Bridge and Structures Office
Washington State
Department of Transportation

Memorandum

TO: All Design Section Staff
FROM: Bijan Khaleghi
DATE: September 7, 2011
SUBJECT: WSDOT Policy for use of Seismic Isolation Bearings

This design memorandum describes WSDOT's policy in application of seismic isolation bearings for bridge structures. Isolation bearings shall be designed per the requirement of the AASHTO Guide Specifications for Seismic Isolation. Use of isolation bearings for new and existing bridges, seismic retrofit, and bridge widening projects needs the approval of WSDOT Bridge Design Engineer.

Type 1 earthquake-resisting system (ERS) as specified in the AASHTO Guide Specifications for LRFD Seismic Bridge Design Article 3.3 is the preferred ERS System for seismic design of bridges. Type 1 ERS requires ductile substructure with essentially elastic superstructure allowing conventional plastic hinging in columns. Type 3 ERS, with elastic superstructure and substructure and a fusing mechanism between the two, may be considered only if Type 1 strategy is not suitable and Type 3 strategy has been deemed necessary for accommodating seismic loads.

The decision for using isolation bearings should be made at the early stage of project development based on the complexity of bridge geotechnical and structural design. A cost-benefit analysis comparing Type 1 design vs. Type 3 design with isolation bearings shall be performed and submitted for approval. The Designer needs to perform two separate designs, one with and one without seismic isolation bearings. The cost-benefit analysis shall at least include:

- higher initial design time and complexity of analysis
- impact of the initial and final design time on the project delivery schedule
- time required for preliminary investigation and correspondences with the isolation bearings suppliers
- life-cycle cost of additional and specialized bearing inspections
- potential cost impact for bearings and expansion joints replacements
- issues related to long-term performance and maintenance, and
- need for large movement expansion joints

Seismic isolation bearings shall not be used between the top of the column and the bottom of the crossbeam in single or multi-column bents.

Isolation bearings may be used for seismic retrofit and bridge widening projects to reduce the demands through modification of the dynamic properties of the bridge as a viable alternative to strengthening weak elements or non-ductile bridge substructure members.

Once approval has been given for the use of seismic isolation bearing, the Designer shall send a set of preliminary design and specification requirements to at least three seismic isolation bearing suppliers for evaluation to ensure that they can meet the design and specification requirements. Comments from isolation bearing suppliers should be incorporated before design of structure begins. Sole source isolation bearing supplier may be considered upon Bridge Design Office, and Project Engineer's office approval.

The Designer shall submit to the isolation bearing suppliers maintenance and inspection requirements with design calculations. Isolation bearing suppliers shall provide maintenance and inspection requirements to ensure the isolators will function properly during the design life and after seismic events. The contract plans shall include bearing replacement methods and details.

Use of seismic isolation bearings are not recommended for conventional short and medium length bridges, or bridges with geometrical complexities. Use of isolation bearings may not be beneficial for concrete bridges under 700 feet long, steel bridges under 800 feet long, bridges with skew angles exceeding 30 degrees, bridges with geometrical complexities, variable superstructure width, and bridges with drop-in spans.

The response modification factors (R-factors) of the AASHTO Guide Specifications for Seismic Isolation Design Article 6 shall not be used for structures, if the provisions of AASHTO Guide Specifications for LRFD Seismic Bridge Design are being followed for the design of the bridge.

Background:

Suitability of isolation bearings for bridge projects should be carefully studied prior to approval. Isolation bearings may not be the effective solution for some bridges and sites since shifting the period to longer period may not reduce the force demand for the soft soils. Design shall consider the near fault effects and Soil Structure interaction of soft soil sites. Designer shall carefully study the effect of isolation bearings on the longitudinal bridge movement. The need for large movement expansion joints shall be investigated. Inspection, maintenance, and potential future bearing replacement should be considered when using the isolation bearings.

In order to have isolators fully effective, sufficient gap shall be provided to eliminate pounding between frames. Recommended bridge length and skew limitation are set to avoid using the modular joints. Most modular joints are not designed for seismic. Bridges are designed for extreme event which may or may not happen in the life span of the bridge. Introducing the modular joints to the bridge system could cause excessive maintenance issues. In estimation of life-cycle cost, specialized bearing inspections, potential cost impact for bearings and expansion joints replacements the isolation bearing suppliers should be consulted.

If you have any questions regarding these issues, please contact Chyuan-Shen Lee at 705-7441, or Bijan Khaleghi at 705-7181.

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