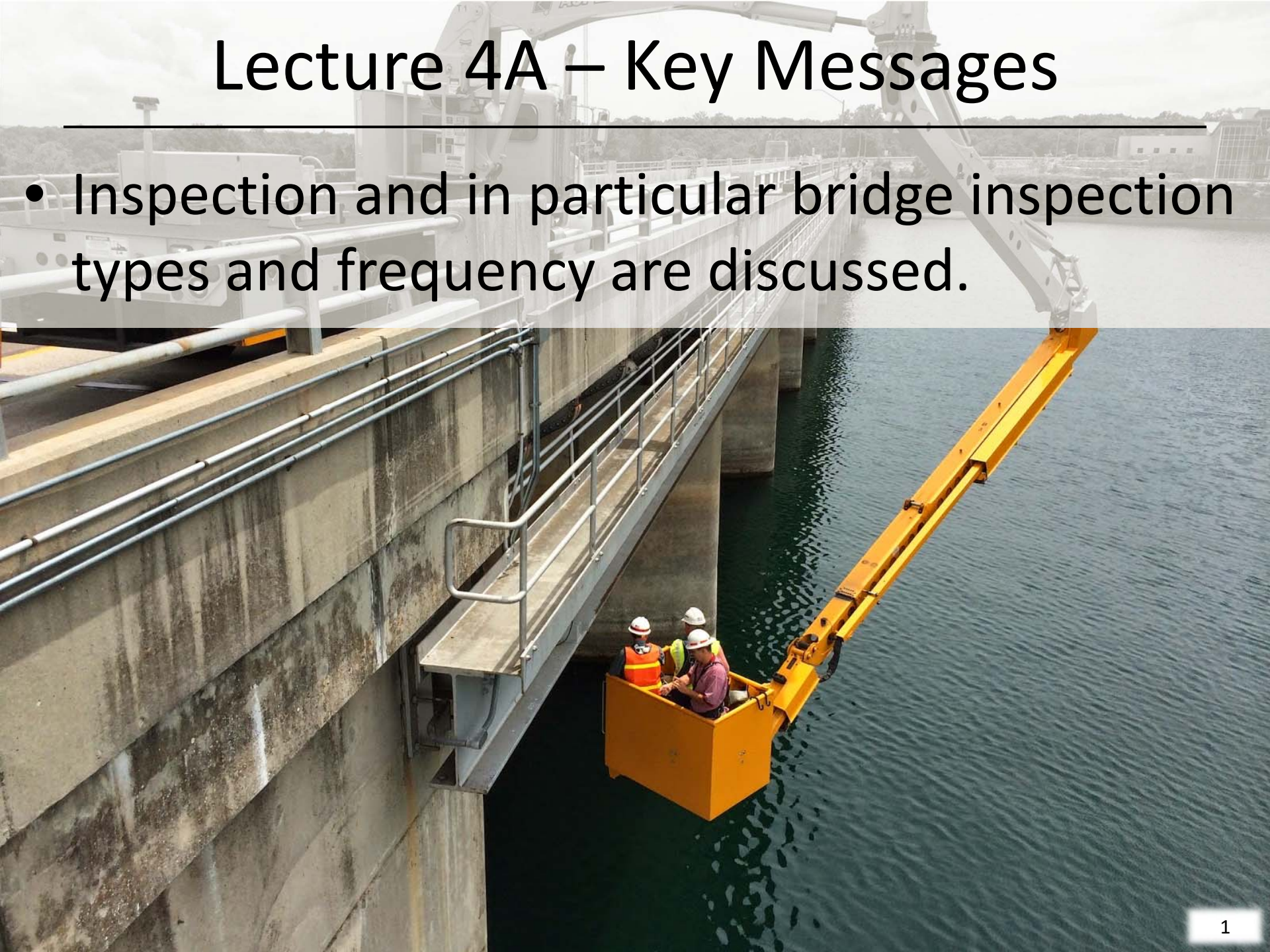
Lecture 4A – Key Messages

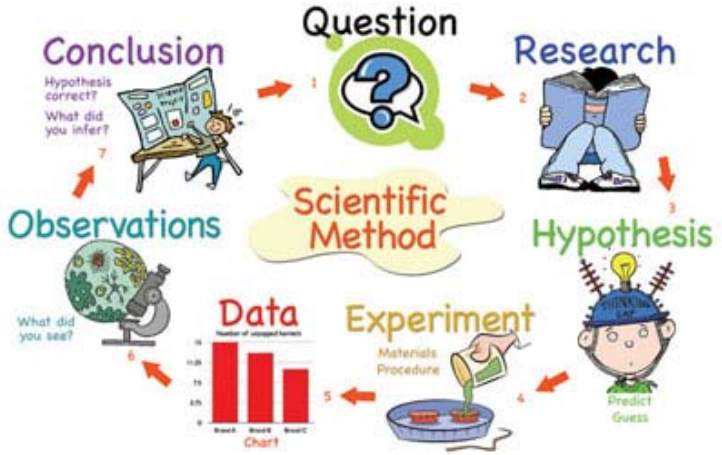
- Inspection and in particular bridge inspection types and frequency are discussed.



Introduction

Damage identification/evaluation involves a forensic analysis employing the scientific method:

- *observe damage*
- *form hypothesis*
- *test hypothesis*
- *determine most likely causes*



The purpose of inspection is not only to document the type of repair and extent of