

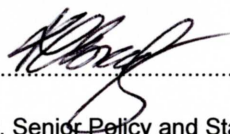
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Guidance Note

Waterproofing Underline Bridge decks

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3	Dec 2007	Substantial revision, with changes to the format, order of text and reference number; revisions to take account of changes to NR/L3/CIV/041; and updating of references.
2	Aug 2001	Minor revisions
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1	April 1998	New document, replaced BR Handbook 42 (1984)

Reference documentation

NR/L3/CIV/041	<i>Waterproofing Systems for Underline Bridge decks</i>
NR/L3/CIV/140	<i>Model Clauses for Civil Engineering works</i>
BS EN ISO 12236	<i>Geosynthetics. Static puncture test (CBR test)</i>

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Comments

The applicability and content of this standard will be reviewed on a regular basis. Written comments on the accuracy and utility will be taken into account when assessing the need for a new issue of the standard; such comments should be sent to the Principal Policy and Standards Engineer (Civil Engineering) at 40 Melton Street, London NW1 2EE.

Reference Note

This Guidance Note supplements [NR/L3/CIV/041](#): *Waterproofing Systems for Underline Bridge decks*: references to parts of that document are given as **1.1** (for example) whilst references to other parts of this Guidance Note are given as **1.1** (for example). All the mandatory requirements given in the text of this Guidance Note are re-iterated from [NR/L3/CIV/041](#): this Guidance Note does not introduce any further requirements.

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

Contents

1	Purpose	5
2	Scope	5
3	Definitions and abbreviations	5
4	Background	7
5	Waterproofing Systems	7
5.1	Types	7
5.2	Components	8
6	Selection of a Waterproofing System	9
6.1	General considerations	9
6.2	Limits and rates of application	10
6.3	New decks	11
6.4	Existing decks	11
6.5	Tightly Bonded Systems	12
6.6	Loose-Laid Systems	13
7	Detailing	14
7.1	Bridge decks	14
7.2	Ends of a deck	14
7.3	Drainage	15
8	Application	15
8.1	General	15
8.2	Waterproofing operatives	16
8.3	Health and Safety	17
8.4	Surface preparation of a deck	17
8.5	Primer application	19
8.6	Membrane application	19
8.7	Membrane inspection	21
8.8	Membrane repair	21
8.9	Membrane protection	22
8.10	Jointing techniques	23
9	Repairs to an existing Waterproofing System	24
10	Performance criteria	24
10.1	Handling of sheet membranes and protective layers	24

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

10.2	Bond strength at joints	25
10.3	Effect of moisture on pinholing	25
10.4	Effect of moisture and temperature on curing time	25
10.5	Water absorption	25
10.6	Resistance to water penetration	25
10.7	Mechanical properties	26
10.8	Resistance to impact	26
10.9	Resistance to indentation by ballast	26
10.10	Tensile adhesion of Tightly Bonded Systems	27
10.11	Crack cycling of Tightly Bonded Systems	27
10.12	Mechanical properties and resistance to water penetration after preconditioning	27
10.13	Effect of ozone	27
Appendix A: Possible configurations of protective layers		28
Appendix B: Adhesion tests on Tightly Bonded Systems		30
Appendix C: Typical waterproofing details		31

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Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

1 Purpose

The purpose of this Guidance Note is to supplement [NR/L3/CIV/041](#): *Waterproofing Systems for Underline Bridge decks* by providing information on;

- the types of Waterproofing System, and their components,
- the selection of a Waterproofing System for a particular bridge deck,
- the detailing of a Waterproofing System,
- the application of a Waterproofing System,
- the performance criteria for Waterproofing Systems.

The information provided herein will be of use to those specifying Waterproofing Systems via the 110-114 Sections of the Model Clauses as given in [NR/L3/CIV/140](#): *Model Clauses for Civil Engineering works*.

2 Scope

The guidance given in this document is applicable to the waterproofing of ballasted Underline Bridge decks.

It is not applicable to;

- other parts of Underline Bridges, such as below ground surfaces and abutments,
- Underline Bridges constructed by a tunnelling technique where the external faces are inaccessible for the application of waterproofing,
- overline bridges,
- the repair of an existing Waterproofing System (but see [9](#)).

