Project Summary

Texas Department of Transportation

7-2941: Long-Term Behavior of HPC Bridges

Background

The purpose of this project was to monitor the long-term performance of high performance concrete (HPC) beams and decks on bridges in Texas. The Texas Department of Transportation (TxDOT) specified the use of supplemental cementitious materials, such as fly ash, silica fume, and slag, as a substitution for cement, with the understanding that higher strength and more durable concrete could be obtained. Early camber loss in one high strength (HS) HPC beam and cracking in HPC decks prompted performance monitoring. Researchers inspected and recorded distress symptoms and performance for 10 years.

What the Researchers Did

Monitoring HPC decks and beams included reviewing the latest Texas Bridge Inspection reports prior to annual site visits. Site visits consisted of visual inspection, crack mapping, material testing, deflection readings, and data reduction of field-collected data files of temperatures and strains from preinstalled bridge instrumentation.

Beam monitoring showed little change, resulting in more emphasis directed to concerns over cracking HPC decks. Researchers met annually with TxDOT personnel in Lubbock, Amarillo, San Angelo, and Houston to inspect HPC decks. Field observations were reported to the project director.

What They Found

HPC Beams

- Prestress losses - Measured parameters worked better than design parameters for predicting prestress losses. The American Association of State Highway and Transportation Officials (AASHTO) and Precast/Prestressed Concrete Institute (PCI) prediction methods from the mid-1990s did not work well for predicting prestress losses in HS/HPC beams. AASHTO revised loss prediction methods to better address HS/HPC considerations independent of this research.

- Deflections and camber - The measured camber values, taken several years after construction of the bridges, remain stable for HS/HPC beams.

HPC Decks

- Cracking trends on the Louetta Road Overpasses reveal that the HS/HPC decks had nearly twice as much cracking compared to the normal strength concrete deck.

- The use of HPC in bridge decks does not reduce the likelihood of concrete cracking. It may also be stated that using HPC could actually increase the likelihood of cracking if proper construction techniques are not adhered to.

Research Performed by:

Center for Transportation Research (CTR), The University of Texas at Austin

Research Supervisor:
David Whitney, CTR

Researchers:
Brian C. Dahm, CTR
Christopher Shoemaker, CTR

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- Monitoring confirmed previous observations that cracks reflected through the cast-in-place (CIP) concrete wearing surface of the deck immediately above underlying precast panel corners and above the joints between the panels. In some cases, fine cracking in the deck surface distinctly outlined precast panels underneath.

- Cracking tended to occur in the thinner CIP sections immediately adjacent to the thickened sections over the bent caps.

- The above patterns were less common in the thicker CIP HPC decks constructed with the stay-in-place metal pan forms (without precast panels).

What This Means

- Using high strength concrete in bridge decks should not be considered HPC since the likelihood of concrete cracking is significantly increased.

- When using precast panels and HPC, adhering to proper construction techniques is a must.

Data Acquisition Systems Recommendations for Monitoring Field Performance

- Deflections and camber - The precise surveying system used to monitor changes in camber and deflections proved impractical and inaccurate. When structures are new and static changes are larger, high-tech surveying or laser levels work well; however, later in the life of the structure, small changes are not easily or reliably monitored.

- Sensors - Vibrating wire strain gages (VWG) with their own temperature sensing were more consistent and more durable than resistance-type electrical strain gages and simple thermocouples for monitoring. VWGs are recommended for any in-place monitoring.

- Data Loggers - Campbell Scientific CR10 data loggers served without problems, other than power sources and remote data transfer, but peripheral equipment for these units has greatly improved.

- Power - 12-volt DC powers the logger and is available from many sources. The following are recommended.
    - Transformers that convert 120 volt AC or 240 volt AC to 12 volt DC are recommended for the power source to the DAS. Most 12-volt battery systems required too much effort in battery maintenance and replacement.
    - Photo-voltaic (solar) cells to automatically maintain battery charges should be used where AC power is not easily available.

For More Information:
Research Engineer - Andrew Griffith, TxDOT, 512-465-7403
Project Director - Kevin Pruski, TxDOT, 512-416-2306
Research Supervisor - David Whitney, CTR, 512-471-4529

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Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080
512-465-7403