

**(21) A05-010 METAL ROOF SYSTEM
/ FLASHING TO METAL ROOF SYSTEM**

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This Section covers the requirements for the construction of metal roofing systems including metal sheets, finishes and insulation. The following types of metal sheets are covered:

- (a) Profiled Metal Sheets
- (b) Standing Seams

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A05-040	Glass Roof System
C05-010	Structural Steelwork
C08-010	Structural Timberwork

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses.

Singapore Standards	
SS EN 1991-1-1	Actions on structures – General actions - Densities, self-weight and Imposed loads for buildings
SS EN 1991-1-4	Actions on structures, Part 1-4: General actions – Wind actions
NA to SS EN 1991-1-4	Singapore National Annex to Eurocode 1 – Actions on structure. Part 1-4: General actions – Wind actions

SS EN 1998-1	Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings
SS CP 7	Code of practice for structural use of timber
SS 72	Specification for treatment of timber and plywood with copper/chrome/arsenic wood preservatives
SS 141	Specification for unplasticised PVC pipe for cold water services and industrial uses
SS 525	Code of practice for drainage of roofs
SS 555 Series	Protection against lightning
SS 572	Code of practice for the use of timber in buildings
SS 631	Specification for metal roofing system
Other Standards	
BS EN 363	Personal fall protection equipment. Personal fall protection systems
BS EN 485-2	Aluminium and aluminium alloys – Part 2: Sheet, strip and plate. Mechanical properties
BS EN 485-3	Aluminium and aluminium alloys – Part 3: Sheet, strip and plate. Tolerances on dimensions and form for hot-rolled products
BS EN 485-4	Aluminium and aluminium alloys – Part 4: Sheet, strip and plate. Tolerances on shape and dimensions for cold-rolled products
BS EN 573-3	Aluminium and aluminium alloys – Chemical composition and form of wrought products – Part 3: Chemical composition and form of products
BS EN 1396	Aluminium and aluminium alloys – Coil coated sheet and strip for general applications. Specifications
BS EN 10088	Stainless steels
BS EN 10143	Continuously hot-dip coated steel sheet and strip – Tolerances on dimensions and shape
BS EN 10223	Steel wire and wire products for fencing and netting
BS EN 13162	Thermal insulation products for buildings – Factory made mineral wool (MW) products. Specification

BS EN 13501-1	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests
BS EN 13501-5	Fire classification of construction products and building elements– Part 5: Classification using data from external fire exposure to roofs test
BS EN 13523	Coil coated metals – Test methods
BS EN 13823	Reaction to fire tests for building products – Building products excluding floorings exposed to the thermal attack by a single burning item
BS ISO 4998	Continuous hot-dip zinc-coated and zinc-iron alloy-coated carbon steel sheet of structural quality
BS ISO 9364	Steel sheet, 55 % aluminium-zinc alloy-coated by the continuous hot-dip process, of commercial, drawing and structural qualities
BS 460	Cast iron rainwater goods – Specification
BS 476	Fire tests on building materials and structures
BS 1449-1.1	Steel plate, sheet and strip – Carbon and carbon-manganese plate, sheet and strip – General specification
BS 6399-3	Code of practice for imposed roof loads
BS 8000-0	Workmanship on construction sites – Introduction and general principles
EN ISO 1182	Reaction to fire tests for products – Non-combustibility test
EN ISO 1716	Reaction to fire tests for products – Determination of gross heat of combustion (calorific value)
EN ISO 11925-2	Reaction to fire tests - Ignitability of products subjected to direct impingement of flame – Part 2: Single-flame source test
ISO 834	Fire-resistance tests – Elements of building construction
AS 1231	Aluminium and aluminium alloys – Anodic oxidation coatings
AS 1397	Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium
AS 1530	Methods for fire tests on building materials, components and structures

AS 1562.1	Design and installation of metal roof and wall cladding, Part 1: Metal
AS 3566.1	Self-drilling screws for the building and construction industries, Part 1: General requirements and mechanical properties
AS 3715	Metal finishing – Thermoset powder coating for architectural applications of aluminium and aluminium alloys
AS 4040.1	Methods of testing sheet roof and wall cladding - Resistance to concentrated loads
AS/NZS 2728	Prefinished/prepainted sheet metal products for interior/exterior building applications – Performance requirements
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C1371	Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
ASTM E90	Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM E108	Standard Test Methods for Fire Tests Of Roof Coverings
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E413	Classification for Rating Sound Insulation
ASTM E903	Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
ASTM E1980	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
AAMA 2605	Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminium Extrusions and Panels

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority â Approved Document ("Approved Document")
Building and Construction Authority â Building Control Regulations
Code of Practice for Fire Precautions in Buildings ("Fire Code")
Code for Environmental Sustainability of Buildings
Code of Practice on Environmental Health
Code on Envelope Thermal Performance for Buildings
Guidelines on Envelope Thermal Transfer Value for Buildings

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.1.1 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority â CONQUAS 21 Enhancement Series, Good Industry Practices Guide Books
Chartered Institution of Building Services â Guide A: Environmental Design

1.4 Trade Preamble

1.4.1 Contractorâs Submissions

The design intent of the metal roof system(s) is indicated in the drawings and type(s) specified in Section A05-010:Clause:3.1.

Engage qualified personnel to carry out and submit the following items to the SO:

1.4.1.1 Design development

Shop drawings with all necessary details, including interfaces with other works.

1.4.1.2 Construction Methods

Method statements for the carrying out the Works, including setting out, fixing and installation of metal roofing and related components, waterproofing, etc. Take into account the performance requirements as set out in Part 2.

1.4.1.3 Temporary Supports

Design of the appropriate temporary supports (including support of personnel working on the roof and roof loading resulting from the installation process), to ensure the roof installation is stable throughout the construction, endorsed by a PE (Structural).

1.4.1.4 Manufacturer and products

Names of manufacturer(s) and product information.

1.4.2 Co-ordination with other Works

Co-ordinate the roofing works particularly the interfacing with the following trades:

- (a) Roof structure
- (b) Skylights
- (c) External masonry and cladding
- (d) Lightning protection
- (e) Services penetrations
- (f) Internal masonry and partitions
- (g) Ceilings
- (h) External painting and coating
- (i) Any equipment located on the roof, e.g. photovoltaic cells panels

1.4.3 Provision of Spare Materials

Deliver to site in appropriate protective packaging marked for identification, and store where directed by the SO, the following spare components and materials for future replacement and repair:

Item	Description	Quantity	.
.	Size, type, etc	.	.
	.	.	.
	.	.	.

[Note: Customise table to reflect project specific requirements.]

1.4.4 Quality Control Plan

Prepare and submit a quality control plan to the SO.

1.4.5 Warranty

Provide the following warranties in accordance with the specimen warranty, or otherwise as approved agreed with the SO:

Item of Works to be Warranted	Period of Warranty Required
SEALANT TO METAL FLASHING	10 years

1.4.6 Maintenance Manual

Prepare and submit a maintenance manual covering all metal cladding systems (including all components and accessories). Refer to Section G01-010:Clause:1.4.5 for details.

Include the following information in the maintenance manual:

- (a) An outline description of the completed roof system.
- (b) A detailed description of specific materials and components with product names, types, serial numbers, etc.
- (c) Cleaning methods for roof surface, roof and gutters to be cleaned every 6 months.
- (d) Roof flashings and sealant to be inspected every 2 years.
- (e) Fall arrest systems to be inspected at intervals not exceeding 2 months.
- (f) Safety advice for maintenance personnel.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

1.5.1.1 U-value

Thermal transmittance

1.5.2 Abbreviations

1.5.2.2 BMT

Base metal thickness

1.5.2.3 ETTV

Envelope Thermal Transfer Value

1.5.2.4 PUR

Polyurethane

1.5.2.5 RETV

Residential Envelope Transmittance Value

1.5.2.6 RTTV

Roof Thermal Transfer Value (applicable for roofs with skylights)

1.5.2.7 RWDP

Rainwater down pipe

2 PERFORMANCE REQUIREMENTS

2.1 Contractor's Brief

When carrying out the proposals as set out in Section A05-010:Clause:1.4.1, take account of the following requirements:

2.1.1 Structural

2.1.1.1 Dead Loads

The self-weight and other associated dead loads of the complete roof system shall comply to C&S engineer's design.

The loads shall be supported and transferred to the main building structure at the appropriate locations as indicated in the drawings.

2.1.1.2 Live Loads

Unless otherwise specified, account for the live loads as stipulated in the Approved Document, and additional requirements of other statutory authorities having jurisdiction over the Works, if any.

2.1.1.3 Wind Loads

Allow for wind loads computed based on SS EN 1991-1 to 4 with a basic wind speed of 35 m/s, and as recommended in SS 631.

2.1.1.4 Thermal Stress and Structural Movement

Allow for all thermal stress and other structural movement.

2.1.1.5 Structural Fixing

Structural fixings shall be able to resist the worst combination of the applied loads, as well as foreseeable vibration transmitted to the roofing system.

2.1.1.6 Maintenance Loads

For accessible areas, allow for maintenance loadings, including loadings from personnel, plant and equipment. Include the dynamic effects of such plants and equipment.

2.1.1.7 Secondary Building Movements

Take into account, movements from secondary support structures, including vibration and thermal movement from M&E equipment and related works.

2.1.2 Fire Resistance

Comply with the requirements of the Fire Code and additional requirements of other statutory authorities having jurisdiction over the Works if any.

2.1.3 Functional

2.1.3.1 Air Infiltration

The metal roofing system shall be sufficiently air tight such as to prevent undesirable noise resulting from wind movements.

2.1.3.2 Invasion of Pests

Gaps and openings shall be sealed off for bird-proofing and for disallowing the invasion of pests.

2.1.4 Environmental

2.1.4.1 Thermal Performance

Comply with the following:

SEALANT TO BE WEATHER PROOF GRADE, NON-TOXIC W COC.

2.1.4.2 Rainwater Drainage

Comply with the requirements of SS 525 for roof drainage, and that of other statutory authorities having jurisdiction over the Works if any.

2.1.4.3 Watertightness

The completed roof is to be impenetrable to water and not give rise to any observable dampness on visible surfaces under normal environmental conditions expected.

2.1.4.4 Durability

Provide necessary corrosion protection to roofing sheets, components and accessories, appropriate to the location, use and design life of the building.

2.1.5 Acoustic Integrity

2.1.5.1 Sound Insulation

Attain acoustic rating as specified in Section A05-010: Clause 3.1.

2.1.6 Maintenance

Comply with the Workplace Safety and Health Act (Cap. 354A) and relevant safety requirements of statutory authorities having jurisdiction over the Works.

The roof system shall be maintainable and replaceable in parts or whole from the exterior.

Allow routine cleaning to be conducted with minimal disruption to the building occupants.

3 MATERIALS

3.1 Metal Roof System

The metal roofing system may be assembled on site with the individual components, or supplied and installed as a composite system incorporating one or more components.

The metal roofing (MR) system(s) shall consist of the following types:

Type: Refer to Architecture Drawing		
Item	Requirements	Clause Reference
Metal Sheet	<i>Aluminium Honeycomb roofing</i>	.
- Base Material	<i>Aluminium</i>	.
- Manufacturer	<i>M Metal</i>	.
-Form of Sheet	<i>Refer to Architect's drawing</i>	.
-Metallic Coating	<i>Refer to Architect's drawing</i>	.
-BMT	<i>Refer to Architect's drawing</i>	.
-Min End Lap Width	<i>Supplier to propose for approval</i>	.
Protective Coating	<i>Supplier to propose for approval</i>	.
-Exposed Side	<i>Refer to Architect's drawing</i>	.
-Exposed Side Colour	<i>To Architect's selection</i>	.
-Reversed Side	<i>To Architect's selection</i>	.
-Reversed Side Colour	<i>To Architect's selection</i>	.
-Daylight Reflectance	<i>To comply to BCA</i>	.
Roof Deck (Liner)	<i>Refer to Architect's drawing</i>	.
Fixings and Fasteners	<i>Supplier to propose for approval</i>	.
Profile fillers/ Rib End Stops	<i>Supplier to propose for approval</i>	.
Sealants	<i>Supplier to propose for approval</i>	.
Acoustic Rating	<i>STC 46 / STC 53</i>	.
Acoustic Treatment:	<i>N.A</i>	.
Underlayment and Insulation System	<i>N.A</i>	.
-Waterproof Underlay	<i>N.A</i>	.
-Vapour Barrier	<i>N.A</i>	.
-Thermal Insulation	<i>N.A</i>	.
-Wire Mesh Support	<i>BRC 3315</i>	.
Rainwater Goods	<i>N.A</i>	.
- General Flashing	<i>Supplier to propose for approval</i>	.
- Penetration Flashing	<i>Supplier to propose for approval</i>	.
- Gutter Material and Profile	<i>N.A</i>	.
-Gutter Support Material	<i>N.A</i>	.
-Gutter Covering Material	<i>N.A</i>	.
- RWDP Material and Profile	<i>N.A</i>	.
-Holder Bat Material	<i>N.A</i>	.
Miscellaneous Components	<i>N.A</i>	.
-Component(s)	<i>N.A</i>	.
Fall Arrest System	<i>N.A</i>	.

3.2 General Material Requirements

3.2.1 Ancillary Products and Accessories

Where ancillary products and accessories and miscellaneous components are not specified, recommend types by the metal sheeting manufacturers, for the intended purpose.

3.2.2 Length of Components

Components, particularly metal sheeting, gutters, down pipes, capping, and flashing shall be in the longest lengths as practical to minimise lapping, joints and wastage.