deterioration identified but also to investigate the cause of deterioration and to provide guidance on the appropriate remedial action to mitigate against its re-occurrence.

Introduction

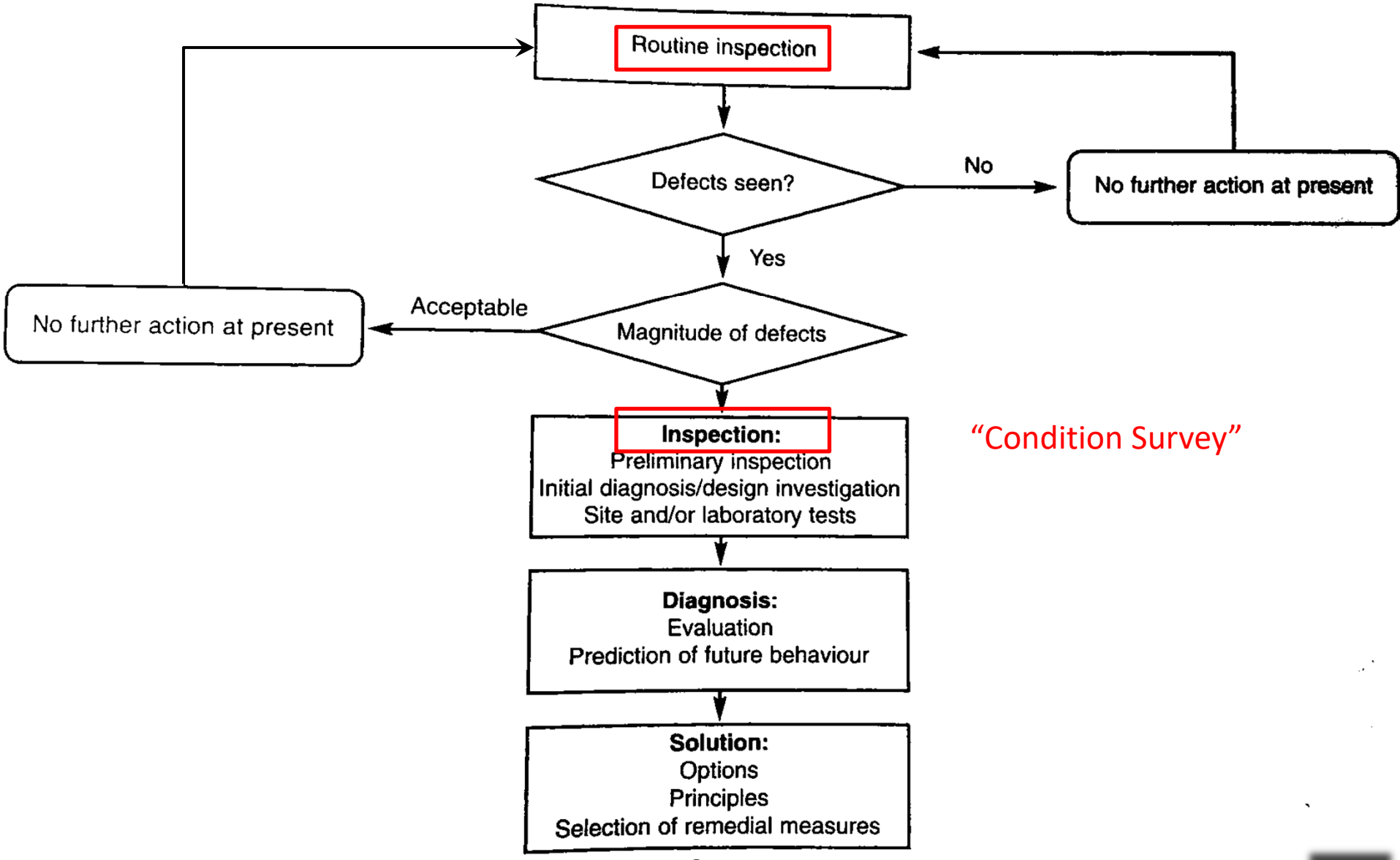
- Routine inspection is important. Why?
  - avoidance of accidents
  - continued operation
  - protection of capital investment
- Frequency of inspection:
  - least inspected: buildings
  - most inspected: public works, especially transportation (roads, bridges)

