Advanced Bridge Materials' Efficacy Tested at NC State University

August 3 2005

One-third of urban bridges in the United States are structurally deficient or functionally obsolete, according to the recent Infrastructure Report Card issued by the American Society of Civil Engineers.

Engineers at North Carolina State University are now utilizing full-scale tests on two materials to gauge their effectiveness in making bridges stronger and safer, as well as reducing the costs and duration of repairs to this critical infrastructure.

Dr. Sami Rizkalla, director of the Constructed Facilities Lab and Distinguished Professor of Civil Engineering and Construction at NC State, and lab colleagues are testing both microcomposite multistructural formable (MMFX) steel, a steel that is highly resistant to corrosion, and fiber-reinforced polymers (FRPs), glass or carbon fibers that are stronger and lighter than steel, as bridge and building reinforcement materials.

An expert in the use of advanced composite materials for construction or rehabilitation, strengthening and repair of bridges and structures, Rizkalla says that concrete buildings and bridges reinforced with traditional steel absorb water, which corrodes the steel over time. “Concrete is like a sponge,” he said. “When the steel in concrete corrodes, it expands. When it expands, it cracks the concrete, and we end up with problems that translate into billions of dollars of deteriorated bridges and structures.”

MMFX steel is similar to black steel that is used to reinforce traditional concrete structures, Rizkalla says, but its microstructure is altered to make it corrosion-resistant. In addition, he adds, MMFX steel in many applications is twice as strong as conventional steel.

Rizkalla's lab is currently testing three full-scale bridge sections to evaluate the structural performance of MMFX-steel-reinforced concrete bridge decks; study the effects of using different reinforcement ratios for MMFX-steel-reinforced concrete bridge decks; compare the behavior to conventionally reinforced concrete bridge decks; and develop standards for MMFX-steel-reinforced concrete bridge decks.

The second project involves using carbon fiber reinforced polymers (CFRP) to repair bridges and concrete structures. According to Rizkalla, "Some of the existing bridges built 40 to 50 years ago had been designed for truckloads weighing less than what we have now and need to be strengthened to carry the new loads. In other cases, bridges damaged by impact or corrosion need to be repaired."

Rizkalla says that, besides being stronger and lighter than traditional steel, fiber-reinforced polymers can be installed quickly.

The N.C. Department of Transportation (NCDOT) commissioned Rizkalla's lab to evaluate the cost effectiveness of using CFRP systems to strengthen or repair bridge girders by increasing their load-carrying capacity. NCDOT provided a number of 43-year-old bridge girders for testing; Rizkalla's lab is currently testing the efficacy of various CFRP systems on 18 of these prestressed girders.

"We have succeeded in increasing their capacity by 70 percent through the special attachment of this material to existing girders," Rizkalla reported.

The advanced bridge material studies are just two of the numerous applied research projects emanating from the state-of-the-art Constructed Facilities Lab. It is one of only four public labs in the United States accredited by International Accreditation Service Inc. to perform code compliance testing for the International Code Council.

Source: North Carolina State University