PANEL ASSESSMENT OF INTERSTATE BRIDGES SEISMIC VULNERABILITIES

Draft Technical Report

December 18, 2006

Columbia River CROSSING

1. Executive Summary

The Columbia River Crossing (CRC) project convened a panel of bridge and geotechnical engineers (the Panel) with relevant seismic design and retrofit experience to consider and discuss critical issues concerning the seismic vulnerability and retrofit possibilities of the existing I-5 Interstate Bridges.

The Panel was asked by the CRC project team to specifically address three questions. The questions and the responses from the Panel are as follows:

1. *Is it feasible to retrofit the existing structures? If so, how?*

   Yes, it is technically feasible to retrofit the existing bridges to the current seismic safety standards. The Panel identified expected vulnerable elements of the bridges and discussed potential retrofit concepts to address these vulnerabilities. Retrofit concepts could include strengthening or replacing significant portions of the existing bridges.

2. *How would a retrofit affect the existing structure with regard to 4(f) sensitivities?*

   For the purpose of protecting the structures' historic significance, the design effort can minimize changes in the structures' appearance. Examples of this include:

   - Foundation and pier strengthening could follow the outline of the existing bridge elements, and although the resulting elements would be larger, there would be minimal visual impact.
   - Bearing retrofit or replacement would be virtually unnoticeable to the untrained eye.
   - If truss member strengthening and tower reconstruction is required, member shapes could be reasonably replicated.

3. *What is the cost to seismically upgrade the existing bridges?*

   The Panel discussed and developed their opinion of estimated raw bridge construction costs to retrofit both bridges. This opinion ranges from $88 million to $190 million. This opinion of cost increases from $125 million to $265 million when design, permitting, right-of-way, construction inspection and management, agency oversight, and contingencies are added. (Note: The Expert Panel determined an opinion on ranges of construction costs and did not estimate the added costs.)

Discussion of these issues and others, including recommended next steps for more clearly defining the retrofit, if needed, are developed in more detail in the body of this report.

2. Introduction

As part of the Alternatives Analysis, the CRC project team will recommend which alternatives to drop and which to carry forward into the Draft Environmental Impact Statement (DEIS). These recommendations will include narrowing the river crossing options, with a key choice being whether to remove or keep the existing bridges over the Columbia River. The “replacement” alternatives would remove the existing I-5 bridges and build new structures. The “supplemental” alternatives would keep the existing bridges in addition to building a new structure.

One of the key factors in considering the "reuse" of the existing bridges (in the Supplemental Alternatives) will depend on the required level of seismic upgrading to withstand loss or significant damage from a major earthquake, and meet the current standards for highway bridges. Questions that need to be answered include:

1. What is the seismic vulnerability of the existing bridges?
2. Is it feasible to retrofit them to current seismic safety standards?
3. What retrofit would be needed for the various uses (interstate, arterial, Bus Rapid Transit, Light Rail, bike/pedestrian)?
4. How would these upgrades change the bridges' appearance?
5. What is the cost to seismically upgrade the existing bridges?

Limited existing information is available to answer these questions. In 1995, ODOT contracted with DGES, Inc. to perform a limited seismic vulnerability study which concentrated on the lift spans, truss span pier foundations, and the typical span bearings. This study did not include subsurface investigation or foundation analysis. Cost estimates were based on information developed in the study and simple extrapolation to the entire structure. This gross approximation of the vulnerability is considered in the Panel’s discussions and referenced occasionally in this report.

2.1 Use of an Expert Review Panel as a First Screening Step

The CRC project team convened a Panel of experts with relevant experience in seismic retrofit projects to conduct a “reasonableness” response to the above questions. CRC project team members from David Evans and Associates, Inc. (DEA) and Parsons Brinckerhoff (PB), under Professional Services Consultant Agreement No. Y 9245 with the Oregon Department of Transportation (ODOT) and the Washington Department of Transportation (WSDOT), organized and assembled the Panel members.

In a two-day workshop held August 28 and 29, 2006, the Panel considered the potential and expected seismic risks and provided conceptual retrofit solutions and an opinion of the construction costs associated with the concepts. To estimate the construction costs for the Alternatives Analysis, approximations of member size, extent of retrofitting, and unit cost averages from similar retrofit projects were used.

The Panel members and their role in the project are listed in Table 2-1. Table 2-2 lists workshop attendees who were observers.

