Historical Performance Evaluation of Iowa Pavement Treatments Using Data Analytics

tech transfer summary

This project analyzed Iowa pavement condition data by evaluating treatment performance and estimating service life.

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RESEARCH PROJECT TITLE
Historical Performance Evaluation of Iowa Pavement Treatments Using Data Analytics

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The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.

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Background

The highway trust fund, established in 1956, is used to fund surface transportation programs using user taxes. In 2013, the Federal Highway Administration (FHWA) received about $41 billion for the construction, reconstruction, and improvement of highways and bridges.

About 32 percent of these FHWA funds were used for road resurfacing, rehabilitation, and reconstruction while only 5 percent were used for new construction. This percentage of spending on road rehabilitation and resurfacing highlights the importance of these activities and indicates that the United States transportation network has reached a mature state where maintenance and rehabilitation are more important than new construction.

Several rehabilitation treatments are currently available to restore the functional and structural performance of existing pavement. The choice to apply a specific rehabilitation treatment is governed by several factors, such as the existing condition of the pavement, available funds, and overall treatment performance.

Problem Statement

Treatment performance significantly affects the economic value of the pavement and is therefore considered an influential factor in the selection process when several treatments are technically feasible. As such, a realistic treatment performance evaluation is needed to improve existing transportation asset management practices.

Project Objectives

- Evaluate the performance of the most-used pavement treatments in Iowa by considering different parameters such as type of treatment, treatment thickness, traffic, and pavement type
- Estimate a service life for each treatment based on the observed historical data
- Compare the performance of different treatments under similar conditions

Research Methodology

The study included four major steps.

1. **Performance of different pavement treatments applied in Iowa were evaluated.**

   In this step of the study, a framework was developed that spatially integrated the needed pavement data from two Iowa Department of Transportation (DOT) databases: the pavement treatment contracts database (offered for use by the Iowa DOT Office of Contracts) and the raw pavement condition database, which contained most of the needed information regarding the highway system such as pavement type, thickness, materials, treatment projects, and traffic. Information regarding treatment type and project length was integrated from the contracts database.

2. **Performance of pavement treatments was evaluated and tested using statistical significance testing.**

   Since all rehabilitation treatments evaluated in this study had an asphalt concrete (AC) surface, in this step, distresses for pavement with AC surfaces were considered as potential performance indicators, which included rut depth, International Roughness Index (IRI), and alligator, transverse, and longitudinal cracking (both on and off the wheelpath). All segments analyzed in this study were investigated based on the individual distress data provided by the Iowa DOT. Each segment was categorized and placed among four groups based on their average annual equivalent single-axle load (ESAL).

3. **Pavement treatment service life was estimated.**

   In this study, the performance evaluation of treatments was conducted by comparing the post-treatment against the pretreatment condition to determine service life. However, service life was terminated if a performance jump was observed during the life of the treatment, which indicated the application of another maintenance or rehabilitation treatment.

4. **Treatment performance was evaluated in terms of ride quality to investigate whether a specific pavement treatment was superior to others under similar conditions.**

   The analysis was conducted using a one-way analysis of variance (ANOVA) test and t-test.

Key Findings

- Almost all distress propagation over time had irregular patterns and abrupt changes except for IRI. For IRI, pavement deterioration was very consistent when compared to other distresses.

- The use of overall condition indices such as the Pavement Condition Index (PCI) or pavement condition rating (PCR) may yield misleading results because of the irregular deterioration pattern of some segments.

- Treatments did not perform well in retarding rutting deterioration when compared to ride quality deterioration.

- For rutting, the average service life of pavement was generally lower than the average service life in terms of ride quality.

- In terms of ride quality, hot-mix asphalt (HMA) resurfacing with cold in-place recycling (CIPR) outperformed HMA resurfacing and HMA resurfacing with milling when traffic loadings were low.

Implementation Readiness and Benefits

- The distress deterioration patterns discovered could help pavement managers understand how distress propagation fits into different severity levels.

- The evaluated estimated service lives of each pavement treatment will benefit other researchers.

Pavement deterioration was analyzed at the distress-level scale. As such, deterioration curves were presented for each segment and for each distress. This research resulted in an important finding concerning performance indicators—that IRI and rutting are the most consistent. The research provides beneficial insights into how individual distresses propagate over time and how these trends could affect the treatment evaluation process.

The study also highlighted the many technical issues associated with the management and recording of pavement data. Data management practices need to be improved in order to clarify ambiguities. Additionally, it was found that the utilization of collected data can be significantly improved by recording missing data such as in-house maintenance projects.

Recommendations

First, maintenance and rehabilitation project data needs to be recorded accurately. Many projects found in this study had inaccurate latitude and longitude data, as the location data provided did not coincide with the known project route.

It is recommended that multiple points with latitudes and longitudes within narrow proximity of the specified project location be collected. This would allow the agency to quickly detect and discard inaccurate location data.

In addition, the location data should represent the midpoint of the project. If this is not the case, it is recommended that location data should be described using textual information like starting point, end point, midpoint, or unspecified.

Maintenance and rehabilitation data should also include key pieces of information that are needed for pavement performance analysis. Additionally, other overlay projects should include inputs that affect the performance of pavement such as binder content and type and air void percentages. Also, basic project information such as overlay and milling thickness should be recorded appropriately.

The pavement distress propagation for many sections in this study had irregular patterns. These irregular patterns were a result of unrecorded in-house maintenance projects and distress recording practices.

For example, the Iowa DOT recorded sealed cracks as low severity cracks. It is recommended that agencies instead record sealed cracks separately or record the percentage of sealed cracks. Future pavement performance data can be better utilized at the distress-level scale if this information is recorded.