British Board of Agrément
PO Box 195
Bucknalls Lane
Garston
Watford
Herts
WD25 9BA

Tel: 01923 665300
Fax: 01923 665301
e-mail: mail@bba.star.co.uk
website: www.bbacerts.co.uk

GUIDELINES DOCUMENT

FOR THE ASSESSMENT AND CERTIFICATION

OF WATERPROOFING SYSTEMS

FOR USE ON CONCRETE DECKS OF HIGHWAY BRIDGES

August 2012

Note: This document may be revised from time to time to take account of improvements and amendments to test and assessment methods and material innovations. Readers are advised to contact the British Board of Agrément to check the latest edition.

HAPAS GUIDELINES

Terms and Conditions of Use

REPRESENTATION ON SPECIALIST GROUP 7 – BRIDGE DECK WATERPROOFING

Association of Consulting Engineers (ACE)
Bridge Deck Waterproofing Association (BWA)
British Board of Agrément (BBA)
ADEPT (Association of Directors of Environment, Economy, Planning and Development)
The Highways Agency (HA) – also representing other overseeing organisations

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1 SCOPE

1.1 The assessment is directed towards the issue of a BBA HAPAS Certificate confirming a Waterproofing System's compliance with the requirements as defined by Specialist Group 7, Waterproofing Systems for use on Concrete Decks of Highway Bridges, and agreed by the Highways Technical Advisory Committee (HiTAC).

1.2 Systems approved under the scheme are deemed suitable for use on highway concrete bridge decks as part of new and maintenance applications. The deck surface shall have a U4, formed or tamped surface (see Appendix B) and shall be at least 28 days old, unless confirmed by testing in accordance with Section 3.3.2.13.

1.4 At the time of installation, the deck shall have a surface temperature in the range 5°C to 35°C. The suitability of a system for use on decks with a surface temperature outside this range shall be assessed at the request of the applicant.

1.5 Systems receiving a Certificate shall be recognised under Highway Authorities Products Approval Scheme (HAPAS), as referenced in Manual of Contract Document for Highway Works Volume 1 (MCHW 1), Specification for Highway Works, Series 2000.

1.6 A condition of Certification shall be that systems are installed by Installers, led by a Site Supervisor, approved by the Certificate holder (see Appendix E). The approved installers shall operate a quality system acceptable to the Certificate holder. The Certificate holder shall periodically audit the installers and make the details of the audits available to the BBA when requested.

1.7 The approval procedures for installers, used by Certificate holders shall be agreed with the BBA, and shall be in accordance with the Check List of Critical Parameters to be considered by Certificate Holder's for Approval of Installers of Bridge Deck Waterproofing Systems (see Appendix D).

1.8 Application of waterproofing onto concrete repair systems for concrete bridge decks is not covered by the scope of the assessment. It is assumed that the applicant shall demonstrate a suitable test method to assess the compatibility of his waterproofing with the concrete repair system used on-site.

1.9 The requirements of BD 47 Waterproofing and Surfacing of Concrete Bridge Decks, Appendix B and C have been adopted within this document. Bridge Deck Waterproofing Systems previously approved under BD 47 would be deemed to satisfy the requirements of Section 3.1, 3.2, 3.3.2.1 to 3.3.2.11 and 3.4 of this Guidelines Document.

2 INTRODUCTION

2.1 The assessment and Certification procedure shall be undertaken in six stages, as follows:

Stage 1: Assessment of applicant's data
Stage 2: Assessment of factory production control and preliminary tests
Stage 3: Laboratory testing (mandatory and optional tests)
Stage 4: System installation trial
Stage 5: Certification

2.2 Generally each stage shall be successfully completed and, where appropriate, a report issued prior to the commencement of the next stage. However, Stages 1 to 4 may at the request of the applicant be undertaken concurrently. The applicant shall have the option of withdrawing from the programme at any stage.

2.3 In the event of an applicant offering a system including a number of options with regard to system components and/or alternative application procedures, the BBA shall define the number of Certificates required and the range of tests to be performed to allow the acceptance of the alternative materials and/or procedures in consultation with the applicant.

2.4 The BBA in consultation with Specialist Group 7 reserves the right to amend or supplement the tests required for BBA assessment and Certification at any time if required. The cost of all further tests shall be borne by the applicant.

2.5 A Certificate shall only be awarded on the system's successful completion of Stages 1 to 5.

3 ASSESSMENT AND CERTIFICATION PROCEDURE

3.1 Stage 1: Assessment of applicant's data

3.1.1 Applicants shall submit at least the details listed below for examination by the BBA. If they are found to be acceptable they shall form the basis of the subsequent assessment.

3.1.1.1 Application for BBA assessment, including applicant details, manufacturer's details, product description, type of material, packaging, site handling/storage, substrate preparation, installation procedures, on site quality control/assurance procedures, details for repair and historical data for the system.

3.1.1.2 Applicant's scheme for approval of installers, to be assessed by the BBA.

3.1.1.3 Testing procedures to establish the compatibility of the waterproofing with a concrete repair system on-site.

3.1.1.4 Quality Plan, including details of the production procedures, controls and tolerances.

3.1.1.5 Questionnaire for the Quality System, including organisational structure, responsibilities, procedures, processes and resources for implementing quality management.

3.1.1.6 Installation Method Statement, including limitation in respect to weather and substrate conditions, substrate preparation, installation procedures, repair details and on-site quality control/assurance procedures.

3.1.2 Should there be, during the assessment, the need to modify the system defined by the applicant (for example as a result of failure of the system to meet the requirements) the content of the assessment and additional work required shall be reconsidered by the BBA. The cost of additional testing shall be borne by the applicant.

3.1.3 If the system includes hazardous substances, i.e. that require special precautions to be taken under the COSHH Regulations, the applicant shall supply all the relevant data. No formal assessment of the suitability of this data, in terms of the COSHH Regulations, shall be undertaken by the BBA. However, this data shall always be required by the BBA, and it's subcontractors, to ensure the safe use and testing of the system in their laboratories. The applicant's instructions for use shall include all necessary data to allow the safe use of the products.

3.2 Stage 2: Assessment of factory production control and preliminary tests

3.2.1 Factory production control

3.2.1.1 The BBA shall assess the applicant's production processes, material controls, records etc to ensure that a consistent product is offered for sale. This shall include a visit to the factory or other manufacturing location to confirm the Quality Plan and Quality System for the product. The assessment of factory production control shall form the basis for subsequent surveillance visits.

3.2.1.2 Where registration to ISO 9000 Series exists, this shall be taken into full account during the assessment.

3.2.2 Preliminary tests

3.2.2.1 Any samples required for testing shall be prepared by the applicant or his representative. Preparation of the samples shall be witnessed by the BBA or their agent. Any concrete blocks used shall be a minimum of 28 days old and have U4 surface finish. The applicant shall provide evidence that the system submitted for this stage is within the declared manufacturing tolerances, e.g. certificate of conformity, including quality control data etc.

a) Characterisation

3.2.2.2 The BBA shall undertake a series of tests to determine the characteristics of the system, and its various constituent parts. These checks also serve to ensure that the system offered for assessment is typical and to enable confirmation of other samples at a later date.

3.2.2.3 Typical characterisation tests are listed in Appendix A. The list is not exhaustive and the final test programme shall be agreed in consultation with the applicant.

3.2.2.4 The applicant shall provide evidence that the system submitted for this stage is within the declared manufacturing tolerances, e.g. certificate of conformity, including quality control data.

b) Tests on sheets and liquid applied membranes

3.2.2.5 Straightness of sheets

Sheets shall be unrolled over the whole length of the roll and laid flat along a straight edge at (23 ±2)°C. The deviation from the straight edge shall be no more than ±10 mm in any 2 metre length.

3.2.2.6 Width of sheets

Width shall be measured to an accuracy of 1.0 mm at 10 evenly spaced intervals along the full length of the sheet. This shall remain uniform within ±10 mm from the nominal.

3.2.2.7 Thickness

Thickness shall be measured to an accuracy of 0.01 mm using a micrometer or dial gauge with an 8 mm diameter circular foot loaded to exert a pressure of 0.02 Nmm^{-2}. Sixty measurements shall be made on specimens taken over the whole area. For mineral dressed sheets measurements shall be made along the selvedge. For sheets measurements shall be made over the full length and width at regular intervals and for cured liquid applied membranes over the central (1 x 1) m, ignoring the edge perimeter width of at least 50 mm. For sheets the thickness at any location shall be within ±10% of the nominal thickness.

3.2.2.8 Weight per unit area

A minimum of three specimens (150 x 150) mm each shall be weighed to an accuracy of 0.01 grammes.

3.2.2.9 Water absorption

The specimens used for weight per unit area measurement shall be immersed in a water bath for 28 days at (23 ±2)°C and then re-weighed after removing the surface water. The increase in weight shall not exceed 7%. Specimens which exceed this limit shall be subjected to freezing for 24 hours at (-10 ±2)°C. After the freeze period the specimen shall be conditioned for at least 4 hours at (23 ±2)°C and then observed under a minimum of x20 magnification for damage or thickness change.

When compared with a control specimen there shall be no damage and for sheets any change in thickness shall be limited to ±10% of the control thickness.

3.2.2.10 Resistance to water penetration

Three specimens of membrane (250 x 250) mm, shall be subjected to a water pressure of 0.6 atmospheres (6 metres head of water) over a diameter of 150 mm at a test temperature of (23 ±2)°C. Specimens consisting of a maximum of 100 mm overlaps shall also be tested (for sheet membranes only). The specimens shall be fully supported by a metal gauze sheet. There shall be no water penetration after 28 days.

3.2.2.11 Handling tests for sheets

a) Rolls of Sheet Membranes

Complying with the applicant's storage conditions, rolls of sheet membranes shall be placed in a temperature-controlled cabinet at (-10 ±2)°C, (23 ±2)°C and (40 ±2)°C respectively for 24 hours. The applicant may declare a reduced temperature range for handling but this shall include 5°C to 35°C and the range limits shall be tested. The rolls of sheet membranes shall then be unrolled immediately on removal from the cabinet.

The following requirements shall apply:

(i) No edge damage to roll during storage.

