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TABLE OF CONTENTS

1. DESIGN

1. Highway and Pedestrian Structures

CAN/CSA-S6-00 except as follows:

a) Live load distribution factors used for girder design shall not be less than the empirical factors specified by S6 unless specifically agreed to by Bridge Engineering Section.

b) Notwithstanding Section 8.8.4.6 (b), for other than segmental concrete construction, the following requirements for tension stresses shall apply at extreme fibres of pre-compressed tension zones for bonded prestressed sections at SLS combination 1.

Designs shall normally aim for no tension stresses. However, when practical limits are reached such that significant cost increases will occur, consideration can be given to allow tension up to a limit of 0.8 fcr or 2.0 MPa, whichever is the lesser. Pre-compressed tension zones include:

Top of deck for full depth post-tensioned construction
Top of girders post-tensioned for continuity prior to casting of the deck
All bottom flange locations except at positive moment connections over piers

Note: AT requires that all bridge decks be provided with a standard deck protection system. (see Clause 13)

c) Intermediate diaphragms are required in bridges with concrete beam and slab superstructures unless their omission is specifically agreed to by Bridge Engineering Section.

d) Stiffened plate girder webs shall in no case have intermediate transverse stiffeners spaced at greater than 1.5 h.

e) Vertical connection plates, such as transverse stiffeners which connect diaphragms or cross frames to steel girders, shall be rigidly connected to the girder flanges if the connection plate is welded to the girder web

f) Diaphragms shall be at least 1/3 and preferably 1/2 the girder depth.

g) Diaphragms and girders shall be designed for construction loads during deck concrete placement in accordance with CSA S6-00 Clause 3.16. Specifically, diaphragms, exterior steel and precast girders carrying deck overhangs shall be checked to ensure sufficient strength and stability for concentrated wheel loads from screeding machines, work bridges and curing equipment, and loads from temporary walkways outside the edge of the deck slab. Loads assumed for such design shall be shown on contract drawings. Whenever possible diaphragms used for erection purposes shall be left in place for possible future maintenance, i.e. widening, rehabilitation, etc.

h) Overhead and cantilevered sign structures shall be designed to the requirements of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. For details, see AT special provisions for sign structures. (Available upon request to Bridge Engineering Section)

i) Mechanically Stabilized Earth Walls shall be designed to the more severe requirements of CSA S6-00 and AASHTO LRFD Bridge Design Specifications.

j) Notwithstanding Clause 10.6.3.1, no painting is required except for the 2000 mm of exterior steel girders directly in front of full integral concrete abutments.

2. LOADINGS

1. Highway

CAN/CSA-S6-00 CL 800 plus Dynamic Load Allowance unless specified otherwise.

2. Pedestrian

CAN/CSA-S6-00 Clause 3.8.9. For flexible structures, dynamic response and sidesway likely to cause discomfort of pedestrians due to crowd loading shall be considered.

3. Future Wearing Surface

Bridges without an asphaltic wearing surface shall be designed for a future 50 mm thick wearing surface.

4. Fatigue

For fatigue design all bridges shall be designed in accordance with Clause 1.5.2.2 “Unless otherwise Approved, all new bridges shall be designed to comply with Class A Highway requirements” was well as Clause 8.5.3 or Clause 10.17.1 as applicable.

3. SPAN LENGTHS

1. Steel Girder and Cast-In-Place or Segmental Concrete Superstructures:

   Centreline bearing to centreline bearing dimensions on superstructure to be measured along bottom flange of girder (tapered girders would be an exception) and to be correct at +20° C. Dimensions on superstructure to be in whole metres only unless otherwise agreed to by Bridge Engineering Section. Centreline bearing lines on substructure to be located such that bearings will be centred at -5° C; i.e., bearing locations (stations) on substructure to be corrected for grade on superstructure and superstructure temperature change of 25° C (+20° C to -5° C).

