



INDOT Research

# TECHNICAL *Summary*

Technology Transfer and Project Implementation Information

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## **Evaluation of INDOT Construction Smoothness Specification**

### **Introduction**

Pavement smoothness is considered to be the most important indicator of pavement riding comfort. Currently, Indiana Department of Transportation (INDOT) is using the California Profilograph as the standard measuring device in its smoothness specifications. The output derived from the profilograph is called Profile Index (PI). PI represents the total accumulated deviations of the profilograph output traces beyond a tolerance zone (blanking band). At present, INDOT is using 0.2-inch blanking band to evaluate the profile traces. The use of 0.2-inch blanking band has raised some concerns because in some instances small unpleasant surface irregularities are covered by the

blanking band and are not counted in the roughness index value. Therefore, there is a need to move towards 0.0-inch blanking band to better assess the riding quality of the newly constructed pavements. In this way all irregularities of the paved surface can be counted.

The major objective of this study was to develop a rational method of interpreting profilograph traces using 0.0- inch blanking band method and to establish a corresponding pavement smoothness specification. The secondary objective was to develop/adopt an automated system for the pavement profile analysis from profilograph traces.

### **Findings**

The study was divided into two phases. In phase I (synthesis study), a literature review was conducted to gather information about the smoothness measuring techniques, indices and methods to develop the smoothness specifications. Also, existing California Profilograph profiles provided by INDOT were analyzed to develop a new manual 0.0- inch blanking band Profile Index reduction procedure ( $PI_{0.0}$ ). The within-operator repeatability and the between-operator reproducibility for the  $PI_{0.0}$  manual reduction were analyzed. The statistical analysis results of the repeatability were good with relatively low standard deviation and coefficient of variation. The reproducibility was lower due to the positioning of the 0.0-inch blanking band and interpretation of the trace deviations. The results also showed that the correlation between PI values using 0.2 and 0.0-inch blanking band was poor, as expected. This indicates that the 0.0-inch blanking band PI index better reflects

the true riding comfort by revealing all small deviations of the pavement surface.

Literature review showed that Kansas DOT (KDOT) has been a leading state to develop the 0.0-inch blanking band specifications. They are also using automated method of analyzing profilograph traces using scanner and analysis program developed by Kansas State University. The analysis system is called Proscan.

In phase II, the KDOT smoothness specifications were selected as the reference for the development and the assessment of the INDOT  $PI_{0.0}$  specifications, because KDOT has been developing and using  $PI_{0.0}$  smoothness specification for ten years now, and they are satisfied with their current form of the specifications.

Several Profile Index conversion models were selected and evaluated to perform the conversion of the current  $PI_{0.2}$  smoothness specification to the  $PI_{0.0}$  specification. The developed conversion was then compared to the

current KDOT and other  $PI_{0.0}$  specifications to further refinements.

The pavement smoothness of several recently completed paving projects was measured using California profilograph and reduced manually and automatically using the Proscan system, developed by Kansas State University. Analysis results showed that the converted  $PI_{0.0}$  specifications reduced the amount of bonus payments compared to  $PI_{0.2}$  specification, as expected. However, the converted specifications did not include any incentive/disincentive policy changers compared to the current  $PI_{0.2}$  smoothness specifications. Therefore, when compared to the KDOT  $PI_{0.0}$  specifications, the converted specifications were more lenient, which may result in bonus payments for “mediocre” quality of construction.

The Proscan results consistently generated lower PI values than the manual reduction. Further analysis indicated that the variation was due to human errors, such as the visual judgment of the centerline alignment, determination of the minimum height of scallops, and counts of multiple peaks, and different reduction procedure for the superelevated curves. The repeatability of the Proscan system was excellent,  $R^2$  being 0.98 for two separate scans and analysis.

It is therefore recommended that INDOT adopts this automated reduction system to reduce the  $PI_{0.0}$  from the California profilograph traces. To comply with the Proscan analysis, the converted specification was modified accordingly, and the final converted INDOT smoothness specifications for Hot-Mix Asphalt (HMA) and Portland cement concrete (PCC) pavements are then presented.

## Implementation

The converted  $PI_{0.0}$  specifications were introduced to the Study Advisory Committee (SAC) members at the end of the research stage. Using these converted specifications, the SAC members constructed initial  $PI_{0.0}$  smoothness specifications for Indiana, incorporating some incentive/disincentive policy changes compared to the current  $PI_{0.2}$  specifications. A new ITM protocol was developed to be used with the new  $PI_{0.0}$  specification.

A first implementation phase of the initial  $PI_{0.0}$  specification will be conducted during summer and fall of 2003. Several paving

contractors will provide California Profilograph traces to Purdue University to be analyzed using Proscan system using the current  $PI_{0.2}$  and new initial  $PI_{0.0}$  specifications. At the end of the summer Purdue will summarize the analysis findings. This analysis work will give the feedback to the contractors and INDOT about the new specifications. The second implementation phase includes purchasing six to seven new Proscan devices for INDOT districts to automate the trace reduction operation. Purdue University will provide training during summer and fall construction season to use the new analysis system.

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