(ii) One-man operation to unroll.

(iii) Minimal increase in stiffness of the sheet.

(iv) Membrane shall lay flat without damage or rucking.

(v) No cracking in the membrane on unrolling.

(vi) Recoil shall not exceed 2.5 m over a length of 10 m.

(vii) Edge curl shall not exceed a height of 50 mm in 150 mm.

(viii) Deviation from the straight edge shall be limited to 10 mm in any 2 metre length.

b) Unrolling Sheet Membranes from a Mandrel.

Three longitudinal and three transverse specimens (450 x 50) mm shall be cut from the roll, wound onto a 25 mm diameter mandrel and secured with tape. These shall then be placed in a temperature-controlled cabinet at (-10 ±2)°C, (23 ±2)°C and (40 ±2)°C respectively for 24 hours. They shall then be unwound slowly at the stored temperature. The following tests shall be conducted:

(i) One end bent through 90° and the other end tapped gently to a 90° corner.

(ii) The ease of cutting shall be checked using a razor edged knife.

The following requirements shall apply:

(iii) A minimal increase in the stiffness with no embrittlement.

(iv) No damage, cracking, permanent set or dimensional instability.

(v) Membrane easily cut to shape with minimal contamination of cutting blade.

(vi) Good resistance to tearing under normal handling.

If the handling tests are unsatisfactory at the minimum and maximum temperatures, the intermediate temperatures may then be checked. The membrane shall be rejected if there is an unsatisfactory performance between 5°C and 35°C.

Membranes not conforming to the full range of temperatures but satisfactory at the reduced range shall have these limits quoted in any BBA HAPAS Certificate issued.

3.2.2.12 Resistance to pin/blow holing for liquid applied membranes

Six size (B) concrete blocks (see Appendix B) shall be used for this test.

Three blocks shall be immersed in water for a minimum of 24 hours and then removed, the surface allowed to dry in still air for up to two hours at (23 ±2)°C. The sealer and/or primer and waterproofing membrane shall then be applied according to the applicant's Method Statement to all six blocks as one or two coats. The samples shall be observed after two hours for pin/blow holes or blisters. Temperature and relative humidity shall be recorded during the test.

There shall be no blisters and not more than four pin/blow holes continuous or non-continuous within a central area of (250 x 250) mm for both samples. The size of any pin/blow hole present shall be recorded and no pin/blow hole shall exceed 1 mm in diameter. The requirement for pin/blow holing applies to single-coat, two or more coat membranes.

Where single coat membranes do not meet the above requirements the applicant shall be given the opportunity of applying the membrane as two or more coats to the same total thickness. If then acceptable the system shall be used as a two or more coat membrane and the remainder of the tests shall be as for a two or more coat membrane.

3.2.2.13 Coverage rates and setting times of liquid applied components of the system

During preparation of the samples, the coverage rates and setting times shall be checked. These shall be within the applicant's Method Statement.

3.3 Stage 3: Laboratory testing (mandatory and optional tests)

3.3.1 All samples submitted for testing shall be prepared by the applicant or his representative. The BBA, or their agent shall witness preparation of the samples. The concrete blocks used shall be a minimum of 28 days old and have U4 surface finish unless otherwise specified for the test. The applicant shall provide evidence that the system submitted for this stage is within the declared manufacturing tolerances, e.g. certificate of conformity, including quality control data etc.

3.3.2 Mandatory tests

3.3.2.1 Tensile adhesion test at -10°C, 23°C and 40°C

Nine size (A) concrete blocks (see Appendix B) with membranes fully bonded shall be used for this test i.e. 3 blocks for each test temperature.

On each block, an area of membrane, (100 x 100) mm, is isolated by cutting down to the concrete without disturbance to the membrane. A steel plate, (100 x 100 x 10) mm is then bonded to this area with a suitable adhesive. A tensile pull off apparatus that locates onto the surface of the plate is used (e.g. see Appendix C Figure 2). The load shall be applied progressively at a rate of (0.4 ±0.2) $kNsec^{-1}$. The test shall be carried out in temperature-controlled conditions at (-10 ±2)°C, (23 ±2)°C and (40 ±2)°C respectively. The test samples shall have been preconditioned at the above temperatures for at least 2 hours.

The stress at failure for each individual sample shall be not less than:

0.3 Nmm^{-2} at (-10 ±2)°C and (23 ±2)°C respectively, and 0.2 Nmm^{-2} at (40 ±2)°C.

3.3.2.2 Resistance to chloride ion penetration

Three size (A) concrete blocks (see Appendix B) with membranes fully bonded shall be used for this test.
A glass vessel, 100 mm diameter shall be sealed with a silicone or similar suitable adhesive to the surface of the membrane (see Appendix C Figure 3). For mineral dressed membranes the dressing may need to be modified or removed in the area of the seal to ensure an adequate seal.

The vessel shall be filled with 1.47 litres of saturated sodium chloride solution which makes contact with the membrane surface. The test is conducted at (23 ±2)°C over a period of 28 days. Water penetration or absorption is detected by a fall in the level of the liquid.

Observations of surface sweating and wicking of salt solution along an interface shall be made periodically. The solution, vessel and membrane shall then be removed. A sample of powdered concrete shall be taken from the surface of the concrete block using the profile grinding technique. The sample shall be obtained by grinding the surface of the concrete to a depth of 3 mm. Approximately 40 grams of dust shall be collected.

Two representative specimens, approximately 5 grams each, shall be taken from the sampled dust and analysed for chloride ion concentration. The average value of the two results obtained from the analysis shall represent the chloride ion concentration for each block.

Salt penetration shall be determined by measuring the percentage of chloride ions present in the powdered concrete sample. Ion selective electrode method or similar shall be used.

The following requirements shall be met after 28 days.

(i) The maximum increase in chloride ion concentration in the concrete shall be not more than 0.04%.

(ii) The maximum loss in volume of the liquid in the test vessel shall be less than 20ml.

(iii) There shall not be any significant surface sweating.

(iv) There shall not be any significant inter-laminar salt penetration.

(v) There shall not be any deterioration or debonding of the membrane from the concrete.

3.3.2.3 Resistance to freeze-thaw

Six size (A) concrete blocks (see Appendix B) with membranes fully bonded shall be used for this test.

The six samples shall be subjected to water absorption using deionised water for 28 days at (23 ±2)°C using a 100 mm diameter vessel and pipe coupling (see Appendix C Figure 4).

Membranes exhibiting up to 7% water absorption determined in accordance with clause 3.2.2.9 shall be subjected to 6 freeze-thaw cycles. Membranes exhibiting more than 7% water absorption shall be subjected to 20 freeze-thaw cycles. Each cycle shall consist of 8 hours freeze at (-10 ±2)°C and 16 hours thaw at (23 ±2)°C. During the thawing period water shall be introduced into the pipe coupling collar to a depth of approximately 50 mm. The water shall then be removed before commencing the freeze cycle. On completion of the freeze-thaw cycling the samples shall be conditioned for at least 24 hours at (23 ±2)°C.

After conditioning three samples shall be subjected to the tensile adhesion test at (23 ±2)°C in accordance with clause 3.3.2.1 and the remaining three samples to the chloride ion test in accordance with clause 3.3.2.2.

3.3.2.4 Resistance to heat ageing at 70°C for 28 days

Six size (A) concrete blocks (see Appendix B) with the membranes fully bonded shall be used for this test.

Samples shall be placed in a ventilated oven and maintained at (70 ±3)°C for 28 days. These shall then be conditioned for at least 24 hours at (23 ±2)°C. After conditioning three samples shall be subjected to the tensile adhesion test at (23 ±2)°C in accordance with clause 3.3.2.1 and the remaining three samples to the chloride ion test in accordance with clause 3.3.2.2.

3.3.2.5 Resistance to chisel impact at -10°C, 23°C and 40°C

Nine size (A) concrete blocks (see Appendix B) with membranes fully bonded shall be used for this test i.e. 3 blocks for each test temperature.

The test shall be carried out in temperature controlled conditions at (-10 ±2)°C, (23 ±2)°C, and (40 ±2)°C respectively. The chisel impact apparatus (see Appendix C Figure 5) and the test specimen shall be preconditioned at the respective temperatures for at least 2 hours.

A chisel head 20 mm wide with a 90° tip angle and weighing 1.0 kg shall be dropped from a height of 200 mm directly onto the central test area of the membrane. Five impacts shall be made within an area delineated by a circle of 75 mm diameter.

The chloride ion test shall then be applied in accordance with clause 3.3.2.2.

3.3.2.6 Resistance to aggregate indentation at 40°C

This test is to simulate the compaction of loose aggregates into the system during normal site activities prior to the surfacing being applied.

Systems ≥20 mm thick shall be exempted from this test.

Three size (A) concrete blocks (see Appendix B) with systems fully bonded (excluding any tack coat) shall be used for this test.

Before application of the system each concrete block shall be measured within the central 75 mm diameter test area at 4 separate locations using a template (see Appendix C Figure 6) with a dial gauge. The system shall then be fully bonded and the block re-measured at the same 4 locations using the template and the dial gauge.

The system thickness shall be calculated by subtracting the measured concrete block thickness from the total thickness and the mean thickness of the system shall be calculated from the 4 results. For sheet systems the thickness shall comply within ±10% of the declared nominal thickness.

Resistance to aggregate indentation test shall be carried out using a steel indentor in the shape of a truncated cone, with the cone angle at 90°, the diameter at the truncation 8 mm and the diameter at the base 25 mm (see Appendix C Figure 7).

The samples shall be preconditioned for at least 4 hours at (40 ±2)°C and the indentor electrically heated to a temperature of (40 ±3)°C. Indentation shall be produced by forcing the truncated end into the system using a test machine that measures force and displacement simultaneously. The test shall be carried out at a temperature of (40 ±2)°C.

Indentations shall be made in the same 4 locations as the thickness measurements. Each indentation shall be made by driving the indentor into the system at a rate of 5 mm per minute. Indentation shall be stopped when the force applied reaches 1000N. The load shall be removed at the same rate. The samples shall then be conditioned for a minimum of 24 hours at (23 ±2)°C.

