AASHTO Technology Implementation Group
Nomination of Technology Ready for Implementation
2005 NOMINATIONS DUE BY FRIDAY, SEPTEMBER 9, 2005

<table>
<tr><td>Sponsoring DOT</td><td colspan="3">1. Sponsoring DOT (State): Missouri</td></tr>
<tr><td rowspan="5">Primary Technical Contact</td><td colspan="3">2. Name: John Wenzlick, P.E.</td></tr>
<tr><td colspan="3">Organization: MoDOT</td></tr>
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john.wenzlick@modot.mo.gov</td><td>Phone: 573 751-1039</td><td>Fax: 573 526-4337</td></tr>
<tr><td rowspan="2">Technology Description</td><td colspan="3">3. Name of Technology:
Microwave Detection and Evaluation of Disbond and Delamination in Carbon Fiber Reinforced Polymer (CFRP) Strengthened Structural Members</td></tr>
<tr><td colspan="3">4. Briefly describe the technology.
Near-field microwave nondestructive testing and evaluation (NDT&E) methods are well-suited for evaluating the properties of layered composite structures. CFRP patches are increasingly used for providing additional shear and flexural strength to bridge and other structural members. However, the presence of defects such as disbond and delamination can significantly reduce the effectiveness of this strengthening technique. Near-field microwave NDT&E methods can provide robust detection of such disbonds and delaminations in addition to providing critical information such as the area extent and severity of these defects. These methods can also provide valuable information about subsequent epoxy-injection repair of these defects. These microwave measurement systems are relatively small, readily portable, handheld, low-power, non-interfering with on-site wireless systems, relatively inexpensive and can easily be incorporated into scanning system to provide raster images of a disbond. These systems can also be autonomously operated with the resulting data being transferred via wireless to a central location for evaluation and temporal cataloging.

5. Briefly describe the history of its development.
Inspection of multi-layered composite structure for NDT&E purposes, using near-field microwave methods, dates back to early 1990's (and even earlier). The utility of these methods for application to CFRP-strengthened structural members was first investigated in 2000. This preliminary investigation was later followed by a more comprehensive investigation in 2002. Currently, this method is being used for evaluating CFRP patches in a bridge in Dallas County, Missouri. The prototype microwave system has been significantly improved and expanded to perform measurements independent of changes in liftoff (distance between the probing device and a CFRP surface). A laboratory version of this new prototype system has been successfully tested during the past few months.</td></tr>
<tr><td rowspan="3">State of Development</td><td colspan="3">6. For how long and in approximately how many applications has your organization used this technology?
This technology has been well-tested in the laboratory and this is the first time it has been used in a bridge (i.e., in-field testing).</td></tr>
<tr><td colspan="3">7. What additional development is necessary to enable routine deployment of the technology?
The technique is fully tested and the laboratory prototype microwave device is 95-100% complete. Additional work for making it completely in-field usable would require better packaging of the components so that it can be routinely used in the field.</td></tr>
<tr><td colspan="3">8. Have other organizations used this technology? If so, please list organization names and contacts.
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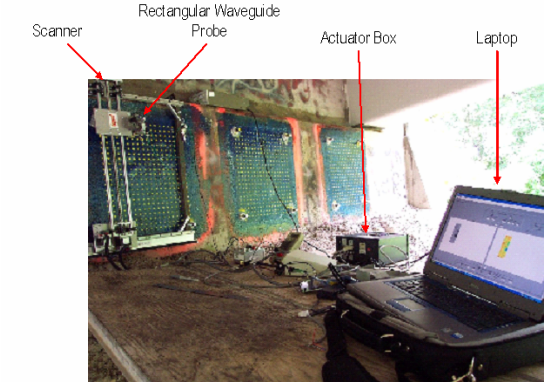
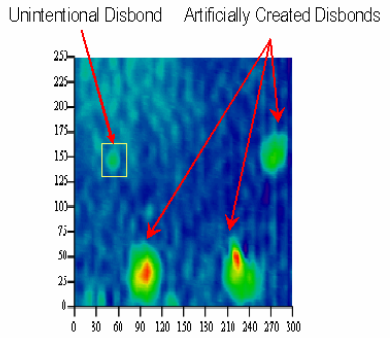
Potential for Payoff	9. What benefits has your organization realized from using this technology? Include cost savings, safety improvements, transportation efficiency or effectiveness, environmental benefits, or other advantages over other existing technologies. Since this technology is new and is just being considered to deployment and use in the field, the anticipated savings in cost, time and other resources is to be determined later.
Implementation Potential	10. Please describe what actions another transportation agency would need to take to adopt this technology. This prototype system is nearly complete and close to deployment (approximately in six months). Once a commercially suitable version is complete, another transportation agency would only need to procure and deploy it.
	11. What is the estimated cost, effort, and length of time required for procurement or adoption by another transportation agency? Once a commercially suitable version is complete, another transportation agency would only need to procure and deploy it. Excluding a scanning mechanism required for producing images of a disbonded region, the cost of the microwave inspection system is estimated at $7,000-10,000.
	12. What organization(s) currently supply and provide technical support for this technology? Professor R. Zoughi at the Applied Microwave Nondestructive Testing Laboratory (*amntl*) in the Electrical and Computer Engineering at the University of Missouri-Rolla, zoughir@umr.edu, (573) 341-4656.
	13. Please describe any legal, regulatory, social, intellectual property, or other issues that could affect ease of implementation. A disclosure of invention has been filed with the university for this technology for automatic removal of surface roughness and standoff distance variation. A subsequent patent application is expected to follow soon.
Willingness to Champion	14. Is the sponsoring DOT willing to promote this technology to other states, if partially supported by the AASHTO Task Force on Technology Implementation? ☒ Yes ☐ No
Date Submitted	15. Date: September 8, 2005

16. Please include image(s) of sketches or photographs, if available ☒Image(s) are attached.*



(a)



(b)

a) Near-field microwave NDT system deployed on the abutment of a bridge in Dallas County, Missouri and its scanning system,
b) microwave image of three intentionally and one unintentionally produced disbands between a CFRP patch and the abutment.

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