Records of all tests and inspections are to be verified by the approved Independent Inspection Authority.

### **12.3 Non-Destructive Testing of Welds**

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#### **12.3.1 Inspection Authority**

Examination of welds is to be carried out by an approved Independent Inspection Authority (IIA) or Examiner/Examining Body unless agreed otherwise by the Architect.

### 12.3.2 Information

The Inspection Authority or Examiner/Examining Body shall be provided with all information to enable inspection to be conducted and reported. This will include access to the contract specification, WPS(s), material certificates (to verify grade), fabrication records (project identification).

Inspection records that fail to be identified to the project or have the correct acceptance criteria stated will be rejected and all work re-inspected. It is the fabricator's responsibility to ensure the inspector has the information required to perform his duties.

### 12.3.3 Records

Keep records to demonstrate that welds have been inspected as required in Clauses 12.5 and 12.6, have complied with the requirements of Clauses 12.3.4 to 12.3.7 and repairs completed where required.

In these records, fabrications and welds shall be clearly identified to enable traceability of any connections inspected. Identification of connections or welds should conform to the system adopted in the fabrication shop and should not be a separate system devised by the inspection company. All defects shall be recorded in a repair register along with remedial actions and final close out report to verify repair on the same sheet as acceptable work. Separate records for acceptable work and defective work are not acceptable.

The Contractor shall keep records of all weld examinations on site and shall be available for inspection when requested.

### 12.3.4 Visual Inspection

Visual examination shall be made in accordance with BS EN 970, sections 8, 9 and 10 over the full length of the weld. Such inspections shall be performed before any required non-destructive inspection and results recorded.

A suitably qualified person for visual inspection of welds may be a welding inspector or a welder who can provide evidence of having been trained and assessed for competence in visual inspection of the relevant types of welds during and after welding by a nationally recognised authority (CSWIP to BS EN 473). Internal company training schemes are not acceptable.

### 12.3.5 Surface Flaw Examination

Magnetic Particle Inspection (MPI) shall be in accordance with Clause 12.5.2 conforming to the recommendations in BS EN 1290.

If MPI is impractical, Dye Penetrant Inspection (DPI) may be used in accordance with the recommendation given in BS EN 571-1, with the permission of the Architect.

Final surface flaw detection of a welded joint shall be carried out after completion of the weld in accordance with the hold times given in Clause 12.3.7.

A suitably qualified person for surface flaw detection of welds should be a welding inspector or a welder who holds a current certificate of competence from a nationally recognised authority (CSWIP to BS EN 473).

### 12.3.6 Ultrasonic Examination

Where ultrasonic examination is required in accordance with Clause 12.5.2 it shall be made in accordance with the requirements of BS EN 1714 using reference level to Method 1, evaluation reference -14dB (20% DAC) and examination Level B unless otherwise agreed by the Architect, and recorded on the inspection report. Evaluation reference -10dB (33% DAC), as stated in BS EN 1714 will not be accepted. Guidance for the required scans should be taken from BS 3923, or Alternatively BS 3923, Level 2B shall be used.

Ultrasonic inspection to AWS D1.1 is not acceptable to the specification.



Ultrasonic examination of the welded joint shall be carried out after completion of the weld in accordance with the hold times given in Clause 12.3.7.

Inspectors carrying out ultrasonic examination shall hold a current certificate of competence from a nationally recognised authority (CSWIP to BS EN 473).

*Note: In addition to weld examination through thickness, ultrasonic examination of the parent material may also be necessary as directed by the Architect for weld geometries susceptible to lamellar tearing.*

### 12.3.7 Hold Times before final NDT

If there is a risk of delayed cracking, a period may be needed before the final inspection is made of as-welded fabrications. Recommended minimum hold times are given in Table 12.1.

Whatever hold time period is used shall be stated in the inspection records.

If it can be demonstrated by the Steelwork Contractor through records that delayed hydrogen cracking is not a risk, hold times may be reduced or waived at the discretion of the Architect.

Notwithstanding the use of waivers or hold times, whether in accordance with Table 12.1 or otherwise, all identified cracks shall be repaired.

**Table 12.1 Recommended Minimum Hold Times**

Material Grade	Weld Size (mm)	Heat Input (kJ/mm)	Hold Time (hours)
All grades covered by the Specification unless notified otherwise by the Architect (S275, S355, S420)	$a \text{ or } s \leq 6$	All	Cooling period only
	$6 < a \text{ or } s \leq 12$	$\leq 3$	8
		$> 3$	16
	$a \text{ or } s > 12$	$\leq 3$	16
		$> 3$	40

(i) Size applies to the nominal throat thickness (a) of a fillet weld, the nominal depth (s) of a partial penetration butt weld or the nominal material thickness (s) of a full penetration butt weld.

For individual partial penetration butt welds, the governing criterion is the nominal weld depth (s), but for pairs of partial penetration butt welds welded simultaneously it is the sum of the weld depths (s).

(ii) If two fillet welds are separated an un-fused root face of less than 10mm then the governing weld size (a) shall be taken as the sum of their individual weld sizes.

(iii) Heat input to be calculated in accordance with Clause 19 of BS EN 1011-1.

(iv) The time between weld completion and commencement of NDT shall be stated in the NDT report. In the case of "cooling period only", this will last until the weld has cooled to ambient temperature.

**Note:** In certain situations, hold times **MAY** need to be greater than shown. This is particularly important when considering weld metal hydrogen cracking of higher strength steels and cases where borderline conditions exist. This remains the responsibility of the Steelwork Contractor to determine.

## 12.4 Acceptance Criteria for Welds and Corrective Action

The acceptance criteria for welds shall comply with Clause 14.3.6 of the HKSC or Quality Level B specified in Clause 5 of BS EN ISO 5817, whichever is more stringent, except that the scope of weld examination shall comply with Clause 12.5 of this Specification.

If cracking or lamellar tearing is located, inspection should increase to 100% for the weld type using the same WPS. For less serious defects in a joint, examine two additional joints in the group represented by the joint. If the results on these two additional joints are acceptable then the original weld may be repaired and re-examined by similar means.

If the non-destructive examination of the two additional joints reveals unacceptable defects, increase inspection to 100% of weld type using the same WPS.

The Contractor shall inform the Architect and keep record of serious defects (cracks, lamellar tears, incorrect weld type). Consideration should be made as to whether the defect is a procedural problem or welder induced. All defective welds shall be repaired and re-tested to meet the minimum requirements at the Contractor's own cost. The Contractor shall propose remedial measures with a specific repair and re-test procedure for the non-conforming welds for agreement with the Architect prior to carry out any repair works.

## **12.5 Scope of Weld Examination**

### **12.5.1 Visual Inspection**

Visually inspect all welds.

### **12.5.2 Non-destructive Examination**

Frequency of non-destructive examination is to be as follows:

(i)	Full penetration butt welds and full strength butt welds	)	100% ultrasonic and 100% magnetic particle or penetrant inspection
(ii)	Partial penetration butt welds and fillet welds with a leg length greater than 12mm	)	100% first 5 of weld type, then 20% min. ultrasonic and 20% min. magnetic particle or penetrant inspection
(iii)	Fillet welds with a leg length $\leq$ 12mm	)	100% first 5 of weld type, then 10% min. magnetic particle or penetrant inspection

### **12.5.3 Selection of Welds to be Examined**

Where there is a requirement for less than 100% examination the method of selection of welds to be examined is to be agreed with the Architect before commencement of the Works.

## **12.6 Shear Stud Welding**

### **12.6.1 Visual Inspection**

Visually inspect all stud welds. Subject any stud weld that does not exhibit full 360 degree 'flash' to a 15-degree bend test such that the area of 'no flash' is put in tension. Under this test, the weld is to show no visible signs of cracking.

### **12.6.2 Bend Test**

Subject a minimum of 5%, but not less than two numbers per beam, of the studs that have satisfied the visual inspection to a 15-degree bend test according to American Welding Society standard AWS D1.1 at locations to be agreed with the Architect. Under this test, the weld is to show no visible signs of cracking or lack of fusion.

Where bend testing reveals an unsatisfactory stud weld, test an additional stud on each side of the defective stud. Should either of the two additionally tested studs fail, then all studs shall be considered to be at risk until further testing deems them to be acceptable by the Architect.

Studs subjected to the bend test shall not be straightened.

### **12.6.3 Defective Studs**

Studs with defective welding or that have failed the bend test shall be replaced with a new stud in an adjacent location. The replacement stud shall be inspected according to Clauses 12.6.1 and tested as in 12.6.2 by bending it towards the defective stud. Inspection shall increase to 5 adjacent studs, if further failures are found the cause shall be determined before resuming welding.

If it is necessary to remove the defective stud, it shall be detached and the surface checked in complying with Clause 8.6.

All the costs shall be borne by the Contractor.

## **12.7 Bolted Connections**

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Following complete assembly of all bolted connections, check the fit and tightness of the bolts at locations to be agreed with the Architect.

### **12.7.1 HSFG Bolted Connections**

Prior to site painting, check to ascertain that the minimum shank tension has been obtained and that appropriate hardened washers have been fitted in accordance with the requirements of BS 4604.

Records will be required to demonstrate that all HSFG bolts are correctly installed and tensioned.

### **12.7.2 Non-HSFG Bolted Connections**

Place bolts in holes without force, and then tighten to draw connected parts firmly together.

### **12.7.3 Drill-in Anchors**

The Contractor shall carry out loading test of the structural drill-in anchors as required by the Architect and BD at his own cost and time. See Annex B for test of drill-in anchors.

If the loading test fails, the failure mode shall be recorded and the cause shall be determined and reported to the Architect. The Contractor shall propose remedial measures, including justification calculations for any alternate design and method statement, for agreement with the Architect prior to carry out any repair works.

## **12.8 Fabrication and Erection Tolerances**

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### **12.8.1 Survey Records**

Records are to be kept of all the required dimensional inspections to demonstrate that the tolerances stipulated in the Specification have been met.

Any deviations from the stated requirements will need a concession from the Architect which will need to be held with the records or steelwork may be rejected. All concessions should clearly identify the member or members affected and should be traceable to individual items.

### **12.8.2 Verification**

The fabrication and erection tolerance records are to be verified as compliant with specified requirements by the Independent Inspection Authority.

## **12.9 Trial Assembly**

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Assemble the portions of the steelwork as described on the Drawings.

## **12.10 Load Testing**

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The Contractor shall test overhead runway beams to BS 2853.

When it is required and directed by the Architect to establish the capacity of an existing structure or component or to verify design or construction that is not entirely in accordance with the design requirements of the HKSC and BS 5950, the Contractor shall carry out the loading tests for such structure or component in accordance with Section 16 of the HKSC.

## **13 CORROSION PROTECTION**

### **13.1 Definitions**

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#### **13.1.1 Dry Film Thickness (DFT)**

Minimum dry film thickness of a paint coating. Minimum local thickness of a sprayed metal or galvanized coating.

#### **13.1.2 Hot Dip Galvanized (HDG)**

Galvanizing in accordance with BS EN ISO 1461.

#### **13.1.3 Flame-sprayed (FS)**

Flame-sprayed in accordance with BS EN ISO 2063.

### **13.2 General Requirements**

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#### **13.2.1 Protective Systems**

Unless otherwise stated on the Drawings, the reference to the type of protective paint system shall have the requirements specified in Clause 13.8.

#### **13.2.2 Volatile Organic Content (VOC) Limits**

All the systems shall comply with local regulations and best practice guidance on VOC emissions from the systems used.

#### **13.2.3 Location**

The locations in which each of the systems is to be used are noted on the Drawings.

#### **13.2.4 Unpainted Elements**

The surfaces of the following elements are to be unpainted:

- In composite constructions, the surfaces of steelwork which will subsequently have concrete cast against it.
- All steel elements which will be fully encased in structural concrete.
- Other elements as specified on the Drawings.

Fasteners and bolt assemblies which are supplied with a protective treatment which is equivalent to the protective treatment on the steelwork need not be painted.

#### **13.2.5 Compatibility**

The Contractor shall provide evidence to demonstrate to the Architect that any further coatings to be applied to the steelwork are fully compatible with the main corrosion protective system.

### **13.3 Materials**

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#### **13.3.1 Proprietary Materials**

##### **13.3.1.1 Evidence of Compliance**

Before commencement of the Works, provide evidence to demonstrate that the proposed materials comply with descriptions in Clause 13.2.1 and on the Drawings.

**13.3.1.2 Complying Materials**

All proprietary materials deemed to comply with coating descriptions shall be submitted to the Architect for approval.

**13.3.2 Manufacturer's Instructions**

Obtain from the manufacturer of any proprietary product detailed instructions on the use of the product, specific to the situation found on the Contract.

Comply with the manufacturer's instructions for the use of any product. If these are in conflict with the requirements of the Specification, notify the Architect before commencement of the Works.

**13.3.3 Source of Paint Materials**

All products in any particular paint scheme are to be obtained from a single manufacturer.

**13.3.4 Multiple Coats of a Product**

Where two or more coats of a product are to be applied, use a different colour for alternate coats.

**13.3.5 Zinc-rich Primers**

Zinc-rich primers are to comply with BS 4652 and BS EN ISO12944: Part 5.

**13.3.6 Pigments****13.3.6.1 Volume**

Where a paint is defined in the protective system as having a specific pigment, the total pigment is to contain at least 50% by volume of the pigment specified.

**13.3.6.2 Primers**

Primers are not to be so coloured that early signs of rust breakthrough may be masked. Red iron oxide (red oxide) is not to be used as the principal colouring agent of any primer, including optional prefabrication primers.

**13.3.7 Metallic Blast Cleaning Abrasives**

Abrasives used for blast cleaning shall be capable of achieving the specified level of cleanliness and surface roughness. Where metal abrasives are used, they shall comply with BS EN ISO 11124.

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**13.4 Workmanship – Identification, Storage and Handling**

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**13.4.1 Identification**

All paints and other products are to be marked or labelled and stored in such a way that identification of product and batch numbers is possible at all times.

**13.4.2 Transportation, Storage and Handling****13.4.2.1 Damage**

Establish transportation, storage and handling procedures for coated steelwork to avoid contamination, damage or breakdown of the protective system.

**13.4.2.2 Galvanized Materials**

Store and transport in such a way as to avoid white rust formation.

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**13.5 Workmanship – General**

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**13.5.1 Surface Preparation**

**13.5.1.1 Cleanliness**

Before surface preparation in accordance with the protective system requirements, clean the steel surfaces of dirt, grease and other contaminants. They shall at no stage have rusted beyond Rust Grade C of Swedish Standard SIS 05 59 00.

**13.5.1.2 Surface Roughness**

After surface preparation, the surface roughness is to be compatible with the coating to be applied in accordance with BS EN ISO 8503-2 but nowhere exceeding a peak-to-trough amplitude of 80 micrometres.

**13.5.1.3 Rectification of Defects**

Rectify all defects in the substrate surface exposed during surface preparation in accordance with Clause 3.5.

Defects which are acceptable to BS EN 10163, BS EN 10210 and BS EN 10219 as appropriate, but which nonetheless will prevent the satisfactory coating of the steelwork, are to be rectified in such a way as to allow coating to be carried out in accordance with the Specification.

**13.5.1.4 Rusting**

Test steelwork, which has rusted to Rust Grade B of Swedish Standard SIS 05 59 00 at any stage before surface preparation, and steel which has been subject to significant contamination prior to blast-cleaning, in accordance with the method of Appendix G of BS 5493 after surface preparation, to demonstrate that the prepared surface is substantially free of salts. Wash with high-pressure water to remove any excessive salts present.

**13.5.2 Surface Condition****13.5.2.1 Contaminants**

Surfaces to which paint is to be applied, whether steel or previous coatings are to be clean and free of any detrimental contaminants.

**13.5.2.2 Quality of Surface**

The prepared surfaces shall be assessed in regard to visual cleanliness, surface profile and chemical cleanliness, using the methods given in BS EN ISO 12944-4. The requirements for the supervision of these aspects of the work, the frequency of assessment, and the location of the assessment work shall be agreed with the Architect.

The quality of surface preparation specified in the protective system is required to be present at the time of painting. If the surface has degraded beyond this level, re-cleaning is to be carried out.

**13.5.3 Application Conditions**

During the execution of the corrosion protection work, care shall be taken that the work is not affected by any outside influences that could lead to a reduction in the quality of the coating. In the planning stage before starting the work, the Contractor shall define the measures by which adverse effects on the environment can be avoided or reduced to a minimum.

**13.5.3.1 Weather Conditions**

In order to ensure the protection required from the coating, the ambient conditions on site shall be checked to ensure that they meet the requirements given in the paint manufacturer's technical data sheet for the particular coating material. This shall also apply to drying and reaction times.

The lowest and highest permissible temperature of the surface to be coated and of the surrounding air plus the permissible relative humidity shall be as stated in the manufacturer's technical data sheet. If adverse weather conditions occur during application, the work shall be stopped and the freshly coated area protected as far as practical.

Coating materials shall not be applied at temperatures below 3°C above the dew point, determined in accordance with BS EN ISO 8502-4. Wet surfaces shall only be painted with those coating materials which are permitted in the technical data sheet or approved by the paint manufacturer.

#### **13.5.3.2 Environment Conditions**

Paint work shall take place in an area separated or protected from the work of other trades (blast-cleaning, welding etc.).

#### **13.5.4 Prefabrication Coatings**

##### **13.5.4.1 Prefabrication Coating**

The Contractor may apply a prefabrication coating at his discretion. This coating, if applied, is to be additional to the main protective system.

##### **13.5.4.2 Evidence of Compatibility**

If a prefabrication coating is applied, the Contractor shall provide evidence to the Architect to demonstrate that it is fully compatible with the main protective system.

##### **13.5.4.3 Blast-cleaning**

If a prefabrication coating is used, all areas in which this coating is not intact after fabrication are to be locally blast-cleaned to the standard required by the protective system before overcoating.

#### **13.5.5 Method of Application**

Where shop applied paint coatings are to be applied by other than airless spray, or site applied paint coatings by other than brush or airless spray, demonstrate that the method of application will result in work in accordance with the Specification.

When painting components are to be welded on site, such components shall be masked in all areas which will be subject to preheating and welding. In the case of multicoated systems, every coat shall be stepped back.

#### **13.5.6 Stripe Coats**

All steelwork that will be externally exposed in the finished works is to have an extra stripe coat of primer applied to all edges and corners, and to seal gaps between adjacent components such as bolted connections.

#### **13.5.7 Hot Dip Galvanizing**

##### **13.5.7.1 Condition**

Supply material to the galvanizer in a suitable condition to be acid-pickled and then galvanized.

High strength steels (in plate, rolled section or bar) of design strength greater than 460 N/mm<sup>2</sup> should not be galvanized in order to avoid metallurgical change or annealing. Bolts of Grade 10.9 or higher grade or equivalent should not be galvanized.

Hollow sections should be vented if they are to be galvanized. The Contractor shall agree with the Architect the position of vent and drainage holes as laid down in BS EN ISO 14713, and any requirements for subsequent sealing.

##### **13.5.7.2 Uniformity**

Carry out galvanizing in such a way as to maximise the smoothness and uniformity of the deposited coating. Only use double-dipping where no alternative exists. Bolts should be spun galvanized.

##### **13.5.7.3 Touch-up**

In accordance with Section 6.3 of BS EN ISO 1461:1999. Preparation is to be as required by the manufacturer of the touch-up product being used.

The maximum size of an area of touch-up is to be determined by locating the point on the damaged surface which is furthest from an intact galvanized coating. If the distance from this point to the galvanizing is in excess of 10mm, then the member is to be re-galvanized or rejected.

#### **13.5.8 Sealing of Flame-sprayed Surfaces**

Immediately after flame-spraying, seal the surface with a suitable sealer, chosen from Table 4C of BS 5493 and follow general guidelines from Section 6.4 of BS EN ISO 2063. The chosen sealer must be compatible with any further coats to be applied.

#### **13.5.9 Life of Shop Applied Protection**

##### **13.5.9.1 Programme**

The Contractor shall liaise with the paint manufacturer, to ensure that the expected life of the shop-applied protection is compatible with erection and site painting programmes.

##### **13.5.9.2 Failure**

If failure of the shop-applied protection should occur, reinstate the steelwork to an equivalent condition to the unfailed protection. The scheme used is to be compatible with any further coatings.

#### **13.5.10 Making Good**

##### **13.5.10.1 Damage**

The Contractor shall make good all damage, weld areas and other areas which are not coated in accordance with the Specification.

##### **13.5.10.2 Method**

The Contractor shall provide details of the proposed method for making good that will result in protection in accordance with the Specification. Details are to include surface preparation of both exposed steel and other coatings, choice of materials if these differ from those originally specified, means of application and any other relevant considerations.

#### **13.5.11 Reinstatement of Damage Protection in Existing Steel Structures**

All reinstatement of damaged coatings in the existing steel structures shall be made good in accordance with Clause 13.5.10.2 to the standard of the original work except otherwise specified on the Drawings.

### **13.6 Workmanship – Connections**

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#### **13.6.1 General**

##### **13.6.1.1 Equivalent Standard**

Prepare and protect all connections, including fasteners, items of bracketry and other small pieces fabricated separately to the main steelwork, to an equivalent standard to the adjacent steel unless noted otherwise on the Drawings.

##### **13.6.1.2 Different System**

Where the Contractor proposes to use a different protective system for any part of a connection to that used for the adjacent steel, provide evidence to demonstrate its equivalence and compatibility.

#### **13.6.2 Friction Grip Interfaces**

Do not apply paint to friction grip interfaces. If necessary, the faying surfaces are to be masked to prevent rusting beyond Rust Grade C of Swedish Standard SIS 05 59 00. If galvanizing or other metal coatings have been applied, provide evidence to demonstrate that a slip factor not less than the design value will be achieved.



**13.6.3 Assembly of Bolted Connections**

Assemble bolted connections in externally exposed steelwork, other than friction grip connections, with a coat of primer still wet on the contact faces.

**13.6.4 Coated Bolts**

Prime galvanized or sherardized bolt assemblies with a compatible etch primer or treat with a mordant solution prior to overcoating.

**13.6.5 Sealing of Bolted Connections**

Seal all bolted joints against the ingress of water. Before site painting commences, plug gaps at joints with a compatible and suitable filler. Take care that water is not sealed within the joint.

**13.6.6 Site Welds****13.6.6.1 Paint**

At the time of welding there is to be no paint, other than suitable prefabrication primer, within 50mm of the weld.

**13.6.6.2 Temporary Protection**

Apply and remove before welding if this is necessary to ensure that rusting does not occur to a level beyond that allowed by the Specification.

**13.6.6.3 Painting of Site Weld Areas**

Site weld areas which are not suitably protected shall be painted with an approved paint system to ensure similar properties, performance and compatibility with the protective treatment system being used on the surrounding surfaces.

**13.7 Quality Control****13.7.1 General****13.7.1.1 Inspections and Tests**

Before commencement of the Works, the Contractor shall provide details of the scope and frequency of all inspections and tests to be carried out to assure compliance with the Specification. As a minimum, include all relevant inspections and tests in Table 8 of BS 5493 and follow general guidelines in BS EN ISO 12944: Part 7.

The frequency of inspection and testing is to be sufficient to detect any non-conformances.

**13.7.1.2 Notice**

The Contractor shall agree with the Architect a period of notice for all tests.

**13.7.2 Method Statement**

The Contractor shall submit a detailed method statement for the application or reapplication of protective coating(s) explaining how it is intended to carry out the works in accordance with the Specification to the Architect for approval prior to the commencement of works.

At locations where there are significant residual stresses inherent in the steel during fabrication (cold working) and welding, the Contractor shall provide effective measures to improve the corrosion resistance of the material.

The Contractor shall carry out all works in accordance with the method statement.

**13.7.3 Test Pieces****13.7.3.1 Test Pieces**

Prepare two sets of test pieces representative in all relevant respects of the Works to be carried out.

**13.7.3.2 Coating**

Coat test pieces in accordance with the method statement.

**13.7.3.3 Tests**

Confirm, by means of tests on one set of test pieces, that the proposed method will result in work which complies with the Specification.

**13.7.3.4 Retention of Test Pieces**

Protect and retain the second set of test pieces for the duration of the Contract.

**13.7.3.5 Results of Tests**

No work is to be carried out until the Contractor has confirmed in writing that the results of the tests comply with the Specification. Provide the Architect with a copy of the test results.

**13.7.3.6 Quality Standards**

The quality standards established by the test pieces are to become the minimum standard for the Works.

**13.7.4 Modification to Method Statement****13.7.4.1 Test Pieces**

If it is proposed to modify the method statement, produce two sets of test pieces, identical with the initial test pieces, using the proposed modified method.

**13.7.4.2 Tests**

Confirm, by means of tests on one set of test pieces, that the proposed modification will not result in a reduction in the quality of work produced below that being produced by the current method.

**13.7.4.3 Retention of Test Pieces**

Protect and retain the second set of test pieces for the duration of the Contract.

**13.7.4.4 Results of Tests**

No work is to be carried out using the modified method until the Contractor has confirmed in writing that the results of the tests comply with the Specification. Provide the Architect with a copy of the test results.

**13.7.4.5 Quality Standards**

The quality standards established by the test results are to become the minimum standard for the Works.

**13.7.5 Testing****13.7.5.1 Coating Thickness**

After the application of each coat of paint, and before the application of following coats, ensure that the coat has been applied to the required dry film thickness by the use of any of the methods in BS 3900: Part C5 and BS EN ISO 2808 for measuring dry film thickness. Wet film thickness measurements are not to be used for this purpose.

**13.7.5.2 Adhesion**

Ensure, by means of adhesion tests to BS 3900: Part E6 and BS EN ISO 2409, carried out on representative areas chosen to be non-obtrusive in the final condition, that the adhesion of any completed paint scheme is not worse than classification 2 of that standard.

The test area is to be touched-up in accordance with the Specification.

**13.7.5.3 Flame-sprayed Zinc**

Test in accordance with Section 8 of BS EN ISO 2063.

#### 13.7.5.4 Hot Dip Galvanized Steel Elements

Test in accordance with Section 6.2 of BS EN ISO 1461:1999 for coating thickness, using coupons of the same material as the element, and galvanized with the element.

All galvanized components shall be subjected to post-galvanizing inspection as specified on the Drawings for Liquid Metal Assisted Cracking (LMAC) in accordance with the procedures in Table 13.1. Any linear or crack-like indications shall be recorded and reported to the Architect as soon as possible. Additional NDT by MPI is required when there is evidence of a susceptibility to cracking. The operator shall be trained to recognise the diffused indicators due to the presence of the coating.

**Table 13.1 Post-Galvanizing Inspection Procedures**

Reference	Visual Inspection	Magnetic Particle Testing
PGI-0	Not required	Not required
PGI-1	100% of all surfaces with special attention to areas around welded connections and joints	Not required
PGI-2A	As required by PGI-1	On 10% of welded connections or node points of welded joints
PGI-2B	As required by PGI-1	On specified areas
PGI-3	Already undertaken	Sufficient to establish the scope and origin of the problem <sup>(1)</sup>
Personnel	Inspection to be undertaken by a suitably experienced person	NDT to be undertaken by a person suitably qualified on the technique to be used
<sup>(1)</sup> Eddy current and alternating current field measurement tests may be used to assist diagnosis.		

If evidence of cracking is identified, then the component and all similarly shaped components fabricated with similar materials and weld details shall be identified and quarantined as non-conforming products. A photographic record of the cracking shall be made and procedure PGI-3 shall then be used to establish the scope and origin of the problem.

Quarantined components may only be repaired for use in the Works with the agreement of the Architect and the components shall be repaired using an appropriate welding repair procedure in compliance with the guidance on the BCSA and GA Publication No. 40/05 – *Galvanizing Structural Steelwork – An Approach to the Management of Liquid Metal Assisted Cracking*. The Steelwork Contractor shall prepare the welding procedure and submit to the Architect for approval prior to carrying out the repair works.

The results of post-galvanising inspection and any repair works shall be recorded. These records shall be made available to the Architect on request.

#### 13.7.6 Inspection of Site Applied Coatings

If coatings are required, other than those covered by Clause 13.6.6, to be applied on site, then an inspection plan for the site application work shall be included in the project quality plan.

The inspection plan shall include steps to monitor the quality of the materials being used, the thickness of the applied coatings, and that the process of application is in accordance with the product manufacturer's recommendations.

### 13.8 Protective Paint Systems

#### Externally exposed steelwork:

##### Type E-1

Surface Preparation:	Blast clean to Sa2½ of Swedish Standard SIS 05 59 00		
Coat	Material <sup>note (1)</sup>	Thickness <sup>note (2)</sup>	Application
Primer	Zinc Rich Epoxy <sup>note (3)</sup>	75	Shop
Barrier	Epoxy MIO <sup>note (4)</sup>	100	Shop
Finish	Acrylic / Urethane	50	Site

##### Type E-2

Surface Preparation:	Blast clean to Sa2½ of Swedish Standard SIS 05 59 00		
Coat	Material <sup>note (1)</sup>	Thickness <sup>note (2)</sup>	Application
Primer	Epoxy Zinc Phosphate	75	Shop
Barrier	Epoxy MIO <sup>note (4)</sup>	100	Shop
Finish	Acrylic / Urethane	50	Site

#### Internal steelwork:

##### Type I-1

Surface Preparation:	None Required		
Coat	Material	Thickness	Application
Primer	No corrosion protective paint required		
Finish			

##### Type I-2

Surface Preparation:	Blast clean to Sa2½ of Swedish Standard SIS 05 59 00		
Coat	Material <sup>note (1)</sup>	Thickness <sup>note (2)</sup>	Application
Primer	Epoxy Zinc Phosphate	75	Shop
Finish	As specified by the Architect		Site

##### Type I-3

Surface Preparation:	Blast clean to Sa2½ of Swedish Standard SIS 05 59 00		
Coat	Material <sup>note (1)</sup>	Thickness <sup>note (2)</sup>	Application
Primer	Epoxy Zinc Rich <sup>note (3)</sup>	75	Shop

##### Type I-4

Surface Preparation:	Blast clean to Sa2½ of Swedish Standard SIS 05 59 00		
Coat	Material <sup>note (1)</sup>	Thickness <sup>note (2)</sup>	Application
Primer	Epoxy primer / finish	125	Shop

Type I-5

Surface Preparation:	Blast clean to Sa2½ of Swedish Standard SIS 05 59 00		
Coat	Material <sup>note (1)</sup>	Thickness <sup>note (2)</sup>	Application
Primer	Epoxy Zinc Phosphate	50	Shop
Barrier	Epoxy MIO <sup>note (4)</sup>	125	Shop
Finish	Acrylic/Urethane	50	Site

- Notes: (1) See Clause 13.3.3.  
 (2) The thickness as quoted is **Minimum** DFT in microns.  
 (3) See Clause 13.3.5.  
 (4) MIO: Micaceous iron oxide

## 14 Fire Protection

### 14.1 General

#### 14.1.1 General Requirements

Unless otherwise specified on the Drawings or encased in solid structural concrete, all steelworks shall be protected against fire by applying insulating materials to ensure that the steel section does not exceed the limiting temperature within the fire resistance period as specified by the Architect or according to the Code of Practice for Fire Resisting Construction 1996 whichever is more stringent.

Clause 13.2.2 regarding the VOC emission limits shall apply.

#### 14.1.2 Compatibility

The Contractor shall provide evidence to demonstrate to the Architect that the fire protection coating to be used for the steelwork is fully compatible with a) the material to which it is applied; b) the decorative or protective surface finishes where required, and its fire protection performance or stickability would not be impaired. The use of alternative primers should be in accordance with the manufacturer's recommendations. (See also Clause 13.2.5)

In all applications the properties of the surfacing finish have to accommodate any dimensional movement of the spray.

#### 14.1.3 Section Factor (Hp/A)

The 'Section Factor' is the ratio of the surface perimeter exposed to radiation and convection, Hp, to the cross-sectional area, A, and has units of m<sup>-1</sup>.

The section factor for different types of protection methods on different shapes/forms of the structural steelwork shall be assessed by the Contractor in accordance with the manufacturer's specifications and agreed with the Architect.

The thickness of protection to be applied to a section having a calculated Hp/A less than the minimum Hp/A given in the manufacturer's data sheets shall be the thickness required at that minimum value. If the calculated Hp/A of a section exceeds the maximum figure in the data sheets reference should be made to the manufacturer for an individual assessment by an appropriate authority as defined in Clause 14.2.1. The thickness should not exceed the maximum coating range for which the product has been validated.

## 14.2 Materials

The fire protection materials and proprietary products shall comply with BS 8202 or ETAG 018 - *Fire Protective Products* and shall be approved by the Architect. Interior or exterior application, impact and abrasion resistance factors shall also be considered in the selection of materials.

### 14.2.1 Fire Testing and Performance Assessment Reports

All fire protection materials should have been subjected to an appropriate fire test in accordance with BS 476-20, BS 476-21 and Clause 12.2.1 of the HKSC. The test report indicating that the construction elements and the structural members are capable of resisting the action of fire for the specified criteria shall include the information as stated in Clause 12 of BS 476-20.

The performance and thicknesses of the fire protection materials should be assessed from standard fire tests at accredited laboratories. The assessment report shall include, but not limited to the following details:

- Fire protection material / product / system - Brief description of generic types.
- Test specimens - Number of specimens and sizes used in the analyses.
- Surface preparation and primer details.
- Details of method of analysis adopted.
- Compliance with criteria of acceptability, details of any constraints and permitted extensions.
- Predictive analyses at each critical temperature with summary of test results and summary of analysis data.
- Predicted thicknesses for various Section Factors and critical temperatures - Data sheets.
- Physical performance and retention of material/product/system.
- Method of application (validity of assessment for the application method).
- The test reports used for the assessment should be appended to the Assessment Report.
- Reasons for the omission of any test data, if any.

The test and assessment reports shall be prepared and endorsed by a HOKLAS accredited laboratory or other accredited laboratory which has mutual recognition agreements / arrangements with the HOKLAS or the BA. Or alternatively, the assessment report may be prepared and endorse by an independent authority having the appropriate qualifications and experience in fire resisting construction recognized by the BA. Both the reports shall be submitted to the Architect for record.