2. Precast Concrete Girder Superstructures:

   Length for precast concrete girders is defined as overall girder length (not centreline bearing to centreline bearing.). Lengths used are to be in whole metres unless otherwise agreed to by Bridge Engineering Section. Bearing lines on substructure to be corrected for location of bearings relative to ends of girders, grade on superstructure, and possibly temperature in the case of longer spans. Consideration should also be given to elastic and inelastic shortening effects resulting from prestressing or post-tensioning of girders.

4. GEOMETRY

1. Whenever practical there should be a longitudinal grade of a minimum of 1%.

2. Skew angles are to be given to the nearest minute; i.e., 12° 41' L.H.F. not 12° 40' 35" L.H.F.

3. Roadway crown slope - 0.02:1.00, except on super-elevated roadways.

4. Curb, sidewalk and median wash slope - 0.03:1.00 towards roadway.

5. Abutment seat and pier cap wash slope - 0:03:1.00.

6. Top of Centreline Finished Crown stations and elevations are to be shown for each end of the structure. Top of Centreline Finished Crown is defined as the point where the headslope line intersects the finished centreline roadway profile. Station is given to the nearest decimeter and elevation to the nearest centimetre.

7. Curved bridges are to have substructure elements referenced to a construction chord established between the points where the centreline of roadway is intersected by abutment bearing centrelines at each end of the structure. A simplified sketch of the substructure

layout referenced to the construction chord is to be shown on the drawings. Curb offsets relative to the construction chord are to be shown also.

8. Pile layouts are to be referenced to the point established where centreline roadway/construction chord and centreline abutment bearings/centreline pier intersect.

9. Girder Deflections and Camber

a) Steel Girders:

Steel girders are normally cambered for 100% of dead load effects to suit final roadway geometry. Factors considered are dead load of girder, dead load of slab, superimposed dead load (wearing surface, curbs, and bridgerail), and final gradeline. Data to be presented on a camber diagram that shows overall camber along with net camber values for individual girder segments.

b) Precast Girders:

Forms for DBC type girders are adjustable to allow a sag to be built into the girder to account for camber resulting from prestressing/post-tensioning. The required form sag is to be presented on the drawings. Forms for NU type girders do not allow for form sag however, the calculated cambers should be shown on the construction drawings.

The deflection data used in determination of the sag should be presented on the drawings; i.e., dead load of girder, camber due to prestressing/post-tensioning, dead load of cast-in-place slab (if used), superimposed dead load, and final gradeline. Maximum form sag that can be accommodated is in the order of 100-125 mm.

c) Cast-in-Place Superstructures:

Data must be presented on drawings to allow setting of form elevations. The deflection data used in the determination of the form elevations should be presented.

10. Calculated critical clearances and locations must be shown on the General Layout for all grade separation structures.

11. Substructure elements are to be numbered in the direction of increasing chainage; i.e., abutment no. 1 (pier no. 1) occurs at the lower chainage location and the numbering increases from there.

5. MATERIALS

1. Concrete:

   a) Standard weight aggregates except in the manufacture of precast girders.

   b) Type 10 or 50 Portland cement unless noted otherwise on drawings.

   c) Classes and strengths:

DESCRIPTION	CLASS	STRENGTH
1. Abutments Unless Noted Otherwise	C	30 Mpa
2. Piers	C or SF	30 or 35 Mpa
3. Cast-in-place decks, abutment roof slabs and tops of abutment backwalls.	SF or Modified SF	35 or 50 Mpa
4. Cast-in-place curbs	SF or Modified SF	35 or 50 Mpa
5. Cast-in-place on precast superstructures and deck panels (blockouts, diaphragms, etc.)	SF	35 Mpa
6. Grout Keys	D	30 Mpa
7. Pipe Piles	Pile	25 Mpa

2. Reinforcing Steel:

   a) In accordance with the current version of C.S.A. Standard G30.18M "Billet Steel for Concrete Reinforcement" - Grade 400.

   b) Grade 400 W steel shall be used if the bars are to be welded. Welded bars are to be denoted with the suffix 'W' on the bar list drawing.

3. Prestressing Strand:

   a) In accordance with A.S.T.M. Standard A-416 or A-421 (fpu = 1860 MPa). Design is normally based on use of low relaxation strand.

