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Tech Brief

Non-Contact Skid Resistance Measurement

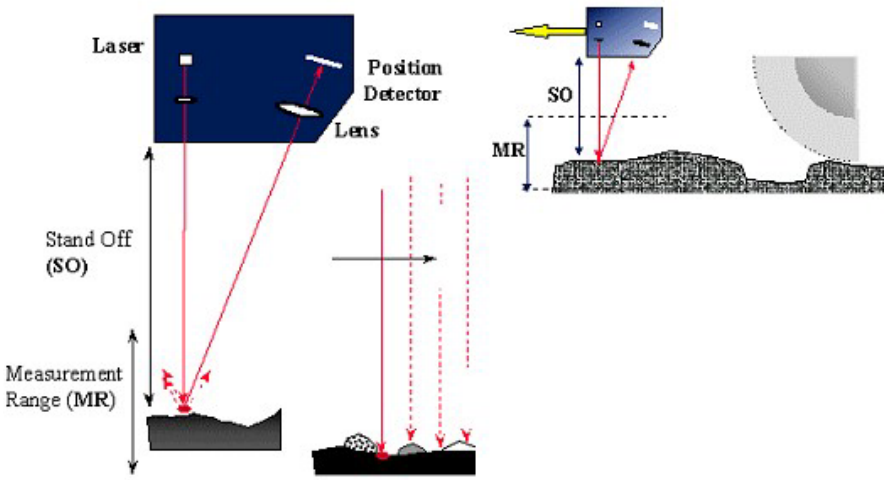
FHWA-NJ-2009-020 December 2009

THE PROBLEM

Skid resistance is the necessary element for the safety of the people who are using NJ roads and inadequate skid resistance will lead to higher incidences of skid related accidents. In order to provide pavement engineers with an effective decision-making tool for planning and scheduling of pavement maintenance and rehabilitation work, NJDOT incorporates the pavement resistance data into its Pavement Management Systems (PMS). Usually, the skid resistance is measured by locked wheel skid trailer. However, this method is very expensive and disturbs the traffic flows during the test. Hence an alternative way of predicting skid resistance based on the pavement texture measured by vehicle-mounted laser at high way speeds was developed. The skid resistance of pavement is related to the roughness of the pavement, and the smoother the pavement is, the lower the skid resistance.. As a result, the vehicle-mounted laser which scans the pavement surface and collect the pavement texture data can be employed to predict the skid resistance of pavement.

OUR SOLUTION

Vehicle-mounted laser devices are typically used to measure macro-texture without disrupting traffic flow. A laser beam is shot to the pavement from a moving vehicle. The reflected beam is collected and processed by a computer in the vehicle to obtain the surface profile of the pavement. Hence pavement texture data can be obtained from a vehicle

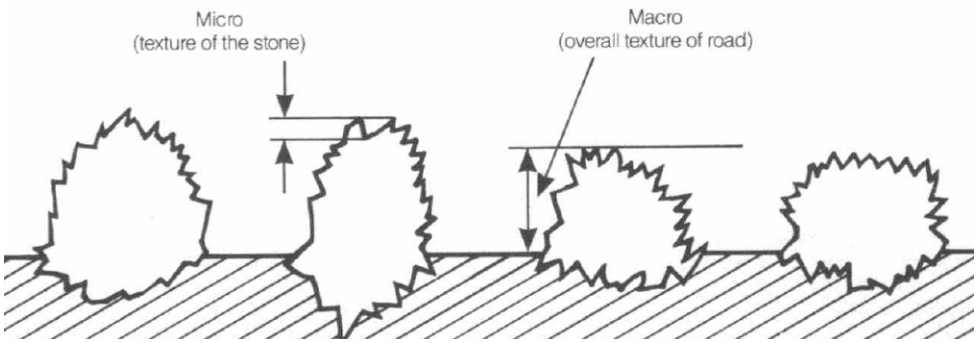


Schematic Representation of Surface Texture Laser

mounted laser moving at highway speeds. Vehicle mounted laser collects texture data at an interval of approximately 0.2mm when operated at highway speeds. In this research our hypothesis was that the laser measured macro-texture should relate to the skid resistance. And if that is the case we can use the high speed laser to get this information at a rapid rate and it can be a fast and, cost-effective way of estimating the pavement skid resistance. As a result, we can save a lot of money for the tax payers.

SKID RESISTANCE AND PAVEMENT TEXTURE

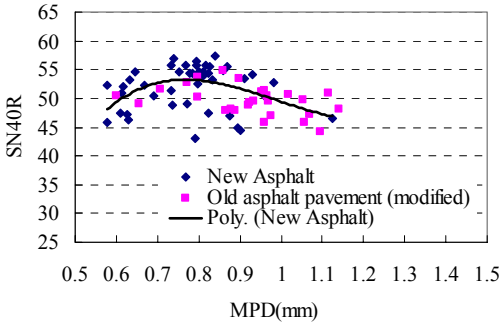
The pavement texture is the controlling factor in the skid-resistance of roadway surfaces. Through a complex interaction of micro and macro textures at the pavement-tire interface, sufficient friction is developed for vehicles to perform routine maneuvers under normal operating conditions. The choice of rock type contributes to micro texture of the aggregate whereas the mixture type adopted is largely contributing to the macro-texture of the road surface. A key role of the macro-texture is to provide a means for removal of this surface water as tires transverse the pavement structure. Earlier research has indicated that measurements conducted using the ribbed tire are highly sensitive to the pavement texture thus are good estimators of pavement skid resistance.



