Evaluation of the MIT-Scan-T2 for Non-Destructive PCC Pavement Thickness Determination

Final Report

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Highway Division

Iowa Department Of Transportation

Evaluation of the MIT-Scan-T2 for Non-Destructive PCC Pavement Thickness Determination

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8. ABSTRACT

The MIT-Scan-T2 device is marketed as a non-destructive way to determine pavement thickness on both HMA and PCC pavements. PCC pavement thickness determination is an important incentive-disincentive measurement for the Iowa DOT and contractors. The thickness incentive can be as much as 3% of the concrete contact unit price and the disincentive can be as severe as remove and replace.

This study evaluated the potential of the MIT device for PCC pavement thickness quality assurance. The limited testing indicates the unit is sufficiently repeatable and accurate enough to replace core drilling as the thickness measurement method. Further study is needed to statistically establish the single user and multi-user/device precision as well as establish an appropriate sampling protocol and PWL specification.

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TABLE OF CONTENTS

DISCLAIMER

INTRODUCTION

Sufficient PCC pavement thickness is critical to the service life of the pavement. Iowa has an incentive-disincentive specification to encourage contractors to strive for the target thickness consistently. To measure thickness, cores must be drilled at random locations throughout the project. This is costly to both the contractor and the DOT:

Contractor Costs

- Truck
- Core drill
- Drill bits
- Staff time for the drilling
- Staff time to deliver cores

DOT Costs

- Staff time to determine and mark core locations
- Staff to observe the drilling and take possession of the cores
- Staff time to make and record the measurement
- Staff time for the independent assurance

There is equipment (MIT-Scan-T2) developed and being used in Europe to measure pavement thickness. According to the manufacturer's literature, the unit is based on pulse induction technology. The analysis of the spatiotemporal gradient, which uses the methods of the electromagnetic tomography, avoids subjective measurement errors. The reported accuracy by the manufacturer is +/- 2.5 mm on 300 mm thick pavement. The FHWA has reported an accuracy of less than +/- 2 mm for thickness up to 450 mm on some testing they did. The equipment determines the thickness by measurements taken over a metal target placed on the subbase during paving.

OBJECTIVE

The objective of the study was to evaluate a unit borrowed from the FHWA CPTP Equipment Loan Program and evaluate its potential for further more extensive investigation.

WORK PROGRAM

The FHWA delivered the MIT-Scan-T2 device and 13 metal targets (0.65mm thick X 300mm diameter) in June, 2008. The targets are from Germany and the galvanized sheet steel complies with a European standard. The project chosen for the testing was NHSN-34-8(80)—2R-51 in Jefferson County. The design thickness is 260 mm over a granular subbase.

Target Placement

Targets were initially placed on the granular subbase with a little concrete on top to hold them in place (Figure 1). The mass of concrete from the belt placer spreader moving over the top of the target, forced the target to slide along the subbase ahead of the concrete flow. Two targets were paced using metal basket stakes and these remained in place.

On a subsequent placement, a quick setting construction adhesive was used to glue the targets to the top layer of rock. The subbase material was coarse on the surface and there were high spots that the targets laid on. The targets would bend and deform under the weight of a person. Approximately, one-half of a cubic foot of concrete was then placed over the targets ahead of the spreader. All the targets remained in place using this method.

Figure 1 Target placed on granular subbase.

Testing

The targets were easy to locate with the MIT device. The MIT was held above the pavement with the wheels off the pavement. The display was readable even in direct sunlight. Using a side to side sweeping motion, the operator could walk while watching the signal. When the signal was the strongest, the wheels were placed on the pavement and the center of the target was determined by moving back and forth across the target (Figure 2 and 3). The center was marked for future reference.

Figure 2 MIT T2 running over test location.

Figure 3 Close up view of MIT T2 screen.

Testing with the MIT device was done at different times to evaluate repeatability. The unit is slowly rolled across the center of the target. After a little less than 2 meters of travel, the unit displays a thickness reading in millimeters. Five runs were made at each location and averaged.

Four-inch diameter cores were taken over the center of each target (Figure 4). As noted previously, the targets rested on the high spots of the subbase. On some of the core bottoms, the target impression caused a bow or slight skewed (Figure 5). The weight of the concrete was sufficient to bend the targets down against the subbase. This deformation did not appear to significantly impact the results.

Since PCC pavements are placed on granular sub base in Iowa, the concrete will slump around the larger aggregate particles. These aggregate particles are removed before testing for thickness, but the resulting core thickness is typically greater than it would be on the target or a treated base. Thus, cores were taken at several locations approximately one foot longitudinally from the first core to determine the difference between those measured on the target and typical core measurements on a granular sub base (Figure 6 and 7). Core thickness measurements were made using an Iowa DOT fabricated 9-point measuring frame (Figure 8). The measurements were made to the nearest 0.05 inches. The results of the testing are shown in table 1 and figure 10.