The overall thickness shall be measured at the same 4 locations using a template (see Appendix C Figure 6) with a dial gauge. Individual thickness measurements shall then be determined by subtracting the concrete block thickness from the overall thickness.

Indentation after the recovery period shall not exceed 50% of the initial thickness of the system.

The chloride ion test shall then be applied in accordance with clause 3.3.2.2.

3.3.2.7 Resistance to aggregate indentation at 80°C

Systems ≥20 mm thick shall be exempted from this test.

Three size (A) concrete blocks (see Appendix B) with systems fully bonded (excluding any tack coat) shall be used for this test.

Before application of the system each concrete block shall be measured within the central 75 mm diameter test area at 4 separate locations using a template (see Appendix C Figure 6) with a dial gauge. The system shall then be fully bonded and the block re-measured at the same 4 locations using the template and the dial gauge.

The system thickness shall be calculated by subtracting the measured concrete block thickness from the total thickness and the mean thickness of the system shall be calculated from the 4 results. For sheet systems the thickness shall comply within ±10% of the declared nominal thickness.

Resistance to aggregate indentation test shall be carried out using a steel indentor in the shape of a truncated cone, with the cone angle at 90°, the diameter at the truncation 8 mm and the diameter at the base 25 mm (see Appendix C Figure 7).

The samples shall be preconditioned for at least 4 hours at (40 ±2)°C and the indentor electrically heated to a temperature of (80 ±3)°C. Indentation shall be produced by forcing the truncated end into the system using a test machine that measures force and displacement simultaneously. The test shall be carried out at a temperature of (40 ±2)°C.

Indentations shall be made in the same 4 locations as the thickness measurements. Each indentation shall be made by driving the indentor into the system at a rate of 5 mm per minute. Indentation shall be stopped when the force applied reaches 500 N. The load shall be removed at the same rate. The samples shall then be conditioned for a minimum of 24 hours at (23 ±2)°C.

The overall thickness shall be measured at the same 4 locations using a template (see Appendix C Figure 6) with a dial gauge. Individual thickness measurements shall then be determined by subtracting the concrete block thickness from the overall thickness.

Indentation after the recovery period shall not exceed 50% of the initial thickness of the system.

The chloride ion test shall then be applied in accordance with clause 3.3.2.2.

3.3.2.8 Resistance to aggregate indentation test at 125°C

Systems ≥20 mm thick shall be exempted from this test.

This test is carried out to verify specific claims, made by the applicant that the waterproofing system is suitable for use with hot rolled asphalt directly i.e. without the need for sand asphalt.

Three size (A) concrete blocks (see Appendix B) with systems fully bonded (excluding any tack coat) shall be used for this test.

Before application of the system each concrete block shall be measured within the central 75 mm diameter test area at 4 separate locations using a template (see Appendix C Figure 6) with a dial gauge. The system shall then be fully bonded and the block re-measured at the same 4 locations using the template and the dial gauge.

The system thickness shall be calculated by subtracting the measured concrete block thickness from the total thickness and the mean thickness of the system shall be calculated from the 4 results. For sheet systems the thickness shall comply within ±10% of the declared nominal thickness.

Resistance to aggregate indentation test shall be carried out using a steel indentor in the shape of a truncated cone, with the cone angle at 90°, the diameter at the truncation 8 mm and the diameter at the base 25 mm (see Appendix C Figure 7).

The samples shall be preconditioned for at least 4 hours at (50 ±3)°C and the indentor electrically heated to a temperature of (125 ±3)°C. Indentation shall be produced by forcing the truncated end into the system using a test machine that measures force and displacement simultaneously. The test shall be carried out at a temperature of (50 ±3)°C.

Indentations shall be made in the same 4 locations as the thickness measurements. Each indentation shall be made by driving the indentor into the system at a rate of 5 mm per minute. Indentation shall be stopped when the force applied reaches 1000N. The load shall be removed at the same rate. The samples shall then be conditioned for a minimum of 24 hours at (23 ±2)°C.

The overall thickness shall be measured at the same 4 locations using a template (see Appendix C Figure 6) with a dial gauge. Individual thickness measurements shall then be determined by subtracting the concrete block thickness from the overall thickness.

Indentation after the recovery period shall not exceed 50% of the initial thickness of the system.

The chloride ion test shall then be applied in accordance with clause 3.3.2.2.

3.3.2.9 Thermal shock, heat ageing and crack cycling at -10°C, 23°C and 40°C

Nine size (C) concrete blocks (see Appendix B) with membranes fully bonded shall be used for this test i.e. 3 blocks for each test temperature. See Appendix C Figure 1 for extent of membrane application. For liquid applied membranes the concrete block shall be masked over length ways, 40 mm either side before applying the membrane.

First the samples shall be subjected to thermal shock and then heat ageing followed by crack cycling.

(i) Thermal shock

A wooden box with no base, having a wall thickness of 50 mm, a height of 55 mm and internal plan of (170 x 170) mm shall be placed on the membrane in the centre of the test block over the area where the crack cycling test is to be made. A thermocouple shall be placed on the surface of the membrane within the box. Aluminium foil (thin gauge) shall be used to line the box and the membrane.

Hot sand heated to a temperature of approximately 240°C shall be poured into the box and sealed in to give a temperature of (145 ±5)°C on the surface of the membrane, measured using the thermocouple. After two hours, the hot sand shall be removed and the sample conditioned at (23 ±2)°C for at least 4 hours.

(ii) Heat ageing

The samples shall be placed in a ventilated oven and heat aged at (70 ±3)°C for 28 days and then conditioned for 24 hours at (23 ±2)°C.

(iii) Crack cycling

Crack cycling shall be conducted at (-10 ±2)°C, (23 ±2)°C and (40 ±2)°C respectively after the recovery period of the heat ageing.

Initial cracking of the sample at the crack inducer (see Appendix C Figure 1) shall be made using a suitable crack cycling apparatus (see Appendix C Figure 8). Cracking shall be induced at (23 ±2)°C to a width of 1.0 mm. The sample shall then be cycled at a rate of 1 cycle per second to the maximum crack width at one of the test temperatures and subjected to a total of 100 cycles. On completion of cycling, the crack shall be maintained at maximum opening for 24 hours at the test temperature. There shall be no visually obvious cracks in the membrane proper at any stage during the test. The samples shall then be conditioned for a minimum of 24 hours at (23 ±2)°C.

The chloride ion test shall then be applied in accordance with clause 3.3.2.2. The complete test shall be repeated for each of the test temperatures.

3.3.2.10 Hot rolled asphalt surfacing to waterproofing system interface shear adhesion test at -10°C, 23°C, and 40°C

This test is carried out to verify specific claims, made by the applicant that the waterproofing system is suitable for use with hot rolled asphalt directly i.e. without the need for sand asphalt.

Nine size (A) concrete blocks (see Appendix B) with systems fully bonded, together with any tack coat specified for the system shall to be used for this test i.e. 3 blocks for each test temperature.

The test shall be carried out in temperature-controlled conditions at (-10 ±2)°C, (23 ±2)°C, and (40 ±2)°C respectively.

Samples shall be prepared with an overlay of hot rolled asphalt using a mixture as specified in BS 594: Part 1: 2003, the rolling temperature shall be within the range specified in BS 594: Part 2: 2003 but not exceeding the maximum values given in Clause 901.9 of the Specification (MCHW 1), and in particular;

(i) Where a minimum rolling temperature to achieve bond to the system is declared, this shall be applied,

Or (ii) where a tack coat forms part of the system the rolling temperature shall be the minimum temperature declared to activate the tack coat.

The hot rolled asphalt shall be prepared as and when required in compliance with BS 594: Part 1: 2003. Reheated material shall not be used.

Hot rolled asphalt shall comply with BS 594: Part 1: 2003, Table 2, Column 2/1, and be compacted to a nominal thickness of 50 mm. The binder shall be 40/60 grade bitumen complying with BS EN 12591: 2000. The coarse aggregate shall comply with BS 594: Part 1: 2003, Clause 4.2, Group (a) granite.

The test samples shall have been pre-conditioned at (-10 ±2)°C, (23 ±2)°C and (40 ±2)°C for at least 4 hours and then supported in a test frame (see Appendix C Figure 9). This complete apparatus shall be placed in a temperature controlled cabinet and maintained at one of the test temperatures.

A shearing force shall be applied to the hot rolled asphalt via a steel loading plate at the rate of 20 mm per minute; the load and deformation characteristics being continuously recorded. The test shall be continued until the sample fails. The assembly shall be removed, the failure interface and peak force noted and failure stress determined.

The stress at failure for each individual sample shall be not less than:

0.2 Nmm^{-2} at (-10 ±2)°C and (23 ±2)°C respectively, and 0.1 Nmm^{-2} at (40 ±2)°C.

3.3.2.11 Hot rolled asphalt surfacing to waterproofing system interface tensile bond test

This test is carried out to verify specific claims, made by the applicant that the waterproofing system is suitable for use with hot rolled asphalt directly i.e. without the need for sand asphalt.

Three size (B) concrete blocks (see Appendix B) shall be used with the system fully bonded together with any tack coat specified for the system.

Samples shall be prepared with an overlay of hot rolled asphalt using a mixture as specified in BS 594: Part 1: 2003, the rolling temperature shall be within the range specified in BS 594: Part 2: 2002 but not exceeding the maximum values given in Clause 901.9 of the Specification (MCHW 1), and in particular;

(i) Where a minimum rolling temperature to achieve bond to the system is declared, this shall be applied,

Or (ii) Where a tack coat forms part of the system the rolling temperature shall be the minimum temperature declared to activate the tack coat.

The hot rolled asphalt shall be prepared as and when required in compliance with BS 594: Part 1. Reheated material shall not be used.

Hot rolled asphalt shall comply with BS 594: Part 1: 2003, Table 2, Column 2/1, and be compacted to a nominal thickness of 50 mm. The binder throughout shall be 40/60 grade bitumen complying with BS EN 12591: 2000. The coarse aggregate shall comply with BS 594: Part 1: 2003, Clause 4.2, Group (a) granite.

