

TECHNICAL USER MANUAL

for

STANDARD MODULAR OVERBRIDGES

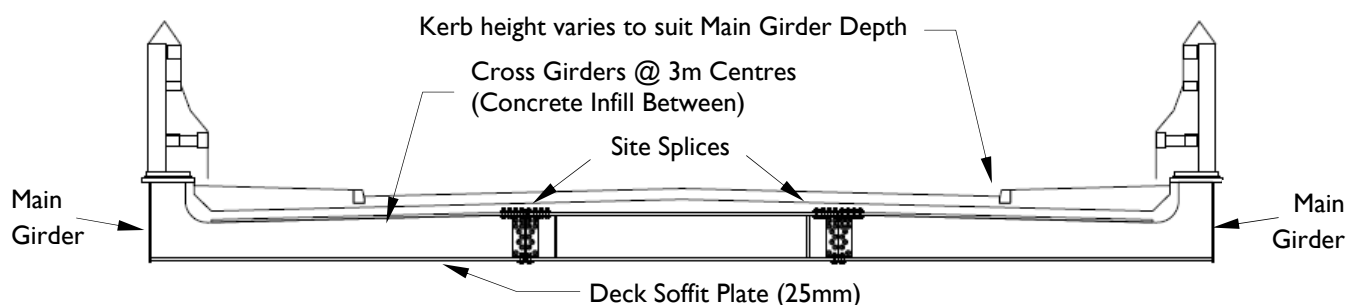
Standard Detail and Design Drawings



Summary

This technical user manual is applicable to the standard modular overbridges comprising a composite steel/concrete trough deck. 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.

Summary of Key Deck Components



Deck Component	Characteristic Features	Critical Design Parameter
Deck Slab	Spans between cross girders at 3m centres Provides redundancy to main steelwork components Acts compositely with Deck Soffit Plate	Provides 100mm concrete cover to cross-girders. Thickness governed by cross-girder depth
Deck Soffit Plate (25mm)	Provides permanent formwork for deck slab Forms bottom flange of cross girders & main girders Acts compositely with Deck Slab	Principal stresses associated with local bending & main girder/cross girder participation
Cross Girders	Spans between main girders Provides U-frame restraint to main girder top flange Spliced at third-points to form "Modular Deck" Relies on additional support derived from deck slab	Deck width/skew Depths governed by moments at bolted splices
Main Girders	Spans between deck end trimmers Additional load path provided by deck slab Main girder depth governs kerb height to carriageway	Deck span Depths governed by top flange stresses at mid-span
Deck End Trimmers	Provides support to ends of main girders Spans between proprietary pot bearings above end abutments	Deck width and span Depths governed by cantilever moments above support bearings
Support Bearings/ Jacking Provision	Proprietary pot bearings below end trimmers Bearings experience dual-curvatures due to trimmer and main girder deformations	Deck width and span Depth available for jack installation above common bearing plinth

Schedule of Standard Drawings

The standard deck details are summarised on twenty drawings. The design of most key deck components has been fully developed, including precamber requirements. A limited number of aspects will require site specific assessment, including foundation details, and temporary jacking arrangements. The following table highlights aspects requiring site specific assessment:

