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Tech Brief

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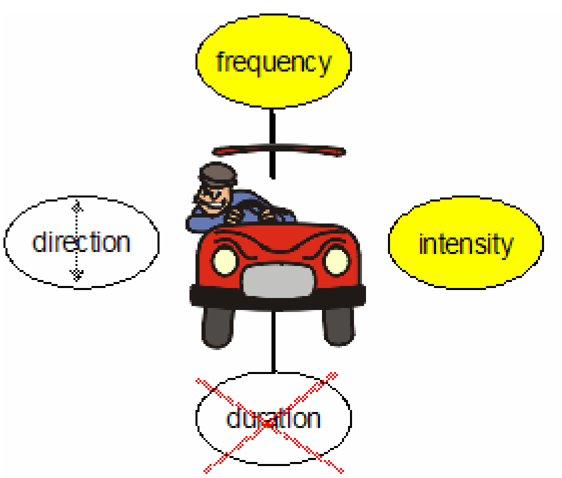
Ride Quality Follow-Up

FHWA-NJ-2005-017 December 2005

HERE IS THE PROBLEM

Ride quality, commonly referred to as pavement smoothness, is one of the most important highway characteristics that impact drivers and riders. In addition to providing a smoother ride, smooth pavements also last longer and cost significantly less over their service lives. To ensure smoothness of newly constructed or rehabilitated pavements it is of outmost importance to have the ability to measure it rapidly, accurately and on a consistent basis. The question came up, how we can do it, and how we can define pavement smoothness to accurately describe the true pavement roughness and drivers' perception of it?



Factors affecting ride quality

AND, HERE IS THE SOLUTION…

The first part of the solution is to identify a device for pavement smoothness measurement of high accuracy and repeatability. In addition, the device should be able to conduct pavement profiling at highway speeds to eliminate costs associated with lane closure and minimize safety risks. The second part of the solution represents identification of ride quality parameters that describe both the true pavement roughness and the user opinion of the ride quality.

IMPLEMENTATION; HERE WE COME…

In 2003, the New Jersey Department of Transportation (NJDOT) in association with the Federal Highway Administration (FHWA) initiated a study of addressing issues identified at the completion of the Phase I study. Those included: identification of a common bench-mark for various profilers through a selection of an official and standard smoothness measuring equipment, and selection of an indicator that better represents ride smoothness as compared to indicators already in use. The results of the study will be the basis of new NJDOT's pavement smoothness specifications.

THESE ARE OBJECTIVES OF THE STUDY…

The main objective of this study was to provide NJDOT with recommendations for a standard pavement profiler and new ride statistics. Particular objectives of the study included:

- Select a pavement profiling device as the Standard Pavement Profiler (SPP) for NJDOT. SPP will be used to calibrate other profilers,
- Develop a procedure, using SPP, to be used to calibrate the NJDOT ride quality acceptance device and other high-speed profilers that may be used for quality control purposes,
- Develop a procedure to correlate high-speed profilers that may be used for quality control purposes with NJDOT SPP,
- Develop or evaluate a standard software to process profile data to calculate of NJDOT ride statistics for new and rehabilitated pavements.

HERE IS WHAT WE DID…

The scope of Phase II study was limited to evaluation of smoothness of asphalt concrete pavements. It included three roughness categories for each of those three test sections were selected for later evaluation of profiling devices. The right and left wheel path profiles of these test sections were measured using different profiling devices. Repeated runs (3 runs) at different speeds (3 speeds for the high-speed profilers) were also performed. To overcome the equipment problems of Phase I, two types of profiling devices were considered, which are bench-mark (Rod and Level - R&L and ARRB Walking Profiler - WP) and high-speed profilers (NJDOT ARAN manufactured by Roadway Corporation, Dynatest 5051-MKIII-022 high-speed profilers and Stantec's RT3000 manufactured by the International Cybernetics Corporation - ICC).

The data collected in Phase II was analyzed using two approaches. In the first approach the traditional ride statistics (IRI, RN, PI and %DL) were used to address the variability among equipment (profile comparisons) equipment related issues (repeatability, effects of testing speed, filtering effects), manufacturers versus standard IRI computations (Proval and RoadRuf) and the impact of summary intervals. In the second approach more detailed investigations were performed on the IRI algorithm and a new ride statistic was developed. Also, advanced profile analysis was performed to diagnose the profile characteristics that impact the rideability and user opinion.

ARAN High Speed Profiler

ICC High Speed Profiler

Field Testing with Walking Profiler

Rod and Level Survey

Based on the visual assessment of the profiles collected using R&L and WP, it was concluded that the two devices provide very similar results. Because of the speed of profiling, WP will be selected as NJDOT SPP. While in some cases there were pronounced differences between the profiles measured using the high-speed profilers and those measured using R&L/WP, in most cases there was a good match of profiles. Also, the repeatability of all devices was found to be in general good.

It was found that the speed, filtering and summary interval can have significant effects on the computed IRI. The effect of speed is especially significant when it is reported at short intervals, e.g. 52.8-ft intervals. The effect of filtering on the computed IRI varies from one device to another, with R&L being the least affected. The differences between the unfiltered IRI and those after band filtering are more pronounced than that between unfiltered IRI and those after high pass filtering. The differences between the results from unfiltered and filtered profiles change depending on the roughness class. The trend of each equipment is not consistent and the differences can be significant. However, the 3-ft low pass filter and the band 3-300 filter have the most significant impact. With respect to the summary interval, a length of 528-ft would be a suitable IRI summary interval for project level investigation.

The difference between the IRI values calculated using the manufacturer IRI routine and those of RoadRuf and Proval could be significant.

Based on the data collected in this project, IRI and PI limits can be established to classify pavement sections in the three roughness classes with no overlaps. These limits could not have been established using RN or %DL.

WHAT IS THE NEXT STEP?

The developed ride statistics could not be validated with a measure of user or rider discomfort. Therefore, it is recommended that a panel study be conducted in which both the driver and a passenger are instrumented to measure the quality or comfort of the ride. The instrumentation of driver and passenger will provide a means of correlating the riders' subjective opinion with an objective measure of the same ride and serve as a basis of validating the Rutgers ride statistics. The instrumented panel study will involve the survey of several sections (at least three) in each roughness category, where the instrumentation should be capable of measuring the individual motion of passengers.

CONCLUSION…

The study has demonstrated that high speed profilers can be successfully used to accurately and consistently measure smoothness of asphalt concrete pavements. Operation of high speed profilers has to be accompanied by a calibration procedure using a Standard Pavement Profiler. Shortcomings of existing ride statistics indices provide the need for development and validation of new ones.

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A final report is available online at
http://www.state.nj.us/transportation/research/research.html
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: **Ride Quality Follow-Up**
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