

<b>230 SUSPENDED CEILINGS</b>
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**230.1 GENERAL**

**230.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Related worksections**

Conform to associated worksections as follows: Adhesives Fixings and Fastenings Metals and Prefinishes.

Insulation and Barriers.

Internal Cladding (Lining).

Vitreous Enamel Panels.

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**230.1.2 CIVIL DEFENCE (CD) REQUIREMENTS**

**General**

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

**230.1.3 STANDARDS**

**General**

Suspended ceilings: To AS/NZS 2785.

**230.1.4 INTERPRETATION**

**Definitions**

Demountability: Ability for the ceiling material to be removed from below by hand or by hand tools without damage to the system, and subsequently reassembled without the need for finishing.

- Fully demountable: Any part or all of the ceiling is demountable.
- Semi demountable: Only designated parts of the ceiling are demountable.

Direct fix ceiling system: A ceiling whose soffit is in close proximity to the structural soffit, and generally is fixed to the structural soffit by rigid connection.

Corridor supporting system: Suspended ceiling system in which primary support members occur only at walls. The ceiling, or ceiling plus secondary members, spans between the primary support members.

Supporting structure: The part or parts of the building to which the suspended ceiling system is attached.

Suspended ceiling system: A ceiling or external soffit and its suspension system, suspended from a supporting structure.

- Cell ceiling system: An egg-crate like structure with open areas to the plenum but with a closed appearance at low angle viewing.
- Concealed grid ceiling system: A ceiling in which the supporting system is not exposed to view.
- Flush ceiling system: A ceiling lined with building board where the joints between the board are either exposed, set or concealed with cover strips, beads or the like, such that the supporting grid members are not visible.
- Linear or strip ceiling system: A ceiling whose soffit has the appearance of continuous strips of infill materials.
- Luminous ceiling system: A ceiling of translucent material with lamps in the ceiling void to light the space below.
- One-way exposed grid ceiling system: A ceiling whose soffit has the supporting grid members visible in one direction.
- Open ceiling system: A suspended ceiling formed of louvres, battens, open cells or similar ceiling components.
- Two-way exposed grid ceiling system: A ceiling whose soffit has the supporting grid members visible in two directions.
- Suspension system: An assembly of ceiling components for suspending ceiling systems.
- Authority's Sample: A sample held by the Authority and available for viewing during the tender

and construction periods.

**Test types**

Site test: A test made on site of the installed suspended ceiling system.

Laboratory test: A test made in a laboratory on a test specimen certified to be a full scale model of the system.

Type test: A test previously conducted by or for the manufacturer on the type of system specified.

**230.1.5 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**230.1.6 PERFORMANCE CRITERIA**

**General**

Provide the ceilings in conformance with the **Suspended ceiling performance schedule**.

**Strength**

General:

- Design live load (kPa): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

External ceilings:

- Upward wind load (kPa): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >
- Downward wind load (kPa): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >
- Terrain category: Cross refer: Civil and Structural Materials and Workmanship Specification: sections >
- Bulkheads:
- Vertical face load (kPa): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >
- Horizontal face load (kPa or kN/m): Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

**Imposed dead loads**

Cross refer: the Suspended ceiling performance schedule.

**Fire performance**

- Non combustible to BS 476, Part 4.

**Acoustic properties**

- Sound absorption coefficient: >
- Sound reduction index: >
- Field transmission loss: >
- Noise reduction coefficient range: >

**Thermal properties**

Thermal resistance (R): As shown on the drawings or required by current legislation in Singapore, whichever is the higher.

**Accessibility**

Access hatches: As shown on the drawings.

**Pressurised plenum systems**

Ventilating ceilings forming part of a pressurised plenum system: Design for the following:

- Pressure differential (Pa): >
- Air volume per unit area per minute: >
- Maximum air speed at distribution points: >

**230.2 QUALITY**

**230.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- The suspension system before installation of the ceiling panels or lining.
- Completed ceiling before site painting, if applicable.
- All areas which will be concealed from view in the final installation.
- >

**Hold points**

- Completion of design prototypes.
- Completion of all confirmation prototypes.
- >

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**230.2.2 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2 ‘Tests’ of the General Requirements.

**Strength tests**

General: To AS/NZS 2785 Section 5.

External ceilings:

- Test load: Include for upper wind load.

**Fire resistance tests**

Resistance to fire: To BS 476, Part 4.

**Acoustic properties tests**

Sound absorption: To AS 1045, ASTM C423 or BS EN 20354.

Airborne sound transmission:

- Sound reduction index (laboratory measurement): To AS 1191.
- Field transmission loss (site measurement): To AS 2253.
- Ceiling normalized level difference: To AS/NZS 2499.

**Performance tests schedule**

Performance to be tested	Type of test		
	Site	Laboratory	Type
Strength	>	>	>
Upward wind load	>	>	>
Fire resistance level	>	>	>
Early fire hazard properties	>	>	>
Sound absorption	>	>	>
Sound transmission loss	>	>	>
Field transmission loss	>	>	>
Ceiling attenuation class	>	>	>

**230.2.3 SAMPLES**

**General**

Submit samples of each of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

- Ceiling material: Sheet, panel, tile and strip, with insulation, showing the extremes and mean of variation in colour, pattern, or texture of the proposed finish.
- Suspension: Sections proposed for suspension system, including wall angles and trim.
- Methods: Methods of jointing, fixing, height adjustment, retaining and removing panels.
- Accessories: Visible accessories including light fittings, diffusers, detectors, hatches and curtain

tracks.

No of samples: 3.

#### **230.2.4 PROTOTYPES**

##### **General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

##### **Design prototype**

General: Erect a design prototype of each ceiling system as directed by the Engineer.

Location: as directed by the Engineer.

Size: Sufficient to show the design intent in all its aspects and allow design development work to take place but in no instances less than 10 m<sup>2</sup>.

- Incorporating: ceiling mounted components supplied by System Wide Contractors and/or as part of the works.
- Access provision.
- Interface with adjacent finishes.

Demonstrate:

- Access through the ceiling.
- Demountability.

##### **Confirmation Prototype**

General: Erect a confirmation prototype of each ceiling system, including at least one example of each of the specified components.

Location: as agreed on site with the Engineer.

Size: Sufficient to demonstrate one complete bay of the appropriate ceiling type but in no case less than 10 m<sup>2</sup>.

Incorporating:

- Ceiling mounted components supplied by System Wide Contractors and/or as part of the works.
- Access provision.
- Interface with adjacent finishes.

Demonstrate:

- Access through the ceiling.
- Demountability.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

#### **230.2.5 SUBMISSIONS**

##### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

##### **Subcontractors**

Submit name and contact details of proposed specialist suspended ceiling suppliers and subcontractor(s).

##### **Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing the relevant details of the ceiling system including, but not limited to, the following where applicable:

- Plan: Reflected plan of ceiling, showing ceiling grid and positions of lights, diffusers, hatches and service penetrations.
- Proposed setting-out indicating cut panels if any.
- Details: Large scale details of construction, suspension system, methods of assembly, trim and fixing, showing dimensions, clearances, and tolerances.
- Demountability: Methods of achieving demountability.
- Partition attachment: Method of attaching heads of partitions to the ceiling support members.
- Vibration reduction: Method of reducing contact vibrations between structure and ceiling.
- Specification: Specification of material to be used, finishes to exposed members, corrosion protection, performance data of components and assemblies, and other pertinent information.

No. of copies to be submitted: As Particular Specification.

**Installation**

Setting out: Submit proposed set-out.

**Authorities**

Submit evidence to confirm acceptance of the suspended ceiling system by:-

- The Building and Construction Authority.
- The Authority's Mechanical and Electrical Engineers.

**Engineering endorsement**

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

Submit copies of current test reports, and certification, including drawings of tested details, for each proprietary material and build up in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No of copies to be submitted: 3.

**Method Statement**

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

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**230.3 MATERIALS AND COMPONENTS**

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**230.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use materials which contain known carcinogenics.

Corrosivity: Non-corrosive.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**230.3.2 SUPPORTS AND TRIM**

**Coated steel**

General: To AS 1397.

- Coating class: Z200 or AZ150 as applicable.

Proprietary galvanised mild steel support system complete with all fixings and brackets.

**Aluminium**

General: To AS 1866.

- Finish: Cross refer: Metals and Prefinishes.

**Finish**

Cross refer: the Suspended Ceiling Construction Schedule.

**230.3.3 FASTENERS**

Cross refer: Adhesives, Sealants and Fastenings.

All fixings and fastenings shall be non-corrosive.

All fixings and fastenings shall be appropriate to the work, shall transmit all imposed loads and stresses, and shall ensure the structural integrity of the ceiling.

**230.3.4 PANELS**

**Plasterboard panels**

Plasterboard: To AS/NZS 2588.

Use moisture resistant plasterboard.

Minimum thickness: 9mm.

Edges: Tapered.

Glass fibre reinforced gypsum plasterboard: To AS 2590.

**Fibrous plaster tiles**

Standard: To AS 2185 with hard cast plaster face.

**Mineral fibre tiles**

Spun mineral fibres pressed together with mineral fillers and binders.

Minimum thickness: >

Density >

Finish >

Colour >

Resistance to moisture >

Tolerance:

- Length >

Diagonal >

**Glass fibre panels**

Glass fibres, bonded with a thermosetting resin into rigid panels.

Minimum thickness: >

Finish >

Tolerance:

- Length +0/-2mm.

- Diagonal +/- 2mm.

**Fibre cement**

Standard: To AS/NZS 2908.2./ISO 8336.

Wall linings: Type A Category 4.

Minimum thickness: 9mm.

Type: Autoclaved compressed panel.

Category: >

Edges: Square.

Pre-finished to match face of board.

Perforations >

Movement from ambient to fully saturated ≤ 0.1%.

Alkalinity Less than pH value 10.

Finish: Double faced

Pre-coated, U.V., graffiti and abrasion resistant.

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Colour: To BS 4800: Any RAL Colour.

Tolerance:

- Length +0/-2mm.

- Diagonal +/- 2mm.

**GRG**

Cross refer: GRG.

**Metal baffle ceilings**

Metal leaves or blades hung vertically on a concealed suspension system in an approved pattern diffusing the superimposed lighting and producing a luminous ceiling effect.

**Steel strips**

Pressed or roll formed from galvanized steel sheet.

**Steel tiles**

Type: Trays pressed from zincanneal sheet with sides formed to locate securely in suspension system.

**Insulation**

Cross refer: Insulation and Barriers.

**Corrugated aluminium foil panels**

Aluminium formed into a transverse corrugated sheet.

**Aluminium strips**

Preformed from 5005 aluminium alloy coil strip.

**Aluminium tiles**

Pressed from aluminium sheet, perforated and suitably backed to give the required acoustic and other performances.

**Glass**

Cross refer: 'Glazing'.

Standard: To SS1.

**230.3.5 SCHEDULE**

**Suspended ceiling construction schedule**

Ceiling code	SC1	SC2	SC3
Location	>	>	>
Demountability	>	>	>
Supporting system:	>	>	>
- Type	>	>	>
- Basic grid (l x b) (mm)	>	>	>
- Material	>	>	>
- Exposed member finish	>	>	>
- Exposed member colour	>	>	>
Ceiling lining/panels/tiles:	>	>	>
- Material	>	>	>
- Form	>	>	>
- Panel size (mm)	>	>	>
- Thickness (mm)	>	>	>
- Pattern	>	>	>
- Colour	>	>	>
- Perforation	>	>	>
- Type	>	>	>
- Mineral fibre content	>	>	>
- Standard	>	>	>
- Grade	>	>	>
- Pitch (mm)	>	>	>
- Depth (mm)	>	>	>
- Edge type	>	>	>
- Density	>	>	>
- Backing	>	>	>
- Surface	>	>	>
- Finish	>	>	>
Trim	>	>	>

**Suspended ceiling performance schedule**

Ceiling code	SC1	SC2	SC3
Location	>	>	>
Additional structural actions	>	>	>
Fire hazard properties:	>	>	>

## 230 SUSPENDED CEILINGS

Ignitability index	>	>	>
Heat evolved index	>	>	>
Smoke developed index	>	>	>
Spread of flame index	>	>	>
Fire resistance level, FRL	>	>	>
Suspended ceiling normalized level difference, $D_{n,c,w}$	>	>	>
Weighted sound absorption coefficient, $\alpha_w$	>	>	>
Weighted sound reduction index, $R_w$	>	>	>

### 230.4 EXECUTION

#### 230.4.1 CONSTRUCTION GENERALLY

##### Proprietary systems

Provide suspended ceilings as complete proprietary systems, each fabricated by one manufacturer and installed by a specialist installer.

##### Protection

Protect existing work from damage during the installation.

##### Ceiling grid

General: Set out the ceiling grid so that panel joints and centrelines of visible suspension members coincide with grid lines shown on the drawings. If not otherwise shown, set out so that opposite margins are equal.

Pattern and texture: Set out patterned or heavily textured materials to give consistency in direction of pattern or texture.

Special sized panels: Provide special sized purpose-made panels to fill non-standard margins, openings and penetrations.

##### Cut tile edges

Conceal, or finish to match prefinished edges.

##### Stability

Install the ceilings level; and fix so that under normal conditions there is no looseness or rattling of ceiling components.

##### Structure-borne sound

Provide a ceiling system which does not amplify structure-borne sound. Provide suitable means of reducing contact vibrations between structure and ceiling.

##### Services

Confirm the service and component installation details with the Authority's Mechanical and Electrical Engineers.

Obtain the Authority's Mechanical and Electrical Engineers' acceptance of the ceiling details adjacent to services and components and the access routes through the ceiling to the services within the ceiling void.

Fit components within the ceiling system to ensure that distortion, overloading or excessive vertical deflection is prevented.

#### 230.4.2 SUPPORTS INSTALLATION

##### Support members

General: Space the support members as required by the loads on the system and the type of ceiling, and allow for the installation of services and accessories, including ductwork, light fittings and diffusers. Provide additional back support or suspension members for the fixing of such items. Do not use screw fasteners in tension.

Services: Do not suspend from services (e.g. ductwork) unless the service has been designed to accept the ceiling load. In locations where services obstruct the ceiling supports, provide bridging and suspension on each side of the services.

Grid members: If required, notch grid members at the junction with the perimeter trim to ensure the panels lie flat on the perimeter trim.

Fixing to steel:

- General: Do not use screw fasteners in tension.
- Fixing type: >
- Fixing to concrete:
- Fixing type: >

**Suspension system**

Height adjustment: Provide height adjustment by means of a length adjustment device at each suspension point, permitting length variation of at least 50 mm. Do not attach the suspension system to the lip of purlins.

Failure: Provide a ceiling system such that failure of any one suspension point does not cause a progressive failure of the ceiling.

**Bracing**

Provide bracing to prevent lateral movement and to resist:

- Imposed forces.
- Imposed civil defence forces.

**Fasteners**

Install fasteners so that they are not visible in the finished ceiling. Do not use screw fasteners in tension.

**Bulkheads**

Construct bulkheads and other similar ceiling formations as an integral part of the ceiling structure. Brace bulkheads to prevent lateral movement.

Provide for civil defence requirements where the ceiling is terminated at a bulkhead.

**External suspended soffits**

Support external suspended soffits on rigid strutting members capable of carrying the imposed loads. Install downstrutting members to minimise any eccentricity, and ensure that the upward and downward wind loads are carried through to the supporting structure.

**Prefinishes**

Repair damaged prefinishes by recoating.

**Movement joints**

Provide control joints in sheet finishes as required in the Internal Cladding worksection.

Alignment: Install the ceiling with control joints to correspond in location and direction to those in the structural frame. Do not bridge any control joint in the structural frame with the ceiling.

Abutments: Install the ceiling to allow for differential movement with abutting surfaces.

**230.4.3 PANELS INSTALLATION**

**General**

General: Fit panels accurately and neatly, free from air leakage and staining. Provide additional support and bracing to panels which are required to carry dead loads other than the panel's own weight.

Panel lock clips: Where panels are exposed to wind loads, sudden changes in air pressure, or where required for security, insert panel lock clips at the junction of carrier rails and panels.

**Control joints**

Location: Provide for control joints in sheet finishes where required by the Internal Cladding Section. Position joints to intersect lighting fixtures, vents or air diffusers.

Movement joints: Form movement joints with purpose-made control joint beads.

**Accessories and trim**

General: Provide accessories and trim necessary to complete the installation.

Fasteners: >

Trim: Provide trim at junctions with other building elements and surfaces, such as walls, beams and penetrations, consistent with the style, materials and finishes of the ceiling system generally.

Type: >

Location: >

Finish: >

Installation: >

Plasterboard trim: Provide purpose-made corner beads, casing beads and stop beads.

**Service penetrations**

Provide openings for, and fit the ceiling system up to components such as light fittings, ventilation outlets, detectors, sprinklers and loudspeakers.

**Aluminium screen panels**

Blade suspension system: Suspend blades vertically from the carrier rails of a suspension system from the same manufacturer. Leave space between end junctions of panels not in single lengths.

Blade Centres >

Space between end junctions of panels >

**Aluminium strips**

Set out: Parallel linear pattern butt jointed at ends with purpose-made concealed sleeve sections.

Strip centres >

Fixing: Fix strips to a proprietary suspension system from the same manufacturer, incorporating carriers to receive the strips, preformed from 5005 aluminium alloy minimum 1 mm thick.

**Smoke curtain recesses**

General: Provide smoke curtain recesses as part of the ceiling system, including all necessary modifications to the ceiling edge and supporting structure to allow for the installation of the smoke curtain.

**230.4.4 ACCESS PANELS**

**Non-demountable ceilings**

General: Provide access panels supported and anchored to permit ready removal and refixing.

Opening size (mm): >

**Finish**

Match the ceiling panels in appearance and performance.

**Reinforcement**

Reinforce the back of the access panel to prevent warping and facilitate handling.

**Ironmongery**

Hinges: Fully concealed.

Catch: Tamper proof.

Handle: Fully recessed finished to match ceiling.

**Identification**

Provide each access panel with an identification mark.

**230.5 COMPLETION**

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**230.5.1 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Protection**

Surfaces: Protect all finished surfaces to prevent damage or defacement.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

**Damage**

Replace damaged items with new.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements including, frequency of inspection and recommended methods of access, inspection, cleaning, repair and replacement.

**Warranties**

Warrant the materials and workmanship as part of the overall assembly in which the metal and/or prefinish is employed using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General requirements.

**230.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>240 CEMENTITIOUS TOPPINGS</b>
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**240.1 GENERAL**

**240.1.1 CROSS REFERENCES**

**Cross reference**

**Associated worksections**

Conform to associated worksections as follows:

- Granite Flooring.
- Tiling.
- Terrazzo.
- Waterproofing.
- Adhesives Sealants and Fasteners.

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**240.1.2 INTERPRETATION**

**Cementitious toppings**

**Topping**

A cementitious material applied to a base slab for the purposes of achieving a flat floor finish. Refers to a stand-alone finish or base to take an applied finish e.g. tiling.

**Bonded Topping**

Toppings that are fully bonded to their substrate.

**240.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**240.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**240.2 QUALITY**

**240.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Completion of preparatory work to the base slab.
- Completion of applied waterproofing on the base slab.

**Hold points**

- Completion of all prototypes.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**240.2.2 TESTS**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

**All Toppings**

BRE impact test to BS 8204.

**Sand and aggregates**

To SS73.

**240.2.3 SAMPLES**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Sand: Submit a 2 kg sample of sand.
- Divider strip: A 300mm length of each type of section proposed.
- Movement joints: A 300mm length of the proposed joint filler.

**Composite stone topping**

Submit samples showing range of colour and texture.

#### 240.2.4 PROTOTYPES

##### General

Provide prototypes in accordance with Section 20.3.5 'Prototypes' of the General Requirements.

##### Design prototype

Provide Design prototypes of all toppings.

Type	As agreed with the Engineer.
Location:	As agreed with the Engineer.
Minimum size (mm):	3.0m x 3.0m or as directed.
Mix	As agreed with the Engineer.
Incorporating	<ul style="list-style-type: none"><li>- Daywork and expansion joints.</li><li>- Edge details as directed.</li><li>- Interfaces as directed.</li></ul>
	>

##### Confirmation prototype

Provide confirmation prototypes of all cementitious toppings.

Location:	As agreed with the Engineer.
Minimum size (mm):	3.0m x 3.0m or as directed.
Incorporating	<ul style="list-style-type: none"><li>- Daywork and expansion joints.</li><li>- Edge details as directed.</li><li>- Interfaces as directed.</li></ul>
	>

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

#### 240.2.5 SUBMISSIONS

##### General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

##### Subcontractors

Submit name and contact details of proposed specialist topping subcontractor(s).

##### Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not limited to, the following information:

- Plans and sections showing the location and type of all cementitious toppings.
- A numbering system enabling all panels to be identified.
- Details of all required joints and interfaces.
- Allowances for movement.

No. of copies to be submitted: As Particular Specification.

##### Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

##### Tests

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

##### Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

**240.3 FINISHES GENERAL**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**240.3.1 TOLERANCES**

**Flatness**

Conform to the **Flatness class table** for the maximum deviation of the finished surface under a straight edge laid in any direction on an area of uniform grade.

**Flatness class table**

Class	Straight edge length	Maximum deviation (mm)
A	3 m	3
B	3 m	6
C	600 mm	6

Deviation shall not occur suddenly with the rate of departure not greater than 1.5mm for each 500mm in distance from any point of contact along the straight edge.

**240.3.2 SURFACE MODIFIERS**

**Seal stripper**

Thoroughly clean the surface before the application of finishes to masonry and cementitious floors. Remove heavy duty polymer finishes, and sealers using a seal stripper.

**Surface hardeners**

Suitable for cementitious toppings or as laid surfaces. Apply to clean surfaces. Do not apply to non-slip topping.

**Floor hardener**

Type: Non-metallic.

Composition: natural aggregates blended with cement and resin mortars.

Abrasion resistance: to ASTM C779-74.

Hardness: 9 mohs minimum.

Adhesion: minimum 4.5. kg/sq.m.

Chemical resistance: required to battery acids.

**240.4 CEMENTITIOUS TOPPINGS**

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**240.4.1 GENERAL**

Toppings shall comply with BRE Information Paper IP 11/84, Table 2, Category A.

**240.4.2 MATERIALS**

Cement: To Section 11 Materials and Workmanship Specification for Civil and Structural Works

Sand: To BS 1199 and 1200 as appropriate.

Plasticiser: To BS 4887: may only be used with the acceptance of the Engineer.

Waterproofing agent: proprietary waterproofing agent accepted by the Engineer.

Bonding compound: proprietary bonding compound accepted by the Engineer.

Reinforcement;

Type: 50 x 50 x 2.5mm thick galvanised wire mesh as recommended by BS 4483.

**240.4.3 GENERAL**

Submit mix designs to the Engineer for acceptance prior to any toppings being laid.

Do not vary the accepted mix without prior agreement from the Engineer.

**240.4.4 CEMENT/SAND TOPPINGS**

**Mix**

Ratio: 3:1 cement:sand.

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Water:cement ratio: 0.5 maximum.

**240.4.5 GRANOLITHIC TOPPINGS**

**Mix**

Ratio: 1:1:1.5 cement:fine aggregate:5 mm coarse aggregate.

Water:cement ratio: 0.5 maximum.

Slump: 50 mm maximum.

**Placing**

Monolithic placing: Compact and float.

**240.4.6 WATERPROOF CEMENT TOPPINGS**

**Mix**

Ratio: 1:2.5 cement:graded coarse aggregate screenings, maximum size 5 mm.

Slump: Zero.

**Waterproofing agent**

Proprietary integral admixture to the Engineer's acceptance.

**240.4.7 "NO FINES" TOPPINGS**

**Mix**

Ratio: 1:6 cement:coarse aggregate, maximum size 10 mm. Mixing water per bag of cement, 20 L maximum.

Slump: Zero.

**Finish**

Trowel to an even natural texture. Rule to the designated pattern.

**240.4.8 COMPOSITE STONE TOPPINGS**

**Execution**

By a specialist subcontractor.

**Mix**

Grading: Cement and selected aggregate graded from fine to coarse, maximum size 6 mm.

Aggregate mix

>

Proportions (cement:fine aggregate:coarse aggregate):

>

**Colour and texture**

Expose the aggregate by washing off the surface cement film with water. Do not use acid.

**240.4.9 MARGINS TO TOPPINGS**

**Integral margins**

Integrally form margins in the topping material.

**Coved skirtings**

General: Form coves in the topping material, and finish the top to a neatly struck line. Mitre internal and external angles.

Location:

>

Radius (mm):

>

Height (mm):

>

**240.4.10 NOSINGS**

Reinforced nosings.

General: Provide a stainless steel angle set flush with the topping, fixed with stainless steel brackets at 450 mm maximum centres, bolted to masonry anchors.

Location:

>

Angle size:

>

**Preformed nosings**

General: Proprietary nosing section to finish flush with the adjoining surface.

Location: >

Material: >

**Anti-slip strips**

General: Form grooves and fill with anti-slip compound consisting of 1:1 cement:silicon carbide grains.

Location: Stair and landing nosings.

Grooves:

- Size: 15 mm wide, 12 mm deep.
- Spacing (mm): >
- Number: >

**240.4.11 CONTROL JOINTS**

**Additional joints**

Provide control joints as necessary to divide the topping into approximately square bays of not more than 15m<sup>2</sup>.

Where additives are used, provide control joints as recommended by the additive manufacturer.

**Edges of joints**

Square.

**Control joint filler**

Preformed strip: Proprietary strip consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying.

Sealant: Cross refer Adhesives Sealants and Fasteners.

Dividing strip: Corrosion resistant minimum 5mm wide x 25mm deep.

Material: >

**240.4.12 JOINT ACCESSORIES**

**Floor finish dividers**

General: At junctions between differing floor finishes provide a corrosion resistant metal dividing strip suitably fixed to the substrate, with top edge flush with the finished floor. Where changes of floor finish occur at doorways make the junction directly below the closed door.

Type: >

Material: >

**240.5 EXECUTION**

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**240.5.1 GENERAL**

**Sub Base**

General: Apply toppings to dry, smooth, firm, continuous surfaces, clean and free from loose or foreign matter.

Bonded Toppings:

- mechanically abrade substrate to expose clean aggregate.
- thoroughly dampen prior to the application of topping and treat with a grout slurry and/or bonding agent.

**Additives**

Use in accordance with the manufacturer's instructions.

**Thickness**

Lay topping to the thicknesses shown on the drawings unless otherwise noted.

**Reinforcement**

Provide reinforcement where toppings are greater than 50mm thick.

Lay reinforcement in the centre of the topping.

Lap mesh 150mm at joints.

**Mixing**

Manufacture by volume-batching or weigh-batching the dry ingredients and machine mixing with the specified water content.

**Placing**

Process: Spread the topping mix in two layers, compact each using a roller or by mechanical means, float to the designated tolerance class and finish.

Monolithic placing: Spread the topping mix as soon as surface water has disappeared from the base.

Placing over membranes: Over waterproof membranes, place cementitious toppings at least 50 mm thick. Lay reinforcement in the centre of the topping.

**Daywork Joints**

Cross refer Control Joints.

**Setting divider strips**

Set divider strips accurately and firmly to the required locations and levels, with epoxy mortar.

**Falls**

Lay toppings to the falls indicated on the drawings.

Lay such that water drains off the floor with none being left standing at any location.

**Finish**

- To a uniform smooth texture using a powered machine float. Hand float areas inaccessible to the machine.
- Steel trowel to produce a finish free of trowel marks and uniform in both texture and appearance.
- Wood float to an even, fine, granular appearance.
- Use a stiff broom to produce a linear directional textured surface.

**Curing**

Keep damp for a minimum of 14 days.

Prevent cracking or crazing resulting from drying shrinkage, without impairing the adhesion of subsequent finishes.

**Movement joints**

Location: Over movement joints in the substructure.

**Cementitious toppings schedule**

	CT1	CT2	CT3
Location	>	>	>
Tolerance class	>	>	>
Type	>	>	>
Finish	>	>	>
Thickness		>	>
Surface modifier	>	>	>

**240.5.2 REPAIR**

Repairs to toppings which fail tests may only be carried out with the prior acceptance of the Engineer.