### 14.2.2 Mechanical Retention

For the sprayed application of coatings, mechanical retention should be provided for elements without a re-entrant profile, or when the structural members are not encapsulated unless test evidence is available to demonstrate that there is adequate bond between the spray and the substrate (including primers or other coatings); or the spray is locked into position by virtue of the shape of the element.

Reinforcement in the form of a corrosion protected wire mesh, 25, 38 or 50mm x 0.9mm, is also required on a) 'I' or 'H' steel sections with dimensions of web exceeding 650mm and flange exceeding 325mm; and b) circular sections with diameter exceeding 325mm or on hollow sections with a single face exceeding 325mm except where applicable test data is available to show such reinforcement is unnecessary. The mesh should be in the middle third of the thickness and be retained by welded pins and non-return washers at nominal 500mm centres.

However, if any mesh reinforcement has been used with the coating system during the fire tests, then the same system must be adopted when used in the Works.

Plastic pins, self-adhesive pins or adhesive fixed pins must not be used for mechanical retention fixings.

Where expanded steel lathing is used to form a hollow encasement, it should be spaced from any steel surface to allow penetration of the lath by the fire protection material to form a mechanical key.

### **14.3 Workmanship**

#### **14.3.1 General**

The supplier/manufacturer's specification for transport, storage and handling of the materials/products should be strictly followed.

To ensure that the stickability of the coating system is not impaired, the application techniques of the products, including the number of coats applied as instructed by the manufacturer must be strictly followed.

For the surface preparation of the steel, reference should be made to the individual requirements specified by the fire protection product manufacturer.

#### **14.3.2 Passive Fire Protection System**

Shall comply with Clauses 10.1 to 10.8 of BS 8202-1:1995.

#### **14.3.3 Reactive Fire Protection System**

Shall comply with Clauses 6.2, 6.3.2 and 6.3.3 of BS 8202-2:1992.

#### **14.3.4 Defects and Damage**

The Contractor shall rectify all the defects and damage to the standard of this Specification.

### **14.4 Quality Control**

#### **14.4.1 Method Statement**

The Contractor shall prepare and submit the method statement including spacing of fixings for the mechanical retention to the Architect for approval prior to the commencement of works.

For materials undergo dimensional changes after application, the Contractor should take special care to recognize this factor for site control purposes.

#### **14.4.2 Passive Fire Protection System**

Shall comply with Clause 10.9 of BS 8202-1:1995.

#### **14.4.3 Reactive Fire Protection System**

Shall comply with Clause 9 of BS 8202-2:1992.

The dry film thickness shall be measured using an instrument employing either the electromagnetic induction or eddy current principle, with a probe contact diameter of minimally 2.5mm according to BS EN ISO 2808. The instrument shall satisfy the following criteria:

- a) Possess a total range greater than the highest thickness to be measured.
- b) Provide a digital display of coating thicknesses and be capable of storing measured values.
- c) Capability to calculate statistical parameters – max/min values, mean and standard deviation.
- d) Capability to provide hard copy print out of data.

The instrument shall be operated in accordance with the manufacturer's instruction for use. Calibration shall be carried out immediately prior to any series of measurements being taken.

In the case of a primer being employed, primer thickness shall be determined prior to application of the intumescent coating and subsequently subtracted from the measured total thickness of primer and intumescent coating.

#### **14.4.4 Deviations**

In respect of fire resistance, section factor ( $H_p/A$ ) and thickness, together with protection details, no deviation can be made except for specific situations where some variation may be necessary. Such variations must be validated by an independent authority as defined in Clause 14.2.1, or an appropriate HOKLAS accredited testing laboratory and subject to the approval by the Architect.



## Annex A: List of International Standards

### A1 British Standards

BS 4-1	Structural steel sections - Part 1: Specification for hot rolled sections
BS 476-20	Fire tests on building materials and structures Part 20: Method for determination of the fire resistance of elements of construction (general principles)
BS 476-21	Fire tests on building materials and structures Part 21: Methods for determination of the fire resistance of loadbearing elements of construction
BS 1449-1.1	Steel plate, sheet and strip Part 1: Specification for carbon and carbon manganese plate, sheet and strip - Section 1.1 General specification
BS 2853	The design and testing of steel overhead runway beams
BS 3692	ISO metric precision hexagon bolts, screws and nuts
BS 3900	Methods of test for paints Part C5: Determination of film thickness Part E6: Cross-cut test
BS 3923	Methods for ultrasonic examination of welds. Part 1: Methods for manual examination of fusion welds in ferritic steels Part 2: Automatic examination of fusion welded butt joints in ferritic steels
BS 4190	ISO metric black hexagon bolts, screws and nuts
BS 4320	Metal washers for general engineering purposes
BS 4395	Specification for high strength friction grip bolts and associated nuts and washers for structural engineering Part 1: General grade Part 2: Higher grade bolts and nuts and general grade washers
BS 4464	Spring washers for general engineering and automobile purposes (metric series)
BS 4604	Specification for the use of high strength friction grip bolts in structural steelwork. Metric series Part 1: General grade Part 2: Higher grade (parallel shank)
BS 4652	Metallic zinc-rich priming paint (organic media)
BS 4800	Schedule of paint colours for building purposes
BS 4921	Sherardized coatings on iron and steel articles
BS 4933	ISO metric black cup and countersunk head bolts and screws with hexagon nuts
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion
BS 5531	Code of Practice for Safety in erecting structural frames
BS 5950	Structural use of steelwork in building Part 1: Code of practice for design - rolled and welded sections Part 2: Specification for materials, fabrication and erection - Rolled and welded sections Part 7: Specification for materials and workmanship: cold formed sections

BS 7371-6	Coatings on metal fasteners. Specification for hot dipped galvanized coatings
BS 7371-8	Coatings on metal fasteners. Specification for sherardized coatings
BS 7419	Specification for holding down bolts
BS 8202-1	Coatings for fire protection of building elements Part 1: Code of practice for the selection and installation of sprayed mineral coatings
BS 8202-2	Coatings for fire protection of building elements Part 2: Code of practice for the use of intumescent coating systems to metallic substrates for providing fire resistance
BS EN 287-1	Qualification test of welders - Fusion welding – Part 1: Steels
BS EN 288-3 (Replaced by BS EN ISO 15614-1)	Specification and approval of welding procedures for metallic materials Part 3: Welding procedure tests for arc welding of steels
BS EN 440	Welding consumables. Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels. Classification
BS EN 473	Non-destructive testing. Qualification and certification of NDT personnel. General principles
BS EN 571-1	Non-destructive testing - Penetrant testing - Part 1: General principles
BS EN 756	Welding consumables. Solid wires, solid wire-flux and tubular cored electrode-flux combinations for submerged arc welding of non alloy and fine grain steels. Classification
BS EN 758	Welding consumables. Tubular cored electrodes for metal arc welding with and without a gas shield of non-alloy and fine grain steels. Classification
BS EN 970	Non-destructive examination of fusion welds. Visual Examination
BS EN 1011-1	Welding - Recommendations for welding of metallic materials Part 1: General guidance for arc welding
BS EN 1011-2	Welding - Recommendations for welding of metallic materials Part 2: Arc welding of ferritic steels
BS EN 1290	Non-destructive examination of welds. Magnetic particle examination of welds
BS EN 1714	Non-destructive testing of welded joints. Ultrasonic testing of welded joint
BS EN 1993-1-3	Eurocode 3: Design of steel structures. Part 1-3: General rules - Supplementary rules for cold-formed members and sheeting
BS EN 10024	Hot rolled taper flange I sections. Tolerances on shape and dimensions
BS EN 10025-1	Hot rolled products of structural steels Part 1: General technical delivery conditions
BS EN 10025-2	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels
BS EN 10025-3	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized / normalized rolled weldable fine grain structural steels
BS EN 10025-4	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels

BS EN 10025-5	Hot rolled products of structural steels Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
BS EN 10025-6	Hot rolled products of structural steels Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition
BS EN 10029	Specification for tolerances on dimensions, shape and mass for hot-rolled steel plates 3mm thick or above
BS EN 10034	Structural steel I and H sections. Tolerances on shape and dimensions
BS EN 10045-1	Charpy impact test on metallic materials test method (V- and U- notches)
BS EN 10055	Hot rolled steel equal flange tees with radiused root and toes. Dimensions and tolerances on shape and dimensions
BS EN 10056-1	Specification for structural steel equal and unequal leg angles Part 1: Dimensions
BS EN 10056-2	Specification for structural steel equal and unequal leg angles Part 2: Tolerances on shape and dimensions
BS EN 10111	Continuously hot-rolled low carbon steel sheet and strip for cold forming Technical delivery conditions
BS EN 10143	Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape
BS EN 10160	Ultrasonic testing of steel flat product of thickness equal or greater than 6mm (Reflection Method)
BS EN 10162	Cold rolled steel sections – Technical delivery conditions – Dimensions and cross-sectional tolerances
BS EN 10163	Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections. Part 1: General requirements Part 2: Plate and wide flats Part 3: Sections
BS EN 10164	Steel products with improved deformation properties perpendicular to the surface of the product – Technical delivery conditions
BS EN 10209	Cold rolled low carbon steel flat products for vitreous enamelling. Technical delivery conditions
BS EN 10210-1	Hot finished structural hollow sections of non-alloy and fine grain steels Part 1: Technical delivery conditions
BS EN 10210-2	Hot finished structural hollow sections of non-alloy and fine grain steels Part 2: Tolerances, dimensions and sectional properties
BS EN 10219-1	Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 1: Technical delivery condition
BS EN 10219-2	Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 2: Tolerances, dimensions and sectional properties
BS EN 10279	Hot rolled steel channels. Tolerances on shape, dimension and mass
BS EN 10326	Continuously hot-dip coated strip and sheet of structural steels-Technical delivery conditions
BS EN 10327	Continuously hot-dip coated strip and sheet of low carbon steels for cold forming. Technical delivery conditions

BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles – Specification and test methods
BS EN ISO 2063 (Replace BS EN 22063)	Thermal Spraying – Metallic and other inorganic coatings – Zinc, aluminium and their alloys
BS EN ISO 2409	Paint and varnishes – Cross-cut-test
BS EN ISO 2560	Welding consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels. Classification
BS EN ISO 2808	Paint and varnishes – Determination of film thickness
BS EN ISO 3506	Mechanical properties of corrosion-resistant stainless-steel fasteners. Part 1: Bolts, screws and studs Part 2: Nuts Part 3: Set screws and similar fasteners not under tensile stress
BS EN ISO 3834-3	Quality requirements for fusion welding of metallic materials. Standard quality requirements
BS EN ISO 3834-5	Quality requirements for fusion welding of metallic materials. Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4
BS EN ISO 5817	Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections
BS EN ISO 6507-1	Metallic materials. Vickers hardness test. Part 1: Test method
BS EN ISO 7089	Plain washers. Normal series. Product grade A
BS EN ISO 7090	Plain washers, chamfered. Normal series. Product grade A
BS EN ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
BS EN ISO 8502-4	Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness. Guidance on the estimation of the probability of condensation prior to paint application
BS EN ISO 8503-2	Preparation of steel substrates before application of paints and related products. Surface roughness characteristics of blast-cleaned steel substrates. Method for the grading of surface profile of abrasive blast-cleaned steel. Comparator procedure
BS EN ISO 9001	Quality management systems. Requirements
BS EN ISO 9018	Destructive tests on welds in metallic materials. Tensile test on cruciform and lapped joints
BS EN ISO 9692-1	Welding and allied processes. Recommendations for joint preparation. Manual metal-arc welding, gas-shielded metal-arc welding, gas welding, TIG welding and beam welding of steels
BS EN ISO 9692-2	Welding and allied processes. Joint preparation. Submerged arc welding of steels
BS EN ISO 11124-2	Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives. Chilled-iron grit
BS EN ISO 11124-3	Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives. High-carbon cast-steel shot and grit

BS EN ISO 12944	Paint and varnishes – Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation Part 5: Protective paint systems Part 7: Execution and supervision of paint work
BS EN ISO 13918	Welding. Studs and ceramic ferrules for arc stud welding
BS EN ISO 14555	Welding. Arc stud welding of metallic materials
BS EN ISO 14713	Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines
BS EN ISO 15609-1	Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding
BS EN ISO 15614-1	Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys

## **A2 Swedish Standards**

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SIS 05 59 00	Pictorial surface preparation standards for painting steel surfaces.
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## **A3 American Standards**

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ANSI/AWS D1.1	Structural Welding Code – Steel
ASTM C939-02	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C940-98a	Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory

## **A4 Japanese Standards**

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JSS II-09	Sets of torshear type high strength bolt, hexagon nut and plain washers for structural joints (by Society of Steel Construction of Japan)
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## **Annex B: Construction, Performance and Test of Drill-in Anchors**

### **B1 Construction and Performance**

The drill-in anchors shall comply with Clauses 11.3 and 12.7.3 of this Specification and the following requirements:

- (a) Qualified site supervision of the drilled-in anchor works by an experienced and competent person should be provided to ensure that the works are carried out in accordance with the plans approved by BD and that the required standards are complied with.
- (b) Strength tests on a representative number of the drilled-in anchors, as directed by the Architect, are required to be carried out in accordance with the test criteria specified in paragraph B2 below and should be carried out by a recognized laboratory independent of the Contractor.
- (c) A method statement on the anchor tests mentioned under item (b) above is required to be submitted to the Architect for BD submission prior to the application for consent to the commencement of the drill-in works.
- (d) Upon completion of the works, a report is required to be submitted to the Architect, which should include:
  - (i) All results of the strength tests of the drilled-in anchors.
  - (ii) A discussion on any problems encountered during the installation of the anchor bolts and how they were overcome.
  - (iii) A statement signed by the Contractor's structural engineer to confirm that all drilled-in anchors have been installed in accordance with the anchor manufacturer's recommendations.

### **B2 Testing**

Strength tests of the drilled-in anchors should satisfy the following criteria:

- (a) Sampling rate should be i) at least 5% of anchors acting in shear and 10% of anchors acting in tension or 5 numbers each, whichever is more, of each type and size of the anchors installed; or ii) as required by BD whichever is more stringent.
- (b) Each representative anchor should be tested for tensile load by pullout test or shear load by shear load test as appropriate.
- (c) Test load should not be less than 1.5 times the recommended working load of the anchor as specified by the anchor manufacturer.
- (d) Upon the maximum test load is reached, the load should be maintained for at least one hour, and the readings of load and deformation should be taken at the beginning and end of this period to establish whether the tested anchor is subject to creep and relaxation of load under this maximum test load.
- (e) Recovery of the deformation after removal of all loads should be at least 80% of the total deformation at the maximum test load, and the tested anchor should not show any signs of separation, plastic deformation or deleterious effect.

Reference may be made to BS 5080 Parts 1 & 2 for the testing procedures for drilled-in anchors including apparatus set-up, load application and results presentation.

Hong Kong Shooting  
Association

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**Proposed Shooting  
Range at Pillar Point**

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Specifications for Civil  
Engineering Works

ARUP

OAP's T 29.11.10 (65 p, double sides)





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- 1. Earthworks**
- 2. Carriageways: Sub-base Material and Bituminous**
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- 4. Miscellaneous Roadworks**



**GENERAL SPECIFICATION  
FOR  
CIVIL ENGINEERING WORKS**

**SECTION |  
EARTHWORKS**



## SECTION I

### EARTHWORKS

#### GENERAL

<i>Reclamation</i>	6.01	Reclamation shall comply with Section 21 except as stated in this Section.
<i>Trip-ticket System</i>	6.02	The disposal of construction and demolition materials generated from the Contract shall comply with the Trip-ticket System promulgated by the Environment, Transport and Works Bureau.

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#### GLOSSARY OF TERMS

<i>Areas of fill</i>	6.03	Areas of fill are areas within the Site, including areas in embankments, platforms and slopes and in excavations for structures, pits and trenches, in which fill material is deposited and compacted as part of the permanent work.
<i>Earthworks final surface</i>	6.04	Earthworks final surface is the surface to which the work included in Section 6 is finished.
<i>Inert construction and demolition material</i>	6.05	Inert construction and demolition material shall mean rock, rubble, earth, soil, concrete, asphalt, brick, tile and masonry generated from construction and demolition works.
<i>Earthworks material</i>	6.06	Earthworks material may consist of soil, rock, or inert construction and demolition material on or below the Site at the commencement of the Contract, or which is imported to the Site to carry out the Works.
<i>Formation</i>	6.07	Formation is that part of the earthworks final surface on which a pavement, structure or utility, is constructed, or on which the blinding or bedding for a pavement, structure or utility is placed.
<i>Intermediate areas of fill</i>	6.08	Intermediate areas of fill are areas of fill which are stated in the Contract as such, and in which fill material is deposited and compacted directly into shallow water or onto naturally occurring soft ground.

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#### MATERIALS

<i>Fill material</i>	6.09	<p>(1) Fill material shall consist of naturally occurring or processed material, or inert construction and demolition material, which at the time of deposition is capable of being compacted in accordance with the specified requirements to form stable areas of fill.</p> <p>(2) Fill material shall not contain any of the following:</p> <p>(a) Material susceptible to volume change, including marine mud, soil with a liquid limit exceeding 65% or a plasticity index exceeding 35%, swelling clays and collapsible soils,</p>
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- (b) Peat, vegetation, timber, organic, soluble or perishable material,
  - (c) Dangerous or toxic material or material susceptible to combustion, and
  - (d) Metal, rubber, plastic or synthetic material.
- (3) The different types of fill material shall have the particle size distributions within the ranges stated in Table 6.1.
- (4) Special fill material shall consist of material which has a liquid limit not exceeding 45%, a plasticity index not exceeding 20% and a coefficient of uniformity exceeding 50.
- (5) Granular fill material shall consist of clean, hard and durable material including recycled aggregates, rock and concrete.
- (6) Rock fill material shall consist of pieces of concrete or hard and durable rock of which the maximum size shall not be greater than three times the minimum dimension of individual pieces and in the opinion of the Engineer not more than 30% by mass is discoloured or shows evidence of decomposition.
- (7) The soluble sulphate content of fill material placed within 500 mm of concrete, cement bound material or cementitious material shall not exceed 1.9 grams of sulphate, expressed as  $\text{SO}_3$ , per litre.
- (8) The total sulphate content, expressed as  $\text{SO}_3$ , of fill material placed within 500 mm of metalwork shall not exceed 0.5% by mass.
- (9) Well-graded material shall consist of material that has a coefficient of uniformity exceeding 10.
- (10) Uniform-graded material shall consist of material that has a coefficient of uniformity of 10 or less.

Table 6.1: Particle size distributions of fill material

Type of fill material	Percentage by mass passing					
	Size		BS test sieve			
	400 mm	200 mm	75 mm	20 mm	600 $\mu$ m	63 $\mu$ m
Fine fill material	-	-	100	-	-	-
General fill material	-	100	75-100	-	-	-
Special fill material	-	-	100	-	-	0-45
Granular fill material	-	-	100	-	0-5	-
Rock fill material (Grade 200)	-	100	20-75	0-50	-	-
Rock fill material (Grade 400)	100	20-75	10-30	0-25	-	-

## SUBMISSIONS

### *Particulars of earthworks*

6.10

(1) The following particulars of the proposed materials and methods of construction for earthworks shall be submitted to the Engineer:

- (a) Details of construction plant and haulage vehicles,
- (b) Methods of excavation and of deposition and compaction of fill material,
- (c) Use of different types of excavated material and sources of imported fill material,
- (d) Arrangements for stockpiling, sorting and separating excavated material, earthworks material and fill material, and for reusing and disposing of such materials,
- (e) Methods of controlling the moisture content of fill material,
- (f) Methods of controlling surface water and groundwater and of protecting earthworks and earthworks material from damage due to water and from weather conditions which may affect the earthworks or earthworks material,
- (g) Methods of monitoring groundwater levels, and
- (h) Methods of monitoring the ground and structures for movements.

(2) The particulars shall be submitted to the Engineer at least 14 days before the relevant work starts.

**Particulars of blasting** 6.11

(1) The following particulars of the proposed blasting procedures shall be submitted to the Engineer:

- (a) Any conditions or restrictions imposed by the Commissioner of Mines, including copies of applications, licences, permits and correspondence,
- (b) Names, qualifications and experience of the persons responsible for the design and supervision of blasting operations,
- (c) Location, diameter, inclination and depth of holes to be charged with explosive,
- (d) Type and total mass of explosive to be used and its mass and distribution in each hole,
- (e) Dimensions of stemming and decking,
- (f) Initiation sequence, delay periods and mass of explosive per delay,
- (g) Burden and bench height,
- (h) Ratio of diameter of explosive to diameter of hole,
- (i) Arrangements for and methods of instrumentation and monitoring the effects of blasting,
- (j) Details of velocity seismographs, including manufacturer's literature,
- (k) Method of controlled blasting,
- (l) Details of blasting trials, and
- (m) Protective measures.

(2) The particulars, other than particulars relating to blasting trials, shall be submitted to the Engineer at least 48 hours before the relevant blasting starts. Particulars relating to blasting trials shall be submitted to the Engineer at least 14 days before the blasting trials are carried out.

## GENERAL EARTHWORKS REQUIREMENTS

**Ownership of earthworks material**

6.12

(1) Earthworks material within the Site at the commencement of the Contract shall remain the property of the Employer except as stated in Clause 6.12(2).

(2) Earthworks material that needs to be disposed of by the Contractor shall become the property of the Contractor when it is removed from the Site and shall be disposed of in tips provided by the Contractor, unless otherwise stated in the Contract.



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| <b><i>Temporary Works for earthworks</i></b>                                     | 6.13 | <p>(1) The design of Temporary Works associated with earthworks, including temporary slopes, stockpiles and drainage, shall be such that the risk of failure is not more than that which would be adopted if the Temporary Works were to be permanent. Allowance may be made in the design of the Temporary Works for the shorter design life and for the risk to persons and property and the surface water and groundwater conditions that are likely to occur during construction.</p> <p>(2) The Contractor shall provide details to the Engineer to demonstrate that the design of Temporary Works has been considered and incorporated measures, which minimise excavation of materials.</p>   |
| <b><i>Handling and storage of earthworks material</i></b>                        | 6.14 | <p>(1) Earthworks material shall not be handled or stored in a manner which will result in segregation, deterioration, erosion or instability of the material.</p> <p>(2) Different types of earthworks material shall be kept separate from each other. Earthworks material that is suitable for use as fill material shall be maintained in a suitable condition and shall not be contaminated.</p> <p>(3) Material handling and storage areas shall be levelled and well drained. Stockpiles of material shall be sprayed with water or a dust suppression chemical to minimize dust generation.</p>  |
| <b><i>Protection from water and weather</i></b>                                  | 6.15 | <p>(1) Earthworks after site clearance, excavation or filling and earthworks material after excavation shall be kept free of water and shall be protected from damage due to water and from exposure to weather conditions which may affect the earthworks or earthworks material. The measures to be taken shall include the following:</p> <ul style="list-style-type: none"> <li>(a) As stated in Clauses 1.19 and 1.20.</li> <li>(b) Surfaces shall be maintained in a stable condition and shall be formed to falls to shed water and to prevent ponding.</li> <li>(c) The area of exposed surfaces shall be kept to a minimum.</li> </ul> <p>(2) Excavations for structures, pits and trenches shall not be carried out on or adjacent to slopes unless measures are taken to drain the excavation and to prevent water from the excavation entering the slope.</p>  |
| <b><i>Earthworks material allowed to become unsuitable or to deteriorate</i></b> | 6.16 | <p>(1) Earthworks material which has been used, or is required for use, in the permanent work and which is allowed to become unsuitable such that in the opinion of the Engineer it no longer complies with the specified requirements for that type of material shall be replaced or dealt with by methods agreed by the Engineer.</p> <p>(2) Earthworks material which is not stated in the Contract to be excavated and which the Contractor causes or allows to deteriorate such that in the opinion of the Engineer the permanent work will be affected shall be replaced or dealt with by methods agreed by the Engineer.</p> <p>(3) Material provided to replace earthworks material, which has been allowed to become unsuitable, or which the Contractor causes or allows to deteriorate, shall be an equivalent material approved by the Engineer. The replacement material shall have the same volume after compaction as the material replaced.</p> <p>(4) The material that is to be replaced shall be disposed of by the Contractor.</p> |

- Additional excavation and stabilisation*** 6.17 (1) Earthworks material which is not stated in the Contract to be excavated but which in the opinion of the Engineer has inadequate strength, durability or stability shall be dealt with by additional excavation or filling as stated in Clause 6.17(2) or by stabilisation as stated in Clause 6.17(3) or by other methods instructed by the Engineer.
- (2) Additional excavation shall be carried out and the resulting voids shall be dealt with as follows:
- (a) General fill material, fine fill material or special fill material shall be deposited and compacted below areas of fill and below formations other than in rock.
  - (b) Grade 10 concrete shall be placed and compacted below formations in rock.
  - (c) Granular fill material shall be deposited below standing water.
- (3) Stabilisation shall be carried out using rock fill material (Grade 400) deposited directly into the original unstable material and compacted to form a stable foundation on which to construct the subsequent work.
- Removal of earthworks material*** 6.18 Earthworks material that is required for use in the permanent work as fill material shall not be removed from the Site unless permitted by the Engineer. The Contractor shall notify the Engineer before any earthworks material is removed from the Site.
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## EXCAVATION

- Disposal of excavated material*** 6.19 (1) The Contractor shall take measures to sort and separate excavated material on site for use in the permanent works as required in the environmental protection measures unless otherwise stated in the Contract. Excavated material, which in the opinion of the Engineer cannot be selected, processed or mixed in a practical manner to make it suitable for use in the permanent works, as fill material shall be disposed of by the Contractor unless otherwise stated in the Contract.
- (2) Excavated material that is surplus to the requirements of the permanent work shall be disposed of by the Contractor unless otherwise stated in the Contract. The Contractor shall, unless otherwise stated in the Contract, take all practical measures to sort and separate the surplus material according to its nature before disposal as required in the environmental protection measures and dispose of the material off-site using the Trip-ticket System.
- Use of excavated material*** 6.20 (1) Excavated material required for use in the permanent work which is capable of being selected, processed and mixed to make it suitable for use as fill material shall not be used for any other purposes unless permitted by the Engineer.
- (2) Excavated material that is required for use in the permanent work as fill material and which the Engineer permits to be removed from the Site or used for other purposes shall be replaced by an equivalent material approved by the Engineer. The replacement material shall have the same volume after compaction as the material replaced.

<i><b>Obstructions in excavations</b></i>	6.21	<p>(1) The Contractor shall inform the Engineer without delay of the nature and location of any unforeseen obstruction encountered during excavation.</p> <p>(2) Boulders that intersect the earthworks final surface or formation shall be dealt with as excavation proceeds by methods agreed by the Engineer. Boulders shall not be left protruding unless permitted by the Engineer.</p>
<i><b>Excavation</b></i>	6.22	<p>(1) Temporary supports or other methods shall be used to maintain excavations in a stable condition and to prevent settlement of structures or utilities due to excavation or dewatering.</p> <p>(2) Construction plant or other vehicles shall not be operated or parked adjacent to excavations and earthworks material or other materials shall not be placed adjacent to excavations unless this has been allowed for in the design of the Temporary Works for the support of the excavation.</p>
<i><b>Excavations adjacent to structures and utilities</b></i>	6.23	<p>(1) Excavations shall be carried out by hand adjacent to utilities that are known, proven or suspected to exist.</p> <p>(2) Unless otherwise permitted by the Engineer excavations next to structures shall be carried out by hand.</p>
<i><b>Excavations for structures, pits and trenches</b></i>	6.24	<p>(1) Excavations for structures, pits and trenches shall be the minimum size necessary to construct the permanent work. The sides of excavations shall be vertical unless otherwise permitted by the Engineer.</p> <p>(2) The length of trench excavation left open at any one time shall not exceed that agreed by the Engineer.</p> <p>(3) Unless permitted by the Engineer, trenches for utilities in fill areas shall not be excavated until the fill material has been deposited and compacted up to the earthworks final surface or formation or up to 1 m above the top of the utility, whichever is lower.</p>

## **BLASTING TRIALS**

<i><b>Blasting trials</b></i>	6.25	<p>(1) Blasting trials shall be carried out for each proposed blasting procedure to demonstrate that:</p> <ul style="list-style-type: none"> <li>(a) The procedure is safe,</li> <li>(b) The resulting ground vibrations at locations stated in the Contract or instructed by the Engineer can be satisfactorily predicted, recorded and are within acceptable limits, and shall not adversely affect the safety and stability of adjoining structures, installations, slopes and land, and</li> <li>(c) The specified tolerances for earthworks final surfaces and formations can be achieved.</li> </ul> <p>(2) Blasting trials shall be completed at least 7 days before the related blasting starts.</p>
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(3) Blasting trials shall be carried out in accordance with the trial procedure submitted to and agreed by the Engineer. The location and size of blasting trials shall be as agreed by the Engineer.

<b><i>Controlled blasting trials</i></b>	6.26	Blasting trials for pre-splitting and other methods of controlled blasting shall be carried out to form a face at least 6 m wide by 6 m high. The blasting trials shall be carried out on rock which has similar properties to that of the earthworks final surface and which is at least 6 m away from the earthworks final surface.
<b><i>Results of blasting trials</i></b>	6.27	If in the opinion of the Engineer any aspect of the proposed blasting procedure as demonstrated by blasting trials is unsatisfactory, particulars of proposed changes to the procedure shall be submitted to the Engineer. Further blasting trials shall be carried out until the procedure is satisfactory.
<b><i>Commencement of blasting</i></b>	6.28	Blasting shall not proceed until in the opinion of the Engineer the procedure as demonstrated by the relevant blasting trials is satisfactory.
<b><i>Changes in blasting procedure</i></b>	6.29	Unless permitted by the Engineer, the satisfactory blasting procedure shall not be changed. Further blasting trials shall be carried out to demonstrate proposed changes to the procedure unless otherwise permitted by the Engineer.

## BLASTING

<b><i>Statutory requirements for blasting</i></b>	6.30	Blasting operations and the supply, transportation, storage, use and disposal of explosives shall be in accordance with conditions and restrictions imposed by the Commissioner of Mines. The Contractor shall make all arrangements with and obtain all licences and permits from the Commissioner of Mines in connection with blasting operations.
<b><i>Recording vibrations due to blasting</i></b>	6.31	<p>(1) Measurements of vibrations due to blasting shall be taken at locations stated in the Contract or instructed by the Engineer at all times when blasting is carried out. Records of the vibrations shall be kept by the Contractor on the Site and a copy provided for the Engineer. Arrangements for installing instruments and taking measurements both inside and outside the Site shall be made by the Contractor.</p> <p>(2) Vibrations due to blasting shall be measured in terms of peak particle velocity, peak particle acceleration and vibrational amplitude. The peak values shall be taken as the maximum resultant calculated by vector summation of the three components of velocity and amplitude respectively, measured as instantaneously as the resolution of the recording instrument permits.</p> <p>(3) Measurements shall be made with velocity seismographs of a type agreed by the Engineer. Seismographs shall be capable of:</p> <ul style="list-style-type: none"> <li>(a) Recording vibrations in terms of peak particle velocity and vibrational amplitude over a frequency of 0 – 200 Hz in three mutually perpendicular directions, and</li> <li>(b) Producing a permanent record of vibrations by tracing an ultra-violet light beam on sensitised paper, or by other methods agreed by the Engineer.</li> </ul>

- (4) The accuracy of seismographs shall be checked before blasting trials are carried out and at regular intervals agreed by the Engineer.
- Preparatory work for blasting** 6.32 Before assessments of blasting safety precautions are made, all vegetation, overburden and soft or loose material shall be removed to expose the rock that is to be blasted.
- Notification of blasting** 6.33 The Contractor shall notify the Engineer by not later than noon of the previous day of his intention to bring any explosives to the Site or to carry out any blasting.
- Storage of explosives** 6.34 Explosives and detonators shall not be stored on the Site overnight unless permitted by the Commissioner of Mines. Explosives and detonators which are not used by the end of each day shall be disposed of as stipulated by the Commissioner of Mines.
- Restrictions on blasting times** 6.35 Blasting shall not be carried out at the following times:
- (a) On General Holidays,
  - (b) Before 8:30 a.m. or after 5:30 p.m. on any day,
  - (c) Unless permitted by the Commissioner of Mines, when a Hong Kong Observatory thunderstorm warning is in force, and
  - (d) Unless permitted by the Commissioner of Mines, when strong wind signal or storm signal No. 3 or higher is hoisted.
- Blasting** 6.36
- (1) Unless otherwise permitted by the Commissioner of Mines, screens and other protective covers shall be erected to prevent the projection of flying fragments of material resulting from blasting. The screens shall be constructed using wire mesh securely supported on steel frames. The nominal diameter of the wire shall be at least 3.5 mm and the wire mesh size shall not exceed 25 mm.
  - (2) Unless permitted by the Commissioner of Mines, plaster blasting shall not be used.
  - (3) Unless otherwise permitted by the Commissioner of Mines blast holes shall be stemmed and decked using free-flowing granular material. Charges shall be covered with thick gunny sacking and 2 m by 2 m squares of steel fabric reinforcement weighed down with filled sandbags. Surface detonating cords, knots, detonating relay conductors and initiating detonators shall be covered with a 300 mm thickness of sand or soil.
  - (4) Unless permitted by the Commissioner of Mines electrical detonators shall not be used within 60 m of overhead power lines. The use of electrical detonators in the vicinity of static or mobile radio transmitters shall comply with BS 6657.
  - (5) Unless otherwise permitted by the Commissioner of Mines delay blasting with millisecond delays shall be used for all blasting, except as stated in Clause 6.37(5).
  - (6) Unless permitted by the Engineer blasting shall not be carried out within a distance of:

- (a) 60 m from water retaining structures or water tunnels, and
- (b) 6 m from water mains or other water supply structures or installations.

(7) Unless permitted by the Engineer the vibrations at structures and installations due to blasting measured in terms of peak particle velocity and vibrational amplitude shall not exceed the values stated in Table 6.2.

(8) Unless otherwise permitted by the Engineer, the vibration at adjoining slopes and land due to blasting measured in terms of peak particle acceleration and peak particle velocity shall not exceed the values stated in the Contract.

