

**TECHNICAL USER MANUAL
for
CONCRETE UNDERBRIDGES**

Standard Detail and Design Drawings

Summary

This technical user manual is applicable to concrete underbridges. It provides guidance on the selection and application of Network Rail's suite of standard drawings. The standard designs and details within these drawings will generally be used for new-build structures, and part replacement e.g. deck replacement.

Issue record

This technical user manual will be updated when necessary by distribution of a complete replacement. A vertical black line in the margin will mark amended or additional parts of revised pages.

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GLOSSARY

Bearing	The elements between the cill/impost and the main girders on which the deck is supported.
Bridge	A deck and its supporting structure (e.g. cill/ impost, abutment or piers).
Cill	Alternative name for impost. The (usually) concrete beam on which the lower part of the bridge bearings are located.
Deck	A pair of main girders and a floor.
Designer	The person responsible for selecting the relevant standard designs and details to suit the specific requirements for a particular scheme.
Dowel Restraint	A device to transmit load effects between deck, cill and abutment support
Filler Beam	A steel and concrete arrangement comprising longitudinal spanning steel sections encased within and acting compositely with a concrete slab.
Impost	Alternative name for cill. The (usually) concrete beam on which the lower part of the bridge bearings are located.
Protective Treatment	A treatment applied to structural elements to protect them from environment.
Scheme	Any planned work that involves the replacement of an existing bridge or deck.
TUM	Technical User Manual
SBB	Solid Box Beam
SDD	Standard Designs and Details
Walkway	A standard detail comprising brackets attached to web stiffeners and longitudinal spanning members positioned to allow railway personnel traverse the bridge away from the track.
Waterproofing	Measures applied to handle and remove water off the deck and away from structural elements.

1 INTRODUCTION TO STANDARD DESIGNS AND DETAILS

The development of the Standard Designs and Details (SDD) has been taken by Network Rail to improve safety, asset reliability and increase efficiency. Their development is linked to Network Rail's overall business objectives, to improve reliability of the railways and reduce the funding requirements for the on-going management and maintenance. The basis of the SDD focuses on two main areas that derive from these issues:

- Ensuring that the design meets Network Rail's requirements
- The design is as successful as the designs of previous railway engineers, who built and maintained bridges that have given good service for approaching 150 years.

1.1 Network Rail's Requirements

Network Rail's requirements are split between two areas, delivery and function:

1.1.1 Delivery Requirements

The SDDs have been taken to a stage where Form As and Bs for each aspect covered (underbridge design, ancillaries etc.) have been submitted and approved. This leads to the following benefits:

- A reduction in the design development timescales and costs.
- Minimising contractor and sub-contractor costs associated with uncertainties in detailing requirements.
- Streamlining the technical approval process for commonly used designs and details.

1.1.2 Functional Requirements

The SDD have been designed to ensure satisfactory performance of the asset under both normal operations and abnormal operations (both planned and unplanned). A further consideration has been Network Rail's requirement to reduce the volume of maintenance and management costs through the adoption of good practice. This leads to a number key design drivers including:

- Failure modes: Critical failure modes should give warning, and alternative load paths should be provided for potential local failures.
- No hidden details: All main structural elements should be visible from at least one side.
- Robustness: It is desirable for elements of the structure to have a degree of robustness so that they are not damaged by unforeseen events disproportionate to the cause.
- Capability to support load.

- Acceptable deformations.
- Structure gauge requirements: The underbridges have been designed to cater for a range of positions of the structure gauge allowing their wide use.
- Safe working environment: The bridges have been designed to minimise the risk to people on or about the bridge.
- Resistance to “bridge bash”: The bridges have been designed to minimise the risk of catastrophic failure in the event of a “bridge bash”.
- Resistance to derailment: The bridges have been designed to cater for the codified derailment loads, as well as protecting the structure whilst mitigating damage to the surrounding structures.

These functional requirements are requirements of draft Network Rail standard NR/L2/CIV/020. Draft 012 of this standard has been used and the requirements therein met in designing the concrete underbridge details.

A library of standard designs and details for a range of half through and concrete deck type underbridges forms meeting these requirements has been produced. This document contains guidance on the use of these standard drawings, including advice on the following:

- The elements and options contained within the suite of standard designs and details.
- Instruction on configuring a design using the standard designs and details
- Specific design restrictions and design assumptions
- Installation guidance
- Safety/CDM/environmental issues

The library will be maintained and distributed by Network Rail to its stakeholders and key external suppliers for adoption across the network at a national level.

2 GUIDANCE FOR USE OF NETWORK RAIL STANDARD DESIGNS AND DETAILS

The underlying philosophy of this standard is that a design details are provided, together with general details of the other components (i.e. cill beams, bearings, walkways, protective treatment, waterproofing etc.) which go to make up a standard concrete underbridges.

This allows the designer to produce a specific bridge design to suit the particular span, skew, track geometry, cable ducting and walking route requirements of any particular location, so long as they are within the limits of validity of the standard.

The flowchart in figure 2.1 demonstrates the use of the technical user manual and standard drawings. The designer should analyse the constraints and requirements that exist for the specific project site. This information should be used in conjunction with the design advice contained within the technical user manual, to decide which elements can be taken from the suite of standard designs and details and which items, if any, need bespoke design. This designer output, and the series of standard drawings can be combined to produce the final concrete underbridge solution.

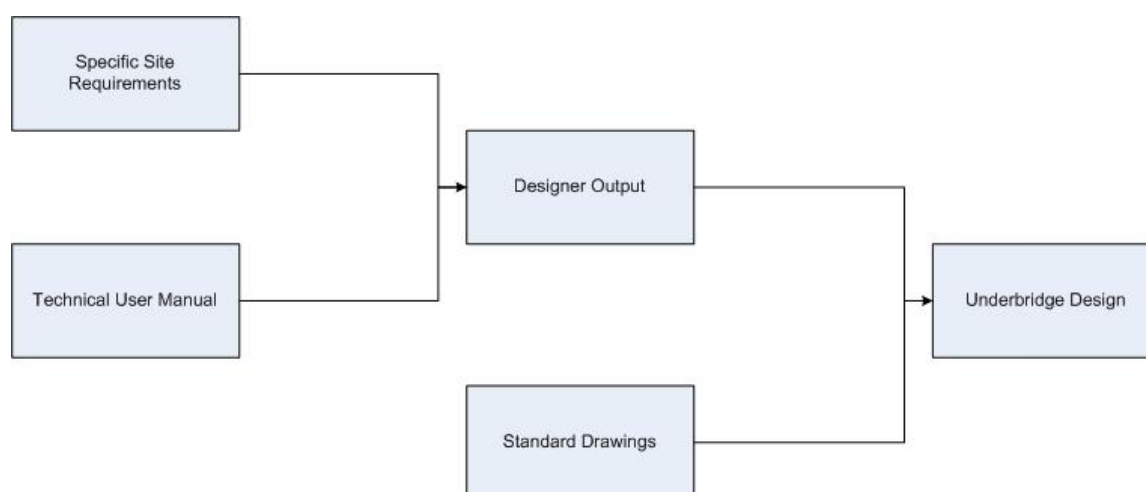


Figure 2.1: Flowchart to show the use of Network Rail's Standard Details and Designs

This manual describes the 2009 standard for rail underbridges using concrete deck type construction arrangements with longitudinal spanning concrete slab, filler beam or prestressed concrete to suit on or off line construction techniques. It is intended to be read in conjunction with the set of standard drawings listed in Appendix A.

This manual is intended to aid the designer in producing an individual bridge design using this standard, or in comparing this standard with other solutions. The manual discusses issues that

will need to be covered in a contract specification for a bridge of this type, but is not intended to form part of any contract documentation.

General arrangements have been developed for reinforced concrete, filler beam and prestressed beam decks including associated cill beam arrangements. The designer will still have to determine the most suitable bridge layout and structural arrangement of components and carry out scheme specific design of the superstructure and substructure as necessary.

The decks and other components have been detailed to cater for a wide range of spans, skews and track geometry within the limits of each of the deck arrangements. For situations outside these parameters, the standard cannot be assumed to be applicable.

In all cases, the scheme specific design will need approval, full design, and an appropriate check.

