The Ohio Department of Transportation
Office of Research & Development
Executive Summary Report

Performance Evaluation of Bridges with Fiber Reinforced Composite Decks

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Principle Investigators:
William Wolfe
Henry Busby

ODOT Contacts:
Technical:
Tim Keller, P.E.
Administrative:
Monique R. Evans, P.E.
Administrator, R&D
614-728-6048

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or call 614-644-8173.

Ohio Department of Transportation
Office of Research & Development
1980 West Broad Street
Columbus, OH 43223

Problem

According to the Federal Highway Administration's 1999 annual report titled "Status of the Nation's Highways, Bridges, and Transit" an estimated 29% of the nation's bridges need to be either rehabilitated or replaced. Aging highway infrastructure, increasing traffic loads and the high cost of rehabilitation have combined to force transportation officials to seek novel, cost effective methodologies to extend the useful life of existing bridges.

Objectives

When the deck of the Stelzer Road Bridge over Fifth Ave and the CSX railroad tracks in Columbus, Ohio was replaced, the northbound side was constructed of reinforced concrete while the southbound side consisted of fiber reinforced composite tubes filled with concrete. The side-by-side construction allowed a direct comparison to be made of the cost and performance of a deck built using conventional construction materials and methods with an experimental composite material that promised shorter construction times, longer design life and lower maintenance costs. The Ohio State University was contracted to determine through measurements of the response of the two deck types to heavy traffic loads whether or not the use of a composite materials in the deck improved bridge performance.

Description

Laboratory tests were conducted to determine the strength, stiffness and coefficient of thermal expansion (CTE) of the fiber reinforced tubes.

During deck reconstruction displacement transducers (LVDTs) were installed to record the movement of the bridge deck under load. Strain gages were affixed to the underside of the deck to measure deck deformation.

Field response was measured with two ODOT trucks loaded with gravel which were used to provide known traffic loads. The trucks traveled across each side of the bridge at specified spacings and speeds while the dynamic bridge response was recorded.

The differences in the two deck systems to load were recorded and the merit of the composite deck as an alternative to conventional construction was evaluated. Monthly measurements of the response of the two decks to normal traffic loads were continued for several months to determine if temperature affected the deck behavior.

Conclusions & Recommendations

While the laboratory measured strengths and stiffnesses of the composite tubes were near the design values, the CTE in the transverse direction was more than 3 times the larger than the value specified. In measurements made of the two bridge decks during the controlled load tests, when the outside temperature was 21^{o}C, deflections on the composite side were, on average, 143% of those measured on the reinforced concrete side. As the temperature rose, the average deflection of the composite deck increased to 190% of the concrete deck deflection.

Cracking in the median and sidewalk on the composite side as well as gaps between the composite deck and its haunch were observed and documented.

The cost of the composite deck system was substantially higher than the conventional system. In addition the cost of increased maintenance likely to result from the repairs made necessary by the extensive cracking that was already evident within a short time after the composite deck was completed, make it clear that the conventional reinforced concrete deck is the preferred short and long term design choice.

Implementation Potential

The results of the monitoring program show that the post-tensioned concrete filled composite tubes did not achieve the desired improvements. With documented construction costs substantially higher and maintenance costs likely to be greater than for the conventional concrete deck, implementation of the composite deck system used on the Stelzer Road bridge at other locations should be delayed until substantive design modifications are made. Documentation to support claims of suitability or improvement should be required before construction is allowed to proceed.