Table 2-1 Seismic Expert Panel Members

Participants	ROLE	ORGANIZATION
Jugesh Kapur, P.E., S.E.	State Bridge Engineer	Washington DOT
Bruce Johnson, P.E., S.E.	State Bridge Engineer	Oregon DOT
Bill Hegge, P.E.	Geotechnical Engineer	Washington DOT
Jan Six, P.E.	Geotechnical Engineer	Oregon DOT
Tim Rogers, P.E.	FHWA Bridge Engineer	OR-FHWA
Mark Hirota, P.E.	Chief CRC Bridge Engineer	Columbia River Crossing/PB
Frieder Seible, P.E.	Panel Consultant, Bridge Engineer	David Evans & Assoc.
Steve Thoman, P.E., S.E.	Panel Consultant, Bridge Engineer	David Evans & Assoc.
Farid Nobari, P.E.	Panel Consultant, Bridge Engineer	Parsons Brinckerhoff
Joe Wang, P.E.	Panel Consultant	Parsons Brinckerhoff
Thomas Cooper, P.E.	River Crossing Bridge Design Engineer	Columbia River Crossing/PB

Table 2-2 Others Attending All or Parts of Meetings

ATTENDEES	ROLE	ORGANIZATION
Kris Strickler, P.E.	Deputy Project Director	CRC
Lynn Rust, P.E.	Engineering Manager	CRC
Frank Green, P.E.	Assistant Engineering Manager	CRC
Jay Lyman, P.E.	Project Manager	CRC/DEA
Ron Anderson, P.E.	Deputy Project Manager	CRC/DEA
Tom Hildreth, P.E.	CRC Engineering Manager	CRC/PB
John Horne, P.E.	Geotechnical Engineer	PB
Matt Deml, P.E.	Senior Bridge Engineer	CRC/PB

Note that both Strickler & Green were CRC officials on the panel. However as IBR officials, they both supported a video characterizing the Interstate Bridge as unsafe, unable to be upgraded/refitted to earthquake standards, and in need of replacement.

2.2 Relevant Background Information of the Structures

The northbound bridge was built in 1917, originally with a flat grade. It was the first bridge built across the Columbia River and is listed in the National Register of Historic Structures. The through-truss superstructure is comprised of laced steel members, which are typical for structures of that era. Note: when the southbound span was built in 1958, the original span was refitted.

The southbound bridge, which is similar to the 1917 bridge, was built in 1958. Instead of laced steel members, the superstructure consists of perforated steel plates. This was also typical for structures of this era. At the same time, the 1917 structure was revised to provide for a better (higher and wider) ship channel. This reconstruction work included replacing two short spans with one long span and adding the hump, to make the older structure configurations compatible with the southbound structure.

Both bridges include an operable vertical lift span at the northern end near the Vancouver shore. The bridges' superstructures are supported on rocker bearings, concrete piers, and timber piles that extend into the alluvium river bed material, but not to rock.

There is little to no information available for the foundation and pier construction of the 1917 bridge. As a result, there is little or no information regarding the pile capacity and pile tip elevations. There is also little or no data on reinforcement in the piers, so the level of seismic performance can only be estimated from the reinforced concrete jacket applied during the 1958 retrofit. Pile records were available for the 1958 bridge and the remedial pile foundation work performed on the 1917 bridge at this time. These records include "As-Constructed" pile tip elevations and this information was very useful in evaluating the effects of liquefaction on the lateral stability of both existing bridges.

As a part of the regular ODOT bridge inspection process, some investigation of the existing footings/scour holes has been done. These investigations include the following observations:

- Pile caps (underwater) have 3 feet to 27 feet of exposure.
- There is no visible undermining of the pile caps.
- No piles are exposed.

Potential Alternatives for the Columbia River Crossing Project

The Alternatives Analysis has identified 12 Alternatives for crossing the Columbia River. Alternatives 1 and 2 consider no action or only Transportation System Management (TSM) improvements and do not include any structural modifications. Alternatives 3 through 7 keep and reuse the existing structures in some capacity – either for carrying mainline I-5 (Alternative 3) or in conjunction with a supplemental structure to carry some portion of I-5 traffic and/or other modes of transportation such as light rail, buses, pedestrians, local roadway, etc. Only Alternative 3 places all of the mainline I-5 traffic on the existing structures.

Alternatives 8 through 12 call for removal of the existing structures and replacement with new structures to carry all modes of transportation required.