2.1 Approval of Schemes Using Standard Designs & Details

The SDDs for the concrete underbridge forms have been submitted and approved by Network Rail at both Form A and Form B (including a category II check) stages of the Network Rail approvals process.

The purpose of the concrete underbridge SDD was not to develop a deck design as these deck forms currently appear not to be widely used and furthermore considered straight forward to design. However, the advantage and significant benefit in developing the concrete underbridge SDD was to produce a set of standard details for various types of concrete deck solutions that are considered to be good practice.

The flowchart in Figure 2.2 demonstrates the general process of using the SDDs and TUMs. The blue shaded boxes assist the designer to select the appropriate details or confirm the suitable options available. A list of typical site parameters to consider in determining the appropriate details or confirm the suitable options available is included in section 4.

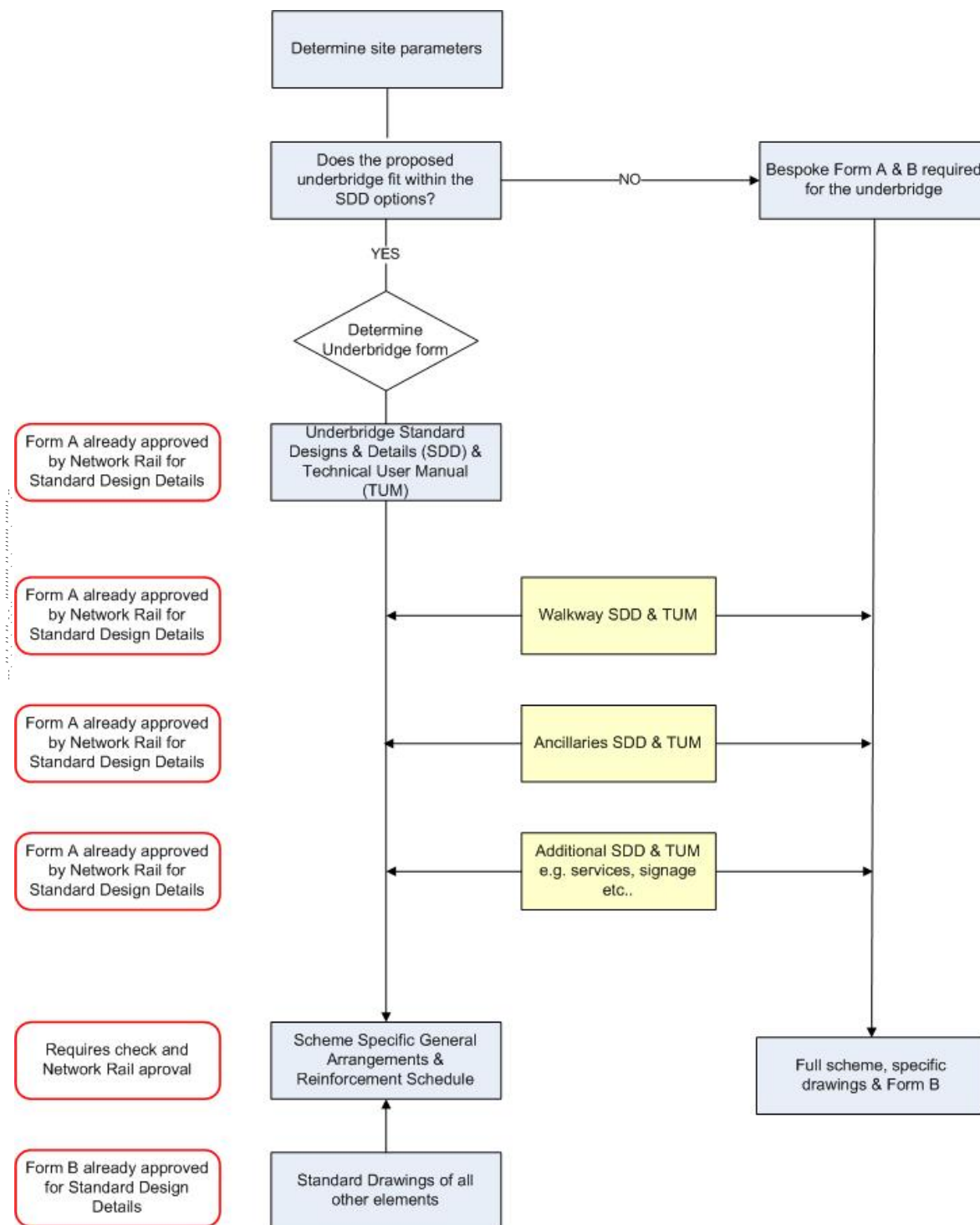


Figure 2.2: Process using the Standard Drawings and Technical User Manuals

The designer will need to produce a scheme specific Form A for the site under consideration. This Form A will detail the site specific parameters and the SDDs that will be used. As discussed previously the SDD Form As have been approved and a site specific Form A is to be produced to gain approval for use of the particular SDDs selected on the scheme.

Following Form A approval the designer will need to produce a full suite of scheme specific drawings, including general arrangement drawings, detailed design drawings, reinforcement schedules and scheme specific details based around the SDD.

The level of checking required is:

- Category I Check of the application of the standard designs and details
- Category II Check of the site specific concrete deck design, general arrangement (including site survey information), detailed design drawings and bar bending schedules

2.2 Drawing Selection Flowchart

The following flowchart assists the designer in deciding the options to select and which drawings to use in detailing a standard walkway and approach:

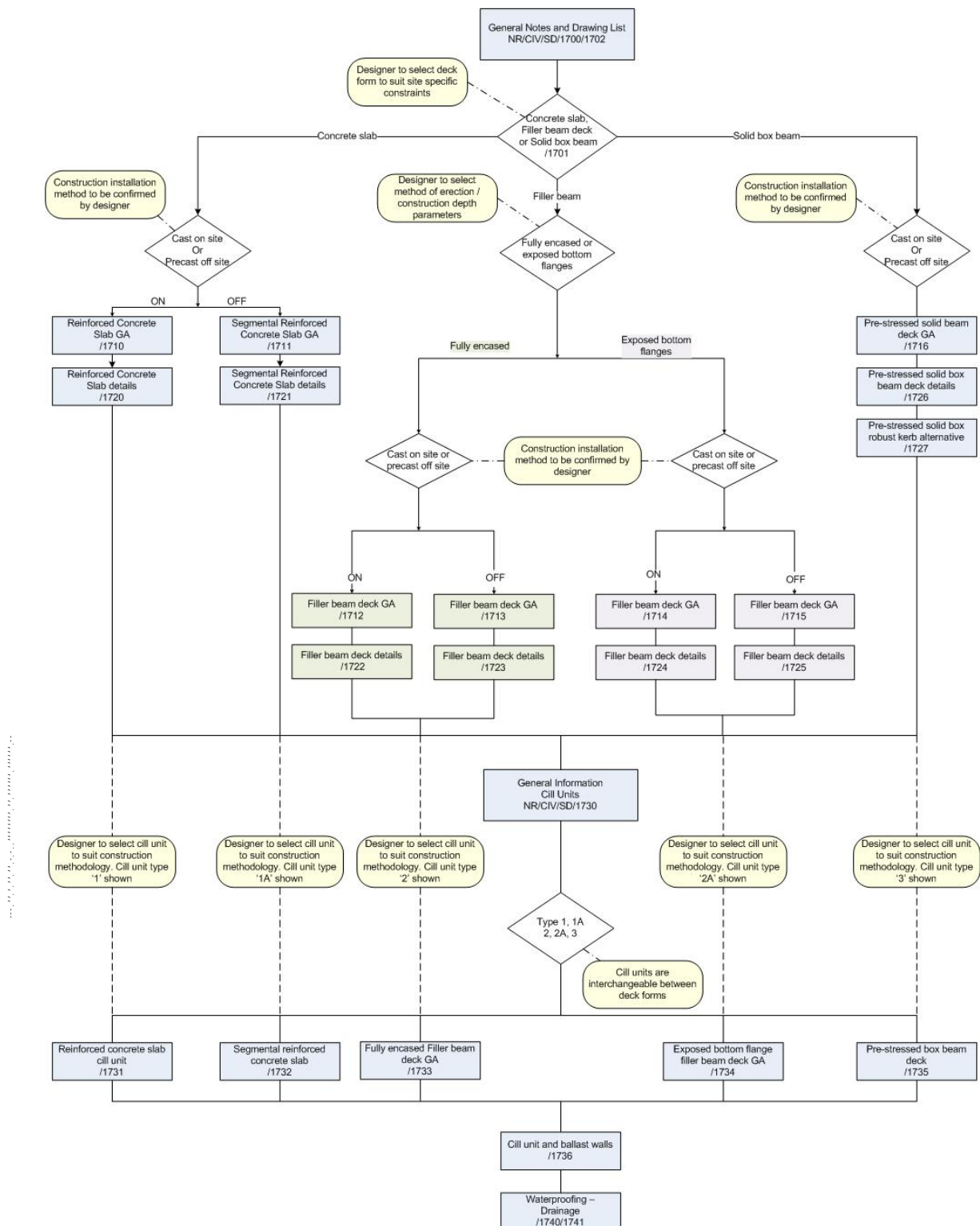


Figure 2.3: Process to determine the Standard Details and Designs to use in detailing a Standard Concrete Underbridge

