AASHTOWare™ BRIDGE DESIGN AND RATING

AASHTO COBS Safety And Evaluation, Asset Management

Presented by Ed Lutgen – MnDOT

Beckie Curtis - MDOT

Restructuring of Technical Committees

At the COBS annual meeting in 2023, a new technical committee structure was formed which included the creation of the Asset Management Technical Committee

Asset Management Committee Members

Committee Members:

MI – Beckie Curtis (Chair)

TX – Bernie Carrasco (Vice Chair – KMWD)

VT – Carolyn Cota (Vice Chair – Research)

CO – Natasha Butler

CT – Jacob Booth

IA – Jim Hauber

IN – Anne Rearick

GA – Donn Digamon

LA – Brian Allen

MD – Maurice Agostino

MDTA – Jim Harkness

ND – Lindsay Bossert

NE – Emilie Hudon

NJ – Harjit Bal

OK – Walt Peters

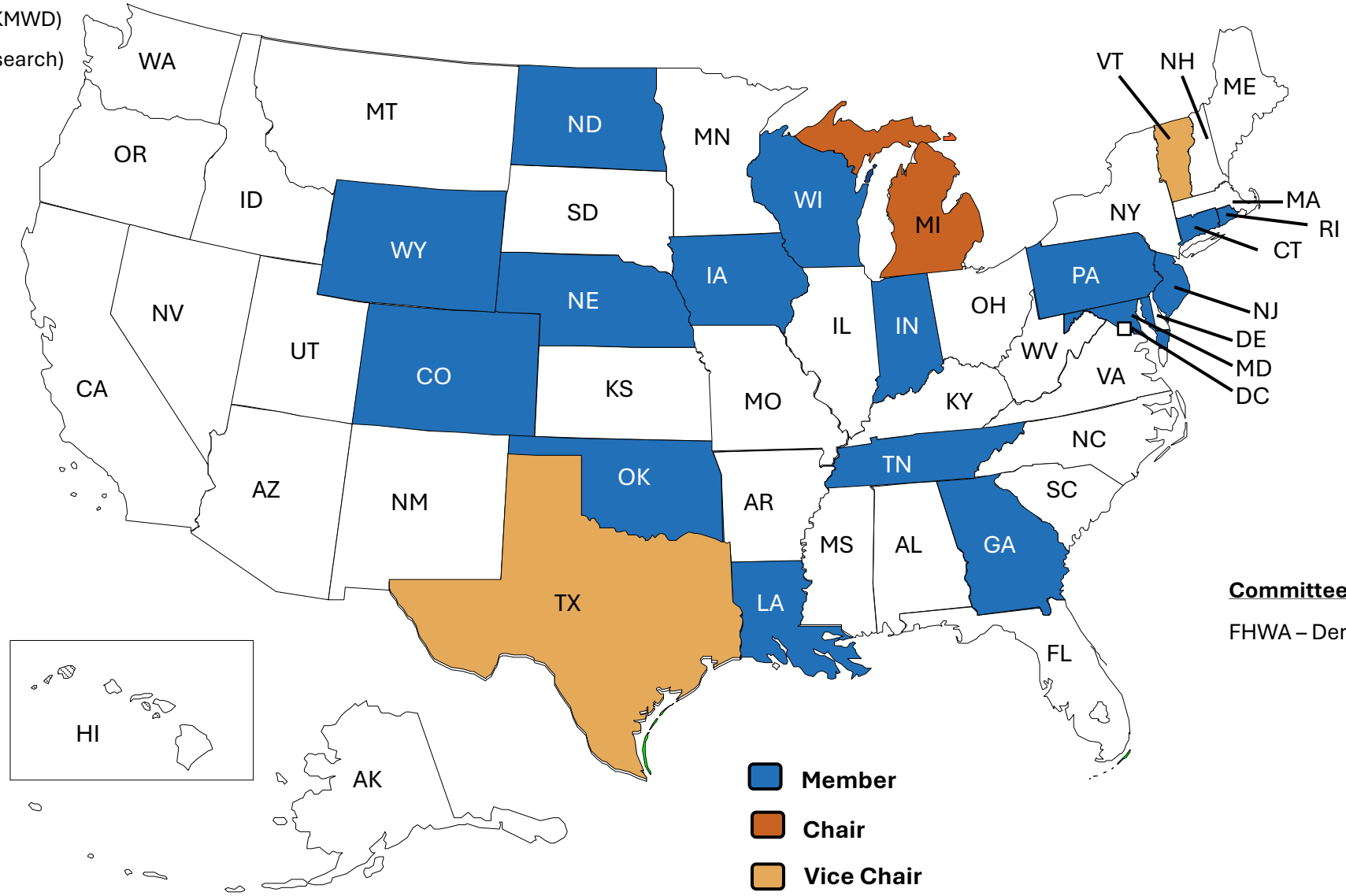
PA – Derek Mitch

RI – Keith Gaulin

TN – Becky Hayworth

WI – Laura Shadewald

WY – Paul Cortez



Committee Liaisons:

FHWA – Derek Constable

This Technical Committee is responsible for the **life cycle management** of bridges and structures **after they are placed into service**. Management includes areas of focus such as risk, resiliency, performance management, benefit cost analysis, incorporating data into asset management decisions and communicating asset management needs and decision.

Responsible Areas

Deterioration Modeling
Life-cycle cost analysis (network level)
Inventory Management
Risk
Resiliency
Benefit Cost Analysis
Performance Management
Asset Management Plans
Communicating Asset Management
Multi-Objective Decision Making
Ancillary Structures Asset Management
Bridge and Structure Management Systems

Accomplishments

- NCHRP Synthesis Project 56-07 – Practices for Incorporating Risk into Bridge Asset Management Planning (report later this year)
- NCHRP 10-154 – Likelihood of Unplanned Bridge Postings and Closure – In progress
- Bridge White Paper on Interstate Bridge Condition
- Modernize the Manual for Bridge Evaluation Roadmap

Ongoing / Future Efforts

- Submitted synthesis topic statement on “State DOT Practices for Communicating and Reporting on Bridge Inventory Data, Performance and Needs”
- Manual for Bridge Element Inspection Modernization RNS
- Asset Management portion of MBE Modernization
- Review of Transportation Asset Risk and Resiliency Manual
- AM TC Strategic Plan (Results of Needs/Challenges/Opportunities Survey)

NCHRP 23-32 Transportation Asset Risk & Resilience Manual

NCHRP Project Purpose, Scope, and Timeline

Acknowledgement and Disclaimer

Acknowledgement

This work was sponsored by the American Association of State Highway & Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration, and was conducted in the National Cooperative Highway Research Program (NCHRP), which is administered by the Transportation Research Board (TRB) of the National Academies.

Disclaimer

The opinion and conclusions expressed or implied in the presentation are those of the research agency. They are not necessarily those of the TRB, the National Research Council, AASHTO, or the U.S. Government. This presentation has not been edited by TRB.

