Chapter

4

Condition Rating and Measurement Systems

Background Information on Condition Rating and Measurement Systems

Understanding Pavement and Bridge Condition Data

The key road performance measure used by MDOT is called Remaining Service Life (RSL). It is defined as the estimated number of years until it is no longer cost effective to perform preventive maintenance on a pavement section. MDOT combines pavement RSL into categories according to ranges of RSL values see table 1, page 2-9, RSL Categories and Rating. For example, Category I pavements have RSL values of 0-2 years, which MDOT identifies as poor.

RSL and Repair Methods

Roads with RSL of 0-2 years (Category I pavement) should be considered for Rehabilitation or Reconstruction (R&R), while roads with RSL of 3 to 25 (Category II+) years should be considered as candidates for Capital Preventive Maintenance (CPM) or Reactive Maintenance (RM). A list of R&R, CPM, and RM fixes is listed in Chapter 3.

How to extend RSL

CPM is a method to extend the RSL of a pavement currently in good or fair condition. CPM allows MDOT to address approximately four to five times the amount of pavement as R&R, with the same amount of money. As with R&R projects, CPM delays road deterioration by preventing moisture and incompressible materials infiltration and further deterioration. CPM also allows MDOT to manage the timeframe in which a reconstruction project becomes necessary.

How RSL is calculated

Factors used to determine RSL

Estimation of RSL involves analysis of historical factors including project history (treatment type & date), standardized service life benefit values per treatment type and, when sufficiently available, mathematically modeled surface condition data (the MDOT Distress Index) for projection of future deterioration (generally involving pavement deterioration analyzed over a six-year period using at least three pavement factors).

Calculating Distress Index

Distress Index (DI) values are calculated from specific distress type/severity/extent observations. When DI equals zero, the surface is described as distress-free. When DI is equal to or greater than 50, the surface condition is considered to be too bad for preventive maintenance work, suggesting that rehabilitation or reconstruction is needed. A DI ≥ 50 correlates to a RSL of zero. Therefore, DI=50 corresponds to RSL=0, as they both indicate the same threshold idea – when R&R work should be considered.

When there is not enough historical DI data collected to forecast the RSL for a specific pavement section, standard RSL values are assigned based on the

treatment type history and commercial average daily traffic (ADT) values for the section.

The Pavement Surface Evaluation Rating System

The Pavement Surface Evaluation Rating (PASER) system has been adopted by Michigan's Transportation Asset Management Council to measure Michigan's entire federal aid paved surface network and is used by most of the local road agencies throughout Michigan. PASER is a visual, windshield, survey to make an assessment of current pavement surface condition. PASER works on a scale from 1 to 10, with 1 being poor and 10 being good.

The International Roughness Index

The International Roughness Index (IRI) is an estimate of the roughness of a stretch of roadway. The lower the IRI number, the smoother the ride is. MDOT has adopted the following general quality ranges for IRI (inches/mile):

- Good 0 – 94
- Fair 95-170
- Poor >170

The Sufficiency Surface Condition rating subjectively evaluates the surface condition on a scale of 1 to 5, with 1 being a segment with an excellent surface condition showing little or no surface deterioration.

The performance measure of RSL and condition measures such as Sufficiency Surface Condition, IRI, DI, PASER, wheel path rutting and joint/crack faulting, are used together to help transportation professionals cost-effectively manage Michigan's trunkline highway network.

Pavement and Bridge Condition Tools

(revised 6-24-2019)

Below is a list of existing pavement and bridge condition tools or resources currently utilized by MDOT to evaluate the condition of MDOT's assets.

Table 2: Pavement and Bridge Condition Tools

Tool Name	Description
 Pavement Condition File	Generated (annually) by the MDOT Construction Field Services (CFS) office in Lansing; provided to Region Pavement Engineers for data verification, extraction, and condition map creation. The Pavement Condition File is the primary source for RSL estimate assignments.
 Road Quality Forecasting System (RQFS)	Software program used by Region Pavement Engineers, Region System Managers and Statewide Planning Staff. This is for program strategy development, analyze/optimizing and monitoring, in line with MDOT pavement network condition goals. RQFS analyzes RSL data~~,~~ project costs, expected inflation and user-created program strategies to estimate~~s~~ the future conditions of State trunkline pavement networks.
 Bridge Condition Forecasting System (BCFS)	Microsoft Excel spreadsheet program used for program strategy development to analyze/optimize network conditions in line with MDOT bridge condition goals. Using National Bridge Inspection (NBI) condition ratings, bridge deterioration rate, project cost, expected inflation, and fix strategies, BCFS estimates the future condition of the state trunkline bridge system. BCFS can compare a mix of fixes by modeling different percentages of preventive maintenance, rehabilitation and replacement projects. Strategies can be modeled on the statewide trunkline network or by region.
 Bridge Management System (BMS)	BMS links data, strategies, programs and projects into a systematic process to achieve desired results.
Pontis	Pontis (Latin for bridge) is an AASHTOWare computer program and relational database designed to be a comprehensive bridge management system. Pontis stores element - level bridge inventory and inspection data; formulates network-wide preservation and improvement policies for use in evaluating the needs of each bridge in a network; and makes

Tool Name	Description
	recommendations for what projects to include in an agency's capital plan for deriving the maximum benefit from limited funds.

