

TECHNICAL USER MANUAL

for

STANDARD HALF THROUGH BOX GIRDER UNDERBRIDGES

Standard Detail and Design Drawings

Summary

This technical user manual is applicable to the standard box girder type half through 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 on which the main girders are supported. Occasionally used to support trimmers.
Bridge	A deck and its supporting structure (e.g. cill/ impost beams, 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, or three, main girders and floor.
Designer	The person responsible for selecting the relevant standard designs and details to suit the specific requirements of a particular scheme.
Floor	The transverse element that supports the ballast and track, which for the box girder standard design comprises steel transverse ribs and steel plate.
Impost	Alternative name for cill. The (usually) concrete beam on which the lower part of the bridge bearings are located.
Main Girder	The primary load sustaining element that spans between bearings and supports the floor. Comprises a trapezoidal shaped box with a pair of flanges, possibly flange double plates, a vertical outer web and an inner inclined web, with internal diaphragm stiffeners.
Protective Treatment	A treatment applied to structural elements to protect them from the environment.
Scheme	Any planned work that involves the replacement of an existing bridge or deck.
Transverse Rib	A steel transverse member formed of a tee rib, generally out of a rolled UB section, and welded to the floor plate.
Trimmer Beam	The first cross member adjacent to the main girder bearings. May or may not support the trimmed ends at adjacent cross members.
TUM	Technical User Manual

SDD	Standard Designs and Details
Walkway	A separate standard detail comprising brackets attached to the outer web, with longitudinal spanning members. Positioned to allow railway personnel to traverse the bridge away from the track.
Waterproofing	Measures applied to handle and remove water off the deck and away from structural elements.
Box Girder Type	A standard underbridge arrangement comprising a pair of, or three, box girders supporting a steel floor.



I INTRODUCTION TO STANDARD DESIGNS AND DETAILS

The development of the Standard Designs and Details (SDD) has been undertaken 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.

I.1 Network Rail's Requirements

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

I.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.

I.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.

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- 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 so that they continue to carry rail traffic in the event of “bridge bash” at the site.
 - 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 and other functional requirements are defined in Network Rail standard NR/L2/CIV/020 (Draft 012) and the requirements therein have been met in designing the Standard Designs and Details.

1.2 The SDD Library

A library of Standard Designs and Details for a range of half through underbridge forms meeting these requirements has been produced. Underbridge forms include Z-Type decks, U-Type decks, E-Type decks and Box Girders. The library also includes details and guidance on elements that are common to a variety of bridge forms, such as walkways, typical deck end details and support cill details.

This document contains guidance on the use of the standard drawings for the Box Girder underbridge, 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.

The use of the SDDs is promoted from the highest level within Network Rail. Alternatives to the SDDs will only be considered where it can be demonstrated that a SDD cannot be used and must be agreed with Network Rail’s Professional Head of Civil Engineering. Failure to use a SDD may lead to authority for the project being withheld. However, selection of a Box Girder solution, or any of the SDD underbridges, must be as a result of a best overall value and function consideration.

2 GUIDANCE FOR USE OF NETWORK RAIL STANDARD DESIGNS AND DETAILS

The underlying philosophy of this standard is that a single basic standard deck design is provided, together with general details of the other components (i.e. main girders, bearings, walkways, protective treatment, waterproofing etc.) which go to make up a standard Box Girder underbridge superstructure.

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 with the minimum of design and drawing time, 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 Box Girder underbridge solution.

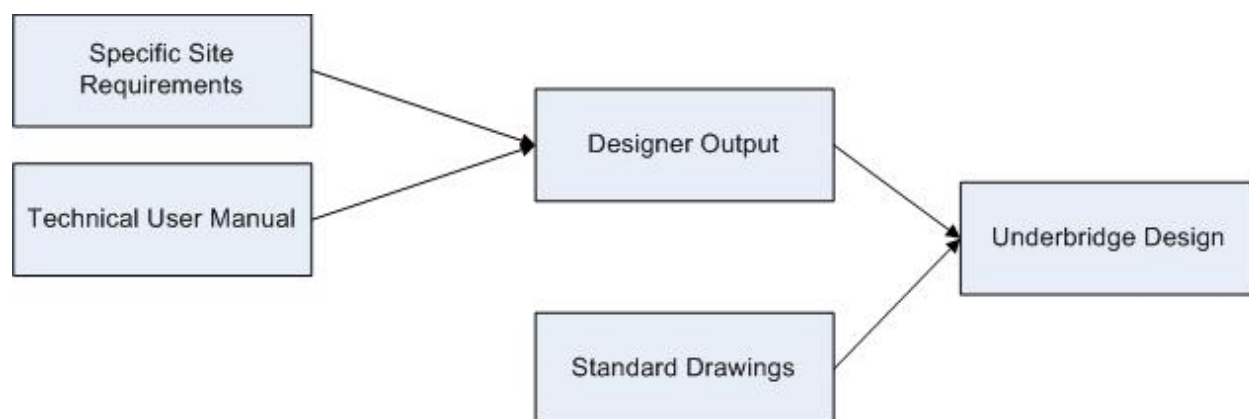


Figure 2.1: Flowchart to show the use of Network Rail's Standard Details and Designs

This manual describes the 2009 standard for rail underbridges using a half through construction arrangement of box girder main girders with a steel floor. 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.

