Preservation Role in Risk-Based Inspections

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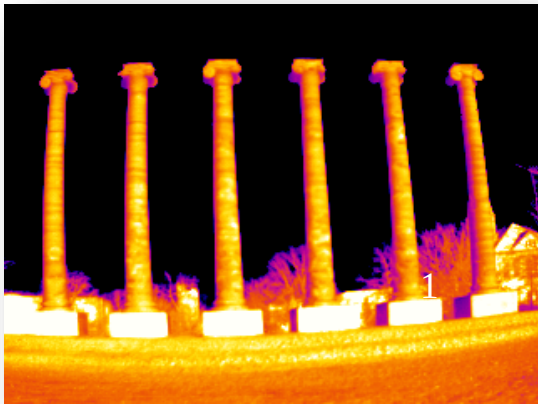
Midwest Bridge Preservation Partnership



NCHRP 12-82

This investigation was sponsored by TRB under the NCHRP Program. Data reported are work in progress. The contents of this presentation has not been reviewed by the project panel or NCHRP, nor do they constitute a standard, specification, or regulation.

NCHRP 12-82 Goals

- Goal: Improve the safety and reliability of bridges
  - focusing inspection efforts where most needed
- Optimize the use of resources
  - Better match inspection requirements to inspection needs
  - Develop a rational process for assessing inspection needs using reliability theories