NCHRP 23-32 Project Purpose

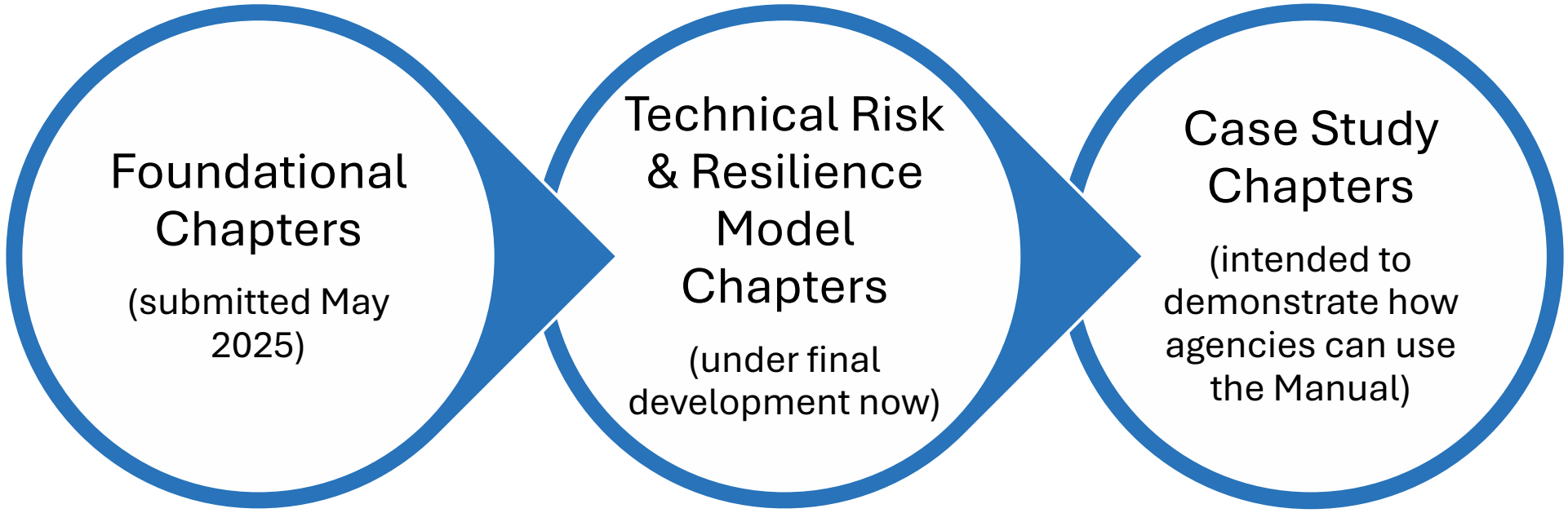
Project Objective: Provide a science-based technical resource to assess risk and resilience in transportation planning, design, construction, operation, and maintenance decisions, including:

- ✓ Quantitative, repeatable methods for conducting risk assessments on top priority threats/hazards for transportation assets
- ✓ A historical data-capture process and system to support risk and resilience modeling and assessments
- ✓ Quantitative resilience assessment methods and metrics for transportation assets
- ✓ Standardized methods to help state DOTs and other transportation agencies identify the most appropriate risk mitigation or resilience improvement strategies

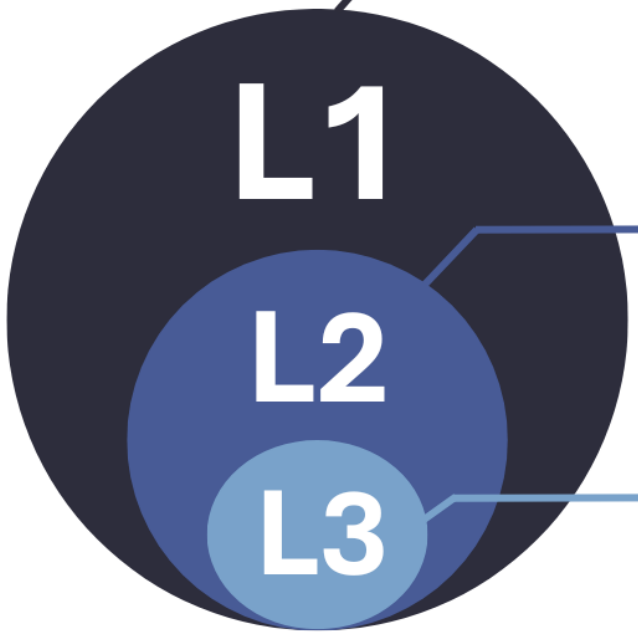
NCHRP 23-32 Threat-Asset Pairs	
Threat	**Asset**
Flood	Bridge
Flood Inundation	Pavement
Flood	NBI Culvert
Storm Surge	Bridge
Sea Level Rise	Pavement
Bridge Scour	Foundation
Rockfall	Pavement
Extreme Temperature	Rail Track
Extreme Temperature	Runway
Wind	Mast Arm
Marine Vessel	Bridge
Erosion	Embankment
Resilience	

Manual Overview

- Ease to use for all Transportation Professionals
- Easy to access data sets
- Readily available tools to generate model inputs when needed
- Three primary sections:



Levels of Analysis



LEVEL 1

Risk exposure methods most applicable when limited asset-specific or location-specific threat data is known. Initial screening models for narrowing the universe of assets that require more detailed analysis to understand annual risk. Reliance on existing threat mapping and asset location mapping. May include a consideration of asset criticality within overall system operations to identify for further assessment.

LEVEL 2

Models that are most applicable when information is available about the setting of the asset including watershed characteristics, NBI data, global design characteristics, etc. Risk assessment is conducted with semi-probabilistic methods.

LEVEL 3

Models that include asset-specific and threat-specific information. Threat-Asset pairs that can be modeled in a fully quantitative manner (deterministic or probabilistic). Level 1 would assess the specific conditions of a given pavement asset or bridge asset under various threats using location-specific threat data (probabilistic or deterministic; stationary or non-stationary).

National Bridge Condition White Paper

- Bridges must maintain a minimum condition to keep the transportation system open and safe
- Bridges are expensive investments in the highway network.
- Bridges are long-lived assets.
- Interstate bridges require increased investment now, with a focus on preservation and rehabilitation, to avoid widespread load restrictions and closures in the next 25 years.

National Bridge Condition White Paper

National Bridge Condition White Paper

2026

EXECUTIVE SUMMARY

A national inventory of more than 600,000 state and locally owned vehicle bridges connect people, communities and the economy. These structures serve as critical links of the transportation system as condition must be maintained at a minimum level of safety for the system to function, and many owners consider bridges as the highest risk asset on their transportation system. As an asset of the transportation system, bridges have three unique characteristics that elevate them from other assets in how agencies must manage them.

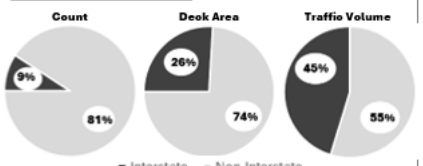
- **Bridges must maintain a minimum condition to keep the transportation system open.** There is an expectation and requirement that a bridge open to traffic is safe for travel. The National Bridge Inspection Standards help ensure that bridge conditions are uniformly evaluated across the country and that, when conditions of a structure deteriorate to the point that safety is no longer reasonably guaranteed, the structure is restricted from certain loads or the structure is closed.
- **Bridges are expensive investments in the highway network.** Bridge reconstruction is more than 3.5 times the cost of an equivalent length of pavement reconstruction.
- **Bridges are long-lived assets.** The average bridge age is 47 years. This long age allows for opportunities for preservation treatments to extend life at a significantly reduced cost over replacement, but only if the funding and asset management practices are in place to perform the right preservation treatment at the right time. Combining constrained funding with the critical nature of bridges in the transportation system, their high asset value, and the opportunity to perform preservation over their long life, bridge owners must use strategic asset management to improve, maintain, or reduce the decline of their bridge inventory. As a part of this strategic asset management, it is necessary to look beyond good, fair, and poor conditions.

Interstate bridges require increased investment now, with a focus on preservation and rehabilitation, to avoid widespread load posting and closures in the next 25-years. While comprising only 9% of the national bridge inventory, interstate bridges are the backbone of the highway system and carry 45% of the daily traffic. Most interstate bridges are older than the historic service life due to the timing of the construction of the interstate. States are replacing under 400 interstate bridges each year, far less than the number that will require replacement as the population ages beyond the normal service life. To avoid widespread postings and closures in the future, states need to preserve, rehabilitate or replace over 1050 bridges each year. Using average replacement costs, an additional $17B of investment on interstate bridges is required to avoid widespread load restrictions or closures.