4. Structural Steel:

a) Girders and all materials welded to girders.	CAN3-G40.21M-Grade 350AT CAT 3
b) Ungalvanized bearing materials not welded to girders and bracing material bolted to girders.	CAN3-G40.21M-Grade 350A
c) Galvanized bearing materials not welded to girders.	CAN3-G40.21M-Grade 300W
d) Miscellaneous steel including deck joints	CAN3-G40.21M-Grade 300W
e) Bolts	A325 or A325M

All steel except reinforcing steel and prestressing strand in cast-in-place or precast concrete shall be hot dip galvanized.

6. CLEAR COVER TO REINFORCING STEEL AND POST-TENSIONING DUCTS

Clear cover for reinforcing steel shall be as specified in Clause 8.11.2.2 except as noted in the following table.

1.	Steel in concrete subject to normal exposure	50 mm
2.	Steel in concrete cast in contact with soil (no form)	75 mm
3.	Steel adjacent to front face of curb or barrier	100 mm
4.	Steel in cast-in-place decks with waterproofing and overlay system.	
	Top layer	50 mm
	Bottom layer	40 mm
5.	Steel in cast-in-place decks without waterproofing and overlay system	
	Top layer	75 mm
	Bottom layer	40 mm

Clear cover for post-tensioning ducts in pre-cast concrete girders shall conform to the following:

1. The inside duct diameter shall not exceed 50% of the web thickness
2. The inside duct area shall be = 250% of the strand area
3. The 28 day concrete strength shall not be less than 65 Mpa

4. The minimum cover to post-tensioning ducts shall be 45 mm (±5 mm)

7. REINFORCING STEEL

1. Bar Lists

   a) Complete rebar details are to be shown on the 'Bar List' drawing.

   b) All reinforcing steel bar marks are to be as per Department Standards.

   c) Bar marks should not be duplicated on a project unless the bars are identical.

   d) Incremented bars should each have their own bar mark.

   e) Mass for individual bar types is to be calculated and shown to the nearest kilogram.

   f) Mass for epoxy coated and plain bars is to be shown on the bar list along with an overall total for each bridge component; i.e. abutments, piers, deck, etc.

   g) Reinforcing steel totals (plain + epoxy coated) for substructure and superstructure are to be shown in the quantity estimate table on the 'Information Sheet' but not in the quantity estimate tables for the individual bridge components.

   h) Bars placed by other than the site contractor are to be identified and totalled separately on the 'Bar List' drawing.

   i) Rebar fabrication is done from the details shown on the 'Bar List' drawing and it is consequently extremely important that the bar list details be correct.

2. Epoxy coated reinforcing steel shall be used for the following bars:

   a) Both layers of steel in cast-in-place decks.

   b) Both layers of steel in abutment roof slabs.

   c) Bars in curbs (abutments and superstructure).

   d) Bars within 150 mm of the top of abutment backwalls.

   e) Dowel bars that connect approach slab to abutment corbel.

   f) Steel in approach slabs.

3. Bar bends and bar laps for lap splices are to be as specified in drafting standards for epoxy coated bars. Minimum hooks are to be specified on the bar lists where the standard hooks will not fit due to member dimensions.

4. Bars are to be denoted with the suffix 'C' on the bar list drawing.

5. Separate totals, as well as a combined total, are to be given for plain bars and epoxy coated bars for each list appearing on the bar list drawing. Combined (overall) totals only are to appear in the Quantity Summary on the Information Sheet drawing.

6. The minimum size of reinforcing steel in all bridge elements except drain troughs shall be 15M.

8. FOUNDATIONS

1. For river crossings, it is preferred that the piers are founded on driven piles or drilled caissons rather than spread footings

2. For substructure elements founded on driven steel H-piles, it is preferred that HP 310 piles be used rather than HP 250 piles.

3. Applied factored loads for abutment and/or pier piles are to be shown in the General Notes on the drawing set's Information Sheet.

