

BC Ministry of Forests

BRIDGE STANDARDS MANUAL



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1. GENERAL

1.1 INTRODUCTION

The BC Ministry of Forests is responsible as the Regulatory Authority for determining appropriate standards for bridges on Forest Service Roads (FSRs) in British Columbia. This *Bridge Standards Manual* (BSM or Manual) provides these standards.

The BSM is comprised of pertinent standards such as guidelines, specifications, requirements, drawings, procedures, forms, policies, and requisition templates. The Manual is intended for use by ministry staff and others, including bridge engineers, engineering technicians, surveyors, hydrologists, river engineers, geoscientists, geotechnical engineers, structural engineers, forest professionals, project managers, bridge fabricators, bridge installers and bridge inspectors.

The standards provided in the BSM (including its appendices) are mandatory for FSR bridges. Explanatory non-mandatory information is provided in the BSM in locations identified as *Commentary*.

The Ministry allows some deviation from these standards for re-installation of used bridges, modification of existing bridges, or other unusual situations. These kinds of projects require approval by a Ministry Engineer who will be responsible to adapt the use of ministry bridge standards as appropriate to suit a specific situation.

Most of the BSM applies to durable bridges (which have a 45 year minimum design life) that are primarily composed of durable materials (e.g.; steel, concrete and treated wood). A small portion of the Manual applies to bridges primarily composed of nondurable materials (e.g.; logs and untreated sawn wood.) FSR bridges shall be composed of durable materials unless otherwise approved by a Ministry Engineer for a specific project.

Bridges with any span > 40 m, continuous multi-span bridges, bridges with total length > 80 m, or otherwise complex or unique bridges require special engineering investigations, and some deviations from common ministry standards. These deviations must be approved by the Ministry Engineer responsible for the project.

In some Manual locations the term “bridge” is used in a general sense to refer to both bridges and major culverts (which are both addressed in the Manual). In other Manual locations the term “bridge” is used in a more specific way that excludes culverts.

A small amount of information in the Manual is provided relating to recreation bridges (for pedestrians and/or ATVs) that the Ministry may occasionally be involved with that are not on FSRs. A Ministry Engineer shall determine appropriate standards for specific recreation bridge projects.

The BSM is regularly being updated and improved. Any printed or downloaded versions that people may make will become obsolete as changes to the official version are made on-line.

The Ministry (FLNREng.Branch@gov.bc.ca) welcomes suggestions and recommendations to assist in refining and improving this Manual.

Commentary

The BSM continues the Ministry of Forests tradition of providing forest bridge standards by building upon and modernizing the “Forest Service Bridge Design and Construction Manual” which is now obsolete:

[Bridge Design & Construction Manual - July 1999 OBSOLETE \(PDF, 460KB\)](#)

Some of the benefits of Bridge Standards include:

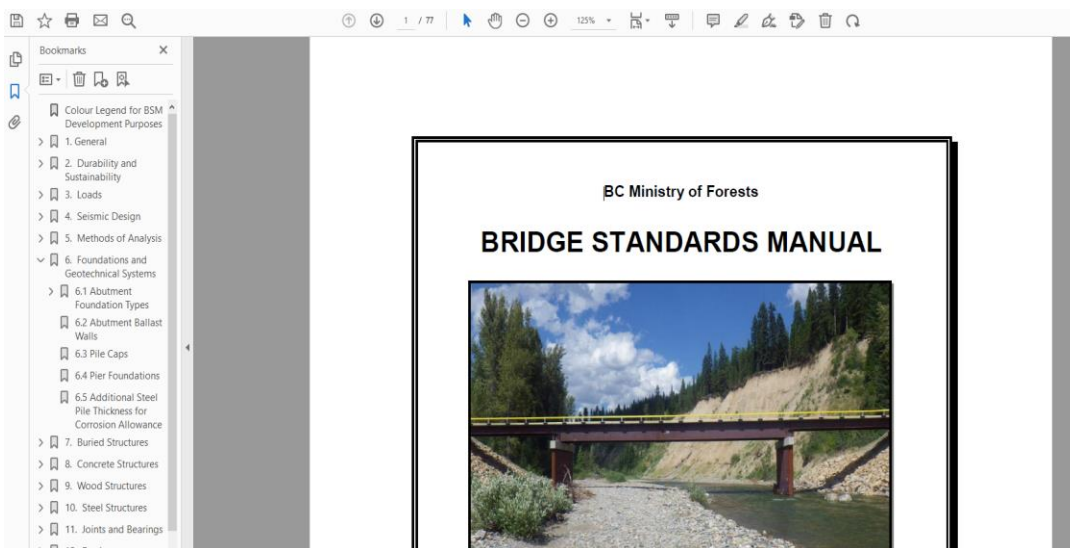
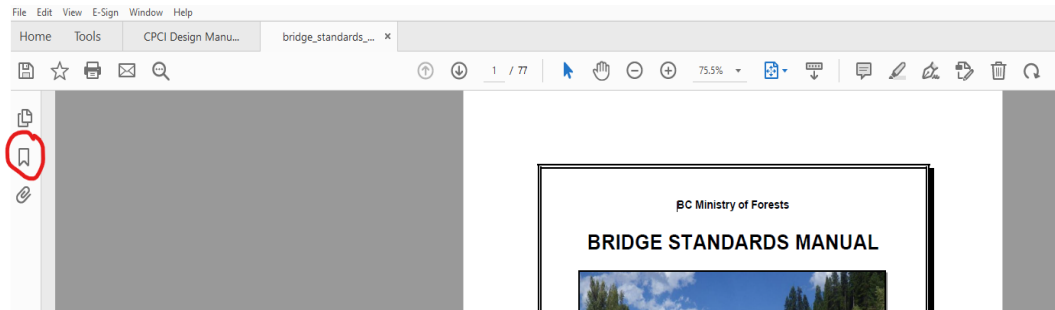
- *Provision of minimum performance requirements in the form of mandatory design and construction practices;*
- *Emphasis on details that result in the lowest life-cycle cost (construction cost plus maintenance cost over the lifetime of a bridge);*
- *Economy of scale and design efficiency for components that exhibit limited variation;*
- *Assurance of safety, consistency and fair competition for supply, fabrication, installation, inspection and evaluation of bridges.*

1.2 HELPFUL FEATURE FOR VIEWING THE MANUAL PDF

When viewing the Bridge Standards Manual pdf, it is helpful to view and utilize a left-hand navigation feature using “bookmarks” that allow a reader to see all table of contents section headings regardless of where they are in the document. Each of the section headings can be expanded to see sub-headings as desired. A reader can click on any of the headings or sub-headings to instantly move to a desired part of the document.

On a typical personal computer, a reader may need to click on “open in desktop app” (see first image below) after they initially open the PDF, to see a “bookmarks” icon on the left side of the screen (second image below). Clicking on the bookmarks icon will allow the left hand navigation feature to become visible (3rd image below).





1.3 LIST OF ACRONYMS

AASHTO	American Association of State Highway Officials
ABCFFP	Association of BC Forest Professionals
ASP	All-Steel-Portable
ASTM	American Society for Testing and Materials
ATV	All-Terrain Vehicle
BCL	British Columbia Loading
BGSS	Bridge Guidelines, Standards and Specifications (website)
BSM	Bridge Standards Manual
CBR	Corporate Bridge Register
CCA	Chromated Copper Arsenate
CHBDC	CSA S6 (<i>Canadian Highway Bridge Design Code</i>)

CL-W	Where referenced by CHBDC shall be interpreted for FSR bridges to mean “design traffic loading”, thereby referring to the specific normal design traffic loading scenario being used for a site.
CRB	Concrete Roadside Barrier
CRP	Coordinating Registered Professional
CSA	Canadian Standards Association
CWB	Canadian Welding Bureau
DFO	Fisheries and Oceans Canada
DLA	Dynamic Load Allowance
EGBC	The Association of Engineers and Geoscientists of BC (doing business as Engineers and Geoscientists BC)
ENV	Ministry of Environment and Climate Change Strategy
FERIC	Forest Engineering Research Institute of Canada (now FPIInnovations)
FHWA	Federal Highway Administration
FOR	British Columbia Ministry of Forests
FPPR	<i>Forest Planning and Practices Regulation</i>
FRPA	<i>Forest and Range Practices Act</i>
FSR	Forest Service Road
GA	General Arrangement
GAE	General Arrangement Engineer
GVW	Gross Vehicle Weight
HOH	Heavy Off Highway
HSS	Hollow Structural Section
HWL	High Water Level
L-###	Logging Truck Loading - GVW in 2,000 lb tons
LOH	Light Off Highway
MoF or MOF	See FOR
MoTI	See TRAN
NPA	<i>Navigation Protection Act</i>
PCI	Precast/Prestressed Concrete Institute
POR	Professional of Record
PWL	Present Water Level
QA	Quality Assurance

QC	Quality Control
SDD	Structural Design Drawing
SDE	Structural Design Engineer
TRAN	British Columbia Ministry of Transportation and Infrastructure

1.4 DEFINITIONS

The definitions provided below apply to the BSM. Definitions in related documents and databases (e.g.; legislation, CHBDC, Ministry Engineering Manual, Ministry CBR database and user manual, EGBC documents, etc.) may vary from these definitions.

- **Buried Structure:** See definition of major culvert.
- **Coordinating Registered Professional:** A professional responsible for coordinating a specific project (see Ministry Engineering Manual and EGBC website for details).
- **Conceptual Drawings:**
 - (1): (aka General Arrangement Drawings) An engineered drawing set showing site information, site works, and some structural design information for a specific site.
 - (2): Any drawings that provide general (but not detailed) information.
- **Crossing:** A site where a road is carried above a stream or other opening.
- **Design Drawings:** Engineered drawings (including General Arrangement Drawings and Structural Design Drawings but not Shop Fabrication Drawings) prepared for the fabrication and/or installation of a structure.
- **Design Engineer:** An Engineer responsible for the design of a specific structure (including general arrangement design and/or structural design.)
- **Design Life:** A period during which a structure is intended to perform its design function for the intended use(s). For portable and semi-portable bridges this includes usage at multiple installation sites.
- **Detailed Design Drawings:** See definition for Structural Design Drawings.
- **Detailed Design Engineer:** See definition for Structural Design Engineer.
- **Durable:** Having a design life of at least 45 years.
- **Durable Culvert:** A culvert that is composed of durable culvert materials.

- **Durable Culvert Materials:** Materials that have a minimum 45 year design life (including concrete, galvanized steel or equivalent durability materials.)
- **Durable Bridge:** A bridge that has girders, deck, substructure (including ballast walls) and barriers composed of durable bridge materials (untreated running planks on an otherwise durable deck are an allowable exception.)
- **Durable Bridge Materials:** Materials that have a minimum 45 year design life (including concrete, treated wood, and steel (except railcar steel); and including aluminum for recreation bridges.)
- **Engineer:** A Professional Engineer registered with EGBC (or another professional allowed by the Ministry Engineering Manual and EGBC to do specific types of professional engineering work.)
- **Forest Service Road:** A road on Crown land that is declared under the Forest Act or a former Act to be a Forest Service Road. When interpreting CHBDC for use in FSR bridge projects, the CHBDC term “Highway” shall be interpreted to mean FSR.
- **General Arrangement Drawings:**
 - (1): (typical) (aka Conceptual Drawings) An engineered drawing set showing site information, site works, and some structural design information for a specific site.
 - (2): (occasional) A drawing included in a drawing set that shows how various components in the drawing set are arranged (i.e.; fit) together.
- **General Arrangement Engineer:** (aka Conceptual Design Engineer) An engineer responsible for a drawing set showing site information, site works, and some structural design information for a specific site.
- **Hazard Marker:** (sometimes incorrectly identified in older ministry documents and drawings as a “bridge delineator”) A warning sign (either Left or Right) typically attached to bridge guardrails.
- **Includes:** Shall be interpreted to mean “includes but is not limited to.”
- **In-plant QA Engineer:** The engineer responsible for Quality Assurance field reviews of bridge components at fabrication plants.
- **Library:** The [FOR Bridge Standards Library](#)
- **Major Culvert:** (aka buried structure) A crossing structure (with earth, gravel, or rock fill on top of it) where at least one of the following applies:
 - 1) The structure is metal or concrete, where at least one of the following applies:

- i) The pipe diameter is $\geq 2,000$ mm;
 - ii) The pipe-arch has a span $>2,130$ mm; or
 - iii) The open-bottom arch has a span $>2,130$ mm;
- OR
- 2) The structure has an opening area $>3\text{m}^2$, but is not a bridge;
- OR
- 3) The structure is not a bridge however the design water flow in the stream is ≥ 6 m^3/sec .

In some locations in this Manual, major culverts are referred to simply as culverts.

- **Manual:** Refers to the Bridge Standards Manual, unless otherwise specified.
- **Ministry:** The British Columbia Ministry of Forests, representing the Province of BC as the Regulatory Authority/Owner.
- **Ministry Engineer:** An engineer who is a Ministry of Forests employee. This engineer is considered to represent the Ministry as an “owner’s engineer”.
- **Minor Culvert:** A culvert smaller and with less design water flow than a major culvert. This Manual does not pertain to minor culverts; they are addressed in the Ministry Engineering Manual.
- **Movable Bridge:** A bascule, swing or lift bridge; as described in CHBDC Section 13. These are generally not used on FSRs.
- **Nondurable:** Having a design life less than 45 years.
- **Nondurable Structure:** A structure that is composed of nondurable materials.
- **Nondurable Materials:** Logs, untreated wood, or sub-standard materials such as railcar steel.
- **Normal Traffic:** Ministry standard traffic loading (BCL-625, L100, L150 and L165.)
- **Portable Bridge:** A bridge that is designed for ease of movement from one installation site to another with the intent that it will be used at multiple sites over its lifetime.
- **Prime Stationary Bridge:** A bridge that is designed for installation at a single site with the intention that it will provide the highest quality ministry standard safety and service for at least a 45 year design life with minimal required maintenance.

- **Professional of Record:** An engineer professionally responsible for engineering work.
- **Project:** Work that involves design and/or fabrication and/or installation of a structure or a component of a structure.
- **Semi-Portable Bridge:** A bridge with less portability than a portable bridge but more portability than a stationary bridge.
- **Shop Fabrication Drawings:** (aka Shop Drawings) Drawings, typically not prepared by engineers, that a fabricator prepares to assist in their fabrication processes.
- **Site:** The location where a crossing structure will be, or is, installed.
- **Specific (bridge, project, site, component, drawing, etc.):** A discrete physical bridge, project, site, component, drawing, etc. (not a generic/standard bridge, project, site, component, drawing, etc.) The term specific is used occasionally in the Manual to emphasize this differentiation.
- **Standard(s):** Guidelines, specifications, requirements, drawings, procedures, forms, policies, requisition templates, and similar mandatory information included in the BSM.
- **Standard Drawings:** Ministry generic drawings that provide information to be used, where appropriate, by engineers that are responsible for specific projects.
- **Standard Drawing Engineer:** An engineer identified on a Ministry Standard Drawing as being involved with the development of the Standard Drawing. A Standard Drawing Engineer is not to be considered a CRP, GAE, SDE, POR or Ministry Engineer for a specific project unless they are actively involved with the project as it is being undertaken and they agree to accept these responsibilities.
- **Stationary Bridge:** A bridge that is designed to be used at only one installation site (i.e.; not portable or semi-portable.)
- **Structure:** A bridge or major culvert.
- **Structural Design Drawings:** (aka Detailed Design Drawings) An engineered drawing intended for fabrication/construction of a specific project that shows all structural engineering details related to a component or structure.
- **Structural Design Engineer:** (aka Detailed Design Engineer) An engineer who is responsible for the structural design of a specific component or specific structure. This includes taking structural engineering responsibility for the use and application of Ministry Standard Drawings or previously used components for a specific project.

1.5 REFERENCES

It is not always possible to keep Ministry standard documents and drawings up-to-date and consistent with continually changing references. Unless otherwise noted, all references in this Manual should be interpreted to refer to the most current version of a reference at the time a project is being undertaken. For example:

- A reference to the obsolete “Forest Service Bridge Design and Construction Manual” or the obsolete “Interim Bridge Design Guidelines” should be interpreted to reference the current BSM;
- A reference to “Ministry of Forests and Range”, “Ministry of Forests, Lands and Natural Resource Operations”, or other similar Ministry names that have now been superseded should be interpreted to refer to the current Ministry name “Ministry of Forests;”
- A reference requiring design to be in accordance with CSA S6-88 (or other obsolete version of CSA S6) should typically be interpreted to be referencing the most recent version of CSA S6 (CHBDC). An exception is that BSM Section 3: Loads is written with some references that are specific to only one version of CHBDC which is CSA S6-19. If clarity is required, a Ministry Engineer should be contacted.

1.6 MANDATORY USE OF THIS MANUAL

1.6.1 GENERAL

All structures shall be designed, constructed, handled, inspected, evaluated and otherwise dealt with in accordance with the standards described and referenced in this Manual, unless approval has been obtained from a Ministry Engineer.

This requirement shall apply to structures built under all ministry contracts and authorizations, including structures authorized in a Timber Sale Licence that have been identified by the Timber Sales Manager to become crown assets after termination of the Timber Sale License.

The Ministry may reject any structures or components that do not adhere to standards.

Engineering of a specific project is the responsibility of the engineers directly involved with the project. This includes the responsibility to use, interpret, investigate (and possibly modify the use of) standards (including Standard Drawings) in a way that is appropriate for a project.

1.6.2 APPROVAL FOR DEVIATION FROM STANDARDS

To be valid, approval from a Ministry Engineer for deviation from bridge standards shall be:

- Specific to one project only;
- Provided in advance of the deviation being made; and
- Specific to one issue (i.e.; routine Ministry Engineer acceptance of a drawing set does not mean that deviations in the drawing set are approved by the Ministry Engineer unless they were specifically discussed with and accepted by the Ministry Engineer.)

Notwithstanding the above, approval from a Ministry Engineer for a deviation from bridge standards for more than one project (i.e.; for the foreseeable future) requires that the approval be obtained as such from the Ministry Bridge Standards Engineer or the Ministry Engineering Standards Group Leader.

Email requests for approval may be sent to FLNREng.Branch@gov.bc.ca, specifying “Request for Ministry Approval” in the title.

The approval process described in this section applies to all references (that occur in this Manual or other ministry drawings, contracts, or documents) to approval or acceptance (provided by a Ministry Engineer) of deviations, alternatives, or variations from ministry bridge standards.

1.7 CLARIFICATION OF DISCREPANCIES IN BRIDGE CONTRACTUAL DOCUMENTS

Contracts managed by the Ministry shall provide guidance to bidders regarding the clarification of possible discrepancies between various types of ministry provided information relevant to a project.

1.8 BRIDGE STANDARDS OVERVIEW

1.8.1 MANDATORY BRIDGE STANDARDS INFORMATION TYPES

The following briefly introduces ministry information types included in this Manual that provide mandatory standards for bridges.

- **Main Body:** Information provided directly within the main body of the Manual;
- **Appendices:** Information provided in documents or drawings that are identified as appendices to the Manual;

1.8.2 CANADIAN HIGHWAY BRIDGE DESIGN CODE (CHBDC)

The standards in the Bridge Standards Manual govern over requirements specified in the Canadian Highway Bridge Design Code CAN/CSA S6 (CHBDC).

For any bridge standards aspects that are not specifically addressed in the BSM, the most recent version of CHBDC shall apply unless:

- otherwise approved by a Ministry Engineer, or
- a particular CHBDC clause is generally understood by experienced FSR bridge engineers and Ministry Engineers to be clearly inapplicable to an FSR bridge.

Commentary

The titles of BSM sections 1 to 17 correlate with the 17 section titles in CHBDC to allow for reasonably consistent categorization of information.

BSM sections numbered 18 and higher provide Ministry Bridge Standards information in sections that do not exist in CHBDC.

1.8.3 NON-MANDATORY BRIDGE STANDARDS INFORMATION

The [Bridge Standards Library \(Library\)](#) provides access to non-mandatory forest bridge standards related items that document research, testing, recommendations, obsolete standards, draft standards, webinars, educational materials, etc. The items include documents, presentations, drawings and videos.

Some of the information in the Library is obsolete or unproven, however may provide ideas that will assist in relation to current projects. An engineer experienced in current forest bridge practices shall be consulted for advice prior to relying on any of the information in the Library.

1.9 LEGISLATION AND ADMINISTRATIVE POLICIES

1.9.1 FOREST PLANNING AND PRACTICES REGULATION (FPPR) REQUIREMENTS

The provincial Act that provides important legislation applicable to Forest Service Roads and bridges is the Forest and Range Practices Act (FRPA). The [Forest Planning and Practices Regulation \(FPPR\)](#) is the primary regulation under this act that provides details pertinent to design and construction of bridges and major culverts (in section 73 and other sections).

1.9.2 THE ENGINEERING MANUAL

The ministry [Engineering Manual](#) is an extensive document that covers a variety of engineering topics. It is the main repository of general ministry engineering policies.

1.10 ENGINEERS AND GEOSCIENTISTS BC (EGBC) REQUIREMENTS

1.10.1 GENERAL

Engineers and Geoscientists British Columbia (EGBC) provides various requirements that regulate the profession of engineering as it relates to FSR bridge design and construction. All applicable requirements shall be followed in relation to FSR bridge projects. Some, but not all, of the requirements are discussed in the section below and in other sections of this manual.

1.10.2 CROSSINGS

One of the applicable EGBC professional practice guidelines specific to forest bridge design and construction is called [Professional Services in the Forest Sector – Crossings \(PDF, 2.1MB\)](#).

Commentary

This guideline was co-produced together with the Association of BC Forest Professionals (ABC FP). Along with other professional issues related to crossing design and construction, the guideline provides detailed information about the qualifications required by EGBC and ABCFP professionals when they are involved with various types of crossing projects.

1.10.3 DOCUMENTED FIELD REVIEWS DURING CONSTRUCTION

Field reviews for FSR bridge and major culvert construction projects shall be undertaken and documented in accordance with the EGBC guideline: [Documented Field Reviews During Implementation or Construction \(PDF, 369KB\)](#).

Field reviews for in-plant inspection are the responsibility of the ministry's in-plant inspection agency as described elsewhere in this manual.

Any proposed changes from the ministry accepted General Arrangement Drawings, Structural Design Drawings or Shop Drawings must be accepted by a Ministry Engineer prior to implementation. This Ministry Engineer shall contact the Design Engineer to discuss any significant proposed changes.

1.11 ECONOMICS

Provided that all safety and durability provisions are met, cost effectiveness of the structure shall be considered in selecting the structure type and materials.

1.12 SAFETY

In the interpretation and application of Ministry bridge standards, the primary concern shall be safety, including but not limited to bridge users, the public, ministry staff, inspectors, and construction and maintenance workers.

All work shall be carried out in full conformance with WorkSafe BC requirements.

1.13 NAVIGATION REQUIREMENTS

Bridge construction projects shall comply with navigation requirements and referral processes specified by Transport Canada, who administers the [Navigation Protection Act](#) (formerly known as the Navigable Waters Protection Act). Transport Canada's mandate includes protection of the public right of navigation.

Commentary

Transport Canada provides guidance for owners of works regarding their obligations and options under the Navigation Protection Act (NPA) as part of their [Navigation Protection Program](#).

1.14 ENVIRONMENTAL REQUIREMENTS

This section provides an overview only and should not be considered a full description of all environmental requirements.

Bridges and their associated works shall be designed and constructed in compliance with all established environmental requirements.

A bridge project shall include assessment of possible environmental effects due to construction and shall limit any adverse effects. Timing and methods of construction may be affected by government agency environmental requirements.

“Environmental Management Plans” and “Environmental Monitoring” are typically required for bridge projects. (see Chapter 4 of the Ministry’s [Engineering Manual](#) for details).