Table 6.2: Restrictions on peak particle velocity and vibrational amplitude

Type of structure or Installation	Peak particle velocity (mm/s)	Vibrational amplitude (mm)
Water retaining structures Water tunnels	13	0.1
Water mains Other structures and pipes	25	0.2

**Controlled blasting** 6.37

(1) Earthworks final surfaces which are to be formed by blasting and which slope at a gradient exceeding 2 vertical to 1 horizontal and exceed 3 m in height shall be formed by pre-splitting. Other methods of controlled blasting shall not be used unless permitted by the Engineer.

(2) Pre-splitting and other methods of controlled blasting shall be carried out in such a manner that the rock mass is cleanly split on the required plane to within the specified tolerances and such that rock outside the earthworks final surface is not shattered or loosened.

(3) Faces formed by pre-splitting or other methods of controlled blasting shall not exceed 15 m in height in any one blasting operation unless permitted by the Engineer.

(4) If an earthworks final surface is to be formed by pre-splitting or other methods of controlled blasting:

- (a) Other blast holes shall be located at a sufficient distance from the earthworks final surface to avoid damaging the surface, and
- (b) The row of blast holes nearest to that surface shall be parallel to the row of pre-splitting holes.

(5) Pre-splitting shall consist of a single row of holes drilled at the appropriate inclination along the line of the earthworks final surface. The holes shall be loaded with explosives not exceeding half the diameter of the hole. The explosives shall be detonated simultaneously or with the minimum amount of delay necessary to reduce ground vibrations.

(6) Holes for pre-splitting shall be at least 50 mm diameter and the ratio of the distance between the centre of the holes and the diameter of the hole shall not exceed 10. The holes shall be within a distance of 0.015 times the length of the hole from their designed position.

(7) Holes for pre-splitting shall not be drilled into the sub-grade below berm levels. Rock that remains in position on berms after blasting shall be removed by methods other than blasting.

## DEPOSITION OF FILL MATERIAL

<i>Types of fill material</i>	6.38	Unless otherwise stated in the Contract, areas of fill shall be formed of general fill material.
<i>Sources of fill material</i>	6.39	Except in public filling area as stated in Clause 6.58, fill material shall be obtained from excavation within the Site. If there is insufficient fill material of the required types within the Site, imported fill material shall be provided by the Contractor from sources outside the Site.
<i>Surface preparation for fill material</i>	6.40	<p>Except as stated in Clause 6.56, surfaces on which fill material is to be deposited shall be prepared after site clearance in accordance with the following requirements:</p> <ul style="list-style-type: none"> <li>(a) Topsoil, grass, and other organic matter shall be removed.</li> <li>(b) Soft spots, boulders and other materials, which in the opinion of the Engineer are unsuitable or unstable, shall be removed.</li> <li>(c) Watercourses shall be diverted as stated in the Contract.</li> <li>(d) Benches shall be cut and sub-soil drainage systems installed as stated in the Contract.</li> <li>(e) Voids shall be dealt with as stated in the Contract or instructed by the Engineer.</li> <li>(f) Surfaces other than rock shall be scarified to a depth of 200 mm and compacted to the same standard as the fill material that is to be deposited.</li> </ul>
<i>Commencement of deposition of fill material</i>	6.41	The permission of the Engineer shall be obtained before deposition of fill material starts in any area of fill.
<i>Haulage of fill material</i>	6.42	Haulage of fill material to an area of fill shall proceed only when the compaction plant operating at the area to be filled is sufficient to achieve the specified requirements for relative compaction of the fill material.
<i>Deposition of fill material</i>	6.43	<p>(1) Fill material obtained from excavations within the Site shall be deposited in its final location as soon as practicable after it has been excavated.</p> <p>(2) Fill material shall be deposited in layers of a thickness appropriate to the compaction method to be used. In deposition of fill material, the Contractor shall ensure that a good bond is achieved between layers of fill, and unless otherwise directed by the Engineer, no material shall be placed</p>

on previously compacted layers unless the surface has been scarified or otherwise broken up and, if necessary, watered.

(3) Unless otherwise permitted by the Engineer, layers of fill material shall be horizontal, except for any gradient required for drainage, and the thickness of each layer shall be uniform over the area to be filled. The fill material shall be brought up from the bottom in uniform horizontal layers, with the top of each layer graded to enable surface water to drain readily.

(4) Except in excavations for structures, pits and trenches, if the difference in level between adjacent areas to be filled exceeds 1 m, the edge of the higher area shall be benched before fill material is placed against it.

(5) Execution of the Works shall be controlled in such a manner that any compaction of the fill material resulting from the passage of construction plant or haulage vehicles is uniform.

(6) Except as stated in Clause 6.56, fill material shall not be deposited by end-tipping, by pushing loose material down slope faces or by other methods which may result in segregation or inadequate compaction of the fill material.

***Overfilling***

6.44 In areas of fill formed of material other than rock fill material, earthworks final surfaces sloping at a gradient exceeding 1 vertical to 3 horizontal shall be formed by overfilling and cutting back after compaction. Over-filling shall extend beyond the earthworks final surface by a horizontal distance of 0.5 m or three times the thickness of the compacted layer, whichever is greater.

***Deposition of fill material adjacent to structures and utilities***

6.45 (1) Except as stated in Clause 6.45(4), fill material deposited within 0.5m of a structure or utility shall be fine fill material unless otherwise stated in the Contract. In addition, the material may contain up to 5% by weight of fresh, slightly decomposed or moderately decomposed rock fragments of up to 200 mm provided that these do not cause any damage to structures, nor do they interfere with the compaction requirements.

(2) Fill material shall not be deposited adjacent to or above structures or utilities until the construction of the structure or utility is sufficiently advanced to accept the imposed forces without disturbance or damage.

(3) Fill material shall be deposited evenly on all sides of structures and utilities and in such a manner that the structure or utility is not disturbed or damaged.

(4) Unless otherwise stated in the Contract, fill material around water, sewage and drainage pipes which are laid as part of the permanent work shall be special fill material. They shall be deposited in layers not exceeding 100 mm thick to a level of 300 mm above the top of the pipe. The fill material shall be deposited in such a manner that the layer on one side of the pipe is not more than 100 mm higher than the layer on the other side.



<b><i>Deposition of rock fill material</i></b>	6.46	<p>(1) The final compacted thickness of each layer of rock fill material shall exceed 1.5 times and shall not exceed twice the nominal Grade size of the rock fill material.</p> <p>(2) The surface voids of each layer of rock fill material shall be filled with fragments of rock before the next layer is deposited. The final surface of rock fill material shall also be blinded with fine fill material.</p>
<b><i>Deposition of fill material in excavations for structures, pits and trenches</i></b>	6.47	If sheet piling, timbering or other temporary supports to excavations for structures, pits and trenches are not to be left in place, the sheet piling, timbering or supports shall be removed as deposition of fill material proceeds. The supports shall be removed in such a manner that the stability of the adjacent ground is maintained and the compacted fill material is not disturbed.

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### **COMPACTION OF FILL MATERIAL**

<b><i>Compaction of fill material</i></b>	6.48	<p>(1) Fill material in areas of fill shall be compacted in layers to a stable condition as soon as practicable after deposition and in a manner appropriate to the location and to the material to be compacted.</p> <p>(2) The permission of the Engineer shall be obtained before the next layer is deposited on each layer of compacted fill material.</p> <p>(3) Except as stated in Clauses 6.50(2), 6.52(1), 6.54(2), 6.57 and 6.66, fill material shall be compacted to obtain a relative compaction of at least 95% throughout unless otherwise stated in the Contract.</p>
<b><i>Moisture content of fill material</i></b>	6.49	Fill material other than rock fill material and material as stated in Clause 6.52(1) shall be at optimum moisture content during compaction. The tolerance on the optimum moisture content percentage shall be $\pm 3\%$ , provided that the fill material is still capable of being compacted in accordance with the specified requirements to form stable areas of fill. All necessary measures shall be taken to achieve and maintain the specified moisture content.
<b><i>Compaction of fill material adjacent to structures and utilities</i></b>	6.50	<p>(1) Fill material shall be compacted in such a manner that structures or utilities are not disturbed or damaged.</p> <p>(2) Fill material around water, sewage and drainage pipes, which are constructed as part of the permanent work, shall be compacted by hand-rammers or manually operated power equipment. Fill material within 300 mm above the top of sewage and drainage pipes shall be compacted to obtain a relative compaction of at least 85% throughout.</p>
<b><i>Compaction of rock fill material</i></b>	6.51	<p>(1) Every layer of rock fill material shall be compacted by at least eight passes of a vibrating roller or by other equivalent compaction method approved by the Engineer. The final surface of rock fill material shall be compacted by at least two additional passes of a vibrating roller or by other equivalent compaction method approved by the Engineer.</p> <p>(2) Vibratory rollers used for the compaction of rock fill material shall have a static load per 100 mm width of roll of at least 2 kN for layers with a compacted thickness not exceeding 500 mm and at least 4 kN for layers with a compacted thickness exceeding 500 mm.</p>

***Compaction of  
general fill material  
with a large portion of  
coarse material***

6.52

(1) For general fill material of which less than 90% passes a 20 mm BS test sieve, it is difficult to determine of the moisture content and maximum dry density according to Clauses 6.75(2), 6.75(3), 6.78(2), 6.81(5) and 6.81(6). This type of material shall be compacted to the requirements of Clauses 6.52(2), 6.52(3) and 6.52(4).

(2) Each horizontal layer of general fill material shall be spread and levelled with a thickness not less than 1.5 times of the maximum size of the general fill material and not exceeding the maximum depth of compacted layer in accordance with Table 6.2A. If there is a presence of over-sized coarse material in the general fill, the over-sized coarse material shall be removed or broken down to sizes acceptable to the Engineer. Each layer shall be systematically compacted by a vibratory roller with the stipulated minimum number of passes corresponding to the minimum static load per 100 mm width of the roller.

(3) The number of passes of the roller shall only be counted when the roller is travelled on the material to be compacted at a speed of not more than 2 km per hour with full vibration. Plant other than a vibratory roller carrying out material spreading or providing some preliminary compaction, to assist the use of heavier plant, shall be disregarded in counting the number of passes.

(4) Variation from the method or the use of plant different from that specified in Clause 6.52(2) will be permitted only if the Contractor demonstrates at site trials that equivalent compaction is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.

(5) Without prejudice to the provision of the Conditions of Contract and in order that the Engineer may take proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.

(6) When materials of widely divergent grading are used in embankments and fill areas, they shall be spread and compacted in separate clearly defined areas.

(7) If more than one class of material is being used in such a way that in the opinion of the Engineer, it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material that requires the greatest compaction effort is being compacted.

Table 6.2A: Compaction requirement for general fill material with a large portion of coarse material

Force per 100 mm width	Well-graded material		Uniform-graded material	
(kN)	Maximum depth of compacted layer (mm)	Minimum no. of passes	Maximum depth of compacted layer (mm)	Minimum no. of passes
0.25 – 0.45			150	16
0.46 – 0.70			150	12
0.71 – 1.25	125	12	150	10
1.26 – 1.75	150	8	200	10
1.76 – 2.30	150	4	225	10
2.31 – 2.80	175	4	250	10
2.81 – 3.50	200	4	275	8
3.51 – 4.20	225	4	300	8
4.21 – 4.90	250	4	300	8

### COMPLETION OF EARTHWORK SURFACES

#### *Completion of earthwork final surfaces*

6.53

(1) Earthwork final surfaces shall be completed to a stable condition as soon as practicable after excavation or after deposition and compaction of fill material has been completed. The subsequent permanent work or surface protection shall be carried out as soon as practicable after the earthworks final surface has been completed.

(2) Earthworks final surfaces shall be completed to smooth alignments without abrupt irregularities unless otherwise stated in the Contract.

#### *Completion of formations*

6.54

(1) Formations above structures or utilities shall be completed after construction of the structure or utility.

(2) Except in excavations in rock and in areas of fill formed of rock fill material or fill material as stated in Clause 6.52(1), formations shall be compacted to obtain a relative compaction of at least 98% to a depth of 200 mm below the formation.

(3) Unless otherwise permitted by the Engineer, proof rolling shall be carried out on formations. The formation shall be rolled in the presence of the Engineer by at least two passes of a non-vibrating rubber tyred roller. The roller shall have a static load per 100 mm width of roll of at least 4 kN and shall travel at a speed not exceeding 2 km/h. Any defect in the formation which is revealed during proof rolling by deformation of the formation which in the opinion of the Engineer is excessive shall be made good as instructed by the Engineer.

(4) After all other formation work and testing have been completed and damage caused by testing reinstated, formations for pavements shall be rolled with one pass of a smooth steel-wheeled non-vibrating roller. The roller shall have a load per 100 mm width of roll of at least 2 kN.

(5) Unless otherwise permitted by the Engineer, formation surfaces that will not be immediately covered by the subsequent permanent works shall be protected by methods agreed by the Engineer.

<b><i>Protection of earthwork final surfaces and formations</i></b>	6.55	<p>(1) Earthwork final surfaces and formations shall be maintained in a stable condition and shall be protected from damage due to water or other causes and from exposure to conditions which may adversely affect the surface.</p> <p>(2) Formation shall not be used by construction plant or vehicles other than those which, in the opinion of the Engineer, are essential to construct the subsequent work.</p>
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### INTERMEDIATE AREAS OF FILL

<b><i>Deposition of fill material in intermediate areas of fill</i></b>	6.56	Fill material may be deposited in intermediate areas of fill by end-tipping or by pushing into position until, in the opinion of the Engineer, it is sufficient to form a stable foundation on which to construct the subsequent work.
<b><i>Compaction of fill material in intermediate areas of fill</i></b>	6.57	<p>Fill material in intermediate areas of fill up to the level stated in Clause 6.56 shall be compacted to a degree, which in the opinion of the Engineer is practicable. Except as stated in Clause 6.52(1), fill material above the level stated in Clause 6.56 shall be compacted to obtain a relative compaction of at least:</p> <ul style="list-style-type: none"> <li>(a) 90% throughout,</li> <li>(b) 95% within 1.5 m of earthworks final surfaces and formations, and</li> <li>(c) 98% within 200 mm of formations.</li> </ul>

### EARTHWORKS IN PUBLIC FILLING AREA

<b><i>Public filling area</i></b>	6.58	Public filling area shall mean any area or portion of earthworks/reclamation works to receive inert construction and demolition material, and other materials disposed of by the public as stated in the Contract.
<b><i>Public fill</i></b>	6.59	Public fill shall mean inert construction and demolition material that is disposed of at a public filling area.
<b><i>Combined reception and exit offices</i></b>	6.60	<p>(1) Combined reception and exit offices for the operation of a public filling area shall be provided at the location shown on the Drawings.</p> <p>(2) The Contractor shall design and provide the combined reception and exit office in accordance with the schematic layout shown on the Drawings. The combined reception and exit office shall comply with the following requirements:</p> <ul style="list-style-type: none"> <li>(a) Each shall consist of two floors and shall be constructed on a 1300mm high raised hollow platform. The upper floor is an inspection cabin, which shall be designed to withstand at least 5kPa live load and equipped with staircases and guard railings.</li> </ul>

- (b) Windows of sliding type with locks and security bars shall be provided at the sides to enable a clear view of the approaching traffic. All windows shall be provided with venetian blinds.
  - (c) Collision barriers, collision bollards, separation barriers, red/green light type automatic signaling system and drop-bars shall be provided as shown on the Drawings.
  - (d) An overhead water-spraying system shall be installed at each of the reception hallways. It shall consist of groups of nozzles and shall be supported firmly with posts standing on the ground. Each overhead water-spraying system shall be capable of emitting 100 litres of water in 30 seconds.
  - (e) The roof and all walls shall be fully lined, well insulated, waterproof and painted.
  - (f) All doors shall have secure and efficient locks.
  - (g) A surveillance system shall be installed in each combined reception and exit office at locations agreed by the Engineer. The surveillance system shall consist of closed circuit digital colour video camera, closed circuit video duplex multiplexer and the accessories with schedule as stated in the Contract. The surveillance system shall be operated in accordance with Clause 6.60(3).
  - (h) Weighbridge system shall be installed at each combined reception and exit office at locations as agreed with the Engineer to measure and record the weight of each and every dump truck using the public filling area. The weighbridge system shall be calibrated by a suitable method and at frequency as agreed with the Engineer.
- (3) The surveillance system shall be operated as follows: -
- (a) The camera of the surveillance system shall allow continuous recording and close surveillance of activities within the public filling area during the operation hours.
  - (b) Images captured by the cameras shall be continuously recorded by DVD recorders. Each recorded DVD shall be kept for at least 6 months. The Contractor shall insert and replace the DVD for the surveillance system so as to ensure the continuous recording of the operation activities.
  - (c) The position and angle of each camera of the surveillance system shall be as instructed by the Engineer. The Contractor shall be responsible for any relocation and/or adjustment required.
- (4) Detailed proposals for the combined reception and exit offices shall be submitted by the Contractor to the Engineer for approval within 14 days of the date for commencement of the Works. The proposal shall include locations, layouts, associated facilities and construction details.

(5) Within 28 days of the date of approval by the Engineer, the Contractor shall complete the construction of the combined reception and exit offices that shall be ready for occupation and operation.

(6) The combined reception and exit offices shall be maintained in a clean, stable and secure condition daily.

(7) Equipment provided for the use of the Engineer shall be maintained in a clean and serviceable condition and all consumables shall be replenished as instructed by the Engineer.

(8) The permission of the Engineer shall be obtained before the combined reception and exit office or equipment is removed. The combined reception and exit office or equipment which are to be left in position or become the property of the Employer after completion of the Works shall be repaired, repainted and serviced as instructed by the Engineer.

***Reception areas,  
queuing areas and  
access roads***

6.61

(1) Reception areas, queuing areas and access roads shall be provided in accordance with the Drawings.

(2) The Contractor shall operate and maintain reception areas, queuing areas and access roads complying with the following requirements:

(a) The riding surfaces shall be kept in good condition without excessive bumps and depressions,

(b) The surfaces shall be kept in wet condition so as to minimize dust generation,

(c) The surfaces shall be kept free of grease, debris and the like, and

(d) Measures shall be taken to prevent ponding and flooding.

***Management of dump  
truck movements***

6.62

(1) The Contractor shall manage entry to and exit from the public filling area to:

(a) Maintain orderly traffic conditions at the reception areas, queuing areas and access roads,

(b) Ensure all dump trucks are inspected and weighed at the combined reception and exit offices before and after deposition. In the event that the materials carried by a dump truck are inspected as not acceptable, the Contractor shall direct the dump truck to leave the Site as instructed by the Engineer, and

(c) Direct dump trucks to the designated deposition point for deposition.

(2) The maximum speed of dump trucks within the public filling area shall be restricted to 10km per hour.

Upon instruction by the Engineer, the Contractor shall within three hours tow away any broken down dump truck from an operation area to a safe area within the Site as agreed with the Engineer so as not to disrupt the operation of the public filling area.

- (3) The Contractor shall supply and erect temporary traffic signs, including speed limit signs, for directing dump trucks and traffic diversion within the public filling area.
- Temporary haul roads and drains** 6.63
- (1) The Contractor shall provide and maintain temporary haul roads and drains to suit the programme of deposition and shall remove all temporary drainage systems after the Works. Lighting facilities shall be provided along the temporary haul roads and at each deposition point to ensure safe operation.
- (2) The Contractor shall design the temporary haul roads and drains to ensure good riding condition and safety. All temporary haul roads shall be paved with granular material. The Contractor shall submit the details of the proposed temporary haul roads and drains to the Engineer for agreement 14 days before implementation or commencement of associated work whichever is earlier.
- (3) The Contractor shall grade, regulate and compact all temporary haul roads as instructed by the Engineer to prevent undulation.
- Handling and storage of wet soil** 6.64
- (1) Public fill may consist of wet soil. Wet soil may be any naturally occurring or processed material, which at the time of deposition is unable to be compacted in accordance with the specified requirements to form a stable area of fill.
- (2) The Contractor shall plan the Works by allowing stockpiling space as agreed with the Engineer for handling wet soil. The Contractor shall process the wet soil received including mixing it with public fill to make it suitable for compaction and use in the Works. The processed material shall be handled and stored in accordance with Clause 6.14. The proposed method of processing and mixing shall be agreed with the Engineer at least 7 days before any processing and mixing starts.
- Deposition of public fill** 6.65
- Clauses 6.43(2), 6.43(3), 6.43(4), 6.43(5), 6.43(6), 6.44, and 6.56 shall apply to deposition of public fill.
- Compaction of public fill** 6.66
- (1) In addition to Clauses 6.48(1), 6.48(2) and 6.50(1), public fill shall be compacted to the requirements of Clauses 6.66(2), 6.66(3) and 6.66(4). The Contractor shall submit the proposed method of compaction including the proposed compaction plant, thickness of compacted layer and minimum number of passes to the Engineer for approval at least 7 days before any compaction starts.
- (2) Each horizontal layer of public fill shall be spread and levelled with a thickness not exceeding the maximum depth of a compacted layer in accordance with Table 6.2B. Each layer shall be systematically compacted by the compaction plant with the minimum number of passes approved by the Engineer.
- (3) Definitions and requirements associated with Table 6.2B are as follows:
- (a) Where combinations of different types or categories of plant are used, the compaction requirements shall be:
- The depth of layer shall be that for the type of plant requiring the least depth of layer; and

- The number of passes shall be that for the type of plant requiring the greatest number of passes.
- (b) The number of passes of the roller shall only be counted when the roller is travelled on the materials to be compacted at a speed of not more than 2 km per hour with full vibration where appropriate.
- (c) The plant other than the approved compaction plant by the Engineer as stated in Clause 6.66(1) to carry out material spreading or to provide some preliminary compaction only to assist the use of heavier plant shall be disregarded in counting the number of passes.
- (d) The force per 100 mm width is the total weight on the roll divided by the total roll width. Where a smooth-wheeled roller has more than one axle the machine will be assessed on the basis of the axle giving the highest value of force per 100 mm width.
- (e) Wheel load is the total weight of the roller divided by the number of wheels.
- (f) Vibratory rollers are machines having means of applying mechanical vibration to one or more rolls.
  - The requirements for vibratory rollers are based on the use of the lowest gear on a self-propelled machine and a towing speed of 1800 - 2400 m/hour for a towed machine. If higher gears or speed are used, an increased number of passes shall be provided in proportion to the increase in speed of travel.
  - Vibratory rollers operating without their vibration mechanism in use will be classified as smooth-wheeled rollers.
  - Vibratory rollers shall only be operated with their vibration mechanism operating at the frequency of vibration recommended by the manufacturers. All such rollers shall be equipped with a device automatically indicating the frequency at which the mechanism is operating.
- (g) Vibrating-plate compactors are machines having a base-plate to which a source of vibration consisting of one or two eccentrically weighted shafts is attached.
  - The static pressure under the plate of a vibrating-plate compactor is calculated by dividing the total weight of the machine in working order by the area in contact with compacted material.
  - Vibrating-plate compactors shall be operated at the frequency of vibration recommended by the manufacturer. They shall normally be operated at travelling speeds of



less than 900 m/hour but, if higher speeds are necessary, the number of passes shall be increased in proportion to the increase in speed of travel.

- (h) Vibro-tampers are machines in which an engine-driven reciprocating mechanism acts on a spring system, through which oscillations are set up in a base-plate.
  - (i) Power rammers are machines that are actuated by explosions in an internal combustion cylinder, each explosion being controlled manually by the operator.
- (4) Variation from the methods or the use of plant different from that specified in Clause 6.66(2) will be permitted only if the Contractor demonstrates by site trials that equivalent compaction effect is achieved by the alternative method or plant. The procedure to be adopted for these site trials shall be agreed with and approved by the Engineer.
- (5) Without prejudice to the provision of the Conditions of Contract and in order for the Engineer to make proper provision for the supervision of compaction in the permanent work, the Contractor shall, not less than 24 hours before he proposes to carry out compaction processes, apply in writing to the Engineer for permission to do so.

Table 6.2B: Compaction requirement

Type of compaction plant	Category	Maximum depth of compacted layer (mm)	Minimum no. of passes
Smooth-wheel roller	Force per 100 mm width		
	2.1 – 2.6 kN	125	10
	2.61 – 5.2 kN	125	8
	More than 5.2 kN	150	8
Grid-roller	Force per 100 mm width		
	5.3 – 7.8 kN	125	12
	More than 7.8 kN	150	12
Pneumatic-tyre roller	Wheel load		
	2 - 2.5 tonnes	125	12
	2.6 - 4 tonnes	125	10
	4 - 6 tonnes	125	10
	6 - 8 tonnes	150	8
	8 - 12 tonnes	150	8
Vibratory roller	More than 12 tonnes	175	6
	Force per 100 mm width		
	0.71 – 1.25 kN	100	12
	1.26 – 1.75 kN	125	8
	1.76 – 2.3 kN	150	4
	2.31 – 2.8 kN	175	4
	2.81 – 3.5 kN	200	4
	3.51 – 4.2 kN	225	4
Vibratory-plate compactor	4.21 – 4.9 kN	250	4
	Static pressure under base plate (kN/m <sup>2</sup> )		
	13.8 - 17.2	100	6
	17.3 - 20.7	150	6
Vibro-tamper	More than 20.7	200	6
	Mass (kg)		
	50 – 65	100	3
	66 – 75	125	3
Power rammer	More than 75	150	3
	Mass (Kg)		
	100	150	6
	More than 500	275	12

*Use of fill material adjacent to structures and utilities in public filling area* 6.67

Fill material shall be used adjacent to structures and utilities in public filling areas as stated in the Contract. Fill material shall comply with Clause 6.09. The use of fill material shall comply with Clauses 6.45, 6.47 and 6.50.

## TOLERANCES

***Tolerances:  
earthworks final  
surfaces and  
formations***

6.68

(1) Earthworks final surfaces and formations shall be within the tolerances of the specified lines and levels stated in Table 6.3. The tolerances for formations do not apply to pipes or preformed structures that require to be supported over their complete length or area.

(2) In excavation, a positive tolerance refers to insufficient excavation and a negative tolerance refers to excess excavation. In areas of fill, a positive tolerance refers to excess fill material and a negative tolerance refers to insufficient fill material.

Table 6.3: Tolerances for earthworks final surfaces and formations

Type of surface	Method of forming surface	Tolerance (mm)	
		+	-
Formations for structures and utilities	Excavation except in rock	0	25
	Excavation in rock	0	150
	Deposition and compaction of fill material	0	25
Formations for pavements, including carriageways, footways, cycletracks, paved areas, aircraft pavements and railway trackbeds.	Excavation except in rock	0	50
	Excavation in rock	0	150
	Deposition and compaction of fill material	0	50
Earthworks final surfaces other than formations, with a gradient not exceeding 1 vertical to 10 horizontal	Excavation except in rock	0	100
	Excavation in rock	0	200
	Deposition and compaction of fill material	0	100
Other earthworks final Surfaces	Excavation except in rock	100	100
	Excavation in rock	100	200
	Deposition and compaction of fill material	100	100

## TESTING: FILL MATERIAL - GENERAL REQUIREMENTS

- Batch: fill material** 6.69 A batch of fill material is any quantity of fill material of the same type and which in the opinion of the Engineer has similar properties throughout. For the purpose of testing for moisture content and relative compaction a batch shall, in addition to the above, be fill material which is deposited in a single layer in any area of fill presented by the Contractor for testing on one occasion.
- Samples: fill material** 6.70 (1) Each sample of fill material shall consist of at least four increments taken from different parts of the batch. The increments shall be combined and thoroughly mixed and shall then be divided by quartering or by using a riffle box to obtain specimens of an appropriate size to carry out the individual tests.
- (2) The size of samples of fill material other than rock fill material shall be in accordance with Geospec 3, Clauses 2.5.1, 4.2 and Table 2.1. Each sample of rock fill material of Grade size not exceeding 200 shall have a mass of at least 250 kg and each sample of rock fill material of Grade size exceeding 200 shall have a mass of at least 1000 kg.

## TESTING: FILL MATERIAL - PARTICLE SIZE DISTRIBUTION, LIQUID LIMIT, PLASTICITY INDEX, COEFFICIENT OF UNIFORMITY AND SULPHATE CONTENT

- Samples: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content** 6.71 Samples of fill material to be tested for particle size distribution, liquid limit, plasticity index, coefficient of uniformity and sulphate content shall be delivered at least 14 days, or such shorter period agreed by the Engineer, before deposition of the fill material starts. The number of samples to be provided from each batch shall be as stated in Table 6.4.

Table 6.4: Number of samples to be tested for particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content, optimum moisture content and maximum dry density

Description	Size of batch	No. of samples per batch
Special fill material	0 - 3,000 m <sup>3</sup>	3
	Exceeding 3,000 m <sup>3</sup>	1 for each 1,000 m <sup>3</sup> or part thereof
Fill material other than special fill material	0 - 15,000 m <sup>3</sup>	3
	Exceeding 15,000 m <sup>3</sup>	1 for each 5,000 m <sup>3</sup> or part thereof

**Testing: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content** 6.72

(1) Each sample of fill material taken as stated in Clause 6.71 shall be tested to determine the particle size distribution. In the case of special fill material, testing shall include calculation of the coefficient of uniformity as stated in Clause 6.72(4). Unless otherwise agreed by the Engineer, each sample of fill material other than rock fill material shall be tested to determine the liquid limit and the plasticity index of that portion of the fill material passing a 425µm BS test sieve. Each sample of fill material, which will be deposited within 500 mm of concrete, cement, bound material, cementitious material or metalwork shall be tested to determine the soluble sulphate content.

(2) The method of testing shall be in accordance with the following:

Particle size distribution	: Clause 6.72(3)
Liquid limit	: Test Method 6.1 of Geospec 3
Plasticity index	: Test Method 6.1 of Geospec 3
Soluble sulphate content	: Test Method 9.3 of Geospec 3
Total sulphate content	: Test Method 9.3 of Geospec 3

(3) The particle size distribution of fill material passing a 75 mm BS test sieve shall be determined in accordance with Geospec 3, Test Method 8.1 or 8.2, whichever as instructed by the Engineer. The size of particles of fill material, which do not pass a 75 mm BS test sieve, shall be taken as the largest dimension measured in any plane.

(4) The coefficient of uniformity (Cu) shall be calculated from the equation:

$$Cu = D_{60}/D_{10}$$

where:

- D<sub>60</sub> and D<sub>10</sub> are the equivalent sieve sizes in millimetres, interpolated from the particle size distribution curve, through which 60% and 10% of the fill material would pass respectively.

**Non-compliance: particle size distribution, liquid limit, plasticity index, coefficient of uniformity, sulphate content** 6.73

(1) If the result of any test for soluble sulphate content of fill material does not comply with the specified requirements for soluble sulphate content, each sample shall be tested to determine the total sulphate content.

(2) If the result of any test for particle size distribution, liquid limit, plasticity index, coefficient of uniformity or total sulphate content of fill material does not comply with the specified requirements for the property, additional samples shall be provided from the same batch and additional tests for the property shall be carried out. The number of additional samples shall be as stated in Table 6.4.

## TESTING: FILL MATERIAL - OPTIMUM MOISTURE CONTENT AND MAXIMUM DRY DENSITY

**Samples: optimum moisture content, maximum dry density**

6.74

(1) Samples of fill material to be tested for optimum moisture content and maximum dry density shall be delivered at least 72 hours, or such shorter period agreed by the Engineer, before deposition of the fill material starts. The number of samples to be provided from each batch shall be as stated in Table 6.4.

(2) The Contractor shall inform the Engineer of the exact location in which the fill material from which each sample is taken is to be deposited.

(3) Samples to be tested for optimum moisture content and maximum dry density shall also be taken after the fill material has been deposited in its final position, at intervals of not more than 28 days.

(4) Samples shall not be provided from:

(a) Fill material including rock fill material which contains an insufficient proportion of particles passing a 20 mm BS test sieve to permit determination of the moisture content and maximum dry density, and

(b) Fill material that is to be deposited as stated in Clause 6.56.

**Testing: optimum moisture content, maximum dry density**

6.75

(1) Each sample of fill material taken as stated in Clause 6.74 shall be tested to determine the optimum moisture content and the maximum dry density.

(2) The method of testing shall be in accordance with Geospec 3, Test Method 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 or 10.8, whichever is instructed by the Engineer.

(3) If agreed by the Engineer, the Hilf method stated in Appendix 6.3 may be used instead of the methods stipulated in Clause 6.75(2) to determine the optimum moisture content and maximum dry density.

(4) If in the opinion of the Engineer there is any undue discrepancy between the results of tests for optimum moisture content of fill material using methods stipulated in Clause 6.75(2) and the results of tests using the Hilf method, the results of tests using methods stipulated in Clause 6.75(2) shall prevail.

**Consistency: optimum moisture content, maximum dry density**

6.76

If the result of any test for optimum moisture content or maximum dry density of fill material indicates that the batch contains material which in the opinion of the Engineer, differs to such an extent that subsequent tests for relative compaction may be affected, the batch shall be divided into smaller batches. Each of the smaller batches shall comprise material with similar properties throughout. Additional samples shall be provided from each of the smaller batches and additional tests for optimum moisture content and maximum dry density shall be carried out. The number of additional samples shall be as stated in Table 6.4.

**TESTING: FILL MATERIAL - MOISTURE CONTENT:**

- Samples:**  
**moisture content** 6.77 (1) Samples of fill material to be tested for moisture content shall be taken during deposition and compaction of fill material and shall be delivered not more than 1 hour after the fill material has been deposited in its final position.
- (2) The number of samples to be provided from each batch shall be as stated in Table 6.5. Samples shall not be provided if, in accordance with Clause 6.74(4)(a) or (b), the optimum moisture content has not been determined.
- Testing:**  
**moisture content** 6.78 (1) Each sample of fill material taken as stated in Clause 6.77 shall be tested to determine the moisture content.
- (2) The method of testing shall be in accordance with one of the following methods:
- (a) Method 1 : Geospec 3, Test Method 5.1 or 5.2, whichever is instructed by the Engineer
- (b) Method 2 : Microwave oven drying method as stated in Appendix 6.2.
- Method 1 shall be used unless otherwise agreed by the Engineer.
- Compliance criteria:**  
**moisture content** 6.79 If in the opinion of the Engineer there is any undue discrepancy between the results of tests for moisture content of fill material using Method 1 and the results of tests using Method 2 in Clause 6.78, the results of tests using Method 1 shall prevail.
- Non-compliance:**  
**moisture content** 6.80 If the result of any test for moisture content of fill material differs from the optimum moisture content by more than the specified amount and if instructed by the Engineer, the moisture content of the whole of the batch of fill material shall be adjusted. Additional samples shall be provided from the same batch and additional tests for moisture content shall be carried out. The number of additional samples shall be as stated in Table 6.5.