On each sample two test areas (100 x 100) mm shall be isolated by cutting down to the concrete without disturbance to the complete system. Steel plates shall then be bonded to the test areas with a suitable adhesive (see Appendix C Figure 10).

The test shall be carried out at (23 ±2)°C on a tensile testing machine using a crosshead speed of 20 mm per minute. The test samples shall have been preconditioned at (23 ±2)°C for at least 4 hours.

Bond failure at the interface of the system and the hot rolled asphalt shall be not less than 0.1 Nmm^{-2} for each specimen.

3.3.2.12 Surface finish of concrete substrate

Three size (A) and three size (D) concrete blocks (see Appendix B) with the waterproofing membrane fully bonded shall be used for this test. The three size (A) blocks shall be with tamped surface finish.

Tensile adhesion test shall then be carried out at (23 ±2)°C in accordance with clause 3.3.2.1.

The stress at failure shall be a minimum value of 0.3 Nmm^{-2}.

3.3.2.13 Age of concrete substrate

Unless the applicant restricts the requirement for the application of the waterproofing system to the age of concrete substrates of a minimum of 28 days, this test shall be carried out.

Three size (A) concrete blocks (see Appendix B) with the waterproofing membrane fully bonded to the concrete blocks of between 7 to 9 days old shall be used for this test.

Preparation of the concrete test blocks shall be in accordance with method defined in Appendix B, except that after 6 days the blocks shall be kept in wet hessian and wrapped in polythene sheet, until ready to prepare the samples. Prior to any surface preparation and application of the waterproofing membrane, all other surfaces including the undersides of the concrete blocks shall be sealed. The top surface of the concrete blocks shall be prepared and the waterproofing membrane applied in accordance with the applicant's Method Statement.

Tensile adhesion test shall then be carried out within 5 days of the sample preparation at (23 ± 2)°C in accordance with clause 3.3.2.1.

The stress at failure shall be a minimum value of 0.3 Nmm^{-2}.

3.3.2.14 Overlapping time

Six size (A) concrete blocks (see Appendix B) with the waterproofing membrane fully bonded shall be used for this test.

The waterproofing membrane (including any tack coat) shall be fully bonded to two sets of concrete blocks. One set shall be covered with blocks of asphalt slabs and the other set left uncovered. Both sets shall be left out on the BBA exposure site for 6 months. Overlapping of a second layer of waterproofing (after removal of any tack coat) shall be made within 24 hours of removal of the asphalt slab or cleaning of the uncovered set.

During exposure of the samples, de-icing salt shall be applied to the surface every month.

Tensile adhesion test shall then be carried out at (23 ±2)°C in accordance with clause 3.3.2.1.

The stress at failure shall be a minimum value of 0.3 Nmm^{-2}.

3.3.3 Optional tests at the request of the applicant

3.3.3.1 Sand asphalt surfacing to waterproofing system interface shear adhesion test at -10°C, 23°C and 40°C

Nine size (A) concrete blocks (see Appendix B) with systems fully bonded, together with any tack coat specified for the system shall be used for this test i.e. 3 blocks for each test temperature.

The test shall be carried out in temperature-controlled conditions at (-10 ±2)°C, (23 ±2)°C, and (40 ±2)°C respectively.

Samples shall be prepared with an overlay of sand asphalt and hot rolled asphalt using mixtures as specified in BS 594: Part 1: 2003, the rolling temperature shall be within the range specified in BS 594: Part 2: 2003 but not exceeding the maximum values given in Clause 901.9 of the Specification (MCHW 1), and in particular;

(i) Where a minimum rolling temperature to achieve bond to the system is declared, this shall be applied,

Or (ii) Where a tack coat forms part of the system the rolling temperature shall be the minimum temperature declared to activate the tack coat.

The sand asphalt and hot rolled asphalt shall be prepared as and when required in compliance with BS 594: Part 1: 2003. Reheated material shall not be used.

Sand asphalt shall be compacted to a nominal thickness of 20 mm and the total overlay thickness made up with hot rolled asphalt laid and compacted to a finished total nominal thickness of 50 mm. Sand asphalt shall comply with BS 594: Part 1: 2003, recipe Type F surface course mixture Designation 0% 0/2 except that (5 ±0.5)% of the total mix shall be inorganic red oxide and regarded as part of the filler content. The make-up of the hot rolled asphalt shall comply with BS 594: Part 1: 2003, Table 2, Column 2/1.

The binder shall be 40/60 grade bitumen complying with BS EN 12591: 2000. The coarse aggregate shall comply with BS 594: Part 1: 2003, Clause 4.2, Group (a) granite and the sand fine aggregate with Clause 4.3.

The test samples shall have been pre-conditioned at (-10 ±2)°C, (23 ±2)°C and (40 ±2)°C for at least 4 hours and then supported in a test frame (see Appendix C Figure 9). This complete apparatus shall be placed in a temperature controlled cabinet and maintained at one of the test temperatures.

A shearing force shall be applied to the sand asphalt and hot rolled asphalt surfacing via a steel loading plate at the rate of 20 mm per minute; the load and deformation characteristics being continuously recorded. The test shall be continued until the sample fails. The assembly shall be removed, the failure interface and peak force noted and failure stress determined.

The stress at failure for each individual sample shall be not less than:

0.2 Nmm^{-2} at (-10 ±2)°C and (23 ±2)°C respectively, and 0.1 Nmm^{-2} at (40 ±2)°C.

3.3.3.2 Sand asphalt surfacing to waterproofing system interface tensile bond test

Three size (B) concrete blocks (see Appendix B) shall be used with the system fully bonded together with any tack coat specified for the system.

Samples shall be prepared with an overlay of sand asphalt using a mixture as specified in BS 594: Part 1: 2003, the rolling temperature shall be within the range specified in BS 594: Part 2: 2003 but not exceeding the maximum values given in Clause 901.9 of the Specification (MCHW 1), and in particular;

(i) Where a minimum rolling temperature to achieve bond to the system is declared, this shall be applied,

Or (ii) Where a tack coat forms part of the system the rolling temperature shall be the minimum temperature declared to activate the tack coat.

The sand asphalt shall be prepared as and when required in compliance with BS 594: Part 1: 2003. Reheated material shall not be used.

Sand asphalt shall be compacted to a nominal thickness of 20 mm, and comply with BS 594: Part 1: 2003, recipe Type F surface course mixture Designation 0% 0/2 except that (5 ±0.5)% of the total mix shall be inorganic red oxide and regarded as part of the filler content.

The binder shall be 40/60 grade bitumen complying with BS EN 12591: 2000. The sand fine aggregate shall comply with BS 594: Part 1: 2003, Clause 4.3.

On each sample two test areas (100 x 100) mm shall be isolated by cutting down to the concrete without disturbance to the complete system. Steel plates shall then be bonded to the test areas with a suitable adhesive (see Appendix C Figure 10).

The test shall be carried out at (23 ±2)°C on a tensile testing machine using a crosshead speed of 20 mm per minute. The test samples shall have been preconditioned at (23 ±2)°C for at least 4 hours.

Bond failure at the interface of the system and the sand asphalt shall be not less than 0.1Nmm^{-2} for each specimen.

3.3.3.3 Installation temperature test

This test is carried out to verify specific claims, made by the applicant that the waterproofing system can be applied when the surface temperature of the concrete substrate is outside the range 5°C to 35°C e.g. (0 +0/-2) °C or (-5 +0/-2)°C.

Claims that the waterproofing system can be applied outside the temperature range 5°C to 35°C shall be verified by carrying out the tensile adhesion test. The waterproofing system shall be fully bonded to the concrete blocks maintained at the claimed surface temperature.

Tensile adhesion test shall then be carried out at (23 ± 2)°C in accordance with clause 3.3.2.1.

The stress at failure shall be a minimum value of 0.3 Nmm^{-2}.

3.4 Stage 4: System installation trial

3.4.1 Part of the requirements for the award of a BBA HAPAS for a bridge deck waterproofing system shall be a successful system installation trial on an actual bridge deck. The applicant or his representative shall arrange for the system to be installed on a suitable bridge.

3.4.2 In arranging the site trial the applicant or his representative shall take into account the following procedures and requirements:

3.4.2.1 Where a bridge is being considered for the site trial the bridge owner or highway authority shall consider the importance of the bridge location (i.e. not on a strategic route), when giving agreement in principle to the installation of a waterproofing system undergoing a Certification site trial.

3.4.2.2 The BBA shall be sent a general arrangement drawing of the bridge showing the size and type of deck including a cross section showing details of the waterproofing system. A minimum deck area of 150 square metres is necessary and the bridge shall include some features such as parapet upstands, service bays, chases and fillets. Also required are details of:

(a) Bridge name, location and bridge owner/highway authority.

(b) Whether the bridge is of new construction or in the course of maintenance.

(c) Age of concrete deck between parapet upstands.

(d) Type of surface finish and/or texture depth measurement of concrete deck between parapet upstands.

(e) Surfacing type and thickness when not given on the drawing.

(f) Proposed dates of installation of the system and surfacing. When this is not known then the likely dates which can be confirmed as the programme progresses.

3.4.3 Where the BBA confirms that the bridge is acceptable for the system installation trial the applicant or his representative may pursue arrangements with the highway authority and the Contractor and shall advise them that the site trial will be formally assessed by the BBA.

3.4.4 The applicant shall arrange for the system installation trial, during daylight hours, to demonstrate the installation and quality control/assurance procedures.

3.4.5 The trial shall be witnessed and assessed by the BBA to cover the installation procedures defined in the applicant's Method Statement.

3.4.6 The Installation Method Statement shall be practicable and sufficiently detailed to cover all foreseen eventualities. It shall include the coverage rates of the liquid applied components of the system, methods of verification to be used on site, repair techniques, on-site quality control and integrity of the system.

3.4.7 The applicant shall provide evidence that the system submitted for this stage is within the declared manufacturing tolerances, e.g. certificate of conformity, including quality control data.

3.4.8 The site trial shall be performed in a workmanlike manner by trained operatives under competent supervision and shall afford the level of quality of workmanship required for the Certification.

3.4.9 The site trial shall include observation of the preparation of the concrete bridge deck, the installation of the waterproofing system and the surfacing. The performance of the system between its installation and prior to overlaying with the surfacing shall also be monitored.