Where existing structures are being removed as part of the new construction process, proper approvals from local government offices shall be received for any waste disposal needs (e.g.; dealing with treated wood and occasionally metal culverts.)

Commentary

The BC [Ministry of Environment and Climate Change Strategy \(ENV\)](#) is concerned with protecting water, land and air quality; managing flood and erosion control; and protecting the population and habitat of animals and resident fish species. ENV administers various Acts relevant to bridge or major culvert construction.

Fisheries and Oceans Canada (DFO) is the lead federal government department responsible for protecting anadromous fish species and their habitat by administering the [Fisheries Act and Regulations](#). Helpful information is provided by DFO on their website [Projects Near Water](#).

The [Forest Planning and Practices Regulation \(FPPR\)](#) contains some pertinent environmental requirements that need to be met.

1.15 SITE PLANS

Site plans shall conform to the requirements of [Bridge Site Plan Standards \(PDF, 33KB\)](#) and shall be prepared by capable survey and drafting staff working with guidance from an engineer experienced in forest bridge design.

Commentary

Professional engineering guidance will help to ensure that surveying and site plan presentation will allow engineering design work to be efficiently undertaken.

1.16 HYDROTECHNICAL DESIGN

Bridge design and scour protection shall be based on the requirements in this sub-section.

1.16.1 HYDROLOGIC DESIGN

The [Bridge Hydrologic Design Standards \(PDF, 92KB\)](#) provides detailed ministry requirements for hydrologic design, which includes reference to the

[Manual of Operational Hydrology in British Columbia, B.C. Ministry of Environment \(PDF, 10.5MB\)](#)

1.16.2 RIPRAP

The [Riprap Standards \(PDF, 208KB\)](#) provide specifications for rock riprap quality, sizing and placement when riprap is required for scour protection, or other uses, at ministry bridge sites.

1.17 DESIGN FOR WILDFIRE RESISTANCE

1.17.1 CHOICE OF BRIDGE COMPONENT MATERIALS

Choice of bridge component materials is critical to designing fire resistant bridges. Exposed wood (treated or untreated), geosynthetics, plastics and aluminum components are quickly and severely damaged in wildfires compared to concrete and steel components. Concrete bridges are typically the most fire resistant.

Engineers preparing General Arrangement Designs shall consider the wildfire risk and the importance of fire resistance specific to a design site and shall specify bridge component materials accordingly.

Commentary

Details relating to wildfire effects on bridge components can be found in [FLNR Post-Fire Bridge Assessment Procedures \(PDF, 3.7MB\)](#).

1.17.2 FLAMMABLE MATERIALS NEAR BRIDGE SITES

Engineers preparing bridge General Arrangement Designs shall consider the wildfire risk and the importance of fire resistance specific to a design site and shall specify site modifications and material disposal requirements accordingly.

Commentary

Not all vegetation adjacent to a bridge site is highly flammable. For example, green deciduous vegetation and other wet area vegetation is not considered to substantially increase fire risk to a bridge.

Examples of problematic materials near a bridge would include dry standing dead timber or branches, and piled wood which could include brush or discarded components from a previous bridge such as decking, curbs, and other wood components.

1.18 BRIDGE GEOMETRY & ALIGNMENT

1.18.1 GENERAL

Bridge horizontal alignment, vertical alignment and plan geometry shall be designed in accordance with this section and Section 3: Loads, to suit site conditions, to accommodate present and future anticipated traffic, and to meet road user safety and stopping sight distance criteria.

1.18.2 APPROACHES

Bridge approaches shall meet the following requirements:

- The approach road alignment (vertical and horizontal) shall provide a smooth transition to the bridge;
- Approach road vertical curves shall be utilized where required but shall not extend onto the bridge deck;
- Where economically possible, bridge decks shall not be flared, and road approaches shall have a minimum 5 m length, immediately at the end of the bridge, that is tangent (vertical and horizontal) to the bridge;
- Bridge approaches shall have adequate and practically maintainable drainage controls that minimize sediment deposition onto bridge decks and into streams;
- Except where unavoidable, bridges shall be located away from the low point of a sag curve in the vertical alignment of the road profile.
- Unless otherwise specified by the Ministry, a vehicle pullout shall be provided at one end of a single lane bridge (within both approach sight lines) to accommodate passing vehicles. Pullouts may be needed at both ends of the bridge for longer span bridges or for other safety reasons.

Commentary

Most FSR bridges have narrow (≤ 6.0 m) single lane widths that clearly do not allow two-way traffic on the bridge. When vehicles travelling in opposite directions meet near such a bridge, one vehicle needs to wait at the end of the bridge to allow the other vehicle to cross. Pullouts at such bridge sites provide the needed space for the waiting vehicle.

Bridge and approach fill design and construction, if not carefully undertaken, may result in substantial and potentially hazardous potholing at the end of bridge decks.

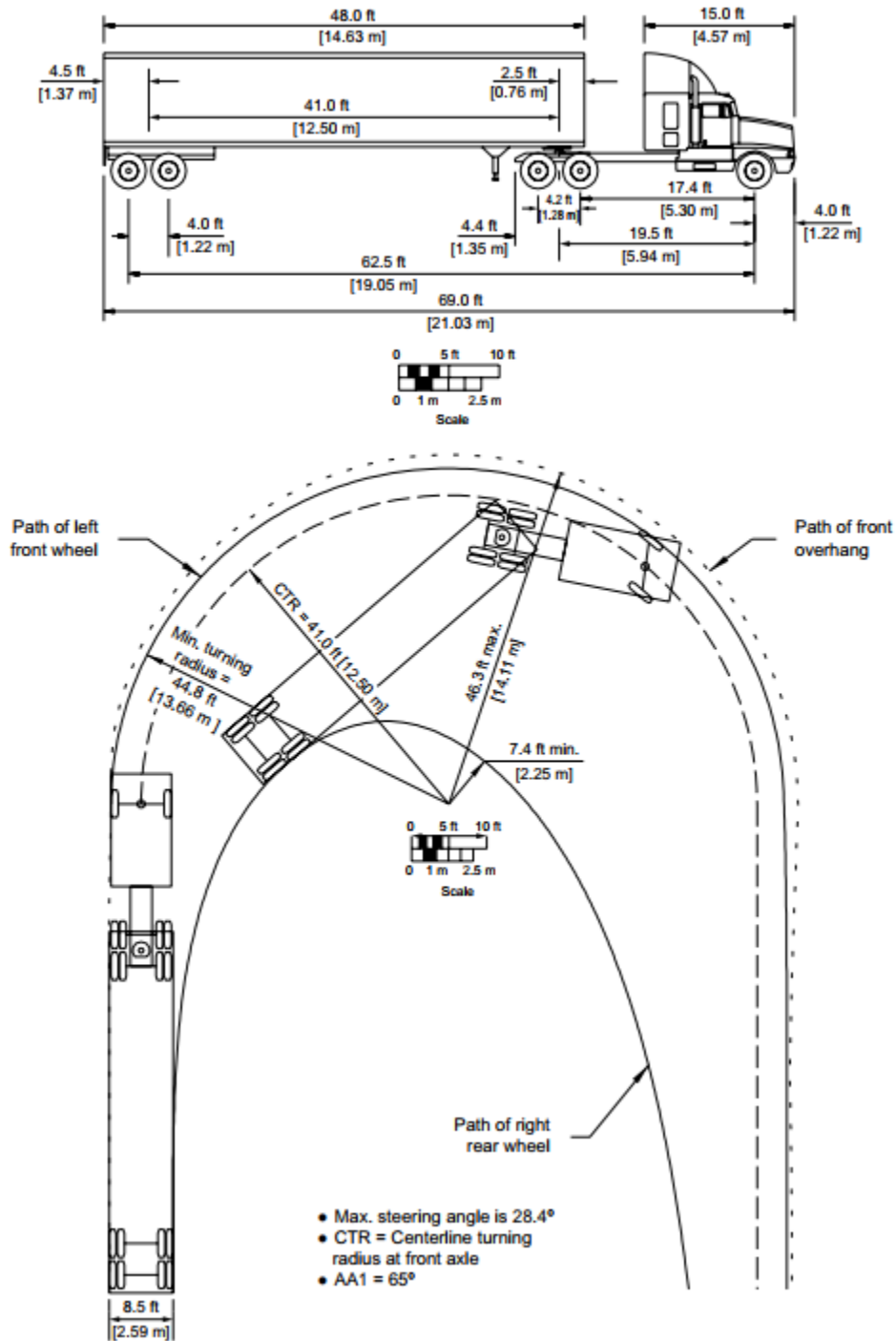
Additional information related to bridge approach roadway design is available in the [Engineering Manual](#), and in a guidance document entitled [Standardizing the Design of Approach Alignment to Bridges on Forestry Roads in British Columbia: Review and Analysis \(PDF, 3.1MB\)](#) which was created by FP Innovations for the Ministry.

1.18.3 VEHICLE HORIZONTAL TRACKING REQUIREMENTS

In addition to the standard bridge widths described in Section 3: Loads, vehicle horizontal tracking requirements shall be considered when determining appropriate bridge widths for sites that are not on straight horizontal alignments.

The WB-19 design tracking vehicle, as described in the AASHTO publication "Geometric Design of Highways and Streets," and as shown below, is to be used together with a minimum clear distance to guardrails of 500 mm unless otherwise specified by the Ministry Engineer.

Figure 1.1: WB-19 Design Tracking Vehicle



Commentary

The following reference documents published by FPInnovations are available on the Ministry website for designers to review:

[Standardizing the Design of Approach Alignment to Bridges on Forestry Roads in British Columbia: Review and Analysis](#)
and [Field Testing to Validate Standardized Bridge Approach Curve Design Recommendations](#).

1.18.4 DECK WIDTH

1.18.4.1 General

Bridge deck widths shall comply with Ministry standard bridge deck geometry, as described in Section 3: Loads, Section 9: Wood Structures, Section 10: Steel Structures, and on Ministry standard drawings.

Deck widths shall be specified in increments of 610 mm (2') (e.g.; 4.267 m, 4.876 m, 5.468 m, etc.)

Commentary

Additional information related to bridge width determination in locations with horizontal roadway curves is available in [Standardizing the Design of Approach Alignment to Bridges on Forestry Roads in British Columbia: Review and Analysis \(PDF, 3.1MB\)](#).

1.18.4.2 Deck Flares

Standard 610 mm deck flares may be specified for steel girder composite concrete deck bridges, as per the STD-EC-030 standard drawing series.

Where possible, deck flare lengths shall be approximately 6 m, however if necessary, the minimum length may be 3 m.

Commentary

Deck flares complicate bridge design and construction, however may be beneficial at some sites with challenging horizontal alignments. Standardizing the flare width at 610 mm allows repeatable designs which is beneficial from an economic and quality control/assurance perspective.

Designing deck panels to be both skewed and flared is discouraged due to the unusual level of complication.

1.18.5 BRIDGE SKEW

1.18.5.1 General

Bridge skew shall be specified in increments of 5 degrees (e.g.; 5, 10, 15, etc.) and is allowed for two types of bridges as described in this section.

Standard square bridge details shall be modified as required for skewed bridges.

1.18.5.2 Concrete Slab Girder Bridges

Maximum skew = 30 degrees.

1.18.5.3 Steel Girder Bridges with Composite Concrete Decks:

Table 1.1: Max. Skews for Steel Girder Bridges with Composite Concrete Decks

Bridge Length (m)	Max. Skew (degrees)
< 20	30
20 to 41	15
> 41	0

1.18.6 DECK GRADIENT

The longitudinal gradient on bridge decks shall be less than or equal to 4 %.

Commentary

Standard bridges are not intended for use at higher gradients. Steeper grades are particularly challenging where bridges may be used in snow and ice conditions.

1.18.7 DECK DRAINAGE

No bridges are permitted to be designed in such a manner that water will “pond” on the deck.

Deck drainage on steel girder bridges with concrete decks shall be aided by providing a 2% transverse cross-fall to either side from a crowned centreline.

1.18.8 STEEL GIRDER LENGTHS

Where possible, steel girders shall be specified to have out-to-out lengths in increments of 3.048 m (10').

Commentary

Steel plate is procured by fabricators in these increments therefore economic benefits result.

1.18.9 CAMBER

1.18.9.1 Concrete Slab Girders

Concrete slab girders with spans > 8 m shall be cambered for 115% of the design dead load deflection. For shorter spans, camber may be in accordance with the foregoing, or the spans may have no camber.

Commentary

Concrete slab bridge decks do not have cross-falls. Camber will assist in precluding ponding on these decks for spans > 8 m.

1.18.9.2 Steel I-Girders with Concrete or Wood Decks

Steel I-girders with spans > 16 m shall be cambered for 115% of the design dead load deflection. For shorter spans, camber may be in accordance with the foregoing, or the spans may have no camber.

Commentary

Standard MOF concrete bridge decks on steel I-girders have cross-falls which will preclude ponding on the deck when no camber is provided.

1.18.9.3 All-Steel-Portable Girders

ASP Girders may have no camber. If camber is provided it shall be no more than 115% of the design dead load deflection.

1.18.9.4 General

Camber shall be specified on the Structural Design Drawings and shall be determined by the Structural Design Engineer to provide for a smooth running surface across the length of the bridge.

Structural designs shall be detailed to ensure that concrete slab girders are in full contact with bearing pads at each abutment.

If a Structural Design Engineer cannot practically meet these specifications with their design, they shall contact the Ministry Engineer

during the design process to discuss the challenges and propose alternate specifications that can be met.

When preparing General Arrangement Designs, GA Engineers shall consider the challenges described above, and in the commentary below, that may be experienced relating to camber for multi-span bridges and skewed bridges.

Commentary

Excessive camber can cause fit-up problems with some bridge components during installation.

Excessive camber on individual spans of multi-span concrete slab girder bridges can create uncomfortable driving conditions.

Camber of skewed concrete slab girders can cause challenges installing girders to properly bear on typical ministry rubber bearing strips.

Precast fabricators may have limited practical ability to provide concrete slab girders with camber that is different from the camber of their normal casting beds.

1.19 SIGNS AT BRIDGE SITES

Bridge sites shall have, at minimum, the following signs:

- Approaches on both sides of the bridge shall be provided with “Narrow Structure” (BC MoTI W-051, 750 mm x 750 mm) warning signs.
- Each end of the bridge shall have one “hazard marker-left” and one “hazard marker-right” (i.e.; BC MoTI 300 mm x 900 mm hazard marker warning signs: one W-054-L and one W-054-R) attached to the bridge guardrails at the ends of the bridge.
- If a bridge has various deck widths along its length (i.e.; has deck flares) a “hazard marker-left” or “hazard marker-right”, as appropriate, shall be attached to the guardrail at the narrowest deck location (i.e. near the kink in the guardrail.)
- Bridge load posting signs, if required (refer to Section 14: Evaluation for additional information).

Commentary

BC MoTI signs are described on the [BC MoTI Traffic Signs & Pavement Marking webpage](#).

1.20 MATERIALS

1.20.1 NEW MATERIALS

Unless otherwise approved by a Ministry Engineer, all materials used for the construction of bridges must be new. The materials or material combinations must

conform to applicable CSA, ASTM or other standards and must have the appropriate supporting identification.

1.20.2 USE IN ACCORDANCE WITH SPECIFICATIONS

All material shall be used in accordance with the manufacturer's specifications and relevant CSA standards, unless otherwise specified by ministry standards or a Ministry Engineer.

1.20.3 NON-STANDARD BRIDGE MATERIALS

Before a non-standard (unapproved by the Ministry) system or product is considered for use on an FSR bridge, it should be brought to the attention of the Ministry Bridge Standards Engineer (mike.penner@gov.bc.ca) for formal evaluation and possible acceptance.

Where an unapproved structure or component is being proposed for a project before a full review as described above has been completed, the Ministry Engineer responsible for the project is responsible to determine whether the proposal is acceptable, and whether site specific implementation requirements may be necessary.

To be acceptable as a substitute for standard materials, proposed materials or material combinations shall be equivalent or better in relation to strength, performance and durability when compared to ministry standard materials used for an application.

1.20.4 MATERIAL AVAILABILITY DESIGN CONSIDERATIONS

The Design Engineers shall investigate and confirm availability of materials prior to finalizing designs.

1.21 BRIDGE DECK SURFACE SAFETY CONSIDERATIONS

Design Engineers shall determine and detail bridge deck surfaces for safety considering anticipated traffic usage at a site. Some issues to be considered are:

- The anti-skid wearing surface on All-Steel-Portable (ASP) bridge decks typically wears off quickly resulting in a smooth steel deck surface with a relatively poor coefficient of friction;
- Un-grouted longitudinal joints in decks (e.g.; between concrete slab girders or between ASP modules) and lifting slots or holes in ASP deck plates may create hazards and steering difficulties for motorcycle or bicycle traffic;

1.22 DESIGN FOR LIFTING, TRANSPORTATION AND INSTALLATION

The Structural Design Engineer shall consider lifting, transportation and installation procedures as part of the design of the bridge. They shall consider the weight of materials, work crews and equipment supported during construction when designing the bridge.

Refer to Section 3: Loads for some details, and Section 8: Concrete Structures for precast lifting anchor design requirements.

1.23 BRIDGE IDENTIFICATION STANDARD

The [Bridge Identification Standard \(PDF, 28KB\)](#) provides detailed specifications for identification methods that are required to be utilized by fabricators prior to supplying bridges to the Ministry.

Commentary

A fabricator is required to provide identification information about the bridge via markings on each bridge that consist either of painted lettering or information on an engraved metal plaque.

1.24 WEIGHT MARKING ON COMPONENTS

Bridge components with weights exceeding 5,000 kg shall have their weight identified on the component or on a durable tag attached to the component, for reference when lifting and handling.

1.25 LIFTING

Components shall be lifted in accordance with the procedures and limitations specified on the structural design drawings and any other applicable installation procedures.

1.26 TRANSPORTATION

1.26.1 GENERAL

Components shall be designed, supported, handled and transported in such a way that they sustain no damage during transportation.

1.26.2 CONCRETE COMPONENTS

Concrete components shall be transported after the 28-day design strength has been achieved unless the design engineer has confirmed in writing or indicated on the drawings that the elements can be shipped at a lower strength.

1.26.3 STEEL I-GIRDERS

The bridge supplier shall provide a transportation plan prepared by an engineer to the Ministry if the I-girders are proposed to be transported “on the flat”.

1.27 INSTALLATION

In addition to installation requirements in other sections of this manual, the requirements described in this section shall apply.

1.27.1 BRIDGE INSTALLATION PROCEDURES

The bridge installer shall follow bridge installation procedures prepared by the Design Engineer or alternative procedures prepared by an installation engineer. These procedures shall be accepted by a Ministry Engineer prior to use.

1.27.2 CONSTRUCTION TOLERANCES

Where construction tolerances are not shown on the drawings or otherwise specified in contract documents, bridge components shall be laid out and constructed so final locations shall not differ from the positions shown on the drawings by more than the tolerances provided in the following table:

Table 1.2: Construction Tolerances

Item	Allowable Tolerance
Bridge Superstructure Horizontal Location: longitudinal direction	± 150 mm
Bridge Superstructure Horizontal Location: transverse direction	± 50 mm
Horizontal location of substructure elements relative to superstructure: pile heads, posts, footings, retaining walls	± 50 mm
Maximum deviation from plumb or specified batter for: piles	20 mm per m
Maximum deviation from plumb or specified batter for: posts	5 mm per m
Horizontal location of anchor bolt groups	± 15 mm
Vertical location of bridge seats	± 10 mm

Any deviation from the final drawings beyond the above tolerances shall be satisfactorily corrected by the bridge contractor at their own expense.

1.27.3 CLEAN GIRDERS

Girders shall be supplied and installed clean and free of shop marks.

1.27.4 SITE CLEAN-UP

All project sites shall be cleaned up following completion of construction and before final demobilization. Site clean-up shall include the removal of all equipment, formwork, materials, trash, construction debris, and dirt and debris on the bridge girders, decks and bearings.

2. DURABILITY AND SUSTAINABILITY

2.1 GENERAL

This section discusses durability and sustainability requirements with a broad lens, including a focus on design life, superstructure types, acquisition methods, certification requirements, quality control, quality assurance, engineering roles and responsibilities, and documentation requirements.

2.2 DESIGN LIFE

2.2.1 DURABLE STRUCTURES (45 YEAR DESIGN LIFE)

New structures (stationary, portable and semi-portable) shall be durable, with a minimum design life of 45 years, except for structures that are exempted by a Ministry Engineer for a specific project (e.g.; log bridges, fully untreated wood decks, untreated wood guardrails, log culverts, etc.)

Material selection, design and quality control shall ensure that the design life of components is achieved.

Special detailing to address corrosion concerns shall be provided for bridges in corrosive environments, including where bridges will be exposed to de-icing salts or dust-control salts on the bridge or on roads in the vicinity of the bridge.

Commentary

While Ministry bridges are industrial in nature, compromises in design or construction are often not acceptable. Industrial users and the Ministry are typically not prepared to easily address major bridge maintenance problems. Additional initial bridge cost is therefore generally preferable to increased future maintenance or repair requirements.

The Ministry has for decades had a standard bridge design life specified as 45 years for bridges composed of durable materials. This allows these FSR bridges to be relatively economical and simple to design, fabricate and install when compared to typical highway or municipal bridges which are required to have a longer design life (e.g.; CHBDC requires 75 years).

De-icing salt is typically not applied on FSR bridges which assists in obtaining 45-year design life with relatively economical bridge detailing. Dust control surfacing applied occasionally to some FRSs may cause bridge corrosion effects similar to those caused by de-icing salts.

2.2.2 STANDARD DURABLE SUPERSTRUCTURE TYPES

Unless otherwise specified or accepted by a Ministry Engineer, bridge superstructures shall:

- be composed of durable materials;

- have a design life of at least 45 years;
- have steel guardrails (except on timber decks); and
- be one of the following standard types:

Stationary Bridge

- Steel girders with composite concrete deck panels;
- Concrete slab girders with grouted shear connection between girders;
- Prestressed concrete box girders with grouted shear connection between girders;
- Compo-I girder with composite concrete deck panels; or
- Compo-Inverted Channel girder with grouted shear connection between girders.

Semi-Portable Bridge

- Steel girders with removable non-composite concrete deck panels;
- Steel girders with treated timber deck panels and untreated continuous running planks;
- Concrete slab girders with welded shear connection between girders.

Portable Bridge

- Steel girders with treated timber deck panels and untreated non-continuous running planks;
- Concrete slab girders without shear connection between girders;
- Two All-Steel-Portable modules; or
- Two Treated All-Timber-Portable modules.

Commentary

The Ministry has Standard Drawings for all the superstructure types described above (except prestressed concrete box girders- see Section 8: Concrete Structures for additional guidance relating to prestressed concrete box girders.)

2.2.3 STANDARD DURABLE SUBSTRUCTURE TYPES

Refer to Section 6: Foundations and Geotechnical Systems for information about standard durable substructure types.

2.2.4 REPLACEABLE COMPONENTS ON DURABLE BRIDGES

The following allowable standard components on durable bridges (that have a 45 year design life) are generally not expected to meet the 45 year design life requirement (i.e.; they are considered to be replaceable components):

- All-Steel-Portable deck coating;

- Non-composite concrete deck transverse joint seals;
- Longitudinal joint filler between concrete slab girders with welded shear connectors;
- Untreated wood running planks;

Replaceable components shall nonetheless be designed and constructed in accordance with all standards and specifications and all efforts shall be made to maximize their service life and minimize maintenance and repair requirements.

2.2.5 PRIME STATIONARY BRIDGES

Prime Stationary Bridges are designed for installation at a single site with the intention that the bridge will provide the highest quality Ministry standard safety and service for at least a 45 year design life with minimal required maintenance. They are intended to be used at sites with unusually high requirements (relative to typical FSR sites) for user safety and service.