Why?

Inspection Context

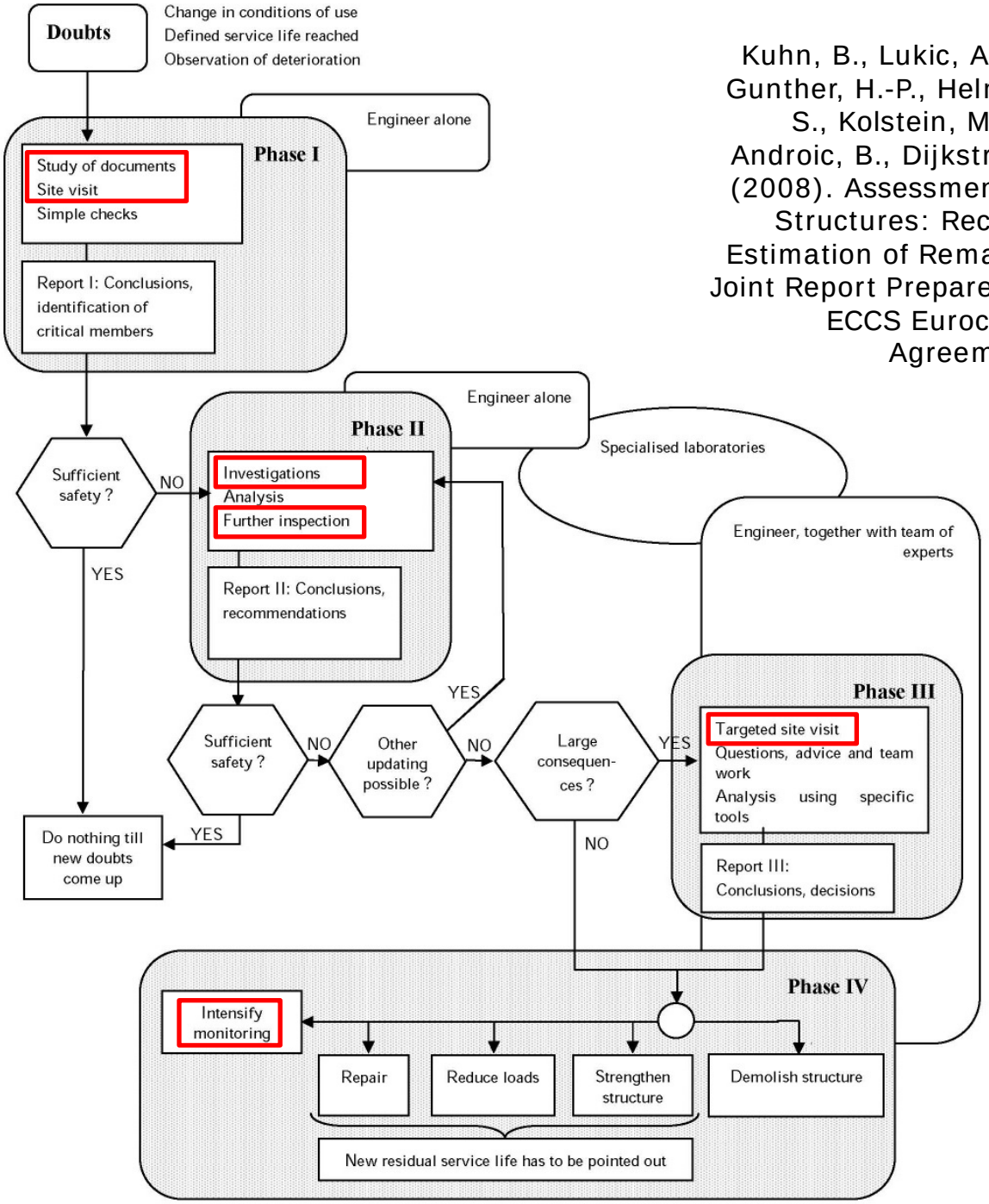
1) Inspection:
   - collect data at specified intervals
2) Analysis:
   - add the latest information to the data base
   - examine progress of damage
   - relate damage to cause
3) Action:
   - alter inspection frequency
   - implement repair
   - put safety procedure in place

