The Bridge Street Bridge Deployment Project
Southfield, Michigan

The Bridge Street Bridge Deployment Project consisted of the replacement of a failing bridge over the Rouge River in the City of Southfield, Michigan, with two parallel concrete bridges. Each bridge contains 3 spans over a 204-foot length and carries traffic in a boulevard configuration. While the first bridge constructed, Structure A, used standard AASHTO precast concrete girders and steel reinforcement, the second bridge, Structure B, was constructed of precast concrete double tee beams that were reinforced, pre-stressed and post-tensioned with rods, tendons, and strands produced from *carbon fiber reinforced polymer (CFRP).*

CFRP products are made from very small diameter fibers of carbon, about the diameter of human hair. These long fibers are woven together and encased in epoxy. Carbon fiber reinforced polymer offers many advantages over steel when used as concrete reinforcement. CFRP is a light weight material with an improved tensile strength over steel. In addition, CFRP is corrosion resistant. This difference should allow improved longevity for the reinforcing material and the entire structure.

The quantity and extent to which carbon fiber reinforced polymer was used in place of steel in the Bridge Street Bridge Deployment Project has established another benchmark for advanced composite technology in a civil engineering application. There is no other bridge of this type anywhere in the nation, nor in the world. Internal pretensioned tendons and external post-tensioned cables were ultimately selected to be the project flexural reinforcement. The non-prestressed reinforcements in the beams and deck structure used CFRP manufactured in bent configurations, straight CFRP rods, CFRP grid reinforcements, and stainless steel reinforcing bars. To optimize bridge durability, the only metallic items embedded were stainless steel.
The bridge caught the attention of City officials when a hole through the bridge deck developed in 1992. One of the primary challenges that the City faced was that the bridge provided sole access to the Bridge Street Industrial Park, housing over fifty light industrial businesses. After exploring more than twenty potential solutions, the concept of building two parallel bridges side by side was selected as the most appropriate solution in 1994.

The cutting edge technology that made this bridge project innovative was a result of research conducted by Southfield-based Lawrence Technological University (LTU) on the complete substitution of high strength carbon fiber products in place of conventional flexural steel reinforcing bars and tendons. LTU's research was a continuation of collaborative work with the University of Windsor in Ontario, Canada. In 1996, the bridge design concept that resulted from this research was recognized by the Civil Engineering Research Foundation (CERF) with the Charles Pankow Award for Innovation. The Bridge Street project provided a timely opportunity to apply this CFRP research to full scale construction.

To assure the success of the project, a multi-task program was assembled for modeling, testing, monitoring, and acquisition of CFRP reinforcements and special services. A diverse group was formed to meet regularly as a task force to explore the possibilities and challenges of design and construction with CFRP. This group grappled with the formidable challenge of forging an overall program for the safe design of a public structure without the benefits of applicable state standards and federal codes.

The Bridge Street Bridge Deployment Project has met the immediate need to provide safe, convenient access to the Bridge Street Industrial Park. The dual bridge concept has also provided an opportunity for on-going study and comparison between the conventional steel and innovative CFRP reinforced structures. Both were constructed with a series of gages and sensors embedded within their structural elements and mounted to exterior surfaces to facilitate continuous monitoring using remote sensing technologies. The data that is collected over the next five years will be made available to researchers, federal and transportation authorities, and the National Science Foundation.

Ultimately, this project is anticipated to demonstrate that the use of carbon fiber reinforced polymer material as structural reinforcement can dramatically increase the potential service life of highway bridges thereby reducing safety hazards and maintenance costs. Promoting confidence in the use of advanced composites will make a positive contribution to many industries including but not limited to civil engineering, automotive, and aeronautics.

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The Bridge Street Bridge Deployment Project in Southfield, Michigan consisted of the replacement of a failing bridge with two parallel concrete bridges.

Carbon Fiber Reinforced Polymer (CFRP) is manufactured in a variety of forms including bent shapes shown here.

Fatique testing of a concrete double tee beam in the Structural Testing Facility at Lawrence Technological University.

July 1997 - Existing bridge road surface shows significant deterioration.

Two 500-ton mobile cranes were used to set the double-tee beams for Structure B.

A full-size double tee beam was fabricated and tested to destruction prior to construction of Structure B.

Extensive instrumentation was installed on both Structures A and B to facilitate continuous monitoring and comparison.

The success of the Bridge Street Bridge Deployment Project can be attributed to a strong alliance of individuals from the United States, Japan, and Canada.

In addition to internal prestressing, each Structure B beam was externally post-tensioned with (4)-40mm (1.6 in.) diameter CFRP cables.

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