

Introduction to Element Level Bridge Inspection

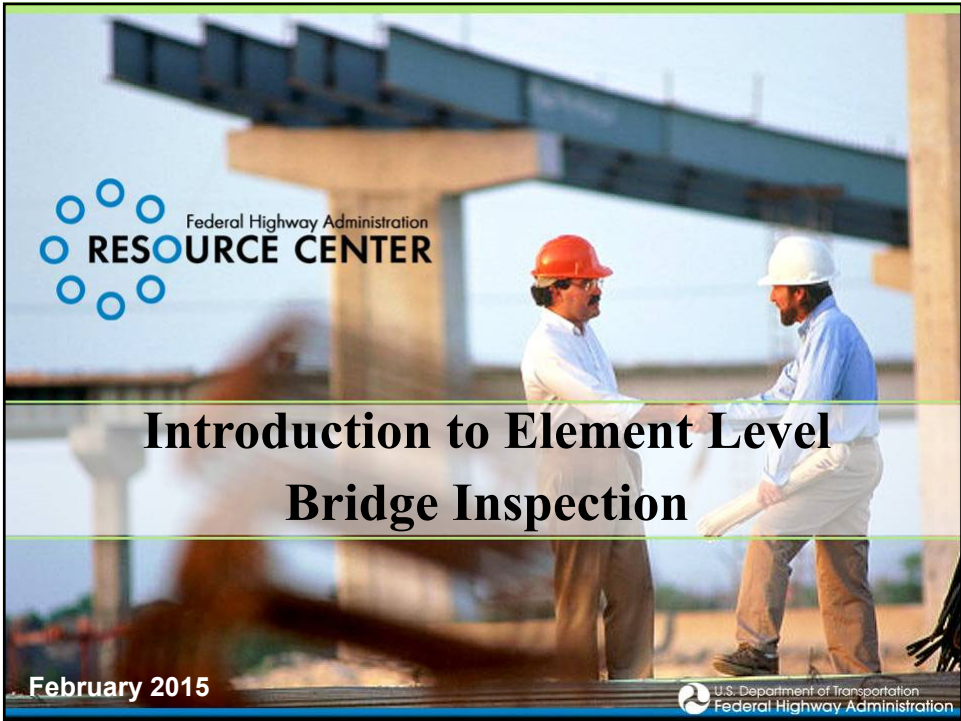
Participant Workbook (3, ½-Day Remote Version)



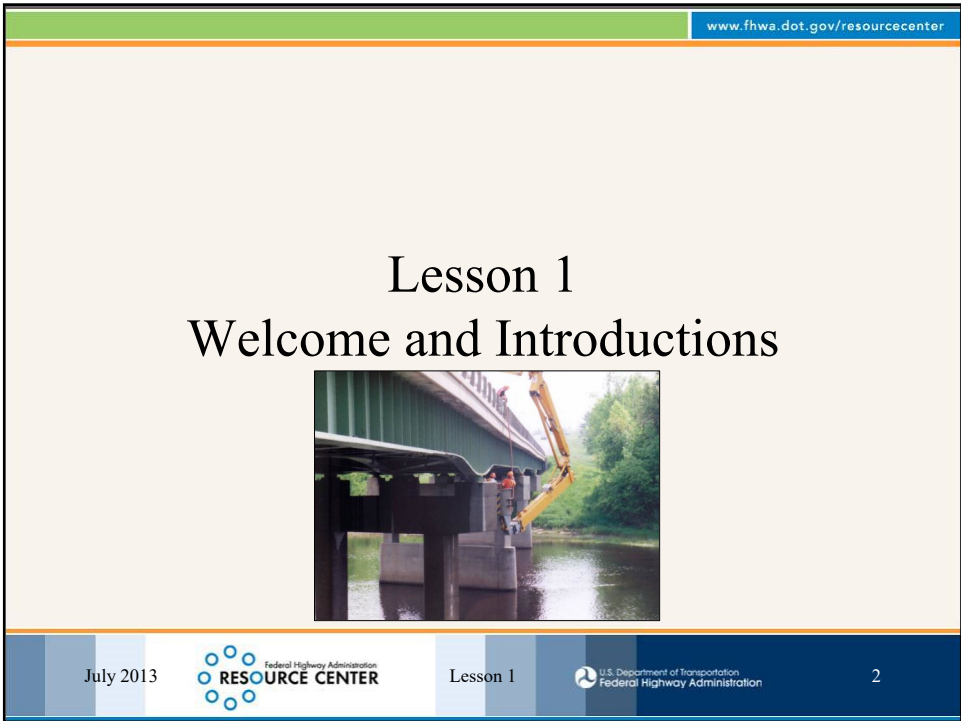
April 2024



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Lesson 1 - Learning Outcomes


- Identify instructors
- Identify participants and goals
- List course learning outcomes
- Define our agenda
- Identify ground rules



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Participants

- Please introduce yourself
 - <https://forms.office.com/g/AxK9ny49Ba>
 - Name and employer/office
 - Job title and responsibilities
 - Years of bridge inspection experience
 - Element level inspection experience
 - Your goals for this course


Participant Introduction and Goals
- Element Level Bridge Inspection
(ELBI) Training



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Course Learning Outcomes

A. Explain the following terms:


- Component vs. Element vs. Safety Inspection Data
- Elements (NBE, BME, ADE)
 - Element Environments
 - Element Condition States
 - Element Defects
- Structures and Structure Units



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Course Learning Outcomes

- B. Explain the rules and conventions for identifying and quantifying elements
- C. Interpret condition state definitions
- D. Review as-built plans to identify bridge elements and determine appropriate units and quantities for elements

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Course Learning Outcomes

- E. Interpret condition state definitions based on visual observations and quantify and record observations
- F. Identify areas of inconsistency and/or differing interpretations
- G. Suggest areas for clarification or further guidance

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Agenda

See training agenda hand-out

Day 1 Morning		
Lesson No.	Topic	Start End
1	Welcome and Introductions	8:00 AM 8:30 AM
2a	Overview	8:30 AM 9:30 AM
Break		
2b	Element Defects and Condition State Definitions	9:30 AM 9:45 AM
3a	Decks/Slabs	9:45 AM 11:15 AM
	Wrap-up (Day 1)	11:15 AM 11:55 AM
Adjourn for Day 1		
Day 2 Morning		
Lesson No.	Topic	Start End
	Welcome/Agenda Review	8:00 AM 8:05 AM
3b	Superstructures	8:00 AM 9:00 AM
3c	Substructures	9:00 AM 10:00 AM
Break		
3d	Culverts	10:00 AM 10:15 AM
4	Identify & Quantify Elements from Plans - Part 1 Ex.	10:15 AM 10:30 AM
5a	Bridge Rails	10:30 AM 11:25 AM
5b	Joints	11:25 AM 11:40 AM
	Wrap-up (Day 2)	11:40 AM 11:55 AM
Adjourn for Day 2		
Day 3 Morning		
Lesson No.	Topic	Start End
	Welcome/Agenda Review	8:00 AM 8:05 AM
5c	Bearings	8:05 AM 8:25 AM
5d	Approach Slabs	8:25 AM 8:40 AM
6	Identify and Quantify Elements from Plans - Part 2 Ex.	8:40 AM 9:30 AM
Break		
7	Assess Element Conditions - Virtual Inspection Exercise	9:30 AM 9:45 AM
Assessment	End of Course Assessment	9:45 AM 11:00 AM
11	Course Evaluations/Wrap-up	11:00 AM 11:45 AM
Adjourn for Day 3		

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Ground Rules


- Save side-bar discussions for breaks
- Parking lot for follow-up questions
- Respect start/end times on agenda
- Cell phones on mute
- Ask questions any time
- Any others?



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QUESTIONS



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Lesson 2a Overview

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Lesson 2a - Learning Outcomes

A. Explain the following terms:


- Component vs. Element vs. Safety Inspection Data
- Elements (NBE, BME, ADE)
 - Element Environments
 - Element Condition States
 - Element Defects
- Structures and Structure Units



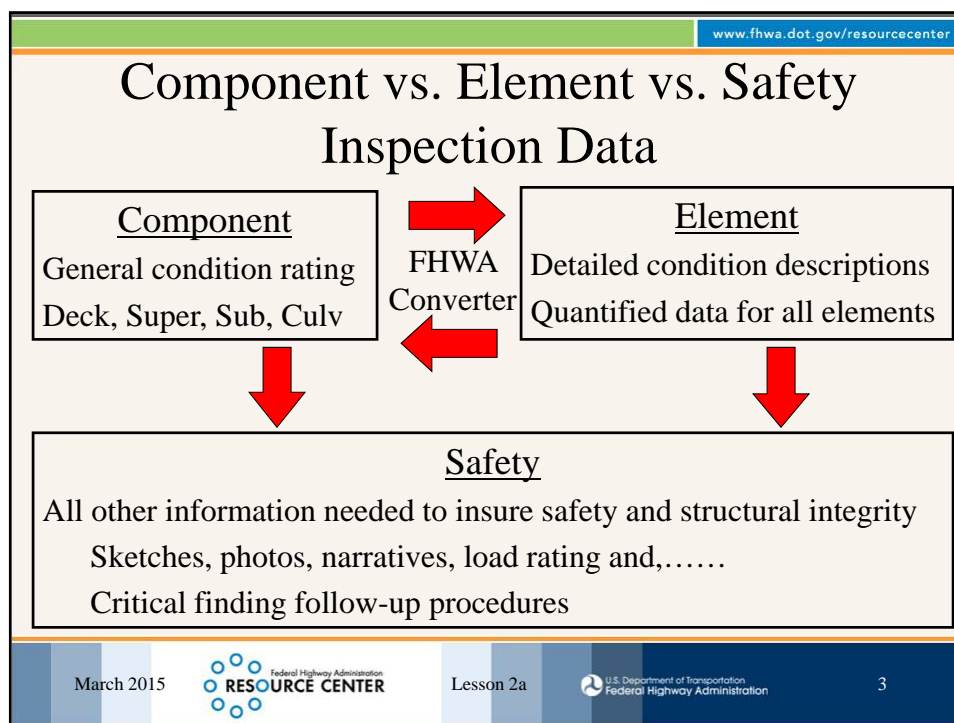
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Elements

