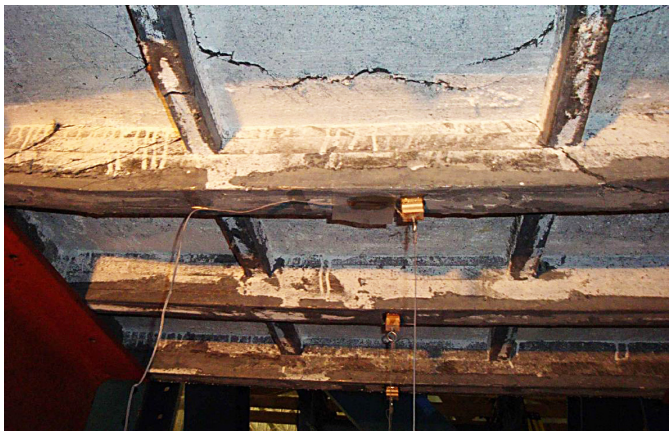
Florida Department of Transportation Research

Alternatives to Steel Grid Decks – Phase II
BDK80 977-06

Most of Florida's extensive inventory of movable bridges are decked with open steel grids. These decks are lightweight and easy to install, but once in service, they have poor skid resistance, tendencies to wear down and separate from support structures, high noise levels, low riding comfort, and more. Seeking an alternative, the Florida Department of Transportation contracted researchers from Florida International University and the University of Central Florida to study the options. In phase I (project BD015-22), the researchers examined three deck types using materials such as fiber-reinforced polymer (FRP), aluminum, and high-strength steel (HSS). However, the most promising alternative was ultra-high-performance concrete (UHPC). The current project undertook studies needed for implementation of UHPC decks on Florida bridges and additional studies of FRP decks.

UHPC deck consists of a thin slab with integral primary and secondary ribs. The UHPC material is a special formulation concrete reinforced by 0.008-in. fibers, often subjected to post-casting treatment. Deck units weigh 25 lb/ft^2, the maximum under current design requirements. Deck units were investigated on both the component and system level.

Researchers first investigated the long-term performance of the UHPC bridge deck system. They conducted a series of tests, including shear and uplift testing of deck-to-girder connections, deck-to-deck connection tests, lateral distribution of live loads, and fatigue and residual strength tests. This work revealed that due to the unique properties of UHPC, both mechanical properties and failure modes — including ductile shear and bond failure — of reinforced members of UHPC differed from normal strength concrete. Further study of UHPC failure modes included dowel action shear tests and uniaxial fatigue tests. The researchers noted the significant contribution of dowel force.



This post-test view of the underside of a UHPC-HSS bridge deck unit in an experimental setup shows the basic deck structure with primary and secondary ribs.

In the second part of the project, an FRP deck product (Structural Composites, Inc., Melbourne, FL) was tested under static and fatigue loading. FRP decks are in service on 40 bridges in several states, including Florida. The FRP bridge deck system was first subjected to a static load up to a target service load to determine its serviceability. The specimen was then unloaded and tested under cyclic (fatigue) loading. Finally, residual strength was evaluated with static loading up to failure. Under static loading, the FRP deck showed linear deflection and strain responses attributable to the linear elastic behavior of the material. After two million cycles of fatigue loading, the deck showed no signs of damage or failure, and deflections and strains were similar to the initial static test. The FRP deck showed residual strength of at least three times the target design load.

This project advanced design knowledge of UHPC and FRP bridge decks significantly. Additional studies of serviceability, especially wearing surfaces, and for UHPC, investigation of weight reduction are needed. Results confirmed earlier evidence demonstrating that UHPC and FRP are excellent alternatives to steel grid decks, promising increased service life, safety, and reduced maintenance for Florida bridges.

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