3.2.3 Compatibility of Materials and Separation

Take into account the compatibility of different materials used in or near the roofing system:

- (a) Prevent contact between incompatible materials/components, particularly contact between incompatible metals, and metals with alloys to avoid bimetallic corrosion.
- (b) Prevent contact with green or chemically treated timber, wet or dry concrete, and soil.
- (c) Materials use for separation of dissimilar materials/components shall have the following quality:
 - (i) Non-conducting, non-compressible and non-water absorbing.
 - (ii) Compatible with elements with which materials come into contact.

3.3 Metal Sheeting

To SS 631.

3.3.1 Materials

3.3.1.1 Steel

To BS 1449-1.1.

3.3.1.2 Stainless steel

To BS EN 10088. Grade 316 shall be used, unless otherwise specified in Section A05-010:Clause:3.1.

3.3.1.3 Aluminium

To BS EN 485-2, 3, 4.

3.3.2 Form of Sheeting

Acceptable forms are as follows:

- (a) Corrugated sheet in sinusoidal or trapezoidal profiles
- (b) Standing seams
- (c) Concealed fix profile

3.3.3 Base Metal Thickness

As specified in Section A05-010:Clause:3.1.

3.3.4 Pitch

Pitch shall be as indicated in drawings and shall comply with the minimum roof pitch recommended by the manufacturer.

3.4 Protective Coatings

3.4.1 Metallic Coatings to Steel Roofing Sheet

Steel roof sheets shall be supplied with one of the following hot-dipped coatings, as specified in Section A05-010:Clause:3.1:

- (a) Aluminium-zinc alloy coated to BS ISO 9364 or AS 1397 and AS/NZS 2728.
- (b) Aluminium coated to BS EN 10143.
- (c) Zinc coated to BS ISO 4998 or ASTM A653.

3.4.2 Anodizing to Aluminium Roofing Sheet

To be 25 micron thick to AS 1231.

3.4.3 Paint Coatings

3.4.3.1 PVF2 Coating

To AAMA 2605.

Resin content shall be minimum 70%. Minimum thickness 25 microns.

3.4.3.2 Polyester Powder Coating

To AS 3715.

Minimum thickness shall be 50 microns.

3.4.3.3 Silicone Polyester or Silicone Modified Polyester

To manufacturer's recommendation to satisfy Section A05-010:Clause:2.1.4.4.

3.4.3.4 Polyurethane

To manufacturer's recommendation to satisfy Clause Section A05-010:Clause:2.1.4.4.

3.4.4 Colour and Daylight Reflectance

To be as specified in Section A05-010:Clause:3.1, and comply with BCA Approved Document.

3.5 Roof Deck (Liner)

Use proprietary metal sheeting recommended by the manufacturer.

3.6 Skylights

Refer to Section A05-040 "Glass Roof System" for general requirement of materials for skylights.

3.7 Accessories

3.7.1 Fixings, Brackets, Screws and Washers

Be in accordance with SS 631, AS 3566.1 and roof sheeting manufacturer's recommendations. Take into account design life of the roofing, and use fasteners of similar life expectancy to roofing sheet.

Use minimum class 3 fasteners, and class 4 in moderate to severe marine environments.

3.7.2 Profile Fillers and Rib End Stops

Be in accordance with roof sheeting manufacturer's recommendations and match the profile of metal sheeting selected.

3.7.3 Weather Seals and Air Seals

Sealants shall be to manufacturer's recommendation and shall be non-staining and compatible with the other components.

Sealant geometry (and cross sections) to be designed to accommodate the anticipated substrate movements.

Unless otherwise approved by the SO, non-structural sealants shall be either one of the following:

- (a) low modulus silicone (exposed or concealed)
- (b) polyurethane (concealed)

Do not use acrylic sealants for frame seals or smoke flashings.
Do not use acid curing sealants.

Backing rods shall not adhere to the sealant and to be compatible with the substrate.

The colour of all visible sealants shall be to the SO's approval.

3.7.4 Acoustic Treatment

Refer to Section A05-010:Clause:3.1 for acoustic treatment material, if any.

To achieve rating specified in Section A05-010:Clause:3.1 when tested to ASTM E90 and ASTM E413.

3.8 Purlins

Refer to Section C05-010 "Structural Steelwork" and C08-010 "Structural Timberwork".

3.9 Underlay and Insulation System

3.9.1 Waterproof Underlay

Waterproof underlay shall be one of the following materials or similar impervious sheet materials of adequate puncture resistance.

(a) Double-sided reflective foil laminates

(b) Waterproofing felts

3.9.2 Vapour Barrier

Vapour barrier shall be one of the following materials or similar impervious sheet materials of adequate puncture resistance.

(a) Double-sided reflective foil laminates

(b) Waterproofing felts

3.9.3 Thermal Insulation

3.9.3.1 Double-sided Reflective Foil Laminates

Where double-sided reflective foil laminate is expected to perform as a waterproof underlay (or vapour barrier) as well, the laminate shall be subject to the requirement of these items.

Double-sided foil shall comply as follows:

(a) BS 476-7, class 1 and BS 476, part 6, class 0

(b) Reflectivity to ASTM C1371, min 95%

- (c) Emissivity to ASTM C1371, min 5%
- (d) Water Vapour Transmission rate to ASTM E 96, 0.01g/m2/h

3.9.3.2 Mineral Wool

Be in accordance with BS EN 13162.

3.9.3.3 Other Types of Insulations

Other types of insulations shall comply with the following requirements:

- (a) Not to contain organic components which may be subject to volatilisation and condensation
- (b) Non-combustible
- (c) Rot and vermin resistant
- (d) Does not degrade in moisture

3.9.4 Wire Mesh Support

Where required, support for roof underlay shall be hexagonal or square wire mesh to BS EN 10223, complying to the following requirements:

- (a) Mesh shall consist of minimum 1.2 mm galvanised wire with tensile strength minimum 450 MPa.
- (b) Does not sag when stretched between supports.
- (c) Rigidly connected at junction without welded joints.

3.10 Rainwater Goods

Be in accordance with SS 525 and manufacturer's recommendations.

3.10.1 Flashing

All flashings and capping to have a minimum BMT of 0.55 mm, with the same coating system and profile as the selected metal sheeting, and comply with SS 631.

3.10.2 Gutters and Gutter Support

As specified in Section A05-010:Clause:3.1. Use the following:

- (a) Stainless steel to BS EN 10088 grade 1.4401 (or AISI 316)
- (b) Galvanised mild steel in accordance with structural specifications

3.10.3 Wire Mesh Gutter Covering

Be in accordance with SS 631. Provide where indicated on drawings or as specified in Section A05-010:Clause:3.1, or otherwise necessary to prevent objects from falling into the gutter which may cause water stagnation and become potential breeding habitat for mosquitoes. Use the following:

- (a) Stainless steel to BS EN 10088 grade 1.4401 (or AISI 316)
- (b) Galvanised mild steel mesh to BS EN 10223

3.10.4 Rainwater Down Pipes

Ductile Iron Pipes and fittings shall be in accordance with BS 460.

uPVC pipes and fittings shall be in accordance with SS 141.

3.10.5 Holder Bats

Use the following:

- (a) Stainless steel to BS EN 10088 grade 1.4401 (or AISI 316)
- (b) Galvanised mild steel in accordance with structural specifications

3.11 Safety and Maintenance

Fall protection shall comply with the Workplace Safety and Health Act (Cap.354A), and relevant regulations.

3.11.1 Maintenance Walkways

Provide maintenance walkway where shown on drawings.

3.11.2 Fall Arrest System

Comply with SS 528.

Fall arrest system(s) shall be as shown in drawings, or specified in Section A05-010:Clause:3.1, to satisfy the purpose of carrying out periodical maintenance and cleaning, and to be capable of taking the load specified in Section A05-010:Clause:2.1.1.6.

3.12 Cavity Barriers

Provide cavity barriers at concealed spaces in the roof space where indicated in the drawings, and comply with the Fire Code.

4 WORKMANSHIP

4.1 General Workmanship Requirements

4.1.1 Method of Works

Carry out the Works in accordance with the method statement as submitted to the SO. Ensure that construction will achieve the design as set out in the approved shop drawings.

4.1.2 Co-ordination and Setting Out

Co-ordinate the works with all interfacing works packages and trades to ensure correct setting out and positioning of all penetrations, attachments, and other constituent materials and elements.

4.1.3 Storage, Handling and Hoisting

4.1.3.1 Storage

Roof sheeting shall be stacked neatly, protected from rain or condensation with waterproof covers and stored in a dry area, clear off the ground.

4.1.3.2 Handling and Hoisting

Handle and hoist assemblies carefully, at all stages to ensure that sections and finishes are not damaged, and are in accordance with manufacturer's recommendations.

4.1.4 Finished Tolerances of Systems

4.1.4.1 Fabrication

Linear dimensions:	± 2 mm
Squareness (diagonal):	± 3 mm
Flatness:	± 0.5 mm in 300 mm

Joint widths shall vary by not more than 2 mm or 10%. Adjacent "flush" surfaces separated by "hair line" joints to step by not more than 0.5 mm.

4.1.4.2 Installation

Linear dimensions:	± 2 mm
Level:	± 2 mm
Position at floor or ceiling:	± 2 mm from grid
Verticality:	$\pm H/500$ or < 5 mm between floors and ceiling
Steps in plane:	± 2 mm
Steps out of plane:	± 1 mm
Camber	.
Bow	.

4.2 Supporting Members

Install supporting members in accordance with structural drawings and specifications. Comply with SS 631 and take into account the following:

- (a) The spacing of supporting members is within tolerances recommended by the roof sheeting manufacturer.
- (b) Any vertical or horizontal misalignment at the abutting ends does not exceed 2 mm.
- (c) The top of the supporting members is substantially in a plane parallel to the specified roof pitch.

4.3 Underlay and Insulation System

4.3.1 Waterproof Underlay

Lay the waterproof underlay to comply with the following requirements:

- (a) In direction of falls
- (b) Fixed to structural support
- (c) Allow for drainage of any water to the outside, or into gutter area
- (d) End and side laps are at least 150 mm

4.3.2 Vapour Barrier

Locate and lay vapour barrier to comply with SS 631, in accordance with manufacturer's recommendations, and to prevent interstitial condensation on visible surfaces. Where condensation is expected, ensure adequate drainage provision is made.

4.3.3 Thermal Insulation and Wire Mesh Support

Locate and lay thermal insulation and wire mesh support to comply with SS 631 and in accordance with manufacturer's recommendations.

4.4 Installation of Metal Roof Sheeting

Carry out the installation of metal roof sheeting, including any roof deck (liner) materials, to comply with SS 631, in accordance with manufacturer's recommendations. Where possible, minimise site work by using sheets cut to length in the factory.

Comply with the following requirements.

4.4.1 Laying the Sheeting

Support sheets as near to their ends as practicable, notwithstanding that the sheet end shall always positively overhang the full width of the supporting surface to prevent water intrusion by capillary action. Ensure compliance with manufacturer's recommended maximum and minimum unsupported end overhang for the sheet.

4.4.2 Fixing of Metal Roof Sheeting

Fix sheeting to manufacturer's recommendation.

Unless otherwise approved by the SO, install fasteners normal to the plane of the roof.

Pay particular attention to combinations of internal and external wind pressures and frictional drag.

Where non-returnable movement is allowed to take place during fixing, make provision for anchoring of the sheets.

Give consideration to the anchoring of roofing against movement down the slope due to vibration and thermal movements.

4.4.2.1 Pierce Fixing

Where pierce fixing is used, always place screws through the crown of a rib, and adequately seal all fasteners which pierce the roofing to prevent leakage.

4.4.2.2 Concealed Fixing

Use clips provided by the roof sheeting manufacturer.

For steep pitches, pierce fix through each sheet under the flashing or capping, along the top of the sheets.

4.4.3 Projections

Adequately flash any projections through roofs such as pipes, ducts and conduits and to approved details.

4.4.4 Vibration Proofing of Fixings

Vibration proof all fixings subject to vibrating loads by the use of locking nuts, locking washers or other methods approved by the SO.

4.4.5 Prevention of Bimetallic Corrosion

Prevent corrosion of dissimilar metals in contact from galvanic action by:

- (a) separating or isolating the dissimilar metals with separator
- (b) appropriate detailing of the overlapping of metal sheets to avoid crevice corrosion.

4.4.6 Drilling, Piercing and Cutting

When making holes, mask the area around the hole to protect the paint from damage by swarf. Remove swarf, nails, screws, other metallic particles, etc, immediately after drilling, piercing and cutting of metal roof sheeting. If swarf becomes stuck to sheeting, remove without damaging paint coating of the sheeting.

Do not punch holes, unless it can be done without causing local distortions to the metal roof sheeting.

4.4.7 End and Side Laps

4.4.7.1 Planning

Plan and lay metal roof sheeting to minimise end and side laps. Avoid formation of laps at roof protrusions and attachments.

4.4.7.2 End Laps

Provide two strips of manufacturer's recommended profile fillers and sealant, one at the low end of the lap to prevent capillary and the other at the high end to prevent condensation from entering the lap. Mechanically fasten when recommended by the manufacturer.

4.4.7.3 Side Laps

For pierced fastened roof sheeting, form side laps with the lap cavity on top of the sheet with profile filler or sealant such that any moisture build-up in this cavity can be drained down the roof slope unobstructed by the filler or sealant.

4.4.8 Sealant Jointing

Apply sealants and jointing in accordance with manufacturer's recommendations.

Carry out the following in respect of the sealant jointing works:

- (a) Clean and prepare joint surfaces before application and ensure that joints are free from dust, grease and other contaminants.
- (b) Apply jointing material so that joints subject to ingress of water are made watertight and are in accordance with details in shop drawings approved by the SO. Ensure backing rods, when needed, are installed at the correct depths.
- (c) Apply sealant on the same day as joint surfaces are cleaned.

4.5 Skylights

Install skylight(s) in accordance with Section A05-040:Clause:4.