Scheme specific design is still required to determine the overall bridge layout. The designer will also have to have to produce survey, proposed general arrangement, substructure details, track layout and levels and setting out drawings, as necessary. This will include the bridge steel layout.

The deck and other components have been designed to cater for a wide range of spans, skews and track geometry. For situations outside these parameters, the standard cannot be assumed to be applicable. Equally it will be obvious that the design here, in catering for such a wide range of circumstances, will inevitably involve conservatism on specific aspects and for specific bridge arrangements. Thus it may be possible to use the existing design in whole or part outside the given limits without modification, or to achieve a less substantial design (e.g. lower weight) within those limits, but again in both cases they will need approval, full re-design, and an appropriate check. If such a course of action is favoured these are matters that will need discussion with the client and with Network Rail's Professional Head of Civil Engineering.

2.1 Approval of Schemes Using Standard Designs & Details

The SDDs for each half through underbridge form have been submitted and approved by Network Rail at both Form A and Form B stages of the Network Rail approvals process; this has included a Category 3 Check.

The flowchart in Figure 2.2 demonstrates the general process of using the SDDs and TUMs.

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 particular SDDs that will be used.

Following Form A approval the designer will need to produce general arrangement and general assembly drawings, and any necessary substructure related drawings, including reinforcement schedules, and finishes details. The SDDs have been approved (Form B). Therefore the checking required for each specific scheme will be of the general arrangement and any substructure related drawings, including reinforcement schedules, to ensure they are suitable in meeting the scheme requirements.

