Eddy-Dowel

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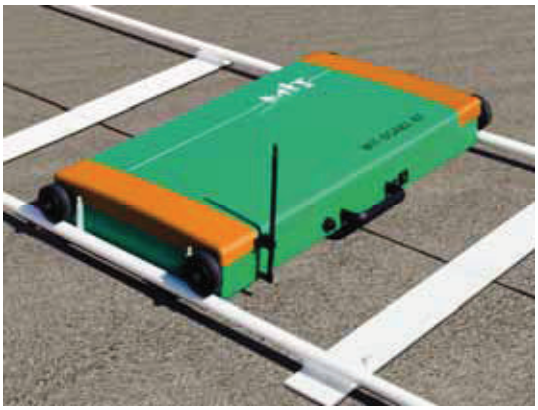
Purpose

The **Eddy-Dowel** is a rail-mounted system for accurate measurement of the position of dowel bars and tie bars used in jointed concrete pavements. The device was developed by MIT Mess- und Prüftechnik GmbH, Dresden, Germany, who named it the "MIT Scan-2." The measuring unit includes five computer controlled eddy current sensors. Data are acquired at a high sampling rate as the measuring unit is pulled along rail system resting on the pavement. The large amount of acquired data allows reconstruction of bar alignment, which can be compared with specification tolerances.



The main features of the **Eddy-Dowel** system include:

- Bar depth and alignment can be measured immediately after concrete has undergone setting
- Portable hand-held computer with wireless communication with the measuring unit for immediate on-site analysis using **MagnoNorm** software
- Comprehensive analysis and visualization of dowel alignment with desktop **MagnoProof** software
- Efficient inspection: up to 500, 16-m traverses per day
- High precision; ±4 mm for depth and horizontal alignment; ±8 mm for longitudinal alignment (side shift)

The **Eddy-Dowel** system has been evaluated by several departments of transportation in North America and it has been found to be capable of making highly accurate measurements of bar location and alignment. See the following reference:

FHWA Concrete Pavement Technology Program, "Tech Brief: Use of Magnetic Tomography Technology to Evaluate Dowel Bar Placement," FHWA-IF-06-002, October 2005, http://www.fhwa.dot.gov/pavement/pccp/pubs/06002/06002.pdf

Principle

The **Eddy-Dowel** uses the pulse induction, eddy current technique to determine the distance to the bars (see page 33 for a description of this method). Because the measuring unit includes five sensors, a fast sampling rate, and an accurate distance sensing system, the acquired signals can be used to reconstruct accurate 3-dimensional images of the embedded bars. These images show the depth and alignment of the bars.

The age of the concrete does not affect the results, so it is possible to take measurements as soon as the concrete is strong enough to support foot traffic. The presence of iron in the aggregates does not interfere with the measurement process. Because measurements are based on sensing low amplitude magnetic fields, precautions are necessary to ensure that magnetic materials, such as steel-toed shoes, tools, and vehicles, are sufficiently distant from the measuring unit.

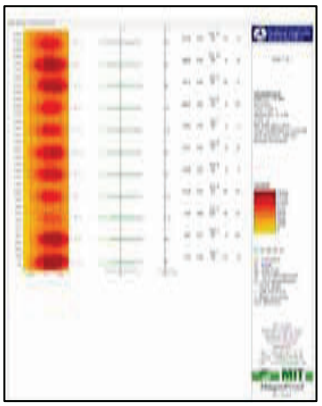
Method of operation

The **Eddy-Dowel** field system includes three principal components: 1) the measuring unit, 2) a portable rail system; and 3) a handheld Pocket PC. Making a measurement of the bars crossing a transverse of longitudinal joint is simple and rapid.

First, the mobile rail system is placed on the pavement so that it is centered along the joint. The rail system is made of lightweight glass fiber reinforced plastic composite. Information about the testing location and type of bars is entered into the Pocket PC. The measuring unit is placed at the starting end of the rail system, and it is then pulled slowly over the rails at a steady speed (0.25 to 0.5 m/s).

