

Specification for Liquid Spray Applied Structural Waterproofing Systems

Particular Requirements

1. The bridge deck waterproofing system shall be a proprietary spray applied waterproofing system minimum film thickness 2mm:-

Waterproofing System	Supplier
PmB polyurethane membrane	Pitchmastic PmB Ltd Bridge Deck Protection Division Panama House 184 Attercliffe Road Sheffield S4 7WZ United Kingdom Tel: 0114 270 0100 Fax: 0114 276 8782
Or of certified equivalence	

2. The waterproofing system shall be tested to international standards and shall hold current roads and bridges certification, by BBA and BAM test authorities as a high performance spray applied product. The waterproofing membrane shall provide long term performance and protection to the concrete/steel from the ingress of water borne chlorides or other deleterious substances.

All waterproofing materials, including primers, tackcoat etc, shall be compatible with each other and shall be supplied by a manufacturer and installer operating the ISO 9001, EN 29001 or similar approved quality assurance schemes. All materials shall have a valid Agreement Certificate for Road and Bridge Structures approved by the relevant Client Authority.

Waterproofing for bridge decks shall be one or two coat, rapid curing and liquid spray applied polyurethane system. The finished membrane shall be free of pinholes. High quality adhesion shall be provided between the membrane and the concrete or steel and between the membrane and the designated type of overlay whereby a firm bond should be achieved. Adhesion between the membrane and the concrete shall be at least 1.0MPa minimum after two hours cure. The membrane shall be Elastomeric and be able to bridge live cracks of up to 3mm.

The membrane shall be resistant to water and chloride ion penetration, embrittlement, abrasion, UV degradation, pedestrian traffic, indentation by hot or cold aggregates and the effect of placing asphalt.

The membrane shall easily accommodate the need for day joints and patch repairs as a result of testing for adhesion or coating thickness, if required by the Engineer.

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Materials testing and approval authorities:-

British Board of Agrément
P O Box No 195
Bucknalls Lane
Garston
Watford
HertsWD2 7NG
United Kingdom
Tel: 01923 670844
Fax: 01923 662133

Bundesanstalt Fur Materialforschung Und-Prüfung (BAM)
Unter Den Eichen 87 D1000
Berlin 45 Germany
Tel: 030 8141
Fax: 030 8112029

Specific product performance requirements as required under the contract specification.

- A. Product performance testing as undertaken by the BBA and BAM shall confirm that the product encompasses the physical qualities to exceed a lifespan of 25 years when subjected to normal application and accepted service life conditions.
- B. Crack bridges and deformation capability min 250% or as contract design.
- C. Adhesion – substrates by design or preparation shall be capable of sustaining tensile adhesion values in excess of 0.75N/mm² after one hour from installation. Minimum adhesion of installed membrane to substrate shall not fall below 1N/mm² after two hours and be achieving cohesive concrete failure.
- D. Quality Assurance testing will be undertaken as described, and records retained by the Engineer.
- E. Adhesion of road surfacing materials - a firm bond of the road surfacing overlay should always be achieved. Without interface voidage at the base of the initial layer.
- F. Applications of the waterproofing system may only be undertaken within the stipulated environmental conditions.
- G. Quality Assurance testing will be undertaken as described and monitored by the Engineers Representative. Quality Assurance records will be retained by the Engineer.
- H. Root Penetration – where deemed applicable, the product shall hold certification to confirm adequate resistance against root penetration.

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- I. The product Manufacturer or installer shall be capable of demonstrating satisfactory references of installed quality and all relevant technical or test data required by the Engineer
- J. Full details of previous bridge deck waterproofing contracts performed in climatic conditions similar to that of the site location including details of contract, contractor, consultant/engineer, client/employer, location, size (m²), temperature and brief description.
- K. The installation will be undertaken by skilled operatives as approved by the product manufacturer.
- L. Full technical literature with test results etc, relevant to US or UK test standards will be required as verification of compliance with this Specification including the following:-

