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"TURNING PROBLEMS INTO SOLUTIONS"

Tech Brief

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Think Jersey DOT

Evaluation of Automated Distress Survey Equipment

FHWA/NJ-2009-007 **September 2009**

SO, HERE'S THE PROBLEM…

The NJDOT Bureau of Drainage and Pavement Technology is upgrading their Pavement Management System and assessing the current protocols for field pavement distress data collection. The current procedures use visual a survey to rate pavement surface distresses. The majority of the pavement distress rating is based on cracking distresses One important aspect of the field data collection that needs to be investigated is the potential use of Automated Distress Survey Equipment to supplement or replace the current manual visual distress data collection. The advances in this technology warrant the evaluation of these systems for use in New Jersey.

AND, HERE'S OUR SOLUTION…

- Evaluate the capabilities, limitations and repeatability of the various automated distress survey equipment technologies on various distress types on different pavement surfaces types at various distress severity levels, lighting conditions and highway speeds.
- Assess the capabilities, limitations and repeatability of NJDOT's PMS rater staff on various distress types on different pavement surfaces types at various distress severity levels, lighting conditions and highway speeds.
- Assess the level of effort and time required to process the images from the automated distress survey equipment.
- Determine which types of distress are better collected with the automated distress survey equipment and which distress types should continue to be collected manually by PMS staff.
- Determine how the data collected by the automated distress data collection equipment can be incorporated into the pavement management system.

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AND, HERE'S WHAT WE DID…

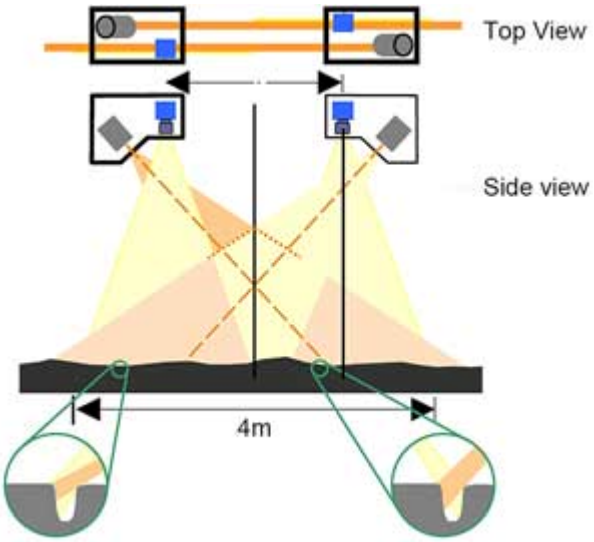
Based on the literature search, and Sates' survey, two vendors were selected to collect and analyze image data for the presence, severity and extent of cracking distresses on fourteen test sites. The NJDOT team used an International Cybernetics Corporation (ICC) profiler with visual rater keyboard (windshield survey) to collect pavement distress data (cracking, patch condition, shoulder condition, inside and outside the wheel paths) at three severity levels in accordance with their current protocols at 50 mph. The Furgo-Roadware team used an ARAN with area-scan imaging system to collect the pavement images and Wisecrax software to analyze the images. The Dynatest-Waylink team used a Dynatest profiler with INO line-scan imaging system and Waylink Automated Distress Analysis (ADA) software to analyze the images. The analyses included manual and automated review of the images under different lighting conditions (morning, noon, and afternoon) on asphalt-surfaced pavements. A statistical analysis was used to evaluate the repeatability of the NJDOT staff and the automated distress survey equipment and software.

The Furgo-Roadware team

- Recorded continuous series of non-overlapping, area scan images that add to 4.9 ft (longitudinal) by 13 ft (transverse).
- Synchronized strobe lights eliminate shadows overhead objects.
- Collected at variable highway speeds up to 50 mph.

The Dynatest-Waylink team

- Used INO Laser road imaging system (LRIS) that combines a line scan camera with laser illumination imaging system.
- Recorded 1.15 mm (0.045") wide (longitudinal) images across the 13 foot pavement lane width. (The laser system eliminates shadows from overhead object collected at variable highway speeds up to 50 mph).