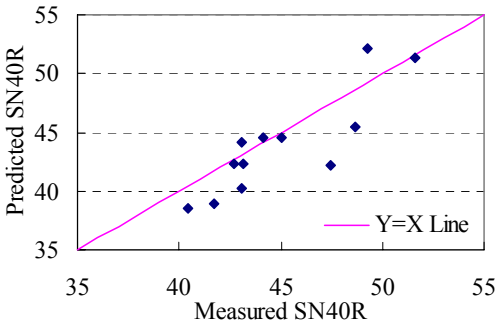
Micro and Macro Texture

OUR RESEARCH

We tested five new asphalt pavements sections to develop a correlation between skid resistance measured by locked wheel trailer and pavement macro-texture collected by vehicle mounted laser. We also tested four older asphalt pavements with an average road age of over 20 years and developed a reduction coefficient which is a function of pavement treatment time and traffic volume to take into account the traffic polishing effect on the microtexture of pavement.



Proposed Correlation



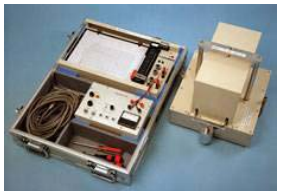
Field Validation of the Correlation

In order to verify the accuracy of the proposed we performed two detailed field tests, one is on a new pavement and the other one is on an old pavement. Besides the vehicle mounted laser and locked wheel skid tester which were used in the test, the following tests are also conducted in field on different purposes:

- *Sand Patch Test (SPT):* The sand patch test has been used to quantify visual observations of differences in the surface macro-texture. Good correlation was found between visual observations of non-uniform textured areas and the sand patch test results for measuring surface macro-texture.

Sand Patch Test

- Dynamic Friction Test (DFT): The DFT has three rubber sliders that are spring-mounted on a horizontal rotary disk at a distance of 350mm. The disk is initially suspended above the pavement and accelerated 90 km/h. Water is then applied to the pavement and the disk is lowered to the test surface. The friction force is measured as the disk touches the pavement.



DTF

- *Circular Track Meter (CTM):* The CTM uses a laser to measure the profile in an 800-mm circumference circle. The mean depth of texture is computed according to ASTM standard practice. The CTM is designed to measure the same circular track that is measured by the DFT.

CTM

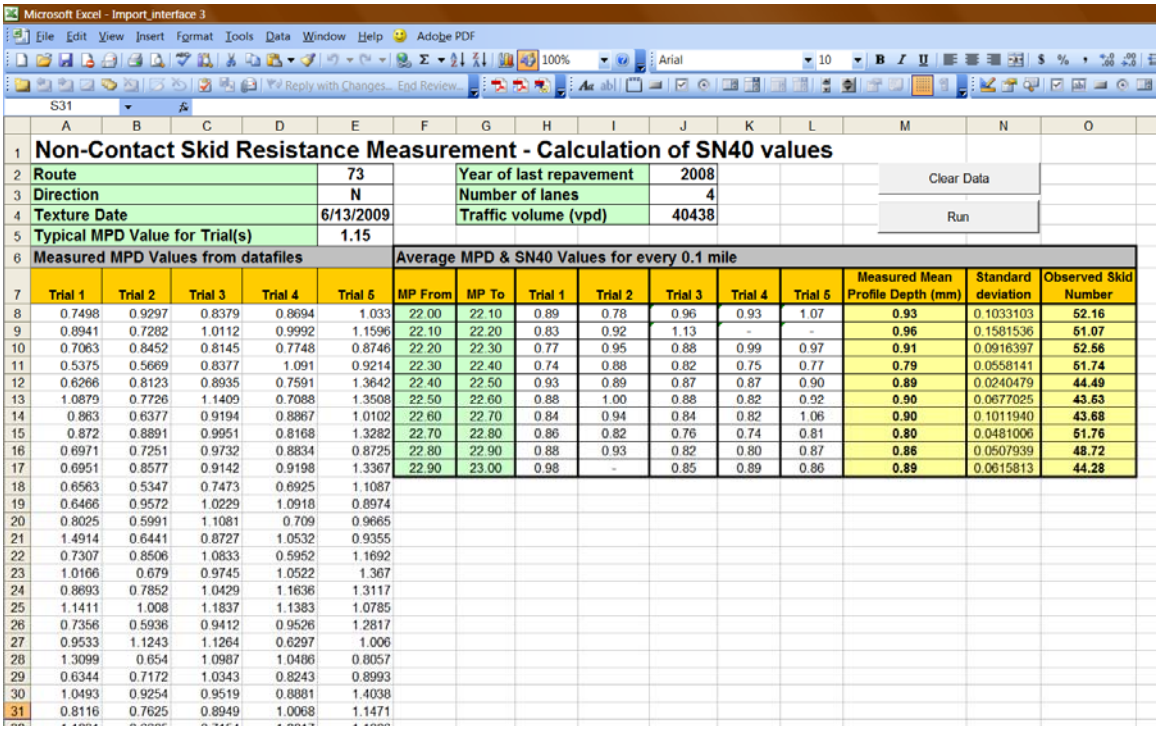
The field test results showed that the measured skid number and predicted skid matched each other very well for both two pavements which validate the developed correlation between skid resistance and macro-texture of pavements. The field test data also showed that DFT test may not fully capture the micro-texture of pavements, especially those with low macro-texture (the micro-texture is partially lost with water on the pavement), as a result, it is inappropriate to use DFT to measure the micro-texture of a pavement without taking into account the macro-texture.