Property	Test Method	Requirements
Minimum Thickness	As approved by the engineer	2mm minimum 2.7 nom
Density	DIN 53479	0.85-0.95MG/m ³ as published
Static crack Bridging	BRE (UK) EN1067 +23°C - 10°C	14mm extension no failure
Low temperature flexibility	ASTM C 836 - 26°C	satisfactory
Tensile Strength	BS 903 Part A2 1989 ASTM D638	10mpa nominal 1815 PSI + 0.9%
Elongation	BS 903 Part A2 1989 ASTM D638 + 10% - 20%	300% nominal
Tear Strength Standard	BS 903 Part A3 RT/CE/S/041 8.1.2	28KN/M 20KN/M minimum
Adhesion to Concrete	Elcometer Test (minimum)	0.75mpa after only one hour 1.0MPa/Nmm ² minimum 370 PSI – 2.64N/MM ²
Adhesion to Steel	ASTM D4541 Test Value ASTM D4541 Test Value	2.0MPG/NMM ² minimum 855/PSI 6.1N/MM ²
Adhesion to Road Surfacing	To UK Highways standard BD 47/94 tensile and shear adhesion	Satisfactory shear resistance and tensile adhesion firm bond

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Puncture Resistance	ASTM E154 Min 95 KGF/MIN	174 KGF tested
Electrical Resistivity	ASTM D257 Min 5 x 10 ³ ohm-cm	Result 91 x 10 ³ ohm-cm
Moisture Vapour transmission rate	ASTM E96 BW	Acceptable
Abrasion resistance	DIN 53516 ASTM D1044	Acceptable resistance
Water penetration	UK Dept of Transport Tech memo BE27 DIN 1048	Zero Watertight Report 437/5043
Crack Bridging ability	ASTMC 836-95	3.2mm per hour at -26°C (-15°F) - No failure
Glass transition temperature	Finland RAT 9359	-42°C mean
Bonding test	ASTM D1737-79	-50°C no failure
<u>Chemical resistance/Chemical transmission</u>		
Dilute acids	100 day test	Resistant
Dilute alkalis	As approved by the engineer	Resistant
Sulphates	As approved by the engineer	Resistant
Hydraulic oil	As approved by the engineer	Resistant
Chlorides	BD 47 B4.2(F)	0.04% maximum Resistant
Microbial Attack	As approved by the engineer	Resistant
Resistance to aggregate indentation	BD47 B4 (I)	Satisfactory
Resistance to ballast penetration	Railtrack RT/CE/S/041 Section A8 test	Resistant
Resistance to flow and heat during road surfacing	BS4147 Report RAT 9359	240°C
No adverse effect	BAM 2.33/23529	250°C

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Holidays (pinholes)	As approved by the engineer using electronic pinhole detector	None after rectification Site Testing
Blisters		None Site Inspection
Cathodic Disponding	ASTM-G8-90 method B	No change after 130 days testing
Bonding Test	RAT 9359 ASTM D1737-79 -20°C to -50°C	No Failure
Resistance to embrittlement	UK Dept of Transport Tech memo BE27 90° Mandrel Test at 0°C Appendix B Low Temperature Flexibility	No cracking
Resistance to chisel impact	UK Dept of Transport checks Appendix B BD47/94	No indentation

NB The waterproofing membrane manufacturer shall be capable of verifying performance qualities by the provision of test certification undertaken independently to international accreditation standards.

Alternative bridge deck waterproofing systems will only be accepted if they meet the requirements certification and subject to the approval of the Engineer.

3. The Contractor shall provide with all batches of material delivered to site, a certificate of compliance with Appendix 20/1 and Annex 'A'.
4. The Contractor shall continuously monitor the wet film thickness using a gauge pin or provide thickness samples from the applied works. The Contractor shall provide the Engineer with daily sheets indicating the amount of resin sprayed per the measured area and indicate the average materials consumption applied.
5. The Contractor shall provide two free film samples 200mm square, minimum film thickness 2mm, marked with the chainage location and batch number. One sample per 500 square metres or per area sprayed if less. The Engineer shall retain one sample, and the applicator the other, for his contract file. At 12 hours of cure the samples shall be inspected visually for cure and flexible quality. Should sample quality be in doubt, the sample may be tested by the Engineers Test Authority, to confirm physical membrane qualities.