Table 6.5: Number of samples to be tested for moisture content and number of tests for relative compaction

Description	Size of area of fill in batch	No. of samples/No. of tests per batch
Areas of fill in excavations for structures, pits and trenches and on formations	0 - 100 m <sup>2</sup>	3
	100 - 500 m <sup>2</sup>	2 for each 100 m <sup>2</sup> or part thereof
	exceeding 500 m <sup>2</sup>	1 for each 100 m <sup>2</sup> or part thereof
Other areas of fill	0 - 1 ha	4 for each 1000 m <sup>2</sup> or part thereof
	1 - 10 ha	3 for each 1000 m <sup>2</sup> or part thereof
	exceeding 10 ha	2 for each 1000 m <sup>2</sup> or part thereof

## TESTING: FILL MATERIAL - RELATIVE COMPACTION

### *Testing: relative compaction*

6.81 (1) Unless otherwise agreed by the Engineer, each batch of fill material shall be tested to determine the relative compaction. Tests shall be carried out after the fill material has been deposited and compacted in its final position. The number of tests on each batch shall be as stated in Table 6.5. Tests shall not be carried out on:

- (a) Fill material including rock fill material which contains an insufficient proportion of particles passing a 20 mm BS test sieve to permit determination of the relative compaction, and
- (b) Fill material that has been deposited as stated in Clause 6.56.

(2) Tests shall be carried out at positions, which in the opinion of the Engineer are representative of the batch of compacted fill material as a whole.

(3) Testing will be carried out by the Engineer.

(4) The relative compaction of fill material shall be determined in accordance with one of the following methods:

- (a) Method 1: Geospec 3, Test Method 11.4

$$RC = IDD/MDD \times 100\%$$

where:

- IDD is the in-situ dry density determined as stated in Clause 6.81(5)
- MDD is the maximum dry density determined as stated in Clause 6.75(2)

- (b) Method 2: The relative compaction (RC) shall be calculated from the equation:

$$RC = IBD/MCBD \times 100\%$$

where:

- IBD is the in-situ bulk density determined as stated in Clause 6.81(5)
- MCBD is the maximum converted bulk density determined by the Hilf method as stated in Appendix 6.3

Method 1 shall be used unless otherwise permitted by the Engineer.

(5) The in-situ bulk density and the in-situ dry density of fill material shall be determined in accordance with one of the following methods:



(a) Method 1 : Geospec 3, Test Method 11.1 or 11.2

(b) Method 2: Nuclear densometer method as stated in Geospec 3, Test Method 11.3

Method 1 shall be used unless otherwise permitted by the Engineer.

(6) The maximum converted bulk density of fill material of which more than 5% is retained on a BS 20 mm test sieve, shall be adjusted as stated in Appendix 6.4.

***Compliance criterion:*** 6.82  
***relative compaction***

If in the opinion of the Engineer there is any undue discrepancy between the results of tests for relative compaction of fill material using Method 1 and the results of tests using Method 2 in Clause 6.81, the results of tests using Method 1 shall prevail.

***Non-compliance:*** 6.83  
***relative compaction***

If the result of any test for relative compaction of fill material does not comply with the specified requirements for relative compaction, additional tests for relative compaction shall be carried out on the same batch. The number of additional tests shall be as stated in Table 6.5.

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**APPENDIX 6.1****TEST METHODS FOR FILL MATERIAL**

- General** 6.1.1 The definitions, terms, abbreviations symbols, and grouping of materials stated in BS 1377 shall apply except as stated in Clauses 6.1.2 and 6.1.3.
- Terms and symbols** 6.1.2 Terms used in the GS, and in BS 1377 are identified in the GS by the abbreviations and symbols stated in Table 6.1.1.

Table 6.1.1: Abbreviations and Symbols

Abbreviation/ Symbol	Term
BD	Bulk density
CBD	Converted bulk density
DD	Dry density
IBD	In-situ bulk density
IDD	In-situ dry density
MDD	Maximum dry density
MCBD	Maximum converted bulk density
RC	Relative compaction
W	Moisture content
$w_i$	In-situ moisture content
$w_o$	Optimum moisture content

- Grouping of material** 6.1.3 (1) Fine-grained material is material of which at least 90% passes a 2 mm BS test sieve.
- (2) Medium-grained material is material of which at least 90% passes a 20 mm BS test sieve and more than 10% is retained on a 2 mm BS test sieve.

**APPENDIX 6.2****DETERMINATION OF THE MOISTURE CONTENT OF FINE GRAINED AND MEDIUM GRAINED MATERIAL BY THE MICROWAVE OVEN DRYING METHOD**

- Scope** 6.2.1 This method covers the determination of the moisture content of fine-grained and medium-grained material as a percentage of the mass of the dry material.
- Apparatus** 6.2.2 The following apparatus is required:
- (a) A microwave oven with a timer and an adjustable power setting.
  - (b) An airtight container of microwave safe and non-reflective material.
  - (c) A balance readable and accurate to 0.01g.
  - (d) A desiccator containing anhydrous silica gel.
- Procedure** 6.2.3 The procedure shall be as follows:
- (a) The container shall be cleaned, dried and weighed to the nearest 0.01g ( $m_1$ ).
  - (b) A specimen shall be crumbled and placed loosely in the container and the lid shall be replaced. Each specimen of fine-grained material shall be at least 30 g and each specimen of medium-grained material shall be at least 300 g. Specimens of medium-grained material may be tested in several parts each less than 300 g and the results aggregated.
  - (c) The container and contents shall be weighed to the nearest 0.01g ( $m_2$ ).
  - (d) The lid of the specimen container shall be removed and the container with its lid and contents shall be placed in the microwave oven and dried. The specimen shall be considered to be dry when, after an initial drying period, successive weighings at intervals of 1 minute produce results that are the same to the nearest 0.01g. Alternatively, the oven may be set to an appropriate time and power setting to dry the specimen as determined by calibration of the oven on soil of a similar type.
  - (e) After drying, the container and contents shall be removed from the microwave oven and placed in the desiccator to cool.
  - (f) The lid shall be replaced and the container and contents shall be weighed to the nearest 0.01g ( $m_3$ ).

**Calculation**

- 6.2.4 The moisture content of the material (w) shall be calculated as a percentage of the dry mass of the material from the equation:

$$w = (m_2 - m_3)/(m_3 - m_1) \times 100\%$$

where:

- $m_1$  is the mass of the container (g)
- $m_2$  is the mass of the container and contents before drying (g)
- $m_3$  is the mass of the container and contents after drying (g)

**Reporting of results**

- 6.2.5 The following shall be reported:

- (a) Source and identification of the soil.
  - (b) The moisture content of the material to the nearest 0.1%.
  - (c) That the test method used was in accordance with this Specification.
-

## APPENDIX 6.3

### DETERMINATION OF THE MAXIMUM CONVERTED BULK DENSITY BY THE HILF METHOD

- Scope** 6.3.1 This method covers the determination of the maximum converted bulk density and the difference between the optimum moisture content and the in-situ moisture content of a material by relating the converted bulk density and the moisture added.
- Apparatus** 6.3.2 The following apparatus is required:
- (a) Apparatus in accordance with Geospec 3, Test Method 10.1 or 10.2, whichever as instructed by the Engineer.
  - (b) Apparatus for determination of the moisture content in accordance with either Geospec 3, Test Method 5.1 or 5.2 or Appendix 6.2, whichever as instructed by the Engineer.
  - (c) Apparatus to extract specimens from the mould.
  - (d) Apparatus, such as a warm air blower, for rapid drying of the material.
- Procedure** 6.3.3 The procedure shall be as follows:
- (a) A sample of material shall be taken immediately after completing the in-situ bulk density test at the same location as the test. The sample shall be obtained by digging to the same depth as that of the in-situ bulk density test, keeping the sides of the excavation vertical and the bottom flat and level. The size of the sample shall be sufficient to yield a minimum of 10 kg after screening over a 20 mm BS test sieve.
  - (b) The sample shall be weighed to the nearest 0.01 g.
  - (c) The sample shall be screened over a 20 mm BS test sieve, ensuring that moisture loss is kept to a minimum and that any free moisture appearing in the containers is worked back into the sample.
  - (d) The amount retained on the sieve shall be weighed to the nearest 0.01 g and expressed as a percentage of the mass of the sample. If the percentage exceeds 5%, an adjustment for coarse material shall be made in accordance with Appendix 6.4. If the percentage does not exceed 5%, no adjustment is required.
  - (e) The material to be tested shall be thoroughly mixed and divided by quartering or by using a riffle box to obtain a minimum of four specimens of at least 2500 g each, ensuring that moisture loss is kept to a minimum. Alternatively, if it has previously been ascertained that the material is not susceptible to crushing, a single specimen of at least 2500 g may be used for repeat testing.

- (f) Each specimen shall be weighed to the nearest 0.01 g and the result shall be taken as the mass of the specimen at the in-situ moisture content.
- (g) Each specimen and any remaining material shall be placed in separate moisture-tight containers and the containers sealed.
- (h) The converted bulk density of at least three specimens shall be plotted against the amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content (z) on a graph as shown in Civil Engineering and Development Department Standard Drawing No. C2006, in accordance with the procedure stated in Clause 6.3.3(i) to (o).
- (i) The first point on the graph shall be obtained as follows:
  - A specimen shall be compacted at its in-situ moisture content in accordance with Geospec 3, Test Method 10.1, Clause 10.1.5 or Test Method 10.2, Clause 10.2.5, whichever is instructed by the Engineer.
  - A diametrical slice of approximately 400 g to 500 g shall be cut from the specimen along its entire length. The in-situ moisture content of the slice ( $w_i$ ) shall be determined in accordance with either Geospec 3, Test Method 5.1 or 5.2 or Appendix 6.2, whichever as instructed by the Engineer.
  - The bulk density ( $BD_1$ ) shall be calculated as stated in Clause 6.3.4(1) and plotted on the 0% ordinate of the graph as the converted bulk density ( $CBD_1$ ).
- (j) The second point on the graph shall be obtained as follows:
  - A second specimen shall be examined and, if the in-situ moisture content obviously exceeds the optimum moisture content, the procedure stated in Clause 6.3.3(k) shall be followed.
  - The moisture content of the specimen shall be increased by adding an amount of water equal to 2% of the mass of the specimen. The specimen shall be thoroughly mixed and compacted in accordance with the method stipulated in Clause 6.3.3(i).
  - The bulk density ( $BD_2$ ) shall be calculated as stated in Clause 6.3.4(1), adjusted to converted bulk density ( $CBD_2$ ) as stated in Clause 6.3.4(2) and plotted on the +2% ordinate of the graph.

- (k) If the in-situ moisture content of the second specimen obviously exceeds the optimum moisture content, the specimen shall be dried until the amount of water removed is approximately 2% of the mass of the specimen and cooled. The specimen shall be thoroughly mixed and compacted in accordance with the method stipulated in Clause 6.3.3(i). The amount of water removed shall be determined. The bulk density (BD<sub>2</sub>) shall be calculated as stated in Clause 6.3.4(1), adjusted to converted bulk density (CBD<sub>2</sub>) as stated in Clause 6.3.4(2) and plotted on the negative ordinate of the graph at a point which corresponds to the amount of water removed.
- (l) The third point on the graph shall be obtained as follows:
- If the plotted value of CBD<sub>2</sub> is equal to or greater than the plotted-value of CBD<sub>1</sub>, the moisture content of a third specimen shall be increased by adding an amount of water equal to 4% of the mass of the specimen. Alternatively, if the procedure stated in Clause 6.3.3(k) has been followed, the specimen shall be dried until the amount of water removed is approximately 4% of the mass of the specimen after cooling.
  - If the plotted value of CBD<sub>2</sub> is less than the plotted value of CBD<sub>1</sub>, the third specimen shall be dried until the amount of water removed is approximately 2% of the mass of the specimen after cooling. Alternatively, if the procedure stated in Clause 6.3.3(k) has been followed, the moisture content shall be increased by adding an amount of water equal to 2% of the mass of the specimen.
  - The specimen shall be thoroughly mixed and compacted in accordance with the method stipulated in Clause 6.3.3(i). The amount of water removed shall be determined.
  - The bulk density (BD<sub>3</sub>) shall be calculated as stated in Clause 6.3.4(1), adjusted to converted bulk density (CBD<sub>3</sub>) as stated in Clause 6.3.4(2) and plotted on the graph at a point which corresponds to the amount of water added or removed.
- (m) If the centre point of the three points plotted is lower than one of the other two points, or is higher than one point and equal to the other, an additional point or points shall be obtained by proceeding in 2% increments or decrements as appropriate.
- (n) If it is apparent that the moisture condition of the material is such that a total of five points will not result in the determination of the optimum moisture content, increments and decrements of 3% moisture content may be adopted for the entire procedure.
- (o) A smooth approximately parabolic curve shall be drawn to the plotted points. The peak value of the curve shall be determined as the maximum converted bulk density (MCBD).

- (p) The amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content corresponding to the maximum converted bulk density shall be determined ( $z_m$ ).
- (q) The value of the moisture correction curve passing through the peak value of the plotted parabolic curve shall be determined ( $z_c$ ). If there is no moisture correction curve passing through the peak value of the curve, a moisture correction curve shall be drawn through the peak by interpolating to the nearest 0.1%.

**Calculation**

- 6.3.4 (1) The bulk density (BD) shall be calculated from the equation:

$$BD = (m_2 - m_1)/V \quad \text{Mg/m}^3$$

where:

- $m_1$  is the mass of the mould and base (g)
- $m_2$  is the mass of the mould, base and wet material (g)
- $V$  is the volume of the mould (mL)

- (2) The converted bulk density (CBD) shall be calculated from the equation:

$$CBD = BD/(1+z/100) \quad \text{Mg/m}^3$$

where:

- $z$  is the amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content
- $z$  is negative for values below the in-situ moisture content

- (3) The difference between the optimum moisture content ( $w_o$ ) and the in-situ moisture content ( $w_i$ ) of the material shall be calculated from the equation:

$$w_o - w_i = z_m + z_c \quad \%$$

where:

- $z_m$  is the amount of water added or removed as a percentage of the mass of the specimen at the in-situ moisture content corresponding to the maximum converted bulk density (%)
- $z_c$  is the value of the moisture correction curve passing through the peak value of the plotted parabolic curve (%)

- (4) The optimum moisture content ( $w_o$ ) shall be calculated from the equation:

$$w_o = w_i + (1 + w_i/100) z_m \quad \%$$

where:

- $w_i$  is the in-situ moisture content of the material (%)



- (5) The maximum dry density (MDD) shall be calculated from the equation:

$$\text{MDD} = \text{MCBD} / (1 + w_i/100) \quad \text{Mg/m}^3$$

where:

- MCB D is the maximum converted bulk density of the material ( $\text{Mg/m}^3$ )

- (6) The relative compaction (RC), if required, shall be calculated from the equation:

$$\text{RC} = \text{IBD} / \text{MCBD} \times 100\%$$

where:

- IBD is the in-situ bulk density of the material determined in accordance with Geospec 3, Test Method 11.1 or 11.2 as appropriate to the grain size of the material

### ***Reporting of results***

#### **6.3.5 The following shall be reported:**

- (a) Source and identification of the soil.
  - (b) The graph showing the plotted points and the parabolic curve passing through them.
  - (c) The maximum converted bulk density to the nearest  $0.01 \text{ Mg/m}^3$ .
  - (d) The optimum moisture content to the nearest 0.1%.
  - (e) The maximum dry density to the nearest  $0.01 \text{ Mg/m}^3$ .
  - (f) The relative compaction to the nearest 0.1%, if determined.
  - (g) The percentage retained on the 20 mm BS test sieve and the percentage retained on the 37.5 mm BS test sieve to the nearest 1%, if applicable.
  - (h) Whether the test was carried out using individual specimens or repeat testing of a single specimen.
  - (i) Whether a manual or an automatic compaction rammer was used.
  - (j) That the test method used was in accordance with this Specification.
-

## APPENDIX 6.4

### ADJUSTMENT OF THE MAXIMUM CONVERTED BULK DENSITY FOR THE DETERMINATION OF THE RELATIVE COMPACTION

- Scope** 6.4.1 This method covers the adjustment of the maximum converted bulk density determined in accordance with Appendix 6.3 for the determination of the relative compaction of a material containing more than 5% of the mass of the material at the in-situ moisture content retained on a 20 mm BS test sieve.
- Apparatus** 6.4.2 The following apparatus is required:
- (a) Apparatus in accordance with Appendix 6.3.
  - (b) A 20 mm and a 37.5 mm BS test sieve.
  - (c) A mould with collar as used for determination of the California Bearing Ratio (CBR mould).
  - (d) An extrusion device as used for determination of the California Bearing Ratio.
- Procedure** 6.4.3 The procedure shall be as follows:
- (a) If the amount of material retained on the 20 mm BS test sieve exceeds 5% and does not exceed 20%, the material passing the sieve shall be compacted in accordance with Appendix 6.3. The maximum converted bulk density (MCBD<sub>20</sub>) shall be determined and adjusted as stated in Clause 6.4.4.
  - (b) If the amount of material retained on the 20 mm BS test sieve exceeds 20%, the retained material shall be screened over the 37.5 mm BS test sieve. The procedure stated in either Clause 6.4.3(c) or Clause 6.4.3(d) as appropriate shall be followed.
  - (c) If the amount of material retained on the 37.5 mm BS test sieve does not exceed 5%, the procedure stated in Clause 6.4.3(e) shall be followed.
  - (d) If the amount of material retained on the 37.5 mm BS test sieve exceeds 5% and does not exceed 20%, the retained material shall be replaced with an equal mass of material which is of a similar nature and which is retained on a 20 mm BS test sieve but passes a 37.5 mm BS test sieve. The procedure stated in Clause 6.4.3(e) shall be followed.
  - (e) The procedure stated in Appendix 6.3 shall be followed except that the material shall be compacted into the CBR mould and each layer shall be subjected to 62 blows of the rammer.

**Calculation**

- 6.4.4 The maximum converted bulk density (MCBD) shall be calculated from the equation:

where:

- $MCBD_{20}$  is the maximum converted bulk density of the material passing the 20 mm BS test sieve ( $Mg/m^3$ )
- $z$  is the amount of water added as a percentage of the mass of the specimen at the in-situ moisture content corresponding to the maximum converted bulk density (%)

**Reporting of results**

- 6.4.5 The following shall be reported:

- (a) The source and identification of the soil.
  - (b) The results in accordance with Appendix 6.3.
  - (c) The mass of the original material not passing the 20 mm and 37.5 mm BS test sieve as a percentage of the mass of the material at the in-situ moisture content to the nearest 0.1%.
  - (d) The type of mould used.
  - (e) The number of blows per layer.
  - (f) Whether the specific gravity was measured or assumed and, if measured, the method used.
  - (g) That the test method used was in accordance with this Specification, and the results have been adjusted in accordance with this Appendix.
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**GENERAL SPECIFICATION  
FOR  
CIVIL ENGINEERING WORKS**

**SECTION 2  
CARRIAGEWAYS: SUB-BASE MATERIAL AND  
BITUMINOUS MATERIALS**



## SECTION 2

### CARRIAGEWAYS: SUB-BASE MATERIAL AND BITUMINOUS MATERIALS

#### GLOSSARY OF TERMS

<b><i>Nominal maximum aggregate size</i></b>	9.01	Nominal maximum aggregate size is the smallest BS sieve size for which the upper limit of the percentage of the aggregate by mass passing is 100%.
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#### MATERIALS

<b><i>Sub-base material using virgin material</i></b>	9.02	Sub-base material shall be crushed rock and shall have the properties stated in Table 9.1. Sub-base material passing the 425 µm BS test sieve, when tested in accordance with Clause 9.46(4) shall be non-plastic.
<b><i>Recycled sub-base material in lieu of virgin material</i></b>	9.03	<p>(1) Recycled sub-base material shall be crushed rock, crushed concrete or clean crushed inert demolition material and may contain up to 12.5 % by mass of natural sand which passes the 5mm BS test sieve. The material shall lie within the grading limits of Table 9.1, and not be gap graded.</p> <p>(2) The material shall have a 10 % fines value of 50 KN or more when tested in accordance with Clause 9.47(3).</p> <p>(3) The material passing the 425µm BS test sieve shall be non-plastic when tested in accordance with Clause 9.47(4).</p> <p>(4) The aggregate shall be considered suitable if it has a soundness value greater than 65.</p> <p>(5) The material shall have a water-soluble sulphate content of less than 1.9g of sulphate (expressed as SO<sub>3</sub>) per litre, if used within 500mm of cement-bound material, concrete pavements, concrete structures or concrete products.</p> <p>(6) The material shall have a minimum laboratory California Bearing Ratio (CBR) value of 30% or such other higher value as specified by the Engineer.</p> <p>(7) The material shall not contain quantities of contaminants in excess of the percentages given in Table 9.2 unless otherwise approved by the Engineer.</p> <p>(8) Notwithstanding the above sub-clauses, the Contractor may propose for the Engineer's approval the use of virgin aggregates in lieu of recycled aggregates in the sub-base material when there is a shortage of supply of recycled aggregates.</p>

Table 9.1: Properties of sub-base material

Properties	BS test sieve	Percentage by mass passing
Particle size distribution	75 mm	100
	37.5 mm	85 - 100
	20 mm	60 - 85
	10 mm	40 - 70
	5 mm	25 - 45
	600 µm	8 - 22
	75 µm	0 - 10
Ten percent fines value		> 50 kN

Table 9.2 : Allowable contamination of recycled sub-base material

Sub-base type	Type of contamination			
	Maximum sulphate content By mass	Maximum metals content By mass	Maximum foreign material content e.g. glass, soft material etc. By mass	Maximum organic material content (by mass)
Recycled sub-base	1%	1%	1%	0.5%

**Aggregates for bituminous materials**

- 9.04 (1) Coarse aggregate for bituminous materials shall be crushed rock all retained on a 5 mm BS test sieve and shall have the properties stated in Table 9.3.
- (2) Fine aggregate for bituminous materials shall be crushed rock, river sand or a mixture of crushed rock and river sand all passing 5 mm BS test sieve. The water absorption of fine aggregate shall not exceed 2.0%.
- (3) For the purpose of mix design, the combined grading of aggregates for bituminous materials shall be such that the particle size distribution lies within the limits stated in Table 9.4 for the relevant bituminous material.

Table 9.3: Properties of coarse aggregate for bituminous materials

Properties	Nominal maximum aggregate size (mm)			
	37.5	28	20	10
Flakiness index	≤ 25.0%	≤ 26.0%	≤ 27.0%	≤ 30.0%
Ten percent fines value	> 100 kN			
Water absorption	≤ 2.0%			



Table 9.4: Design limits for particle size distribution and bitumen content for bituminous materials

Properties		Type of bituminous material					
		Roadbase (recipe mix)	Base course		Wearing course		Friction course
Nominal maximum aggregate size (mm)		37.5	37.5	28	20	10	10
Particle size distribution	BS test sieve	Percentage by mass passing					
	50 mm	100	100	-	-	-	-
	37.5 mm	90 - 100	91 - 100	100	-	-	-
	28 mm	70 - 94	70 - 94	91 - 100	100	-	-
	20 mm	62 - 84	62 - 84	85 - 95	91 - 100	-	-
	14 mm	-	55 - 76	72 - 87	78 - 90	100	100
	10 mm	49 - 67	49 - 67	55 - 75	68 - 84	87 - 100	85 - 100
	5 mm	37 - 55	37 - 55	35 - 53	54 - 72	62 - 80	20 - 40
	2.36 mm	27 - 43	27 - 43	25 - 40	42 - 58	42 - 58	5 - 15
	1.18 mm	-	20 - 35	15 - 30	34 - 48	34 - 48	-
	600 µm	13 - 28	13 - 28	12 - 24	24 - 38	24 - 38	-
	300 µm	7 - 21	7 - 21	8 - 18	16 - 28	16 - 28	-
	150 µm	-	4 - 14	5 - 12	8 - 18	8 - 18	-
	75 µm	2 - 8	2 - 8	3 - 6	4 - 8	4 - 8	2 - 6
Bitumen content as percentage of total mass including binder	min.	3.0	4.0	4.5	5.0	6.0	4.5
	max.	4.0	4.5	5.0	5.5	7.0	5.5

**Filler for bituminous materials** 9.05

(1) Filler for bituminous materials shall be crushed rock filler, PC, PFAC, PFA or hydrated lime. Filler shall be free-flowing and dry before addition to the bituminous mixture.

(2) Filler for bituminous friction course material shall contain hydrated lime. The amount of hydrated lime, expressed as a percentage by mass of the total aggregates, shall be at least 1.5%.

(3) PC and PFAC shall comply with BS EN 197-1.

(4) PFA shall comply with BS 3892: Part 1 except that the criterion for maximum water requirement shall not apply.

(5) Crushed rock filler and hydrated lime shall comply with ASTM D 242.

<b>Bitumen</b>	9.06	Bitumen for bituminous materials shall comply with ASTM D 946, Grade 60-70 and shall have a softening point exceeding 44°C and less than 55°C. The wax content of the bitumen shall comply with requirements for Grade A specified in JTG F40-2004. Unless otherwise permitted by the Engineer, blending or mixing of bitumen shall be carried out at a refinery approved by the Engineer.
		Amd 2/2007
<b>Bituminous emulsion</b>	9.07	Bituminous emulsion shall be anionic bituminous emulsion complying with BS 434: Part 1, Table 1, Class A1-40 or cationic bituminous emulsion complying with BS 434: Part 1, Table 2, Class K1-40.
<b>Bituminous priming material</b>	9.08	Bituminous priming material shall be medium curing-grade cutback bitumen complying with ASTM D 2027, Table 1, Class MC-30.

## DESIGN OF SUB-BASE MATERIAL AND BITUMINOUS MATERIALS

<b>Design procedure for sub-base material and bituminous materials</b>	9.09	<p>(1) Sub-base material and bituminous roadbase materials shall be recipe mixes. Laboratory design mixes other than those for sub-base material and bituminous roadbase materials shall be made and tested as part of the design procedure at a laboratory approved by the Engineer.</p> <p>(2) Unless otherwise permitted by the Engineer, mix designs and associated tests shall be carried out by the Contractor in the presence of the Engineer. The Contractor shall notify the Engineer at least 7 days, or such shorter period agreed by the Engineer, before carrying out the mix designs.</p> <p>(3) Subject to the approval of the Engineer, the Contractor may use bituminous roadbase material incorporating reclaimed asphalt pavement (RAP) for carriageway works. The specific requirements are as follows: -</p> <p>(a) Roadbase incorporating RAP shall be designed, manufactured, laid and tested in accordance with the requirements for roadbase using non-recycled materials or otherwise specified by the Engineer.</p> <p>(b) The RAP shall comply with the following:</p> <p>(i) RAP shall be obtained from milling or excavation of existing bituminous pavements, and return loads from site and offcuts from bituminous layer joint preparation. Return loads can include bituminous materials rejected from site. RAP shall be crushed and screened as necessary such that the maximum particle size is not greater than the nominal maximum aggregate size of the bituminous roadbase materials being produced and a reasonably well-graded and consistent mixture can be produced.</p> <p>(ii) RAP shall be free of foreign materials such as unbound granular sub-base, broken concrete, or other contaminants.</p> <p>(iii) RAP shall be stored in separate stockpiles before use. RAP that has been stockpiled for some time shall be reprocessed,</p>
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where necessary, to ensure that it is in a free-flowing state at the time of use.

- (iv) The maximum amount of RAP allowable in the bituminous roadbase material shall be 15% by mass of the total mix. Separate mix designs shall be required for roadbase materials incorporating RAP.

***Design of bituminous materials***

9.10

(1) Bituminous materials shall consist of coarse and fine aggregates complying with Clause 9.04, filler complying with Clause 9.05 and bitumen complying with Clause 9.06. The different types of bituminous materials shall have particle size distributions and bitumen contents within the limits stated in Table 9.4.

(2) Subject to the Engineer's approval, the Contractor may use bituminous wearing course and base course materials incorporating reclaimed asphalt pavement (RAP) for carriageway works. The RAP shall comply with the requirements specified in Clause 9.09(3). Wearing course and base course materials incorporating RAP shall be designed, manufactured, laid and tested in accordance with the requirements for these materials using non-recycled materials or otherwise specified by the Engineer.

Amd 1/2007

(3) The properties of the different types of bituminous materials shall be as stated in Table 9.5.

(4) Bituminous materials of all aggregate sizes, other than bituminous roadbase material, shall be designed in accordance with the Marshall Method of Mix Design stated in The Asphalt Institute Handbook 'MS-2 Mix Design Methods for Asphalt Concrete and other Hot-mix Types, Sixth Edition (1997)' with modifications only if agreed by the Engineer. The compaction standard shall be 75 blows per side. The maximum amount of RAP allowable in the bituminous wearing course and base course materials shall be 15% by mass of the total mix. Separate mix designs shall be required for these materials incorporating RAP.

Amd 1/2007

(5) Design procedures for bituminous friction course material shall be as stated in Clause 9.10(4) except that the mixing and compaction temperatures shall be consistent with bitumen viscosities of  $900 \pm 100$  centistokes and  $2000 \pm 200$  centistokes respectively.

Table 9.5: Properties of designed bituminous materials

Properties	Type of bituminous material				
	Base course		Wearing course		Friction course
	Nominal maximum aggregate size (mm)				
	37.5	28	20	10	10
Minimum Marshall stability (kN)	10.0		10.0		-
Maximum flow value (mm)	4.0		4.0		-
Minimum voids in mineral aggregate as a percentage of total bulk volume	12.5	13.0	14.0	16.0	25.0
Air voids in mix as a percentage of total bulk volume	3.0    -    5.0		3.0    -    5.0		18.0    -    25.0

## SUBMISSIONS

### *Particulars of filler and bitumen for bituminous materials*

- 9.11 (1) The following particulars of the proposed filler and bitumen for bituminous materials shall be submitted to the Engineer:
- A certificate from the manufacturer for each type of filler showing the manufacturer's name, the date and place of manufacture and showing that the filler complies with the requirements stated in the Contract and including results of tests for particle size distribution, and
  - A certificate from the manufacturer for bitumen showing the manufacturer's name, the date and place of manufacture and showing that the bitumen complies with the requirements stated in the Contract, including a temperature-viscosity relationship for the bitumen, and including results of tests for:
    - Relative density
    - Softening point
    - Penetration
    - Ductility
    - Retained penetration after thin film oven test
    - Solubility
    - Viscosity
    - Loss on heating

- Wax.

Amd 2/2007

(2) The particulars, including certificates, shall be submitted to the Engineer at the time stated in Clause 9.12(3).

(3) Further certificates showing that the materials comply with the specification shall be submitted at intervals agreed by the Engineer.

***Particulars of mixes  
for sub-base material  
and bituminous  
materials***

9.12

(1) The following particulars of sub-base material and bituminous roadbase materials shall be submitted to the Engineer:

- (a) Source and type of aggregates,
- (b) Grading details in tabular and graphical form, and
- (c) Details of each mixing plant proposed,

(2) The following particulars of bituminous materials shall also be submitted to the Engineer:

- (a) Certified copies of work sheets for mix designs, which shall include the relative density of the mixed aggregates,
- (b) Source of bitumen, and
- (c) If requested by the Engineer, past test records of the same mix produced in the same plant.

(3) The particulars shall be submitted to the Engineer at least 21 days before:

- (a) Trial areas are constructed, or
- (b) The mix is placed in the permanent work if trial areas are not required.

***Particulars of recycled  
sub-base material***

9.13

(1) The following particulars of recycled sub-base material if used in lieu of virgin material shall be submitted to the Engineer:

- (a) Details of the recycling plant, and test results for:
  - Ten percent fines value
  - Soundness value
  - CBR value
  - Content of contaminant in percentage by mass
  - Water-soluble sulphate content
  - Organic material content, and

- (b) Grading details in tabular and graphical form

***Particulars of supplier  
of sub-base material  
and bituminous***

9.14

The name of the supplier and the location of each plant from which the Contractor proposes to obtain sub-base material and bituminous materials shall be submitted to the Engineer at the time stated in Clause 9.12(3).

<b><i>Particulars of methods of laying and compacting sub-bases and bituminous materials</i></b>	9.15	<p>(1) The following particulars of the proposed methods of laying and compacting sub-bases and bituminous materials shall be submitted to the Engineer:</p> <ul style="list-style-type: none"> <li>(a) Details of construction plant, and</li> <li>(b) Programme and rate of working.</li> </ul> <p>(2) The particulars shall be submitted to the Engineer at the time stated in Clause 9.12(3).</p>
<b><i>Samples of sub-base material, aggregate, filler and bitumen</i></b>	9.16	One sample of each type of sub-base material and one sample of each type of aggregate, filler and bitumen for bituminous material shall be submitted to the Engineer at the same time as particulars are submitted.

