

13 MOVABLE BRIDGES

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13.1 SCOPE

Commentary: *Movable bridges shall not be used unless Approved.*

Section 13 Movable Spans of the S6-00 does not address the following items in detail:

- *Technical material advances such as UHMW polyethylene bearings and Teflon spherical plain bearings;*
- *Hydraulic drives;*
- *PLC control systems.*

All these technologies may be acceptable, depending on the particular situation. Any variances from Section 13 will require Approval.

13.4 MATERIALS

13.4.4 Timber

Delete and replace with the following:

Timber materials and fasteners shall be in accordance with Section 9.

13.4.9 Bolts

Delete the second sentence and replace with the following:

High strength structural bolts shall conform to ASTM A325M unless otherwise Approved.

13.5 GENERAL DESIGN REQUIREMENTS

13.5.4 Navigation Requirements

Delete the first sentence and replace with the following:

The location of the movable span relative to the waterway and the vertical and horizontal clearances for the bridge, both in the open and closed positions, shall be in accordance with the requirements of the Navigable Waters Protection Act, Transport Canada.

13.5.9 Aligning and Locking

Commentary: *CCTV systems are suggested to assist the operator in monitoring mechanisms not visible from the operator's cabin.*

13.5.11 New Devices

Delete the second sentence and replace with the following:

If any such devices, materials, or techniques are proposed for use by the designer, they shall be in accordance with good commercial practice, shall have a background of successful application for similar usage, and shall be consented to by the Ministry.

13.5.12 Access for Routine Maintenance

Commentary: *The installation of elevators in tower-drive vertical lift bridges shall be considered for heights greater than 15 metres. This is to allow movement of maintenance materials to the hoisting equipment easily and effectively.*

13.5.13 Durability

Commentary: *The maintenance and inspection manual shall be prepared by the designer.*

13.6 MOVEABLE BRIDGE COMPONENTS

13.6.1 General Features

13.6.1.1 Counterweights

13.6.1.1.7 Concrete

Delete the fifth paragraph and replace with:

The design of the counterweight shall be modified if the experimental density differs from the design density.

Commentary: *The counterweight density may not be designed at 2355 kg/m³.*

13.6.1.4 Span Aligning and Locking

Delete the fourth paragraph and replace with the following:

Where the ends of bascule bridge decks are located behind the centre of rotation and where calculations indicate the toe may be lifted from toe rests under the passage of live load, tail locks shall be provided in order to resist the maximum reactions from live load.

Commentary: *To minimize bridge complexity and future maintenance, tail locks can be eliminated if the toe stays in position under all live load conditions.*

13.6.2 Swing Bridge Components**13.6.2.1 Centre-Bearing****13.6.2.1.2 Disc Bearings**

Delete the first sentence and replace with the following:

Centre-bearing swing bridges shall rotate on spherical thrust bearings.

Commentary: *Traditional bronze disc thrust bearings are being replaced by self lubricated spherical thrust bearings and the change is intended to allow such technology.*

13.6.2.3.2 Pinion Bearing Supports

Delete and replace with the following:

The brackets and connections that support the main pinion bearings are critical to the bridge operation and shall be designed for at least twice the maximum design torque in the pinion.

Commentary: *The maximum torque may occur under braking or acceleration.*

13.6.3 Bascule Bridge Components**13.6.3.2 Locking Devices**

Commentary: *The current code requires locking devices on the toe end of each girder. Depending on the design this may contribute to an overly complex mechanical installation. Locking devices on the toe ends of each outside girder is an acceptable alternative.*

13.6.5 Vertical Lift Bridge Components**13.6.5.3 Counterweight Guides****13.6.5.3.2 Clearances**

Commentary: *The requirement for shims is to ensure the clearances can be correctly set. In addition the guide shoe mounting design shall facilitate easy adjustment and replacement in the future.*

13.7 STRUCTURAL ANALYSIS AND DESIGN

13.7.3 Wind Load

13.7.3.4 Vertical Wind, Normal to the Floor Plane Area

Commentary: Note that for unequal arm swing bridges, the surface area shall be the floor plane area of the larger arm.

