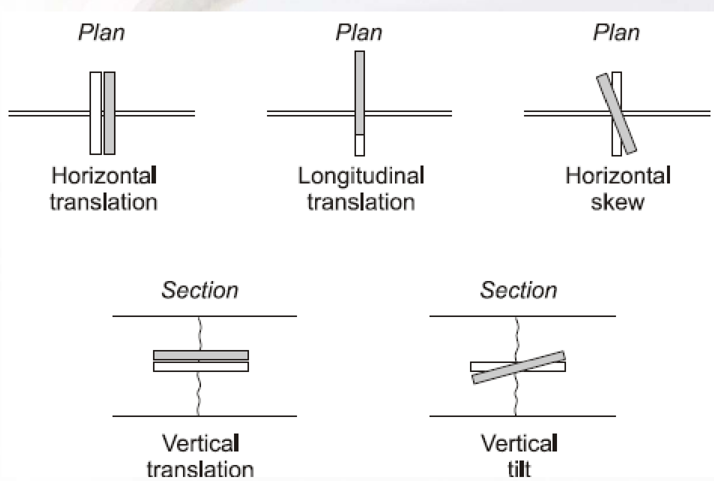
EVALUATION OF THE MIT SCAN-2 ON MN/DOT'S 15 INCH LONG DOWELS

Developed by Magnetic Imaging Tools GmbH (Dresden, Germany), the MIT Scan-2 is a nondestructive testing device that uses magnetic imaging technology to measure the position of metal dowel bars embedded in concrete. It is very quick and easy to use. Less than five minutes are needed to scan each joint and reposition the device for the next joint. The hand held computer that controls the device allows the user to see the positions of the dowel bars in the joints immediately after scanning. It also has a very easy to use analysis program called MagnoProof that uses the specified dowel locations, along with allowable tolerances, to automatically identify misaligned dowels.

Locating dowel bars using the MIT Scan-2



Measuring Tolerances

- Reproducibility ±2 mm
- Horizontal Translation 0.3% ±3 mm
- Distance Between Dowels ±4 mm
- Horizontal Skew ±4 mm
- Longitudinal Translation ±8 mm
- Vertical Translation ±4 mm
- Vertical Tilt ±4 mm

These tolerances are valid for dowels with lengths of 18 in. and diameters of 0.75, 1.0, 1.25, and 1.5 in. The maximum misalignments for the above tolerances to be valid are:

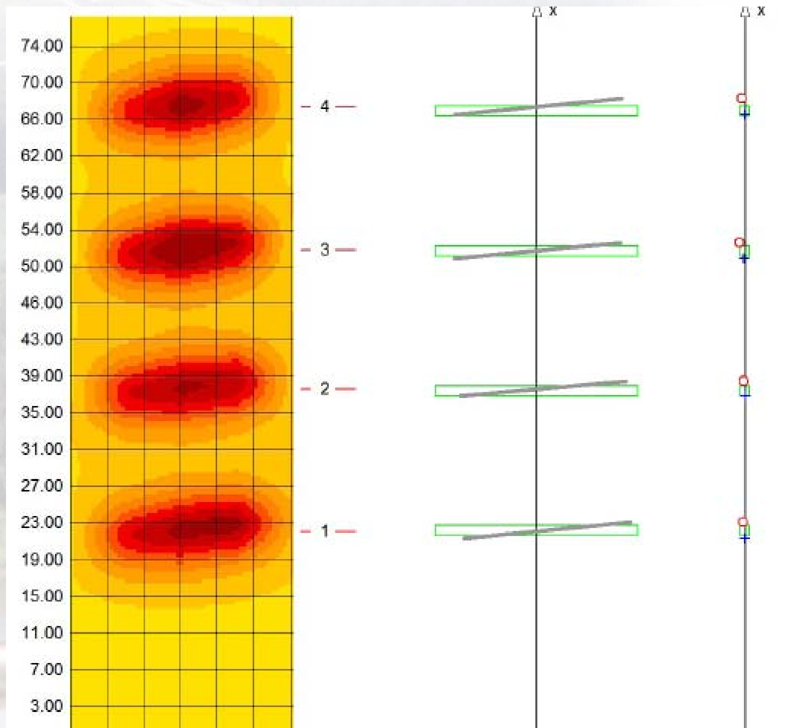
- Dowel depths ranging from 4.3 to 7.0 in.
- Longitudinal translation less than 3.0 in.
- Horizontal skew less than 1.5 in.
- Vertical tilt less than 1.5 in.

