



MONTANA
Department of
Transportation

Implementation Report

DEVELOPMENT OF DETERIORATION CURVES FOR BRIDGE ELEMENTS IN MONTANA

<https://www.mdt.mt.gov/research/projects/structures/deterioration-curves.aspx>

Introduction and Purpose

The Federal Highway Administration (FHWA) has established measures for state departments of transportation to develop an asset management plan that includes deterioration forecasting to improve or preserve bridge conditions. The primary objective of this research was to support Montana’s bridge management system by developing state-specific deterioration curves for bridges owned by the Montana Department of Transportation (MDT). The analysis to develop the deterioration curves used the National Bridge Inventory (NBI) data in combination with maintenance targets estimated by MDT. The deterioration curves and their parameters were calculated using a methodology that is compatible with AASHTOWare’s Bridge Management software (BrM).

The inspection data analysis used a Weibull distribution to calculate the shape factor

(β) and median years in condition state 1 (CS-1) for the deterioration curves of six different bridge elements selected by MDT. These input parameters were used with BrM to define deterioration trends for each element. The calculated deterioration curves for all elements predicted slower deterioration rates than those using BrM default parameters. For steel girders, concrete abutments, and steel culverts, the slower deterioration rates were in reasonable agreement with selected maintenance targets established by MDT. For reinforced concrete decks, prestressed concrete girders, and concrete culverts, the deterioration curves predicted much slower deterioration rates than MDT’s experience. For these elements, the input parameters were refined to represent deterioration targets more closely. Differences in deterioration rates of concrete decks across Montana’s five maintenance districts were also identified.

Results of this research will benefit state departments of transportation by providing baseline deterioration curves

and trends that can be used to improve their optimization analyses. Recommended deterioration parameters for different bridge elements and transportation districts will enable MDT engineers to make efficient resource allocations for the selection and timing of bridge preservation, rehabilitation, and replacement projects.

Implementation Summary

The objective of the implementation task of the research was to evaluate the developed deterioration curve parameters with optimization analyses in BrM. Because maintenance cost information and triggers are currently under development by MDT, a zero-cost optimization (ZCO) analysis was used to investigate the deterioration of the six elements over a 100-year time period.

Results of the ZCO are consistent with the trends observed in the deterioration curve development of this project. Parameters determined in this research by the Western



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Transportation Institute (WTI) result in slower deterioration trends than the default parameters in BrM and better reflect the data collected by MDT. Nine ZCO analyses were conducted that considered the contribution of deterioration from all bridge elements, the combined contribution of the six elements considered in this research, and the individual contribution of the six elements. Results of these analyses predicted a slower deterioration trend than trends calculated using the default parameters and was consistent with the results of the individual deterioration curves.

Based on the study results, five recommendations were made to continue the development of deterioration curves and to support MDT's implementation and refinement of their bridge management system.

Implementation Recommendations

Recommendation 1:

Use the BrM input parameters determined in this research for optimization analyses to reflect Montana's bridge deterioration rates more accurately. These input parameters are statistically derived from Montana's NBI element-level inspection data and have been refined using MDT's estimated maintenance targets and observed trends from the inspection data.

MDT Response:

MDT plans to implement the deterioration parameters developed by WTI for Montana's BrM system.

Recommendation 2:

Environmental factors within BrM can be used to adjust the deterioration rates of reinforced concrete deck elements to reflect subtle differences observed in the five MDT maintenance districts. However, additional research is needed to verify the effect of these environmental factors on deterioration of other bridge elements.

MDT Response:

MDT plans to implement the environmental factors in tandem with the deterioration curves. Additional research will be conducted in the future to identify the best approach. It will be beneficial to have the environmental factors within BrM as an option for analyses where some elements are not included. Regional environmental factors will be valuable as an alternative deterioration adjustment that can be used for specific or targeted optimization analyses.

Recommendation 3:

Identify and implement a method to document the date and type of maintenance activity in the inspection database. Accurate maintenance and rehabilitation data will allow enhanced dataset filtering to target pure deterioration and identify the efficacy of specific maintenance activities.

MDT Response:

The new specification for the national bridge inventory (SNBI) includes data fields that more accurately record and document project history and work events over the bridge service life. MDT agrees this maintenance

history will be beneficial to future projects and deterioration curve development.

Recommendation 4:

Continue recording and prioritize NBI component-level data using a scale of 0 to 9. New BrM optimization strategies are available that are based on these component-level ratings. Results of this research have identified challenges with using less-granular element-level condition state ratings from 1-4 for estimating bridge deterioration.

MDT Response:

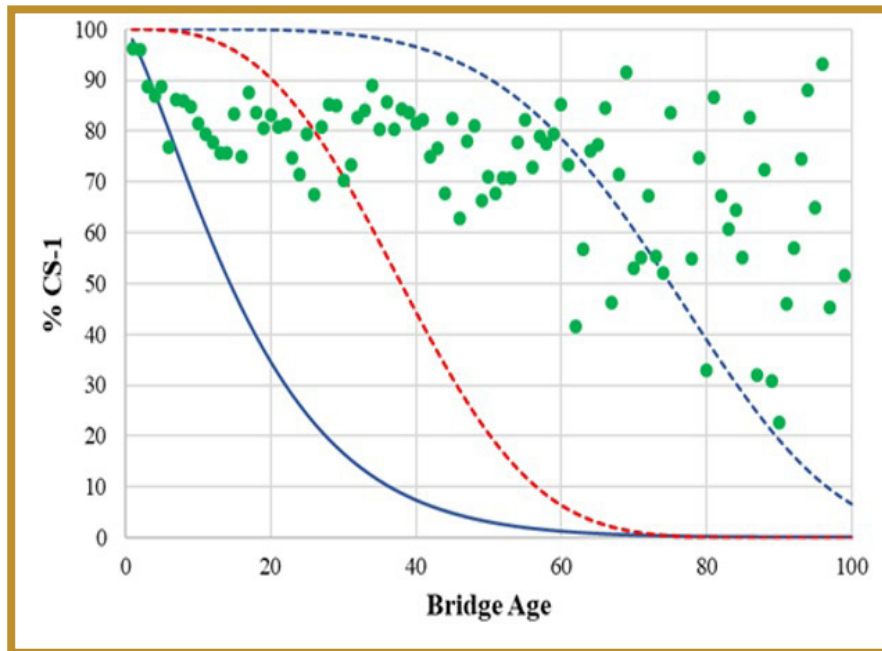
Even though 1 to 9 is a larger scale, most bridges are rated from 4 to 7, reducing the actual scale of the data. MDT will continue recording component-level data as it is required by FHWA inspections.

Recommendation 5:

Create recommendations and guidance for bridge inspection data entry. Consistent data entry will reduce potential variations in deterioration trends that may be caused by variations in inspector objectivity.

MDT Response:

Some of the changes made in the recent SNBI will improve the consistency of data entry. However, MDT also identifies the need to implement additional standards and provide more guidance for inspectors to improve consistency across the state. MDT Bridge Bureau is currently developing a 5-year improvement plan to work toward more consistent inspection data, and the appropriate staffing levels to develop and support the plan.



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