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September 17, 2008

Mr. Ron Paananen
Washington State Department of Transportation
401 2nd Ave. S., 2nd Floor
Seattle, WA 98121

Subject: **Alaskan Way Viaduct: Review of Structural Engineering Reports**
Seattle, WA
MI0801164.00

Dear Mr. Paananen:

As requested, our office reviewed the reports provided by your office including the following documents:

Report Title	Authored by	Date
Seismic Vulnerability Analysis Report	PB	November 2007
Rebuild/retrofit 300	PB	April 2003
Evaluation of Gary's retrofit proposal	TY Lin International	July 2006
Additional retrofit for Gary's modified proposal	TY Lin International	July 2006
Executive summary, geotechnical and Environmental studies: 2001 through 2005	PB and Shannon Wilson	June 2006
Alaskan Way Viaduct Report of Structural Sufficiency review Committee	TY Lin International	June 2001
Report of the ASCE Viaduct Review committee		December 2006
Rebuild/retrofit Alternate report	PB	August 2002

We have been authorized to spend a maximum of 40 hours and 16 hours in structural and geotechnical engineering review, respectively. Therefore, our scope of work is limited to the cursory reviews of the reports provided by your office. We have also participated in the conference call meeting with your office and your consultants.

Findings
A summary of our findings is listed below:

1. The Viaduct in its current configuration is a structurally dangerous structure, and likely will experience partial collapse of several frames or sustain substantial damage by a significant earthquake event. As such, it is imperative to address the seismic vulnerability of the viaduct and finalize retrofit/replacement option as soon as possible to protect lives.
2. The Nisqually earthquake of 2001 was approximately a 108- to 150-year return period event.
3. For seismic rehabilitation to be viable, it must be cost effective. This implies that the retrofit cost should not significantly exceed 50% of the replacement cost. However, traffic flow and business interruption costs must be a part of the cost assessment.
4. The design performance should be the collapse prevention for the 1000-year return period event. This performance criterion is consistent with the current FHWA/AASHTO seismic guidelines. The performance objective is the same for both replacement and rehabilitated options.

1450 Halyard Drive, Suite One West Sacramento, CA 95691 t 916.373.1995 f 916.373.1466
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5. There is less confidence in the performance of the rehabilitated structure compared to the replacement structure since the existing material characteristics will not be fully known for the existing structure.
6. Viaduct rehabilitation or replacement will require ground improvement.
7. A comprehensive material testing program for concrete and rebar was not conducted.

Recommendations

There have been several important analyses conducted to date to investigate the anticipated performance of the viaduct both in its current configuration and when retrofitted. However, to date, a comprehensive schematic phase plan has not been formulated to assess accurately the cost impact. It is not an easy task to provide the cost estimate of structural rehabilitation. Even an experienced contractor bidding on the full contract documents, often faces difficulty in estimating. It is our recommendation that the complete schematic phase plan should be prepared and it should include the following the scope of work.

a. Geotechnical and Foundation
   1. Seawall strengthening and the viaduct rehabilitation or replacement should be pursued as integrated and interrelated projects. Seawall strengthening design criteria should consider the ground deformation requirements of the backlands that now form the corridor for the existing viaduct structure or will form the corridor for somewhat realigned replacement structure.
   2. Investigate various ground and/or structural improvements to mitigate liquefaction hazard and related consequences.
   3. Develop foundation retrofit schemes to include addition of new large diameter shafts, enlargement of footings with addition top reinforcement for existing soil conditions modified using ground improvement techniques.
   4. Develop revised site-specific response spectra and sets of spectra matched time histories for the 1000-year earthquake and improved ground conditions.
   5. Develop new soil springs for the upgraded foundation and strengthened soil conditions.

b. Structural
   1. Perform comprehensive material testing to establish concrete and steel strength and connection details for all critical structural elements including columns, beams, and footing.
   2. Perform comprehensive material testing to define the condition of existing steel reinforcement corrosion.
   3. Perform nonlinear dynamic (response history) analysis to assess the performance of the retrofitted viaduct when supported on enhanced foundation/soil and when subjected to the new seismic hazard obtained from Task a.

c. Cost Assessment
   1. Using this complete schematic data, prepare construction cost estimates.
   2. In developing cost estimate for retrofit or replacement, include non-structural issues such as the effect on business interruptions and traffic flow analysis.

Conclusions

The replacement structure poses higher value for seismic performance confidence level, serviceability, and potentially larger traffic flow. Therefore, if the rehabilitated option is used, this option must be cost effective including construction cost, traffic flow and business interruption cost. This cost should not significantly exceed 50% of the replacement cost. It is important to develop a comprehensive schematic plan including a comprehensive material testing program since cost estimate of the rehabilitation is not an easy task. The Alaskan Way Viaduct is a dangerous and old concrete structure. It is critical to address this issue in a timely matter to protect the lives of Seattle citizens and users of this viaduct.

Please do not hesitate to call with questions.

Very truly yours,
Miyamoto International, Inc.

Heather Landrum for

Amir S. Giliani, Ph.D, S.E.
Structural Specialist

H. Kit Miyamoto, M.S., S.E.
President & CEO

JP S

J.P. Singh, Ph.D, G.E.
Principal, J.P. Singh & Associates

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