Lecture 4B – Key Messages

- Inspection planning guidelines are provided and defect classification and material condition states are discussed.

Inspection Planning

Site visit

- Site visit to inspect the structure advised before planning detailed investigation...

Who should do it?

- client's representative + consulting engineer

What are the factors that need to be considered?

- Is the integrity of the structure or any element in doubt?
- Do adequate drawings exist of the as-built construction?
- If not, do we need to determine the missing data prior to any repair (e.g. concrete strength, rebar layout)?

Inspection Planning

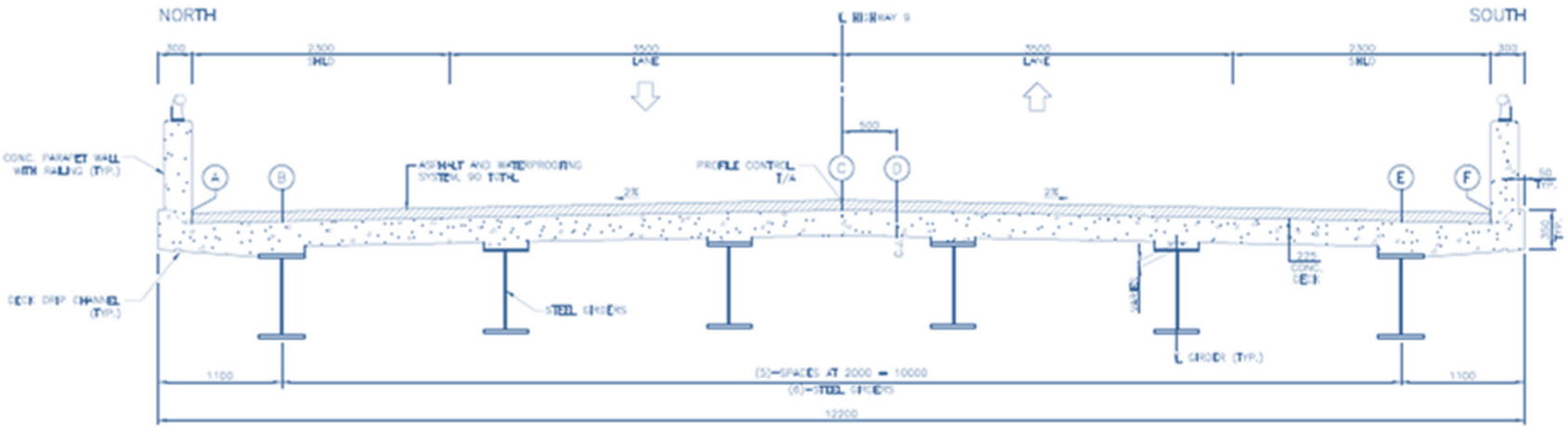
- Is access to parts of the structure easy or difficult?
- Is there a deadline for the work to be completed?
- Are there any requirements for the personnel that will be undertaking the work (structural engineer, geotechnical engineer, etc...)
- Is it necessary to define extent of deterioration for budget estimation or preparation of approximate bill of quantities?
- What are the expect-ations / needs of the client in terms of the remaining service life?

Inspection Planning

Existing drawings:

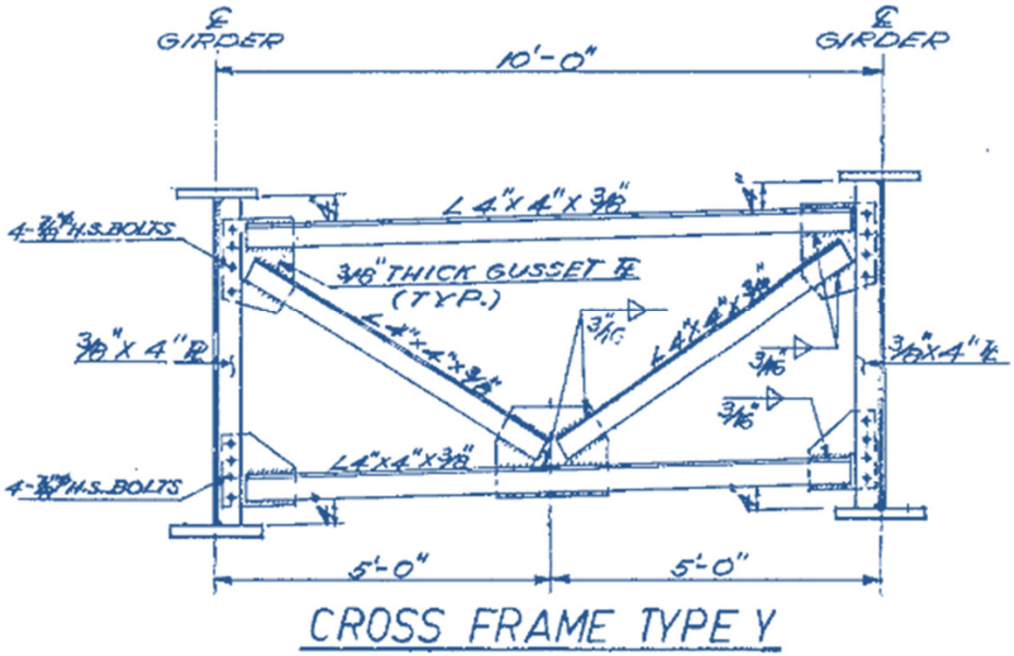
The available documents and drawings should be examined for the following information:

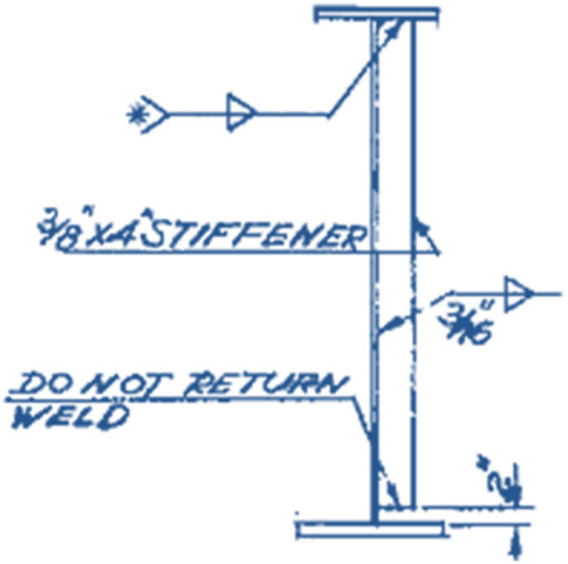
1) age and details of any previous remedial works
2) construction details on aspects including the foundation, joints, and reinforcement



Inspection Planning

3) details of the concrete, including specifications, mix design, and test results
4) records of any previous inspections, such as major investigations of bridges





Inspection Planning

5) scale drawings, general arrangements, plans, etc.
   - original drawings, service records
   - details of previous repairs
   - data from instrumentation/monitoring
   - identity of original contractor/engineer
   - performance history of structures in the area
   - environmental and service exposure

The structural safety analysis is performed based on existing information.

Inspection Planning

- determine inspection type
- identify personnel and equipment
- identify previously noted defects / concern areas
- estimate inspection duration and schedule
- coordinate with other agencies / notify public
- prepare field recording forms
- plan underwater inspection, non-destructive evaluation (NDE), or other specialized testing (as needed)

[AASHTO 2008]

Inspector's Responsibilities

The main responsibilities of inspectors are:

- inspecting all elements that comprise the structure
- recording all areas of material defects for each element, and categorizing them based on condition state (CS)
- identifying suspected performance deficiencies
- noting areas of the structure where maintenance req'd.
- making recommendations for repairs and rehabilitation
- indicating the suggested time frame or urgency of the proposed work
- identifying additional detailed investigations required
- ensuring appropriate actions taken to address concerns

[OSIM 2008]

Inspection Equipment

- binoculars
- camera
- chalk, markers, and paint markers
- inspection forms and clip boards
- flashlight (focussing type)
- length of chain (2 m)
- light chipping hammer
- measuring tapes (3 m, 30 m)
- “workers ahead” signs
- mirror with extension arm
- plumb bob
- pocket knife or multi-tool
- range poles
- safety belts and lanyard
- boots, hat, gloves, vest
- flotation vest
- safety cones and flashing light

- scraper
- screwdriver (large)
- sounding line (lead line)
- straight edge (1 m)
- air thermometers
- wire brush
- chordless drill with bits
- grinder
- wood borer and treated plugs
- eye level and hand level
- string-line
- other equipment as required

[OSIM 2008]

Special Equipment

- extension or folding ladder (3.5 m)
- boat or barge
- scaffolds: mobile, cable-supported, stationary
- truck-mounted inspection bucket
- scissor lift
- “cherry picker”
- “Bridge Master”
- lane closures

[OSIM 2008]

Inspection Preparation

- Obtain and review existing records of the structure prior to field work, including design and "as-built" drawings, previous inspection reports, correspondence and details of repairs, rehabilitations, or modifications.
- Prepare inspection forms.
- Record dimensions and calculate the quantities for the bridge elements under consideration.
- Decide the time schedule for the inspection and any required special equipment, including traffic protection.
- Make plans for special equipment and traffic control.
- Obtain permission from railway if bridge is over tracks.