3.4.10 On arrival at the trial site the BBA shall inspect the condition of the concrete bridge deck surface. The concrete deck surface between the parapet upstands shall be U4, formed or tamped finish. The deck surface shall be clean, dry, and free from ice, frost and laitance.

3.4.11 Before any part of the waterproofing system is installed the BBA shall verify that the system is as that submitted for the laboratory tests.

3.4.12 Minor discrepancies that arise with respect to either site conditions or changes to the waterproofing system shall be agreed with the BBA before the site trial can proceed.

3.4.13 On site the deck surface and air temperature shall be measured by the applicant or his representative using thermocouples or similar. This shall be checked frequently over the period of the site trial. The relative humidity shall also be noted at the same time.

3.4.14 The coverage rates and setting times of the liquid components of the system shall accord with the applicant's specification. Checks shall be made for ponding of primers and the degree of ponding shall be in accordance with the Method Statement.

3.4.15 During and after installation of the system the following requirements shall apply:

i) The temperature of the hot bitumen adhesives for sheet systems shall not be greater than 240°C measured using a suitable temperature probe by the applicant or his representative.

ii) The thickness of liquid membranes shall be a minimum of 2 mm over peaks, arrises and irregularities in the concrete deck and shall be checked with a wet film thickness gauge or other appropriate method by the applicant or his representative.

iii) There shall be appropriate bond to the concrete substrate checked by the applicant or his representative and it shall be virtually free from visible defects including pin/blow holes and blisters which shall be made good by repair before being covered.

iv) Sheet systems shall be laid to follow the contours of the deck surface and be free from ripples and rucks.

v) Laps in sheet systems shall be in accordance with the Method Statement.

vi) The applicant or his representative laying the waterproofing system at the site trial shall demonstrate to the BBA an acceptable repair method.

vii) The applicant or his representative shall demonstrate the integrity of the waterproofing membrane by an appropriate NDT method agreed with the BBA.

3.4.16 The waterproofing system shall be checked for damage before application of the sand asphalt or hot rolled asphalt surfacing. Where damage has occurred it shall be suitably repaired before the trial proceeds.

3.4.17 In order to dispense with the requirement of the sand asphalt for waterproofing systems which is less than 20 mm thick and which have complied with the 125°C aggregate indentation test in the laboratory, Sections 3.4.16 to 3.4.24 shall apply except that the sand asphalt shall be replaced with hot rolled asphalt.

3.4.18 The application temperature of the sand asphalt or hot rolled asphalt surfacing, measured with a suitable temperature probe by the manufacturer or their representative shall not exceed 145°C. The minimum rolling temperature of the sand asphalt or hot rolled asphalt surfacing shall not be less than that specified in BS 594: Part 2: 2003 or less than the minimum declared activation temperature for bond to the system, whichever is greater.

3.4.19 Prior to the completion of the sand asphalt or hot rolled asphalt surfacing application, a sample area of the compacted but still hot surfacing is removed from the system and any damage to the waterproofing membrane is observed.

3.4.20 If damage has occurred restrictions on any further application of the surfacing may be imposed and the damaged waterproofing membrane shall be repaired or replaced.

3.4.21 Where no damage has occurred the cut back areas shall be filled with new surfacing and compacted.

3.4.22 Throughout the site trial, workmanship, supervision and general site procedure shall be observed by the BBA. Where this is at an unacceptably low standard, Certification shall not be granted.

3.4.23 Where the system is deemed to have failed the site trial, the bridge owner/highway authority reserve the right to instruct the Contractor to have the failed system removed from the bridge deck and waterproofed with an approved system.

3.4.24 If during the site trial it is considered that the system is unlikely to proceed to a successful conclusion, then the applicant or his representative may be given an opportunity to abort the site trial and propose modifications to the system/procedures to be considered for a further trial. The applicant or his representative shall provide a written report to the BBA with proposed changes that would overcome identified deficiencies in the original submission. If the proposed modifications are acceptable to the BBA the applicant or his representative will be allowed to make arrangements for a further site trial.

3.5 Stage 5: Certification

3.5.1 Any Certificate issued shall be in the HAPAS Product Sheet format and shall verify the system's compliance with the requirements given in this document. The Certificate shall also define the system assessed and the conditions of use.

3.5.2 The assessment and any Certificate issued shall be subject to the Terms and Conditions of the relevant BBA Contract, which shall include the following:

a) Any Certificate issued shall have an unlimited validity provided that:

(i) The specification of the system is unchanged by the manufacturer unless proposed changes are assessed, and agreed, by the BBA prior to implementation.

(ii) The manufacturer continues to have the system checked by the BBA, which shall include ongoing surveillance of the production (see 3.5.3).

(iii) The validity is confirmed by a Review carried out every five years by the BBA.

The validity of a Certificate can be checked by referring to the BBA Web site or by contacting the BBA.

(iv) The requirements of the Guidelines Document remain unchanged.

b) In the event of the Certificate Holder going into liquidation the Certificate shall be suspended and may be withdrawn.

c) Reinstatement of a suspended or expired Certificate shall be the subject of a review by the BBA. Certificates which have been suspended or expired for longer than two years shall no longer be valid for reinstatement.

3.5.3 During the validity of any Certificate issued the BBA shall carry out up to two visits each year to each production location and/or the Certificate Holders offices (where appropriate), to ensure that the procedures and controls defined at the outset continue to apply.

4 ACCEPTANCE OF DATA SUPPLIED BY THE APPLICANT

4.1 The BBA shall accept test data from laboratories with UKAS accreditation for the specific tests referred to in Appendix B which are performed on samples approved by the BBA. The BBA would require the test laboratory to submit a copy of their UKAS testing schedule.

4.2 In the absence of a laboratory meeting the conditions of Section 4.1, the BBA may accept test data from other UKAS accredited testing laboratories, or laboratories approved by the BBA, that have demonstrated their competence and ability to perform the relevant tests to the satisfaction of the BBA Quality Manager.

4.3 Test data from overseas, external, independent testing laboratories that have the equivalent national accreditation for the specific tests, may be accepted if there is a reciprocal agreement between UKAS and the national accreditation authority of the country in question, and the test methods used have been demonstrated as being equivalent to the satisfaction of the BBA.

4.4 Other data supplied in support of the assessment (e.g. background information, test data relating to generic materials etc), where the above conditions are not met, shall only be accepted after having been individually assessed and approved as being suitable by the BBA.

APPENDIX A

Typical characterisation tests

1 Liquid applied systems

1.1	Infrared spectroscopy	
1.2	Viscosity	BS EN 12092 : 2001
1.3	Specific gravity	BS EN ISO 1675 : 1998
1.4	Pot life (hand grade materials)	
1.5	Drying times (hand grade materials)	
1.6	Setting times (hand grade materials)	
1.7	Application rates/minimum and maximum dry film thickness (hand grade materials)	
1.8	Weight per unit area (hand grade materials)	
1.9	Ash content	BS EN ISO 3451-1
1.10	Density of dry film	BS 2782 : Part 6 :Method 620A : 1991(1996)
1.11	Tensile strength of dry film	BS EN ISO 527-1 and 3: 1996
	1.11.1 unaged	
	1.11.2 heat aged at 70°C for 28 days	
1.12	Elongation at break of dry film	BS EN ISO 527-1 and 3:
	1.12.1 unaged	
	1.12.2 heat aged at 70°C for 28 days	

2 Prefabricated membrane – reinforced, polymer modified bitumen

2.1	Fines content (coating medium)	MOAT 30/31 : 6F : 1984
2.2	Ring and ball (coating medium)	BS EN 1427 : 2007 – BS 2000-58 : 2007
	2.2.1 unaged	
	2.2.2 heat aged at 70°C for 28 days	
2.5	Tensile strength	BS EN ISO 12311-1 : 2000
	2.5.1 unaged	
	2.5.2 heat aged at 70°C for 28 days (membrane only)	
2.6	Elongation at break	BS EN ISO 12311-1 : 2000
	2.5.1 unaged	
	2.5.2 heat aged at 70°C for 28 days (membrane only)	

3 Primer – used with prefabricated membrane

3.1	Viscosity	BS EN 12092 : 2001
3.2	Specific gravity	BS EN ISO 1675 : 1998
3.3	Drying times	

APPENDIX B

Preparation of concrete test blocks

Four sizes of concrete test blocks are required for the bonded membrane tests.

(A) (170 × 170 × 55) mm
(B) (300 × 300 × 55) mm
(C) (400 × 220 × 55) mm with crack inducer (see Appendix C Figure 1)
(D) (170 × 170 × 50) mm

The tolerance on concrete block dimensions shall be ±3mm.

The surface of the concrete test blocks shall be U4 finish, prepared in accordance with Clause 1708 of the specification of Highway Works (MCHW 1). In addition to the U4 finish, size (A) block shall also be prepared with a tamped surface finish. Test block (D) shall be prepared with a timber formed surface finish.

Concrete mix proportions:-

Portland Cement to BS 12 shall be used with mix proportions by weight 1: 2: 3.5 (cement: sand: aggregate) using 20 mm gravel aggregate for blocks (A) and (B), and 10 mm gravel aggregate for blocks (C) and (D) in accordance with BS 882 and having a water cement ratio of 0.5 maximum. In addition, block (A) with a tamped surface finish shall be produced using 10 mm gravel aggregate.

The surface to which the membrane is to be bonded shall have a U4, formed or tamped finish. Blocks with a tamped finish prepared as described below is considered representative of a deck surface having a surface texture depth, measured using the Sand Patch Test defined in BS 598-105: 2000, not exceeding 1.0 mm.

Timber formed surface finish shall be achieved by placing a timber form (shuttering plywood) 5 mm thick face up at the bottom of the mould.

The tamped surface finish shall be prepared as follows:

a) Steel floated to top of mould.

b) Tamped surface with trough to peak irregularities of about 4 mm, at intervals of approximately 15 mm produced using a hardwood tamping bar 25 mm square, 415 mm long, with triangular sections cut from the bar.

c) Gently re-vibrated to close surface of concrete.

