RESEARCH PAYS OFF

CALTRANS RESEARCH EASES ROAD ROUGHNESS MEASUREMENTS

Until recently the California Department of Transportation (Caltrans) used response-type road-roughness meters to collect data on the relative smoothness of the state's highways. The meters accumulate measurements of the movement of the rear axle of an automobile relative to its body and report these measurements as a ride score—a weighted accumulation of axle displacements resulting in a numeric value ranging between 0 (perfectly smooth) and 70 (impassable). Before being used for data collection, the meters were calibrated at sites with known ride scores to correlate their output, allowing Caltrans to build a data base of ride scores dating back to 1978 for approximately 77 000 lane-kilometers (47,845 lane-miles) of pavement statewide.

PROBLEM

Roughness data are reported to the Federal Highway Administration as part of its Highway Performance Monitoring System program (HPMS). To improve the quality of these data, FHWA revised the calibration procedures for the equipment used to collect them. Satisfying the rigorous new requirements would have been prohibitively expensive for Caltrans: about $500 per month (not including the cost of downtime) for each of its six road-roughness meters, which already were coming to the end of their useful lives.

SOLUTION

Caltrans decided to replace its road-roughness meters with a profile measurer, which is subject to comparatively few calibration requirements and which allows the department to preserve the contents of its historical data base of pavement-ride scores. Because the cost of a profile measurer with the desired specifications is high—approximately $400,000—Caltrans developed its own, basing the design on PRORUT, a system built in the early 1980s by the University of Michigan Transportation Research Institute under contract to FHWA.

PRORUT consists of a van equipped to measure longitudinal pavement profile and rut depth while traveling at highway speeds. Caltrans updated the system with custom-designed circuit boards, a contemporary computer, and new power supplies and sensors. It also rewrote the PRORUT software, using the more modern "C" programming language. This research and development effort cost approximately $250,000.

APPLICATION

The high-speed profile measurer is being used by Caltrans's Office of Roadway Maintenance to survey pavement conditions. One profile measurer with a single driver-operator surveys approximately 77 000 lane-kilometers (47,845 lane-miles) of highway on a continuous basis. Within 2 years, pavement conditions across the entire state can be appraised.

Every 2 years, Caltrans publishes a "State of the Pavement" report on the basis of the roughness data that it has collected. Each Caltrans district uses the report to assess priorities for pavement rehabilitation; it also plans rehabilitation projects for 0.8-kilometer segments of highway on the basis of measured roughness and the signs of distress observed by manual raters.

BENEFITS

Ride-score collection using road-roughness meters required frequent and rigorous calibrations of the meters and manual entry of roughness data into a laptop computer. With the profile measurer, calibrations are few in number and easily accomplished, and no manual data entry is necessary. Because profile measurers measure the road profile directly, calculating the International Roughness Index (IRI) for HPMS-test sections—another new FHWA requirement—is also a simple

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matter: mathematical equations of motion for a car simulation are solved using the measurement of the longitudinal pavement profile as the input to the simulation.

Caltrans estimates that the overall productivity of its road-roughness meters was about 145 lane-kilometers (90 lane-miles) per day. By contrast, the base productivity of its profile meter is about 320 lane-kilometers (199 lane-miles) per day. After factoring in the time it takes to process data to calculate a usable IRI, estimated overall productivity is about 250 lane-kilometers (155 lane-miles) per day [320 lane-kilometers minus 40 lane-kilometers (25 lane-miles) for post-collection data processing and 30 lane-kilometers (19 lane-miles) for downtime]. This figure represents a productivity increase of 72 percent.

While productivity is increasing, the cost of collecting and processing roughness data is decreasing. With road-roughness meters, the cost was $2.14 per lane-kilometer; with the profile measurer, the cost is approximately $1.20 per lane-kilometer. As bugs are worked out of the new system, the latter figure should drop to $1.10 per lane-kilometer, assuming a decrease in downtime from the current 10 percent to 5 percent.

The profile measurer offers other advantages. It improves the quality and consistency of roughness data and generates profile data, which road-roughness meters currently cannot provide. Because profile data indicate a road surface's actual contour, not just its overall roughness, they are valuable in identifying strategies for rehabilitating pavement. According to Caltrans, these potential benefits far outweigh the direct costs associated with operating its profile measurer.

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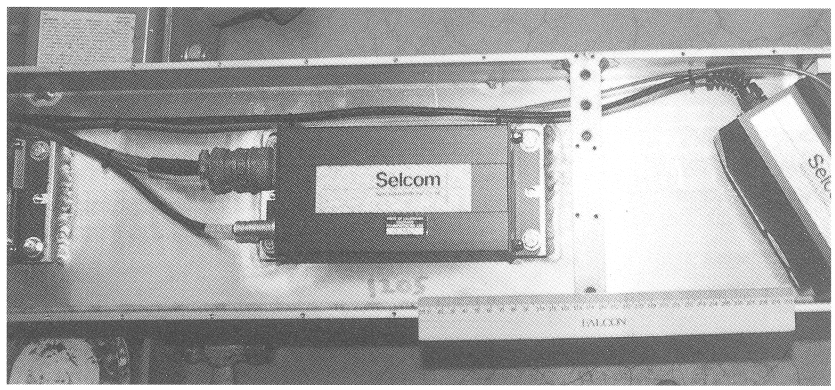

The profile measurer used by Caltrans consists of a van equipped to measure longitudinal pavement profile while traveling at highway speeds. The van's front bumper (shown here with the cover plate removed) houses laser sensors and accelerometers.