

# Executive Summary, Research Readiness Level Assessment and Technology Transfer

## Early Detection of Near-Surface Void Defects in Concrete Pavement Using Drone-Based Thermography and GPR Methods

### Research Objectives

- Further validated the effectiveness of the proposed approach in different environmental situations on detecting and locating near-surface void defects through both lab and field studies.
- Further validated the effectiveness of the proposed approach in different environmental situations on detecting and locating near-surface void defects through both lab and field studies.
- Identified the best timing of detecting these defects in different seasons.
- Developed a field detection procedure which is practical, fast, and low-cost for a coverage of 2,000-4,000 feet of pavement per day (approx. Width = 48 ft.).

### Research Benefits

- Enhanced quality control during construction and reduced cost of repair work of concrete pavement projects.
- Fast, minimal-interference, and low-cost assessment of large pavement areas.
- Minimized field time of locating voids by using accurate location mapping technology.

### Principal Investigators

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### Lead TAC Member

Wally Heyen, PCC Engineer

### Background

Near-surface (i.e., less than 4 in deep) voids that are 1/2" or larger in diameter (in both horizontal and vertical directions) is a common consolidation issue during the construction of concrete pavements. This issue was observed by NDOT in concrete pavements constructed by different contractors, on different roads (highways and local roads), and with different thicknesses (9-14 in). These voids can be caused by improper vibration, overly dry mix, and/or long wait time between concrete batches (Legg 1974). These large voids or concentrations of smaller voids can be detrimental to the durability and/or strength of the pavements (Freeman and Zollinger 2008). Being able to detect these voids at an early stage will enable NDOT to direct timely correction orders during the construction process. As a result, costlier repair and maintenance actions can be avoided.

Non-destructive testing (NDT) methods, including GPR and Thermography have been used in detecting concrete defects for a long time, including the detection of pavement delamination, deterioration, spalling and pumping issues (Sebest and Scullion 2005; Morcouc and Sekpe 2010) with varying levels of success. However, very few reports were found on using these two NDT approaches to detect defects during the hydration time due to many constraints and challenges, including weak compression strength during the early hydration process for heavy inspection vehicles or equipment.

### Conclusion

In this project, both laboratory and field tests were conducted with both methods, and coring samples were used for validation of results. The results from multiple specimens and multiple experiments suggested that both technologies performed well in detecting the subsurface voids in the concrete pavement's initial set stage. Despite some limitations discussed in the report, the outcomes of the project provided evidence that these technologies can be used separately or together on the field as efficient and economical quality control tools in concrete pavement construction.



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Interested in finding out more?

Final report is available at:  
[NDOT Research Website](#)

## NDOT Recommendations Based Off of Research Project

The research has shown the use of thermography is not a solution for detecting voids in concrete. Thermography does work, but there are too many limitations on timing of the day, environment, the use of cure compound, etc. Thermography is not a solution.

Ground Penetrating Radar (GPR) also has limited use, but will work in a small area. The department will propose the GPR to be used in an area and verify with a core. GPR could be used the next day in areas that may be questionable in nature. Coring requires a minimum of three days before any testing can be performed.

Depending on the Materials and Research equipment budget, a purchase may be made for a GPR device in the next year for forensic purposes.

- *As provided by Wally Heyen, Lead TAC Member*

## Research Readiness Level (RRL) Assessment

### Level 4: Implementation

Research/Technology refined and adopted by the Department. Benefits of the implementation will be evaluated for a time frame of 5 years.

**RRL 4**

## Technology Transfer

### PUBLISHED JOURNAL PAPERS AND THESES/DISSERTATION

- Shen, Zhigang, Cheng, Chongsheng. "Semi real-time detection of subsurface consolidation defects during concrete curing stage", submission to the ScienceDirect website - <https://www.sciencedirect.com/science/article/abs/pii/S0950061820334930?via%3Dihub>

### JOURNAL PAPERS SUBMITTED FOR REVIEW

- McCabe, T.\*, Erdogmus, E., Morcous, G., Kodsy, A. "Early Detection of Honeycomb in Concrete Pavements Using GPR," submitted to the ASCE Journal of Performance of Constructed Facilities. Submitted on 5/5.

**This brief summarizes Project SPR-P1 (19) M082  
"Development of an NDT Tool for In Situ Assessment of Prestress Loss"  
Nebraska Department of Transportation Research Program**