4. Applied unfactored loads for the critical Ultimate Limit State Load Combination shall be shown in the General Notes on the abutment and/or pier drawings with an indication that bearing piles are to be driven to the indicated capacity based on a bearing value formula. Friction piles are driven to a defined elevation unless the required pile capacity is achieved in bearing at a higher elevation.

5. Exposed steel piles shall be hot-dip galvanized to a minimum of one metre below grade or stream bed. Galvanizing damaged by field welding shall be zinc metallized.

9. DECKS

Deck slabs for steel girder bridges shall be designed in accordance with Section 8.18.4 of CAN/CSA-S6-00 except that clause 8.18.4.1 (b) be amended to limit girder spacing to slab depth ratio to 15.0. Use of this method requires composite action between the slab and girder over the entire girder length. The use of any other design method must be specifically agreed to by Bridge Engineering Section.

10. CURBS

a) For bridges with cast-to-grade concrete wearing surface the curb height shall be 200mm.

b) For bridges with asphaltic wearing surface protection system the curb height above the asphalt shall be 150mm.

11. BEARINGS

Bearing types in common use in AT projects are:

- Continuous plain elastomeric bearing strips for Standard SC and SCC bridges.
- Steel reinforced elastomeric bearing pads with or without stainless steel and teflon sliding surfaces.
- Fixed steel plate rocker bearings
- Fixed steel pin rocker bearings
- Expansion steel rocker bearings
- Pot bearings

Justification for the selection of bearing type is to be provided at the 'choose design' stage along with relevant cost and other factors.

1. Steel reinforced elastomeric bearing pads are to be used whenever possible. Standard pad thickness is 60 mm unless design considerations dictate otherwise Expansion bearings to have teflon bonded to top of elastomeric pad with stainless steel on mating surface. Stainless steel to conform to AISI Type 304, No. 4 polished finish. Teflon to be unfilled 1 mm thick. Elastomeric pads to be restrained by means of keeper bars on base plate. Keeper bars are to be detailed so as to be removable for bearing resetting or replacement. Base plate to be self-levelling if design allows.

2. Elastomeric material shall meet the requirements of AASHTO Grade 5.

3. Elastomeric bearing pads on skewed bridges are to be orientated perpendicular to the longitudinal girder axis unless it is not practical to do so.

4. The use of steel rocker bearings is encouraged on long span steel girder bridges, or where the loads will exceed the practical range of reinforced elastomeric bearing pads. Rocker bearings shall be stress relieved prior to machining.

5. Pot bearings can be used where there is a preference for their shallow depth. Service rotation due to live load is often in the order of .005 radian, however, a rotational allowance of not less than .01 radian shall be added for fabrication and installation tolerance. In some cases, an allowance for construction uncertainties of .02 radian may be required.

6. For expansion bearings, sliding planes shall be set level by using tapered shoe plates to correct for effects of roadway grade, girder cambers and girder end rotations during construction. When the sliding planes have to be set on an incline for proper functioning of expansion joints, or may deviate from the level due to un-predicability of prestress camber, the effects of the incline shall be fully accounted for in the design of the structure.

7. Expansion bearings shall have a 'temperature setting' table or graph provided.

8. Expansion bearings shall provide an excess travel capacity in each direction of at least 25% of the theoretical thermal movement, but not less than 25 mm, beyond theoretical travel. Allowance is to be made for additional movement if such is indicated by foundation conditions.

9. Bearings shall be grouted after girder erection and prior to pouring deck concrete unless bearing components are specifically designed for the temporary construction loads that may be encountered.

10. Base plate shall be self-levelling using the pintel detail to ensure full uniform contact with the underside of the supported girder at erection. The requirement in Clause 11.6.1 of designing for one extra degree rotational capacity shall be waived for elastomeric bearings.

11. Notwithstanding Clause 11.6.1, an 80mm thick grout pad shall be used with a 40 mm deep grout pocket under bearings. The grout pocket shall be 75 mm larger than the base plate around the perimeter.

12. Uplift bearings shall not be used.

12. DECK JOINTS

1. Wherever practical, expansion and/or fix joints shall be avoided or placed in the approach pavement away from the end of the superstructure by the use of integral or semi-integral abutment designs.