HERE'S WHAT WE CAME UP WITH…

After confirming the validity of the correlation between skid number and pavement texture for asphalt pavements, a was developed to process the texture data obtained using high speed laser and import the predicted skid data to the Pavement Management System (PMS). The software consists of a MS Excel macro spreadsheet allowing users to import raw laser test files directly into a spreadsheet and predict the skid resistance at each 0.1 milepost based on the average macro-texture of 20-meter-length section of pavement at the corresponding to that milepost.

THE BOTTOM LINE…

The proposed correlation and the PMS interface will be used by the NJDOT to screen all the roadway pavements belonging to the state of New Jersey using high speed laser and the predicted skid numbers that will be included in the NJDOT Pavement Management Database. Hence with the predicted skid numbers NJDOT could reduce the use of expensive locked wheel skid tester saving thousands of taxpayer dollars.



Microsoft Excel - Import_interface 3

File Edit View Insert Format Tools Data Window Help Adobe PDF

S31

Non-Contact Skid Resistance Measurement - Calculation of SN40 values

Route				73		Year of last repavement		2008		Clear Data									
Direction				N		Number of lanes		4											
Texture Date				6/13/2009		Traffic volume (vpd)		40438		Run									
Typical MPD Value for Trial(s)				1.15															
Measured MPD Values from datafiles						Average MPD & SN40 Values for every 0.1 mile													
Trial 1	Trial 2	Trial 3	Trial 4	Trial 5		MP From	MP To	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Measured Mean Profile Depth (mm)		Standard deviation		Observed Skid Number		
0.7498	0.9297	0.8379	0.8694	1.033		22.00	22.10	0.89	0.78	0.96	0.93	1.07	**0.93**		0.1033103		**52.16**		
0.8941	0.7282	1.0112	0.9992	1.1596		22.10	22.20	0.83	0.92	1.13	-	-	**0.96**		0.1581536		**51.07**		
0.7063	0.8452	0.8145	0.7748	0.8746		22.20	22.30	0.77	0.95	0.88	0.99	0.97	**0.91**		0.0916397		**52.56**		
0.5375	0.5669	0.8377	1.091	0.9214		22.30	22.40	0.74	0.88	0.82	0.75	0.77	**0.79**		0.0558141		**51.74**		
0.6266	0.8123	0.8935	0.7591	1.3642		22.40	22.50	0.93	0.89	0.87	0.87	0.90	**0.89**		0.0240479		**44.49**		
1.0879	0.7726	1.1409	0.7088	1.3508		22.50	22.60	0.88	1.00	0.88	0.82	0.92	**0.90**		0.0677025		**43.63**		
0.863	0.6377	0.9194	0.8867	1.0102		22.60	22.70	0.84	0.94	0.84	0.82	1.06	**0.90**		0.1011940		**43.68**		
0.872	0.8891	0.9951	0.8168	1.3282		22.70	22.80	0.86	0.82	0.76	0.74	0.81	**0.80**		0.0481006		**51.76**		
0.6971	0.7251	0.9732	0.8834	0.8725		22.80	22.90	0.88	0.93	0.82	0.80	0.87	**0.86**		0.0507939		**48.72**		
0.6951	0.8577	0.9142	0.9198	1.3367		22.90	23.00	0.98	-	0.85	0.89	0.86	**0.89**		0.0615813		**44.28**		
0.6563	0.5347	0.7473	0.6925	1.1087															
0.6466	0.9572	1.0229	1.0918	0.8974															
0.8025	0.5991	1.1081	0.709	0.9665															
1.4914	0.6441	0.8727	1.0532	0.9355															
0.7307	0.8506	1.0833	0.5952	1.1692															
1.0166	0.679	0.9745	1.0522	1.367															
0.8693	0.7852	1.0429	1.1636	1.3117															
1.1411	1.008	1.1837	1.1383	1.0785															
0.7356	0.5936	0.9412	0.9526	1.2817															
0.9533	1.1243	1.1264	0.6297	1.006															
1.3099	0.654	1.0987	1.0486	0.8057															
0.6344	0.7172	1.0343	0.8243	0.8993															
1.0493	0.9254	0.9519	0.8881	1.4038															
0.8116	0.7625	0.8949	1.0068	1.1471															

Screen Shot of Software Interface Developed

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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, Bureau of Research, 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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