National Interstate Bridge Condition

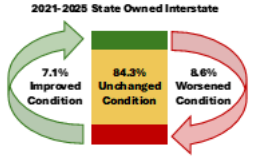
Bridges must maintain a minimum condition to keep the transportation system open and safe ● Bridges are expensive investments in the highway network ● Bridges are long-lived assets ● Interstate bridges require increased investment now to avoid widespread load restrictions and closures in the next 25 years.

Interstate Inventory



The importance of the population of interstate bridges is highlighted by the fact that, while only 9% of the number of bridges nationally, interstate bridges carry 45% of the average daily traffic.

Bridge Cycle of Life

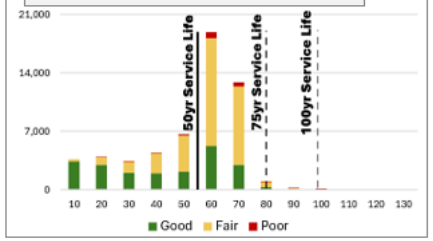


The deterioration of the inventory has outpaced bridge owners' ability to maintain it, with a decline of 1.5% over the last four years.

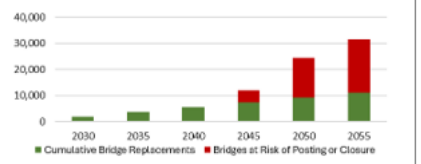
Cost Trends

The unit cost to replace a bridge per square foot of deck has increased significantly. This cost does not include all costs involved a project.

Age of Bridges vs Service Life



Bridges at Risk of Closure or Load Restriction

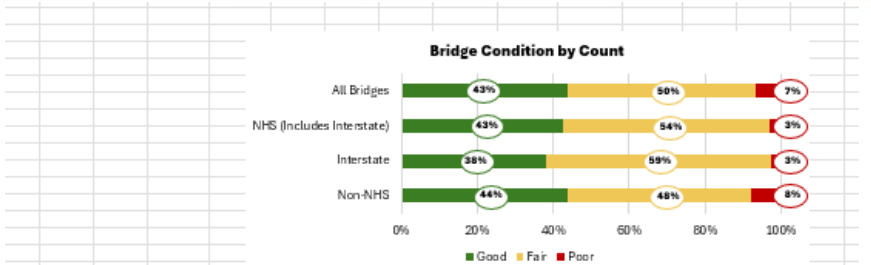


When compared to the current number of interstate replacements, in 2050 the wave of aging bridge replacements leads to an overwhelming 12,000 interstate bridges at risk of closure or load restrictions.

Additional Investment Needed

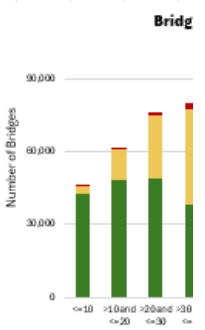
$17 B per year

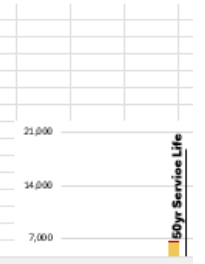
To manage resource demands on the industry, balance funding, and mitigate the mobility impacts of construction, it is necessary to start addressing more interstate bridges now before the unmet influx of bridge closures and load restrictions hits in 2050. Using average interstate deck area and average unit costs, it is estimated that state DOTs would need to invest an additional $17 B each year on interstate bridges.



	all bridges				interstate			
	Good	Fair	Poor		Good	Fair	Poor	
<=10	42836	3006	75		3408	247		10
>10 and <=20	48378	12245	322		2370	904	8	20
>20 and <=30	48725	26183	1124		2034	1370	19	30
>30 and <=40	38242	38355	2544		1319	2438	41	40
>40 and <=50	23951.00	41734.00	#####		2170.00	4331.00	125.00	50
>50 and <=60	#####	56301.00	#####		5267.00	12932.00	715.00	60
>60 and <=70	18040.00	50531.00	7031.00		#####	3414.00	544.00	70
>70 and <=80	7021.00	21208.00	3311.00		293.00	686.00	34.00	80
>80 and <=90	5489.00	20151.00	#####		61.00	126.00	19.00	90
>90 and <=100	4331.00	18178.00	4231.00		23.00	102.00	5.00	100
>100 and <=110	802.00	5393.00	#####		3.00	14.00		110
>110 and <= 120	341.00	1988.00	1156.00			2.00	1.00	120
>120 and <=130	567.00	2172.00	1146.00		2.00	2.00		130
>130	163.00	833.00	335.00					
	262158	238938	40460	601556	21106	32688	1511	55305
	0.4358	0.49694	0.0673		0.3816	0.59105	0.0273	

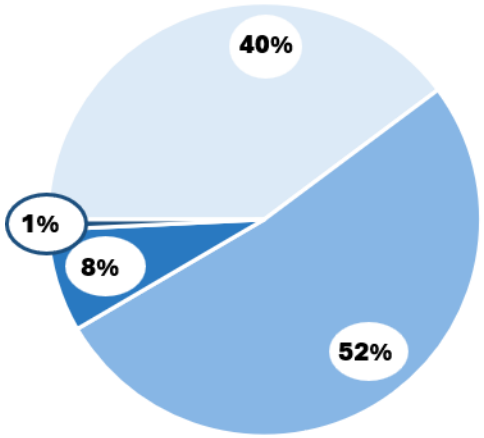
Count of Column Labels				Count of Column Labels				
Row Lab	Good	Fair	Poor	Row Lab	Good	Fair	Poor	Grand Total
<=10	42836	3006	75	<=10	3408	247		3655
>10 and <	48378	12245	322	>10 and <	2370	904	8	3882
>20 and	48725	26183	1124	>20 and	2034	1370	19	3423
>30 and	38242	38355	2544	>30 and	1319	2438	41	4458
>40 and	23951	41734	4628	>40 and	2170	4331	125	6686
>50 and ·	23272	56301	6885	>50 and ·	5267	12932	715	18314
>60 and	18040	50531	7031	>60 and	2944	3414	544	12302
>70 and ·	7021	21208	3311	>70 and ·	293	686	34	1013
>80 and	5489	20151	4743	>80 and	61	126	19	206
>90 and	4331	18178	4231	>90 and	23	102	5	136
>100 and	802	5393	2268	>100 and	3	14		17
>110 and	341	1988	1156	>110 and <=120		2	1	3
>120 and	567	2172	1146	>120 and	2	2		4
>130	163	833	335	Grand T<	21106	32688	1511	55305
Grand T<	262158	238938	40460					