All blocks shall be cured and thoroughly dry before use. A suitable curing regime is:

i) De-mould after 24 hours. For timber formed surface finish blocks, place with moulded form surface up after removing from mould.
ii) Store under wet hessian and polythene sheet at normal ambient room conditions for 6 days.
iii) Store uncovered at normal ambient room conditions for at least 21 days.

The following minimum number of concrete blocks are required to test one waterproofing system:

66 size (A) blocks (U4 finish)
9 size (B) blocks (U4 finish)
9 size (C) blocks with crack inducers (U4 finish)
3 size (D) blocks (tamped surface)
3 size (A) blocks with timber formed surface

APPENDIX C

Figures

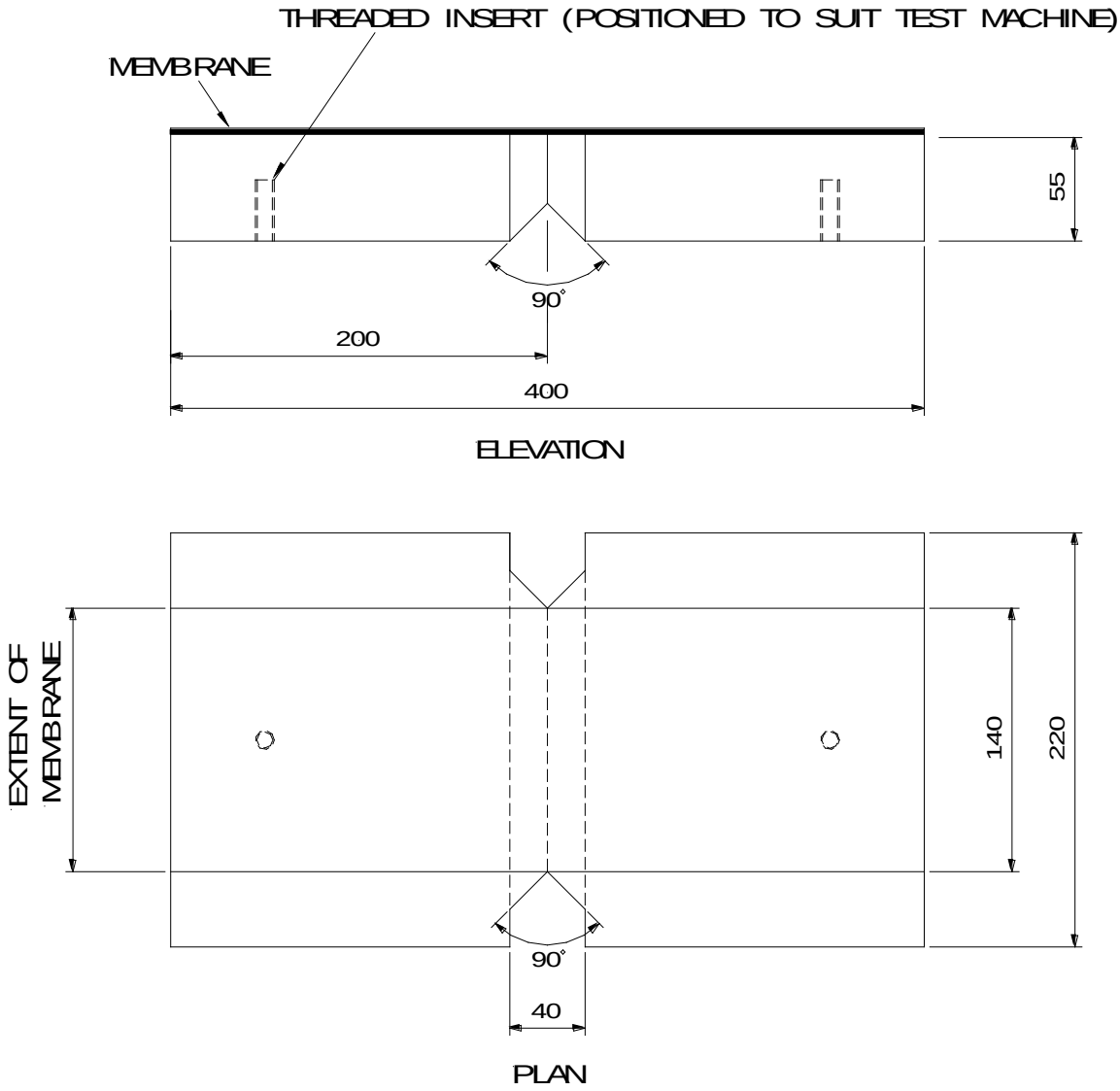

FIGURE 1 CONCRETE TEST BLOCK WITH CRACK INDUCER
ALL DIMENSIONS ARE IN mm

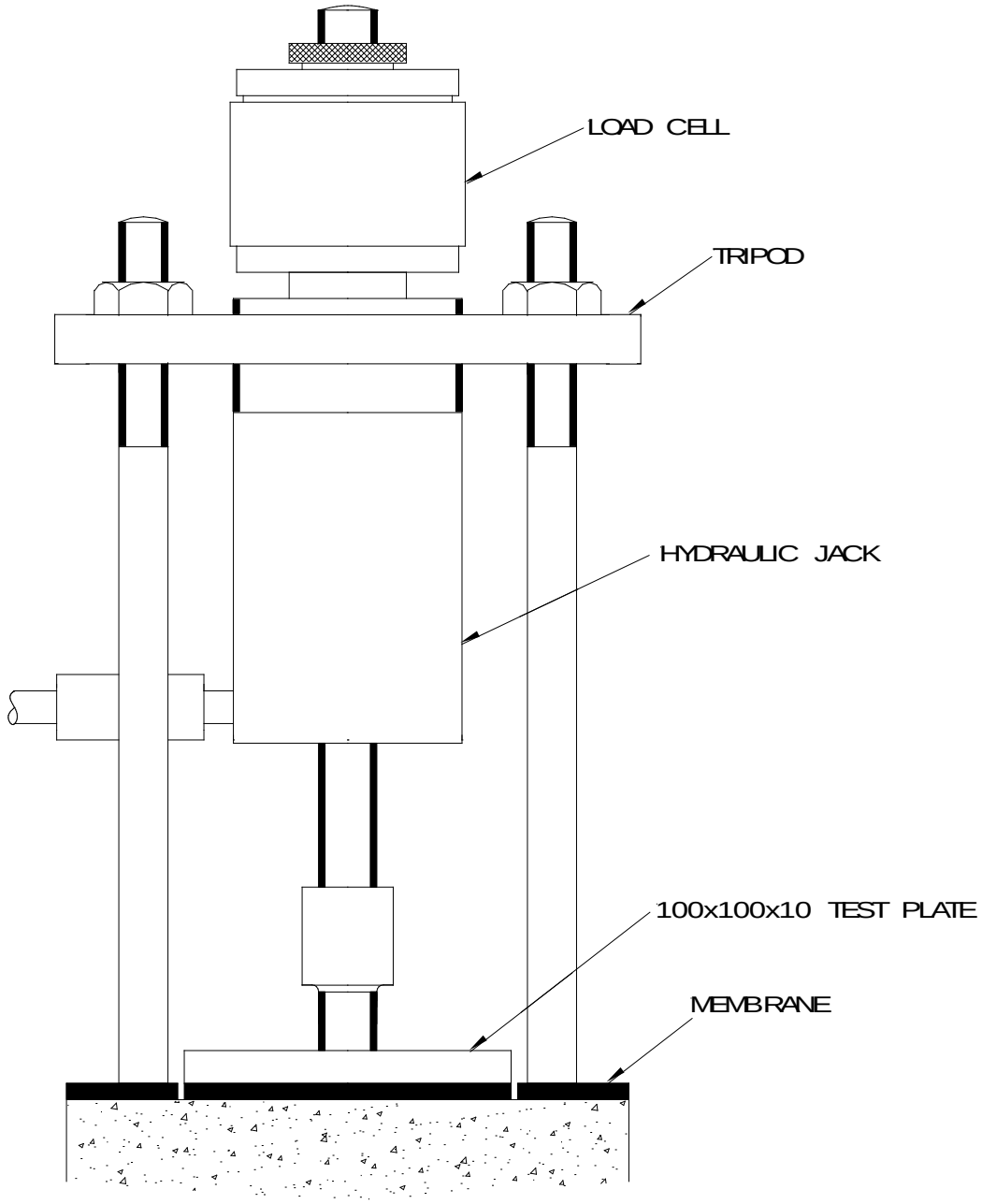

FIGURE 2 EXAMPLE OF A TENSILE PULL- OFF APPARATUS (ELEVATION)
ALL DIMENSIONS ARE IN mm

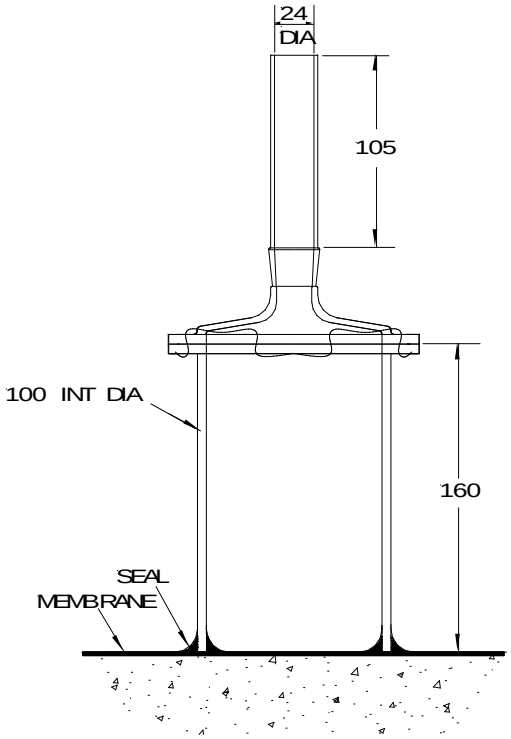

FIGURE 3 ELEVATION OF CHLORIDE ION PENETRATION TEST APPARATUS ALL DIMENSIONS ARE IN mm

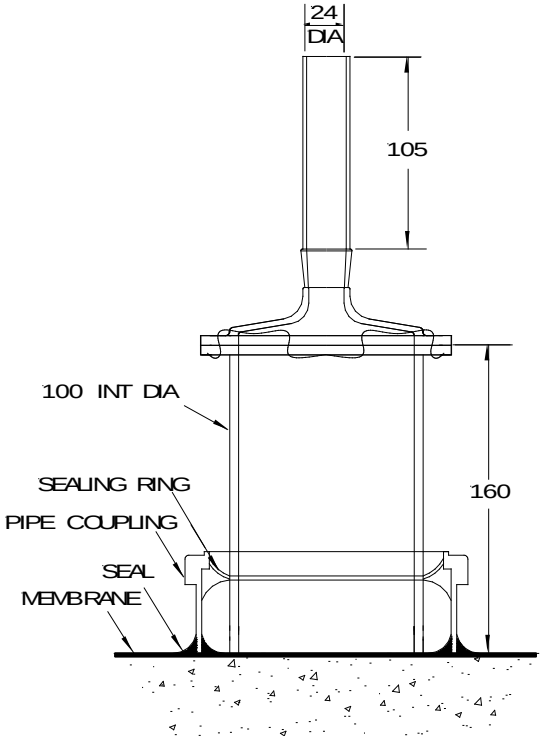

FIGURE 4 ELEVATION OF EXPOSURE TO WATER OR CHLORIDE IONS GLASSWARE ALL DIMENSIONS ARE IN mm

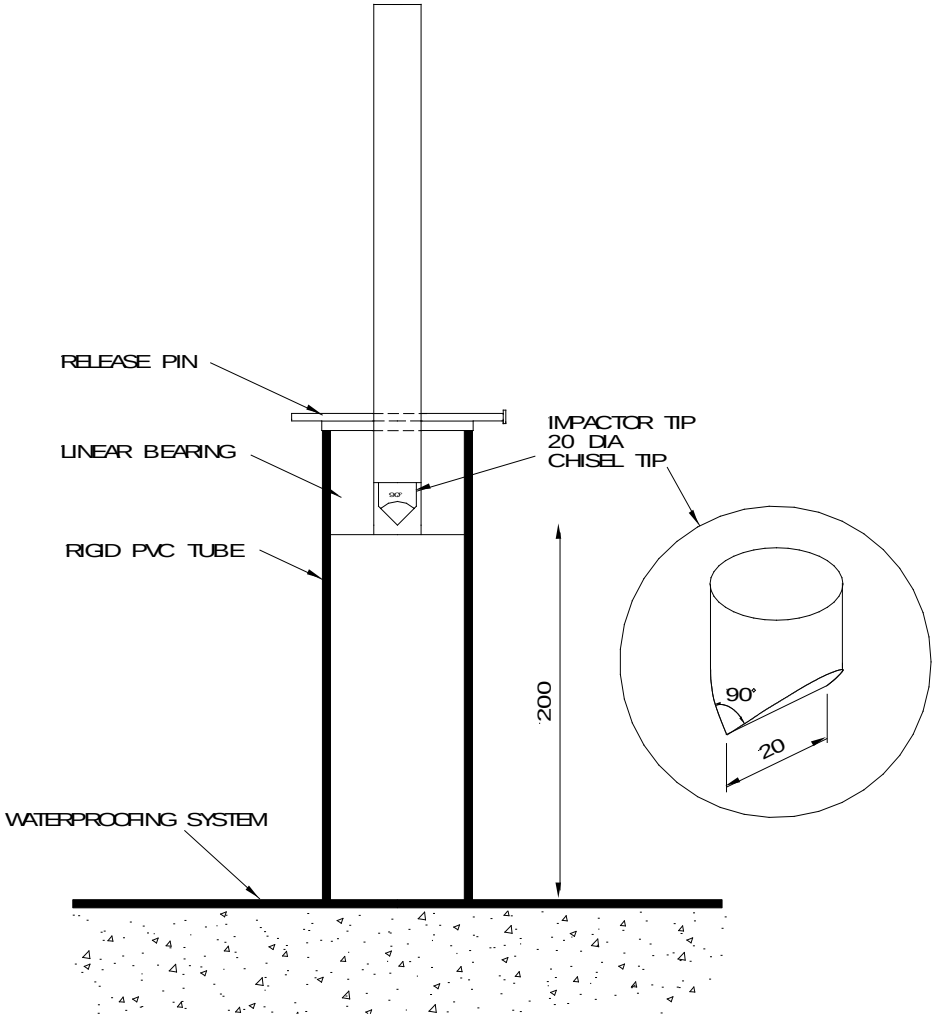

FIGURE 5 ELEVATION OF CHISEL IMPACT APPARATUS
ALL DIMENSIONS ARE IN mm

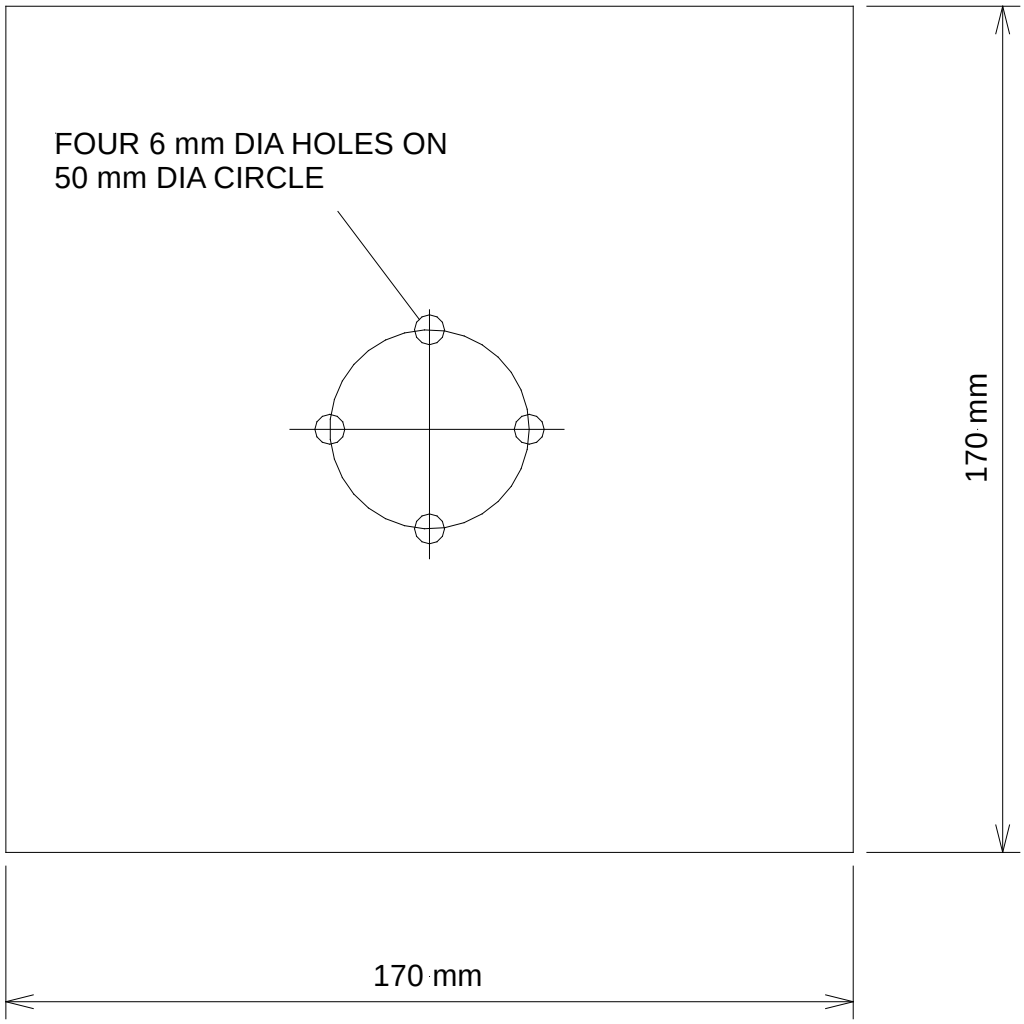

FIGURE 6 AGGREGATE INDENTATION TEST TEMPLATE

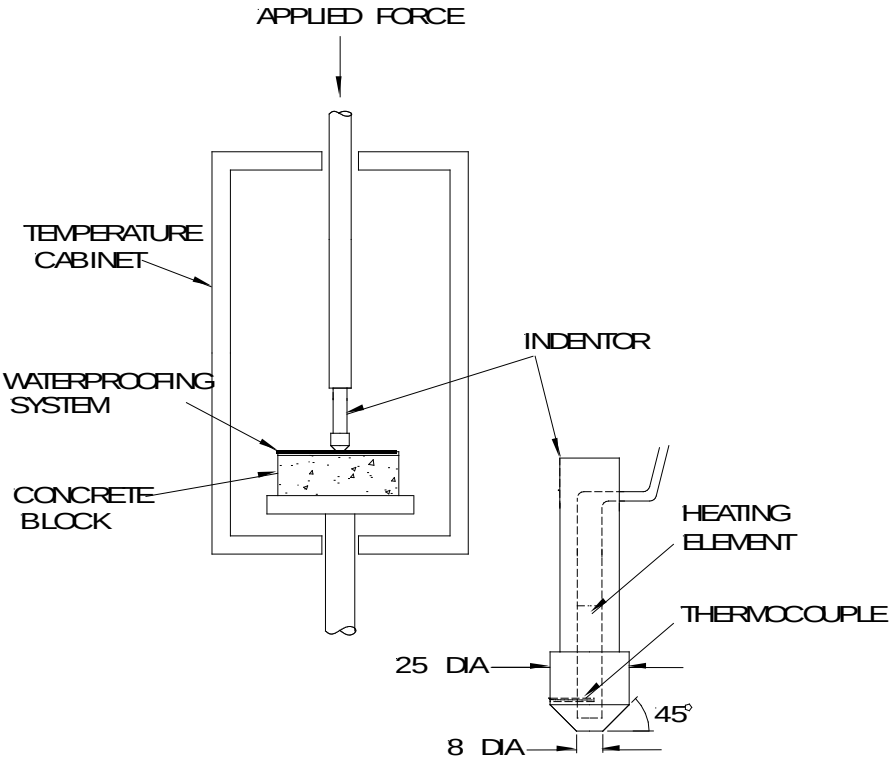

FIGURE 7 ELEVATION OF AGGREGATE INDENTATION APPARATUS
ALL DIMENSIONS ARE IN mm

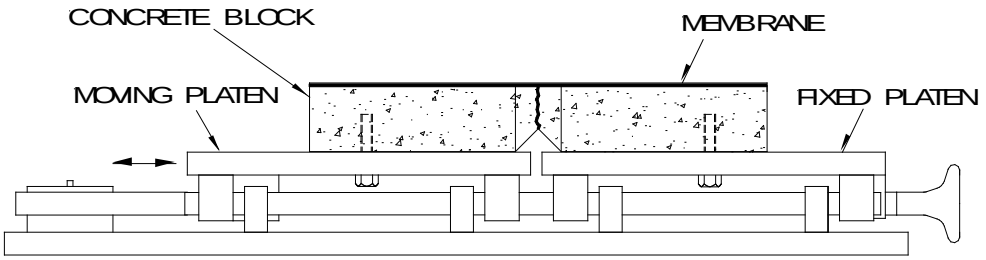

FIGURE 8 ELEVATION OF CRACK CYCLING APPARATUS

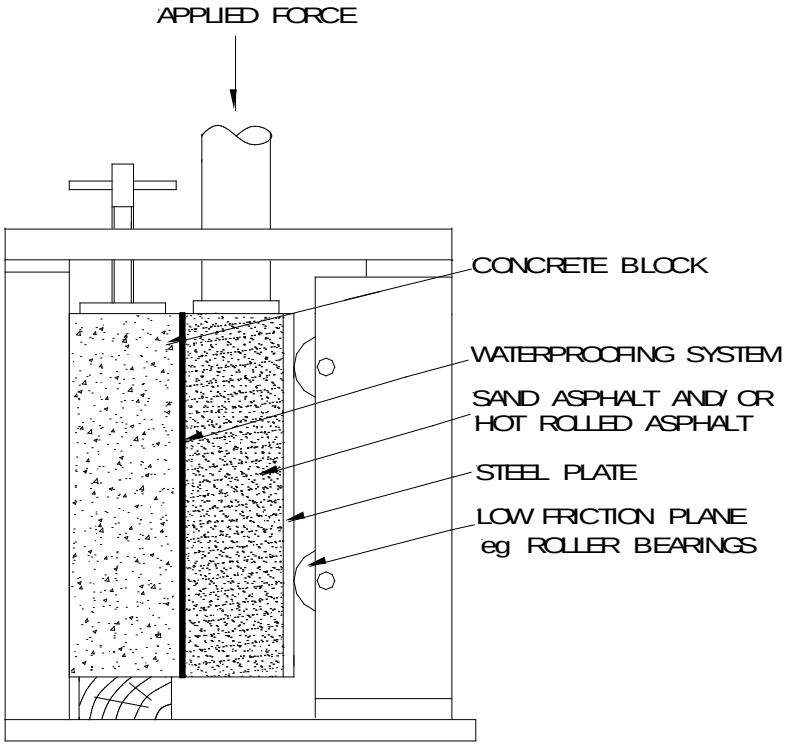

FIGURE 9 ELEVATION OF SHEAR ADHESION APPARATUS

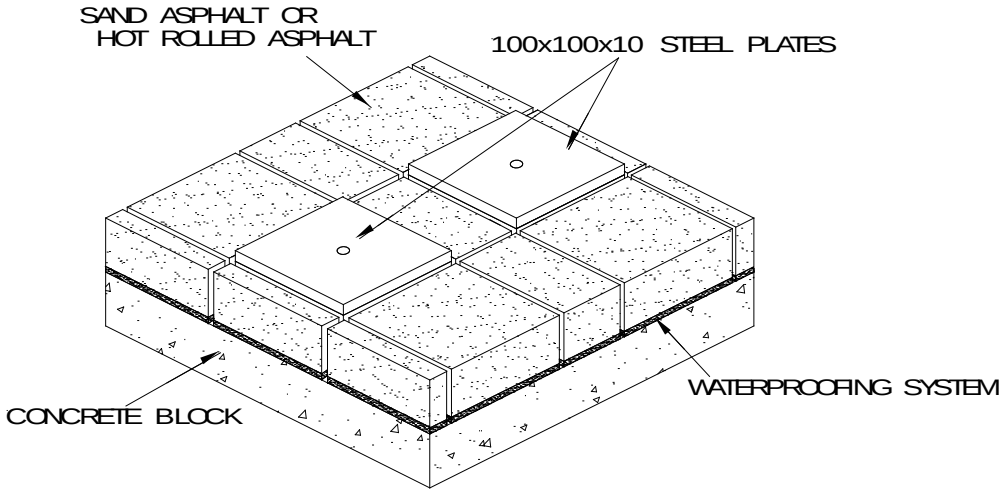

FIGURE 10 VIEW OF PREPARED SAMPLE FOR INTERFACE TENSILE BOND TEST
ALL DIMENSIONS ARE IN mm

APPENDIX D

Check List of Critical Parameters to be Considered by Manufacturers for Approval of Installers of Bridge Deck Waterproofing Systems

1 General

1.1 Installers shall be trained by Certificate holders/manufacturers for their own Certificated bridge deck waterproofing system.

1.2 Installers shall receive a certificate stating the individual's name and the name of the waterproofing system they have received approval to install.

1.3 The certificate should only be issued to indicate areas of training covered. These should be reviewed every three years.

1.4 Where registration to ISO 9000 Series is held by the company employing the installers, they should be working to these procedures.

1.5 Installers should be issued with identification cards, which should include the individual's name and a photograph.

