PAVEMENT TECHNOLOGY ADVISORY
- DATA COLLECTION VEHICLES -
PTA-T2

INTRODUCTION

The Illinois Department of Transportation (IDOT) owns two Data Collection Vehicles (DCVs) that aid in data collection for IDOT's Pavement Management System. The Bureau of Materials and Physical Research (BMPR), in cooperation with the Office of Planning and Programming (OPP), uses the DCVs to collect information on the entire state-maintained highway system, as well as other pavements, as requested. These data can be used to identify rough roads, areas of high rutting, and to assist in monitoring ride quality. Since 1990, Illinois' entire interstate system has been surveyed annually using DCVs.

DCV SYSTEM

DCVs provide a safer and more effective tool than manual surveys. DCV units also help target field operations to use IDOT resources effectively and efficiently.

Figure 1: Data Collection Vehicle (DCV)

Each DCV can collect digital images on and along the highway, in addition to sensor data for measuring rutting, roughness, and faulting. Six cameras are used to record images from the roadway, as shown in Figure 1. Three front-facing perspective cameras capture a panoramic view of the pavement, shoulders, and surroundings, while a single rear-facing camera captures images of the roadway behind the DCV. Two pairs of cameras aimed directly at the pavement collect 6-foot snapshots of the pavement surface. One pair is mounted in front of the vehicle and the other is mounted behind the vehicle, allowing the operator to select the surface view with optimal lighting. The perspective cameras collect an image approximately every 18 feet, while the surface-view cameras collect images approximately every 6 feet to provide a nearly continuous view of the pavement.

INFORMATION PROCESSING

All six images are captured as JPEG images and stored on removable hard drives for transfer to a workstation, where they can be viewed and analyzed. The images are synchronized with sensor data by storing a common time-code as part of the filename.

Sensor data for roughness, rut depth, and faulting are saved to a computer in the DCV. A database of sections is installed in the DCV and used by the crews to delineate survey sections. The data can be viewed later and manipulated at workstations to: calculate sensor data for almost any distance interval; add Condition Rating Survey (CRS) values; and/or edit data segments.

WORKSTATIONS

There are 15 workstations available for use by IDOT personnel at different geographic locations throughout the state. Each district office has one workstation. BMPR and OPP each have 3 workstations. Distress surveys and inventories of signs, bridges, and guardrails may be compiled without leaving the office. A historical database containing image and sensor information is maintained so that the performance of highway segments may be monitored over time.

ROUGHNESS DATA

The International Roughness Index (IRI) was created to provide a common roughness rating for pavements worldwide. IRI is actually calculated from a mathematical model that simulates a vehicle's suspension response to roughness. The model is referred to as a "quarter car simulation" because it represents the roughness response created by one wheel of a typical passenger vehicle, as illustrated in Figure 2:

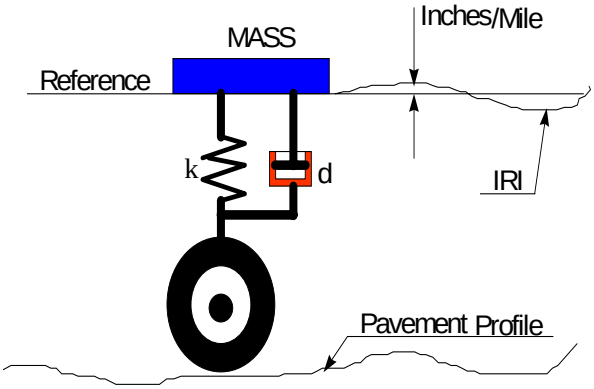

Figure 2: Quarter Car Simulation

A measured pavement profile is necessary to calculate the IRI. IDOT DCVs use a laser mounted to the vehicle to measure the pavement profile, which is then used as an input for the quarter car simulation. A spring constant (k) and dampening factor (d) are used to mimic the springs and shock absorbers of a car. The output is the IRI value, representing the sum of vertical deviations from a reference line (in inches), divided by the overall length of the pavement segment (in miles). Higher values of IRI correspond to rougher pavement.

In the five year period from 1999 to 2003, the smoothest 25% of all Illinois interstate pavements showed IRI values less than about 67 inches per mile, and the roughest 25% showed IRI values greater than about 118 inches per mile. The system-wide average IRI was about 99 inches per mile.