Figure 4 Coring at test locations.

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Figure 6 Skew on bottom of core.

Figure 7 Core bottom showing difference between on target versus granular subbase.

Figure 8 Core thickness difference between on target versus on granular subbase.

Figure 9 Iowa Department of Transportation nine point core measurement apparatus.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be made from this study:

1) The unit was simple, easy, and quick to operate.
2) The unit has acceptable accuracy and repeatability for QA based on the limited testing.
3) A domestic source of targets needs to be established.
4) A simpler method of anchoring the targets to a granular base is needed. Placing a nail through a center hole or possibly 3 holes may be an improvement.
5) Care must be taken to make sure that the subbase material is level under the target.
6) There is a significant difference between thickness measuring to the top of the subbase and using the current Iowa method.

Based on the results of this limited study, further research should be pursued as outlined in the proposal in the Appendix.

Figure 1. Resuts of Thickness Testing.

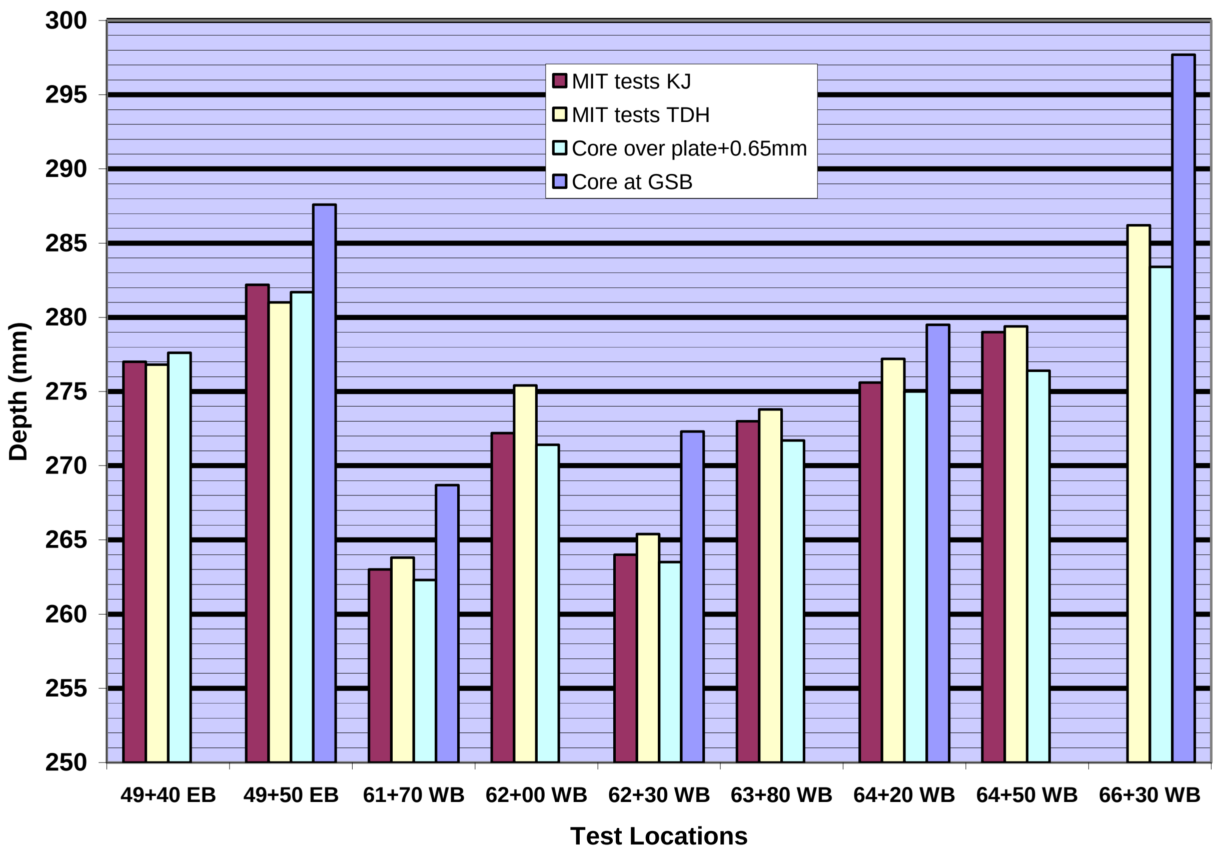

Table 1 Results of thickness testing.