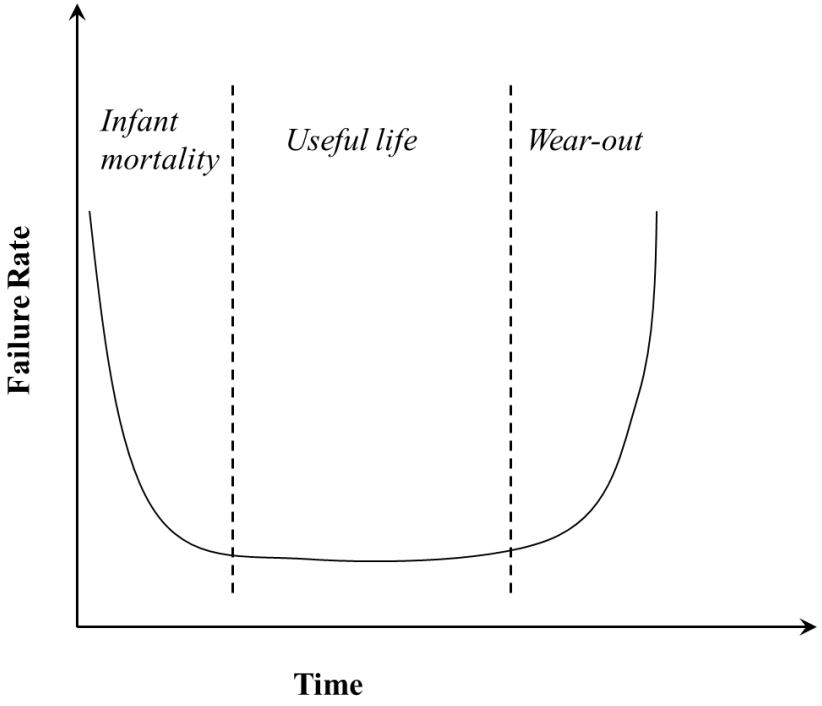
Agenda

- What is Risk-Based Inspection
- How does Preservation fit in?
- Conclusion

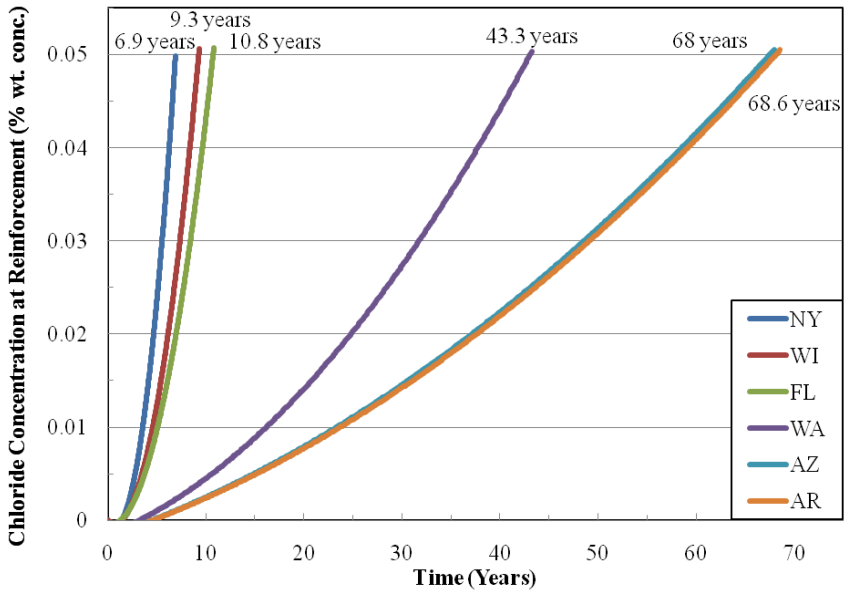
Risk-Based Bridge Inspection

- Inspections that consider
  - The reliability of bridge elements
    - Likelihood of deterioration and damage
      - Condition, design, materials and loading
  - The consequences of that damage
    - Minor serviceability issues, safety issue?
- Inspection interval and scope
  - Match inspection requirements with inspection needs for a bridge

Motivation



Typical lifetime performance



Time to corrosion initiation for RC

Example Guidelines

- ASME (2007). Inspection Planning Using Risk-Based Methods, The American Society of Mechanical Engineers**:** 92.
- API (2002). "Risk-Based Inspection, API Recommended Practice 580." 45. (updated)
- API (2008). "Risk-Based Inspection Technology, API Recommended Practice 581.“
- (2003). Surveys Using Risk-Based Inspection for the Offshore Industry Houston, TX, American Bureau of Shipping**:** 62.
- INTERIM ADVICE NOTE 148/12, Risk Based Principal Inspection Intervals
- Transport Wales Framework Lot 5,Task Order 5/2, BD 63/07 Risk Based Inspections Guidance Note February 2010
- NRC docs

Definitions

- **Reliability:** Ability of an item, component or system to operate safely under designated operating conditions for a designated period of time or number of cycles.
- **Risk:** Combination of the probability of an event and its consequence.

Risk – Based Approaches

R = POF x C
R = Likelihood x C
R = Frequency x C
R = Occurrence x C

Requires time interval

Consequences:

- Economic
- Environmental
- Safety

Reliability-Based Inspection (RBI)

- What can go wrong?
  - Identify damage modes for elements
  - Deterioration mechanisms
- How likely is it?
    - Categorization based on reliability characteristics of bridge elements
    - Based on expert judgment and expert elicitations
      - Past experience
      - Analysis of existing or potential damage modes
      - Deterioration data if available (and relevant)
      - ***Preservation activities***
- What are the consequences?
  - How important is it?

Factors in RBI

- Damage Modes and deterioration mechanisms
  - Attributes affecting likelihood
- Occurrence factor (POF)
- Consequences
  - Experience, redundancy, situation (ADT, traffic speed), analysis, etc.

