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DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

TECHNICAL SUMMARY

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PROJECT COST:
$118,834

Prioritizing maintenance on the pavement network based on costs and benefits can be a challenge.

Optimizing Pavement Network Maintenance

What Was the Need?

Maintaining Minnesota's 14,000 miles of pavement is challenging, especially with the growth in traffic volume resulting in system needs that exceed available funding. MnDOT is continuously improving its efforts to optimize resources while providing the maximum possible level of service to drivers. Doing so requires appropriate measures representing pavement conditions and costs over a range of management choices, and accurate models to predict pavement performance and deterioration rates.

New ways to characterize pavement conditions and methodologies to determine the optimal maintenance schedule for individual road segments will allow planners to optimize resources while providing the highest possible ride quality across the pavement network.

Remaining service life (RSL) is a traditional measure used by MnDOT to estimate the years remaining until a road's ride quality deteriorates to the point where the pavement needs significant rehabilitation or replacement. Previous research set out to develop RSLs applicable to both highways and bridges. However, using RSL alone is insufficient for determining pavement investment strategies.

Prior to the end of a road's service life, interim conditions such as roughness, cracking or rutting may benefit from maintenance alternatives besides substantial rehabilitation or replacement. Because RSL was not intended to inform the timing and types of a range of road maintenance policies, other measures were needed to optimize pavement investments.

Maintaining pavement condition over the course of its life may be more cost-effective over the long term than waiting until it needs to be replaced. Knowing when pavement segments will need which level of service would support more effective, efficient and consistent maintenance.

What Was Our Goal?

The goal of this research was to collect data to characterize pavement condition and develop methodologies to analyze the time and funding needed to provide the highest possible level of service with available resources across the pavement network. MnDOT needed these methods and tools to optimize pavement management decisions.

What Did We Do?

The project team first worked with MnDOT's Office of Materials and Road Research to understand the current pavement management system and to obtain historical data on pavement conditions across the state. This data includes measures of pavement roughness, rutting, cracking and other pavement distresses. One indicator used by MnDOT is ride quality index (RQI), in which a higher value represents a smoother road. MnDOT develops RQI by combining information obtained from an inspection vehicle that measures up-and-down movement as the vehicle moves along the road with actual driver opinions about ride quality.

Investigators then calculated three metrics for MnDOT to characterize pavement condition:

- Percent remaining service interval, originally recommended by the Federal Highway Administration, measures time remaining until a defined maintenance or construction activity is required.
- Asset sustainability ratio measures the sustainability of investments in pavement by comparing pavement replenishment (the annual average life added to the network with each maintenance

continued

"This work will definitely benefit the long-term health of our pavement network—and Minnesota drivers—by helping us make the most efficient and effective investments."

—Glenn Engstrom,
Director, MnDOT Office of Materials and Road Research

"This research will allow MnDOT to use its existing data and factor in multiple variables, which it couldn't do before, to optimize funding spent on managing pavement."

—Mihai Marasteanu,
Professor, University of Minnesota Department of Civil, Environmental and Geo-Engineering

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One metric used to describe pavement condition is the RQI. The road on the left, with limited surface deterioration, has an RQI of 3.2 while the RQI of the road on the right is 1.6.

activity performed) with pavement wear (the annual average life consumed as a function of lane or vehicle miles traveled).

- Deferred preservation liability estimates the funding required to address the cumulative backlog of deferred pavement maintenance.

Mathematical modeling enabled investigators to predict pavement performance and deterioration rates based on factors such as the functional roadway classification, pavement base thickness and last maintenance treatment.

Lastly, adding various maintenance activities to the model and using an optimization algorithm, investigators created a tool that determines the optimal repair sequences for any given pavement section.

What Did We Learn?

This research resulted in new measures of pavement condition and a spreadsheet tool allowing users to compare costs and benefits of alternative maintenance treatments. Inputs include measures of pavement characteristics, costs of repair and the economic value associated with pavement condition measured as RQI.

With the output, pavement managers can prioritize spending in earlier stages of pavement life, reducing greater future rehabilitation or reconstruction costs. The tool demonstrates that if rehabilitation is done too soon, part of the pavement life is wasted; if rehabilitation is done too late, the repairs will be more costly.

What's Next?

MnDOT expects to use this research to inform its evaluations of pavement investments. The three new pavement condition measures can be used immediately. The spreadsheet tool may require more adjustments to include, for example, additional potential maintenance activities.

The economic value associated with RQI is a primary parameter of the analysis as it represents the benefit against which costs are compared. However, more exploration is needed to sufficiently monetize RQI.

This Technical Summary pertains to Report 2022-02, "Remaining Service Life Asset Measure, Phase 2," published February 2022. The full report can be accessed at mndot.gov/research/reports/2022/202202.pdf.