Rails provide precise scan

Real-time display of scan

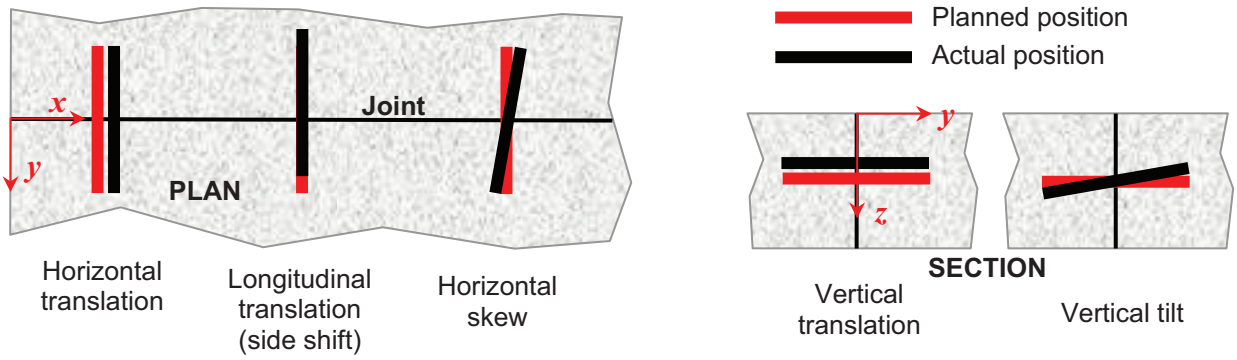


Post processing report

Control of the measurement process and data acquisition is done by the Pocket PC, which communicates wirelessly with the measuring unit. During a scan, the acquired data are shown on the display of the Pocket PC for immediate feedback of data quality. After the scan is completed, the program **MagnoNorm,** running on the Pocket PC, calculates the positions of the bars and displays a table listing bar depth, bar spacing, and bar misalignment. The results can be printed immediately on-site. Detailed reports of the measurements and three-dimensional images of bar positions and alignment can be created with the post processing software **MagnoProof**. This Windows® based software allows rapid analysis of large quantities of data and includes tools for the analysis of bar alignments that deviate greatly from planned locations. It can also assist in analyzing the results of complex measurement situations such as crossing bars at the intersection of longitudinal and transverse joints.

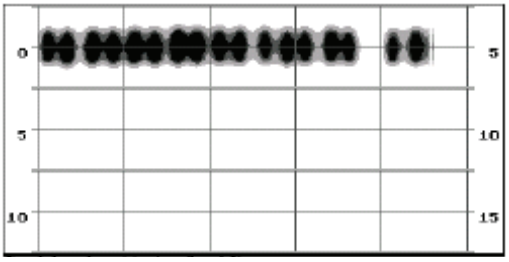
Application

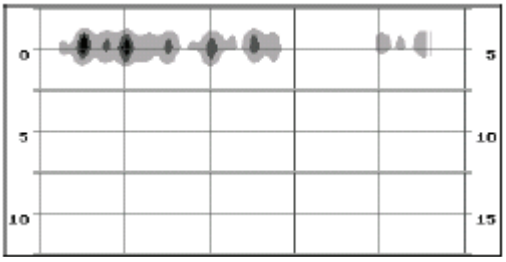
Dowel bars are designed to allow load transfer across transverse joints cut into the slab but at the same time allow pavement sections to expand and contract freely. Tie bars serve the same functions across longitudinal joints. If the bars are not aligned properly these two functions are compromised and joint failures may occur. The following figure shows five types of misalignments that are of concern. Horizontal skew and vertical tilt are of especially problematic because they prevent the bars from slipping freely across the joint and introduce restraint forces that can lead to joint spalling and slab cracking.



The **MagnoNorm** software running on the Pocket PC analyzes rapidly the data acquired during a scan and provides a gray-scale image and a summary table of the results. The gray-scale image is a contour plot of signal amplitude (which is related to depth) as a function of distance from the starting point. The contour plot provides an overall assessment of relative bar depth and bar position. The image below on the left shows an example of a contour plot for bars with relatively uniform depth and alignment, but irregular spacing. By changing the intensity level of the display,

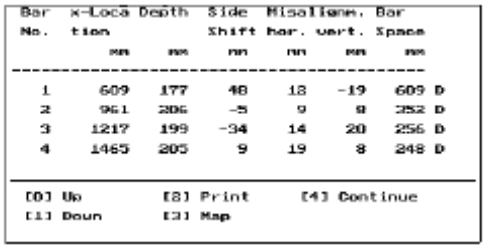
different details can be viewed. The image on the right shows irregular contour plots due to variations of bar depth.





The table of results provides the following information about each bar:

- Sequential bar number
- Distance from the starting point of the scan
- Average depth
- Longitudinal misalignment (side shift)
- Horizontal misalignment
- Vertical misalignment
- Distance between adjacent bars



Bar No.	x-Location	Depth	Side Shift	Misalignm. hor.	Misalignm. vert.	Bar Space	
	mm	mm	mm	mm	mm	mm	
1	609	177	48	18	-19	609	D
2	961	206	-5	9	8	352	D
3	1217	199	-34	14	20	256	D
4	1465	205	9	19	8	248	D

[0] Up [1] Down [2] Print [3] Map [4] Continue

Eddy-Dowel Specifications

Measurement	Measurement range	Accuracy
Depth	110 to 190 mm	± 4 mm
Side shift	80 mm maximum	± 8 mm
Horizontal translation	40 mm maximum	± 4 mm
Vertical translation	40 mm maximum	± 4 mm

Operating conditions	
Operating temperature	-5 to 50 °C
Storage temperature	-10 to 50 °C
Humidity	Operates on wet surfaces and young concrete
Daily output	500 to 600 joints for 16 m joint length

Eddy-Dowel Ordering Numbers

Item	Order #
Measuring unit Size 1160 x 655 x 95 mm Weight 16.5 kg 12 V rechargeable battery (8 h operating time; 4 h recharging time) Carrying case Manual	ED-2001
Rail system Segment length 1 m Rail width 1.18 m Total length 10 m standard Wheeled cross ties Carrying case	ED-2002
Pocket PC Large battery pack Memory card USB cable MagnoNorm and MagnoProof software Manual	ED-2003

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