13.7.6 Hydraulic Cylinder Connections

Delete and replace with the following:

The loads on the structural connections to the cylinders shall be based on the greater of:

- Wind, ice, inertia or other structural loads assuming the cylinder as a rigid link; and,
- Driving and braking mechanical loads assuming a cylinder force developed by 150% of the setting of the pressure-relief valve that controls the maximum pressure available at the cylinder.

Commentary: The design philosophy is that the hydraulic cylinder is supposed to be the weakest link, not the structural attachments to the bridge.

13.8 MECHANICAL SYSTEM DESIGN

13.8.6 Requirements for Wedges

Commentary: Unless separate supports are provided, the end-lift machinery of swing bridges shall also be capable of supporting the span under the specified loading. Systems which might creep under vibration or load shall not be used.

13.8.7 Requirements for Brakes

13.8.7.1 General

13.8.7.1.2 Holding

Commentary: The braking requirements of this clause are also applicable for hydraulically driven bridges.

13.8.8 Frictional Resistance**13.8.8.1 Machinery**

Commentary: *Self-lubricated bearing materials may be appropriate for some applications. For proprietary bearing materials the coefficients of friction shall be as advised by the suppliers.*

13.8.9 Torque**13.8.9.1 Torque at Prime Mover for Main Machinery**

Commentary: *For hydraulic cylinder actuated spans the bridge torque will need to be converted into an equivalent cylinder force.*

13.8.9.4 Torque at Prime Mover for Locks and Wedges

Commentary: *For hydraulic cylinder operated span lock and wedge machinery, the sum of all resistances to be overcome shall be reduced to a single equivalent force in the cylinder.*

13.8.9.6 Torque for Lock and Wedge Machinery

Where span locks and wedges are operated by hydraulic systems, the hydraulic systems shall be capable of providing 150% of the maximum span lock torque or equivalent force at the normal operating pressure.

Commentary: *Cylinder operated locks and wedges are common and therefore basic design guidelines are required.*

13.8.11 Machinery Loads

- (e) machinery operated by hydraulic systems shall be designed for 100% of the maximum hydraulic system relief valve pressure.

Commentary: *The relief valve pressure is above the normal operating pressure and therefore the system could potentially develop the relief valve pressure with all the resultant forces in the machinery. Therefore the relief valve pressure must be one of the design cases.*

13.8.13 Bearing Pressures – Moving Surfaces**13.8.13.2 Determination of Bearing Pressure**

Commentary: *Where alternate bearing materials are considered, the maximum bearing pressures shall be in accordance with the supplier's recommendations.*

13.8.17 Machinery Fabrication and Installation

13.8.17.4 Plain Bearings

13.8.17.4.3 Bushings

Delete the first sentence and replace with the following:

Bearings shall have bronze bushings unless otherwise consented to by the Ministry.

Commentary: *Self-lubricated non bronze bushings may be appropriate for some applications; however, their use is subject to consent by the Ministry.*

13.8.19 Power Equipment

13.8.19.2 Brakes

13.8.19.2.2 Electrically Operated Brakes

Commentary: *Brakes shall be arranged for hand release regardless of power source.*

13.10 ELECTRICAL SYSTEM DESIGN

13.10.3 General Requirements for Electrical Installation

Revise the second paragraph to read:

“.....(NEMA), and Canadian Standards Association (CSA) as applicable.”