4.6 Installation of Rainwater Goods

Install rainwater goods to comply with SS 525, in accordance with manufacturer's recommendations, the requirements of ENV and any other statutory authorities having jurisdiction over the Works.

4.6.1 Flashing

Flash and cap all parts of the roof to prevent water penetration and dampness into the inner parts of the building, including areas around vent pipes, skylights, ducts, and all other penetrations, ridges, verges, and along roof slopes that abut walls.

4.6.2 Gutters

- (a) Install to required fall, space gutter support at 600 mm centres.
- (b) Box gutters shall be continuously supported.
- (c) Fix stop ends shall match gutter profile and colour.
- (d) Lap all gutters in the direction of flow and seal all joints.

4.6.3 Down Pipes

Space all down pipes at required centres, fit to gutters and fix securely to walls or columns with holder bats spaced at 1200 mm centres. Seal all joints.

4.7 Protection

4.7.1 Completion of Roof

Ensure that from completion of the roof until contractual completion:

- (a) The roof is not used as a working platform unless fully protected to the satisfaction of the SO.
- (b) Do not allow solvents or other harmful chemical to come into contact with the roof surface.
- (c) Protect the finished roof areas from damage by subsequent building operations.

4.7.2 Wet Weather

In wet weather, carry out the following:

- (a) Provide temporary covers and drainage as required to keep unfinished areas of the roof dry.

- (b) Suspend work in severe or continuously wet weather unless an effective temporary roof is provided over the working area.
- (c) If unavoidable wetting of the construction occurs, take prompt action to minimise and make good any damage.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in the construction programme, events for submission of the following information:

- (a) Name of the metal roof manufacturer and all components of the roofing system, and relevant technical data.
- (b) Name of Subcontractor (if any).
- (c) All other submissions specified in this Section.

5.1.1.1 Computation Submissions

Where only performance values are specified, submit computations as follows:

- (a) Structural calculations for fixing system
- (b) Thermal performance calculation
- (c) Sound transmission performance data
- (d) Temporary support system calculation (if necessary)

5.1.2 Work Submissions

5.1.2.1 Method Statements

Prior to commencing construction work, submit a detailed method statement to the SO. Include at least the following information:

- (a) Sequence of construction.
- (b) Acceptance of structure and substrate.
- (c) Fixing and installation of the roof system.
- (d) Method of forming laps, joints and penetrations, and application of sealant and fillers.
- (e) Accommodation of lightning protection systems.

- (f) Accommodation of all penetrations and other trades/items which impact the roof.

5.1.2.2 Shop Drawings

Where specified, prepare shop drawings, and include:

- (a) Typical and non-typical details of roof system and associated components including interfaces and flashings with adjacent structure and/or other cladding elements.
- (b) End and side lap details and details at scales agreed with the SO, of ridge, eaves, gutters, valley, hips and any changes in roof pitch.
- (c) Provision and supports for insulation, underlay and vapour barriers.
- (d) Waterproofing of penetration through roof, including lightning protection points and/or tapes, and vent pipes etc.
- (e) Details of roof drainage system
- (f) Penetrations to roof

Do not commence fabrication until shop drawings have been reviewed and permission to proceed has been obtained from the SO.

5.1.3 Test Reports and Certificate Submissions

Submit relevant test reports and certificates from a recognised Certification Body to demonstrate compliance with all required material and system characteristics specified.

- (a) **Tests**

Carry out tests as follows:

Material	Test	Description
Roof sheeting	.	.
Structural support members	.	.
Fasteners	.	.
Underlay	.	.
Insulation	.	.
Rain water goods	.	.

[Note: Check the required tests under the BCA Approved Document, Code for Environmental Sustainability of Buildings, Fire Code, etc.]

(b) Certificates

Provide certificates as follows:

Material	Certificate	Description
.	.	.
.	.	.

[Note 2: Check the required certification under the BCA Approved Document, Code for Environmental Sustainability of Buildings, Fire Code 2018 Chapter 11, etc.]

5.1.4 Quality Control Plan Submissions

Prepare and submit the quality control plan to the SO prior to starting work.

5.1.5 Warranty

Submit the warranty to the SO upon completion of the Works, if required under Section A05-010:Clause:1.4.5.

5.1.6 Maintenance Submissions

Submit maintenance manual on completion of the Works, to Section A05-010:Clause:1.4.6.

5.2 Samples and Mock-ups

5.2.1 Samples

For each system type specified in Section A05-010:Clause:3.1, provide samples of each component to demonstrate compliance with material quality, thickness, finishes and profile.

5.2.2 Mock-Ups

Within the timeframe shown in the construction programme, provide mock-up panel of sufficient size to obtain agreement on the intended construction. Also include the following elements, where applicable:

- (a) Eaves
- (b) Ridge
- (c) Edge/gutter
- (d) Upstand
- (e) Vent pipes / other building services protrusions / penetrations

If approved by the SO, this mock-up panel may form part of the Works.

Provide additional mock-ups as follows:

Mock-up	Requirements
.	.
.	.

[Note: Customise table to reflect project specific requirements.]

5.3 Inspections

Inform the SO on completion of the substrate / roof structure and each stage of installation for each roof system specified in Section A05-010:Clause:3.1. Proceed to next stage after approval by the SO.

5.4 On-Site Tests

5.4.1 Water Tests

Carry out on-site water tests upon completion of a part of the Works, in accordance with the following procedure:

- Spray with a continuous water jet from a water hose with normal tap pressure. Hold the hose at 1.2 m away from the roof surface. Place the hose at the level of horizontal joints so that the jet cone scatter will cover the joints.
- The test is deemed as passed if there is no water seepage or dampness observed from the underside of the roof.
- Any areas showing water seepage or other defects to be made good after a method statement for reinstatement has been approved by the SO.
- Use tested areas as a site quality standard for the remainder of the project.

Carry out on-site water test at the following area and frequency:

Area of Test	Frequency of Test
ON ALL APPLIED AREA EITHER WITH NEW FLASHING OVER EXISTING OR APPLICATION OF SEALANT TO EXISTING FLASHING.	THERE IS NO FREQUENCY OF TEST BUT ANY LEAKAGE WITHIN DLP SHALL BE REPAIRED/ REPLACED/ RE-APPLIED BY CONTRACT EITHER OR NOT THE METHOD STATEMENT/SHOPDRAWING/ MATERIAL IS APPROVED BY CONSULTANT.
.	.

5.4.2 Roof Drainage Tests

Upon completion of the roofing works and installation of rain water goods, carry out on-site drainage test to verify proper functioning and performance of the roof drainage system, in accordance with SS 525.

5.4.3 Acoustic Tests

Conduct field tests and measurements at locations to be agreed with the SO, to verify that acoustic rating specified in Section A05-010:Clause:3.1 is achieved.

(23) A05-030 CONCRETE ROOF SYSTEM

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This section covers the general requirements for applied finishes for flat roofs, including various combinations of the following:

- (a) **Waterproofing**
- (b) **Insulation**
- (c) **Surfacing**

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A02-030	Plasters and Renders
A02-040	Wall Tiling
A05-040	Glass Roof System
A07-010	Floor Screeds and Hardeners
A14-020	Liquid Applied Membrane System
A14-030	Cementitious System
A15-010	Hardscape
A16-010	Conventional Rainwater Drainage System
A16-020	Siphonic Rainwater Drainage System

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the Standards and Codes listed below or referenced in the body of the Specification. Alternative Standards and Codes may be submitted to the SO, provided it can be demonstrated that the alternative Standards and Codes comply with the requirements of the standards specified. All Standards and Codes referenced below and elsewhere in this Specification shall be the latest editions.

In event that the Standards or Codes are partially superseded or become obsolete, Contractor is to refer to the latest edition or approved substitution for the relevant editions and highlight to the Architect in the submissions.

Singapore Standards	
SS 133	Bituminous emulsion for Roof Waterproofing
SS 141	Unplasticized PVC pipe for cold water services and industrial uses
SS 374	Preformed Waterproofing Membranes for Concealed Roof
SS 637	Code of practice for waterproofing of reinforced concrete buildings
CP 33	Lightning Protection
CP 82	Waterproofing of Reinforced Concrete Buildings
Other Standards	
BS EN 363	Personal protective equipment against falls from a height – Fall Arrest Systems.
BS EN 10088	Stainless Steels
BS 460	Cast iron for rainwater goods
BS 3837-1	Expanded Polystyrene Boards – Part 1: Specifications for Boards Manufactured from Expandable Beads
BS 3837-2	Expanded Polystyrene Boards – Part 2: Specification for extruded boards
BS CP 3	Code of basic data for the design of buildings: Chapter V Loading

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority â Approved Document ("Approved Document")
Building and Construction Authority â Building Control Regulations
Code of Practice for Fire Precautions in Buildings ("Fire Code")
Code for Environmental Sustainability of Buildings
Code of Practice on Environmental Health
Guidelines on Envelope Thermal Transfer Value for Buildings

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.3.3 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority â CONQUAS 21 Enhancement Series, Good Industry Practices Guide Books
--

1.4 Trade Preamble

1.4.1 Contractorâs Submissions

The design intent and types of flat roof finishes for the project are set out in Section A05-030:Clause:3.1 and locations are indicated in the drawings. Based on the information, engage qualified and experienced personnel to carry out and submit the following items to the SO.

1.4.1.1 Design Development

Develop all necessary details including connections and interfaces etc. for the construction of the roof waterproofing system based on the design drawings.

1.4.1.2 Construction Methods

Submit suitable methods to carry out the Works including setting out, application of waterproofing membranes, installation and fixing of associated components, etc. Take into account the performance requirements as set out in Clause 2.1 and submit the construction method to the SO.

1.4.1.3 Manufacturer and products

Submit names of manufacturers and products to the SO, to meet with specified requirements.

Certification for materials with low volatile organic compound (VOC) products shall be certified by an approved local Certification Body, tested in accordance to the relevant standards.

1.4.1.4 Shop Drawings

Prepare coordinated shop drawings incorporating all developed details.

1.4.2 Co-ordination with other Works

Co-ordinate the roofing works, particularly the interfacing with the following trades:

- (a) Main structural roofing works
- (b) External masonry and cladding
- (c) Lightning protection
- (d) Plumbing works
- (e) Mechanical services
- (f) Electrical services
- (g) Ceilings
- (h) Balustrades
- (i) External doors and thresholds
- (j) External painting and coating

Liaise and coordinate with services engineer for location of roof penetrations, attachments and other services to be fixed into and or onto the roof(s).

1.4.3 Provision of Spare Materials

Deliver to Site in strong protective packages marked for identification, and store where directed, components and materials for future replacement and repair.

1.4.4 Quality Control Plan

No item.

1.4.5 Warranty

Provide warranty in accordance with contract conditions for the following items:

- (a) Waterproofing materials and watertightness of the roofs
- (b) Insulation systems of the roofs
- (c) Surfacing screed, other accessories and components

The period of warranty required for the listed items are as follows:

Items Requiring Warranty	Period of Warranty Required
Waterproofing & watertightness of the roof	10 years
Insulation system of the roof	Defects Liability Period
Surfacing screed, other accessories & components	Defects Liability Period

1.4.6 Maintenance Manual

No item.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.5.1 Definitions

No item.

1.5.2 Abbreviations

1.5.2.1 DFT

Dry Film Thickness

1.5.2.2 OTTV

Overall Thermal Transfer Value

1.5.2.3 RC

Reinforced concrete

1.5.2.4 RWDP

Rainwater downpipe

1.5.2.5 STL

sound transmission loss

1.5.2.6 WFT

Wet Film Thickness

2 PERFORMANCE REQUIREMENTS

2.1 Contractor's Brief

When carrying out the proposals as set out in Section A05-030:Clause:1.4.1, take account of the following requirements.

2.1.1 Structural

2.1.1.1 Dead Loads

The self-weight and other associated dead loads of the complete applied finishes system shall not exceed the assumed design value as indicated.

The self-weight and other associated dead loads of the complete roof finishing system shall not exceed [2.4 kN/m²]

Refer to Structural Specification where relevant.

2.1.1.2 Live Loads

Unless otherwise specified, account for the live loads as stipulated in the Building Control Regulations, and additional requirements of other statutory authorities having jurisdiction over the Works, if any.

2.1.1.3 Wind Uplift

Account for possible wind uplift effects for loosely laid systems.

2.1.1.4 Thermal Stress and Structural Movement

Account for all thermal stress and other structural movement.

2.1.1.5 Structural Fixing

Structural fixings shall be able to resist the worst combination of the applied loads, as well as foreseeable vibration transmitted to the roofing system.

2.1.1.6 Maintenance Loads

For accessible areas, allow for maintenance loadings including loadings from personnel, plant and equipment, Include the dynamic effects of such plants and equipment. Refer to Project Specific Data for maintenance loading requirements. Account for maintenance loading requirements of 30.0 kN/m²

2.1.1.7 Secondary Building Movements

Take into account, movements from secondary support structures, including vibration and thermal movement from M&E equipment and related works.

2.1.2 Fire Resistance

Comply with the requirements of the FSSD and additional requirements of other statutory authorities having jurisdiction over the Works, if any.

2.1.3 Environmental

2.1.3.1 Thermal Performance

Comply with the applicable OTTV or U-value requirements in accordance to the

OTTV of the roof shall be [to be inserted] W/m²

U-value of the roof shall be [to be inserted] W/m²°K

Or in accordance to the BCA Code on Envelope Thermal Performance for Buildings.

2.1.4 Acoustic and Noise Performance

2.1.4.1 Acoustic performance

Ensure that the proposed roofing finishes, waterproofing and insulation system that form part of flat roof achieve the following sound transmission loss (STL) values against noise break-in.