3 Definitions and abbreviations

Application Guidelines

Manufacturer's document(s) that define for a particular Waterproofing System;

- the application process, including any limiting environmental conditions,
- the requirements for preparing the substrate.

Certificate of Conformity

A document, issued by the PITH, that lists the tests carried out for the assessment of the Waterproofing System, the results of such tests, and instruction and guidance on the installation of the System.

Fuel and Lubricating Oils

Diesel, and hydraulic oils used for lubrication.

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

Integral Protective Layer (IPL)

A layer (formed from sheets or boards) that is an essential part of a Waterproofing System, and which is laid over the top of the membrane to protect it from damage immediately following its installation and from ballast penetration in service.

Loose-Laid System

A Waterproofing System comprising a preformed impermeable sheet or liquid-applied membrane applied to a synthetic textile which is not bonded or only partially bonded to the substrate; that is one that does not satisfy the requirements for the minimum tensile adhesion as defined in [NR/L3/CIV/041](#): *Waterproofing Systems for Underline Bridge decks*.

Manufacturer

The term Manufacturer is used as shorthand to cover the manufacturer of the waterproofing membrane, the manufacturer's representative, and the promoter/installer/contractor for a particular system. The Manufacturer is the organisation responsible for submission of the System for registration and for initiating the five-year review.

Minimum Thickness

The minimum dry film thickness of the membrane of a liquid-applied Waterproofing System declared by the Manufacture as that required for the System to perform satisfactorily.

Nominal Thickness

The mean thickness of the membrane of a liquid-applied Waterproofing System.

Non Integral Protective Layer (NIPL)

A layer that is not an essential part of a Waterproofing System but which can be;

- placed over the membrane to protect it from damage immediately following its installation and/or from ballast penetration in service (for example, for a System that does not have an IPL),
- laid over an IPL (to provide additional protection) when the depth of the ballast is less than 300mm or, if lower, the thickness of the layer of ballast used in the resistance to indentation by ballast test,
- placed beneath the membrane of a Loose-Laid System to protect it from puncture and/or damage due to the presence of contaminants or bitumen on the substrate.

Parts And Drawing System (PADS)

A database of approved products that is maintained and controlled by SERCO Railtest.

PADS Form

A document issued by the PITH that lists the essential details of a Waterproofing System (such as limitations on its applicability).

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

Tightly Bonded System

A Waterproofing System consisting of either (a) a liquid-applied membrane or (b) a preformed sheet membrane that is bonded to the substrate with an adhesive, and which in either case satisfies the requirement for the minimum tensile adhesion as defined in [NR/L3/CIV/041](#): *Waterproofing Systems for Underline Bridge decks*.

Underline Bridge

A structure of one or more spans of greater than or equal to 1.8 metres whose main purpose is to carry rail traffic over an obstruction or gap.

Waterproofing System

A material or combination of materials, including a membrane (and where applicable a primer, adhesive, and an Integral Protective Layer), that is laid to form an impervious barrier to protect a bridge deck from the damaging effects of water.

4 Background

The service life of a bridge can be significantly extended by the application of an effective Waterproofing System: it will not be extended by the application of an ineffective System.

The effectiveness of a Waterproofing System is dependent upon;

- its design and detailing (see 7 and 7),
- the quality of the application (see 8 and 8) and, in particular, the skill and care taken during the preparation of the substrate (see 8.3 and 8.4),
- site activities following its application.

A shortcoming in any of the above can substantially reduce the effectiveness of a Waterproofing System.

Products approved for use on Network Rail's infrastructure are registered in PADS (see Appendix C). The Certificate of Conformity and PADS Form specify the components of a Waterproofing System that have been tested and shown to meet the performance requirements of [NR/L3/CIV/041](#): *Waterproofing Systems for Underline Bridge decks*.

A System applied in accordance with its Application Guidelines should give satisfactory performance. Any deviation from these Guidelines may substantially reduce the effectiveness of a System.

5 Waterproofing Systems

5.1 Types

Waterproofing Systems are defined by type as either Tightly Bonded, or Loose-Laid, and are classified as being 'resistant' or 'not resistant' to Fuel and Lubricating Oils.