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## TRIALS

<b><i>Trial areas</i></b>	9.17	<p>(1) Trial areas of each type and layer of bituminous materials shall be constructed to demonstrate that the proposed materials, mixes, methods of production and methods of construction are capable of producing a carriageway that complies with the specified requirements. Unless otherwise stated in the Contract, the trial areas shall be constructed as part of the permanent carriageway at locations agreed by the Engineer. The width of each trial area shall be at least one lane of carriageway, and the length shall be at least 60 m.</p> <p>(2) Trial areas shall be constructed using the materials, mixes, methods of production and methods of construction submitted to the Engineer. Materials shall be delivered in not less than two loads.</p> <p>(3) The Contractor shall inform the Engineer 48 hours, or such shorter period agreed by the Engineer, before constructing trial areas.</p> <p>(4) The permission of the Engineer shall be obtained before each layer of material is placed in the trial area.</p> <p>(5) The Engineer shall be given sufficient time to determine whether the specified requirements have been produced in the trial area before further material of the same type is placed in the permanent carriageway.</p> <p>(6) Trial areas shall be protected from damage and shall be left in position unless the Engineer instructs their removal. Trial areas which form part of the permanent carriageway and which comply with the specified requirements shall not be removed.</p>
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Table 9.6: Sampling and testing bituminous materials

Type of material	Properties	Methods of sampling	Methods of testing
Bituminous base course and wearing course material	Particle size distribution	Clause 9.55	Clause 9.56
	Bitumen content	Clause 9.55	Clause 9.56
	Rice's specific gravity	Clause 9.55	Clause 9.56
	Void content	Clause 9.62	Clause 9.63
Bituminous friction course material	Particle size distribution	Clause 9.59	Clause 9.60
	Bitumen content	Clause 9.59	Clause 9.60
	Texture depth and permeability	-	Clause 9.66

- Samples: trial areas**      9.18      (1) One sample of bituminous materials, excluding bituminous roadbase materials, shall be provided from each mix used in trial areas. The method of sampling shall be as stated in Table 9.6.
- (2) Ten cores shall be cut from each layer of base course and wearing course in trial areas. The method of taking cores shall be as stated in Clause 9.62.
- Testing: trial areas**      9.19      (1) Each sample of bituminous material taken as stated in Clause 9.18, shall be tested to determine the properties stated in Table 9.6. The method of testing shall be as stated in Table 9.6.
- (2) If the layer is to form part of the permanent work, each layer of bituminous material in trial areas, excluding bituminous roadbase material, shall be tested as stated in Clause 9.40 to determine the level of the surface.
- (3) The layer which is to be the final layer of the carriageway in each trial area shall be tested as stated in Clauses 9.42 and 9.43 to determine the surface regularity, if the layer is to form part of the permanent work.
- (4) The layer of friction course in each trial area shall be tested as stated in Clauses 9.66 to 9.68 to determine the texture depth and permeability.
- (5) Cores shall be tested as stated in Clauses 9.62 to 9.65 to determine the compacted layer thickness and air void content.
- Compliance criteria: trial areas**      9.20      The properties of the materials, the levels of the surface, compaction, surface regularity, texture depth and permeability of bituminous materials laid in the trial areas shall comply with the specified requirements for the permanent carriageway.
- Non-compliance: trial areas**      9.21      (1) If the result of any test on trial areas does not comply with the specified requirements for trial areas, particulars of proposed changes to the materials, mixes, methods of production or methods of construction shall be submitted to the Engineer. Further trial areas shall be constructed until the result of every test on trial areas complies with the specified requirements for the trial areas.

(2) Unless otherwise permitted by the Engineer, trial areas or parts of trial areas, which do not comply with the specified requirements for the trial area, shall be removed.

**Approved mix for  
bituminous materials  
other than bituminous  
roadbase material**

9.22 (1) A mix for bituminous materials other than bituminous roadbase material that complies with the specified requirements for designed mixes and for trial areas shall become an approved mix.

(2) The approved gradation envelope for bituminous materials other than bituminous roadbase material shall be the gradation envelope found by applying the tolerances stated in Table 9.7 to the particle size distribution of the approved mix.

(3) The approved bitumen content range for bituminous materials other than bituminous roadbase material shall be the bitumen content range formed by applying a tolerance of  $\pm 0.5\%$  to the bitumen content of the approved mix.

Table 9.7: Tolerances for particle size distribution from approved mix

BS test sieve	Tolerance of particle size distribution in percentage by mass of total mix passing BS test sieve			
	Nominal maximum aggregate size (mm)			
	37.5	28	20	10
50 mm	0	-	-	-
37.5 mm	$\pm 4$	0	-	-
28 mm	$\pm 7$	$\pm 4$	0	-
20 mm	$\pm 7$	$\pm 7$	$\pm 4$	-
14 mm	$\pm 7$	$\pm 7$	$\pm 7$	0
10 mm	$\pm 7$	$\pm 7$	$\pm 7$	$\pm 4$
5 mm	$\pm 7$	$\pm 7$	$\pm 7$	$\pm 7$
2.36 mm	$\pm 7$	$\pm 7$	$\pm 7$	$\pm 7$
1.18 mm	$\pm 7$	$\pm 7$	$\pm 7$	$\pm 7$
600 $\mu\text{m}$	$\pm 5$	$\pm 5$	$\pm 5$	$\pm 5$
300 $\mu\text{m}$	$\pm 5$	$\pm 5$	$\pm 5$	$\pm 5$
150 $\mu\text{m}$	$\pm 3$	$\pm 3$	$\pm 3$	$\pm 3$
75 $\mu\text{m}$	$\pm 2$	$\pm 2$	$\pm 2$	$\pm 2$

**Commencement of  
placing bituminous  
materials**

9.23 Bituminous material shall not be placed in the permanent works until the Engineer has approved the mix.

**Changes in materials  
and methods of  
construction**

9.24 Unless permitted by the Engineer, the materials and methods of production used in producing the approved mixes and the methods of construction used in trial areas shall not be changed.



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## HANDLING, STORAGE AND TRANSPORT OF MATERIALS

### *Handling and storage of sub-base material and bituminous materials*

- 9.25 (1) Cement and PFA shall be stored as stated in Clause 16.33.
- (2) Material handling and storage areas shall be levelled and well drained. Sub-base material and bituminous materials shall not be handled or stored in a manner which will result in mixing of the different types and sizes or in segregation or contamination of the materials. Measures to protect the materials from the effects of weather shall be submitted to the Engineer for approval.
- (3) Unless otherwise permitted by the Engineer, bituminous materials shall not be stored in heated surge bins for more than 12 hours or in transport vehicles for more than 3 hours.
- (4) Bituminous friction course material shall not be stored in surge bins for more than 30 minutes.

### *Transport of sub-base material and bituminous materials*

- 9.26 (1) Sub-base material and bituminous materials shall be protected by covers while being transported and before laying. Covers for bituminous materials shall be heavy canvas or a similar insulating material. The covers shall completely cover the material and shall be securely fixed to minimize loss of heat and to protect the materials from contamination by dust or other deleterious material.
- (2) Sub-base material and bituminous materials shall be transported in clean vehicles with smooth trays and sides.
- (3) The trays of vehicles transporting bituminous materials may be lubricated with soap solution or light oil sprayed on the trays. Vehicles transporting bituminous friction course material shall not be lubricated with light oil.
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## MIXING OF SUB-BASE MATERIAL AND BITUMINOUS MATERIALS

### *Mixing of sub-base material and bituminous materials*

- 9.27 Mixing of sub-base material and mixing of bituminous materials shall be carried out before delivery to the Site at mixing plants approved by the Engineer. The plants shall be designed and operated to produce uniform mixes that comply with the specified requirements.

### *Mixing plant for bituminous materials*

- 9.28 (1) The mixing plant for bituminous materials shall have at least four separate cold-feed bins for preliminary cold batching of the coarse and fine aggregates, and a rotary drum dryer, which will continuously agitate the aggregates during the heating and drying processes. After passing through the dryer, the aggregates shall be screened into at least four hot storage bins before mixing.
- (2) Bitumen heating and storage tanks shall be fitted with circulating pumps to ensure an even temperature throughout the tanks.

(3) The mixing plant shall be provided with sampling devices to enable samples of hot aggregates, filler and bitumen to be taken before mixing.

(4) Insulated surge bins, if fitted to the mixing plant, shall be designed and operated to prevent segregation occurring in the mix. Heating devices fitted to surge bins shall be capable of maintaining the temperature of the mix to within the specified limits.

(5) Measuring and weighing equipment shall be maintained in a clean, serviceable condition. The equipment shall be set to zero daily and calibrated before mixes for the permanent work are produced, and at regular intervals not exceeding 6 months.

(6) Alternative methods of mixing bituminous materials may be used with the approval of the Engineer.

**Mixing bituminous materials** 9.29

(1) Aggregates and filler for bituminous materials shall be measured to an accuracy of  $\pm 3.0\%$  by mass. The aggregate moisture content after drying shall not exceed  $0.4\%$  by mass.

(2) Mixing of bituminous materials shall continue after the addition of all constituents for such period as is necessary to ensure that the aggregates and filler are uniformly coated with bitumen.

(3) Bituminous materials shall comply with the temperature requirements as stated in Table 9.8 during and after mixing.

Table 9.8: Temperature requirements for bituminous materials

Type of bituminous material		Roadbase, base course and wearing course	Friction course
Aggregate temperature at mixing (°C)	Min.	130	115
	Max.	175	135
Binder temperature at mixing (°C)	Min.	135	115
	Max.	165	165
Bituminous mixture temperature after mixing (°C)	Min.	130	115
	Max.	165	135
Bituminous mixture temperature at laying (°C)	Min.	-	110
	Max.	-	135
Bituminous mixture temperature at start of compaction (°C)	Min.	-	85

## PRELIMINARY WORK

**Installation of utilities** 9.30

(1) Pipes, cables, manholes, chambers, gullies and other utilities below carriageways shall be completed and fill material shall be deposited and compacted in trenches before the carriageway is constructed. Openings to manholes, chambers and gullies shall be protected with temporary covers or by other methods agreed by the Engineer.

(2) Covers, frames and other hardware which will prevent continuous laying of bituminous materials for roadbase and base course shall not be fixed in position until such work is complete.

(3) After the penultimate layer of bituminous material has been laid and compacted, the layers of asphalt shall be cut out, temporary covers shall be removed and the permanent covers, frames and other hardware shall be installed.

(4) Finishing around covers, frames and other hardware shall be carried out using bituminous material of the same type as that in the adjacent surface unless otherwise permitted by the Engineer. The material shall be compacted in layers not exceeding 50 mm thick using hand rammers or mechanical equipment up to the underside of the wearing course or friction course.

## LAYING AND COMPACTION OF SUB-BASE MATERIAL

### *Laying and compaction of sub-base material using virgin material*

9.31

(1) Sub-base material shall be laid and compacted in a manner that will not result in segregation of the material and at a moisture content that allows the compaction stated in Clause 9.31(6) to be achieved. The moisture content shall not be less than 2%.

(2) Sub-base material shall be laid in layers in such a manner that the compacted thickness of each layer will not exceed 225 mm. If the specified final compacted thickness of the sub-base exceeds 225 mm, the material shall be laid in two or more layers. The minimum thickness of each layer shall be 100 mm and, if the layers are of unequal thickness, the lowest layer shall be the thickest.

(3) Each layer of sub-base material shall be evenly spread immediately after placing in position and shall be compacted immediately after spreading.

(4) The minimum compaction plant to be used for compaction of sub-base material shall be of the type as stated in Clause 9.36(1).

(5) The permission of the Engineer shall be obtained before the next layer is placed on each layer of compacted sub-base material.

(6) Sub-base material shall be compacted to obtain a relative compaction of at least 95% maximum dry density throughout.

(7) The surface of each layer of sub-base shall be maintained in a compacted condition until the next layer of sub-base material or roadbase material is laid. The surface shall not be disturbed by construction plant or other vehicles, and shall be free of ridges, cracks, loose material, pot-holes, ruts or other defects.

***Laying and  
compaction of recycled  
sub-base material in  
lieu of virgin material***

- 9.32 (1) Recycled sub-base material shall be laid and compacted in a manner which will not result in segregation of the material and at a moisture content which allows the compaction stated in Clause 9.32(7) to be achieved. The moisture content shall not be less than 2%.
- (2) The recycled sub-base shall consist of an upper layer of virgin sub-base material overlying a layer of recycled sub-base material. The ratio of the thickness of the recycled sub-base layer to that of the virgin sub-base layer shall be approximately 6 to 4. During laying and compaction, the thickness of each of these two layers shall take into account the layer thickness requirements given in sub-clause (3) below.
- (3) Recycled sub-base material shall be laid in layers in such a manner that the compacted thickness of each layer will not exceed 225 mm. If the specified final compacted thickness of the sub-base exceeds 225 mm, the material shall be laid in two or more layers. The minimum thickness of each layer shall be 100 mm and, if the layers are of unequal thickness, the lowest layer shall be the thickest.
- (4) Each layer of recycled sub-base material shall be evenly spread immediately after placing in position and shall be compacted immediately after spreading.
- (5) The minimum compaction plant to be used for compaction of recycled sub-base material shall be as stated in Clause 9.36(1).
- (6) The permission of the Engineer shall be obtained before the next layer is placed on each layer of compacted recycled sub-base material.
- (7) Recycled sub-base material shall be compacted to obtain a relative compaction of at least 95% maximum dry density throughout.
- (8) The surface of each layer of recycled sub-base shall be maintained in a compacted condition until the next layer of sub-base material or roadbase material is laid. The surface shall not be disturbed by construction plant or other vehicles, and shall be free of ridges, cracks, loose material, pot-holes, ruts or other defects.

## **LAYING AND COMPACTION OF BITUMINOUS MATERIALS**

***Laying and  
compaction of  
bituminous materials***

- 9.33 (1) Bituminous materials shall not be laid during periods of wet weather or when ponding water is present on the underlying surface unless in the opinion of the Engineer the works will not be adversely affected.
- (2) Bituminous wearing course material shall not be laid when the ambient air temperature is below 8°C and bituminous friction course material shall not be laid when the ambient air temperature is below 10°C. Temperatures shall be measured in the shade near to the surface on which laying is to be carried out.
- (3) Surfaces on which bituminous materials are laid shall be clean and free of mud, grit and other deleterious material.

(4) If instructed by the Engineer, a tack coat of bituminous emulsion shall be applied to surfaces on or against which bituminous materials will be laid. The tack coat shall be evenly applied at a rate of between 0.4 L/m<sup>2</sup> and 0.6 L/m<sup>2</sup> using a spray machine complying with BS 434: Part 2 Bituminous materials shall not be laid until the tack coat has cured. construction plant and other vehicles necessary shall only run on the tack coat as necessary to lay the bituminous materials.

(5) If approved by the Engineer, surfaces of existing carriageways may be regulated before the overlying bituminous material is laid. Bituminous regulating course material shall be a material approved by the Engineer complying with the requirements for the 10 mm nominal maximum aggregate size wearing course material as specified in Table 9.4. Regulating course material shall be laid by paving machines unless laying by manual methods is instructed by the Engineer.

(6) Bituminous materials shall comply with the temperature requirements as stated in Table 9.8 during laying and compaction.

***Laying bituminous materials by paving machine***

9.34

(1) Unless otherwise permitted by the Engineer, bituminous materials shall be placed and spread using a self-propelled paving machine with a screw auger and attached screed capable of spreading and laying the material to the full width required. The paving machine shall be capable of giving initial compaction to the material and finishing it to a level suitable for subsequent compaction.

(2) Paving machines may be fitted with cut-off shoes or extensions to limit or extend the width of the screed. Screed extensions shall not be used unless the screw auger is extended in accordance with the manufacturer's recommendations. The surface texture produced by paving machines shall be free of segregation and pushing or dragging marks.

(3) Bituminous materials laid by paving machines shall be placed directly from the vehicles transporting the material into the hopper of the paving machine. Delivery of materials to the paving machine and laying of the materials shall be at a uniform rate appropriate to the capacity of the paving machine and compaction plant.

(4) If any delay in laying operations occurs, the paving machine shall be removed, the uncompacted cold material shall be removed and a transverse joint shall be formed as stated in Clause 9.37.

(5) Paving machines working in echelon shall be as close as practicable. The machines shall be not more than 30 m apart unless a longitudinal joint is formed as stated in Clause 9.37.

(6) Manual placing of materials on freshly laid surfaces shall only be used for the purpose of locally correcting levels as paving operations proceed, before compaction by rolling is commenced.

***Laying bituminous materials by manual methods***

9.35

Bituminous materials shall be laid by manual methods only if in the opinion of the Engineer the use of a paving machine is impracticable. If approved by the Engineer, bituminous materials may be laid by manual methods:

- (a) In courses of irregular shape and varying thickness,

- (b) In confined locations,
- (c) Adjacent to expansion joints, covers, frames and other hardware, and
- (d) In reinstatements to trenches.

***Compaction of  
bituminous materials  
and sub-base material***

9.36

- (1) The minimum compaction plant to be used to compact bituminous roadbase, base course, regulating course, wearing course and sub-base material shall be:

- (a) A smooth three-wheeled steel-wheeled roller with a mass of between 6 t and 12 t, or a vibratory tandem steel-wheeled roller with an effective mass of between 6 t and 12 t, and

A smooth pneumatic-tyre roller with a mass of between 12 t and 25 t, and with not less than seven overlapping wheels which have tyres that are capable of having pressures varying between 300 MPa and 800 MPa, and

Suitable mechanical rammers and hand-tools, or

- (b) Other types of rollers, vibrating plates and rammers approved by the Engineer, or other similar plant approved by the Engineer, necessary to produce the required degree of compaction.

- (2) Bituminous roadbase, base course, regulating course and wearing course materials shall be initially rolled using a steel-wheeled roller operated in a longitudinal direction along the carriageway with the driving wheels nearest the paving machine.

- (3) All roller marks shall be removed from the surface of bituminous roadbase, base course and wearing course materials using either a smooth-wheeled dead-weight roller or a smooth-wheeled vibratory roller in non-vibrating mode.

- (4) Bituminous friction course material shall be compacted using rollers as stated in Clause 9.36(1)(a) without the application of vibration. Rollers shall not have an excessive film of water over the front and rear wheels. Bituminous friction course material shall be compacted until all roller marks are removed and compaction is complete.

- (5) Rollers shall not be parked on newly laid or compacted bituminous materials.

- (6) Bituminous materials immediately adjacent to kerbs, covers, frames and other hardware where rollers cannot operate effectively shall be compacted using hand-operated mechanical compaction plant.

***Joints in bituminous  
materials***

9.37

- (1) The screed of the paving machine shall overlap previously laid strips of bituminous material by at least 50 mm and shall be sufficiently high that compaction will produce a smooth dense flush joint. Bituminous materials overlapping the previously laid strip shall be pushed back to the edge of the previously laid strip and the excess material shall be removed.

(2) Longitudinal joints in friction course or wearing course shall be formed coincident with the specified position of the lane-markings unless otherwise permitted by the Engineer.

(3) A prepared joint shall be formed between hot bituminous material and cold material or existing bituminous material which is at a temperature below the minimum specified laying temperature.

(4) The distance between prepared longitudinal joints in different layers shall be at least 150 mm and the distance between prepared transverse joints in different layers shall be at least 500 mm.

(5) Prepared joints in base course and wearing course shall be formed by cutting back the face of the cold material or existing bituminous material for a minimum distance of twice the depth of the layer or 100 mm, whichever is greater. A vertical face shall be cut for the full depth of the layer. All loosened materials shall be removed and the face shall be coated with bituminous emulsion. The bituminous emulsion shall not be applied beyond the edges of the joint. The hot bituminous materials shall be laid and compacted against the coated face with a joint formed as stated in this clause.

(6) Unless otherwise permitted by the Engineer friction course joints shall not be coated with bituminous emulsion.

## **PROTECTION OF SURFACES OF SUB-BASE MATERIAL AND BITUMINOUS MATERIALS**

***Protection of surfaces  
of sub-base material  
and bituminous  
materials*** 9.38

(1) The surface of each layer of sub-base material and bituminous materials shall be kept clean and free of deleterious material. If instructed by the Engineer, bituminous priming coat shall be applied to the final surface of the sub-base layer at a rate of between 0.9 L/m<sup>2</sup> and 1.1 L/m<sup>2</sup>.

(2) Layers of carriageways under construction shall not be used by construction plant or vehicles other than those which in the opinion of the Engineer are essential to construct the work.

(3) Unless otherwise permitted by the Engineer, bituminous courses shall not be used by construction plant or other vehicles until 6 hours after the material has been laid and compacted.

## **TOLERANCES**

***Tolerances:  
alignment of  
carriageway*** 9.39

The line of the edges of carriageways shall be within 25 mm of the specified line, except at the edges of structures where it shall be within 6 mm.

- Tolerances: level of carriageway** 9.40
- (1) The levels of the surface of each layer of sub-base, roadbase, base course, wearing course and friction course shall be determined on a grid at 10 m centres in the longitudinal direction and at 2 m centres in the transverse direction.
  - (2) The level of the surface of each layer of sub-base, roadbase, base course, wearing course and friction course shall be within the tolerances stated in Table 9.9.
  - (3) The difference in level of the surface of wearing course and friction course across joints shall not exceed 3 mm.
  - (4) The combination of permitted tolerances in levels shall not result in a reduction in the thickness of the pavement, excluding the sub-base, of more than 15 mm from the specified thickness nor a reduction in the thickness of the bituminous wearing course or friction course of more than 5 mm from the specified thickness.

Table 9.9: Tolerances in level

Type of surface	Permitted tolerance in level (mm)
Sub-base	+ 10                      - 20
Roadbase course	+ 8                         - 15
Base course	± 6
Wearing course	
Friction course	

- Tolerances: covers, frames and other hardware** 9.41
- The level of covers, frames and other hardware shall be not lower than, and shall not be more than 5 mm higher than the surface of the carriageway. The level of gully gratings shall not be higher than, and shall not be more than 5 mm lower than, the surface of the carriageway.

## TESTING: SURFACE REGULARITY

- Testing: surface regularity** 9.42
- The surface regularity of the final layer of the pavement shall be determined as stated in Clause 10.55.
- Compliance criteria: surface regularity** 9.43
- The results of tests for surface regularity shall comply with Clause 10.56.

## TESTING: SUB-BASE MATERIAL

- Batch: sub-base material** 9.44
- A batch of sub-base material is a quantity not exceeding 250 m<sup>3</sup> of sub-base material of the same type and same mix produced at the same mixing plant, and delivered to the Site at any one time.



**Samples:**  
**sub-base material**

9.45 (1) Unless otherwise permitted by the Engineer, one sample of each type of sub-base material shall be provided from each batch of sub-base material delivered to the Site.

(2) The size of each sample shall be at least 50 kg. The method of sampling shall be in accordance with BS 812: Part 102.

**Testing:**  
**sub-base material**  
**using virgin material**

9.46 (1) Each sample of sub-base material shall be tested to determine the particle size distribution, ten percent fines value, maximum dry density, optimum moisture content and plasticity index of the portion passing a 425µm BS test sieve.

(2) The method of testing for particle size distribution shall be in accordance with BS 812: Part 103.1.

(3) The method of testing for ten percent fines value shall be in accordance with BS 812: Part 111, except that the sample shall be soaked in water at room temperature for 24 hours and shall not be oven-dried before testing.

(4) The method of testing for plasticity index shall be in accordance with Geospec 3, Test Method 6.1, except that sample preparation shall be by wet sieving the material over a 425 µm BS test sieve.

(5) The method for testing for maximum dry density and optimum moisture content shall be in accordance with Geospec 3, Test Method 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 or 10.8, and Appendix 6.4 of this Specification, whichever as instructed by the Engineer.

**Testing:**  
**Recycled sub-base**  
**material in lieu of**  
**virgin material**

9.47 (1) Each sample of recycled sub-base material shall be tested to determine the particle size distribution, 10 % fines value, maximum dry density, optimum moisture content, plasticity index of the portion passing a 425µm BS test sieve, CBR value, soundness value, water-soluble sulphate content and percentage of contaminants as defined in Table 9.2.

(2) The method of testing for particle size distribution shall be in accordance with BS 812:Part 103.1.

(3) The method of testing for 10 % fines value shall be in accordance with BS 812:Part 111, except that the sample shall be soaked in water at room temperature for 24 hours and shall not be oven-dried before testing.

(4) The method of testing for plasticity index shall be in accordance with Geospec 3, Test Method 6.1, except that sample preparation shall be by wet sieving the material over a 425 µm BS test sieve.

(5) The method for testing for maximum dry density and optimum moisture content shall be in accordance with Geospec 3, Test Method 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7 or 10.8, and Appendix 6.4 of this Specification, whichever as instructed by the Engineer.

(6) Soundness value shall be determined in accordance with BS 812:Part 121.

(7) Water-soluble sulphate content shall be determined in accordance with BS 1377: Part 3.

(8) The maximum organic material content shall be determined in accordance with BS1377: Part3.

(9) The maximum metals and foreign material content shall be determined in accordance with the following procedure:

By means of the sampling procedure detailed in BS812: Part101, a sample shall be obtained of the aggregate containing at least 500 particles. The particles shall then be sorted manually into the following separate fractions:

- (i) Concrete and dense or normal weight aggregates.
- (ii) Brick, mortar, lightweight block and lightweight aggregate.
- (iii) Asphalt, bitumen, tar and mixtures of these materials with aggregate.
- (iv) Wood.
- (v) Glass.
- (vi) Metal.
- (vii) Other foreign material such as clay lumps and plastics

Because of the adherence of dust, it may be necessary to wash or break some particles to make a positive identification. The resulting fractions shall be weighed and expressed as a percentage of the total weight of material.

Notes:

(a) Lightweight block material - This should be noted as a separate category if more than 1% by volume (approx. 5 pieces in 500).

(b) Ultra-lightweight material (e.g. insulation) - This should be noted if more than 1% by volume (5 pieces in 500).

(10) CBR value shall be determined in accordance with BS1377:Part 4 with surcharge discs. The material shall be tested at the density and moisture content likely to develop in equilibrium pavement conditions, which shall be taken as being the density relating to a uniform air voids content of 5% and the optimum moisture content determined in compliance with BS 5835:Part 1:1980.

## TESTING: RELATIVE COMPACTION OF SUB-BASE

**Testing:**  
**relative compaction of**  
**sub-base**

9.48

(1) Each area of sub-base which contains sub-base material of the same type and same mix produced at the same mixing plant and which is laid and compacted in a single layer in one day shall be tested to determine the relative compaction. Tests shall be carried out after the sub-base material has been laid and compacted in the final position.

(2) Two tests shall be carried out on each area of 1000 m<sup>2</sup> or part thereof laid and compacted each day.

(3) Tests shall be carried out at positions, which in the opinion of the Engineer are representative of the area of compacted sub-base as a whole.

(4) The method of testing for relative compaction shall be as stated in Clause 6.81(4).

**Compliance criteria:** 9.49 The results of tests for relative compaction of sub-base shall comply with the requirements stated in Clause 9.31(6).  
*relative compaction of sub-base*

**Non-compliance:** 9.50 If the result of any test for relative compaction of sub-base does not comply with the specified requirements for relative compaction of sub-base, the area shall be re-compacted and two additional tests for relative compaction of sub-base shall be carried out on the area.  
*relative compaction of sub-base*

### TESTING: AGGREGATES, FILLER AND BITUMEN FOR BITUMINOUS MATERIALS

**Batch:** 9.51 A batch of aggregates, filler or bitumen for bituminous materials is any quantity of aggregates, filler or bitumen for bituminous materials of the same type, manufactured or produced in the same place and covered by the same certificates delivered to the Site at any one time.  
*aggregates, filler and bitumen for bituminous materials*

**Samples:** 9.52 (1) One sample of each type of aggregate, filler and bitumen for bituminous materials shall be provided from each batch.  
*aggregates, filler and bitumen for bituminous materials*  
(2) The size of each sample and the method of sampling shall be as stated in Table 9.10.

Table 9.10: Size of samples and method of sampling for aggregates, filler and bitumen

Material	Minimum size of sample	Method of sampling
Aggregate, nominal maximum aggregate size exceeding 28 mm	50 kg	BS 812: Part 102
Aggregate, nominal maximum aggregate size 5 mm to 28 mm	25 kg	
Aggregate, nominal maximum aggregate size less than 5 mm	10 kg	
Filler	5 kg	ASTM D 242
Bitumen	2 litres	ASTM D 140

**Testing:  
aggregates, filler and  
bitumen for  
bituminous materials**

9.53 Each sample of aggregate, filler and bitumen for bituminous materials shall be tested to determine the properties stated in Table 9.11. The method of testing shall be as stated in Table 9.11.

Table 9.11: Testing aggregates, filler and bitumen for bituminous materials

Material	Property	Method of testing
Coarse aggregate	Relative density Water absorption	BS 812: Part 2
	Ten percent fines value	BS 812: Part 111
	Particle size distribution	BS 812: Part 103.1
	Flakiness index	BS 812: Part 105
Fine aggregate	Relative density Water absorption	BS 812: Part 2
	Particle size distribution	Geospec 3, Test Method 8.2
Filler	Relative density	BS EN 196-6
	Particle size distribution	BS 812: Part 103.1
Bitumen	Relative density	ASTM D 3289
	Softening point	BS 2000
	Penetration	ASTM D 5
	Ductility	ASTM D 113
	Retained penetration after thin film oven test	ASTM D 1754
	Solubility	ASTM D 2042
	Viscosity	ASTM D 2171 or BS 2000
	Loss on heating	BS 2000

## TESTING: BITUMINOUS MATERIALS OTHER THAN BITUMINOUS FRICTION COURSE MATERIAL

- Batch:** *bituminous materials other than bituminous friction course material* 9.54 A batch of bituminous materials other than bituminous friction coarse material is a quantity not exceeding the limits stated in Table 9.12 of bituminous materials of the same type and same mix produced at the same mixing plant in one day.

Table 9.12: Maximum size of batch for bituminous materials other than bituminous friction course material

Material	Maximum batch size
Wearing course	100t
Base course	150t
Road base	200t

- Samples:** *bituminous materials other than bituminous friction course material* 9.55
- (1) One sample of bituminous materials other than bituminous friction course material shall be provided from each batch unless otherwise required by the Engineer.
  - (2) The size of each sample shall be as stated in Table 9.13.
  - (3) Samples shall be taken at the mixing plant or at the location where the bituminous material will be laid as instructed by the Engineer. Samples taken at the mixing plant shall be taken from the delivery vehicle immediately after loading from the plant or from the surge bin. Samples taken at the location where the bituminous materials will be laid shall be taken from the delivery vehicle.
  - (4) Unless otherwise agreed by the Engineer the method of sampling shall be in accordance with ASTM D 979.

Table 9.13: Size of samples for bituminous materials other than bituminous friction course material

Material	Minimum size of sample (in kg)
Wearing course (10mm nominal maximum aggregate size)	10
Wearing course (20mm nominal maximum aggregate size)	16
Base course	24
Roadbase	24

**Testing:**  
**bituminous materials**  
**other than bituminous**  
**friction course**  
**material**

9.56 (1) Each sample of bituminous materials taken as stated in Clause 9.55(1) shall be tested to determine the particle size distribution, bitumen content and Rice's specific gravity.

(2) The method of testing shall be in accordance with the following:

Particle size distribution : ASTM C 136 with modifications and ASTM C 117, Method B

Bitumen content : ASTM D6307 or  
ASTM D 2172, Method A

Rice's specific gravity : ASTM D 2041,  
Weighing-in-water method

Bulk specific gravity : ASTM D 2726

(3) For particle size distribution tests in accordance with ASTM C 136, the modifications are:

(a) Sieves to BS 410 instead of sieves to ASTM E 11 shall be used.

(b) Each sample of bituminous materials taken as stated in Clause 9.55 shall be reduced to a test specimen of suitable size as follows:

<u>Nominal Maximum Aggregate Size (mm)</u>	<u>Minimum Sample Size (kg)</u>
37.5	2.5
28.0	2.0
20.0	1.5
10.0	1.0

(4) The residual pressure manometer specified in ASTM D 2041 may be replaced by a vacuum gauge.

**Compliance criteria:**  
**bituminous materials**  
**other than bituminous**  
**friction course**  
**material**

9.57 (1) The results of tests on bituminous materials other than bituminous roadbase and friction course materials shall comply with the following requirements:

(a) The particle size distribution shall be such that not more than two points on the particle size distribution curve are outside the approved gradation envelopes determined as stated in Clause 9.22(2). Notwithstanding the above distribution, the percentage passing the 75  $\mu$ m BS test sieve shall not exceed the approved design value by more than 3%.

(b) The bitumen content shall be within the approved bitumen content range determined as stated in Clause 9.22(3).

(2) The results of tests on bituminous roadbase material shall comply with the following requirements:

(a) The particle size distribution shall be such that not more than two points on the particle size distribution curve are outside the design limit as stated in Table 9.4. Notwithstanding the above

distribution, the percentage passing the 75  $\mu\text{m}$  BS test sieve shall not exceed 8 % as specified in Table 9.4.

- (b) The bitumen content shall be within the allowable bitumen content range as specified in Table 9.4.

### TESTING: BITUMINOUS FRICTION COURSE MATERIAL

**Batch:**  
*bituminous friction  
course material*

- 9.58 A batch of bituminous friction course material is a quantity not exceeding 100 t of bituminous friction course material of the same mix produced at the same mixing plant in one day.

**Samples:**  
*bituminous friction  
course material*

- 9.59 (1) One sample of bituminous friction course material shall be provided from each batch of bituminous friction course material.
- (2) The size of each sample shall be at least 15 kg.
- (3) Samples shall be taken at the mixing plant from the delivery vehicle immediately after loading from the plant or from the surge bin.
- (4) Unless otherwise agreed by the Engineer the method of sampling shall be in accordance with ASTM D 979.

**Testing:**  
*bituminous friction  
course material*

- 9.60 (1) Each sample of bituminous friction course material shall be tested to determine the particle size distribution and bitumen content.
- (2) The method of testing shall be in accordance with the following:

Particle size distribution : ASTM C 136 with modifications  
and ASTM C 117, Method B

Bitumen content : ASTM D 2172, Method A

- (3) For particle size distribution tests in accordance with ASTM C 136, the modifications are:

- (a) Sieves to BS 410 instead of sieves to ASTM E 11 shall be used.
- (b) Each sample of bituminous materials taken as stated in Clause 9.59 shall be reduced to a test specimen of suitable size as follows:

<u>Nominal Maximum Aggregate Size (mm)</u>	<u>Minimum Sample Size (kg)</u>
37.5	2.5
28.0	2.0
20.0	1.5
10.0	1.0

- Compliance criteria:** 9.61 The results of tests on bituminous friction course material shall comply with the following requirements:
- bituminous friction**
- cours material**
- (a) The particle size distribution shall be within the approved gradation envelopes as determined in Clause 9.22(2).
  - (b) The bitumen content shall be within the approved bitumen content range as determined in Clause 9.22(3).

