Innovative CFCC Prestressed Decked Bulb T Beam Bridge System

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Summary

Precast prestressed beams have been widely deployed in bridge construction due to their high load carrying capacities and their low-span-to-depth ratio. However, durability issues associated with the corrosion of the steel reinforcement have been a major concern for this type of bridge superstructures. To overcome the problem of steel corrosion, this study investigates a new concept for bridge construction using decked bulb T beams reinforced/prestressed with corrosion-free carbon fibre composite cable (CFCC) strands instead of the conventional steel reinforcement. An experimental investigation has been conducted to evaluate the performance of the new bridge superstructure under service and ultimate limit states. The investigation comprised the construction, instrumentation, and testing of three single decked bulb T beams prestressed/reinforced with different reinforcement materials and a one-half-scale bridge model composed of five adjacent CFCC prestressed decked bulb T beams. The bridge model had a total span of 9,750 mm, a width of 2,590 mm, and a depth of 356 mm. To expedite the construction process, no cast-in-place deck slab was provided. Instead, the decked bulb T beams in the bridge model were interconnected at their top flanges and at the diaphragms using ultra high performance concrete (UHPC) shear key joints.

The key objectives of the study are to investigate the performance of CFCC reinforced decked bulb T beams under different limit states and to evaluate the behaviour of a newly developed shear key joint between the top flanges of the adjacent beams. The experimental investigation revealed that CFCC precast prestressed decked bulb T beam bridge superstructures has a consistent, reliable, and predictable performance. In addition, UHPC shear key joints are stronger than the flanges of the beams. Therefore, it is concluded that the newly developed bridge superstructure can be easily deployed in bridge construction to achieve an enhanced performance, expedited construction process, and extended lifespan.

Keywords: Decked bulb T beams; Post-tensioning; Prestressing; CFRP; CFCC; Bridges.

1. Introduction

In North America today, there are more than 150,000 bridges that are structurally deficient or obsolete and more than 3,000 new bridges are added each year [1]. Therefore, there is always a call to build better bridges, reduce travel times, and improve repair techniques. Besides, bridge rehabilitation or construction projects are often constrained by time and space to avoid traffic interruption. To overcome construction and time problems, a new technique called accelerated bridge construction (ABC) has been recently developed and implemented in bridge industry.

The ABC is gaining popularity day after another because of its exceptional benefits such as: reducing onsite construction time, minimizing traffic disruption, reducing environmental impact, improving worker and motorist safety, improving constructability, and increasing the quality of the constructed bridge. The increased quality comes as a result of the increased quality control, adequate cure time, ease of access, and controlled environment. Few projects have been executed in different states using some of the ABC techniques. For instance, in George Washington Memorial Parkway Bridge, VA, the deck was replaced using precast panels in 2002 while the bridge was open

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