Drawing No.	Drawing Title	Items Requiring Site Specific Assessment
NR/CIV/SD/2500	General Notes	None
NR/CIV/SD/2501	Cross Girder Layout for a Range of Spans	Intermediate spans/skews may require alternative setting out
NR/CIV/SD/2502	Urban Option Cross Sections	Highway authority approval of kerb details
NR/CIV/SD/2503	Rural All Purpose Option Cross Sections	Highway authority approval of kerb details
NR/CIV/SD/2504	Accommodation Option Cross Sections	Highway authority approval of kerb details
NR/CIV/SD/2505	Cross Girder Splice Details	Bolt setting-out for intermediate skews
NR/CIV/SD/2506	End Trimmer Details	Bolt setting-out for intermediate skews
NR/CIV/SD/2507	Trimmer Splice Details	Bolt setting-out for intermediate skews
NR/CIV/SD/2508	Shear Stud Layout and Weld Details Sheet 1 of 2	Modifications to cross girder rebar holes if "Alternative Deck Splice" adopted
NR/CIV/SD/2509	Shear Stud Layout and Weld Details Sheet 2 of 2	Modifications to cross girder rebar holes if "Alternative Deck Splice" adopted
NR/CIV/SD/2510	Alternative Longitudinal Deck Joint Detail	Choice of "Alternative Deck Splice" or standard splice detail
NR/CIV/SD/2511	Urban Option Plans, Elevations and Sections (Typical Example)	Choice of parapet system, site specific foundation details
NR/CIV/SD/2512	Erection Scheme Layout for Rural All Purpose and Urban Options	Method of placing "Pour 2" deck slab concrete beneath main girder top flange to suit highway vertical alignment
NR/CIV/SD/2513	Erection Scheme Layout for Accommodation Option	As above
NR/CIV/SD/2514	Bearing Schedule	Consideration of bearing/plinth heights to suit site-specific jacking requirements (Section 4.14)
NR/CIV/SD/2515	Typical Deck Reinforcement Details	Modifications to cross girder rebar holes if "Alternative Deck Splice" adopted
NR/CIV/SD/2516	Reinforced Earth Abutment and Cill Details	Choice of abutment type, site specific foundation details and jacking clearance requirements
NR/CIV/SD/2517	Reinforced Concrete Pad Foundations	Choice of abutment type, site specific foundation details and jacking clearance requirements
NR/CIV/SD/2518	Vertical Alignment and Superelevation Details	Choice of normal crossfall or superelevation
NR/CIV/SD/2519	Drainage Details and Service Duct Locations	Highway authority approval of 100mm dia. drainage outlet. Main girder/footpath depth may be increased to suit large diameter services

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.

Revision	Date	Comments
Draft 1	July 2010	Draft issue for comment
Draft 2	August 2010	Draft re-issue
A	August 2010	Form B Approval

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GLOSSARY

Bearing	The elements on which the deck is supported, via deck end trimmers.
Bridge	A deck and its supporting structure (e.g. cill/impost beams, abutments).
Cill	Alternative name for impost. The concrete beam on which the lower part of the bridge bearings are supported.
Cross Girder	The secondary load sustaining element that spans between main girders and supports the in-situ concrete slab. Comprises an I-shaped beam with a thick, narrow top flange, a vertical web, and a wide, thin bottom flange also forming the exposed soffit of the deck.
Deck	A pair of supporting main girders and floor between.
Designer	The person responsible for selecting the relevant standard designs and details to suit the specific requirements of a particular scheme.
Filler Beam	A steel and concrete floor arrangement comprising transverse spanning steel sections encased within and acting compositely with a concrete slab.
Floor	The transverse element that supports the carriageway and footways, comprising steel transverse cross girders, and steel soffit plate acting compositely with the in-situ concrete slab.
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 abutments and supports the floor. Comprises an unsymmetric beam with a thick, narrow top flange, a vertical web, and a wide, thin bottom flange also forming the exposed soffit of the deck.
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.
SDD	Standard Designs and Details

Trief Kerb	A raised precast concrete kerb with a concave recess facing the carriageway designed to protect against errant vehicles by 'trapping' the bulge in tyre sidewalls, preventing wheels from climbing up the kerb and safely redirecting them onto the carriageway in a line dictated by the kerb.
Trimmer Beam	The first cross member spanning between support bearings. Trimmers extend beyond corner bearings to provide (cantilever) support to the main girders.
TUM	Technical User Manual
Two-Stage Pour	<p>Process of placing the in-situ concrete infill in two, separate operations, rather than a single, full depth pour. Concrete allowed to gain sufficient strength between successive pours that primary slab pour acts (partially) compositely with supporting steelwork to reduce overall deflections and locked-in steelwork stresses.</p> <p>Due to large shear flows in (composite) slab, first stage pour would require suitable surface preparation (eg. scabbling, blasting) to ensure good bond with second pour.</p>
Waterproofing	Measures applied to top surface of concrete deck slab to prevent water infiltration into structural elements.

1 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.

1.1 Network Rail's Requirements

Network Rail's requirements are split between two areas – cost effective 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 (overbridge 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



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- Structure gauge requirements – the overbridges 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.

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 Modular Overbridges.



2 GUIDANCE FOR USE OF NETWORK RAIL MODULAR OVERBRIDGE DESIGNS

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

This allows the designer to produce a specific bridge design to suit the particular span, skew, carriageway width, highway geometry, 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 Modular Overbridge solution.