2. Consultant shall use Standard Drawings as far as possible, and cover all site specific details, dimensions, temperature setting tables, etc. on site specific drawings.

3. Strip seal type deck joints in accordance with Drawing S-1493 shall be used when maximum joint gap is less than 115 mm. Minimum joint gap of 60 mm or manufacturer's recommendation, whichever is larger, is to be maintained by stop movement bars to facilitate future seal replacements. This will result in a net usable movement range of 55 mm. For strip seal type deck joints with skew angles within the range of 20º to 45º, snow plow guard plates shall be installed in accordance with Drawing S-1626. Snow plow guard plates shall not be located directly under wheel paths.

4. Strip seals with coverplates in accordance with Drawing S-1448 shall be used for bridges on gravel roads. Coverplates are to be attached on the deck side of the joint at abutments

5. Only approved strip seals listed on the Standard Drawings shall be used.

6. Where the maximum joint gap exceeds 115 mm, closed finger plate type joints in accordance with Drawings S-1638, S-1639 and S-1640 are to be used. Fingers are to be detailed and installed to allow jacking of the superstructure. Neoprene drip sheets and stainless steel collector drains are to be provided with finger plate type joints to intercept water passing through the joint.

7. Modular seal systems are not to be used.

8. Deck joints on steel girder superstructures are to be erected by bolting to the girders. Bolted connections are to utilize slotted holes to provide adjustment in vertical, lateral, and longitudinal directions.

9. Deck joints on concrete superstructure or abutments are to be erected on adjustable supports by projecting dowels with threaded couplers for elevation adjustment.

10. Notwithstanding Section 11.5.1.5 access to the underside of single opening sealed deck joints is not required.

13. DECK PROTECTION AND WEARING SURFACE

1. The standard deck protection system has a total thickness of 90 mm consisting of a 5 mm rubberized asphalt membrane + 5 mm protective board + two 40 mm lifts of asphaltic concrete pavement. This system is to be used unless otherwise specified.

2. An alternative system consisting of a thin polymer membrane (approximately 3 mm thickness) with a single 50 mm lift of asphaltic concrete pavement can be used where dead load needs to be minimized or where the bridge will be crossed on a regular basis by trucks with heavily loaded axles such as logging trucks.

3. Asphaltic Wearing Surface - Type H2 is used basically on Primary Highway bridges and/or high traffic volume highways or local roads. Asphaltic Wearing Surface - Type M1 is used on low traffic volume highways or local roads when an asphaltic overlay is applied.

14. BRIDGERAILS

1. Traffic:

   See Appendix "A": Bridge Rail standards for New Construction

   Note: Maximum difference in panel length between adjacent panels should not exceed 750mm.

2. Pedestrian:

   a) Standard 1150 mm Vertical Bar Type Handrail as shown on Dwg. No. S-1401

      Designed for use at the outside of sidewalks. Can only be used when there is a traffic railing/barrier located on the traffic side of the sidewalk or if the bridge is for pedestrian usage only. Maximum panel length is 3000 mm and panel lengths used should be multiples of 150 mm.

   b) Standard 1150 mm Staggered Vertical Bar Type Handrail as shown on Dwg. No. S-1426

      Designed for use at the outside of sidewalks, especially for situations where there is an intersection close to the end of the bridge and enhanced vehicle visibility is desired. Can only be used when there is a traffic railing/barrier on the traffic side of the sidewalk or if the bridge is for pedestrian usage only. Maximum panel length is 3000 mm and panel lengths used should be multiples of 150 mm. Orientation of staggered bars must be described on the engineering drawings to suit the site situation.

3. Approaches:

See Appendix "A": Bridge Rail Standards for New Construction.

4. Layout:

All dimensions for bridgerail layouts are to be given on centreline of bridgerail anchor bolts.

15. DRAINS

1. Concrete drain troughs are commonly placed at all abutment locations where the roadway grade carries water off of the bridge.

2. Deck drains may be required on river crossings where the road grade is relatively flat and are a must in sag vertical curve situations where the low point is on the structure.