- AASHTO Manual for Bridge Element Inspection
 - National Bridge Elements (NBEs)
 - Bridge Management Elements (BMEs)
 - Agency Developed Elements (ADEs)
 - NBE or BME sub-elements
 - ADE-NBE or ADE-BME
 - ADE
 - Defects

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Elements

- An inspector may find elements or materials that are not defined in the AASHTO Manual during their inspection
 - For elements, the inspector should use judgment to select the closest matching element or use the “Other” element types
 - For materials, the inspector should use the general description of the condition states to determine the appropriate condition or “Other”



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Elements





- Each element has a...
 - Description
 - Classification
 - Units of measurement
 - Quantity calculation
 - Condition state definitions
 - Element commentary

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Elements - NBEs

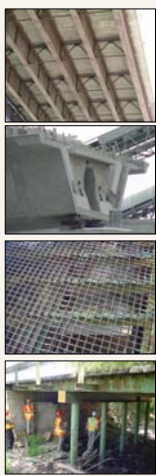
- Primary structural elements of bridges necessary to determine the overall condition and safety of the primary load carrying members
- Designed to remain consistent from agency to agency across the country
- FHWA plans to collect data for all NBEs



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Elements - NBEs

Decks		
#	Element	Units
12	Reinforced Concrete Deck	AREA
13	Prestressed Concrete Deck	AREA
15	Prestressed Concrete Top Flange	AREA
16	Reinforced Concrete Top Flange	AREA
28	Steel Deck—Open Grid	AREA
29	Steel Deck—Concrete Filled	AREA
30	Steel Deck—Corrugated/Orthotropic/Etc.	AREA
31	Timber Deck	AREA
60	Other Material Deck	AREA







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Elements - NBEs

Slabs		
#	Element	Units
38	Reinforced Concrete Slab	AREA
54	Timber Slab	AREA
65	Other Material Slab	AREA









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Elements - NBEs

Superstructures		
#	Element	Units
102	Steel Closed Web/Box Girder	LENGTH
104	Prestressed Concrete Closed Web/Box Girder	LENGTH
105	Reinforced Concrete Closed Web/Box Girder	LENGTH
106	Other Closed Web/Box Girder	LENGTH
107	Steel Open Girder/Beam	LENGTH
109	Prestressed Concrete Open Girder/Beam	LENGTH
110	Reinforced Concrete Open Girder/Beam	LENGTH
111	Timber Open Girder/Beam	LENGTH
112	Other Open Girder/Beam	LENGTH








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Elements - NBEs

Superstructures (continued)		
#	Element	Units
113	Steel Stringer	LENGTH
115	Prestressed Concrete Stringer	LENGTH
116	Reinforced Concrete Stringer	LENGTH
117	Timber Stringer	LENGTH
118	Other Stringer	LENGTH
120	Steel Truss	LENGTH
135	Timber Truss	LENGTH
136	Other Truss	LENGTH






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Elements - NBEs

Superstructures (continued)		
#	Element	Units
141	Steel Arch	LENGTH
142	Other Arch	LENGTH
143	Prestressed Concrete Arch	LENGTH
144	Reinforced Concrete Arch	LENGTH
145	Masonry Arch	LENGTH
146	Timber Arch	LENGTH
147	Steel Main Cables	LENGTH
148	Secondary Steel Cables	EACH
149	Other Secondary Cable	EACH






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Elements - NBEs

Superstructures (continued)		
#	Element	Units
152	Steel Floor Beam	LENGTH
154	Prestressed Concrete Floor Beam	LENGTH
155	Reinforced Concrete Floor Beam	LENGTH
156	Timber Floor Beam	LENGTH
157	Other Floor Beam	LENGTH
161	Steel Pin, Pin and Hanger Assembly, or both	EACH
162	Steel Gusset Plate	EACH






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Elements - NBEs

Substructures		
#	Element	Units
202	Steel Column	EACH
203	Other Column	EACH
204	Prestressed Concrete Column	EACH
205	Reinforced Concrete Column	EACH
206	Timber Column	EACH
207	Steel Tower	LENGTH
208	Timber Trestle	LENGTH

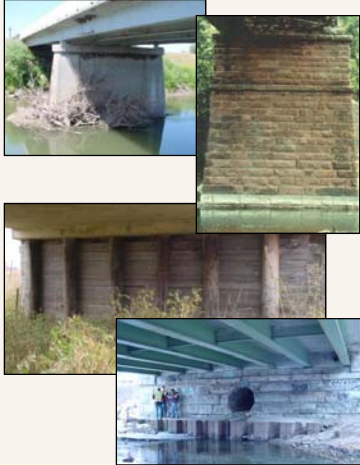




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Elements - NBEs

Substructures (continued)		
#	Element	Units
210	Reinforced Concrete Pier Wall	LENGTH
211	Other Pier Wall	LENGTH
212	Timber Pier Wall	LENGTH
213	Masonry Pier Wall	LENGTH
215	Reinforced Concrete Abutment	LENGTH
216	Timber Abutment	LENGTH
217	Masonry Abutment	LENGTH
218	Other Abutments	LENGTH
219	Steel Abutment	LENGTH






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Elements - NBEs

Substructures (continued)		
#	Element	Units
220	Reinforced Concrete Pile Cap/Footing	LENGTH
225	Steel Pile	EACH
226	Prestressed Concrete Pile	EACH
227	Reinforced Concrete Pile	EACH
228	Timber Pile	EACH
229	Other Pile	EACH






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Elements - NBEs

Substructures (continued)		
#	Element	Units
231	Steel Pier Cap	LENGTH
233	Prestressed Concrete Pier Cap	LENGTH
234	Reinforced Concrete Pier Cap	LENGTH
235	Timber Pier Cap	LENGTH
236	Other Pier Cap	LENGTH






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Elements - NBEs

Culverts		
#	Element	Units
240	Steel Culvert	LENGTH
241	Reinforced Concrete Culvert	LENGTH
242	Timber Culvert	LENGTH
243	Other Culvert	LENGTH
244	Masonry Culvert	LENGTH
245	Prestressed Concrete Culvert	LENGTH






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Elements - NBEs

Bearings		
#	Element	Units
310	Elastomeric Bearing	EACH
311	Movable Bearing	EACH
312	Enclosed/Concealed Bearing	EACH
313	Fixed Bearing	EACH
314	Pot Bearing	EACH
315	Disk Bearing	EACH
316	Other Bearing	EACH






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Elements - NBEs

Bridge Rails		
#	Element	Units
330	Metal Bridge Railing	LENGTH
331	Reinforced Concrete Bridge Railing	LENGTH
332	Timber Bridge Railing	LENGTH
333	Other Bridge Railing	LENGTH
334	Masonry Bridge Railing	LENGTH





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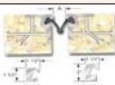
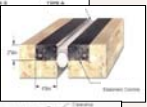
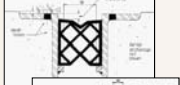
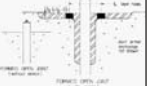
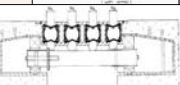
Elements - BMEs

- Elements such as joints, approach slabs, wearing surfaces and protective systems
 - Typically managed by agencies utilizing Bridge Management Systems (BMS)
- FHWA plans to collect BMEs for joints, wearing surfaces and protective coatings



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Elements - BMEs

Joints		
#	Element	Units
300	Strip Seal Expansion Joint	LENGTH
301	Pourable Joint Seal	LENGTH
302	Compression Joint Seal	LENGTH
303	Assembly Joint with Seal	LENGTH
304	Open Expansion Joint	LENGTH
305	Assembly Joint without Seal	LENGTH
306	Other Joint	LENGTH

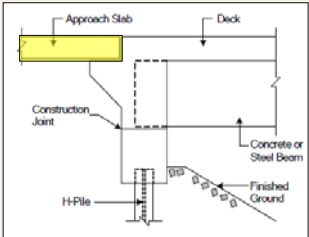
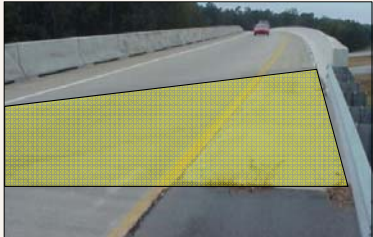