The Contractor shall measure the adhesion of the fully cured membrane to the deck. One test will be required per 500 sq metres of sprayed membrane. The Contractor shall provide the Engineer with the test values and locations of test. The Contractor shall reinstate the test areas including primer if necessary. It should be noted that the

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Test values below 0.75N/mm² after one hour from installation will require spraying operations to be suspended while further investigation is undertaken. Areas deemed not to meet this figure will require to be removed and resprayed to the satisfaction of the Engineer at the Contractors cost. Bond tests shall also be carried out on dayjoints/overlaps to prove adhesion levels between the two layers of waterproofing.

6. The finished waterproof membrane surface shall be inspected by the Engineers Representative for defects. Any imperfections detected shall be rectified to the satisfaction of the Engineer by the Contractor at his own expense. The Contractor shall make allowance in his programming for providing attendance and assisting the Engineer to carry out the above testing. The entire membrane shall be tested for defects/pinholes using an electronic pinhole detector set at the approximate voltage as determined by the waterproofing membrane manufacturer
7. The Contractor shall ensure that the surface of the waterproofing membrane is clean and dry, prior to inspection.
8. No tackcoat, shear resistant layer or additional protective layer, shall be applied over the waterproofing membrane until the membrane has been inspected and approved by the Engineer.
9. Substrate preparation to receive spray applied waterproofing

A. New Concrete - U4 Standard of Finish

Design requirements - water cement ratio in any event, shall not exceed 0.5 excessive water will promote porosity, and weak interface adhesion, and shall not be permitted. The concrete tensile interface strength, shall be capable of exceeding 1N/mm² at 4 days from cast.

Placement Method New Concrete

The concrete shall be levelled and screeded, utilising vibratory equipment, producing a uniform surface. The surface shall be flattened by, steel/pole/float. When the concrete has sufficiently hardened to a plastic state, following bleed water evaporation, the surface shall be steel trowelled, preferably by power float, to fill all open blow holes and capillaries. The surface shall be free of screed marks, and exposed aggregate.

The concrete surface finish, shall be stipulated by the waterproofing Manufacturer Supplier. In all instances, the surface shall be free of weak laitance scum, and general soiling. If rain is encountered during concrete cast, it may be necessary to remove resultant weak laitance, by mini-plane or abrasive blast methods. Concrete interface density, free of voidage is of paramount importance, to all waterproofing products, and should be provided. Concrete curing. Resin or wax based curing membranes, will adversely affect waterproofing adhesion. They should not be used. Polythene or sheet curing methods are preferred, although certain types of degradable spray curing types may be acceptable after site testing.

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B. Maintenance works - Concrete Preparation

Following the removal of the existing road surfacing layer, and any existing waterproof membrane, the concrete surface shall be prepared, by abrasive blast or scabbling methods, to provide a surface free of bituminous product, surface laitance oil staining, soiling and dust. The surface shall be inspected for repair, by the Engineers Representative, and following any necessary repairs, further inspected by the waterproofing applicator, and accepted as being suitable for primer application.

C. Steelwork

All steel should be prepared to a suitable SA2½ or similar accepted standard. To ensure that the steel is free of all oxidation, oil, grease or other deleterious matter.

If a rust inhibitor is used, then advice should be sought from the manufacturer of the waterproofing system as to compatibility. Most zinc and epoxy primers are suitable. After the steel has been abrasive blasted the primer should be applied within four hours to prevent re-oxidation of the steel.

Any sharp sections or protrusions which may cause puncturing under loading should be ground down and removed

10. Application of the waterproofing system

The primer and waterproofing membrane comprising the waterproofing system, shall all be applied, strictly in accordance with the Manufacturers Method Statement. Joints in the membrane shall be formed with laps, and the use of adhesion promoters as recommended by the Manufacturer. Where a spray applied system is used, the minimum rate of spread, and minimum coating thickness' shall be achieved.

11. Lapping/Dayjoints

In order to ensure cleanliness of longitudinal laps, then a 150mm wide 1mm thick galvanised steel strip or similar method shall be placed over all first phase laps. The protection plate will be affixed by spraying membrane in continuity over the plate along the inner edge preventing tackcoat contamination. The outer edge will be sprayed only to hold the plate down. Upon the second phase the protective plates will be cut free and removed. The clean lap will be abraded by mechanical wire brush prior to application of primer and membrane in accordance with the Method Statement.