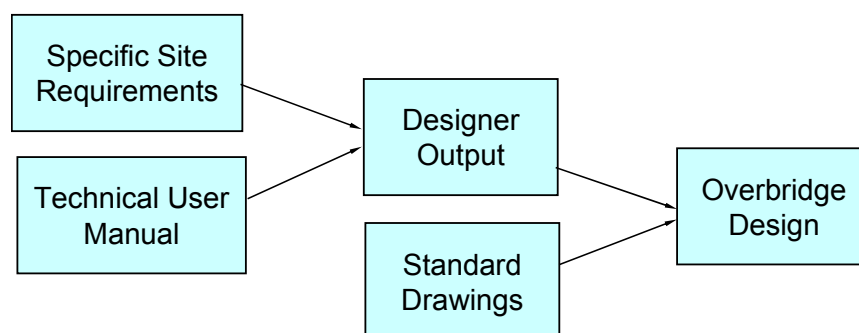


Figure 2.1: Flowchart showing use of Network Rail's Standard Details & Designs

This manual describes the 2010 standard for highway overbridges using a half through construction arrangement of main girders with a steel/concrete composite floor. It is intended to be read in conjunction with the set of standard drawings listed on Page 3.

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 produce survey, proposed general arrangement, substructure details, track clearances and setting out drawings, as necessary. This will include the bridge steel layout and may require consideration of precambers to compensate for deflections during in-situ concreting.

The deck and other components have been designed to cater for a wide range of spans, skews and highway 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 modular overbridge 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.