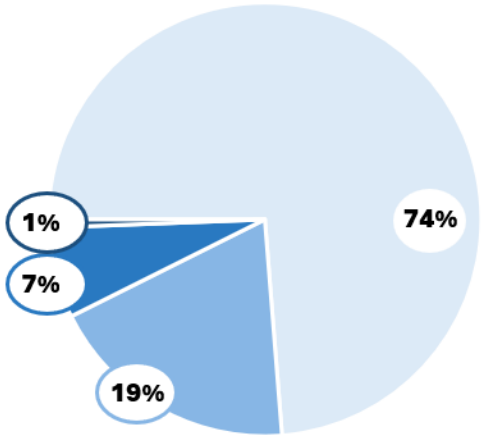


Michigan Bridge Condition – By Owner

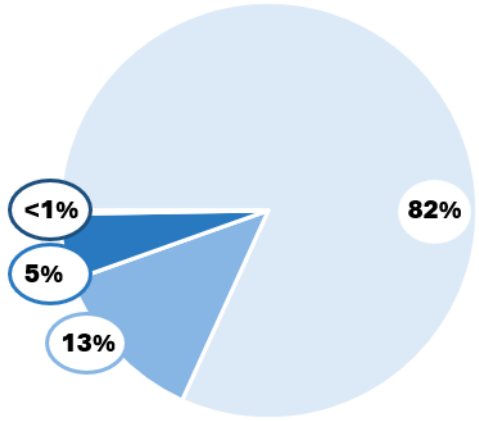
Bridge Count



Deck Area



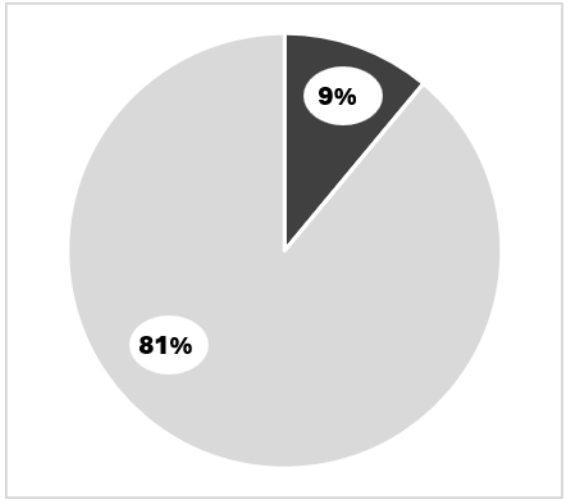
Average Daily Traffic



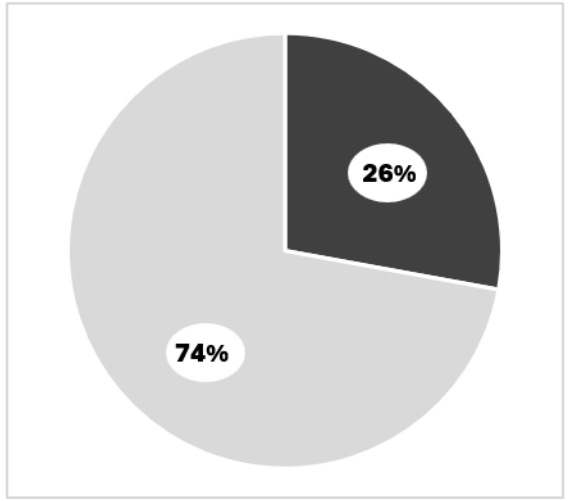
State Highway Agency | County Highway Agency | City or Municipal Highway Agency | Other State and Local Agencies