To verify bond quality levels a minimum of one lap bond test per overlap will be conducted.

All laps shall be treated and prepared in accordance with the Method Statement.

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12. **Tackcoat – Road Surfacing Overlay Greater than 60mm depth**

For use where surfacing depths are **above 60mm** and a dense interface surfacing is adopted (see note 12A of this section).

Adhesion promoter for bonding bituminous road surfacing overlay. A polymer modified tack coat of minimum 100°C softening point shall be applied to the areas of membrane intended to receive the additional protection layer (APL) of sand asphalt or initial layer of dense road surfacing overlay. (See note 12A of this section).

Surfacing design mix should aim to achieve almost 100% interface contact without voidage for optimum adhesion. The firm bond shall be sufficient to prevent shear failure slippage due to braking force load at the interface of the installed waterproofing

Aggregated Shear Resistant Layer

Road Surfacing Overlays Less than 60mm Depth

Suitable as shear resistant adhesion promoter for dense bitumen wear surfaces, mastic, concrete, or resinous wear surface overlays.

Typically as appropriate 1-3mm aggregates of nominal 80% coverage, are chemically bonded via a polyurethane binder to the installed PmB membrane. This layer provides a positive key and bond for enhanced shear resistance of the subsequent overlay product.

Prior to overlay of the aggregated key coat, the specialist overlay contractor, as appropriate, shall apply a suitable and compatible primer or tack coat to bond the specified type of overlay.

With regard to dense bituminous asphalt overlay then it is recommended to utilise a polymer modified bitumen variant of tack coat of 100°C softening point to preclude softening and stripping during overlays in warm summer conditions. (In addition see note 12A of this section).

12A Road Surfacing

The initial road surfacing layer above the waterproofing membrane, shall be finely graded mix design, able to demonstrate an interface without voidage, or void continuity, whereby water ingress, is unable to become pressurised by traffic wheel action. Sub-surface drainage shall be provided wherever water collection is likely, to avoid pressurisation, and stress of the road surfacing layer. Where the asphalt overlay is applied in two layers vertical joints should be avoided and each layer stepped back/staggered. Avenues for free water ingress should be similarly avoided.

13. **Protection of Bridge Deck Waterproofing System During Construction**

On any structure, providing no damage results, only plant and equipment fitted with rubber tyres may stand or travel on proprietary waterproofing systems with the prior

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approval of the Engineer solely for the purpose of laying an additional protective layer or surfacing course on that structure.

Rollers shall not be permitted to stand or travel directly on the waterproofing system.

Where it is necessary for plant, equipment or traffic to stand or travel on a bridge deck that has been waterproofing with a proprietary system before the laying of an additional protective layer, suitable temporary protection shall be provided to the satisfaction of the Engineer. All such plant and equipment shall have its tyre treads regularly inspected and any embedded stones removed.

Temporary protection shall be provided where damage to the waterproofing, protective layer or additional protective layer could result from particular site traffic.

The protective layer of two layer waterproofing system, or any protective layer additional to that included as part of the waterproofing system, shall be laid immediately after the waterproofing layers bonding agent has set or cured.

Where a waterproofing system also serves as an adhesion promoter for the protective layer, any additional protective layer shall not be laid until the liquid waterproofing membrane/key coat /tack coat has set or cured, in accordance with the supplier's instructions, or Method Statement.

Workmanship

Proprietary waterproofing systems shall be installed only by applicators approved by the manufacturers and the Engineer and in accordance with the approved installation procedures.

The formation of defects affecting the integrity of the membrane including pin/blow holes and blisters in the waterproofing shall

- (i) be made good by repair in accordance with the manufacturers procedure before any subsequent layers are applied; or
- (ii) require the system to be replaced where directed by the Engineer.

Proprietary waterproofing systems shall be laid to follow the contours of the concrete surface and shall be incapable of flow and slump.

Integrity Testing of Applied System

To verify the integrity of the applied system an electronic pinhole survey should be undertaken. The methods and voltage used should be appropriate to the type of waterproofing system. Please consult the manufacturer in this respect and refer to the specific method statement for the particular system. The manufacturer should be consulted over the relevant dielectric resistance of the membrane