The benefit/cost analysis was performed in 1999

JTRP/INDOT RESEARCH PROGRAM

Research Pays Off

Strand Debonding in Pretension Beams

The purpose of this project was to examine the advantages and disadvantages of debonding versus draping and to determine an optimal extent of debonding in pretensioned bridge beams. Debonding reduces flexure-shear capacity, however, it also enables the girders to be fabricated faster and more safely and economically. Debonding eliminates the need for draping hardware and because the strands are horizontal the jacking forces do not induce uplift loads which can create an unsafe fabrication work area.

The research was conducted to evaluate the limits for stresses in the extreme compression at the continuous end of precast prestressed I-beam type bridges with debonded strands and to evaluate the shear strength of pretensioned bridge girders with debonded strands. Four two-span continuous specimens were fabricated and tested. The specimens consisted of three TYPE-I AASHTO girders and one INDIANA TYPE CB-27 box girder. Following the continuous testing of these four specimens, the continuity was destroyed and they were further tested as simple supported beams. Two more TYPE-I AASHTO girders were fabricated and tested simply supported only.

Research Findings and Implementation

The current approach tends to overestimate the continuity effects by assuming a knife-edge type support. A better estimate is provided by taking into account the relative stiffness of the connection over the support (CTL-approach). This is more significant after flexural cracking appears over the continuous support in the composite slab. Time dependent restraint moments computed with the PCA method showed good agreement with observed values when continuity was established at early ages of the precast girders. The CTL approach gave reasonable estimates at different ages of the precast girders particularly when the top steel was introduced. The current approach for web-shear cracking estimates is conservative. Flexure shear cracking with current development length requirements is not conservative for fully bonded beams. The current requirement of doubling the development length for debonded strands leads to adequate estimates of flexure shear cracking. All the specimens where the current development length requirements were used for the fully bonded strands began to slip. Close stirrup spacings in these specimens did not prevent this failure mode. Only in the Type-I specimen, where the fully bonded strands were provided with an anchorage length of about 70% larger than the current requirements, was this mode of failure avoided.

Implementation will be in the form of the following design recommendations that are being considered for the Department's new Design Manual: a) debond no more than 50% of the strands in any row; b) outside strands should not be debonded, c) debonding points should be staggered at no less than 1.0-meter intervals, and d) no more than 4 strands should be debonded at any point.

Benefits

The project provided information for development of debonding guidelines and other guidelines on subjects that current design specifications do not address. It also resulted in improved performance and safety of bridges composed of precast, prestressed concrete beams. From two major fabricators (Hydro-Conduit and Prestress Services), it was reported there are approximately 450 - 550 bridge sections fabricated and installed per year in Indiana. Using a conservative estimate of 500 sections per year and a savings of $100/beam with debonding, an annual saving of $50,000 is estimated.

Cost of Research $155,000

Estimated Economic Value Over 20 Years At 5% Discount Rate

Number of Bridge Beams Per Year	Savings Per Beam	Annual Savings	Discounted Savings (20 years)	Benefit/Cost Ratio
500	$100	$50,000	$623,111	4.0

Contacts

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