3 CONCRETE UNDERBRIDGE APPLICATION DETAILS

The standard Concrete Underbridge design may be used at any suitable location in UK and complies with The Railways (Interoperability)(Amendment) Regulations 2007 (S.I No. 3386).

The standard drawings provide a complete set of preferred details for a range of concrete deck forms and cill beam arrangements. For a particular bridge, the designer needs to determine the specific layout, choose the appropriate deck form and associated cill beam drawings and modify the arrangements to suit site specific dimensions.

The standard drawings are generally applicable for spans between 2.5m to 20m for a range of skews up to 50°. Although, it is acknowledged that certain deck forms can be taken beyond these limitations, their use is not often exploited as the increased weight and construction depth are generally prohibitive and other deck forms are often adopted for spans over 20m.

The designer should therefore choose the relevant drawings for his particular bridge skew range from the full set of standard drawings and modify them as appropriate to suit the site specific contract. Refer to flowchart in Figure 2.3.

The standard drawings were not developed to be used as fabrication drawings and fabricators may have to produce accurate bridge specific drawings.

3.1 Check List of Standard and Non-Standard Items

Such is the range of possible concrete decks applications, the concrete deck forms and cill beams were developed to a low level of standardisation.

The check list (not exhaustive) in Figure 3.4 lists the standard and non-standard items, design responsibilities and notes.

CONCRETE UNDERBRIDGE STANDARD DETAILS – DESIGN RESPONSIBILITIES			
Element	Item	Standard Detail or Designer to Determine	Notes
General Arrangement	Span	Designer	Site specific
	Deck Skew	Designer	Site Specific
	Deck Width	Designer	Site Specific
	Construction Depth	Designer	Site Specific
Deck	Concrete	Designer	Designer to confirm concrete constituents in accordance with BS 8500 – 2: 2006.
	Steelwork	Designer	Designer to confirm section / plate sizes
	Bearing Stiffener	Designer	Designer to consider requirement for bearing stiffener through all stages of construction
	Reinforcement	Designer	Designer to confirm reinforcement arrangement and provide bar bending schedules
	Pre-stressing	Designer	Designer to confirm strand arrangement and confirm pre-stressing information
	Joints	Standard	Designer to confirm requirement and select joint as appropriate.
Bearings	Elastomeric Pads	Designer	Designer to confirm elastomeric pad size and provide bearing schedule.
	Uplift Restraint	Designer	Designer to confirm requirement for uplift restraint. Refer to Technical User Manual
	Lateral Restraint	Designer	Designer to confirm requirement for Lateral restraint. Refer to Technical User Manual
Protective Treatment		Standard	-
Waterproofing and Deck End Drainage		Standard	Refer to Drawings NR/CIV/SD/1740 & 1741
Walkways		Standard	Designer to confirm anchorage requirements
Lifting Arrangements		Designer	Designer to confirm lifting arrangements

Figure 3.4: Check List for Standard and Non Standard Items

4 DETAILS OF STRUCTURAL FORM

The standard concrete forms comprise single, double or multiple track deck type longitudinal spanning arrangement of reinforced concrete, filler beam or pre-stressed solid box beam construction.

Refer to the figures in Appendix D for general arrangement details.

4.1 Geometry and Configuration

The designer will need to utilise the following Railway Group Standards (or their successors, where appropriate):

- GE/RT8073 – Requirements for the Application of Standard Vehicle Gauges.
- GC/RT5112 – Loading Requirements for the Design of Bridges.
- GC/RT5203 – Infrastructure Requirements for Personal Safety in Respect of Clearance and Access.
- GC/RT5212 – Requirements for Defining and Maintaining Clearances.
- GE/GN8573 – Guidance on Gauging
- NR/L2/CIV/020 – Design of Bridges and Culverts (a copy of draft 12 appended to this TUM)
- GC/RC5510 – Recommendations for the Design of Bridges.

4.2 Deck Types

There are three deck arrangements, a reinforced concrete, filler beam and pre-stressed solid box beam options.

All options can be pre-cast off site and transported from the shop in manageable sections and assembled on site in their final position which should be suitable for the majority of schemes. Alternatively, should there be a longer period over which the railway is blocked then options for cast on site have been provided, noting that these would also apply to constructing immediately offline and transporting into position during a possession.

The selection of the preferred deck arrangement is dependant upon many factors and Figure 4.5 highlights the key constraints to each of the deck types. Two variants to the filler beam have been detailed with the encased sections being preferred. The alternative exposed bottom flange arrangement is often utilised where construction depths do not permit the fully encased option and also the arrangement lends itself to being erected piecemeal allowing formwork to span between bottom flanges eliminating the need for significant falsework to construct.

The preference would be to reduce the number of joints within the deck but is recognised that this is not always possible due to the various site constraints.

4.3 Span

The span range of the standard concrete forms considered in the SDD is the span measured between centres of bearings and is 2.5m to 20.0m.

4.4 Skew

The skew range, measured between the bearing centre line and perpendicular to the track centreline, is 0° (square) to 50° (maximum), with limitations on the Pre-stressed Solid Box Beam (SBB) where manufacturing constraints limits the skew ends to 45°. However, special consideration and detailing of the beam ends will need to given when skews in excess of 45° are to be adopted.

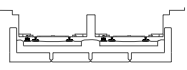
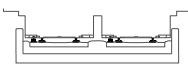
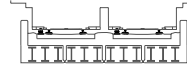
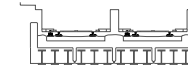
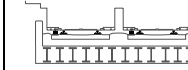
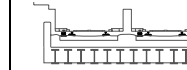
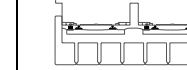
Deck Type							
Description	Segmental Reinforced Concrete Slab	Reinforced Concrete Slab	Segmental Fully Encased Filler Beam Deck	Segmental Exposed Bottom Flanges Filler Beam Deck	Fully Encased Filler Beam Deck	Exposed Bottom Flanges Filler Beam Deck	Pres-stressed Solid Box Beam
Typical Span Range	Up to 6m	Up to 6m	Between 5m and up to 15m	Between 5m and up to 15m	Between 5m and up to 15m	Between 5m and up to 15m	Between 10m and Up to 20m
Typical Skew Range	Up to 50°	Up to 50°	Up to 50°	Up to 50°	Up to 50°	Up to 50°	Up to 45°
Typical Depth of Section	1 in 10 short span 1 in 18 long span	1 in 10 short span 1 in 18 long span	1 in 15 short span 1 in 25 long span	1 in 15 short span 1 in 25 long span	1 in 15 short span 1 in 25 long span	1 in 15 short span 1 in 25 long span	1 in 18
Typical width Range	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Deck Joint Selection	No connection for spans < 6m (refer to 4.7.1 for limitations) Shear connection Post tensioned for skews less than 10°	N/A	No connection for spans < 6m (refer to 4.7.1 for limitations) Shear connection for spans > 6m Post tensioned for skews less than 10° and > 6m	No connection for spans < 6m (refer to 4.7.1 for limitations) Shear connection for spans > 6m Post tensioned for skews less than 10° and > 6m	N/A	N/A	Shear connection
Cill Unit Selection	All Types Type 1A (preferred)	All Types Type 1 (preferred)	All Types Type 1A (preferred)	All Types Type 1A (preferred)	All Types Type 1 (preferred)	All Types Type 1 (preferred)	Type 2, 2A & 2B Type 2A (preferred)

Figure 4.5: Deck Type Selection Matrix

For the reinforced concrete and filler beam decks there is the option to cast on site (final position). This approach is not common to most schemes as this would be more appropriate to a new build railway or where a lengthy closure has been granted to an existing railway line.

