Fracture Critical Policy Update

A PRESENTATION TO THE AASHTO COMMITTEE ON BRIDGES AND STRUCTURES

TECHNICAL COMMITTEE T-14

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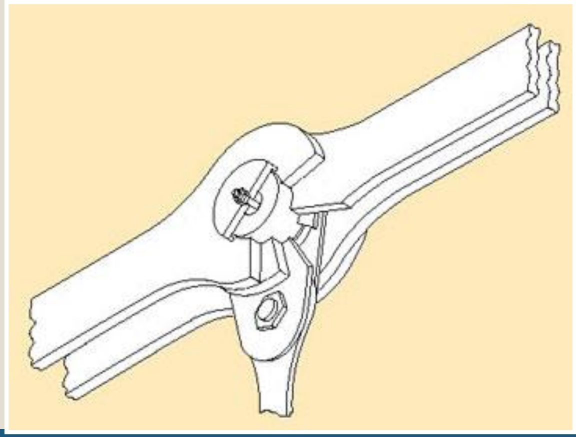
JUNE 25, 2019 • MONTGOMERY, AL

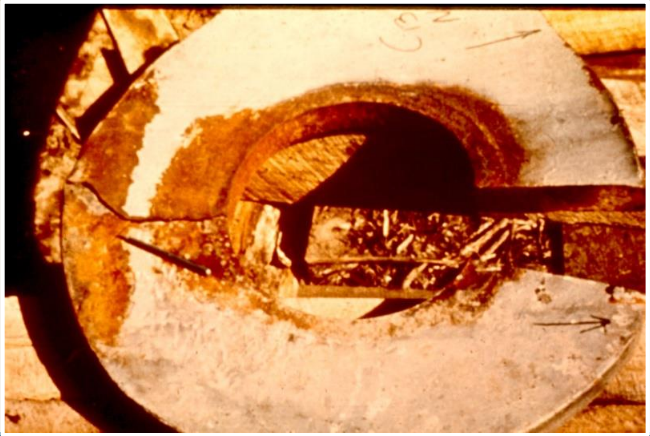
U.S. Department of Transportation
Federal Highway Administration
Office of Infrastructure

Fracture Critical Member

“a steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse.”

(ref. Code of Federal Regulations, National Bridge Inspection Standards)





Current Fracture Critical Policy

- "Clarification of Requirements for FCMs" published 6/20/2012
  - *Memo introduced a new member class "System Redundant Member" (a member that gains redundancy through system behavior)*
  - *Encouraged use of refined analysis to show redundancy*
  - *State must submit through the Division Office to the FHWA Office of Bridge and Structures for review the detailed analysis and evaluation criteria that will be used*

New Developments

- Research at Univ. of Texas, Purdue Univ., and FIU
- Updates to LRFD BDS provisions
- Ongoing collaboration between FHWA, T-14, and Industry
- AASHTO Guide Specs for System Redundancy and Internal Redundancy
- FHWA Guidelines for Refined Analysis (https://www.fhwa.dot.gov/bridge/pubs/hif18046.pdf)

Fracture Critical Policy Update

- "*FHWA Requirements for Classification and Treatment of Steel Bridge Members for Fracture Control*" memo has been drafted and distributed for industry review and comment
- The new approach to define policy will include:
  - Memo with general requirements
  - Technical Advisories for specific bridge types

New Fracture Control Memo Highlights

- Member classifications and treatments: LPRM, IRM, SRM, or FCM
- Recognize internal redundancy
- Accept (but not require) the use of new AASHTO IRM and SRM Guide Specs.
- Currently allow the use of SRM Guide Spec to post-1978 bridges.

Load Path Redundant Member (LPRM)

"A steel primary member in tension, or with a tension element, that has redundancy based on the number of main supporting members between points of support, such that fracture of one cross section of one member will not cause a portion of or the entire bridge to collapse."

- Note: LPRMs are usually longitudinal and parallel, such as girders or trusses. Redundancy can be determined by engineering judgement or simple calculation. Primary members in common girder bridges with three or more girders are classified as LPRMs in most cases.