Inspection Context



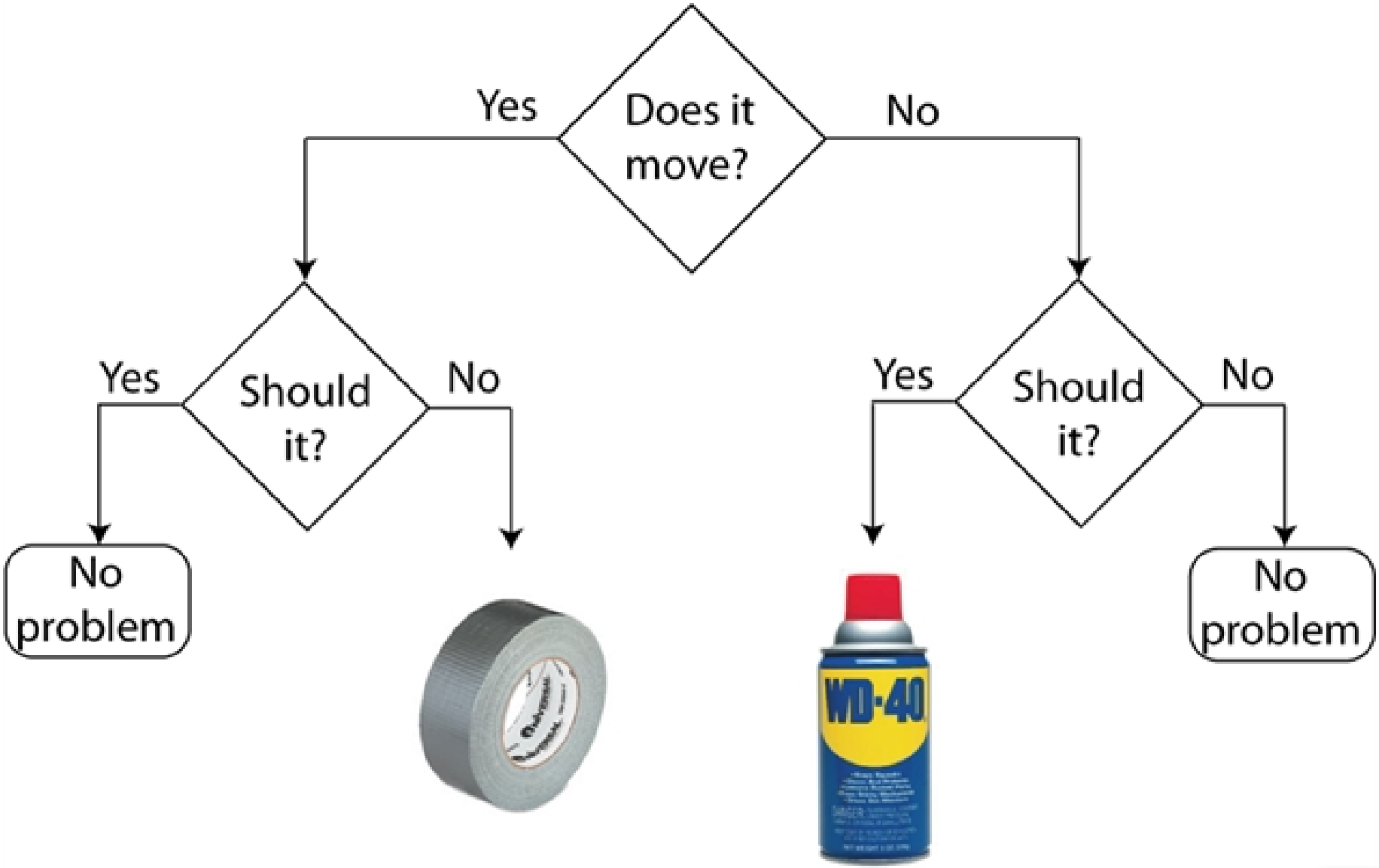
"Condition Survey"