The last option available to all deck forms would be to erect the new structure adjacent to the final position on temporary works and manoeuvred into position. Again this option is not common to most schemes, and is often not cost effective and tends to be adopted where constraints, either inherent with the site or where possessions are to be kept to the minimum that permit the whole structure to be removed and installed within a short period.

4.5 Construction Depth

The total construction depth should be the summation of the span to depth ratios as given in the **Figure 4.6** and track form which has been assumed to be the following: depth of track (rail, rail pads and sleeper) of 368mm, the nominal ballast depth, waterproofing (assumed as 15mm thick) and the chosen floor type depth.

The construction depth varies for each deck form and associated span. Indicative span to depth ratios have been provided on the drawings and summarised in **Figure 4.6** below. These are for guidance purposes only to aid the designer in selecting the appropriate deck form to suit the site specific constraints.

Reinforced Concrete Slab		Filler Beam Deck		Pre-stressed Solid Box Beam	
Span	Ratio	Span	Ratio	Span	Ratio
<2.5m	Min 250mm slab	n/a	n/a	n/a	n/a
2.5m<>5m	1:10 to 1:12.5	<5m	Min 400mm slab	n/a	n/a
5m<>10m	1:12.5 to 1:15	5m<>10m	1:10 to 1:12.5	n/a	n/a
10m<>15m	1:15 to 1:18	10m<>15m	1:12.5 to 1:15	10<>18m	1:18 * ¹
15m +	1:18	15m +	1:15 to 1:18		

Figure 4.6: Indicative Span to Depth Ratio for longitudinal Spanning Concrete Decks

*¹ The span to depth ratio for Pre-stressed Solid Box Beams are to suit manufacturing limitations and standard mould depths.

4.6 Deck Width

There is no limit on the width of deck and the width of individual units should be such to keep joints to a minimum and where possible away from being directly under the rails.

Ideally robust kerbs should preferably be set at least 1500mm from the adjacent rail running edge (so that the back of the “offside” wheel of a derailed train will be restrained by the cess rail before the “nearside” wheel strikes the kerb.) However, it is accepted that in many cases it will not be practicable to achieve this with reasonable economy.

Where not practicable this dimension should be a minimum of 760mm plus any allowance for track curvature, cant, construction and future track slue tolerances.

Deck widths and the position of any cess walkways will also be affected by the cant, curvature and track alignment of each particular bridge location and consideration must also be given to the existing abutment width and adjacent structures, walkway positions and bridge end access requirements.

4.7 Deck Joints

The individual pre-cast off site concrete units for the three alternative deck forms are to be preferably shear connected together by an in situ cementitious stitch.

Should possession constraints be such that there is insufficient time available to prepare the stitch and subsequently fill with a cementitious material, the joint should either be transversely post tensioned to overcome the transfer of load between joints or in some cases a nominal gap can be maintained between adjacent units. However, both alternatives have limitations which are set out below.

4.7.1 No Connection

The preference is to have an integral deck but it is recognised that in some instances this is not achievable. Having individual units placed alongside one another with no shear connection introduces differential movement between adjacent units, especially on a multiple track railway line where one line is loaded and the adjacent line is not. The magnitude of this differential movement is a function of the span and stiffness of the deck units and it is recommended that spans over 6m should have shear connected decks unless it can be demonstrated otherwise that this differential movement reduced or alternatively accommodated between decks.

Where the decks are to be laid side by side the designer is to allow for the difference in level and associated tolerances as specified within Section 80 of the Network Rail specification.

The designer is to consider the stability of the decks to resist lateral load effects when applied to the robust kerb. The arrangement of the edge units and restraint on the bearings should be suitable to resist these applied load effects.

The designer is to consider the ability of the individual units to resist accidental load effects and to provide the necessary restraint mechanisms to cater for such effects.

4.7.2 Shear Connection

The stitch joint between the units needs to be filled with a cementitious material with the following general properties:

- Rapid strength gain and high early strength (dependent on design requirements and time to loading/trafficking);
- Adequate longer-term strength;
- Easy to place and compact within the congested area of the joint;
- Low shrinkage or shrinkage-compensated;
- Intrinsic durability and provision of good protection to reinforcing steel from chlorides, carbonation etc.

The designer should consider the requirement for early strength dependent on structural requirements and the length of possession. The early-age strength of the joint filling material should be specified as appropriate (eg. '10 N/mm² at 12 hours') but should not be higher than is required as this is likely to unnecessarily restrict the choice of available materials and may create other problems (see below).

Proprietary rapid-hardening cements are available for site mixing with suitable aggregates. Pre-mixed one-part and two-part bagged mortars and 'microconcretes' are also available, which can be extended with coarse aggregates (maximum aggregate size should not exceed 10mm to allow adequate placement and compaction). Rapid hardening cements are likely to include a range of accelerators and other chemical and mineral additives, and strengths of up to 20 N/mm² can be attained in an hour using magnesium-phosphate cements. The materials used should also meet the longer-term requirements of the stitch by achieving suitable 28-day strengths and having a low shrinkage (proprietary materials may be shrinkage-compensated).

Requirements for on-site mixing, placement, compaction and curing are also very important considerations. Given the congested area of the joint, the filling material should ideally be pourable/pumpable and self-compacting or compactable with minimal effort. This may be difficult to achieve with some very rapid hardening concrete mixes, which may be stiff and also tend to have very short working times.

Manufacturer's recommendations for mixing and placement should be followed, but typically the concrete surfaces of the box beam sections which will be in contact with the joint filler material should be clean and free from laitance, oil, grease etc. and should normally be pre-wetted (but surface-dry at the time of filling). The base of the joint should be sealed and during filling a continuous flow of pumped or poured material should be ensured. If poured, a header box should be used to maintain a head of material throughout the pour.

Ambient temperatures may be a consideration, and can significantly affect the rate of strength gain. Rapid hardening materials typically generate a lot of heat so are less sensitive to cold-weather working than ordinary cementitious materials, but may suffer from resulting from thermally-induced cracking particularly in hot weather.

Proprietary rapid hardening materials are specialist products with a wide variety of characteristics and manufacturers should be consulted to ensure selection of materials which will meet performance requirements, and to determine requirements for mixing, placing, compaction and curing.

4.7.3 Post Tensioned Connection

An alternative to having a fully integral deck but having some form of transverse distribution is to install pre-stressing steel ties / bars in ducts across the width of the deck and applying a post tensioning force sufficient to generate a contact pressure between units to overcome the applied load effects.

Post tensioning of skew decks is recommended for either square spans or low skews of no more than 10°.

Adjacent pre-cast concrete units are to be match cast against one another to obtain the appropriate fit up between units.

Sufficient tolerance on alignment of transverse holes should be considered and the diameter of the hole should generally be equal to at least twice the bar diameter.

4.8 Bearings

The standard details and designs assume that elastomeric bearing pads will be used to support the bridge deck with lateral and longitudinal fixity of the deck provided by stainless steel dowels.

The arrangements shown on the drawings show the minimum number of elastomeric bearings required but the designer should confirm the most efficient number and arrangement to suit the span, skew, width and loading requirements.

Where segmental units are shown two bearings have been shown and in the case of filler beam decks, the steelwork filler beam in the middle does not have a bearing which will provide space for restraint systems.

The designer is to consider the stability of the pre-stressed solid box beam when placed on a single bearing and the size of the bearing may have to be increased to suit construction methodology.

The installation of the bearings should be in accordance with the manufacturer's recommendations including the bedding requirements.