Internally Redundant Member (IRM)

"A steel primary member in tension, or with a tension element, that is not qualified as an LPRM but has redundancy in the cross-section such that fracture of one element will not propagate through the entire member, and is discoverable by the applicable inspection procedures."

- Note: IRMs shall be classified through calculation, analysis or other criteria supported by experimental verification and approved by FHWA. One acceptable approach is given in the AASHTO Guide Specifications for Internal Redundancy of Mechanically-fastened Built-up Steel Members.

System Redundant Member (SRM)

"A steel primary member in tension, or with a tension element, that is not qualified as an LPRM but has redundancy in the bridge system, such that fracture of one cross section of the member will not cause a portion of or the entire bridge to collapse."

- Note: SRMs shall be classified through calculation, analysis or other criteria supported by experimental verification and approved by FHWA. One acceptable approach is to use refined analysis per the AASHTO Guide Specifications for Analysis and Identification of Fracture Critical Members and System Redundant Members.

Future Technical Advisories

Bridge-specific guidelines to be published

- Twin tub girders
- Mechanically fastened built-up members (riveted bridges first?)
- Low ADTT and low risk two-girders
- Trusses
- Tied arches
- Steel pier bents/Straddle Caps
- Others

Future Technical Advisories

TAs address the specific requirements for a bridge type (group), on design, fabrication, and inspection.

- Reduce unnecessary FCM requirements with simple, deemed to satisfy rules, without analysis.
- Free more from FCM, using engineering-level analysis/calculation.
- Leave option open to evaluate redundancy, using research-level analysis/calculation.
- OR, stay as FCM.

TA for Twin Tub Girders

- Designed to AASHTO LRFD Bridge Design Specifications.
- Spans do not exceed 250ft and are continuous.
- Horizontal curvature ≥700 feet.
- All supports radial or with skew angle <10°.
- Girders connected by full-height, external, solid-plate diaphragms at piers and throughout span at spacing not to exceed 40 feet nor one-third of the span.
- Girders are composite with deck along full length and satisfy the following:
  - Concrete deck has minimum 8-inch thickness
  - Shear connectors extend a minimum of 2-inches beyond the deck bottom rebars mat into the core of the deck, and
  - Shear connector pitch ≤24-inches.
- Crash barrier is solid concrete and MASH approved with TL-3 rating or greater
- Girders are fabricated to AASHTO/AWS D1.5/D1.5M Bridge Welding Code including the "Clause 12 - Fracture Control Plan" provisions.

All Part of A Risk Based Approach

- Federal statute (MAP-21) required update to NBIS
  - Ref. USC Sect. 144 (h)(6)
- The Secretary [FHWA] shall:
  - “update inspection standards to cover – (B)the frequency of inspections”
  - “consider a risk based approach to determining the frequency of bridge inspections.”

New Policy on Risk Based Inspection Interval

- FHWA memo issued June 8, 2018

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **INFORMATION**: Risk-Based Interval Determination for Routine Bridge Inspections

Date: June 8, 2018

From: /Original signed by/
Joseph L. Hartmann, PhD, P.E.
Director, Office of Bridges and Structures

In Reply Refer To: HIBS-30

To: Division Administrators
Federal Lands Highway Division Directors

- https://www.fhwa.dot.gov/bridge/nbis/180608.pdf
- *Scope and Purpose: to provide approach to implement a risk-based interval for routine inspection in bridges.*

New Policy on Risk Based Inspection Interval

- Memo allows use of an interval that is commensurate with the risk of safety or service loss for each bridge
- Establishes a general framework and process for assessment of risk