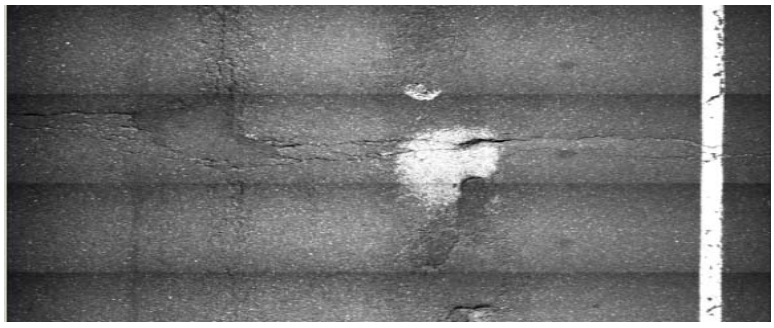
The NJDOT current visual distress assessment program is dependent on visual image quality to rate pavement distress severity and extent.

Morning Image

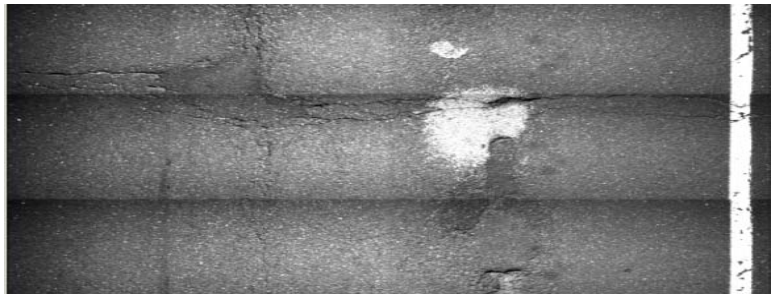
Afternoon image

The lighting and direction affect the manual rating.

The strobe lighting used on the ARAN and the laser lighting used on the INO imaging system produce high quality pavement images at any time of the day.



Morning Pavement Image


Afternoon Pavement Image

Crack Characterization

After the images were collected

- ARAN area-scan images were processed in the office for crack characterization through Wisecrax
- Semi-automated Wisecrax crack characterization was reviewed by Roadware staff to identify any false crack characterization and adjustments were made to the crack summary

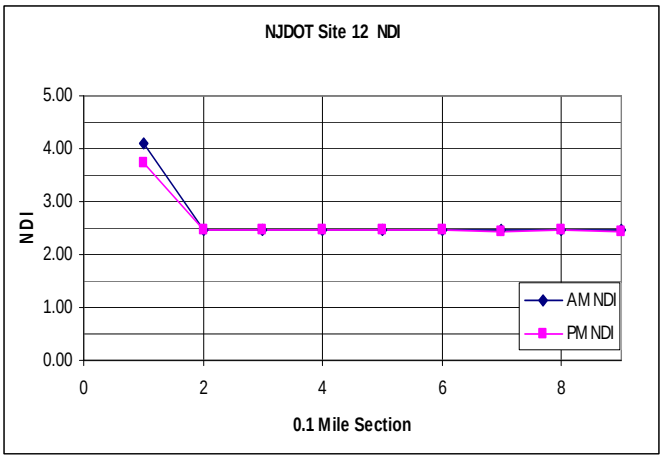
- Dynatest line-scan images were processed in the office
- Dynatest automated crack characterization software (Waylink ADA) can rate the pavement crack condition on HMA and Portland Cement concrete pavement surfaces while the van is collecting images data, but this feature was not used by the Dynatest crew
- Dynatest raters in the office also performed a manual evaluation based on the ROW/downward camera images (ADA software was not used)

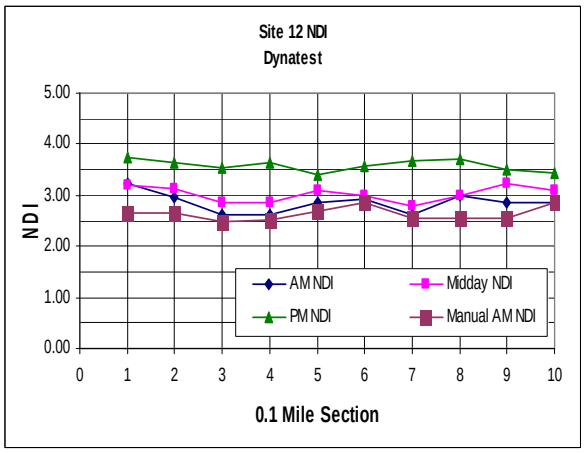
- The NJDOT data was analyzed in the office
- The NJDOT uses a surface distress index based on distress type, weight, severity, and extent for each 52.8 foot pavement section
- Cracks are rated at the highest severity level
- Extent is calculated based on the number of 52.8 foot sections in the 528 foot (0.1 mile) test section that exhibits a given level of severity for each distress type
- Only the Non-load associated distress index (NDI) was used for the comparison in this project.