Output

The output of the MIT Scan-2 includes a spread sheet with x, y, z (horizontal, longitudinal, and vertical translation) coordinates of the left, right, and middle of each dowel bar.

Another spreadsheet lists the misalignment of each dowel including rotations. Dowels with misalignments greater than the allowed specification are automatically identified by the MagnoProof program.

A graphical map shows the intensity of the magnetic image and the location of the dowel bars. The locations of the dowel bars (gray) in relation to their allowed tolerances (green box) is also shown in plan and cross sectional view.



Graphical map of dowel locations

Calibration for 15 inch Dowels

Since Mn/DOT's standard dowel length is 15 in., the accuracy of the MIT Scan-2 for measuring 15 in. long dowel locations was investigated. A wooden frame was built to hold 1.25 in. diameter dowels at various depths and misalignments. First 18 in. long dowels were scanned. This gave the exact location and misalignment of the dowels. They were then replaced with 15 in. dowels and rescanned. Each dowel was centered on its wooden stand so that the coordinates of the center of the dowel would be the same for the 15 in. and 18 in. long dowels. The dowels were scanned three times in each position and the average coordinates of the three scans were used.

Frame used for calibration of 15 in. dowels

The MIT Scan-2 measured the horizontal (distance from the pavement edge) location of the 15 in. dowels very well (see calibration plots in Appendix) but it had difficulty with the y (embedment length) and z (depth) locations of the 15 in. dowels. The MIT Scan-2 measured the length of the dowels at 18 in. even if 15 in. dowels were used. It was not able to find the correct depth or embedment length of the 15 in. dowels. The accuracy of the measurements decreased as the misalignment increased.

Conclusion and Recommendations

While the MIT Scan-2 finds the coordinates of dowel bars, its greatest strength is that it indicates when a dowel bar does not meet specifications. Therefore it is very important that the designed locations of the dowel bars are entered correctly. The analysis program assumes small misalignments so if there are great deviations between the design locations of the dowels and the actual locations, problems can occur. For example, if the operator enters into the program that there are 12 dowels at each joint but there are actually only 6 dowels in the joint, the program will assume it measured 12 dowels and give the locations of 12 dowels. For severely misaligned dowels (two times or greater than the operating range), the accuracy of the measured locations is also greatly reduced.

Limitations

- If dowel baskets are used, the dowels need to be epoxy coated. If baskets are not used, epoxy coating is not necessary
- Stainless steel dowels in baskets will not work
- Flat dowels will not work. They will show up as severely misaligned round dowels
- The basket transfer ties need to be cut for best results
- The device is not calibrated for skewed joints and measurements made on skewed joints will not be accurate
- For 15 in. long dowels, only the horizontal (along the joint) locations are accurate. All other locations could be off 2 or 3 inches.

Despite these limitations, this device may still be useful for finding problem joints. This is because in the NCHRP Project 10-69, Khazanovich, Hoegh, and Darter found that severe misalignments are needed to reduce shear capacity and the greatest restriction on joint performance is the lack of lubrication on dowel bars. This means that for problems to occur, the dowel bars need to be severely misaligned in the pavement. While this device cannot measure the locations of 15 in. long dowels and dowels in skewed joints accurately enough to check specifications, the magnetic image can be used to detect severe misalignments and an operator may be able to identify problem joints.

Benefits

- Graphical display allows the operator to see the locations of dowel bars immediately after scan
- Extremely easy and fast to use
- Can identify problem joints when 15 in. long dowels are used but not accurate enough to check if dowels meet specs
- Can identify problems in skewed joints but not accurate enough to check if dowels meet specs

Disadvantages

- High initial cost
- Currently not calibrated for 15 inch long dowels, although calibration could easily be done by the manufacturer for a fee
- Will not work on stainless steel dowels in baskets

Recommendations

With the high initial cost, it may not be worth the investment for Mn/DOT to buy this device although the FHWA has several devices available for loan. It is recommended that Mn/DOT have the manufacturer calibrate the MIT Scan-2 for 15 in. long dowels. Then, if dowel bar misalignments are suspected in a pavement section, the MIT Scan-2 can be obtained from the FHWA and used to accurately find the dowel bar locations.