### TESTING: BITUMINOUS MATERIAL CORES

- Samples:** 9.62
- bituminous material**
- cores**
- (1) Each area of roadbase, base course and wearing course which contains bituminous material of the same type and same mix produced at the same mixing plant and which is laid and compacted in a single layer in one day shall be tested to determine the compacted layer thickness.
  - (2) Unless otherwise approved by the Engineer each area of bituminous material to be tested shall be divided into approximately equal sub-areas as stated in Table 9.14. One core shall be taken at random from each sub-area.
  - (3) Cores shall not be taken from within 300 mm of covers, frames and other hardware, or construction joints in the bituminous material.
  - (4) Cores shall be taken by a mechanically operated coring machine.
  - (5) Cores shall be 150 mm diameter for bituminous material with a designed layer thickness of 40 mm or greater and shall be 100 mm diameter for bituminous material with a designed layer thickness of less than 40 mm.
  - (6) Cores shall be taken as soon as practicable but not later than 48 hours after completion of the paving operation.
  - (7) If agreed by the Engineer, the sampling rate for roadbase may be applied to wearing course and base course.
  - (8) Holes formed by taking cores shall be filled with compatible bituminous material as soon as practicable after the core has been taken.

Table 9.14: Rate of sampling for bituminous material cores

Area of bituminous material laid and compacted in one day	No. of sub-areas/cores	
	Roadbase	Wearing course and Base course
< 5 000 m <sup>2</sup>	4	10
5 000 - 10 000 m <sup>2</sup>	10	15
> 10 000 m <sup>2</sup>	20	20



**Testing:**  
**bituminous material**  
**cores**

- 9.63 (1) Each bituminous material core shall be measured to determine the compacted layer thickness of the bituminous material and tested to determine the air void content.
- (2) The method of testing for air void content shall be in accordance with ASTM D 3203.

**Compliance criteria:**  
**bituminous material**  
**cores**

- 9.64 The results of tests on bituminous material cores shall comply with the following requirements:
- (a) The average air void content of the cores taken from an area of bituminous base course or wearing course material shall be not less than 3.0% and not greater than 6.0%.
  - (b) The air void content of each core taken from an area of bituminous base course or wearing course material shall be not less than 2.5% and not greater than 7.5%.
  - (c) The air void content of each core taken from an area of bituminous roadbase material shall be not less than 3.0% and not greater than 9.0%.
  - (d) The compacted layer thickness as measured from each core shall comply with the thickness requirements stated in Clause 9.40(4) and shall be compatible with the level tolerances stated in Table 9.9.

**Non-compliance:**  
**bituminous material**  
**cores**

- 9.65 (1) If the result of any test for air void content of cores does not comply with the specified requirements for air void content, the following procedure shall apply:
- (a) Four additional cores shall be taken from each sub-area for which the original core did not comply with the specified requirements for air void content. The cores shall be taken at locations evenly spaced throughout the sub-area such that in the opinion of the Engineer they are representative of the sub-area as a whole.
  - (b) Each additional core shall be tested to determine the air void content and the test results of the additional cores from the same sub-area shall be averaged.
  - (c) The average air void content of the sub-area thus obtained shall replace the original air void content of the respective sub-area. The new average air void content of the area of bituminous material tested shall then be calculated for compliance checking.
- (2) If the air void content of any of the four additional cores determined as stated in Clause 9.63(2) is less than 2.5% or greater than 7.5% for bituminous base course material and bituminous wearing course material, or less than 3.0% or greater than 9.0% for bituminous roadbase material, the sub-area from which the cores were taken shall be considered as not complying with the specified requirements.

(3) The area of bituminous material tested shall be considered as not complying with the specified requirements for average air void content if the average air void content of the cores taken from the area does not comply with the specified requirements for average air void content.

(4) If the result of any test for compacted layer thickness of cores is not compatible with the requirements of Table 9.9 or Clause 9.40(4), four additional cores shall be taken from the same sub-area and the average compacted layer thickness determined. The cores shall be taken at locations evenly spaced throughout the sub-area such that in the opinion of the Engineer they are representative of the sub-area as a whole.

(5) If the average compacted layer thickness determined as stated in Clause 9.65(4) is not in accordance with the permitted compacted layer thickness stated in Clause 9.64(d), the sub-area from which the cores were taken shall be considered as not complying with the specified requirements.

## TESTING: TEXTURE DEPTH AND PERMEABILITY

### *Testing: texture depth and permeability*

- 9.66
- (1) Unless otherwise agreed by the Engineer each area of friction course to be tested shall be divided into approximately equal sub-areas as stated in Table 9.15. Tests for texture depth and permeability shall be carried out on each sub-area at positions, which in the opinion of the Engineer are representative of the sub-area of friction course as a whole. No measurement shall be taken within 300 mm of the longitudinal edge of the carriageway.
  - (2) If agreed by the Engineer the number of tests for texture depth and permeability may be reduced to the minimum stated in Table 9.15.
  - (3) Tests shall be carried out before the area of friction course is used by construction plant or other vehicles.
  - (4) Testing to determine the texture depth will be carried out by the Engineer. The method of testing shall be by the sand patch test in accordance with Appendix 10.1.
  - (5) Testing to determine the permeability will be carried out by the Engineer. The method of testing shall be in accordance with Appendix 9.1.

### *Compliance criteria: texture depth*

- 9.67
- The results of tests for texture depth on an area of friction course shall comply with the following requirements:
- (a) The average texture depth shall not be less than 1.5 mm.
  - (b) Not more than one of the tests for texture depth shall give a result of less than 1.2 mm.

**Compliance criteria:** 9.68 The time for 150 mL of water to drain into the friction course in the permeability test stated in Clause 9.66(5) shall not exceed 30 seconds.

Table 9.15: Rate of testing for texture depth and permeability

Area of bituminous material laid and compacted in one day	No. of sub-areas/tests	
	Normal	Minimum
< 5 000 m <sup>2</sup>	10	4
5 000 - 10 000 m <sup>2</sup>	15	10
> 10 000 m <sup>2</sup>	20	20

## APPENDIX 9.1

### DETERMINATION OF THE PERMEABILITY OF FRICTION COURSE MATERIAL

<b>Scope</b>	9.1.1	This method covers the determination of the permeability of friction course material by measuring the time taken for 150 mL of water to drain into the material.
<b>Apparatus</b>	9.1.2	<p>The following apparatus is required:</p> <ul style="list-style-type: none"> <li>(a) A non-porous ring with an internal diameter of 150 mm <math>\pm</math> 2 mm, and a minimum height of 20 mm.</li> <li>(b) Suitable sealant for sealing one end of the ring onto the friction course surface.</li> <li>(c) A measuring cylinder for measuring 150 mL of water to an accuracy of 1 mL.</li> <li>(d) Two containers, each suitable for containing and pouring 150 mL of water.</li> <li>(e) A stopwatch.</li> </ul>
<b>Procedure</b>	9.1.3	<p>The procedure shall be as follows:</p> <ul style="list-style-type: none"> <li>(a) Carefully inspect the specified test location and record any unusual features.</li> <li>(b) Place one end of the ring on the friction course at the location to be tested, and seal the interface with sealant to prevent any leakage of water.</li> <li>(c) Prepare two volumes of water of 150 mL each using the measuring cylinder and the two containers.</li> <li>(d) Pour one 150 mL measure of water into the ring quickly and steadily without spillage.</li> <li>(e) As soon as all of the water has drained into the friction course, pour the second 150 mL of water into the ring quickly and steadily without spillage, and at the same time start the stopwatch.</li> <li>(f) Record the time taken for the second 150 mL of water to drain into the friction course surface.</li> </ul>
<b>Reporting of results</b>	9.1.4	<p>The following shall be reported:</p> <ul style="list-style-type: none"> <li>(a) The test location.</li> <li>(b) The time taken for the second 150 mL of water to drain into the friction course surface, to the nearest one second.</li> <li>(c) That the test was carried out in accordance with this Specification.</li> </ul>

**GENERAL SPECIFICATION  
FOR  
CIVIL ENGINEERING WORKS**

**SECTION 3  
CONCRETE CARRIAGEWAYS**



## SECTION 3

### CONCRETE CARRIAGEWAYS

#### GENERAL

<i>General requirements</i>	10.01	The works and materials specified in Clauses 10.02 to 10.06 shall comply with the sections stated, unless otherwise stated in this Section.
<i>Formwork and finishes</i>	10.02	Formwork and finishes to concrete for concrete carriageways shall comply with Section 14.
<i>Reinforcement</i>	10.03	Steel reinforcement for concrete carriageways shall comply with Section 15.
<i>Concrete</i>	10.04	Concrete for concrete carriageways shall comply with Section 16.
<i>Curing compound</i>	10.05	Curing compound for concrete carriageways shall comply with Section 16.
<i>Earthworks</i>	10.06	Earthworks for concrete carriageways shall comply with Section 6.

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#### MATERIALS

<i>Reinforcement</i>	10.07	<p>(1) Fabric reinforcement shall be steel fabric complying with BS 4483. The fabric shall be manufactured from steel wire which complies with BS 4482 and which has a type 2 bond classification.</p> <p>(2) Dowel bars, tie bars, cradles and tie bars for cradles shall be Grade 250 plain round steel bars complying with CS 2. Dowel bars and tie bars shall be straight. Both ends of dowel bars and one end of tie bars shall be sawn square with all burrs removed.</p>
<i>Cement mortar for cradles</i>	10.08	Cement mortar for supporting cradles shall consist of 1 part of cement to 3 parts of fine aggregate together with the minimum amount of water necessary to achieve a consistency suitable for the required work. Fine aggregates shall be sand or crushed rock to BS 1200 and shall pass a 5 mm BS test sieve.
<i>Fine aggregate</i>	10.09	Fine aggregate for concrete shall be natural river-deposited sand consisting of at least 95% by mass of quartz grains or clean, hard and durable crushed rock in accordance with Section 16.
<i>Polyethylene sheeting</i>	10.10	Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.
<i>Joint filler</i>	10.11	Joint filler shall be of a proprietary type approved by the Engineer and shall be a firm, compressible, single thickness, non-rotting filler.
<i>Joint sealant</i>	10.12	(1) Joint sealant shall be of a grade suited to the climatic conditions of Hong Kong and shall perform effectively over a temperature range of 0°C to 60°C.

(2) Joint sealant shall be a cold poured two-part polymer-based sealant complying with BS 5212, Type N.

(3) Primers and caulking material for use with joint sealant shall be of a proprietary types recommended by the joint sealant manufacturer and approved by the Engineer.

<b><i>Bond breaker tape</i></b>	10.13	Bond breaker tape shall be of a proprietary type recommended by the joint sealant manufacturer and approved by the Engineer. The tape shall be a polyethylene film with adhesive applied on one side and shall be the full width of the groove.
<b><i>Groove forming strip</i></b>	10.14	<p>(1) Groove forming strip shall be of a proprietary type approved by the Engineer. The strip shall be a firm compressible strip of either ethylene vinyl acetate foam with a density of at least 90 kg/m<sup>3</sup> or synthetic rubber. The strip shall be 25 mm deep and 5 mm thick and shall be sufficiently rigid to remain in position during concreting without deforming or stretching.</p> <p>(2) Adhesive for groove forming strip shall be of a proprietary type recommended by the groove forming strip manufacturer and approved by the Engineer.</p>
<b><i>Sleeves for dowel bars and tie bars</i></b>	10.15	Sleeves for dowel bars and tie bars shall be uPVC and shall have a nominal wall thickness not exceeding 1.5 mm. The sleeves shall fit tightly to the bars.
<b><i>Epoxy resin grout</i></b>	10.16	Epoxy resin grout shall be of a proprietary type approved by the Engineer.

## CONCRETE

<b><i>Concrete mix</i></b>	10.17	<p>Concrete for concrete carriageways shall comply with the following requirements:</p> <p>(a) Concrete shall be Grade 40/20 and shall be a designed mix.</p> <p>(b) The concrete mix shall contain either PFAC or a minimum of 265 kg of PC plus a minimum of 85 kg of PFA per m<sup>3</sup> of compacted concrete.</p> <p>(c) The percentage by mass of fine aggregate to total aggregate shall be at least 30%.</p> <p>(d) The workability in terms of designed slump value shall not exceed 30 mm.</p>
<b><i>Cementitious content of concrete</i></b>	10.18	The minimum cementitious content of concrete for concrete carriageways shall be 350 kg/m <sup>3</sup> .



## SUBMISSIONS

***Particulars of  
materials for joints***

- 10.19 (1) The following particulars of the proposed materials for joints in concrete carriageways shall be submitted to the Engineer:
- (a) Manufacturer's literature and a certificate for joint filler showing the manufacturer's name, the date and place of manufacture and showing that the joint filler complies with the requirements stated in the Contract and including results of tests for:
    - Disintegration and shrinkage
    - Recovery value and reduction in mass
    - Extrusion,
  - (b) Manufacturer's literature for joint sealant, including details of the method and time required for mixing the different components, and a certificate showing the manufacturer's name, the date and place of manufacture and showing that the sealant complies with the requirements stated in the Contract and including results of tests for:
    - Application life
    - Tack-free time
    - Resistance to flow
    - Recovery
    - Adhesion and cohesion in tension and compression
    - Resistance to heat ageing,
  - (c) Manufacturer's literature and a certificate for groove-forming strip showing the manufacturer's name, the date and place of manufacture and showing that the groove forming strip complies with the requirements stated in the Contract and including results of tests for density, and
  - (d) Particulars of primers and caulking material for joint sealant, adhesive for groove forming strip, bond breaker tape and sleeves for dowel bars and tie bars.
- (2) The particulars, including certificates, shall be submitted to the Engineer at least 14 days before the first delivery of the material to the Site. Certificates shall be submitted for each batch of the material delivered to the Site.

***Particulars of methods  
of construction***

- 10.20 Particulars of proposed methods of construction for concrete carriageways shall be submitted to the Engineer at least 7 days before the trial length is constructed.

- Samples of materials***      10.21      Samples of the following proposed materials shall be submitted to the Engineer at the same time as particulars of the material are submitted:
- (a) Polyethylene sheeting,
  - (b) Joint filler,
  - (c) Bond-breaker tape,
  - (d) Groove-forming strip, and
  - (e) Sleeves for dowel bars, including compressible filler, and for tie bars.
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### TRIALS

- Compliance criteria: trial-mix concrete***      10.22      The results of the tests on trial-mix concrete for concrete carriageways shall comply with the following requirements:
- Each of the six slump values shall not exceed 40 mm, and the average of the six slump values shall not exceed 35 mm.
- Trial length***      10.23      (1) A trial length of concrete carriageway shall be constructed to demonstrate that the proposed materials, mix design, methods of production and methods of construction will produce a concrete carriageway which complies with the specified requirements.
- (2) The trial length shall be constructed using the materials, mix design, methods of production and methods of construction submitted to the Engineer.
- (3) If it is not stated in the Contract that the trial length is to be constructed in a location separate from the permanent carriageway, the trial length shall be the first 30 m of the permanent carriageway, or such other length agreed by the Engineer. The trial length shall be constructed over a width of two bays and shall include at least one expansion joint, one contraction joint and the longitudinal joint between the bays.
- (4) The Contractor shall inform the Engineer at least 48 hours, or within a shorter period agreed by the Engineer, before constructing the trial length.
- (5) The trial length shall be completed in sufficient time before the permanent carriageway is constructed to allow the Engineer a period of at least 7 days to determine if the specified requirements have been complied with in the trial length.
- (6) The trial length shall be protected from damage and shall be left in position unless the Engineer instructs its removal. A trial length which forms part of the permanent carriageway and which complies with the specified requirements shall not be removed.

<b>Testing: trial length</b>	10.24	<p>(1) The trial length shall be tested to determine the accuracy of the alignment and level, the surface regularity and the texture depth. The method of testing the surface regularity shall be as stated in Clause 10.55. The method of testing the texture depth shall be as stated in Clause 10.57.</p> <p>(2) Concrete cores shall be cut from the trial length to determine the thickness of the slab, the positions of the reinforcement and joint components, the amount of segregation of the constituents and the presence of voids. The method of taking, preparing, inspecting and testing concrete cores shall be as stated in Clauses 10.62 and 10.63.</p>
<b>Compliance criteria: trial length</b>	10.25	<p>The results of tests on trial lengths shall comply with the following requirements:</p> <ul style="list-style-type: none"> <li>(a) The alignment, levels and thickness of the carriageway shall comply with Clauses 10.53 and 10.54.</li> <li>(b) The surface regularity shall comply with Clause 10.56.</li> <li>(c) The texture depth shall comply with Clause 10.58.</li> <li>(d) The positions of the reinforcement and joint components shall comply with Clauses 10.49, 10.50, 10.51 and 10.53.</li> <li>(e) The amount of segregation of the constituents and the presence of voids shall comply with Clause 10.64.</li> </ul>
<b>Non-compliance: trial length</b>	10.26	<p>(1) If the result of any test on the trial length does not comply with the specified requirements for the trial length, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer. Further trial lengths shall be constructed until the result of every test on the trial length complies with the specified requirements for the trial length. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial length was not due to the concrete mix.</p> <p>(2) Unless otherwise permitted by the Engineer, trial lengths, or parts of trial lengths, which do not comply with the specified requirements for the trial length shall be removed.</p>
<b>Commencement of concreting</b>	10.27	<p>(1) Concrete shall not be placed in the permanent carriageway other than in a trial length until the result of every test on the trial length complies with the specified requirements for the trial length.</p> <p>(2) Concrete may be placed in the permanent carriageway before the results of tests for compressive strength of the trial mix are available provided that the result of every other test on the trial mix and trial length complies with the specified requirements for trial mix concrete and for the trial length.</p>
<b>Changes in materials and methods of construction</b>	10.28	<p>Unless permitted by the Engineer, the materials, mix design, methods of production and methods of construction used to produce a trial length which complies with the specified requirements shall not be changed.</p>

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## STORAGE OF MATERIALS

<i>Storage of materials for joints and polyethylene sheeting</i>	10.29	<p>(1) Joint sealant, primer for joint sealant and adhesive for groove forming strip shall be stored in sealed containers marked to identify the contents and protected from exposure to conditions that may adversely affect the material. The materials shall be stored in accordance with the manufacturers' recommendations and shall not be used after the recommended shelf life has been exceeded.</p> <p>(2) Polyethylene sheeting, joint filler, bond breaker tape, groove forming strip and sleeves for dowel bars and tie bars shall be stored in accordance with the manufacturers' recommendations in a dry, weatherproof store with a raised floor. Joint filler shall be stored in sealed plastic bags and shall not be exposed to moisture or air.</p>
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## PRELIMINARY WORK

<i>Installation of utilities</i>	10.30	<p>(1) Pipes, cables, manholes, chambers, gullies and other utilities below concrete carriageways shall be completed and fill material shall be deposited and compacted in trenches before the carriageway is constructed. Openings to manholes, chambers and gullies shall be protected by temporary covers or by other methods agreed by the Engineer.</p> <p>(2) Box-outs shall be formed in concrete carriageways for covers, frames and other hardware. The covers, frames and other hardware shall be fixed in position after the main slab has been concreted and before the infill slab is concreted.</p>
<i>Preparation of formation and sub-base</i>	10.31	Construction of concrete carriageways shall start as soon as practicable after the formation or sub-base has been completed. The formation shall be protected as stated in Clause 6.52 and the sub-base shall be protected as stated in Clause 9.35 until construction of the carriageway starts.
<i>Laying polyethylene sheeting</i>	10.32	Polyethylene sheeting below concrete carriageways shall be laid flat without creases. Laps shall be at least 300 mm and there shall be no gaps at the edges of bays.

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## FORMWORK

<i>Formwork</i>	10.33	<p>(1) Unless otherwise approved by the Engineer, formwork for concrete carriageways shall be steel. The finish to concrete surfaces for transverse and longitudinal joints shall be Class F3. The finish to concrete surfaces for other edges of the carriageway shall be Class F2.</p> <p>(2) Concrete shall not be placed against excavated surfaces or against kerbs unless permitted by the Engineer.</p> <p>(3) Formwork shall not be loosened or removed until at least 7 hours after concreting has been completed.</p>
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## FORMING JOINTS

- |                                   |       |  |
|-----------------------------------|-------|--|
| <b><i>Forming joints</i></b>      | 10.34 | <p>(1) Materials for joints in concrete carriageways shall be used in accordance with the manufacturers' recommendations or as otherwise stated in the Contract.</p> <p>(2) Dowel bars, tie bars and their sleeves shall be securely fixed in position through holes in the formwork before concreting. The bars shall be parallel to the top surface of the slab and to each other. Bars at transverse joints shall be parallel to the adjacent longitudinal joint or to the longitudinal axis of the carriageway if there is no longitudinal joint or to other lines instructed by the Engineer.</p> <p>(3) Joint filler shall be cut to size before fixing and shall be securely fixed in position to the existing concrete surface before concreting. There shall be no gaps between the joint filler and the formation. Holes in joint filler for dowel bars shall be cut to form a sliding fit to the sleeved bar.</p> <p>(4) Joints shall be formed perpendicular to the top surface of the slab.</p> |
| <b><i>Transverse joints</i></b>   | 10.35 | <p>(1) Unless otherwise permitted by the Engineer, transverse joints in concrete carriageways shall be straight and perpendicular to the longitudinal axis of the carriageway.</p> <p>(2) Transverse expansion joints and transverse contraction joints shall be formed only at the specified positions. The joints shall be continued across longitudinal joints and shall be in line and of the same type on both sides of the longitudinal joint. The joints shall be continued through kerbs, edgings and quadrants and their foundation and backing. The joint dimensions and materials shall be the same as the transverse joints with the omission of dowel bars. The location of additional contraction joints in accordance with Clause 11.54(3) shall be as instructed by the Engineer.</p> <p>(3) The joint filler and groove for joint sealant at transverse expansion joints shall provide complete separation of adjacent slabs.</p>   |
| <b><i>Longitudinal joints</i></b> | 10.36 | Longitudinal joints in concrete carriageways shall be formed only at the specified positions.  |
| <b><i>Isolation joints</i></b>    | 10.37 | Isolation joints shall be formed in concrete carriageways at manholes and chambers.  |
| <b><i>Forming grooves</i></b>     | 10.38 | <p>(1) Grooves in concrete carriageways for joint sealant shall be straight, shall have parallel sides and shall be perpendicular to the top surface of the slab. The bottom of the groove shall be flat and shall be parallel to the top surface of the slab.</p> <p>(2) Grooves at transverse expansion joints and at isolation joints at manholes and chambers shall be formed by sawing the groove to the specified width and depth not less than 7 days after concreting. The grooves shall be located over the joint filler such that the upper surface of the joint filler is entirely contained in the groove.</p> <p>(3) Grooves at transverse contraction joints shall be formed using one of the following methods:</p>   |

Method 1: An initial groove shall be sawn as soon as practicable after concreting without causing spalling of the edges. The width of the initial groove shall be less than the specified width of the final groove and the depth of the initial groove shall be between 1/4 and 1/3 of the thickness of the slab. The final groove shall be sawn to the specified width and depth not less than 7 days after concreting. The center-lines of the initial and final grooves shall coincide.

Method 2: The final groove shall be sawn to the specified width and depth as soon as practicable after concreting without causing spalling of the edges.

(4) Grooves at transverse construction joints shall be formed by fixing groove-forming strip with adhesive to the concrete already placed before concreting the adjacent slab.

**Protection of grooves**      10.39      Before permanent sealing, grooves in concrete carriageways for joint sealant shall be protected from contamination by a temporary sealing strip or by other methods agreed by the Engineer.

**Sealing joints**      10.40      (1) The permanent sealing of joints in concrete carriageways shall be carried out at least 7 days after concreting unless otherwise permitted by the Engineer.

(2) Immediately before permanent sealing, groove forming strips, temporary seals, dirt and loose material shall be removed from the groove and the sides of the groove shall be cleaned and roughened by water jetting, sand blasting or by other methods agreed by the Engineer.

(3) Caulking material shall be firmly packed in the bottom of the groove if the joint sealant is not required to extend to the bottom of the groove.

(4) Bond breaker tape shall be fixed continuously and evenly along the bottom of the groove for the full width and length of the groove.

(5) Primer for the joint sealant shall be applied to the sides of the groove in accordance with the manufacturer's recommendations.

(6) Joint sealant shall be applied between the minimum and maximum drying times of the primer recommended by the manufacturer. The components of the sealant shall be thoroughly mixed in accordance with the manufacturer's recommendations using a power operated paddle mixer for sufficient time to produce a homogeneous mass without entrapped air. The sealant shall be dispensed into the groove as soon as practicable after mixing and within the time recommended by the manufacturer.

(7) The groove shall be clean and dry at the time of applying the primer and joint sealant.

(8) Excess joint sealant shall be removed by using a purpose made finishing tool such that the finished surface of the sealant is between 4 mm and 6 mm below the surface of the slab.

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## PLACING AND COMPACTING CONCRETE

### *Placing and compacting concrete*

- 10.41
- (1) Concrete shall be placed continuously between the joints in concrete carriageways unless otherwise permitted by the Engineer.
  - (2) Concrete in unreinforced slabs shall be placed and compacted to the full thickness of the slab in one operation.
  - (3) Unless otherwise permitted by the Engineer, concrete in reinforced slabs shall be placed and compacted to the specified level of the fabric reinforcement. The fabric reinforcement shall be placed in position and concrete shall be placed and compacted to the remaining thickness of the slab. The time between compaction of the first layer and placing of the remaining layer shall not exceed 30 minutes unless in the opinion of the Engineer the concrete already placed is sufficiently workable and the permission of the Engineer has been obtained. If permission is not obtained, a construction joint shall be formed as stated in Clause 16.45. Concrete shall not be placed against the concrete already placed for at least 24 hours unless permitted by the Engineer.
  - (4) Concrete in infill slabs at covers, frames and other hardware shall be placed and compacted after the covers, frames and hardware have been fixed in position and shall not be placed at the same time as the concrete in the main slab.
- 

## CONSTRUCTION JOINTS

### *Construction joints*

- 10.42
- (1) Construction joints shall be formed in concrete carriageways only where approved by the Engineer or in cases of emergency if concreting is interrupted by adverse weather, plant breakdown or similar circumstances. Construction joints shall not be formed within 2.5 m of an existing or planned expansion or contraction joint.
  - (2) Transverse construction joints shall be formed by either:
    - (a) Using formwork and cast-in tie bars, or
    - (b) Breaking back from an unformed edge and fixing the tie bars and sleeves with epoxy resin grout in drilled holes.
- 

## SURFACE FINISH

### *Surface regulation*

- 10.43
- (1) Unless combined double beam compactor-levellers are being used, then after compaction, the concrete in concrete carriageways shall be struck off to slightly above the levels of the formwork and the surface shall be regulated by a regulating machine or a vibrating beam.
  - (2) Regulating machines shall be purpose made and shall span the full width of the slab either transversely or obliquely. The machine shall be equipped with at least two oscillating-type transverse screeds and shall be supported on a carriage.

(3) Vibrating beams shall have a steel or aluminium surface and shall be mounted on a separate carriage. The beam shall be driven by a motor to provide a vibration frequency of at least 3500 cycles per minute.

(4) After regulation by the regulating machine or vibrating beam, the surface of the carriageway shall be regulated by at least two passes of a scraping straight edge with a blade length of at least 1.8 m. Scraping straight edges that operate in conjunction with regulating machines shall pass across the surface at right angles to the longitudinal axis of the carriageway. If the surface is torn by the straight edge, the surface shall be regulated again by the regulating machine or vibrating beam and by the scraping straight-edge.

(5) Wooden floats may be used to tamp and regulate small areas of the carriageway as agreed by the Engineer. Steel floats or trowels shall not be used.

### ***Surface texturing***

- 10.44 (1) After the surface of the concrete carriageway has been regulated and before the curing compound is applied, the surface, other than the surface of channels and edges of slabs that do not require to be textured, shall be textured by brushing with a wire broom.
- (2) The wire broom shall be at least 450 mm wide and shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in each row shall be at 10 mm centres and in line with the centre of the gaps between the tufts in the other row. The tufts shall contain an average of 14 wires, each of 32 gauge and initially 100 mm long. The broom shall be replaced if any tuft wears down to a length of 90 mm.
- (3) The surface texture shall be produced by brushing evenly across the slab in one direction at right angles to the longitudinal axis of the carriageway. Brushing shall be carried out after the moisture film has disappeared from the concrete surface and before the initial set is complete.

## **CURING CONCRETE**

### ***Curing concrete***

- 10.45 The surface and edges of concrete carriageways shall be protected by one of the methods stated in Clause 16.46 except that covering with hessian, sacking, canvas or other absorbent material as stated in Method 2 shall not be used. If Method 1 is used, the curing compound shall be applied to the surface immediately after the surface has been textured and shall be applied to the edges immediately after the formwork has been removed.

## **PROTECTION OF CONCRETE CARRIAGEWAY**

### ***Protection of concrete carriageway***

- 10.46 (1) Immediately after the curing system has been applied, the concrete carriageway shall be fenced off from pedestrian traffic and covered with protective sheeting for at least 24 hours. The sheeting shall be lapped and securely held in position in such a manner that the surface of the carriageway will not be damaged.



(2) Loads from materials not forming part of the permanent work or from construction plant or other vehicles shall not be applied to the concrete carriageway until at least 7 days after concreting has been completed and until all grooves at joints have been temporarily or permanently sealed or protected.

## TOLERANCES

<b><i>Tolerances: sub-base</i></b>	10.47	The level of the sub-base below concrete carriageways shall not be more than 10 mm higher, and shall not be more than 20 mm lower, than the specified level.
<b><i>Tolerances: formwork</i></b>	10.48	<p>(1) The line of formwork for concrete carriageways shall be within 10 mm of the specified line of the concrete carriageway.</p> <p>(2) The level of the top of the formwork shall be within 3 mm of the specified level of the concrete carriageway.</p> <p>(3) Abrupt irregularities in the line of the formwork and in the level of the top of formwork shall not exceed 3 mm.</p>
<b><i>Tolerances: reinforcement</i></b>	10.49	The cover to fabric reinforcement in concrete carriageways shall be within 10 mm of the specified cover.
<b><i>Tolerances: dowel bars and tie bars</i></b>	10.50	<p>(1) Dowel bars at joints in concrete carriageways shall be within 20 mm of the mid-depth of the slab.</p> <p>(2) Dowel bars shall be parallel to within 3 mm in half the length of the bar to:</p> <ul style="list-style-type: none"> <li>(a) The longitudinal joint, or the longitudinal axis of the concrete carriageway if there is no longitudinal joint,</li> <li>(b) The top surface of the slab, and</li> <li>(c) Adjacent dowel bars.</li> </ul>
<b><i>Tolerances: grooves</i></b>	10.51	Unless otherwise recommended by the manufacturer of the joint sealant the depth of grooves for joint sealant in concrete carriageways shall be within 3 mm of the specified depth.
<b><i>Tolerances: covers, frames and other hardware</i></b>	10.52	The level of covers, frames and other hardware shall not be higher than, and shall not be more than 3 mm lower than, the surface of the adjacent carriageway.
<b><i>Tolerances: alignment of concrete carriageway</i></b>	10.53	<p>(1) The best-fit straight line of straight joints and of straight edges of concrete carriageways shall be within 25 mm of the specified line. The line of straight joints and of straight edges of concrete carriageways shall be within 10 mm of the best-fit straight line.</p> <p>(2) The best fit curved line of curved joints and of curved edges of concrete carriageways shall be as agreed by the Engineer and shall be within 25 mm of the specified line. The line of curved joints and of curved edges of concrete carriageways shall be within 10 mm of the best-fit curved line.</p>

<b><i>Tolerances: level of concrete carriageway</i></b>	10.54	<p>(3) Joints in concrete carriageways shall be continuous across intersections of joints to within 5 mm of the best fit straight lines or best fit curved lines of each joint.</p> <p>(1) The levels of the surface of concrete carriageways shall be determined 200 mm from the edges of each bay at 10 m centres in the longitudinal direction and at 2 m centres in the transverse direction.</p> <p>(2) The level of the surface of concrete carriageways shall be within 6 mm of the specified level. In low lying and flat areas the Contractor shall pay special attention to level control to ensure that falls on the surface of the carriageway are in the specified direction.</p> <p>(3) The difference in level of the surface of concrete carriageways across joints shall not exceed 3 mm.</p> <p>(4) The thickness of concrete carriageway slabs shall not be less than the specified thickness minus 10 mm.</p>
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### TESTING: SURFACE REGULARITY

<b><i>Testing: surface regularity</i></b>	10.55	<p>(1) The surface regularity of concrete carriageways shall be determined by measuring the number of irregularities in the surface. An irregularity means that the gap between the surface of the carriageway, and a 3 m straight-edge placed on the surface of the carriageway, exceeds the specified amount. Irregularities shall be measured in millimetres perpendicular to the straight edge.</p> <p>(2) The longitudinal surface regularity of carriageways with a total length of 75 m or more may be measured using a rolling straight-edge of the type designed by the UK Transport and Road Research Laboratory. The longitudinal surface regularity of carriageways with a total length of less than 75 m and the transverse surface regularity of carriageways shall be measured using a 3 m straight edge.</p> <p>(3) The longitudinal surface regularity shall be measured along lines parallel to the longitudinal axis of the carriageway and approximately 1 m from the nearside edge of each carriageway lane. The transverse surface regularity shall be measured along lines at right angles to the longitudinal axis of the carriageway at 10 m intervals along the length of the carriageway.</p> <p>(4) Testing to determine the surface regularity will be carried out by the Engineer.</p>
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**Compliance criteria:** 10.56 The results of tests for surface regularity of carriageways shall comply with the following requirements:

**surface regularity**

- (a) The size and number of irregularities in the longitudinal direction shall not exceed the size and permitted number of irregularities stated in Table 10.1.
- (b) There shall be no irregularity exceeding 4 mm in a 3 m length in the transverse direction for Category A roads and there shall be no irregularity exceeding 7 mm in a 3 m length in the transverse direction for Category B roads.

Table 10.1: Permitted irregularities in the longitudinal direction

Total length of carriageway	Size of irregularity	Permitted number of irregularities (Category A road)	Permitted number of irregularities (Category B road)
< 75 m	> 4 mm	(9 x total length)/75	(18 x total length)/75
	> 7 mm	1	2
75 m - 300 m	> 4 mm	9 in any 75 m length	18 in any 75 m length
	> 7 mm	1 in any 75 m length	2 in any 75 m length
> 300 m	> 4 mm	20 in any 300 m length	40 in any 300 m length
		9 in any 75 m length	18 in any 75 m length
	> 7 mm	2 in any 300 m length	4 in any 300 m length
		1 in any 75 m length	2 in any 75 m length

Category A roads are roads with a legal speed limit greater than 70 kilometre per hour. All other roads are Category B roads.

