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

<table>
<thead>
<tr>
<th>Item</th>
<th>Bascule Bridge</th>
<th>Other Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Design Code</td>
<td>• AASHTO LRFD Movable Highway Bridge Design Specifications, 2nd Edition, with</td>
<td>• BC MoT Supplement to S6-06</td>
</tr>
<tr>
<td>(in order of precedence)</td>
<td>2008 and 2010 Interim Revisions</td>
<td>• S6S1-10, Supplement No. 1 to S6-06</td>
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<td></td>
<td>• BC MoT Supplement to S6-06</td>
<td>• CAN/CSA-S6-06</td>
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<td></td>
<td>• S6S1-10, Supplement No. 1 to S6-06</td>
<td>AASHTO LRFD 2010</td>
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<tr>
<td>Service Life</td>
<td>• 100 years for all main structural components</td>
<td>• 75 years Design life as per</td>
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<td></td>
<td>• 125 years for corrosion</td>
<td>CAN/CSA-S6-06 Clause 1.4.23 for</td>
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<tr>
<td></td>
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<td>all main structural components</td>
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<tr>
<td></td>
<td></td>
<td>• 100 years for corrosion</td>
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<tr>
<td>Seismic Design</td>
<td>• Lifeline Bridge</td>
<td>• Lifeline Bridge for Approaches</td>
</tr>
<tr>
<td></td>
<td>• AASHTO Guide Specifications for LRFD Seismic Bridge Design (Performance</td>
<td>• Other Bridge for Pedestrian Bridge</td>
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<tr>
<td></td>
<td>Based Seismic Design)</td>
<td>• AASHTO Guide Specifications for</td>
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<td></td>
<td>• ATC 49</td>
<td>LRFD Seismic Bridge Design (</td>
</tr>
<tr>
<td></td>
<td>• ATC 32</td>
<td>Performance Based Seismic Design)</td>
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<td></td>
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<td>• ATC 49</td>
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<tr>
<td></td>
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<td>• ATC 32</td>
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</tbody>
</table>
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.

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