Widening of two bridges on SH16

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Abstract

State Highway 16 (SH16) between Brigham Creek and Waimauku is an important link for the local community and provides resilience within the wider Upper North Island state highway network. SH16 Brigham Creek to Waimauku improvements project delivered by NZ Transport Agency Waka Kotahi (NZTA) focuses on improving safety and efficiency in the area. The section of SH16 between Huapai and Waimauku was a relatively narrow corridor presenting several safety risks for road users. Stage 1 of the improvements project addressed this by widening the existing two-lane carriageway and shoulders and installing right turn bays at critical intersections.

Berry Bridge and Kumeu No. 2 Bridge lie along the project alignment and were too narrow to carry the proposed widened carriageway. Instead of replacing the existing bridges with wider new bridges, bridge widening has utilised the remaining life of the existing assets and delivered cost and sustainability benefits, while minimising disruption of SH16 operations during construction.

This presentation presents the design philosophy, criteria and methodologies adopted in the design, and discusses the key challenges encountered and lessons learnt.

General descriptions

The existing Berry Bridge was a three-span haunched reinforced concrete slab bridge on piled foundations, constructed in 1954. The widened structure replicates the existing arrangement, with a new haunched deck slab cast integrally with new concrete blade pier and abutment beam extensions supported on new concrete bored piles.

The existing Kumeu No. 2 Bridge, constructed in 1939, was a single span bridge comprising reinforced concrete T beam superstructure cast integrally with abutment walls supported on precast concrete piles. The bridge was strengthened in 2008 with the addition of external post-tensioning tendons to the T beams. The widened structure generally replicates the existing arrangement, with three new rectangular reinforced concrete girders and deck slab all cast integrally with concrete abutment wall extensions supported by new concrete bored piles.

For both bridges, the new portion is connected to the existing portion via in-situ stitch pours. Both existing bridges had been through NZTA HPMV screening and were open to HPMVs.

Design philosophy and criteria

A condition assessment has been carried out which determined the existing bridges were likely to have more than 50 years of service life remaining without significant repairs.

The design philosophy for the widening work is consistent with section 6.2 of the NZTA Highway Structures Design Guide, i.e. the new work complies with the requirements for a new structure, and the altered structure continue to comply with the new structure requirements to at least the same extent as before the alteration. Following this approach, if an existing element is not made worse after widening, it will continue to comply with the Building Act.

Existing member capacity limit and the lack of as-built information are some of the key challenges when widening old existing bridges. Costly site investigation is often required to collect material and reinforcement information for capacity assessment and strengthening design. The widening design solution focuses on limiting the additional load demand on the existing elements after widening, which minimises bridge strengthening work and the extend of site investigation.

The new part of the widened structure is designed to the requirements for new structures of the NZTA Bridge Manual (3rd edition amendment 2 at the time), except for the following key approved departures:

- Design for HPMV evaluation live loads instead of full HN-HO
- Design for lower DCLS seismic event
- Use semi-rigid TL4-thrie beam legacy barrier system

Design methodology

Construction was required to be staged to allow the weight of the new structure to be supported on new foundations before connecting the new and existing structures together. New pile design utilises shaft resistance only at ULS to limit settlement.

To avoid increasing demand on existing structure from live load, bridge widening provides clear load paths which do not use existing elements to transfer dead loads to the ground. The new elements are designed to have similar but slightly higher stiffness as the existing elements to share some loads from existing members, but also avoids attracting too much load to the new portion and overstressing the connection between new and existing portions.

Conclusions

Section 6.2 of the NZTA Highway Structures Design Guide provides a pathway for Building Code compliance of bridge widening works. A design approach and construction methodology focusing on limiting the additional load effects on existing elements can minimise assessment and strengthening works.

Departures and a pragmatic approach to design criteria is important to support a cost-effective design solution.