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Elements - BMEs


Approach Slabs		
#	Element	Units
320	Prestressed Concrete Approach Slab	AREA
321	Reinforced Concrete Approach Slab	AREA


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Elements - BMEs



Wearing Surfaces and Protective Systems		
#	Element	Units
510	Wearing Surfaces	AREA
515	Steel Protective Coating	AREA
520	Concrete Reinforcing Steel Protective System	AREA
521	Concrete Protective Coating	AREA











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Elements - ADEs



- Agency Developed Elements (ADEs) can be sub-elements of NBEs or BMEs
 - ADE-NBE
 - ADE-BME
- Or independent agency defined elements without ties to the AASHTO Manual elements
 - ADE

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Elements – ADE-NBE

- Must have 4 condition states
- Condition state and defect definitions are the same for the NBE and the ADE-NBE sub-element
- Element must be aggregated back together with the NBE for reporting to the FHWA
- 807-Steel Open Girder/Beam, End (NBE 107)

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Elements – ADE-NBE

Example data collected by agency using ADE-NBE

Element	Total Qty	Units	CS 1 Qty	CS 2 Qty	CS 3 Qty	CS 4 Qty
107 - Steel Open Girder/Beam	800	ft.	400	400	0	0
807 - Steel Open Girder/Beam, Ends	200	ft.	0	160	40	0

Example data aggregated for NBE



Element	Total Qty	Units	CS 1 Qty	CS 2 Qty	CS 3 Qty	CS 4 Qty
107 - Steel Open Girder/Beam	1000	ft.	400	560	40	0

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Elements – ADE-BME

- Must have 4 condition states
- Condition state and defect definitions are the same for the BME and the ADE-BME sub-element
- Element must be aggregated back together with the BME for reporting to the FHWA
- 915-Steel Protective Coating, Lead (BME 515)

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Elements – ADE-BME

Example data collected by agency using ADE-BME

Element	Total Qty	Units	CS 1 Qty	CS 2 Qty	CS 3 Qty	CS 4 Qty
107 - Steel Open Girder/Beam	1000	ft.	400	560	40	0
915 - Steel Protective Coating, Lead	6400	sq. ft.	0	5760	0	640

Example data aggregated for BME



Element	Total Qty	Units	CS 1 Qty	CS 2 Qty	CS 3 Qty	CS 4 Qty
107 - Steel Open Girder/Beam	1000	ft.	400	560	40	0
515 - Steel Protective Coating	6400	sq. ft.	0	5760	0	640

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Elements – Independent ADE


- Independent agency defined elements
 - Not an NBE nor BME sub-element
- Must have 4 condition states
- Most flexibility
 - May or may not have defined feasible actions, defined deterioration, and need not follow any pre-defined condition state or defect definition
- Not reported to the FHWA



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Elements – Independent ADE

- Could include approach guardrail, slope paving, seismic retrofit members, drains, lighting, signs, earth retaining walls.....
- Examples
 - 901 Deck Drains
 - 902 Temporary Supports






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Element Environments

- Environments are an important concept for element deterioration modeling and forecasting future conditions with a BMS
- A particular element may exist in one of four environments
- FHWA does not plan to collect element environments





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Element Environments



- Environments are generally used to describe different weather or operating conditions
 - Traffic and truck movements
 - Exposure to water, salt, and other corrosive materials
 - Condition of protective and water proofing systems
 - Temperature extremes either from nature or human

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Element Environments

- The environment designation of an element can change over time
 - if operating policies were changed to reduce the use of road salt
- The environment designation would not change as the result of maintenance work or deterioration


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Element Environments

- Environments defined in AASHTO Manual
 - Benign (1)
 - Low (2)
 - Moderate (3)
 - Severe (4)

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Element Environments

- Benign (1)
 - Not likely to significantly change the condition of the element over time
 - Or mitigated by the presence of highly effective protective systems

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Element Environments



- Low (2)
 - Does not adversely influence the condition of the element over time
 - Or substantially lessened by the application of effective protective systems
- Moderate (3)
 - Change in the condition over time is likely to be quite normal (typical by the agency)

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Element Environments



- Severe (4)
 - Contributes to the rapid decline in the condition of the element over time
 - Or protective systems are not in place or not effective

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Element Environments




- Example
 - All elements in environment 2 (low) unless
 - No exposure to road salt (e.g., near drinking water supply) = environment 1 (Benign)
 - Regularly exposed to both road salt and ocean salt = environment 3 (Moderate)
 - Element is within 5 feet of a joint = increase environment by 1



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Structures and Structure Units

- Database management systems are used to store data on various types of highway structures
 - Typically bridges, tunnels and culverts







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Structures and Structure Units

- Structures can have one or more structure units
 - Used to organize elements on a structure
 - May correspond to spans, or groups of spans

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Structures and Structure Units

Structure Number (NBI Item 8): 328753372743437

Pourable Joint

Metal Bridge Railing (coated)

RC Approach Slab

Assembly Joint w/Seal

RC Deck

RC Top Flange

Elastomeric Bearings


RC Abutment (coated)



RC Column (coated)

RC Pier/Bent Cap (coated)

RC Open Girder/Beam (coated)


Steel Open Girder/Beam (coated)



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Structures and Structure Units - 1



One Structure Unit

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Structures and Structure Units - 1

Element/ Str. Unit #	Env.	Element/ Str. Unit Description	Total Qty	Units
1		Span(s): All		
DECK/SLAB				
12	3	RC Deck	8663	sq. ft.
16	3	RC Top Flange	7877	sq. ft.
JOINTS				
301	3	Pourable Joint Seal	218	ft.
303	3	Assembly Joint/Seal	193	ft.
APPROACH SLABS				
321	3	RC Approach Slab	1548	sq. ft.
BRIDGE RAILINGS				
330	3	Metal Bridge Railing	378	ft.
515		Steel Protective Coating	2294	sq. ft.



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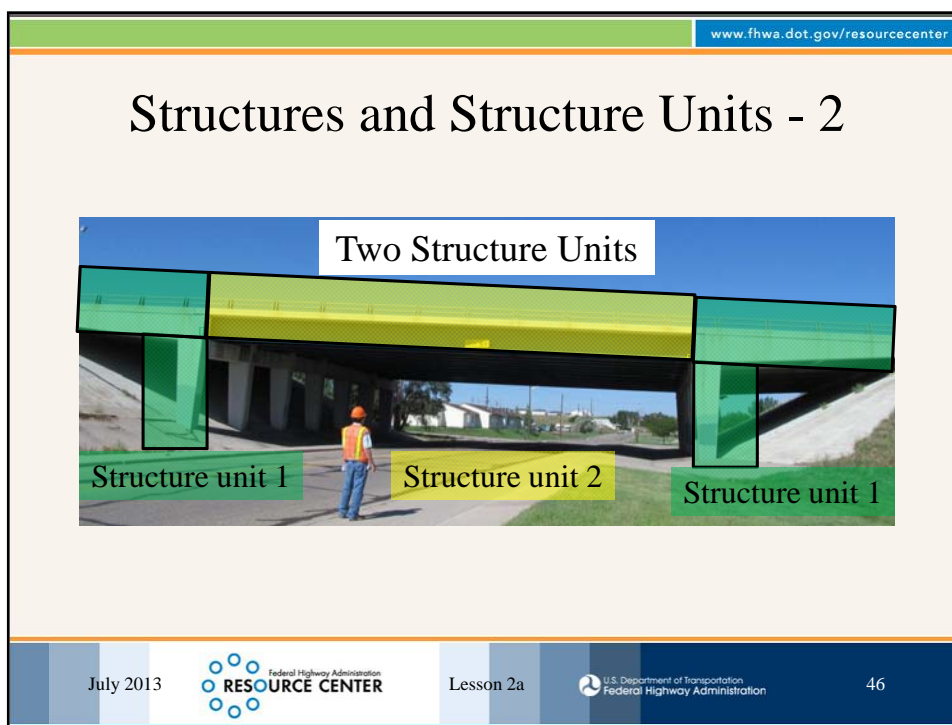
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Structures and Structure Units - 1				
Element / Str. Unit #	Env.	Element / Str. Unit Description	Total Qty	Units
1		Span(s): All		
SUPERSTRUCTURE				
107	3	Steel Open Girder	1098	ft.
515		Steel Protective Coating	13931	sq. ft.
110	3	RC Open Girder	610	ft.
521		Concrete Protective Coating	5490	sq. ft.
BEARINGS				
310	3	Elastomeric Bearings	24	each
SUBSTRUCTURE				
205	3	RC Column	14	each
521		Concrete Protective Coating	2500	sq. ft.
215	3	RC Abutment	188	ft.
521		Concrete Protective Coating	1034	sq. ft.
234	3	RC Cap	184	ft.
521		Concrete Protective Coating	5671	sq. ft.
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Structures and Structure Units - 2



Element / Str. Unit #	Env.	Element/ Str. Unit Description	Total Qty	Units
1		Span(s): 1&3		
DECK/SLAB				
16	3	RC Top Flange	7877	sq. ft.
JOINTS				
301	3	Pourable Joint Seal	218	ft.
APPROACH SLABS				
321	3	RC Approach Slab	1548	sq. ft.
BRIDGE RAILINGS				
330	3	Metal Bridge Railing	165	ft.
515		Steel Protective Coating	990	sq. ft.