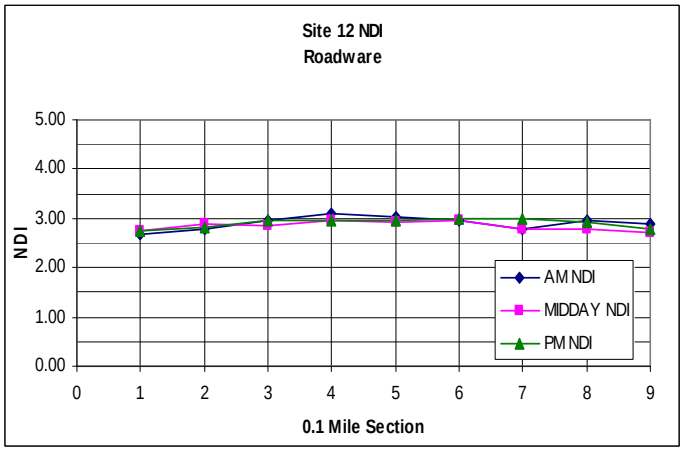
AND, HERE'S WHAT WE CAME UP WITH…

Repeatability

Repeatability of the analysis for different sites, distresses, and severity levels was assessed on a visual and statistical basis for the fully automated, semi-automated, and fully manual procedures.







Statistical Analysis

The statistical assessment of repeatability of NDI used T-Test of Differences to determine the effects of lighting, imaging equipment, and analysis software.

Hypothesis (Ho): The difference between pair of NDI values for the same 0.1 mile section of the test site is not significant with a 90% confidence level

H1 : The difference between pair of NDI values for the same 0.1 mile section of the test site is significant with a 90% confidence level

Results Summary:

Dynatest (Fully Automated)		
Ho	17	47%
H1	19	53%
Roadware (Semi-Automated)		
Ho	23	64%
H1	13	36%
NJDOT (Manual)		
Ho	9	75%
H1	3	25%
Overall		
Ho	**59**	**55%**
H1	**49**	**45%**

The automated distress image equipment can capture high quality images at any time of the day. While the analysis software can assess cracking severity (crack width) and extent, some quality control check should be incorporated into the analysis procedure to improve repeatability.

The imaging/analysis software provides a tool that can be used to improve the collection of cracking data for surface distress analysis. The imaging analysis software can be stopped, reversed, and zoomed to get a more accurate assessment of the cracking within the lane (within and outside to the wheel path) and other distresses to provide a quality control check of the distress data. This cannot be easily done using a windshield survey and rater keyboard to collect distress data. The imaging tools also allow the NJDOT distress rater to concentrate on patch condition, shoulder condition and the condition of the other pavement lanes while taking advantage of the automated distress system's to characterize the cracking distresses.

THE BOTTOM LINE…

The research

- Illustrated the abilities and limitations of the Automated Distress Survey Equipment and software to collect, characterize, and analyze pavement cracking distresses under different lighting conditions.
- Assessed the NJDOT's profiler crew in evaluating these same sections.
- Analyzed the colleted data, made graphical comparisons and statistical analyses to make assessments of repeatability of multiple test runs under different lighting conditions and different degrees of data processing

- Based on the analysis, the Automated Distress Survey Equipment can be used to collect cracking distress data with quality control checks to ensure that the cracking data collected, characterized, and analyzed is accurate
- The NJDOT needs to work with the vendor to refine the data collection and analysis procedures to differentiate the location of cracking (within and outside of the wheel paths) and to provide quality control on the data collection and analysis.

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A final report is available online at:
http://www.state.nj.us/transportation/refdata/research/

If you would like a copy of the full report, please FAX the NJDOT, Division of Research and Technology, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for:

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