4.9 Cill Units

Three types of cill unit have been detailed to cover a range of application to suit both the deck form and site constraints. The selection of the cill unit arrangement can vary to suit certain criteria as highlighted in Figure 4.7 which is dependant upon the bearing plinth and ballast wall arrangement as follows:

Cill Beam Type 1 (integral ballast wall), 1A (separate ballast wall) and 1B (Block wall ballast wall) have discrete plinths in which the main deck units are supported from, which improves the access to the bearing shelf area. There is also the opportunity to post grout holding down restraints once the deck has been placed.

Cill beam Type 2 (integral ballast wall), 2A (separate ballast wall) and 2B (block wall ballast wall) have a raised full length bearing shelf, which provides flexibility on the position of bearings.

The integral ballast wall is recommended where one or more of the following would apply: time constraints do not permit the lifting of separate ballast walls and/or reinstatement of backfill needs to be carried out immediately after placing the cill; construction tolerances are adequate to place a deck between two fixed walls; access to the rear of the bearings is not required when placing the deck. Where this is not the case, consideration can be given to having separate ballast walls at either one or both ends to suit site constraints.

The block wall ballast wall is recommended where either the spans are less than 6m (small movements) or where sheet membrane is used to waterproof the deck.

There is an option to have an exaggerated chamfer on the leading edge to improve access to the bearings and bearing shelf to assist both maintenance and bearing replacement activities.

A typical gap between the end of the deck and cill unit / ballast wall should be 75mm (± 25 mm).

The merits of locating the drainage channel in the cill unit towards the front of the cill unit was considered but not recommended on the basis that the water would have to run passed the bearings in order to drain away and also the position of the drainage channel would impinge on the temporary jacking area to remove the bearings.

Although access to maintain the drainage channel at the rear can be problematic, the designer is to consider potential locations where rodding / cleaning points can be made to suit site constraints.

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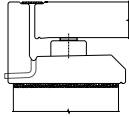
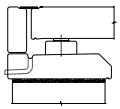
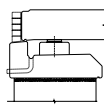
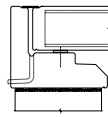
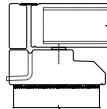
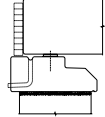
Cill Type	Type 1	Type 1A	Type 1B	Type 2	Type 2A	Type 2B
						
Selection Criteria	<p>Suited for all bridge spans and deck forms</p> <p>An integral ballast wall reduces the number of crane lifts and other site activities such as back fill material to can be placed immediately after cill unit / back of wall drainage has been installed.</p> <p>Permits variation in bearing levels (skew decks) by altering plinth heights</p> <p>Cill Holding down restraints in between plinths can be post grouted after deck installation.</p> <p>Provides good access to drainage</p> <p>Option to chamfer leading edge to improve access</p>	<p>Generally as Type 1 but provides flexibility and more tolerance on placement of deck</p> <p>Permits access to rear of deck to install longitudinal stitch reinforcement and installation of cementitious material</p> <p>Introduces additional ballast wall to cill dowelling activity during the possession.</p> <p>Permits access to rear of bearing during deck placement.</p> <p>Level of ballast wall can be marginally adjusted to suit line and level that deck has been placed.</p>	<p>Suited for bridge spans of small movements (spans of 6m or less).</p> <p>Suited for use with sheeted membrane</p> <p>Permits access to rear of deck to install longitudinal stitch reinforcement and installation of cementitious material</p>	<p>Suited for all bridge spans and deck forms</p> <p>Lateral restraints to be installed at the same time as deck installation.</p>	<p>Suited for all bridge spans and deck forms</p> <p>Permits access to rear of deck to install longitudinal stitch reinforcement and installation of cementitious material</p> <p>Lateral restraints to be installed at the same time as deck installation.</p>	<p>Suited for bridge spans of small movements (spans of 6m or less).</p> <p>Suited for use with sheeted membrane</p> <p>Permits access to rear of deck to install longitudinal stitch reinforcement and installation of cementitious material</p> <p>Lateral restraints to be installed at the same time as deck installation.</p>

Figure 4.7: Selection Criteria for Cill Units

4.10 Lateral Restraints

Lateral forces are to be resisted at all interfaces between the deck and supporting substructure. The deck is to be adequately restrained against the cill unit and likewise the cill unit is to be adequately restrained against the existing substructure.

Lateral restraints between the deck and the cill unit are to be provided by using either the elastomeric bearings or stainless steel dowels. Lateral restraints between the cill units and the substructure are to be provided using stainless steel tie rods effectively anchoring the cill unit to the masonry abutment / pier at suitable spacing and depth to generate sufficient lateral resistance.

The Elastomeric bearings are to be designed to resist lateral load effects utilising their friction capacity in accordance with BS5400 Part 9. Where insufficient resistance exists alternative lateral restraints are to be provided on the basis that all the applied load effects are to be resisted by the alternative mechanism, i.e part contribution between elastomeric bearings and alternative restraints is not permitted.

Subject to design calculations, double or multiple track bridges (integral or shear connected units) of spans 10m or above with a minimum of 5 elastomeric bearings do not generally require lateral restraints as they can rely on the inherent mass of the concrete deck to provide the necessary frictional capacity from the elastomeric bearings alone to resist the applied effects. However, single track bridges would generally require lateral restraints up to and around 20m.

Double or multiple track bridges (integral or shear connected units) of all spans do not generally require lateral restraints between the cill unit and substructure as they can rely on the inherent mass of the concrete deck to provide the necessary frictional capacity between the substructure and cill unit interface. For the purposes of calculating the frictional resistance between the underside of the cill unit and mortar bed / masonry abutment a nominal coefficient of friction can typically range between 0.4 and 0.6, with the factor of safety against sliding generally assumed to be 1.5.

Single track bridges would generally require lateral restraints up to and around 10m.

Where restraints are required between the cill unit and substructure, these are generally anchored to the masonry abutments by having pre formed pockets in the cill unit whereby an oversized hole can be cored through the holes provided in the cills into the existing abutment to the required depth to achieve an effective embedment.

A threaded stainless steel tie rod is placed into the hole and a pourable cementitious grout is then pumped to fill the void between the bar and masonry core to the level of the top of the cill

unit, whereby a holding down plate and nut is hand tightened to provide the anchorage. The depth of embedment will vary depending upon the lateral load effect to be resisted but it is generally relied upon and subsequently sized by the vertical load effect from a vehicle collision (Refer to Section 4.11)

4.11 Uplift Restraints

Vertical forces are to be resisted at all interfaces between the deck and supporting substructure. The deck is to be adequately restrained against the cill unit and likewise the cill unit is to be adequately restrained against the existing substructure.

Uplift restraints between the cill unit and the substructure are generally the same restraint as the lateral restraint mechanism by introducing a grouted tie rod to the required embedment.

For short span single track bridges of around 6m span or less, special consideration should be given to uplift restraints as generally there is insufficient inherent mass to resist the applied load affects both in terms of the deck itself and the abutments.

The uplift restraint between the deck and cill unit will be bespoke depending upon the residual vertical load effect that is to be resisted. These bespoke connections can be anchored into the stitch area or connected directly to the concrete or steel soffit of the bridge.

4.12 Clearances

4.12.1 Structure Gauge Clearances

The designer should:

- Ensure that adequate clearance is provided between existing and proposed vehicles and the structure.
- Ensure that the structure gauge considered for the standard designs is suitable for the line considered for each specific scheme, in accordance with current Network Rail and Railway Group Standards.
- Ensure that the required track radius and cant (if any) will not result in encroachment on the structure gauge by any part of the deck or walkway.
- Prepare a gauging diagram(s) at Form A Stage.

4.12.2 Clearances Limits Affecting Design.

Generally, clearances will not affect the design of the deck. A robust kerb must be provided and an absolute minimum clearance of 25mm to the Lower Structure Gauge should be assumed.

The maximum vertical distance between the rail and top of robust kerb considered in the standard designs is 350mm. Note that the designer should assess if this is acceptable for specific bridges, i.e. permanent way clearances and requirement to maintain gauge, track maintenance requirements, or construction and installation tolerances, as a minimum clearance of 50mm is desired for possible future works

4.13 Track Arrangement

An absolute minimum clearance of 25mm to the Lower Structure Gauge should be allowed for, although it is recommended that where possible, a minimum clearance of 50mm should be provided for possible future works.

The designer should ensure the effects of curved track (end and centre throws) does not cause the structure gauge to foul the structure and that sufficient installation tolerances are provided.

