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Project Summary Report 0-4385-S
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Project 0-4385: Improving Ride Quality of Portland Cement Concrete Pavement

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PROJECT SUMMARY REPORT

Improving Ride Quality of Portland Cement Concrete Pavement: Summary Report

The objective of this research was to determine if early detection of inadequate ride or smoothness in Portland cement concrete (PCC) pavements can be determined and, if so, to identify the appropriate correction device or procedures that can be used to apply before the concrete has hardened. The Texas Department of Transportation (TxDOT) places importance on developing or locating a device that can be used for the early detection of roughness in new PCC pavements.

While the existing specification stipulates that the cost for correcting deficiencies is to be borne by the contractor, in reality penalties are factored into the contractor's bid. Thus, if a method for early bump detection is available for the contractor to use, the reduction in his or her risk could potentially translate to a lower bid with the result that a superior riding pavement is achieved at less cost.

What We Did…

This report provides details of research for the development of a method and suitable device for bump detection on newly poured concrete that will be consistent with current TxDOT ride specifications. During the first year of the research, existing practices for building smooth concrete pavements were investigated, site visits to various ongoing construction projects were made, and current instruments or procedures for early detection for bumps were considered. The research also included an extensive survey of what would be needed for such a device.

At the end of the first phase, no instrument was found that could be obtained for the purpose of early bump detection on wet concrete, although two companies were working on possible units. Gomaco was developing a unit, but it was not ready for demonstration. Ames Engineering was working on a device called the Real Time Profiler (RTP) that had been tested on several construction projects. The Ames device used three lasers that were moved along the pavement and used to measure the displacement between the laser and the pavement. It was viewed during a site visit to Ames Engineering.

Since neither unit was yet available, although Ames Engineering appeared closest to having a working system, it was decided to also investigate a modified version of The University of Texas at Arlington (UTA) low-speed push cart profiler that had been developed in an earlier project. The idea behind investigating the measuring procedure used on the old UTA push cart concept was based on observations of watching the autofloat unit on the back of a paver. Researchers came up with the idea of a floating or sliding profiler which would implement a similar method as the earlier push cart. Researchers then built the sliding profiler* to test

* *Patent pending*

its concept for early detection of bumps on wet pavements. The construction efforts and testing of this device are discussed in Report 0-4385-1.

Sliding Profiler Development

During the research effort, researchers met with a number of contractors to discuss the concept of early bump detection during placement of wet concrete on PCC projects with the sliding profiler. These visits identified relevant criteria researchers considered in development of this instrument. The comments received reflected consensus on the following needs:

- glides on wet concrete;
- priced affordably so that contractors may purchase multiple units to monitor the wheel paths of the travel lanes and to check the work of finishers as necessary;
- easy to use;
- of rugged workmanship to handle rigors of the construction environment (machine vibrations, water sprays, chemical retardants, and others);
- mounts on existing equipment; and
- shows defect locations.

A bump detection instrument that glides on wet concrete implies a method of measurement where the instrument is in contact with the surface being tested. Researchers took this approach for two reasons:

- to develop an alternative to the Ames RTP, which was undergoing development and testing at the time of this project; and
- to develop a method that is affordable to contractors.

Since the UTA push cart determines an estimate of profile by summing the vertical displacements as the device is pushed along the pavement, it was thought that the method might work in a similar manner. Instead of the measuring platform rolling along the pavement, it could ‘slide’ along the wet concrete. See Figure 1.

If an inclinometer is used in place of the gyroscope, the costs per wheel path of such a system would be very low, less than a couple of thousand dollars. The profiler electronics are housed inside a box that is mounted on a ski similar to the autofloat ski used on construction projects. The ski uses a distance encoder on a wheel that also travels along the wet concrete. Data from the profiler are transmitted through a local area network (LAN) or wireless LAN. The operator can view measurements made with the profiler using a portable notebook computer, which will record the data for later analysis.

In the initial development of the sliding profiler, researchers adapted a chafer pan as the housing unit for the profiler components. The rationale for this approach was that, if the profiler can be assembled with ready-made materials and components, the cost of production could be reduced. Since no custom molding had to be made, only a minimal amount of machining was needed to put together the initial sliding profiler.

