1.3.3 Ductility

Revise as follows:

The structural system of a bridge shall be proportioned and detailed to ensure the development of significant and visible inelastic deformations at the strength and extreme event limit states before failure.

~~It may be assumed that the requirements for ductility are satisfied for a concrete structure in which the resistance of a connection is not less than 1.3 times the maximum force effect imposed on the connection by the inelastic action of the adjacent components.~~

~~Energy-dissipating devices may be accepted as means of providing ductility.~~ Energy-dissipating devices may be substituted for or used to supplement conventional ductile earthquake resisting systems and the associated methodology addressed in these Specifications or the *AASHTO Guide Specifications for LRFD Seismic Bridge Design.*

~~For the strength limit state:~~

~~$\eta_D \geq$ 1.05 for nonductile components and connections~~

~~$=$ 1.00 for conventional designs and details complying with these Specifications~~

~~$\geq$ 0.95 for components and connections for which additional ductility enhancing measures have been specified beyond those required by these Specifications.~~ ~~This reduction shall not be taken where the ductility enhancing measure was designed for the extreme event limit state, only.~~

For all ~~other~~ limit states:

$\eta_D = 1.00$

C1.3.3

Add text after the last Paragraph as follows:

A value of 1.0 is being used for $_D$ until its application is better defined.

1.3.4 Redundancy

Revise as follows:

Multiple-load-path and continuous structures should be used unless there are compelling reasons not to use them.

~~Main elements and components whose failure is expected to cause the collapse of the bridge shall be designated as failure-critical and the associated structural system as nonredundant. Alternatively, failure-critical members in tension may be designated fracture-critical.~~

~~Those elements and components whose failure is not expected to cause collapse of the bridge shall be designated as nonfailure-critical and the associated structural system as redundant.~~

~~For the strength limit state:~~

~~$\eta_R \geq$ 1.05 for nonredundant members~~

~~=~~ ~~1.00 for conventional levels of redundancy,~~ foundation elements where ϕ already accounts for redundancy as specified in Section 10.5

~~≥ 0.95 for exceptional levels of redundancy beyond girder continuity and a torsionally closed cross section.~~

For all ~~other~~ limit states:

η_R = 1.00

C1.3.4

Revise as follows:

A value of 1.0 is being used for $_R$ until its application is better defined.

For each load combination and limit state under consideration, member redundancy classification (redundant or nonredundant) should be based upon the member contribution to the bridge safety. Several redundancy measures have been proposed (*Frangopol and Nakib 1991*).

Single-cell boxes and single-column bents may be considered nonredundant at the Owner's discretion. For prestressed concrete boxes, the number of tendons in each web should be taken into consideration. For steel cross-sections and fracture-critical considerations, see Section 6.

The Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges (2003 w/'05 Interims) defines bridge redundancy as "the capability of a bridge structural system to carry loads after damage to or the failure of one or more of it's members." System factors are provided for post-tensioned segmental concrete box girder bridges in Appendix E of the Guide Manual.

System reliability encompasses redundancy by considering the system of interconnected components and members. Rupture or yielding of an individual component may or may not mean collapse or failure of the whole structure or system (Nowak 2000). Reliability indices for entire systems are a subject of ongoing research and are anticipated to encompass ductility, redundancy, and member correlation.

1.3.5 Operational Importance

Revise as follows:

~~For the strength limit state:~~

η_I ~~≥ 1.05 for important bridges~~

~~=~~ ~~1.00 for typical bridges~~

~~≥ 0.95 for relatively less important bridges.~~

For all ~~other~~ limit states:

η_I = 1.00

C1.3.5

Add text after the last Paragraph as follows:

A value of 1.0 is being used for η_I until its application is better defined.

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