2 Areas of Training

(All items are mandatory for Site Supervisors. Items marked * are minimum requirements for Installers)

2.1 Site Supervisors should have a basic knowledge of contractual matters.

2.2 *A waterproofing team shall be led by a Site Supervisor who is also an Installer. Installers should know why they are doing the job as well as how to do it.

2.3 The function served by the waterproofing should be well understood i.e. to present a continuous impermeable layer to protect the top surface of the deck from the detrimental effects of surface water or/water-borne de-icing salts.

2.4 *The waterproofing should stick to the concrete to provide bond for surfacing to resist braking etc, and to prevent the migration of water underneath in the event of a localised breakdown.

2.5 The waterproofing should be compatible with the surfacing materials and remain unaffected by their placement.

2.6 *The ability of waterproofing to be trafficked.

2.7 *The importance of details i.e. sealing at features such as expansion joints, manholes, gullies etc and overlap at joints.

2.8 *The use of materials in respect of handling, laying, temperature limitations for material, air and surface.

2.9 How the system works i.e. waterproofing layer and protective layer.

2.10 *Conditions of use i.e. surface texture, cleanliness, weather conditions, shelf life, overlaps and time lags.

2.11 Problems i.e. difficulty of securing continuity in repairs, cost of traffic management in the event of having to return and so important to get it right first time.

2.12 *Training to include application of bridge deck waterproofing system in all areas, i.e. horizontal, vertical, around corners, obstructions and laps.

2.13 *Knowledge of Client Specification – usually Highways Agency, including identification of the three types of finish, U4, tamped, formed and the treatment and preparation required for each surface type.

2.14 Knowledge of site methods for testing bond and presence of pin-holing.

2.15 Knowledge of remedial measures required to correct defects in the system.

2.16 Knowledge of remedial measures required when exposed surface finishes are different, especially in maintenance applications.

2.17 Compatibility with other materials i.e. deck/repairs, adjacent treatments and likely overlays.

2.18 Compatibility of bridge deck waterproofing system with other manufacturer's systems and joints, including detail of overlapping/butt joints and lapping to existing bridge deck waterproofing for maintenance work.

2.19 *Use of proper protective equipment and knowledge of health and safety aspects connected with particular materials used.

