RUTGERS
Center for Advanced Infrastructure and Transportation

Project Overview Report

1. UTC Identifying Number

   DTRT13-G-UTC28

2. Center Identifying Number

   CAIT-UTC-NC28

3. Project Title

   Improving the Durability of the Inverted T-Beam Bridge System

4. Principal Investigator & Contact Information

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5. Rutgers/CAIT Project Manager

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6. Customer Principal

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7. Project Description

   Develop Design Tables and New Shapes for Span Lengths from 20 to 60 ft.
   The current Inverted-T shape works for span lengths around 45 ft, but changes in the cross-sectional geometry are needed to allow the system to work for span lengths from 20 to 60 ft. In this task, at least two additional cross-sectional shapes will be developed. Preliminary design tables will be prepared indicating number of strands required for various size strands, concrete release and 28 day strengths, and concrete unit weights. Typical end zone details will also be prepared for each cross-section and maximum number of prestressing strands.

   Investigate Additional Mix Designs and Develop Recommendation for Topping Mixture
   The key to the success of the Inverted T-Beam System is the enhanced durability which results from the control of reflective cracking specifically, and reduction of all types of topping cracking, as compared to conventional adjacent member bridges. The reduction in cracking is a function of the cross-sectional shape of the precast elements, but is also due to careful design of the topping concrete to reduce the stresses that develop in the topping due to restrained shrinkage. Work was performed in the first study to develop a mix design which had relatively low shrinkage, and high creep. Creep allows the relaxation of stresses which develop from restraint. In the first test program, seven mixtures were compared based on ASTM standard tests for compressive and tensile strength, modulus of elasticity, shrinkage and creep. The best performing mixtures were a normal weight concrete with fly ash, and a normal weight concrete with saturated lightweight fine aggregate. Work will be performed to further refine the mixtures for both normal weight and lightweight concrete. Innovative materials will be investigated as possible constituents in the new mix designs. In addition to the ASTM tests, mock up tests will be developed to better represent the interaction between the precast concrete and the topping. These tests will be designed to gather data on the stresses that develop due to restrained shrinkage, and the time to onset of cracking. Tests to characterize tensile creep will also be performed.

Perform Further Investigations of the Elimination of Horizontal Shear Connectors
In the first project, one proof test was performed which illustrated that horizontal shear connectors were not required between the precast inverted T-beams and the cast-in-place topping. This work will be expanded to further investigate the horizontal shear strength provided by surfaces roughened by undulating formwork, a raked finish and an exposed aggregate finish. The horizontal shear capacities will be compared using simple push-off tests. Both normal weight and lightweight concrete will be used in the testing.

8. Implementation of Research Outcomes (or why not implemented)

   As mentioned previously, the Inverted-T Beam system has already been deployed on two bridges in the commonwealth of Virginia. VDOT is very interested in future deployments and in the development of standard details so the bridge can be easily implemented on a range of span lengths. Several cross-sections will be developed and standardized, and the topping mixture will be optimized to minimize cracking. All associated details will also be refined and standardized.

9. Impacts/Benefits of Implementation (actual, not anticipated)

   TBD

10. Dates and Budget

    Start Date: 2/10/2016
    End Date: 5/9/2017
    UTC (CAIT) Dollars: $ 63,568
    Cost Sharing: $ 63,848
    Total Dollars: $ 127,416

11. Keywords

    prestressed concrete, Inverted T-Beam

12. Web Links (Reports and Project Website)

    https://cait.rutgers.edu/cait/research/improving-durability-inverted-t-beam-bridge-system