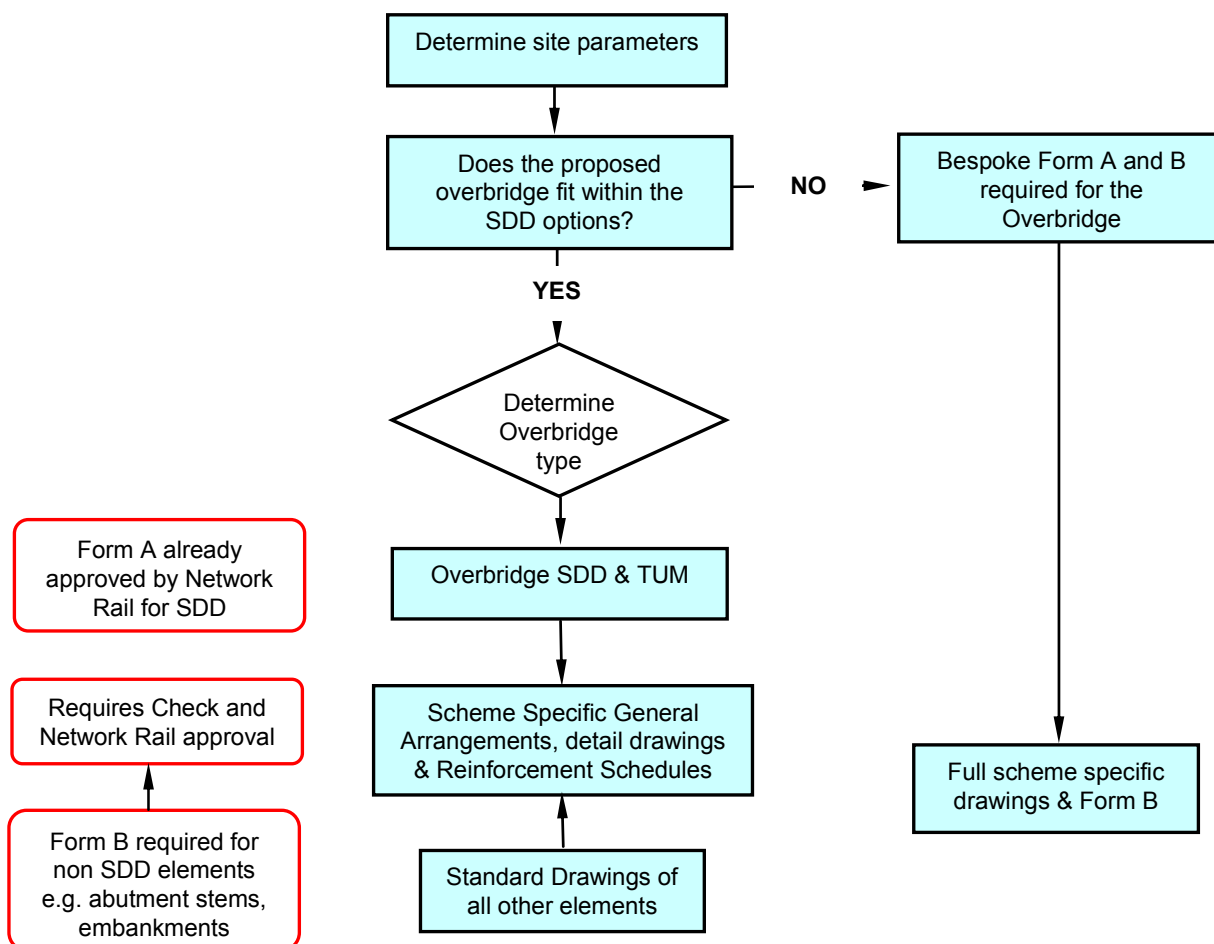


Figure 2.2: Process using the Standard Drawings and Technical User Manuals

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 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.

2.2 Drawing Selection Flowchart

The flowchart presented in Figure 2.3 may assist the designer in deciding the options to select and which drawings to use in detailing a standard modular deck.



