Washington State
Department of Transportation
Bridge & Structures Office

Design Memorandum

TO: All Design Section Staff

FROM: Bijan Khaleghi
DATE: October 6, 2009
SUBJECT: Design of Steel Reinforced Elastomeric Bearings

The 2009 Interim Revisions to the AASHTO LRFD Bridge Design Specifications (4th ed.) substantially revises the design procedures for steel reinforced elastomeric bearings. The revised provisions are included in Section 14.7.6 (Method A) and Section 14.7.5 (Method B). The revised design procedures incorporate the research results and recommendations from NCHRP Project 12-68 *Improved Rotational Limits of Elastomeric Bearings*, which were incorporated into *NCHRP Report 596 Rotation Limits for Elastomeric Bearings*.

The Method B design procedure has been completely reformulated based upon the experimental and theoretical findings of NCHRP Project 12-68. The revised procedure limits total elastomeric shear strain. Axial, rotational, and shear loading generate shear strain in the constituent elastomeric layers of a typical bearing. The new procedure distinguishes between static and cyclic components of shear strain. An amplification factor of 1.75 is applied to the cyclic components to reflect cumulative degradation caused by repetitive loading. The requirement that applied shear deformation not cause a shear strain greater than 0.50 remains unchanged. Stability requirements also remain unchanged. For bearings without bonded (vulcanized) external steel plates, lift-off is free to occur without the need to check for hydrostatic tension. If bonded external plates exist, then hydrostatic tension must be checked.

The allowable design capacities for Method A designed bearings were also increased based upon the findings of NCHRP Project 12-68. The fundamental form of the Method A design equations remain unchanged, although the increased capacities are based upon the more extensively revised Method B.

Design Policy Revisions

Henceforth, all steel reinforced elastomeric bearings shall be designed using the Method B procedure, which provides more relief in meeting rotational demands than does Method A. Additionally, constituent elastomer will be specified by shear modulus instead of durometer hardness (i.e. 165 psi in lieu of durometer 60).

Spreadsheets containing the revised Method A and Method B design procedures have been developed. They are available to designers and have been uploaded to J:\Bearings. Anyone interested in learning more is urged to consult *NCHRP Report 596 Rotation Limits for Elastomeric Bearings*.

Specifications Revisions

Consistent with recommendations provided by the NCHRP Project 12-68 research team, the WSDOT Standard Specifications will be revised allowing all bearings less than 8 inches thick and less than 1,000 square inches in plan to be tested and accepted based upon criteria less stringent than currently stipulated in the AASHTO M 251 specification for Method B designed bearings. Furthermore, the Standard Specifications will be revised to require that all edges of steel shims be ground smooth, that bearings less than or equal to 5 inches thick have ¼" edge cover, and that bearings greater than 5 inches thick have ½" edge cover.

Background

Previous elastomeric bearing design provisions were developed in NCHRP Project 10-20. These provisions were introduced into the first edition of the LRFD Bridge Design Specifications in 1994. Because bearing rotation was not considered a high-priority issue at that time, the design provisions that were developed were based upon conservative interpretation of past theoretical analysis and empirical observations.

In recent years, the expanded use of elastomeric bearings for steel bridges and the use of deeper prestressed concrete girders to span longer distances have imposed greater rotational demands on elastomeric bearings. In many instances, the overly conservative rotational design capacities unreasonably limited elastomeric bearing application or prevented usage altogether. In other instances, it was observed that older in-service bearings not satisfying the latest AASHTO design requirements were providing exceptionally good performance without problems. Stringent uplift requirements for lightly loaded bearings required very thick bearings that violated stability criteria. In response to these concerns, NCHRP Project 12-68 was funded to develop improved rotational design criteria through experimental and analytical research.

The revised design provisions, particularly for Method B, should extend the range of theoretical applicability of steel reinforced elastomeric bearings. This should provide significant relief to designers who previously experienced difficulty in satisfying rotational demands imposed by current superstructure configurations.

Research has demonstrated that the correlation between durometer hardness and shear modulus is sometimes tenuous. This has not been problematic with previous conservative elastomeric bearing design criteria. Because shear modulus is the best predictor of how an elastomeric bearing performs under load, it is rational to impose shear modulus requirements when designing for higher compressive stresses and rotations using the new Method B procedure.

The additional fabrication requirements should assure satisfactory performance and durability for more heavily loaded bearings without having to conduct the more expensive tests specified for Method B designed bearings as currently required by AASHTO M 251.

The design and specifications revisions noted herein immediately supersede WSDOT Bridge Design Manual Section 9.2.5A as currently written. If you have any questions regarding these issues, please contact Ralph Dornsife at 705-7199 or Bijan Khaleghi at 705-7181.

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