Damage Modes

Damage Mode: Section Loss
Det. Mechanism: Corrosion

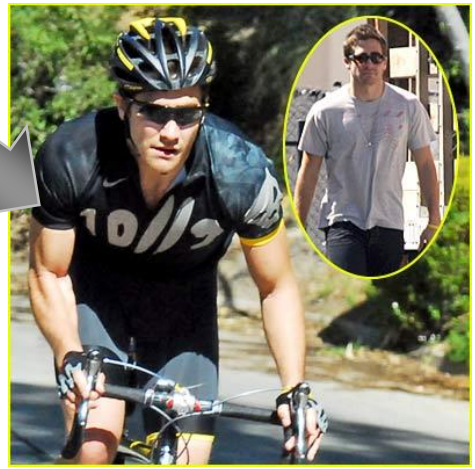
Damage Mode: Impact?
Det. Mechanism: Impact

Identifying Damage Modes

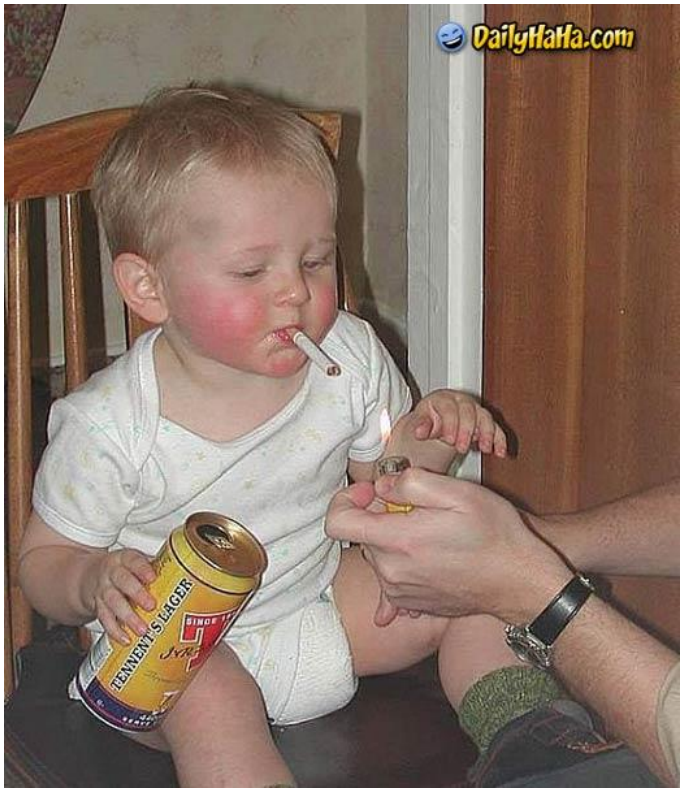
Cause of death	Likelihood (%)
Heart attack	●●●●●○○○○○
Hit by car	●●●○○○○○○
Murdered	●●○○○○○○○
Brain Aneurism	○○○○○○○○○○
Lightning	○○○○○○○○○○