[OSIM 2008]

During the Inspection

- Complete a brief overview of the site to:
  - assess the overall integrity of the structure and identify areas where more detailed examination may be required,
  - observe the bridge under traffic loading and identify abnormal flexibility, deflections or noises (rattling of members, etc.),
  - look for abnormal deflections, settlements or rotations by looking along the rail or barrier wall or other members,
  - identify obstacles that may either interfere with the inspection or indicate a need for additional special equipment.
- Inspect bridge elements in a systematic fashion (top to bottom or bottom to top) completing various parts of the inspection form.
- Note material defects, performance deficiencies, maintenance needs, recommended work and time frame for each element.
- Record observations and make sketches where appropriate.

[OSIM 2008]

During the Inspection

- Take photographs to adequately describe structure and defects.
- Take the following photographs:
  - One that shows the deck cross-section, number of traffic lanes, curbs and sidewalks, medians, and railing system.
  - One of the elevation of the structure that shows the number of bridge spans and the superstructure type.
  - One of the underside (soffit) that shows the type and number of main superstructure element(s).
  - Individual photographs of all areas in a poor condition state, taken at sufficiently close range such that the type, location and extent of the defects are clearly visible and apparent.
- Record any observed discrepancies with the existing records.
- Identify additional detailed investigations that are required.

[OSIM 2008]


WELL IT CERTAINLY LOOKS STRUCTURALLY DEFICIENT.

Identification of Elements

The first step in performing a detailed visual inspection is to divide the structure into individual elements, e.g:

Table 2.1: Element List and Condition State Cross Reference Table

Element Group	Element Name[6,7,8]	Unit for Quantity[1,2,3,4]	Applicable Condition State Table Number [5]
Abutments	Abutment walls	Sq.m.	4.5, 4.11, 4.19
	Ballast walls	Sq.m.	4.5, 4.11, 4.19
	Bearings	Each	4.2
	Wingwalls	Sq.m.	4.5, 4.11, 4.19
Accessories (Attachments and Signs)	Bridge Mounted Sign Supports[9]	Each	4.12
	Electrical[9]	Each	4.12
	Noise Barriers	m[10]	4.12
	Other	Each	4.12
	Signs	Each	4.12
	Utilities	Each	4.12
Approaches	Approach slabs	Sq.m.	4.5, 4.6
	Barriers[9]	m[10]	4.17,4.19
	Curb and Gutters	m.	4.5
	Drainage System	Each	4.7
	Sidewalk/Curbs	Sq.m.	4.5

[OSIM 2008]

Identification of Elements

Quantification of each element type required:

2.3.1.1 Element Group: Abutments

Element Name	Sub-element	Length (m)	Width (m)	Height (m)	Count	Quantity (Sq.m)[1]	Comments
Abutment walls		N/A	average width of abutment from wing wall to wing wall	Average top of bearing seat elevation – average top of ground elevation + bearing seat width + visible part of footing	# of abutments (2 max.)	width x height x count	a
Ballast walls		N/A	average width wing wall to wing wall	For Decks without exp. Joints Average underside of deck soffit elevation – average bearing seat elevation For Decks with exp. joints Top of deck elevation – average bearing seat elevation	# of ballast walls	width x height x count	b
Bearings		N/A	N/A	N/A	Total # of bearings at abutments	count (Units are Each)	
Wingwalls		average length of wing walls (from centreline bearing to end of approach)	N/A	Average visible height	# of wingwalls	length x height x count	

COMMENTS: a) Includes bearing seat width and top of footing (if visible). For abutments with timber piles use 2 locations: "Pile" = pile area (πDL): "Cap" = pile cap beam area

b) Quantity includes entire ballast wall even if some areas are not visible due to diaphragms.

[OSIM 2008]

Defect Classification

Defects classified according to severity, e.g. for corrosion:

- Light - Light rust stain on the concrete surface;
- Medium - Exposed reinforcement with uniform light rust. Loss of reinforcing steel section less than 10%;
- Severe - Exposed reinforcement with heavy rusting and localized pitting. Loss of reinforcing steel section between 10% and 20%;
- Very Severe - Exposed reinforce-ment with very heavy rusting and pitting. Severe Loss of rein-forcing steel section over 20%.

