Highlights of Recent TxDOT Precast/Prestressed Concrete Research

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The Texas Department of Transportation (TxDOT) has been a leader in the design of cost-effective prestressed concrete bridges for nearly 50 years. During this time, typical spans have increased from 50 to more than 100 ft, intermediate and end diaphragms have been eliminated, and prestressed concrete deck panels have been introduced as stay-in-place formwork for cast-in-place bridge decks. Each of these improvements has increased the speed of construction, reduced the cost of bridge construction in Texas, and demonstrated TxDOT's commitment to incorporating innovative design concepts into practice.

As part of the TxDOT's commitment to advancing the state of knowledge and practice, they recently sponsored several research projects in which simple, cost-effective design and construction details were developed. In this paper, the research conducted under three different TxDOT sponsored projects is summarized:

1. A current concern for TxDOT is the design and construction of bridge decks at expansion joints. The most common detail used by TxDOT is the I-beam thickened slab (IBTS) detail, which involves casting a 4-ft wide, 10-in. deep, heavily-reinforced slab along the expansion joint. This detail increases the transverse stiffness of the slab near the expansion joint and eliminates the need for diaphragms at the ends of the spans. However, the detail also complicates the construction process because special formwork is required at the expansion joints due to the increased thickness of the slab relative to the interior portions of the deck. The primary objective of this project was to develop precast solutions to eliminate the need to construct formwork at the expansion joints. The resulting details reduced construction time and costs and provided a safer work environment for contractors.
2. In another research project, the allowable tensile stress limits of prestressed concrete were examined. The project was funded by TxDOT after field observations were made of flexural cracking in the end regions of AASHTO Type IV beams at the time of prestress transfer. Girders that exhibited cracking were relatively short in length (20 to 60-ft) with highly eccentric strand configurations resulting in tensile stresses in the range of $6\sqrt{f'_c}$ to $7.5\sqrt{f'_c}$. A thorough review was conducted of the documentation and research relating the tensile and compressive strengths of concrete to one another; followed by the material testing of Type III concrete mixes at a very early-age (less than 24 hours). Seven full-scale AASHTO Type IV beam specimens were fabricated and tested at the Ferguson Laboratory at the University of Texas at Austin. Strains were measured in the end regions of each beam; resulting in 14 separate tests. The purpose of measuring the strains was to validate the assumptions of the mechanics of prestress transfer. Beams with an extreme fiber tensile stress greater than $4.5\sqrt{f'_c}$ exhibited cracking at the time of release. In light of these test results code provisions (ACI 318 and AASHTO LRFD Bridge Design Specifications) were critically examined.
3. The current allowable stress in compression at prestress transfer has created a lot of debate in the precast/prestressed concrete industry. Many individuals within the industry support the increase of the current stress of $0.60f'_{ci}$, as specified in the ACI and AASHTO codes. A research study was initiated to investigate the implications of increasing this compression limit on the live-load performance of prestressed members. Static testing was performed on 24 laboratory-scaled specimens that were subjected to compressive stresses at release ranging from $0.46f'_{ci}$ to $0.91f'_{ci}$. The results of this research indicate that exposing concrete at early ages to high levels of stress damages the microstructure of the concrete. The findings of this research project suggest that an increase in the allowable stress to $0.75f'_{ci}$ is not acceptable. However, an increase of the allowable stress to a value between $0.60f'_{ci}$ and $0.70f'_{ci}$ may be possible.