Existing Road and Bridge Data (revised 6-24-2019)

Below is a list of existing pavement and bridge condition data that can be obtained through the condition tools.

Remaining Service Life

Data Scale	Description
Good = 8+ (Cat III+) Fair = 3-7 (Cat II) Poor = 0-2 (Cat I)	A combined indicator of pavement condition and performance: provides an estimate of remaining time (in years) until a given pavement section's most cost-effective treatment would be either reconstruction or major rehabilitation.

International Roughness Index

Data Scale	Description
Good = 0-94 Fair = 95-170 Poor ≥171 (inches/mile)	IRI estimates the amount of roughness. It is calculated from longitudinal profiles measured by laser sensor in both the inside and outside wheel paths of a pavement section (by a rapid-travel profiler (RTP) vehicle). MDOT reports a pavement section's roughness as the average of the two wheel paths' individual IRI values (also known as the Mean Roughness Index – MRI).

Distress Index

Data Scale	Description
Good = 0-25 Fair = 26-49 Poor ≥50	The total accumulated distress point value for a given pavement section normalized to a 0.1-mile length. It is a unitless value that gives a "snapshot" indication of a pavement's present surface distress condition.

Rutting

Data Scale	Description
Low = 0.0 to 0.25 inches Medium = 0.25 inches to 0.50 inches High ≥ 0.50 inches	Rutting is longitudinal surface depressions in the wheel path of an HMA pavement, caused by plastic movement of the HMA mix, inadequate compaction or abrasion from studded tires.

Faulting

Data Scale	Description
Low = 0.0 inches to 0.25 inches Medium = 0.25 inches to 0.75 inches High ≥ 0.75 inches	Faulting is differential vertical displacement of a slab or other member adjacent to a joint or crack. Faulting commonly occurs at transverse joints of concrete pavements that do not have adequate load transfer.

Pavement Surface Evaluation and Rating (PASER)

Data Scale	Description
Good = 6-10 Fair = 4-5 Poor = 1-3	PASER is based on visual inspection to evaluate pavement surface conditions.

Friction

Data Scale	Description
Friction Number (FN) less than 30 requires additional review (such as crash numbers)	Surface friction is measured with a locked wheel skid trailer. Values for friction are complicated by macro-texture (texture that allows drainage, in order to prevent hydroplaning), micro-texture (the actual texture of the stone aggregate particles), changes in micro-texture due to aggregate polishing, the tire type (including its rubber composition), and tread pattern. MDOT does not have a minimum required friction level due to several factors, including varying traffic volumes, speeds and road geometrics which all have an impact on the minimum required friction levels (Making engineering judgments about pavement friction based on friction testing alone is not recommended).

National Bridge Inspection Standards (NBIS) Rating

Data Scale	Description
Good = 9, 8, 7 Fair = 6, 5 Poor = 4 Serious = 3 Critical= 2 Closed = 0, 1	The NBIS is a visual survey to determine bridge condition and ensure safety. The NBIS rating system goes from 0 to 9, with 0 being the worst and 9 being a new structure.* Note: The NBIS ratings are used to develop the Bridge Safety Inspection Reports (BSIR).

* Descriptions for each rating are provided by FHWA's *Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges*.

Condition ratings are given for the three major elements of a bridge: the deck, the superstructure and the substructure.[1] MDOT also collects over 20 other Michigan specific condition ratings using the NBIS 0 to 9 rating scale.

NBI ratings are given to all highway bridges, pedestrian bridges and railroad bridges. MDOT is required by federal regulations to inspect each bridge having a span length greater than 20 feet at least once every two years. The NBI information from each inspection is collected, stored, and reported to the FHWA annually. In accordance to state law, MDOT also inspects and inventories culverts/structures with span lengths 10 to 20 feet.

Using the NBI scale, an element rated 7 through 9 is considered as being in good condition. Structures that are good or fair are candidates for Capital Scheduled Maintenance (CSM) (See Preservation guidelines in Chapter 5 of this manual for further information).

Bridge elements rated 5 and 6 are considered in fair condition. Structures that are fair are candidates for Capital Preventive Maintenance (CPM) (See Preservation guidelines in Chapter 5 of this manual for further information).

A bridge element rated 4 or less is considered poor, and requires rehabilitation or replacement of the poor elements or the entire bridge.

Pontis

Data Scale	Description
Good = 1 Fair = 2-3 Poor = 4 Serious = 5	Pontis independently evaluates various components or elements of a structure. In General a Condition State of 1 is good and as an element deteriorates the condition state rating increases to a higher number. Some elements will have 5 condition states, and some elements will only have 3 condition states. It is important to be aware that the condition ratings are specific to the element's material type. Note: Pontis "condition states" are quantity based, that elements of a bridge can have quantities in multiple condition states, and shouldn't be used in the same way as NBIS ratings.

