SYSTEM PERFORMANCE OF A PRECAST BRIDGE INCORPORATING FULL-DEPTH DECK PANELS AND PRESTRESSED INVERTED BULB-TEE GIRDERS

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ABSTRACT
The South Dakota Department of Transportation (SDDOT) currently uses prestressed precast double-tee girder bridges on many of its county roads because they are cost-effective and fast in construction. Current bridges are designed for a service life of 75 years. However, some double-tee bridges need total replacement after 40 years of service. Alternative durable prefabricated bridge systems are needed to provide more options to local governments. The present study was carried out to investigate the feasibility and performance of a new bridge system using precast full-depth deck panels and prestressed inverted bulb-tee girders. A full-scale 50-ft long by 9.5-ft wide bridge representing two interior girders from a prototype bridge was tested under fatigue and strength loading. The bridge was first tested under 500,000 cycles of the AASHTO Fatigue II loading using a point-load applied at the midspan. Next, the performance of transverse joints was evaluated by applying 150,000 AASHTO Fatigue II load cycles using two point loads applied adjacent to the middle panel transverse joints to maximize the shear transfer. Stiffness tests were performed at every 50,000 load cycle interval for both fatigue tests. No significant damage beyond shrinkage cracks was observed through the entire fatigue testing, and the overall bridge stiffness did not deteriorate. Finally, the proposed bridge system was monotonically loaded to 263 kips to investigate the ultimate capacities. It was found that the first crack loading magnitude was higher than the equivalent AASHTO Service and Strength I limit states indicating sufficient performance. Based on the construction, testing, and cost analysis, it was concluded that the proposed bridge system is a viable alternative to the double-tee girder bridges. The presentation discusses the design and construction methods and highlights the findings of the experimental study.
INTRODUCTION
The South Dakota Department of Transportation (SDDOT) currently uses prestressed precast double-tee girder bridges on many of its county roads because they are cost-effective and fast in construction. Current bridges are designed for a service life of 75 years. However, some double-tee bridges need total replacement after 40 years of service. Alternative durable prefabricated bridge systems are needed to provide more options to local governments. The present study was carried out to investigate the feasibility and performance of three bridge systems suitable for local roads: (i) precast full-depth deck panels (FDDPs) supported by prestressed inverted bulb-tee girders (Tazarv et al., 1), (ii) glulam timber girder bridge, and (ii) glulam timber slab bridge (Tazarv et al., 2). The extended abstract and the presentation discuss the design and construction methods and highlight the findings of the experimental study of the first alternative.

TEST SPECIMEN AND RESULTS
A full-scale 50-ft long by 9.5-ft wide bridge (Fig. 1) representing two interior girders from a prototype bridge (Fig. 1a) was tested under fatigue and strength loading. The test specimen was consisted of two prestressed inverted bulb-tee girders and five 8-in. thick FDDPs. The deck panels were connected to the girders through hidden pockets (Fig. 1c), which were filled with conventional grout, and full-depth (open) pockets, which were filled with latex modified concrete (LMC). Double-headed and inverted U-shape studs were respectively used in the hidden and open pockets. The deck panels were connect transversely using a female-to-female joint (Fig. 1e) and longitudinally incorporating dowel bars (Fig. 1f).

Figure 1. Full-Scale Fully-Precast Bridge Test Specimen (1)

The bridge was first tested under 500,000 cycles of the AASHTO Fatigue II loading (equivalent to 91 years of service) using a point-load applied at the midspan. Next, the performance of transverse joints was evaluated by applying 150,000 AASHTO Fatigue II load cycles (equivalent to 27 years of service) using two
point loads applied adjacent to the middle panel transverse joints to maximize the shear transfer. Stiffness tests were performed at every 50,000 load cycle interval for both fatigue tests.

No significant damage beyond some shrinkage cracks was observed throughout the entire fatigue test. Furthermore, the bridge stiffness did not deteriorate under the fatigue testing (Fig. 2) confirming that all joints performed satisfactorily. Subsequently, the bridge was monotonically loaded to 263 kips to investigate the ultimate capacities (Fig. 3). It can be seen that the first crack loading magnitude was higher than the equivalent AASHTO Service and Strength I limit states indicting sufficient performance.

A cost analysis was performed for the superstructure of prototype proposed precast and double-tee bridges, each 50-ft long and 34.5-ft wide. The cost per deck area of the proposed precast system was 10% higher than that for the double-tee bridge.

CONCLUSIONS

Based on the construction, testing, and cost analysis, it can be concluded that the proposed bridge system is a viable alternative to double-tee girder bridges. The presentation discusses the design and construction methods and highlights the findings of the experimental study.

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REFERENCES