Florida Department of Transportation Research

Comparative Testing of Radiographic Testing, Ultrasonic Testing and Phase Array Advanced Ultrasonic Testing Non Destructive Testing Techniques in Accordance with the AWS D1.5 Bridge Welding Code — BDK84-977-26

To ensure that Florida bridges remain safe and structurally secure for their 50-year-plus service life, they are inspected regularly. For steel bridges, welds critical to the bridge's integrity do not even leave the workshop unless they meet rigorous standards governed by the American Welding Society's Bridge Welding Code (AWS Standard D1.5). To detect flaws without damaging the weld, the code requires use of nondestructive testing (NDT), either radiographic testing (RT) or conventional ultrasonic testing (UT).

In RT, the weld is irradiated from one side and a detector, usually film, is placed on the opposite side. The patterns of light and dark that form the image represent the amount of radiation reaching each area of the film. As radiation presents serious safety issues, RT must be performed by specialized operators, which imposes significant costs. More costs are due to work disruption caused by excluding workers from the RT test area.

UT, as specified in D1.5, uses a single-element probe to emit an ultrasonic beam in a fixed direction, so that the probe must be moved to cover an area of interest. Compared to RT, UT is more portable, easily penetrates to greater depths, is nonhazardous, requires access to only one surface, and determines depth of flaws better. However, UT requires great skill to use the probe and interpret received signals, and most UT systems do not record, so results can only be interpreted on the spot.

In this report, University of South Florida (USF) researchers investigated use of an NDT technique called phased array ultrasonic testing (PAUT), which uses a multielement probe. PAUT can sweep through a wide area at high speed without physical manipulation, increasing the accuracy, efficiency, and reach of testing.

The researchers sought to compare RT, UT, and PAUT to support AWS adoption of PAUT for inspecting steel bridge welds. In a collaboration among the USF researchers, the Florida Department of Transportation State Materials Office (FDOT SMO), and a commercial steel fabricator, Tampa Tank, Inc./Tampa Structural Steel, all three techniques were used to test actual bridge welds in the fabricator's shop. Thus, defect frequency and type, welding techniques and procedures, NDT protocols, and work practices represented current steel bridge fabrication practices and testing in Florida.

Steel bridges are built from welded units in which each weld must meet rigorous standards.

Testing and result interpretation were performed by certified technicians. Thirty-five pieces were inspected, yielding 92 PAUT tests, 54 UT tests, and 108 RA tests. Welds were rejected by PAUT (8.7%) at a slightly lower rate than RT (9.3%), but higher than UT (7.4%), allaying concerns that PAUT would generate significantly more rejections and costly rewelding. However, flaws detected by RA that were not detected by PAUT were a concern. Researchers addressed this issue by testing plates specially made with numerous weld defects. Inspections of these test plates and an expanded PAUT test protocol resolved concerns about false positives.

The promising results from this project further support the use of PAUT in steel bridge inspection, bringing with it the advantages of speed, accuracy, safety, and economy.

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For more information, visit http://www.dot.state.fl.us/research-center