[1] There is a separate overall condition rating for culverts, since this type of structure does not have the same elements as typical bridge structures.

Scour-Critical Bridges (Structural Inventory and Appraisal Item 113)

Bridges that cross over waterways are evaluated for their susceptibility to scour. Scour is the erosion of streambed or bank material due to flowing water; often considered as being localized around piers and abutments of bridges. A scour critical bridge is a structure with a foundation element that has been determined to be unstable for the observed or evaluated scour condition.

Data Scale	Description
Stable for Scour = 4, 5, 6, 7, 8, 9	The scour evaluation is performed by hydraulic/geotechnical/structural engineers to determine the structure's vulnerability to scour. U – Bridge with "unknown" foundation 9 - Bridge foundations (including piles) on dry land well above flood water elevations. 8 - Bridge foundations determined to be stable for the assessed or calculated scour condition. Scour is determined to be above top of footing by assessment, by calculation or by installation of properly designed countermeasures. 7 - Countermeasures have been installed to mitigate an existing problem with scour and to reduce the risk of bridge failure during a flood event. 6 - Scour calculation has not been evaluated. 5 - Bridge foundations determined to be stable for assessed or calculated scour condition. Scour is determined to be within the limits of footing or piles, by calculations or by installation of properly designed countermeasures. 4 - Bridge foundations determined to be stable for assessed or calculated scour conditions; field review indicates action is required to protect exposed foundations.
Scour Critical = 3, 2, 1, 0	3 - Bridge is Scour Critical; bridge foundations determined to be unstable for assessed or calculated scour conditions: - Scour within limits of footing or piles. - Scour below spread-footing base or pile tips. 2 - Bridge is scour critical; field review indicates that

	extensive scour has occurred at bridge foundations. 1 - Bridge is scour critical; field review indicates that failure of piers/abutments is imminent. 0 - Bridge is scour critical. Bridge has failed and is closed to traffic.

The Hydraulics Unit in the Design Division in Lansing should be consulted for assistance with all bridges which may be considered scour critical.

Fracture-Critical Bridges

MBIS

A Fracture Critical (FC) bridge is a structure containing a steel member in tension or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse. MDOT has a fracture critical bridge inspector who inspects the fracture critical elements on all of MDOT's fracture critical bridges annually. A fracture critical inspection report is filed in the Michigan Bridge Inspection System's (MBIS) special inspection reports, and the condition ratings are taken into consideration when the inspector assigns an overall superstructure NBI condition rating (as described above). Fracture critical bridge elements should be maintained in good or fair condition.

Data Scale	Description
Good = 9, 8, 7 Fair = 6, 5 Poor = 4 Poor (Critical) ≤ 3	A fracture-critical bridge is a structure containing a steel member in tension or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.

Bridge Inspection Reports are developed using the NBI Ratings to issue a report format. See additions to NBI below.

Structurally Deficient Rating

NBI condition ratings, along with Federal Structural Inventory and Appraisal (SI&A) ratings, can also be used to classify a bridge as Structurally Deficient (SD) or Functionally Obsolete (FO). SD and FO are long-standing and very common performance measures for bridges. They are required by the FHWA and used by all the states. Following are definitions for each.

Generally, a bridge is SD if any major component is in poor condition or if the structure has insufficient load carrying capacity or insufficient waterway (beneath the structure). If any one or more of the following are true, then the bridge is SD:

- Deck rating is less than 5
- Superstructure rating is less than 5
- Substructure rating is less than 5
- Culvert rating is less than 5

- Structural evaluation is less than 3
- Waterway condition is less than 3

Functionally Obsolete Rating

Generally, a bridge is FO, if its geometrics are significantly below current design standards for the volume of traffic being carried on or under the bridge. Bridges that are FO no longer meet current highway design standards, often because of narrow lanes, inadequate under clearances or poor alignment. If any one or more of the following are true, then the bridge is FO:

- Structural evaluation (SI&A Item # 67) is equal to 3
- Deck geometry (SI&A Item # 68) is less than 4
- Under clearance (SI&A Item # 69) is less than 4 and there is another highway under the bridge
- Wawaterway adequacy (SI&A Item # 71) is equal to 3
- Approach roadway alignment (SI&A Item # 72) is less than 4

A bridge may not be classified as both SD and FO. If a bridge qualifies for both, then it is reported as SD.

Summary

MDOT's management systems and rating tools ensure that MDOT employees can develop a cost effective, yet high-quality method of maintaining Michigan's trunkline system, using a mix of fixes.

For information about mix of fixes, see Chapter 2, "MDOT's Program Development." For information about putting condition data into use, see Chapter 3, "Strategy Development for Roads and Bridges" and Chapter 5, "Signs of Pavement and Bridge Distress and Fix Selection Guidelines."

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