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Structures and Structure Units - 2



Element / Str. Unit #	Env.	Element / Str. Unit Description	Total Qty	Units
1		Span(s): 1&3		
SUPERSTRUCTURE				
110	3	RC Open Girder	610	ft.
521		Concrete Protective Coating	5490	sq. ft.
BEARINGS				
SUBSTRUCTURE				
205	3	RC Column	14	each
521		Concrete Protective Coating	2500	sq. ft.
215	3	RC Abutment	188	ft.
521		Concrete Protective Coating	1034	sq. ft.
234	3	RC Cap	184	ft.
521		Concrete Protective Coating	5671	sq. ft.

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Structures and Structure Units - 2



Element / Str. Unit #	Env.	Element/ Str. Unit Description	Total Qty	Units
2		Span(s): 2		
DECK/SLAB				
12	3	RC Deck	8663	sq. ft.
JOINTS				
303	3	Assembly Joint/Seal	193	ft.
APPROACH SLABS				
BRIDGE RAILINGS				
330	3	Metal Bridge Railing	213	ft.
515		Steel Protective Coating	1304	sq. ft.

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Structures and Structure Units - 2

Element / Str. Unit #	Env.	Element / Str. Unit Description	Total Qty	Units
2		Span(s): 2		
SUPERSTRUCTURE				
107	3	Steel Open Girder	1098	ft.
515		Steel Protective Coating	13931	sq. ft.
BEARINGS				
310	3	Elastomeric Bearings	24	each
SUBSTRUCTURE				

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Structures and Structure Units - 3



Three Structure Units



Structure unit 1 Structure unit 2 Structure unit 3

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Structures and Structure Units - 3

Element / Str. Unit #	Env.	Element/ Str. Unit Description	Total Qty	Units
1		Span(s): 1		
DECK/SLAB				
16	3	RC Top Flange	3938	sq. ft.
JOINTS				
301	3	Pourable Joint Seal	109	ft.
APPROACH SLABS				
321	3	RC Approach Slab	774	sq. ft.
BRIDGE RAILINGS				
330	3	Metal Bridge Railing	83	ft.
515		Steel Protective Coating	495	sq. ft.

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Structures and Structure Units - 3				
Element / Str. Unit #	Env.	Element / Str. Unit Description	Total Qty	Units
1		Span(s): 1		
SUPERSTRUCTURE				
110	3	RC Open Girder	305	ft.
521		Concrete Protective Coating	2745	sq. ft.
BEARINGS				
SUBSTRUCTURE				
205	3	RC Column	7	each
521		Concrete Protective Coating	1250	sq. ft.
215	3	RC Abutment	94	ft.
521		Concrete Protective Coating	517	sq. ft.
234	3	RC Cap	92	ft.
521		Concrete Protective Coating	2836	sq. ft.

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Structures and Structure Units - 3				
Element / Str. Unit #	Env.	Element/ Str. Unit Description	Total Qty	Units
2		Span(s): 2		
DECK/SLAB				
12	3	RC Deck	8663	sq. ft.
JOINTS				
303	3	Assembly Joint/Seal	193	ft.
APPROACH SLABS				
BRIDGE RAILINGS				
330	3	Metal Bridge Railing	213	ft.
515		Steel Protective Coating	1304	sq. ft.

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Structures and Structure Units - 3



Element / Str. Unit #	Env.	Element / Str. Unit Description	Total Qty	Units
2		Span(s): 2		
SUPERSTRUCTURE				
107	3	Steel Open Girder	1098	ft.
515		Steel Protective Coating	13931	sq. ft.
BEARINGS				
310	3	Elastomeric Bearings	24	each
SUBSTRUCTURE				



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Structures and Structure Units - 3

Element / Str. Unit #	Env.	Element/ Str. Unit Description	Total Qty	Units
3		Span(s): 3		
DECK/SLAB				
16	3	RC Top Flange	3939	sq. ft.
JOINTS				
301	3	Pourable Joint Seal	109	ft.
APPROACH SLABS				
321	3	RC Approach Slab	774	sq. ft.
BRIDGE RAILINGS				
330	3	Metal Bridge Railing	82	ft.
515		Steel Protective Coating	495	sq. ft.

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Structures and Structure Units - 3				
Element / Str. Unit #	Env.	Element / Str. Unit Description	Total Qty	Units
3		Span(s): 3		
SUPERSTRUCTURE				
110	3	RC Open Girder	305	ft.
521		Concrete Protective Coating	2745	sq. ft.
BEARINGS				
SUBSTRUCTURE				
205	3	RC Column	7	each
521		Concrete Protective Coating	1250	sq. ft.
215	3	RC Abutment	94	ft.
521		Concrete Protective Coating	517	sq. ft.
234	3	RC Cap	92	ft.
521		Concrete Protective Coating	2835	sq. ft.
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Element Condition States				
<ul style="list-style-type: none"> • AASHTO NBEs and BMEs have 4 defined condition states that address defect severity • General condition state descriptions are <ul style="list-style-type: none"> – CS 1 (Good) – CS 2 (Fair) – CS 3 (Poor) – CS 4 (Severe – load capacity implications) <ul style="list-style-type: none"> • Structural review warranted 				
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Element Condition States


Condition State Definitions: *Element 12 - RC Deck*

Defect	CS 1	CS 2	CS 3	CS 4
Delamination / Spall / Patched Area (1080)	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Exposed Rebar (1090)	None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	
Efflorescence / Rust Staining (1120)	None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	
Cracking (1130)	Insignificant cracks or moderate width cracks that have been sealed.	Unsealed moderate width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	



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Element Condition States				
Condition State Definitions: Element 12 - RC Deck (continued)				
Defect	CS 1	CS 2	CS 3	CS 4
Abrasion / Wear (1190)	No abrasion or wearing	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
Damage (7000)	Not applicable	The element has impact damage. The specific damage caused by the impact has been captured in condition state 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 4 under the appropriate material defect entry.
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Element Condition States

- Element quantities are distributed to one or more of the 4 condition states depending upon the condition of the element
- Conditions of element protective systems are assessed using separate elements

Element	Total QTY	Units	CS-1 QTY	CS-2 QTY	CS-3 QTY	CS-4 QTY
107 - Steel Open Girder/Beam	1098	ft.	1018	80	0	0
515 - Steel Protective Coating	13931	sq. ft.	0	13851		80

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Element Condition States

- Surface or surfaces not visible for inspection are assessed based on
 - available visible surface or
 - destructive and nondestructive testing or
 - indicators in the materials covering the surface
- Historical records may also provide information to support assessed conditions

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Lesson 2a - Learning Outcomes

A. Explain the following terms:


- Component vs. Element vs. Safety Inspection Data
- Elements (NBE, BME, ADE)
 - Element Environments
 - Element Condition States
 - Element Defects
- Structures and Structure Units





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QUESTIONS



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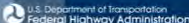
Lesson 2b Element Defects and Condition State Definitions

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Lesson 2b - Learning Outcomes



- Interpret condition state definitions (C)

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Defects


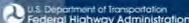
- Defects are an important concept for element deterioration modeling and feasible action recommendation in a BMS
- Defects may be recorded for an element to identify controlling defects for specific condition state quantities
- Defects share the same unit of measure as the element they are applied to

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Defects - Recording and Reporting



- Recording specific defects and their condition state quantities for each element is optional
- FHWA does not plan to collect defect specific condition state quantities

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Defect Condition State Definitions



- Defect condition state (CS) definitions are generally material specific (RC, PSC, Steel, Timber, Masonry, Other)
- Exceptions
 - Bearings and Joints
 - Wearing Surfaces
 - Steel and Concrete Protective Coatings
 - Concrete Reinforcing Steel Protective System

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Defect Condition State Definitions



- There are 4 defined condition states for each defect (general description)
 - CS 1 (Good)
 - CS 2 (Fair)
 - CS 3 (Poor)
 - CS 4 (Severe – load capacity implications)
 - Structural review warranted

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Defect Condition State Assignment

- Compare identified defects with their CS definitions to assign CS quantities
- More than one defect may be present in the same general location for an element
 - Defects in different condition states: Defect with worst condition state is recorded
 - Defects in same condition state: Agency policy determines which defect is recorded



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Defect Codes

- Defect codes are used to identify defects controlling condition state quantities
- Each material defect has a unique code



Defect	CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Delamination / Spall / Patched Area (1080)	None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.

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Defects – Reinforced Concrete (RC)


#	Defect
1080	Delamination / Spall / Patched Area
1090	Exposed Rebar
1120	Efflorescence / Rust Staining
1130	Cracking (RC)
1190	Abrasion / Wear (PSC/RC)
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage


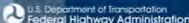
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RC - Delamination/Spall/Patched Area (1080)




CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Delaminated. Spall 1 in. or less deep or 6 in. or less in diameter. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Patched area that is unsound or showing distress. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			



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RC - Exposed Rebar (1090)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Present without measurable section loss.	Present with measurable section loss, but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.