Before commencing repairs submit details of the proposed repair method for acceptance.

**240.6 COMPLETION**

**240.6.1 General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

**Protection**

Where intended to be exposed, protect the completed toppings against all forms of damage until the completion of the works.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage exposed cementitious toppings from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

**Damage**

Replace damaged items with new.

**Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all toppings against loss of adhesion with the substrate below.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**240.6.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

250 TERRAZZO
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**250.1 GENERAL**

**250.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows: Cementitious Toppings.

Gratings.

Adhesives, Sealants and Fasteners.

Waterproofing.

>

**250.1.2 INTERPRETATION**

**General**

Substrate: The building element to which the tiles are to be bedded.

Underlay: An intermediate layer (e.g. render, screed or sheeting) applied to the substrate to provide a suitable surface for tile bedding.

Separation layer: A membrane laid on the substrate beneath the bedded finish to prevent the two elements from adhering to each other.

Waterproof Membrane: A membrane laid on the substrate beneath the underlay to prevent dampness penetrating across from one side of the membrane to the other. Cross refer: Waterproofing.

Isolation Membrane: A membrane laid on the substrate beneath the underlay to isolate the floor finish from stray electrical currents.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**250.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**250.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**250.2 QUALITY**

**250.2.1 INSPECTION**

**General**

Terrazzo shall be inspected from a minimum distance of 1400 mm under the specified permanent artificial luminance or 500 lux, whichever is greater.

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- Items to be embedded, including reinforcement, dividing strips, in place.
- Underbed placed and surfaced to receive the terrazzo.
- Terrazzo placed and surfaced before finishing.
- Completion of finishing.
- Precast items on site before installation.
- Joints formed and ready for filling with joint filler.

**Hold points**

- Substrate immediately before tiling.
- Location of setting out point.

- >

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

### 250.2.2 TESTS

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

#### **Sand and aggregates**

To SS73.

### 250.2.3 SAMPLES

#### **General**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Terrazzo: Sample panels, each at least 300 mm x 300 mm, of every type of surface colour, pattern and finish specified, showing the extremes of the range.
- Facing aggregate: For each surface type, a 25 kg sample of the natural stone aggregate to be used in the facing layers, showing the range of aggregate size.
- Fine aggregate: For each surface type, a 10 kg sample of the sand (if any) to be used in the facing layers.
- Cement: For each surface type, a 1 kg sample of the cement or cement blend to be used in the facing layers.
- Divider strip: A 300mm length of each type of section proposed.
- Movement joints: A 300mm length of the proposed joint filler.
- Proprietary carborundum anti-slip strips: A 300mm strip.

No of samples: 3.

### 250.2.4 PROTOTYPES

#### **General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

#### **Confirmation Prototype**

Prepare confirmation prototypes of each type of finish. Include junction details and trim.

Location: As agreed with the Engineer.

Size: At least 3 m<sup>2</sup>.

Retain all confirmation prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

#### **Trial set-out**

Trial set-out: On horizontal surfaces make a trial set-out for each area.

### 250.2.5 SUBMISSIONS

#### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### **Subcontractor**

Submit names and contact details of proposed suppliers and installers.

#### **Terrazzo Mix**

Submit details of the aggregate and matrix for each type of terrazzo proposed including the relative proportions of each constituent.

#### **Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'submissions' of the General Requirements.

Submit shop drawings of the terrazzo work showing, but not limited to, the following:

- Layout of all areas of tiled terrazzo, including tile dimensions and setting out points.
- Method of bedding or attachment to the base.
- Thickness of beds, underbeds and toppings.
- Separation layer type.
- Reinforcement of underbed and precast items.
- Divider strips, type and location.
- Movement joints and jointing material.
- Dimensions of precast items.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all materials and components used together with certification that they comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

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**250.3 MATERIALS**

**250.3.1 MATERIALS**

**General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**Water**

Free from matter harmful to terrazzo or to items embedded in it or in contact with it.

**Cement**

Type to SS26.

Colour: as required by the surface colour.

**Aggregates**

Standard: To SS31.

Sand: Fine aggregate.

Coarse aggregate (in underbeds and cores): Dense natural rock aggregate.

Facing aggregate: Dense natural rock aggregate.

- Characteristics: Natural stone, angular in shape, as distinct from elongated or flaky, graded within the required sizes, free from dust, and free from deleterious material.

- Stone type: >

**Pigments**

Standard: To BS EN 12878.

General: Resistant to lime bloom and efflorescence.

Pigment proportion: ≤ 5% by weight of cement.

**Reinforcement**

Standard: To SS18.

Protective coating: Galvanized.

Reinforcement supports: Purpose-made concrete or plastic reinforcement supports, for supports which will be visible on the surface of the terrazzo in its final position.

**Divider strips**

Type: Proprietary preformed strips, width appropriate to the topping thickness and such that the strip is anchored firmly in the underbed.

Material: aluminium, grade suitable for use against wet cementitious materials.

**Coved divider strips**

Select from the following:

- Provide matching divider strips formed to the cove radius, and insert in the cove to coincide with the divider strips in the adjoining plane surfaces.

**250.3.2 RESIN TERRAZZO MATERIALS**

**General**

Do not use resin terrazzo or grout materials which, when subject to fire conditions, will emit excessive smoke or dangerous fumes.

**Resin terrazzo**

Facing aggregate in a resin matrix.

**Compatibility**

Ensure the compatibility of the resin terrazzo materials, grout, sealer, and primer.

**Colouring material**

Provide colouring material which is permanent, stable, compatible with the matrix, and factory-dispersed into the resin by the manufacturer.

**Grout**

Resinous material.

**Fire Performance**

Incombustible when tested to BS 746 Part 4.

**Primer**

Prime the substrate before installing the resin terrazzo.

**Divider strips**

A proprietary ebonite "T" section.

**250.4 EXECUTION**

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**250.4.1 SUBSTRATE PREPARATION**

**Cleaning**

Remove deleterious materials which could adversely affect adhesion. Leave the surface dust-free and clean. If removal is not possible, render harmless using remedial treatment.

**Substrates for adhesives**

Ensure that substrates which will receive adhesives are dry, with a moisture content below 6%. Cure concrete substrates before application.

**Preparation for bonding**

Prepare the substrate to guarantee the adhesion of the terrazzo by either roughening the surface after placing topping, or by removing the hardened surface to a depth of at least 2 mm. Expose the aggregate leaving a clean, firm granular surface for the permanent adhesion of the finish.

Non-horizontal substrates: To vertical or steeply sloping surfaces or soffits, securely fix a non-corrosive steel mesh to the substrate.

**Resin terrazzo**

Finish the substrate using a steel float.

**250.4.2 SEPARATION LAYER**

**Bitumen emulsion**

Standard: To AS 1160.

Grade: Slow-setting grade ASS/170-60 or CSS/170-60.

Application: Ensure that the substrate is free of surface irregularities which could cause mechanical bonding of the terrazzo. Brush the emulsion on over the substrate to a thick paint consistency.

**250.4.3 DAMP PROOF COURSE**

**General**

If the substrate slab is subject to damp, provide a damp proof course consisting of one of the following:

- Asphalt tanking membrane: A proprietary waterproofing membrane at least 5 mm thick, of bituminoid asphalt materials, reinforced with fabric and a layer of corrosion-resistant metal foil, laid generally to AS CA55.
- Butyl rubber membrane: A proprietary waterproofing membrane of black butyl rubber at least 1.5 mm thick, adhesive fixed.

**250.4.4 UNDERBEDS****Mix proportions (by volume)**

Underbed ≤ 42 mm thick: 1:4 cement:sand.

Underbed > 42 mm thick: 1:2:3 cement:sand:coarse aggregate graded up to 13 mm.

**Slump**

60 mm maximum.

**Minimum thickness**

Placed over separation layer: 42 mm.

Fully bonded: 22 mm.

Fully bonded, with embedded items: 60 mm.

**Maximum thickness**

75 mm.

**Reinforcement**

Type: 50 x 50 x 2.5mm thick galvanised wire mesh as recommended by BS 4483.

**250.4.5 PLACING UNDERBEDS****Method of placement**

>

**Placing**

General: Place the underbed over the prepared surface or separation layer and float to the required levels or slopes within 3 hours of placing.

Cementitious matrix underbeds: Roughen the surface to provide a key for the terrazzo topping.

Resin matrix underbeds: Steel float.

**Fully bonded method**

Thoroughly dampen the surface of the substrate and leave it free of standing water. Immediately before placing, scrub a coat of neat cement grout into the surface, or apply a proprietary adhesive.

**Reinforcement**

Place reinforcement 13 mm above the bottom of the underbed. Lap joints minimum 150mm and tie with matching wire. Terminate reinforcement at movement joints.

**Setting divider strips**

Set divider strips accurately and firmly to the required locations and levels, with epoxy mortar.

**250.4.6 MIXING****In situ cement-matrix terrazzo**

Manufacture by volume-batching or weigh-batching the dry ingredients, machine mixing with the minimum water consistent with workability, laying or casting, rolling to compact and to remove excess water, grinding, grouting, polishing and curing.

**250.4.7 FALLS AND LEVELS****Falls**

Grade terrazzo floors to even falls where required. Otherwise, lay level.

**Finished levels**

Maintain finished floor levels without step or break at changes of floor finish including carpet.

**Tolerance**

Determine tolerance classes using a straight edge placed anywhere on the surface in any direction.

**Tolerances class table**

Class	Measurement	Maximum deviation (mm)
A	3 m straight edge	3

Deviation shall not occur suddenly with the rate of departure not greater than 1.5mm for each 500mm in distance from any point of contact along the straight.

**Substrate levels**

Grade or step the surface of the substrate slab to maintain the minimum thickness of terrazzo underbed and finishes. Limit the ratio of maximum to minimum underbed thickness to 3:2.

**250.4.8 CURING****Cementitious surfaces**

Curing: Keep the cementitious surfaces, including underbeds, toppings and grouting, in a moist condition for at least 7 days from the time of placing or until the commencement of the next process.

Curing agents: Do not use proprietary agents.

**Resin terrazzo**

Obtain the written approval of the resin manufacturer if chemical curing agents are proposed.

**250.5 IN SITU TERRAZZO**

**250.5.1 TERRAZZO**

**Cement matrix terrazzo**

Mix proportions (by weight): 4:9 cement:facing aggregate.

Water:cement ratio: 18 L:40 kg water:cement.

**Terrazzo toppings schedule**

Designation	T1	T2	T3
Terrazzo type	>	>	>
Location	>	>	>
Surface:	>	>	>
- Colour	>	>	>
- Pattern	>	>	>
- Finish	>	>	>
Facing aggregate:	>	>	>
- Type	>	>	>
- Size(s) (mm)	>	>	>
- Resin matrix	>	>	>
Pigments:	>	>	>
- Type	>	>	>
- Proportions	>	>	>
Non-horizontal substrate:	>	>	>
- Mesh material	>	>	>
- Mesh size (mm)	>	>	>
- Separation layer type	>	>	>
- Vapour barrier type	>	>	>

**250.5.2 PLACING TERRAZZO**

**Cementitious toppings**

On underbed: Place the terrazzo as soon as possible after placing the underbed. Immediately before placing, scrub a coat of neat cement grout, of the same cement type as the terrazzo, into the surface. Place the terrazzo between the divider strips and screed level.

Monolithic placing: As soon as the surface water has disappeared from the newly placed concrete substrate, scrub a coat of neat cement grout, of the same cement type as the terrazzo, into the surface. Set the divider strips into the substrate accurately, firmly, and to the required levels, and make good as necessary to the substrate surface. Place the terrazzo between the divider strips while the substrate is still “green”, and screed level.

Finishing: Seed the surface with facing aggregate, matching that of the mix and trowel in. Roll using heavy rollers until excess water has been extracted. Trowel to a uniform surface revealing the line of the divider strips.

**Resin matrix toppings**

Place resin terrazzo terrazzo in the resin recommended manner.

Method of placement: >

**Topping**

Finished thickness (mm): >

**250.5.3 FINISHING**

**Cementitious terrazzo**

Grinding: At least 3 days after placing the terrazzo, machine grind the surface first using coarse grit, and then immediately afterwards using a fine grit. Keep the surface wet during grinding. Prevent water from carrying grinding products into the drainage system.

Grouting: Remove grinding dust and fines using water and rinse the surface thoroughly using clean water. Grout the wet surface with cement to match the matrix colour. Fill voids. Cure the grout until stoning commences.

Stoning: At least 3 days after grouting, machine grind using fine grit and hand stoning where necessary until the surface shows at least 75% of facing aggregate.

Cleaning: Immediately upon completion of stoning, wash the surface using mild detergent soap or a solution of non-discolouring neutral cleaner and rinse.

Sealing: As soon as the surface is dry, apply a penetrating fluorosilicate sealer, free from harmful ingredients, specially prepared for terrazzo.

**Resin matrix terrazzo**

Grind and polish in the recommended manner, including grouting and sealing.

**250.6 JOINTS**

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**250.6.1 MOVEMENT JOINTS**

**Locations**

Form movement joints, filled with suitable joint filler, through the full depth of the terrazzo finish and underbed directly over movement joints in the substrate.

**Movement joints schedule**

Location	Type	Exposed surface finish
>	>	>
>	>	>
>	>	>

**Movement joint filler**

A proprietary preformed strip consisting of a neoprene elastomeric core sandwiched between metal or ebonite plates, with lugs or nibs for mechanical keying to the terrazzo.

**Movement joint core**

- Tensile strength: 586 kg/cm<sup>2</sup>
- Shore A hardness: 60 -70
- Movement Accommodation Factor: 5%

Chemically resistant to, dilute acid, alkalis, detergents and common pollutants.

**250.6.2 DIVISIONS**

**Requirement**

Divide in situ terrazzo into panels with divider strips.

**Setting divider strips**

Set divider strips accurately and firmly to the required locations and levels, with epoxy mortar.

**250.6.3 JOINT ACCESSORIES**

**Floor finish dividers**

General: Finish tiled floors at junctions with differing floor finishes with a dividing strip suitably fixed to the substrate, with top edge flush with the finished floor. Where changes of floor finish occur at doorways make the junction directly below the closed door.

Type: >

Material: >

**250.7 PRECAST TERRAZZO**

---

**250.7.1 TERRAZZO TILES**

**Type**

Precast terrazzo tiles formed in a suitable machine to give sufficient compaction and density to the finished surface, and moisture cured before grinding at the place of manufacture.

**Terrazzo tiles**

Length (mm): >

Width (mm): >

Overall thickness (mm): >

Facing thickness (mm): >

Core material proportion: >

Abrasion resistance >

Joint: >

**Surface**

Colour:	>
Pattern:	>
Finish:	>

**Facing aggregate**

Type:	>
Size(s):	>
Resin matrix:	>

**Pigments**

Type:	>
Proportions:	>

**Non-horizontal substrate**

Mesh material:	>
Mesh size (mm):	>
Separation layer type:	>
Vapour barrier type:	>

**Underbed**

Mix proportions by volume: 1:4 cement:sand.

Slump: 25 mm maximum.

Method of placement:	>
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Minimum thickness:

- Bonded: 13 mm.
- Placed over separation layer: 25 mm.

**Reinforcement**

General: Reinforce underbeds placed over a separation layer with galvanized wire netting, 25 mm mesh, 1.4 mm wire diameter.

- Standard: To AS 2423.

**Bedding tiles**

Wet the tiles before laying. Brush the tile back with neat cement. Bed the tiles firmly and true to line.

**Grouting**

Between 12 and 24 hours after laying, fill the joints solidly with cement grout matching the matrix colour.

**250.7.2 PRECAST UNITS****Type**

Terrazzo units, precast cured and finished under factory conditions.

**Composition**

Carry the facing mix right through, unless precast units consist of a facing or facings bonded to a core of different material, and the minimum facing thickness is maintained.

**Facing**

Mix proportions, by weight: 4:9 cement:facing aggregate.

Water:cement ratio: 18 L:40 kg water:cement.

Minimum thickness: 13 mm, or gauge of coarsest aggregate plus 3 mm, whichever is the greater.

**Core materials**

Cement, sand, coarse aggregate.

**Fabrication**

Cast the units in suitable moulds and compact. Fully bond the facing to the core by placing the second mix immediately after the first. Where units are designed for bedding, suitably key the bedding surface.

**Finishing**

Finish free edges to 3 mm radius.

**Tolerances on dimensions**

Thickness:

- Free standing units:  $\pm 1.5$  mm.
- Bedded units:  $\pm 3$  mm.

Length and width:  $\pm 1/1000$ th of the dimension or 0.5 mm, whichever is the greater.

Flatness, twist, winding and bow: Maximum 1.5 mm deviation from a 1.5 mm straightedge placed in any position.

Edges: Maximum 1.5 mm deviation from the intended true line.

**Handling**

Handle the units so as not to cause damage such as cracking, or deflections exceeding the specified limits. Do not subject units to handling stresses until they have attained their 28 day compressive strength, except that grinding of units may commence upon the attainment of half this strength.

**Handling limits schedule**

Element	Limit of deflection	28 day compressive strength
>	>	>
>	>	>
>	>	>

**250.7.3 PRECAST PARTITIONS**

**Type**

Precast terrazzo partitions, consisting of divisions, fronts and nibs, with polished facing on visible surfaces including free edges, reinforced, drilled for and supplied with fixings and hardware including bolts, dowels, brackets, standards, cappings and stabilising bars.

**General**

Location: >

Installation method: >

**Surface**

Colour: >

Pattern: >

Finish: >

Edge finish: >

Radii (mm): >

Facing aggregate size (mm): >

**Pigments**

Type: >

Proportions: >

Core material proportions: >

**Reinforcement**

Machine-welded mesh: To AS/NZS 4671.

Dimensions (mm): >

Mass: >

**Precast partitions dimensions schedule**

Unit	Height (mm)	Width (mm)	Thickness (mm)
Division	>	>	>
Front	>	>	>
Nib	>	>	>

**Set out dimensions (mm)**

Finished floor to underside of units: >

Finished floor to top of units: >

**Fixings and hardware**

General: Provide purpose-made items.

Type: >

**Installation**

Sequence: Set partitions in position before wall or floor finishes are applied.

Fronts extending to floors: Bed solidly to the floor with two stainless steel dowels to each front: diameter >

Free-standing fronts:

Support	>
Material	>
Dimensions	>
Fixing	>

Heads of openings: Fix stabilising head channels, screwed to the tops of the partitions. Provide an infill strip to the channel across the opening.

Support	>
Material	>
Dimensions	>
Fixing	>
Anti graffiti finish	>

**Precast partitions fixings schedule**

Item	Material	Finish
Angle bracket	>	>
Floor standard	>	>
Stabilising head channel: - Infill strip	>	>

**250.7.4 PRECAST STAIR TREADS**

**Location** >

**Surface**

Colour:	>
Pattern:	>
Finish:	>
Facing aggregate size (mm):	>

**Pigments**

Type:	>
Proportions:	>
Core material proportions:	>

**Reinforcement**

Dimensions (mm):	>
Mass:	>

**Precast stair treads dimensions schedule**

Unit	Length (mm)	Width (mm)	Thickness (mm)
Treads T1	>	>	>
Treads T2	>	>	>
Treads T3	>	>	>

**Anti-slip strips**

Type:	>
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**Installation**

Bed units on a mortar underbed.

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## **250.8 COMPLETION**

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### **250.8.1 General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

#### **Protection**

Protect the completed terrazzo against all forms of damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the floor finish from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

#### **Damage**

Replace damaged items with new.

#### **Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all bonded toppings against loss of adhesion between the topping and substrate below.

#### **Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

#### **Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements, including published instructions for the maintenance of the terrazzo finishes.

### **250.8.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>260 GRANITE FLOORING</b>
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**260.1 GENERAL**

**260.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

Take into account the recommendations of Conquas 21 “Good Industry Practices- Ceramic Tiling & Marble and Granite Finishes”.

**Associated worksections**

Conform to associated worksections as follows: Cementitious toppings.  
Adhesives, Sealants and Fastenings.  
Gratings.

**260.1.2 INTERPRETATION**

**General**

Inclusion: An irregular and sudden change in the colour, texture, or geological constituents of the granite.

Substrate: The actual surface to which the granite flooring is to be bedded or attached.

Dry Lay: The layout of granite flooring as defined on the drawings prior to placing for the purposes of verifying the colour, tone and texture of individual granite units.

Granite Finishes: to the definitions of the American National Building Granite Quarries Association Inc. Viz:-

- Polished : Mirror glass with sharp reflections.
- Honed : Dull sheen, without reflections.
- Flamed : Produced by the application of high temperature flame to the surface. Large surfaces shall not have shadow lines caused by the overlapping of the torch.
- Fine Rubbed : Smooth and free from scratches – no sheen.
- Shot ground : Plane surface with pronounced circular markings or trails having no regular pattern.
- Sand blasted, coarse stippled : Coarse plane surface produced by blasting with an abrasive, coarseness varies with type of preparatory finish and grain structure of the granite.
- Sand blasted, line stippled : Plane surface, slightly pebbled with occasional slight trails or scratches.
- 8-cut : Fine bush hammered.
- 6-cut : Medium bush hammered.
- 4-cut : Coarse bush hammered.

Saw cut: The finish obtained from the saw used to cut the granite.

Authority’s Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**260.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 ‘Design’ of the General Requirements.

**260.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**Building structure**

Expected amounts of differential movements:

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

**260.2 QUALITY**

**260.2.1 INSPECTION**

**General**

Granite shall be inspected from a minimum distance of 1400 mm under the specified permanent artificial luminance or 500 lux, whichever is greater.

Granite containing an inclusion which cannot be covered in its entirety by a disk 20mm in diameter shall be rejected.

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- Proposed stone source (quarry, storage yard).
- Proposed mason's yard.
- Materials stored at the yard or on site.
- The preparation of the stone sample range.
- Items to be embedded, including reinforcement, dividing strips, in place.
- Substrate placed and surfaced to receive the granite flooring.
- Application of sealer on granite surfaces.
- Completion of flooring.
- Movement joints formed and ready for filling with joint filler.

**Hold points**

- Stone laid out before laying.
- Completion of prototype.
- Touch voltage insulation layer in place.
- Completion of every >sq.m. of flooring.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**260.2.2 SAMPLES**

**General**

Submit samples of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

**Granite samples**

For each type and grade of granite submit at least 6 quality control samples

- either the full size of the unit, or 300 x 300 mm, whichever is the greater; and
- showing the expected range of variation of colour, pattern, texture, and surface finish in stone to be supplied.

**Associated materials and products**

- Sand: Submit a 2 kg sample of sand.
- Divider strip: A 300mm length of each type of section proposed.
- Movement joints: A 300mm length of the proposed joint filler.
- Sealer: Submit copies of all literature available from the manufacturer, including test data

No. of samples: 3.

**260.2.3 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

General: Obtain test samples, representative of each required type of granite, and have the tests carried out at the following stages:

- Before awarding a stone supply contract.
- On stone prepared for the works, at intervals during the course of the works.

Testing authority: >

**Granite tests schedule**

Property to be tested	Test standard	Test criterion (if not in the test standard)	Number and frequency of tests
Unconfined compressive strength (dry and saturated):		>	>
- Intact rock core specimens	ASTM D2938	>	>
- Dimension stone	ASTM C170	>	>
Surface absorption rate	ASTM C97	0.4% maximum	>
Porosity	ASTM C97	>	>
Wet and Dry density	ASTM C97	2560kg/m <sup>3</sup>	>
Modulus of rupture	ASTM C99	10.34 MN/m <sup>2</sup>	>
Compressive strength	ASTM 0170	131 MN/m <sup>2</sup>	>
Flexural strength	ASTM C880	>	>
Other properties	>	>	>

**Sand and aggregates**

To SS 73.

**260.2.4 PROTOTYPES**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

**Confirmation prototype**

Prepare in agreed positions, confirmation prototype panels of the completed flooring for the Engineer's approval.

Size of panel >

Location >

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

**260.2.5 SUBMISSIONS**

**General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

**Subcontractor**

Submit names and contact details of proposed specialist suppliers and installers.

**Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings of the granite flooring work showing relevant details, including the following, if applicable:

- Layout of all areas of granite paving, including tile dimensions and setting out points.
- Method of bedding or attachment to the base.
- Thickness of beds, underbeds and toppings.
- Touch voltage insulation.
- Reinforcement of underbed.
- Divider strips, type and location.
- Movement joints and jointing material.
- Interfaces with access hatches, gratings, signs etc.
- Skirtings and upstands.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

**260.3 MATERIALS**

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**260.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**260.3.2 GRANITE**

**General**

Provide granite which is

- of the appropriate quality grade for the purpose;
- of uniform quality within that grade;
- selected for the optimum matching of visual properties such as colour, tone and pattern; and
- sound and free from defects liable to affect its strength, appearance, durability or proper functioning under the intended conditions of use.
- obtained from quarry stone extracted in blocks sufficiently large to suit the project requirements, and containing no more than a small degree of microcracking.

**Granite selection**

Use "non-rusting" granites (i.e. granites that do not develop rust spots or patches).

Grading: Select stone of the appropriate quality grade for particular purposes.

Matching: Within each grade, select stone for the optimum matching of visual properties such as colour, tone and pattern.

**Source of stone supply**

Nominated source: >

Alternative source: >

**Water**

Free from matter harmful to granite or to items built into it or in contact with it.

**Cement**

Type: To SS26.

**Aggregates**

Standard: To SS 31.

Sand: Fine aggregate.

**Reinforcement**

Standard: To SS 18.

Protective coating: Galvanized.

**Sealer**

Standard: >

A colourless penetrating sealer intended for brush or roller application and which will prevent the absorption of moisture from the substrate or its transmission through the tile

**Grout**

**Type**

Cement based proprietary grout: Mix with water. Fine sand may be added as a filler in wider joints.

Portland cement based grout: Mix with fine sand. Provide minimum water consistent with workability.

- For joints < 3 mm: 1:2 cement:sand.
- For joints ≥ 3 mm: 1:3 cement:sand.

**Pigments**

Pigments for coloured grout: Provide colourfast fillers compatible with the grout material. For cement-based grouts, provide lime-proof natural or synthetic metallic oxides compatible with cement.

**260.3.3 TOLERANCES**

Maximum deviation from required dimensions.

**Granite slabs**

Face dimensions: ± 1.0mm.

Squareness (difference between diagonals): ≤ 1.5 times the tolerance on a long edge.

Thickness: ± 1.0mm.

Flatness:

- Polished or honed faces: ± 0.5 mm per metre.
- Sawn or sandblasted faces: ± 1.5 mm per metre.
- Flame exfoliated faces: ± 3 mm per metre.
- Fine tooled or hammered faces: ± 2 mm per metre.

Edge straightness: ± 0.5 mm per metre.

Bow or twist: Maximum deviation of stone face from plane: 1.5 mm in 1200 mm.

**Falls and level**

Deviation of the finished floor from its true form: Maximum 1:300.

**Deviation between laid slabs and/or adjacent floor finishes**

Maximum 0.5mm.

**260.3.4 SLIP RESISTANCE**

To Singapore Standard 485: 2001, 'Slip Resistance Classification of Public Pedestrian Surface Materials'. Follow Appendix E modified as below:-

Station area	Description in Standard
External paving	External colonade, walkways and pedestrian crossings
External ramps	External ramps
Station entrances and lifts serving grade	External foyers hotel, office, public building
Internal ramps	Internal ramps
Lift lobbies except those serving grade	Lift lobbies above external entry level
Toilets	Toilet facilities in offices, hotels, shopping centres
Subways and passages	Undercover concourse areas of sports stadium
Concourse	Undercover concourse areas of sports stadium
Platform	Undercover concourse areas of sports stadium
Stair tread	External stair nosings

Test all slip resistance on wet granite

**260.4 EXECUTION**

**260.4.1 SUBSTRATE PREPARATION**

**Cleaning**

Remove deleterious materials which could adversely affect adhesion. Leave the surface dust-free and clean. If removal is not possible, render harmless using remedial treatment.

**Substrates for adhesives**

Ensure that substrates which will receive adhesives are dry, with a moisture content below 6% measured using an accepted moisture meter. Cure concrete substrates before application.