Figure 2.2.3 Very Severe Erosion of a Concrete Footing

[OSIM 2008]

Material Condition States

- Material Condition States (CSs) are used to categorize element condition based on defect severity.
- There are four CSs: Excellent, Good, Fair, and Poor.
- Areas within a bridge element may be in different CSs, or the whole element may be in the same CS.
- For each bridge element, the inspector assesses and records the amount* in each of the four CSs.
- This assessment is based mainly on visual observations, however, some non-destructive testing may be required to determine or verify areas in poor condition.
- Where an area in poor condition is noted, the area is to be measured (if practicable), or estimated.

[OSIM 2008]

**Lots of rules for doing this…*

Material Condition States

Concrete:

Figure 8.4(c) Concrete T-Beam

Condition State: Fair

- Full height, medium shear crack.

Performance Deficiency: Load Carrying Capacity

- Potentially inadequate beam capacity. An evaluation is required to determine the extent of strength reduction.

[OSIM 2008]

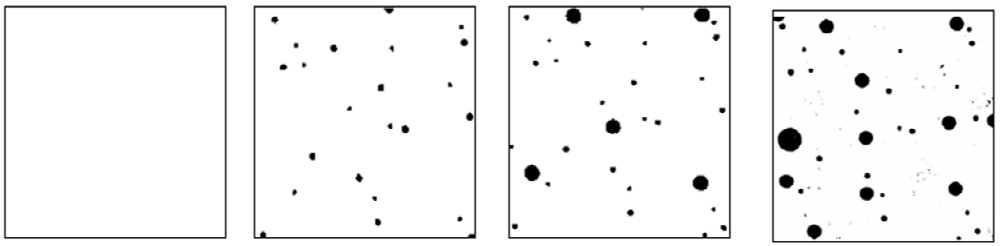
Material Condition States

Table 4.16: Steel or Aluminum – Substructures and Superstructures

Excellent Condition	Good Condition	Fair Condition	Poor Condition
No observed material defects	Light corrosion – no section loss	Medium corrosion - up to 10% section loss	Severe and very severe corrosion – more than 10% section loss
			All cracks (immediate action is required -estimate repair area)
			Permanent deformations
	Light connection deficiencies	Medium connection deficiencies	Severe connection deficiencies
			Evaluation and condition survey* if > 10% in this state.

* Involves measuring thickness of critical members to determine section loss as it varies across the element.

Rust Category 1 2 3 4



[OSIM 2008]

Material Condition States

Coating:

Figure 8.6(a) Through Truss - Connection of Primary Components

Condition State: Excellent

- No defects in coating material.

Performance Deficiency: Not Applicable

Figure 8.6(b) Railing

Condition State: Poor

- Material defects and severe surface rust (Rust Condition Rating - Category 4).

Performance Deficiency: Not Applicable

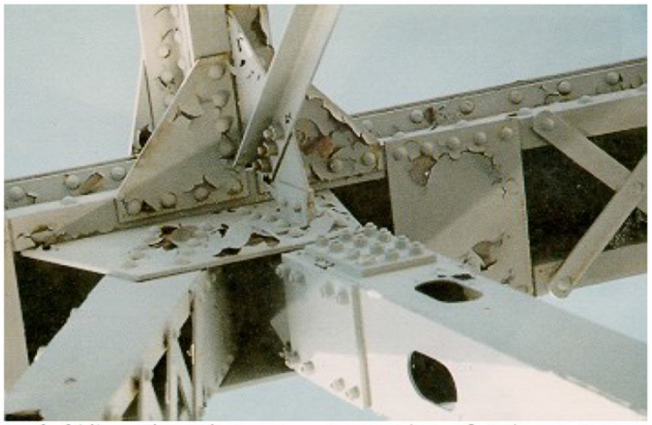


Figure 8.6(d) Through Truss - Connection of Primary Components

Condition State: Poor

- Coating is peeling.

Performance Deficiency: Not Applicable

Figure 8.6(e) Steel Pony Truss

Condition State: Fair

- Material defects and medium surface rust (Rust Condition Rating - Category 3).

Performance Deficiency: Not Applicable

[OSIM 2008]

Post-Inspection Procedures

- Ensure that the appropriate action is taken for any critical structural defects or deficiencies and all other unsafe conditions that are discovered in the field.
- Make sure all inspection equipment and temporary traffic control devices are removed and site is cleaned up.
- Ensure the appropriate follow-up action is taken for any suspected performance deficiencies noted.
- Submit maintenance needs list to maintenance crew.
- Ensure any additional investigations are initiated in the timeframe recommended.
- Write all necessary follow-up correspondence and reports.

[OSIM 2008]