If considered appropriate, Ministry Engineers may specify that bridges be designed and constructed as Prime Stationary Bridges for sites that have some of the following anticipated attributes:

- High traffic volume;
- High traffic speed;
- Long-term access requirement;
- Critical access requirement;
- Community access requirement;
- Double lane;
- Need to minimize maintenance;
- High-risk road/bridge alignment issues.

If a bridge is specified by the Ministry to be designed as a Prime Stationary Bridge, it shall meet the following requirements:

- All major bridge components (including ballast walls, guardrails and approach barriers) are steel or concrete;
- The deck surface is concrete with no longitudinal joints that are un-grouted and no regular transverse joints that are un-grouted;
- The bridge has CL-3 bridge guardrails that are connected to ministry standard approach barriers which are anchored into the approach fills;
- Interlocking concrete blocks are not used;
- Driven piles are used for substructures unless spread footing substructures are designed and installed to have exceptionally low scour risk at the site;

- The bridge is designed to pass, with minimal consequences, 100 year return period events for:
 - floods, including debris;
 - ice; and
 - debris flows;
- If applicable, the bridge is qualitatively designed in accordance with Section 4: Seismic Design.

Commentary

The Ministry will commonly specify and accept bridges that are not Prime Stationary Bridges. A Prime Stationary Bridge utilizes specific ministry bridge standards options that will minimize ongoing maintenance requirements while maximizing structure resilience and user safety attributes.

Although not specifically required for design purposes, it is likely that Prime Stationary Bridges will commonly have a design life of 75 years.

2.3 CONSIDERATIONS FOR CHOICE OF SUPERSTRUCTURE TYPE

Superstructures shall be designed to be appropriate for a specific project.

Commentary

The following information is provided to help guide the choice of superstructure type for typical single-lane, simply supported, single-span bridges.

For spans 14 m or less, concrete slab girder structures are typically economical. They are particularly conducive where there are alignment issues such as skews or where extra roadway width is required to accommodate vehicle tracking on curves. Grouted connections between girders provides a high-quality standard ministry deck type for stationary bridges.

For semi-portable bridges, non-composite concrete decks on steel girders may be economical. The bolted deck connections provide for bridge removal and use elsewhere. Long term maintenance of deck joints between concrete deck panels for non-composite bridges can be problematic.

For stationary spans greater than 15 m, composite concrete decks on steel girders are typically the most economical. Concrete composite deck panel installation involves substantial grouting that requires careful attention to field installation quality control. Bridges with composite deck panels are not easy to dismantle if they are required to be moved to a new location.

For crossing sites requiring a portable bridge, an economical solution may be a modularized treated timber deck on steel girder superstructure or an all-steel-portable superstructure. All-steel-portable superstructures have many use-

restrictions, as noted on the Standard Drawings. Timber decked bridges require substantial ongoing maintenance and have a relatively high vulnerability to wildfire damage, however they may be desired where lugged vehicles or tracked vehicles may damage bridge decks; timber running planks may be frequently, and relatively easily, replaced in these locations.

2.4 FSR BRIDGE ACQUISITION METHODS

2.4.1 CONTRACTS MANAGED BY MINISTRY STAFF

Commentary

Most FSR bridges are designed, supplied and installed through contracts directly managed by Ministry staff. The following describes three methods commonly used by the Ministry for arranging these projects.

2.4.1.1 Pre-Design Method

Commentary

The “pre-design” method entails the preparation of both the conceptual bridge design and detailed bridge design prior to contracting for bridge supply and/or installation. By using this method, all details of the final product are known prior to issuing a supply and/or install contract which reduces risk to the Ministry.

This method can be beneficial by creating a detailed design that is “shelf-ready” for rapid supply when budget becomes available. Another benefit is that this method allows detailed design engineering to be undertaken by Engineers that are not selected exclusively based on lowest price submitted by a contractor for a project.

This method is especially beneficial for unusual crossings that require specialized professional bridge engineering expertise to develop an optimum final solution prior to contracting for fabrication and installation.

For many stationary durable bridge projects, the most efficient process will be to use the pre-design method, then contract for a combined supply and install contract.

2.4.1.2 Design-Supply Method

Commentary

With this method, the bridge supply contractor is responsible to provide the Ministry with detailed bridge design drawings. Installation of the bridge at a bridge site in accordance with conceptual drawings is accomplished through a subsequent contract independent of the “design-supply” contract.

Some of the Ministry's standard bridge requisition templates are written with detailed contractual language that is specific to this method, however the templates are also intended to be used (with some modification required) for projects when the "pre-design" or the "design-supply-install" methods are used.

The design-supply method may create contracting complications due to the Ministry Engineer being required to take on additional responsibilities in managing arrangements between a design-supply contractor and an installation contractor. Additionally, if pre-design has not been undertaken, the Ministry Engineer may need to communicate assumed installation equipment and methods to a design-supply contractor so their Detailed Design Engineer is able to design the components in a way that will suit the Ministry's anticipated installation contractor.

2.4.1.3 Design-Supply-Install Method

Commentary

With this method, a bridge conceptual design is created prior to the Ministry embarking on a competitive contract process for a combined package which includes detailed design, supply and installation of bridge components.

This method is generally preferable to the "design-supply" method because it reduces contract management complications and provides streamlined processes and communications between the detailed designer, the supplier and the installer.

2.4.2 CONTRACTS NOT MANAGED DIRECTLY BY THE MINISTRY

2.4.2.1 General

Some FSR bridges are designed, supplied and installed through contracts that are not directly managed by Ministry staff. Typically, this situation occurs when a bridge project is managed by a proponent (e.g.; a Road Use Permit holder or a Timber Sale License holder). These projects require the proponent to receive Ministry authorization prior to proceeding. A Ministry Engineer shall be involved in communications with the proponent as these projects are planned and implemented. These projects shall be undertaken in accordance with this Manual even though the contracts are not directly managed by the Ministry.

2.4.2.2 Significant Road Work Authorization Process

The Ministry has recently implemented a new process that shall be used when bridge projects are undertaken through contracts not managed directly by the Ministry.

This process is described in the [Guidelines for Applying for Significant Road Work Authorization in relation to a Forest Service Road](#).

2.5 ENGINEERING ROLES AND RESPONSIBILITIES FOR PROJECTS

2.5.1 GENERAL

Projects shall involve engineers as appropriate and as described in this section.

The six primary engineering roles in a typical new FSR bridge construction project are listed below and further described subsequently in this section:

- Coordinating Registered Professional (CRP);
- General Arrangement Engineer (GAE);
- Structural Design Engineer (SDE);
- In-plant Quality Assurance Engineer (In-plant QA Engineer);
- Construction Assurance Engineer;
- Ministry Engineer.

A Standard Drawing Engineer does not fulfill any of the roles listed above for a specific project unless they are actively involved with the project as it is being undertaken and they agree to accept the responsibilities.

Continuity of engineering services shall be provided for projects. If continuity of services from an engineer is not possible for the duration of the project, relevant information shall be passed forward to engineers joining the project after it has commenced.

Where possible, projects shall be coordinated so that the General Arrangement Engineer is also the Construction Assurance Engineer.

Commentary

For many projects one engineer will be responsible for more than one engineering role.

Two possible examples (among many) for a new bridge construction project are:

- *Example 1 (common for “Design-Supply” or “Design-Supply-Install” contracts):*
 - *Engineer 1: CRP, GAE and Construction Assurance Engineer;*

- *Engineer 2: Ministry Engineer;*
- *Engineer 3: SDE;*
- *Engineer 4: In-plant QA Engineer.*

- *Example 2 (common for “Pre-Design contracts):*
 - *Engineer 1: Ministry Engineer; CRP;*
 - *Engineer 2: GAE, SDE and Construction Assurance Engineer;*
 - *Engineer 3: In-plant QA Engineer.*

Two possible examples (among many) for a bridge project involving previously used components (e.g.; installation of a used portable bridge) are:

- *Example 1:*
 - *Engineer 1: GAE, SDE;*
 - *Engineer 2: Ministry Engineer;*
 - *Engineer 3: Construction Assurance Engineer.*

- *Example 2:*
 - *Engineer 1: GAE, substructure SDE;*
 - *Engineer 2: Ministry Engineer;*
 - *Engineer 3: Construction Assurance Engineer, superstructure SDE.*

One example (among many) for a bridge repair/retrofit project (e.g.; replacing timber guardrails with steel guardrails, replacing timber deck panels on a steel girder bridge, etc.):

- *Example:*
 - *Engineer 1: Ministry Engineer, CRP, GAE, SDE and Construction Assurance Engineer;*
 - *Engineer 2: In-plant QA Engineer.*

Simple maintenance work (e.g.; cleaning, minor painting, replacement of non-structural components with identical replacement components, minor improvements to scour protection, minor grout repairs, etc. typically do not require involvement of most of the engineers described in this section.)

2.5.2 COORDINATING REGISTERED PROFESSIONAL

The CRP shall be responsible for coordinating a project (see Ministry Engineering Manual and EGBC website for details.)

2.5.3 GENERAL ARRANGEMENT ENGINEER

The General Arrangement Engineer is responsible for a drawing set showing site information, site works, and some structural design information for a specific site.

Frequently for small, simple projects the GA Engineer is responsible for geotechnical engineering, road design, and hydrotechnical engineering. For other projects, specialist engineers may be responsible for these aspects of a project.

The GA Engineer is considered to also be the Structural Design Engineer for a project if there is no other engineer actively involved with the project responsible for this role.

2.5.4 STRUCTURAL DESIGN ENGINEER

The Structural Design Engineer is responsible for the structural design of a specific component or specific structure. This includes taking structural engineering responsibility for the use and application of Ministry Standard Drawings or previously used components for a specific project.

Structural Design Engineers are responsible for detailed review of Shop Fabrication Drawings that are prepared for a project to ensure they are satisfactory. Documentation of this review shall be provided by the Structural Design Engineer to the Ministry Engineer prior to the Ministry Engineer accepting the Shop Fabrication Drawings.

A specific bridge project must have at least one SDE that is actively involved in the project.

If one engineer is the substructure SDE and another engineer is the superstructure SDE, at least one of these SDEs, or another SDE, must take responsibility for the connections between the substructure and the superstructure, as well as for the overall structural design of the bridge.

If a portable bridge superstructure was not designed for use at a specific site, or if it is being moved from one site to another, there shall be a SDE actively involved with the project who takes responsibility for the structural design of the superstructure for the site, including consideration of any superstructure deterioration or damage. In this situation the superstructure will have an original SDE and a SDE for its use at the site.

Commentary

Some of the requirements above are meant to ensure that projects re-using portable superstructures are not undertaken with GA Engineers and/or Crossing Assurance Engineers assuming the SDE that originally designed a portable superstructure can be considered the SDE for any/all bridge projects utilizing the portable superstructure throughout its design life, even when the original SDE is unaware of the project.

2.5.5 IN-PLANT QUALITY ASSURANCE ENGINEER

The In-plant QA Engineer is responsible for:

- Quality Assurance field reviews of bridge components at fabrication plants; and
- Preparation of a Fabrication Assurance Statement.

Additional details are provided in the sub-section relating to in-plant QA inspections.

2.5.6 CONSTRUCTION ASSURANCE ENGINEER

The Construction Assurance Engineer is responsible for:

- Directing installation field reviews;
- Completing a Construction Assurance Statement; and
- Preparing record drawings.

2.5.7 MINISTRY ENGINEER

2.5.7.1 Project Proponents to Ensure Ministry Engineer Involvement

Ministry staff involved with projects and individuals outside the Ministry that lead projects are responsible to ensure that a Ministry Engineer is involved with every project throughout the life of the project.

2.5.7.2 Summary of Ministry Engineer Responsibilities

Ministry Engineer responsibilities for each project include (at minimum):

- Provision of specific guidance for a project relating to use of bridge standards;
- Review and acceptance of Design Drawings, Shop Fabrication Drawings and specifications;
- Review and acceptance of any significant design or construction changes;
- Liaison with the Ministry's in-plant quality assurance (QA) inspection agency (details provided in the sub-section relating to in-plant QA inspections);
- Ensuring final documentation is appropriately prepared and utilized.

2.5.7.3 Accepting Drawings Prepared by Others

The disclaimer provided in this section shall be used when Ministry Engineers routinely accept drawings prepared by others for projects on FSRs when the Ministry Engineer is not also the Structural Design Engineer. Depending on circumstances, a Ministry Engineer may need to revise the disclaimer.

The Ministry Engineer shall ensure that drawings are authenticated appropriately by others and are attached to the acceptance email sent by the Ministry Engineer.

The acceptance e-mail is required to be filed as official documentation for the project. Refer to the Heads-up Notice of Impending Project Requiring QA Inspections sub-section for details regarding cc's that may also be needed, and other related details.

The disclaimer should not be used in Ministry Engineer emails discussing drawings that are not fully accepted. For example, a Ministry Engineer may review submitted drawings and request changes to them prior to providing ministry approval.

Ministry Engineers shall require that sealed drawings they accept have indicated the name of the individual that undertook checking/review, and the date that checking/review was accomplished.

Standard Disclaimer

The drawings attached to this email (or email string) have been accepted by the Ministry (the Regulatory Authority) to allow a project to proceed. A regulatory review of some or all the drawings (or previous versions of the drawings) has been undertaken by the Ministry and comments may have been provided, however the undersigned has not undertaken detailed technical review and is not responsible for the professional aspects or accuracy of the engineering work shown on the drawings.

Commentary

Accepting drawings on behalf of the Ministry is an important step in a project. A standard disclaimer was developed because there was previously sometimes a misperception that Ministry Engineers routinely accepting drawings prepared by others were formally performing professional technical review functions.

In some circumstances a Ministry Engineer may be working unusually closely in cooperation with a consultant in the preparation of certain drawings. In these cases, the disclaimer would not be appropriate, and the Ministry Engineer's name and role would likely be required to be noted on the drawings. For example, a Ministry Engineer may have

agreed to provide formal professional technical review services in cooperation with a consultant on a project.

Engineers and Geoscientists BC provides helpful information relevant to this topic in their Practice Advisory: Professional Conduct Between Submitting Professionals and Authorities having Jurisdiction.

2.6 ENGINEER QUALIFICATION REQUIREMENTS

2.6.1 LICENSING

Engineers responsible for FSR bridge work must be licensed by EGBC to practice in the Province of BC.

2.6.2 EXPERIENCE

Engineers must have successfully completed, and taken full responsibility for by authenticating, work similar to the work they propose to undertake for a specific project, for at least 5 bridges in the Province of BC similar in size, scope, and complexity to the specific project, within the 5 years prior to the specific project.

Alternatively, Engineers must have equivalent bridge engineering experience that confirms a sufficient ability to undertake work associated with a specific project.

Proof of meeting experience requirements must be provided, upon request, to a Ministry Engineer and must be accepted by the Ministry Engineer.

Proof must include: the name and contact information of the Engineer, representative bridge engineering work authenticated by the Engineer, and names and contact information for clients of the previous bridge engineering work undertaken by the Engineer.

2.7 CONCRETE FABRICATOR CERTIFICATION REQUIREMENTS

2.7.1 CERTIFICATION FOR STRUCTURAL PRECAST CONCRETE

2.7.1.1 General

Fabricators responsible for precast concrete fabrication (except for concrete roadside barriers and unreinforced interlocking blocks which are addressed in a different sub-section) must be certified, at the time of bidding and for the duration of fabrication, in accordance with CSA A23.4 “Precast Concrete- Materials and Construction” as described in the two tables below, by:

- the CSA Group Testing & Certification Inc.; or
- the Canadian Precast Concrete Quality Assurance Certification Program (CPCQA).

2.7.1.2 Bridge Components

The following table applies for bridge components:

Table 2.1: Acceptable CSA A23.4 Fabricator Certification Categories for Precast Structural Components for Ministry Bridges

(Note: fabricators are limited within each category in accordance with any limitations specified by the certifying agency).

Category /Group ID	Category /Group Name	Sub-category ID	Sub-category Name	Examples of Precast Structural Components for Ministry Bridges
B*	Bridges			
		B1	Precast bridge products	Reinforced non-prestressed components: (e.g. slab girders, compo-girders, deck panels, ballast walls, cap beams, footings, abutments, etc.).
		B2**	Prestressed miscellaneous bridge products	No ministry standard or typical components.
		B3***	Prestressed straight strand bridge members	Prestressed (with straight strands) superstructure components (e.g. prestressed box girders or prestressed slab girders).
		B4****	Prestressed deflected strand bridge members	No ministry standard or typical components.

Footnotes:

* If a fabricator is certified in a category that has an A beside the B (e.g. BA1) it indicates the fabricator is certified for a specific Group B category (e.g. B1) and the fabricator is also certified to apply architectural finishes (not required for ministry components) to products in that category in accordance with CSA A23.4.

** also includes certification for products in category B1.

*** also includes certification for products in categories B1 and B2.

**** also includes certification for products in categories B1, B2 and B3.

2.7.1.3 Culvert, Retaining Wall, and Cattleguard Components

The following table applies for culvert, retaining wall and cattleguard components:

Table 2.2: Acceptable CSA A23.4 Fabricator Certification Categories for Precast Structural Components for Ministry Structures other than Bridges

(Note: fabricators are limited within each category in accordance with any limitations specified by the certifying agency).

Category /Group ID	Category /Group Name	Sub-category ID	Sub-category Name	Examples of Precast Structural Components for Ministry Structures other than Bridges (reinforced & non-prestressed components)
B	Bridges	(all- see previous table)	(all- see previous table)	Culverts: - Box culverts, arch culverts; - Footings, pile caps, headwalls, etc.
OR				
D	Drainage Products	D1	Standard precast concrete drainage products	Retaining Walls: - Mechanically Stabilized Earth (MSE) facing; - “L” or “inverted T” walls. Cattleguards: - abutments/sills.

2.7.2 CERTIFICATIONS FOR PRECAST BLOCKS AND BARRIERS

Fabricators responsible for unreinforced concrete blocks or concrete roadside barriers shall be certified as per the following table:

Table 2.3: Acceptable Fabricator Certification Requirements for Precast Barriers and Blocks

Example Component	Fabricator Certification Requirements
Interlocking Concrete Blocks (typ. 1500x750x750 mm)	Fabricator certified to category B or D (see previous tables) OR Fabricators shall have their operations and products inspected and approved by a Ministry Engineer.
Concrete Roadside Barriers/ Bridge Approach Barriers	Fabricator certified to category B or D (see previous tables) OR Fabricator shall provide proof (if requested by the ministry) of recent satisfactory fabrication of barriers in accordance with BC MoTI “Standard Specifications for Highway Construction” Section 941.

2.8 STEEL FABRICATOR CERTIFICATION REQUIREMENTS

2.8.1 GENERAL

Companies responsible for **shop welded construction** must be certified, at the time of project tender and for the duration of fabrication, to Division 1 or Division 2 of CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures.

Companies responsible for **field welded construction** must be certified, at the time of project tender and for the duration of fabrication, to Division 3 or better, of CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures.

2.8.2 CERTIFICATION BODY (CWB)

The Canadian Welding Bureau (CWB) is accredited by the Standards Council of Canada as a Certification Body for the administration of the applicable CSA standards, including W47.1, for:

- Certification of companies involved in welding;
- Certification of welding inspection companies;
- Certification of welding inspectors; and
- Certification of welding electrodes.

All CWB certified companies are required to have certified welders and approved welding procedures for each specific type of weld produced (Welding Procedure Data Sheets).

Commentary

A list of CWB certified companies can be found on the [Canadian Welding Bureau \(CWB\) website](#).

2.9 FABRICATOR'S QUALITY CONTROL

2.9.1 GENERAL

Quality Control (QC) is generally defined as the 'checking activities' undertaken by a fabricator to ensure a product meets contract requirements, and that the causes of unsatisfactory production have been eliminated. For example, QC for structural steel will normally require implementation of QC checklists for layup and welding of individual members, and other checking and verification processes aimed at identifying, rejecting, and correcting defects in the finished product. Similarly, QC for precast concrete normally includes, among other checking and verification processes, the preparation of, and adherence to, a Quality Control Plan (QC Plan) which is a formal written document prepared by the fabricator that describes the policies and procedures used in the fabrication process to achieve contract requirements.

Fabricators producing bridge components for installation on Forest Service Roads are solely responsible for all QC. These activities include monitoring, inspecting, and testing the means, methods, materials, workmanship, processes and products as necessary to ensure the work conforms with applicable designs, standards and specifications.

Fabricators shall implement a well-coordinated approach to all operations related to performance of the works and shall organize their team and operations in keeping with the goal of doing things right the first time (i.e., mistakes should be eliminated).

Fabricators shall prepare and implement a Quality Control Plan (QC Plan) for a fabrication project. Each component of the QC Plan shall address materials, processes, products, and documentation. The QC Plan is required to cover the work in its entirety, including without limitation, all materials the fabricator and any sub-contractors are supplying, and all items and phases of fabrication related to the project. The QC Plan shall include, among other requirements as necessary, quality control checklists for each element of the work in sufficient detail to gauge conformance with all significant contractual requirements.

Fabricators shall also ensure that all workers are familiar with the QC Plan, its goals, and their role under it; as well as with the contract specifications associated with the work they are to undertake. Fabricators shall appoint a QC Manager to oversee the QC Plan.

The work shall be undertaken in accordance with the QC Plan and shall be well managed, with any testing being representative of actual operations. A fabricator's QC Plan may be operated wholly or in part by a qualified sub-contractor or an independent agency/organization. However, the QC Plan's administration (including conformance with the plan and its modifications) and the quality of the fabrication work, remains the responsibility of the fabricator.

Fabricators are responsible for obtaining and providing mill test certificates, radiographic or ultrasonic test reports, concrete test reports, and other documentation for each project as applicable. Additionally, fabricators shall submit to the ministry's Quality Assurance (QA) inspection agency all completed QC checklists signed-off by responsible parties as close to the actual work as appropriate to the nature of the work (e.g., by the actual worker or a foreman for most work) demonstrating that the submitted checklists have been checked for compliance with contractual requirements and as evidence of that responsibility. The ministry may request the fabricator submit additional QC documentation (e.g., copies of its completed and signed-off QC checklists), relevant to the project.

2.9.2 WELDING QUALITY CONTROL

2.9.2.1 General

The fabricator shall carry out an ongoing quality control program as required by CSA Standard W47.1 Certification of Companies for Fusion Welding of Steel, and CSA Standard W59 Welded Steel Construction (Metal Arc Welding).

Non-destructive testing is the responsibility of the fabricator. If non-destructive testing of welded joints reveals imperfections, the fabricator shall correct the quality of welds to the ministry's in-plant QA inspector's satisfaction at the fabricator's own expense.

2.9.2.2 Detailed Requirements

In addition to any other requirements specified by CSA requirements, the fabricator shall ensure that:

- Only documented materials are used for the project;
- All materials intended for incorporation into bridges or bridge components are examined after cutting for size, shape and quality;
- Before assembling any plate girders or complex parts, the surfaces of all materials are examined for imperfections and the joint edge preparation for all groove welds is verified as conforming with the Canadian Welding Bureau's approved welding standards acceptable tolerances;

- After assembling any plate girders or complex parts, and before starting the strength welding, the assembly is checked for dimensional conformance;
- Any non-conformance is resolved;
- Welding procedures (and accompanying proof that the welds are Canadian Welding Bureau pre-qualified) are available for review by an inspector.
- The strength level and chemical composition of all filler materials used in structural assemblies conform to the approved drawing details;
- All welding consumables conform to the standards and are received, stored and conditioned in accordance with the standards;
- Any preheating required before welding is done according to the standards; and
- The welding procedure, including the use of treatment in welding any joint in a structural component, conforms to the standards.
- All welds shall be visually inspected;
- All tension butt welds shall be radiographically or ultrasonically tested;

2.10 IN-PLANT QUALITY ASSURANCE INSPECTIONS

2.10.1 GENERAL

All materials and fabricated components shall conform to the current ministry standards and shall not be acceptable without in-plant inspection by the ministry's in-plant quality assurance (QA) inspection agency. The following requirements for in-plant quality assurance apply to structures built under all ministry contracts and authorizations, including structures authorized in a Timber Sale Licence that have been identified by the Timber Sales Manager to become crown assets after termination of the Timber Sale License.