**Preparation for bonding**

General: Prepare the substrate either by roughening the surface after screeding, or by removing the hardened surface to a depth of at least 2 mm. Expose the aggregate and leaving a clean, firm granular surface for the permanent adhesion of the finish.

**260.4.2 TOUCH VOLTAGE INSULATION LAYER**

Where required by the drawings, provide a touch voltage insulation layer to the requirements of the Engineer.

**260.4.3 VAPOUR BARRIER**

**General**

If the substrate slab is subject to damp, provide a vapour barrier consisting of one of the following:

- Asphalt tanking membrane: A proprietary waterproofing membrane at least 5 mm thick, of bituminoid asphalt materials, reinforced with fabric and a layer of corrosion-resistant metal foil, laid generally to AS CA55.
- Butyl rubber membrane: A proprietary waterproofing membrane of black butyl rubber at least 1.5 mm thick, adhesive fixed.

**260.4.4 UNDERBEDS**

Cross refer 'Cementitious Toppings'.

**260.4.5 FALLS AND LEVELS**

**Falls**

Grade granite flooring to even falls where required. Otherwise, lay level.

**Finished levels**

Maintain finished floor levels without step or break at changes of floor finish.

**Substrate levels**

Maintain the minimum thickness of granite underbed and finishes. Limit the ratio of maximum to minimum underbed thickness to 3:2.

**260.4.6 CURING**

**Cementitious surfaces**

Cross refer 'Cementitious Toppings'.

**260.5 GRANITE PAVING**

**260.5.1 GRANITE PAVING SCHEDULE**

<b>Designation</b>	<b>G1</b>	<b>G2</b>	<b>G3</b>
Granite type	>	>	>
Location	>	>	>
Finish	>	>	>
Slip resistance to SS485:2001	>	>	>
Dimensions (l x w x t)	>	>	>
- Touch voltage insulation layer type	>	>	>
- Vapour barrier type	>	>	>
- Sealant type	>	>	>

**260.5.2 PLACING GRANITE**

Dry lay all granite in its final position.

Obtain the Engineers acceptance of the dry lay prior to placing granite.

Replace all granite units rejected by the Engineer in the dry lay until an acceptable mix of granite units has been achieved.

Place all granite in the locations used in the dry layout.

Seal the back and all sides of the granite tiles prior to laying in accordance with the sealer manufacturer's printed instructions.

Do not seal granite surfaces visible in the completed installation unless instructed by the Engineer.

Bed granite on underbed and set in place by tapping or beating with a resilient block to ensure that it is fully bonded and to the correct level.

**260.5.3 FINISHING**

Grouting: allow the granite to set for 24 hours then rinse the surface thoroughly using clean water.

Grout the wet surface with coloured grout to match the granite. Fill all voids.

Grout the wet surface with grout accepted by the Engineer. Fill all voids.

Remove all excess grout from the surface of the granite.

Ensure that the granite does not become stained in the process of grouting.

**Curing**

Protect the completed granite paving from drying out for a minimum of 7 days.

**Protection**

Protect completed floor finish prior to handover.

Prevent items likely to damage the floor finish from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

Relay all granite damaged on site prior to handover.

**260.6 JOINTS**

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**260.6.1 MOVEMENT JOINTS**

**Locations**

Form movement joints through the full depth of the granite and underbed directly over movement joints in the substrate.

**Joint schedule**

Location	Type	Exposed surface finish
>	>	>
>	>	>
>	>	>
>	>	>

**Movement joint filler**

Check existing spec

Select from the following:

- A proprietary preformed strip consisting of a neoprene elastomeric core sandwiched between metal or ebonite plates, with lugs or nibs for mechanical keying to the terrazzo.
- A proprietary sliding joint cover system.

**260.6.2 JOINT ACCESSORIES**

**Divider strips**

General: Finish tiled floors at

Type: >

Material: >

**Weather bars**

General: Provide a corrosion resistant metal weather bar under hinged external doors. Locate under the centres of closed doors.

Type:	>
Material:	>
Finish:>	
Dimensions:	>
Fixing:	>

**260.6.3 DIVISIONS****Requirement**

Divide granite paving into panels with divider strips.

Form junctions with differing floor finishes with a corrosion resistant metal dividing strip.

**Setting divider strips**

Set divider strips accurately and firmly to the required locations and levels, with epoxy mortar.

Fix divider strips to the substrate, with top edge flush with the finished floor. Where changes of floor finish occur at doorways make the junction directly below the closed door.

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**260.7 COMPLETION****260.7.1 COMPLETION****General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Protection**

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect all completed granite flooring on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the granite from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

**Damage**

Replace damaged items with new.

**Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in item 20.5.1 'Warranties' of the General requirements.

Warrant all granite against loss of adhesion between the granite and substrate below.

**Record drawings**

Provide record drawings in accordance with item 20.5.2, Record Drawings, of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

**260.7.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

261 TACTILE PAVING

**261.1 GENERAL**

**261.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

Take into account the recommendations of Conquas 21 'Good Industry Practices- Ceramic Tiling & Marble and Granite Finishes'.

Conform to the requirements of the current edition of the Singapore 'Code on Barrier Free Accessibility in Buildings' unless directed otherwise by the Engineer.

Conform to the details of tactile paving shown on the Authority's standard drawing No. LTA/1261B/ARC/ADF/0001.

**Associated worksections**

Conform to associated worksections as follows:

- Adhesives, Sealants and Fastenings.
- Metals and Prefinishes.
- Cementitious toppings.
- Granite Flooring.
- Tiling.

**261.1.2 INTERPRETATION**

**General**

Inclusion: An irregular and sudden change in the colour, texture, or geological constituents of granite.

Substrate: The actual surface to which flooring is bedded or attached.

Dry Lay: The layout of flooring as defined on the drawings prior to placing for the purposes of verifying the colour, tone and texture of individual granite units.

Granite Finishes: Cross refer, 'Granite Flooring'.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**261.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**261.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

Follow the general tactile paving layout provided by the Engineer ensuring that the tactile paving is integrated into any existing floor patterns. Ensure the integrity of the pattern is maintained without detriment to the tactile layout.

**261.2 QUALITY**

**261.2.1 INSPECTION**

**General**

Tactile paving shall be inspected from a minimum distance of 1400 mm under the specified permanent artificial luminance or 500 lux, whichever is greater.

Granite containing an inclusion which cannot be covered in its entirety by a disk 20mm in diameter shall be rejected.

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- Proposed mason's yard.
- Materials stored at the yard or on site.
- Setting out.

**Hold points**

- Completion of prototype.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**261.2.2 SAMPLES**

**General**

Submit samples of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

**Tactile paving samples**

For each type and grade of ceramic and granite tactile paving submit:

Both decision and direction paving.

- 300 x 300 mm square.
- showing the expected range of variation of colour, pattern, texture, and surface finish in stone to be supplied.

**Metal studs**

**Decision and direction studs**

Ceramic and/or granite paving incorporating decision and directional studs.

- 300 x 300mm square.

**Associated materials and products**

- Adhesive used to fix studs in position.

No. of samples: 3.

**261.2.3 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Pull out test to show studs adherence to the base material.

**Granite tests schedule**

Cross refer: 'Granite Flooring'.

**261.2.4 PROTOTYPES**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

**Confirmation prototype**

Provide confirmation prototype comprising:-

Minimum 1.8m length of 'directional' tile.

'Decision' square, minimum 600mm square.

At least one change of direction.

>

Location: As agreed with the Engineer.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

**261.2.5 SUBMISSIONS**

**General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

**Subcontractor**

Submit names and contact details of proposed specialist suppliers and installers.

**Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings of the tactile paving work showing relevant details, including the following, if applicable:

- Layout of all areas of tactile paving, including tile dimensions and setting out points.
- Method of bedding or attachment to the base.
- Thickness of beds, underbeds and toppings.
- Touch voltage insulation.
- Reinforcement of underbed.
- Divider strips, type and location.
- Movement joints and jointing material.
- Interfaces with access hatches, gratings, signs etc.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of tactile paving meets all of the Authority's equipotential bonding requirements.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statements**

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

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**261.3 MATERIALS**

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**261.3.1 GENERAL**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**261.3.2 GRANITE**

General: Provide granite which complies with the requirements of the 'Granite Flooring' section of this specification.

Colour:

Base granite: to match adjacent granite flooring.

Raised portion of granite tactile tiles: either nominally black, or nominally white.

Contrast to the base granite: minimum 30% luminance.

Finish:

Base granite: to match adjacent granite flooring.

Top surface of all raised areas: flamed.

45° bevelled surface surrounding raised areas: polished.

Ensure studs forming the raised portion of granite tactile paving penetrate the entire thickness of the paving and are secured in place to the acceptance of the Engineer.

Maximum joint width between the base and raised portions of granite tactile tiles: 0.5mm.

Ensure adhesive penetrates the entire depth of the joint between the base and raised portions.

Remove all traces of adhesive from the finished top surface of the completed tactile paving.

Reinforcement applied to the rear surface shall be to the acceptance of the Engineer.

**261.3.3 HOMOGENEOUS UNGLAZED CERAMIC TACTILE TILES**

Provide homogeneous unglazed ceramic tactile tiles complying with the following:-

Hardness: minimum 6 mohs per DIN 18155.

Abrasion resistance: 6/cms<sup>3</sup>/50 cm<sup>2</sup> maximum per DIN 52108.

Contrast to the surrounding surface: minimum 30% luminance.

**261.3.4 METAL STUDS**

Type: Homogeneous with integral ribbed shanks.

Material: Stainless steel.

Grade: 316 to BS EN 10088.

Yield strength: 21kg/mm<sup>2</sup>.

## 261 TACTILE PAVING

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Tensile strength	53kg/ mm <sup>2</sup> .
Elongation	40%.
Hardness (H <sub>R</sub> B)	90.
Hardness (H <sub>V</sub> )	200 below.
Finish:	
Top surface of all raised areas:	textured comply with SS485. Cross refer, 'Granite Flooring'.
45° bevelled surface surrounding raised areas:	mirror polished.

Allow for overspill of adhesive when studs are fixed into holes drilled in existing granite flooring.

### **Adhesive**

General: Cross refer Adhesives, Sealants and Fasteners.

Type:	synthetic resin.
Cure time:	to allow the strips and studs to take pedestrian traffic during the entire revenue period immediately after they are fixed in place.

### **Water**

Free from matter harmful to granite or to items built into it or in contact with it.

### **Cement**

Type to AS 3972: GP.

### **Aggregates**

Standard: To AS 2758.1.

Sand: Fine aggregate.

### **Reinforcement**

Standard: To AS 3600.

Protective coating: Galvanized.

### **Sealer**

A colourless penetrating sealer intended for brush or roller application and which will prevent the absorption of moisture from the substrate or its transmission through the tile.

### **261.3.5 GROUT**

#### **Type**

Cement based proprietary grout: Mix with water. Fine sand may be added as a filler in wider joints.

Portland cement based grout: Mix with fine sand. Provide minimum water consistent with workability.

- For joints < 3 mm: 1:2 cement:sand.
- For joints ≥ 3 mm: 1:3 cement:sand.

#### **Pigments**

Pigments for coloured grout: Provide colourfast fillers compatible with the grout material. For cement-based grouts, provide lime-proof natural or synthetic metallic oxides compatible with cement.

## **261.4 EXECUTION**

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### **261.4.1 GENERAL**

Do not store combustible materials in any area of the works accessible to the public.

Ensure the safety of the public and transport staff using existing facilities.

Minimise disruption to passenger flow and transport operations.

Where work is carried out in Railway Engineering Hours, ensure that all materials and equipment are cleared away and that the worksite is in a secure and safe state prior to the start of railway operations.

### **261.4.2 SUBSTRATE**

#### **Substrate preparation**

General: Cross refer: 'Granite flooring' and/or 'Tiling' as appropriate.

#### **Touch voltage insulation layer**

General: Cross refer: 'Granite flooring' and/or 'Tiling' as appropriate.

#### **Vapour barrier**

General: Cross refer: 'Granite flooring' and/or 'Tiling' as appropriate.

#### **Underbeds**

Cross refer 'Cementitious Toppings' and/or 'Tiling' as appropriate.

**261.4.3 FALLS AND LEVELS**

**Falls**

Grade tactile paving to even falls where required. Otherwise, lay level.

**Finished levels**

The base of all tactile flooring shall finish flush with adjacent flooring.

**261.4.4 CURING**

**Cementitious surfaces**

Cross refer 'Cementitious Toppings'.

**261.4.5 TACTILE PAVING SCHEDULE**

**Tactile Pavings Schedule**

<b>Designation</b>	<b>TP1</b>	<b>TP2</b>	<b>TP3</b>
Type	>	>	>
Location	>	>	>
Finish	>	>	>

**261.4.6 PLACING TACTILE PAVING**

**Granite**

Cross refer: 'Granite Flooring'.

**Homogeneous tiling**

Cross refer: 'Tiling'.

**Metal studs**

Accurately locate the holes required to take metal studs and strips.

Tolerance on location of studs and strips: +/- 0.5mm.

Ensure holes in the existing floor finish are drilled to suit the length of the stud/strip shank. Prevent overdrilling.

Ensure the integrity of any touch voltage protection existing below tactile paving areas.

Submit proposals to reinstate any damage to this during the course of the works.

**261.4.7 FINISHING**

**Granite**

Cross refer: 'Granite Flooring'.

**Homogeneous tiling**

Cross refer: 'Tiling'.

**Curing**

Protect the completed granite paving from drying out for a minimum of 7 days.

**261.4.8 JOINTS**

**Movement joint locations**

Where required, movement joints in the surrounding flooring shall extend through the line of the tactile paving.

**Movement joint filler**

Cross refer: 'Granite Flooring' and/or 'Tiling' as appropriate.

**Joint Accessories**

Cross refer: 'Granite Flooring' and/or 'Tiling' as appropriate.

**Divisions**

Cross refer: 'Granite Flooring' and/or 'Tiling' as appropriate.

**261.5 COMPLETION**

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**261.5.1 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Protection**

Protect the surrounding floor finishes during the installation of stainless steel studs.

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect all completed tactile paving on site from damage until handover.

## **261 TACTILE PAVING**

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Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the tactile paving from finding their way between the protection and the paving finish below. Check and remove all such items regularly.

### **Public Access**

For work in operational areas, ensure that all construction materials, dirt, dust, and refuse, have been removed and the area left safe to the satisfaction of the engineer, prior to the public being granted access to the paving.

### **Damage**

Replace damaged items with new.

### **Warranties**

Warrant the materials and workmanship as part of the flooring using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all granite and tile areas against loss of adhesion with the substrate below.

Warrant all stainless steel studs against becoming loose.

### **Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

### **Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

### **261.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

270 ACCESS FLOORS

**270.1 GENERAL**

**270.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows: Adhesives, Sealants and Fasteners.  
Metals and Prefinishes.  
Resilient Floor Finishes.

**270.1.2 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**270.1.3 STANDARDS**

**General**

Access floors: To AS 4154.

**270.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**270.1.5 PERFORMANCE**

**Use**

Area function: Passenger Service Centre (PSC).  
Station Master's Room (SMR).  
Signal Equipment / PSD Room.  
Operations Control Room.  
Operational Sub-Centre.  
>

Intended use of system: A readily accessible underfloor space suitable for running electrical, mechanical, computer or communication services and the like.

**Stability**

General: Provide a completed floor system which is rigid, free from vibration, creep, squeaking, and the like, which has a smooth and uniform finished surface, and which will maintain these conditions when sufficient panels have been removed for normal access.

Access for maintenance: All panels to be capable of removal using special panel lifting tools provided for the purpose.

**Air tightness of air plenums**

General: Provide an edge to edge fit of the panels which is air tight within the following limits:

- Maximum: >
- Minimum: >

**Dimensional tolerances of installations**

Horizontal dimensions (mm):

- Maximum deviation from true floor grid: 3mm.

**Dimensional tolerances of tiles**

Squareness: +/- 0.51mm for 600x 600mm tiles to AS 4155.3.

**Fire rating**

Tiles and pedestals: Non-combustible as defined by BS 476: Part 4.

Floor finish: To comply with the requirements of the "Standard for Fire Safety in Rapid Transit Systems".

**Structural loading**

Superimposed loads: Provide an access floor system which is capable of carrying a minimum of 1.5kN/m<sup>2</sup> without failure.

## 270.2 QUALITY

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### 270.2.1 INSPECTION

#### Witness points

Give sufficient notice so that inspection may be made of the following:

- Pedestal setting out prior to the installation of services.
- Completion of Subfloor sealant.
- Subfloor services installed before access floor installation.
- Floor panels placed before surface covering, if not integral.

#### Hold points

- Completion of prototype.
- >

#### Corrosion

Cross refer: General Requirements Clause 20.4.1.

### 270.2.2 TESTS

#### General

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

#### Fire rating

Compliance with the fire rating : Required.

#### Electrical resistance of computer access floors

Testing to AS 4155.6: Required.

#### Structure

Compliance with structural loading requirements: Required.

#### Air leakage of air plenums

Testing: Required.

Test pressure (Pa): >

### 270.2.3 SAMPLES

#### General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Panel complete with all applied finishes.
- Panel to demonstrate treatment of cut edge.
- Panel to demonstrate treatment of all cut-outs for service outlets etc.
- Stringer.
- Pedestal.
- Applied skirtings intended to conceal edges of cut panels.

Obtain and submit samples of System Wide Contractor's components for installation in the access floor.

Size of samples

- Sample panels: minimum 600mm sq.
- Linear samples : minimum 600mm.

No. of samples: 3.

### 270.2.4 PROTOTYPES

#### General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

#### Confirmation Prototype

Description: Erect a confirmation prototype of the access floor, including at least one example of each of the following components:

- Panel complete with all applied finishes.
- Panel to demonstrate treatment of cut edge.
- Panel to demonstrate treatment of all cut-outs for service outlets etc.
- Stringer.
- Pedestal.

- Applied skirtings intended to conceal edges of cut panels.
- >

Demonstrate junction between cut tile and wall.

Location and extent: As agreed on site with the Engineer.

Incorporate:

- System Wide Contractor's components as identified by the Engineer.
- >

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

### **270.2.5 SUBMISSIONS**

#### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### **Subcontractors**

Submit names and contact details of proposed manufacturers and installers.

#### **Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not be limited to, the following information:

- Floor plan layout showing grid modules, interruptions to grid, location of stringers, panels requiring drilling or cut-out for services, location of non-standard panels (if any), grilles, registers, and perforated panels.
- Stringer section showing material and dimensions.
- Panel section showing construction, materials, dimensions and finishes.
- Pedestals showing material, dimensions, limit of vertical adjustment, method of locking, methods of attachment to floor and to stringers or panels.
- Edge details and junctions with adjoining work.
- Location and size of cut tiles.
- Details of all service outlet points.

No. of copies to be submitted: As Particular Specification.

#### **Engineering endorsement**

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

- compliance with all relevant Singapore legislation and regulations.

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of the access floor meets the requirements of Singapore Standard CP5.

#### **Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

#### **Tests**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

#### **Method Statement**

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

**270.3 COMPONENTS**

**270.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**270.3.2 PEDESTALS**

**Description**

Material:	Metal: corrosion resistant. >
Finish:	To Engineers acceptance. >
Head to panel connection:	Lugs. >
Floor fixing:	Adhesive accepted by the Engineer. >

**Adjustable floors**

General: Incorporate in each unit a means of height adjustment within the limits specified, without requiring rotation of the head, and a means of locking the adjustment to prevent accidental displacement.

Clear height:	>
Height adjustment limits (mm):	
- Maximum extension:	To Engineer's acceptance.
- Minimum extension:	To Engineer's acceptance.

**Fire rating**

Non-combustible, made using materials with melting point  $\geq 350^{\circ}\text{C}$ .

**Location**

Under every corner of every panel.

**270.3.3 STRINGERS**

**Description**

Material:	Metal: corrosion resistant. >
Finish:	To Engineer's acceptance.
Form:	To Engineer's acceptance.
Spanning:	In both directions between pedestals.
Connection to pedestal heads:	Mechanically interlocked.

**Fire rating**

Non-combustible, made using materials with melting point  $\geq 350^{\circ}\text{C}$ .

**270.3.4 PANELS**

**Description**

Form:	Pressed steel top and bottom pans.
Material:	Zinc-coated minimum 0.6mm steel.
Core:	Foamed lightweight concrete.
Edge strips:	To the acceptance of the Engineer.
Finish:	Factory applied corrosion resistant coating to the acceptance of the Engineer.

**Dimensions**

Coordinating size:	600 x 600 mm.
Minimum size of cut tiles (mm):	Show on shop drawings and obtain Engineer's acceptance.
Overall thickness (mm):	To be accepted by the Engineer.

Maximum weight: 18 kg.

**Cut outs**

General: Provide cut outs for cable access and air grilles as necessary.

Edge cut outs: Provide stringer or pedestal, or both, support.

Omitted panels: Permanently omitted panels are not permitted.

**Labelling**

Non-standard panels: Identify for relocation purposes.

**270.3.5 ACCESSORIES**

**Ramps**

Slope: In accordance with the requirements of the Code on Barrier Free Access.

Load characteristics: Match floor panels.

**Stairs**

>

**Railings**

>

**Vertical edging panels**

>

**Skirting trims**

>

**Services**

Electrical outlets: To be supplied by system wide contractor.

Data outlets: To be supplied by system wide contractor.

Telephone outlets: To be supplied by system wide contractor.

Combined services boxes: To be supplied by system wide contractor.

Cable access grommets: To be supplied by system wide contractor.

**Air grilles to air plenums**

Conductive air grilles: Insulate from electrical earth.

Non-conductive air grilles: Do not expose metal screws.

Air flow rating:

>

Adjustability:

>

Air plenum dividers

>

**Lifting devices**

Number required:

4

Marking: If panels must not be lifted from the side, mark lifting devices "Lift panel vertically at centre".

**270.4 FINISHES**

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**270.4.1 FINISHES**

**General**

Steel elements: Galvanized.

- Coating class for sheet: At least Z350.

**Panels**

Integral floor finishes: Required.

- Material:

>

- Adhesive:

>

- Surface treatment: Preserve conductive properties of floor surface.

Underside facing: Non-combustible.

**Underfloor**

Corrosion-resistant finish to metal understructure.

**Sealing**

Perimeter gap sealing method:

>

Vermin sealing of underfloor space: Required.

**Subfloor surface treatment**

Seal concrete/screed surface: Cross Refer Cementitious Toppings.

## 270.5 EXECUTION

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### 270.5.1 INSTALLATION

#### Protection

Provide temporary protection from surface damage and concentrated loads, during installation of access floor and of items which it supports.

#### Site cutting

Trim and seal edges of all cut panels and support on special wall or corner pedestal assemblies as appropriate and in accordance with the manufacturer's recommendations.

#### Equipotential bonding

Required.

## 270.6 COMPLETION

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### 270.6.1 COMPLETION

#### General

Cross refer: Item 20.5 'Completion' of the General Requirements.

#### Operation and Maintenance Manual

General: On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Contents: Include the following information:

- Limitation on maximum and minimum height of floor, cross-bracings, stringers or additional pedestal fixings required above a particular height.
- Limitation on adjustability.
- Installed mass of system per square metre.
- Maximum number and positions of panels that may be temporarily removed during servicing without endangering safety of floor system.
- Method of cleaning of floor covering with particular reference to adhesives and panel substrate, wet mopping, and use of waxes and floor polishes.
- Equipotential bonding method.

#### Protection

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect all completed cladding on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

#### Damage

Replace damaged elements with new.

#### Cleaning

General: Clean access floor thoroughly, before delivery of items which it supports.

Air plenum: Vacuum underfloor area so it is free of dust, metal filings and the like.

#### Warranties

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

#### Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

### 270.6.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>280 PLASTERING</b>
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**280.1 GENERAL**

**280.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows:

- Waterproofing.
- Brick and Block Construction.
- Painting.
- Heavy Duty Galvanized Coatings.
- Metals and Prefinishes.
- Adhesives Sealants and Fasteners.

**280.1.2 INTERPRETATION**

**Definitions**

The terms “plaster” and “plastering” include the terms “render” and “rendering”, except where the context otherwise requires.

**280.1.3 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**280.1.4 STANDARD**

**General**

Plastering: To SS CP 56.

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**280.2 QUALITY**

**280.2.1 INSPECTION**

**General**

Completed plastering shall be inspected from a minimum distance of 1800 mm under the specified permanent artificial luminance or 400 lux, whichever is greater.

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Background immediately before plastering.
- Each completed coat before the application of subsequent coats.
- Completed work before decorative coating.

**Hold points**

- Completion of Prototypes.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**280.2.2 TESTS**

Carry out all tests in accordance with Section 20.3.2, ‘Tests’ of the General Requirements.

**Sand**

To SS 73.

**280.2.3 SAMPLES**

Submit samples of each of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

- Metal lath, including lath fixings.
- All plastering accessories.
- A 2 kg sample of sand.

**280.2.4 PROTOTYPES**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

**Confirmation prototype**

Prepare in agreed positions, confirmation prototype panels of each plaster finish for the Engineer's approval.

Plaster finish	Panel size	Number of panels	Location
>	>	>	>
>	>	>	>
>	>	>	>

All prototypes shall incorporate:

- Horizontal and vertical joints.
- Corner and edge details as directed.
- Interfaces as directed.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

**280.2.5 SUBMISSIONS**

**General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

**Subcontractors**

Submit name and contact details of proposed specialist plastering subcontractor(s).

**Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not be limited to, the following information:

- Plans and sections showing the location and type of all plastering.
- Location and details of all required joints and interfaces.
- Allowances for movement.

No. of copies to be submitted: As Particular Specification.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

**280.3 MATERIALS AND COMPONENTS**

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**280.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

### 280.3.2 MATERIALS AND COMPONENTS

#### Plaster materials

Cement type to SS26.

Off-white cement: Iron salts content  $\leq 2.5\%$ .

Lime: To AS 1672.1.

Sand: To AS CA27, graded to Table 1 of the Appendix.

Pigments: Manufactured either synthetically or from naturally occurring mineral ores, resistant to lime bloom and efflorescence.

- Standard: To BS EN 12878.

Pigment proportions:

-  $\leq 5\%$  by weight of cement.

- Follow manufacturer's recommendations.

Gypsum plaster: To AS 2592.

Admixtures: Use proprietary products. Submit all proposed admixtures for the Engineer's acceptance prior to the start of work on site.

Bonding Agents: Use proprietary products. Submit all proposed bonding agents for the Engineer's acceptance prior to the start of work on site.

#### Metal lath

Metallic coated sheet steel expanded to a mesh by slitting and stretching: Coating class Z275 (minimum).

Stainless steel expanded to a mesh by slitting and stretching.

Self-furring type: Metal lath with staggered indentations which hold the body of the sheet 10 mm clear of the substrate.

Ribbed type: Metal lath with integral ribs designed to increase the strength of the lath and the allowable span between supports.

Base metal thickness (mm):

0.42mm minimum.

0.65mm minimum for fire resistant conditions.

#### Lime putty mixes

Make a coarse mix of lime putty and sand 24 hours before use. Prevent from drying out.

#### Gauged mixes

If required to improve workability, gauge mixes specified to contain only cement and sand by the addition of lime up to 25% of the cement content (i.e. not as a substitute for the cement).

#### Autoclaved aerated concrete walls

Provide a proprietary render or premixed plaster recommended by the wall system manufacturer.

## 280.4 EXECUTION

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### 280.4.1 SUBSTRATE

#### Correction of substrate

Before plastering make good any defects in the substrate. Hack off excessive projections. Fill voids and hollows with a mix not stronger than the substrate nor weaker than the first coat.

#### Untrue substrate

One coat work: If the substrate is not sufficiently true to comply with the thickness limits for one coat, or has excessively uneven suction resulting from variations in the composition of the substrate, carry out the work in two coats.

Where the substrate is out of tolerance and it is impossible to correct the deviation through changes to the substrate, provide a method statement to show how plaster thickness will be amended and/or reinforced to deal with the deviation. Do not start work until the method statement has been accepted by the Engineer.

#### Cleaning

Remove deleterious and loose material and leave the surface clean and dust free.

