Brunette River Bridge: New Upgrade, New Constraints

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Summary

The Brunette River Bridge, near Vancouver, Canada, is a four-span, 100 m-long, prestressed concrete girder bridge carrying a major highway and jet fuel pipeline. Originally built in 1963, the bridge was first widened and retrofitted in 1997. Recently, the bridge was upgraded for a second time. Endangered fish habitat constrained the latest widening: unique, post-tensioned cantilevers were constructed to avoid impacting the river below. The original seismic retrofit concept was retained, even though the criteria had changed. Highway traffic and the jet fuel pipeline constrained repairs of corrosion damage to the deck and girders. Corrosion damage often extended beyond the areas indicated in the pre-construction condition survey. Design sought to anticipate potentially unwelcome surprises during construction, and had to react quickly to address the surprises that were encountered.

Keywords: bridge; widening; repair; rehabilitation; seismic retrofit; post-tensioning; shear walls; endangered species; risk; uncertainty.

1. Introduction

The Brunette River Bridge is a four-span, 100 m-long bridge located near Vancouver, British Columbia, Canada (Fig. 1), built in 1963 to carry the then-new Trans-Canada Highway. In 1969, a jet fuel pipeline was added to the bridge, and in 1997 the bridge was widened and a seismic retrofit completed. In 2009, design commenced for a second widening, retrofit and repair to the structure. Design and construction of the latest works faced several new constraints, including an endangered species of fish, changed seismic design criteria, live highway traffic, an active jet fuel pipeline, and uncertainty regarding the condition and configuration of the existing structure.

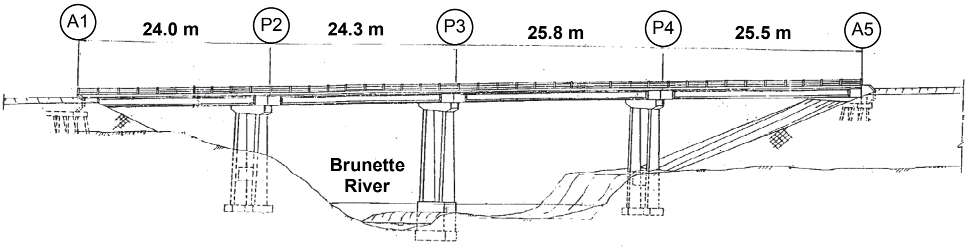

Fig. 1: Brunette River Bridge longitudinal section from original design drawings.

2. Fish Habitat

The Nooksack Dace is a small fish found in the Brunette River, and that was declared endangered in 2003. Thus, construction in the river was not permitted for the latest works. At the river pier, two

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Fig. 2: Widened P3 cantilevers.

Fig. 3: Typical girder damage.

post-tensioned cantilever deep beams (Fig. 2) carry loads from the widened superstructure into the existing footings. Additional, infill shear walls were required to resolve the large cantilever forces. Multiple layers of existing structure constrained the design of the cantilevers.

3. Seismic Criteria

The current retrofit of the Brunette River Bridge was to the 2005 BCMoT Seismic Retrofit Design Criteria, which emphasized global displacement ductility capacity over force- and component-based checks from the original seismic retrofit. The existing retrofit concept was generally sufficient under the new criteria, although additional cable restrainers were required to prevent loss of span during an earthquake.

4. Highway and Pipeline

The contractor sought to minimize construction on the bridge deck as the bridge had to remain fully open to live traffic. Three existing girders exhibited corrosion damage and required jacking to complete repair (Fig. 3). The jet fuel pipeline was adjacent to the jacked girders and had little tolerance for movement. To avoid impacting the pipeline, the contractor jacked the damaged girder ends only to unweight the bearings, without actually lifting the girders.

5. Uncertainty

The pier cap beams also suffered noticeably from corrosion. Cap beam damage typically extended beyond the areas indicated in the pre-construction condition survey. The contractor was encouraged to keep spare bearings on hand for quick replacement in case the repairs extended beneath existing girder supports. Coring through the pier columns risked damaging existing reinforcement. The design explicitly considered the allowable extent of damage from coring. Some details in the original structure did not match the as-built drawings, requiring changes to the design during construction. It was important for the design team to respond quickly to surprises and new information encountered along the way.

6. Conclusions

Construction of the latest works to the Brunette River Bridge is currently nearing completion. The project has been a success, in part due to a close working relationship between the design and construction teams from the outset of the project.

The multiple constraints on the Brunette River Bridge upgrades—the sensitive Nooksack Dace habitat, the changes to seismic codes, the active highway, and the jet fuel pipeline—all created significant potential construction risks. Design of the upgrades sought to eliminate or mitigate construction risks, which limited the potential range of structural solutions.

Consideration of future widening of the Brunette River Bridge was not a design requirement for the latest works. Such consideration, however, may be a relevant consideration for this type of project given the history of relatively frequent, incremental highway expansion. The post-tensioned cantilevers will complicate any further widening of the Brunette River Bridge and possibly encourage replacement the next time it becomes functionally obsolete, with a much-larger impact on the surrounding environment.