



RESEARCH SERVICES SECTION

TECHNICAL SUMMARY

Technical Liaison:

Paul Kivisto, Mn/DOT
paul.kivisto@dot.state.mn.us

Administrative Liaison:

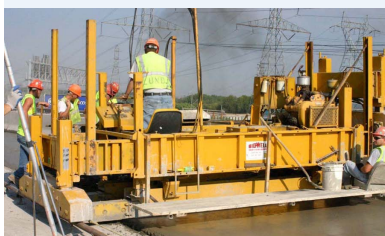
Ann McLellan, Mn/DOT
ann.mclellan@dot.state.mn.us

Principal Investigator:

Arturo Schultz, University of Minnesota

PROJECT COST:

\$137,500



Reoverlay can be a cost-effective fix for deteriorated decks. In the final step (above), the new overlay is applied.

Repair or Replace Concrete Bridge Decks? Methods to Select the Lowest Cost Alternative

What Was the Need?

In Minnesota, the use of low-slump concrete overlays began in the mid-1970s and rapidly gained acceptance as an efficient way of protecting and rehabilitating concrete bridge decks. “Low slump” refers to the relatively low water/cement ratio in this concrete, which gives it superior strength and durability. Between 1974 and 1981, hundreds of new and existing bridges in the state received these overlays, and their decks are now beginning to reach the end of their service lives.

Assuming a cost of \$40 per square foot to replace the estimated 8.5 million square feet of these decks, the cost would exceed \$300 million. Available technical literature about managing repair or replacement of bridge decks needed to be applied to Minnesota’s bridges to make cost-effective economic decisions about which decks to repair to acceptable condition and which to replace.

What Was Our Goal?

The objective of this research was to enable the best use of taxpayer funds by providing Mn/DOT with economic strategies for guiding the maintenance and replacement of these bridge decks.

What Did We Do?

Investigators first reviewed previous research studies on concrete overlay and deck performance and identified several physical and geometric variables that potentially affect the performance and deterioration of LSC overlays and decks. Researchers collected data from the National Bridge Inventory database and Mn/DOT about the characteristics and deterioration history of bridges that received the overlays. Data collected from 492 Minnesota bridges comprised the data set.

Researchers then performed a statistical analysis to determine which of the variables actually had significant effects on deck deterioration. They calculated average deterioration rates for each bridge based on deck condition data spanning from 1983 to 2003. The results of this analysis were used to divide the bridge group into three subgroups that displayed similar deck deterioration rates to improve the accuracy of calculations of deterioration and service life. A service life plot (deterioration curve) showing deck condition rating over time was constructed for each group.

Finally, researchers performed present value cost analyses to price various sequences of repair and replacement actions. These analyses drew upon the deterioration curves; Mn/DOT cost data for typical deck repair and replacement procedures; and values for inflation (4 percent), discount rate (12 percent) and time frame (20 years). A spreadsheet and Visual Basic program were created to perform an analysis for each bridge in the data set under three different scenarios that maintained each deck above a minimum acceptable [NBI condition rating](#) (4, 5 or 6). Based on the results, researchers created a flowchart for each of the three ratings to illustrate the probable least-cost repair/replace-ment strategies for achieving the ratings for any of the bridges.

“This study provides helpful information to fall back on when we’re deliberating about using a particular maintenance action.”

–Paul Kivisto,
Mn/DOT Metropolitan
Region Bridge Engineer

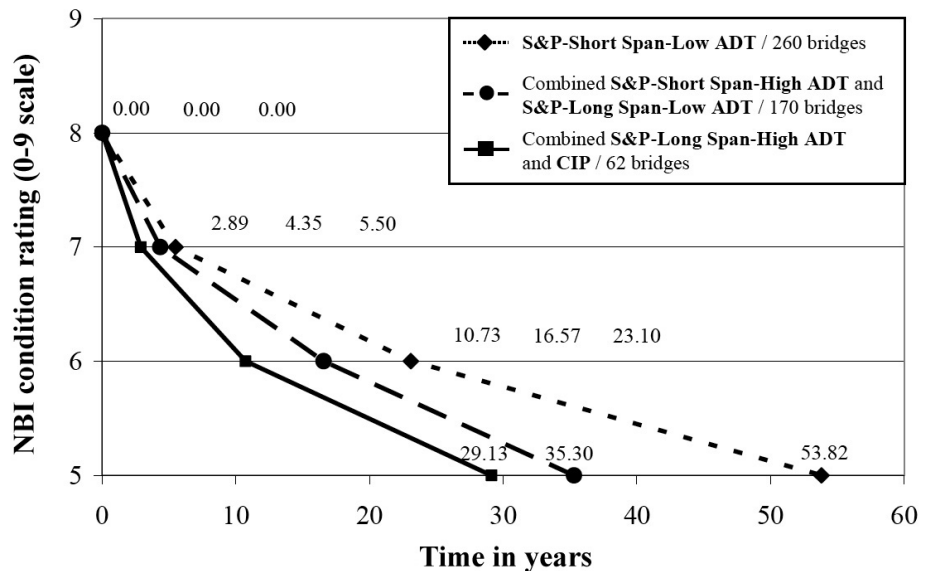
“The study results significantly advance the management of concrete bridge decks with low-slump concrete overlays.”

–Arturo Schultz,
Professor, University of
Minnesota Department
of Civil Engineering

Produced by CTC & Associates for:

Minnesota Department
of Transportation
Research Services Section
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
(651) 366-3780

www.research.dot.state.mn.us



The deterioration curves for three groups (representing common deck deterioration levels) of bridges show how NBI deck condition ratings declined over time.

What Did We Learn?

Researchers found that the most significant variables affecting deterioration were superstructure material type, maximum superstructure span length and average daily traffic.

Results of the economic analysis indicate that approximately 12 percent of the bridge decks would need repair to maintain ratings above 4, about 33 percent would need repair or replacement to stay above 5, and all of the decks would need repair or replacement to stay above 6. Based on current prices, the project report suggests that repair is preferable to redecking if repair can elevate a deteriorated deck to an acceptable rating. Which repairs to use and when depends largely on the deck’s current condition, its deterioration curve and the minimum acceptable rating. Flowcharts were prepared to highlight the least-cost repair strategies for each assumed value of the minimum acceptable rating; specific recommended strategies included the following trends:

- To maintain ratings above 4, use reoverlay for repair after the deck has deteriorated to that level. A secondary action—reoverlay or redecking—may be needed.
- To stay above 5, redeck if the initial rating is 4; reoverlay or mill and patch decks currently at 5 or 6. A secondary action may be needed.
- To maintain ratings above 6, reoverlay or mill and patch with a possible secondary action.

What’s Next?

The Mn/DOT Bridge Office is using the results of this study as part of its process to identify bridge projects to undertake over the next four to five years. Mn/DOT is also using the results to help guide decisions on when to implement a particular maintenance strategy: reoverlay, mill and patch, or redeck.

Researchers observed that the study methodology could also be used to develop least-cost repair strategies for other bridge elements and to develop deterioration curves for service life estimation and life-cycle modeling of bridge systems.

This Technical Summary pertains to Report 2007-14, “Determining Economic Strategies for Repair and Replacement of Low Slump Overlays of Bridge Decks,” published May 2007. The full report can be accessed at <http://www.lrrb.org/PDF/200714.pdf>.