4.14 Cant and Deck Super Elevation

The designer should ensure that the effects of cant, such as cant throw do not cause the structural gauge to foul the structure.

4.15 Ballast Depth

The desired ballast depth is 300mm at mid span under the low rail. Shallower ballast depths may be used, to a minimum of 200mm, however permanent way approval will be required. The maximum ballast depth below the sleeper shall be generally limited to 400mm averaged over the span.

4.16 Sleeper and Rail Details

The total depth of the rail, chair and sleeper has been taken as 368mm. The designer should ensure that the chosen rail and sleeper combination will not cause the structural gauge to foul the structure and sufficient distance is provided between the sleeper ends and the robust kerbs. A minimum distance of 50mm is assumed between the robust kerb and sleeper end with a lateral positioning tolerance of 25mm to ensure the 50mm is maintained.

4.17 Site Constraints

The designer will need to consider the site constraints, including but not limited to: OLE, existing abutments, S&T, location of cess etc. Headroom above highways or waterways should be maximised where possible and appropriate signage fixed to the structure (ideally to the bash

beam or walkway). Refer to ancillary details in NR/CIV/SD/1800 series). Note that the signs will be the responsibility of the local authority, Highways Agency or similar authority.

4.18 Direct Fastening Systems

The standard concrete underbridges have not been developed specifically to accommodate direct fastening systems but the use of the standard drawings does not limit their use to ballasted track. Where a direct fastening system is required for a specific scheme, the designer shall select the suitable standard design with the required track/structure performance. Additional design checks will be required to ensure suitability of the chosen detail as the intensity of the railway loads will be greater than for ballasted track. Form A and Form B submission and approval will be required.

5 INSTALLATION GUIDANCE

It has been assumed that the standard concrete underbridges will be either constructed in situ, piecemeal erected in situ using mobile road and rail cranes or constructed offline and lifted, slid, jacked or transported into its final position using self propelled lifting vehicles (SPLV). Specific details will need to be determined by the designer.

Where possible, to minimise railway possession times, the designer should consider installing the deck with bottom ballast in place, though the designer should ensure it's stability and that the ballast is suitably retained.

5.1 Trial Erection

As stated on drawing NR/CIV/SD/1702 the bridge should be fully trial erected: The trial erection should include all superstructure and ancillary items such as walkways, cill/impost, ballast walls and cover plates. This is particularly important for skew bridges.

5.2 Installation Tolerances

The typical tolerances to be assumed in the standard design are usually for the installation of the deck units by crane. The designer should develop the scheme to allow for the decks to be typically positioned within 10mm and the track placed within 15mm of the design position on plan. Vertical positioning tolerance should typically be 10mm on the assumption that the track profile could be locally adjusted on site if necessary.

Installation by alternative methods will require these tolerances to be reviewed.

The designer should check that the effects of curved track (end and centre throws) does not cause the structure gauge to foul any parts of the structure and that sufficient installation tolerances are provided.

5.3 Lifting Guidance

Where the deck units are installed by lifting them into position by lifting eyes / brackets attached to the deck units, the designer should ensure that lifting points are located perpendicularly opposite to one another. Details are not given on the standard drawings but have assumed that proprietary lifting eyes cast into the concrete will be provided.

The designer is to check that section has sufficient capacity to span between lifting points and to ensure that provision has been made for additional local reinforcement to the lifting eye (if necessary) to prevent it from punching out of the deck.

The lifting points should ideally be located between the quarter and third points of the span. In all cases the designer must ensure that during the lift, the stresses (a safety factor of 2.0 is recommended) in the deck does not exceed the theoretical permanent load stresses at the end installation.

5.4 Check List for Installation Options

The following check list (not exhaustive) lists checks to be undertaken and items to be designed or checked by the designer for the scheme specific installation option. Where appropriate, a separate Form C will be required.

- The effect of the proposed lifting / support arrangement on;
 - o the lifting lugs (where applicable),
 - o the load distribution to each lifting / support point,
 - o the effect on the deck unit. Twist during installation or fabrication shall be minimised. No one bearing shall move more than span/500 vertically compared to the plane of the other three bearings.
- The suitability of the substructure:
 - o check the load effects from the new deck including pressure at base and under the impost / cill beam,
 - o check overturning and sliding stability with and without the new deck in place.
- Undertake suitable geotechnical investigation to determine soil properties.
- Check that the differential settlement predicted does not exceed at SLS, 1 in 1000 along the abutment
- Check installation tolerances noting that methods of installation other than by crane may be more suited for installation in short (8 hour) possessions but may require additional installation tolerances.

The following check list (not exhaustive) lists typical issues to be considered by the designer for the particular scheme when deciding on the available options to install the deck.

- Access to site
 - Clearances to street furniture, overhead cables etc.,
 - Road profile (horizontal and vertical): Proximity to hump back bridges, tight curves etc. that may restrict access to site or plant movement.
 - Location for site compound.
- Services: Highway / waterway.
 - Services in or alongside the highway or waterway must be protected from bridge installation activities.
- Services: Railway.
 - Services may restrict or complicate installation of new bridge decks. Some methods of installation will be more suited for sites with numerous railway services, e.g. if services cannot be raised, this may preclude installation with SPLV.
- Access around site
 - Consider size of compound to construct the deck off line, rig cranes, store plant and materials, store bridge elements, staff accommodation and welfare provision.
- Site properties
 - Strength of ground (ground reinforcement or piling for cranes or temporary works),
 - Access to site (haul roads and access agreements with land owner),
 - Environmental issues (minimise damage to habitat, restrictions due to the presence of rare or protected fauna and flora, relocation of rare or protected fauna and flora, limitations on time of year to do the work to minimise impact on flora and fauna).
 - Working above water.
- Available possessions
 - Minimise all possession times.
 - Railway possessions. Strive for an 8 hour railway possession. Installation with SPLV is usually quicker, thus minimising railway possessions, but will need larger installation tolerances (refer to Section 5) and will not be suitable for all sites.
 - Highway and waterway possessions may be limited at certain times of the year, depending on the site location, e.g. a highway possession will be unlikely in December if the site adjacent to a retail outlet, and a waterway possession unlikely in July and August if heavily trafficked with recreational vessels.

6 GUIDANCE FOR USE OF THE CONCRETE UNDERBRIDGE STANDARD DESIGNS AND DETAILS

6.1 General Arrangement Drawing

General arrangement drawings should be produced in line with Network Rail's requirements for the specific site. However it is expected that this drawing should normally include the following:

- Plan, bridge elevation and a cross-section through the bridge including the elevation of one abutment and the bridge seating arrangement.
- Geotechnical information, details of services (railway and other), details of land ownership and details of adjacent infrastructure,
- Principal dimension information such as span, skew, clearances from rail to main girders and walkway parapets, six foot gap (where applicable), bearing, bridge soffit, rail, walkway and parapet levels, clearance to road (or river or rail as applicable).
- Lower sector gauging diagram(s).
- List of drawings forming the complete bridge design.

6.2 General Assembly Drawings

The setting out and arrangement of components will be unique in most instances and dependent upon many variables including, bridge span, abutment skew and clearance requirements.

Scheme specific general assembly drawings should be provided.

6.3 Details Drawings

The designer should provide detailed drawings of all components except the standard details provided for concrete profiles, interfaces between units, waterproofing and end of deck drainage.

6.4 Concrete and Reinforcement Drawing

All detailed concrete outline and reinforcement drawings and bar bending schedules are to be prepared by the designer. In addition to the general guidance given on the standard drawings, the designer shall consider:

- Reinforcement and cover to any steelwork should be maintained.
- The position of the edge steel section with respect to the reinforcement within the robust kerb to avoid clashing with the top flange
- The anchorage of reinforcement from the robust kerb
- The placement of links within the stitch area should be staggered with respect to adjacent units to avoid clash
- The radius bend of the link around the steel sections within each unit and the requirement to have a minimum edge distance between steel flange and outer concrete face. This would also apply to the deck end.

Floors should be detailed to allow easy placement of reinforcement as well as meeting all relevant design requirements.

6.5 Bar Bending Schedules

Production of deck specific bar bending schedules to accompany the deck drawings are necessary in all instances.