#### Embedded items

Ensure that all embedded items are sheathed to permit movement. If ungalvanized steel items are to be embedded in gypsum plaster, provide rust protection treatment not inferior to prime painting with zinc rich primer.

**Chases**

If chases or recesses are more than 50 mm wide, cover with metal lath extending at least 75 mm beyond each side of the recess.

**Suction**

Control suction by dampening if necessary. Avoid over-wetting.

**Dense concrete**

If not sufficiently rough to provide a mechanical key, roughen by scabbling or the like to remove 3 mm of the surface and expose the aggregate; then dash coat. If scabbling and dash coating does not provide a good key for external render, cover with expanded metal lath.

**Brickwork**

If not rough-jointed, rake out joints 5 mm deep. If raking out is impracticable, hack at close intervals to roughen the surface, or cover with expanded metal lath.

**Concrete blockwork**

Apply a dash coat or a proprietary bonding agent.

**Metal backgrounds**

Fix metal lath to provide a key.

**Previously painted surfaces**

Remove paint, hack at close intervals, or cover with expanded metal lath.

**Calcium silicate brickwork**

Select preparation from the following:

- Apply bonding agent and dash coat.
- Provide a proprietary water-retentive additive in lieu of lime in the plaster mix.

**Dash coat**

Application: Mix to the consistency of a thick slurry and forcibly dash on to the background to give a roughcast coating 3 – 5 mm thick.

Curing: Allow the dash coat to harden in damp conditions and protect it from drying out before applying the next coat.

**Fixing metal lath**

Generally: Provide the necessary accessories. Run the long way of the mesh across supports. In vertical applications slope the strands inwards and downwards away from the background face. Lap ends at least 20 mm and sides at least 10 mm. Tie laps with 1.25 mm galvanized wire every 150 mm. Do not finish edges of sheets at corners but bend around.

Fixing: Fix lath to the background at edges and at supports with fixings approved by the lath manufacturer, spaced at 150 mm maximum centres. Place fixings in the mesh corners so that the heads cover 2 strands.

Fixing to masonry: Use non-corrosive masonry anchors, or masonry or concrete nails. Do not provide explosive powered fastenings.

Fixing to metal studs or furring: Use non-corrosive self-tapping screws, or galvanized wire.

**280.4.2 PLASTERING**

**Two or three coat set plaster**

Undercoats: 1:1:6 cement:lime putty:sand.

Setting coat: 1:1 lime putty:gypsum plaster.

**Hard-wall gypsum plaster**

Undercoat: 2:5 gypsum plaster:sand.

- Finish: Leave off the rule.

Setting coat: 3:1 gypsum plaster:lime.

Thickness: Maximum 4 mm.

**White-set plaster**

General: Provide 3:1 gypsum plaster:lime putty, applied as a skim coat direct to the substrate.

Thickness: Maximum 4 mm.

**Cement render**

Proportions (cement:lime:sand):

- Clay brick, concrete: 4:1:16.
- Concrete block: 1:0:6.
- Calcium silicate brick: 3:2:16.

**Waterproof render**

General: Provide cement based render with proprietary waterproofing admixture.

Protection: Avoid puncturing or plugging waterproof render. Where it is necessary to drill through waterproof render for installation of services or fixings, restore the barrier by sealing around the penetrations.

**Vermiculite plaster**

Gypsum plaster and expanded vermiculite aggregate. Apply using power spray equipment.

**Self coloured render**

Colour the finishing coat to match the approved sample panel. Provide white cement, white sand, and pigments. Mix the pigments with the white cement before adding sand and water. Steel trowel finish.

**Plastering schedule**

	PT1	PT2	PT3
Location	>	>	>
Coating type	>	>	>
Thickness (mm)	>	>	>
Proportions	>	>	>
Number of coats	>	>	>
Admixtures	>	>	>
Pigments	>	>	>
Surface finish	>	>	>
Metal lath:	>	>	>
- Location			

**Thickness limits**

One coat work: 12 – 15 mm.

Multi-coat work:

- First coat: 9 – 15 mm.
- Floating coat (if any): 6 – 9 mm.
- Finishing coat (except setting coats): 6 – 9 mm.
- Setting coat: 2 – 3 mm.

**Tolerances**

Finish plane surfaces within a tolerance of 3 mm in 1.8 m, determined by a 1.8 m straight edge placed anywhere in any direction. Finish curved surfaces within equivalent tolerances. Deviation shall not occur suddenly with the rate of departure not greater than 1.5mm for each 500mm in distance from any point of contact along the straight edge.

Finish corners, angles, and edges, within a tolerance of 1.5 mm in 1.8 m, determined by a 1.8 m straight edge.

Utilise appropriate beads and accessories to achieve the tolerance limits

**Proportioning**

Apply successive coats no stronger (i.e. no richer in cement) than the substrate or undercoat to which they are applied.

**Hidden surfaces**

Insides of cupboards, if any, are included in the plaster finish required to any area.

**Incidental work**

Return plastering into reveals, beads, sills, recesses and niches. Plaster faces, ends, and soffits of projections in the substrate, such as string courses, sills, pilasters and corbels. Run throating on soffits of external projections neatly finished. Trim around openings.

**Joining up**

If joining up is unavoidable in a large area of work, make joints invisible in the finished work.

**Cement based undercoats**

Before applying the next coat, allow the undercoat to dry out, dust down, and, if necessary, dampen to give correct suction.

**Keying**

General: Press plaster through the apertures of metal lath, and wings of casing beads.

Keying undercoats: In multi coat work, scratch comb each undercoat in two directions when it has stiffened.

**Surface finishes**

Wood float: Provide an even texture by wood floating the finishing coat.

Fine sand textured finish: Provide an even surface by wood float and finish with a plastic foam float to a fine sand textured finish.

Carborundum stone finish: Provide a fine sand textured finish. When the wall is set, rub down with a fine carborundum stone to a smooth finish free from sand.

Steel trowel: Provide a smooth dense surface free from texture and free from shrinkage cracks, but not glass-like.

**Curing**

Cement-based work: Prevent rapid or uneven drying out.

Gypsum-based work: Keep dry after work has set.

**280.4.3 JOINTS**

**Movement joints**

General: Provide movement joints in the finish which coincide with movement joints in the substrate. Ensure that the substrate joint is filled with the specified jointing material, and is not bridged during plastering.

Plastering on metal lath: Provide movement joints to divide the plastering area into rectangular panels not exceeding 16m<sup>2</sup>.

Location: As identified on shop drawings.

Depth: Extend the joint right through the plaster to the substrate.

Width: 3 mm, or the same width as the substrate joint, whichever is greater.

Joint finish: >

Joint filling (joints more than 3 mm wide): Fill with a resilient sealant.

**V-joints**

Provide V-joints, cut right through the plaster to the substrate, at the following locations:

- Junctions between different substrate materials.
- Abutments with other finishes.
- Abutments with metal door frames.

**280.4.4 TRIM**

**Terminations**

Re-entrant corners: Finish square.

Salient angles: Finish up to a 1.6 mm radius corner bead.

Edge trim: Provide the necessary corner beads, casing beads and stop beads.

- Material: Purpose-made metallic-coated steel sections.
- Fixing: Nail to structure at 300 mm centres. Wire to metal lath.

**Edge trim schedule**

	ET1	ET2	ET3
Location	>	>	>
Type	>	>	>
Material	>	>	>

**Cement rendered skirtings**

General: Provide the mix proportions specified for one coat cement render and bring the surface to a true uniform finish using a steel trowel. Form a V joint at junctions with other finishes.

Location: >

Height (mm):

- Above finished floors: >
- Above line of stair nosings: >

Projection: >

Salient edges: >

Junction with floor: >

**Finish without cornice**

General: Produce a square re-entrant corner between ceiling and wall finishes.

**280.4.5 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

**280.5 COMPLETION**

**280.5.1 General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

**Protection**

Protect the completed plaster against all forms of damage until the completion of the works.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

**Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all plaster against loss of adhesion with the substrate below.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**280.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

**281 GLASS REINFORCED GYPSUM (GRG)**

**281.1 GENERAL**

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**281.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows: Adhesives, Sealants and Fasteners.

>

**281.1.2 CIVIL DEFENCE (CD) REQUIREMENTS**

**General**

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of fixing methods for CD stations.

**281.1.3 INTERPRETATION**

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**281.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**281.2 QUALITY**

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**281.2.1 PERFORMANCE CRITERIA**

**Minimum requirements**

Provide glass reinforced gypsum panels which:

- Are constant in size, profile, and shape within the limits of tolerance given below.
- Do not hold static charges.
- Do not sustain fungal growth.
- Will not lose strength due to the absorption of atmospheric humidity.
- Are non combustible in accordance with BS 476: Part 4: 1970.
- Will not significantly attenuate the signal levels required for the acceptable operation of the LCX cable installation.
- Will resist a point load of 75kg placed anywhere on the surface of the panel.

**281.2.2 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- The manufacturer's production facilities.
- The production of moulds.
- Panel production.
- The installation of all supporting bracketry.
- All items which will be concealed in the completed installation.
- All joints prior to sealing.

**Hold points**

- Completion of confirmation prototypes

**Corrosion**

Cross refer: General Requirements Clause 4.1.

### **281.2.3 TESTS**

#### **General**

Carry out all tests in accordance with Section 20.3.2 'Tests' of the General Requirements.

Where required by the Engineer submit all samples required by the system wide contractors to allow them to test the level of attenuation to the LCX signals.

Submit full size panels and bracketry for CD shock tests.

Submit test reports confirming.

- The fire performance of a panel.

### **281.2.4 SAMPLES**

#### **General**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

No. of samples: 3.

- Panel finish including edge finishes.
- Junction between panels.
- All fixings and accessories.

Size of samples: 300mm square.

No. of samples: 3.

Label each sample giving the brand name and product name, manufacturer's code reference and date of manufacture.

### **281.2.5 PROTOTYPES**

#### **General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

#### **Confirmation Prototype**

Location: As directed by the Engineer.

Size of prototype: Complete panel, or as directed by the Engineer.

Retain accepted prototypes for the duration of the works.

Incorporate accepted prototypes into the work as directed by the Engineer.

### **281.2.6 SUBMISSIONS**

#### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### **Subcontractor**

Submit name and contact details of proposed suppliers and specialist installer(s).

#### **Manufacture**

Submit details of the panel manufacturer including, but not limited to the following:

- level of experience in panel manufacture.
- number of employees.
- name and address of similar projects completed over the past 5 years.

#### **Shop drawings**

General: General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:

- Plans, section and elevations incorporating a numbering system which allows each individual panel to be correctly orientated and identified.
- Plans, section and elevations of all GRG areas showing the supporting structure and layout of all panels and components.
- Setting out point.
- the supporting bracketry .
- individual panel drawings showing all panel dimensions and any reinforcement built into the panel.
- Method of erection.
- Connection to, or junction with, adjoining structures and materials, as applicable.
- Joint details between adjacent panels.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Test Reports**

Submit copies of current test reports, and certification, including drawings of tested details, in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

- General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

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**281.3 MATERIALS AND COMPONENTS**

**281.3.1 MATERIALS AND COMPONENTS**

**General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**GRG**

Standard: ASTM C 1355c – '96 except for the following.

- Paragraph 4.1.2 - do not use chopped glass fibre strands.
- Paragraph 4.1.3 - adjust the water/cement ratio to create minimum porosity and maximum density.
- Paragraph 5.2.1.6 – cure at a temperature not greater than 35°C until 92% of the free moisture has dried from the cast.

**Additives:**

Submit all intended additives to the Engineer for acceptance prior to the start of manufacture.

**Release Agents:**

Do not use release agents likely to have an adverse effect on the surface of the panels.

**Metallic Reinforcement**

Do not use metallic reinforcement without demonstrating that it will have no adverse effect on the passage of LCX signals.

**Ironmongery**

Material: Stainless steel, grade 316.

Fasteners.

Cross Refer: Adhesives Sealants and Fasteners.

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**281.4 TOLERANCES**

**Standard**

Part 6 of ASTM C 1381-97.

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**281.5 SURFACE DEFECTS**

Unfinished panels exhibiting pinholes or other surface damage visible from a distance of 1.5m under an illumination of 500 lux will not be acceptable

**281.6 EXECUTION**

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**281.6.1 INSTALLATION**

- Store all units level on a clean dry surface in an area protected from the weather and in accordance with the panel manufacturer's written recommendations.
- Do not cut panels. Cast all panels to the sizes required.
- Provide overhead panels with a safety mechanism to prevent the panel falling to the ground in the event of a failure in the panel fixings.
- Install panels to allow for final adjustment to maintain a true line and level.
- Joint panels as recommended by the manufacturer to render the joint invisible to the eye on completion.

General: Keep the installation free of debris and loose material during construction, and leave it unobstructed on completion.

**Thermal movement**

Provide for thermal movement to suit the climatic conditions in Singapore including the provision of movement joints and fastenings.

**281.7 COMPLETION**

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**281.7.1 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Include:

- A completed certification document endorsed by the manufacturer confirming that all GRG has been correctly installed and is in compliance with this specification.

**Protection**

Protect all GRG on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works remove all materials used as a means of protection.

**Damage**

Replace damaged items with new.

**Warranties**

Warrant the materials and workmanship as part of the overall assembly in which the GRG is employed using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**281.7.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>290 TILING</b>
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**290.1 GENERAL**

**290.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

Take into account the recommendations of Conquas 21 “Good Industry Practices- Ceramic Tiling & Marble and Granite Finishes”.

**Associated worksections**

Conform to associated worksections as follows:

- Adhesives, Sealants and Fastenings .
- Cementitious Toppings.
- Gratings.
- Waterproofing.

>

**290.1.2 INTERPRETATION**

**Definitions**

Substrate: The building element to which the tiles are to be bedded.

Underlay: An intermediate layer (e.g. render, screed or sheeting) applied to the substrate to provide a suitable surface for tile bedding.

Separation layer: A membrane laid on the substrate beneath the bedded finish to prevent the two elements from adhering to each other.

Waterproof Membrane: A membrane laid on the substrate beneath the underlay to prevent dampness penetrating across from one side of the membrane to the other. Cross refer: Waterproofing.

Isolation Membrane: A membrane laid on the substrate beneath the underlay to isolate the floor finish from stray electrical currents.

Authority’s Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**290.1.3 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**290.2 QUALITY**

**290.2.1 INSPECTION**

**General**

Tiling shall be inspected from a minimum distance of 1400 mm under the specified permanent artificial luminance or 500 lux, whichever is greater.

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Initial and trial set-outs.
- Items to be embedded, including reinforcement, dividing strips, in place.
- Joints formed and ready for filling with joint filler.
- Completion of tiling.

**Hold points**

Substrate immediately before tiling.

Location of setting out point.

>

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**290.2.2 TESTS**

Carry out all tests in accordance with Section 20.3.2, ‘Tests’ of the General Requirements.

**Sand**

To SS 73.

### 290.2.3 SAMPLES

#### General

General: Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements .

- Tiles to show the extent of variation in colour ,pattern, or texture.
- All accessories.
- Grout to show finished colour.

### 290.2.4 PROTOTYPES

#### General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

#### Confirmation Prototypes

Prepare confirmation prototypes of each type of finish:

Include:	Junction details and trim. Corners and edges.
Location:	As agreed with the Engineer.
Size:	Minimum 2 m <sup>2</sup> .

Retain all prototypes until the completion of the works or as directed by the Engineer.  
Incorporate accepted prototypes into the work as directed by the Engineer.

#### Trial set-out

Trial set-out: On horizontal surfaces make a trial set-out for each area.

### 290.2.5 SUBMISSIONS

#### General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### Subcontractor

Submit names and contact details of proposed suppliers and installers.

#### Execution

Margins: If it appears that minor variations in joint widths or overall dimensions will avoid cut tiles, submit a proposal.

#### Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not limited to, the following information:

- Elevations plans and sections of all tiling layouts showing the tiling layout and identifying the setting out point(s).
- Details of the substrate and underlay.
- Details of all required joints and interfaces.
- Details of all penetrations.
- Allowances for movement.

No. of copies to be submitted: As Particular Specification.

#### Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

#### Tests

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

#### Method Statement

Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

**290.3 MATERIALS AND COMPONENTS**

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**290.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**290.3.2 TILES AND ACCESSORIES**

**Ceramic tiles**

Standard:

To SS 301: Specification for ceramic floor and wall tiles.

To SS483: Ceramic tiles – definitions, classifications, characteristics and marking.

To SS 57: Specification for glazed ceramic wall and floor tiles.

Provide homogeneous tiles unless previously agreed with the Engineer.

**Stair nosing tiles**

Provide specialist stair nosing tiles with a slip resistance to SS:485 - Slip Resistance Classification Of Public Pedestrian Surface Materials.

**Exposed edges**

In positions where the edge is exposed provide purpose-made border tiles with the exposed edge (whether round, square or cushion) glazed to match the tile face. If such tiles are not available, submit proposals for the protection of all exposed edges.

**Accessories**

Provide tile accessories which match the composition, colour and finish of the surrounding tiles.

**Coves, nosings and skirtings**

Provide matching stop ends and internal and external angle tiles moulded for that purpose.

**Accessories schedule**

Location	>	>	>
Type	>	>	>
Size (mm)	>	>	>
Colour	>	>	>

**290.3.3 ADHESIVES**

**General**

Standard: To AS 2358.

PVA (polyvinyl acetate) based adhesives: Do not provide in wet areas or externally.

**Type**

Generally: Provide adhesives compatible with the materials and surfaces to be adhered.

Prohibited uses: Do not provide the following combinations:

- Cement-based adhesives on metal, painted or glazed surfaces, gypsum-based plaster.
- Organic solvent-based adhesives on painted surfaces.
- Organic PVC-based adhesives and organic natural rubber latex adhesives in damp or wet conditions.

**Adhesives schedule**

Adhesive	Substrate
>	>
>	>
>	>

**290.3.4 MORTAR**

**Materials**

Cement type to SS 26.

- White cement: Iron salts content  $\leq 1\%$ .
- Off-white cement: Iron salts content  $\leq 2.5\%$ .

Lime: To AS 1672.1.

Sand: Fine aggregate with a low clay content selected for grading.

Water: To AS 3958.1.

**Bedding mortar**

Proportioning: Select proportions from the range 1:3 - 1:4 cement : sand to obtain satisfactory adhesion. Provide minimum water.

Mixing: To AS 3958.1.

**290.3.5 GROUT**

**Type**

Cement based proprietary grout: Mix with water. Fine sand may be added as a filler in wider joints.

Portland cement based grout: Mix with fine sand. Provide minimum water consistent with workability.

- For joints < 3 mm: 1:2 cement:sand.
- For joints ≥ 3 mm: 1:3 cement:sand.

**Pigments**

Pigments for coloured grout: Provide colourfast fillers compatible with the grout material. For cement-based grouts, provide lime-proof natural or synthetic metallic oxides compatible with cement.

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**290.4 EXECUTION**

**290.4.1 General**

To SS CP 68.

**290.4.2 SUBSTRATES**

**Drying and shrinkage**

Before tiling, allow at least the following times to elapse (for initial drying out and shrinkage) for these substrates:

- Concrete slabs: 42 days.
- Concrete blockwork: 28 days.
- Toppings on slabs and rendering on blockwork: A further 21 days.

**Preparation**

Suitably prepare substrates to receive the bedded finish and guarantee the adhesion of the tiles, including the following:

- mechanically abrade substrate to expose clean aggregate.
- Remove deleterious and loose material and leave the surface dust-free and clean.
- For mortar bedding wet the substrate as necessary to achieve suitable suction. Alternatively apply a bonding agent to the substrate to improve adhesion.

**290.4.3 ISOLATION MEMBRANE**

Where required by the drawings, provide an isolation membrane to the requirements of the Engineer.

**290.4.4 TILING GENERALLY**

**Sequence**

Fix wall tiles before floor tiles.

**Cutting and laying**

Cutting: Saw cut tiles neatly to fit around fixtures and fittings, and at margins where necessary. Drill holes without damaging tile faces. Saw cut recesses where necessary for fittings such as soap holders. Rub edges smooth without chipping.

Laying: Return tiles into sills, reveals and openings. Butt up to returns, frames, fittings, and other finishes. Strike and point up beds where exposed.

**Variations**

Mix tiles or tile batches before laying to distribute variations in hue, colour, or pattern uniformly.

**Protection**

Floor tiles: Keep traffic off floor tiles until the bedding has set and attained its working strength.

Cleaning: Keep the work clean as it proceeds and protect finished work from damage.

On completion, cover all floor tiles with an accepted impervious material which will resist all anticipated site traffic. Tape joints between individual material sheets.

**290.4.5 SETTING OUT**

**General**

Joint widths: Set out tiles to give uniform joint widths within the following limits:

- Internal tiling: 1.5 - 3 mm.
- External tiling: 4 - 9 mm.
- Mosaic: Nominal 2 mm or as dictated by pattern.
- Quarry tiling: 6 - 12 mm.
- Chemical resistant epoxy jointed floor tiling: 5 - 6 mm.

Joint alignment: Set out tiling with joints accurately aligned in both directions and wall tiling joints level and plumb, to a tolerance of  $\pm 2$  mm in 2 m from the design alignment.

Margins: Provide whole or purpose-made tiles at margins where practicable, otherwise set out to give equal margins of cut tiles. If margins less than half tile width are unavoidable, locate the cut tiles where they are least conspicuous.

Fixtures: If possible position tiles so that holes for fixtures and other penetrations occur at the intersection of horizontal and vertical joints or on the centre lines of tiles. Continue tiling fully behind fixtures which are not built in to the tiling surface. Before tiling ensure that fixtures interrupting the tile surfaces are accurately positioned in their designed or optimum locations relative to the tile layout.

#### 290.4.6 FALLS AND LEVELS

##### General

General: Grade floor tiling to even and correct falls to floor wastes and elsewhere as required. Make level junctions with walls. Where falls are not required lay level.

Fall, as shown on drawings: >

Fall, in shower areas: as shown on drawings: 1:60 minimum.

Deviation: Maximum deviation of the finished floor level between points of contact under a 2 m straight edge laid in any direction on an area of uniform grade to be 1:300 or 3 mm, whichever is the lesser.

Sudden changes of level will not be accepted.

Maximum difference in level between two adjacent tiles: 0.5mm.

Change of finish: Maintain finished floor level across changes of floor finish including carpet.

#### 290.4.7 BEDDING

##### Preparation of tiles

Adhesive bedding: Fix tiles dry; do not soak.

Mortar bedding: Soak porous tiles in water for half an hour and then drain until the surface water has disappeared.

##### Bedding

Use bedding methods and materials which are appropriate to the tile, the substrate, the conditions of service, and which leave the tile firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

##### Thin adhesive beds

General: Provide only if the substrate deviation is less than 3 mm when tested with a 2 m straight edge. Cover the entire tile back with adhesive when the tile is bedded.

Thickness: 1.5 - 3 mm.

##### Thick adhesive beds

General: Provide on substrates with deviations up to 6 mm when tested with a 2 m straight edge: with tiles having deep keys or frogs: and with tiles having uneven backs.

Nominal thickness: 6 mm.

##### Mortar beds

For floor tiles: Either lightly dust the screeded bed surface with dry cement and trowel level until the cement is damp, or spread a thin slurry of neat cement, or cement-based thin bed adhesive, on to the tile back. Do not provide mortar after initial set has occurred.

- Nominal thickness: 25 mm.

For wall tiles: Apply the bed to the substrate as a floated coat, bring up to a true surface with a wood float and allow to stiffen for up to 2 hours. Then either apply a back-up skim coat (1 - 2 mm thick) of 1:2 mortar to the bed, or butter the tile with 1:2 mortar or a cement based thin bed adhesive, before applying the tile to the bed.

- Nominal thickness: 15 mm.

Thick reinforced beds: Place mortar bed in two layers, and incorporate the mesh reinforcement in the first layer.

##### Additives

Use in accordance with the manufacturer's instructions.

### Mechanical fixing

Provide a proprietary system of support and fixing appropriate to the type of tile and the substrate conditions.

#### 290.4.8 SCHEDULES

##### Wall tiling schedule

Designation	WT1	WT2	WT3
Tile type:	>	>	>
- Size (mm)			
- Colour	>	>	>
- Surface	>	>	>
- Edge	>	>	>
Bedding:	>	>	>
- Type			
- Thickness (mm)	>	>	>
Tile or bond pattern	>	>	>
Mechanical fixing:	>	>	>
- Support system			
- Fixing method	>	>	>
Grout:	>	>	>
- Type			
- Colour	>	>	>
- Pigment proportions	>	>	>
- Special properties	>	>	>

##### Floor tiling schedule

Designation	FT1	FT2	FT3
Tile type:	>	>	>
- Size (mm)			
- Colour	>	>	>
- Surface	>	>	>
Separation layer:	>	>	>
- Location			
- Type	>	>	>
Bedding:	>	>	>
- Type			
- Thickness (mm)	>	>	>
- Reinforcement	>	>	>
Tile or bond pattern	>	>	>
Grout:	>	>	>
- Type			
- Colour	>	>	>
- Pigment proportions	>	>	>
- Special properties	>	>	>

#### 290.5 JOINTS

##### 290.5.1 MOVEMENT JOINTS

###### General

Location: Provide movement joints.

- over structural (isolation, contraction, expansion) joints;
- at internal corners;
- at junctions between different substrates; and
- to divide large tiled areas into bays, maximum 5 m wide, maximum 15 m<sup>2</sup>.

Depth of joint: Right through to the substrate.

Sealant width: 6 - 25 mm.

Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

**Movement joint materials**

Cross refer: Adhesives, Sealants and Fastenings.

Preformed strip: A proprietary expansion joint consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying. Set flush with the finished surface.

Sealant: Two-pack self-levelling non staining, non-hardening mould resistant, one-part silicone or polyurethane sealant applied over a backing rod. Finish flush with the tile surface.

Backing rod: Compressible closed cell polyethylene foam with a bond-breaking surface.

**Floor movement joint materials**

- Tensile strength: 586 kg/cm<sup>2</sup>.
- Shore A hardness: 60 -70.
- Movement Accommodation Factor: 5%.
- Chemically resistant to, dilute acid, alkalis, detergents and common pollutants.

**Movement joints schedule**

Location	>	>	>
Joint side-plate material	>	>	>
Joint fixing	>	>	>
Sealant:	>	>	>
- Type	>	>	>
- Colour	>	>	>
- Width (mm)	>	>	>

**290.5.2 DIVIDER STRIPS**

**Setting divider strips**

Set divider strips accurately and firmly to the required locations and levels, with epoxy mortar.

**290.5.3 GROUTED AND CAULKED JOINTS**

**Grouted joints**

General: Commence grouting as soon as practicable after bedding has set. Clean out joints as necessary before grouting.

Face grouting: Fill the joints solid and tool flush. Clean off surplus grout. Wash down when the grout has set. When grout is dry, polish the surface with a clean cloth.

Edges of tiles: Grout exposed edge joints.

Epoxy grouted joints: Ensure that tile edge surfaces are free of extraneous matter such as cement films or wax, before grouting.

Grouting mosaics: If paper faced mosaics are to be bedded in cement mortar, pre-grout the sheeted mosaics from the back before fixing. After fixing, rub grout into the surface of the joints to fill any voids left from pre-grouting. Clean off surplus grout. When grout has set, wash down. If necessary use a proprietary cement remover.

**Caulked joints**

General: Provide caulked joints filled with sealant and finished flush with the tile surface as follows:

- Where tiling is cut around sanitary fixtures.
- Around fixtures interrupting the tile surface, for example pipes, brackets, bolts and nibs.
- At junctions with elements such as window and door frames and built-in cupboards.
- At internal corners.

Width: 5 mm.

Depth: Equal to the tile thickness.

**290.5.4 JOINT ACCESSORIES**

**Floor finish dividers**

General: Finish tiled floors at junctions with differing floor finishes with a corrosion resistant metal dividing strip suitably fixed to the substrate, with top edge flush with the finished floor. Where changes of floor finish occur at doorways make the junction directly below the closed door.

Type: Stainless steel.

>

Material: Grade 316.

Finish: Top edge polished	>
	>
Width	6mm.
	>
Depth:	>

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## 290.6 COMPLETION

### 290.6.1 COMPLETION

#### General

Cross refer: Item 20.5 'Completion' of the General Requirements.

#### Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

#### Protection

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect completed tiling prior to handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the floor finish from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

#### Damage

Replace damaged items with new.

#### Cleaning

Clean tiled surfaces using an appropriate tile cleaning agent, and polish.

#### Warranties

Warrant the materials and workmanship as part of the element in which they were used using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all tiling against loss of adhesion between the granite and substrate below.

#### Record drawings

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

### 290.6.2 REPAIR

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>300 RESILIENT FINISHES</b>
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**300.1 GENERAL**

**300.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows: Cementitious Toppings.

**300.1.2 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Comply with the requirements of Section 13.9 of the Authority's Design Criteria Volume 2 of 2, and Singapore Standard CP5.

**300.1.3 STANDARD**

**General**

Laying: To AS 1884.

Slip Resistance: To SS 485 - Slip Resistance Classification Of Public Pedestrian Surface Materials.

Fire rating: To comply with the requirements of the Standard For Fire Safety In Rapid Transit Systems.

**300.1.4 INTERPRETATION**

**Definitions**

Resilient floor coverings classification: To BS EN 685.

Substrate: The building element to which the finish is to be applied. Includes "subfloor" as defined in AS 1884.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**300.1.5 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**300.2 QUALITY**

**300.2.1 INSPECTION**

**General**

Resilient finishes shall be inspected from a minimum distance of 1400 mm under the specified permanent artificial luminance or 500 lux, whichever is greater.

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Completion of laying underlay, if any.
- Substrate immediately before fixing sheets or tiles.
- Surface before application of each coat (multi-coat work).
- Finished surface before applying sealers or polishes (if any).
- Completed installation.

**Hold points**

- Completion of prototypes.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

### 300.2.2 TESTS

#### General

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

#### Seamless finishes

Epoxy base coat test: Using the base coat epoxy as an adhesive, glue to the prepared base, at approximately 4 m centres, at least four M10 hexagon steel bolts. When the adhesive has set, pull the bolts off the surface using a lifting apparatus. The test has failed if the fracture occurs at the glue line or within the epoxy. For each failure, carry out 2 further tests in the same area after rectification.

Adhesion test: To AS 1580.408.4, modified as follows:

- Sample: Delete clause 5.
- Test areas: Delete clause 8(a). Select the areas to be tested on the in situ finished surface, at the rate of one test area per 10 m<sup>2</sup> of surface (or part thereof) for surfaces up to 40 m<sup>2</sup>, one to 25 m<sup>2</sup> for surfaces 40 – 200 m<sup>2</sup>, and one to 50 m<sup>2</sup> for surfaces greater than 200 m<sup>2</sup>. Test the areas 24 – 48 hours after application.
- Procedure: Delete clauses 8(c)(i) and (ii) and 8(k). Make 6 cuts, spaced 2 mm apart, or 3 mm apart if the average film thickness exceeds 150 µm and the substrate has an uneven profile.
- Test report: Delete clauses 9(c) and 9(j).
- Acceptance: Test results are acceptable if classified 0, 1, or 2 to Table 1.

### 300.2.3 SAMPLES

#### General

Submit samples of all floor coverings in accordance with Section 20.3.4 'Samples', of the General Requirements to illustrate the range of colour, pattern or texture as seen in the finished work.

#### Size

Minimum size per sample:

- Sheet and seamless material: 450 x 450 mm.
- Tiles: A whole tile or 0.09 m<sup>2</sup>, whichever is the greater.
- Linear accessories (coving, skirting, stair nosing, protection strips, and the like): A piece 300 mm long.

#### Welded joints

Submit a sample joint 300 mm long.

### 300.2.4 PROTOTYPES

#### General

Provide confirmation prototypes in accordance with Section 20.3.5 'Prototypes' of the General Requirements.

#### Confirmation prototype

Location:	As directed by the Engineer.
Size (mm):	1.8m square.
	>
Incorporating	Service outlet point. Skirting.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

#### Trial set-out

Prepare a trial set-out before fixing.

### 300.2.5 SUBMISSIONS

#### General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### Subcontractors

Submit names and contact details of proposed suppliers and installers.

**Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not limited to, the following information:

- General arrangement to show the location of all resilient flooring.
- A numbering system enabling all flooring to be identified.
- Details of all required interfaces.
- The location of all day joints in seamless flooring.

No. of copies to be submitted: As Particular Specification.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with section 20.3.6, 'Submissions' of the General Requirements, including, where relevant

- composition, thickness, finish and time between coats for multi-coat work;
- thickness and width of sheet or size of tile;
- adhesive and jointing method;
- resistance to wear, indentation, chemicals, light, fire, and the like; and
- flexibility and bending strength.
- Slip resistance.
- Fire Rating.
- Electrical resistance.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

- Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

**300.3 MATERIALS**

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**300.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**300.3.2 MARKING**

**Identification**

Deliver materials to the site in the manufacturer's original sealed containers legibly marked to show the following:

- Manufacturer's identification.
- Product brand name.
- Product type.
- Dimensions and quantity.
- Product reference code and batch number.
- Date of manufacture.
- Material composition and characteristics such as volatility, flash point, light fastness, colour and pattern.
- Handling and installation instructions.

**300.3.3 SHEETS AND TILES**

**Edges of sheets and tiles**

Ensure edges are firm, unchipped, machine-cut accurately to size and square to the face, and that tile edges are square to each other.

**Underlays**

Cementitious: Polymer modified cementitious self smoothing and levelling compound.

- Surface tolerances: To AS 1884 clause 2.1.1.3.
- Thickness: 3 mm minimum.

**Linoleum**

Standard: To BS EN 548.

**Antistatic sheet vinyl**

Unbacked flexible PVC sheet, with antistatic properties.

**Adhesives**

Standard: To AS 3553.

Use adhesive recommended by the resilient finishes manufacturer.

Use conductive adhesive in all static control situations.

**Sheet and tile schedule**

Designation	RF1	RF2	RF3
Type	>	>	>
Form	>	>	>
Colour	>	>	>
Pattern	>	>	>
Sheet width (mm)	>	>	>
Thickness (mm)	>	>	>
Surface	>	>	>
Tile dimensions (mm)	>	>	>
Underlay	>	>	>

**300.3.4 SEAMLESS FINISHES**

**Epoxy base coat**

An odourless, non-flammable, low toxicity, two pack pigmented epoxy resin of selected colour, chemically cured, capable of bonding on to fresh or damp concrete when applied by brush or roller.

**Polyurethane undercoat**

Two-pack aromatic polyurethane.

**Polyurethane top coat**

Two-pack light stable aliphatic polyurethane.

**Seamless finishes schedule**

Location	>	>	>
Type	>	>	>
Colour	>	>	>
Pattern	>	>	>
Surface	>	>	>
Minimum finished dry film thickness (µm)	>	>	>
Undercoat	>	>	>
Edge finish	>	>	>
Underlay	>	>	>

**300.4 EXECUTION**

**300.4.1 SUBCONTRACTORS**

**General**

Use specialist installers recommended by the materials manufacturers.

**300.4.2 PREPARATION**

**Substrate**

General: Suitably prepare the substrate to receive the installation, including the following:

- Repairs: Make good to the surface finish as necessary. Fill depressions with a suitable filler, and remove high spots and projections. If necessary lay a steel-trowelled underlay to concrete substrates.
- Fixtures and fittings: Remove door stops and other fixtures, and refix in position undamaged on completion of the installation.

Concrete substrates:

- Dryness: Test concrete substrates for dryness using the hygrometer test method described in AS 1884 Appendix A. If necessary provide artificial means for drying out the substrate before installation.
- Cavity filling material: >
- Prepare concrete to receive base coats in accordance with the coating manufacturer's instructions.
- Etching: Acid etch concrete surfaces to receive epoxy base coats using a solution of hydrochloric acid and water in equal parts, applied at 0.5 L/m<sup>2</sup>. After reaction, wash concrete and allow to dry.
- Levelling compound: Where substrate surface levels exceed maximum permissible tolerances, apply a proprietary levelling compound compatible with the adhesive.

**Cleaning and protection**

General: Keep traffic off floors until bonding has set or for 24 hours after laying, whichever period is the longer. Do not allow water in contact with the finish for 7 days.

Reinstatement: Repair or replace faulty or damaged work. If the work cannot be repaired to the satisfaction of the Engineer, replace the whole area affected.

**Cleaning**

Keep the surface clean as the work proceeds.

**300.4.3 SHEET AND TILE INSTALLATION**

**Sheet set out**

Set out sheets to give the minimum number of joints.

**Tile set out**

General: Set out tiles from the centre of the area. Wherever possible cut tiles at margins only, to give a cut dimension of at least 100 mm x full tile width. Match edges and align patterns. Arrange the material so that variation in appearance is minimised.

Tile laying pattern: >

**Joints**

Non-welded: Butt edges together to form tight neat joints showing no visible open seam.

**Junctions**

Scribe neatly up to returns, edges, fixtures and fittings. Finish flush with adjoining surfaces.

**Tolerance**

Maximum deviation of the finished floor level: 1:300 or 3 mm, whichever is the lesser, measured between points of contact under a 2 m straight edge laid in any direction on an area of uniform grade.

**Rolling**

Where rolling is required, roll the finish in 2 directions before the adhesive sets, using a 70 kg multi-wheeled roller.

**Change of finish**

Maintain finished floor level across changes of floor finish including carpet.

**Finishing schedule**

Sheet and tile type	Finish	Rolling after laying
>	>	>
>	>	>
>	>	>

**300.4.4 VINYL SHEETING**

**Welded joints**

Heat welding: After fixing, groove the seams using a grooving tool and weld the joints with matching filler rod and using a hot air welding gun. When the weld rod has cooled, trim off flush.

Cold welding: Apply seaming compound 100 mm wide to the substrate centrally under the seam. Roll the seam until the compound is forced up into the joint. Clean off flush using a damp cloth.

Epoxy jointing: Join seams with epoxy adhesive.

**Welded joints schedule**

Sheet and tile type	Welding type
>	>
>	>
>	>

**Conductive vinyl sheeting**

Install conductive vinyl sheet on a copper grid comprising copper tape 80 µm thick x 10 mm wide adhered to the floor with conductive adhesive. Lay copper tape along each length of sheet vinyl and connect it at right angles to a 1 MΩ resistor. Connect to earth with copper tape at 20 – 30 m<sup>2</sup> intervals.

**300.4.5 SEAMLESS FLOORING**

**General**

Seamless flooring: Do not install seamless flooring when the temperature in the laying area is outside the recommended range.

**Protection**

Keep traffic off finished work for 60 hours.

**Polyurethane**

Epoxy base coat: Apply colour epoxy base coat or coats at a rate which gives a finished thickness of at least 250 µm.

Vinyl chips: Spread vinyl chips evenly over the floor into the epoxy base coat or into the first polyurethane coat, or both.

Sanding: After the first or second polyurethane coat has been applied, sand the surface lightly using power sander. Remove sanded material by vacuuming.

Polyurethane top coats: Apply at least 3 polyurethane top coats so that the epoxy base coat does not show through and provide a total thickness of polyurethane above the chips of at least 200 µm, and a total thickness of the top coats of at least 50 µm.

Anti-slip surface: Sprinkle glass beads at the rate of 125 g/m<sup>2</sup> into the first polyurethane coat applied after sanding, and while the floor is still wet.

**Epoxy and polyester**

Laying in alternate bays: Divide the floor into bays up to 2 m wide. Lay every alternate bay. Where required provide screed rails firmly anchored and accurately set to levels. Complete each bay in one continuous operation to eliminate visible joints.

- Intermediate bays: May be laid the next day. First remove screed rails, and prime edges.

Laying in adjoining bays: Divide the floor into bays up to 2 m wide. Where required provide screed rails firmly anchored and accurately set to levels. Complete the floor in one continuous operation, to ensure bonding and to eliminate visible joints.

Sealing and finishing: After the screeded floor has cured (at least 12 hours after laying) remove loose material and irregularities from the surface. Apply sealer to the surface in 2 coats, the second within 48 hours of the first.

Anti-slip surface: Incorporate anti-slip aggregates into the second sealer coat.

**Seamless flooring schedule**

Designation	SF1	SF2	SF3
Seamless finish type	>	>	>
Laying method:	>	>	>
- Number of coats	>	>	>
- Spreading rate per coat	>	>	>
- Time between coats for multi-coat work	>	>	>
Finish	>	>	>

**300.4.6 STAIRS**

**Vinyl**

Preformed: Provide purpose-made vinyl stair finish combining riser, nosing and tread in the one element. Lay each step consecutively with the joint at the bottom of each riser.

Formed in situ: Fit the sheet vinyl to each tread, and to the riser above, in one piece, coved in the angle. Accurately scribe, cut and fit to stair nosings and perimeters.

**Stair nosings**

Aluminium: Purpose-made extruded anti-slip aluminium nosing.

Vinyl: Purpose-made moulded anti-slip section, matching the stair finish.

**Stair finishes schedule**

Designation	STF1	STF2	STF3
Location	>	>	>
Nosing	>	>	>
Colour	>	>	>
Pattern	>	>	>
Material	>	>	>

**300.4.7 JOINTS AND ACCESSORIES**

**Junctions**

Finish junctions flush with adjoining surfaces. Where changes of floor finish occur at doorways locate the joint on the centreline of the closed door leaf.

Agree the location of all day joints with the Engineer.

**Seamless finish junctions**

For day joints, make the junction or exposed edge by one of the following methods:

- Overlap: Carry the finish 100 mm past the junction line to be overlapped by the adjoining finish.

**Accessories**

General: Provide purpose-made matching moulded accessories for nosings, coves, skirtings, edge cover strips and finishes at junctions, margins, and angles, if available. Otherwise form accessories from the sheet material. Provide solid backing for radiused coves and nosings.

**Accessories schedule**

Accessory type	Location
>	>
>	>
>	>

**Cover strips**

General: Provide edge cover strips at junctions with different floor finishes and to exposed edges.

Metal cover strip: Extruded tapered strip 25 mm wide, of the same thickness as the sheet or tile. Fix with matching screws to timber bases or to masonry anchors in concrete bases, at 200 mm maximum centres.

- Material: >

**Movement joints**

Location: Provide movement joints

- over structural (isolation, contraction, expansion) joints; and
- at junctions between different substrates.

Depth of joint: Right through to the substrate.

Sealant width: 6 – 25 mm.

Depth of elastomeric sealant: One half the joint width, or 6 mm, whichever is the greater.

Preformed strip: A proprietary expansion joint consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying. Set flush with the finished surface.

**Floor movement joint sealant**

- Tensile strength: 586 kg/cm<sup>2</sup>.
- Shore A hardness: 60 -70.
- Movement Accommodation Factor: 5%.

## 300 RESILIENT FINISHES

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Chemically resistant to, dilute acid, alkalis, detergents and common pollutants.

### Seamless finish joints

Carry the seamless finish material over the edges and down the sides of the control joint in the base.

### Movement joints schedule

Designation	MJ1	MJ2	MJ3
Location	>	>	>
Joint side-plate material	>	>	>
Cross section	>	>	>
Joint fixing	>	>	>
Sealant:	>	>	>
- Type			
- Colour	>	>	>
- Width (mm)	>	>	>

### Vinyl skirting

Feather edge: Moulded PVC skirting section.

Flat skirting: Flat PVC skirting section.

Fixing: Scribe as necessary. Mitre corners. Fix to walls with contact adhesive.

Minimum height: 100 mm.

### Coves and nosings

Coved skirtings: Carry the flooring material up over a profiled coving section to form skirting, weld all joints.

Location: >

Minimum radius: Formed in-situ:

- Vinyl finishes: 20 mm.
- Rubber finishes: 25 mm.

## 300.5 COMPLETION

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### 300.5.1 COMPLETION

#### General

Cross refer: Item 20.5 'Completion' of the General Requirements.

#### Operation and Maintenance Manual

On completion submit an Operation and Maintenance Manual in accordance with Item 25.3 'Operation and Maintenance Manuals' of the General Requirements.

#### Protection

Protect completed floor finishes prior to handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the floor finish from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

#### Cleaning

Clean the finished surface. Buff and polish. Before handover, mop and leave the finished surface clean and undamaged on completion.

#### Cleaning antistatic and conductive flooring

Do not use sealers, wax or floor polish. Clean using a mild neutral detergent and lukewarm water. A clean floor may be dry buffed using a normal scrubbing machine and a white nylon pad.

#### Damage

Replace damaged items with new.

#### Warranties

Warrant the materials and workmanship as part of the element in which they were used using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all bonded resilient finishes against loss of adhesion between the granite and substrate below.

#### Certificate of compliance

Provide a Certificate of compliance for antistatic and conductive floor installations.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**300.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>310 GRATINGS</b>
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**310.1 GENERAL**

**310.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows:

- Adhesives, Sealants and Fasteners.
- Waterproofing.
- Roofing.
- Plumbing and Sanitary Fixtures.
- Tiling.
- Terrazzo.
- Granite Flooring.
- Metal Fixtures.
- External Paving.

**310.1.2 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**310.1.3 TOUCH VOLTAGE PROTECTION**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**310.1.4 STANDARD**

**General**

To the requirements of the Department of the Environment, Public Utilities Board.

**External Drainage**

Load class to EN 124.

- Load Class A15: to 15kN.
- Load Class B125: to 125kN.
- Load Class C250: to 250kN.

**310.1.5 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**310.2 QUALITY**

**310.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Connection of all fittings to extract pipework.
- Completion of basic drain runs and outlets.
- Installation of waterproofing membranes.

**Hold points**

- The installation of the first of any type of fitting.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**310.2.2 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Cross Refer: Item 120.2.3, 'Roofing'.

### 310.2.3 SAMPLES

#### General

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Channel drainage system complete with cover.
- Each type of floor drainage outlet.
- Each type of roof drainage outlet.
- Each type of floor grating.
- All accessories and fixings.
- All jointing materials.
- >

Size of samples

- Linear items: minimum 600mm sq.
- Outlets: complete item.
- Gratings: as agreed with Engineer.
- Accessories: one off.

No. of samples: 3.

### 310.2.4 PROTOTYPES

#### General

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

#### Confirmation prototype

Provide confirmation prototypes of all grating installations.

Location:	As agreed with the Engineer.
Minimum size (mm):	As required by the fittings and accessories involved.
Incorporating	<ul style="list-style-type: none"><li>- All accessories.</li><li>- All supports as directed.</li><li>- Edge details as directed.</li><li>- Interfaces as directed.</li><li>- &gt;</li></ul>

Retain all prototypes until the completion of the works or as directed by the Engineer.  
Incorporate accepted prototypes into the work as directed by the Engineer.

### 310.2.5 SUBMISSIONS

#### General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### Subcontractor

Submit names and contact details of proposed specialist suppliers and installers.

#### Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit drawings and schedules showing but not limited to the layout and details of the system, including:

- Layout drawings complete with an identification system to allow each grating and outlet to be identified.
- Schedule of all outlets.
- Location, and type of all gratings.
- Installation details.
- Corner and junction details.
- Interfaces with all adjoining materials.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Roof Drainage System: Submit hydraulic calculation of the roof drainage system endorsed by a specialist for the SO's acceptance.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Tests**

- Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

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**310.3 MATERIALS AND COMPONENTS**

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**310.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

The manufacturer's name, class designation, relevant standard, and year of manufacture shall be legibly and durably marked on each item.

**Accessories**

Provide the accessories necessary for the correct installation of all items.

**310.3.2 DRAINAGE CHANNELS**

Type:	To DIN 19580.
Material	- Polymer concrete. - Stainless Steel, grade 316.
Minimum invert	>
Fall:	5% minimum.
Outlets:	Preformed knock-out.
Caps:	>
Load Classes	>
Sumps	>
Grating locks	Precast.

**Polymer Concrete**

Compressive strength	90N/mm <sup>2</sup> .
Flexural bending strength	18N/mm <sup>2</sup> .
Water absorption (by weight)	<0.05%.

**310.3.3 DRAINAGE CHANNEL GRATINGS**

Loading	>
Type	- To DIN 19580. - Fixed. - Hinged.
Openings	- Slotted. - Perforated. - Mesh.

## 310 GRATINGS

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	- Discreet.
	- Integral.
Material	- Galvanised steel.
	- Stainless steel, grade 316.
	- Polymer concrete.
Load class	>
Heelguard protection	>
Locking system	- Locking bar and bayonet.
	- Security bolts.
	- >

### 310.3.4 FLOOR GULLIES

General:

Provide gullies with rounded bodies and without sharp corners which might trap dirt.

Conform with Euronorm 1253 for floor gullies.

Loading	>
Type	- Circular.
	- Square.
	- >
Material	Stainless steel, grade 316.
Gratings	Flat.
Material	Stainless steel, grade 316.
Fixings	- No visible fixings.
	- Screws.
Finish	- Anti-slip mesh.
	- Plain mesh.
	- Ladder.
	- Perforated.
	- Slotted.
	- Solid.
Top edge	>
Sediment baskets	>
Pipe connections	>

### 310.3.5 RAINWATER OUTLETS

Type	- Roof.
	- Balcony.
	- Two way.
	- Gulley.
	>
Material	- Aluminium to BS 1490.
	- Gunmetal to BS 1400.
Gratings	- Flat.
	- Domed.
Fixing	- Bolted.
	- Twist action release.
Finish	- Slotted.
Raising ring	>
Outlet	- vertical.
	- 45°.
	- 90°.
Overflow Unit	>

## 310 GRATINGS

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### 310.3.6 OPEN GRID FLOORING

Loading	>	
Material	-	Stainless steel grade 316.
	-	Aluminium.
	-	Steel to AS 3679, grade 250.
Finish	-	Mill finish.
	-	Pickled and passivated.
	-	Electropolished.
	-	Galvanised to AS 1650.
	-	>
Wearing surface	-	Flat.
	-	Serrated.
Bar size	>	
Grid size	>	
Edge treatment	>	
Fixing method	>	

### 310.3.7 TREE GRATINGS

Loading	>	
Material	-	Polymer concrete.
	-	>
Type	-	Circular.
	-	Square.
	-	Rectangular.
Perforation	-	Slotted.
	-	Randon.
	-	>
	-	>
Thickness	>	
Support Structure	>	
Fixing method	>	

## 310.4 SCHEDULES

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### Drainage channel schedule

Designation	DC1	DC2	DC3
Location	>	>	>
Material	>	>	>
Size	>	>	>
Fall	>	>	>
Outlets	>	>	>
Caps	>	>	>
Load classes	>	>	>
Sump	>	>	>
Grating type	>	>	>

### Drainage channel grating schedule

Designation	DC1	DC2	DC3
Location	>	>	>
Loading	>	>	>
Type	>	>	>

### 310 GRATINGS

Size	>	>	>
Material	>	>	>
Load classes	>	>	>
Heelguard	>	>	>
Locking system	>	>	>

#### Floor Gully schedule

Designation	FG1	FG2	FG3
Location	>	>	>
Loading	>	>	>
Type	>	>	>
Size			
Fixings	>	>	>
Finish	>	>	>
Top edge	>	>	>
Sediment basket	>	>	>
Pipe connections	>	>	>

#### Rainwater outlet schedule

Designation	RO1	RO2	RO3
Location	>	>	>
Type	>	>	>
Size	>	>	>
Material	>	>	>
Gratings	>	>	>
Fixings	>	>	>
Finish	>	>	>
Raising Ring	>	>	>
Outlet	>	>	>
Overflow unit	>	>	>
Waterproofing finish	>	>	>

#### Open grid flooring schedule

Designation	DC1	DC2	DC3
Location	>	>	>
Loading	>	>	>
Material	>	>	>
Finish	>	>	>
Wearing surface	>	>	>
Bar size	>	>	>
Grid size	>	>	>
Edge treatment	>	>	>
Fixing method	>	>	>
Support structure	>	>	>
Equipotential Bonding			

**Tree grating schedule**

Designation	TG1	TG2	TG3
Location	>	>	>
Loading	>	>	>
Material	>	>	>
Perforation	>	>	>
Colour	>	>	>
Thickness	>	>	>
Support structure	>	>	>
Fixing method	>	>	>

**310.5 EXECUTION**

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**310.5.1 GRATINGS**

**General**

Check and ensure that all preparatory work is complete and that the area is ready for the installation of the items covered in this specification

Install all items in accordance with the manufacturer's printed instructions and, where appropriate his standard drawings and details.

Ensure floor and external drainage fittings are set out to coincide with the paving and/or tiling layout and to eliminate the need for cut paviors/tiles.

Ensure that all items are capable of carrying the anticipated loads.

Ensure that the orientation of all slotted gratings corresponds with the manufacturer's recommendations.

**Drainage channels**

Ensure that the ground conditions suit the required channel invert depths.

Ensure sufficient bed and lateral support is provided to restrain the channel and prevent movement.

Check the relationship between the channel invert and finished paving utilising the grating type to be fitted.

Use stepped connectors to join invert channels of different depths.

Utilise the manufacturer's pre-formed unions to connect the channel to the drainage system.

Trim closing end caps to suit the channel inverts.

Agree all change of direction details with the Engineer prior to the start of the works on site.

**Drainage channel gratings**

Ensure that the edges of the gratings are isolated from floor/pavement finishes.

Ensure that gratings are locked into position to prevent unauthorised removal.

Ensure that gratings are securely fixed and properly bedded to avoid movement under the action of pedestrian or vehicular traffic. Noise as traffic passes over gratings will not be acceptable.

**Floor gulleys**

Level tolerance with adjacent flooring : +/-0.5mm.

**Rain water outlet**

Comply with the requirements of SS CP 26.

Ensure all roof outlets are installed complete with grating to prevent blockage due to leaves etc. being washed into the down pipe.

Ensure the roof finish is dressed into the outlet in accordance with the manufacturer's instructions and that a watertight seal is achieved.

Ensure that the connection between the outlet and down pipe is made in accordance with the manufacturer's details.

**Open grid flooring**

Comply with the requirements of Section 13.9 of the Authority's Design Criteria Volume 2 of 2, and Singapore Standard CP5.

Do not cut or weld grid flooring sections without prior acceptance by the Engineer.

**Tree Grating**

Ensure grating supports are provided in accordance with the manufacturer's requirements.

**310.5.2 SEALANTS**

Cross Refer: Adhesives, Sealants and Fasteners.

**310.6 COMPLETION**

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**310.6.1 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

**Protection**

Protect all completed items on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

**Damage**

Replace damaged items with new.

**Warranties**

Warrant the materials and workmanship as part of the item in which the gratings is installed using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**310.6.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>320 PLUMBING AND SANITARY FIXTURES</b>
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**320.1 GENERAL**

**320.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows:

- Adhesives, Sealants and Fasteners.
- Metals and Prefinishes.
- Gratings.

**320.1.2 STANDARD**

**Toilet fittings and accessories**

General:

- To the Guidebook for Better Public Toilet Design and Maintenance.
- To the requirements of the Department of the Environment, Public Utilities Board.

Toilets for use by disabled persons:

- To the Code on Barrier Free Access.

**320.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**320.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**320.2 QUALITY**

**320.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Completion of concealed services.
- Connection of all fittings to supply and extract pipework.

**Hold points**

- >
- The installation of the first of any type of fitting.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**320.2.2 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

Make in-use tests to the satisfaction of the Engineer to assure proper functioning of water closet, wash basin and urinals.

**320.2.3 SAMPLES**

**General**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

- Each sanitary fitting used.
- Each type vanity top showing proposed backing and edge details round wash basin.
- All accessories and fixings.
- All jointing materials.
- >

Size of samples

- Vanity tops : minimum 600mm sq.
- Sanitary fittings: one off.

- Accessories: one off.

#### **320.2.4 PROTOTYPES**

##### **General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

##### **Confirmation prototype**

Provide confirmation prototypes of all sanitary installations.

Location:	As agreed with the Engineer.
Minimum size (mm):	As required by the fitting and accessories involved.
Incorporating	<ul style="list-style-type: none"><li>- All accessories.</li><li>- All supports.</li><li>- Edge details as directed.</li><li>- Interfaces as directed.</li><li>- &gt;</li></ul>

Retain all prototypes until the completion of the works or as directed by the Engineer.  
Incorporate accepted prototypes into the work as directed by the Engineer.