Commentary: *This section includes a number of instructions aimed at the Contractor. The designer shall review the instructions and ensure the relevant instructions to the Contractor are incorporated into the Contract Documents prepared by the designer on behalf of the Ministry.*

13.10.4 Working Drawings

13.10.4.1 General

Commentary: *This section includes a number of instructions aimed at the Contractor. The designer shall review the instructions and ensure the relevant instructions to the Contractor are incorporated into the Contract Documents prepared by the designer on behalf of the Ministry.*

13.10.8 Motor Temperature, Insulation, and Service Factor

Commentary: *AC motors should have class F insulation in accordance with CSA or NEMA standards.*

13.10.11 Speed of Motors

Motors for hydraulic pumps shall not exceed 1800 rpm.

13.10.15 Electrically Operated Motor Brakes

Delete the third sentence in the second paragraph and replace with the following:

Brakes for the span operation shall be provided with hydraulic, mechanical, or electrical interlocks, such that all the brakes will not be applied at the same time.

Commentary: *Interlocks is the more common industry term.*

13.10.21 Programmable Logic Controllers

Revise the first paragraph to read:

“...to meet the requirements of the applicable CSA, NEMA and IEEE Standards...”

Commentary: *The specified applicable standards should also include CSA as well as NEMA and IEEE.*

Add the following at the end of the second paragraph:

The incoming AC power line to the PCL shall be provided through a UPS. The AC source shall feed a UPS inverter, complete with batteries and battery charger, which provides power to the PLC and I/O systems. The UPS must be able to provide power for a minimum of 1 hour.

Add the following paragraph at the end of the clause:

The PLC shall be provided with a communication card installed to allow remote communication monitoring by the Ministry at its Provincial Control Centre.

13.10.26 Circuit Breakers and Fuses

Commentary: *Electronic Circuit Breakers with programmable trip settings are acceptable types of circuit breakers.*

13.10.36 Control Console**13.10.36.3 Control**

Commentary: *Industrial type touch screens or menu driven graphical interfaces may be provided for the normal control functions as an alternative to the pushbuttons specified.*

Fibre optic wires may also be used, either multi-mode or single mode fibres pending equipment manufacture recommendations.

13.10.39 Electrical Wires and Cables

Commentary: *The code prefers wire in conduit. Armoured cables with PVC jacketing may be an acceptable alternative. Therefore external wiring to control panels and consoles shall be wire types as listed in CEC Standard, Table 19, for exposed wiring in wet locations.*

13.10.42 Raceways, Metal Conduits, Conduit Fittings, and Boxes**13.10.42.7 Wireways**

Delete the third sentence in the second paragraph and replace with the following:

Wireways and trays shall not be used outside the operator's house except with armoured cables. Tray and fittings shall be stainless steel complete with cover. The designer shall detail all wireways such that they do not impose a tripping hazard for the operator.

Commentary: *The use of corrosion resistant material and lids is to reduce the problems with birds and their residue.*

13.10.50 Spare Parts

Commentary: *The listing of spare parts specified for the Contractor to provide shall be included in the Contract Documents prepared by the designer on behalf of the Ministry. The list should be reviewed to include spare parts for PLC's and UPS.*

13.11 CONSTRUCTION

Commentary: *This section includes instructions to the Contractor which need to be reviewed and appropriately transferred to the Contract Documents prepared by the designer on behalf of the Ministry.*

13.12 OPERATIONAL INSTRUCTIONS

Commentary: *This section includes instructions to the Contractor which need to be reviewed and appropriately transferred to the Contract Documents prepared by the designer on behalf of the Ministry.*

13.13 OPERATIONAL AND MAINTENANCE HANDBOOK

Commentary: *The designer shall provide the Operation and Maintenance Handbook, not the Contractor. In addition to the drawings specified in this clause and Clause 13.10.4 the handbook shall also include:*

- *A regular schedule of inspection, and lubrication;*
- *A schedule of operating or testing the bridge. The test operations should occur at regular intervals and should include emergency operating conditions;*
- *A hardcopy and softcopy of the software program, clearly listing all safety interlocks used in the PLC controls of the movable bridge;*
- *Calibration and set points of all devices; and*
- *A copy of the testing and commissioning records.*