References

TechBrief, FHWA-IF-06-002, October 2005.
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S. Hossain and M. Elfino (2006). "Field Demonstration of Magnetic Tomography Technology for Determination of Dowel Bar Position in Concrete Pavement," *Report No. FHWA/VTRC 06-R40*, Virginia Transportation Research Council, Charlottesville, VA.

L. Khazanovich, K. Hoegh, and M. Snyder (2009). "Guidelines for Dowel Alignment in Concrete Pavements," *NCHRP Report 637, Project 10-69*, Transportation Research Board, Washington, D.C.

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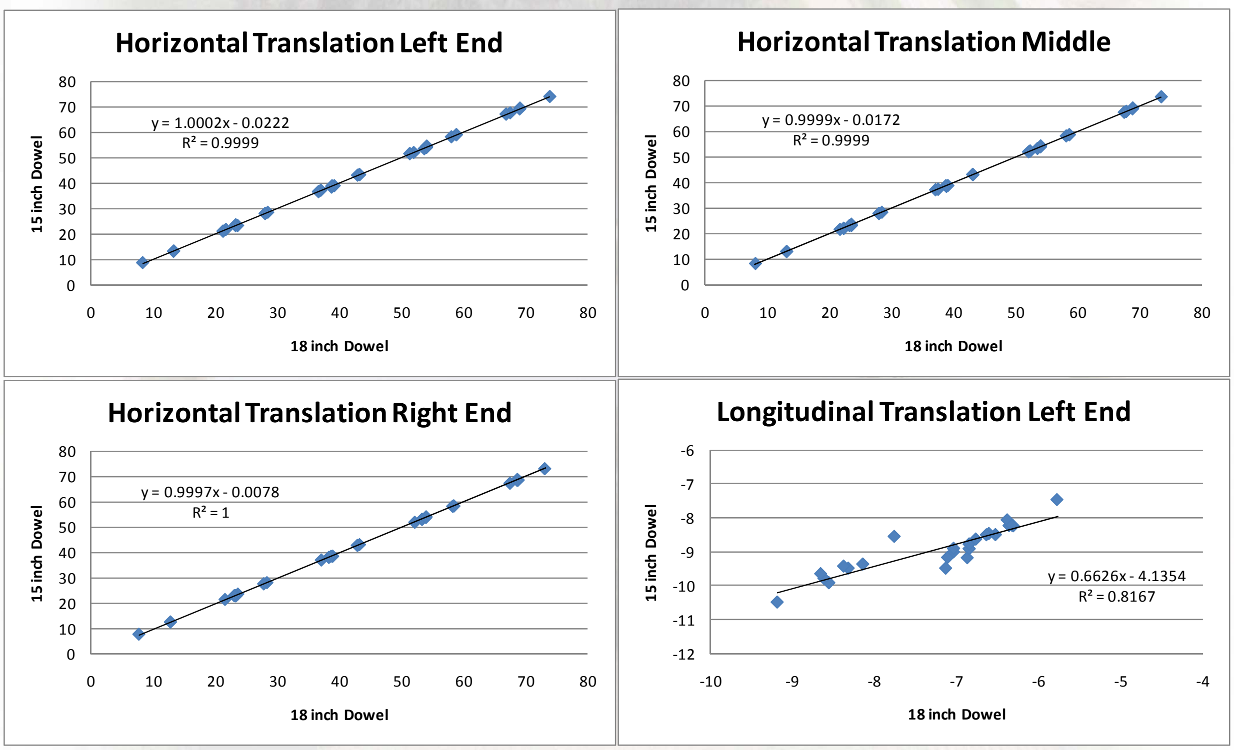
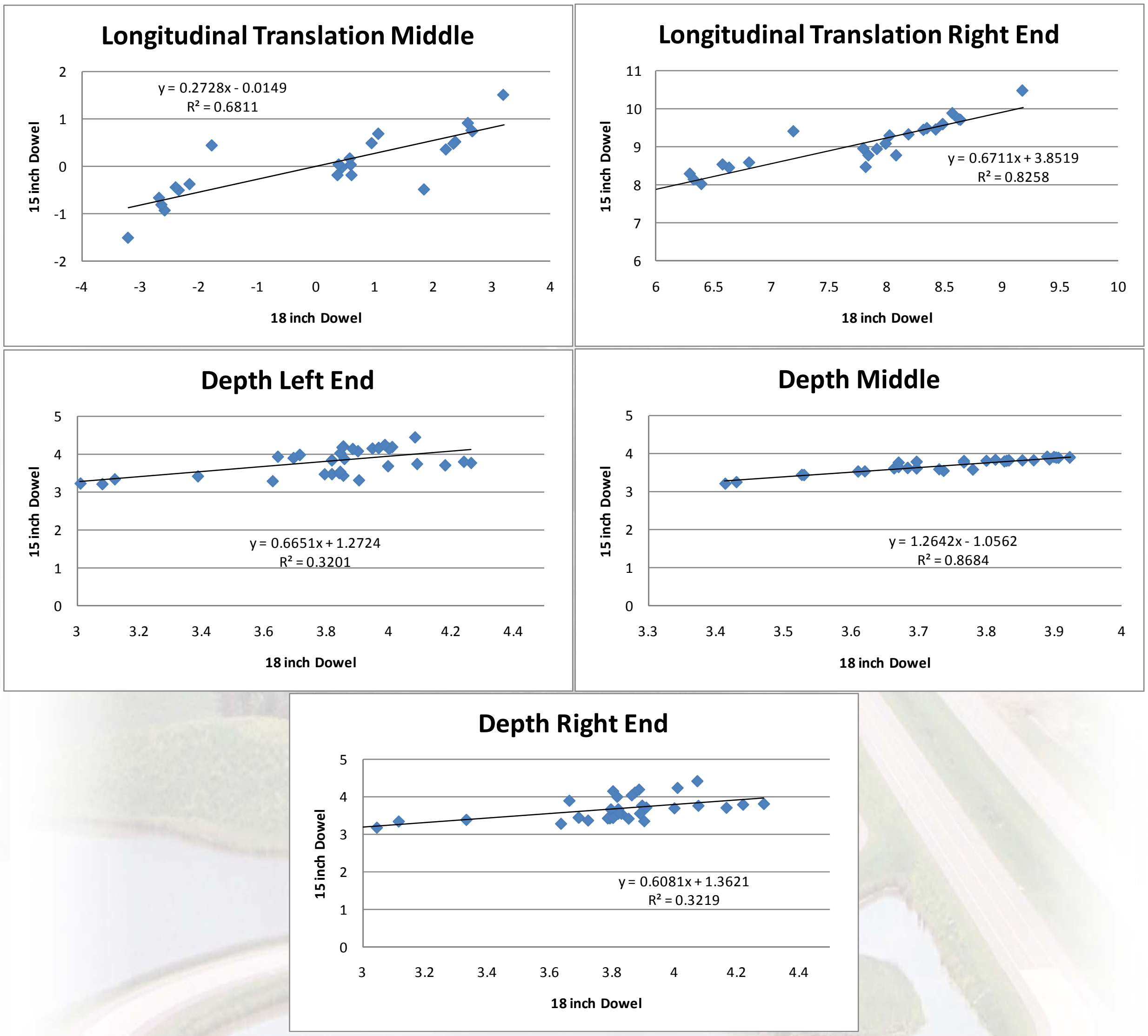
Appendix: Calibration plots for 15 in. dowels

The MIT Scan-2 is calibrated for specific dowel diameters and only for 18 in. long dowels. While Magnetic Imaging Tools GmbH will calibrate the MIT Scan-2 for 15 in. long dowels for a fee, Mn/DOT Research attempted to find a correlation for 15 in. dowels. A frame was built that held several dowels at specific misalignments. The misalignments were initially measured using the MIT Scan-2 and 18 in. dowels. The 18 in. dowels were then replaced with 15 in. dowels, rescanned, and compared. The results are plotted below with the 18 in. dowel coordinates on the horizontal axis and the 15 in. dowel coordinates on the vertical axis.

The MIT Scan-2 gives the coordinates for the left, middle, and right end of the dowel bar. The horizontal translation is the distance from the edge of the pavement to the dowel bar, along the length of the joint. The longitudinal translation is the embedment of the dowel and the depth is the distance from the surface to the center of the dowel.



Comparison of 15 and 18 inch long dowel bar alignment using the MIT Scan-2



Comparison of 15 and 18 inch long dowel bar alignment using the MIT Scan-2