6.6 Bearing Details and Schedules

Production of deck specific bearing details and schedules to accompany the deck drawings are necessary in all instances.

6.7 Protective Treatment, Waterproofing and Deck End Drainage

6.7.1 Basic Principles and General Comments

The basic principles are as follows:

- All buried surfaces beneath or at the sides of the track are protected by a waterproofing arrangement designed to ensure water and other train related pollutants do not come into contact with the bridge superstructure and support/end units.
- Drainage arrangements, such as providing a longitudinal fall, should be incorporated in the overall bridge design to minimise maintenance requirements.
- Steel surfaces permanently exposed in the final structure are specified as receiving a protective treatment in accordance with NR/GN/CIV/002 and agreed with the scheme sponsor.

Both protective treatment and waterproofing should be carried out as far as possible in shop conditions to ensure the maximum integrity and quality. Details are shown on the standard drawings of the residual site joint protection involving hand applied protective treatment and

waterproofing system. It is envisaged that some remedial site painting will be required, to be carried out in accordance with the Network Rail Specification.

6.7.2 Protective Treatment

The standard steelwork protective treatment specified is a type N1 system in accordance with NR/SP/CIV/039. The standard drawings show details in accordance with NR/GN/CIV/002. Where no guidance is provided the requirements of NR/GN/CIV/002 shall apply. Points to note are include:

- Areas fully encased in concrete (e.g. Filler Beam section) should remain untreated, only loose rust or mill scale removed.
- Exposed areas of partially encased sections in concrete (e.g. exposed bottom flanges of filler beam section) should receive full paint system.
- Where the concrete finishes the protective treatment for the adjacent area should be extended not less than 25mm into the concreted area and a sealant applied in a rebate in the concrete to minimise the risk of water ingress at the steel/concrete interface.
- Where appropriate, concrete surfaces that may be exposed to chlorides (e.g. decks above highways) should receive a hydrophobic pore lining impregnant in accordance with Highways Agency Document BD43/03.

6.7.3 Waterproofing

The waterproofing system shown is based upon either an acrylic spray or sheet membrane system protected with a protective layer against local damage. The waterproofing details are shown on drawing NR/CIV/SD/1740 & 1741. Deck ends are waterproofed to ensure water drains from the deck to the back of deck drainage.

Where there are no limits on application, the use of a tightly bonded system (spray applied acrylic) is much preferred to a loose laid system (sheet membrane). This is because, with the former, leakages through defects are much likely to be small and, hence, affect only a small of a deck and so have little detrimental effect on the service life of the bridge.

6.8 Drainage

Positive drainage should be considered where possible. Details of drainage provision options are shown on drawing NR/CIV/SD/1740 & 1741. Generally, drainage locations and thus the profile of the back of the cill/impost unit may be governed by the abutment thickness. A narrow abutment invites a simple arrangement of deck end and upstand aligned vertically with the rear of the abutment. Ideally the drainage pipe should be located below the final top of the existing abutment. This should ensure that water will not permeate along the underside of the impost and then down the abutment face.

Where the existing abutment is much wider and the new deck stops short then providing drains in the impost at the deck end and below cill/impost to the rear of the abutment is often preferred even to the extent of terminating the waterproofing at the cill/impost drain.

6.9 Substructure and Ancillary Items

Within the standard detail suite of drawings, details are provided for underbridge ancillary items (drawing series NR/CIV/SD/1800 and associated technical user manual).

To ensure a smooth transition from the stiffness of the bridge approach to the stiffness of the deck and then the stiffness of the deck to the stiffness of the approach, the designer should consider the use of a suitable transition detail.

Where an existing substructure is being reused the scheme design should ensure that there is no significant change in the loads or points of application, and also the acceptability both the re-use of the existing substructure and foundations.

The design of the standard deck details covered in this TUM have assumed a maximum abutment differential settlement at SLS of 1 in 1000. The load applied shall be in accordance with BS 5400-2:2006 and include railway loads. The designer shall determine the soil parameters and ensure that the maximum design settlement is not exceeded. Refer to the check list in Section 5.4 for guidance and limits on differential settlement allowed for in the standard designs.

6.10 Bonding/Stray Current/Insulation

The designer must ensure that suitable details are provided to ensure that the structure is adequately bonded/insulated/protected from stray current effects.

7 FABRICATION AND CONSTRUCTION

The details are generally straightforward and a competent fabricator or contractor should be able to determine their own procedures for ensuring the required quality is achieved. The areas where the details require particular attention are discussed below.

7.1 Fabrication

The fabricator must also pay due attention to the reinforcement location and orientation to ensure holes in the steel beams (filler beam floors) are suitable to facilitate the accurate fixing of reinforcing bars and concreting.

7.2 Construction

When constructing the concreted areas, the contractor must be careful to ensure suitable clearance between reinforcing bars is provided to allow concrete to surround all reinforcing bars.

The contractor should consider the use of vibrating shutters where the reinforcement is congested and limited access for pokers,

8 SAFETY/CDM AND ENVIRONMENTAL

The general (non site specific) risks associated with the bridge design, construction and operation are listed on drawing NR/CIV/SD/1702. In addition there may be others arising from site-specific considerations, such as the presence of overhead line equipment (OHLE) or vulnerable services.

Environmental issues can only be determined on a site by site basis, bridge aesthetics including its colour, should be considered also.

The effect of renewing the protection scheme on the environment, particularly any watercourses, should be taken into consideration during the selection of the elements of the protection scheme.

Appendix A SCHEDULE OF STANDARD DRAWINGS

Description	Drawing
NR/CIV/SD/1700	Index of Drawings
NR/CIV/SD/1701	General Information Concrete Underbridge Forms - Key to Types
NR/CIV/SD/1702	General Notes and H&S Risk Register
NR/CIV/SD/1710	Cast on Site Reinforced Concrete Slab General Arrangement
NR/CIV/SD/1711	Pre-cast off Site Segmental Reinforced Concrete Slab General Arrangement
NR/CIV/SD/1712	Cast on Site Fully Encased Filler Beam Deck General Arrangement
NR/CIV/SD/1713	Pre-cast off Site Fully Encased Filler Beam Deck General Arrangement
NR/CIV/SD/1714	Cast on Site Exposed Bottom Flange Filler Beam Deck General Arrangement
NR/CIV/SD/1715	Pre-cast off Site Exposed Bottom Flange Filler Beam Deck General Arrangement
NR/CIV/SD/1716	Pre-cast off Site Pre-stressed Solid Box Beam Deck General Arrangement
NR/CIV/SD/1720	Cast on Site Reinforced Concrete Slab Details
NR/CIV/SD/1721	Pre-cast off Site Segmental Reinforced Concrete Slab Details
NR/CIV/SD/1722	Cast on Site Fully Encased Filler Beam Deck Details
NR/CIV/SD/1723	Pre-cast off Site Fully Encased Filler Beam Deck Details
NR/CIV/SD/1724	Cast on Site Exposed Bottom Flange Filler Beam Deck Details
NR/CIV/SD/1725	Pre-cast off Site Exposed Bottom Flange Filler Beam Deck Details
NR/CIV/SD/1726	Pre-cast off Site Pre-stressed Solid Box Beam Deck Details
NR/CIV/SD/1727	Pre-cast off Site Pre-stressed Solid Box Beam Robust Kerb Alternative
NR/CIV/SD/1730	General Information Cill Units – Key to Types
NR/CIV/SD/1731	Cast on Site Reinforced Concrete Slab Cill Unit General Arrangement
NR/CIV/SD/1732	Pre-cast Segmental Reinforced Concrete Slab Cill Unit General Arrangement
NR/CIV/SD/1733	Cast on Site Fully Encased Filler Beam Deck Cill Unit General Arrangement.
NR/CIV/SD/1734	Pre-cast off Site Exposed Bottom Flanges Filler Beam Deck Cill Unit General Arrangement
NR/CIV/SD/1735	Pre-cast off Site Pre-stressed Solid Box Beam Deck Cill Unit Arrangement
NR/CIV/SD/1736	Cill Unit & Ballast Wall – General Details
NR/CIV/SD/1740	Deck End – Waterproofing & Drainage Details Sheet 1 of 2
NR/CIV/SD/1741	Deck End – Waterproofing & Drainage Details Sheet 2 of 2

Appendix B DESIGN ASSUMPTIONS

Structural Models

The proposed new decks should be analysed using a linear elastic model of a complete deck. One bearing should be fixed in position, usually in one corner of the deck. Other bearings should allow rotation and movement longitudinally, laterally or in both directions. A quasi-static approach should be used.