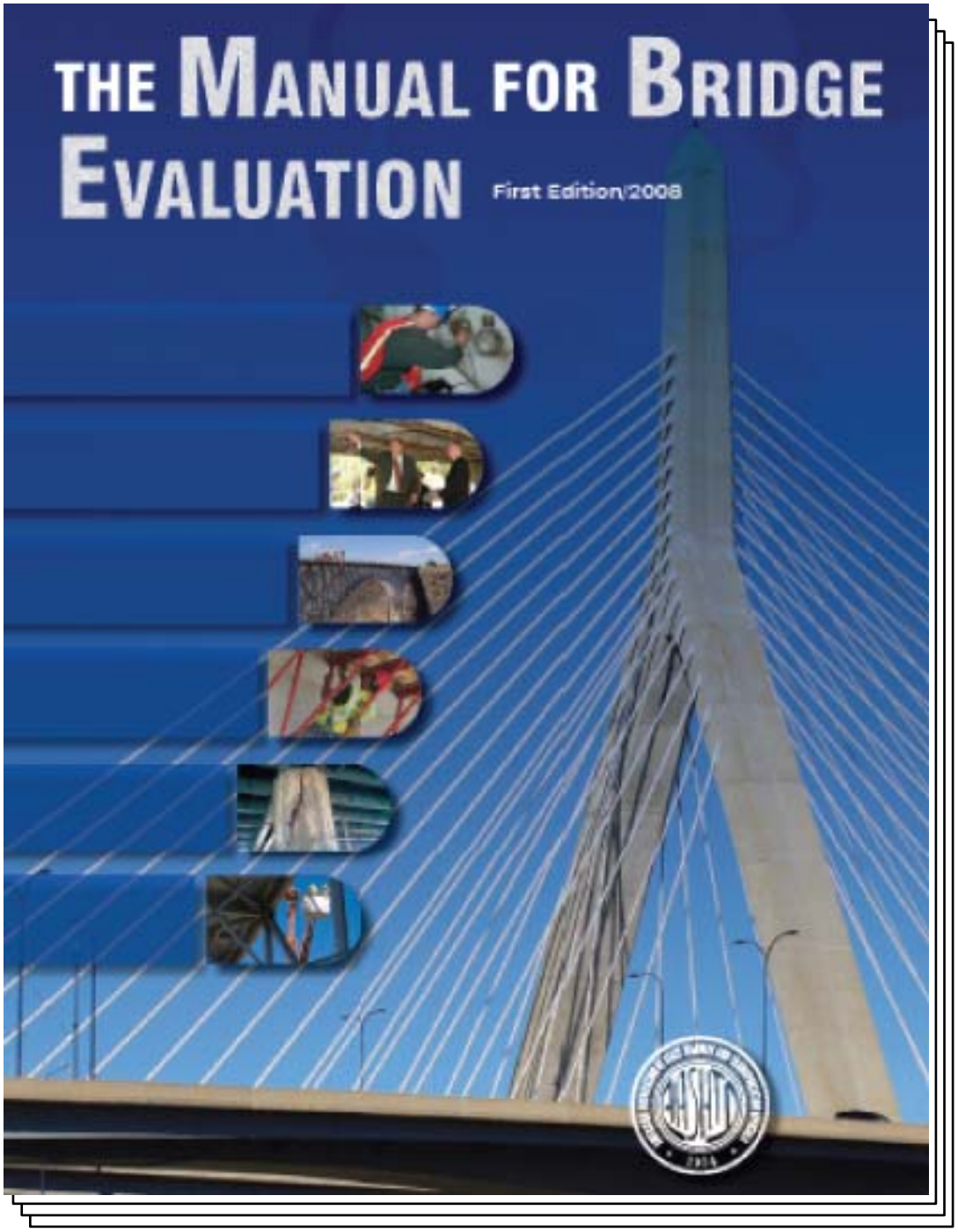
RECALL:



