PARTICULAR SPECIFICATION

APPENDIX AR

PROTECTIVE COATING

PROTECTIVE COATING TO CONCRETE SURFACE

1 CONTRACTOR TO PROPOSE COATING SYSTEM

1.1 The Contractor shall propose the types of protective coating to concrete surfaces. The proposed coating system should match the existing structures and be applicable and suitable for all surfaces of the road structures. The Contractor's proposal shall include the type, catalogue, colour plate, application procedure, surface treatment, proven track record, relevant test data, quality assurance tests/procedures, and literature on the proposed coating system including the method and devices for application, etc.

1.2 Specific application to areas for painting:

Treatment surface	Type of paint
Parapet walls	Approved polyurethane
Box culverts	Approved epoxy/silane based
Below flyovers	Approved anti-carbonation
Underpass & Tunnels	Approved anti-carbonation

1.3 Scope

1.3.1 Not limited to Clause 1.2 above, protective coatings shall also be applied to concrete surface areas as follows:

i. Approved anti-carbonation / epoxy / silane based protective coatings on all repaired concrete surfaces (such as jacketing repairs, patch repairs and crack repairs).

ii. Approved polyurethane coatings on the bridge parapet system covering the outer face (traffic side), top sides, inner face (pedestrian side or edge of the bridge), end and wing walls.

iii. Approved anti-carbonation protective coatings for all exposed structural elements at the underside of bridges including beams, columns, soffit of deck slab, abutments, crossheads, transverse beams, diaphragm beams, wing walls, etc.

iv. Approved epoxy/silane based protective coatings for all exposed structural elements of drain culverts and at the underside of bridges spanning across waterways including beams, columns, piers, soffit of deck slab, abutments, crossheads, transverse beams, diaphragm beams, wing walls, exposed piles, etc.

1.3.2 The Contractor is required to carry out all works as specified and indicated by the Engineer. When applying the coatings, it must be able to mask the repair areas and attain a uniform appearance compared to the surrounding surface.

2 SAMPLING REQUIREMENTS FOR PROTECTIVE COATING

2.1 The minimum sampling of protective coating shall be in accordance to **Table 1.1**. If the delivery consists of different batches, then containers from every batch shall be sampled in accordance to **Table 1.1**. The tests shall be carried out by a Singapore Accreditation Council (SAC-SINGLAS) accredited laboratory that is accredited to carry out the tests specified in **Table 1.2**. If the tests show that the protective coatings do not meet the performance requirements in **Table 1.2**, the entire batch of the protective coating shall be rejected and the Contractor shall submit rectification proposal for the Engineer's acceptance.

Table 1.1: **Minimum Sampling Rates for Protective Coating in accordance to SS 5: Part A1: 2003**

Total Number of Container [(1)] Delivered to Site (For each batch), **N**	Minimum Number of Containers to be Sampled, **n**
Up to 2	All
3 to 8	2
9 to 25	3
26 to 100	5
101 to 500	8
501 to 1000	13
Thereafter	n = SQRT(N/2)
Note: 'Containers' shall include barrels, drums, sacks and tins.	

3 PERFORMANCE OF COATING

3.1 Protective coatings shall be capable of improving the appearance of the concrete surface with the capability to repel dust and dirt; prevent fungus and algae growth; and bridge and seal hairline cracks.

3.2 The protective coatings shall be of an anti-graffiti type that is easily washable with non-stick capability that would allow for easy cleaning and removal of graffiti paint with the use of solvent.

3.3 The protective coatings shall be non-toxic, environmentally friendly and safe for use.

The minimum requirements for protective coating shall comply with **Table 1.2**.

Table 1.2 Minimum Requirements for Protective Coating

Algae Resistance	SS 345: 1990 Appendix B	No algae growth
Alkali Resistance	SS 5: Part G2: 200	No visible change
Adhesion Test to Dry Concrete	EN ISO 4624: 2003	1.1N/mm^2 for Vertical Surface 1.5N/mm^2 for Horizontal surface
Adhesion Test to Wet Concrete	EN 1542: 1999	$\geq$1.5 N/mm^2 at typical DFT
Compatibility of Coating to Wet Concrete Surface	EN 13578: 2003	Surface free from blistering
Accelerated Weathering	EN 1062-11: 2002	No blistering, cracking or flaking after 3000hrs
Crack Bridging Properties	BS EN 1062-7: 2004	Up to 2mm
Elongation at Break	BS ISO 37: 2005	125% at 130microns DFT

Water Vapour Transmission Rate	EN ISO 7783-1: 2000 EN ISO 7783-2: 1999	Less than 4m equivalent air layer thickness
Carbon Dioxide Diffusion	EN ISO 1062-6: 2002	Diffusion equivalent air layer thickness, R >50m

4 PROPRIETARY MATERIALS

4.1 The Contractor shall submit details of all proposed proprietary materials of the protective coatings system complete with proven track record and relevant test data of the proposed materials used in similar tropical weather condition to Singapore to the Engineer for acceptance.

