Design and Construction of the William R. Bennett Bridge

Darryl MATSON
Vice President
Buckland & Taylor Ltd.
North Vancouver, Canada
dmatson@b-t.com

Svein-Erik JAKOBSEN
Director Bridge Division
Aas-Jakobsen AS
Oslo, Norway
sej@aaj.no

Per Norum LARSEN
Project Engineer
Johs. Holt AS
Oslo, Norway
pnl@johsholt.no

Karsten VENG
Project Engineer
Buckland & Taylor Ltd.
North Vancouver, Canada
kveng@b-t.com

Eduardo PRADILLA
Resident Engineer
WRB Bridge Group
Kelowna, Canada
eduardo@wrbbridgegroup.com

Summary

The William R. Bennett Bridge is a new floating bridge across Okanagan Lake in Canada. It will replace an existing aging structure. The unique nature of this project presented numerous challenges that were resolved with innovative thinking and close coordination between the design and construction teams.

Keywords: Bridge, design, construction, floating, concrete.

1. Introduction

Okanagan Lake, located in the interior of British Columbia, Canada, is 135 km long and, on average, between 4 and 5 km wide. Its maximum depth exceeds 260 meters. The only lake crossing is located roughly at the mid point of the lake, via an existing 3-lane bridge.

The existing bridge, built in the 1950's, carries three lanes of traffic (one in each direction and a central, alternating counter flow lane).

Although in reasonably good shape, the maintenance costs for the existing structure were increasing, and as such, the decision was made by the Provincial Government to replace the aging structure.

The new bridge has been designed as a replacement of the existing Okanagan Lake Bridge, with increased capacity (5 lanes), a permanent navigation channel, and a design life of 75 years.

2. Bridge replacement

In 2003, the Provincial Government decided to replace the bridge under a Public Private Partnership (P3) model as a Design/Build/Finance/Operate project.

Under the P3 form of contract, the Concessionaire is fully responsible for design, construction and maintenance. The integration of the three groups allowed the team to focus on the life cycle cost of the structure and design optimization for construction.

The Concessionaire's team consisted of the following: SNC Lavalin (Concessionaire and Financier); SNC Lavalin/Vancouver Pile Driving (Construction Joint Venture Partners); Greyback Construction (pontoon construction); Emil Anderson (road works construction); SNC Lavalin (roads design and design coordinator); Buckland & Taylor Ltd. (bridge design lead and fixed structure design); Aas-Jakobsen AS / Johs. Holt AS (floating structure design); Ben C. Gerwick Inc.(pontoon anchor design); Northwest Hydraulics (wind and wave loading for the floating structure); Trow (geotechnical design, environmental design, and quality management); and DMD Electrical (electrical design).

3. Design

In order to re-use the existing road infrastructure, the new bridge is located alongside the existing

https://doi.org/10.2749/222137908796292533

bridge. Also, to minimize the cost of the project, the new bridge re-uses the anchors and lower portion of the anchor cables from the existing bridge.

The new design eliminates the lift span by providing a fixed, elevated approach structure with a navigation span on the west side of the bridge. The middle portion of the bridge is comprised of the floating pontoon string, and transition spans are provided from the west elevated structure and the east shore to the pontoons.

Because of the movement in the floating structure (up/down, north/south and rolling), the transition spans must accommodate significant movements while maintaining the rideability of the roadway surface.

The floating part of the bridge consists of a continuous concrete pontoon approximately 700 m long and 25 m wide. The depth of the pontoon varies from 5.14 m to 7.8 m. The roadway is situated directly on the pontoon top slab over the middle length of the pontoon. The pontoons were constructed as nine separate parts in a graving dock and were, subsequently, floated out to the bridge site where they were connected together by means of post-tensioned tendons.

The elevated decks are designed as a light weight structure with composite steel plate girders, with relatively short 20 m spans, to distribute the weight of the superstructure evenly onto the pontoon and to improve stability.

The Concession Agreement for the project required that the pontoon connections be stronger than the pontoon structures, and that the joints be under compression for all service load combinations. To allow for construction tolerances, and to be able to connect the pontoons and install all the PT tendons and the high strength bars across the joint, it was necessary to design the connections with a relatively large tolerance at the location of the tendons and the DYWIDAG bars.

Twenty of the existing pontoon anchors were re-used for the new bridge. However, four additional anchors were required for the new bridge. The new anchors are reinforced concrete structures with a footprint measuring 6 m by 10 m, and a thickness that tapers from 200 mm to 350 mm, which gives the anchor a total weight of 65 tonnes. Due to the water level fluctuation on the lake, the floating pontoons are designed with a cable gallery that allows for the anchor cable tension to be adjusted.

4. Construction

The construction of a floating structure presents a rather unique set of challenges, which required innovative thinking.

The pontoon design is driven by the need for buoyancy and water tight compartments. Typical internal walls range from 150 mm to 200 mm thickness and heights in excess of 5.4 m. Placing concrete in such thin, tall and heavily reinforced walls was achieved by using self compacting concrete and developing placing techniques and tools, which reduced the risk of segregation and other defects.

The pontoons, once finished and floated, were installed in their final position, next to the existing structure. Since the old and new bridges share 20 out of 24 existing anchors during the construction period, it was imperative to ensure the integrity of the old structure and the safety of the public.

The pontoons were installed without the superstructure. Therefore, the elevated deck was installed on a floating structure to which additional pontoons continued to be added at regular intervals. Water was used inside the pontoons as temporary ballast, placed in such a way as to mimic the final pontoon draft and to maintain the shear stresses and bending moments within acceptable limits.

5. Discussion, final comments and conclusion

The P3 process for the replacement of the floating Okanagan Lake Bridge allowed the design, construction, and operations teams to effectively collaborate in the development of the design of the new bridge.

The uniqueness of the floating bridge required the development of a project specific design criteria that augmented the Canadian Bridge Code with requirements from the Norwegian and other codes.