3. Bridge decks with waterproofing membranes are to have provisions made along the gutter lines to allow for the drainage of water that penetrates the asphaltic wearing surface.

16. APPROACH SLABS

Approach slabs shall be in accordance with the provisions of Clause 1.8.2 except as noted:

1. It may be determined by the designer that an approach slab is not required where a new bridge is being built on an existing road and a negligible amount of new fill material is being placed.

2. Standard Details:

   a) Class C concrete.

   b) 175 mm thick.

   c) Minimum 3600 mm long (measured parallel to centreline of roadway) except for bridges with SCC superstructures where the approach slab shall be 3000 mm long.

   d) Longitudinal reinforcing: 15M bars @ 175 (placed parallel to centreline of roadway).

e) Transverse reinforcing: 15M bars @ 350 (placed parallel to backwall).

f) Slab overlay: 50 mm of asphaltic wearing surface.

17. UTILITY ACCOMMODATION

1. A single 100 ø Rigid PVC duct with pull wires is normally placed in each curb.

2. Additional conduits, weatherproof boxes, and anchor bolts for light poles will likely be required in situations where lighting is to be provided on the structure or on the adjacent approaches. Conduit sizes and locations of boxes and light fixtures will, in most instances, be provided by the utility company.

3. Notwithstanding the above, it is the opinion of Alberta Transportation (AT) that in the long term utilities that are attached to the exterior of a bridge will invariably become a problem when major maintenance of the structure is required. It is AT's strong preference that whenever practical utility lines are not attached to a bridge, and that alternative means of crossing an obstruction be actively pursued by Utility Companies. However, if other options are not reasonably available, and a Company still wishes to pursue a request to attach a line to a structure, the following conditions must be met:

   - Complete details of the proposed attachment must be submitted to AT for review and written approval prior to the commencement of the installation under consideration.

   - All costs associated with the installation, maintenance, and operation of a utility are the responsibility of the utility owner.

   - At the discretion of AT, moving or removal of the utility, including all associated costs shall be borne by the owner of the utility line. Typically a 'request for removal' will (or may) be issued to facilitate major maintenance, rehabilitation, replacement, closure, or removal of a bridge.

   - In the event that a utility line is no longer required the owner of the utility line shall advise AT, arrange for the line to be removed, and when applicable for the structure to be restored to condition commensurate with that prior to the installation of the line. Any restoration work that may be required shall be completed to the satisfaction of AT and all costs associated with the work shall be borne by the owner of the utility line.

18. QUANTITIES

1. Bridge Contracts are tendered on a unit price for most bid items. The following items, with their indicated units, are among the most commonly used:

Piling (Type and size) – supply	-	m
Piling (Type and size) – drive	-	m
Piling (Type and size) – set up	-	pile
Concrete – Type	-	m^3
Reinforcing steel - plain	-	kg
Reinforcing steel – epoxy coated	-	kg
Concrete Slope Protection	-	m^2
Rock Rip-Rap – Class	-	m^3
Bridgerail	-	m
Handrail	-	m
Bridge Deck Waterproofing	-	m^2
Wearing Surface – Two course hot-mix ACP (Type)	-	m^2
Wearing Surface – Hot-mix ACP	-	m^2

Piling, concrete, and rip-rap require a separate quantity for each size or type used.

2. Quantities, with the exception of slope protection and rip-rap, are to be calculated and shown to the nearest whole unit. Slope protection and rip-rap quantities are to be calculated and shown to the nearest 10 units.

3. Individual quantity estimate tables are to be shown on the applicable drawings for the abutments, piers, and deck and are to be summarized on the quantity estimate table shown on the 'Information Sheet'.

4. Quantities done by other than the site contractor are to be so identified on the quantity estimate tables.

5. Structural steel mass for steel girder superstructures shall be calculated and the mass, in tonnes, shown in the 'General Notes' area on the girder drawings. Mass includes girders, diaphragms, stiffeners, and splice plates but does not normally include deck joints, bearings, and bolts.