Kuhn, B., Lukic, A., Nussbaumer, A., Gunther, H.-P., Helmerich, R., Herion, S., Kolstein, M.H., Walbridge, S., Androic, B., Dijkstra, O., & Bucak, O. (2008). Assessment of Existing Steel Structures: Recommendations for Estimation of Remaining Fatigue Life, Joint Report Prepared under the JRC – ECCS Eurocode 3 Cooperation Agreement, Luxembourg.

Engineering Flowchart



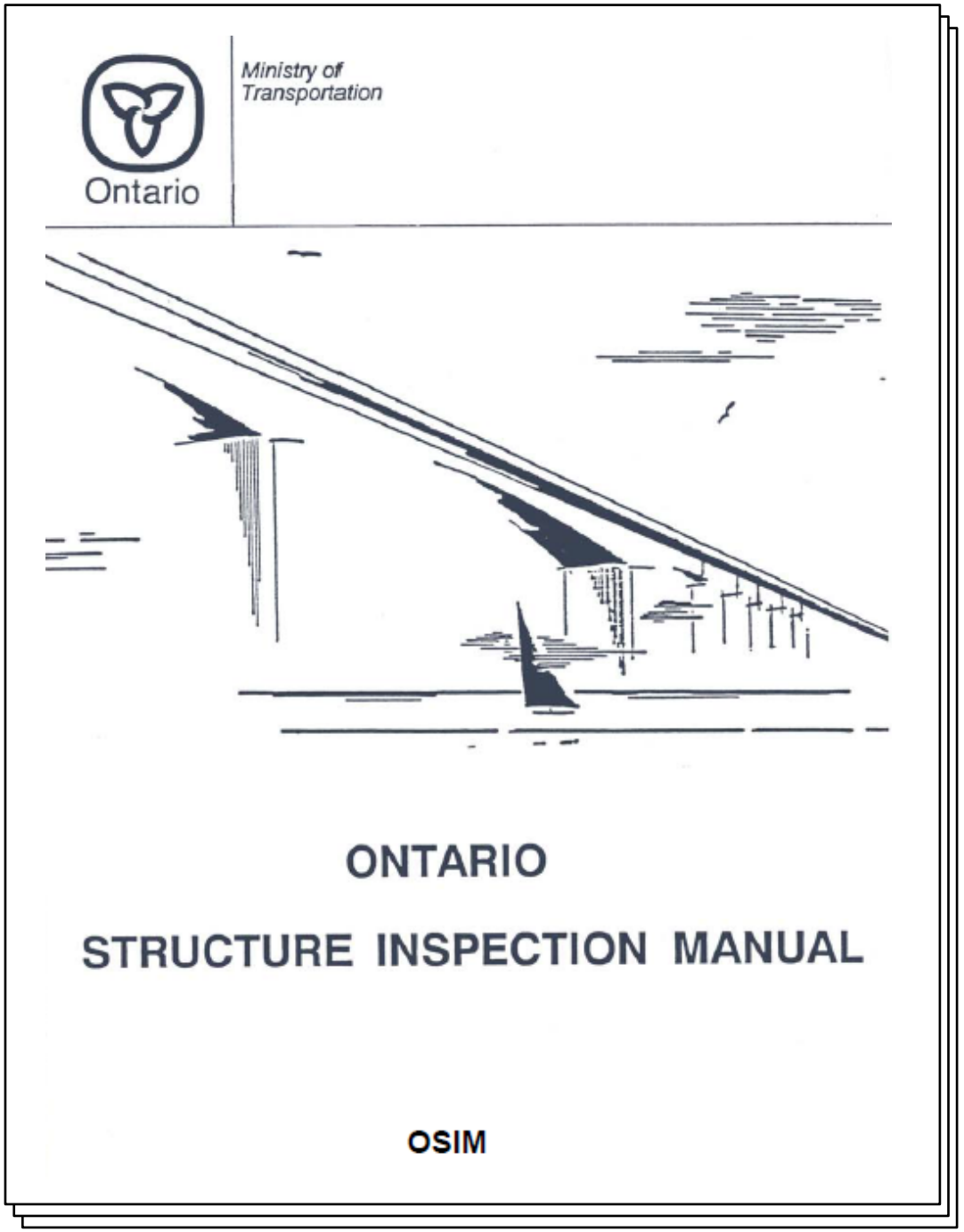


[AASHTO MBE 2008]

Inspection Purpose

Bridge inspections are conducted to determine the physical and functional condition of the bridge; to form the basis for the evaluation and load rating of the bridge, as well as analysis of overload permit applications; to initiate maintenance actions; to provide a continuous record of bridge condition and rate of deterioration; and to establish priorities for repair and rehabilitation programs.

[AASHTO 2008]


Ministry of
Transportation
Ontario
ONTARIO
STRUCTURE INSPECTION MANUAL
OSIM

[OSIM 2008]

Inspection Goals and Objectives

- Goal of inspection is to ensure acceptable standard in terms of public safety, comfort, and convenience, within economic constraints.
- Objectives:
  - maintain safe condition
  - extend life of structure
  - identify maintenance and repair needs
  - provide input for management to identify future projects and funding needs

[OSIM 2008]

Inspection Frequency

Frequency of inspection depends on:

1) Class of structure:
   - Class 1: failure of the structure would have catastrophic consequences or the structure is of vital importance
   - Class 2: failure might cost lives or structure is of considerable importance
   - Class 3: failure is unlikely to be fatal and a period of time with the structure out of service could be tolerated

Inspection Frequency

Frequency of inspection depends on:

2) Environment and loading:

- Very severe: environment is aggressive and there are cyclic or fatigue loads
- Severe: environment is aggressive with static loading, or environment is normal with cyclic or fatigue loading
- Normal: environment is normal with static loading

Inspection Frequency

Frequency of inspection depends on:

3) Structural appraisal:
   - Does the present condition mean that safety is impaired?
   - What are the causes for the structure's present state?
   - Will the structure, without repair, become dangerous?
   - Does the present condition affect operation of the facility?

Inspection Frequency and Types

- Ontario bridges are inspected every two years.
- *"Detailed visual inspection is element-by-element close-up visual assessment of material defects, performance deficiencies and maintenance needs. Close-up is defined as a distance close enough to determine the condition of the element."*
- More frequent inspections for: structures in poor condition, with load limits, new structure types, single load path structures, fatigue or fracture-prone structures, structures with pins.