The ministry may reject any supplied structure components that have not undergone in-plant inspection by the ministry's in-plant QA inspection agency.

Prior to, or during, fabrication and assembly of steel, concrete and wood components, a fabricator shall show or provide written documentation to the in-plant QA inspector that indicates all materials meet the contract requirements. Additionally, a fabricator shall submit quality control documentation in accordance with the requirements and time frames specified under a contract.

Quality Assurance (QA) is a process, independent of the fabricator's QC, that encompasses the activities undertaken by the ministry's QA inspection agency (by persons or companies independent of those doing the work) to verify that the final product satisfies contract requirements (generally meeting the requirements of the

materials, drawings, and specifications). This includes verifying that quality control has been performed effectively by the fabricator, thereby providing confidence that the product satisfies the relevant quality standards.

Keys to the success of a QA process are:

- Inspecting most, if not all, of the outputs to preclude hidden problems or field fixes that may delay the project or result in increased costs, including bringing any observed shortfalls to the attention of the fabricator for remedial action in the plant; and
- Proceeding with the QA only when the fabricator has completed its QC work.

Similar to the fabricator's QC Plan, each component of the in-plant QA Program will address materials, processes, products, and documentation.

Independent of the QA inspections by the ministry's in-plant QA inspection agency, the fabricator shall carry out its ongoing QC Plan during the performance of the works. The ministry's QA Program activities will not relieve the fabricator of its QC responsibilities under the terms of a contract.

The ministry's in-plant QA inspection agency will conduct inspections of the work once the fabricator has advised that it has completed its QC work. If the ministry's QA inspectors observe non-conformances with the work, they will advise the fabricator and report them to the ministry.

In planning the work flow, and prior to commencement of the work, the fabricator shall coordinate with the ministry's in-plant QA inspection agency to determine any "hold points" and "witness points" for inspection or non-destructive testing. For any identified hold points, work shall not proceed past the hold point until it has been signed off by the fabricator's QC and ministry's QA processes.

A hold point is a mandatory verification point beyond which a work cannot proceed without approval by the ministry's in-plant QA inspection agency. The work cannot proceed until the ministry's in-plant QA inspection agency is able to verify the quality of the completed work.

A witness point is an identified point in the fabrication process where the ministry's in-plant QA inspection agency may review, witness, or inspect the material, method or process of work. The fabrication activities, however, may proceed.

The in-plant QA inspection agency completes an in-plant inspection report for each bridge and submits it to the ministry. The ministry keeps on file all relevant material documentation, such as mill test certificates, test results, and inspector reports.

2.10.2 HEADS UP NOTICE OF IMPENDING BRIDGE FABRICATION PROJECT REQUIRING QA INSPECTIONS

Immediately after contract award of a project that includes fabrication, the Ministry contract issuing office (or the Ministry office responsible for administering an RUP or Timber Sale Licence) shall ensure that a Ministry Engineer is aware of the contract details and is prepared to notify the In-plant Quality Assurance (QA) Inspection Agency that inspections are required.

The project could be a "Bridge supply" or a "Bridge supply and install" contract issued by the Ministry (Operations or BCTS) or by a proponent such as:

- a Road Use Permit (RUP) holder; or
- a Timber Sale Licence holder (if a Bridge has been identified by the Timber Sales Manager to become a crown asset after termination of a Timber Sale Licence.)

Ministry Engineers are required to complete the following form for all FSR bridge projects that involve fabrication.

[Heads-up Notice of Impending Bridge Fabrication Project Requiring QA Inspections \(DOCX, 71KB\)](#)

Detailed description of appropriate use of the form is provided on the form.

2.10.3 QA INSPECTION SCHEDULING FOR CONCRETE BRIDGE COMPONENTS

The ministry QA inspections shall be scheduled at the following stages during fabrication as a minimum:

- Pre-pour inspection (to CSA Standard A23.4 and project documentation), which includes:
 - Inspection of forms for size, shape and quality; and
 - Inspection of reinforcement and inserts for quantity, quality, shape, spacing, size and placement in forms.
- Post-pour inspection and reporting, during which:
 - Dimensions of all elements shall be verified to ensure tolerances are being maintained as per the specifications;
 - Location, type and number of inserts shall be verified;
 - Finishes, blockouts, keyways and epoxy protection of the cut-off strands (prestressed only) shall be verified;
 - Camber or crown shall be checked, as per project drawings; and
 - All non-conformities shall be corrected to the inspector's satisfaction.

2.10.4 QA INSPECTION SCHEDULING FOR STEEL BRIDGE COMPONENTS

The ministry inspections shall be scheduled at the following stages during fabrication, as a minimum:

- Prior to welding, which includes:
 - Verification of material mill certificates, material dimensions and layout; and
 - Verification of welding equipment, consumables, welding procedures and welder qualifications.
- On completion of welding and before shipment, which includes:
 - Verification of weld locations, sizes, profiles and workmanship; and
 - Verification of finished dimensions, camber, and sweep.

2.10.5 IN-PLANT QA FABRICATION ASSURANCE STATEMENT

The following form shall be completed by the In-plant QA Engineer after fabrication has been completed and the material documentation has been reviewed.

[In-plant QA Inspection- Fabrication Assurance Statement \(DOCX, 51KB\)](#)

2.11 PREPARING, OBTAINING, AND RETAINING BRIDGE INFORMATION

2.11.1 GENERAL

The following bridge and major culvert fabrication and construction information shall be prepared, obtained, and retained in accordance with [section 77 of the Forest Planning and Practices Regulation](#):

- Pile driving records;
- For new materials, mill test certificates, in-plant steel fabrication drawings, and concrete test results;
- Soil compaction results;
- Other relevant field and construction data including but not limited to: field inspection reports, changed field conditions, grout test results, construction assurance documents, and wood grading and treatment results; and
- As-built/Record drawings of the bridge or major culvert.

2.11.2 RECORD DRAWINGS

Record drawings (formerly often referred to as “as-built” drawings) are required to be prepared for all FSR bridge and major culvert projects. These drawings show the “as-constructed” structure and indicate any significant changes from the design drawings.

2.11.3 ASSURANCE DOCUMENTATION

These statements confirm, among other things, that construction work for a project substantially complied with the engineering concepts or intent reflected in the engineering design documents.

[FS1414: CRP Crossing Assurance Statement \(PDF, 208KB\)](#)

[FS1414TRAN CRP Transfer Prof Responsibility Statement \(PDF, 166KB\)](#)

[FS138: POR Construction Assurance Statement \(PDF, 158KB\)](#)

[FS137: Assurance of Field Reviews \(DOC, 496KB\)](#)

2.11.4 INVENTORY DATA FORMS

The following forms describe information that is required to be collected and entered into the Ministry's Corporate Bridge Register (CBR) by Ministry Engineers or others working under the direction of Ministry Engineers.

[FS1342: Site Inventory Data Form \(DOC, 162 KB\)](#)

[FS1343: Structure Inventory Data Form – Culverts \(DOC, 182KB\)](#)

[FS1344: Structure Inventory Data Form – Bridges \(DOC, 189KB\)](#)

3. LOADS

3.1 GENERAL

Bridges that are exclusively designed for light recreational use, such as for pedestrians, cyclists, snowmobiles, horses and/or all-terrain vehicles, are not currently addressed in this section of the BSM. A Ministry Engineer shall be consulted for information relating to loading requirements for these types of recreational use structures.

3.2 SERVICEABILITY LIMIT STATES

Structural components shall satisfy the requirements for the serviceability limit states specified in this section of the Manual for the appropriate loading combinations.

Superstructures shall be proportioned so that the maximum deflection due to factored traffic load, including dynamic load allowance, does not exceed:

- Span/350 for concrete slab girder bridges, all steel portable bridges and inverted channel compo-girder bridges;
- Span/450 for all other bridges (including: steel girder/concrete deck bridges, steel girder/timber deck bridges, compo-I-girder/concrete deck bridges).

Commentary

Span-deflection limits like those described above have been successfully used for decades in FSR bridge design.

3.3 LOAD FACTORS AND LOAD COMBINATIONS

Tables 3.1 and 3.2 provide example limit states scenarios that need to be considered when engineers are designing superstructures for FSR bridges.

Table 3.1: Superstructure Design Fatigue Limit States and Serviceability Limit States Examples

Limit State Combination	Type of Superstructure	Example CSA S6-19 CHBDC Clause References	Comments (referencing CSA S6-19 CHBDC)
FLS1	General	1.4.2.1, 3.4.3, 3.5	Applies only to steel components (including rebar)
	Reinforced concrete superstructures	8.5.3.1	Applies to reinforcing bars
	Steel superstructures	10.5.4, 10.17	Applies to Girders, bracing, steel decks, girder splices, welds, bolted connections, stud shear connectors
SLS1	General	1.4.2.1, 3.4.4, 3.5	According to CHBDC Section 3.5, Table 3.1, SLS1 loading includes dead loads, however not always (e.g. not for deflection of wood components according to 9.4.2.)
	Reinforced concrete superstructures	8.5.2, 8.12,	Addresses cracking and deformation limitations.
	Steel superstructures	10.5.3, 10.18.2.3	<ul style="list-style-type: none"> Addresses yielding of sections: 10.5.3.3 applies: “Members of all classes of sections shall be proportioned so that general yielding shall not occur. Localized limited yielding may be used.” Addresses slipping of bolted joints: 10.18.2.3 applies for continuous girders: “Joints of primary members subjected to stress reversal shall be designed as slip-critical connections.” FSR bridge steel decks do not meet the definition of “orthotropic steel decks” therefore the deflection provisions of 10.16.4 do not strictly apply.
	Wood superstructures	9.4.2	Deflection of wood components caused by live load is limited to Span/400.
SLS2	General	1.4.2.1, 3.4.4, 3.5	According to CHBDC Clause 3.5, Table 3.1, SLS2 applies for superstructure vibration only. For FSR bridges SLS2 shall apply for bridge deflection limits.
	Reinforced concrete superstructures	8.5.2.5	
	Steel superstructures	10.5.3.5	
	Wood superstructures	9.4.2	

Table 3.2: Superstructure Design Ultimate Limit States Examples

Ultimate Limit States Combination	Types of Loads Considered (in addition to dead loads and earth pressures)
1	Live loads
2	Live loads plus other strains (including thermal forces, etc.)
3	Live loads plus other strains (including thermal forces, etc.) plus wind load on bridge plus wind load on traffic
4	Other strains (including thermal forces, etc.) plus wind load on bridge
5	Earthquake loads
6	Loads from streams, ice and debris torrents
7	Loads from Ice accretion plus wind on bridge
8	Loads from vehicle or vessel (boat) collisions with bridge
9	No additional loads, however uses an increased load factor for dead loads

Commentary

The intention of providing these tables is to provide engineers a typical indication of the Ministry’s expectations for the thoroughness of the limit states design process. The tables provide common examples only and do not portray all situations.

It is important to note that these tables do not provide detailed information relating to the use of limit states for the design of substructures.

3.4 DEAD LOADS

Dead loads for bridges with a concrete running surface shall include an allowance for a 50 mm future concrete overlay over the full area of the bridge deck.

For timber deck bridges, design dead loads shall include an allowance for a 75 mm thick layer of running planks, if running planks are not already included in the bridge design.

These loads shall be noted on the detailed design drawings.

For the unit weight of softwood, use:

- Untreated Softwood: 6.0 kN/m³; and
- Treated Softwood: 7.0 kN/m³

3.5 LIVE LOADS

3.5.1 DESIGN LANES

3.5.1.1 Standard single lane bridge widths

- 4.268 m for BCL-625 and L-100; and
- 4.876 m for L-150 and L-165.

Bridges with deck widths less than or equal to 6.0 m shall be considered single lane bridges and shall not be designed to carry two lanes of traffic.

Commentary

FSR bridges are typically single lane, although in special situations, such as high traffic volumes, challenging horizontally curved alignments or poor sight lines for vehicles approaching from opposing directions, bridges wider than 6.0 m are occasionally utilized.

3.5.1.2 Standard two-lane bridge widths

- 9.144 m for BCL-625 and L-100; and
- 10.973 m for L-150 and L-165.

Commentary

The 9.144 m two-lane bridge width is based on two 4.268 m single lane bridge widths for the BCL-625 and L-100 traffic loads, with additional deck width to accommodate passing of vehicles. The 10.973 m two-lane bridge width is based on two Pacific Truck P16 bunk widths of 15 ft with additional deck width to accommodate passing of vehicles.

3.5.1.3 Bridge safety considerations

Single lane bridges shall not be designed with a width greater than 6.0 m and less than the standard two-lane bridge width, other than where required by tracking.

Commentary

When a bridge width is greater than 6.0 m and less than 9.144 m it may be difficult for drivers to determine whether the bridge is wide enough to safely accommodate two-way traffic when vehicles are simultaneously approaching from opposite directions. This uncertainty can create safety concerns.

A standard BCL-625 or L-100 two-lane bridge with a width of 9.144 m on a reasonably straight horizontal alignment will clearly allow two-way

traffic on the bridge for typical vehicles.

3.5.2 TRAFFIC LOADS

3.5.2.1 Normal Traffic

FSR bridges shall be designed for L-100 or heavier traffic loading unless otherwise approved by a Ministry Engineer. In no cases shall an FSR bridge be designed for less than BCL-625 traffic loading. If traffic loading heavier than L-100 is required, L-150 or L-165 traffic loads shall be used. Required design traffic loading for a specific bridge shall be determined or approved by a Ministry Engineer.

Commentary

General:

L-series traffic loading has historically been used for design of FSR bridges, together with some BC TRAN design traffic loading scenarios (e.g.; BCL-625.)

L-100 accommodates typical traffic loading on most FSRs, except some coastal off-highway roads. Bridges designed to L-100 should generally have capacity to accommodate the new (2022) BC TRAN minimum traffic loading scenario of CL-800 if a new FSR bridge may be transferred to TRAN in the future.

CL-800:

In 2022 BC TRAN began using a BC TRAN CL-800 traffic loading scenario for design of typical new TRAN bridges, except for the design of components that are governed by axle or wheel loads (e.g.; bridge decks). For these components on TRAN bridges CL-625 is intended to be used as the design traffic loading scenario.

Traffic loading scenarios for FSR bridges have historically increased wheel and axle loads as the total vehicle weights of scenarios increased, meaning that an FSR bridge with a higher design vehicle GVW also has a deck designed for higher axle and wheel loads. For example, an L-100 bridge can carry a heavier truck than a BCL-625 bridge, and its deck can safely carry heavier axle and wheel loads than a BCL-625 deck. Since the BC TRAN CL-800 traffic loading scenario varies from this concept, the Ministry of Forests has determined that it should not be used for design of FSR bridges.

LOH and HOH (Light Off-Highway and Heavy Off-Highway):

In recent decades the Ministry, and other specialists, undertook extensive surveys and studies to determine if L-series design traffic loads produce

force effect envelopes that are reasonably representative of logging vehicles in use in British Columbia and whether it is appropriate to use L-series design traffic loads with load factors from CHBDC. The analysis concluded that:

- *Bridges designed for L100 and L150 design traffic loading were found to be slightly deficient for short span bridges (<15 m) and somewhat over designed for long span bridges (>15 m).*
- *Bridges designed for L-165 design traffic loading were found to be conservative for both short and long spans.*
- *Different live load factors would theoretically be required for short and long span bridges if the ministry wanted to maintain a rigorously consistent level of safety for all bridges designed with L-series design traffic loading.*

The results of the studies were used to develop LOH & HOH design traffic loads theoretically to better represent logging trucks in British Columbia, to use a single live load factor specified in CHBDC, and to provide a more rigorously consistent level of safety between bridges with different span lengths and different design traffic loading scenarios.

After detailed consideration, the ministry determined that there were substantial practical benefits to continuing use of the L-series vehicles for design traffic loading on new bridges, therefore LOH and HOH theoretical traffic loading scenarios are not to be used for design of FSR bridges.

3.5.2.2 Truck & Lane Load

The BCL-625 traffic load consists of the BCL-625 truck and the BCL-625 lane load defined in Figure 3.1 and Table 3.3.

The LOH traffic load consists of the LOH truck and the LOH lane load defined in Figure 3.2 and Table 3.3.

The HOH traffic load consists of the HOH truck and the HOH lane load defined in Figure 3.3 and Table 3.3.

The L-100 traffic load consists of the L-100 truck and the L-100 lane load defined in Figure 3.4 and Table 3.3.

The L-150 traffic load consists of the L-150 truck and the L-150 lane load defined in Figure 3.5 and Table 3.3.

The L-165 traffic load consists of the L-165 truck and the L-165 lane load defined in Figure 3.6 and Table 3.3.