19. STANDARD DETAILS & ENGINEERING DRAFTING GUIDELINES

1. The use of standard drawings and details is encouraged wherever possible.

2. Drafting standards and standard details shall be in accordance with Section 2 – Guidelines for Bridge Projects of the 'Engineering Drafting guidelines for Highway and Bridge Projects" http://www.trans.gov.ab.ca/Construction/DoingBusiness.asp

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20. ORGANIZATION OF DRAWING SET

1. Preferred drawing order for bridge type structures is as follows:

   a) General Layout.

   b) Information Sheet/Sheets.

   c) Abutments.

   d) Pier/Piers.

   e) Bearings.

   f) Girders.

   g) Deck.

   h) Deck Joints.

   i) Other (If used).

   j) Bar List.

   k) Standard Drawings.

2. Other types of structures (culverts, etc.) should follow the same basic order with drawings added and/or deleted as necessary.

3. Bridge Engineering Section drawing numbers are to be used in all cases. Numbers will be established when exact number of drawings in set is known.

4. Index listing all drawings included in the drawing set is to be shown on the first sheet of the set. The index is normally orientated from the bottom up; i.e., sheet No. 1 shown at the bottom and successive sheets listed upward from there.

5. Consultants who are not familiar with Alberta Transportation bridge design drawings are encouraged to obtain recently completed drawing sets for their guidance.

21. APPENDIX "A" BRIDGERAIL STANDARDS FOR NEW CONSTRUCTION

Experimental crash testing has demonstrated that current static design procedures are inadequate to predict complex vehicle/bridgerail interaction and dynamic behaviour. As a result, 'CAN/CSA-S6-00 Canadian Highway Bridge Design Code - Section 12 - Barriers and Highway Accessory Supports' requires that the adequacies of new bridgerails and their transitions with approach guardrails, be proven by crash testing. This can be achieved by crash testing new designs, or by adopting designs successfully crash tested by others. Also, a multiple Performance Level approach has been adopted from AASHTO to suite the different traffic and geometric conditions at different bridge sites. The traffic conditions and crash testing requirements for Performance Levels 1, 2 and 3 are defined in Section 12.

In order to bring the Bridgerail Standards up-to-date and improve safety, Alberta Transportation has reviewed crash tested designs that might be suitable for the Alberta environment. As a result, five designs are adopted as new Standard Bridgerails to cover different bridge site conditions.

There are two economical Performance Level 1 Thrie Beam designs which have no curbs. They are suitable for use mainly on small bridges on low traffic volume gravel roads, which are not intended to be paved for the foreseeable future. It is anticipated, however, that occasionally the odd bridge may be paved.

Three Performance Level 2 designs are available for use for bridges on all paved highways, except where a Performance Level 3 design is required by the code for high traffic volume locations:

1. The PL-2 open tube rail is the most preferred design for the following considerations:

   - Reduced snow accumulation and drifting, and safer traffic operation. Reduced snow removal effort.
   - See through visibility.
   - Shrinkage cracking of concrete barriers has been a recurring problem with no apparent solution. These cracks often result in increased maintenance.

2. The PL-2 Thrie Beam with curb design is for use on culverts and short bridges, to avoid transitioning between different bridgerail types within a short length. In this case the Thrie Beam from the approach transitions is carried along the full length of the bridge. The use of this design should be limited to bridge lengths of about 20m or less.

3. The PL-2 single slope concrete barrier may be used when there is a preference for architectural reasons, mainly around urban areas.

A standard design for Performance Level 3 has not been done as it is not expected to be required for most rural Alberta traffic conditions. If a Performance Level 3 requirement is identified, please consult with TSB.

Each bridgerail design comes with their specific Approach Guardrail Transitions.