Irregularities greater than 7 mm shall also be counted as greater than 4 mm.

No irregularity greater than 10 mm shall be permitted.

## TESTING: TEXTURE DEPTH

- Testing: texture depth** 10.57
- (1) The texture depth of concrete carriageways shall be determined by the sand patch test. Tests shall be carried out at least 2 days after the surface texturing has been carried out and before the area is used by construction plant or other vehicles.
  - (2) Each carriageway lane shall be divided into sections of equal length not exceeding 150 m. Tests shall be carried out at ten locations on each Section at approximately equal spacings as instructed by the Engineer. No measurement shall be taken within 300 mm of the longitudinal edges of the sections.

(3) Testing to determine the texture depth will be carried out by the Engineer. The method of testing shall be in accordance with Appendix 10.1.

<b><i>Compliance criteria: texture depth</i></b>	10.58	The results of tests for texture depth for each Section of concrete carriageway lane shall comply with the following requirements: <ul style="list-style-type: none"> <li>(a) The average texture depth shall not be less than 0.70 mm, and</li> <li>(b) Not more than one out of the ten measured texture depths shall be less than 0.6 mm.</li> </ul>
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### TESTING: CONCRETE

<b><i>Testing: workability and compressive strength of concrete</i></b>	10.59	Testing to determine the workability and compressive strength of concrete in concrete carriageways shall be as stated in Clauses 16.52 to 16.62 except as stated in Clauses 10.60 and 10.61.
<b><i>Compliance criteria: workability of concrete</i></b>	10.60	The average slump value of the two specimens taken from one sample of concrete shall not exceed the approved slump value by more than 10 mm.
<b><i>Samples: compressive strength of concrete</i></b>	10.61	One sample of concrete shall be provided from each 25 m <sup>3</sup> or 25 batches of concrete or from the amount of concrete produced each day, whichever is less.

### TESTING: CONCRETE CORES FROM TRIAL LENGTHS

<b><i>Samples: concrete cores from trial lengths</i></b>	10.62	<p>(1) Two concrete cores shall be provided from each bay, and one core shall be provided from each joint, of concrete carriageway in the trial length. The positions from which the cores are taken shall be as instructed by the Engineer.</p> <p>(2) Concrete cores shall be 150 mm diameter unless otherwise permitted by the Engineer and shall be the full depth of the slab. Cores shall be taken as soon as the concrete has hardened sufficiently for the core to be taken.</p> <p>(3) The method of taking concrete cores shall be in accordance with CS1.</p> <p>(4) Holes formed by taking concrete cores from trial lengths that form part of the permanent carriageway shall be reinstated using the approved concrete mix. Joints shall be repaired as instructed by the Engineer.</p>
<b><i>Testing: concrete cores from trial lengths</i></b>	10.63	<p>(1) Each concrete core from trial lengths in concrete carriageways shall be inspected to determine the thickness of the slab and the positions of the reinforcement and joint components. Each core shall be inspected for evidence of segregation of the constituents and for the presence of voids.</p> <p>(2) The method of preparing and inspecting concrete cores shall be in accordance with CS1.</p>

<b><i>Compliance criteria: concrete cores from trial lengths</i></b>	10.64	The concrete core shall be considered as non-compliant if it exhibits honeycombing which means interconnected voids arising from, for example, inadequate compaction or lack of mortar.
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### TESTING: MATERIALS FOR JOINTS

<b><i>Batch: joint filler, joint sealant</i></b>	10.65	A batch of joint filler or joint sealant shall comply with Clause 16.89.
<b><i>Samples: joint filler, joint sealant</i></b>	10.66	Samples of joint filler or joint sealant shall comply with Clause 16.90.
<b><i>Testing: joint filler, joint sealant</i></b>	10.67	Testing of joint filler and joint sealant for joints in concrete carriageways shall be as stated in Clauses 16.91 and 16.92 except as stated in Clause 10.68.
<b><i>Testing: joint sealant</i></b>	10.68	Each sample of joint sealant shall be tested to determine the application life, tack-free time, resistance to flow, recovery, adhesion and cohesion in tension and compression and resistance to heat ageing. The method of testing shall be in accordance with BS 5212.

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## APPENDIX 10.1

### DETERMINATION OF THE TEXTURE DEPTH OF CARRIAGEWAYS

**Scope** 10.1.1 This method covers the determination of the texture depth of carriageways by the sand patch test.

**Materials** 10.1.2 The following material is required:

Dry natural sand, with a rounded particle shape, which has been washed and then screened such that it meets the grading stated in Table 10.1.1.

Table 10.1.1: Grading of sand

BS test sieve	Percentage by mass passing
600 $\mu\text{m}$	100
300 $\mu\text{m}$	95 - 100
150 $\mu\text{m}$	0 - 6

**Apparatus** 10.1.3 The following apparatus is required:

- (a) A soft brush.
- (b) A robust measuring cylinder having an internal diameter of  $20 \pm 2$  mm and a flat top surface such that its internal volume is  $25 \pm 0.1$  mL.
- (c) A flat wooden disc of  $65 \pm 2$  mm diameter with a 1.5 mm minimum thickness hard rubber disc attached to one face and a handle fixed to the other face.
- (d) A steel rule calibrated to 1 mm.
- (e) A suitable windshield.
- (f) A funnel with an outlet tube at least 100 mm long with a bore of between 4 mm and 6 mm, and capable of accepting a volume of at least 200 mL.
- (g) A steel straight edge for screeding off the measuring cylinder.
- (h) A steel-wire brush.

**Procedure** 10.1.4 The procedure shall be as follows:

- (a) The test location shall be at least 300 mm square. It shall be vigorously brushed ten times in two directions at right angles using the steel wire brush, and then dried and swept clean with the soft brush.

- (b) Sand shall be poured into the measuring cylinder to fill it to overflowing, and any excess sand shall be screeded off using the straight edge. All sand on the outside of the cylinder shall be removed, taking care not to drop any sand onto the test location. Alternatively, this step in the procedure may be carried out in a laboratory, and the sand transferred to a suitable container ready for pouring.
- (c) The measured volume of sand shall be poured onto the centre of the test location through the funnel to form a heap. The windshield shall be used to protect the test location if required.
- (d) The sand shall be spread outwards with a circular motion over the test location, using the rubber-faced disc with its face parallel to the surface of the carriageway. This shall be continued until the patch of sand is approximately circular and will spread outwards no more.
- (e) The size of the circular patch of sand shall be measured to the nearest 1 mm along three diameters, which are aligned at approximately 120 degrees to each other.
- (f) If the difference between the maximum and minimum of the three measurements exceeds 20% of the average of the three measurements, then all the measurements shall be discarded and the test repeated at an adjacent location.
- (g) The test shall be repeated for all the ten test locations for each Section of carriageway lane.

**Calculation**

- 10.1.5 (1) The texture depth (T) for each test shall be calculated from the equation:

$$T = 31000 / D^2 \text{ mm}$$

where:

- D is the average of the three diameter measurements of the sand patch calculated to the nearest 1 mm.

- (2) The average texture depth for the ten tests shall be calculated.

**Reporting of results**

- 10.1.6 The following shall be reported:

- (a) The test location.
- (b) The average diameter of the sand patch for each test to the nearest 1 mm.
- (c) The texture depth for each test to the nearest 0.1 mm.
- (d) The average texture depth to the nearest 0.1 mm.
- (e) That the test was carried out in accordance with this Specification.





**GENERAL SPECIFICATION  
FOR  
CIVIL ENGINEERING WORKS**

**SECTION 4  
MISCELLANEOUS ROADWORKS**

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## SECTION 4

### MISCELLANEOUS ROADWORKS

#### PART 1: GENERAL REQUIREMENTS

##### GENERAL

<i>General requirements</i>	11.01	The works and materials specified in Clauses 11.02 to 11.08 shall comply with the sections stated, unless otherwise stated in this Section.
<i>Earthworks</i>	11.02	Earthworks shall comply with Section 6.
<i>Sub-base material and bituminous materials</i>	11.03	Sub-base material and bituminous materials shall comply with Section 9.
<i>Joints in concrete</i>	11.04	Joints in concrete shall comply with Section 10.
<i>Formwork</i>	11.05	Formwork and finishes to concrete shall comply with Section 14.
<i>Reinforcement</i>	11.06	Steel reinforcement shall comply with Section 15.
<i>Concrete</i>	11.07	Concrete shall comply with Section 16.
<i>Steelwork</i>	11.08	Steelwork shall comply with Section 18.

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##### MATERIALS

<i>Cement mortar</i>	11.09	Cement mortar shall consist of one part of cement to three parts of fine aggregate by volume together with the minimum amount of water necessary to achieve a consistency suitable for the required work. Fine aggregates shall be sand or crushed rock to BS 1200 and shall pass a 5 mm BS test sieve.
<i>Polyethylene sheeting</i>	11.10	Polyethylene sheeting shall be impermeable and shall have a nominal thickness of 0.125 mm.

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## PART 2: CONCRETE PROFILE BARRIERS

### MATERIALS

<i>Concrete mix</i>	11.11	Concrete for concrete profile barriers shall be Grade 30/20.
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### SUBMISSIONS

<i>Particulars of concrete profile barriers</i>	11.12	<p>(1) The following particulars of the proposed methods of construction for concrete profile barriers shall be submitted to the Engineer:</p> <ul style="list-style-type: none"> <li>(a) Particulars of formwork as stated in Clause 14.21 for in-situ construction using fixed forms,</li> <li>(b) Details of slip-form machine for in-situ construction between sliding forms, and</li> <li>(c) Methods of manufacture, handling, transport, storage and fixing in position of precast units.</li> </ul> <p>(2) The particulars shall be submitted to the Engineer for information at least 14 days before construction of concrete profile barriers starts.</p>
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### TRIALS

<i>Trial length</i>	11.13	<p>(1) A trial length of concrete profile barrier shall be constructed to demonstrate that the proposed materials, mix design, methods of production and methods of construction will produce a concrete profile barrier which complies with the specified requirements. If it is not stated in the Contract that the trial length is to be constructed in a location separate from the permanent concrete profile barrier, the trial length shall be the first 25 m of the permanent barrier.</p> <p>(2) The trial length shall be constructed in sufficient time before the permanent barrier is constructed to allow the Engineer a period of at least 7 days to determine if the specified requirements have been produced in the trial length.</p> <p>(3) The Contractor shall inform the Engineer at least 24 hours, or such shorter period agreed by the Engineer, before constructing the trial length.</p> <p>(4) The trial length shall be constructed using the materials, mix design, methods of production and methods of construction submitted to the Engineer.</p> <p>(5) The trial length shall be used as a means of comparison against which the Engineer shall determine the compliance or otherwise of the permanent concrete profile barrier. The trial length shall be protected from damage and shall be left in position unless the Engineer instructs its removal. A trial length which forms part of the permanent barrier and which complies with the specified requirements shall not be removed.</p>
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<b>Testing: trial length</b>	11.14	(1) The trial length shall be tested to determine the accuracy of the alignment and level and the finish of the concrete surface.  (2) Concrete cores shall be cut from the trial length to determine the amount of segregation of the constituents and the presence of voids. The method of taking, preparing, inspecting and testing concrete cores shall be as stated in Clause 11.26.
<b>Compliance criteria: trial length</b>	11.15	The results of tests on trial lengths shall comply with the following requirements:  (a) The alignment and levels of the barrier shall comply with Clause 11.25.  (b) The finish of concrete surfaces shall comply with Clause 14.44.  (c) The amount of segregation of the constituents and the presence of voids shall comply with Clause 10.64 for concrete carriageways.
<b>Non-compliance: trial length</b>	11.16	(1) If the result of any test on the trial length does not comply with the specified requirements for the trial length, particulars of proposed changes to the materials, mix design, methods of production or methods of construction shall be submitted to the Engineer. Further trial lengths shall be constructed until the result of every test on the trial length complies with the specified requirements for the trial length. Further trial mixes shall be made unless in the opinion of the Engineer non-compliance of the trial length was not due to the concrete mix.  (2) Unless otherwise permitted by the Engineer, trial lengths, or parts of trial lengths, which do not comply with the specified requirements for the trial length shall be removed.
<b>Commencement of concreting</b>	11.17	(1) Except as stated in Clause 11.17(2) concrete shall not be placed in the permanent barriers until the result of every test on the trial length complies with the specified requirements for the trial length.  (2) Concrete may be placed in the permanent barriers before the results of tests for compressive strength of the trial mix are available provided that the result of every other test on the trial mix and trial length complies with the specified requirements for trial mix concrete and for the trial length.
<b>Changes in materials and methods of construction</b>	11.18	Unless permitted by the Engineer, the materials mix design, methods of production and methods of construction used to produce a trial length that complies with the specified requirements shall not be changed. Further trial lengths shall be constructed to demonstrate any proposed changes unless otherwise permitted by the Engineer.

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## FORMWORK AND FINISHES TO CONCRETE

<b>Formwork</b>	11.19	(1) Formwork for concrete profile barriers shall be steel unless otherwise permitted by the Engineer.
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(2) Formwork shall not be loosened or removed until at least 7 hours after concreting has been completed.

<i>Finishes to concrete</i>	11.20	<p>(1) The finish to unformed concrete surfaces of concrete profile barriers shall be Class U5.</p> <p>(2) The finish to concrete surfaces for transverse joints shall be Class F3 and the finish to exposed concrete surfaces shall be Class F5.</p>
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## JOINTS IN CONCRETE PROFILE BARRIERS

<i>Joints in concrete profile barriers</i>	11.21	<p>(1) Joints shall be formed in concrete profile barriers at locations which coincide with expansion or construction joints in the adjoining structure or carriageway or at intervals not exceeding 12 m, whichever is less.</p> <p>(2) Joints in concrete profile barriers shall comply with Section 16.</p>
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## CONSTRUCTION OF CONCRETE PROFILE BARRIERS

<i>Construction by slip-form machine</i>	11.22	Construction of concrete profile barriers by slip-form machine between sliding forms shall be carried out in accordance with BS 5931. Slip-form machines shall comply with BS 5931, Appendix A.
<i>Construction using precast units</i>	11.23	Precast concrete profile barriers shall be laid on a cement mortar regulating layer of between 10 mm and 40 mm thick.

## PROTECTION OF CONCRETE PROFILE BARRIERS

<i>Protection of concrete profile barriers</i>	11.24	Immediately after the formwork has been removed or the curing compound has been applied, concrete profile barriers shall be protected by polyethylene sheeting for at least 24 hours from exposure to conditions that may affect the concrete. The sheeting shall be lapped and securely held in position in such a manner that the surface of the concrete will not be damaged.
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## TOLERANCES

<i>Tolerances: concrete profile barriers</i>	11.25	<p>Concrete profile barriers shall comply with the following requirements:</p> <ul style="list-style-type: none"> <li>(a) The horizontal dimensions of cross-sections shall be within 5 mm of the specified dimensions.</li> <li>(b) The vertical dimensions of cross-sections shall be within 10 mm of the specified dimensions.</li> <li>(c) The horizontal alignment along the centreline shall be within 10 mm of the specified centreline.</li> </ul>
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- (d) The level of the formation shall be within 10 mm of the specified level.
  - (e) The level of the top of the barriers shall be within 10 mm of the specified level.
  - (f) The barriers shall form a smooth alignment.
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### **TESTING: CONCRETE CORES FROM TRIAL LENGTHS**

***Testing: concrete  
cores from trial  
lengths***

- 11.26 (1) Two concrete cores shall be provided from each trial length of concrete profile barriers. The positions from which the cores are taken shall be as instructed by the Engineer.
- (2) Samples, testing and compliance criteria for concrete cores from trial lengths shall be as stated in Clauses 10.62 (2) to (4), 10.63 and 10.64 for concrete carriageways.
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## PART 3: PEDESTRIAN GUARD-RAILING

### GENERAL

<i>Design of pedestrian guard-railing</i>	11.27	Pedestrian guard-railing which is proposed by the Contractor as an alternative to that stated in the Contract or which is erected as Temporary Works shall be designed in accordance with BS 3049, Table 1, Class C.
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### MATERIALS

<i>Steel</i>	11.28	Steel for pedestrian guard-railing shall comply with the following:	
		Hot finished seamless tubes	: BS 6323: Part 3
		Steel tubes and tubulars suitable for screwing to BS 21 pipe threads	: BS 1387
		Hot rolled sections	: BS 4: Part 1
		Hot rolled structural steel sections - equal and unequal angles	: BS 4848: Part 4
		Weldable structural steels	: BS 4360.
<i>Stainless steel</i>	11.29	Stainless steel for pedestrian guard-railing shall be Grade 316 S 31 and shall comply with the following:	
		General inspection and testing procedures and specific requirements for carbon, carbon manganese and stainless steels	: BS 970: Part 1
		Stainless steel tubes suitable for threading in accordance with BS 21	: BS 6362.



**Aluminium**

- 11.30 (1) Aluminium for pedestrian guard-railing shall be H 30 TF and shall comply with the following:

Wrought aluminium and  
aluminium alloys for  
general engineering  
purposes

- plate, sheet and strip : BS 1470

- drawn tube : BS 1471

- bars, extruded round  
tubes and sections : BS 1474.

- (2) Aluminium shall be anodised to Grade AA 25 in accordance with BS 1615.

**Bolts, nuts, screws,  
washers and rivets**

- 11.31 (1) Bolts, nuts, screws, washers and rivets for pedestrian guard-railing shall comply with the following:

ISO metric black  
hexagon bolts,  
screws and nuts : BS 4190

ISO metric black cup  
and countersunk head  
bolts and screws with  
hexagon nuts : BS 4933

Metal washers for  
general engineering  
purposes : BS 4320

Rivets for general  
engineering purposes : BS 4620

Wrought aluminium and  
aluminium alloys for  
general engineering  
purposes  
- rivet, bolt and  
screw stock : BS 1473.

- (2) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.

- (3) Rag, indented and expansion bolts and resin bonded bolts shall be of proprietary types approved by the Engineer and shall be capable of withstanding the design loading.

- (4) Galvanized bolts, nuts, screws, washers and rivets shall be used with galvanized pedestrian guard-railing. Aluminium materials shall be insulated from ferrous materials by a non-conductive insulator at least 2 mm thick of a type approved by the Engineer.

<b>Mesh infill</b>	11.32	Mesh infill for pedestrian guard-railing shall comply with BS 4483. The mesh infill shall be free of surface defects, surface irregularities and mesh misalignment.
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## FABRICATION OF PEDESTRIAN GUARD-RAILING

<b>Galvanizing to steel</b>	11.33	<p>(1) Steel components forming pedestrian guard-railing shall be hot-dip galvanized in accordance with BS EN ISO 1461.</p> <p>(2) Galvanizing to steel shall be applied after welding, drilling and cutting are complete.</p>
<b>Welding steel</b>	11.34	<p>(1) Welding for fabrication of pedestrian guard-railing shall be fillet welds. Welded surfaces shall be clean and flush before application of the protective coating.</p> <p>(2) Steel shall not be welded after galvanizing unless permitted by the Engineer. If permitted, the welded areas shall be free of scale and slag and shall be treated with an alternative zinc-coating system approved by the Engineer.</p>

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## SUBMISSIONS

<b>Particulars of pedestrian guard-railing</b>	11.35	<p>(1) The following particulars of the proposed pedestrian guard-railing shall be submitted to the Engineer:</p> <ul style="list-style-type: none"> <li>(a) A certificate from the manufacturer showing the manufacturer's name, the date and place of manufacture and showing that the materials comply with the requirements stated in the Contract, and</li> <li>(b) Details of alternative designs proposed by the Contractor, including drawings, showing the proposals and that the pedestrian guard-railing has been designed in accordance with Clause 11.27.</li> </ul> <p>(2) The particulars shall be submitted to the Engineer at least 28 days before fabrication of the pedestrian guard-railing starts.</p>
<b>Samples of materials</b>	11.36	<p>Samples of the following proposed materials shall be submitted to the Engineer for approval of the source and type of each material at the same time as particulars of the pedestrian guard-railing are submitted:</p> <ul style="list-style-type: none"> <li>(a) Each type of pedestrian guard-railing,</li> <li>(b) Mesh infill, and</li> <li>(c) Each type of bolt, nut, and washer.</li> </ul>

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## STORAGE OF MATERIALS

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| <i><b>Storage of pedestrian guard-railing</b></i> | 11.37 | Pedestrian guard-railing shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner which will not result in damage or deformation to the guard-railing or in contamination of the guard-railing. Pedestrian guard-railing shall be protected from damage and damaged guard-railing shall not be used in the permanent work unless permitted by the Engineer. Measures to protect the materials from the effects of weather shall be submitted to the Engineer for approval. |
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## INSTALLATION OF PEDESTRIAN GUARD-RAILING

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|--|-------|---|
| <i><b>Installation of pedestrian guard-railing</b></i> | 11.38 | <p>(1) Pedestrian guard-railing shall be installed to a smooth alignment to within 10 mm of the specified position and height.</p> <p>(2) Pedestrian guard-railing which is to be installed to a radius of less than 45 m shall be curved in the workshop and shall not be made up of a series of straight lengths.</p> <p>(3) Pedestrian guard-railing shall be fixed to concrete using rag, indented, expansion or resin bonded bolts and shall be bolted to metalwork. Bolts for fixing to concrete shall be fitted into pockets filled with cement mortar or resin grout.</p> |
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## PART 4: UNTENSIONED BEAM BARRIERS

### MATERIALS

#### *Beams*

- 11.39 (1) Beams for untensioned beam barriers shall be formed from steel plates complying with BS 1449: Part 1, type BHR, Grade 43/25.
- (2) The beams shall be capable of withstanding a tensile force of at least 300 kN and shall not deflect by more than 40 mm when loaded centrally with a point load of 1 t over a simply supported span of 3 m.
- (3) Beams shall comply with the following requirements:
- (a) The base metal thickness shall be within 0.2 mm of the specified thickness.
  - (b) The strip width shall be within + 2.5 mm and - 0 mm of the specified width.
  - (c) The camber of the strip length shall be within 8 mm of the specified camber.
  - (d) The beam shall be straight to within 1.5 mm in a 1.5 m length.
  - (e) Angles at bends shall be within 2° of the specified angle.
- (4) Bolt slots in beams for connection to posts shall be prepared in the workshop by cold saw-cutting. The spacing of the slots shall be such that posts will be spaced at either 4 m or 2 m.
- (5) Beams shall be hot-dip galvanized to BS EN ISO 1461.
- (6) Welds for end beam sections shall be full-penetration butt welds.

#### *Posts*

- 11.40 (1) Posts for untensioned beam barriers shall be formed from Grade 43A steel complying with BS 4360.
- (2) Posts shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.
- (3) Posts fabricated from hollow sections shall be sealed by welding mild steel sealing plates over the open ends. The plates shall be at least 3 mm thick.
- (4) Posts shall be within the tolerances stated in BS 4.

#### *Cleats and struts*

- 11.41 (1) Cleats and struts for untensioned beam barriers shall be fabricated from angle sections complying with BS 4 and shall be weldable structural steel complying with BS 4360, Grade 43A.
- (2) Cleats and struts shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.
- (3) The dimensional tolerances of steel angles for cleats and struts shall comply with BS 4.

**Bolts and nuts**

- 11.42 (1) Bolts for untensioned beam barriers shall be M 16 size and strength Grade 4.6 complying with BS 4190. Bolts for beam splicing, bolts for connecting beams to posts and bolts for connecting beams to cleats shall be round or button-headed with oval shoulders. Other bolts shall be ISO metric black hexagon type.
- (2) Nuts for untensioned beam barriers shall be strength Grade 4 or 5 complying with BS 4190.
- (3) Bolts and nuts shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.
- (4) Nuts shall be tapped 0.4 mm oversize to accommodate the galvanized coating.
- (5) The length of bolts shall be such that the threaded portion of each bolt projects through the nut by at least one thread and by not more than four threads.
- (6) Rag, indented and expansion bolts and resin bonded bolts shall be of a proprietary type approved by the Engineer and shall be capable of withstanding the design loading.

**Washers**

- 11.43 (1) Washers for untensioned beam barriers shall be black mild steel and shall comply with BS 4320, Form E, F or G. Washers shall be manufactured from steel complying with BS 1449: Part 1, Grade 250.
- (2) Plain washers shall be 2 mm thick and shall be of dimensions suitable for use with M 16 bolts and nuts.
- (3) Plain washers shall be hot-dip galvanized in accordance with BS EN ISO 1461:1999.
- (4) Shaped washers shall have a thickness of at least 5 mm and shall be cast iron complying with BS 3468. The washers shall be shaped to fit the curvature of circular hollow sections used as posts.

**SUBMISSIONS****Particulars of  
untensioned beam  
barriers**

- 11.44 (1) The following particulars of the proposed materials and methods of construction for untensioned beam barriers shall be submitted to the Engineer:
- (a) A certificate from the manufacturer for beams in the format stated in BS 4360 showing the manufacturer's name, the date and place of manufacture and showing that the beams comply with the requirements stated in the Contract and including carbon equivalent values, and
  - (b) Details of method of installation.
- (2) The particulars, including certificates, shall be submitted to the Engineer for approval of the source and type of materials at least 14 days before installation of the beams starts. Certificates shall be submitted for each batch of beams delivered to the Site.

- Samples of materials***      11.45      Samples of the following proposed materials shall be submitted to the Engineer for approval of the source and type of each material at the same time as particulars of the material are submitted:
- (a) Beams,
  - (b) Posts, cleats and struts, and
  - (c) Bolts, nuts and washers.
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## **STORAGE OF MATERIALS**

- Storage of beams and posts***      11.46      Beams and posts for untensioned beam barriers shall be stored off a levelled, well drained and maintained hard-standing ground on level supports and in a manner that will not result in damage or deformation to the beams and posts or in contamination of the beams and posts. Beams and posts shall be protected from damage and damaged beams and posts shall not be used in the permanent work unless permitted by the Engineer. Measures to protect the materials from the effects of weather shall be submitted to the Engineer for approval.
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## **CONSTRUCTION OF UNTENSIONED BEAM BARRIERS**

- Installation of untensioned beam barriers***      11.47      (1) Untensioned beam barriers shall be ready for assembly when delivered to Site. Beams and posts shall be free of blisters, flux, uncoated spots and other defects.
- (2) Untensioned beam barriers shall be installed to a smooth alignment to within 10 mm of the specified position and height. Transition sections shall provide a smooth and uniform transition.
- (3) Beams which are to be installed to a radius of less than 45 m shall be curved in the workshop.
- (4) Untensioned beam barriers shall be fixed to concrete using rag, indented, expansion or resin bonded bolts and shall be bolted to metalwork. Bolts for fixing to concrete shall be fitted into pockets filled with cement mortar or resin grout.
- Compacted earth footings***      11.48      (1) Sub-base material shall be deposited and compacted in the bottom 250 mm of pits for foundations of untensioned beam barriers with compacted earth footings. Fine fill material shall be deposited and compacted to the remainder of the pit. The sub-base material and fill material shall be compacted to obtain a relative compaction of at least 95% throughout.
- (2) Posts for untensioned beam barriers shall be securely fixed in position during deposition and compaction of fill material.

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|---------------------------------|-------|--|
| <b><i>Concrete footings</i></b> | 11.49 | (1) Concrete for concrete footings shall be Grade 20/20.<br><br>(2) The top surface of concrete footings shall be finished level with the adjoining ground. The finish to the concrete surface shall be Class U5.<br><br>(3) Posts shall be surrounded with polyethylene sheeting before concrete is placed and shall be securely fixed in position during concreting. |
| <b><i>Anchor blocks</i></b>     | 11.50 | (1) Concrete for anchor blocks shall be Grade 20/20.<br><br>(2) The finish to concrete surfaces of anchor blocks shall be Class F5 for formed finishes and Class U5 for unformed finishes.   |
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## PART 5: KERBS, EDGINGS AND QUADRANTS

### MATERIALS

- |  |       |   |
|--|-------|---|
| <i>Concrete kerbs, edgings and quadrants</i> | 11.51 | <p>(1) Concrete for kerbs, edgings and quadrants shall be Grade 30/20. Concrete for foundations and backings to kerbs, edgings and quadrants shall be Grade 20/20.</p> <p>(2) Precast concrete kerbs, edgings and quadrants shall comply with BS 7263: Part 1 except that the requirement for testing of water absorption shall not be applied. The nominal length of kerbs shall be 1 m and the nominal length of edgings shall be 750 mm.</p>   |
| <i>Granite kerbs, edgings and quadrants</i>  | 11.52 | <p>(1) Granite kerbs, edgings and quadrants shall be worked straight or circular. Corners shall be square and the top front and back edges shall be parallel. The length of granite kerbs and edgings shall be at least 600 mm.</p> <p>(2) The ends of the kerbs, edgings and quadrants shall be chisel-dressed square to form a close butt-joint with adjacent kerbs. Kerbs shall be chisel-dressed to a depth of at least 140 mm on the front face, at least 75 mm on the back face and for the full width of the top face.</p> |

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### CONSTRUCTION OF KERBS, EDGINGS AND QUADRANTS

- |  |       |   |
|--|-------|---|
| <i>Construction of precast concrete and granite kerbs, edgings and quadrants</i> | 11.53 | <p>(1) Precast concrete and granite kerbs, edgings and quadrants shall be laid and bedded on a regulating layer of cement mortar. The thickness of the layer shall be at least 10 mm and shall not exceed 40 mm.</p> <p>(2) Except as stated in this clause, joints between each kerb, edging and quadrant shall not exceed 10 mm in width and shall be filled and flush pointed with cement mortar. Joints in kerbs, edgings and quadrants at expansion joints on bridge decks shall be as stated in the Contract. Transverse expansion and contraction joints in kerbs, edgings and quadrants laid on or adjacent to concrete carriageways shall be in accordance with Clause 10.35(2).</p> <p>(3) Radius kerbs shall be used for curves less than 10 m external radius.</p>          |
| <i>Construction of in-situ kerbs, edgings and quadrants</i>                      | 11.54 | <p>(1) In-situ concrete kerbs, edgings and quadrants shall be constructed in accordance with BS 5931 and shall be laid by an automatic extrusion machine of a type approved by the Engineer.</p> <p>(2) In-situ concrete kerbs, quadrants and edgings shall have regular sides, edges, arrises and chamfers. The finish to the concrete surface shall be Class U5. Kerbs, edges and quadrants shall not be finished or dressed with cement mortar.</p> <p>(3) Contraction joints shall be formed at intervals not greater than approximately 4 m. Transverse expansion and contraction joints in kerbs, edgings and quadrants which are laid on or adjacent to concrete carriageways shall be in accordance with Clause 10.35(2). Joints shall be flush pointed with cement mortar.</p> |



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## TOLERANCES

***Tolerances:  
kerbs, edgings and  
quadrants***

- 11.55 (1) The line of kerbs, edgings and quadrants shall be within 3 mm of the specified line.
- (2) The level of the top of kerbs, edgings and quadrants shall be within 3 mm of the specified level.
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## PART 6: FOOTWAYS, CYCLETRACKS AND PAVED AREAS

### MATERIALS

<i>Concrete for footways, cycletracks and paved areas</i>	11.56	Concrete for footways, cycletracks and paved areas shall be Grade 30/20.
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### CONSTRUCTION OF FOOTWAYS, CYCLETRACKS AND PAVED AREAS

<i>In-situ concrete footways, cycletracks and paved areas</i>	11.57	In-situ concrete for footways, cycle tracks and paved areas shall be laid in areas not exceeding 20 m <sup>2</sup> . The finish to the concrete surface shall be Class U4.
<i>Flexible surfacing to footways, cycletracks and paved areas</i>	11.58	<p>(1) Bituminous materials for footways, cycletracks and paved areas shall be laid and compacted with steel-wheeled and pneumatic-tyred rollers. Compaction shall start before the temperature of the newly laid material falls below 100°C and shall continue until all roller marks have been removed. For locations where rollers cannot operate effectively, the bituminous material can be compacted by hand-operated mechanical compaction plant approved by the Engineer.</p> <p>(2) Cores shall be taken in accordance with Clause 9.62 for the checking of air void content and compacted layer thickness of the bituminous material for works with area of not less than 200m<sup>2</sup>. For works with area smaller than 200m<sup>2</sup> but greater than 50m<sup>2</sup>, at least 2 cores shall be taken from each layer of bituminous material laid. For works with area less than 50m<sup>2</sup>, no coring is required unless otherwise instructed by the Engineer.</p> <p>(3) The cores taken in accordance with Clause 11.58(2) shall be tested to determine the air void content. The average air void content of the cores shall be not less than 3% nor greater than 9%. If the test result does not comply with the specified requirement, 2 additional cores shall be taken at locations agreed by the Engineer and the average air void content determined from these 2 cores shall replace the original value for compliance checking. Notwithstanding this, no cores shall have an air void content of less than 2.5% nor greater than 10%.</p> <p>(4) Each core taken from the final surfacing layer shall also be measured to determine the compacted layer thickness that shall not deviate by more than 5mm from the specified thickness. If the measured thickness does not comply with the requirement, 2 additional cores shall be taken at locations agreed by the Engineer and the average thickness determined from these 2 cores shall replace the original measured value for compliance checking.</p> <p>(5) If no bulk sample is taken for determination of the Rice's specific gravity, the corresponding value obtained from the mix design shall be used in determining the air void content of the core unless other value is suggested by the Contractor and agreed by the Engineer.</p>

- (6) If either the air void content or the compacted thickness of the core is outside the specified limits, the sub-area from which the cores were taken shall be considered as not complying with the requirements specified in this clause.
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## **PROTECTION OF FOOTWAYS, CYCLETRACKS AND PAVED AREAS**

<b><i>Protection of footways, cycletracks and paved areas</i></b>	11.59	Footways, cycletracks and paved areas shall not be used by construction plant or vehicles other than those, which in the opinion of the Engineer are essential to construct the subsequent work.
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## PART 7: PRECAST CONCRETE UNITS FOR PAVING

### GLOSSARY OF TERMS

<i>Unit</i>	11.60	<p>(1) Unit is a term used to describe a precast concrete paving slab, block or sett unless otherwise specified by the Engineer.</p> <p>(2) Depending on their quality, units are classified as either Grade A or Grade B as follows:</p> <ul style="list-style-type: none"> <li>- Grade A units shall comply with all the clauses of this PS.</li> <li>- Grade B units shall comply with all the clauses of this PS except those stipulated for Grade A units only.</li> </ul>
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### MATERIALS

<i>Units</i>	11.61	<p>(1) The dimensions of units shall be within 3 mm of the specified dimensions unless otherwise stated. Chamfers shall not exceed 5 mm in width and depth or shall be round unless otherwise approved by the Engineer.</p> <p>(2) Units may incorporate integral spacer nibs to aid the laying but these spacer nibs shall not be included in the size of the units.</p> <p>(3) Units shall come in wide ranges of colours to facilitate pavement design by the Engineer. The colours of units shall be consistent over the area to be paved, stable and fade resistant under any outdoor climate situations.</p> <p>(4) Units shall not exhibit defects such as cracking or flaking.</p> <p>(5) Units shall be free of any surface sealant unless otherwise directed by the Engineer.</p>
<i>Precast concrete paving slabs</i>	11.62	<p>(1) Paving slabs shall be square or rectangular of metric size 200 mm x 300 mm or 300 mm x 300 mm unless otherwise specified by the Engineer.</p> <p>(2) Paving slabs shall be 60 mm thick for footpaths. Paving slabs of other thickness may be used if approved by the Engineer.</p>
<i>Precast concrete paving blocks</i>	11.63	<p>(1) Paving blocks shall be as shown in relevant Highways Department Standard Drawings, unless otherwise specified by the Engineer. 200 x 200 x 60 mm paving units shall be considered as paving blocks.</p> <p>(2) Paving blocks shall be 60 mm thick for footpaths and 80 mm thick for carriageways and vehicular accesses. Paving blocks of other thickness may be used if approved by the Engineer.</p>
<i>Precast concrete paving setts</i>	11.64	<p>(1) Paving setts shall be square of metric size 100 mm x 100 mm unless otherwise specified by the Engineer.</p> <p>(2) Paving setts shall be 60 mm thick for footpaths and 80 mm thick for carriageways and vehicular accesses. Paving setts of other thickness may be used if approved by the Engineer.</p>

**Concrete**

- 11.65 (1) Concrete for units in footways and cycle tracks shall be Grade 30. Concrete for units in carriageways or areas to which vehicles will have access shall be Grade 45.

