A State's Concerns with the FHWA's Highway Performance Monitoring System Roughness Requirements

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When the FHWA issued requirements for the collection of roughness data for the Highway Performance Monitoring System in December 1987, it was well received in Texas. The benefits of a national pavement roughness standard and the concerns that evolved from a study conducted by the Center for Transportation Research at the University of Texas at Austin to ensure compliance with the new FHWA pavement roughness requirements, and from the experience gained from collection of pavement roughness data on a state-wide basis since 1983 are discussed. Measures for alleviating the issues presented are recommended.

When the FHWA issued requirements for the collection of pavement roughness data for the Highway Performance Monitoring System (HPMS) in December 1987 (*1*), it was well received in Texas. The benefits of the FHWA roughness requirements and some concerns with the requirements are discussed. These concerns evolved from a study conducted by the Center for Transportation Research (CTR) at the University of Texas at Austin to ensure Texas compliance with the new FHWA roughness requirements (*2*), and from the experience gained from collecting pavement roughness data on a state-wide basis for the Texas State Department of Highways and Public Transportation (SDHPT). Measures for alleviating the issues presented are recommended.

BENEFITS

The FHWA's issuance of requirements for the collection of roughness data for the HPMS was a large step toward the establishment of a national roughness standard. The current roughness index and standardized calibration and data collection procedures that have been used in Texas for many years allow monitoring the performance of a particular road over time and comparing the performance of various roads across the state. These procedures also allow Texas to look at the performance of the roads by maintenance section, by district, or by any desired level within the state. This process permits Texas to see if over time the roads are getting better or worse.

The establishment of a national roughness index and respective calibration and data collection procedures would give each state the capabilities Texas has. Additionally, each state would be able to take advantage of the experiences of other states by having information that is collected under the same conditions, and therefore that is readily comparable. Similarly, if the standards being developed and used in the Strategic Highway Research Program (SHRP) are readily acceptable and used by all or most states, then one of the fundamental benefits that can come from the program will be the participating states' ability to compare and share information.

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CONCERNS

As asserted previously, the cited FHWA order was well received and is considered a large step toward the establishment of a national roughness standard. However, Texas is concerned that many will not be aware that this is just the first step and that there is a great need for several revisions to the order if the order is to provide meaningful comparison of roughness data.

The discussion of SDHPT concerns is based on (a) the findings of a study conducted by the Center for Transportation Research at the University of Texas at Austin in an effort to ensure the procedures to be used by Texas would comply with the FHWA's HPMS roughness requirements, and (b) the experience gained from several years of pavement roughness evaluation. The following issues are presented as an example of revisions that are needed to make the FHWA order more meaningful and useful:

- The order permits the user to select the wheel path to test (left, right, or both). The experience in Texas has indicated that the pavement roughness results vary considerably between the different wheel paths for most of the pavements in Texas. In most cases, the right or outside wheel path was found to be predominately rougher. This is especially true for all but the pavements within the smooth roughness range (IRI $<$ 190 in./mi). Although there are many arguments for the selection of each of the wheelpath options, it is considered far more critical for the wheel path selection to be standardized so that all states will be using the same wheelpath in their evaluations and hence valid comparisons can be made of the results.
- The order does not specify location of wheel path or the wheel track width required for evaluation by the equipment. The AASHTO Materials Reference Laboratory (AMRL) surveyed the states in 1987 and found that the wheel path and wheel track width of the roughness evaluation equipment being used at that time varied from 57 to 88 in., and Texas has the

same range with the equipment currently being used. SHRP has established 65 in. as the standard wheel track width for its roughness evaluation. Texas has found significant differences in the test results that could be attributed to wheel track width differences, and therefore feels that without the establishment of a standard wheel track width meaningful roughness comparisons cannot be made.

- The order does not specify a standard length of pavement to be evaluated. Texas has found that the reported roughness tends to be more repeatable as the section length increases, because the data are being smoothed or averaged over longer distances. In order to reduce the impact of averaging and to increase the ability to identify both smooth and rough sections, it is recommended that a standard section length of 0.2 mi be established. Again, the important point is that a standard section length be used by all states so that more meaningful comparisons can be made with the results.
- The order contains inconsistent and often impractical precision and bias for calibration of equipment. At one extreme, manual profiling is required to be within 1.5 percent bias, and at the other extreme when using response type road roughness measurement (RTRRM) equipment, a 10 percent bias is allowed. If the required 10 percent bias cannot be met, then outlying data can be eliminated by taking new readings until at least five readings fall within the required 10 percent bias. This is not sound statistically and the resulting correlation equation will probably not be representative of the data reported by the equipment.
- The order requires that the calibration sections must include roadways that have a measured roughness that meets or exceeds the range of actual values that will be collected. Although Texas agrees that extrapolation is not desirable, it would be much more reasonable and practical to expect at least 95 percent of the pavements evaluated to fall within the roughness range of the calibration sections. This is considered very acceptable, because the pavement sections that exceed the rough range are probably already candidates for rehabilitation, and the pavement sections that exceed the smooth range may not even be distinguishable by the RTRRM equipment being used.
- The order requires that the equipment be calibrated or verified at least monthly or every 2,000 mi, whichever comes first. Although this practice may be highly recommended, the decision of how often to calibrate should be left up to management. As long as the equipment is in calibration when it went in the field and is checked before submitting the data, the data would be considered good if the equipment remained in calibration and bad if it did not.
- Because of the complexity and its susceptibility to error, the program provided by reference in the order for calculating the international roughness index (IRI) from elevation data should have a sample data set and output included to verify that the program has been programmed correctly and is working properly.
- The roughness calibration ranges provided in the order need to be shifted toward the smooth end approximately 40 in. per mile to balance the scale. This is especially true if the use of both wheel paths is going to be continued. In Texas, RTRRM equipment is used, which in effect averages both wheel paths, and pavements with an IRI greater than 320 in. per mile are difficult to find and in most cases are unsafe when traveling at 50 mph. This point is further supported by the continuing need to select new calibration sections, as a result of the city or county rehabilitating the sections.
- The order does not provide adequate procedures for the calibration and collection of data at speeds other than 50 mph. Even though it is known that roughness as reported by RTRRM equipment will vary with speed, the calibration procedures are based on the transformation of profile data. The profile data will not vary with changes in speed or to the IRI by the program provided.

CONCLUSIONS AND RECOMMENDATIONS

The FHWA has taken a large step toward the development of a national roughness standard, but there are many issues that need to be addressed if meaningful comparisons are to be made from the data collected.

It is recommended that the FHWA advise the states and other concerned entities of their intent to revise the HPMS roughness requirements, in an effort to prevent the purchase of pavement roughness evaluation equipment and the collection of data that will not be readily usable in the future.

Creating a national roughness standard that is compatible with as many types of roughness instrumentation as possible is no easy task. Each state highway authority should be contacted for its active support to aid in the development, because it is the states who will carry out the purchase of the equipment and the collection of data. Once accomplished, the FHWA order for the collection of pavement roughness data will provide an effective and powerful tool to aid in the management of pavement systems.

REFERENCES

1. *Highway Performance Monitoring System Field Manual, Appendix J.* Publication M5600.1A, Change 3. FHWA, U.S. Department of Transportation, April 20, 1990.
2. C. B. Bertrand, R. Harrison, and B. F. McCullough. *Evaluation of FHWA Requirements for the Calibration of Pavement Roughness Instrumentation.* Research Report 969-2F. Center for Transportation Research, University of Texas at Austin, Feb. 1990.

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