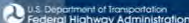
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RC - Efflorescence/Rust Staining (1120)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Surface white without build-up or leaching without rust staining.	Heavy build-up with rust staining.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.



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RC - Cracking (1130)



CS 1 – Good	CS 2 – Fair	CS 3 – Poor	CS 4 - Severe
Insignificant cracks or moderate width cracks that have been sealed.	Unsealed moderate width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.


AASHTO Commentary: The inspector should use judgment when utilizing the condition state defect definitions, especially for concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or non-structural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general reinforced concrete cracks less than 0.012 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.012 to 0.05 inches can be considered moderate, and cracks greater than 0.05 inches can be considered wide.


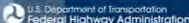
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RC - Abrasion / Wear (1190)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
No abrasion or wearing	Abrasion or wearing has exposed coarse aggregate but the aggregate remains secure in the concrete.	Coarse aggregate is loose or has popped out of the concrete matrix due to abrasion or wear.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.


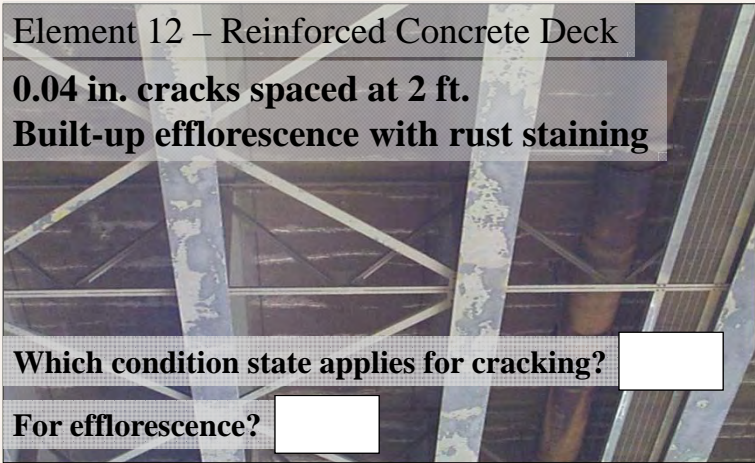


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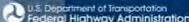
Reinforced Concrete - Exercise

Element 12 – Reinforced Concrete Deck
0.04 in. cracks spaced at 2 ft.
Built-up efflorescence with rust staining



Which condition state applies for cracking?


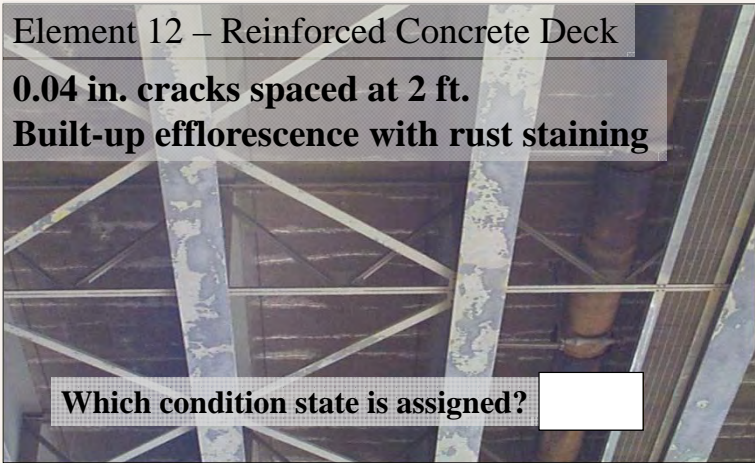
For efflorescence?

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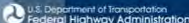
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Reinforced Concrete - Exercise

Element 12 – Reinforced Concrete Deck
0.04 in. cracks spaced at 2 ft.
Built-up efflorescence with rust staining





Which condition state is assigned?

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Defects – Prestressed Concrete (PSC)


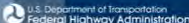
#	Defect
1080	Delamination / Spall / Patched Area
1090	Exposed Rebar
1100	Exposed Prestressing
1110	Cracking (PSC)
1120	Efflorescence /Rust Staining
1190	Abrasion / Wear (PSC/RC)
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage

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PSC - Exposed Prestressing (1100)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Present without section loss.	Present with section loss, but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			



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PSC - Cracking (1110)

CS 1 – Good	CS 2 – Fair	CS 3 – Poor	CS 4 - Severe
Insignificant cracks or moderate width cracks that have been sealed.	Unsealed moderate width cracks or unsealed moderate pattern (map) cracking.	Wide cracks or heavy pattern (map) cracking.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.


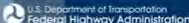
AASHTO Commentary: The inspector should use judgment when utilizing the condition state defect definitions, especially for prestressed concrete cracking. The crack defect description definitions describe generalized distress, but the inspector should consider width, spacing, location, orientation, and structural or nonstructural nature of the cracking. The inspector should consider exposure and environment when evaluating crack width. In general prestressed concrete cracks less than 0.004 inches can be considered insignificant and a defect is not warranted. Cracks ranging from 0.004 to 0.009 inches can be considered moderate, and cracks greater than 0.009 inches can be considered wide.

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Defects - Steel



#	Defect
1000	Corrosion
1010	Cracking
1020	Connection
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage

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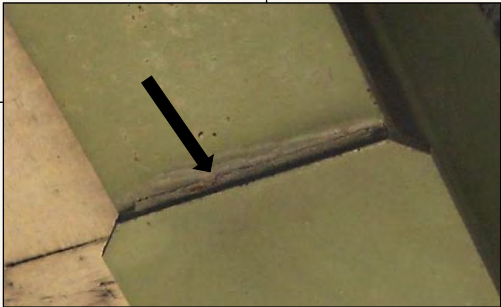
Steel - Corrosion (1000)


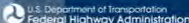
CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Freckled Rust. Corrosion of the steel has initiated.	Section loss is evident or pack rust is present but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			

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Steel - Cracking (1010)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Crack that has self arrested or has been arrested with effective arrest holes, doubling plates, or similar.	Identified crack exists that is not arrested but does not warrant structural review	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			



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Steel - Connection (1020)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Connection is in place and functioning as intended.	Loose fasteners or pack rust without distortion is present but the connection is in place and functioning as intended.	Missing bolts, rivets, or fasteners; broken welds; or pack rust with distortion but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.

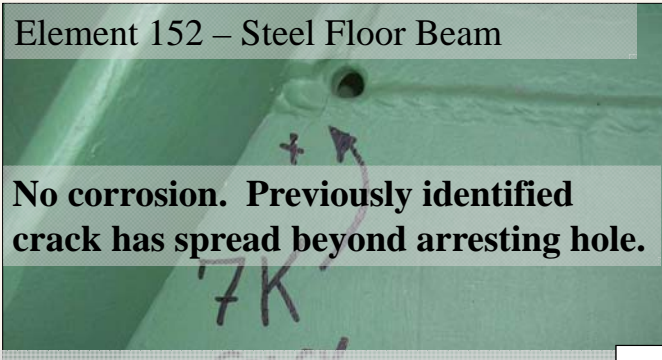


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Steel - Exercise

Element 152 – Steel Floor Beam





No corrosion. Previously identified crack has spread beyond arresting hole.

Which condition state applies for corrosion?

For cracking?

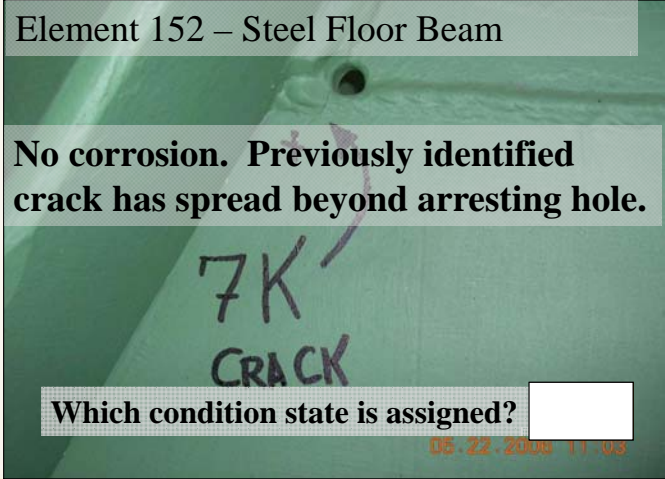
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Steel - Exercise



Element 152 – Steel Floor Beam



No corrosion. Previously identified crack has spread beyond arresting hole.

Which condition state is assigned?


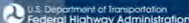
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Defects - Timber


#	Defect
1020	Connection
1140	Decay / Section Loss
1150	Check / Shake
1160	Crack
1170	Split / Delamination
1180	Abrasion / Wear
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage



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Timber - Decay / Section Loss (1140)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Affects less than 10% of the member section.	Affects 10% or more of the member but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.





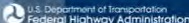
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Timber - Check / Shake (1150)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Surface penetration less than 5% of the member thickness regardless of location.	Penetrates 5% - 50% of the thickness of the member and not in a tension zone.	Penetrates more than 50% of the thickness of the member or more than 5% of the member thickness in a tension zone. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.




