Johnson Street Bridge
Seismic Update

Update to Council

March 12, 2015

Background

- In 2010 Technical Report by MMM, it was reported that "recent studies have indicated that there is a 35% probability of a major earthquake (M7.5) occurring in Victoria in the next 50 years".

- There are suggestions that a much lower level of seismic protection has been provided for the new JSB than was recommended to the City in 2010.

Background to City Requirements

- Project Definition Report (PDR) dated July 31 2012 including Appendix D - Seismic Design Criteria has been posted on Project website for more than two years

Project Definition Report Design Criteria

Item	Bascule Bridge	Other Structures
Reference Design Code (in order of precedence)	• AASHTO LRFD Movable Highway Bridge Design Specifications, 2nd Edition, with 2008 and 201O Interim Revisions • BC MoT Supplement to S6-06 • S6S1-10, Supplement No. 1 to S6-06 • CAN/CSA-S6-06	• BC MoT Supplement to S6-06 • S6S1-10, Supplement No. 1 to S6-06 • CAN/CSA-S6-06 AASHTO LRFD 2010
Service Life	• 100 years for all main structural components • 125 years for corrosion	• 75 years Design life as per CAN/CSA-S6-06 Clause 1.4.2.3 for all main structural components • 100 years for corrosion
Seismic Design	• Lifeline Bridge • AASHTO Guide Specifications for LRFD Seismic Bridge Design (Performance Based Seismic Design) • ATC 49 • ATC 32	• Lifeline Bridge for Approaches • Other Bridge for Pedestrian Bridge • AASHTO Guide Specifications for LRFD Seismic Bridge Design (Performance Based Seismic Design) • ATC 49 • ATC 32

Explanations

- ATC means Applied Technology Council of California (heads research on seismic in the US)
- Following ATC standards are the most comprehensive supplements currently in use in BC by MoTI
- ATC49: Recommended LRFD Guidelines for the Seismic Design of Highway Bridges
- ATC32: Improved Seismic Design Criteria for California Bridges
- LRFD: Load and Resistant Factor Design

Seismic Design Principles

- Magnitude of an earthquake is a measure of the amount of energy released during an earthquake.
- It is frequently described using the Richter scale.
- A return period is the average period in years between the occurrence of an event such as earthquake and the next occurrence of an event of the same type.
- Codes do not use the Richter scale but are based on firm ground acceleration modified by soil type and profile.

Earthquake Measure

- Richter: magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs
- Moment Magnitude: used by seismologists to measure the size of earthquakes in terms of the energy releases
- Peak Ground Acceleration (PGA) is a measure of maximum amplitude of ground acceleration and is an important input parameter for earthquake engineering, also known as the design basis earthquake ground motion (DBEGM)

Firm Ground Acceleration

- FGA is the term frequently used by seismologists and is defined as Site Class C in the National Building Code of Canada 2010 (site specific data).
- Firm ground is typically defined as a soil profile comprising very dense soil or soft rock with a shear wave velocity of 360 m/sec to 760 m/sec or by other test parameters
- Unlike the Richter and Moment Magnitude Scales, FGA is not a measure of the total energy (magnitude or size) of an earthquake, but rather a measure of earthquake acceleration of the firm ground as defined above which indicate how hard the earth shakes (the intensity)

Design Standards

- The AASHTO LRFD Movable Highway Bridge Design Specifications are the most comprehensive and relevant design requirements for bascule bridges in North America.

- H&H's final design based on the AASHTO LRFD Bridge Design Specifications, Fifth Edition (2010) and the AASHTO LRFD Movable Highway Bridge Design Specifications, Second Edition (2007) with revisions through 2010.

Applicability of Standards

- The AASHTO LRFD Movable Highway Bridge Design Specifications are more onerous than any Project-generated design criteria for bascule span seismic design.

- Therefore the statement in the design criteria memo that says “Possible permanent loss of service” for 1 in 1000 year design earthquake has been exceeded by the use of the AASHTO standard.

Canadian vs AASHTO Standards

- Canadian Highway Bridge Design Code CSA-S6-06 has a short section on Movable Bridges, but it is not as comprehensive as AASHTO LRFD Movable Highway Bridge Design Specifications.
- The CSA-S6-06 refers to AASHTO LRFD Movable Bridge Design Specifications in its Commentary. Because of unique nature of movable bridges, the general bridge design codes such as CSA-S6-06 or AASHTO LRFD Bridge Design Specifications do not cover all aspects of movable bridge design.
- That's our fundamental reason of selecting AASHTO LRFD Movable Highway Bridge Design Specifications for the new JSB.

Lifeline Bridge

- The new JSB has been designed as a “Critical Bridge” per AASHTO. This is equivalent to the CSA-S6-06 definition of “Lifeline Bridge”, the performance required by the City.

- The design of new JSB will allow the bridge to be available to all traffic after a design earthquake of 1/1000 years. This performance is as good or better than the Lifeline requirements given in the Canadian Code CSA-S6-06 which is designed for immediate use after a 1:475 earthquake, and emergency access after the 1:1000 earthquake.

Lifeline Bridge

- As per AASHTO commentary, the new JSB designed as a "Critical Bridge" will “be usable by emergency vehicles and for security/defense purposes immediately after a large earthquake, e.g. a 2500-yr return period event”. This is one level higher than the current Canadian Code S6

Conclusions

- The JSB is being designed and constructed to a very high seismic standard meeting the most stringent current codes in North America

- The bridge will be available to all traffic after a design earthquake of 1/1000 years

- The JSB will “be usable by emergency vehicles and for security/defense purposes immediately after a large earthquake, e.g. a 2500-yr return period event”

- This is one level higher than the current Canadian Code CSA-S6-06

Recommendations

Council could consider one of three possible recommendations:

- Accept this report and bring closure to the issue with the letters of assurance on the project providing the guarantee that Council's direction has been followed.
- The City retains an independent expert to verify the seismic design of the JSB. That would involve significant cost.

The City has provided 3,000+ pages of computer data through FOI request. Design criteria are already on the JSB website. If City requires independent verification, this can be done in a transparent way using an independent expert.

Thank you