2.20 *The training must include a sufficient period of site experience with an experienced gang to ensure varying seasons and conditions.

2.21 This period of training to include feedback sessions to discuss experience gained.

2.22 Throughout all this period it is important to emphasise what should be done as well as what should not be done.

2.23 There should be adequate documentation of on-site quality controls.

APPENDIX E

Definitions and acronyms

ACE	Association of Consulting Engineers.
BBA	British Board of Agrément.
Laboratory approved by the BBA	A laboratory approved by the BBA to carry out specific test work. Before approval, the laboratory shall have demonstrated to the BBA that it has the relevant expertise, equipment and quality control systems in place to carry out the work required.
BD47	DETR Design Manual for Roads and Bridges Technical Memorandum on Waterproofing and Surfacing of Concrete Bridge Decks.
BWA	Bridgedeck Waterproofing Association.
Certificate of conformity	A Certificate providing evidence that a material has been tested and meets any required performance/specification requirements. A Certificate of Conformity shall be traceable to a specific batch or delivery of the material and will normally be required to show the results of agreed performance / specification tests.
C.O.S.H.H.	Control of Substances Hazardous to Health.
ADEPT	Association of Directors of Environment, Economy, Planning and Development.
HA	Highways Agency (acting on behalf of the overseeing organisations of the Department for Transport; the Scottish Executive Development Department; the Welsh Assembly; the Department for Regional Development, Northern Ireland.
HAPAS	Highway Authorities Product Approval Scheme.
HiTAC	Highways Technical Advisory Committee. A committee, appointed by the Council of the BBA, consisting of representatives of parties responsible for overseeing and controlling the HAPAS scheme and the work of the BBA in this area.
Installer	Applicator of the Bridge Deck Waterproofing System, trained and approved by the Certificate holder to a minimum agreed procedure with the BBA.
MCHW	Manual of Contract Documents for Highway Works.
Site supervisor	Person in charge of waterproofing team trained and approved by the Certificate holder to an accepted standard procedure agreed with the BBA.
Specialist group	A Specialist Group formed under the auspices of HiTAC. The objectives of the Group are to develop guidelines and offer specialist advice for the assessment and Certification of products for highways.
UKAS	The United Kingdom Accreditation Service.

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