

**Proposed Transportation Pooled Fund (TPF) Study - Bridge Element Deterioration for Mid-west States**

**Background:**

Asset management (of bridges) is a strategic and systematic process of developing, operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis based upon quality research, information and analysis. Asset management will identify a structured sequence of preservation, maintenance, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair (SOGR) over the lifecycle of the assets at minimum practicable cost. Fundamental to achieving this as a process is the current condition of bridges from inspection data, criteria to identify work actions based on condition thresholds, and the ability to deteriorate current conditions to identify future needs and work actions.

Asset management connects user expectations for system condition, performance, and availability with data-driven system management and investment strategies. Bridges are inspected at regular intervals and inspection information collected in the National Bridge Inventory System (NBI) condition data for many components of the bridges (deck, superstructure, substructure, and others). This NBI data has been collected since 1992 for structures. Some DOTs had collected Commonly Recognized (CoRe) Structural Elements since the early 1990s. FHWA has required State DOTs to use bridge element level inspection in addition to NBI inspection starting in April 2015. The element level inspection provides for more granular (quantified) information on the magnitude and extent of deterioration of bridge elements as well as the causes of the deterioration (defects).

The identification of needs based on current conditions is fundamental to current operations of many DOTs. Each DOT has criteria to identify work actions based on common conditions states of their bridges.

As such, many Mid-west DOTs are required to manage their bridge assets in such a manner that it is necessary to have insight to rates of deterioration to be able to anticipate future work actions. Forecasting future condition based on accurate current condition and deterioration rates provides the ability to identify, prioritize, plan, budget, and implement work in a systematic manner.

Deterioration curves need to be developed through data analysis and research that are reflective of the Mid-west environment (winter/summer), operations practices (application of deicing chemicals and representative rates of application), maintenance practices, and design/construction details. In addition, these deterioration curves need to be specific and focused to address key transition points in a life of bridge structures so that accurate determination of timing of work actions is possible. These deterioration models must be compatible and compliment the effectiveness of various Bridge Management Systems (BMS) used by agencies (BrM, Agile Assets, and other).

**Objectives:**

The objective of this pooled fund research is to have multiple Mid-west DOTs pool resources and historic Mid-west DOT bridge data related to element level deterioration, operation practices, maintenance activities, and historic design/construction details. This data will provide the basis for research to determine deterioration curves. A select number of deterioration curves will provide needed utility for the time-dependent deterioration of bridge elements to be used in making estimates of future conditions and work actions. This effort will pool data and through the analysis and research processes create results that will improve accuracy of various bridge management and asset management applications that the member DOTs use (BrM, Agile Assets, and other).

This study will be sequenced into three tiers based on the priorities of the DOTs:

**Tier 1 National Bridge Elements (NBE) & National Bridge Inventory)**

* Develop element level deterioration curves for Reinforced Concrete Deck from data that will provide the basis for research to determine the deterioration curves
* Develop element level deterioration curves for Reinforced Concrete Slab from data that will provide the basis for research to determine the deterioration curves
* Develop deterioration curves for NBI items from data that will provide the basis for research to determine the deterioration curves
* Develop element level deterioration curves for Reinforced Concrete Deck after a major preservation activity such as mill and overlay with rigid concrete wearing course
* Develop predicted improvement in condition of Reinforced Concrete Deck element after a major preservation activity such as mill and overlay
* In addition to probabilistic deterioration curves, also develop deterministic deterioration curves that better may fit with field observations

**Tier 2 Bridge Management Elements (BME)**

* Develop element level deterioration curves for each type of wearing surface (bare concrete, sealed concrete, thin polymer overlay, PPC overlay, ridged concrete overlay, Polymer Modified Asphalt overlay, and asphalt overlay with membrane) from data that will provide the basis for research to determine the deterioration curves
* Develop element level deterioration curves for Strip Seal Deck Joints and Modular Deck Joints from data that will provide the basis for research to determine the deterioration curves
* Determine defect level deterioration curves that describe defect development and progression (e.g., cracking and delamination)
* Develop defect level deterioration curves for Paint system (protective steel) effectiveness
* Develop defect level deterioration curves for Steel Girder corrosion, and correlate to Paint system effectiveness; specifically, how long from new paint to 75% and 50% effective and end of life
* Develop element level deterioration curves for substructure elements in harsh environments (i.e., pier caps under expansion joints, pier columns in spray zone from snow plows, etc.)

**Tier 3 (similar Agency Defined Elements (ADE) & Inspection related)**

* From research results, determine what type of inspection information (nondestructive testing) Mid-west DOTs have that translates into information on element level defects (GPR, Thermograph, other)
* Use DOT past data and research and analysis results to determine the reliability of Infrared Thermography and Ground Penetrating Radar (GPR) for defect reporting (to describe delamination and deterioration) of concrete bridge decks

**Scope of Work:**

The anticipated duration of this study will be **24 months.** It is mainly the identification, collection, and analysis of existing information from the partner DOTs that will drive the schedule. We would like DOT Partners to participate for two years. This effort will stay abreast of and coordinate with other national efforts (AASHTO BrM and FHWA LTBP) to ensure efficiency and effectiveness in integration of results of this project into current BMS systems.

1. Work with DOT partners to identify and prioritize limited number of bridge elements and defects to develop deterioration models and curves from data that will provide the basis for research to determine the deterioration curves.
2. Data sources:
   1. FHWA can provide past submittals of NBI and NBE information
   2. Participating states in the study will provide access/copies of their bridge inspection data
   3. Non-participating states in the Mid-West Bridge Preservation Partnership will be encouraged to provide access/copies of their bridge inspection data
3. Contact FHWA Long Term Bridge Preservation to collect relevant data to analyze.
4. Use data to provide the basis for research to produce first generation of select deterioration curves with documented methodology to update these curves and add additional element curves.
5. Identify nondestructive technologies (NDT) to correlate historic element information (past NDT results) with actual field conditions.

**Comments:**

**The project was developed with the support of the 14-state Mid-West Bridge Preservation Partnership; while the research will be focused on the Mid-West, participation by states outside the region with similar winter/summer environmental conditions would be welcome.**

Commitment level per year and target to launch the project:

* The project seeks at least five state DOT partners committing $20,000 per year for two years.
* $100,000 is the minimum amount in commitments needed to launch the project—to cover the first year of activity/contracting.

A waiver for the non-Federal matching requirement for SPR-Part B funding will be requested.

**Subjects:** Bridges, Bridge Inspection, Other Structures, and Asset Management, Deterioration Curves