#### **320.2.5 SUBMISSIONS**

##### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

##### **Subcontractor**

Submit names and contact details of proposed specialist suppliers and installers.

##### **Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit drawings and schedules showing but not limited to the layout and details of the system, including

- location, and type of sanitary ware.
- Installation of all accessories.
- Support details.
- Interfaces with all adjoining materials.

No. of copies to be submitted: As Particular Specification.

##### **Engineering endorsement**

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

##### **Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

##### **Tests**

- Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

##### **Method Statement**

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

### 320.3 MATERIALS AND COMPONENTS

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#### 320.3.1 General

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

#### 320.3.2 AUTHORISED PRODUCTS

##### Standard

All sanitary ware and accessories shall be approved by the Ministry of the Environment for use in Singapore.

#### 320.3.3 SANITARY FIXTURES

##### General

Provide the accessories necessary for correct installation.

Tolerances on all dimensions quoted are  $-5\%/+10\%$  unless otherwise noted.

##### Fixings

- In accordance with Section 2.5 of 'Adhesives, Sealants and Fasteners'.
- As required by manufacturer.

##### W.C. :public toilets

Type: wall mounted, syphonic flush.

Length: 605mm.

Width: 355mm.

Height to rim, 370mm.

- in disabled toilets **height to seat** to be 450mm minimum, 480mm maximum.

Finishes: Vitreous China.

Colour: >

Outlet: To suit stack position

Accessories: seat and cover to SS 16.

##### W.C. : staff toilets

Type: Close coupled .

Length: 605mm.

Width: 355mm.

Height to rim, 370mm.

Finishes: Vitreous China.

Colour: >

Outlet: To suit stack position.

Accessories: seat and cover to SS 16.

Cistern capacity: 4.5 litre to SS 378.

Cistern flush: lever operated.

- Toilet seat must not affect operation of cistern flush lever when in the upright position.
- Water supply to cistern to be controlled by fully accessible chromium plated bronze or brass cast valve.

##### W.C. Asian Style (squat)

Type:

- complete with footrests minimum 255mm long, x 120mm wide.
- to finish flush with adjacent floor finish.

Length: 670mm.

Width: 305mm.

Depth: 300mm.

Finishes: Vitreous China.

Colour: >

Outlet: To suit stack position.

**Urinal**

Type: Wall hung with fully concealed fixings.

Overall height: 800 mm.

Overall width: 460mm.

Height to rim 530mm.

Finishes: Vitreous China.

Colour: >

Fixings: fully concealed, corrosion resistant.

Accessories: automatic flushing mechanism.

**Wash Basin**

Type: To be mounted below counter.

Width: 500mm.

Breadth: 360mm.

Depth: 200mm.

Basin capacity: 8.0 litres.

Finishes: Vitreous china.

Colour >

Fixings: Fully concealed, non corrosive.

Junction with counter top to be fully sealed using silicone sealant.

Remarks:

Do not provide plug.

Provide chromium plated cast bronze or brass outlet.

Provide opening to take single tap.

**Cleaner's Sink**

Type: heavy duty gauge stainless steel, floor mounted by means of support legs.

Fixings: wall mounted cantilever brackets.

Remarks: outlet shall be fitted with a diameter 50 mm CI S-trap.

Taps: chrome bib taps.

**W.C. Automatic Flush Sensor With Push Button Switch**

Type: Photoelectric sensor to automatically activate flush valve when user steps away from the toilet bowl.

Finishes: Grade 304 grade hairline finish stainless steel polished using 180 - 240 grit.

Fixings: Fully concealed, non corrosive fixings.

**W.C. Automatic Flush Valve**

Type: Fully concealed.

Finishes: Chromed bronze or brass casting.

Fixings: Fully concealed non-corrosive.

Remarks:

- Must deliver maximum 6.0 litre flush.
- Must be supplied complete with vacuum breaker.
- To be fully compatible with automatic flush sensor and obtained from the same manufacturer.

**Automatic Urinal Flush**

Type: Infrared detection type sensor to identify a person standing within 600mm of the urinal and send a message to flush if the detection lasts more than 5 seconds.

Finishes: Grade 304 grade hairline finish stainless steel polished using 180 - 240 grit.

Fixings: Fully concealed, non corrosive, and compatible with all adjoining metals.

Remarks:

- No user over-ride button to be provided.
- Must deliver maximum 2.5 litre flush.

**Self Closing Delay Action Tap**

Location: All wash basins except those fitted in cubicles for the disabled.

Finishes: Bronze or brass casting chromium plated.

Fixings: Fully concealed, non corrosive.

Through opening in whb.

Remarks:

- To be capable of being pressure operated by one hand using a force no greater than 22N.
- To close after supplying water for not more than 3 seconds.
- Push button to be centred on spout.

**Long Shank Basin Pillar Tap**

Location: All wash basins in cubicles for the disabled.

Finishes: Bronze or brass casting chromium plated.

Fixings: Fully concealed, non corrosive.

Through opening in whb.

Remarks:

- To be capable of being operated by one hand using a force no greater than 22N.

**Wall Mounted Bib Tap**

Location: All squat w.c. cubicles.

Finishes : Chromium plated.

Fixings: Fully concealed, non corrosive.

Remarks: To be fitted with a bidet spray and hose to allow for personal hygiene.

**Bidet Spray And Hose**

Location: All squat w.c. cubicles.

Finishes: Rubber hose, bronze or brass cast wall outlet and bracket with chromium plated finish, chromium plated metal spray and nozzle.

Fixings:

- Vandal proof connection between hose and bib tap.
- All fixings to be fully concealed and non-corrosive.
- To be supplied complete with polished stainless steel wall clip to retain shower spray head.

Hose length: 1200mm maximum.

Remarks

- Spray to be adjustable by use of lever handle at outlet.
- Hose to be clear of ground when shower head is held by bracket.
- Hose to be capable of withstanding water pressure of 17.5 bar.

**Shower Head**

Type: Heavy duty fixed angle shower head.

Location: Staff shower areas.

Finishes: Cast bronze or brass with chromium plating and matching perforated metal shower outlet.

Fixings:

- Fully concealed non corrosive.
- Flange with matching finish to be provided to cover wall penetration.

**Automatic Hand Drier**

Type: Wall mounted.

Size: 340mm wide x 300mm high, x 120mm deep, all dimensions +/- 10%.

Finishes: Vandal resistant non-plastic finish.

Colour: to contrast with background and be easily visible to people with impaired sight.

>

Fixings: To be fully concealed, non-corrosive.

Air temperature Range: 50 – 55°C.

Operating noise: less than 80 Db.

Remarks

To be capable of being operated with one hand.

To start within 0.5 – 0.8 seconds after hand is positioned within 200mm of hot air outlet.

To turn off automatically after 60 seconds maximum.

**Soap Dispenser**

Type: Recessed and wall mounted with vandal resistant refill window.

Location: adjacent to all whb's.

Capacity: 1.3 litres, minimum.

Finishes: 304 stainless steel with hairline finish polished using 180-240 grit.

Fixings: Fully concealed non-corrosive fixings.

Ironmongery:

- Full length heavy duty recessed hinge and tumbler locks on door giving access to soap container.
- Corrosion resistant valve to dispense liquid soaps lotions and detergents.

Remarks

- Enclosed soap container to allow for easy refilling.
- To be operated with one hand without grasping pinching or twisting of the wrist.
- Valve activation to require no more than a force of 22.0 N.

**Toilet Roll Dispenser**

Type: 'Jumbo' toilet roll holder with a supply status viewing window.

Location: All w.c cubicles.

Size: 285mm dia. x 110mm depth +/- 10%.

Capacity: rolls of 400.0m with spindle of 45mm.

Finishes: 304 stainless steel with hairline finish polished using 180-240 grit.

Fixings: Fully concealed non-corrosive.

**Baby Changing Shelf**

Type: Fold down complete with pneumatic shock absorber.

Location: In all disabled toilets except those opening off male toilets.

Size: 900mm wide, 100mm deep, projecting 510mm when open.

Finishes: High impact plastic.

Fixings: Fully concealed non-corrosive.

Remarks:

- To be fitted with baby holding straps.
- To be devoid of sharp corners.
- To be shaped to conform with child's body.
- To be capable of being opened and closed with one hand.

**Sanitary fixtures schedule**

Location	Fixture	Description
>	>	>
>	>	>
>	>	>

**320.4 EXECUTION**

**320.4.1 SANITARY PLUMBING**

**Soil, waste and ventilating pipework**

Refer to the Authority’s standard specification Section 21.3, pipes and fittings for sanitary system.

**Cold water supply pipework**

Refer to the Authority’s standard specification Section 21.2, pipes and fittings for water supply.

**Pipe support schedule**

Location	Type	Maximum spacing (mm)	Fixing method
>	>	>	>
>	>	>	>
>	>	>	>

**Traps**

Type: >  
 Material: >  
 Dimensions (mm): >

**320.4.2 PIPING**

**Finishes**

General: All piping in public areas to be concealed.

Finish exposed piping in plant and staff areas, including fittings and supports, as follows:

- In locations such as toilet and kitchen areas: Chrome plate copper piping to AS 1192 service condition 2, bright.
- In concealed but accessible spaces (including cupboards and non-habitable enclosed spaces): Leave copper unpainted except for identification marking. Prime steel piping and iron fittings.

Valves: Finish valves to match connected piping.

**320.5 COMPLETION**

**320.5.1 COMPLETION**

**General**

Cross refer: Item 20.5 ‘Completion’ of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 ‘Operation and Maintenance Manuals’ of the General Requirements.

**Protection**

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Protect all completed items on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage sanitary ware from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

Ensure site personnel do not make use of sanitary ware prior to handover.

**Damage**

Replace damaged items with new.

**Warranties**

Warrant the materials and workmanship using the Authority’s standard warranty form for the period(s) stated in Item 20.5.1 ‘Warranties’ of the General Requirements.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**320.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

**330 PAINTING**

**330.1 GENERAL**

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**330.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

Refer to the LTA Materials and Workmanship Specification for Civil and Structural Works for paint on structural metalwork.

**Associated worksections**

Conform to associated worksections as follows:

- Heavy duty galvanised coatings.
- Civil and Structural Works.
- Brick and Block Construction.
- Concrete Finishes.
- Metals and Prefinishes.

**330.1.2 STANDARDS**

**General**

Painting: Comply with the recommendations of those parts of AS/NZS 2311 and AS/NZS 2312 which are referenced in this section.

**330.1.3 INTERPRETATION**

**General**

Steelwork: refers to all fabricated work, including castings, of a structural or general nature, in grades of steel other than stainless steel.

Aluminium: refers to all fabricated work, including castings, of a structural or general nature, in aluminium.

Paint System: refers to a series of compatible paint coats applied to a substrate and which, together, constitute a protective system for that substrate.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**330.2 QUALITY**

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**330.2.1 INSPECTION**

**General**

Paintwork shall be inspected from a distance of 1800mm. under the specified permanent artificial luminance or 400 lux, whichever is greater.

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- Completion of all sample panels.
- Completion of all preparatory work.
- After application of all coats.
- Paintwork prior to the installation of protection.

**Hold points**

Completion of prototypes.

Completion of prototype repair on all damaged paintwork.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**330.2.2 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, ‘Tests’ of the General Requirements.

Test substrates for moisture using an electronic moisture meter accepted by the Engineer.

- Abrasion resistance to >
- Sealant compatibility: To ASTM C1087.
- Fire retardant paintwork to AS/NZS 1530.3.
- UV resistance to
- Algae Resistance: To SS 345: 1990.
- Washability: To SS5 Part FB: 1992.

Methods of tests for paints and related materials : to SS 5.

**330.2.3 SAMPLES**

**General**

Submit samples of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

**Coated samples**

Submit, on representative substrates, 1 m<sup>2</sup> samples of each coating system showing surface preparation, colour, gloss level, texture, and physical properties. Show the completed surface on 50% of the sample. Layer the remaining 50% to show each stage of the paint build up.

**Coated samples schedule**

Substrate	Paint system	Colour	Sample size
>	>	>	>
>	>	>	>
>	>	>	>

**330.2.4 PROTOTYPES**

**General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, ‘Prototypes’ of the General Requirements.

**Confirmation Prototypes**

Provide a confirmation prototype for all paints and substrates.

- Location: As agreed with the Engineer.
- Minimum size (face of panel): Full size painted panel, or as directed by the Engineer.
- Incorporating
- Sealants at joints as agreed with the Engineer.

Provide a confirmation prototype for all repairs to damaged paintwork.

Retain all prototypes until the completion of the works or as directed by the Engineer.

**330.2.5 SUBMISSIONS**

**General**

Make all submissions in accordance with the requirements of Section 20.3.6, ‘Submissions’ of the General Requirements.

**Subcontractors**

Submit name and contact details of proposed specialist painting subcontractor(s).

**Manufacturers’ information**

Technical Literature: Submit the manufacturer’s technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, ‘Submissions’ of the General Requirements.

Instructions: Submit copies of relevant manufacturers’ instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

No. of copies to be submitted: 3.

### **Test Reports**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.  
No. of copies to be submitted: 3.

### **Materials and components**

Submit statements from the manufacturers of the paint certifying that the substrate and sealant materials, and environment for the completed paintwork.

- will not be detrimental to the long term performance, weathering capabilities and visual qualities of the paint;

Painter's data: Submit the painting subcontractor's statement certifying that the substrate is suitable for the application of paint.

### **Method Statement**

Submit method statements in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

## **330.3 MATERIALS**

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### **330.3.1 MATERIALS AND COMPONENTS**

#### **General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

#### **Paints**

Provide PSB accepted paint systems.

#### **Algae Resistant Emulsion paint**

To SS 345.

#### **Gloss enamel**

To SS 7.

#### **Undercoat paint for gloss enamel**

To SS 34.

#### **Aluminium paint**

To SS 37.

#### **Lead and chromate free primers for Iron and Steel substrates**

To SS 494.

#### **Combinations**

General: Do not combine paints from different manufacturers in a paint system.

#### **Delivery**

Deliver paints to the site in the manufacturer's labelled and unopened containers.

#### **Storage**

Store all paint in a secure ventilated area away from other building products.

Do not store paint in underground locations.

Ban all smoking and naked flames in the vicinity of stored paint.

#### **Tinting**

General: Provide only products which are colour tinted by the manufacturer or supplier.

#### **Colour Selection**

Use standard colours from:

BS4800.

German RAL range.

SS 269.

#### **Putty**

General: Polymeric based.

Do not provide oil based or glazing putty.

**Fillers**

Use proprietary fillers intended for the background and accepted by the Engineer.

**Mineral Solvents**

To SS 88.

**Extenders for paints**

To SS 89.

**Solvent based paint removers**

To SS 91.

**Toxic ingredients**

Do not use paints containing pigments incorporating barium or cadmium.

Do not use paints containing toxic solvents.

Do not use lead based paints.

Do not use paints containing mercury.

**330.4 EXECUTION**

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**330.4.1 PAINTING**

**Standards**

General: To SS CP 22.

Protection of steelwork: To AS/NZS 2312 Sections 4, 8 and 10.

**Order of work**

Other trades: Before painting, complete the work of other trades as far as practicable within the area to be painted, except for installation of fittings, and laying flooring materials.

Do not paint when plastering is in progress or is drying.

Do not apply external paint under adverse weather conditions, for example, extremes of temperature, or rain and mist.

**Adequate lighting**

Provide the specified permanent artificial luminance or 400 lux, whichever is greater throughout the entire painting works.

**Protection**

Fixtures: Remove door furniture, switch plates, light fittings and other fixtures before starting to paint, and refix in position undamaged on completion of the installation.

Do not mask door furniture, switch plates, light fittings and other fixtures before starting to paint.

Adjacent surfaces: Protect adjacent finished surfaces liable to damage from painting operations. Use drop sheets of adequate size and thickness.

Do not store, mix or stir paint in areas or on surfaces liable to damage.

Prohibit access to areas being painted to all but painting operatives.

**“Wet paint” warning**

Place notices conspicuously and do not remove them until paint is dry.

**Restoration**

Clean off marks, paint spots and stains progressively and restore damaged surfaces to their original condition. Touch up damaged decorative paintwork or misses only with the paint batch used in the original application and using the original method of application.

**Substrate preparation**

General: Prepare substrates to receive the painting systems in accordance with the recommendations of the system manufacturer.

Cleaning: Clean down the substrate surface. Do not cause undue damage to the substrate or damage to, or contamination of, the surroundings.

Filling: Fill cracks and holes with fillers, sealants, putties or grouting cements as appropriate for the finishing system and substrate, and sand smooth.

Clear finish: Provide filler tinted to match the substrate.

Ensure the moisture content of the substrate does not exceed the system manufacturer’s recommendations.

Test moisture content using an electronic moisture meter.

Brush down all surfaces immediately prior to decorating to remove dust, dirt and loose materials.

**Preparation schedule**

Substrate	Preparation	Paint type
Concrete	Remove all projecting nibs, scrape and brush down. Make good any defective joints.	Mineral silicate >
Mild Steel	to Swedish Standard SA 2½.	Epoxy Polysiloxane >
Render	Cut out and fill all cracks. Finish filler with a texture to match the background.	>
>	>	>

**Paint application**

Apply paint in accordance with the manufacturer's published instructions and data sheets.

Apply paint by brush or roller to match the method used in the preparation of the appropriate sample and prototype panels.

Do not use spray application in underground areas.

Prime backs of frames and bottom of doors before fixing.

Prime rebates and beads before glazing.

Prime and paint or seal putty after glazing and extend coating on to glass up to sight line.

Apply a different tint for each underscoat.

Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Ensure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture, and free of runs, sags, blisters, or other discontinuities.

**Services**

Paint services and equipment in statutory colours.

Do not paint chromium, stainless steel, or non-metallic flexible materials and normally lubricated machined surfaces.

**Repair of galvanizing**

General: For galvanized surfaces which have been subsequently welded: Power clean the affected area to AS 1627.2, Class 3.

Degrease and remove all surface contaminants.

Apply 2 coats zinc rich primer, 50% solids by volume to a minimum dry film thickness of 100 microns.

Stipple edges of painted area to achieve the optimum appearance of the repair.

**Factory applied coatings**

All paint on steelwork or aluminium shall be factory applied prior to the delivery of fabricated work to the site unless agreed with the Engineer.

Do not transport or handle assemblies until the paint is dry.

Protect the paintwork during transport and handling.

**Repair of damaged paintwork**

Reinstate damaged paintwork to match surrounding undamaged surfaces.

Repaint entire surfaces where it is not possible to match the surrounding surfaces to the Engineer's satisfaction.

Repaint all areas subject to condensation damage.

**Protection**

Protect all completed paintwork until handover to the client.

**330.4.2 PAINT SYSTEMS**

**Paint system description**

Final coat: If a paint is referred to only by its final coat (for example by the generic name) provide in addition to the final coat, the manufacturer's recommended stains, primers, sealers and undercoats, suitable for the substrate and compatible with the finish coat and each other.

No system description given: If a surface is to be painted but no system is nominated select the system from AS/NZS 2311 clause 5.1, using System 1 where a choice is offered.

**Number of coats**

Unless specified as one coat or two coat systems, each paint system consists of at least 3 coats.

Provide additional coats if necessary to

- prepare porous or reactive substrates with prime or seal coats consistent with the manufacturer’s recommendations;
- achieve the total film thickness or texture; or
- achieve a satisfactory opacity.

**Tinting**

Ensure each coat of an opaque coating system has a noticeably different tint from the preceding coat, except for top coats in systems with more than one top coat.

**Access panels**

Match the paint system used on the walls/ceiling in which the panel occurs.

**Interior painting schedule**

Surface identification	Substrate	Paint system	Colour name or code
>	Concrete	Mineral Silicate	>
>	Masonry	Waterborne Epoxy Polyamide	>
>		Acrylic Emulsion	>
>	Render	Waterborne Epoxy Polyamide	>
>		Acrylic Algae Resistant Emulsion	>
>	Calcium Silicate and Fibre Cement Board	Acrylic Algae Resistant Emulsion	>
>	Mild steel	Epoxy Polysiloxane	>
>		Polyurethane	>
>		Micaceous Iron Oxide	>
>	Galvanised steel	Epoxy Polysiloxane	>
>		Polyurethane	>
>	Aluminium	Polyurethane	>
>	>	>	>

**Exterior painting schedule**

Surface identification	Substrate	Paint system	Colour name or code
>	Concrete	Mineral Silicate	>
>		Algae Resistant Resin Emulsion sprays with texture additives	>
>	Mild steel	Epoxy Polysiloxane	>
>	Galvanised steel	Epoxy Polysiloxane	>
>	>	>	>

**Paint systems schedules**

General: These schedules specify, for each of the paint systems listed in the **Painting schedules**, and for each substrate to which those systems are applied in the project,

- the number and order of coats;
- the paint type for each coat; and
- the minimum dry film thickness for each coat, where applicable.

Paint type: **Mineral Silicate**

Substrate	Primer	1st Coat	2nd Coat	3rd Coat
Pre-cast concrete	--	Mineral Silicate	Mineral Silicate	--
In-situ Concrete	--	Mineral Silicate	Mineral Silicate	--

### 330 PAINTING

Paint type: <b>Mineral Silicate</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
>	>	>	>	>

Paint type: <b>Epoxy Polysiloxane</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
Mild Steel	>	>	>	>
Galvanised Mild steel	>	>	>	>
>	>	>	>	>

Paint type: <b>Waterborne Epoxy Polyamide</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
Masonry	>	>	>	>
Render	>	>	>	>
>	>	>	>	>

Paint type: <b>Algae Resistant Acrylic Emulsion</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
Concrete	>	>	>	>
Masonry	>	>	>	>
Render	>	>	>	>
>	>	>	>	>

Paint type: <b>Micaceous Iron Oxide</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
Mild Steel	>	>	>	>
>	>	>	>	>

Paint type: <b>Polyurethane</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
Mild Steel	>	>	>	>
Galvanised Steel	>	>	>	>
Aluminium	>	>	>	>
>	>	>	>	>

Paint type: <b>Algae Resistant Resin Emulsion sprays with texture additives</b>				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
External Concrete	>	>	>	>
>	>	>	>	>

Paint type: >				
Substrate	Primer	1st Coat	2nd Coat	3rd Coat
>	>	>	>	>
>	>	>	>	>
>	>	>	>	>
>	>	>	>	>

**330.4.3 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Protection**

Protect all completed paintwork on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

**Cleaning**

Remove all protection and leave paintwork free from defects, and in good condition.

**Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

Warrant all paintwork against:-

- Peeling.
- Flaking.
- Blistering.
- Cracking.
- Fading.
- Discolouration.
- Fungus Growth.
- >

**Operation and Maintenance manual**

Submit manufacturers' published recommendations for service use.

Include the following in the maintenance manual:-

- Schedule of materials used in the paint systems identifying manufacturer's name and contact details, location of paint system, colours used.
- >

**330.4.4 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>340 METAL FIXTURES</b>
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**340.1 GENERAL**

**340.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

Conform to the LTA Materials and Workmanship Specification for Civil and Structural Works for structural metalwork.

**Associated worksections**

Conform to associated worksections as follows: Metals and Prefinishes.

- Heavy Duty Galvanised Coatings.
- Adhesives, Sealants and Fasteners.
- Glazing.
- Painting.
- Gratings.

**340.1.2 CIVIL DEFENCE (CD) REQUIREMENTS**

**General**

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

**340.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**340.1.4 INTERPRETATION**

Fixing: the term 'fastener' shall be taken to mean:-

- Supporting fixings that transfer the self weight of the fixture to the structure. Supports may also include a restraint function.
- Restraint fixings: Fixings that tie back the fixture to the structure and resist variable loads such as crowd loads.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**340.1.5 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**340.1.6 MOVEMENT**

**General**

General: Provide for deflections, displacements and other movements within the building, including movements caused by ambient temperature changes, crowd loads, design dead and live loads and shrinkage.

Ensure that there will be no failure of seals or fasteners, or other damage as a result of the loads identified.

Accommodate movements silently and without permanent deformation, reduction of performance, or other detrimental effects such as

- damage to or undue stress on fixtures.
- failure of joints.

Ambient temperature range (°C): 20 – 40°C.

**Building movements**

- General: See the Civil and Structural Materials and Workmanship Specification: clauses >

**Deflection limits**

Restrict the maximum deflection/span ratios of members subject to the identified loads to the performance requirements of AS/NZS 4284, except that

- the deflection/span ratio of the member will be restricted to a maximum of 1:360; and

- restrict the deflection of the cantilevered end of a cantilevered structural member of cantilever length L to the maximum given in the Civil and Structural Materials and Workmanship Specification clauses >.

**Loads**

For details of crowd loads see the Civil and Structural Materials and Workmanship Specification clauses >.

**340.2 QUALITY**

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**340.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- Examples of the fabricator's previous work.
- Fabricator's workshop prior to the start of work.
- Shop fabricated or assembled items ready for delivery to the site.
- Commencement of shop or site welding.
- Site erected assemblies on completion of erection, before covering up by cladding and encasing.
- Surfaces prior to factory applied finishes.
- Steel surfaces prepared for, and immediately before, site applied finishes.

**Hold points**

- Completion of all prototypes.

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**340.2.2 TESTS**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

**Weld testing**

Cross refer: Civil and Structural Materials and Workmanship Specification: sections >

**340.2.3 SAMPLES**

**General**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

Submit samples of the following:

- Each type of joint.
- Each type of finish.
- Sections for use in fabricated work.
- Each fabricated component.

Size of samples.

- Panels: minimum 600mm sq.
- Linear samples : minimum 600mm.
- Components: as required.

**340.2.4 PROTOTYPES**

**General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

**Design prototype**

Provide design prototypes of all fixtures:

Location:

As agreed with the Engineer.

Minimum size (mm):

As required by the fixture.

Incorporating (where applicable)

- Horizontal and vertical joints.
- Edge details as directed.
- Interfaces as directed.
- Internal and external corners.
- >

**Confirmation prototype**

Provide confirmation prototypes of all fixtures:

Location:	As agreed with the Engineer.
Minimum size (mm):	As required by the fixture.
Incorporating (where applicable)	<ul style="list-style-type: none"><li>- Horizontal and vertical joints.</li><li>- Edge details as directed.</li><li>- Interfaces as directed.</li><li>- Internal and external corners.</li><li>- &gt;</li></ul>

Retain all prototypes until the completion of the works or as directed by the Engineer.

**340.2.5 SUBMISSIONS**

**General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

**Subcontractors**

Submit name and contact details of proposed manufacturers and installers.

**Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Shop drawings shall show, but not be limited to, the following information:

- General arrangement drawings to show the location of all fixtures.
- A numbering system enabling all fixtures to be identified.
- Details of fabrication and components.
- Information necessary for site assembly.
- Interfacing details.
- Provisions for equipotential bonding.
- Provisions for items supplied as part of a System Wide Contract.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Submit calculations and drawings from a Singapore licensed Professional Engineer in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Materials**

Stainless steel: For each batch of stainless steel supplied to the works, submit the certificate of compliance or test certificate specified in the applicable standard.

**Execution**

Welding procedures: Submit details of proposed welding procedures before fabrication.

Welding dissimilar metals: Submit the following details:

- Type and thickness of materials to be welded.
- Proposed joint preparation and welding procedures.
- Proposed filler metal.
- Expected dilution (proportion of fused parent metal in the weld metal).

Fastenings to aluminium (including aluminium alloys): If cadmium-plated steel fastenings are proposed, submit proposals.

**Tests**

Submit reports of all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.  
No. of copies to be submitted: 3.

**Method Statement**

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

**340.3 MATERIALS**

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**340.3.1 General**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use products which give off toxic emissions in the event of a fire.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**340.3.2 MATERIALS AND COMPONENTS**

**Metals**

Performance: Provide metals suited to their required function, finish and method of fabrication, in sections of strength and stiffness adequate for their purpose.

Performance: Provide metals so that they transmit the loads imposed and ensure the rigidity of the assembly without causing deflection or distortion of finished surfaces.

Incompatible metals: Separate using concealed layers of suitable materials in appropriate thicknesses.

**Copper alloys (brass, bronze, etc.)**

Cross refer: Metals and Prefinishes.