Michigan Bridge Condition – By Owner

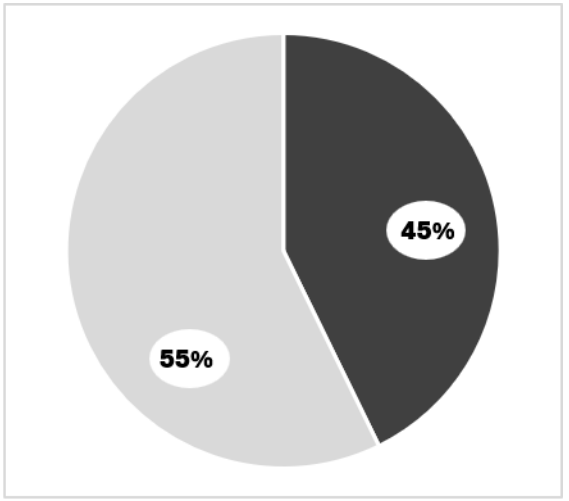
Bridge Count



Deck Area

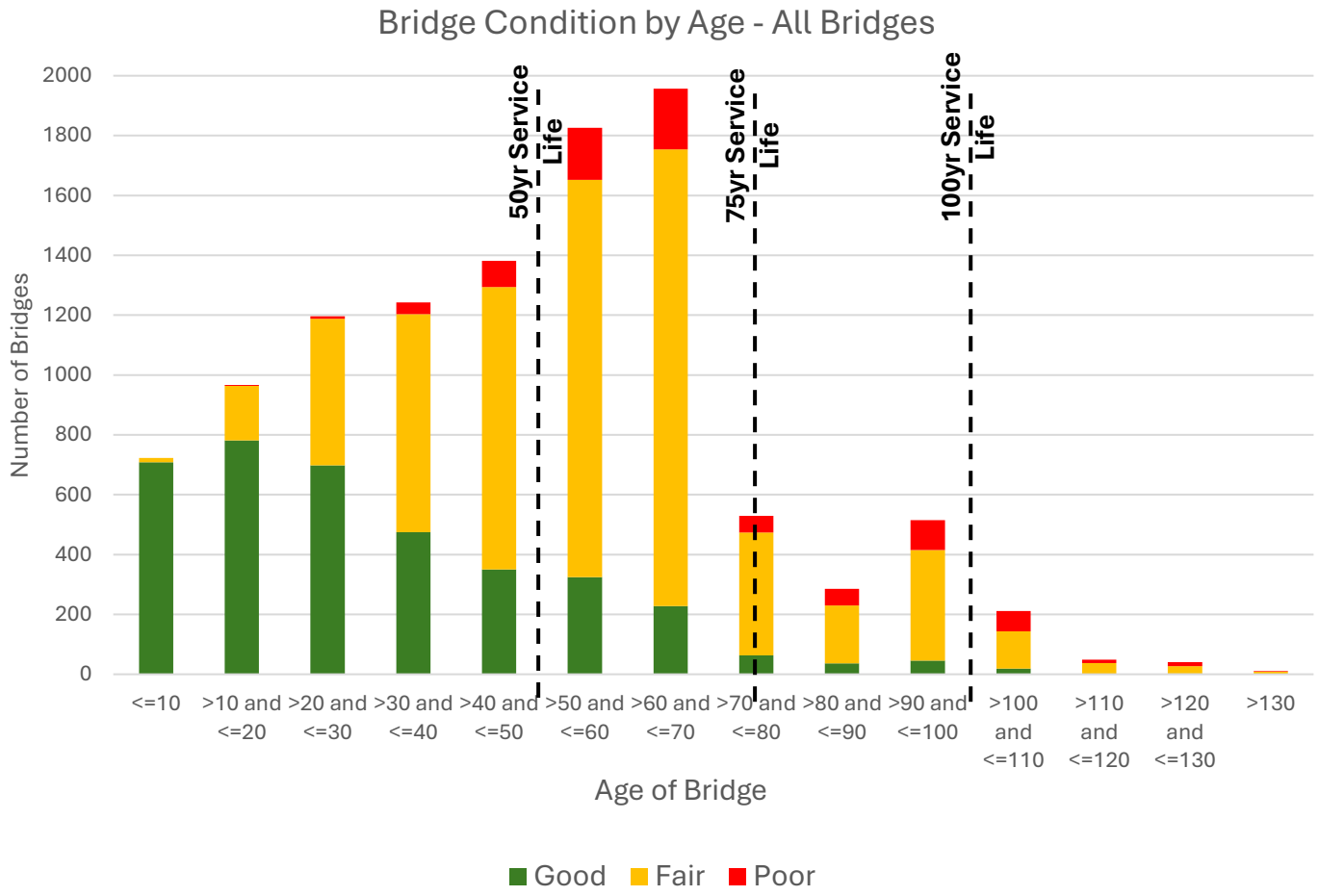


Average Daily Traffic

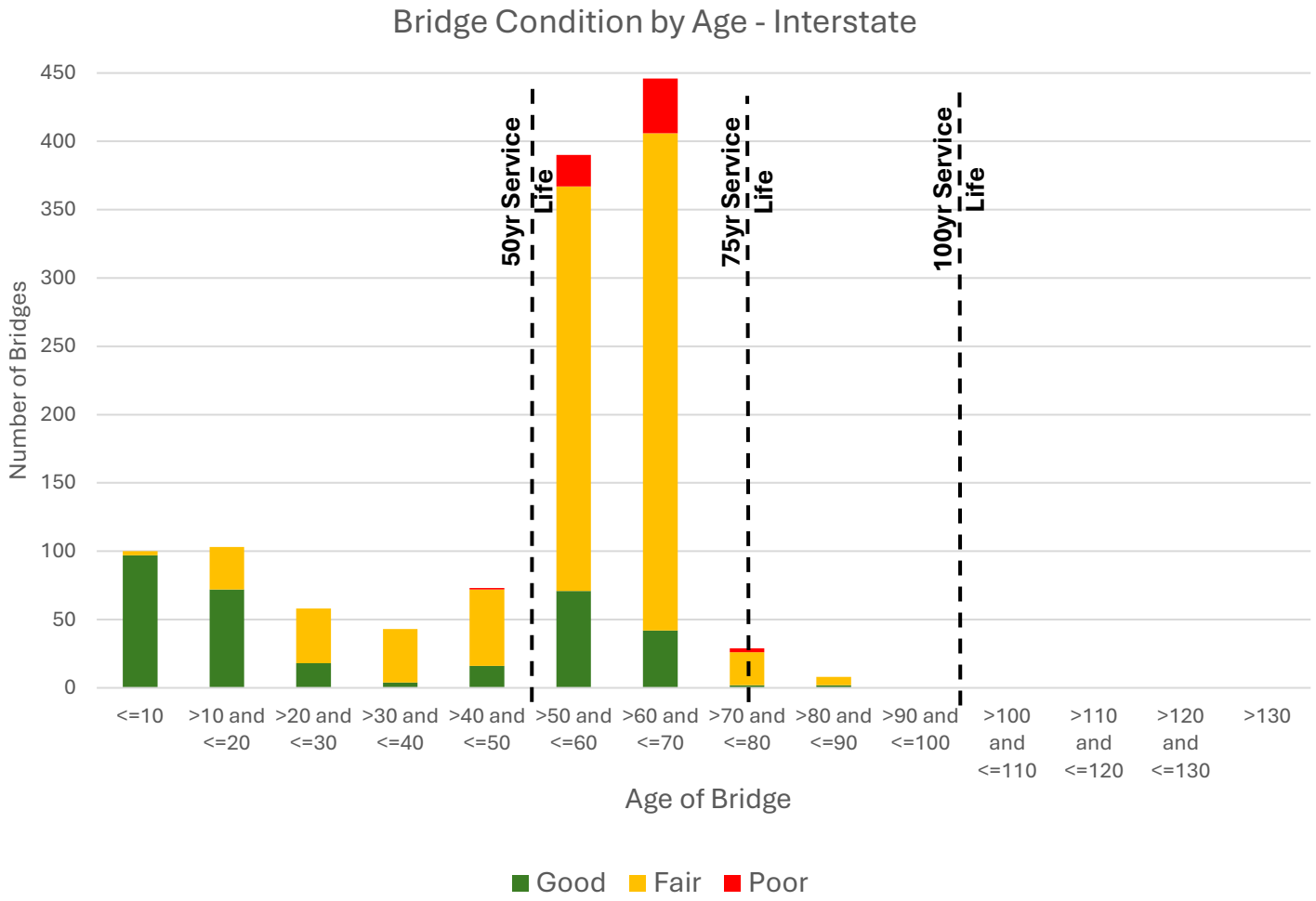


■ Interstate ■ Non-Interstate

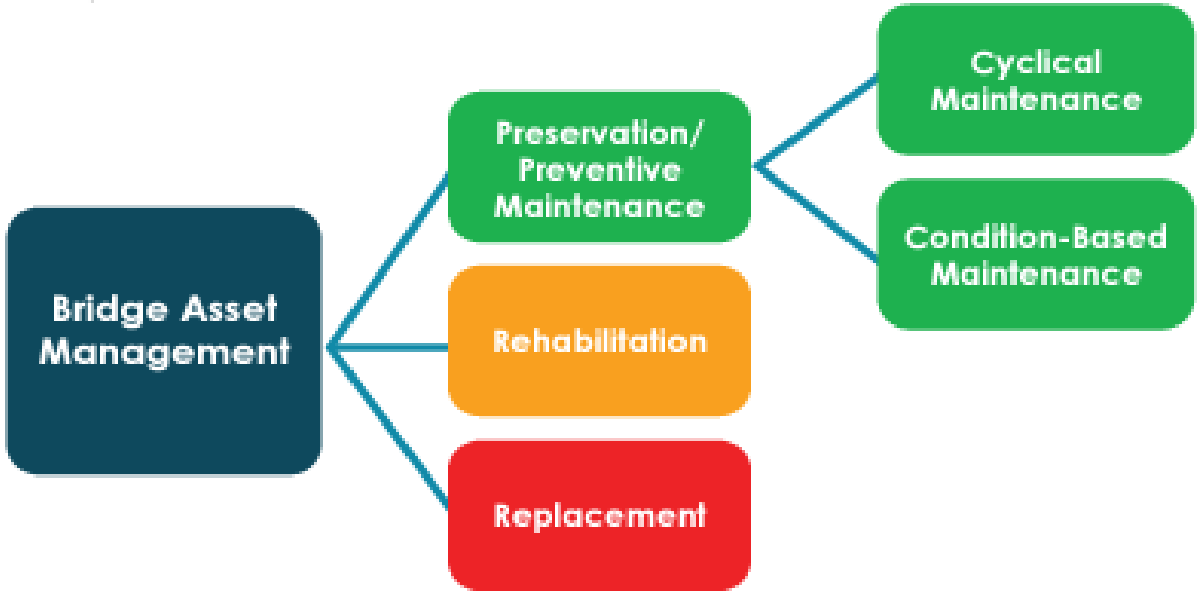
All Michigan Bridges

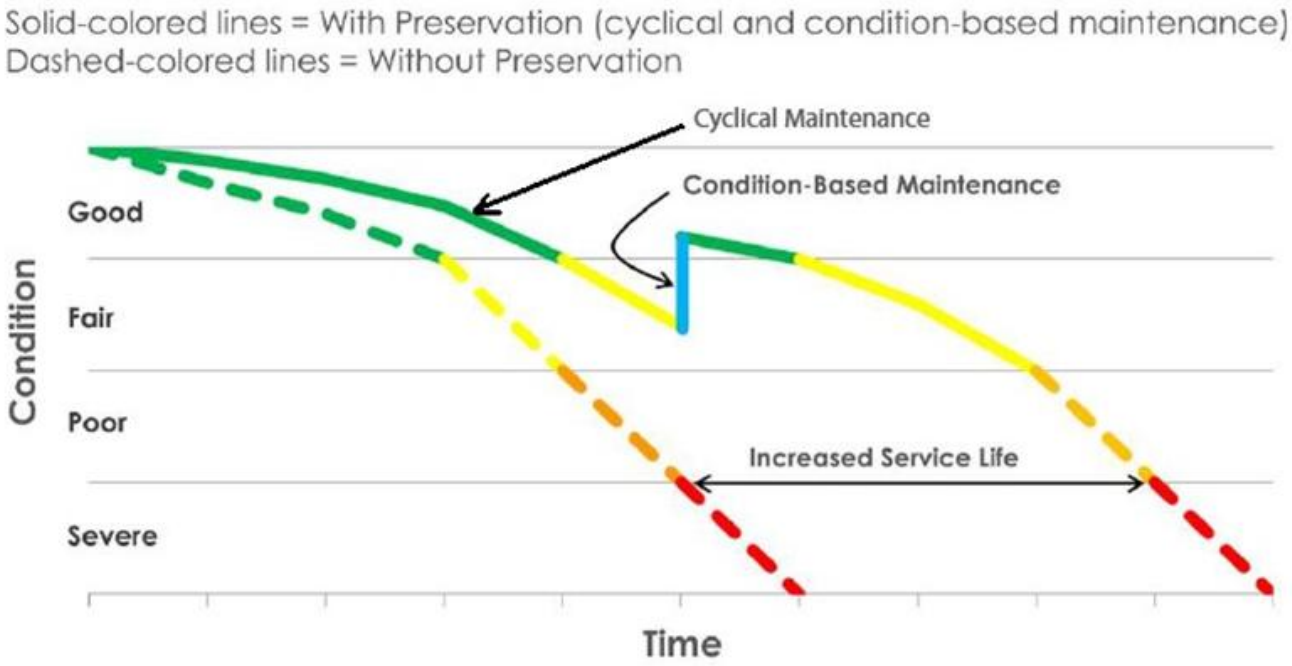


Michigan Interstate Bridges

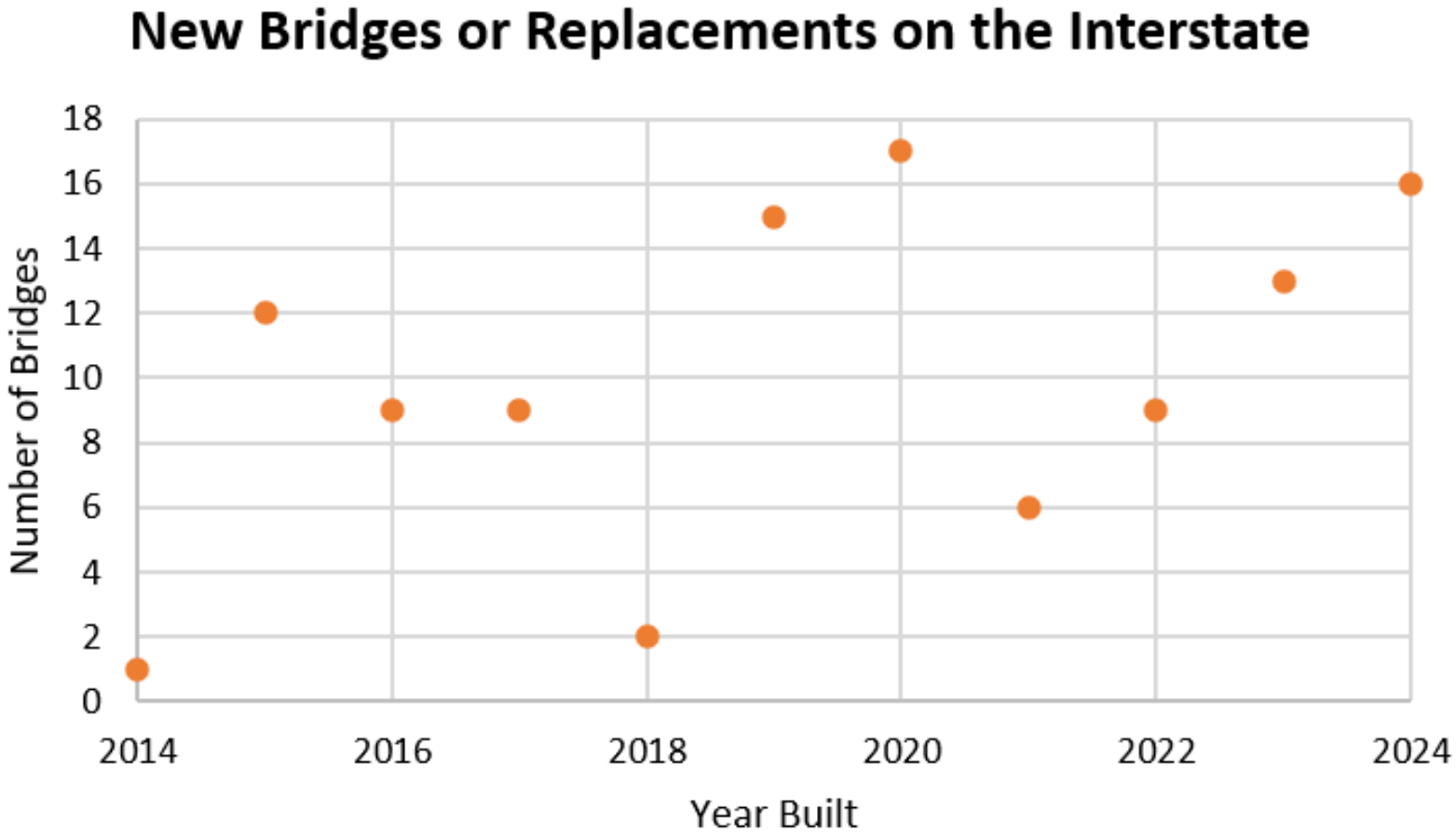


White Paper Discussions

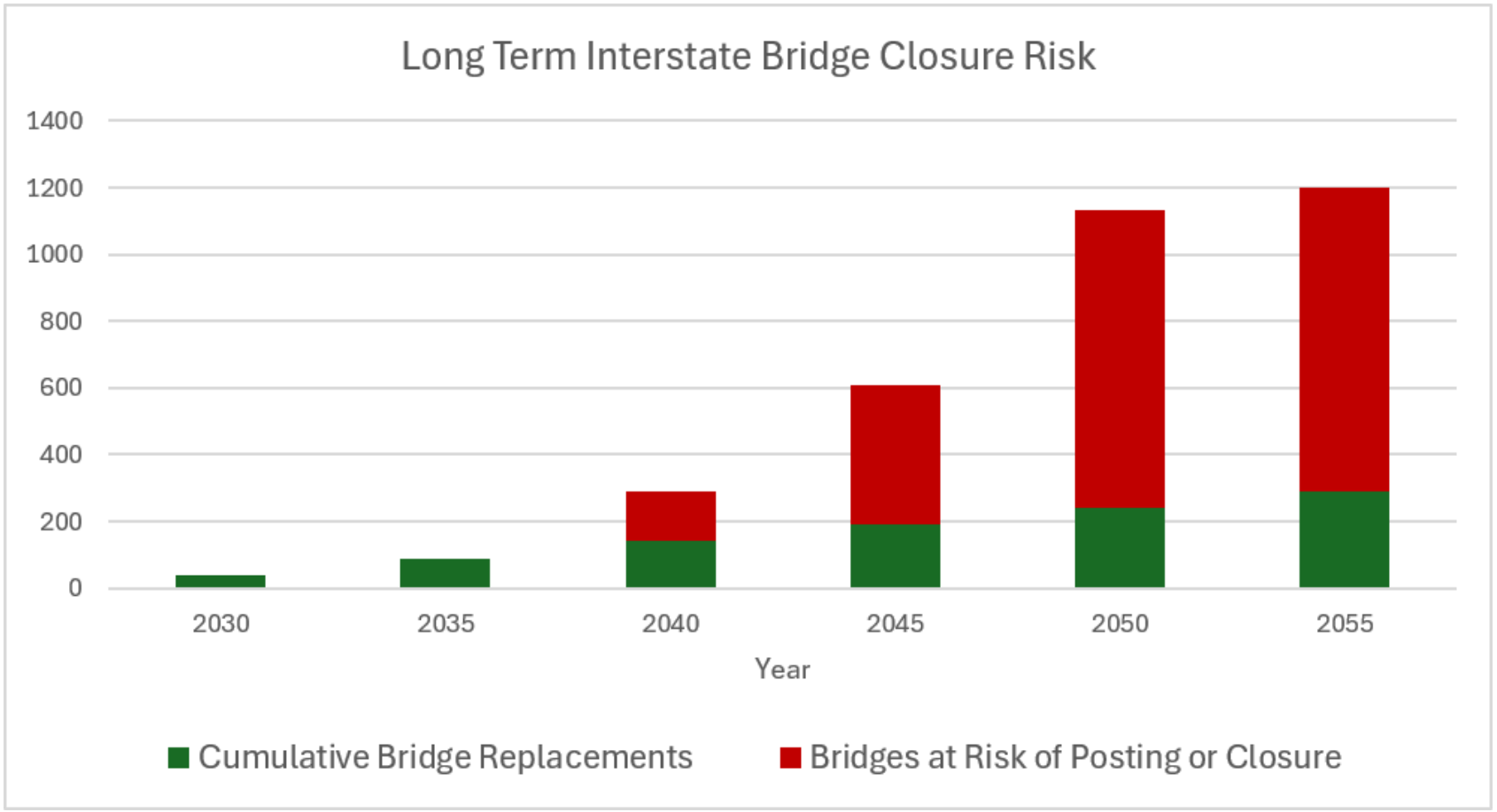




Michigan Interstate Bridges



Michigan Interstate Bridges – posting or closure risk



Additional Investment Needed

$410 M per year

To manage resource demands on the industry, balance funding, and mitigate the mobility impacts of construction, it is necessary to start addressing more interstate bridges now before the unmet influx of bridge closures and load restrictions hits in 2040. Using average interstate deck area and average unit costs, it is estimated that Michigan would need to invest an additional $410 M each year on interstate bridges.