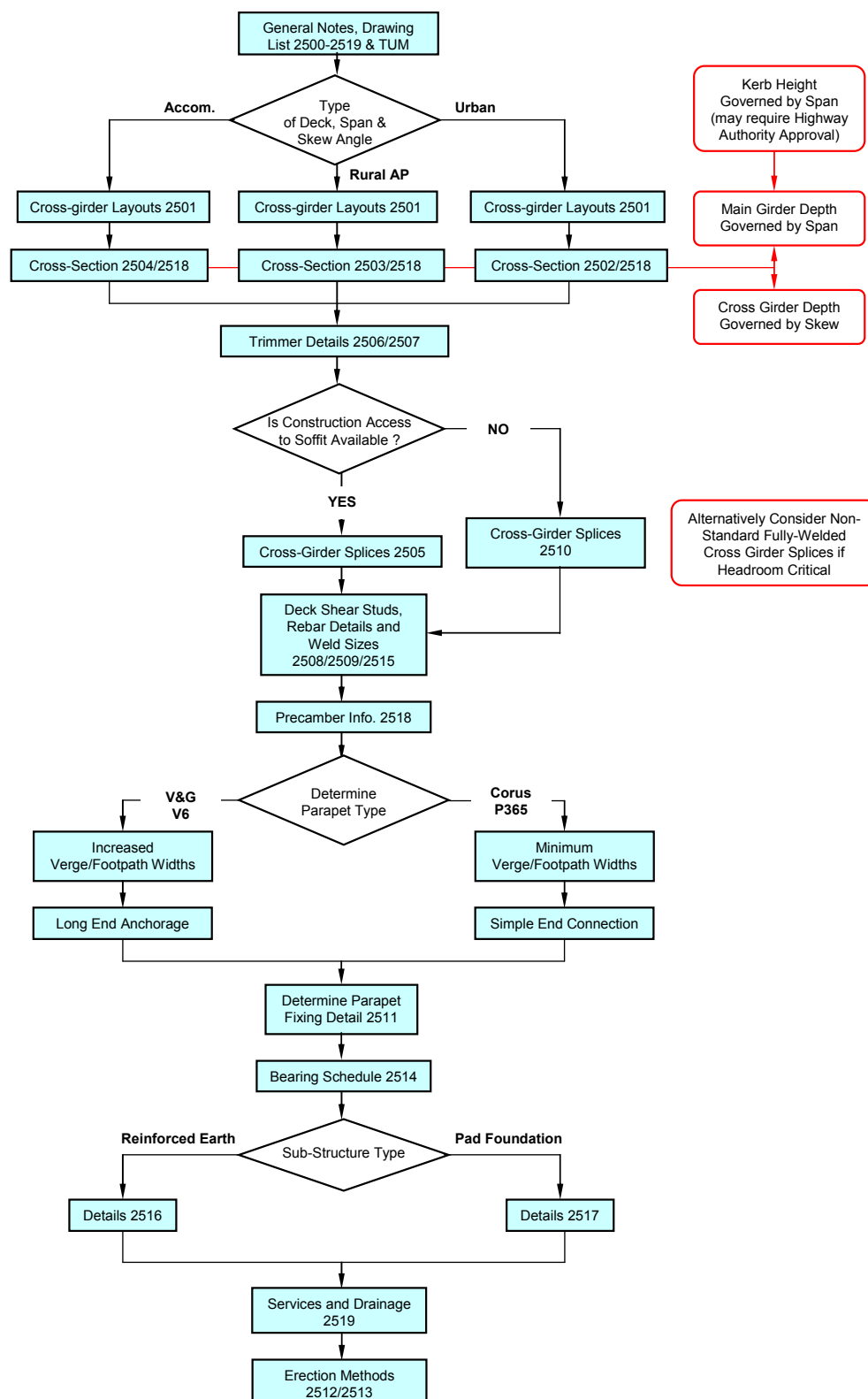


Figure 2.3: Determination of Standard Details for a Modular Overbridge

3 MODULAR OVERBRIDGE APPLICATION DETAILS

The standard Modular Overbridge design may be used at any suitable location in UK.

The standard drawings provide a complete set of details for the superstructure including the bearings and substructure elements. 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.

Details are also provided for substructure elements. Substructures comprise reinforced earth, or conventional reinforced concrete abutments (new-build applications) or reinforced concrete cills onto existing masonry abutments (deck replacements).

The substructures and approach embankments are intended to provide vertical clearances between the top of rail and the soffit of the deck of 5.2m minimum and 5.7m enhanced for new build situations. Clearances for reconstructions will be determined by existing highway and rail alignments and are to be confirmed by the scheme designer.

3.1 Scope of Application

The drawings cater for spans from 8.5m to 22m (square to abutments) in nine increments and skews from 0° to 30° in three increments (i.e. 0°, less than 15° and less than 30°).

Three standard deck arrangements are considered:

Designation	Carriageway Widths	Footway Widths	Verge Widths	Total Between Parapet Faces
Urban	2 x 3.65m	2 x 1.80m (min)	n/a	10.90m (min.)
Rural All Purpose	2 x 3.65m	1 x 1.80m (min)	1 x 0.60m (min)	9.70m (min.)
Accommodation	1 x 3.65m	n/a	2 x 0.60m (min)	4.85m (min.)

Table 3.1: Deck Arrangements Considered in Standard Details

The designer should choose the relevant drawings for the particular bridge type, span and skew range from the full set of standard drawings. Refer to flowchart in Figure 2.2.

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 designer should choose the relevant drawings for the particular bridge type, span and skew range from the full set of standard drawings. 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.

3.2 Loading Criteria

The design loading criteria adopted for the standard details is summarised in Table 3.1. Further information is provided in Appendix B.

Design Highway Loading	Special Vehicle Loading	Footway Loading	Provision for Exceptional Loads (if any)	Standard of Parapet Containment	Road Traffic Design Speed
Load Models 1 & 2 in accordance with BS EN 1991-2.	Load Model 3 as represented by SV100 in accordance with NA to BS EN 1991-2	Load Model 4 in accordance with BS EN 1991-2	None	H4(a) in accordance with BS EN 1317	70mph (max) Design speed dependent on vertical curvature

Table 3.2: Design Loading Standards Applicable to Standard Modular Overbridge Designs

Other loading standards may require modifications to deck details.

3.3 Typical Construction Details

Figure 3.1 illustrates a typical “Urban” deck cross-section.