Frequency (Hz)	125	250	500	1000	2000	4000
STL (dB)	25	27	30	33	30	26

Provide the appropriate enclosure to meet the required functions of the rooms:

S.No.	Room Type	STC Requirement (Enclosure)
1	Residential Units	≥ 40
2	Rooms beside M&E Rooms with Mechanical Equipment	≥ 60

If the rooms have no references to the above, then the base of acoustic performance shall be as defined:

Achieve STC 45 rating.

Achieve resistance to flanking and floor to floor sound transmission of STC 45.

Insulation layer or other proposed acoustic seal systems to meet the required performance are deemed to be included in the Main Contract.

2.1.4.2 Noise

Reduce drumming, creaking, rattling, whistling and any other noise from the roof such that no sound is audible to occupants. Insulation layer or other proposed acoustic seal systems to meet the required performance are deemed to be included in the Main Contract.

2.1.4.3 Rainwater Drainage

Take into account, compliance with the requirements of SS CP 26 for roof drainage, and that of other statutory authorities having jurisdiction over the Works, if any.

If siphonic rainwater discharge system is proposed, the system shall be designed to specialist's details. All pipes shall not be exposed and pipes shall avoid crossing bedroom / living area / dining area. Vertical pipes should be concealed. All box up shall be deemed to be included.

The waterproofing system detailing with the drainage design for the roof shall be highlighted at early stage to understand construction sequence and ease of installation to accommodate waterproofing system and the siphonic drainage system.

2.1.4.4 Watertightness

The completed roof shall be impenetrable to water and not give rise to any observable dampness at the underside of the roof structure under the normal environmental conditions expected.

2.1.5 Maintenance

2.1.5.1 The roof system shall be maintainable and replaceable in parts or whole from the outside.

2.1.5.2 Allow routine cleaning to be conducted with minimal disruption to the building occupants.

2.1.6 Greenmark Requirements

All proposed systems shall have Green Label/ Singapore Green Building Product Certification. Contractor shall submit the relevant certifications or equivalent standards to the SO for review during material submission.

3 MATERIALS

3.1 Types of Applied Finishes System

The applied finishes system(s) for the project may consist of varying combination of different components as set out in Table 2.

The finishes system shall either be assembled on site with the individual components, or supplied and installed as a composite system incorporating one or more components.

Table 2. Types of applied finishes

S/N	Type	Details	Location
WP*		(Read in relation to the drawings)	

WP1	Liquid applied waterproofing membrane	<ul style="list-style-type: none"> ● RC slab cast ● 50 mm cement sand screed ● Single component, solvent-free liquid applied elastomeric water proofing membrane (to Supplier's specifications and recommendations) ● 50 mm thick extruded polystyrene board insulation board of 35 kg/m3 density ● Separation layer: geo-textile (100 gsm) ● 3 m x 3 m, 50 mm thick cast in- situ grade 30 panels with polyurethane sealant at joints. 	All RC flat roofs including roof of staircases, lift shafts, M&E shafts / doghouses, upstands, gutters, roof terraces, open terraces and driveway etc.
WP2	Cementitious waterproofing membrane	<p><u>Wall Application</u></p> <ul style="list-style-type: none"> ● Surface shall be reasonably smooth and inspected to receive waterproofing membrane. ● 2 coats of cementitious waterproofing system to be applied to supplier's specifications and recommendations up to a height of 1.8 m. ● Min. 25 mm cement:sand protection screed to receive finishing ● Finishes to Architectural specification / schedule of finishes <p><u>Floor Application</u></p> <ul style="list-style-type: none"> ● 2 coats of cementitious waterproofing system shall be applied to supplier's specifications and recommendations ● Min 25 mm cement:sand protection screed to receive finishing ● Finishes to Architect's Specifications / Schedule of Finishes 	All wet areas e.g. balcony, kitchens, bathrooms, WCs, RC ledges, sun and pool decks, bin centre, refuse chute / chambers, planter boxes / landscape areas (only applicable for ground cover / turfing / low shrubs, etc. and M&E rooms.
WP3	Waterproofing membrane system	Refer to Structural Specification – on Waterproofing system for Underground Structures	Basement structures and slabs in contact with ground
WP4	Integral concrete waterproofing system	Refer to Structural Specification – Section 8 on Waterproofing system for Underground Structures	Undersoil structures Refer to C&S Engineer's Specifications

WP5	Root resistant waterproofing membrane system	<ul style="list-style-type: none"> ● R.C Slab cast to fall <p>Root resistant Waterproofing membrane system to supplier's specifications and recommendations</p> <ul style="list-style-type: none"> ● Min. 25mm thick protective screed ● Green Roof Drainage Mat / Panel (or equivalent system) ● Separation Fleece ● Planting Medium Trees/Shrubs 	Planter boxes and landscape area (for large plants)
WP6	Root-resistant Waterproofing membrane system with substrate, water storage/drainage system	<ul style="list-style-type: none"> ● Cement: sand screed to fall ● Root resistant Waterproofing membrane system to supplier's specifications and recommendations ● Green roof drainage mat system (or equivalent system) ● Min 100mm thick garden media/Substrate (or equivalent system) ● Plantings (Ground Cover and Low Shrub. 	Roof Garden/Landscape

** WP is the shortened form for waterproofing.*

3.1.1 Performance Requirements

Performance Standards are required to match or surpass the following.

3.1.1.1 WP1 (Liquid applied waterproofing membrane)

Property	Value	Test Method
Tensile Strength	$\geq 1.5 \text{ N/mm}^2$	ASTM D412
Resistance to Water Pressure	No water penetration-Pass	DIN 1048
Water Vapor Transmission	$< 25 \text{ g/m}^2/24\text{hrs}$	ASTM E96
Adhesion to substrate	0.50 N/mm^2	ASTM D4541
Cracking Bridging (2mm)	Passed	ASTM C836
Elongation at Break	$\geq 500\%$	ASTM D412
Hardness Shore A	≥ 30	ASTM D2240

3.1.1.2 WP2 (Cementitious Waterproofing Membrane)

Table 5. Requirements for cementitious waterproofing membrane

No.	Tests	HDB'S Criteria	Acceptance	Test Results
1	Resistance to water penetration (mm)		Depth of penetration should be zero.	0
2	Adhesion to substrate after 28 days cure (N/mm ²)	$\geq 0.3 \text{ N/mm}^2$		0.92
3	a) Before ageing b) After ageing at 50 °C, 14 days c) 0.5% (v/v) NaOCl d) 1.25% (v/v) NH ₄ OH e) 3.7% (v/v) HCl	$\geq 1.5 \text{ N/mm}^2$ $\geq 1.2 \text{ N/mm}^2$ After immersion in the following chemicals for 72 h at room temp. and -ve change $\leq 40\%$. No limit for +ve change.		1.83 2.96 62% 1.60 -13% 1.55 -15% 1.63 -11%
	a) Before ageing	$\geq 150\%$		280
	b) After ageing at 50 °C, 14 Days			198 -29%

	Elongation at break (%)	After immersion in the following chemicals for 72 hrs. at room temp.	c) 0.5% (v/v) NaOCL	≥ 120% And -ve change ≤ 40%. No limit for +ve change.	277	-1%
			d) 1.25% (v/v) NH ₄ OH		259	-8%
			e) 3.7% (v/v) HCl		265	-5%
4	Crack bridging	1) No cracking at 2 mm width			No Cracks	
		2) No cracks after 10 cycles of stretching and closing to a width of 1 mm			No Cracks	
5	Hardness (Shore A) After 7 days cure		≥ 40		89	
6	Set-to-touch (mins)		Should touch dry within 2 hrs		80	
7	Chloride content		< 0.1%		0.001	
8	Verification of base polymer		Polymer which undergoes hydrolysis should not be used		Butyl Arcylate & Styrene	

3.1.1.1 WP4 (Integral Waterproofing Admixture)

Table 4. Requirements for integral waterproofing admixture

Property	Value	Test Method
Water Permeability	< 20 mm	DIN 1048
Chloride content	$\leq 0.1\%$	ISEA Method
Toxicity	Passed	SS 375:2001
Water absorption	< 1.5%	SS 78 Part A22:1987

3.1.1.2 WP5 (Root-resistant waterproofing membrane system)

Table 6. Requirements for root-resistant waterproofing membrane system

Property	Value	Test Method
Thickness of film	≥ 2 mm (PVC) ≥ 3 mm (liquid applied)	-
Solid content (M. Wt. >100,000)	> 85%	-
Dimensional stability	$\leq 1\%$	DIN 16726
Tensile strength	> 2 N/mm ² / 2MPa	DIN 16726
Puncture resistance	Passed	DIN 16726
Elongation at break	> 600 %	DIN 16726
Joint strength	Passed	DIN 16726
Vapour diffusion resistance	< 15,000	DIN 5312
Fire resistance	Passed B2/ Class E	DIN 4102/ EN 13501-1
Root penetration	Passed/ Root impenetrable	DIN 16726/ EN13948/FLL
Bitumen resistance	Passed	DIN 16937/ EN 1548
Heat ageing treatment	Passed	DIN 16726
Chemical corrosion resistance	Passed	DIN 16726
Durability (UV Exposure, high temperatures & waters)	Passed	EN 1297

3.1.1.3 WP6 (Root Resistant Waterproofing membrane system with substrate, water storage/drainage system)

(a) Substrate type

Table 7. Substrate type

Property	Value
Colour	Brownish Black with White
Composition	Natural inorganic volcanic material, compost, organic and inorganic fertilizer
Density (Dry)	1.04 g/cm ³
(Wet)	1.43 g/cm ³
Organic Content	Not less than 25%
p H Value	7.0+/- 0.2
Nutrients Absorption Capacity	130mmol/z/l
Water Absorption Capacity	35%

(b) Water storage or drainage element

Table 8. Water storage or drainage element

Property	Value
Sizes	1.25 mx1.0mx62mm thick
Density	25 kg/m ³
Water Storage	16 litres/sqm
Drainage Capacity (3úll)	0.03% litre/sqm/sec
Thermal Insulation	0.60 m ² K/W

(c) **Waterproofing membrane**

Table 9. Waterproofing membrane

Property	Value	Test Method
Thickness of Film	≥ 1.5mm (PVC) ≥	-
Dimensional Stability	≤ 1%	DIN 16726
Tensile Strength	> 2 N/mm ² / 2MPa	DIN 16726
Puncture Resistance	Passed	DIN 16726
Elongation at Break	> 600 %	DIN 16726
Joint strength	Passed	DIN 16726
Vapour diffusion resistance	<15,000	DIN 5312
Fire Resistance	Passed B2/ Class E	DIN 4102/ EN 13501-1
Root Penetration	Passed/ Root impenetrable	DIN 16726/ EN13948/FLL
Bitumen resistance	Passed	DIN 16937/ EN 1548
Heat Ageing treatment	Passed	DIN 16726
Chemical Corrosion resistance	Passed	DIN 16726
Durability (UV Exposure, high temperatures & waters)	Passed	EN 1297

3.1.2 Proprietary Composite Systems

Where specified, submit suitable supplier for the proprietary systems specified, to the SO. The individual components shall comply with the requirements specified each component, and the performance as a composite system shall match or exceed the performance requirements specified for the whole system.

3.2 General Material Requirements

3.2.1 Ancillary Products and Accessories

Where ancillary products, accessories and miscellaneous components are not specified, submit suitable types for the intended purpose to the SO.

3.2.2 Length of Components

Components, particularly sheet waterproofing membrane, down pipes, capping, and flashing shall be in the longest lengths practicable to minimise lapping, joints and wastage.

3.2.3 Compatibility of Materials and Separation

Take into account compatibility of different materials used for the roofing system in particular.

- (a) Prevent contact between incompatible materials/components, particularly primer with metal pipes and metals with alloys.
- (b) Materials used for separation of dissimilar materials/components shall comply with the following quality:
 - (i) Non-conducting, non-compressible and non-water absorbing.
 - (ii) Compatible with the elements with which it comes into contact.

3.3 Substrate Preparation Materials

3.3.1 Base Slab and Screed

Where practicable construct the structural base slab to a fall of 1:80.

Where not possible or se to construct the base slab to a fall, apply a base screed to achieve a fall of 1:80. Base screed to be cement/sand with proprietary additives. Refer to work Section A07-010 "Floor Screeds and Hardeners", Clause 3 for general requirement of screed materials.

Provide galvanised wire mesh reinforcement when the average screed thickness exceeded 50 mm.

Substrate to receive waterproofing shall be clean and free of all water puddles, laitance, oil grease, curing agents, dust or other foreign matters. Verify that the substrate is relatively flat, with all voids and cracks filled ridges and fins removed.

Screed shall be appropriately cured to prevent shrinkage and cracking.

Mixes containing cement shall be used up within one hour of the final contact of the cement with water and all mixes remaining after this period shall be discarded and not be re-used. Do not mix old and new batches.

Any joints in screeds or paving are to correspond with those in the base slab and are to be formed against properly braced formwork. Extend the base screed into gutters and around outlets.

Minimum thickness of base screed shall be 50 mm with the maximum thickness dictated by the fall gradient requirement.

Screed surface shall be finished to a smooth and even surface throughout to within plus or minus 3.0 mm when tested with a 3 m long straight edge and the rate of departure shall not be greater than 1.5 mm for each 500 mm in distance from any point of contact along the straight edge.

Unless otherwise stated, all reinforced concrete roof slabs, troughs, skirtings, etc. shall be provided with waterproofed cement and sand screed and waterproofing membrane.

All pipe penetrations above roof shall be fixed with approved sleeves in accordance with manufacturers details and instructions or with approved flashing sleeve and sealant to Manufacturer's details and instructions.

3.3.2 Wall Render

Refer to Section A02-030:Clause:3 for general requirement of external render materials for walls, parapets, upstands and curbs.

3.4 Waterproofing Systems: Membranes

3.4.1 Liquid Applied Membranes

3.4.1.1 Bituminous

Bituminous liquid applied membrane to comply with SS 133.