AASHTOWare™ BRIDGE DESIGN AND RATING

AASHTO COBS Safety And Evaluation, Asset Management

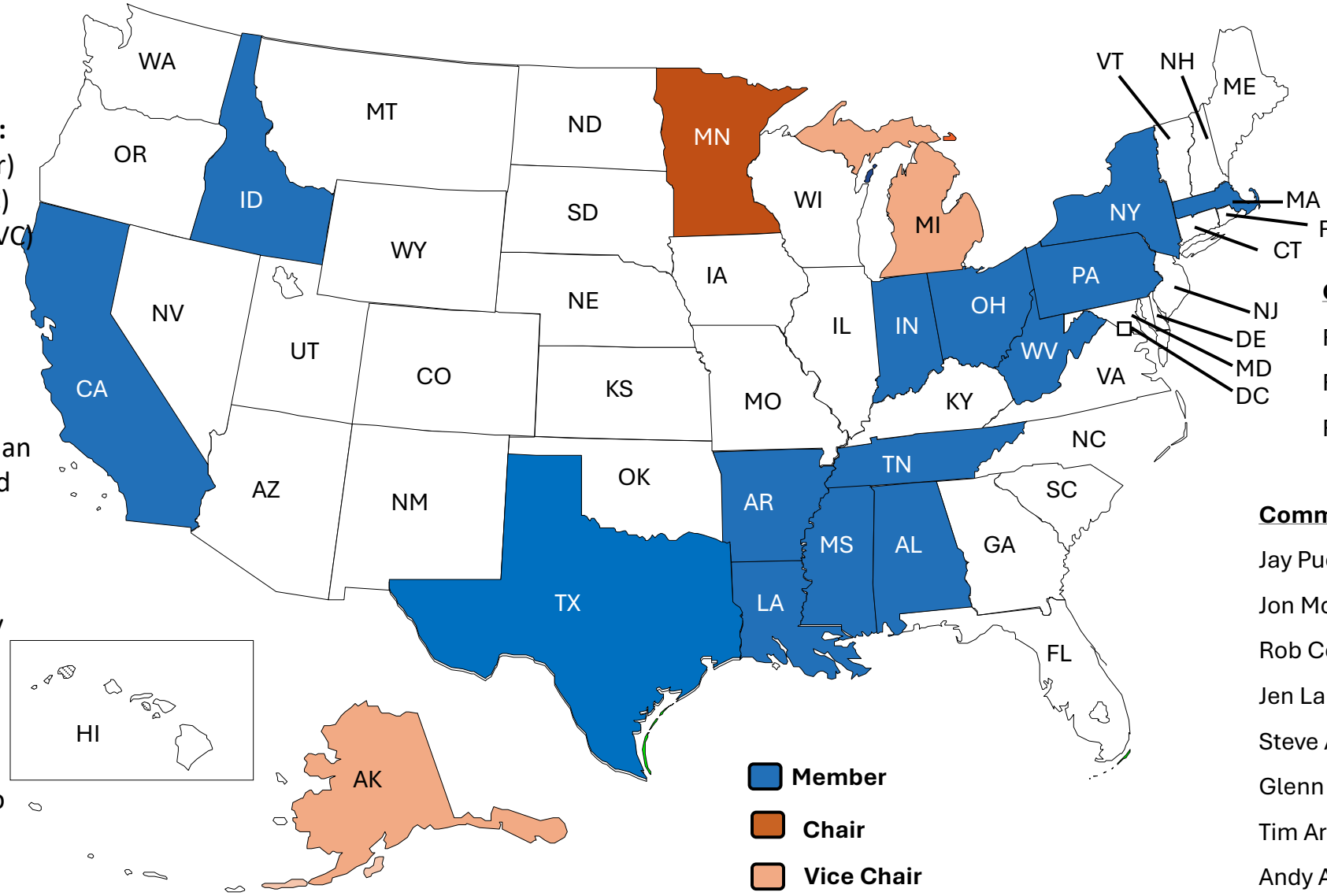
Presented by Ed Lutgen – MnDOT

Beckie Curtis - MDOT

Safety and Evaluation Committee Members

Committee Members:

MN – Ed Lutgen (Chair)
MI – Beckie Curtis (VC)
AK – Jesse Escamilla (VC)
MA – Matt Weidele
PA – Jonathon Moses
WV – Tracy Brown
NY – Mark Struzinsky
IN – Jennifer Hart
AR – Andrew Nanneman
MS – Scott Westerfield
LA – Mark Bucci
TX – Bernie Carrasco
TN – Becky Hayworth
ID – Melissa Hennessy
UT – Becky Daniels
CA – Vassil Simeonov
AL – Daniel Jones
OH – Brad Noll
Support – Frank Russo



Committee Liaisons:

FHWA – Stephen Bartha
FHWA – Lubin Gao
FHWA – Hoda Azari

Committee Friends:

Jay Puckett
Jon McGormley
Rob Connor
Jen Laning
Steve Austin
Glenn Washer
Tim Armbrecht
Andy Adams

MBE 4th Edition

- AASHTO publications ready for purchase September ???
- Last 4 years of passed ballot items (not 2026)
  - Gusset plates
  - Lateral buckling
  - Permit vehicle
  - Load Testing Chapter 8
  - Fern Hollow Recommendations
  - Segmental bridges (NCHRP 12-123)
  - Table 6B.5.2.1-1 and 6B.5.2.1-2
    - Historical Steel Properties report

Committee Upcoming Work (2027 COBS)

- 2027 COBS
  - Engineering Judgement
  - Fatigue realignment
  - Neg. Moment Truck Train and shear clarifications
  - HL-93, Truck Train, Posting Truck History Document
  - Develop commentary for reduced culvert load factor
  - Longitudinal strain for concrete
  - Element 15/16 for prestressed adjacent beam update
  - Concrete Slab Edge Girder clarification

Committee Upcoming Work (2028+ COBS)

- 2028 Ballot
  - NCHRP 12-127 – Load Rating of Long Span Bridges
  - NCHRP 12-129 - Evaluating Concrete Girders with Noncompliant Shear Details
  - MCFT
  - Emergency Vehicles
- 2028 + Ballot
  - NCHRP 12-133 MBE Rewrite
  - NCHRP 10-161 Establishment of QA/QC for NDE
  - NCHRP 10-159 Investigation of Shear Capacity with Undersized Stiffeners