http://thewritepractice.com/emergency-your-creativity-is-dying/

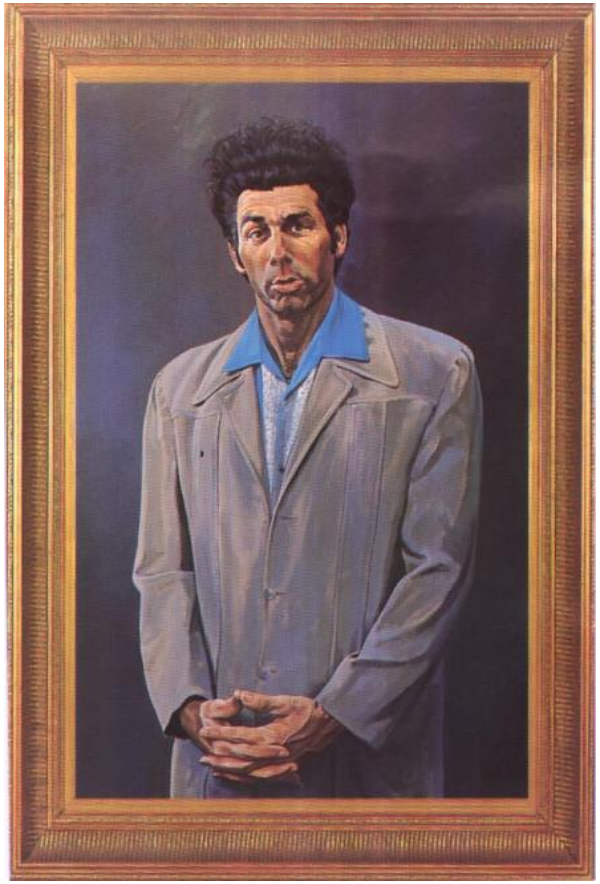
Concept - Likelihood



Concept - Likelihood

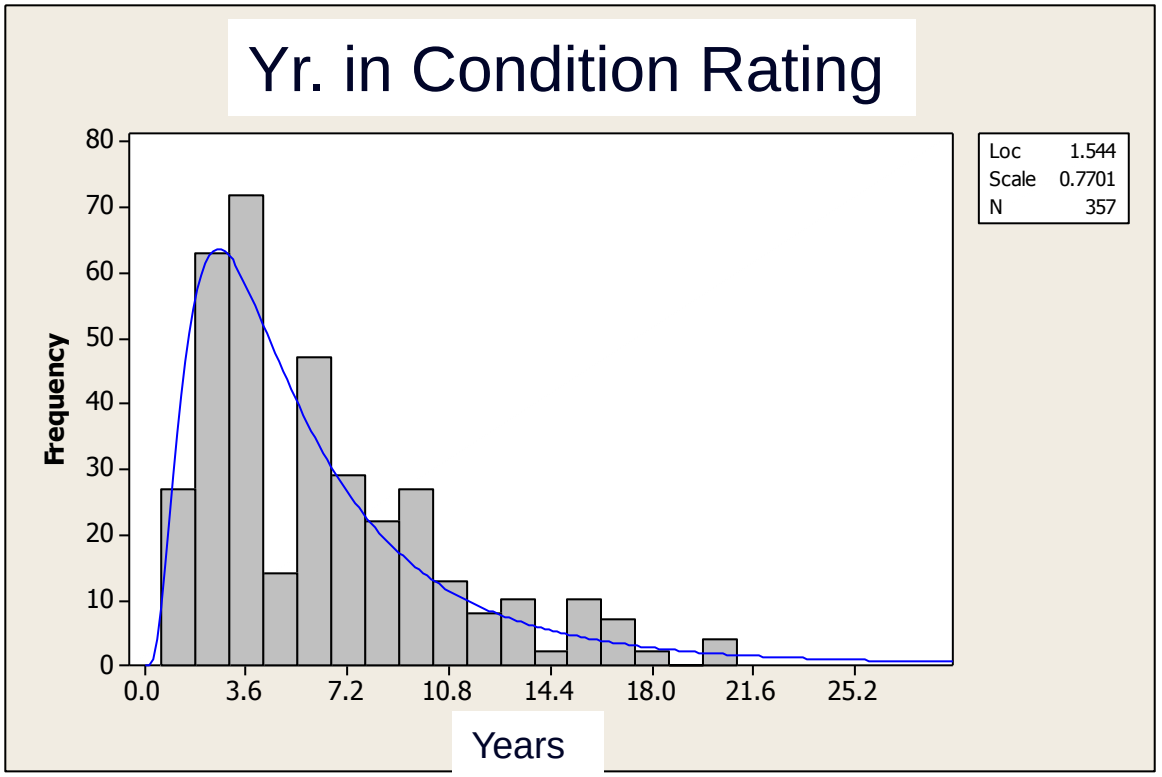


Bad attributes



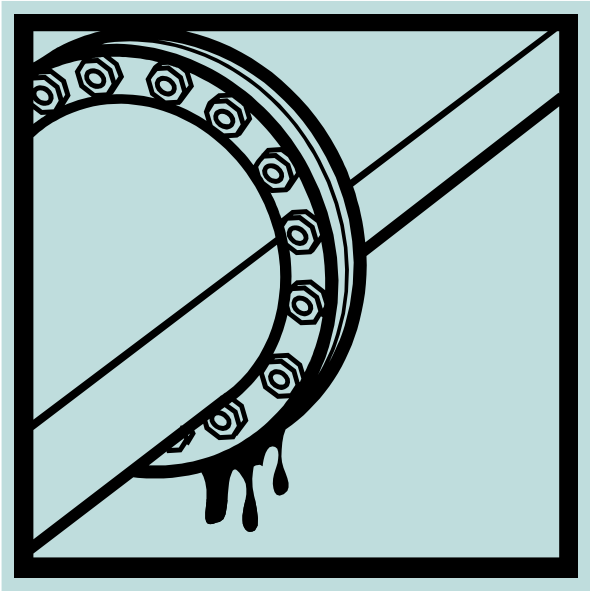
Unique

Where does a bridge fall on the distribution?



Concept - Consequences