4.2 All accepted proprietary materials shall be used in strict accordance with the manufacturers' recommendations.

5 COLOUR SCHEMES FOR COATING

5.1 The Contractor shall submit the colour chart of the coatings to the Engineer for selection. The Engineer may select a few colour schemes and the Contractor is required to demonstrate by preparing the concrete surface and applying the coatings to the standard as specified by the manufacturer and this Specification. The location of demonstration shall be as indicated by the Engineer. When the demonstration is successful, the demonstration panel shall be kept as the reference panel.

6 ANTI CARBONATION COATINGS

6.1 Anti-carbonation coatings shall be applied in at least two coats to give a total dry film thickness of not less than 200 microns. The thickness of the coating shall be determined in accordance with SS 5: Part B1. Coatings shall be applied evenly and shall be free from imperfections, brush marks or pinholes.

7 POLYURETHANE RESIN COATINGS

7.1 Polyurethane resin coatings shall be 2-coat system consisting of a high build epoxy polyamide prime coat and a polyurethane enamel finish coat giving a total dry film thickness of not less than 180 microns. The thickness of the coating shall be determined in accordance with SS 5: Part B1.

8 COATINGS FOR MARINE ENVIRONMENT / WATERWAYS

8.1 Epoxy/silane based protective coatings shall make up of at least 3 coats consisting of a primer, an undercoat and a finishing coat giving a total dry film thickness of not less than 240 microns. The thickness of the coating shall be determined in accordance with SS 5: Part B1. When required, an alkali resistant sealer shall be applied to the concrete surface to provide an even surface with good key to the primer.

9 WORKMANSHIP FOR CONCRETE PROTECTIVE COATINGS

9.1 Preparation of concrete surfaces

9.1.1 Areas to receive protective coatings shall be prepared as follows:

i. Coatings shall be prepared and applied strictly to the method as recommended by the manufacturer. Surfaces to receive coatings shall be sound, free from laitance and contamination such as oils and greases and shall be at least 28 days old.

ii. The concrete surface shall be coated as soon as possible after cleaning. There shall be no wet sheen or obvious damp appearance on the concrete surface at the start of coating.

iii. Remove all existing decorations, surface coatings and projections. The Contractor shall be responsible to liaise and obtain the necessary approval from all relevant authorities before removing any creepers, plants, etc that affect their works.

iv. Remove all dirt, grease, mould oils, curing compounds, organic growth and loose materials by water jet or other process accepted by the Engineer.

9.1.2 The Contractor shall patch and cover blowholes, depressions and shrinkage cracks and cracks less than 0.4 mm wide with approved cementitious mortar. For cracks more than 0.4mm, the Contractor shall submit a repair methodology to the Engineer for his acceptance. The Contractor must ensure that all surfaces receiving the coatings are prepared, clean and free of defects before application of coatings.

9.2 Cementitious Mortar

9.2.1 Cementitious mortar to patch off or cover up unevenness or repair defective surfaces shall be applied as a thin layer not more than 10 mm in thickness to areas as directed by the Engineer.

9.2.2 Such patched over areas and other repaired areas shall be properly cured for at least 14 days before the application of any protective coating.

Recoating Requirements

i. The Contractor shall provide information on the methods of preparation to be used in the event that recoating of the painted surface is required.

ii. The Contractor shall state which type of paint, other than the original product, are compatible with the finish coat for recoating purposes.

iii. The Contractor shall provide information on the technique which can be used to repair local damage to the coating, with particular reference to colour and gloss matching of finish coats applied after a time lapse of 5 years.

iv. The Contractor shall provide information on the most appropriate techniques for cleaning of the finish coat to remove surface soiling, with particular reference to ease of removal of graffiti or glued posters, where possible, without damage to the existing finish.

10 WARRANTY

10.1 The Contractor shall warrant the coatings system against peeling, blemish, growth and all defects and any malfunctioning for ten (10) years from the Date of Completion of the whole of the Works. All defects occurring during this period are to be made good by the Contractor. The Warranty is to be provided jointly and severally by the Contractor and the manufacturer and shall be in the format as specified.