New Policy on Risk Based Inspection Interval

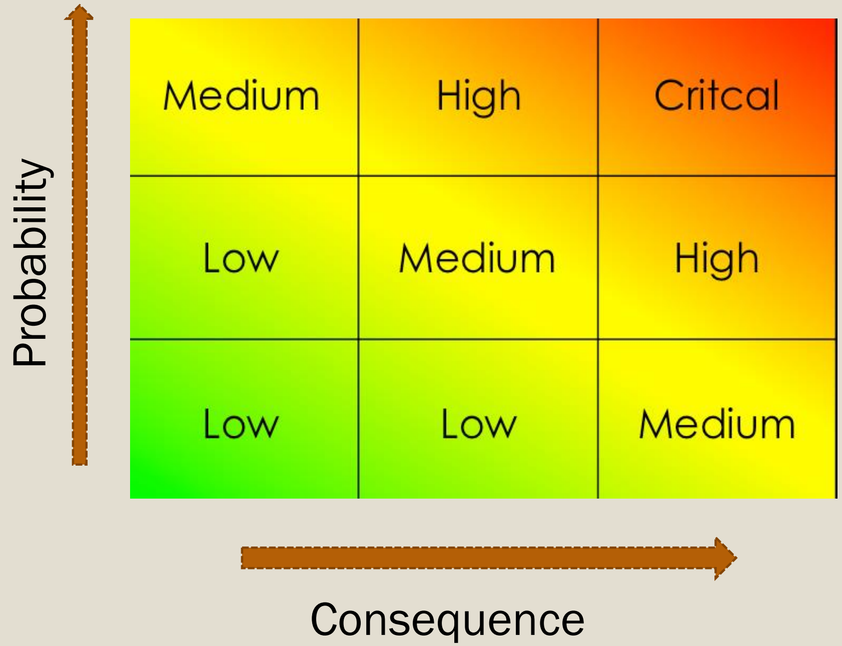
- Provides flexibility to DOTs by applying experience and engineering knowledge to optimize the use of limited resources across their bridge inventory
- Allows intervals of 12, 24, 48 months

New Policy on Risk Based Inspection Interval

- Based on NCHRP Project 12-82 "Risk Based Inspection Practices"
- DOT must assemble a Risk Assessment Panel (RAP)
- Define risk levels, categories, probability, consequence, damage modes, attributes to conduct a "scoring" of bridges
- Apply to inventory of bridges and classify
- Submit to FHWA for approval

Risk Based Framework for Bridges

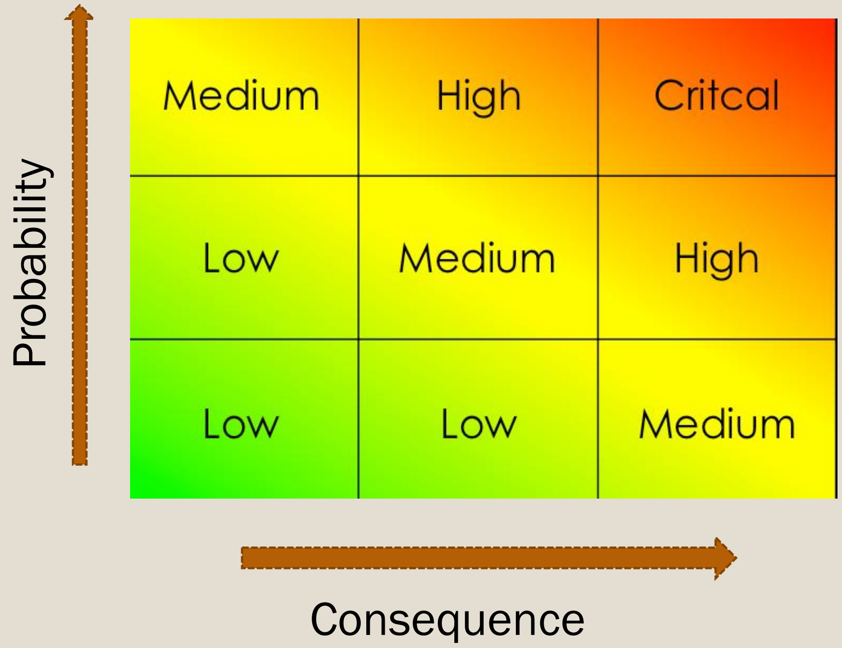
- Risk is the exposure to the possibility of a structural safety or serviceability loss (failure).
- It is defined by the combination of probability and consequence of the failure event
- Inspection requirement is the outcome of the risk assessment. When risk is high, inspect more. When risk is low, inspect less