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Timber - Crack (1160)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Crack that has been arrested through effective measures.	Identified crack exists that is not arrested, but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			

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Timber - Split / Delamination (1170)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Length less than the member depth or arrested with effective actions taken to mitigate.	Length equal to or greater than the member depth, but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			


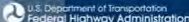
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Timber - Abrasion / Wear (1180)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None or no measurable section loss.	Section loss less than 10% of the member thickness	Section loss 10% or more of the member thickness but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.



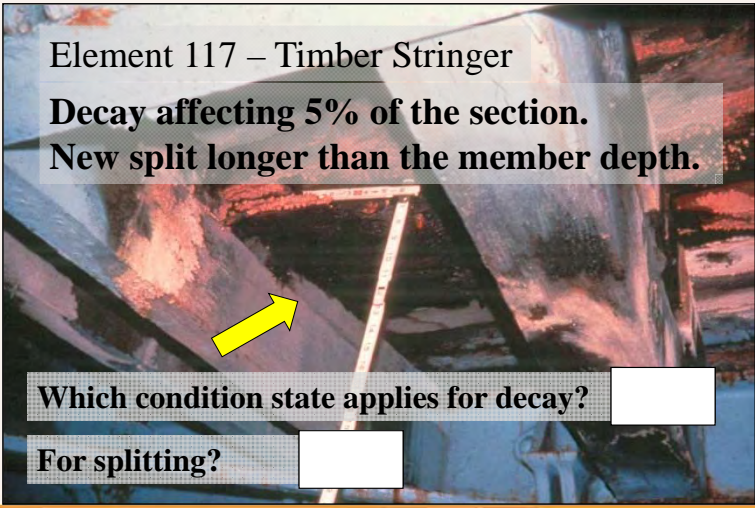
August 2013  Lesson 2b  31

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Timber


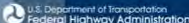
Element 117 – Timber Stringer

**Decay affecting 5% of the section.
New split longer than the member depth.**



Which condition state applies for decay?

For splitting?

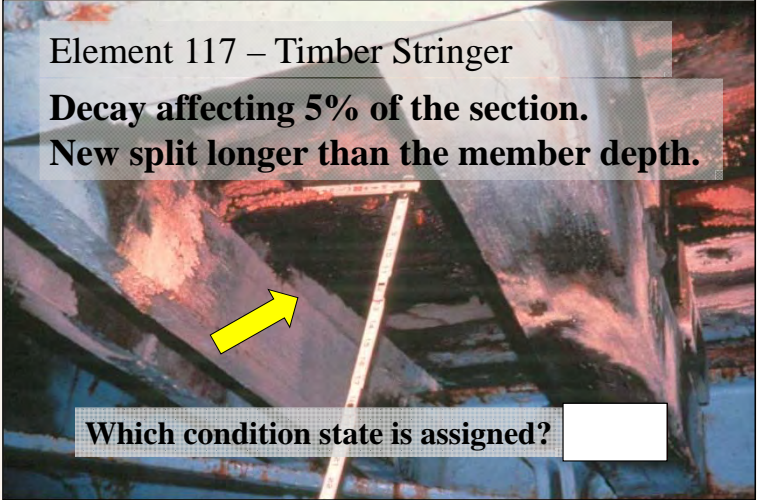
July 2013  Lesson 2b  32

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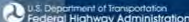
Timber

Element 117 – Timber Stringer

**Decay affecting 5% of the section.
New split longer than the member depth.**



Which condition state is assigned?

July 2013  Lesson 2b  33

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Defects - Masonry


#	Defect
1080	Delamination / Spall / Patched Area
1120	Efflorescence / Rust Staining
1610	Mortar Breakdown
1620	Split / Spall
1630	Patched Area
1640	Masonry Displacement
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage



February 2014  Lesson 2b  34

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Masonry - Mortar Breakdown (1610)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Cracking or voids in less than 10% of joints.	Cracking or voids in 10% or more of the of joints	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.






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Masonry - Split / Spall (1620)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Block or stone has split or spalled with no shifting.	Block or stone has split or spalled with shifting but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.





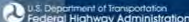
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Masonry - Patched Area (1630)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Sound patch.	Unsound patch.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.





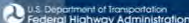
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Masonry Displacement (1640)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Block or stone has shifted <u>slightly</u> out of alignment.	Block or stone has shifted <u>significantly</u> out of alignment or is missing but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.





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Defects - Other Materials


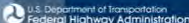
#	Defect
1000	Corrosion
1010	Cracking
1020	Connection
1080	Delamination / Spall / Patched Area
1120	Efflorescence / Rust Staining
1130	Cracking (RC and Other)
1220	Deterioration (Other)
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage

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Other - Deterioration (1220)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Initiated breakdown or deterioration.	Significant deterioration or breakdown, but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.



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Defects – All Materials

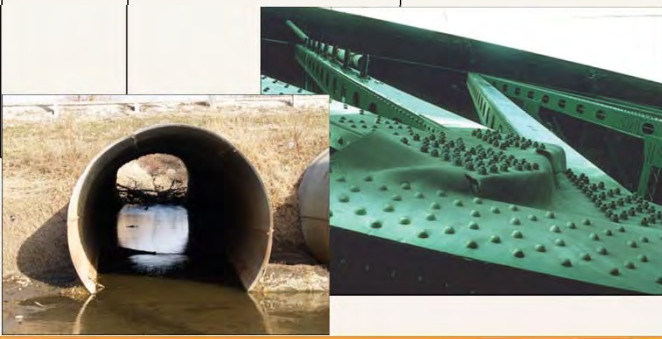
- Defects that are common to all materials


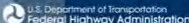
#	Defect
1900	Distortion
4000	Settlement
6000	Scour
7000	Damage

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Distortion (1900)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Distortion not requiring mitigation or mitigated distortion.	Distortion that requires mitigation that has not been addressed but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			


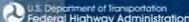
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Settlement (4000)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Exists within tolerable limits or arrested with no observed structural distress.	Exceeds tolerable limits but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.





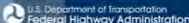
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Scour (6000)



CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Exists within tolerable limits or has been arrested with effective countermeasures.	Exceeds tolerable limits, but is less than the critical limits determined by scour evaluation and does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.


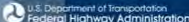


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Damage (7000)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Not applicable.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 2 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 3 under the appropriate material defect entry.	The element has impact damage. The specific damage caused by the impact has been captured in condition state 4 under the appropriate material defect entry.
			

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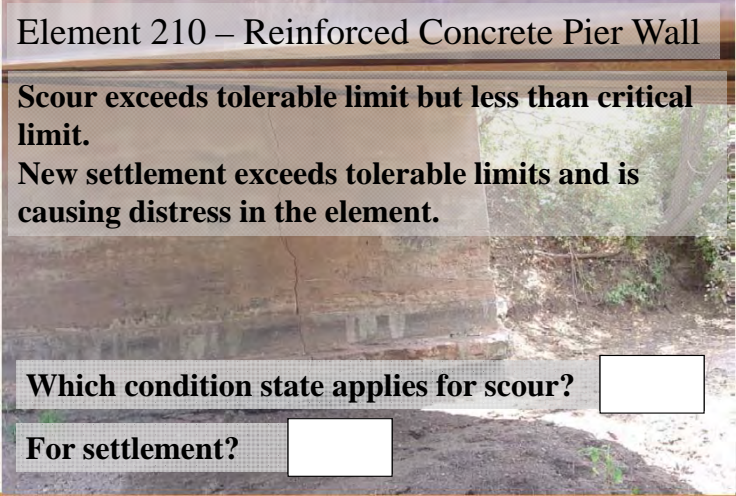
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Scour and Settlement - Exercise

Element 210 – Reinforced Concrete Pier Wall


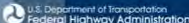
Scour exceeds tolerable limit but less than critical limit.

New settlement exceeds tolerable limits and is causing distress in the element.



Which condition state applies for scour?

For settlement?

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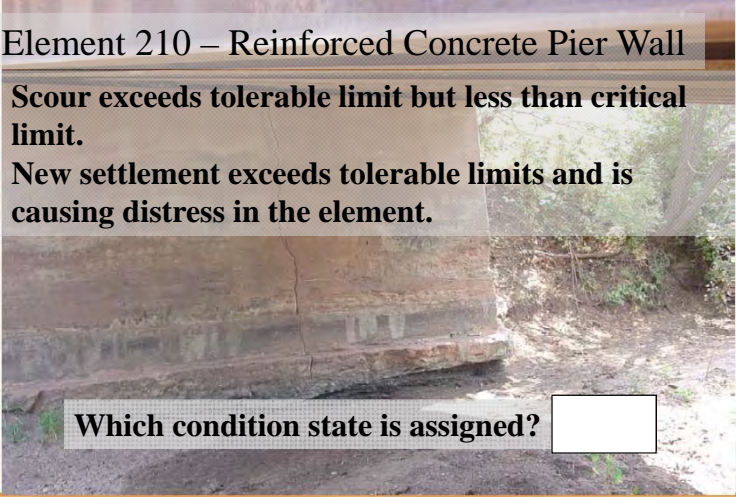
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Scour and Settlement - Exercise (cont'd)



Element 210 – Reinforced Concrete Pier Wall

Scour exceeds tolerable limit but less than critical limit.