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

Tightly-Bonded Systems adhere to the substrate and, therefore, prevent the spread of water under the membrane from edges, imperfections or small punctures. A Tightly Bonded System is normally applied as a liquid but it may be formed from a preformed sheet membrane, which may be either self-adhesive or bonded onto the substrate by an adhesive.

Loose-Laid Systems are not intimately bonded to the substrate and, therefore, cannot prevent the spread of water under the membrane from poorly sealed edges, imperfections, small punctures or defective joints. This type of System includes those that incorporate a self-adhesive sheet membrane which is only tack bonded to the substrate to provide resistance against wind uplift.

Dependent on type, a System may comprise;

- a primer for the substrate (for some Tightly Bonded Systems),
- an adhesive to bond the membrane to the substrate (for some Tightly Bonded Systems),
- a waterproofing membrane,
- an Integral Protective Layer (IPL).

5.2 Components

5.2.1 Primers

Where a Tightly Bonded System is applied to a steel, concrete or composite steel/concrete deck, a primer is required to both seal and provide adequate adhesion between the membrane and the substrate: the primer should be tested as part of the Waterproofing System for the particular substrate.

Primers do not form part of a Loose-Laid System.

5.2.2 Adhesives

Adhesives are used to provide an intimate bond between the sheet membrane of a Tightly Bonded System and the substrate.

For Loose-Laid Systems, contact adhesives (or similar materials) may be used to tack bond a sheet membrane to the deck, and also at vertical surfaces such as perimeter skirtings and the ends of bridge decks.

5.2.3 Protective Layers

An IPL is placed directly over the waterproofing membrane. Where a System does not have an IPL, a Non-Integral Protective Layer (NIPL) is required to be placed directly over the membrane.

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

Where the ballast depth is less than the thickness of the layer of ballast used in the resistance to indentation by ballast test (as specified in the Application Guidelines), and an IPL is specified as part of the Waterproofing System, a NIPL shall be placed over the IPL that directly overlays the waterproofing membrane. A NIPL may be formed from, for example;

- textile sheet¹,
- 6 mm thick fibre reinforced cement boarding,
- 12 mm thick bitumen boarding
- concrete paving slabs.

Bitumen-bound or bitumen-bonded Protective Layers should not be used with membranes that are not resistant to bitumen.

Boards and slabs should not be placed below ballast where the contours of the substrate prevent them making full contact with the membrane.

In addition to the placement of one or two Protective Layers over the membrane, another NIPL may be required to be installed below the membrane of a Loose-Laid System (see 6.6.3). Possible configurations for Protective Layers are shown in Appendix A.

The type and details of any NIPL need to be agreed with Network Rail's Senior Project Engineer for the project at hand.

6 Selection of a Waterproofing System

6.1 General considerations

Factors that should be considered when selecting a Waterproofing System for a particular application are:

- 1 The time available for the application.
- 2 The location of the work site, and access for the plant, materials and labour.
- 3 The risk of exposure in service to a significant quantity of Fuel and Lubricating Oils: locations where this risk arises include stations, depot approaches and other locations where diesel engines are likely to idle, and heavily canted sharp curves. Systems that are resistant to such Oils should be used in these locations.
- 4 Potential damage to the waterproofing membrane by its exposure to ultra-violet light and, where necessary, the means of protecting the edges of a membrane from this form of degradation.

¹ A sheet having a 4000N static puncture resistance (to BS EN ISO 12236: *Geosynthetics. Static puncture test (CBR test)*) is required [8.7].

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

- 5 Where a deck has construction and expansion joints;
 - the ability of the System to seal and/or span the joints and meet the design movement values,
 - the availability and use of proprietary expansion joints.
- 6 The ease of sealing the waterproofing membrane at its edges.
- 7 The complexity of the deck end detailing.
- 8 The condition of the substrate; such as its strength, porosity and surface finish, and the presence of any protective coatings. The tensile adhesion of a Tightly Bonded System to concrete that is less than seven days old may be less than the minimum value specified in Appendix B and B.
- 9 The geometry of the deck; for example, steelwork decks with awkward details such as stiffeners and bolted connections.
- 10 The requirements for working safely, such as defined in Health and Safety legislation.