Risk Based Framework for Fracture Control

Failure definition:

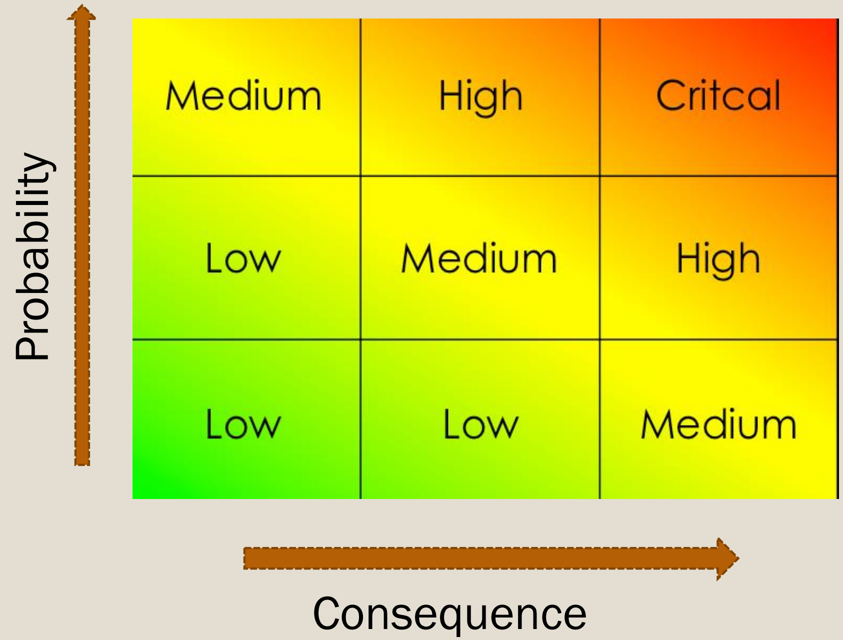
- The most credible failure event scenario is a fatigue crack growing to a critical size and becoming unstable and fracture of member, and progressive bridge collapse



Risk Based Framework for Fracture Control

Probability

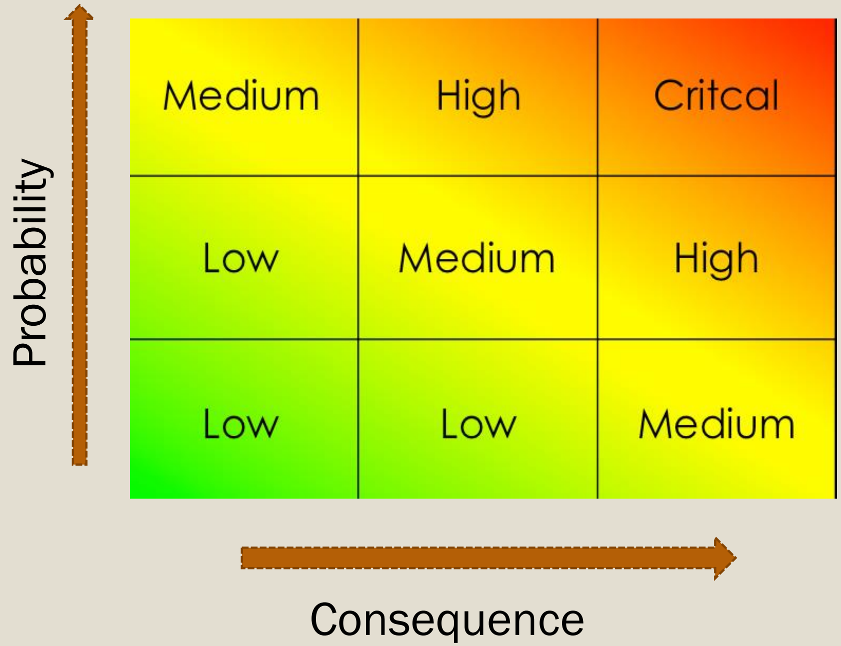
- Stress
- Details
- Material Toughness
- Fabrication
- Testing
- Certification



Risk Based Framework for Fracture Control

Consequence

- Redundancy



Thank you for your time and attention.

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