- Water = low consequence
- Nuclear waste = Severe

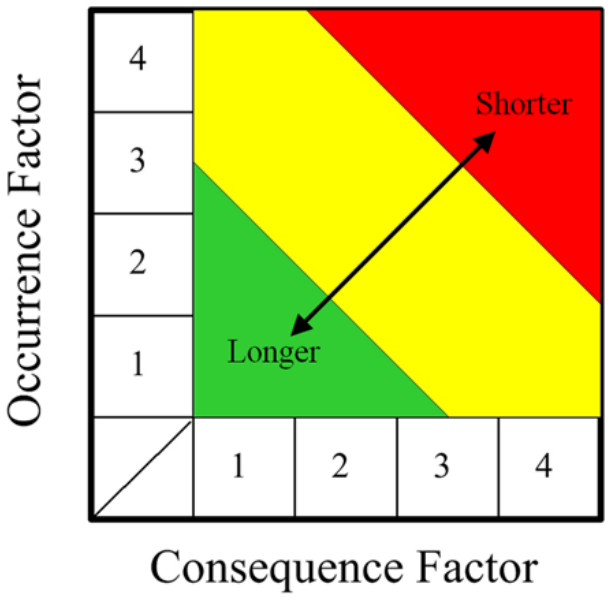


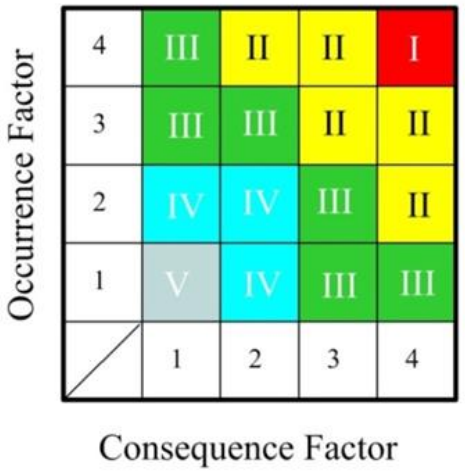
Consequences…

- Ex. Multi-girder 3 span PS vs. pin and hanger in two-girder (fracture critical) bridge
- Low, moderate, high and severe
- Design characteristics, scenario, documented experience, calculation