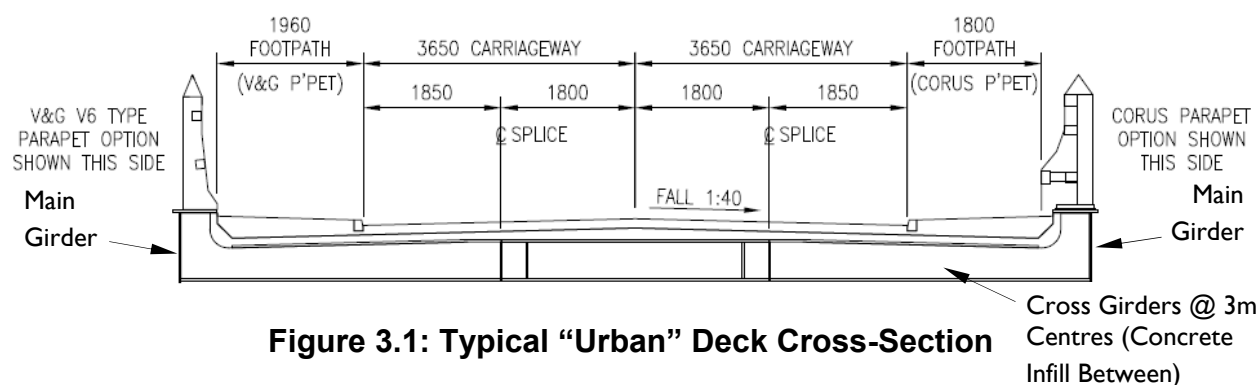


Figure 3.1: Typical “Urban” Deck Cross-Section

The deck comprises a series of regularly spaced cross girders spanning between edge main girders. The main girders span between deck end trimmers supported on proprietary pot bearings. Cross-girders and end trimmers are subsequently encapsulated in in-situ concrete, topped with sprayed waterproofing and 120-125mm of highway surfacing. A 25 mm steel floor plate is used for all decks.

A half-through form of construction is adopted, with the deck floor below main girder top flanges. This offers a particularly shallow form of construction – comparable with traditional “filler-beam” decks. Typical construction depths measured from the top of roadway centreline to underside of deck soffit are in the range 590-846mm (depending on deck type), inclusive of 125mm deck surfacing and waterproofing.

Parapets are fixed directly to the top of the main girders. The decks are designed to accommodate two alternative High Containment parapets:

1. A conventional Corus post-and-rail system – total width 682mm.
2. An alternative Varley and Gulliver V6 system – total width 455mm.

Varying kerb heights are used to accommodate the variation in main girder depths with span (see Figure 3.2). Increased kerb heights may also be used to accommodate large diameter services.

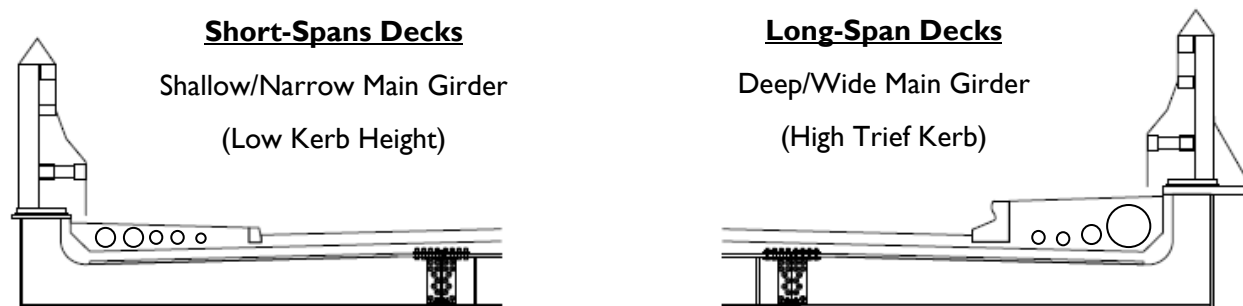


Figure 3.2: Typical Construction Details for Short-Span & Long-Span Urban Decks

The standard cross-section incorporates a “normal” crossfall, although superelevation and vertical curvature can also be accommodated - see Section 4.16.

3.4 Utility Provision on Bridge Decks

The standard decks have been detailed with service provision in the footway infill, above structural slab level. On short-span decks, footway construction would generally be limited to around 220mm, limiting service provision to around 150mm diameter ducts. However, scope exists for footpath construction to be made deeper if dictated by larger diameter services. Main girder depths would have to be increased to suit, as illustrated in Figure 3.2 above.

Standard details for longer-span decks inherently cater for larger service ducts via increased main girder depths. Ducts of up to 450mm diameter could be accommodated in 22m span, skewed decks. Larger ducts could be accommodated via bespoke detailing.

4 DETAILS OF STRUCTURAL FORM

The basic form of the structure comprises a composite steel and concrete trough deck superstructure supported by reinforced concrete cill units on existing substructures for reconstruction situations, or reinforced concrete abutments for new build situations.

A continuous steel soffit plate forms the base of the trough and acts as permanent formwork for the deck slab which acts compositely with the steel deck. The soffit plate is profiled to suit the highway vertical alignment and extends over the complete area of the deck acting as the bottom flange of both the cross girders and the main girders. The main edge girders have vertical webs and wide top flanges to minimise construction depths and provide the necessary mounting width for the parapet. Figure 4.1 illustrates some typical cross sections. The overall depth of the structure ranges from 765mm to 1255mm.