Figure 3.1: BCL-625 Traffic Load

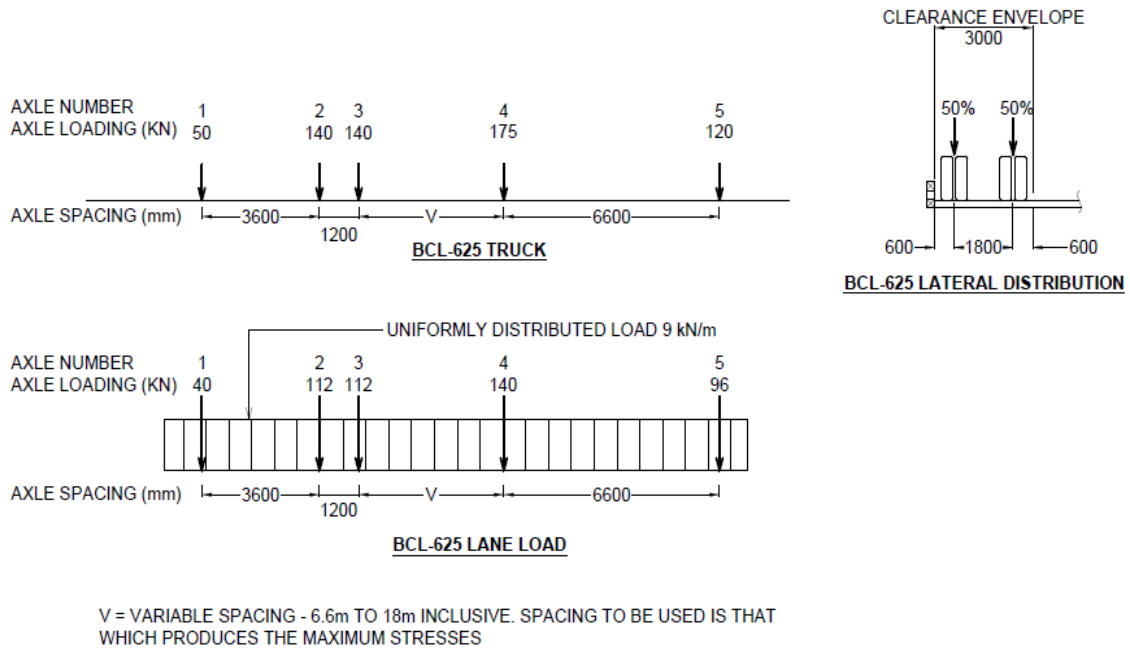


Figure 3.2: LOH Traffic Load

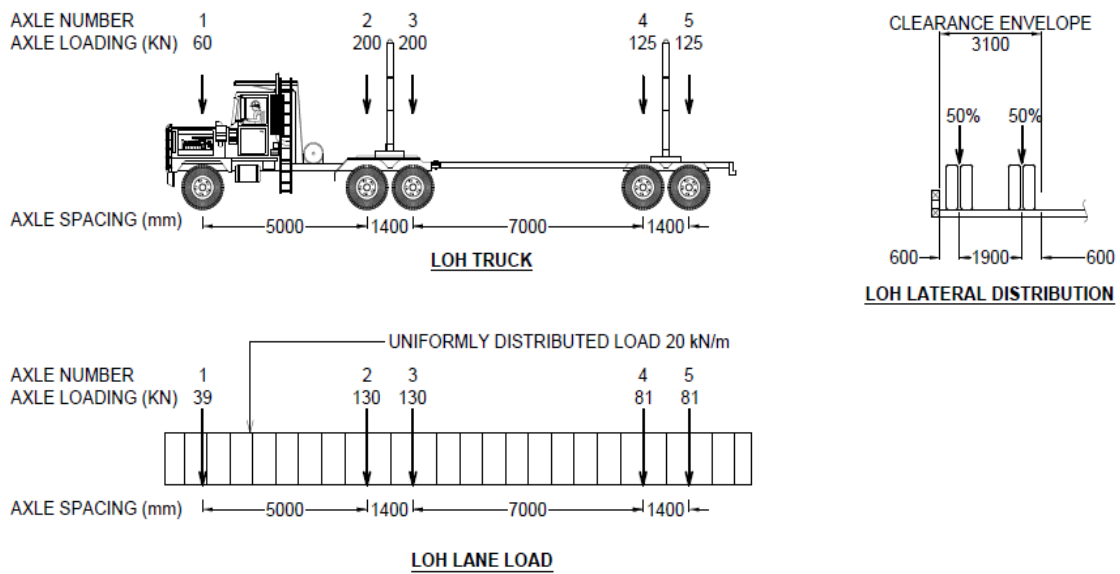


Figure 3.3: HOH Traffic Load

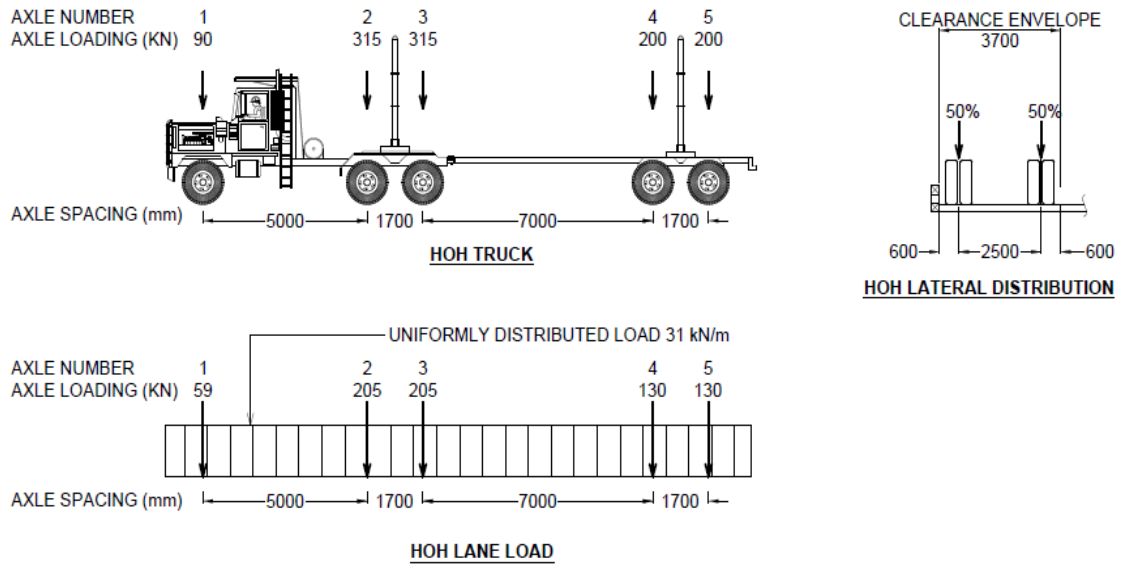


Figure 3.4: L-100 Traffic Load

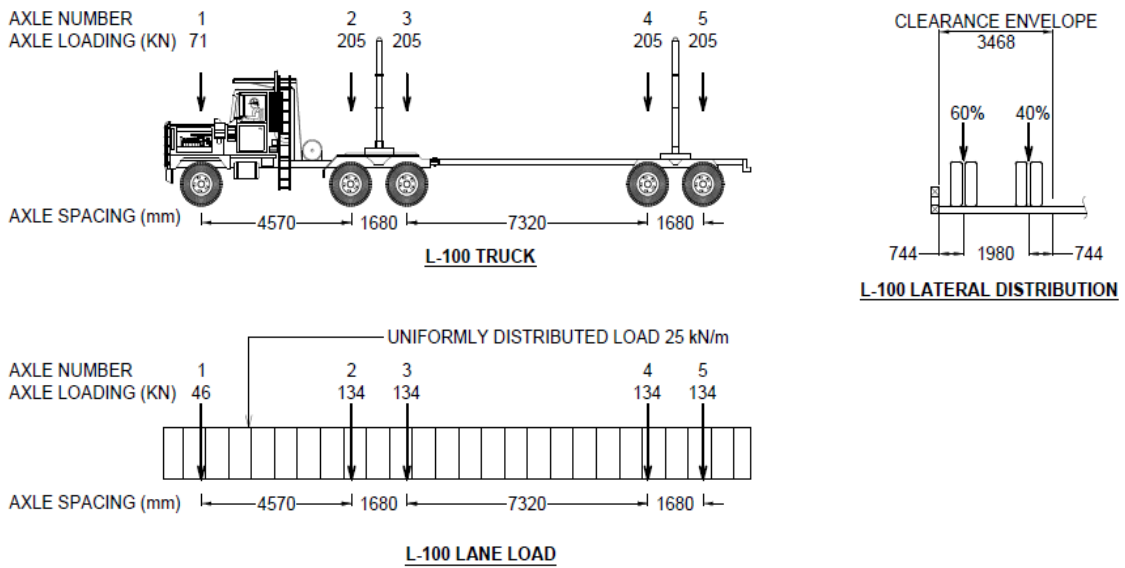


Figure 3.5: L-150 Traffic Load

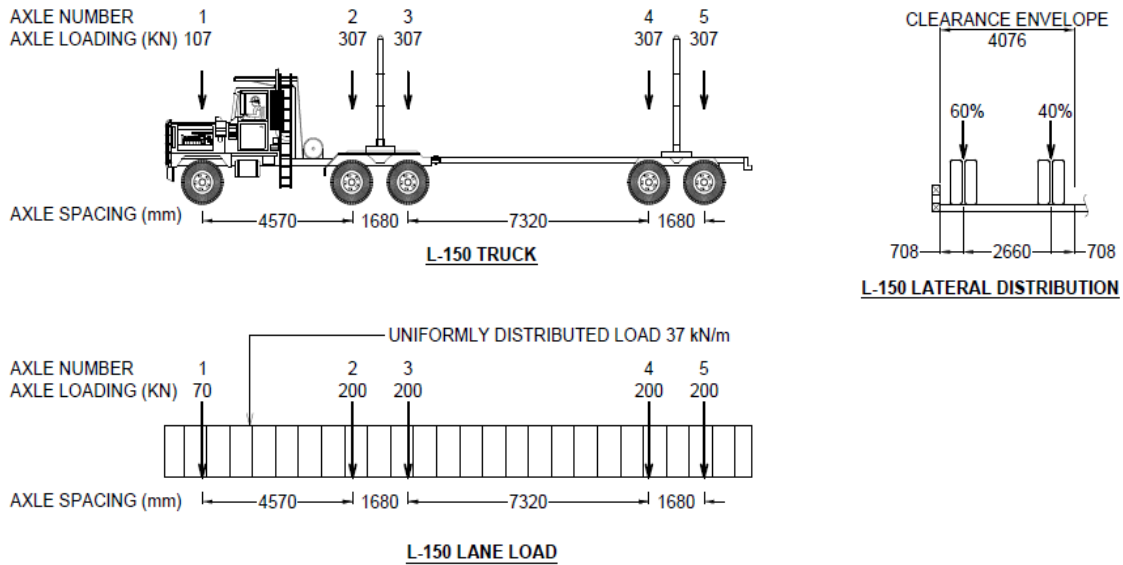
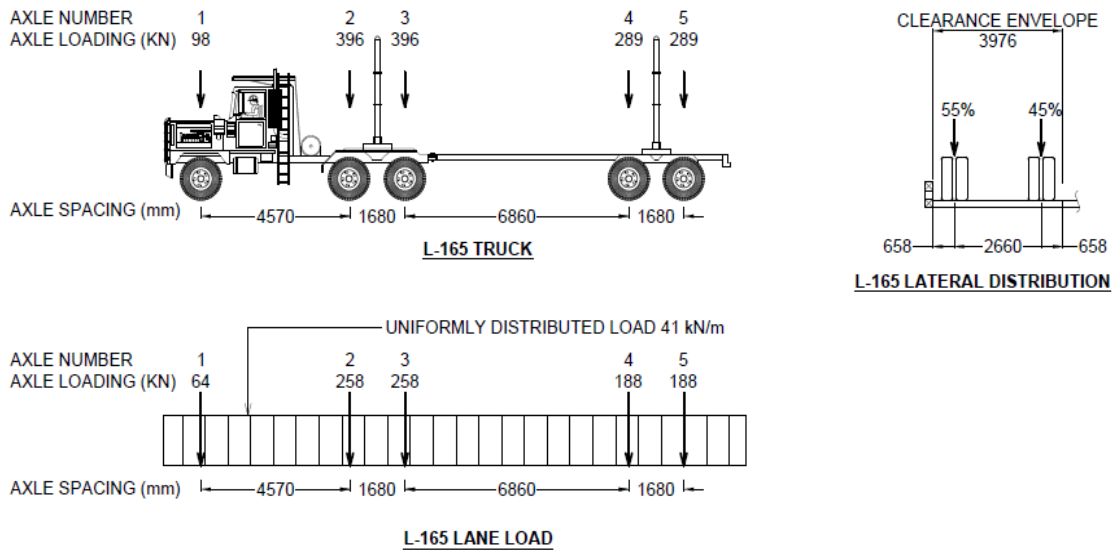


Figure 3.6: L-165 Traffic Load



Commentary

The clearance envelope for L-series vehicles has been determined from the previous Ministry standard methodology which described placement of these vehicles laterally on a bridge deck based on an eccentricity from the centreline of the bridge, which varied depending on the design vehicle and the bridge deck width.

3.5.2.3 Dual Wheel Footprint Dimensions

Table 3.3: Traffic Load Dual Wheel Footprint Dimensions

	Units	Traffic Load					
		BCL-625	LOH	L-100	HOH	L-150	L-165
Transverse	mm	600	800	800	800	800	800
Longitudinal	mm	250	250	275	350	400	450

3.5.3 APPLICATION

3.5.3.1 General

The following requirements shall apply:

- a. Truck axles that reduce load effect shall be neglected.
- b. The uniformly distributed portion of the lane load shall not be applied to those parts of a design lane where its application decreases load effect.
- c. For FLS and SLS Combination 2, the traffic load shall be one truck increased by the dynamic load allowance and placed at the centre of the design lane. The lane load shall not be considered. The lateral wheel load distribution shall be 50%-50%. For L-165 bridges, the L-150 truck shall be used for FLS and SLS Combination 2 analysis.
- d. For SLS Combination 1 and for ULS, the traffic load shall be the truck load increased by the dynamic load allowance or the lane load, whichever produces the maximum load effect. This load shall be placed longitudinally and transversely within the design lane at a location and in a direction that produces the maximum load effect. The lateral wheel load distribution and minimum lateral offsets for the truck and lane load shall be as specified in Figure 3.1 to Figure 3.6 and shall be in accordance with Ministry standards for two-lane bridges.

3.5.3.2 Multi-Lane Loading

3.5.3.2.1 Normal Traffic Only

Two-lane bridges shall either be 9.144 m wide or 10.973 m wide as described elsewhere in this Manual. Single lane

bridges shall not be designed with a width greater than 6.0 m and less than the standard two-lane bridge width, other than where required by tracking.

The number of design lanes for traffic shall be determined from Table 3.4.

For single-lane traffic loading, the lateral wheel load distribution shall be as specified in Figure 3.1 to Figure 3.6. For the two-lane loading scenario, the lateral wheel load distribution for both vehicles shall be 50%-50% and the traffic load shall be multiplied by a modification factor of 0.9. Design lanes that are loaded shall be selected to maximize the load effect.

Table 3.4: Traffic Loading Based on Bridge Width

Traffic Load	W_c (Deck Width, m)	n (number of design lanes)	W_e (Lane Width, m)
BCL-625	≤ 6.0	1	$W_e = W_c$
	> 6.0	1 & 2	$W_e = W_c \& W_c/2$
LOH	≤ 6.2	1	$W_e = W_c$
	> 6.2	1 & 2	$W_e = W_c \& W_c/2$
HOH	≤ 7.4	1	$W_e = W_c$
	> 7.4	1 & 2	$W_e = W_c \& W_c/2$
L-100	≤ 6.936	1	$W_e = W_c$
	> 6.936	1 & 2	$W_e = W_c \& W_c/2$
L-150	≤ 8.152	1	$W_e = W_c$
	> 8.152	1 & 2	$W_e = W_c \& W_c/2$
L-165	≤ 7.952	1	$W_e = W_c$
	> 7.952	1 & 2	$W_e = W_c \& W_c/2$

Bridges designed for off-highway traffic loads with deck widths greater than 6.0 m and less than 8.152 m shall be designed for two-lanes of BCL-625 loading in addition to the design traffic load.

Commentary

Bridges wide enough for two lanes of traffic shall be designed for a single lane traffic loading scenario and a two-lane traffic loading scenario.

At some sites with horizontally curved alignments, a bridge designed as single lane for a design tracking vehicle may be wide enough to allow two short trucks to pass on the bridge. For this reason, the Ministry requires all bridges wide enough for two-way traffic to be designed as two-lane bridges as described herein. The deck width limits in Table 3.4 are based on two clearance envelopes for the respective traffic load in Figure 3.1 to Figure 3.6.

Bridges designed for off-highway traffic loads, that are wider than 6.0 m for tracking purposes, are wide enough for two-lanes of BCL-625 traffic. Therefore, these bridges shall also be designed for two-lanes of BCL-625 traffic.

3.5.3.3 Local Components

For the design of decks and other components whose design is governed by axle loads, the tandem axle increased by the applicable dynamic load allowance shall be considered. For BCL-625 traffic loading axle no.4 shall also be considered.

For deck overhangs or adjacent to a curb, railing, or barrier, the minimum distance from the centres of the wheels to the guardrail shall be as specified in Table 3.5.

Table 3.5: Minimum Lateral Offset - Design of Components Governed by Axle Loads

Units	Traffic Load					
	BCL-625	LOH	HOH	L-100	L-150	L-165
mm	300	400	400	400	400	400

Commentary

The minimum lateral offsets in Table 3.5 are based on the wheel being

positioned against the curb, railing or barrier.

3.5.4 BARRIER LOADS

3.5.4.1 Traffic Barriers

Bridge curbs, railings and barriers shall be in accordance with Ministry standard designs and guidelines.

Commentary

Ministry barrier design loading is generally described in Table 3.6 and is outlined in Associated Engineering Ltd. report “[Development and Testing of CL-2 and CL-3 Barriers, Rev.1 \(PDF, 9.5MB\)](#)”.

Table 3.6 Barrier Design Criteria

<i>Factored Design Forces</i>	<i>Containment Level</i>		
	<i>CL-1</i>	<i>CL-2</i>	<i>CL-3</i>
<i>Transverse Load, F_T, kN</i>	-	45	120
<i>Longitudinal Load, F_L, kN</i>	-	20	40
<i>Vertical Load, F_v, kN</i>	-	20	20
<i>Load Application Height, mm</i>	-	450	510
<i>Minimum Barrier Height, mm</i>	-	525	585
<i>Notes:</i>			
1. <i>When completing an analytical evaluation of a barrier, these forces represent factored forces; resistances should be calculated assuming nominal material strengths.</i>			
2. <i>Height measured from travel surface.</i>			

3.6 WIND LOADS

3.6.1 REFERENCE WIND PRESSURE

The following simplified reference wind pressure shall be used for the design of FSR bridges.

The hourly mean reference wind pressure, q , shall be as follows:

- For in-service conditions, q_{is} , shall be 700 Pa.
- For construction, q_c , shall be 300 Pa.

Alternate values of hourly mean reference wind pressure for construction may be used for supply install contracts or as approved by the Ministry Engineer.

The maximum allowable wind speed for construction activities shall be 20 km/h unless further detailed analysis is undertaken. The maximum allowable wind speed for construction activities shall be stated on the design drawings.

Design reference wind pressures shall not be increased to account for wind funneling.

Commentary

The simplified reference wind pressure methodology has been adopted to address the nature of the materials procurement process for FSR bridges, where the designer may not know the intended location of a structure. An in-service hourly mean reference wind pressure of 700 Pa is equivalent to some of the highest 50-year return period values in CSA S6-19 CHBDC Table A3.1.1 for B.C. locations. A construction hourly mean reference wind pressure of 300 Pa has historically been used for construction wind loading for forestry bridges in B.C. This approximately reflects the 95th percentile hourly mean reference wind pressure for locations in B.C. with a return period of 1 year. This construction wind loading is deemed appropriate given the accelerated construction methods used for typical forestry bridge construction, which results in very short periods between the non-composite and composite conditions of steel girder composite concrete deck bridges. The maximum allowable wind speed for construction activities is intended to provide a conservative limit on the wind speed in which crew or equipment may be on a composite concrete deck steel girder bridge while it is in non-composite condition.

The CHBDC 20% increase for sites that may experience wind funnelling has been assumed to not apply for the development of the Ministry's wind loading methodology. Instead 0% increase is assumed. The 20% increase for sites with funnelling has not been used in order to keep wind loading reasonable in relation to the lower risks associated with wind loading on FSR bridges in comparison to highway bridges.

3.6.2 GUST EFFECT COEFFICIENT

A gust effect coefficient (C_g) of 2.0 shall be used for FSR bridges.

3.6.3 WIND EXPOSURE COEFFICIENT

A wind exposure coefficient (C_e) of 1.0 shall be used for FSR bridges except for sites where the height of the top of the superstructure (H) above low water level is known to be >25 m in which case CSA S6-19 CHBDC Table 3.9 shall apply.

3.6.4 NON-UNIFORM LOADING

Consideration of non-uniform loading is not required.

3.6.5 WIND LOAD ON LIVE LOAD

The horizontal wind load per unit exposed frontal area of live load shall be calculated in accordance with CHBDC S6-19 Clause 3.10.2.2., except that C_h shall be taken as 1.2. For “in-service” wind loading, the exposed frontal area of the live load shall be assumed to be 5 m high x 20 m long, located on the bridge to produce the maximum load effect.

3.7 DEBRIS FLOWS

In this manual the term “debris flow” shall be considered to include debris torrents, debris floods and other similar events.

All bridges subject to potential debris flows shall be designed to accommodate the debris flows without damage to the structure or approaches unless otherwise directed by the Ministry Engineer.

If a site has debris flow potential, the General Arrangement Engineer shall ensure that reasonable investigations into the probability and size of debris flows are undertaken.

This engineer shall identify the approximate opening size and design requirements expected to be required to accommodate debris flows for estimated return periods of 1, 10 and 100 years. This professional shall discuss their conclusions with the Ministry Engineer at the initial design stage to obtain Ministry direction relating to acceptable risk for structure design at the site.

Commentary

Although in some situations a GA Engineer may rely on detailed investigation and analysis by a professional specialist, it may frequently be acceptable to make reasonable professional judgements relating to size and frequency of debris flows based on site inspection, watershed investigation and research into past experiences with debris flows at a site or in the vicinity of a site.

3.8 ICE LOADS

All bridges subject to potentially damaging ice loads shall be designed to accommodate the ice loads without damage to the structure unless otherwise directed by the Ministry.

If a site has significant ice loading potential, the engineer responsible for the general arrangement design of the structure shall investigate the probability and severity of reasonably anticipated ice loads. This professional shall discuss their conclusions with

the Ministry Engineer at the initial design stage to obtain Ministry direction relating to acceptable risk for structure design at the site.

3.9 EARTHQUAKE EFFECTS

Refer to Section 4: Seismic Design.

3.10 VESSEL COLLISIONS

Not required unless specified by the Ministry.

3.11 VEHICLE COLLISION LOAD

Not required unless specified by the Ministry.

3.12 CONSTRUCTION LOADS AND LOADS ON TEMPORARY STRUCTURES

3.12.1 GENERAL

The maximum permissible construction equipment loads shall be stated on the design drawings.

Wind loads on construction equipment need not be considered provided the maximum allowable wind speed for construction activities (stated elsewhere in section 3) is followed.

3.12.2 BRIDGES WITH DECK PANELS

As a minimum, bridges with deck panels shall be designed for the following construction loads:

- Self weight of the structure, supported at the bearings, including all deck panels in position but not secured to the girders.
- A vertical live load of 445 kN (40-ton equipment + 10-ton panel) distributed over a length of 4 m, positioned on the bridge to produce maximum load effect, eccentricity = 100 mm.
- Load factors in accordance with CHBDC.
- Minimum dynamic load allowance of 10% (assumed design speed = 10 km/h).

3.12.3 CONCRETE SLAB GIRDER DESIGN FOR CANTILEVERED INSTALLATION

Slab girder top longitudinal reinforcement shall be designed to allow installation by cantilevered launching, assuming a maximum cantilever of 50% of the slab length.

4. SEISMIC DESIGN

4.1 GENERAL

Rigorous analytical seismic design is not required unless specified by the Ministry. Durable stationary bridges in moderate to high seismic zones shall be qualitatively detailed for seismic resiliency, for example:

- Robust connection of superstructures to substructures;
- Use of continuous superstructures for multi-span bridges;
- Minimization of bridge skew;
- Avoiding use of interlocking concrete block abutments.

5. METHODS OF ANALYSIS

5.1 GENERAL

Methods of analysis shall follow CHBDC requirements unless specified otherwise by the Ministry.

5.2 LOAD DISTRIBUTION BETWEEN SHEAR-CONNECTED CONCRETE SLAB GIRDERS

Load distribution may be determined by refined analysis or by consideration of a methodology provided by the Ministry.

Commentary

Load distribution methodologies provided by the Ministry include the following:

- [*Design of Single-Lane Shear-Connected Slab Bridges - Oct 2004 \(PDF, 1.4 MB\)*](#)
- [*Analysis of Skew: Single-Lane Shear-Connected Concrete Plank Bridges - June 2004 \(PDF, 786KB\)*](#)

6. FOUNDATIONS AND GEOTECHNICAL SYSTEMS

6.1 STANDARD DURABLE ABUTMENT TYPES

Unless otherwise specified or accepted by a Ministry Engineer, bridge abutments shall:

- be composed of durable materials;
- have a design life of at least 45 years; and
- be one of the following standard types:

Stationary Bridge

- steel piles with concrete caps;
- concrete spread footings with steel columns and concrete caps;
- concrete spread footings with steel columns;
- concrete inverted “T” abutments;
- concrete spread footings; or
- galvanized steel binwalls.

Semi-Portable Bridge

- any of the abutment types listed for stationary or portable bridges.

Portable Bridge

- concrete sill (or treated timber sill) on interlocking concrete blocks (plus concrete base slabs where required);
- concrete spread footings;
- concrete spread footings with short steel columns; or
- concrete spread footings with short steel columns and concrete caps.

The Ministry has standard drawings for all the abutment types listed above (except for galvanized steel binwalls.)

6.2 STANDARD DURABLE PIER TYPES

Unless otherwise specified or accepted by a Ministry Engineer, bridge piers shall:

- be composed of durable materials;
- have a design life of at least 45 years;
- have diaphragms between piles to prevent debris accumulation between the piles (unless there is no possibility of debris); and
- be one of the following standard types:

Stationary, Semi-Portable or Portable Bridges

- steel piles with concrete caps.

The Ministry has standard drawings for steel piles with concrete caps.

Portable and semi-portable multi-span bridges shall be avoided where possible.

6.3 PILES

In soils where there is potential for scour, pile tips shall penetrate at least 4.5 m below the maximum design scour depth.

The substructure design engineer shall specify the required pile capacity and minimum penetration for piles.

6.4 SPREAD FOOTINGS AND BIN WALLS

Spread footing abutment foundations (including inverted “T” abutments, spread footings with pipe columns, and spread footings with interlocking concrete blocks) and binwalls can be used where they are located below the maximum design scour elevation.

6.5 ABUTMENT BALLAST WALLS

Ballast walls shall be composed of concrete, treated timber or an alternative durable material pre-approved by the Ministry.

Welded connections for precast concrete ballast walls shall not be buried in soil unless they are designed and protected to match the design life of the precast ballast wall components.

Bridges with composite concrete decks shall have concrete ballast walls with a welded connection to the girders.

6.6 CAPS

6.6.1 CAPS ON PILES

All piled abutments shall have concrete pile caps.

6.6.2 CAPS ON COLUMNS

Steel columns at an abutment (i.e.; “pad & post” abutments) may be designed with concrete caps in any situation and are required to have concrete caps for all multiple span bridges.

Composite concrete decked bridges with steel column abutments are required to have concrete caps on the columns when the total length of steel girders exceeds 31 m.

6.7 BRIDGE ENDFILL

Bridge endfill (e.g.; behind ballast walls, caps, wing walls, columns, etc.) shall meet the specifications in this section.

Bridge endfill for interlocking concrete block abutments, and any abutments using reinforced soil systems shall have custom engineered bridge endfill specifications specified by the Design Engineer.

6.7.1 FILL MATERIAL

- Clean free-draining sand and gravel with a maximum aggregate size of 100 mm and a maximum fines content (silt/clay particles) of 5%;
- Free of snow, ice and frozen material.

6.7.2 FILL PLACEMENT

- Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled;
- Maintain even levels around structures as work progresses, to equalize earth pressures;
- Place fill material in 300 mm lifts, adding water if required to achieve the specified density;
- Existing subgrade and each layer of material shall be compacted to 95% Standard Proctor Density (ASTM D698);
- Compaction shall be provided by a 1000 lb. vibratory compactor within 1 m of ballast walls or other abutment components, with care exercised to ensure no damage to components.

7. BURIED STRUCTURES

7.1 GENERAL

This Manual uses the terms “buried structure”, “culvert”, and “major culvert” interchangeably.

“Minor culverts” are primarily addressed in the Ministry Engineering Manual.

For culvert projects, a Ministry Engineer will be responsible to adapt the use of Ministry standards for bridges as necessary and appropriate to a particular culvert situation. This section provides additional standards that apply exclusively to culverts.

Culverts shall be designed, constructed, and installed in accordance with manufacturer’s recommendations, and in conformance to CHBDC, unless otherwise specified by the Ministry.

Refer to [Section 7 of the appendices](#) for additional detailed requirements.

For Design Drawing requirements, refer to Section 21: Design Drawing Requirements.

7.2 STANDARD DURABLE CULVERT TYPES

Unless otherwise specified or accepted by a Ministry Engineer, culverts shall:

- be composed of durable materials;
- have a design life of at least 45 years;
- be one of the following standard types:
 - closed bottom galvanized corrugated steel pipe products;
 - open bottom galvanized corrugated steel pipe products on:
 - concrete footings without piles; or
 - concrete caps with steel piles;
 - closed bottom concrete products;
- corrugated products with equivalent or greater durability relative to galvanized steel may be proposed for Ministry Engineer acceptance;
- The design engineer shall evaluate corrosion, abrasion, bedload, debris, debris flow, scour and fish passage risks and requirements for each specific site to ensure the structure will meet the 45 year design life requirement.