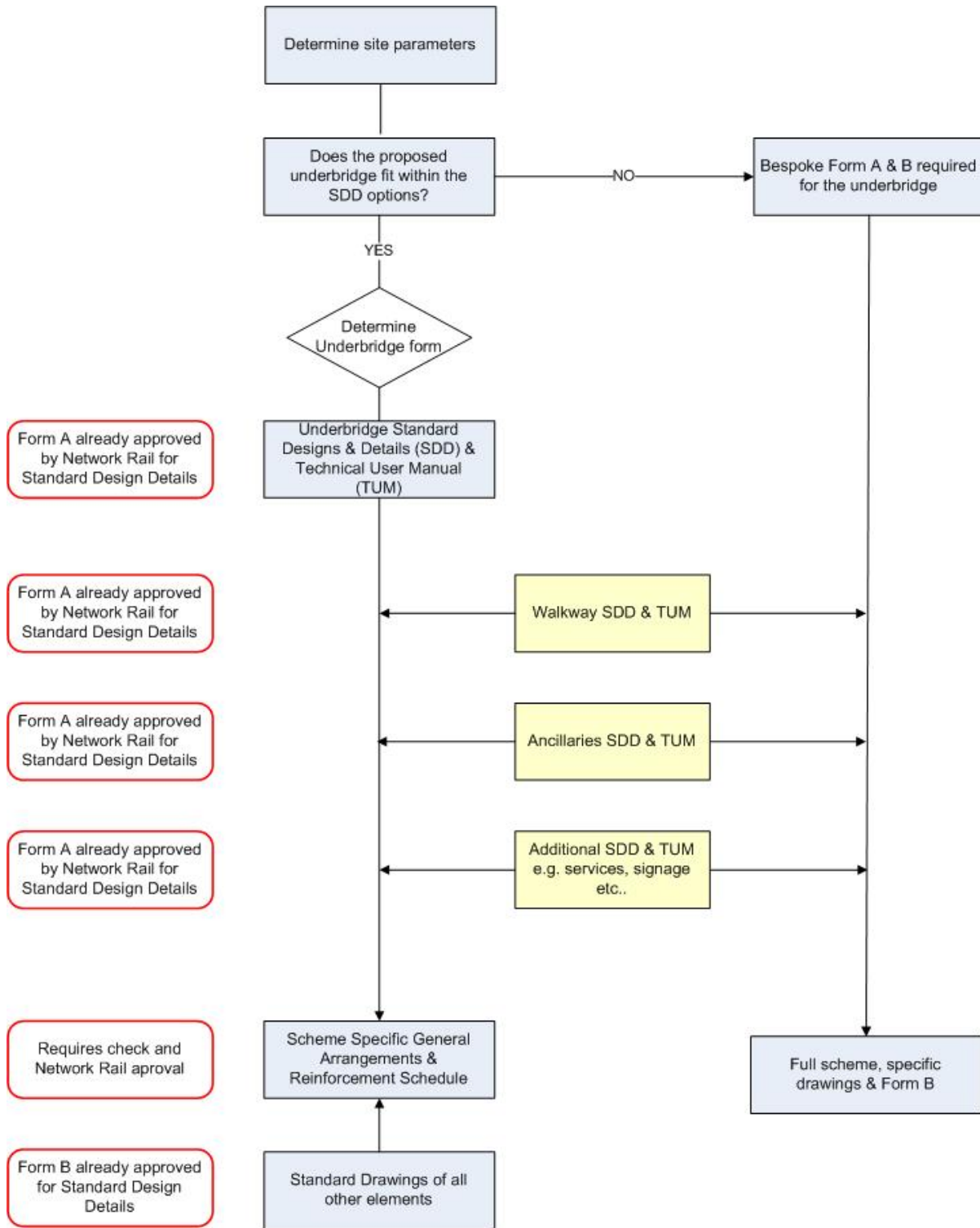


Figure 2.2: Process using the Standard Drawings and Technical User Manuals

3 BOX GIRDER TYPE UNDERBRIDGE APPLICATION DETAILS

The standard Box Girder 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 details for the superstructure including the bearings. For a particular bridge, the designer needs to determine the specific layout, choose the appropriate drawings, add the necessary dimensions and exercise specific options on these standard drawings

It is intended that only those standard drawings relevant to the specific contract are issued to the contractor as part of the contract drawings, together with general arrangement drawings particular to the specific bridge. The general arrangement drawing prepared by the designer will specify all principal dimensions and sizes, including material grades. Standard drawings relevant to the particular bridge should be listed on the general arrangement drawing.

The drawings cater for three deck arrangements and spans from 18m up to 39m. The box girder underbridges detailed are double track two girder arrangements (from 21m to 39m in 3m increments), double track three girder arrangements (from 21m to 27m in 3m increments) or single track two girder arrangements (from 21m to 27m in 3m increments). The 21m span box section is intended for use for spans down to 18m, or for shorter spans if other forms of underbridge are not suitable.

The box girder form of underbridge is particularly advantageous for skew ended decks; this is due to the shear plate connection between the deck and the main box girders that allows a degree of rotation. However, due to track twist criterion this SDD limits skew angles to 55°.

For the double track two girder bridge arrangement, two floor widths - "narrow" (6750 mm maximum) and "wide" (8600 mm maximum) - are available, depending on track geometry and depth of main girder. For the double track three girder or single track two girder bridge arrangements, the floor width is a maximum of 3200 mm. There is also a double track "shallow narrow" floor (6900mm maximum) for use in an alternative deck arrangement to double track three girder bridges, or where construction depth is particularly limited.

In particular cases, in order to assist with limiting track twist deformations of the deck, the "wide" floor will need to be deeper.

Where skew affects the design details (e.g. cross girder/ transverse rib details), there are separate standard drawings. For other details which are not skew related (e.g. bearings) there is a single drawing.

The designer should therefore choose the relevant drawings for the particular bridge skew range from the full set of standard drawings.



For skew bridges, the SDD drawings show a particular skew and floor width, which may not match the particular bridge under design. The standard design has considered all skew variations and the details shown can be rotated to suit the required direction of skew.

For the overall layout of the superstructure the key drawings are:

- The steelwork general assembly – for the relevant skew range, showing box girder sizes and diaphragms, positioned to take account of floor rib to box connections.
- The steel floor dimensional details – for the relevant skew range.

The standard drawings were not developed to be used as fabrication drawings. If the designer wishes to produce accurate bridge specific drawings then most views will need adjustment to the dimensions chosen for the particular bridge.



4 DETAILS OF STRUCTURAL FORM

The bridge concept is a half through deck comprising trapezoidal box girders and a Tee-rib stiffened plate deck. The box girders are proportioned to achieve the shortest possible floor span whilst located within the platform clearance of the standard structure gauge. The inclined inner face of the girder retains the track ballast via ballast plates and supports a steel floor of minimal depth consistent with requirements for strength, including fatigue, and stiffness. All inner webs are sloped at 3 (horizontal) to 25 (vertical).

The standard Box Girder design is suitable for double track in either a two girder or three girder arrangement, and single track bridges with two girders. The floor is steel with transverse spanning ribs, generally cut out of rolled UB sections, welded to the deck plate. The main girders are simply supported on fabricated line rocker bearings. Trimmer girders are supported on the inside face of the box adjacent to the main bearings, except for higher skewers when the trimmer is supported on bearings direct to suit the width of floor panels. Provision is made for low headroom bridges over highways for which vehicle collision restraint devices are detailed.

Walkways, with parapets, are cantilevered from the main girder outer webs and can incorporate a cable route to support services. Details of walkways are contained in a separate SDD package; the box girder SDD includes details of additional stiffening to the outer web at walkway bracket positions.

Permanent access for inspection (and tightening connections at time of construction) is provided through a hinged door in the end diaphragms of the main girders. A minimum number of intermediate diaphragms, with an access for inspection, are provided within the box girders consistent with the need to reduce warping and distortion stresses and to assist in fabrication.

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
- GC/RC5510 – Recommendations for the Design of Bridges.