3.4.1.2 Non-Bituminous

Non-Bituminous liquid applied membranes to be of the following types.

- (a) Rubber-based systems
- (b) Polyurethane systems

Submit suitable proprietary products and relevant technical literatures, standards referred to and product specifications to the SO.

3.4.2 Sheet Membranes

Sheet membranes shall be of the following types and shall comply with SS 374 unless otherwise agreed:

- (a) Bituminous
 - (i) Self-Adhesive
 - (ii) Torch-On
- (b) Thermoplastic

3.4.3 Flexible Cementitious Membranes

Submit suitable proprietary products and relevant technical literatures, standards referred to and product specifications to the SO.

3.4.4 Root Resistant Waterproofing Membranes

The waterproofing membrane shall be a rot-proof root-impenetrable and shall be membranes that are seamless or those whose seams are fusion welded. For areas where the waterproofing membrane shall be fully adhered, the cold applied adhesive shall be according to the manufacturer's recommendations.

The waterproofing membrane shall be manufactured to ISO 9001 quality assurance.

Membrane shall be extended with flashings and shall be terminated not less than 200 mm above the top of the soil level.

3.5 Waterproofing Systems: Waterproof Screed

Minimum 20 mm thick, comply with CP 82 or SS 637.

Where required, these shall be proprietary pre-packed product, organic or inorganic. Refer to Section A05-030: Clause:3.1 for product(s) specified for this project if any.

3.6 Waterproofing Systems: Auxiliary Components

3.6.1 Membrane Reinforcement

Membranes reinforcement shall comply with SS 133 and SS 374. The following materials may be used:

- (a) Polyester film with glass fibre matt
- (b) Perforated fibre glass matt
- (c) Non-woven polyester fabric

3.6.2 Slip Sheet

Submit suitable product of the following materials to the SO:

- (a) Polyester geotextile fabric overlaid with polyethylene sheeting
- (b) Polypropylene
- (c) PVC sheeting

3.6.3 Filter Fabric

Polyester woven file fabric, minimum 140 g/m².

3.6.4 Pressure seals

Pre-drilled extruded aluminium with head recess to allow for the formation of a suitably shaped sealant joint. Submit suitable product to the SO.

3.7 Waterproofing Systems: Primers and Bonding Compounds

3.7.1 Primer

Primer shall be proprietary type, compatible with the membrane used and recommended for the intended purpose by the membrane manufacturer, to be submitted to the SO.

3.7.2 Bonding Compounds

Unless otherwise agreed, use oxidised bitumen as recommended by the membrane manufacturers for the conditions and types of surfaces.

3.7.3 Bonding Compounds for Insulation

Use cold bonding bituminous adhesive, complying with SS 133 and recommended by the insulation manufacturer.

3.8 Waterproofing Systems: Materials for Joints

3.8.1 Sealants for Joints

Sealant materials used for joints shall be approved silicone, polyurethane or polysulphide, complying with CP 82 or SS 637.

3.8.2 Sealants for Use in Water

Where there is permanent contact with water, sealants shall be polyurethane or polysulphide, to be submitted to the SO.

3.8.3 Sealants for use in Traffic Loads

Use high modulus sealants in these conditions, to be submitted to the SO.

3.8.4 Gaskets

Natural rubber compounds protected by a synthetic rubber skin. If special properties such as resistance to oils are desired, synthetic rubber and plastics materials shall be specifically formulated for the intended use. Gaskets can be solid or hollow sections of various profiles formed from cellular or non-cellular material or combinations of these materials or sections. Submit suitable product to the SO.

3.8.5 Sealing Strips

Sealing strips shall be mastic strips and impregnated or coated cellular strips, complying with CP 82 or SS 637.

3.8.6 Joint Fillers

Joint filler such as cellular plastics and rubbers shall comply with CP 82 or SS 637.

3.8.7 Baffles

Materials for baffles shall comply with SS 637.

3.8.8 Pipe Penetrations in Concrete Slabs

All pipe penetrations shall have sleeves, hydrophilic pipe wraps to seal off pipe penetrations and shall comply with CP 82 or SS 637.

3.8.9 Expansion Joints in Concrete

Where expansion joints are required for higher expected movement for structures, a metal or mechanical expansion system shall be designed and provided during design stage in accordance to CP 82 or SS 637.

3.8.10 Construction Joints and Form Tie Holes in Concrete

Hydrophilic water bars shall be used in all concrete joints. Hydrophilic form tie rings shall be used to seal against water ingress and comply to CP 82 or SS 637.

3.9 Insulation

3.9.1 Rigid Insulation

3.9.1.1 Expanded Polystyrene Board

To BS 3837-1.

3.9.1.2 Extruded Polystyrene Board

To BS 3837-2.

3.10 Surfacing Materials

3.10.1 Topping Screed

Topping screed shall be cement/sand and proprietary additives and shall achieve a fall of 1:80 unless otherwise indicated in the drawings.

Provide galvanised steel mesh reinforcement when the screed is thicker than 50 mm.

3.10.2 Reinforced Concrete Topping

Unless otherwise specified, topping shall be grade 25 concrete with coarse aggregate not exceeding 14mm, reinforced with steel reinforcement as indicated in the drawings.

For material requirement refer to structural specifications.

Submit suitable joints and joint filler material to the SO.

3.10.3 Surface Tiling

Refer to Section A02-040:Clause:3.2 and Section A15-010:Clause:3 for general requirement of materials.

Refer to Section A05-030:Clause:3.1 for type of tiles selected for the project.

3.10.4 Ballast

Ballast materials shall be of stone, aggregate, gravel, precast concrete pavers and clay pavers. Refer to Section A15-010:Clause:3.4, for general requirement of materials.

Submit to the SO, suitable products, able to resist the expected wind uplift, protect the membrane from surface pedestrian traffic and other imposed loads.

3.11 Rainwater Goods

Comply with SS CP 26 and in accordance with membrane manufacturer's recommendations.

3.11.1 Counter and Cap Flashing

Use the following:

- (a) Stainless steel grade 1.4401 (formerly 316), in compliance with BS EN 10088.
- (b) Galvanised mild steel in accordance with structural specifications.

3.11.2 Drain Covering

Comply with the requirements of ENV. Use the following:

- (a) Stainless steel grade 1.4401 (formerly 316), comply with BS EN 10088
- (b) Galvanised mild steel in accordance with structural specifications.

3.11.3 Rainwater Downpipes

Ductile iron pipes and fittings shall be in accordance with BS 460.

uPVC pipes and fittings shall be in accordance with SS 141.

3.11.4 Holder Bats

Use the following:

- (a) Stainless steel grade 1.4401 (formerly 316), comply with BS EN 10088.
- (b) Galvanised mild steel in accordance with structural specifications.

3.12 Fall Arrest System

Provide a support system for the purpose of carrying out periodical maintenance and cleaning, and capable of taking the load of two number operatives. Comply with the requirements of SS 528.

4 WORKMANSHIP

4.1 General Workmanship Requirements

4.1.1 Method of Works

Carry out the works in accordance with the method of works, as submitted to the SO. Consider that construction will achieve the design as set out in the approved shop drawings.

Waterproofing shall be executed by the specialist to be approved by the SO. The Contractor shall arrange for a representative of the Specialist Sub-Contractor to provide field supervision of the installation of the complete waterproofing system, monitor the work in progress and submit written evidence of satisfactory work completion.

The waterproofing system and installation details shall be provided and endorsed by an experienced Waterproofing Specialist.

The waterproofing system and installation details shall be provided together with the manufacturer's name and product description. Packaged materials shall be stored in manufacturer's wrappings and containers with manufacturer's labels and seals intact.

The installation of the waterproofing system shall be carried out by a qualified Specialist Waterproofing Contractor who have been in existence under the same name for at least 5 years, registered with BCA under Workhead CR13.

The design, supply and installation of all waterproofing systems and products specified herein include all components such as cement and sand screed to falls (if required), insulation, pre-formed corners, outlets, fillers, primers, galvanised iron reinforcement mesh, metal flashings, protection layer, etc. and all other measures and materials required to satisfactorily complete the waterproofing system.

4.1.2 Co-ordination and Setting Out

Co-ordinate the roofing works with all interfacing works packages and trades to ensure correct setting-out and positioning of all penetrations, attachments, and other constituent materials and elements.

4.1.3 Handling and Hoisting

Handle and hoist assemblies carefully, at all stages to ensure that sections and finishes are not damaged, and in accordance with manufacturer's recommendations.

4.2 Preparation

4.2.1 Slope to Fall

Grade all substrate to a fall of 1:80 towards drainage outlets, either by tilting the RC structural base slab or by means of screeding. Refer to Section A07-010:Clause:4 for general requirements on workmanship for screeding.

4.2.2 Render to Walls

Flush point mortar joints and render walls with cement/sand mix to the extent of waterproofing application. Refer to Section A02-030:Clause:4 for general requirements on workmanship for rendering.

4.2.3 Surface Preparation

Prepare all horizontal and vertical surfaces, to which membrane shall be applied (including elevations, upstands, curbs, and protrusions), ensuring that the substrates shall be clean, dry, smooth, free from honeycombs, sharp protrusions, voids, laitance, dust, loose material, sand particles, paint, oil, incompatible curing agent or any other contaminants, unwanted particles, and other defects.

4.2.3.1 Moisture Content Test

Use a moisture meter to carry out a moisture content test to verify that the moisture content of the substrate is within the product specific tolerance, suitable for the application of waterproofing membrane.

4.2.4 Cracks

Seal all cracks and movement joints, with reinforcement and sealant, and allow to cure. Repair all structural cracks to the SO's approval.

4.2.5 Chamfering of Corners

Provide fillet beads to chamfer all 90 degree corners (such as those formed by RC deck to wall, RC deck to curb etc.), reinforce, seal, and allow to dry or cure. Provide 50 mm x 50 mm triangular beads from sealants or mortar.

4.2.6 Priming

Apply primer to substrate, ensuring full coverage and allow to dry prior to application of membrane.

4.3 Application of Membranes

4.3.1 General Requirements

4.3.1.1 Extent of Waterproofing

Apply waterproofing membrane to the entire floor area for waterproofing. Turn up every wall to a minimum height of 300 mm from the finished floor level.

4.3.1.2 Dressing of Membrane

Dress membrane over penetrations and attachments, and down into floor outlets.

4.3.1.3 Perimeter of Membrane

Mechanically secure pressure seal at all edge conditions, changes of plane, curb flashings, upstands, etc.

Lay a strip of reinforced membrane at the edge of the horizontal plane and mechanically fasten.

Dress membrane over all perimeter profiles. Bond to substrate and to secured perimeter reinforcing strip.

4.3.2 Application of Liquid Applied Membranes

Where liquid applied membranes consist of two formulations (1 for horizontal and 1 for vertical application), determine the correct formulation prior to application.

For two components (two-part) systems, ensure that the compounds are accurately measured and mixed for the time recommended by the membrane manufacturer.

4.3.2.1 Bituminous

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump-free and workable liquid for application.

Where required, apply a proprietary recommended primer.

Apply the bituminous liquid applied membrane onto all prepared and primed surfaces, using brush, roller, spray, or squeegee, in accordance with the following product specific requirements.

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (after final coat)

Where reinforcement is required, apply polyester reinforcement fabric over the membrane, ensuring no entrapment of air in between.

In an exposed system, overlay a proprietary recommended capping sheet to protect the membrane from UV exposure.

In a concealed system, provide a proprietary recommended surface protection course over the membrane and add a slip sheet in between, if recommended by the membrane manufacturer.

Ensure provisions of protection against unfinished works in the event of rain.

4.3.2.2 Non-Bituminous

Mix mechanically, the waterproofing compounds as necessary, to achieve a lump free and workable liquid for application.

Where require, apply a proprietary recommended primer.

Apply the non-bituminous liquid applied membrane onto all prepared and primed surfaces to be waterproofed, using roller, spray, brush, trowel, or squeegee, in accordance with the following product specific requirements:

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (after final coat)

4.3.3 Application of Sheet Membranes

4.3.3.1 Bituminous: Self-Adhesive

Plan the installation of the self-adhesive sheet membrane to avoid joints at corners and penetrations.

Install the membrane from the lowest point to the highest point of a surface to ensure that laps are self-flashing to facilitate shedding water.

Install the membrane, by bonding the membrane to the prepared and primed substrates.

Do not allow entrapment of air, bubble or wrinkles.

Lap and seal all longitudinal and transverse joints.

Apply a proprietary recommended protection course and or material(s), to protect the membrane.

4.3.3.2 Bituminous: Torch-On

Plan the installation of the torch-on sheet membrane to avoid joints at corners and penetrations.

Install the membrane by starting from lowest point to the highest point of a surface to ensure that laps are self-flashing to facilitate shedding water.

Install the membrane on to prepared and primed substrates by torch bonding.

Do not overheat through to the top surface of the sheet.

Lap and seal all longitudinal and transverse joints.

Seal all exposed perimeter edges.

Apply a proprietary recommended protection course and/or material(s), to protect the membrane.

4.3.3.3 Thermoplastic: Loosely Laid

Plan the installation of the membrane to avoid joints at corners and penetrations.

Install the membrane by starting from lowest point to the highest point of a surface to ensure that laps are self-flashing to facilitate shedding water.

Clean and dry the joint surfaces for the full width of the lap prior to welding.

Weld and seal all laps with a hot air welder or other equipments recommended by the membrane manufacturer. The extent of lapping shall be in accordance with product specific requirements. Where cold solvents are used for welding of laps, follow the manufacturer's instructions. Test the joint after welding by drawing a metal probe along the seam edge. Make good any defective welds.

Mechanically fix compatible proprietary metal profiles along edges and corners.

In a conceal system, follow the manufacturer's instructions to protect the membrane prior to application of ballast or other surfacing materials.

