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Executive Summary Report

INVESTIGATE FEASIBILITY OF USING GROUND PENETRATING RADAR IN QC/QA OF RUBBLIZATION PROJECTS

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Project Background

Rubblization and Roll (R/R) is an activity routinely practiced by the state DOTs for the rehabilitation of in-service composite pavements. The AC layer is milled and the exposed concrete pavement is broken (rubblized) into small fragments using heavy duty pavement breakers. Specifications dictate the size of resulting fragments be well within the prescribed limits. For example, ODOT specification requires the existing concrete pavement is reduced into particles ranging from sand sized to pieces not exceeding 6" in their largest dimension. Certain DOTs allow larger fragments, up to 12".

Compliance with the size specification reportedly has many advantages including the ability to eliminate reflection cracking, provide a *superior* flexible base layer resulting in economic construction, improve overall pavement performance and reduce life cycle costs. On the other hand, noncompliance with the size specification results in reflection cracks causing premature failure of the pavement and waste of tax dollars. Hence a thorough QC/QA process is critical to the success completion of a rubblization project. In Ohio, quality assurance requirements are met by visually observing the size of particles in a test pit to be made at the beginning of the process. Making test pits has its own pros and cons. They expose the fragments underneath and provide a true picture of the extent to which the concrete pavement has been rubblized. However, the process is time consuming, expensive, and limited. In addition, they pose smoothness issues after the restoration.

Ground Penetrating Radar is an electromagnetic device that is used to nondestructively map subsurface information. Electromagnetic waves travel at a specific velocity determined primarily by the dielectric constant of the material. The relationship between the velocity of the wave and material properties is the fundamental basis for using GPR to investigate the subsurface. This study investigated if Ground Penetrating Radar can offer a suitable technology for mapping the physical condition of fractured slab rapidly, particularly under the steel reinforcement, without disturbing the fractured layer.

Study Objectives

- Document GPR technology
- Review QC/QA of rubblization in other states
- Conduct field experiment with GPR to investigate its feasibility for QC/QA
- Compare GPR data with visual observation from test pits
- Conduct deflection studies using Falling Weight Deflectometer to determine if the load distribution characteristics can be related to particle size distribution
- Construct physical models in the laboratory to validate field data
- Generate information to determine the potential of GPR for quality assessment of rubblization projects

Description of Work

A 4000' long composite pavement section was selected on BUT/WAR 75. The asphalt concrete layer was milled and the jointed reinforce concrete pavement was exposed. About 1000' was rubblized using resonant type pavement breaker and the remaining with multi head type pavement breakers. The exposed pavement was documented through: (i) a review of construction drawings, (ii) visual survey, and (iii) Falling Weight Deflectometer Survey.

A thorough GPR assessment of the pavement prior to rubblization was performed, allowing a "baseline" condition assessment. Three passes were made to collect data along two wheel paths and the center of the lane. Following this, the exposed concrete pavement was rubblized in accordance with ODOT's rubblization specification. GPR tests were conducted on the rubblized layer at the same locations. Soon after completing GPR studies, several test pits were made using a backhoe. Physical measurements of the particle sizes were made through the depth of concrete pavement. This information, *ground truth*, was used to verify the information obtained from GPR signals. The data was analyzed to investigate any evidence leading to determination of fragments exceeding the size specification.

Research Findings &Conclusions

Rubblization transforms the homogeneous concrete layer into two distinct layers – one above the steel *fully rubblized* and below the steel *partially rubblized*. Even though the two layers are made up of the same material, the effective dielectric constant may be different because of the variation in the air gap. As a result, it can be hypothesized that signal path through the two layers may not remain the same and should result in a peak at the interface of two layers.

The data obtained in the present study was analyzed to verify the above hypothesis. First the data collected on the intact slab was analyzed. The intact slab being nearly homogeneous, no significant peak in reflection of signals was found between the top and bottom of the slab. Analysis of the data on rubblized layer showed some peaks. However, the strength of the signals (reflections) was not strong enough to detect significant peaks. This analysis revealed the sensitivity of the data was not adequate enough to distinguish two layers within the concrete slab. In other words, the data did not indicate significant peak at the interface of rubblized and partially rubblized layers within the concrete slab. It became apparent that by increasing the signal-to-noise ratio, it may become possible to differentiate and distinguish the two internal layers.

The present study provided insight into additional data needed to establish GPR as a potential device in the future for evaluating the size fragments in R/R project. Lessons learned lead to a conclusion that, further work is needed to establish GPR as a rational, non-destructive and quick procedure to estimate the particle sizes in a rubblization project.

Implementation Recommendations

GPR may have the ability to provide vital information that may not be otherwise available through traditional procedures such as test pits and visual observation of fracturing pattern. However, more work is needed before it can be used in quality control/quality assurance of rubblized projects. It is recommended ODOT further explore this idea by utilizing the concepts underlined in this study and carrying out additional research.