[OSIM 2008]

Inspection Frequency and Types

- Emergency inspections may be required as a result of collisions, spring flooding events, earthquakes, observed cracks, or falling concrete.
- Special inspection types include:
  - deck condition surveys,
  - asphalt delamination surveys,
  - coating surveys,
  - underwater surveys,
  - fatigue investigations, and
  - seismic investigations.

[OSIM 2008]

Inspection Frequency and Types

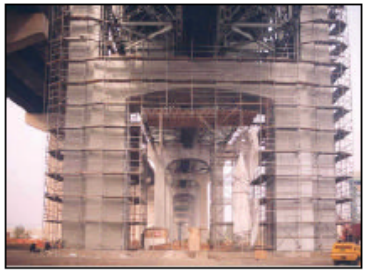
Each bridge should be inspected at regular intervals not to exceed 24 months or at longer intervals for certain bridges where such action is justified by past reports and performance history and analysis.

Inspection Types

- initial inspection
- routine inspection
- damage inspection
- in-depth inspection
- fracture-critical inspection
- underwater inspection
- special inspection

[AASHTO 2008]

STRUCTURE REHABILITATION MANUAL



Ontario

POLICY, PLANNING AND STANDARDS DIVISION
ENGINEERING STANDARDS BRANCH
BRIDGE OFFICE
MINISTRY OF TRANSPORTATION

ISBN 0-7794-6430-3

[CSAY 2004]

Condition Surveys

"Condition Surveys involve carrying out a detailed visual inspection of the structure and detailed condition surveys of the various structure components. The purpose of the surveys is to determine and document the deterioration in the structure so as to establish the type of rehabilitation and prepare contract documents. It may also provide information for an evaluation of the load carrying capacity of the bridge as described in the Canadian Highway Bridge Design Code."

[CSAY 2004]

Condition Surveys Triggers

Table 1: Material Condition Survey Triggers

Condition Survey Type	Description	Condition Survey Trigger	References
Concrete Deck (Asphalt or Concrete surface)	Involves the testing of various core samples, sawn samples and the delineation of delaminated areas and areas of high corrosion potential (using half-cell survey)	10% of deck top or soffit element in "Poor" Condition State	Structure Rehabilitation Manual
Non-destructive Delamination Survey of Asphalt Covered Decks	Involves the delineation of delaminated areas using non-destructive testing techniques such as Ground Penetrating Radar, Impact Echo testing, etc	5% of element in "Poor" Condition State	Structure Rehabilitation Manual
Concrete Substructure	Involves the testing of various core samples, etc, and the delineation of delaminated areas and areas of high corrosion potential (using half-cell survey)	10% of element in "Poor" Condition State	Structure Rehabilitation Manual
Post-Tensioned Strand Investigation	Involves exposing areas of post-tensioning strands to determine possible corrosion and extent of duct grouting.	50% of "Deck End" element in "Poor" Condition State	Structure Rehabilitation Manual
Wood Substructure or Superstructure	A detailed investigation of the wood components using techniques such as probing, drilling, coring, etc.	10% of element in "Poor" Condition State	Part 4 of this manual
Structural Steel Coating	A detailed survey of the condition of the coating to confirm the feasibility of over-coating. The survey involves testing coating adhesion, dry film thickness, etc. If deterioration is still in the early stages (Combined area of Fair and Poor greater than 25%, and Poor is less than 10% at the visual inspection stage), "over-coating" of the steel may be a viable rehabilitation option. This involves cleaning the surface with a wire brush and "over-coating" the entire surface. If deterioration exceeds the above thresholds, traditional coating techniques (sandblasting the surface, priming, etc.) would probably have to be used.	25% of combined area in "Fair" and "Poor" Condition States and the percentage in Poor is less than 10%.	Structural Steel Coating Manual

[OSIM 2008]