4.3.3.4 Thermoplastic: Mechanically Fasten Expose System

Plan the installation of the membrane to avoid joints at corners and penetrations.

Install the membrane by starting from lowest point to the highest point of a surface to ensure that laps are self-flashing to facilitate shedding water.

Mechanically fasten the membrane along edges, corners and the lower sheet of the lapping area with fasteners and equipment recommended by the membrane manufacturer.

Clean and dry the joint surfaces for the full width of the lap prior to welding.

Weld and seal all laps with a hot air welder or other equipments recommended by the membrane manufacturer. The extent of lapping shall be in accordance with product specific requirements. Where cold solvents are use for welding of laps, follow the manufacturer's instructions. Test the joint after welding by drawing a metal probe along the seam edge. Make good any defective welds.

4.3.3.5 Thermoplastic: Adhesive Bonding

Plan the installation of the membrane to avoid joins at corners and penetrations.

Install the membrane by starting from lowest point to the highest point of a surface to ensure that laps are self-flashing to facilitate shedding water.

Bond the membrane to prepared and primed surfaces with a proprietary adhesive or a bonding agent recommended by the membrane manufacturer. Lay sheets on a continuous even coating of adhesive, allowed to dry until tacky, taking care to avoid wrinkles and any stretching of the membrane. Ensure there is a full bond over the whole surface, with no air pockets.

Clean and dry the joint surfaces for the full width of the lap prior to welding.

Weld and seal all laps with a hot air welder or other equipment recommended by the membrane manufacturer. The extent of lapping shall be in accordance with product specific requirements. Where cold solvents are used for welding of laps, follow the manufacturer's instructions. Test the joint after welding by drawing a metal probe along the seam edge. Make good any defective welds.

Follow the manufacturer's instructions to protect the membrane prior to application of ballast or other surfacing materials.

4.3.4 Application of Flexible Cementitious Membrane

Where the flexible cementitious membrane consists of two formulations (one for horizontal and one for vertical application), determine the correct formulation prior to application.

Ensure that the two components (A and B) are accurately measured and mixed for the time recommended by the membrane manufacturer.

Mechanically mix the cementitious waterproofing components to the consistency required.

Pre-water the surfaces to which the membrane shall be applied.

Do not apply the membrane onto a hot substrate.

Apply the flexible cementitious membrane onto prepared and primed surfaces, from lowest point to the highest point, using brush, trowel, squeegee, roller or spray, in accordance with the following product specific requirements.

- (a) Minimum number of coats required
- (b) WFT per coat
- (c) Drying time between coats
- (d) Minimum total DFT
- (e) Tile-over time (after final coat)

Allow the applied flexible cementitious membrane surfaces to cure.

Protect the applied flexible cementitious membrane surfaces from rain, ponding of water, wind and direct sunlight, with plastic sheeting, during the curing period.

4.3.5 Surfacing

Where required, apply a 20 mm thick waterproof screed over the membrane.

Apply surfacing material over the waterproof screed.

Where tiles are laid directly onto the waterproof screed or membrane, use a compatible proprietary adhesive recommended by the membrane manufacturer.

Where the surfacing material is a RC topping slab or ballast materials, add a proprietary recommended slip sheet in between the membrane and surfacing material.

4.4 Waterproof Screed

Apply strictly, according to manufacturer's recommendations and accepted methods.

4.5 Insulation

Lay rigid insulation boards in accordance with accepted methods and supplier's recommendations.

4.5.1 Installation of Rainwater Goods

Provide and install rainwater goods to comply with SS 525, in accordance with manufacturer's recommendations, the requirements of ENV and any other statutory authorities having jurisdiction over the works.

4.5.2 Flashing

Flash all exposed vertical edges of membrane above the finished roof level.

Seal all membrane edges around upstands with pressure seal, protrusions and services penetrations with fillet beads or other sealant materials, to be submitted to the SO.

4.5.3 Rainwater Downpipe

Space all rainwater downpipes (RWDPs) at required centres, fit to drains and fix securely to walls or columns with holder bats. Space at 1 200 mm centres. Seal all joints.

4.6 Protection

Ensure that from completion of the waterproofing works until practical completion:

- (a) the waterproofed area is not used as a working platform unless fully protected to the satisfaction of the SO
- (b) petroleum based solvents or other chemicals harmful to bitumen shall not come into contact with the waterproofed surface
- (c) waterproofed areas are protected from damage by subsequent building operations.

4.6.1 Wet Weather

Provide temporary covers and drainage as required to keep unfinished areas dry.

Suspend work in severe or continuously wet weather unless an effective temporary roof is provided over the working area.

If unavoidable wetting of the construction does occur, take prompt action to minimise and make good any damage.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in the construction programme, event for submission of the following information:

- (a) Name of the waterproofing membrane manufacturer and inclusion of copies of technical data relating to system
- (b) Name of Sub-Contractor (if sub-contracted)

Information of current or similar jobs completed during the previous 5 years and details of Quality Control Procedures adopted.

5.1.2 Work Submissions

5.1.2.1 Method Statements

Prior to commencing construction work, submit a detailed method statement to the SO. Include at least the following information:

- (a) Sequence of construction
- (b) Application of waterproofing system
- (c) Accommodation of lightning protection systems

5.1.2.2 Shop Drawings

Where specified, prepare shop drawings, particularly include the following items:

(a) Typical and Non-Typical Details

Sectional details of the finishing system and associated components, including:

- Composition of the roof finishing system
- Flashing at upstands
- Interfaces with adjoining structure and/or other cladding elements

(b) Drainage System

Typical details of drainage system include the following:

- Cross section of drain
- Detail at drainage outlet
- Waterproofing treatment to RWDP and drain
- Fixing details of RWDP

(c) Penetrations to Roof

Waterproofing of lightning protection points, all perforation through roof, including vent pipes and other building services protrusions.

Do not commence fabrication until shop drawings have been reviewed and permission to proceed has been obtained from the SO.

5.1.3 Test Reports and Certificate Submissions

5.1.3.1 Material Certification

Provide the SO with certification from the manufacturers of the following materials/components, certifying that the respective materials are of the correct grade, strength, size, finish, etc, and are in accordance with the relevant codes and standards specified:

- (a) Waterproofing membrane**
- (b) Rigid board insulation**
- (c) Vapour barrier**
- (d) Flashing and reinforcement materials**
- (e) Surfacing materials**
- (f) Sealant materials**
- (g) Rainwater goods**

5.1.4 Quality Control Plan Submissions

Prepare and submit a quality control plan for the SO's acceptance to General Requirements Section G01-010:Clause:1.3.12 and Section G01-010:Clause:5.5, in accordance with SS ISO 9001-2000. Endorsed forms of the inspections shall be done by supplier, applicator, Contractor Supervisor and Resident Technical Officer of all waterproofing areas shall be submitted to the SO.

5.1.4.1 Leakage Response Plan

Prepare and submit the leakage response plan to the SO during the material submission.

The Contractor shall rectify reported leakage within the agreed response time spelt out in the contractual clauses.

- (a) Response time for rectification during construction and maintenance period
- (b) Rectification procedures

5.1.5 Warranty

Submit the warranty for the SO's acceptance upon completion of the Works, in accordance with Section G01-010: Clause:5.8.

5.1.6 Maintenance Submissions

Submit the method of statement for maintainability, operations and maintenance.

For manual & other submissions, refer to General Requirements Section G01-010:Clause1.4.5.

Submit maintenance/replacement manual at the completion of the construction with the following:

- (a) An outline description of the completed roof finishing system.
- (b) A detailed description of specific materials and components with product names, types, serial numbers, etc.
- (c) Recommendation on maintenance periods and planned preventive maintenance procedures.

5.2 Samples and Mock-ups

5.2.1 Samples

For each system type specified, provide samples of each component to permit approval of material quality, thickness, finishes and profile.

5.2.2 Mock-ups

Within the time frame as directed, provide a mock-up panel of sufficient size to permit approval of the intended construction. Include the following elements where applicable:

- (a) Typical composition of roof system
- (b) Upstand
- (c) Vent pipes or other building services protrusions
- (d) Rainwater outlet
- (e) Connection of rainwater outlet to drain

If approved, this sample mock-up panel may form part of the Works.

5.3 Inspections

5.3.1.1 Inspections

Carry out inspections at the following stages, ensuring that the Works is carry out in a proper and orderly manner:

- (a) Preparation of the slab deck, ready for the application of the waterproofing membrane
- (b) Application of the waterproofing membrane
- (c) Commencement of any required testing, on site or off site

5.3.1.2 Application Photographs

Provide progressively, photographs to verify the composition and sequence of each successfully completed stage of the waterproofing system, to the SO.

5.4 On-Site Tests

5.4.1 On-Site Water Test

The Contractor shall note and allow a cost in the tender sum for water ponding tests to be carried out for watertightness test as described in the Specification. The cost of the tests including the supply and disposal of water and all rectification works shall be borne by the Contractor.

At the conclusion of the waterproofing treatment but prior to the installation of the other components forming the floor and roof system, the waterproofed area shall be tested by ponding either entirely or in sections for at least 24 hours.

Carry out on site water test(s) to verify serviceability and watertightness, in accordance with the following procedure and the waterproofing manufacturer's recommendations and specifications.

- (a) Inform the SO 5 days prior to carrying out the test(s).
- (b) Do not conduct on-site water test until the membrane is cured and set.
- (c) Carry out the water test(s) by blocking up the drain holes and flooding the floor to a depth of 25 mm above the highest point of the floor for 72 hours.
- (d) Any areas showing water penetration through the floor, signs of seepage or other defects, shall be made good. Submit a method statement and remedial measures to the SO. Retest the area after the remedial works have been completed.

5.4.2 On-Site Drainage Test

Carry out on-site drainage test in accordance with SS CP 26 to verify proper functioning and performance of roof drainage system.

Comply with SS CP 26 when discharging water after the completion of each stage of the above on site water tests.

There should not be any water ponding/stagnation on the roof slab surface, so ensure good falls based on SS CP 26. Any stagnation of water on the roof areas shall be rectified before waterproofing membrane installation and after final finishes such as topping cement sand panels are completed on the roof.

(25) A07-010 FLOOR SCREEDS AND HARDENERS

1 GENERAL

Read this Section with G01-010 "General Requirements" and all other contract documents.

1.1 Scope

This Section covers the requirements for common floor screeds applied in buildings, including bonded and un-bonded cement sand screeds, self-levelling screeds and polymer modified toppings. The Section also covers the requirement for common floor hardeners.

1.2 Related Sections

Read this Section in conjunction with the relevant requirements of the following sections:

A14-020	Liquid Applied Membrane System
A14-030	Cementitious System

1.3 Standards, Codes, Regulations and Technical References

1.3.1 Standards and Codes

Unless otherwise agreed by the SO, ensure all of the Works comply with the relevant requirements of the standards and codes listed below or referenced in the body of the Specification. Alternative standards and codes may be proposed for approval by the SO, provided it can be demonstrated that the alternative standards and codes comply with the requirements of the standards specified. All standards and codes quoted are the current version, unless specific year references are noted.

In the event that the standards or codes are partially superseded or have become obsolete, refer to the current edition or the approved substitution for the relevant clauses.

Singapore Standards	
SS EN 197	Cement
SS EN 206	Concrete – Specification, performance, production and conformity
SS EN 12620	Specification for aggregates for concrete
SS EN 15167	Ground granulated blast furnace slag for use in concrete, mortar and grout
SS CP 68	Ceramic wall and flooring tiling
SS 32	Welded steel fabric for the reinforcement of concrete

SS 78	Testing concrete
SS 485	Specification for slip resistance classification of pedestrian surface materials
Other Standards	
BS EN 197	Composition, specifications and conformity criteria for low early strength blast furnace cements
BS EN 934-2	Admixtures for concrete, mortar and grout – Part 2: Definitions, requirements, conformity, marking and labelling
BS EN 12878	Pigments for the colouring of building materials based on cement and/or lime – Specifications and methods of test
BS EN 13318	Screed material and floor screeds
BS EN 13813	Screed material and floor screeds – Screed material. Properties and Requirements
BS ISO 3310	Test sieves – Technical requirements and testing
BS 1052	Specification for mild steel wire for general engineering purposes
BS 1521	Specification for waterproof building papers
BS 4483	Specification for steel fabric for the reinforcement of concrete
BS 4551	Mortar. Methods of Test for Mortar and Screed. Chemical Analysis and Physical Testing
BS 4841-1	Rigid polyisocyanurate (PIR) and polyurethane (PUR) products for building end-use applications – Part 1: Specification for laminated insulation boards with auto-adhesively or separately bonded facings
BS 5385-3	Wall and floor tiling – Part 3: Code of practice for design and installation of internal and external ceramic and mosaic floor tiling in normal conditions
BS 5385-5	Wall and floor tiling – Part 5: Code of practice for the design and installation of terrazzo tile and slab, natural stone and composition block flooring
BS 6213	Guide to selection of construction sealants
BS 8000-9	Workmanship on construction sites – Part 9: Code of practice for cementitious levelling screeds and wearing screeds

BS 8204-1	Screeds, bases and in situ floorings – Part 1: Code of practice for concrete bases and cementitious levelling screeds to receive floorings
BS 8204-2	Screeds, bases and in situ floorings – Part 2: Code of practice for concrete wearing surfaces
BS 8204-3	Screeds, bases and in situ floorings – Part 3: Code of practice polymer modified cementitious levelling screeds and wearing screeds

1.3.2 Regulations

Refer to the following regulations for compliance in carrying out the Works:

Building and Construction Authority à Approved Document ("Approved Document")

The above regulations refer to the latest edition (including any amendments) that are currently in use.