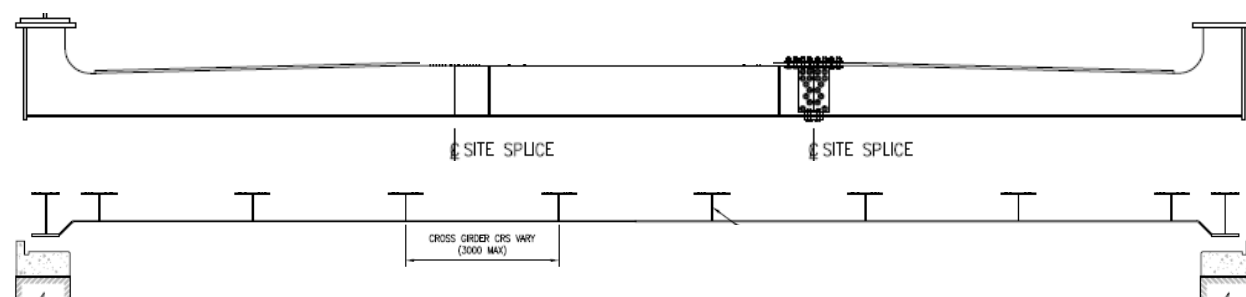


Figure 4.1: Typical Steelwork Details

a) Transverse Cross-Section b) Longitudinal Section (Main Girders not Shown for Clarity)

The external steelwork contains the reinforced concrete elements of the composite deck for convenient site casting and to avoid vulnerable external steel/concrete interfaces and crevices. The smooth external profile minimises protruding features or ledges thus avoiding corrosion traps and roosting platforms and is especially efficient for future maintenance. The web plate can be profiled to the highway alignment (including precamber) and will assist with efficient achievement of the necessary headroom clearances. It is arranged to over-sail the bottom flange by 20mm to ensure a good line to the soffit and to act as an effective drip to run off from the outer face.

Cross girders, generally spaced at 3.0m centres comprise a steel tee welded to the floor plate. The web of each tee extends to the full distance between the main girder webs and returns upwards to meet the underside of the main girder flange to create a diaphragm/stiffener in the main girder. The cross-girder web also serves as a U-frame restraint to the main girder top flange in the (sagging) bending region.

Cross girder flanges are curtailed near to their ends to avoid a slotted detail at the upturn of the web and transverse welding to the main girder web. Cross girders are

nominally 550mm deep for the widest (Urban) deck but reduce to 345mm for narrower decks. Cross girder spans and composition also vary with deck skew.

Deeper end trimmers are provided on the centre line of bearings over the abutments with the floor plate folded down and the main girder webs profiled to follow for neat external appearance avoiding any requirement for check walls on the abutment cills. End trimmers are nominally 500-1200mm deep (depending on deck width and main girder span). Trimmers incorporate bearing stiffeners approximately 900mm in board from the deck edge to allow bearings to be mounted on abutments of limited width (such as when high containment parapets demand extended deck widths). Proprietary pot bearings are provided at each support location to provide rotation capability about both plan axes to cater for wet concrete and in-service deformations. Trimmers have designated jacking locations for future maintenance provision and for new build situations opportunity exists to re-detail the bridge ends to incorporate semi-integral construction removing the need for expansion joints.

On completion of erection, all cross-girders and trimmers are encapsulated in concrete. To limit overall construction depth, the reinforced concrete floor slab provides a minimal 100mm cover to the top of the cross girders to limit corrosion damage, mobilise composite strength and provide a durable top surface for normal waterproofing and surfacing systems. The lower edge of the deck concrete is contained at the end of the deck by the folded floor plate and the web of the trimmer. The top surface of the slab extends over the top of the trimmer and encapsulates the rear face to provide a durable encasement at the expansion joint.

Permanent access for inspection of steelwork elements and connections is limited by the presence of the deck slab concrete. However, once the steelwork is encapsulated, there should be little or no reason to inspect these components during their service life. The steelwork soffit and edge girder should be visible for inspection from below, or possibly via road mounted access gantry. The deck end expansion (asphalt plug) joint) is likely to require regular access for inspection and repair. This is accessible from above deck level.

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.