The simple approach to fatigue assessment (without damage calculation) should be used.

Loading

The following is a summary of the design loads under current UK standards, BS 5400 and draft Network Rail standard, NR/L2/CIV/020 (draft 12):

Dead Loads

Item	Density/Load	Load Factor (g_{fl})
Concrete	25 kN/m ³	1.2
Ballast	21 kN/m ³ – depth 575mm over full floor area between webs of main girders (appropriate to 300mm depth under sleepers with additional average 100mm allowance for variations in ballast depth due to cant, track gradients, deflections etc)	1.75
Track	2.514 kN/m (per track, including extra over ballast, for 113A (continuously welded) rail and F27 concrete sleepers and pads)	1.2
Waterproofing	0.36 kN/m ² over floor area (equivalent to 15mm thickness at 24 kN/m ³)	1.2
Trackside Cables	1.0 kN/m (equivalent to 7 no. solid 40mm diameter lead cables)	1.2

Live Loads

Load	Reference	Notes
RU Loading	BS5400-2:2006 Clause 8.2.1.1 NR/L2/CIV/020	An additional a factor of 1.1 has been applied to provide adequacy in accordance with TSIs for high speed lines, or g_{det} for standard lines.
Dynamic Effects	BS5400-2:2006 Clause 8.2.3	Factor taken as 2 for shorter span bridges, as detailed below.
Centrifugal Force*	BS5400-2:2006 Clause 8.2.9	Value based upon $V_t = 120\text{kph}$, $R = 654\text{m}$ Maximum line speed 200kph.
Fatigue	BS5400-10:1980 Clause 9.1	Simplified Method adopted Maximum traffic 42 MTPA
Walkways ⁺	NR/L2/CIV/020 – Draft 12	Uniformly Distributed load: 5.0 kN/m^2 Single Point Load: 2.0 kN Parapet Lateral Load on top rail: 0.74 kN/m
Longitudinal	BS5400-2:2006 Clause 8.2.10	The track is assumed not continuous over the bridge for the purpose of distributing longitudinal live loads off the bridge, i.e. all longitudinal load resisted by the bridge.
Crane Loading (temporary case)	KIROW KRC1 200UK Rail Mounted Crane	Refer to NR/L2/CIV/020 for Axle Distribution, and reduced partial load factors apply.

Notes:

* - Maximum Centrifugal Force Factor (defined as the vertical effect of the centrifugal force on a girder expressed as a fraction of the static RU load): 0.2P. Note that the designer must determine the minimum track radius a deck can accommodate, considering clearances, tolerances etc.

⁺ - These loads are used for the walkway, parapet, walkway bracket and main girder intermediate stiffener design.

Collision Loads.

The decks and bearing arrangements are to be designed in accordance with the load requirements of BD60/04.

For longer span decks and high ballast depths, the designer may justify not providing an uplift bracket otherwise a suitable uplift restraint should be provided.

Design of Deck

The filler beam floor is assumed to act compositely in the longitudinal direction and is treated as a 'filler beam' floor (for the purposes of design to BS 5400-5:2005). The surface area acting to provide bond strength between the concrete and steel section shall be considered as only that acting in compression (locally, ignoring global tension effects).

The concrete floor (and concrete specification) should be designed to reduce early thermal cracking effects, to reduce the deck's susceptibility to chloride ingress, to limit the risk of spalling and to improve its durability generally. The concrete class at the soffit location has been taken as XD3 for chloride induced (corrosion, cyclic wet and dry) as the soffit is likely to be exposed to spray from potential highways below. The top surface is protected by waterproofing, and would be a lower classification. In determining nominal cover the value of D_c has been taken as 10mm. The designer should consider applying a hydrophobic pore lining impregnant in accordance with Highways Agency document BD43/03 where the deck may be exposed to chlorides.

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Appendix C Hidden Parts

The standard designs and details have, where possible, practicable and in accordance with NR/L2/CIV/020 (draft 12), minimised the number of structural elements that are considered, i.e. that cannot be inspected from at least one side. The areas considered as hidden parts on the concrete underbridges are listed below with a description of how the details are protected and access is provided for inspection.

Filler Deck	Beam	Description of hidden part	Protection provided	Access provided
Filler beam Deck.		Longitudinal filler beam section.	Encased in concrete that provides protection	None.

Appendix D Draft 12 of NR/L2/CIV/020 Design of Bridges & Culverts

Ref	NR/L2/CIV/020
Issue	1 (Draft 12)
Date	2008

Level 2

Design of Bridges & Culverts

Endorsement & Authorisation

Endorsed by:

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Authorised by:

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A. Dray, Head of Structures Engineering

Accepted for issue by:

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M. McManus, National Standards Manager

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Issue Record

Issue	Date	Comments
1	 2008	New standard. Incorporates and supersedes RT/CE/S/007 : <i>Design loading for accommodation and occupation overbridges.</i>

Compliance

This Network Rail standard specifies mandatory requirements and must be complied with by Network Rail and its contractors **from.....**

It is permissible for projects that have formally completed GRIP Level 4 at the compliance date (i.e. acceptance of Form A in accordance with NR/L2/CIV/003: *Technical approval of design, construction and maintenance of civil engineering infrastructure*) to continue to comply with the Network Rail standards and other standards and requirements as identified in the Form A and not to comply with the requirements contained herein, unless otherwise stipulated in the accompanying Briefing Note or Network Rail's specific requirements for the project.

Reference documentation

Railway Group Standards

GC/RT5021	Track System Requirements
GC/RT5112	Loading Requirements for Design of Bridges
GC/RT5203	Infrastructure Requirements for Personal Safety in Respect of Clearances and Access
GC/RT5212	Requirements for Defining and Maintaining Clearances
GE/RT8073	Requirements for the application of standard vehicle gauges
GE/RT8025	Electrical Protective Provisions for Electrified Lines
GL/RT1253	Mitigation of DC Stray Current effects
GM/RT2149	Requirements for Defining and Maintaining the Size of Railway Vehicles

Railway Approved Code of Practice / Guidance

GC/RC5510	Recommendations for the Design of Bridges
GE/GN8573	Guidance on gauging.

Network Rail Standards

At the time of publication a new reference system for Network Rail standards was being introduced; the references given to the following standards are those anticipated to be adopted in their next issue.

NR/L1/CIV/044	Managing structures works
NR/L2/CIV/003	Technical approval of design, construction and maintenance of civil engineering infrastructure
NR/L2/CIV/017	Examination of Bridges and Culverts
NR/L2/CIV/035	Assessment of structures
NR/L2/CIV/037	Managing the risk arising from mineral extraction and landfill
NR/L2/CIV/039	Specification RT98 – protective treatments for Railtrack infrastructure
NR/L2/CIV/041	Waterproofing systems for underline bridges
NR/L2/CIV/067	Design of equipment support structures
NR/L2/CIV/071	Design of earthworks, earthwork remediations and geotechnical aspects of foundations for structures
NR/L2/CIV/076	Management of bridge strikes from road vehicles & waterborne vessels
NR/L2/CIV/140	Control and use of model clauses
NR/L3/CIV/001	Waterproofing for underline bridge decks
NR/L3/CIV/002	Application and reapplication of protective treatments to Railtrack infrastructure
NR/L3/CIV/008	Model clauses for specifying civil engineering works
NR/L3/CIV/025	The structural assessment of underbridges
NR/L3/CIV/202	Management of the risk of bridge strikes
NR/L3/TRK/030	Lineside security
NR/SP/ELP/21085	Design of earthing and bonding systems for 25 kV A.C. electrified lines
NR/SP/OHS/069	Lineside facilities for personal safety
NR/SP/TRK/038	Longitudinal timbers – design, installation and maintenance
NR/SP/TRK/102	Track construction standards
NR/SP/TRK/9006	Design, installation and maintenance of lineside drainage
RT/CE/S/007	Loads for occupation/accommodation bridges (<i>Superseded by this standard</i>)