1.1.1 Technical References

Refer to the following technical references for guidance in carrying out the Works:

Building and Construction Authority à CONQUAS 21 Enhancement Series, Good Industry Practices Guide Books
--

1.4 Trade Preamble

1.4.1 Contractor's Submissions

The intended types of floor screeds for the project are set out in Section A07-010:Clause:3.1 and locations are indicated in the drawings. Based on the information, submit the following items to the SO:

- (a) Manufacturer(s) and products of pre-packed or proprietary screeds and hardeners where specified.
- (b) Suitable mix and application methods, taking into account the performance requirements as set out in Section A07-010:Clause:2.1.

1.4.2 Co-ordination with Other Works

Co-ordinate the screeding works particularly the interfacing with the following trades:

- (a) Floor finishes

- (b) Floor waterproofing
- (c) Drywalls
- (d) Internal masonry (including external and internal walls and partitions).

Liaise and co-ordinate with SO for location of services penetrations in the floor.

1.4.3 Provision of Spare Materials

Deliver to Site in strong protective packages marked for identification, and store where directed, components and materials for future replacement and repair.

Provide the following spare materials and store in an area agreed with the SO:

Item	Description
.	.
.	.

1.4.4 Quality Control Plan

Prepare a quality control plan based on ISO 9001 and submit to the SO for review.

All systems are based on specialist drawings, details, and specification.

Installation of all components shall be carried out by a single company who has successfully completed works of similar design and intent.

The SO shall be the sole judge for the acceptability of quality.

1.4.5 Warranty

1.4.5.1 Floor Hardeners

Provide a 5-year indemnity for the floor hardeners where specified, in accordance with the specimen warranty, or otherwise as agreed with the SO.

in the project.

1.4.6 Maintenance Manual

Prepare and submit a maintenance manual covering all floor screeds and hardeners. Refer to Section G01-010:Clause:1.4.5 for details.

The maintenance manual should indicate all elements of the floor screeds and hardeners requiring maintenance including cleaning, intervals to conduct such maintenance, and details for carrying out such maintenance, including a list of products that are allowed and prohibited for use during maintenance operations.

1.5 Definitions and Abbreviations

The following definitions and abbreviations apply within this Section.

1.1.2 Definitions

No item.

1.1.3 Abbreviations

1.1.3.1 BRE

Building Research Establishment

1.1.3.2 DPM

Damp-proof membrane

1.1.3.3 PVA

Polyvinyl alcohol

2 PERFORMANCE

2.1 Contractor's Brief

When carrying out the proposals as set out in Section A07-010:Clause:1.4.1, take account of the performance requirements listed below.

2.1.1 Structural Movement and Movement between Works by Others

Take into account that performance, appearance and proper functioning of screeding works are not affected by any movement, settlement, deflection, expansion or contraction which can be expected to occur in the building or the construction process.

Junction between the screeding works and adjacent work by others shall be formed to take into account, possible structural deflection or movement in that adjacent element without distortion to the Works, or disintegration of joints between Works.

2.1.2 Environmental

Consider the environment for which the Works shall be applied, paying particular attention to the following environmental effects:

- (a) Daily variations in humidity and temperature resulting from air-conditioning operations within the building.
- (b) For non-air-conditioned areas, daily and seasonal variations in humidity and temperature in the tropics.

- (c) Humidity or damp variations or other consequences resulting from the activities occurring within the spaces for which the Works are applied or in proximity.

2.1.3 Appearance

Include any measures necessary to take into account, that the surface finishes are uniform and consistent in colour, tonality and texture and appearance throughout.

Surface of screed shall not have presence of cement laitance, shrinkage, hairline cracks or stain marks.

Surface of screeds shall also not be unduly rough or patchy.

Provide expansion at intervals as determined and agreed with the SO.

Achieve surface level tolerance as set out in BS 8204.

2.1.4 Other Considerations

Ensure floor screeds and hardeners to achieve the following:

- (a) Evenness of surface (not more than 3.0 mm per 1.2 m).
- (b) Ensure no cracks, visible damages and defects.
- (c) Due care and consideration to be given to surface evenness to prevent ponding at wet- prone areas.
- (d) No hollow sounds when tapped with a hard object.
- (e) No signs of any delamination.

3 MATERIALS

3.1 Types of Floor Screed Systems

Floor screed (FS) shall consist of the following types:

Type: CS		
Item	Requirements	Clause References
Screed Method	.	.
Substrate	.	.
Preparation of Substrate	.	.
Maximum Ridge Height in Substrate	.	.
Finish Tolerance	.	.
Slip Sheet	.	.
First Layer	.	.
Surface Finish	.	.
Movement Joints	.	.
Hardener	Metallic Hardener	.

3.1.1 Cement-Sand Screed

The screed system shall consist of the following components.

3.1.1.1 Bonding Agent

Bonding agent shall be mixed with cement to produce bonding slurry. Bonding agent shall comply with the following properties:

Slant shear bond strength (Type II)	ASTM C1042	ASTM C1059 \approx 8.7N/mm ²
Average Compressive Strength	ASTM C109	\approx 25 N/mm ² \approx 40 N/mm ²
Shrinkage	Coutinho Ring	No Crack
Flow	ASTM C1437	80% $\hat{=}$ 120%
Water Absorption	ASTM C413	< 5%
Flexural Strength	ASTM C348	> 2 N/mm ²
Water Retentivity	BS 4551	> 90%
Stiffening Time a) 1.0 N/mm ² b) 2.0 N/mm ²	BS EN 1015-9 (Method A)	$\hat{=}$ 360 mins $\hat{=}$ 420 mins
Volume Change	ASTM C827	Shrinkage value of not more than 1%.

3.1.1.2 General

Portland cement, sand and water shall be as specified under Concrete Specification.

3.1.1.3 Screed System

Screed system shall have a moisture content of less than 3 percent using the Speedy moisture tester and compliance with Category A soundness classification in accordance with BS 8204, which is to be tested and verified with the BRE test apparatus; both tests to be conducted 7 days after screed installation.

3.1.1.1 Proprietary Pre-Packed Screed

Proprietary pre-packed screed consisting of ordinary Portland cement, graded sand, aggregates and chemical additives shall comply with the following performance requirements:

3.1.2 Self-Levelling Screed

- (a) Polymer-based quick drying levelling screed, ready to use, high performance, retarded screeding mortar, which is suitable for all conventional screed applications.
- (b) Minimum compressive strength shall be achieved ≥ 30 N/mm² after 28 days. Thickness to manufacturer's recommendation.

3.1.3 Lightweight Screeds

- (a) Lightweight aggregate screeds shall consist of cement and lightweight aggregate at a ratio of 1:8 for roofs and 1:6 for floors unless contrary to the manufacturers' recommendations.
- (b) Air entrained screeds shall have a dry density of not more than 1,200 kg/m³.
- (c) Lightweight screeds shall be 50 mm (minimum) thick, excluding topping.
- (d) Finish lightweight screeds with cement and sand or granite fines at 1:4 topping 15 mm (minimum) thick laid monolithically with screed.
- (e) When specified, lay vapour barrier under lightweight roof screeds. Lap 150 mm at joints.

3.2 Material Requirement for Different Screed Types

3.2.1 Fully Bonded Screed

3.2.1.1 Base

Base shall be in-situ slab mechanically prepared or heavily roughened and thoroughly cleaned base concrete substrate.

3.2.1.2 Thickness

Thickness shall be 25 mm to 50 mm unless otherwise indicated in the drawings. Mesh reinforcement is required for screed thickness \geq 40mm.

3.2.1.3 Reinforcement for Crack Control

Mesh Type D49, D98 or other conforming to BS 4483 or SS 32 shall be provided for every 16m² of screed area and at all joints.

3.2.1.4 Mix

- (a) Cement: Ordinary Portland to SS EN 197 or Portland blast furnace to SS EN 15167.
- (b) Sand / Fine aggregate: To SS EN 12620, grading limit M, but with not more than 10% passing sieve size 150 microns.
- (c) Mix proportions: 1:3 for flexible floor finishes and/or 1:4~4.5 for thick or rigid floor finishes.
- (d) Admixture: Conform to BS 8204-1: Table 1.

3.2.1.5 Finish

Refer to Section A07-010:Clause:3.1.

3.2.1.6 Soundness

Test shall be according to BS 8204-1: Annex D

3.2.1.7 Maximum Depth of Indentation

Category A: 3 mm for areas expected to take very heavy foot traffic and/or heavy trolleys, or where any breakdown of the screed would be unacceptable.

Category B: 4 mm for areas expected to take heavy foot traffic including medium weight trolleys e.g. public areas and main corridors.

Category C: 5 mm for other areas subject to mainly foot traffic and light trolleys.

3.2.2 Cement-Sand Screed $\hat{=}$ Unbonded

3.2.2.1 Base

Separating layer or DPM on concrete not prepared to achieve bonding.

3.2.2.2 Thickness

Thickness shall be a minimum of 50 mm unless otherwise indicated in the drawings.

3.2.2.3 Reinforcement for Crack Control

Mesh Type D49, D98 or others conforming to BS 4483 or SS 32 shall be provided for every 16m² of screed area and at all joints.

3.2.2.4 Mix

- (a) Cement: Ordinary Portland to SS EN 197 or Portland blast furnace to SS EN 15167.
- (b) Sand and fine aggregate: To SS EN 12620, grading limit M, but with not more than 10% passing sieve size 150 microns.
- (c) Mix proportions: 1:3 for flexible floor finishes and 1:4~4.5 for thick or rigid floor finishes.
- (d) Admixture: Conform to BS 8204-1, table 1.

3.2.2.5 Finish

Refer to Section 07-010:Clause:3.1.

3.2.2.6 Soundness

Test in accordance with BS 8204-1, Annex D.

3.2.2.7 Maximum Depth of Indentation

Depth shall be as for bonded screed.

3.2.3 Floating Screed

3.2.3.1 Base

Separating layer on thermal or acoustic insulation shall be on base concrete.

3.2.3.2 Thickness

Thickness shall be a minimum of 75 mm unless otherwise indicated in the drawings.

3.2.3.3 Reinforcement for Crack Control

Mesh Type D49, D98 at mid-depth of the screed, according to BS 4483 or SS 32.

3.2.3.4 Insulation

Thermal or Acoustic insulation shall be in accordance with performance requirements.

3.2.3.5 Mix

- (a) Cement: Ordinary Portland to SS EN 197 or Portland blast furnace to SS EN 15167.
- (b) Sand/ Fine Aggregate: To SS EN 12620, grading limit M, but with not more than 10% passing sieve size 150 microns.
- (c) Coarse aggregate: To SS EN 12620, 10 mm single sized.
- (d) Mix proportions: 1:4 to 1:5 total aggregate, proportion of sand to coarse aggregate between 60/40 and 40/60, adjusted to facilitate trowelling.
- (e) Admixture: Conform to BS 8204-1, Table 1.

3.2.3.6 Finish

Refer to Section A07-010:Clause:3.1.

3.2.3.7 Soundness

Test in accordance with BS 8204-1, Annex E

3.2.3.8 Maximum Depth of Indentation

Category A: 3 mm for areas expected to take very heavy foot traffic and/or heavy trolleys, or where any breakdown of the screed would be unacceptable.

Category B: 4 mm for areas expected to take heavy foot traffic including medium weight trolleys, e.g. public areas and main corridors.

Category C: 2.5 mm (using 2 kg weight only) for other areas subject to mainly foot traffic and light trolleys.

3.2.4 Quick Drying Screed

3.2.4.1 Construction

Bonded, unbonded or floating construction.

3.2.4.2 Minimum Thickness at Any Points

Depth may vary in accordance with manufacturer's recommendations; however, the general rule of thumb is as follows:

- (a) Bonded: 25 mm to 50 mm
- (b) Unbonded: 50 mm at minimum
- (c) Floating: 75 mm at minimum

3.2.4.3 Reinforcement for Crack Control

Type D49, D98 at mid-depth of the screed, according to BS 4483 or SS 32.

3.2.4.4 Insulation

Thermal or acoustic insulation shall be in accordance with performance requirements.

3.2.4.5 Manufacturer

Submit names and details of manufacturers to the SO.

3.2.4.6 Mix

- (a) Cement: Ordinary Portland to SS EN 197.
- (b) Sand / Fine aggregate: To SS EN 12620, grading limit M, but with not more than 10% passing sieve size 150 microns.
- (c) Coarse aggregate: This may be included in the manufacturers list for screed over 75 mm. Delete if not appropriate.
- (d) Mix proportions: 1:4 to 1:5 total aggregate, proportion of sand to coarse aggregate between 60/40 and 40/60, adjusted to facilitate trowelling.

3.2.4.7 Finish

Refer to Section A07-010:Clause:3.1.

3.2.4.8 Soundness

Test to BS 8204-1, Annex D and E.

3.2.4.9 Maximum Depth of Indentation

As for bonded, unbonded or floating screed.

3.2.5 Polymer Modified Screed

PVA materials are water sensitive. Do not use in areas where permanent dampness is expected.

3.2.5.1 Base

Mechanically prepared or heavily roughened and thoroughly cleaned base concrete substrate.

3.2.5.2 Construction

Bonded in accordance to BS 8204-3.

3.2.5.3 Minimum Thickness at Any Points

Thickness varies in accordance with manufacturer's recommendations and may be at a minimum of 6 mm, depending on service conditions. The design thickness shall minimise shrinkage stresses, but a minimum thickness of 20 mm shall be retained where high impact forces might occur in order to reduce any damaging effect of an impact on the bond line. The maximum thickness laid in a single application shall not exceed 40 mm.

3.2.5.4 Manufacturer

Submit names and details of manufactures to the SO.

3.2.5.5 Mix

Pre-blended proprietary mix

Mix proportions: Polymer content in accordance with manufacturer's recommendations or refer to BS 8204-3, Clause 6.3, Table 2.

3.2.5.6 Finish

Refer to Section 04-010:Clause:3.1.

3.2.5.7 Soundness

Test to BS 8204-1, Annex D.