A range of curb heights between 150 mm to 200 mm is allowed to provide some flexibility for different bridge deck design situations. Bridges with exposed concrete to grade will use a curb height of 200 mm. This provides an allowance for 50 mm of future deck overlay, which will reduce the final curb height to 150 mm. For bridge decks with 90 mm ACP wearing surface and waterproofing, no future increase in wearing surface thickness is anticipated. In fact, the thickness is more likely to decrease if the ACP is ultimately removed and replaced with a thinner overlay. In this scenario, it is undesirable to have a curb height that is too high because it will move the lower steel tube of the double tube rail out of the optimum position. The lower rail is strategically located to match the bumper height of small cars. Therefore a curb height of 150 mm should be used in conjunction with a 90 mm ACP design.

A height of 850 mm was chosen for the concrete barrier. This includes a 50 mm allowance for future overlay.

It is the **consultants' responsibility** to ensure that the bridgerail type chosen is appropriate for the site specific Performance Level requirements according to the CAN/CSA-S6-00. The consultants are also responsible for designing bridge deck and curb reinforcement to ensure that the bridgerail anchorages can be fully developed, and do not become the weak link in the system, except for Department Standard Bridge Designs.

The following summary table provides a list of the Standard Bridgerail Drawings and a brief description on how they are used.

1.0 Summary Table – Standard Bridgerails

Drawing No.	Title	Remarks
S-1642-00 Rev 1	PL-2 Double Tube Type Bridgerail - Bridgerail Details	Open steel tube rail. **Most preferred PL-2 design** for all bridges on paved highways. Also used for large structures with low traffic volume where only PL-1 is required.
S-1643-00 Rev 1	PL-2 Double Tube Type Bridgerail – Approach Rail Transition Details	Transition details for Double Tube Bridgerail.
S-1644	Thrie Beam Guardrail – Sheet 1 of 2	Thrie Beam Details
S-1645	Thrie Beam Guardrail – Sheet 2 of 2	Thrie Beam Details
S-1646	Thrie Beam Terminal Connector	
S-1647	W-Thrie Beam Transition Panel	

S-1648-00	PL-2 Thrie Beam on Curb Bridgerail – Bridgerail Details	For use on box culverts, ABC culverts, short bridges < 20 m to avoid transitioning between different bridgerail types. The Thrie Beam from the transitions is carried across the full length of the bridge.
S-1649-00	PL-2 Thrie Beam on Curb Bridgerail – Approach Rail Transition Details	Transition details for Thrie Beam Bridgerail.
S-1650-00	PL-2 Single Slope Concrete Bridge Barrier – Barrier Details	Solid concrete barrier, may be used in lieu of open tube rail for architectural reasons where snow drifting is not a problem.
S-1651-00	PL-2 Single Slope Concrete Bridge Barrier – Approach Rail Transition Details.	Transition details for single slope barrier.
S-1652-00	PL-1 Thrie Beam Bridgerail	Economical no curb design for low traffic volume roads. Mainly for Standard SC girder bridges. One drawing contains both bridgerail and transition details.
S-1653-00	PL-1 Low Height Thrie Beam	Same as above but for clear roadway < 9 m. Lower height for farm equipment crossing where necessary.

Diaphragms and girders shall be designed for construction loads during deck concrete placement in accordance with CSA S6-00 Clause 3.16. Specifically, diaphragms, exterior steel and precast girders carrying deck overhangs shall be checked to ensure sufficient strength and stability for concentrated wheel loads from screeding machines, work bridges and curing equipment, and loads from temporary walkways outside the edge of the deck slab. Loads assumed for such design shall be shown on contract drawings.

The concrete deck slab will have a total minimum thickness of 180mm which will include 50mm cover on the top of the slab and 40mm cover on the bottom of the slab. The slab will be designed to include provision for the 90mm waterproofing/ACP superimposed dead loda.

The usual wearing system will consist of the Department's standard Deck Waterproofing System with 80mm two course hot mix asphalt concrete pavement as per the current version of Standard Drawing S-1443. This system consists of a 5mm asphalt membrane, 5mm protection board and 2-40mm lifts of hot-mix asphalt concrete pavement.

APPENDIX B

Arch Beam Culvert Structural Design Guidelines

APPENDIX C

Guidelines for Design of Integral Abutments

APPENDIX D

Guidelines for Upgrading of Existing Bridgerails/Approach Rail Transitions in Alberta