**Fasteners**

Performance: Provide fasteners so that they do not cause galvanic corrosion.

Materials: Provide fasteners in materials of mechanical strength and corrosion resistance at least equal to that of the lowest resistant metal joined.

To copper and copper alloys: Provide copper or copper-alloy fixing devices only.

To aluminium and aluminium alloys: Provide aluminium alloy or non-magnetic stainless steel fixing devices only.

To stainless steel: Provide appropriate stainless steel materials only.

**Stainless Steel**

**Surface finish**

Type: Cross refer: Metals and Prefinishes.

Finish: Continuous hairline achieved using a 180-240 grit size.

>

**Fixings**

**General**

Cross refer : Adhesives, Sealants and Fasteners.

**340.4 EXECUTION**

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**340.4.1 CONSTRUCTION GENERALLY**

**Aluminium structures**

Standard: To AS/NZS 1664.1 or AS/NZS 1664.2.

**Fabrication**

Workshop: Fabricate and pre-assemble items in the workshop wherever practicable.

Edges and surfaces: Keep clean, neat and free from burrs and indentations. Remove sharp edges without excessive radiusing.

Tube bends: Form bends in tube without visibly deforming the cross section.

Colour finished work: Match colours of sheets, extrusions and heads of fasteners.

Thermal movement: Accommodate thermal movement in joints and fastenings.

**Fabrication tolerances**

Structural work generally:  $\pm 2$  mm.

**Joints**

General: Fit joints to an accuracy appropriate to the class of work. Finish visible joints made by welding, brazing or soldering using grinding, buffing or other methods appropriate to the class of work, before further treatment.

Self-finished metals: Free of surface colour variations, after jointing.

Joints: Fit accurately to a fine hairline.

**Marking**

Provide suitable and sufficient marks or other means for identifying each member of site-erected assemblies, and for their correct setting out, location, erection and connection. Mark bolted connections to show the bolting category. Do not mark stainless steel by notching.

**Splicing**

Provide structural members in single lengths.

**340.4.2 WELDING AND BRAZING**

**General**

Quality: Provide finished welds which are free of surface and internal cracks, slag inclusion, and porosity.

Site welds: Do not weld on site.

Butt weld quality level: Not inferior to the appropriate level recommended in AS 1665 Appendix A.

**Finishing**

Visible joints: Finish visible joints made by welding, brazing or soldering using methods appropriate to the class of work (including grinding or buffing) before further treatment such as painting, galvanizing or electroplating. Ensure self-finished metals are without surface colour or textural variations after jointing.

**Brazing**

General: Ensure brazed joints have sufficient lap to provide a mechanically sound joint. Do not use butt joints relying on the filler metal fillet only.

Filler metal: >

**340.4.3 STAINLESS STEEL FABRICATION**

Welding stainless steel.

Certification of welders: To AS 1796.

**Riveting**

Riveting may be used only to join stainless steel sheet or strip less than 1 mm thick. Drill (not punch) the rivet hole, and drive the rivet cold. On completion, clean and passivate the riveted assembly.

**Soldering**

Do not solder stainless steel.

**340.5 COMPONENTS**

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**340.5.1 PLATFORMS AND WALKWAYS**

**Standard**

Materials, design and construction: Comply with the recommendations of AS 1657.

**Design loads (kPa):** Cross Refer Civil and Structural Materials and Workmanship Specification: clauses >

**Material** >

**Prefinish** >

**Flooring type** >

**Kickplate (toe board)**

Required height (mm): >

**Fixing method** >

**340.5.2 HANDRAILS & BALUSTRADES**

**Standard**

Materials, design and construction: Comply with the recommendations of AS 1657.

**Design**

As shown on drawings.

**Fabrication**

Method: Welding.

>

Joints: Produce smooth unbroken surfaces at joints. On welded joints scribe the joints between posts and rails. Make end-to-end joints over an internal sleeve.

Bends:

- Make changes of direction in rails by evenly curved pipe bends.
- Where handrails are bent to a large radius to follow a curve on plan, ensure that the radius continues in a smooth unbroken line across all joints in the handrail. 'Segmented' curves will not be accepted unless they are identified as such on the design drawings.

Free ends: Seal the free ends of pipes with fabricated or purpose-made end caps.

Ensure no extraneous materials are trapped within the pipes prior to sealing.

**Fixing to structure**

Provide fabricated predrilled or purpose-made brackets or post bases, and attach the pipework to the building structure with fixings, including bolts into masonry anchors, and coach screws or bolts into timber, of metal compatible with the pipework.

**Galvanizing**

Cross Refer: Heavy Duty Galvanised Coatings.

**340.5.3 SERVICE GATES**

**Design**

As shown on drawings.

**Fabrication**

General: Fabricate all service gates in controlled workshop conditions.

Method: Welding.

**Ironmongery**

Provide for fixing ironmongery including hinges and, using backplates and lugs sufficient to carry the weight of the gates and the forces acting on it. Screw fix the hinges into tapped holes in the back plates.

Hinges: provide steel rising but hinges to match the material of the gate, complete with matching screw fixings.

**AMS Locking**

Provide all required reinforcement within the gate to cope with the AMS locks provided under a System Wide Contract.

Co-ordinate with the System Wide Contractor to ensure that all necessary provisions have been made.

**340.5.4 METAL STAIRS**

**Standard**

Materials, design and construction: Comply with the recommendations of AS 1657.

**Service access stairs**

Location: >

**Service access stairs materials and finishes schedule**

Item	Location	Material	Finish
>	>	>	>
>	>	>	>
>	>	>	>

**340.5.5 FIXED LADDERS**

**Standard**

Materials, design and construction: Comply with the recommendations of AS 1657.

**Fixed ladders schedule**

Ladder type	FL1	FL2	FL3
Location:	>	>	>
Metal:	>	>	>
Finish:	>	>	>
Landing surface:	>	>	>
Ladder cage:	>	>	>
Safety device:	>	>	>

**Fixing**

Fix ladder stiles securely to the building structure at tops and bottoms of flights, and at intermediate points.

**340.5.6 CORNER PROTECTION**

**General**

Provide metal corner protection

- fitting close to adjoining surface finishes;
- solidly grouted up at the back to eliminate voids; and
- securely fixed by a method which does not cause distortion in the metal surface, and consists of either concealed built in lugs, or flush countersunk head fixings into masonry anchors.

**Location**

>

**Material**

>

**Dimensions (mm)**

Height:

>

Angle leg length:

>

Sheet thickness:

>

Corner radius:

>

**Finish**

>

**Fixings**

Type:

>

Material:

>

**340.6 COMPLETION**

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**340.6.1 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Maintenance manual**

Submit a maintenance manual including recommendations for the care and maintenance of the metal fixtures, with instructions for demounting and relocation where applicable. Include a list of manufacturers and suppliers of the various components incorporated into the fixtures.

**Protection**

Protect fixtures against all forms of damage until handover.

On or before completion of the works, or before joining up to other surfaces, remove all materials used as a means of protection.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the fixtures from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

**Damage**

Replace damaged elements with new.

**Warranties**

Warrant the all fixtures as part of the item in which they are used using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

**340.6.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>350 FURNITURE AND FITTINGS</b>
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**350.1 GENERAL**

**350.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows: Quality.

Adhesives, Sealants and Fasteners.

Metals and Prefinishes.

**350.1.2 INTERPRETATION**

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**350.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**350.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**350.2 QUALITY**

**350.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Custom-built furniture items fabricated and ready to be delivered to the site.
- Furniture items delivered to site before installation.
- Building locations or substrates prepared to receive furniture before the furniture is installed.

**Hold points**

- Completion of prototypes.
- >

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**350.2.2 STANDARDS**

Provide furniture and fittings in accordance with the following standards:

- >

**350.2.3 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

**Fire hazard limits**

Non combustible to BS476: Part 4.

An index of performance (I) not exceeding 12 and a sub-index (i) not exceeding 6 when tested to BS 476:Part 6.

**Weighted sound reduction index (R<sub>w</sub>)**

Movable office and workstation screens: Type test screens required to have a particular weighted sound reduction index (R<sub>w</sub>) rating, to AS/NZS 1276.1.

**350.2.4 SAMPLES**

**General**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

Submit samples, each at least 300 x 300mm, showing specified properties and the range of variation

- All materials intended for use in custom built furniture and fittings.

- All accessories and ironmongery items.
- All fixings.
- All joints visible in the completed works.
- All edges and corners visible in the completed works.

Size of samples

- Minimum 300 x 300mm: 600mm for linear samples.

No. of samples: 3.

### **350.2.5 PROTOTYPES**

#### **General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

#### **Design prototypes**

Provide a design prototype for the following items:

- >

Location:	As agreed with the Engineer.
Minimum size:	<ul style="list-style-type: none"><li>- Full size.</li><li>- As directed by the Engineer.</li></ul>
Incorporating	<ul style="list-style-type: none"><li>- Horizontal and vertical joints.</li><li>- Support details as directed by the Engineer.</li><li>- Interfacing materials as directed by the Engineer.</li></ul>

#### **Confirmation prototypes**

Provide a confirmation prototype for the following items:

- >

Location:	As agreed with the Engineer.
Minimum size (face of panel):	<ul style="list-style-type: none"><li>- Full size.</li><li>- As directed by the Engineer.</li></ul>
Incorporating	<ul style="list-style-type: none"><li>- Horizontal and vertical joints.</li><li>- Support details as directed by the Engineer.</li><li>- Interfacing Materials as directed by the Engineer.</li></ul>

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

### **350.2.6 SUBMISSIONS**

#### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### **Subcontractors**

Submit names and contact details of proposed suppliers and installers.

#### **Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'submissions' of the General Requirements.

Submit shop drawings of all items of furniture showing, but not limited to the following information:

- General arrangements incorporating a numbering system which will allow each piece of furniture to be separately identified.
- Schedules of all furniture giving location, numbers, type etc.
- Construction, and assembly for custom designed (non standard) furniture.
- All service installations within furniture items.
- All items provided by system wide contractors.
- Fixing details.
- Interfacing details for fixed furniture.
- The proposed layout for furniture installations.

Submit the manufacturer's standard drawings and details showing methods of construction, with dimensions and tolerances.

No. of copies to be submitted: As Particular Specification.

**Engineering endorsement**

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

**Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

**Test Reports**

Submit copies of current test reports, and certification that materials comply with the required standards in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

**Method Statement**

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

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**350.3 MATERIALS AND WORKMANSHIP**

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**350.3.1 HAZARDOUS MATERIALS**

**Fire hazard**

General: Do not provide materials which, when subject to fire conditions, will emit excessive smoke or dangerous fumes.

Do not use materials which contain known carcinogenics.

**Toxins**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

**350.3.2 MATERIALS**

**Metals Generally**

Cross refer Metals and Prefinishes.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**Steel tube**

Surface:

- For painted work: To AS 1450 Semi-bright.
- For electroplated work: To AS 1450 Bright.

**Steel sheet**

Surface finish:

- For electroplating: P (plating quality).
- For painting: B (bright) or M (matt).

**Stainless steel**

Grade:

- 316.
- 304 (internal use only).

Surface finish: continuous hairline achieved using a 180 – 240 grit size.

>

**Textile upholstery fabrics**

Standard: To AS 2687.

Performance classification (minimum): 5.

Wool and woolblend fabrics:

- Insect resistance: To IWS E-10.
- Woolmark/Woolblendmark: Required.

**Decorative overlays**

Standard: To AS/NZS 1859.3.

**High-pressure decorative laminate sheets**

Standard: To AS/NZS 2924.1.

Thickness (minimum):

- For horizontal surfaces fixed to a continuous background: 1.2 mm.
- For vertical surfaces fixed to a continuous background: 0.8 mm.
- For post formed laminate fixed to a continuous background: 0.8 mm.
- For vertical surfaces fixed intermittently (e.g. to studs): 3.0 mm.
- For edge strips: 0.4 mm.

**Solid laminate (for use in toilet areas only)**

- Type: To ANSI Z124.3 & 6, BS3794 and BS 4965.
- Tensile strength: not less than 6000 psi,
- Tensile modulus of  $1.5 \times 10^3$  psi,
- Elongation: not more than 0.4% (ASTM-D-638).
- Hardness: 94 according to the Rockwell 'M' scale.
- Water absorption shall be less than 0.04 (ASTM-D-570). There shall be no visible Boiling water resistance: no change (NEMA-LD-3.05).
- Colour stability: no change (NEMA-LD-3.10).
- Impact resistance: 0.24 ft/lbs minimum (ASTM D256, Method A).
- Flame spread: 25 maximum (ASTM D570).
- Smoke Developed: 30 Maximum (ASTM D570).

**Non-combustible board**

- Type: asbestos free calcium silicate matrix reinforced with selected fibres and fillers with a smooth sanded surface.
- Moisture movement: 0.1% maximum from ambient to saturated.
- Alkalinity: less than pH value 10.

**Adhesives**

Cross refer Adhesives, Sealants and Fasteners.

---

**350.4 SCREENS, BARRIERS**

**350.4.1 MOVABLE OFFICE SCREENS**

**Location** >

**General**

Type: Proprietary modular floor mounted screens, consisting of:-

>

Panels:

- Width (mm): >
- Height (mm): >
- Thickness (mm): >
- Floor clearance (mm): >
- Weighted sound reduction index ( $R_w$ ): >
- Curve radius (mm): >

Shelf mounting strips: >

Skirting: >

Cable ducting: >

Floor mounting: >

---

**350.5 CURTAINS, BLINDS**

**350.5.1 VERTICAL LOUVRE BLINDS**

**Location** >

**General**

Type: Louvres supported by a carrier system which traverses on wheels and operates with a friction spring loaded clutch mechanism.

Vertical blind fabrics: To AS 2663.3.

**Louvre blades**

General: Vinyl coated fabric blades in single, straight lengths finishing 10 mm above floor or sill level, without twists, warp, bows, edge ripples or fraying. Fix a weight into a pocket formed in the bottom of each blade.

Blade width (mm): >

Solar optical properties: >

**Installation**

Space the blades evenly with plastic spacers which lock into the carrier rail to provide a continuous linkage, and fix with sealed plastic slat holders carried by plastic rotation pivots. Connect the bottoms of the blades by a plastic link chain with reversers.

**Tracks**

Material: Extruded aluminium alloy 6063-TS, 1.2 mm thick.

Track size (mm): >

Track finish: >

Fixing: Secure the track to the ceiling with ceiling clamps so that there are neither light gaps nor fixings through the track.

**Operation**

General: Single bead continuous loop chain controlling the functions of tilting and drawing.

Operation mode: >

**350.5.2 VENETIAN BLINDS**

Location: >

**General**

Type: A proprietary interior mounted system for sun and daylight control of glazed areas, comprising

- horizontal slats, at least ten per 300 mm, of thermoset pre-coated aluminium, spring tempered, with a yield strength of at least 350 MPa, capable of withstanding a 180° bend of 35 mm diameter without permanent deformation;
- rigid thermoset pre-coated aluminium top and bottom slats;
- polyester fibre cords and ladders for location and control; and
- cord control of tilting, raising, lowering and locking in raised or part raised positions.

**350.5.3 BLACKOUT CURTAINS**

Location: >

**350.6 CONTAINERS, BINS, CABINETS**

---

**350.6.1 LETTER BOX**

**Type**

Proprietary stainless steel letter box compliant with Singapore Post's 'Letter boxes, Guidelines and General Information' with weatherproof body, weather protected letter slot, lockable hinged door, etched and coloured unit number in Ocean Sans font, and accessories necessary for correct installation.

**350.6.2 WASTE BINS**

**General**

The internal form and surface of the bin shall not trap the contents when the bin is being emptied.

Type: Free standing : round.

Material: Stainless steel complete with cover and aluminium liner.

Accessories: Sticker logo 150 x 150 mm: design to be provided by the operator.  
Integral weight of approximately 8.5 kg for stability.  
Stainless steel ashtray cum stubbing plate on top of the bin cover. Ensure water does not collect in the ashtray.

Minimum Capacity 40 litres.  
85 litres.

**350.7 SHELF UNITS**

---

**350.7.1 Steel shelving**

Standard: To AS 2143.

Finish to steel:

>

- shelf height adjustable in increments not exceeding 50 mm;
- shelves capable of carrying a minimum uniformly distributed load of 55 kg/m of span, without deflection exceeding 5 mm; and
- other accessories necessary for the satisfactory erection and service use of the shelving.

**Arrangement**

Type:

>

Layout:

>

Bay width (mm):

>

Shelf depth (mm):

>

**Accessories**

>

**350.8 DISPLAY SURFACES**

---

**350.8.1 PINBOARDS**

**Location**

>

**Pinboard panels**

Thickness: At least 6 mm.

Facing: Felt.

Board: Fibre insulating board to AS/NZS 1859.4 (Int).

Backing: Fix board to a 6 mm calcium silicate backing with a synthetic resin adhesive accepted by the Engineer.

Size (mm):

>

Trim: Trim the edges of the pinboard panels with clear anodised aluminium sections, mitred at corners.

**Installation**

Attach the panels to building substrates with

- wallboard adhesive to AS 2329;
- fasteners capable of transmitting the loads imposed, and sufficient to ensure the rigidity of the assembly.

**350.8.2 WHITEBOARDS**

**Location**

>

**Whiteboard panels**

General: White seamless vitreous enamel surface on sheet steel base, resistant to chipping and fracture when the base is slightly flexed, fixed with a suitable contact adhesive to a backing of calcium silicate at least 9 mm thick.

Size (mm):

>

Surface: Suitable for use with fast-evaporation, dry-erase pens.

Edges: Trim the edges of the panels with clear anodised aluminium sections mitred at corners.

Pen rails: Proprietary aluminium section fixed to the full width of the bottom edge of the board.

**Installation**

Attach the panels to building substrates with

- wallboard adhesive to AS 2329;
- fasteners capable of transmitting the loads imposed, and sufficient to ensure the rigidity of the assembly.

**350.8.3 RETRACTABLE PROJECTION SCREENS**

**Location**

>

**General**

Type: Proprietary extendible screen system for front projection, mounted so as to be fully retractable when not in use.

Screens: Flexible synthetic fabric, flame retardant and mildew resistant, presenting a flat plane surface when extended.

Screen surfaces: Textured to control the distribution of projected light evenly over a wide viewing angle.

- Type: Motorised.

Finishes: Metal components factory prefinished by plating, anodising, or a thermoset powder coating.

Size (mm): >

**Hanging types**

A screen system extendable from a top roller, suspended from proprietary hanging brackets fixed to the building structure, with provision for mechanical locking in the fully or partially extended pull-down positions.

**Motorised screens**

Screen extension and retraction operated by an electric motor mounted in the roller, activated by a limit switch with automatic stops in the terminal (up or down) positions, and at adjustable preset intermediate positions.

**Accessories** >

**350.9 WORKSTATIONS**

**350.9.1 WORKSTATIONS**

**Location** >

**General**

A system comprising an assembly of demountable acoustic screens, work tops, mobile pedestal or credenza storage units, drawer units, individual bookshelves, ceiling ducted services with power poles or floor ducted cable enclosures, and accessories necessary for satisfactory assembly and installation.

**Standard**

General: AS/NZS 4443.

**Screens**

Core material: >

Finish: >

Height (mm): >

R<sub>w</sub> rating: >

**Work surfaces**

Core material: >

Finish: >

Height (mm): >

Height adjustment: >

**Skirtings**

Material: >

Finish: >

Height (mm): >

**Accessories** >

**Dimensional tolerances (maximum)**

No misalignment (of adjoining surfaces at junctions)

Deviation (from true grid lines and planes): 1:1000 or 3 mm.

Screen thickness: + 1 mm, - 0 mm.

**Strength and stability**

Imposed loads: Provide a screen system which

- will support the designated imposed eccentric loads (e.g. loads on attached shelves or brackets); and
- deflects under designated imposed eccentric loads less than 1:1000 or 3 mm, whichever is the lesser.

Imposed eccentric loads: >

**Installation**

Install each workstation system in its required location

- using concealed fixings; and
- so that the components of the system may be demounted and reassembled using standard hand tools, or special tools supplied as part of the system.

**Serviced equipment**

General: If equipment requiring connection to power, telex, computer, telephone or other services is to be installed as part of the workstation system, make the necessary service connections.

Keyboard supports: Fit the keyboard support section of computer equipment with a mechanism capable of being operated by a seated person to raise and lower the keyboard above or below the level of the work surface.

**350.10 BUILT-IN CUPBOARDS AND FITMENTS**

---

Material: calcium silicate with laminate finished surfaces  
 Size: as shown on the drawings.  
 Accessories: all necessary hinges, catches, pull handles, drawer runners, shelf pins and the like and with all associated bearers and fixings.

**350.11 BENCH TOP AND VANITIES**

---

**Support Framing**

Type Fully concealed.  
 Material Stainless steel (wet areas only).  
 Galvanised steel.

**Top**

Material  
 - Stone: Type >  
 Finish >  
 - Solid Laminate Thickness.  
 Colour.  
 Upstand Provide upstand at all junctions with walls.  
 Height >  
 Fascia Provide fascia at all exposed edges.  
 Depth >  
 Cut-outs To suit basins and taps.  
 Remarks Provide raised lipping along all edges to prevent spillages falling to the floor.

**350.12 LOOSE FURNITURE**

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**350.12.1 LOOSE FURNITURE**

**Fixed height chairs**

Standard: To AS/NZS 4688.1.

AFRDI Blue Tick: >

**Height adjustable swivel chairs**

Standard: To AS/NZS 4438.

AFRDI Blue Tick: >

**350.12.2 WORKMANSHIP**

**General**

Fabricate and pre-assemble all purpose made items in the workshop prior to delivery to site.  
 Fabricate all worktops as entire lengths in the workshop then cut at points agreed with the Engineer to facilitate delivery to site.  
 Provide all necessary templates, lining blocks, stops and the like.  
 Undertake all trimming, tonguing, and mitring etc incidental to the work even though not specifically mentioned.  
 Construct all components square and install plumb.  
 Ease and adjust moving parts.  
 Lubricate all hardware.  
 Frame, trim and provide openings required for services.  
 Ensure fixings will not be visible in the coimpleted work unless previously agreed with the Engineer.

**Dimensions**

Check all dimensions on site prior to fabrication.

**Fabrics**

Fabric surfacing: Prepare and apply so that the finished surface is smooth and without irregularities.

Fabric upholstery: Make the front of the upholstered component in one piece between pipings, if any, with side joins at the rear or underside. Fix with upholsterer's staples.

Piping: 3 mm diameter beads with core.

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**350.13 COMPLETION**

**350.13.1 COMPLETION**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Protection**

Protect all furniture and fittings from damage prior to the handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the granite from finding their way between the protection and the floor finish below. Check and remove all such items regularly.

Remove all materials used as a means of protection immediately prior to handover and clean all furniture and fittings.

**Damaged Items**

Inspect all furniture and fittings on site and identify all damaged items and all items not in compliance with this specification.

Damage on the face of furniture and fittings or on surfaces exposed to view will not be accepted and all items deemed by the Engineer to be damaged shall be replaced.

Carry out remedial work only following the Engineers acceptance and in accordance with the panel manufacturer's printed instructions.

**Warranties**

Warrant the materials and workmanship as part of the item in which the furniture and/or fitting has been used using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**Operation and Maintenance manual**

On completion submit an Operation and Maintenance Manual in accordance with item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements. Submit the manufacturers'

- recommendations for demounting and relocation;
- recommendations for service use, care and maintenance; and
- list of manufacturers and suppliers of replacement parts.

**360 SIGNS, ADVERTISING AND DISPLAY**

**360.1 GENERAL**

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**360.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows:

Land Transport Authority Signage Design Guidelines Manual.

Adhesives, Sealants and Fastenings.

Metals and Prefinishes.

**360.1.2 CIVIL DEFENCE (CD) REQUIREMENTS**

**General**

Where stations are identified as having Civil Defence (CD) requirements, refer to the CD Design Criteria for requirements and information relating to the upgrading of materials, material thicknesses, composition and fixing methods for CD stations.

**360.1.3 EQUIPOTENTIAL BONDING REQUIREMENTS (EPB)**

**General**

Cross Refer: Section 20.2.7 'Design' of the General Requirements.

**DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**360.1.4 STANDARDS**

**Signs**

Signs generally - design and use: To Land Transport Authority Signage Design Guidelines Manual.

Public information signs: To Land Transport Authority Signage Design Guidelines Manual.

Statutory signs - design and use: To current Singapore legislation.

**360.1.5 INTERPRETATION**

**Definitions**

Changeable plate systems: Sign systems consisting of fixed plate holders to which may be attached or inserted removable interchangeable sign plates.

Variable room identification system: Changeable plate systems incorporating fixed room numbers and removable name strips.

Changeable letter systems: Sign systems consisting of display boards or holders into which can be inserted removable individual letters, numbers, etc.

Illuminated signs: Signs consisting of cabinets enclosing an illuminated source, lighting translucent face panels bearing the specified signage.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods.

**360.2 QUALITY**

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**360.2.1 INSPECTION**

**General**

Signage shall be inspected from a minimum distance of 1500 mm under the specified permanent artificial luminance or 500 lux, whichever is greater.

**Witness points**

Give sufficient notice so that inspection may be made at the following stages:

- Custom-built graphics items fabricated and ready to be delivered to the site.
- Graphics items delivered to site before installation.
- Building locations or substrates prepared to receive graphics items before they are installed.

**Hold points**

Completion of signage artwork.

Completion of the artwork for all maps and diagrams.

>

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**360.2.2 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, 'Tests' of the General Requirements.

**Fire hazard limits**

Non combustible to BS476: Part 4.

An index of performance (I) not exceeding 12 and a sub-index (i) not exceeding 6 when tested to BS 476 : Part 6.

**360.2.3 SAMPLES**

**General**

Submit samples in accordance with Section 20.3.4 'Samples', of the General Requirements.

Materials: Submit samples showing each colour and finish of exposed graphics materials and accessories. If there is a range of colours and/or textures for a particular item, submit samples showing the extremes and mean of the range.

Fabricated items: Signage box and supports.

>

Engraved items >

No. of samples: 3.

**360.2.4 PROTOTYPES**

**General**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

**Design prototype**

Provide a design prototype for the following items:

- Signage box and supports as directed by the Engineer.
- Advertising panels and boxes.
- >

Location: As agreed with the Engineer.

- Minimum size:
- Full size.
  - As directed by the Engineer.

Incorporating Support details as directed by the Engineer.  
Interfacing materials as directed by the Engineer.

**Confirmation prototype**

Provide a confirmation prototype for the following items:

- Signage box and supports as directed by the Engineer.
- Advertising panels and boxes.
- >

Location: As agreed with the Engineer.

- Minimum size (face of panel):
- Full size.
  - As directed by the Engineer.

Incorporating Support details as directed by the Engineer.  
Interfacing Materials as directed by the Engineer.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

### **360.2.5 SUBMISSIONS**

#### **General**

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### **Subcontractors**

Submit names and contact details of proposed suppliers and installers.

#### **Shop drawings**

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings showing, but not limited to, the following information:-

- General arrangements incorporating a numbering system which will allow each piece of furniture to be separately identified.
- Schedules of all signs giving location, numbers, type etc.
- Layout, construction and fixing details for custom designed (non standard) sign systems.
- Large scale (full size if practicable) lettering layouts for individual letter signs.
- Full size artwork for all signs, maps, and diagrams.
- Full size spacing templates for individually mounted characters.
- Location template drawings for anchorages to permanent construction. Show type of anchorage.
- Wiring diagrams as directed by the Engineer.

No. of copies to be submitted: As Particular Specification.

#### **Engineering endorsement**

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of internal cladding is in compliance with Section 13.9 of the Authority's Design Criteria Volume 2 of 2, and Singapore Standard CP5 and meets all of the Authority's equipotential bonding and touch voltage protection requirements.

#### **Installation**

Submit the signage-manufacturer's standard drawings and details showing methods of construction, with dimensions and tolerances.

No. of copies to be submitted: As for shop drawings.