(2) The nominal maximum aggregate size for concrete in precast units shall be 10 mm.

**Additional requirements for Grade A units**

- 11.66 (1) Grade A units shall have an abrasion resistance of not more than 23 mm to BS 6717.

(2) Colour Pigments for Grade A units shall comply with BS 1014. They shall be UV-stable and shall be iron oxides, chrome oxide, titanium oxide or cobalt aluminium oxide unless otherwise approved by the Engineer.

**Sand**

- 11.67 (1) Sand for bedding units shall have the particle size distribution stated in Table 11.1. The sand shall have a moisture content exceeding 4% and not exceeding 8% at the time of laying.

(2) Sand for filling joints between precast units shall have the particle size distribution stated in Table 11.2. The sand shall have a moisture content of less than 0.5% at the time of filling joints.

Table 11.1: Particle size distribution of sand for bedding units

BS test sieve size	Percentage by mass passing
10 mm	100
5 mm	85 - 100
2.36 mm	65 - 100
1.18 mm	40 - 98
600 $\mu$ m	25 - 72
300 $\mu$ m	10 - 35
150 $\mu$ m	0 - 15
75 $\mu$ m	0 - 10

Table 11.2: Particle size distribution of sand for filling joints between units

BS test sieve size	Percentage by mass passing
2.36 mm	100
1.18 mm	90 - 100
600 $\mu$ m	60 - 90
300 $\mu$ m	30 - 60
150 $\mu$ m	15 - 30
75 $\mu$ m	5 - 10

## SUBMISSIONS

- Particulars of paving units** 11.68 (1) The Contractor shall submit the following particulars of the proposed materials and methods of construction for the paving units to the Engineer:
- (a) Name and address of manufacturer,
  - (b) A certificate from the manufacturer showing the source and the particle size distribution of the aggregates,
  - (c) A certificate from the manufacturer showing the manufacturer's name, the date and place of manufacture, and results of tests for:
    - compressive strength of concrete cubes at 28 day,
    - bending strength of paving slabs to BS 7263-1; and
    - compressive strength of paving blocks and setts to Appendix 11.1.
  - (d) Drawings showing the layout of the units within the paved area.

(2) The particulars as required under Clause 11.68 (1) shall be submitted to the Engineer for approval of the source, type and layout of the units at least 14 days before laying of units starts.

- Particulars of units - additional requirements for Grade A units** 11.69 (1) The following particulars of the proposed materials for Grade A units shall be submitted to the Engineer:
- (a) A certificate from the manufacturer showing the results of tests for:
    - Dimensional deviations of paving slabs to BS 7263-1; ;
    - Dimensional deviations of paving blocks and setts to BS6717;
    - Slip/skid resistance value of paving slabs to BS EN 1344;
    - Slip/skid resistance value of paving blocks to BS EN 1344, or unpolished slip/skid resistance value of paving blocks to BS 6717;
    - Slip/skid resistance value of paving setts to BS EN 1342;
    - 24-hour cold water absorption value of paving slabs, blocks and setts to AS/NZS 4456.14; and
    - Abrasion resistance of paving slabs, blocks and setts to BS 6717.

<i>Samples of materials</i>	11.70	Samples of each type of units shall be submitted to the Engineer for approval of the source and type of each unit at the same time as particulars of the units are submitted.
<i>Samples of materials - additional requirements for Grade A units</i>	11.71	<p>(1) Samples of each type of Grade A units showing the actual size, colour, variation in colour, finish/texture as specified, and general characteristics of the appearance shall be submitted to the Engineer for approval at the time as particulars of the units are submitted.</p> <p>(2) Samples submitted to the Engineer shall be subject to a visual inspection by the Engineer and shall comply with the following requirements:</p> <ul style="list-style-type: none"> <li>(a) When examined in accordance with BS 6717, there shall not be significant visible differences in colour and texture between any samples;</li> <li>(b) When examined in accordance with BS 6717, the samples shall not exhibit defects such as cracking, flaking or dislodging of aggregates;</li> <li>(c) Fine materials shall not be easily dislodged from the surfaces of any samples during gentle manual handling; and</li> <li>(d) The edges of all samples shall be sharp and straight without any defect.</li> </ul>

## HANDLING AND STORAGE OF MATERIALS

<i>Handling and storage of units</i>	11.72	Units shall be handled and stored on pallets to avoid damage to corners and chamfer edges. Pallets shall be stored on a levelled, well drained and maintained hard-standing ground and in a manner which will not result in damage or contamination to the units. The units shall be protected from damage and damaged units shall not be used unless permitted by the Engineer.
<i>Storage of sand</i>	11.73	Sand for filling joints between units shall be stored off ground in waterproof bags and shall be kept under cover on a levelled, well drained and maintained hard-standing ground on level supports until use.

## LAYING UNITS

<i>Laying units</i>	11.74	<p>(1) Units shall not be laid until the layout of the units within the paved area has been approved by the Engineer.</p> <p>(2) Kerbs and edgings shall be completed before the units are laid. The compressive strength of the concrete used for in-situ concrete kerbs and edgings shall be at least 20 MPa before units are laid.</p> <p>(3) Measures shall be taken to prevent water draining across or through the area during laying, bedding and compaction of the units.</p>
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(4) Laying of units shall start as soon as practicable after the formation has been completed. The formation shall be protected as stated in Clause 6.55 until laying starts.

(5) Paving blocks for carriageways and paved areas to which vehicles will have access shall be laid in a herringbone pattern unless otherwise stated in the Contract.

(6) Units shall be cut to size where required using mechanical cutting devices. The cut edge shall be true to line and free of chips and cracks.

(7) The units shall be laid to any design or pattern specified by the Engineer. The design or pattern may involve a single colour or a combination of different colours.

***Laying sand***

11.75 (1) A layer of sand shall be laid and shall be screeded and tamped to a uniform depth over the complete width of the area to be paved. The quantity and thickness of sand shall be appropriate to the methods of preparation of the sand layer, and shall be sufficient to give the required nominal thickness of the sand layer after compaction of the sand and units.

(2) The sand layer shall not be disturbed by additional compaction, footmarks or other damage after the layer has been screeded and tamped to the required level and before the units are laid.

***Bedding paving slabs***

11.76 (1) Paving slabs shall be laid on the prepared sand layer immediately after screeding and tamping in such a manner that the sand is not disturbed.

(2) Paving slabs shall be adjusted to form uniform joints between 2 mm and 3 mm wide and shall be bedded into the final position using a wooden mallet or a plate vibrator fitted with a rubber base-pad.

(3) Paving slabs shall not be bedded within 1 m of an unrestrained edge of the screeded sand layer.

(4) Final levelling of the paving slabs shall be carried out as soon as practicable after bedding and before changes in the moisture content of the prepared sand layer occur.

(5) Damaged paving slabs shall be immediately removed and replaced.

***Bedding paving blocks and setts***

11.77 (1) Paving blocks and setts shall be laid on the prepared sand layer immediately after screeding and tamping in such a manner that the sand is not disturbed. Paving blocks and setts shall be individually laid on the prepared sand layer by manual methods or in clusters by mechanical methods.

(2) Paving blocks and setts shall be laid in such a manner that the blocks and setts are not in direct contact with each other and that uniform joints of between 2 mm and 3 mm wide are formed. Paving blocks and setts shall be bedded flush by at least two passes of a heavy-duty plate compactor fitted with a rubber base-pad.

(3) Final levelling of the paving blocks and setts shall be carried out as soon as practicable after bedding and before changes in the moisture content of the prepared sand layer occur.



(4) Paving blocks and setts shall not be bedded within 1 m of an unrestrained edge of the screeded sand layer.

(5) Damaged paving blocks and setts shall be immediately removed and replaced.

**Filling joints and  
compaction of units** 11.78

(1) After the units have been bedded, sand for filling joints shall be spread over the surface of the units and brushed into the joints in such a manner that all joints are completely filled.

(2) Joints shall be filled as soon as practicable after bedding and on the day the units are laid and bedded.

(3) After all joints are completely filled with sand, units shall be fully compacted by using a plate compactor fitted with a rubber base-pad. Additional sand shall be added to refill the joints as required and compacted into the joints by using the plate compactor with two or more passes.

(4) Carriageways and paved areas with regular heavy traffic shall be compacted by at least ten evenly-spaced passes of a pneumatic tyred roller having a gross weight of between 10 t and 12 t, or by a plate compactor which shall have the following capacity:

- Minimum plate area of 0.25 m<sup>2</sup>;
- Minimum effective force per unit area of plate of 75 kN/ m<sup>2</sup>;
- Frequency of 65 –100 Hz; and
- Minimum mass of 200 kg.

Other suitable compacting equipment to the approval of the Engineer can be used. Sand shall be added as required and brushed and compacted into the joints.

(5) Units shall not be compacted closer than 1 m behind the laying edge of the units other than on completion of the paved area against a kerb or edging.

(6) Excess sand shall be removed after completion of compaction.

(7) Damaged units shall be immediately removed and replaced.

**Mortar and concrete  
seal** 11.79

Pigmented mortar or concrete shall be placed to full depth of the units to fill up the gaps between units and adjacent kerbs, edgings, quadrants, covers, frames and other hardware. The work shall only be carried out upon the approval by the Engineer. Unless otherwise instructed by the Engineer, colour of pigmented mortar or concrete shall match the colour of the adjacent units.

## REINSTATEMENT OF UNITS

**Reinstatement of units** 11.80

(1) If excavation is to be carried out in areas paved with units, the units shall be extracted by manual methods for a distance of at least 300 mm beyond the limit of the excavation.

(2) Unbroken units shall be thoroughly cleaned to remove all sand and deleterious material. The units shall be stacked on pallets for re-use.

(3) Units to be re-used shall be re-laid in accordance with Clauses 11.74 to 11.79.

## TOLERANCES

<i>Levels</i>	11.81	The level of paved areas constructed using units shall be within 3 mm of the specified level. The difference in level of adjacent units shall not exceed 2 mm.
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## TESTING

<i>Batching</i>	11.82	<p>(1) A batch of units shall be any quantity of paving slabs, blocks, or setts of the same type, size, and finish, of the same concrete grade, manufactured in the same place, covered by the same certificates and delivered to the Site at any one time. Paving slabs, blocks, or setts of different colours can be grouped together to form their respective batches provided that they are manufactured with the same type of materials and production methods.</p> <p>(2) Sampling shall be carried out at random. The sample shall comprise units that are distributed throughout the batch.</p>
<i>Testing requirements for units</i>	11.83	<p>(1) Paving slabs shall be tested for bending strength as stated in Clause 11.84.</p> <p>(2) Paving blocks shall be tested for compressive strength as stated in Clause 11.85.</p> <p>(3) Paving setts need not be tested for bending strength, compressive strength or slip/skid resistance unless otherwise required by the Engineer.</p>
<i>Bending strength test of paving slabs</i>	11.84	<p>(1) One sample of units in a batch shall be provided from every 1000 m<sup>2</sup> of units or part thereof. A batch with units for area(s) less than 1000 m<sup>2</sup> may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 8.</p> <p>(2) Each sample of paving slabs shall be tested to determine the bending strength to BS 7263-1.</p> <p>(3) The mean bending strength of a sample of paving slabs shall not be less than 3.7 MPa with bending strength of individual paving slabs not less than 3.0 MPa.</p>
<i>Compressive strength test of paving blocks</i>	11.85	<p>(1) One sample of units in a batch shall be provided from every 1000 m<sup>2</sup> of units or part thereof. A batch with units for area(s) less than 1000 m<sup>2</sup> may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 8. For paving blocks of size 200x200x60mm, specimens of size 200x100x60mm shall be cut from these blocks in accordance with Clause 11.74 (6) to form samples.</p>

(2) Each sample of paving blocks shall be tested to determine the characteristic compressive strength at 28 days.

(3) The method of testing shall be as stated in Appendix 11.1.

(4) The characteristic compressive strength of a sample of paving blocks shall be:

(a) 30 MPa for paving blocks in footways and cycle tracks, and

(b) 45 MPa for paving blocks in carriageways and paved areas to which vehicles will have access.

***Additional testing for  
Grade A units:  
dimensional deviation  
of paving slabs, blocks  
and setts***

11.86

(1) One sample of units in a batch shall be provided from every 1000 m<sup>2</sup> of units or part thereof. A batch with units for area(s) less than 1000 m<sup>2</sup> may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 8. The sample can be used for other tests.

(2) The overall dimensions and thickness of each sample of paving slabs shall be measured in accordance with BS 7263-1.

(3) The overall dimensions and thickness of each sample of paving blocks and setts shall be measured in accordance with BS 6717.

(4) The tolerances for the dimensions of each individual units shall be within  $\pm 2$  mm for length and width, and  $\pm 3$  mm for thickness.

***Additional testing for  
Grade A units: slip/  
skid resistance of  
paving slabs and  
blocks***

11.87

(1) One sample of units in a batch shall be provided from every 1000 m<sup>2</sup> of units or part thereof. A batch with units for area(s) less than 1000 m<sup>2</sup> may be added to the untested previous or following batch(es) as the case may be for testing purposes. The number of specimens in each sample shall be 5. The sample can be used for other tests.

(2) Each sample of paving slabs shall be tested to determine the slip/ skid resistance to BS EN 1344.

(3) Each sample of paving blocks shall be tested to determine the slip/skid resistance to BS EN 1344.

(4) The mean slip/skid resistance of a sample shall not be less than 45 Skid Resistance Value for units in footways and cycle tracks.

(5) Notwithstanding sub-clause (4) above, if considered appropriate by the Engineer for application on steep roads, pavements with steep pedestrian crossings or exceptional high cross fall, or other difficult site conditions, the required slip/skid resistance of the units in footways and cycle tracks may be increased up to 60 Skid Resistance Value.

***Additional testing for  
Grade A units: water  
absorption value of  
paving slabs and  
blocks***

11.88

(1) One sample of units in a batch shall be provided from every 1000 m<sup>2</sup> of units or part thereof. A batch with units for area(s) less than 1000 m<sup>2</sup> may be added to the untested previous or following batch (es) as the case may be for testing purposes. The number of specimens in each sample shall be 10. The sample can be used for other tests.

(2) Each sample of paving slabs and blocks shall be tested to determine the 24-hour cold water absorption value to AS/NZS 4456.14.

(3) The sample shall have a characteristic water absorption value not more than 6% by 24-hour cold immersion method to AS/NZS 4456.14.

(4) The characteristic water absorption value ( $W_c$ ) shall be calculated from the following equation:

$$W_c = W_m + 1.65 X_s \%$$

where:

- $W_m$  is the average water absorption rate of the sample
  - $X_s$  is the unbiased standard deviation as stated in AS/NZS 4456.2.
-

## APPENDIX 11.1

### DETERMINATION OF CHARACTERISTIC COMPRESSIVE STRENGTH OF PAVING BLOCKS

- Scope** 11.1.1 This method covers the determination of the characteristic compressive strength at 28 days of paving blocks by means of a load test.
- Apparatus** 11.1.2 The following apparatus is required:
- (a) A compression test machine complying with CS1. Bearing faces of the platens on the test machine shall be at least as large as the paving blocks and shall have a flatness tolerance of 0.05 mm.
  - (b) If a test machine with platens smaller than the paving blocks is used, auxiliary plates of adequate size shall be placed centrally between the platens and the paving block to be tested. The flatness tolerance of the bearing faces of the auxiliary platens measured in accordance with CS1 shall not be more than 0.05 mm and the thickness of the plates shall be at least 25 mm.
  - (c) Two pieces of packing, each with a thickness of between 5 mm and 6 mm and dimensions exceeding the paving block by between 15 mm and 25 mm. The packing shall be plywood, chipboard or medium density hardboard.
- Procedure** 11.1.3 The procedure shall be as follows:
- (a) The paving block shall be capped on the running surface and underside with a suitable capping material in accordance with Clause 15.5.2 of CS1 and immersed in water for at least 24 hours before compression.
  - (b) The paving block shall be placed symmetrically on the lower platen of the test machine, between the two pieces of packing with the running surface facing upwards.
  - (c) Load shall be applied without shock and shall be steadily increased at a constant rate within a stress range of between 150 kPa/s and 700 kPa/s.
  - (d) The load at which the paving block fractures shall be recorded as the breaking load.
  - (e) The test shall be repeated for the other seven paving blocks.

**Calculation**

- 11.1.4 (1) The compressive strength (C) of each paving block shall be calculated from the equation:

$$C = \frac{W}{A} \times \frac{2.5}{1.5 + \frac{L}{H}} \quad \text{MPa}$$

where:

- W is the breaking load (N)
- A is the nominal gross plan area based on the manufacturing dimensions of the paving blocks or the area of the tested portion if the block size is reduced for testing (mm<sup>2</sup>)
- L is the lesser of the two plan dimensions (mm)
- H is the thickness of the block (mm)

- (2) The unbiased standard deviation (s) shall be calculated from the following equation:

$$s = \sqrt{\frac{\sum C^2 - n(Cm)^2}{n-1}} \quad \text{MPa}$$

- where:
- n is the number of paving blocks
- $\sum C^2$  is the sum of the square of the compressive strengths of the n number of paving blocks (MPa)
- Cm is the average of the compressive strengths of the n number of paving blocks

- (3) The characteristic strength (Cc) of the batch shall be calculated from the following equation:

$$Cc = Cm - 1.65s \quad \text{MPa}$$

where:

- Cm is the average of the compressive strengths of the n number of paving blocks as stated in Clause 11.1.4(2)
- s is the unbiased standard deviation as stated in Clause 11.1.4(2)

**Reporting of results**

- 11.1.5 The following shall be reported:

- (a) Source, name of manufacturer and type of paving blocks.
- (b) Identification marks of paving blocks.
- (c) Date of manufacture of paving blocks.

- (d) Nominal gross plan area of each block to the nearest 100 mm<sup>2</sup>.
  - (e) Nominal height of each block to the nearest mm.
  - (f) Breaking load of each block to the nearest kN.
  - (g) Compressive strength of each block to the nearest MPa.
  - (h) Average of the n number of compressive strengths to the nearest MPa.
  - (i) Unbiased standard deviation to the nearest MPa.
  - (j) Characteristic compressive strength to the nearest MPa.
  - (k) That the test method used was in accordance with this Specification.
-





**SPECIFICATION - SECTION 2 - TECHNICAL  
ENVIRONMENTAL PRECAUTIONARY MEASURES**

## **Precautionary Measures in Construction Phase:**

### **Noise**

In all circumstances, the Contractor responsible for construction of the proposed shooting range shall observe and comply with the Noise Control Ordinance and its subsidiary regulations. The construction contractors shall implement the followings throughout the construction:

- Best management practices to control and suppress noise generation from the subject site in order to minimize any adverse impact;
- All plant and equipment to be used onsite shall be properly maintained in good operating condition;
- Noisy construction activities shall be effectively sound-reduced by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens or other means, to avoid disturbance to any nearby noise sensitive receivers;
- Devise, arrange methods of working and carry out the Works in such a manner so as to minimise noise impacts on the surrounding environment; and
- Shall provide experienced personnel with suitable training to ensure that these methods are implemented.

### **Air Quality**

In all circumstances, the Contractor shall observe and comply with the Air Pollution Control Ordinance and its subsidiary regulations, particularly the Air Pollution Control (Open Burning) Regulation and Air Pollution Control (Construction Dust) Regulation and Air Pollution Control (Smoke) Regulation. The followings shall be implemented by the Contractor:

- Best management practice shall be followed by the Contractor at all times to prevent dust nuisance and smoke as a result of the construction activities;
- Provision of adequate water supply/storage for dust suppression where necessary;
- Devise, arrange methods of working and carrying out the works in such a manner so as to minimise dust impacts on the surrounding environment; and
- Provide experienced personnel with suitable training to ensure that these methods are implemented.

### **Water Quality**

In all circumstances, the Contractor shall comply with the Water Pollution Control Ordinance and its subsidiary regulations. The followings shall be implemented by the Contractor:

- Works shall be carried out in such a manner as to minimise adverse impacts on the water quality during the execution of the Works and rearrange the working method to minimise water pollution within and outside the site area; and
- Follow the practices and be responsible for the design, construction, operation and maintenance of all the mitigation measures as specified in the Professional Persons

### **Waste Management**

In all circumstances, the contractor is required to observe and comply with the Waste Disposal Ordinance and its subsidiary regulations. The followings shall be implemented by the Contractor:

- The contractor shall apply for registration as chemical waste producer under the Waste Disposal (Chemical Waste) (General) Regulation when chemical waste is produced;
- All chemical waste shall be properly stored, labelled, packaged and collected in accordance with the Regulation;
- Avoidance and minimization of waste generation shall be achieved through changing or improving design and practices, careful planning and good site management;
- Segregation of different types of wastes on-site and stored them in different containers, skips or stockpiles to facilitate reuse/recycling of waste and, as the last resort, disposal at different outlets as appropriate;
- Reuse and recycling of waste shall be practised as far as possible;
- The recycled materials shall include paper/cardboard, timber and metal etc.;
- The C&D waste which comprises metal, timber, paper, glass, junk and general garbage shall be reused or recycled and, as the last resort, disposal of at landfills;
- Records of the amount of wastes generated, recycled and disposed of (including the disposal sites) shall be kept;
- Trip ticket system shall be adopted for the disposal of C&D materials, if any, to any designated public filling facility and/or landfill; and
- Training shall be provided for workers about the concepts of site cleanliness and appropriate waste management procedure, including waste reduction, reuse and recycling.

### **Landfill Gas Hazard**

In general, the contractor should be aware of, and shall inform construction contractors the followings:

- Methane and carbon dioxide are always likely to be present in the soil voids;
- Physical and chemical nature of landfill gas;
- Methodologies for landfill gas detection;
- Fire and explosion hazards associated with landfill gas;
- Toxicity effects and health hazards associated with landfill gas; and

- Potential health effects from direct contact with leachate/groundwater contaminated by leachate.

Hazards may arise which are related either to the flammability of landfill gas or its potentially asphyxiating properties. Appropriate measures shall be implemented by the Contractor during the construction activities, including but not be limited to the followings:

- Precautions shall be clearly laid down and rigidly adhered to with respect to trenching and excavation; and creation of confined spaces at, near to or below ground level such that potential hazard on workers from landfill gas/ leachate migration are minimized;
- In addition to normal site safety procedures, gas detection equipment and appropriate breathing apparatus shall be available and used where necessary when entering confined spaces without proper ventilation. A properly-trained dedicated person (e.g. Safety Officer) shall be present on site throughout the construction stage;
- All personnel who work on site and all visitors to the site shall be made aware of the possibility of ignition of gas in the vicinity of excavations and possibility of asphyxiation in confined area (e.g. deep trench or underground area with only small opening entrance) due to landfill gas migration. Safety notices shall be posted warning of the potential hazards;
- Those staff who work in, or have responsibility for 'at risk' areas, including all excavation workers, supervisors and engineers working within the Consultation Zone of 250m from the perimeter of a landfill, shall receive appropriate training organised by the contractor or other appropriate parties on working in areas susceptible to landfill gas, fire or explosion hazards;
- An excavation procedure or code of practice to minimise risks including landfill gas related risk shall be devised and carried out by the contractor;
- Safe practice shall be followed by workers while working in the construction site;
- Smoking, naked flames and all other sources of ignition shall be prohibited within the subject site. 'No smoking' and 'No naked flame' notices shall be posted prominently on the construction site and, if necessary, special areas designated for smoking;
- Any electrical equipment, such as motors and extension cords, shall be intrinsically safe. Construction plant shall be fitted with vertical exhaust of sufficient height and with spark arrestors where necessary;
- During piping assembly or conduiting construction, all valves/seals shall be closed immediately after installation where possible. As construction progresses, all valves/seals shall be closed as installed to prevent the migration of gases through the pipeline/conduit. All piping/conduiting shall be capped at the end of each working day;
- Mobile offices, equipment stores, mess rooms etc. shall be located on an area which has been proven to be gas free (by survey with portable gas detectors) and ongoing monitoring shall be carried out to ensure that these areas remain gas free. Alternatively, such buildings shall be raised clear of the ground with a minimum clear separation distance of 500mm;
- During construction, adequate fire extinguishing equipment, fire-resistant clothing and breathing apparatus (BA) sets shall be made available on site. The operator

shall formulate a health and safety policy, standards and instructions for site personnel to follow;

- For drilling operations, "Special Advice Relating to the Drilling of Boreholes" in Landfill Gas Hazard Assessment Guidance Note (EPD/TR8/97) shall be referenced to ensure that such operations are properly supervised, and provided with safety equipment and clothing and well-defined working and safety procedures; and
- Welding, flame-cutting or other hot works, where necessary, shall be confined to open areas at least 15m from any trench or excavation if possible. They may only be carried out in trenches or confined spaces when controlled by a 'permit to work' procedure, properly authorized by the Safety Officer or other appropriately qualified person. The 'permit to work' procedure shall set down the requirements for continuous monitoring for methane, carbon dioxide and oxygen throughout the period during which the hot works are in progress. The procedure shall also require the presence of an appropriately qualified person in attendance outside the 'confined area', who shall be responsible for reviewing the gas measurements, and who shall have executive responsibility to suspend the work in the event of unacceptable or hazardous conditions. Only workers who are appropriately trained and fully aware of the potentially hazardous conditions shall be permitted to carry out hot works in confined areas.

For other work in confined space, if any, controlled by the Factories and Industrial Undertakings (Confined Spaces) Regulations of the Factories and Industrial Undertakings Ordinance, the Safety Guide to Working in Confined Spaces shall be followed to ensure compliance with the regulations mentioned above. Key issues with regards to confined spaces which are at risk of landfill gas build-up are listed out below:

- The entry or access point shall be clearly marked with a warning notice (in English and Chinese) which states that there is the possibility of flammable and asphyxiating gases accumulating within;
- The warning notice shall also give the telephone number of an appropriate competent person who can advise on the safety precautions to be followed before entry and during occupation of the confined space;
- Personnel shall be made aware of the dangers of entering confined spaces potentially containing hazardous gases and, where appropriate, shall be trained in the use of gas detection equipment;
- Prior to entry, the atmosphere within the chamber shall be checked for oxygen, methane and carbon dioxide concentrations. The chamber may then only be entered if oxygen is greater than 18% by volume, methane is less than 10% of the Lower Explosive Limit (LEL), which is equivalent to 0.5% by volume (approximately), and carbon dioxide is less than 0.5% by volume;
- If either carbon dioxide or methane are higher, or oxygen lower, than the values given above, then entry to the chamber shall be prohibited and expert advice sought;
- Even if conditions are safe for entry, no worker shall be permitted to enter the chamber without having another worker present at the surface. The worker who enters the chamber shall wear an appropriate safety/recovery harness and, preferably, shall carry a portable methane, carbon dioxide and oxygen meter; and

- In general, when work is being undertaken in confined spaces sufficient approved resuscitation equipment, breathing apparatus and safety torches shall be available. Persons involved in or supervising such work shall be trained and practised in the use of such equipment. A permit-to-work system for entry into confined spaces shall be developed by an appropriately qualified person and consistently employed.

### *LFG Monitoring*

Landfill gas (LFG) monitoring shall be carried out by the Contractor during construction to ensure that landfill gas does not accumulate in the work areas (those with relatively poor ventilation, e.g. pits, trenches, caissons and voids) likely to pose a risk of explosion or hazards to the workers. Contractor shall ensure/ implement the followings:

- During the LFG monitoring, any levels of LFG can be readily detected and that timely remedial measures and actions can be taken to bring the LFG level down to a safe level so that works can be resumed
- The level of LFG shall be checked daily before work at the existing monitoring well along the site boundary adjacent to the landfill with portable measuring instrument which is intrinsically safe and capable of measuring the following gases in the range indicated:
  - methane 0-100 % LEL and 0-100 % v/v
  - carbon dioxide 0-100 % and
  - oxygen 0-21 %
- The following action plan shall be implemented by the Contractor:

Parameter	Measurement	Action
O <sub>2</sub>	< 19 %  < 18 %	Ventilate trench/void to restore O <sub>2</sub> level to > 19% Stop works. Evacuate personnel/ prohibit entry increase ventilation to restore O <sub>2</sub> to > 19%
CH <sub>4</sub>	> 10 % LEL  > 20 % LEL	Post 'No Smoking' signs prohibit hot works ventilate to restore CH <sub>4</sub> to < 10% LEL Stop works evacuate personnel/ prohibit entry increase ventilation to restore CH <sub>4</sub> to < 10% LEL
CO <sub>2</sub>	> 0.5 %  > 1.5 %	ventilate to restore CO <sub>2</sub> to < 0.5% Stop works evacuate personnel/ prohibit entry increase ventilation to restore CO <sub>2</sub> to < 0.5%

- Monitoring is to be carried out in excavations and any other confined and semi-confined spaces that may have been created where necessary. All measurements in excavations, if necessary, shall be made with the monitoring tube located not more than 10mm from the exposed ground surface. Prior to hot works and any works involving naked flame in the confined or semi-confined area, if any, monitoring shall be carried out.

## 利比 RLB | Rider Levett Bucknall

Ref. 编号	Item 项目	Total 总额
	<p style="text-align: center;"><u>SUMMARY OF TENDER</u></p> <p style="text-align: right;"><u>Page</u></p> <p>SPECIFICATION</p> <p style="text-align: center;">SECTION 1 - PRELIMINARIES 1.S/8</p> <p style="text-align: center;">SECTION 2 - TECHNICAL -</p> <p><u>ELEMENTAL SUMMARY OF SCHEDULE OF QUANTITIES AND RATES</u></p> <p>(<u>Note</u> : The Tenderer shall submit with his tender the Schedule of Quantities and Rates for the following lump sum prices as required under Specification, Section 1 - Preliminaries, Clause 7.03).</p> <p style="text-align: center;">1. CHAIN LINK FENCE AND GANTRIES</p> <p style="text-align: center;">2. EVA AND FOOR PATH</p> <p style="text-align: center;">3. ENVIRONMENTAL PRECAUTIONARY MEASURES</p> <p>Provide the provisional sum of \$200,000.00 for contingencies to be expended in part or in whole as directed by the Architect or wholly deducted from the Contract Sum if not required.</p> <hr/> <p>Allow for all other miscellaneous works which are not mentioned in the Specification or shown on the Drawings but which are essential for the satisfactory completion of the Works. (The Tenderer shall submit a breakdown of the cost for this item, if none, state NIL in the extension column).</p>	200,000.00
SHOOTING RANGE AT PILLAR POINT TOTAL - CARRIED TO FORM OF TENDER \$ ADVANCE WORKS H:/6206.3		

**SCHEDULE of DRAWINGS**

The following drawings have been issued as part of the tender documentation.

<u>Drawing No.</u>	<u>Revision</u>	<u>Description</u>
D-01	0	Block Plan, Notes, Symbol & Legend
D-02A	0	Master Ground Floor Plan with Existing
D-03A	0	Master Layout Plan
B-03	D	Floor Plan, Section, Elevation Reception, Arms Ammunition & Store, E&M Services Block) (Temporary Building)
B-04	D	Floor Plan, Section, Elevation (Outdoor 25 m Pistol, 2 Bay x 4 sects of Tagets (Temporary Building)
H-01	0	Hoarding Plan & Notes
H-02	0	Hoarding Details
D6-04	-	Finishes Schedule 4
EVA/SK01	-	General Notes (Sheet 1 of 2)
EVA/SK02	-	General Notes (Sheet 2 of 2)
EVA/SK03	-	Typical Concrete Pavement Construction
EVA/SK04	-	Details of Expansion Joint in Concrete Carriageway
EVA/SK05	-	Details of Contraction Joint in Concrete Carriageway
EVA/SK06	-	Details of Longitudinal Joint and Isolation Joint in Concrete Carriageway
EVA/SK07	-	Details of Joint Groove for Transverse Joints



