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INSPECTIONS

Studies in Suspense Flourish in New York

Researchers are delving into bridge cable corrosion's causes, rate of growth and prevention

With five Hudson River structures and a small staff, New York State Bridge Authority chief engineer William Moreau looks to consultants—and new ideas—to help figure out how to make his "babies" last longer. In the field of maintaining suspension bridges, "everyone is an expert, but nobody has the right answer," he says. U.S. suspension bridges are aging and there's no one way to predict if, when, and why cables weaken.

NYSBA is in the fourth year of a five-year, $125-million capital improvement program for its five toll crossings and one new pedestrian bridge, but maintenance work goes back much further. The 4,281-ft-long Mid-Hudson Suspension Bridge in Highland, for example, has undergone $75 million in deck replacement, repainting and other rehabilitation work over 20 years. Now Modjeski & Masters' local office is conducting a cable inspection contract on the 1,500-ft-long main span.

That gives Khaled M. Mahmoud, director of long-span bridges for New York City-based Hardesty & Hanover, an opportunity to apply his new technique for assessing the residual strength in cable wires. As a subcontractor to M&M, he is studying the effects of loading and environment—particularly hydrogen embrittlement—on the rate of cracking and fracture toughness.

The three-month inspection involves opening 11 cable sections with wood wedges, unwrapping the cable and pulling out broken wires among the 6,090 within, says Michael S. Januszkiewicz, M&M senior engineer. He gave wires pulled last month to Mahmoud, who will evaluate the cracks' shapes under an electron microscope at Lehigh University in Bethlehem, Pa.

According to Mahmoud, cracks flatten out in proportion to how advanced they are. Mahmoud will evaluate how much effect hydrogen and stress corrosion had on the fractures, then establish patterns of deterioration and predict the remaining safe life of the cable. The aim is "to enhance [previous studies] with better models to describe wire behavior and see if variability can be minimized," says

▲ **Cable Close-Up.** Bridge crews insert wedges to open up a cable in Mid-Hudson River Bridge.

PHOTO COURTESY OF MODJESKI & MASTERS PC

▲ **Team.** Januszkiewicz, Mahmoud, Moreau.

PHOTO BY AILEEN CHO FOR ENR

John Fisher, Lehigh civil engineering professor emeritus. "Other studies...focus more on how cracks form. [This] is trying to create a better predictive model for fracture crack extension."

"Khaled's is a specific kind of research into how cracks progress through wires," notes Peter Sluszka, vice president of Amman & Whitney, New York City. He says he was uncertain of the "practical application" of the method, but "the more we know, the better off we are."

And suspension bridge engineers are striving to know more. New York City-based Weidlinger Associates is wrapping up a report for the National Cooperative Highway Research Program on inspection of parallel-wire cables. David Beal, NCHRP project manager, says the study will provide guidelines for evaluating and testing cables but doesn't address loads and safety limits. "We're only studying the deterioration and loss of strength" in cables, he says. "Any single study can't answer every possible question."

Moreau says Mahmoud's study could help give a better idea of what materials to use in future maintenance. NYSBA has experimented with anti-moisture measures such as acrylic paint and dehumidifiers in the anchorages and tower tops. The practices are new to the U.S. but common in Asia and Europe.

To the north, Amman & Whitney is monitoring the NYSBA-owned 2,258-ft-long Bear Mountain Bridge with an acoustic system that can "hear" wires break, says Sluszka. Ultimately, NYSBA will decide if it will keep adding side cables or replace the main cables entirely while keeping traffic open—a feat that would be a first in the U.S. ■

By Aileen Cho on the Mid-Hudson Bridg