Concrete Committee Collaboration Ballot

Topics for Discussion with Concrete SMEs

TOPIC	DESCRIPTION
1	Assume strain = 0 for uncracked sections when using MCFT Appendix B5.2 (BSSD-5758)
2	Effect of strand development on A_{ps} used to compute longitudinal strain, ε_s (BSSD-5725)
3	Article 5.7.3.5 – Longitudinal Reinforcement provision (BSSD-3560)
4	Assumed Post-Tensioning Force Distribution Depth (FHWA-HIF-22-025 Publication)
5	Applicability of 'Minimum M_u' Provision Near Contraflexure Points (BSSD-4782)
6	'Minimum M_u' Provision Not Enforced for $M_u < M_{cr}$ Check (FHWA-HIF-22-025 Publication)
7	'Mininum M_u' Provision Applied to Longitudinal Reinforcement Check (FHWA-HIF-22-025 Publication)

NCHRP 20-123 (21) MBE Roadmap

- **AASHTO MBE becomes three separate documents:**
  1) AASHTO Manual for Rating of Highway Structures (MRHS)
  2) AASHTO Manual for Inspection of Highway Structures (MIHS)
  3) AASHTO Manual for Asset Management of Highway Structures (MAMHS)

- **It requires:**
  - MBE Rewrite to develop the ***MRHS***
  - MBEI and MBE Inspection Section Rewrite to develop the ***MIHS***
  - Development of a new Asset Management Manual, using MBE Section 3, the AASHTO Transportation Asset Management Hub, and/or other available resources to create ***MAMHS***

- **The goal is to:**
  - Better alignment with target user needs
  - Improve usability and access
  - Clearer structure and guidance
  - Easier maintenance and updates

AASHTO Manual for Rating of Highway Structures (MRHS)

Section	Name
1	Introduction
2	Load Rating Procedures
3	Loads
4	Concrete Structures
5	Steel Structures
6	Other Structures
7	Material Testing
8	Nondestructive Load Testing
9	Posting of Structures
10	Bridge Files
A	Illustrative Examples

No.	Section Name		Source Document
1	**Introduction**	MBE	6A.1
2	**Load Rating Procedures**	MBE	6A.1
2.1	QA/QC	New	
2.2	LRFR	MBE	6A
2.2.1	Introduction	MBE	6A.1
2.2.2	Limit States	MBE	6A.1
2.2.3	Rating Levels	MBE	6A.1, 6A.4
2.2.4	Design Load Rating	MBE	6A.1, 6A.4
2.2.5	Legal Load Rating	MBE	6A.1, 6A.4
2.2.6	Permit Load Rating	MBE	6A.1, 6A.4
2.2.7	Load Rating Equation	MBE	6A.1, 6A.4
2.2.8	Condition Factor	MBE	6A.1, 6A.4
2.2.9	System Factor	MBE	6A.1, 6A.4
2.2.10	Structural Analysis	MBE	6A.3
2.3	LFR/ASR	MBE	6B
2.3.1	Introduction	MBE	6B.1
2.3.2	Rating Methods	MBE	6B.3
2.3.3	Rating Levels	MBE	6B.2
2.3.4	Design Load Rating	MBE	6B.6
2.3.5	Legal Load Rating	MBE	6B.6
2.3.6	Permit Load Rating	MBE	6B.6
2.3.7	Load Rating Equation	MBE	6B.4
2.3.8	Structural Analysis	MBE	-
3	**Loads**	MBE	6A.2, 6B.6
3.1	LRFR	MBE	6A.2
3.1.1	Dead Loads	MBE	6A.2
3.1.2	Permanent Loads	MBE	6A.2
3.1.3	Vehicular Live Loads	MBE	6A.2
3.1.3.1	Application of Vehicular Live Load	MBE	6A.2.3.2

AASHTO Manual for In Service Inspection of Highway Structures (MISIHS)

No.	Section Name
1	Introduction
2	NBIS Requirements
3	QA/QC for Bridge Inspection
4	Nonregulatory Inspection Practices
5	Element Inspection (MBEI)
6	Scour Appraisal
7	Nondestructive Testing and Evaluation Methods
8	Bridge Files
A1	Agency-Defined Elements (MBEI)
B1	Element-level Inspection Example (MBEI)
C1	Component-level Inspection Example
D1	Element Grouping (MBEI)
E1	List of Feasible Action by Material Type (MBEI)
F1	QC/QA Frameworks
H1	Risk Based Inspection Example Risk Models

No.	Section Name	Source Document	
1	Introduction	MBE	Section 1
2	NBIS Requirements	23 CFR	650 Subpart C
2.1	Bridge Inspection Organization	MBE	Section 4
2.2	Qualifications of Personnel	MBE	Section 4
2.3	Inspection Types	MBE	Section 4
2.4	Inspection Intervals	MBE	Section 4
2.5	Risk-Based Inspection Practices	MBE	Section 4
2.6	Required Inspection Procedures	MBE	Section 4
3	QA/QC for Bridge Inspection	New	-
3.1	NBIS Requirements for QC/QA	New	-
3.2	Quality dimensions and tolerance	New	-
4	Nonregulatory Inspection Practices	MBE	Section 4
5	Element Inspection (MBEI)	MBEI	Section 1
5.1	Introduction to Element-Level Inspection	MBEI	Section 2
5.2	Element Location Matrix	MBEI	Section 2
5.3	Detailed Element Descriptions	MBEI	Section 3
6	Scour Appraisal	HEC	18 and 20
7	Nondestructive Testing and Evaluation Methods	MBE	Section 8
8	Bridge Files	MBE	Section 2
A1	Agency-Defined Elements (MBEI)	MBEI	Appendix A
B1	Element-level Inspection Example (MBEI)	MBEI	Appendix B
C1	Component-level Inspection Example	New	-
D1	Element Grouping (MBEI)	MBEI	Appendix C
E1	List of Feasible Action by Material Type (MBEI)	MBEI	Appendix D
F1	QC/QA Frameworks	New	-
H1	Risk Based Inspection Example Risk Models	New	-

AASHTO Manual for Asset Management of Highway Structures (MAMHS)

No.	Section Name	Source Document	
1	Introduction	MBE	Section 3
2	Objectives of Highway Structures Asset Management	MBE	Section 3
3	TAMP Requirements for Highway Structures	23 CFR	Part 515
4	Components of Highway Structures Asset Management	New	
5	Inventory Management	New	
6	Condition Assessment	New	
7	Risk	New	
8	Resiliency	New	
9	Preservation Policy	New	
10	Performance Measures	New	
11	Deterioration Models	New	
12	Life Cycle Cost	New	-
13	Cross Asset Allocation and Programming	New	-
14	Components of a Structures Asset Management System	MBE	Section 3
A1	Illustrative Examples	New	-

AASHTO New / Future Research

- NCHRP 10-159 – Investigation of Shear Capacity with Undersized Transverse Stiffeners – project beginning this fall
- NCHRP 10-161 – Establishment of Personnel Certification and Quality Control and Quality Assurance Processes for Nondestructive Testing of Concrete and Steel Bridge Elements – project beginning this fall
- NCHRP 12-133 – Rewrite and Modernize the Manual for Bridge Evaluation for Compliance with the Revised National Bridge Inspection Standards – project beginning this fall

- Framework for Using WIM Data in Bridge Live-Load Evaluation – recommended for funding (late 2027)
- Modernize the Manual for Bridge Element Inspection (MBEI) - recommended for funding (late 2027)

AASHTO Future Research – Working to include in Roadmap

- Develop a Bridge Asset Management Manual - RNS created in MBE Roadmap

RNS's under development:

- Old structures are punished by current design and detailing procedures; Implementation of LRFR
- Guidance for when inspection findings should trigger a load rating / Lack of reliable metrics linking observed damage to structural performance / Difficulty modeling damage
- Incorporating field-measured behavior into rating methods; limited material/property data leads to conservative ratings
- Culvert/slab bridge load ratings
- Reliability Based Inspection that considers: Level of inspection; inspection period; level of the inspector; risk of inspection finding
- Rating for Concrete Service, what is really needed for load rating NDE Requirements for Moveable Bridges