New settlement exceeds tolerable limits and is causing distress in the element.





Which condition state is assigned?

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Defects - Bearings


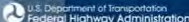
#	Defect
1000	Corrosion
1020	Connection
2210	Movement
2220	Alignment
2230	Bulging, Splitting or Tearing
2240	Loss of Bearing Area
7000	Damage

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Bearings - Movement (2210)


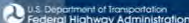
CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Free to Move.	Minor Restriction.	Restricted but not warranting structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			

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Bearings - Alignment (2220)



CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Lateral and vertical alignment is as expected for the temperature conditions.	Tolerable lateral or vertical alignment that is inconsistent with the temperature conditions.	Approaching the limits of lateral or vertical alignment for the bearing but does not warrant a structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			

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Bearings - Bulging, Splitting, or Tearing (2230)



CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Bulging less than 15% of the thickness.	Bulging 15% or more of the thickness. Splitting or tearing. Bearing's surfaces are not parallel. Does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			

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Bearings - Loss of Bearing Area (2240)



CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Less than 10%.	10% or more but does not warrant structural review.	The condition warrants a structural review to determine the effect on strength or serviceability of the element or bridge; OR a structural review has been completed and the defects impact strength or serviceability of the element or bridge.
			

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Defects - Joints


#	Defect
2310	Leakage
2320	Seal Adhesion
2330	Seal Damage
2340	Seal Cracking
2350	Debris Impaction
2360	Adjacent Deck or Header
2370	Metal Deterioration or Damage
7000	Damage



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Joints - Leakage (2310)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Minimal. Minor dripping through the joint.	Moderate. More than a drip and less than free flow of water.	Free flow of water through the joint.






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Joints - Seal Adhesion (2320)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Fully adhered.	Adhered for more than 50% of the joint height.	Adhered 50% or less of joint height but still some adhesion.	Complete loss of adhesion.

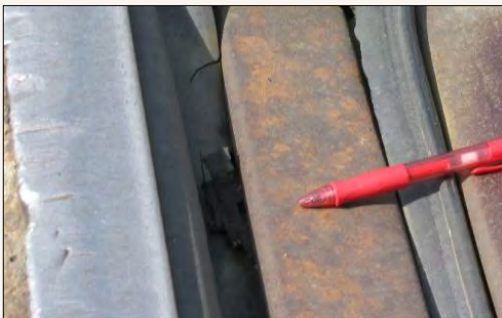



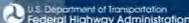
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Joints - Seal Damage (2330)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Seal abrasion without punctures.	Punctured or ripped or partially pulled out.	Punctured completely through, pulled out, or missing.






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Joints - Seal Cracking (2340)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Surface crack.	Crack that partially penetrates the seal.	Crack that fully penetrates the seal.





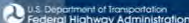
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Joints - Debris Impaction (2350)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
No debris to a shallow cover of loose debris may be evident but does not affect the performance of the joint.	Partially filled with hard-packed material, but still allowing free movement.	Completely filled and impacts joint movement.	Completely filled and prevents joint movement.





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Joints - Adjacent Deck or Header (2360)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Sound. No spall, delamination or unsound patch.	Edge delamination or spall 1 in. or less deep or 6 in. or less in diameter. No exposed rebar. Patched area that is sound.	Spall greater than 1 in. deep or greater than 6 in. diameter. Exposed rebar. Delamination or unsound patched area that makes the joint loose.	Spall, delamination, unsound patched area or loose joint anchor that prevents the joint from functioning as intended.



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Joints - Metal Deterioration or Damage (2370)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None	Freckled rust, metal has no cracks, or impact damage. Connection may be loose but functioning as intended.	Section loss, missing or broken fasteners, cracking of the metal or impact damage but joint still functioning.	Metal cracking, section loss, damage or connection failure that prevents the joint from functioning as intended.



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Defects - Wearing Surfaces (WS)


#	Defect
3210	Delamination / Spall / Patched Area / Pothole (Wearing Surfaces)
3220	Crack (Wearing Surface)
3230	Effectiveness (Wearing Surface)
7000	Damage


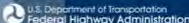
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WS - Delamination/Spall/Patched Area/Pothole (3210)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Delaminated. Spall less than 1 in. deep or less than 6 in. diameter. Patched area that is sound. Partial depth pothole.	Spall 1 in. deep or greater or 6 in. diameter or greater. Patched area that is unsound or showing distress. Full depth pothole.	The wearing surface is no longer effective.





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WS - Crack (3220)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Width less than 0.012 in. or spacing greater than 3.0 ft.	Width 0.012–0.05 in. or spacing of 1.0–3.0 ft.	Width of more than 0.05 in. or spacing of less than 1.0 ft.	The wearing surface is no longer effective.



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WS - Effectiveness (3230)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Fully effective. No evidence of leakage or further deterioration of the protected element.	Substantially effective. Deterioration of the protected element has slowed.	Limited effectiveness. Deterioration of the protected element has progressed.	The wearing surface is no longer effective.



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Defects - Steel Protective Coatings (SPC)


#	Defect
3410	Chalking (Steel Coatings)
3420	Peeling/Bubbling/Cracking (Steel Coatings)
3430	Oxide Film Degradation Color / Texture Adherence (Steel Coatings)
3440	Effectiveness (Steel Coatings)
7000	Damage



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SPC - Chalking (3410)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Surface Dulling.	Loss of Pigment.	Not Applicable.

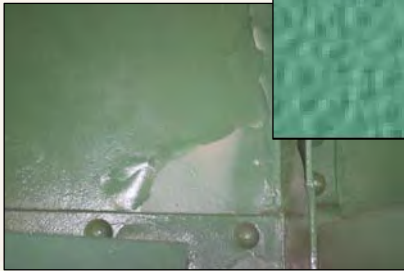






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SPC - Peeling / Bubbling / Cracking (3420)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Finish coats only.	Finish and primer coats.	Exposure of bare metal.


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SPC - Oxide Film Degradation (3430)

- Color, texture, adherence of weathering steel patina

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Yellow-orange or light brown for early development. Chocolate-brown to purple-brown for fully developed. Tightly adhered, capable of withstanding hammering or vigorous wire brushing.	Granular texture.	Small flakes, less than 1/2 in. diameter.	Dark black color. Large flakes, 1/2 in. diameter or greater or laminar sheets or nodules.






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SPC - Effectiveness (3440)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Fully effective.	Substantially effective.	Limited effectiveness.	Failed, no protection of the underlying metal




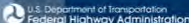
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Defects - Concrete Protective Coatings (CPC)





#	Defect
3510	Wear (Concrete Protective Coatings)
3520	Chalking (Concrete Protective Coatings)
3530	Peeling / Bubbling / Cracking (Concrete Protective Coatings)
3540	Effectiveness (Concrete Protective Coatings)
7000	Damage

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CPC - Wear (3510)


CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Underlying concrete not exposed, coating showing wear from UV exposure, friction course missing.	Underlying concrete is not exposed, thickness of the coating is reduced.	Underlying concrete exposed, treated cracks are exposed.



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CPC - Chalking (3520)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Surface Dulling.	Loss of Pigment.	Not Applicable.






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CPC - Peeling / Bubbling / Cracking (3530)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
None.	Finish coats only.	Finish and primer coats.	Exposure of bare concrete.





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CPC - Effectiveness (3540)

CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.



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Defects - Concrete Reinforcing Steel Protective System

#	Defect
3600	Effectiveness – Protective System (e.g. cathodic)
7000	Damage



CS 1 - Good	CS 2 - Fair	CS 3 - Poor	CS 4 - Severe
Fully effective.	Substantially effective.	Limited effectiveness.	The protective system has failed or is no longer effective.

