REPLACEMENT PRIORITIZATION OF PRECAST DECK PANEL BRIDGES

PROBLEM STATEMENT

Precast deck panel bridges have a long history of premature deterioration in Florida. A ten year, $78 million program is currently underway to systematically replace selected deck panel bridges in Districts 1 and 7 with full-depth, cast-in-place concrete decks. As not all the bridges are in the same state of disrepair, a strategy was needed to objectively rank relative deterioration and thereby optimize the replacement process.

OBJECTIVES

The goal of this research project was to develop a simple, rational procedure that would assist in prioritizing the replacement of deck panel bridges in Districts 1 and 7.

Originally, it was envisaged that this goal would be met using three-dimensional finite element analysis. The numerical model would be calibrated using inspection records, laboratory testing, and limited non-destructive field evaluation to identify bearing support for the panels. However, a literature review and responses from a survey of State DOTs indicated that non-destructive evaluation using ground penetrating radar would not be suitable for this application.

Therefore, a modified approach was developed in which greater emphasis was placed on inspection data and on the on-site forensic studies of the deck panel bridges being replaced. The forensic studies yielded data that permitted the development of a progressive degradation model. This model was the basis for the ranking procedure and was incorporated into a computer program (PANEL) developed for this study. PANEL uses information on deterioration from inspection reports, along with other factors (e.g., importance of the bridge), to arrive at rankings for replacement.

FINDINGS AND CONCLUSIONS

Numerical analysis conducted using non-linear finite element models indicated that differential shrinkage and, to a much lesser extent, creep were responsible for longitudinal cracking at the vertical precast panel / cast-in-place interface region along the girder support. Differential shrinkage is a function of the time that elapses between the casting of the precast panel and the pouring of the cast-in-place concrete. This information was unavailable. As a result, prioritization relied more on inspection data.

Researchers reviewed inspection records spanning twenty years for all deck panel bridges in Districts 1 and 7, including the Crosstown Expressway, and conducted a detailed analysis of localized failures that occurred in five deck panel bridges. Additionally, the research team inspected all deck panel bridges and made precise measurements of damage. Forensic studies were also conducted on eight precast deck panel bridges in different states of disrepair before and during the demolition of the deck. The forensic study clearly demonstrated the critical role of the

continuous fiberboard material used as a bearing material in deck panel construction. Three of the eight bridges in good condition had precast panels that were partly supported by fiberboard and partly by grout, which is the recommended construction practice in Texas and elsewhere where deck panel bridges have proven successful.

Based on the inspection records and forensic study, a progressive degradation model was developed. Researchers developed a computer program (PANEL) incorporating this model. This user-friendly program has an updateable database and contains historical inspection data extending over 20 years. The program also allows users to assign weighting factors for parameters such as safety, importance, and cost. This information, along with the inspection history, can be used to create lists that rank the order for deck replacement efforts.

BENEFITS

The comprehensive investigation led to the development of a degradation model that can identify damage that can result in localized failure. This model provides critical markers that can make inspections more efficient and cost effective. The computer program developed can be updated to include the latest inspection data and subsequently used in the future to re-prioritize rankings over the time frame necessary to complete the replacement.

The research program was conducted by Rajan Sen, Ph.D, P.E. at the University of South Florida. For more information, contact Steve Womble, Project Manager at (813) 744-6050, steve.womble@dot.state.fl.us