RUT DATA

Rutting in hot-mix asphalt (HMA) pavements is estimated using five lasers mounted in the front bumper of the DCV. One sensor is located in the middle, one in each wheelpath, and one on each side oriented at a 45º angle, as shown in Figure 3:

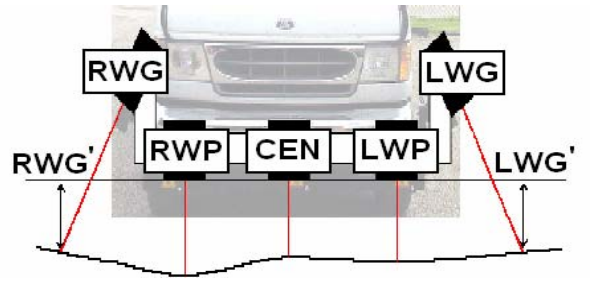

Figure 3: DCV Laser Configuration

Rut Depth Calculations:
Left Rut = LWP – (CEN + LWG')/2
Right Rut = RWP – (CEN + RWG')/2
Center Rut = (RWP + LWP)/2 - CEN

Rut depth is calculated where RWP, CEN, and LWP are the respective distances between the right wheelpath, center, and left wheelpath sensors and the pavement surface. The right wing (RWG) sensor and left wing (LWG) sensors are used to determine pavement surface heights (RWG' and LWG') at the edges of the test lane.

The current 5-sensor configuration allows separate rut measurements for each wheelpath. Before 2002, IDOT DCVs with a 3-sensor configuration provided only the estimated "center rut" by comparing the height at the center of the pavement with the average depth in the wheelpaths. For the purpose of comparing current and historical data, the center rut measurement is stored in a pavement management database.

In the five year period from 1999 to 2003, the least rutted 25% of all Illinois interstate pavements showed average rut depth values less than about 0.04 inch, and the most rutted 25% showed average values greater than about 0.16 inch. The system-wide average rut depth was about 0.11 inch.

Locations measured by a DCV that have average rut depths exceeding 0.35 inch are considered high severity rutting locations by IDOT. If high severity rutting is detected by a DCV, the pavement should be reviewed in the field with an approved straight edge and manual rut gauge available from BMPR. Corrective action is recommended if high severity rutting is confirmed with manual rut measurements. Contact BMPR for assistance in determining rutting severity levels and appropriate corrective methods.

FAULT DATA

Faulting in concrete pavements is estimated from DCV sensor data by comparing the difference in successive height measurements taken every 3 inches along the roadway. Measurements are taken at the left and right wheelpaths, and at the center of the lane. A computer calculates the statistical variance of all recorded height differences. If all three sensors show height differences exceeding the variance at the same location, then the average height difference is recorded as a fault. Adjustments can be made for pavements having skewed joints. The identified faults over a length of roadway are summed and divided by the total number of occurrences. If only one fault of 0.25 inch is recorded over 10 miles of pavement, then the average faulting for that section is reported as 0.25 inch.

IDOT considers pavements with average faulting in excess of 0.5 inch, or individual faults in excess of 0.75 inch to be high severity locations. If high severity faulting is indicated by a DCV survey, the pavement should be reviewed in the field with an approved manual fault gauge available from BMPR. Corrective action is recommended if high severity faulting is confirmed by manual measurements. Permanent patches may be adequate to correct isolated severe faults. Widespread severe faulting may require an extra-thick HMA overlay. Contact BMPR for assistance in determining faulting severity levels and appropriate corrective methods.

TESTING REQUESTS

Currently, IDOT DCVs record interstate pavements annually and non-interstate pavements biennially. As such, BMPR has only a limited amount of test time available for special requests from districts and local agencies. The latest IRI, rutting, faulting, and CRS information for specific route segments is accessible in the Illinois Roadway Information System (IRIS) database. Please check with the district or OPP to determine if current information in IRIS will meet your needs. If testing is needed, please prepare the following information and contact BMPR at the address provided:

- Marked route (include mileposts)
- Contract and section number (if available)
- Detailed Location map (REQUIRED) (e.g. cover map from plans)
- Pavement type
- Name and telephone number of test requester
- Mix design (on new construction or rehabilitation projects)
- MISTIC ID number
- ADT

Please direct questions or requests to:

Pavement Technology Engineer
Bureau of Materials and
Physical Research
126 East Ash Street
Springfield, IL 62704-4766
(217) 782-7200

Note: Before submitting a request, please contact the Pavement Technology Engineer for testing availability. If testing is available, please submit the request as far in advance as possible to allow time for scheduling and data analysis.