14.2 Definitions

Add the following definition:

Supervision – monitoring of the passage of an overload by a BC registered professional engineer familiar with bridge design to ensure bridge crossing restrictions in an overload permit are followed by the permit vehicle. Monitoring of the weighing of a permit vehicle is also to be performed if called for in the overload permit. The engineer shall have the authority to stop further movement of the permit vehicle if it is not in compliance with permit requirements. Records of vehicle weight and dimension measurements and of each bridge crossing by the permit vehicle shall be kept by the engineer and a report detailing these observations sent to the Ministry on completion of the move.

14.7 Material strengths

14.7.4 Strengths based on date of construction

14.7.4.2 Structural steel

Commentary: *Further information on historical steel grades may be found on the CISC website, specifically at the following URL:*

http://www.cisc-icca.ca/solutions-centre/technical-resources/technical-resources/historical-info

14.9 Transitory loads

14.9.1 Normal traffic

14.9.1.1 General

Delete and replace with:

Unless otherwise consented to by the Ministry, evaluation shall be to the Evaluation Level 1 loading (vehicle trains) described in Clause 14.9.1.2 with W as 625 kN. The BCL-625 design loading shall not normally be used for evaluation.

Commentary: *Loadings that differ from the CL1-W loadings specified in Section 14.9 may be specified by the Ministry on a project-to-project basis.*

14.12 Target reliability index

14.12.1 General

Commentary: Table 14.6 is based on the assumption that for PC traffic the number of people on and or under the bridge at the same time as the permit vehicle is to be minimized and preferably 3 or less people on the bridge.

14.12.2 System behaviour

Add to Item (a), Category S1 the following:

Simply supported girder in a three-girder system.

14.12.3 Element behaviour

Add to Item (a), Category E1 the following:

This can also include timber in bending, compression parallel to grain (slender members) and tension, when element is subject to sudden loss of capacity with little or no warning and no post failure capacity,

Add to Item (b), Category E2 the following:

Timber in bearing, when element is subject sudden loss of capacity with little or no warning and with post failure capacity, i.e. crushing of timber

Add to Item (c), Category E3 the following:

Timber in shear, when element is subject to gradual failure with warning of probable failure, end splits are signs of gradual failure

Commentary: *This section does not give any guidance for timber element behavior.*

Steel in tension at net section shall remain in Category E1 but, for evaluations, the new resistance adjustment factor specified under Clause 14.14.2 shall be applied to the axial tensile resistances determined in accordance with Clauses 10.8.2(b) and 10.8.2(c).

The axial tensile resistances for effective net sectional areas, A_{ne} and A'_{ne}, specified in Clause 10.8.2(b) and (c) contain a 0.85 reduction factor to account for the reduced warning of failure that may be provided if fracture occurs on the net section prior to yielding of the component on the gross section. The provisions of Clause 14.12.3 address the same issue by effectively increasing the factored loadings on components that provide little or no warning of failure.

The intent of both these provisions was to individually provide an additional margin of safety against this type of failure. Applying both of these provisions for evaluations results in the component being penalized twice for the same behaviour. To remove this double penalty, a new resistance adjustment factor has been developed to remove the reduction in the component resistance while maintaining the increased factored loadings. The new resistance adjustment factor is specified under Clause 14.14.2.

14.13.3 Transitory Loads

When permit vehicle loaded lanes are mixed with normal traffic loaded lanes, each lane will be assigned its corresponding different live load factor based on the traffic in the lane. For example, a PS loaded lane will get a PS live load factor (Table 14.13) and the other lanes will get normal traffic live load factors (Table 14.9).

Alternatively, if using the simplified method of analysis, then the permit vehicle shall be used in all lanes with the permit vehicle live load factor in all lanes. The engineer shall ascertain that this is a conservative approach.

14.14 Resistance

14.14.1.6 Shear in concrete beams

14.14.1.6.1 General

Delete and replace with the following:

Concrete beams shall have their shear resistance calculated in accordance with Clause 8.9.3 with the exception that the factored sectional shear force and factored bending moment used to calculate longitudinal strain of the member, ε_x in Clause 8.9.3.8 is given by:

$$V_f = \alpha_D V_{DL} + F\,(\alpha_L V_{LL})$$
$$M_f = \alpha_D M_{DL} + F\,(\alpha_L M_{LL})$$

where, a value for F is first assumed, and the calculations repeated, iterating the value of F, until V_r from Clause 8.9.3.3 converges to the value of V_f given above. The value of F at convergence is the live load capacity factor. All other aspects of Clause 8.9.3.8 remain unchanged, except as modified in Clauses 14.14.1.6.2 and 14.14.1.6.3.

Commentary: *The shear design provisions of Clause 8.9.3.8 are based on the Modified Compression Field Theory (MCFT). Simplifications were made to the theory to create a suitable procedure for the design of new concrete beams. According to the MCFT, the shear resistance of a concrete member depends on the longitudinal strain ε_x of the member. The longitudinal strain in turn depends on a number of factors such as the amount of longitudinal reinforcement and the applied loads including the applied shear force. Thus* *according to MCFT, the shear resistance of a concrete member depends on the applied shear force at failure. Iteration (trial and error) is therefore generally needed to determine the shear resistance of a member according to MCFT. A simplification in Clause 8.9.3.8 that avoids iteration is the longitudinal strain ε_x being calculated from the design forces rather than the forces at shear failure. This is a reasonable assumption for design as the shear resistance is adjusted through the selection of stirrup quantity and concrete section properties to be approximately equal to (slightly greater than) the design shear force V_f.*

The simplifying assumptions described above for design cannot be used for determining the ultimate shear resistance for evaluation. The sectional shear force V_f, the corresponding bending moment M_f, as well as any applied axial force N_f used in Clause 8.9.3.8 to determine longitudinal strain εx, which in turn is used to determine shear resistance, must be the sectional forces that result from the total bridge loading that causes shear failure. Thus evaluating the shear resistance of existing concrete beams using Clause 8.9.3 requires trial and error.

One method of doing these calculations is to include the Live Load Capacity Factor (F) in the equations for calculating V_f and M_f and iterate the value of F until V_r equals V_f.

14.14.1.7 Wood

14.14.1.7.2 Shear

The size factor (k_{sv}) given in Clause 14.14.1.7.2, shall be applied to both sawn timber and glue-laminated beams. The value of longitudinal shear (f_{vu}) for glue laminated beams shall be taken from Table 9.15.

14.15.4 Combined load effects

Add to the first paragraph:

Combined shear and moment in steel plate girders with slender webs relying on tension field action to carry shear (refer to Clause 10.10.5.2) shall be calculated by successive iteration or another suitable method.

Add the following paragraph:

Interaction formulas for combined load effects shall be based on factored material strengths which include the resistance adjustment factor U of Clause 14.14.2.

14.17 Bridge posting

14.17.1 General

Replace the third sentence of the first paragraph with the following:

Posting requirements for a bridge evaluated as being deficient shall be determined by the responsible Ministry bridge engineer.

Commentary: *Ministry posting requirements and standards vary from those specified in Clause 14.17.*

14.18 Fatigue

For fatigue in riveted connections, the stress Category "D" shall be used in determining the allowable range of stress in tension or reversal for base metal at the net section of riveted connections.

Commentary: *This category will be useful during the evaluation and rehabilitation of existing riveted bridge structures.*