7.3 INLET DEBRIS PROTECTION

Where necessary, designs shall incorporate inlet debris protection.

Commentary

Refer to the [“Steel Pipe Trash Rack” standard drawing \(PDF, 77KB\)](#) for one example that could be considered.

7.4 PROPRIETARY TERRASPAN GRS ARCH STRUCTURES

Refer to the [standard drawing set STD-C-050-01 to 05 \(PDF, 2.5MB\)](#) for details of this proprietary product.

7.5 LOG CULVERTS

Refer to Section 18: Log Structures for additional information about log culverts.

7.6 CULVERTS IN ROADWAY FORDS

Limited Ministry guidance for culverts embedded in roadway fords is provided in chapter 3 of the [Engineering Manual](#).

8. CONCRETE STRUCTURES

8.1 GENERAL

This section describes Standards for precast concrete, cast-in-place concrete, and field grouting. It includes Standards for reinforcement.

Any references to an obsolete Ministry document entitled “Bridge Component Concrete Standard” shall now be considered to refer to the Standards provided in this section.

For quality control, quality assurance and precast fabricator certification requirements refer to Section 2: Durability and Sustainability.

For guidance on concrete repair refer to Section 15: Rehabilitation and Repair.

Except for steel reinforcement and steel lifting anchors, Standards for embedded steel materials such as plates, sections, threaded couplers, blockouts/ducts and fabricated assemblies are provided in Section 10: Steel Structures.

8.2 STRUCTURAL CONCRETE MATERIALS AND FABRICATION

8.2.1 CONFORMANCE TO CSA STANDARDS

All precast concrete must be designed, mixed, transported, cast, cured, tested and fully supplied in accordance with CSA A23.4 “Precast Concrete - Materials and Construction.”

Precast and cast in place concrete must be designed, mixed, transported, cast, cured, sampled, tested and otherwise supplied in accordance with CHBDC and CSA Standard A23.1/A23.2, “Concrete Materials and Methods of Concrete Construction /Test Methods and Standard Practices for Concrete.”

Formwork for cast-in-place concrete must be designed, supplied, and installed in accordance with CAN/CSA-S269.3-M, “Concrete Formwork.”

8.2.2 CONCRETE MIX DESIGN REQUIREMENTS

Concrete mixes for bridge components shall conform to the requirements in the following table and the requirements of CSA A23.1.

Table 8.1: Concrete Mix Design Requirements

Bridge Component Type	Typical Component Example	Exposure Class (As per CSA A23.1 Table 1)	Minimum Compressive Strength @ 28 days (MPa)	Maximum Water to Cementing Materials Ratio (by mass)	Air Content (%)	Maximum Nominal Size of Course Aggregate (mm)
Precast Components	Slab girders Deck panels Footings "T" Abutments Ballast Walls Pile Caps Sills	F1	35	0.40	5-8	20
Cast-in-Place Components	Footings Abutments Pipe pile in-fill	F1	30	0.50	4-7	28

The supplier of concrete products shall monitor concrete slump and ensure that it is maintained at appropriate values such that the concrete products are produced to meet all required specifications.

The supplier will make the concrete mix design available for review by the ministry's in-plant quality assurance inspector to verify conformance to ministry standards and specifications.

Provided that the supplier's concrete mix design conforms to ministry standards and specifications, the supplier's mix design does not need to be reviewed or pre-approved by the Ministry Engineer. However, alternative concrete specifications may be required for bridges that are expected to have substantial chloride exposure. For these bridges, alternative concrete specifications shall be developed on a case-by-case basis by the Ministry Engineer and provided in the contract documents specific to each bridge.

8.2.3 REINFORCING STEEL

8.2.3.1 General

Reinforcing steel, including tendons, must meet the requirements of CHBDC. Reinforcing bars shall be CSA G30.18M Grade 400 (R or W).

Reinforcing steel shall not be welded (including tack welded) unless noted otherwise.

8.2.3.2 Corrosion Resistant Reinforcement

In adverse durability conditions, such as a bridge deck that will be regularly exposed to road salt or portions of structures in the splash or spray zone of

salt water, corrosion resistant stainless steel reinforcement shall be provided if specified by the ministry.

8.2.4 CHAMFERS

All edges of concrete components shall have 20 mm x 20 mm chamfers unless otherwise specified on Ministry standard drawings or by the Ministry.

8.2.5 CONCRETE FINISHING

Surface finishes shall be in accordance with the following table.

Table 8.2: Concrete Surface Finish Requirements

Surface	Finish*
Submerged or buried surfaces	Class 1
Underside of deck panels or slab girders	Class 1
Outer face of deck panels, concrete slabs, or concrete girders	Class 2
Exposed faces of ballast walls, pile caps, retaining walls, abutments, piers	Class 2
Top of deck	Transverse broom finish
Bearing seats	Magnesium trowelled finish

* Finish Description:

Class 1 – Class 1 finish is the basic finish to be produced on all formed surfaces not exposed to view unless a better finish is specified or required by the Drawings or Special Provisions.

- In order to produce a Class 1 finish, the formwork shall be mortar tight. Panel marks and texture are of no importance.
- All ties, bolts, nails and other metal specifically required for construction purposes shall be removed or cut back to a depth of 50 mm from the surfaces of the concrete and the resulting holes filled.
- No dry ties shall be permitted; form tie rods shall remain embedded and terminate not less than 50 mm from the formed face of the concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of a regular shape for reaming and filling.
- Honeycombs and voids over 500 mm² in area shall be filled.
- Honeycombs and voids shall not be repaired until inspected by the Ministry Representative as special methods of repair may be required where occurring in structural elements.

- Otherwise, concrete surfaces shall be repaired in accordance with the repair product manufacturer's specifications.

Class 2 – Class 2 Finish is to be produced on all formed surfaces exposed to view from a moderate distance, such as surfaces of abutments and piers, and to any surfaces for which a Class 2 finish is specified or required by the Drawings or the Special Provisions. A Class 2 finish shall provide surfaces of uniform colour and texture as viewed from a distance of 25 m.

- In order to produce a Class 2 finish, formwork shall be mortar tight and shall render a true surface. Fins 3 mm wide (maximum) shall be allowed at the panel joints; however, sheathing joints must be mortar tight.
- Irregularities of 3 mm in height with areas of 50 mm x 75 mm shall be allowed to a maximum of four such areas per 3 m² of formwork. Patches of dissimilar material will not be permitted. Horizontal and vertical joints shall be aligned. All ties, bolts, nails and other metal specifically required for construction purposes shall be removed or cut back to a depth of 50 mm from the surfaces of the concrete and the resulting holes filled.
- No dry ties shall be permitted; form tie rods shall remain embedded and terminate not less than 50 mm from the formed face of the concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of a regular shape for reaming and filling.
- Honeycombs, voids, or bugholes over 10 mm diameter shall be filled. All fins and projections shall be removed with a hand stone or power grinder. The use of a power grinder shall be kept to a minimum and confined to the areas required. When a rubbed finish is not called for, patches shall be textured with a mortar float or lightly brushed after trowelling smooth.
- Where more than 50 voids or bugholes over 5 mm diameter occur per square metre, or if the surfaces are not acceptably uniform in colour or texture, the entire area affected shall be given a rubbed finish, repaired in accordance with the repair product manufacturer's specifications.

8.2.6 CONCRETE COVER FOR PRECAST COMPONENTS

Concrete cover shall be as specified in the following table.

Table 8.3: Specified Concrete Cover and Tolerances for Precast Concrete Bridge Components

Precast Concrete Bridge Component ¹	Design Concrete Cover Requirements ² (mm)	Tolerances for Placement of Reinforcement in Forms	
		Allowable Tolerance for Reduction to the Required Cover ³ (mm)	Allowable Tolerance for Increase to the Required Cover ⁴ (mm)
Precast Deck Panels			
Top of deck panel	50	- 8	+ 8
Underside of deck panel ⁵	25	- 6	+ 8
Vertical face of exposed deck panel edge	50	- 8	+ 8
Blockouts and Grouted Deck Joints			
Face of blockouts for shear studs, dowels, anchor bolts ⁶	25	- 6	+ 8
Vertical face of transverse grouted deck joint	25	- 6	+ 8
Precast Concrete Slab Girders			
Top of slab girder	50	- 8	+ 8
Underside of slab girder	30	- 7	+ 8
Vertical face of exposed slab girder	50	- 8	+ 8
Ballast Walls, Footings and Caps			
all	35	- 8	+ 8

Footnotes:

1 The cover for precast concrete is reduced from the cover used in cast-in-place concrete because of greater dimensional control of formed concrete, tighter tolerances on placement of reinforcing, and better quality of concrete in plant-controlled conditions (Ref. Table 1 of CSA A23.4).

2 Concrete cover is the distance from the concrete surface to the nearest deformation (or surface for smooth bars or wires) of the reinforcement. Concrete cover includes tie wire for reinforcement because tie wire (when exposed) could corrode and potentially crack concrete.

3 Allowable tolerance for reduction to the required cover shown in the above table is determined based on the lesser of 8 mm or ¼ required concrete cover, based on Clauses 14.4.1 (a) and 14.4.2 of CSA A23.4. Allowable tolerances in the table above were rounded down to nearest whole mm.

4 Allowable tolerance for increase to the required cover shown in the above table is 8mm based on Clause 14.4.1 (a) of CSA A23.4.

5 Concrete cover requirements do not apply at drip groove locations on the underside of deck panels.

6 Rectangular blockouts for precast concrete deck panels (made with removable forms and as shown on ministry standard drawing series STD-EC-030) are subject to the required concrete cover on all faces of the blockout and the allowable tolerances as specified above. However, where corrugated steel pipe (CSP) ‘stay-in-place forms’ are used to build blockouts for shear studs, dowels, anchor bolt, etc., and where it is

unavoidable, reinforcement may be placed in direct point contact with the CSP ‘stay-in place-forms’ provided the final resulting blockouts will be filled in the final construction stage.

8.2.7 CONCRETE COVER FOR CAST-IN-PLACE COMPONENTS

Concrete cover for cast-in-place components shall be in accordance with CHBDC.

8.2.8 PRESTRESSED CONCRETE

Prestressed concrete has rarely been used for FSR bridges due to handling constraints that may be challenging for typical FSR bridge installers to implement therefore a designer should first consider other options. If prestressed concrete is determined to be justified for a particular bridge, BC TRAN specifications shall be modified by a Ministry Engineer and utilized for prestressed components that are part of a project.

Commentary

Prestressed concrete box girders are commonly used by BC TRAN. With special engineering considerations they can be a practical solution for durable stationary bridges on some FSRs when the span range is approximately 16 to 26 m, if transportation routes and installation contractor equipment and capabilities are appropriate, and there is a high confidence level that the bridge is intended to be stationary. Engineering shall ensure that the tops of the box girders are appropriately designed for heavy axle loading appropriate for the FSR, and barrier attachment detailing is appropriate for standard FOR barriers. Alternatively, standard TRAN precast bolt-down parapet barriers may be considered, ensuring that deck drainage is addressed.

8.2.9 GROUT

8.2.9.1 General

- Grout shall be Target Traffic Patch fine or coarse, or Ministry pre-approved equivalent, as specified for the uses below.
- Target Traffic Patch fine shall be supplied for the following uses unless noted otherwise by the Ministry Engineer for a specific structure:
 - transverse grouted joint between deck panels on composite bridges;
 - grouted deck panel to girder connections on non-composite concrete deck bridges;
 - slab girder to abutment dowel connections; and
 - all other uses where the grout layer will be less than 25 mm thick.
- Target Traffic Patch coarse shall be supplied for all other uses unless noted otherwise by the Ministry Engineer for a specific structure.

- Grout at the time of delivery shall have a minimum remaining shelf life of 8 months.

8.2.9.2 Structural Field Grouting, Sampling and Testing

The [*Structural Field Grouting, Sampling and Testing Standard \(PDF, 112KB\)*](#) provides detailed information and specifications for structural grouting that is done at a bridge site during construction.

8.2.10 WATERPROOFING MEMBRANE

8.2.10.1 Situations Requiring Waterproofing Membrane

The following table specifies when waterproofing membrane is required for standard bridges.

Table 8.4: Situations Requiring Waterproofing Membrane

Bridge Type	Specific Situation	Location
Steel girder concrete deck (composite)	all	Deck end joint
Steel girder concrete deck (non-composite)	If bridge is intended to be installed at the bridge site longer than 10 years.	Deck end joint
Slab girder bridge	If the slab girders are shear-connected.	Deck end joint

Waterproofing membrane may be specified in other bridge locations and situations by the Ministry or bridge designers.

8.2.10.2 Waterproofing Membrane Details

Waterproofing membrane shall be designed and installed in accordance with the standard drawings, the manufacturer’s specifications, and the following:

- Waterproofing membrane shall be Bituthene 3000, or Bituthene Low Temperature, as appropriate for the installation temperature;
- Waterproofing membrane shall be protected with asphalt impregnated fibreboard;

- Before applying the waterproofing membrane, the concrete shall be primed with Bituthene Adhesive Primer B2 LVC.
- The top of wall termination (i.e.; top edge of the waterproofing membrane) shall be sealed with Bituthene Liquid Membrane.

Alternative equivalent materials may be proposed for Ministry Engineer acceptance consideration.

8.3 STRUCTURAL CONCRETE DESIGN

8.3.1 CONCRETE DECK PANELS

8.3.1.1 Panel Edge Thickness

The following table specifies standard deck edge thickness for square precast concrete deck panels. Variations may be required for skewed or flared deck panels.

Table 8.5: Standard Concrete Deck Panel Edge Thicknesses

Traffic Loading	Deck Width mm (ft)	Deck Edge Thickness mm
BCL-625	4268 (14')	175
	4876 (16')	175
L-100	4268 (14')	200
	4876 (16')	200
L-150, L-165	4876 (16')	225

8.3.1.2 Panel Length

The preferred length of concrete deck panels is 3048 mm (10'). Notwithstanding, deck panel lengths shall conform to the following:

Table 8.6: Standard Concrete Deck Panel Lengths

Item	Length (mm)
Minimum deck panel length	1524
Maximum internal deck panel length	3048
Maximum end deck panel length (deck over ballast wall)	3300

8.3.1.3 Joint between End Panel and Ballast Wall

Concrete deck panels at the end of a bridge shall cover the top of the ballast wall (i.e.; “deck over ballast wall”.) Bridges shall not be designed with deck panels that end beside ballast walls (i.e.; “deck beside ballast wall.”)

End deck panels shall be designed assuming the ballast wall provides no vertical support to the panel when the standard end deck panel/ballast wall joint filled with evazote (as shown on the standard drawing) is used.

If structural design of a concrete deck panel requires full support from a ballast wall, special detailing shall be proposed by the Structural Design Engineer for Ministry Engineer approval consideration.

Commentary

Bridges with “deck beside ballast wall” designs have, in the past, experienced more frequent instances of concrete damage than “deck over ballast wall” designs. They are also more prone to leakage through the joint.

8.3.1.4 Traffic Load Sharing at Interior Transverse Deck Panel Joints

Non-composite deck panels shall be designed assuming no sharing of load between panels across the compression seal joints. Designers shall pay special attention to panel design at this location for design traffic wheel loads, so that panel cracking and/or local failure does not occur.

Composite panels may be designed assuming some shear transfer between panels across the grouted joints.

Commentary

Non-composite deck panels have a transverse free edge. These panels have occasionally experienced cracking and local failure at the transverse deck joint due to vehicle loading.

8.3.1.5 Gaps between Deck Panels and Girder Top Flanges

Construction Assurance Engineers shall document any gaps between deck panel soffits and girder top flanges when the panels are placed on the flanges. The Construction Assurance Engineers shall ensure the gaps are acceptable to themselves, the Ministry Engineer and the Structural Design Engineer. If the gaps are not acceptable, remediation shall be undertaken.

8.3.1.6 Empirical Design Method Not Allowed for Deck Design

The empirical design method described in CHBDC shall not be used for FSR bridges.

8.3.2 PRECAST CONCRETE SLAB GIRDERS

8.3.2.1 Minimum Depth

Minimum slab girder depth shall be 250 mm.

8.3.2.2 Design as Flexural Members

All slab girders with aspect ratios (span/width) greater than 2 shall be designed as flexural members rather than slabs with respect to shear.

8.3.2.3 Connection to Abutments

Incorporate sufficient connection of the slab to abutment (steel dowels) to resist all applied loads including braking loads and earth pressures.

Minimum number and size of dowels: One dowel (min. 25 mm dia.) at each end of each slab.

Dowels shall be smooth round steel bars. Filling of blockouts in slab girders around dowels shall ensure no bond is developed with the dowel that will transfer vertical traffic loads or other vertical loads from the slab girder to the dowel (i.e. compression of rubber bearing pads shall not be restrained due to vertical loads being carried by dowels.) Tape around dowels, foam taped to top of dowels, plastic sleeves around dowels, and other methods may be used to isolate the dowels from the blockout fill material (grout (for stationary bridges) or asphalt (for portable bridges)).

8.3.3 PRECAST LIFTING ANCHORS

8.3.3.1 Introduction

Precast concrete components (except concrete roadside barriers and unreinforced interlocking concrete blocks) shall be designed in accordance with this section.

Some components and situations will benefit from the use of Ministry Engineer approved variations from the standards described herein, for example if the Ministry Engineer has approved that some or all lifts of the component (including during installation) may be assumed to:

- be crane lifts;
- be 2 excavator lifts;
- use rigging that has been confirmed by a Professional Engineer to equally distribute load to 4 anchors in a lift by one machine using 4 anchors.

8.3.3.2 Anchor and Clutch Types

Components shall have embedded lifting anchors that are compatible with Dayton-Superior P91S Fleet-Lift Ring Clutches (4-6 ton Ring Clutch or 8-12 ton Ring Clutch).

If anchors other than Dayton-Superior anchors are proposed to be supplied, a Professional Engineer sealed confirmation shall be supplied together with the proposed structural design drawings to the Ministry Engineer stating that the anchors are compatible with Dayton-Superior P91S Fleet-Lift Ring Clutches (4-6 ton Ring Clutch or 8-12 ton Ring Clutch) and that the bridge supplier accepts liability for any possible issues (including safety) that may be caused by using anchors supplied by a manufacturer that is not the clutch manufacturer (which typically voids warranties from both the anchor and clutch manufacturers).

Components (e.g.; ballast walls) may be designed to be thicker than typical ministry standard components if necessary to allow a sufficient length anchor to be cast into the component. The increased thickness may be localized in the vicinity of the anchors or may be for the entire component.

The top of ballast walls shall have anchors that are specifically designated as erection anchors by Dayton-Superior such that the wall can be tilted by the anchors from a flat position to a vertical position without spalling around the anchors unless a practical alternate lifting procedure is specified for tilting the ballast wall position from flat to vertical without damaging the wall.

8.3.3.3 General Design

The component structural design drawings shall specify:

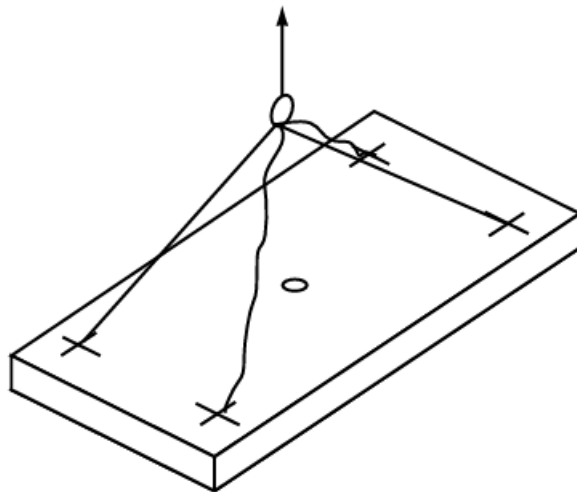
- The location; installation requirements and specific type of lifting anchors;
- The specific required ring clutches;
- Lifting procedures and limitations assumed by the structural design engineer.

Components shall be designed for balanced lifting.

Components shall be designed to be lifted by one excavator, as per typical FSR bridge component lifting and installation methods unless otherwise noted herein.

When a component has 4 anchors in one face intended to be used simultaneously, it shall be designed to be lifted by one excavator using four equal length slings/chains in a 4 leg bridle hitch, assuming only 2 of the 4 anchors carry load at any time, as per the following figure.

Figure 8.1: Four Leg Bridle Hitch (Excerpt from Dayton Superior Precast Handbook)



2 anchors will carry load when using 4 individual slings. The other 2 anchors will act to balance the precast concrete element.

Concrete slab girders shall be designed to be lifted and moved by one excavator. They shall additionally have lifting anchors at each end that will allow one excavator to lift one end while a second excavator lifts the other end when the slab girder is being placed on its abutments.

Designs shall specify low impact lifting only, with sling angles no flatter than 30 degrees from vertical.

Lifting anchor recesses shall be specified to be grouted after installation unless otherwise specified by the Ministry (e.g.; for some portable bridge components).

8.4 PRECAST CONCRETE UNREINFORCED INTERLOCKING BLOCKS

Precast concrete unreinforced interlocking blocks shall meet the following specifications:

- Concrete must have a 28 day strength of 20 MPa minimum unless otherwise specified.
- Blocks shall be cast monolithically (i.e., no cold joints allowed).
- The finish shall meet Class 1 (unless noted otherwise by the ministry) requirements as described in Section A above.
- Standard full block size must be 1500x750x750 mm.
- Dimensional tolerance must be ± 20 mm for length, width and height and the blocks shall be reasonably square, with the diagonals within a tolerance of ± 15 mm of each other.
- Top and bottom surfaces must be flat to a tolerance of ± 3 mm under a 600 mm straight edge.
- Concrete shall be air entrained 4-7% to protect the surface from freeze thaw degradation.
- Each block must contain a satisfactory embedded lifting device.
- Interlock pattern and geometry must be approved by the ministry.
- Edges shall be chamfered.

8.5 PRECAST CONCRETE ROADSIDE BARRIERS

Concrete roadside barriers shall meet the standards (including drawings) established by the BC Ministry of Transportation and Infrastructure in Section 941 of their “Standard Specifications for Highway Construction”, available at:

https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/highway-specifications/volume_2_ss2020.pdf

The Ministry of Forests has one unique concrete roadside barrier, the anchor CRB, which is described in the standard drawing set: Anchored/Connected Bridge Approach Barriers (STD-EC-010-17 to 22).

9. WOOD STRUCTURES

9.1 GENERAL

This section (and the corresponding CHBDC section) provides requirements that typically apply to wood structures that are not composed of logs, however many aspects would still be applicable to log structure design.

Log bridges are also addressed in Section 18: Log Structures.

Log culverts (aka wood box culverts) are also addressed in Section 18: Log Structures and in Section 7: Buried Structures.

9.2 WOOD MATERIALS AND FABRICATION

9.2.1 BRIDGE TIMBERS AND LUMBER MATERIAL STANDARD

The [Bridge Timbers and Lumber Material Standard \(PDF, 229KB\)](#) provides detailed specifications that apply to the supply of wood components for bridges, including quality assurance requirements.

9.2.2 WOOD TREATMENT

9.2.2.1 Pressure Treated Wood Standard

The [Pressure Treated Wood Standard for Timber Deck Bridge Components \(PDF, 736KB\)](#) provides detailed specifications, including quality assurance requirements, for the supply of wood that may be treated with one of the following preservatives: creosote, pentachlorophenol, chromated copper arsenate, or ammoniacal copper zinc arsenate.

9.2.2.2 CCA Treatment of Coastal Douglas-fir Wood

The [Interim Process Specification for CCA Treatment of Coastal Douglas-fir Wood \(PDF, 147KB\)](#) provides detailed specifications, including quality assurance requirements, for the ministry specific process for treatment of Coastal Douglas-fir wood with a chromated copper arsenate (CCA) preservative. Unless otherwise specified by the ministry, treated wood shall be CCA treated Coastal Douglas-fir as described in this process specification.