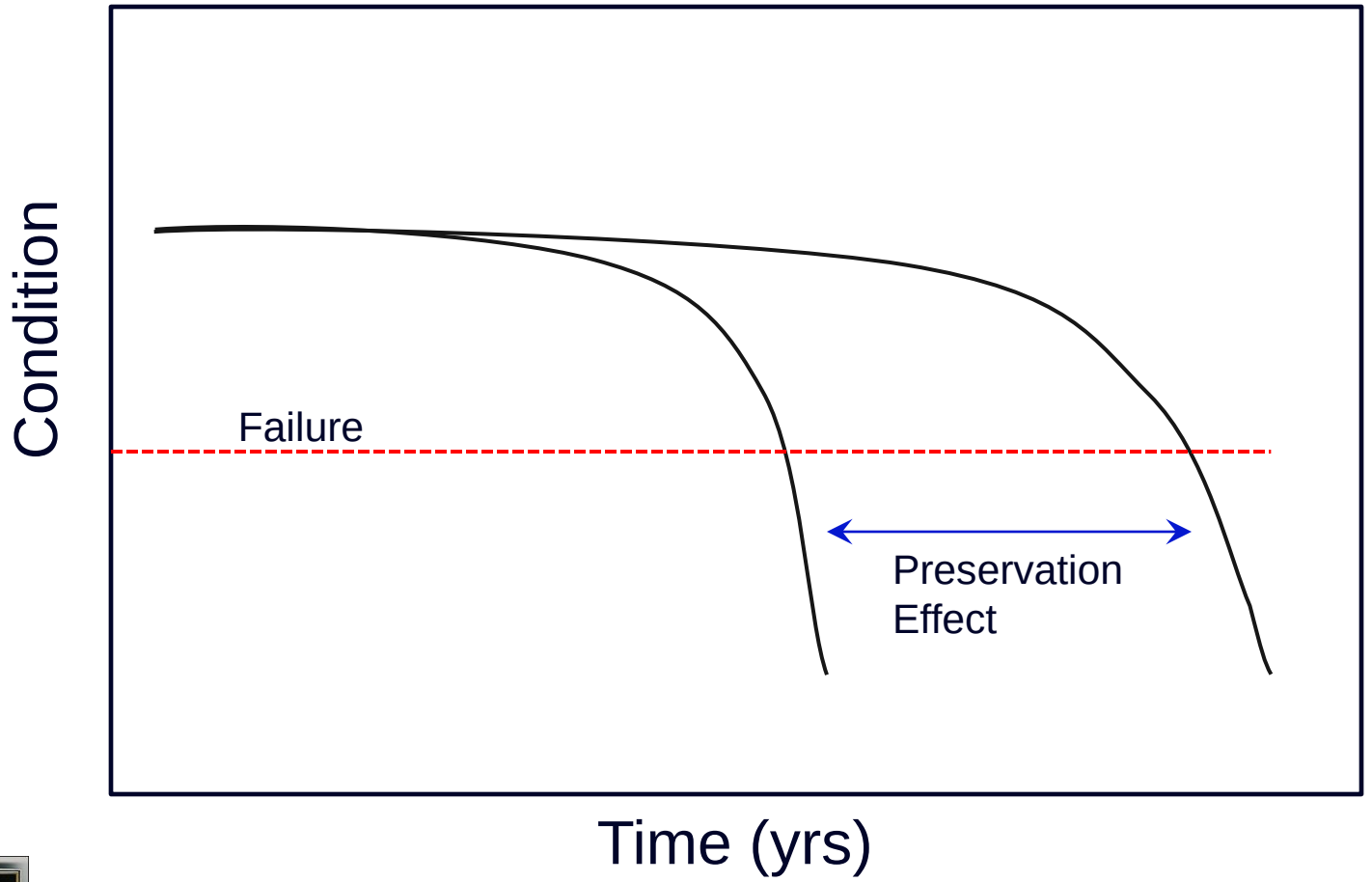
Risk Matrix

- Plot values of likelihood and consequence
- Components in the top right corner are “high risk”
- High likelihood may not mean high risk, if consequence is small
- High consequence may not be high risk, if the likelihood is low

