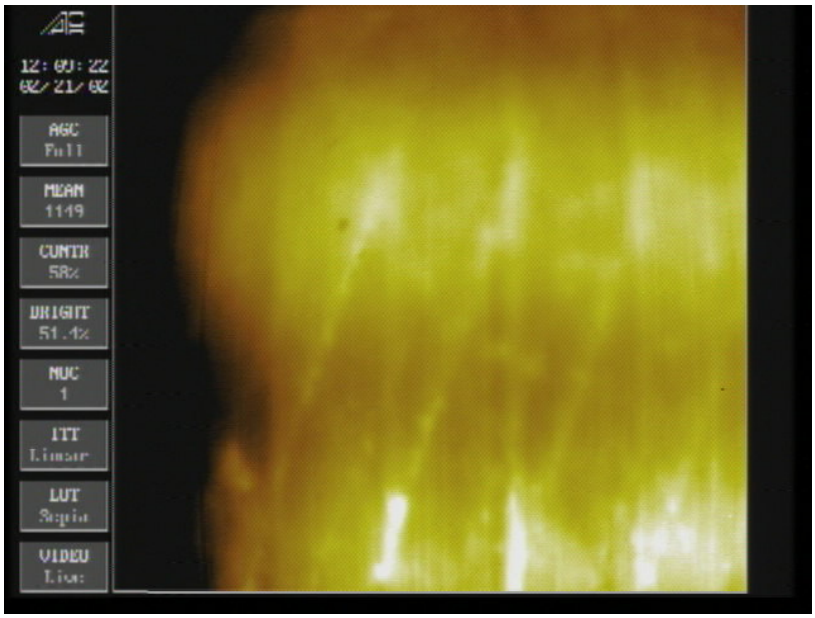
Oregon Department of Transportation

Research Notes

RSN 05-08 April 2005

Non-Destructive Evaluation of FRP-Strengthened Reinforced Concrete

Many reinforced concrete structures across the country are being strengthened with fiber reinforced polymer (FRP) composites to increase the load capacity. In many cases, composites provide the most cost effective strengthening option, and they do not significantly alter the appearance of the structures. Though construction criteria for acceptable FRP composite applications have been developed, viable methods for detecting defects that occur during application or while under service have not been investigated. In addition, how specific defects affect performance has not been well documented. Consequently, ODOT funded a research project with the University of California at San Diego to evaluate non-destructive detection methods for composites and to develop guidelines on the criticality of various defects.



Thermographic image showing internal features in a composite laminate.

The research classified potential defects based on location in the concrete-composite system and when defects can occur. Defect types were illustrated with schematics and photographs, and the potential effects of these defects on structural integrity, durability, and aesthetics were described. The information provides bridge personnel with a valuable reference for inspection, maintenance, and quality assurance.

Possible non-destructive evaluation (NDE) techniques for detecting defects in FRP composites were reviewed. The theoretical and practical aspects of each method were addressed including information on equipment, portability, data storage as well as its capabilities and limitations. Subsequently, the findings were incorporated into a ranking matrix that summarized the applicability of the methods for inspecting FRP-rehabilitated concrete components. Visual and tap tests were recognized as the mainstream, conventional inspection techniques and therefore were included in the review.

The review of NDE methods showed that infrared thermography can be an effective inspection tool. Thermography detects differences in heat dissipation from the surface of the composite to locate defects. It is relatively easy to conduct and does not require extensive training or certification.

Research has shown that vibration analysis may be effective for a bridge owner who needs to monitor the long term health of a bridge. Vibration analysis relies on changes in the way a structure vibrates over time to detect damage or reduced performance. It requires a high degree of expertise, but unlike all the other methods discussed, which can only detect defects locally, vibration analysis can monitor the entire structure for damage progression.

As more bridges are strengthened nationwide using FRP composites, bridge personnel will need to determine the condition of the composite system on each bridge over time. This research will help transportation departments set allowable defect levels and provide guidance in selecting appropriate inspection techniques.

For more information, contact Steve Soltesz at 503-986-2851, or via e-mail at *Steven.M.Soltesz @odot.state.or.us*

To request a copy of the report *"Methods for Detecting Defects in Composite Rehabilitated Concrete Structures"* on CD, contact the ODOT Research Unit by phone at 503-986-2700.

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