9.2.2.3 Use and Disposal of Treated Wood

The following document was jointly produced by the BC Ministry of Transportation and Infrastructure (TRAN) and FOR: [Guidelines for Use of Treated Wood In and Around Aquatic Environments and Disposal of Treated Wood \(PDF, 2MB\)](#).

9.2.3 TIMBER FASTENERS

Bolts used in timber connections shall be in accordance with ASTM A307, and be galvanized, complete with galvanized malleable iron washers and galvanized nuts.

Screws (aka lag screws or lag bolts) shall be in accordance with ASTM A307 and be galvanized.

Nails shall be galvanized.

9.3 WOOD DESIGN**9.3.1 GENERAL**

Wood design shall be in accordance with CHBDC unless otherwise specified by the Ministry.

9.3.2 CROSS TIE SIZE & SPACING FOR STEEL GIRDER TIMBER DECK BRIDGES

The following table provides information relevant to the Ministry's Standard Steel Girder Timber Deck drawing set (STD-EC-020 Series).

Table 9.1: Cross Tie Size & Spacing for Steel Girder Timber Deck Bridges

Traffic Load	Deck Width (mm)	Girder c/c Spacing (mm)	Cross Tie Size (mm x mm)	Cross Tie c/c Spacing (mm)
BCL-625	4268	3000	200 x 250	406
	4876	3600		
L-100	4268	3000	200 x 300	406
	4876	3600		
L-150	4876	3600	250 x 300	406
L-165	4876	3600	250 x 300	305

10. STEEL STRUCTURES

10.1 GENERAL

This section provides standards for steel components, including assemblies that are embedded in concrete components, and fasteners.

Standards for reinforcing steel and steel lifting anchors embedded in concrete components are addressed in Section 8: Concrete Structures.

For quality control, quality assurance and steel fabricator certification requirements refer to Section 2: Durability and Sustainability.

Unless otherwise specified, steel grade references in this section are to Canadian Standards Association (CSA) grades.

10.2 STEEL PLATES, BARS AND SECTIONS

10.2.1 CSA STANDARD

Unless otherwise specified by the ministry, structural steel shall comply to CSA Standard G40.20 / G40.21 “General Requirements for rolled or welded structural quality steel / Structural Quality Steel.”

10.2.2 FRACTURE-CRITICAL MEMBERS

For fracture-critical members, Charpy V-notch tests shall be specified on a per heat frequency (contrary to the CHBDC requirement for per plate testing) as defined in CSA G40.20/G40.21. The steel shall meet the impact energy requirements specified in CHBDC.

10.2.3 GRADES

10.2.3.1 General

Unless otherwise specified by the ministry, all structural steel shall be uncoated atmospheric corrosion resistant (weathering) steel (350A or 350 AT as applicable). If non-weathering steel is allowed by the ministry, the steel shall have corrosion protection.

Unless otherwise specified on ministry standard drawings, the grades described in the following sub-sections (or similar higher grades) shall be used.

Alternative grades specified in the tables below are considered acceptable. Other alternatives require approval by the Ministry Engineer and Structural Design Engineer, for a specific project.

Commentary

Section 10 of the BC TRAN document "[Supplement to CHBDC](#)" provides helpful guidance regarding commonly available steel grades and sizes in BC.

10.2.3.2 Steel Girder Superstructures

Table 10.1: Steel Grades for Steel Girder Superstructure Components

Component	Corrosion Protection	Steel Grade	Alternative Grade
Girder flange and web plates (including splices)	Weathering Steel	350AT category 3	
Other plates and rolled sections	Weathering Steel	350A	ASTM A588, ASTM A709 50W

10.2.3.3 Substructure Steel

Table 10.2: Steel Grades for Substructures

Component	Corrosion Protection	Steel Grade	Alternative Grade
Pipe Columns (& related plates & bracing)			
Pipe Columns	Field-painted	ASTM A252 Grade 2	ASTM A53, API 5L X42
Pipe Column related plates (e.g. gusset plates, base plates and bracing spacer plates)	Field-painted	300W	ASTM A572 44, ASTM A709 50
Pipe Column bracing sections (i.e. angles)	Field-painted	350W	ASTM A572 50, ASTM A709 50
Piles			
Piles- Round	Add 3 mm to structurally required thickness	ASTM A252 Grade 2	ASTM A53, API 5L X42
Piles- HP	Add 6 mm to structurally required thickness	350W	ASTM A572 50, ASTM A709 50
Inverted T-abutments			
Inverted T-abutment welded or bolted connection plates	Weathering Steel & Field-painted	350A	ASTM A588, ASTM A709 50W
Bearings			
Bearing Plates (top and bottom)	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Bearing keeper bars (increase size to 9x9 if 6 x 6 bar is unavailable)	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Other			
Connector Plate (between Ballast Wall & Steel Girder End Plate)	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Plate washers for ballast wall & Inverted T-abutment bolted connections	Galvanized	300W	ASTM A572 44, ASTM A709 50
Other plates and rolled sections	Weathering Steel	350A	ASTM A588, ASTM A709 50W

Commentary

For typical FSR bridges, some uncoated components in the table above require an additional 3mm or 6mm thickness added to the structurally

required thickness to allow for some corrosion to occur without compromising the necessary capacity of the component. The following bullets provide additional details:

- *Round piles: 3mm additional thickness required due to one side of uncoated steel in contact with ground;*
- *HP piles: 6mm additional thickness required due to two sides of uncoated steel in contact with ground.*

Inverted T-abutment welded or bolted connection plates are required to be field-painted when they are in contact with ground because uncoated weathering steel is not recommended for ground contact situations.

10.2.3.4 Steel Embedments in Concrete Components

Table 10.3: Steel Grades for Embedments in Concrete Components

Component	Corrosion Protection	Steel Grade	Alternative Grade
Embedded in Superstructures			
Angle shear connectors & plates between connectors (for concrete slab girders and inverted channel compo-girders)	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Round Bars (welded to slab girder shear connector)	Fully embedded in concrete	ASTM A36	
Compo-Girder flange plates	Weathering Steel	350AT category 3	
Steel armour plates for deck ends	Assembly galvanized	300W	ASTM A572 44, ASTM A709 50
CL-3 guardrail insert angles	Assembly galvanized	350W	ASTM A572 50, ASTM A709 50
Embedded in Substructures			
Ballast Wall embedded plates	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Inverted T-abutment embedded plates for welded connections	Weathering Steel (& Field-painted if in contact with ground)	350A	ASTM A588, ASTM A709 50W
Concrete cap embedded plates (for connections to pipe columns or piles)	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Embedded in Superstructures & Substructures			
Corrugated steel pipe blockouts	Galvanized	G401	
Dowels- Round (aka pins, drift pins, smooth bars: typ. min. 25mm dia. for substructure connections or substructure to superstructure connections)	Essentially fully embedded in grout, concrete or asphalt	300W	ASTM A572 44, ASTM A709 50
Other plates	Weathering Steel	350A	ASTM A588, ASTM A709 50W
Other rolled sections	Weathering Steel	350A	ASTM A588, ASTM A709 50W

Commentary

Inverted T-abutment embedded plates for welded connections are required

to be field-painted when they are in contact with ground because uncoated weathering steel is not recommended for ground contact situations.

10.2.3.5 Steel for Bridge Barriers and Approach Barriers

Unless otherwise specified in the BSM, steel grades for bridge barriers and approach barriers shall be as specified on the standard bridge drawings.

10.3 STEEL STUDS AND FASTENERS

10.3.1 BOLTS FOR STRUCTURAL STEEL CONNECTIONS

Bolts for structural steel work shall meet the specifications of ASTM F3125 Grade A325 Type 3 M22 installed in accordance with CHBDC unless otherwise specified by the Ministry.

10.3.2 THREADED RODS

Threaded rods shall be ASTM A193 Grade B7 (galvanized) or ASTM A307 (galvanized) as specified on the standard drawings.

Cut ends of galvanized threaded rods shall be coated with 3 coats of Galvacon or equivalent.

10.3.3 NUTS AND COUPLERS

Nuts and couplers shall be in accordance with ASTM A563 and shall be compatible with the bolts, threaded rods or threaded reinforcing bar specified, to develop the full strength of the bolt, rod or bar.

Couplers embedded in concrete shall meet the above requirements and shall be galvanized “Burrard” couplers.

Commentary

Example standard uses of “Burrard” couplers are:

- *CL-1 and CL-2 guardrail connections to concrete slab girders and concrete deck panels;*
- *Steel guardrail connections to Anchor CRBs.*

10.3.4 STUDS

Studs that are welded to composite girder steel top flanges or other steel plates or sections and are intended to be embedded in concrete or grout shall be headed studs that meet the requirements for stud shear connectors specified in CHBDC.

10.3.5 FASTENERS FOR BRIDGE BARRIERS, APPROACH BARRIERS AND WOOD COMPONENTS

Fasteners for bridge barriers, approach barriers and wood components shall be in accordance with the standard drawings.

10.4 STEEL DESIGN**10.4.1 STEEL I-GIRDERS****10.4.1.1 Standard Steel I-Girder Spacing**

Standard steel I-girder transverse spacing for several deck widths is provided in the table below.

Table 10.4: Standard Steel I-girder Spacing

Deck Width mm (ft)	Standard Girder Spacing (mm)
4267 mm (14')	3000
4876 mm (16')	3600

10.4.1.2 Steel I-Girder Bolted Splices

Provide bolted I-girder splices on all steel I-girders procured through a design/supply contract when girders have an overall length >24.384 m (80') unless otherwise directed by the ministry engineer.

For design/supply/install contracts, bolted steel I-girder splices shall be provided at the discretion of the detailed design engineer.

10.4.1.3 Diaphragms between Steel I-Girders

Diaphragms shall be provided between steel I-girders at bearing locations and at interior locations with a maximum spacing of 8 m between diaphragms.

10.4.1.4 Plan Bracing between Non-Composite Steel I-Girders

Provide continuous plan bracing for all bridges.

10.4.1.5 Plan Bracing between Composite Steel I-Girders

For bridges procured through a design/supply contract:

- When overall girder length \leq 24.384 m:

- Provide at least one plan brace for erection purposes when there is no bolted girder splice;
- Provide at least one plan brace for erection purposes at each bridge end when there is a bolted girder splice.
- When overall girder length > 24.384 m: Provide continuous plan bracing.

For bridges procured through a design/supply/install contract:
Plan bracing shall be at the discretion of the detailed design engineer who shall consider the method of erection.

10.4.1.6 Stud Groups for Composite Deck Panels

Design of stud groups placed in pockets shall take account of reduced effective strength for stud spacings less than 4 diameters;

10.4.1.7 Short Span Composite Girders

Composite bridges with spans < 15 m may be designed so that the girders carry all loads without relying on composite action with the deck.

Commentary

Stud fatigue requirements in CHBDC become problematic for very short composite bridges if the girders are designed to be fully composite.

10.4.1.8 Steel Girder End Panel Tension Field Analysis

For steel girder end panel tension field action analysis and for the purposes of application of CSA S6 Section 10.10.5.1: for the girder end panels and adjacent to large openings in the web, the shear capacity shall be calculated using $F_t=0$.

Refer to Chapter 14 for guidance on the evaluation of existing steel I-girders that may not have been designed in accordance with the paragraph above.

Commentary

Prior to approximately 2022, the Ministry did not have detailed standards relating to this issue.

10.4.2 FATIGUE

10.4.2.1 General Fatigue Design

Fatigue design shall be undertaken in accordance with Section 3 and the following:

- Fatigue Stress Range

$f_{sr} < F_{SR}$ where:

f_{sr} = the calculated stress range at the detail due to the passage of the design vehicle; and

F_{SR} = Fatigue stress range resistance;

- Number of Design Cycles

500,000 for spans > 12 m; and

1,000,000 for spans \leq 12 m.

10.4.2.2 Fatigue resistance of stud shear connectors

Contrary to CHBDC, stud shear connectors shall be designed for the following stress range:

$$\tau_{sr} = \frac{V_{sc} Q_s}{A_{sc} I_n n} \leq F_{sr}^D$$

Where:

V_{sc} = range of design shear force at the section along the length of the beam where the shear resistance of shear connectors is being evaluated for the design traffic loading.

10.5 STEEL FABRICATION

10.5.1 CERTIFICATION, QUALITY CONTROL & QUALITY ASSURANCE

Refer to Section 2: Durability and Sustainability.

10.5.2 STEEL PLATE ROLLING DIRECTION

Steel plates for main members, splice plates for flanges, and main tension members shall be cut and fabricated so the direction of rolling is parallel to the direction of the primary stresses.

10.5.3 WELDING SPECIFICATIONS

- All welding shall be done under suitable cover;
- All welding, and inspection of welding, must conform to CSA W59 *Welded Steel Construction (Metal Arc Welding)*;

- Fabricate girders as fracture critical members in accordance with CHBDC except that Charpy V-notch testing results are only required on a per heat frequency;
- Weld metal of primary tension members and fracture critical members shall meet the CVN toughness requirements specified in CHBDC;
- Welds shall be 6 mm fillet welds, unless noted otherwise;
- The desired objective for flange to web welds, for both I-girders and all-steel portable girders, is that they be made as continuous, uninterrupted and uniform welds free of abnormalities that could result in stress concentrations;
- Generally, web to flange welds shall be made continuously by machine or automatic welding using submerged arc welding, flux-cored arc welding or metal-cored arc welding;
- I-girder flange to web welds shall be made using submerged arc welding;
- There may be instances where the ministry may accept girder web to flange welds with stops and starts in the deposition of weld material (e.g., at plate diaphragm locations on box girders, at certain end of girder locations with limited access, or upon occasions of unexpected power outages). However, continuous welds made by automatic or machine methods are required wherever it is reasonably physically possible (e.g., welds made on the outside of all steel portable box girders, and interior welds on all steel portable box girders except as previously noted);
- Where welds require repair, they may be repaired using a semi-automatic or manual process, but the repaired weld shall blend smoothly with the adjacent welds. Weld repairs shall be undertaken in accordance with CSA W59;
- The welding procedure data sheets, as per CSA W47.1, shall be available for ministry review prior to fabrication;
- Where pile splicing is necessary, it must be done in accordance with details shown on the drawings prepared by the detailed design engineer.
- Field welding of steel girders (other than connections to bearings and ballast walls) is not permitted except as specifically pre-approved by the ministry.

Commentary

Ministry bridge construction typically involves two types of welding:

- *Shop welding, including: primary steel superstructure load carrying members, some bracing, inserts for embedment into concrete; bearing components, superstructure post base plates, guardrails; and*
- *Field welding required during installation of bridge components, including: bearing components, steel substructure components, shear connections between precast members.*

10.5.4 SHOP TRIAL FIT OF GIRDER SPLICES

Shop trial fit shall be undertaken for all girder bolted splices unless CNC equipment is used.

10.6 CORROSION & STEEL COATINGS

10.6.1 GENERAL

Steel coatings and consideration of corrosion shall be in accordance with this section, the steel grade tables provided above, and the standard bridge drawings.

10.6.2 GALVANIZING

Unless specified elsewhere by the ministry, galvanizing shall be undertaken in accordance with ASTM A123, minimum 610 g/m².

All steel to be galvanized shall meet chemical composition recommendations to ensure against embrittlement as specified by the American Galvanizers Association:

www.galvanizeit.org.

Structural Design Drawings shall detail components to be galvanized to have adequate drainage, as per the reference above, to allow safe and high-quality galvanizing.

10.6.3 SUBSTRUCTURE PAINT

All non-galvanized buried steel except for driven piling shall be protected against corrosion using Xymax Mono Guard™ or a similar Ministry pre-approved equivalent, applied in accordance with the manufacturer's specifications (accelerator to be used as recommended by the manufacturer for specific humidity and temperature conditions).

10.6.4 STEEL GUARDRAIL PAINT

The [Steel Guardrail Component Paint Standard \(PDF, 261KB\)](#) provides detailed specifications to be used when HSS bridge guardrail systems, or portions of those systems, are to be painted.

Commentary

This paint standard was specifically developed to provide a non-fading high visibility safety yellow coating. Various pre-approved paint systems are described, including a powder-coated option. Also included are surface preparation requirements and directions for approval of alternate paint systems. Older painted HSS guardrails on FSR bridges may have been coated with a different (epoxy only) safety-yellow paint system that quickly faded and became chalky.

10.6.5 NATURALLY CORROSIVE ENVIRONMENTS

10.6.5.1 General

This section provides standards applicable to bridges in naturally occurring corrosive environments. Naturally corrosive environments include:

- Marine coastal areas, including estuaries;

- Sites in close proximity to waterfalls or other water features that produce nearly continuous mists that affect bridges;
- Sites where bridges are nearly continuously wet from fog, shade, mist, rain, condensation, etc.

Commentary

All FSR bridges are affected by corrosion over time, however they are not all considered to be in a “naturally corrosive environment” as it is described in this section.

10.6.5.2 Uncoated Weathering Steel Prohibited

Uncoated weathering steel shall not be used for stationary bridges in naturally corrosive environments. Concrete or coated structural steel shall be specified in these situations.

Commentary

FSR weathering steel girder bridges in naturally corrosive environments have frequently not met their intended 45 year design life due to rapid and excessive corrosion.

See the Federal Highway Administration (FHWA) Technical Advisory 5140.22 [FHWA Uncoated Weathering Steel in Structures](#) document for details regarding situations where weathering steel use is not recommended.

10.6.5.3 Naturally Corrosive Environment Steel Coating Specification

10.6.5.3.1 Situations for Use

This naturally corrosive environment steel coating specification shall only apply where it has been specified. For most FSR bridges this specification will not be applicable.

Components to be coated to this specification shall be specifically identified in advance of bridge supply bidding, and typically may include such items as girders, bracing, guardrails, bearing assemblies, exposed substructure components, etc.

10.6.5.3.2 Specification

- Steel components to be installed shall be shop-coated in accordance with all aspects of BC Ministry of Transportation and Infrastructure (TRAN) coating specifications, including but not limited to quality control/assurance and documentation requirements, as described in the

Standard Specifications for Highway Construction (TRAN) Section 216: Coating of Steelwork and Section 308: Coating Systems, with exceptions as provided herein.

- In the above noted TRAN specifications, for the purpose of FOR projects, the term “ministry” shall refer to “FOR”; and the term “ministry representative” shall refer to the “FOR ministry engineer” or to the FOR “ministry in-plant quality assurance inspector.”
- The coating system shall be chosen by the contractor from category SS1 or SS4, as described in the [TRAN Recognized Products List](#);
- Surface preparation shall be SSPC-SP10.
- Unless otherwise specified by the Ministry, paint colour shall be in accordance with the [TRAN Recognized Products List](#), except that guardrail components shall be safety yellow.
- Steel to be coated to this specification may be weathering (e.g., A or AT) or non-weathering (e.g., W or WT), as chosen by the contractor. Typical FOR notch toughness (T) requirements shall be met for components made of non-weathering (W) steel.

10.6.6 CORROSIVE ROAD SURFACE TREATMENTS

When corrosive road surface treatments are applied to bridge decks or road surfaces in the vicinity of bridges, bridge design and detailing shall direct corrosive runoff from approaches and decks away from steel superstructure and substructure components.

In these situations, decks with exposed steel, including All-Steel-Portable decks (even if they are coated) and concrete slab girders with welded shear connections shall not be used.

Commentary

De-icing and dust-suppression salts applied to bridges or to roads in the vicinity of bridges cause unusual and rapid corrosion of steel bridge components they contact.

All-Steel-Portable deck coatings wear off rapidly due to traffic therefore the coating is ineffective in providing corrosion protection for the steel deck.

Typical ministry bridge standards assume that corrosive road surface treatments are not used. Some standard FSR bridge details are not appropriate in locations where corrosive road surface treatments are used.

11. JOINTS AND BEARINGS

11.1 JOINTS

Most ministry bridges are of a semi-integral design where expansion deck joints are not required at the bridge ends. Long span bridges shall utilize joints if the thermal expansion/contraction is excessive for use of the typical semi-integral system.

For multi-span bridges the joint design between spans shall be proposed by the general arrangement engineer or detailed design engineer for approval consideration by the ministry engineer.

All joints shall be designed to ensure that leakage detrimental to the structure (e.g.; onto girders or bearings below) does not occur.

Notwithstanding the above, typical joints between concrete deck panels, timber deck panels and concrete slab girders shall be in accordance with the standard drawings.

If multi-span composite bridges have continuous spans, the transverse joints between concrete deck panels in negative moment regions (i.e.; over piers) shall be reinforced to minimize cracking in the joint.

11.2 BEARINGS

Bearings shall be ozone resisting natural rubber (natural polyisoprene) designed in accordance with CHBDC, unless otherwise specified by the Ministry.

Bearings must be protected against water ponding and accumulation of dirt and debris.

Maximum average pressure on plain elastomeric bearings shall not exceed 4.5MPa at SLS Combination 1, including Dynamic Load Allowance.

Where expansion bearings are used, the Structural Design Drawings shall specify sufficient information to facilitate installation at various temperatures.

Accommodate longitudinal grades greater than 2% with a bevel plate or sloped cap beam unless otherwise specified on a ministry standard drawing.

Steel reinforced elastomeric bearings shall have a minimum of two steel reinforcing plates and the cover of elastomer for the top and bottom plates shall be 5 mm. Side cover on all reinforcing plates shall be 5 mm.

12. BARRIERS

12.1 GENERAL

Ministry standard barriers include bridge vehicle barriers, combination vehicle/pedestrian barriers and approach barriers. Ministry projects shall utilize standard ministry barrier drawings customized for each specific bridge rather than having entirely unique barrier designs created for projects.

Refer to the following for additional details:

- Section 2 for concrete roadside barrier and steel fabricator certification requirements
- Section 3 for barrier loading and design information;
- Section 8 for concrete roadside barrier fabrication requirements; and
- Section 10 for steel guardrail fabrication and coating requirements.

In some situations the Ministry may determine that a bridge barrier system is required that is more robust than ministry standard systems, or is designed to accommodate other traffic types (e.g.; bicycles).

12.2 SELECTING BRIDGE BARRIERS AND APPROACH BARRIERS

Refer to: [Guidance for Selecting Bridge Guardrail Containment Level and Determining Need for Bridge Approach Barriers on FSRs \(PDF, 329KB\)](#)

12.3 APPROACH BARRIERS

Refer to: [Considerations for Use of Ministry Standard Drawings STD-EC-010-05 and STD-EC-010-17to22 Bridge Approach Barriers for FSR Bridges \(PDF, 172KB\)](#)

12.4 COMBINATION PEDESTRIAN/VEHICLE BRIDGE BARRIERS

Refer to: [Guidelines on Use and Application of Ministry Standard Drawings STD-EC-010-10 and STD-EC-010-11 Pedestrian Railings for Attachment to CL-2 and CL-3 Vehicle Guardrails on FSR Bridges \(PDF, 424KB\)](#)

13. MOVABLE BRIDGES

13.1 GENERAL

The Ministry does not utilize movable bridges such as mechanical lift bridges. A Ministry Engineer will determine specifications if the need arises. Ministry portable bridges are not considered to be movable bridges.

14. EVALUATION

14.1 GENERAL

This section provides some Ministry standards relating to inspection and evaluation of bridges. The Ministry [Engineering Manual](#) provides additional details relating to inspection of FSR bridges.

14.2 CORPORATE BRIDGE REGISTER

The Ministry maintains a database of bridges and inspections called the Corporate Bridge Register (CBR). Details about CBR are available for Ministry staff on the [Ministry's internal website](#).

14.3 ROUTINE INSPECTION FORMS

The following standard routine inspection forms are required to be used for routine inspections. These forms may be modified slightly as required to suit inspection methodologies that utilize iPads or computers for field data collection.

