Doctorate Dissertation Defense Announcement

FLEXURAL BEHAVIOR OF CFRP-PRETENSIONNED GIRDERS

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ABSTRACT

Highway bridge girders are subjected to large number of loading cycles, aggressive environments as well as temperature fluctuations. The combination of all these effects can result in the deterioration of the serviceability and strength of highway bridge girders. Beams prestressed with steel are susceptible to corrosion when subjected to environmental exposure. The corrosion of the prestressing steel reduces the load carrying capacity and may result in catastrophic failures. Carbon Fiber Reinforced Polymers (CFRP), as an emerging material, has the potential to replace prestressing steel and provide corrosion free prestressed bridge girders. The application of this novel CFRP material in bridges warrants the understanding of some of the critical parameters that affect the design and long-term behavior of prestressed concrete bridge girders. Additionally, a standardized guideline for CFRP prestressing would encourage and facilitate the use of the innovative material with confidence. In the United States, there is a lack of comprehensive design guidelines for the use by the bridge engineers, especially in the American Association of State Highway Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) format.

This dissertation comprehensively investigates the use of prestressing CFRP in bridge girders using experimental, computational and analytical approaches. The experimental study includes construction, testing and analysis of eight full-scale composite AASHTO Type-I prestressed concrete beams under flexural monotonic and fatigue loading. Results of the experimental studies showed that the CFRP prestressed beams can exhibit higher strength and similar or lower deformability compared to steel prestressed beam. Furthermore, the wide distribution of cracks and the deformation at ultimate load provide enough warning before failure. The computational study consists of validating the Finite Element (FE) model and investigating the effect of different parameters: level of prestressing, composite behavior, and reinforcement ratio on the behavior of CFRP prestressed beams. The analytical study consists of evaluation of prediction models and reliability study to calibrate the strength reduction factors for CFRP prestressed beams. Results from the analytical studies showed that the conventional prediction models can be easily implemented to perform flexural analysis of CFRP prestressed beams. Additionally, the reliability study indicated a strength reduction factor of 0.75 for CFRP prestressed beams. Finally, design guidelines for CFRP prestressed beams are also presented based on the findings of this study.