3.2.5.8 Maximum Depth of Indentation

Meets Category A of BS 8204-1, table 4.

3.2.5.9 Slip Resistance

Where required, to conform to BS 8204-3, clause 10.5.

3.2.5.10 Abrasion Resistance

Where required, to conform to BS 8204-3, clause 10.4.

3.2.6 High Strength Concrete Toppings (Including Granolithic)

3.2.6.1 Base

Direct finished base slab or in-situ concrete slab.

3.2.6.2 Construction

Bonded in accordance with BS 8204-2.

3.2.6.3 Minimum Thickness at Any Point

Unless otherwise indicated in the drawings, monolithic screed shall be 15 +/- 5 mm. Screed laid separately shall be as follows:

- (a) Bonded: 20 mm minimum
- (b) Unbonded: 100 mm minimum
- (c) Floating: 100 mm minimum

3.2.6.4 Mix

- (a) Cement: Ordinary Portland to SS EN 197 or Portland blast furnace to SS EN 15167.
- (b) Sand/Fine aggregate: Natural sand of uniform colour, to SS EN 12620, grading limit M.
- (c) Coarse aggregate: To SS EN 12620, 10 mm single sized.
- (d) Mix proportions: 1:1:2
- (e) Admixtures: Conform to BS 8204-2, table 1.

3.2.6.5 Finish

Refer to Section A07-010:Clause:3.1.

3.2.6.6 Soundness

Test to BS 8204-1, Annex D

3.2.6.7 Maximum Depth of Indentation

Meets Category A of BS 8204-1: table 4.

3.2.6.8 Slip Resistance

Where required, conform to BS 8204-2, clause 12

3.2.6.9 Abrasion Resistance

Where required, conform to BS 8204-2, clause 12.

3.2.7 Polymer Modified Cementitious Topping

- 3.2.7.1 Base**
Surface strength and hardness of base shall be in accordance with BS 8204.
- 3.2.7.2 Construction**
Bonded.
- 3.2.7.3 Manufacturer**
Submit names and details of manufacturers to the SO.
- 3.2.7.4 Mix**
Proportions: To proprietary manufacturer's recommendations.
- 3.2.7.5 Finish**
Refer to Section 07-010:Clause:3.1.
- 3.2.7.6 Soundness**
Test to BS 8204-1, Annexe D
- 3.2.7.7 Maximum Depth of Indentation**
Meets Category A of BS 8204-1, table 4.
- 3.2.7.8 Slip Resistance**
Where required, conform to BS 8204-3, clause 10.5.
- 3.2.7.9 Abrasion Resistance**
Where required, conform to BS 8204-3, clause 10.4.
- 3.2.8 Flow Applied Cementitious Topping**
- 3.2.8.1 Base**
Concrete substrate shall be prepared in accordance with manufacturer's recommendations.
- 3.2.8.2 Construction**
Fully Bonded - this type of topping should fully reflect any movement joints within the structural base.

3.2.8.3 Manufacturer

Submit names and details of manufacturers to the SO.

3.2.8.4 Mix

Proportions shall be in accordance with manufacturer's recommendations.

3.2.8.5 Finish

Finish shall be in accordance with manufacturer's recommendations.

3.3 Movement Joint

3.3.1 Metal Edgings

Refer to Section A07-010:Clause:3.1 for selected proprietary product to be used for movement joint. Bed in a 1:3 ratio of cement to sand, centred over joint and to finished floor level. Mechanically fix with stainless steel screws to base.

3.3.2 Movement Joint Filler

Closed cell polyethylene filler, bond breaking tape and sealant as noted in Section A07-010:Clause:3.1.

3.4 Floor Hardener

3.4.1 Non-metallic Floor Hardener

3.4.1.1 General

Proprietary ready-to-use, premixed, non-metallic hardener designed for the hardening of concrete surfaces.

3.4.1.2 Manufacturer

Submit names and details of manufacturers to the SO.

3.4.1.3 Mix

3.5 kg/m² to 7 kg/m² or in accordance with manufacturer's recommendations dry shake on surface of fresh concrete to achieve the required abrasion resistance under Section A07-010:Clause:3.4.1.4.

3.5.1.1 Abrasion Resistance

Test to BS EN 13892-4.

Class AR1: < 0.1 mm wear depth for areas expected to take very high abrasion; steel or hard plastic wheeled traffic and impact, e.g., heavy duty industrial workshops, intensively used warehouse, etc.

Class AR2: < 0.2 mm wear depth for areas expected to take high abrasion; steel or hard plastic wheeled traffic e.g., medium duty industrial and commercial.

3.5 Liquid Floor Hardener and Dustproofer

Proprietary water-based, ready-to-use, silicate solution designed to be dustproof and to harden concrete and/or screed floors

3.5.1 Manufacturer

Submit names and details of manufacturers to the SO.

4 WORKMANSHIP

4.1 Preparation

4.1.1 Suitability of Bases

Before starting work ensure the following:

- (a) Bases are sufficiently flat to permit specified levels and flatness of finished surfaces, bearing in mind the permissible minimum and maximum thicknesses of the screed/topping.**
- (b) Bases are clean and free from plaster, dirt, dust and oil.**

4.1.2 Bonded Construction

Shortly before laying screed/topping, completely remove mortar matrix from surface to expose coarse aggregate over entire area of hardened base slab using abrasive blasting or, for in-situ slabs only, pneumatic scabbling. Remove all dust and debris.

Keep base slab well wetted for several hours before laying screed/topping. Remove free water, then brush in recommended bonding agent à cement slurry.

Lay screed/topping while slurry is still wet to ensure a good bond.

4.1.3 Partially Bonded Construction

Before surface of base slab has completely hardened, brush off all surface laitance with a stiff broom.

Thoroughly clean base slab and keep well wetted for several hours before laying screed. Remove free water then brush in recommended bonding agent & cement slurry.

Lay screed/topping while slurry is still wet to ensure a good bond.

4.1.4 Unbonded Construction

Lay separating sheet of polythene not less than 65 microns thick (250 gauge) on base and lap all joints not less than 50 mm.

4.1.5 Floating Construction

Lay insulation with tight butt joints and turn up for full depth of screed at all wall abutments.

Lay separating sheet of polythene not less than 125 microns thick (500 gauge) with 50 mm laps.

Lay wire netting to SS 32 or BS 4483, mesh size 50 mm, wire designation 19 over separating sheet with 50 mm laps tied securely with tying wire at 300 mm centres.

4.1.6 Conduits

Haunch up in cement to sand ratio at 1:4 on both sides of conduits.

Conduits which shall be cast into screeds shall be overlaid with 500 mm wide strip of steel fabric to SS 32 or BS 4483, reference D49. Place the reinforcement at mid-depth between the top of the conduit and the screed surface.

4.2 Batching and Mixing

4.2.1 Batching

Batch proportions of mixes by weight. Batching by volume may be permitted on the basis of the previously established weight-volume relationship(s) of the particular materials and using accurate gauge boxes.

Batch proportions of mixes made with lightweight aggregates by volume using accurate gauge boxes.

4.2.2 Mixing

Keep water content of mixes to the minimum, slump not exceeding 25 mm, necessary to achieve full compaction, low enough to prevent excessive water being brought to the surface during compaction.

Mix materials thoroughly to a uniform consistency. Mixes other than no-fines shall be mixed in a suitable forced action mechanical mixer: Do not use a free fall type (drum) mixer.

Use all mixes within 2 hours or time limit set out by supplier/manufacture. Discard all left over mixes.

Use while sufficiently plastic for full compaction.

4.3 Laying

4.3.1 Sand and Cement Screeds

Fully compact by double beam vibrator or plate vibrator or, where this is not practicable, by hand.

4.3.2 Fine Concrete Screeds/Toppings

Either:

Lay in 2 layers of approximately equal thickness, thoroughly hand compacting both layers. Roughen the surface of the lower layer and lay the upper layer within one hour; or

Lay in a single layer and compact by double beam vibrator or plate vibrator.

4.3.3 Joints in Screed

Unless otherwise specified, cast screeds continuously, as far as possible without defined joints, using "wet screeds" between strips or bays.

4.3.3.1 Bay sizes for floor and roof screeds

Lay screeds in bays of 15 m² (maximum) with length not more than 1.5 times the width in chequerboard pattern. Allow 24 hrs (minimum) interval between laying adjoining bays.

4.3.3.2 Movement Joints

Ensure that movement joints are taken through the full depth of the screed and are clean prior to the insertion of the filler strip.

4.3.3.3 Joints in Toppings

Unless otherwise specified, bay sizes shall not be more than 16 m² ratio of length to breadth, not more than 3:2, a joint occurring over every construction joint in the base slab.

Where location of bay joints is not shown on drawings, obtain approval before starting work.

Forms shall be square edged with steel top surfaces, securely fixed. Compact thoroughly at edges to give level, closely abutted joints with no lipping.

Alternatively, toppings may be cast continuously, bay joints being formed with approved plastics or metal dividing strips.

4.4 Finishing

4.4.1 Timing

Carry out all finishing operations at optimum times in relation to the setting and hardening of the material. Do not wet surfaces to assist surface working. Do not sprinkle cement onto surface.

4.4.2 Wood Floated Finish

Use a wood float to give an even and slightly coarse texture with no ridges or steps.

4.4.3 Trowelled Finish

Trowelled finish shall receive applied floor finishes.

Float to an even surface with no ridges or steps.

Hand or power trowel shall give a uniform, smooth, but not polished surface free from trowel marks and other blemishes, and suitable to receive the specified flooring material.

4.4.4 Accuracy of the Works

Tolerances for finished surfaces shall be as follows:

Finish	Maximum abrupt irregularity (mm)	Gradual irregularity expressed as maximum deviation over any 500mm straight edge (mm)
Basic/Plain	5	8
Fine	3	5
Superfine	1	2
Trowelled	0.5	2

Maximum departure from the datum level over whole floor/surface shall be ± 5 mm.

4.5 Floor Hardeners

4.5.1 Non-metallic Floor Hardener

4.5.1.1 Application

Place, compact and level base concrete to the desired floor finished level. Once the bleed water disappears before the initial set, sprinkle the hardener uniformly from a low level over the floor.

The shake-on of the hardener shall be done in 2 operations perpendicular to each other.

Trowel mechanically the hardener, until a hard, dense surface is achieved.

The treated concrete floor shall be cured by a spray-on curing membrane as described by ASTM C309 in accordance to ASTM C156, at the manufacturer's recommended rate to ensure complete coverage of the surface.

Liquid curing membranes shall not be used on floors that are to receive further surface treatment unless such liquid curing membranes are first effectively removed e.g. by grinding or shot-blasting.

4.5.2 Liquid Floor Hardener and Dustproofer

- (a) Surface preparation and application shall be in accordance with the manufacturer's recommendation.
- (b) New concrete must be thoroughly dry and cured a minimum of 10 days, prior to application of liquid floor hardener. For best results, cure for a full 28 days.
- (c) Apply liquid hardener by roller, spray, brush, or squeegee. Distribute evenly and mop up excess solution or puddles, and allow to dry.

4.6 Curing

Unless otherwise specified:

- (a) Immediately after laying, protect surface from wind, draughts and strong sunlight.
- (b) As soon as screed/topping has set, closely cover with polythene sheeting and keep in position for not less than 7 days.

4.7 Protection

Adequately protect the surface from construction traffic.

If, because of inadequate finishing or protection, the surface of the screed is not suitable to receive the specified flooring material, submit to the SO and carry out remedial measures.

5 VERIFICATION AND SUBMISSION

5.1 Submissions

5.1.1 Technical Submissions

Include in construction programme, event for submission of the following information:

- (a) Name of the manufacturer and inclusion of copies of technical data relating to each screed system proposal.
- (b) Name of sub-contractor, if any.
- (c) Information of current or completed similar jobs during the previous 5 years and details of Quality Control Procedures adopted.

5.1.2 Work Submissions

Prepare an installation strategy, containing the following information, prior to the preparation of detailed shop drawings:

- (a) Sequence of construction
- (b) Method statements

5.1.3 Test Reports and Certificate Submissions

Submit relevant test reports and certificates from a recognised certification body to demonstrate compliance with all required material and system characteristics specified.

- (a) Tests

Carry out tests as follows:

Material / Characteristic	Test	Description
.	.	.
.	.	.

[Note 2: Check the required tests under the BCA Approved Document, Code for Environmental Sustainability of Buildings, Fire Code, etc.]

- (b) Certificates

Provide certificates as follows:

System / Material	Certificate	Description
Low VOC Certificate	Yes	.
SGBC Green Certificate	Yes	.
.	.	.

[Note 2: Check the required certification under the BCA Approved Document, Code for Environmental Sustainability of Buildings, Fire Code, etc.]

5.1.4 Quality Control Plan Submissions

No item.

5.1.5 Warranty

Submit the warranty upon completion of the Works.

5.1.6 Maintenance Submissions

No item.

5.2 Samples and Mock-ups

5.2.1 Samples

Provide samples of all visible components of the floor hardeners to the SO for review. All samples shall include the actual proposed finishes for the Works.

5.2.2 Mock-ups

Provide mock-ups for the Works as follows:

Mock-Ups	Clause Reference
.	.
.	.

[Note: Customise table to reflect project specific requirements.]

Each mock-up shall be no smaller than 2 m x 2 m and to include movement joints and skirting when the latter is formed from the screed material.

5.3 Inspections

Arrange for inspection on site to be carried out by the SO for each specified section before proceeding with further works. Provide proper and safe access for such inspections.

Delivery of materials shall be inspected and checked by manufacturers upon reaching site storage area before arrangement for SO to conduct random checks.

5.4 On-Site Tests

5.4.1 Tap Tests

Tap test all screeded areas 4 weeks after laying at 1 m intervals and submit a report to the SO. There shall be no hollows in the completed screed.