Researchers tested the prototype sliding profiler on a PCC paving project along I-20 in the Fort Worth District. Tests were conducted on a segment of the construction project located just west of the US 281 junction near New Salem (see map in Figure 2). Prior to the start of paving operations, researchers set up the

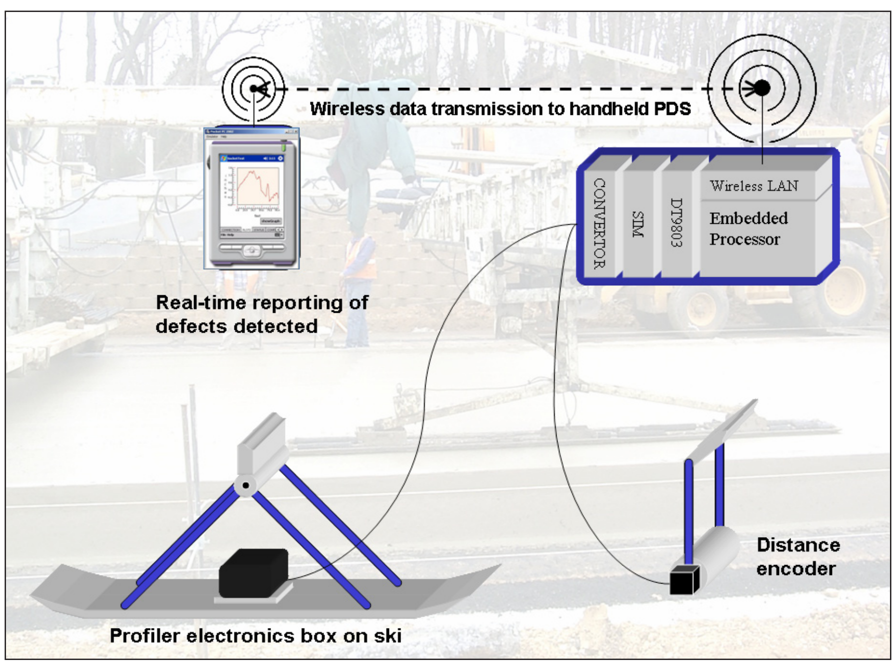

Figure 1. Sliding Profiler Concept.

instrument as shown in Figure 3. Once construction began, the profiler was pulled along the existing concrete surface, across the header joint and onto freshly placed concrete, as illustrated in Figure 3. Results of these and other tests are provided in Report 0-4385-1.

What We Found…

During this project, researchers found that it was possible to use the concept of the UTA push cart and apply it to the data gathered from the sliding profiler to compute a simple profile. From the simple profile, a bump detection algorithm could be developed. Researchers were able to construct a suitable device for sliding on the pavement while it was still wet, and gather this information. Researchers were able to attach the sliding profiler device to the back of the autofloat of the paving train. Several sections of data were collected from an actual construction site to verify the results with the reference profile obtained from the walking profiler.

Several problems are still to be worked out if the sliding profiler is further implemented, and they will be addressed, as indicated in the next section.

The Researchers Recommend…

The sliding profiler concept has been tested with limited verification. It is recommended that further verification begin on several construction jobs. Runs before and after the finishers where defects are detected would help determine if improvements were made. Comparisons with the walking profiler over sections where the sliding profiler was used or not used could provide information about its usefulness in locating bumps or dips. Comparisons with bump profiles from the sliding profiler and reference profile are needed to fine-tune the profile/bump calculation algorithm.

Development of the sliding profiler involved three phases: data acquisition, recording, and then bump computations. The bump computations were not done in real time during this project. In the future, the bump computations should be done in real time, as well as the addition of a global positioning system (GPS) so that the profile can be compared with reference measurements. An operator control console and interface could be included along with the bump indicator to report location, height, and width of a bump, and to provide a summary of defects found at the end of the day's production. Additional consideration should be given to the following:

- Design and fabrication of production version,
- Determination of best target hardware and software platform,
- Redesign and fabricate sliding profiler carriage, and
- Redesign and fabricate sliding profiler mounting system.

At the time of this report, many of these recommendations are being implemented by Implementation Project 5-4385-01. The implementation project will develop three units for deployment in TxDOT's operations.

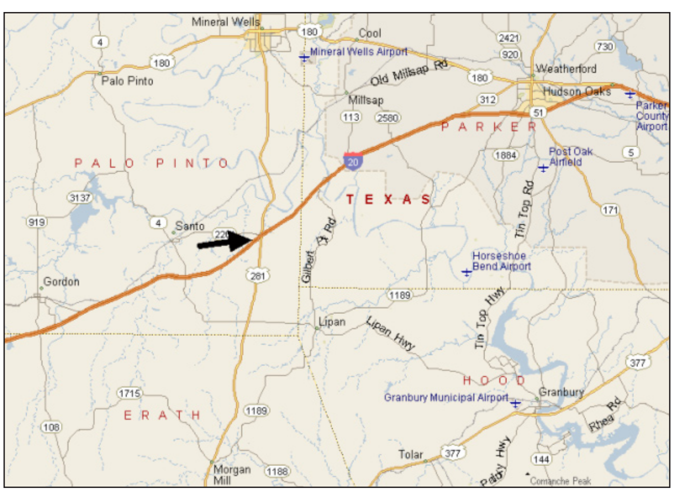

Figure 2. Location along I-20 of Sliding Profiler Tests.

Figure 3. Sliding Profiler at Construction Site.

For More Details...

The research is documented in Report 0-4385-1, *Improving Ride Quality of Portland Cement Concrete Pavement (PCCP)*.

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