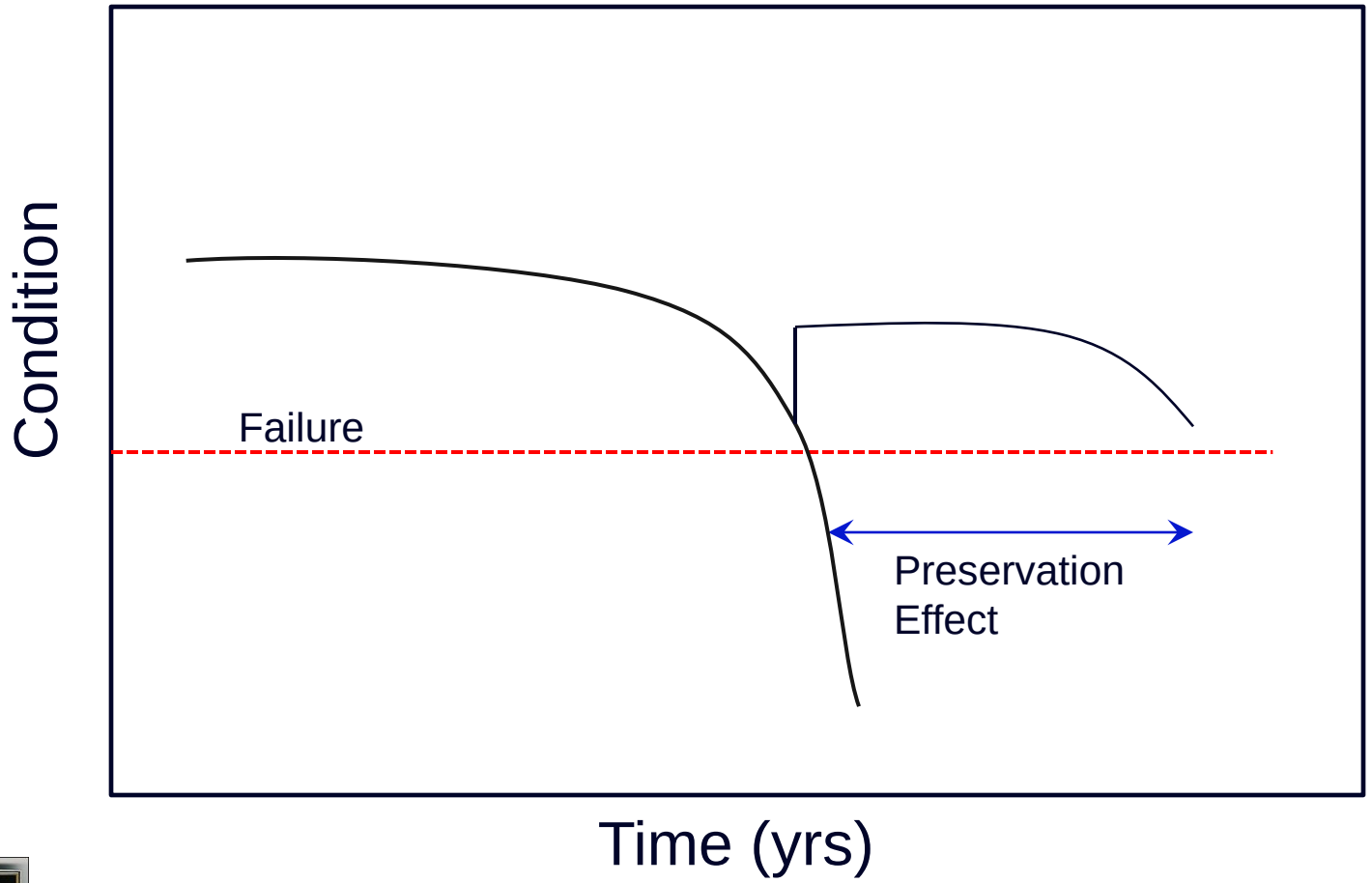




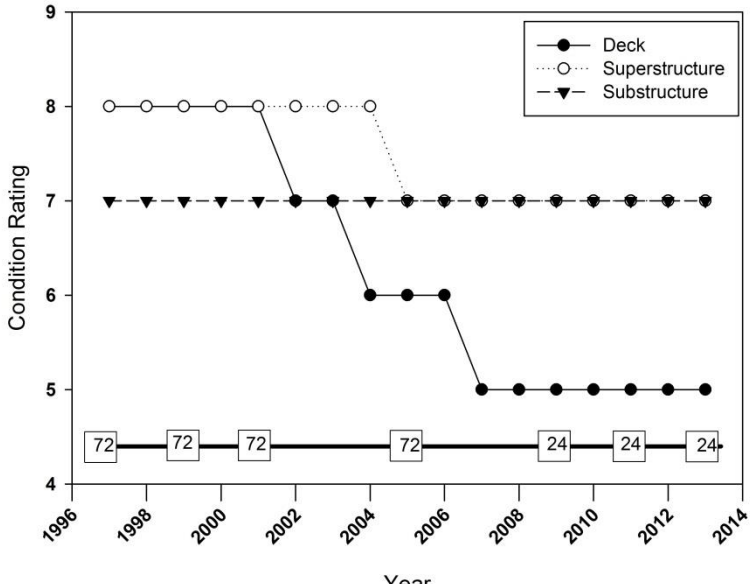
Preservation Effect

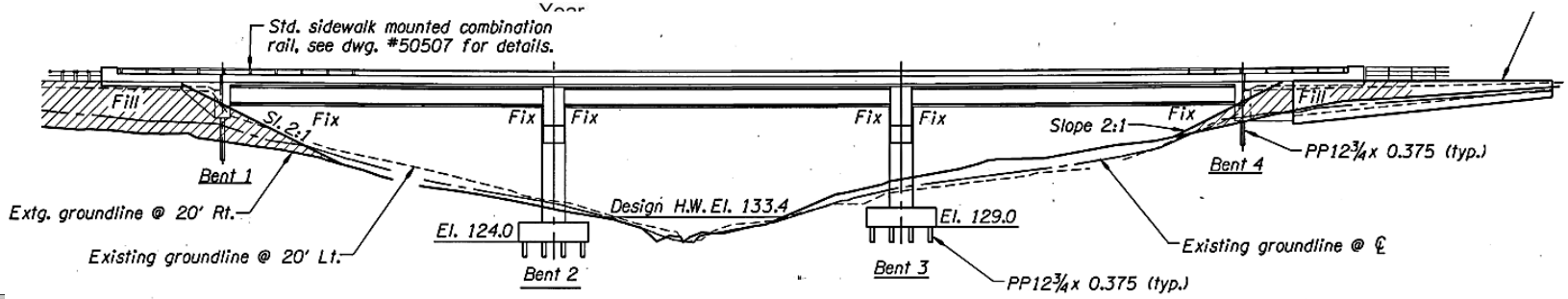


Preservation Effect



Example


Deck
Superstructure
Substructure
Condition Rating
9
8
7
6
5
4
72
72
72
72
24
24
24
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


Std. sidewalk mounted combination rail, see dwg. #50507 for details.
Fill
Sl. 2:1
Fix
Fix
Fix
Fix
Fix
Slope 2:1
Fix
Fill
Bent 1
Bent 4
PP12¾x 0.375 (typ.)
Extg. groundline @ 20' Rt.
Existing groundline @ 20' Lt.
Design H.W. El. 133.4
El. 124.0
El. 129.0
Bent 2
Bent 3
Existing groundline @ ℄
PP12¾x 0.375 (typ.)

Potential Benefits of RBI

- Better, more effective and purposeful inspections
  - Inspection plan (scope and interval) supported by engineering assessment by RAP
    - *Vs. Calendar-based inspection strategy*
  - Rational inspection strategies
    - Flexible intervals based on need and engineering analysis
- Allocate resources more effectively
  - Focus inspections resources where most needed
- Value-added to preservation activities
- **Improved bridge reliability and safety**

Preservation Role in RBI

- Preservation can reduce the POF and thereby reduce the risk
  - Reduce unnecessary inspections
  - Focus inspection where most needed
  - Allocate resources more effectively

Questions

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