#### **Manufacturers' information**

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

#### **Test Reports**

Submit copies of current test reports, and certification that materials comply with the required standards in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

#### **Method Statement**

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

**360.3 MATERIALS AND WORKMANSHIP**

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**360.3.1 HAZARDOUS MATERIALS**

**Fire hazard**

General: Do not provide materials which, when subject to fire conditions, will emit excessive smoke or dangerous fumes.

Do not use materials which contain known carcinogenics.

**Toxins**

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

**360.3.2 MATERIALS**

**General**

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

**Materials standards**

Aluminium:

- Plate for engraving: Alloy and temper designation 6063-0.
- For casting: To AS 1874.

Stainless steel:

Grade:

- 316.
- 304 (internal use only).

Surface finish: Continuous hairline achieved using a 180 – 240 grit size.

>

Plastics: Do not use moulded plastics without the acceptance of the Engineer.

**360.3.3 WORKMANSHIP**

**Production**

General: Form graphics items accurately with clean, well defined edges or arises, free from blemishes.

Engraving: Precision machine engraving resulting in sharp edges and smooth excavated surfaces, filled with the colour, or excavated to expose the substrate in two-colour sheet plastic engraving.

Casting: Produce shapes free of pits, scale, blow holes or other defects, hand or machine finished if necessary.

Cut-out shapes: Cut from solid material and hand finish as necessary.

Built-up shapes: Fabricate individual three dimensional shapes by building up the faces and edges from separate pieces neatly and securely joined.

Photoprinting: Permanently print the characters on plate or sheet materials.

**Installation**

General: Install signage level and plumb, securely mounted, with concealed theft-resistant fixings.

**360.4 SIGNAGE**

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**360.4.1 SIGNS**

**Signage type schedule**

Designation	S1	S2	S3
Sign type	>	>	>
Sign plate holder:	>	>	>
- Material	>	>	>
- Finish/colour	>	>	>
- Fixing method	>	>	>
- Size (l x h x t) (mm)	>	>	>
Sign plate:	>	>	>
- Material	>	>	>
- Size (l x h x t) (mm)	>	>	>
- Finish/colour	>	>	>

## 360 SIGNS, ADVERTISING AND DISPLAY

Designation	S1	S2	S3
- Fixing method	>	>	>
Characters:	>	>	>
- Material	>	>	>
- Method of forming	>	>	>
- Letter height/thickness (mm)	>	>	>
- Finish/colour	>	>	>
- Typeface	>	>	>
- Filling	>	>	>
- Fixing method	>	>	>

### Changeable letter systems

Location:	>
Display board:	
- Material:	>
- Covering:	>
- Colour:	>
Frame or case:	
- Material:	>
Enclosure:	>
Locking:	>
Fixing method:	>
Letters:	
- Material:	>
- Colour:	>
- Quantity (approx.):	>

### Illuminated signs

Electrical fittings: Co-ordinate with System Wide Electrical Contractor.

### Plaques

Location:	>
Material:	>
Method of forming:	>
Finish:	>
Text:	>

## 360.5 COMPLETION

### 360.5.1 COMPLETION

#### General

Cross refer: Item 20.5 'Completion' of the General Requirements.

#### Protection

Protect all signage from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Remove all materials used as a means of protection immediately prior to handover and clean all signage.

#### Lamps

Re-lamp all illuminated signage where lamps have been used for the purposes of testing.

Agree the amount of lamp usage with the Engineer and provide replacement lamps sufficient to compensate for the reduction in the life of the lamps being handed over.

#### Damaged Items

Inspect all signage to ensure compliance with this specification.

Pinholes on illuminated panels will not be accepted.

Damage on surfaces exposed to view will not be accepted.

Replace all items deemed by the Engineer to be damaged with new.

**Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

Ensure the manual refers to the following:

- recommendations for relamping;
- recommendations for demounting;
- recommendations for service use, care and maintenance; and
- list of manufacturers and suppliers of replacement parts.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**360.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>370 EXTERNAL PAVING</b>
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**370.1 GENERAL**

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**370.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows:

- Adhesives, Sealants and Fastenings.
- Metals and Prefinishes.
- Metal Fixtures.
- Cementitious Toppings.
- Gratings.
- Tiling.
- Civil and Structural Materials and Workmanship Specification: sections: >

**370.1.2 STANDARD**

Slip resistance: To SS485, Table E.1 interpreted as follows:

Location	Description in Standard
External paving	External colonade, walkways and pedestrian crossings.
External ramps	External ramps.
Stairs and Steps	External stair nosings.

**370.1.3 INTERPRETATION**

**Definitions**

Class A foundation: Most sand and rock sites.

Class S foundation: Most silt and some clay sites.

Class M foundation: Moderately reactive clay sites.

Light traffic: Vehicles with a gross mass < 3 t.

Medium traffic: Vehicles with a gross mass between 3 t and 10 t, with infrequent use by heavier vehicles.

Density ratio: Percentage of the maximum density at optimum moisture content as determined by AS 1289.5.2.1.

Dry Lay: The layout of paving as defined on the drawings prior to placing for the purposes of verifying the colour, tone and texture of individual units.

Authority's Sample: A sample held by the Authority and available for viewing during the tender and construction periods

**370.1.4 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

**370.2 QUALITY**

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**370.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made of the following:

- Items to be embedded, including reinforcement, dividing strips, in place.completed subgrade, and basecourse preparation;
- Precast items on site before installation;
- completed dry lay;
- Joints formed and ready for filling with joint filler, and
- completed pavements.

**Hold points**

- Completion of confirmation prototype.
- Location of setting out point.
- >

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**370.2.2 TESTS**

**General**

Carry out all tests in accordance with Section 20.3.2, ‘Tests’ of the General Requirements.

**Masonry interlocking paver tests schedule**

Attribute	Test method	Number of tests
Potential to effloresce	AS/NZS 4456.6	>
Moisture content and dry density	AS/NZS 4456.8	>
Abrasion resistance	AS/NZS 4456.9	>
Resistance to salt attack	AS/NZS 4456.10	>
Coefficients of expansion	AS/NZS 4456.11	>
Coefficient of contraction	AS/NZS 4456.12	>
Pitting due to lime particles	AS/NZS 4456.13	>
Water absorption properties	AS/NZS 4456.14	>
Tensile strength	AS/NZS 4456.18	>

**Slip resistance:**

To SS485.

**370.2.3 SAMPLES**

**General**

Submit samples of each of the following in accordance with Section 20.3.4 ‘Samples’, of the General Requirements.

Submit samples of surface materials either full size or at least 600 x 600mm square, whichever is the larger.

Submit ‘linear’ samples a minimum of 600mm long.

- All paving materials.
- All edging materials.
- All jointing materials.

Submit samples of the pavement finishes to show the full range of texture and colour of the material.

No. of samples: 3.

**Prototypes**

Construct all prototypes in accordance with the requirements of Section 20.3.5, ‘Prototypes’ of the General Requirements.

**Confirmation prototype**

General: Prepare confirmation prototype panels of designated finishes, including samples of junction details and trim.

Segmental paving pattern: Prepare a trial set-out for each area.

- Ensure all samples incorporate:
- Horizontal and vertical joints.
  - Steps.
  - Ramps.
  - Interfaces with adjacent materials.

**Sample panels schedule**

Pavement finish	Sample panel size (mm)	Number of panels	Location
>	As directed by the Engineer	1	As directed by the Engineer
>	>	>	>
>	>	>	>

#### 370.2.4 SUBMISSIONS

##### General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

##### Subcontractors

Submit names and contact details of proposed suppliers and installers.

##### Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings of all paving showing, but not limited to the following information.

- General arrangements incorporating a numbering system which will allow each area of paving to be separately identified.
- Schedules of all paving giving location, materials, finish etc.
- All service installations within paved areas.
- All items provided by system wide contractors.
- Interfacing details.

No. of copies to be submitted: As Particular Specification.

##### Engineering endorsement

Submit a report from a Singapore registered Electrical Engineer certifying that the design and installation of fixtures is in compliance with Singapore Standard CP5 and meets all of the Authority's equipotential bonding requirements.

##### Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

##### Test Reports

Submit copies of current test reports, and certification that materials comply with the required standards in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

##### Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

#### 370.3 MATERIALS AND COMPONENTS

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##### 370.3.1 MATERIALS

##### General

Toxic materials: Use materials which are certified free of asbestos and lead, or any other known toxin, and free of, nor requiring the use of, toxic solvents.

Do not use materials which contain known carcinogenics.

Confirm that materials used in conjunction are compatible with one another, the substrates on which they are used, and all adjacent materials in the completed building.

Fill for subgrade: Sand, gravel or quarry rubble.

Subbase: Well-graded. Sand, gravel or crushed rock. Maximum particle size  $\leq$  1/3 subbase layer thickness.

Basecourse: Well-graded crushed rock or gravel, free from deleterious material. Maximum particle size 26.5 mm. Uniformly graded. Maximum clay content 6% by mass.

##### Concrete pavements

Materials and construction: To AS 3600.

Concrete: To SS 289.

##### Segmental pavements

Bedding sand: Coarse, well-graded, washed, free from deleterious material including organic material and soluble salts or other contaminants liable to cause efflorescence or reduce slip resistance.

- Grading: Maximum particle size 4.75 mm, not more than 30% passing 0.3 mm sieve.

Bedding cement: SS 26.

**Bedding sand grading schedule**

Sieve aperture (mm)	Percentage passing (by mass)
>	>
>	>
>	>

**Concrete for edging**

Concrete: To SS 289.

Grade: >

**Tiling**

Cross refer: 'Tiling'.

**Pebble Wash**

Cross refer; 'Cementitious Topping'.

**370.3.2 COMPONENTS**

**Concrete pavement reinforcement**

Machine-welded mesh: To AS/NZS 4671.

Bar: To SS 18.

Finish: galvanised.

**Interlocking pavers**

Standard: To AS/NZS 4455.

Dimensional category: DPA1 and DPB1.

Minimum thickness:

- Foot and bicycle traffic: 40 mm.
- Light traffic: 50 mm.
- Medium Traffic: 65 mm.

Potential to effloresce (maximum): >

Moisture content (maximum) (%): >

Dry density (minimum) (kg/m<sup>3</sup>): >

Abrasion index (minimum): 1.2.

Resistance to salt attack category: Exposure.

Coefficient of expansion (maximum): >

Pitting due to lime particles (maximum): >

Water absorption properties (maximum): >

Tensile strength (kN) (minimum): >

Unconfined compressive strength (fired clay units) (minimum): 10 MPa.

Unconfined compressive strength (concrete units) (minimum): 12 MPa.

Breaking load ( minimum):

- Foot and bicycle traffic: 2 kN.
- Light traffic: 3 kN.
- Medium traffic: 5 kN.

**Granite Paving (foot traffic only)**

Cross refer: Granite Flooring.

**Tactile Markings**

Cross refer: Granite Flooring.

**Jointing Strip**

Material: Stainless Steel.

Grade: 316.

Width 5mm.

Depth: 25mm or the depth of the paving material whichever is the greatest.

**Geotextile fabric**

Type: >

**Concrete kerbs and channels (gutters)**

Manually or machine placed: To AS 2876.

**Tree grates**

Sections: Proprietary grating comprising purpose-made removable equal segments.

Material >

Size(s) (mm): >

Finish >

**External duct covers**

Type: Proprietary system removable cover or grating in a fixed frame, with the necessary accessories, and suitable for the duct size and pavement loading.

Duct cover accessories: >

**External duct covers schedule**

Duct cover designation	DC1	DC2	DC3
Loading	>	>	>
Duct or trench size:	>	>	>
- Depth (mm)	>	>	>
- Width (mm)	>	>	>
Cover:	>	>	>
- Type	>	>	>
- Material	>	>	>
- Finish	>	>	>
Frame:	>	>	>
- Material	>	>	>
- Finish	>	>	>
- Method of fixing	>	>	>

**370.4 EXECUTION**

**370.4.1 GENERAL**

**Execution**

If it appears that minor variations to joint widths will obviate cutting, submit proposals.

**Subgrade**

General: Remove topsoil containing grass roots. Fill and compact as necessary. Ensure strength and stiffness is similar throughout, including soft spots and service trenches. If necessary, loosen the subgrade to a depth of 200 mm and adjust the moisture content before compaction.

Level tolerance: + 0, - 25 mm.

Clay fill: Moisture condition near long term equilibrium moisture condition.

Cohesive subgrade soils:

- Minimum dry density ratio (standard compaction) to AS 1289.5.4.1: 100%.

Cohesionless subgrade soils:

- Minimum density index to AS 1289.5.6.1: 80%.

**Subbase**

Minimum dry density ratio: 98% to AS 1289.5.2.1.

Thickness tolerance: + 0, - 5 mm.

Level tolerance: ± 25 mm.

**Basecourse**

Placing: Spread and compact the basecourse. Adjust the moisture content to facilitate compaction.

Minimum dry density ratio: 98% to AS 1289.5.2.1.

Thickness tolerance: + 0, -5 mm.

Level tolerances: Generally - 0, + 25 mm, but at existing structures - 0, + 10 mm. Over 3 m length of design profile, ± 10 mm.

**Drainage**

Finished surface crossfalls: Between 1% and 10%.

Ponding: Grade pavements to even falls so as to drain away from buildings to drainage outlets without ponding.

Surface run-off: Provide channels and drains to discharge points.

Poorly drained sites: Select from the following:

- Stabilise subgrade or pavement courses.
- Provide subsurface drains or pervious granular material, slotted or pervious pipes, or both, under or beside the pavement.

At walls: Set finished level of pavements below damp-proof course, weep holes and drainage openings.

**Embedded Services**

Place all embedded services at substrate level unless instructed otherwise by the Engineer.

**Surface tolerances**

Surfacing layer thickness: + 5 mm, - 0 mm.

Surfacing layer level:  $\pm 10$  mm.

Surfacing profile: Over 3 m length of design profile,  $\pm 10$  mm.

Junctions: Maximum deviations:

- Across junctions between adjacent pavement surfaces: 2 mm.
- Across junctions between adjacent pavement unit surfaces: 2 mm.

Flatness: Maximum deviation of the finished surface under a 3 mm straight edge laid in any direction: 10 mm.

**Control joints**

General: Provide movement joints over structural joints in the base (isolation, contraction, expansion) right through the paving and bed to the substrate. Fill joints with a compressible material.

Joint filler: Cross refer: Adhesives, Sealants and Fasteners.

**Pavement finish junctions**

Location: Where changes of pavement finish occur at gateways, locate the junction directly beneath the closed gate.

Dividing strip: Insert a dividing strip the full width of junctions between different pavement finishes, with the top edge flush with the finished pavement.

Fixing: Embed strip in solid finishes, or screw fix to the substrate.

Dividing strip material: >

**370.4.2 INTERLOCKING PAVING**

**Basecourse thickness**

Foot and bicycle traffic: Not required.

**Bedding sand course**

Thickness: Roughly uniform, minimum 30 mm after compaction. Do not disturb the bedding course before the units are laid.

**Mortar bedding course**

Over concrete base slabs: Lay units on a mortar bedding course at least 12 mm thick.

- Mix: 1:3 cement:sand.

**Geotextile fabric**

Fabric separation or drainage layer: Required.

**Placing**

Laying: After laying, tamp the units using a vibrating plate compactor.

Paving pattern: >

**Joints**

Thickness: 3 mm nominal, except where spacer nibs are provided.

Dry joints: Fill the joints flush with clean, fine sand or screened bedding sand passing a 1.18 mm sieve, vibrated into the joints using a vibrating plate compactor.

Mortar joints: Fill the joints flush with dry cement sand mortar, brush in, and dampen using a fine water spray. Clean pavement progressively to remove mortar smears and discolouration.

Open joints: Close butted, or spaced as required.

**Interlocking paver schedule**

Location	Area 1	Area 2	Area 3
Type	>	>	>
Thickness (mm)	>	>	>

**370.4.3 EDGING**

**Lateral restraint to interlocking paving**

Perimeter: Provide concrete edge restraints to bedding and units, where not provided by other structures.

Type:

Proprietary.

In-situ.

**Restraint at base of slopes/ramps**

Provide restraint to the lower edge of all slopes/ramps steeper than 1 in 10 to prevent the displacement of pavers and/or loss of substrate under the anticipated loads.

**370.4.4 SURFACE DRAINAGE**

Cross refer: 'Gratings'.

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**370.5 COMPLETION**

**370.5.1 MAINTENANCE**

**General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

**Interlocking paving**

Refill joints as required.

**Cleaning**

Leave paving clean on completion.

**Final inspection**

Cracking in bound pavements: Width  $\leq$  1.0mm.

Subsidence: Offset under 1.5 m length of the design profile,  $\leq$  10mm.

Stepping: Between adjacent elements within the pavement area,  $\leq$  3mm.

Chipping and spalling to pavement units: Maximum 5 per 100 units with chipped or spalled arrises.

Ponding 15 minutes after rain ceases will not be accepted.

**Protection**

Protect all completed external paving on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

Prevent items likely to damage the paving from finding their way between the protection and the finish below. Check and remove all such items regularly.

**Damage**

Replace damaged items with new.

**Warranties**

Warrant the materials and workmanship using the Authority's standard warranty form for the period(s) stated in Item 20.5.1 'Warranties' of the General Requirements.

**Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

**Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with Item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

**370.5.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.

<b>380 FENCING</b>
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**380.1 GENERAL**

**380.1.1 CROSS REFERENCES**

**General**

Conform to the General Requirements worksection.

**Associated worksections**

Conform to associated worksections as follows: Metals and Prefinishes.  
Heavy Duty Galvanized Coatings.  
External Paving.  
>

**380.1.2 DESIGN**

**Drawings**

Contract drawings show generic design principles and design intent only.

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**380.2 QUALITY**

**380.2.1 INSPECTION**

**Witness points**

Give sufficient notice so that inspection may be made of the following:

>

**Hold points**

Setting out.  
Completion of prototype.  
>

**Corrosion**

Cross refer: General Requirements Clause 20.4.1.

**380.2.2 SAMPLES**

**General**

Submit samples of each of the following in accordance with Section 20.3.4 'Samples', of the General Requirements.

Fencing materials.

Submit 'linear' samples a minimum of 600mm long.

Submit 'area' samples a minimum of 600mm square.

No. of samples: 3.

**Prototypes**

Construct all prototypes in accordance with the requirements of Section 20.3.5, 'Prototypes' of the General Requirements.

**Confirmation prototype**

General: Prepare confirmation prototype fencing :

Location	As agreed with the Engineer.
Type:	All fencing types.
Size:	One bay or 2.4m, whichever is smaller, subject to the acceptance of the Engineer.
Incorporating:	Interfacing junctions. One corner. Change of level.

Retain all prototypes until the completion of the works or as directed by the Engineer.

Incorporate accepted prototypes into the work as directed by the Engineer.

### 380.2.3 SUBMISSIONS

#### General

Make all submissions in accordance with the requirements of Section 20.3.6, 'Submissions' of the General Requirements.

#### Subcontractors

Submit names and contact details of proposed suppliers and installers.

#### Shop drawings

General: Submit shop drawings in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Submit shop drawings of all paving showing, but not limited to the following information.

- General arrangements incorporating a numbering system which will allow each length of fencing to be separately identified.
- Schedules of all fencing giving location, materials, finish etc.
- Details of all changes of level and direction.
- Interfacing details.

No. of copies to be submitted: As Particular Specification.

#### Engineering endorsement

Submit calculations and drawings from a Singapore licensed Professional Engineer concurrently with the shop drawings and showing, but not limited to, the following:-

Compliance with all relevant Singapore legislation and regulations.

#### Manufacturers' information

Technical Literature: Submit the manufacturer's technical literature for all proprietary materials used together with certification that materials comply with the required standards in accordance with Section 20.3.6, 'Submissions' of the General Requirements.

Instructions: Submit copies of relevant manufacturers' instructions including standard drawings and details.

Material safety data sheets (MSDS): Submit MSDS.

No. of copies to be submitted: 3.

#### Test Reports

Submit copies of current test reports, and certification that materials comply with the required standards in accordance with Section 20.3.2, 'Tests' of the General Requirements.

No. of copies to be submitted: 3.

#### Method Statement

General: Submit method statements in accordance with Section 20.3.6 'Submissions' of the General Requirements.

## 380.3 MATERIALS AND COMPONENTS

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### 380.3.1 STEEL

#### General

Cross refer: 'Metals and Prefinishes', 'Heavy Duty Galvanized Coatings'.

#### Steel tubes

Posts, rails, stays: To AS 1163.

- Grade: C350L0.

#### Wire

Chainwire, cable wire, tie wire and barbed wire: To AS 2423.

Finish: Match chainwire.

- Coating: >

#### Fasteners

Cross refer: 'Adhesives, Sealants and Fasteners'.

Use fasteners capable of transmitting all applied and dead loads.

Use tamper proof fasteners requiring specialised tools for their removal.

### 380.4 EXECUTION

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#### 380.4.1 CONSTRUCTION GENERALLY

##### Set out

Set out the fence line and mark the positions of posts, gates, bracing panels and straining posts.

##### Clearing

Except trees or shrubs to be retained, clear vegetation within 1 metre of the fence alignment. Grub out the stumps and roots of removed trees or shrubs and trim the grass to ground level, but do not remove the topsoil.

##### Landscaping

Ensure that the adjacent ground has been brought to the correct level and that the installation of topsoil is complete.

##### Excavation

Excavate post holes so that they have vertical sides and a firm base. Do not allow surplus material to be deposited or spread beyond the boundary of the site without the Engineer's prior acceptance.

##### Line and level

Erect posts vertically.

- Set heights to follow the contours of natural ground.
- Set heights as shown on the accepted shop drawings.

##### Earth footings

Backfill with earth around posts, compacting firmly by hand or machine in 150 mm deep layers.

##### Concrete footings

In ground: Place mass concrete around posts and finish with a weathered top falling 25 mm from the post to ground level.

On slabs: Provide welded and drilled post flanges and fix with 3 masonry anchors per post.

#### 380.4.2 GATES

##### Hardware

Cross refer: 'Door and Window Hardware'.

Provide the following:

- Drop bolt and ferrule to each leaf of double gates.
- Latch to one leaf of double gates.
- Provision for locking by padlock.
- Hinges to ensure smooth operation.

##### Hand access

Where required, provide hand holes to give access from outside to reach locking provision.

### 380.5 FENCE TYPES

---

#### 380.5.1 CHAINWIRE BARRIERS

##### Standard

General: To AS 1725.

##### Fence dimensions

Maximum post spacing: 3000 mm.  
>

##### Component sizes

Intermediate posts: 42.4 mm diameter, 2.6 mm wall thickness.  
>

End, corner and gate posts: 60.3 mm diameter, 2.9 mm wall thickness.  
>

Chainwire: 3.15 mm diameter wire woven to form uniform mesh.

- Selvedges: Knuckled.
- Mesh generally: 50 mm.
- Mesh at playing end of sports enclosures: 40 mm.

Tie wire: 2 mm diameter.

Post and rail barriers:

- Rails and support stays: 33.7 mm diameter, 2.6 mm wall thickness.
-

Railless barriers:

- Struts: 42.4 mm diameter, 2.6 mm wall thickness.
- Cable wires:
  - . Two strands: 3.15 mm diameter wire.
  - . One strand: 4 mm helicoil wire.

Security barriers:

- Chainwire selvages: Twisted and barbed.
- Barbed wire to security fencing post extensions: Barbs at 95 mm maximum centres.

**Installation**

Posts: Do not splice members.

Fit tightly fitting steel caps to posts, except where fixed to overhead structure.

Chainwire: Lace chainwire to end and gate posts. Tie chainwire twice around members at 250 mm maximum intervals. Twist ends twice and cut off neatly.

Cable wire: Tension cable wire(s) to support chainwire after at least 24 hour curing of concrete footings.

Footing type: Concrete.

- Footing size:
  - . Intermediate and end posts: 225 mm diameter x 600 mm depth.
  - . >
  - . Corner posts and gate: 225 mm diameter x 900 mm depth.
  - . >

Bracing:

- Provide bracing sufficient to ensure that the fence is capable of resisting the live and dead loads identified by the Singapore licensed Professional Engineer and accepted by the Engineer.

Post and rail barriers:

- Rails: Connect rail(s) to posts using bolted split pipe fittings and purpose-made caps and brackets with rail apertures.
- Continuous rail type fences: Join the rails together in long lengths using purpose-made sleeves or socketed connections, and pass them through the apertures of caps and brackets on intermediate posts.

Railless barriers:

- Struts: Provide struts at ends, corners and gates.

Security barriers:

- Security fencing: Strain barbed wire between post extensions.

**Gates**

Frame tubes:

- 33.7 mm diameter, 2 mm wall thickness.
- >

Chainwire: Match fence.

Maximum width: 3600 mm.

Security barriers:

- Barbed wire security gate extension supports:
  - . 26.9 mm diameter, 2 mm wall thickness.
  - . >
- Barbed wire: Match fence.

**Chainwire barriers schedule**

Designation	CB1	CB2	CB3
Type of barrier	>	>	>
Height (excluding post extension, if any) (mm)	>	>	>
Post and rail barriers: Number of rails	>	>	>
Railless barriers: Number of cable wires	>	>	>

## 380 FENCING

Designation	CB1	CB2	CB3
Security barriers: Post extension height (mm)	>	>	>
Post extension form	>	>	>
Gates: Size (h x w)	>	>	>
Locking	>	>	>

### 380.5.2 WELDED FENCING

#### Fence dimensions

Height (mm): >

Maximum post spacing: 2440 mm.

#### Component sizes

End, corner and intermediate posts:

- 42.4 mm diameter, 2.6 mm wall thickness.
- >

Gate posts (personnel):

- 60.3 mm diameter, 2.9 mm wall thickness.
- >

Gate posts (vehicle):

- 88.9 mm diameter, 3.2 mm wall thickness.
- >

Panel wire:

- Horizontal: 4.95 mm diameter at 75 mm centres.
- Vertical: 4.95 mm diameter at 50 mm centres.

#### Installation

General: Fit tightly fittings caps to steel posts. Attach panels to posts with fixing clips and hexagon head bolts before concreting footing.

Footing type: Concrete.

#### Gates

Frame tubes:

- 33.7 mm diameter, 2 mm wall thickness.
- >

Wire: Match fence.

### 380.6 VEHICLE BARRIERS

#### 380.6.1 WHEEL STOPS

##### Precast concrete wheel stops

Material: Precast concrete units with predrilled holes located 300 mm from each end for fixing to ground surface.

Size: 2000 x 150 x 100 mm high.

Installation: Drive 12 mm diameter galvanized steel rods 600 mm into the ground to finish 25 mm below the top of the wheel stop, or bolt the stop to masonry anchors in concrete slabs. Grout the holes flush to match the concrete finish.

#### 380.6.2 BOLLARDS

##### Steel tube bollards

Type:

- Proprietary to the Engineer's acceptance.
- Precast Concrete
- Steel
- Hinged.
- Removeable
- >

Finish:

Steel: Galvanize after fabrication.

Precast Concrete: Cross refer Concrete Finishes.

Footing: Encase in a concrete footing at least 600 mm deep x 250 mm diameter.

On slabs: Weld on a 10 mm thick baseplate drilled for 4 bolts, and bolt to masonry anchors utilising anchors sufficient to transmit the loadings in use from the bollard to the footing.

Filling: Fill the tube with 15 MPa concrete.

### **380.6.3 INSTALLATION**

#### **Tolerances**

+/- 15mm from the theoretical position on plan.

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## **380.7 COMPLETION**

### **380.7.1 COMPLETION**

#### **General**

Cross refer: Item 20.5 'Completion' of the General Requirements.

#### **Operation and Maintenance Manual**

On completion submit an Operation and Maintenance Manual in accordance with item 20.5.3 'Operation and Maintenance Manuals' of the General Requirements.

#### **Protection**

Protect all completed fencing and bollards on site from damage until handover.

Temporary measures: submit details of all proposed temporary protection measures to the Engineer for acceptance.

On or before completion of the works remove all materials used as a means of protection.

#### **Damage**

Replace damaged items with new.

#### **Warranties**

Submit all proprietary materials manufacturer's published product warranties.

#### **Record drawings**

Provide record drawings in accordance with Item 20.5.2, Record Drawings, of the General Requirements.

### **380.7.2 REPAIR**

Before commencing repairs submit details of the proposed repair method for acceptance.