		MIT Results				Core Results		Comments
		K. Jones		T. Hanson				
Location	Date placed	Date tested	(mm)	Date tested	(mm)	Over target +0.65mm	Over granular subbase	
49+40	6/17/2008	7/9/2008	277	7/15/2008	277			used 2 steel pins to hold in place
EB DL			278		277			
			277		276			
			277		277			
			276		277			
Average			**277**		**276.8**	**277.6**		
49+50	6/17/2008	7/9/2008	282	7/15/2008	281			used 2 steels pins to hold in place
EB DL			282		281			
			281		281			
			284		281			
			282		281			
Average			**282.2**		**281**	**281.7**	**287.6**	
61+70	7/9/2008	7/10/2008	263	7/15/2008	263			
WB DL			263		264			
			263		264			
			263		264			
			263		264			
Average			**263**		**263.8**	**262.3**	**268.7**	
62+00	7/9/2008	7/10/2008	272	7/15/2008	273			
WB DL			272		273			
			273		279			
			272		276			
			272		276			
Average			**272.2**		**275.4**	**271.4**		
62+30	7/9/2008	7/10/2008	264	7/15/2008	266			
WB DL			264		264			
			264		264			
			264		265			
			264		268			
Average			**264**		**265.4**	**263.5**	**272.3**	
63+80	7/9/2008	7/10/2008	273	7/15/2008	274			
WB DL			273		274			
			273		274			
			273		274			
			273		273			
Average			**273**		**273.8**	**271.7**		
64+20	7/9/2008	7/10/2008	276	7/15/2008	279			
WB DL			276		276			
			275		280			
			275		276			
			276		275			
Average			**275.6**		**277.2**	**275**	**279.5**	
64+50	7/9/2008	7/10/2008	279	7/15/2008	280			
WB DL			279		279			
			279		279			
			279		279			
			279		280			
Average			**279**		**279.4**	**276.4**		
66+30	7/10/2008			7/15/2008	286			Target blown off by water truck.
SE of bridge					287			Placed on subbase with dry
WB DL					286			adhesive on the target.
					286			
					286			
Average			**--**		**286.2**	**283.4**	**297.7**	

ACKNOWLEDGEMENT

The authors wish to extend appreciation to the FHWA for loaning the equipment and targets for the study. The help and cooperation was much appreciated from the Flynn Company, the Mount Pleasant Resident Construction Office, and the District 5 Materials Office staff. Kevin Merryman, Office of Construction PC Paving Engineer, provided valuable advice and assistance.

APPENDIX

Proposal for Use of NDT for PCC Pavement Thickness Determination

Introduction

Sufficient PCC pavement thickness is critical to the service life of the pavement. Iowa has an incentive-disincentive specification to encourage contractors to strive for the target thickness consistently. To measure thickness, cores must be drilled at random locations throughout the project. This is costly to both the contractor and the DOT:

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Objectives

The objectives of the study/ technology implementation are:

1. Purchase two MIT-Scan-T2 units for evaluation.
2. Evaluate the units accuracy and repeatability.
3. Develop a procedure for maintaining the integrity and randomness of the thickness verification with the NDT equipment.
4. Compare results with current pavement thickness acceptance procedures on actual projects.
5. Develop a PWL specification based on the NDT procedure and results.

Work Plan

At least 2 projects will be selected, one with pavement 8 to 9 inches thick and one with pavement 11inches thick or more. The reference targets would be placed separate from the random core locations to maintain the integrity of the current system.
The thickness would be determined at each location as follows:

1 day after paving- both gauges separate operators.
3 to 5 days after paving- both gauges separate operators.
7 days after paving- one gauge and take cores.

The thickness index in Article 2301.35 will be computed from the MIT-Scan results and compared to the project thickness index from the core measurements.

If the gauge is able to accurately determine the pavement thickness, several advantages over cores would be realized:

1) Positive separation between the concrete and the granular base layer for thickness measurement.
2) No destructive core drilling except in areas of deficient thickness.
3) No need for DOT observation during core drilling except in 2 above.
4) Targets in place for later Independent Assurance of thickness determination.

One drawback to placing metal targets ahead of the paving operation is that the contractor sees the random thickness measurement locations in advance. One way around this may be to place enough additional targets so that the contractor can't adjust the paver to run thicker at the targets.

Evaluation and Reporting

After data collection on the projects, the results will be summarized in a report. If the testing is successful, the report will include recommendations for the NDT procedure and specification language for a Developmental Specification for use on future projects.

Project Costs

2 units	$44,000
Core Drill Equipment Costs	$ 1,000
120 Staff hours @ 50 per hour	$ 6,000

Principal Investigators

Kevin Jones will conduct the research with expert assistance from Kevin Merryman, Todd Hanson, and the District Materials Engineers where the projects are located.

Time Frame

The research will be complete 1 year after the gauges are received.