KANSAS SMOOTHS WAY TO COST-EFFECTIVE ROAD PROFILES

Most states specify road smoothness and have incentive clauses to encourage quality construction. Road roughness typically is measured with a manual profilograph. Although automated profilograph systems cost more initially, the information gathered is more accurate and requires less time to reduce and analyze.

Road roughness—defined as the deviations from a smooth or planar surface that affect vehicle dynamics, ride quality, dynamic loads, and drainage—is expressed as the pavement roughness index, which is calculated by integrating the recorded profile height that exceeds a specified deviation from a smooth surface and then dividing the result by the length of the road segment. PRI is expressed as millimeters of profile height per kilometer of road length (inches per mile).

PROBLEM

The Kansas Department of Transportation has included pavement-smoothness specifications for portland cement concrete pavement contracts since 1985 and for asphalt-concrete pavement contracts since 1990. The specifications require the contractors to compute the pavement roughness index within 24 hours after the ashpalt-concrete pavement is placed and within 48 hours after the portland cement concrete pavement is placed. The prompt calculation after construction provides quality-control checks on new pavements. KDOT elected to have the contractor collect and analyze the roughness data and provide results to the state inspector because of the large number of paving operations performed throughout the state simultaneously during the summer construction season.

Before 1992 all profilographs used in Kansas were manual, with hand reduction of the data collected in the field. The hand-reduction process is time consuming, requires a certain level of training and expertise, and has potential for variation in results with different operators because of its subjective nature. KDOT was interested in extending the accuracy and efficiency of the 26 existing manual profilographs without incurring the prohibitive costs of replacing all units with expensive automated systems.

RESEARCH

A joint research effort was conducted by KDOT and Kansas State University to develop an automated method of capturing and analyzing the data collected with manual profilographs. A hand-held scanner and an image-enhancement program were used to digitize the data collected in the field on the hard-copy strips.

A second software program was developed to calculate the PRI. This semi-automated system can digitize and analyze data from a 0.1-kilometer (0.06-mile) section of roadway in approximately 12 seconds. A paper-transport device was developed to hold the scanner in position while the hardcopy strip passes under the scanner at a constant speed. This allowed analyses of a large volume of data in a short time. The software analyzes the data and produces a summary report. A schematic of the semi-automated system is shown in Figure 1.

During each of the construction seasons from 1992 through 1995, an average of 965 lane-kilometers (600 lane-miles) of surface were constructed with 1930 kilometers (1,199 miles) of wheelpath profiles each year. The automated process analyzed the field data at a rate of 29 kilometers per hour (18 miles per hour), 18 times faster than the manual method. The semi-automated system required about 70 hours to capture and analyze the data with a high degree of accuracy each year; this was significantly less than the nearly 1,200 hours the manual method would have taken.

BENEFITS

Use of the semi-automated system has provided objective analysis of data and eliminated variations due to operators. Significant reduction in time required to analyze the roughness data has enabled KDOT to avoid the costs of the fully automated systems while enforcing quality control on construction, promptly determining needed corrections, and effectively addressing the incentive-

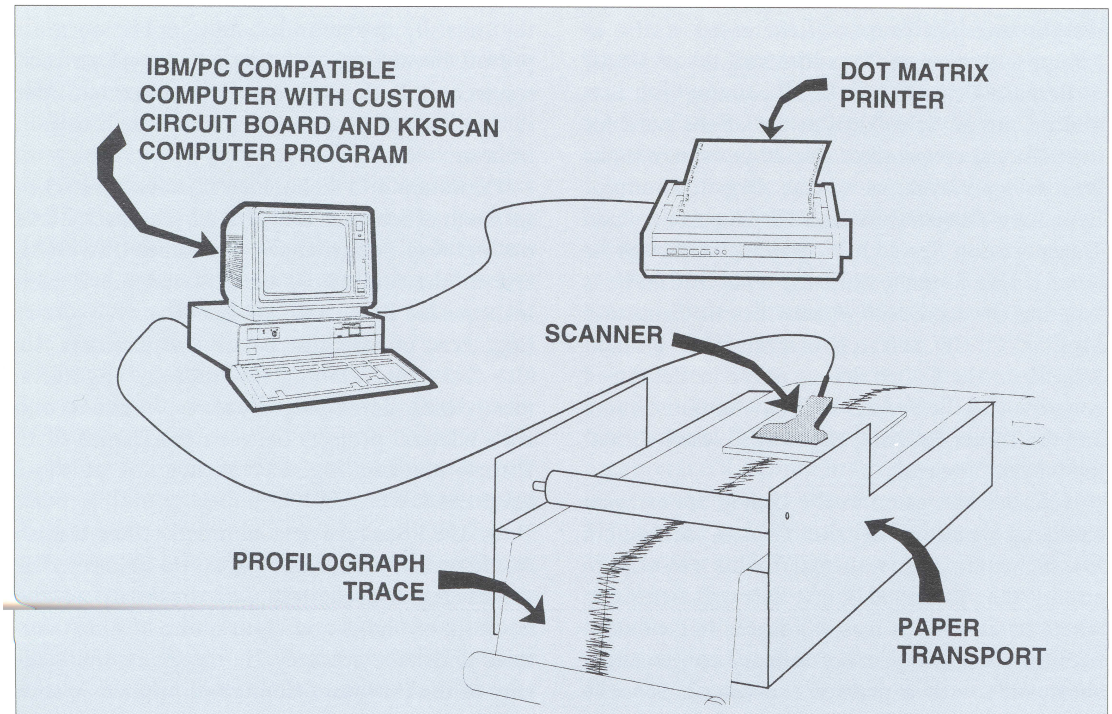

FIGURE 1 Hardware and software package for analyzing profilograph traces.

disincentive contract clauses. A total of $45,000 in labor costs has been saved in 3 years.

Smoother pavements in Kansas are expected to require less maintenance, with an estimated maintenance cost savings of $10,000 the first year and an increase in savings for the life of the pavements. Motorists also benefit through reduced wear on vehicle components, reduction in driver fatigue, and improved road safety.

The Federal Highway Administration and more than one dozen states have procured the semi-automated system for use with their existing manual profilographs. With wider application of the product developed in Kansas, the cost and accuracy benefits will be extended to other states. The total investment on this project was $40,000.

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