- [FS1337A-1: Log or Timber Stringer Structures \(PDF, 1.3MB\)](#)
- [FS1337B-1: Bridges – Excepting Log or Timber Stringer Structures \(PDF, 1.3MB\)](#)
- [FS1337C: Routine Condition Culvert Inspection Form \(PDF, 1.1MB\)](#)

14.4 INSPECTION OF BEARINGS

Inspection of bridge bearings shall be undertaken with consideration of the following: [Protocol for Inspection of Bridge Bearings \(PDF, 3MB\)](#).

14.5 POST-FIRE BRIDGE ASSESSMENT

Inspection and evaluation of bridges affected by fires shall be undertaken in accordance with [Post-fire Bridge Assessment Guidance & Procedures \(PDF, 3.7MB\)](#).

14.6 SHEAR CAPACITY EVALUATION OF END PANELS ON EXISTING STEEL I-GIRDERS

Evaluation of existing steel I-girder end panels for shear capacity shall be undertaken in accordance with the following document, if required.

[Alternative Methodology for Determining the Shear Capacity of End Panels on Existing Girders \(PDF, 1.7MB\)](#)

Commentary

Evaluation of some existing steel I-girders using conservative assumptions may conclude that the girders are substantially deficient in shear capacity. The document referenced above provides a more refined methodology that may indicate higher shear capacities.

14.7 MAJOR CULVERT INSPECTION ADDITIONAL INFORMATION

See Appendices to Section 7: Buried Structures.

14.8 “NORMAL” TRAFFIC LOADING FOR EVALUATIONS

The standard traffic loading scenarios for FSR bridges, as described in section 3, are to be considered “normal” traffic loading for evaluation purposes.

14.9 BRIDGE LOAD POSTING SIGNS

If a bridge is not capable of carrying highway legal traffic, or if a bridge has a lower capacity than would be expected at a bridge site, it shall have load posting signs on each approach that indicate the load capacity of the bridge.

When a bridge requires a load posting sign, the sign shall show maximum load limits (weights) that are determined specifically for the bridge by an engineer. The sign, and the methodology for determining the load limits on the sign, shall generally be in accordance with section 14 of CHBDC.

Commentary

An engineer may determine that the example bridge load limit sign shown on the [Forest Service Road sign standards webpage](#) is appropriate for a specific bridge, however caution should be exercised by engineers when determining the various weights to be shown on this sign. For example:

- If the max. GVW at the top of the sign is shown to be the GVW of the original bridge design traffic loading vehicle, it may be excessively conservative and may limit long trucks that may need to use the bridge;*
- Excessively conservative load limits on bridge load posting signs may result in unnecessary negative economic impacts to road users and/or bridges being replaced unnecessarily; and*
- Care should be taken to ensure that the load limit shown for the short 3 axle truck is logical when compared to the sum of the load limits for the single axle and the tandem axle group.*

Although the following document has not been revised to be consistent with current ministry standards, it may provide information that engineers will find helpful when they are evaluating bridges:

[Forest Bridge Capacity Signage - A Technical Review of Bridge Load Rating \(PDF, 1.2MB\)](#).

15. REHABILITATION AND REPAIR

15.1 GENERAL

Rehabilitation and repair of structures shall be undertaken in accordance with directions from a Ministry Engineer or shall be approved by a Ministry Engineer prior to being undertaken. Rehabilitation and repair of structures does not entirely need to be done in accordance with section 15 of CHBDC.

15.2 CONCRETE REPAIR GUIDE FOR CONCRETE BRIDGE COMPONENTS

Concrete repairs shall be undertaken in accordance with the following guide: [Concrete Repair Guide for Concrete Bridge Components \(PDF, 826KB\)](#), except that the use of a bonding agent, as specified in this document, is not advisable if it is contradicted by a grout manufacturer's directions for use (e.g.; Target Traffic Patch).

16. FIBRE-REINFORCED STRUCTURES

16.1 GENERAL

The Ministry does not commonly use fibre-reinforcement. A Ministry Engineer will determine appropriate specifications if required.

17. ALUMINUM STRUCTURES

17.1 PEDESTRIAN/ATV RECREATION BRIDGES

The Ministry occasionally is involved with recreation bridges that utilize aluminum as the primary structural material. In such cases a Ministry Engineer will determine the appropriate specifications utilizing the following standard bridge requisition template.

[Aluminum Pedestrian and ATV Bridge Superstructure Requirements & Specifications \(DOCX. 69KB\)](#)

18. LOG STRUCTURES

18.1 GENERAL

Log structures are not required to meet all the typical Ministry standard requirements described in this manual that apply to durable bridges. For example, they are not required to:

- Meet a 45 year design life requirement; or
- Receive in-plant Quality Assurance inspection.

However, with a Ministry Engineer's prior approval, a log structure may be an acceptable bridge on an FSR in some situations. The approving Ministry Engineer will be responsible to adapt the use of Ministry bridge standards as appropriate for this situation.

For design drawing requirements refer to Section 21: Design Drawing Requirements

Log bridges and culverts shall be designed and constructed in accordance with published references on log bridges and in general accordance with CHBDC interpreted for log structures.

Commentary

Suggested references include the FERIC Log Bridge Construction Handbook (availability of new copies unknown), and the ministry's [Log Bridge Stringers and Needle Beam Sizing. \(PDF, 4MB\)](#), 1981, guide. Note that neither of these references have been updated in recent decades therefore should be considered together with current guidance provided by a Professional Engineer.

18.2 LOGS

Logs used for stringers, sills, cribs, and other bridge components shall meet the specifications provided by the design engineer. Log cribs and sills shall be composed of cedar logs, except for ephemeral installations where other log types may be considered by the Ministry Engineer.

18.3 TIMBER-DECKED LOG BRIDGES

Commentary

Timber decked log bridges are currently rarely used.

18.4 GRAVEL-DECKED LOG BRIDGES

Commentary

Gravel decked log bridges are occasionally used on FSRs in remote areas.

18.5 LOG CULVERTS

Refer to Section 7- Buried Structures for some standards relating to culverts. Additionally, the Ministry Engineering Manual has substantial information relating to standards for log culverts.

Commentary

Log culverts are sometimes known as wood box culverts. They are occasionally used on FSRs in remote areas.

19. STANDARD BRIDGE MATERIAL REQUISITION TEMPLATES

19.1 MINISTRY BRIDGE COMPONENT SUPPLY CONTRACTS

19.1.1 GENERAL

In recent years, the Ministry has developed standard bridge material requisition templates to be used by Ministry staff as contract documents in bridge supply contracts or in contracts where bridge supply is part of a contract. A Ministry Engineer shall be involved with the use of standard bridge material requisition templates for each specific project.

The templates specify requirements, including necessary qualifications for bidders, related to bridge component supply. The templates provide a standard layout of bridge information that assists bidders in efficiently determining the bridge supply requirements related to a specific contract.

Fabricators, consulting engineers, contractors, and others can view the standard requisition templates to determine typical ministry contractual requirements for contracts that include bridge supply.

The following link provides access: [Standard bridge material requisition templates.](#)

19.1.2 STRUCTURAL DESIGN REQUIREMENTS TO BE ASSESSED

Some of the standard bridge material requisition templates specify that Structural Design Drawings are required to be prepared by a bidder's engineer. Other standard requisition templates do not require this.

The Ministry Engineer involved with the use of a template for a specific project shall revise the template if required to match the actual need for structural design work, for example if detailed structural design of a bridge has been undertaken prior to advertising for material supply.

19.2 MINISTRY SUPPLY AND INSTALL CONTRACTS

The standard bridge material requisition templates do not describe requirements related to bridge installation activities that occur at an actual crossing location.

If bridges or bridge components are to be supplied as part of a complete supply and install contract, the Ministry Engineer involved with preparing the contract documents (typically a complete tender package) shall ensure that all relevant supply requirements contained in the standard bridge material requisition template for the specific structure being ordered are included in the contract documents that apply to the supply and install contract.

19.3 FSR BRIDGE CONTRACTS NOT MANAGED BY THE MINISTRY

The standard bridge material requisition templates are specifically written for use in contracts that are directly managed by the Ministry, however, FSR bridge projects managed by others (e.g.; Road Use Permit holders) shall be in general conformance with the standard requirements described in the templates.

19.4 LIST OF STANDARD BRIDGE MATERIAL REQUISITION TEMPLATES

This section lists and describes the standard bridge material requisition templates that are currently available. Template users shall ensure they are using current templates, since they are frequently being updated.

19.4.1 STEEL GIRDER CONCRETE DECK BRIDGE

The [*Steel Girder Concrete Deck Bridge Supply Special Provisions \(DOCX, 75KB\)*](#) template addresses orders for steel girder bridges that have concrete decks. The deck may be either composite with the girders or non-composite.

19.4.2 CONCRETE SLAB BRIDGE

The [*Precast Reinforced Concrete Slab Bridge Supply Special Provisions \(DOCX, 94KB\)*](#) template addresses orders for bridges with superstructures composed of multiple reinforced concrete slabs that act as both the girders and the deck for the bridge. The slabs may be connected (welded or grouted) to each other, or unconnected to each other.

19.4.3 STEEL GIRDER TIMBER DECK BRIDGE

The [*Steel Girder / Timber Deck Bridge Requirements & Specifications \(DOCX, 103KB\)*](#) template addresses orders for new steel girder bridges that have timber decks. The timber decks may be composed of discrete pre-constructed modular panels, or the deck may be built on site as a continuous timber deck.

19.4.4 ALL-STEEL-PORTABLE BRIDGE

The [*All-Steel-Portable Bridge Requirements & Specifications \(DOCX, 96KB\)*](#) template addresses the ordering of portable bridges, of varying lengths, that are composed of steel box girders with a composite steel plate deck.

19.4.5 ALL-TIMBER-PORTABLE BRIDGE

The [*All Timber Portable Bridge \(6.1 m out-to-out\) Requirements & Specifications \(DOCX, 59KB\)*](#) template addresses the ordering of a single length (6.1 m span) timber portable bridge.

19.4.6 TIMBER DECK

The [*Timber Deck Requirements & Specifications \(DOCX, 55KB\)*](#) template addresses orders for timber deck materials, when re-decking of an existing steel girder/timber deck (or other type of timber decked bridge) is required.

19.4.7 STEEL HSS GUARDRAIL RETROFIT SYSTEM

The [*Steel HSS Guardrail System Requirements & Specifications for Retrofit Guardrail \(DOCX, 70KB\)*](#) template addresses orders of steel HSS bridge guardrail materials, for use in repairs or replacement of existing bridge guardrails which may have originally been timber or steel.

19.4.8 PEDESTRIAN RAILING FOR RETROFIT

The [*Pedestrian Railing for Retrofit \(DOCX, 94KB\)*](#) template addresses orders for steel pedestrian railings that are intended to be installed on top of standard vehicle railings to create a combination barrier.

19.4.9 ALUMINUM PEDESTRIAN AND ATV BRIDGE

The [*Aluminum Pedestrian and ATV Bridge Superstructure Requirements & Specifications \(DOCX, 67KB\)*](#) template addresses orders for lightweight aluminum truss bridges for pedestrian and/or ATV recreation use that is not on an FSR.

20. STANDARD DRAWINGS

20.1 GENERAL DESCRIPTION OF THE STANDARD DRAWINGS

Ministry Standard Drawings provide standards that shall be used, where appropriate, by engineers responsible for specific projects.

Engineers involved with specific projects shall determine whether standard drawing requirements are appropriate for their project. If they determine that certain requirements are inappropriate, they shall propose variations for Ministry Engineer approval.

Standard Drawings are not to be used directly for construction (i.e.; fabrication and/or installation.) Project specific drawings shall be created for construction of specific projects.

The following link provides access to the drawings: [Standard Drawings](#).

Commentary

Some of the Standard Drawings are quite detailed in nature and may require limited additional engineering if the Design Engineer confirms that few changes from the Standard Drawing are required for their specific Design Drawings.

Several of the Standard Drawings address proprietary component conceptual designs that have been approved by the Ministry. Proponents whose proprietary designs have been approved have provided proof to the Ministry that their components meet stringent requirements for structural integrity and durability.

The Ministry has historically utilized Standard Drawings to assist in communicating requirements for bridges and bridge components. A substantial number of Standard Drawings were created in previous decades for the Forest Service Bridge Design and Construction Manual. Many of those drawings have since been replaced or updated.

20.2 CATEGORIES OF STANDARD DRAWINGS

The various categories of Standard Drawings are described below.

20.2.1 STEEL GIRDER CONCRETE DECK BRIDGE

Drawings (STD-EC-030-01 to 10) are provided for steel girder bridges with composite or non-composite precast concrete deck panels.

Commentary

This is one of the most common bridge types on FSRs. Composite deck panels are intended to be used for stationary bridges. Non-composite panels are intended to be used for semi-portable bridges.

20.2.2 PRECAST REINFORCED CONCRETE SLAB BRIDGE

Drawings (STD-EC-070-01 to 04) are provided for reinforced concrete slab girder bridges. The girders may be connected to each other with welded steel connections or with grouted connections. An option is also provided to utilize the girders without connections between girders.

Commentary

These bridges are commonly used for various types of short span applications.

20.2.3 STEEL GIRDER TIMBER DECK BRIDGE

Drawings (STD-EC-020-01 to 07) are provided for steel girder bridges with continuous timber decks and for steel girder bridges with decks composed of discrete timber panels/modules.

Commentary

When the modular deck panels are utilized, the resulting bridge is considered to be portable or semi-portable.

20.2.4 ALL-STEEL-PORTABLE BRIDGE

Drawings (STD-EC-091-01 to 05) are provided for all-steel-portable (ASP) bridges. These bridges are composed of steel trapezoidal boxes with steel plate decks.

Commentary

ASPs are commonly used for short-term portable bridge installations.

20.2.5 ALL-TIMBER-PORTABLE BRIDGE

Drawings (STD-E-025-01 to 03) are provided for a 6.1 m long portable bridge composed completely of timber and associated steel fasteners.

Commentary

These drawings for a specific length portable timber bridge are infrequently utilized. If fully untreated, this superstructure will have a short lifespan.

20.2.6 SUBSTRUCTURE DRAWINGS

A variety of substructure component drawings (STD-EC-050- 01 to 21) are provided, including:

- Ballast walls;
- Substructures for steel bridges;
- Substructures for concrete bridges;
- Cap details;

- Modular concrete block abutments; and
- Precast concrete “Inverted T” abutments for concrete slab bridges.

20.2.7 BARRIERS

The barriers category includes drawings for:

- Timber and steel bridge vehicle guardrails (STD-EC-010-01 to 04 and 06) with containment levels varying from CL-1 (weakest) to CL-3 (strongest);
- Steel pedestrian railings (STD-EC-010-10 and 11) for attachment to CL-2 and CL-3 vehicle guardrails for create a combination vehicle/pedestrian barrier;
- Simple log and concrete bridge approach barriers (STD-EC-O10-05); and
- More robust anchored/connected concrete approach barriers (STD-EC-010-17 to 22).

Detailed guidelines relating to use of the barrier drawings listed above are described in Section 12 of this manual.

20.2.8 MISCELLANEOUS

20.2.8.1 Proprietary Concrete/Steel Hybrid Girders

Designs for the following two proprietary concrete/steel hybrid bridge girders are provided:

- Compo-Girder™ Composite Girder (STD-E-011-01);
- Compo-Girder™ Inverted Channel Beam (STD-E-011-02).

Generally, it is not recommended to directly specify these products for FSR bridges, however the two Compo-Girders™ may be proposed as contract alternatives in certain situations by a contractor with permission to use the proprietary designs. The Ministry needs to evaluate any proposed contract alternatives on a case-by-case basis.

20.2.9 STANDARD MAJOR CULVERT DRAWINGS

The Ministry’s two major culvert related drawings are described below.

20.2.9.1 Terraspan GRS Arch™

The Terraspan GRS Arch™ open bottom culvert (STD-C-050-01 to 05) is a proprietary concept which utilizes a corrugated steel arch installed in a specific manner, as described on this drawing.

20.2.9.2 Steel Pipe Trash Rack

The steel pipe trash rack (STD-C-040-01) is a tripod structure that can be utilized to minimize the risk of large debris, such as logs, plugging the inlet of a culvert.

21. DESIGN DRAWING REQUIREMENTS

21.1 GENERAL

This section describes the requirements related to Design Drawings for various types of bridges and major culverts.

21.2 DESIGN DRAWINGS FOR BRIDGES OTHER THAN LOG BRIDGES

This sub-section describes the requirements related to Design Drawings for bridges, other than log bridges. In some cases (when general arrangement design and full structural design is undertaken for a specific site prior to contracting for bridge supply) a single design drawing set may address all the requirements for General Arrangement Drawings and Structural Design Drawings.

21.2.1 GENERAL ARRANGEMENT DRAWINGS

21.2.1.1 Overview

Typically, the General Arrangement Drawings consist of a set of drawings showing the components and configuration of the proposed bridge crossing overlain on-site plans and profiles. The General Arrangement Drawings reference specific Ministry Standard Drawings and documents from the BSM.

The Ministry has a [Sample Bridge General Arrangement Drawing \(PDF, 3.4MB\)](#).

General Arrangement Drawings for specific bridge sites (simple or complex crossings) shall be prepared to be similar to this sample drawing set.

21.2.1.2 Details

Ensure that General Arrangement Drawings clearly depict the proposed components and configuration of the bridge in relation to the forest road, stream, and streambanks.

Bridge General Arrangement Drawings shall include, but not be limited to, the following:

- Site location key map;
- Designer's name (and seal);
- Name of the stream, road, and station (km) and adequate information to detail the location of the structure;
- Traffic loading scenario (e.g.; BCL-625 etc.)
- Design vehicle configuration used for horizontal alignment (e.g.; WB-19, etc.);

- Design references (e.g. CHBDC, BSM, specific ministry standard drawings);
- Expected design life of the structure in place and, if portable or semi-portable, the total design life of the structure;
- Design high-water elevation for bridges and design discharge;
- Clearances between the design high-water level and soffit (low point of underside of superstructure) of bridges;
- Details of debris passage or management strategies, if required;
- Road approaches and grades, including width requirements (e.g., allowance for vehicle side tracking) and side slopes, to a sufficient distance back from the bridge to show potential problems, or to the end of the first cut or fill;
- Dimensions and location of turnouts;
- Dimensioning and labelling of component parts;
- Connection requirements for component elements;
- Drawing scales;
- Relevant site plan and profile data;
- Location (vertical and horizontal) of proposed structure relative to field reference points;
- Deck elevations at bridge ends;
- Possible ford or temporary bridge crossing locations;
- Road and bridge or culvert signs;
- Approach barriers, if required;
- Critical elevations of substructure components;
- Scour protection: dimensions, composition, extent of placement, design slope, design high water, and other considerations;
- Rip rap extents;
- Limits of construction for contract purposes;
- Special provisions related to the unique nature of the site and crossing, including specific instructions to bidders related to process or results, as appropriate; and
- Special instructions relating to component installation standards, requirements, or methods as deemed necessary.

21.2.2 STRUCTURAL DESIGN DRAWINGS

21.2.2.1 Overview

These drawings are often prepared after, and elaborate upon, the General Arrangement Drawings.

For some projects (especially those using the “pre-design” bridge acquisition method) the information required for Structural Design Drawings and the information required for General Arrangement Drawings are combined into one all-encompassing Design Drawing set. In this scenario general arrangement details and structural details can be discussed and finalized by the design engineers prior to completion of any Design Drawings.

In combination, the General Arrangement Drawings and the Structural Design Drawings shall provide all information necessary to fabricate and install a bridge.

21.2.2.2 Details

Structural Design Drawings shall include, but not be limited to, the following:

- Layout of all components put together;
- Design references (e.g. CHBDC, BSM, specific ministry standard drawings, general arrangement drawings specific to the design);
- Design Traffic Loading
- Individual member shapes, dimensions and connection details;
- Material specifications and references (e.g.; CSA, ASTM, etc.);
- Steel grades, impact category, finish;
- Timber species, grades, preservative treatment;
- Concrete strength, slump, and air entrainment;
- Superstructure elements, configuration, and connections;
- Dimensions and sizes of components;
- Fracture critical and primary tension component identification;
- Weights of:
 - Single girder;
 - Assembled steel girders plus bracing and diaphragms;
 - Deck panels, ballast walls, caps, slabs and footings.
- Girder or stringer arrangements and connections;
- Span lengths;

- Camber;
- Bridge width;
- Curb and rail configuration, connections, and component elements;
- Bridge identification requirements;
- Field fabrication details;
- Abutment elements, configuration, and connections;
- Piers;
- Bearing materials and connections;
- Where expansion joints and/or slotted bearings are used, sufficient information shall be provided to facilitate installation at various temperatures.
- Location and sizes of piles or posts;
- Pile-driving specifications, minimum expected pile penetrations, set criteria, and required service level capacities;
- Field welding requirements;
- Bracing and sheathing configurations;
- Foundation requirements, material types and depth, and compaction level;
- Allowable wind velocity during construction procedures shall be stated on the drawings, when necessary;
- Design requirements for lifting, transportation and installation as described elsewhere in the BSM.

Note that the Structural Design Drawings are sometimes supplemented by Shop Drawings prepared by a fabricator for their convenience in undertaking fabrication in accordance with the Structural Design Drawings.

21.3 MAJOR CULVERT DESIGN DRAWINGS

Major culvert Design Drawings shall include all relevant mandatory information as described above for bridge General Arrangement Drawings and shall also include, but not be limited to, the following:

- Location of the culvert, such as a key map;
- Design traffic loading;
- Fill height, depth of cover, maximum and minimum cover requirements;
- Design slopes of fill and riprap;
- Culvert invert elevations at the inlet and outlet;

- Culvert specifications and dimensions: opening dimensions, length, corrugation profile, gauge, material type, and inlet bevel specifications;
- Site preparation requirements;
- Embedment requirements, including a description of the substrate and any rock used to anchor the bed material in the pipe;
- Foundation details;
- Backfill and installation specifications;
- Installation camber;
- Culvert gradient;
- Seepage barrier details if required;
- Special attachments or modifications;
- Inlet requirements (rip rap layout, stilling basin, etc.);
- Outlet requirements (rip rap layout, stilling basin, backwater weir for fish passage, etc.);
- Rip rap specifications, including dimensions and configuration;
- Design high-water elevation and design discharge, inlet or outlet control;
- Connection details for pipe sections; and
- Any existing improvements and resource values in the vicinity of the culvert that would influence or be influenced by the structure.

21.4 TIMBER DECKED LOG BRIDGE DESIGN DRAWINGS

Since log stringer and crib materials are variable in nature and finished dimensions are not uniform, log bridge Design Drawings are somewhat schematic.

The log bridge superstructure and log crib Design Drawings should include all relevant information described in a previous sub-section for bridge General Arrangement Drawings and should also include, but not be limited to, the following:

- Schematic layout indicating width and span;
- Reference source for stringer and needle beam sizing;
- Minimum stringer, curb, and needle beam dimensions;
- Stringer, curb, needle beam, and crib logs specifications, including species, quality characteristics of acceptable logs, and seasoning;
- Stringer-to-cap bearing details, including shim types and stringer and cap- bearing width and surface preparation;
- Dap details at log connections;
- Needle beam locations and connection details, if applicable;
- Space to add stringer, curb, and needle beam sizes as part of the as-built record;
- Deck layout, indicating tie sizes and spacing, plank thickness, and connections;
- Other material specifications, including sawn timber, hardware, and shims;
- Excavated depth relative to scour depth for mudsill or bottom bearing log;

- General layout and arrangement of front, wing wall, deadman, and tieback logs, and their connections to each other and to the bearing log or cap;
- Description of crib fill material;
- Layout and description of in-stream protection, if applicable; and
- Rip rap protection layout and specifications (as required).