6.2 Limits and rates of application

Where there are no limits on application, the use of a Tightly Bonded System is much to be preferred to a Loose-Laid System; this is because, with the former, leakages through defects are much more likely to be small and, hence, affect only a small area of a deck and so have little detrimental effect on the service life of the bridge. However, because of the usual severe constraints on the time available for installation, it is likely that a Loose-Laid System will be adopted when refurbishing an existing bridge deck.

Whatever type of System is used, sufficient time has to be available to apply it in accordance with the Application Guidelines. The benefits of waterproofing will be lessened considerably, if not lost altogether, where sufficient time is not available to ensure that the waterproofing is continuous across the deck and is sealed at joints, edges and construction details.

The time available for installing a Waterproofing System will depend on;

- the type, condition, geometry and size of the deck,
- the method of constructing or repairing a bridge deck,
- the extent of preparation required,
- the extent of the System that can be pre-applied or pre-formed off site,
- the speed of application on site,
- the tolerance of the System to the environmental conditions prevailing during its application (such as humidity, temperature and wind speed),

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

- the curing times of primers, adhesives and liquid-applied membranes,
- the time required to inspect the System,
- the time required to repair any defects,
- whether or not the membrane is to be protected by one or more Protective Layers,
- the time before ballasting and trafficking is permitted.

6.3 New decks

Whilst it is desirable to install a joint-less membrane, the time required for site works can be much reduced by applying the Waterproofing System to the deck (or part of it) at the fabricator's factory. However the time required to form joints on site should not be overlooked.

Although better control can be exercised on the application of a Waterproofing System off-site than on site, the following need to be considered;

- the potential for damage during transportation/installation, particularly at the edges where no Protective Layer has been placed,
- the means of sealing joints to achieve continuity between the off-site and on-site parts.

6.4 Existing decks

In selecting a Waterproofing System for an existing deck, consideration should be given to;

- the type and condition of the substrate,
- compatibility with any existing waterproofing, if this is to remain in place,
- the time available for application,
- the likelihood of damp weather or extreme temperatures occurring during the site works,
- limitations on application as defined in the Application Guidelines.

Where necessary, trial holes should be dug in the ballast to examine the condition of the substrate before the System is selected. Where this cannot be undertaken and there are doubts concerning the condition of the substrate a Loose-Laid System should be selected.

Reference	NR/GN/CIV/001
Issue	3
Publication date	26th August 2008
Compliance date	N/A

6.5 Tightly Bonded Systems

6.5.1 Application rate and detailing

The use of a sprayed membrane can accommodate changes in the surface profile of the substrate, and so spraying can achieve both a high rate of application and consistency in the thickness of the membrane. Membrane material may also be applied by hand to small areas, but the rate of application will be slower and the consistency of thickness less regulated than if it was sprayed.

Liquid-applied Systems may be applied in one or two coats. Each coat of a two-coat system should be colour contrasted. It may be beneficial to apply two coats when there is a risk of out-gassing (see [8.4.1](#) and [10.3](#)).

Because of difficulties in their installation, preformed sheets should not be used on decks that have complex surface profiles or details.

6.5.2 Effect of weather conditions

A Tightly Bonded System can be applied equally effectively on site, when the weather conditions are favourable, than in the factory. However, on site, full protection from the weather can only be provided by tenting or covering the work area to keep it free from rain and/or heated to attain the minimum temperature for the application of the waterproofing.

Unless otherwise specified in the Application Guidelines, application shall not normally proceed until the surface temperature is greater than 4 °C and rising, the surface temperature is 3 °C above the dew point, and the relative humidity is less than 90 % (see [8.4](#)). Beyond these limits, water may condense on the surface and affect the bond between the membrane and substrate.

Primers which dry by solvent evaporation (air drying) can be temperature sensitive, with curing times varying between 1 and 24 hours. In general, primers that cure by chemical reaction are not much affected by extreme temperatures.

The curing time of a liquid-applied membrane is also dependent on the ambient temperature. The curing times of the primer and membrane in the Application Guidelines should be used for planning purposes.

The effects of wind need to be considered when primers and membranes are applied by spraying, particularly when there is a risk of the spray being blown into watercourses or onto neighbouring properties.