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Bringing It All Together - Example


Element/ Str. Unit #	Env	Element/ Str. Unit Description	Total Qty	Units	Condition State Quantity			
					CS 1	CS 2	CS 3	CS 4
1		Span(s) - All						
DECK/SLAB								
12	3	RC Deck	8663	sq. ft.	8114	543	6	
1080		Delamination / Spall / Patched Area	39	sq. ft.		33	6	
1130		Cracking	510	sq. ft.		510		
16	3	RC Top Flange	7877	sq. ft.	7697	96	84	
1080		Delamination / Spall / Patched Area	114	sq. ft.		40	74	
1120		Efflorescence / Rust Staining	66	sq. ft.		56	10	

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Element/ Str. Unit #	Env	Element/ Str. Unit Description	Total Qty	Units	Condition State Quantity			
					CS 1	CS 2	CS 3	CS 4
JOINTS								
301	3	Pourable Joint Seal	218	ft.	208	10		
2350		Debris Impaction	10	ft.		10		
303	3	Assembly Joint/Seal	193	ft.	177	13		3
2330		Seal Damage	3	ft.				3
2350		Debris Impaction	13	ft.		13		
APPROACH SLABS								
321	3	RC Approach Slab	1548	sq. ft.	1483	15	50	
1130		Cracking	65	sq. ft.		15	50	

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Element/ Str. Unit #	Env	Element/ Str. Unit Description	Total Qty	Units	Condition State Quantity			
					CS 1	CS 2	CS 3	CS 4
BRIDGE RAILINGS								
330	3	Metal Bridge Railing	378	ft.	322	53	3	
1000		Corrosion	2	ft.		2		
1080		Delamination / Spall / Patched Area	40	ft.		40		
1130		Cracking	14	ft.		11	3	
515		Steel Protective Coating	2294	sq. ft.	2293			1
3440		Effectiveness (Steel Protective Coatings)	1	sq. ft.				1

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Element/ Str. Unit #	Env	Element/ Str. Unit Description	Total Qty	Units	Condition State Quantity			
					CS 1	CS 2	CS 3	CS 4
SUPERSTRUCTURE								
107	3	Steel Open Girder /Beam	1098	ft.	1018	80		
1000		Corrosion	80	ft.		80		
515		Steel Protective Coating	13931	sq. ft.		13851		80
3410		Chalking (Steel Protective Coatings)	13851	sq. ft.		13851		
3440		Effectiveness (Steel Protective Coatings)	80	sq. ft.				80
110	3	RC Open Girder/Beam	610	ft.		604	6	
1130		Cracking	610	ft.		604	6	
521		Concrete Protective Coating	5490	sq. ft.	5456			34
3540		Effectiveness	34	sq. ft.				34
BEARINGS								
310	3	Elastomeric Bearings	24	each	24			


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Element/ Str. Unit #	Env	Element/ Str. Unit Description	Total Qty	Units	Condition State Quantity			
					CS 1	CS 2	CS 3	CS 4
SUBSTRUCTURE								
205	3	Reinforced Concrete Column	14	each		14		
1130		Cracking	14	each		14		
521		Concrete Protective Coating	2500	sq. ft.	2480			20
3540		Effectiveness (Concrete Coatings)	20	sq. ft.				20
215	3	Reinforced Concrete Abutment	188	ft.	136	52		
1130		Cracking	52	ft.		52		
521		Concrete Protective Coating	1034	sq. ft.	999			35
3540		Effectiveness (Concrete Coatings)	35	sq. ft.				35
234	3	RC Cap	184	ft.	182	2		
1130		Cracking	10	ft.	8	2		
521		Concrete Protective Coating	5671	sq. ft.	5671			

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Lesson 2b - Learning Outcomes


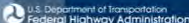
- Interpret condition state definitions (C)

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QUESTIONS



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Lesson 3a Deck and Slab Elements

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Lesson 3 – Learning Outcomes



- Explain the rules and conventions for identifying and quantifying elements (B)
- Interpret condition state definitions (C)

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Decks / Slabs – NBEs		
#	Element	Units
12	Reinforced Concrete Deck	Area (sq. ft.)
13	Prestressed Concrete Deck	Area (sq. ft.)
15	Prestressed Concrete Top Flange	Area (sq. ft.)
16	Reinforced Concrete Top Flange	Area (sq. ft.)
28	Steel Deck - Open Grid	Area (sq. ft.)
29	Steel Deck - Concrete Filled Grid	Area (sq. ft.)
30	Steel Deck - Corrugated/Orthotropic/Etc.	Area (sq. ft.)

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Decks / Slabs – NBEs		
#	Element	Units
31	Timber Deck	Area (sq. ft.)
38	Reinforced Concrete Slab	Area (sq. ft.)
54	Timber Slab	Area (sq. ft.)
60	Other Deck	Area (sq. ft.)
65	Other Slab	Area (sq. ft.)


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Decks / Slabs

- What's the difference between a Deck and Slab?






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Decks / Slabs



- Unit of measure is Area (sq. ft.)
- Total quantity calculated as edge-to-edge width times edge-to-edge length*
- Quantities are assigned amongst 4 condition states based upon existing conditions
- Additional wearing surface or protection systems addressed separately

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Decks / Slabs

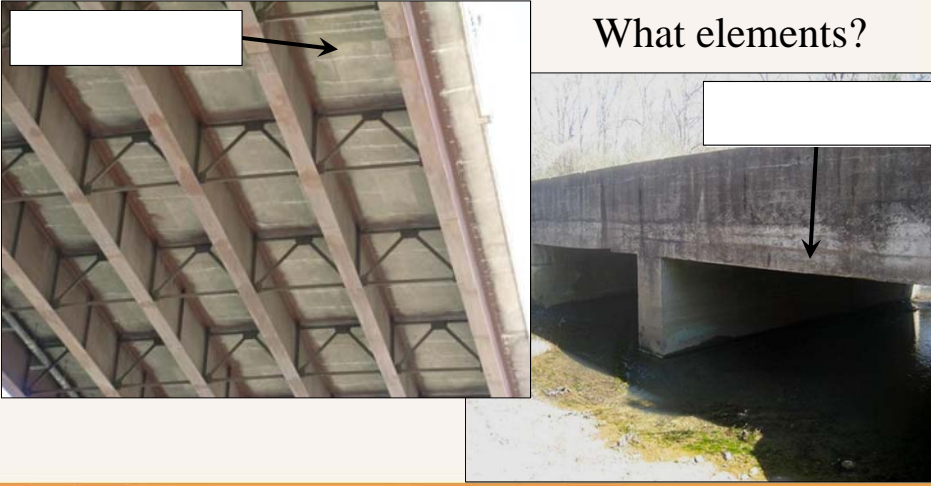
- Visual evaluation is 3-Dimensional
 - Look for defects on top, bottom and edges
- If surface or surfaces not visible
 - Example - additional wearing surface and/or stay-in-place forms
 - Assess based on available visible surface or destructive and nondestructive testing or indicators in the materials covering the surfaces



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Decks / Slabs – Reinforced Concrete

What elements?






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Decks / Slabs – RC Top Flange

What element?





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Decks / Slabs – RC Top Flange

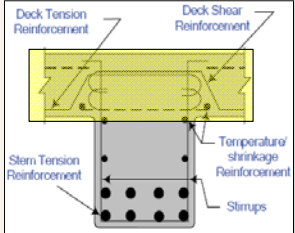
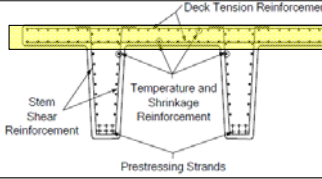
- Element 16 – RC Top Flange
 - Quantity is for top flange riding surface only
 - Girder web and bottom flange evaluated by appropriate girder element
 - Assess similarly as decks/slabs
 - Additional wearing surface or protective systems addressed separately
 - Reinforced concrete condition state definition

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Decks / Slabs – RC Top Flange

16 - RC Top Flange

Tee-beams, deck bulb-tees, and girder top flanges that have traffic riding directly on them



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Decks / Slabs / Top Flange – RC Defects

#	Defect	Units
1080	Delamination / Spall / Patched Area	Area (sq. ft.)
1090	Exposed Rebar	Area (sq. ft.)
1120	Efflorescence / Rust Staining	Area (sq. ft.)
1130	Cracking	Area (sq. ft.)
1190	Abrasion / Wear	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.


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Decks / Slabs – RC Deck Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
12	RC Deck	4500	sq. ft.				
			sq. ft.				

No spalls, delaminations or patches. 0.03 in. wide cracks at 2 ft. spacing throughout.



Which condition state applies?




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Decks / Slabs – RC Deck Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
12	RC Deck	4500	sq. ft.				
			sq. ft.				

No spalls and/or delaminations. 50 sq. ft. of 0.010 in. wide cracks with efflorescence and spaced more than 3 ft. apart.



Which condition state applies?






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Decks / Slabs – Prestressed Concrete

What elements?





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Decks / Slabs – PSC Top Flange

- Element 15 – PSC Top Flange
 - Quantity is for top flange riding surface only
 - Girder web and bottom flange evaluated by appropriate girder element
 - Assess similarly as decks/slabs
 - Additional wearing surface or protective systems addressed separately
 - Prestressed concrete condition state definition

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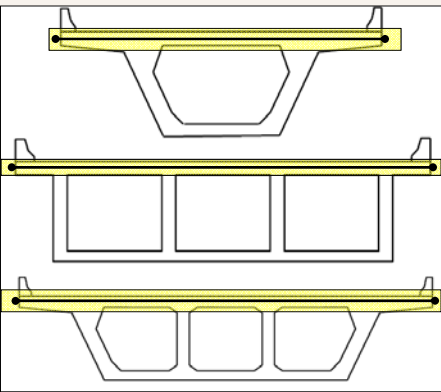
Decks / Slabs – PSC Top Flange



15 - PSC Top Flange

Typical for box girders with PSC top flanges that have traffic riding directly on them.

No additional structural concrete deck.

Transverse post-tensioning typical in top flange.





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Decks / Slabs / Top Flange – PSC Defects

#	Defect	Units
1080	Delamination / Spall / Patched Area	Area (sq. ft.)
1090	Exposed Rebar	Area (sq. ft.)
1100	Exposed Prestressing	Area (sq. ft.)
1110	Cracking	Area (sq. ft.)
1120	Efflorescence / Rust Staining	Area (sq. ft.)
1190	Abrasion / Wear	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

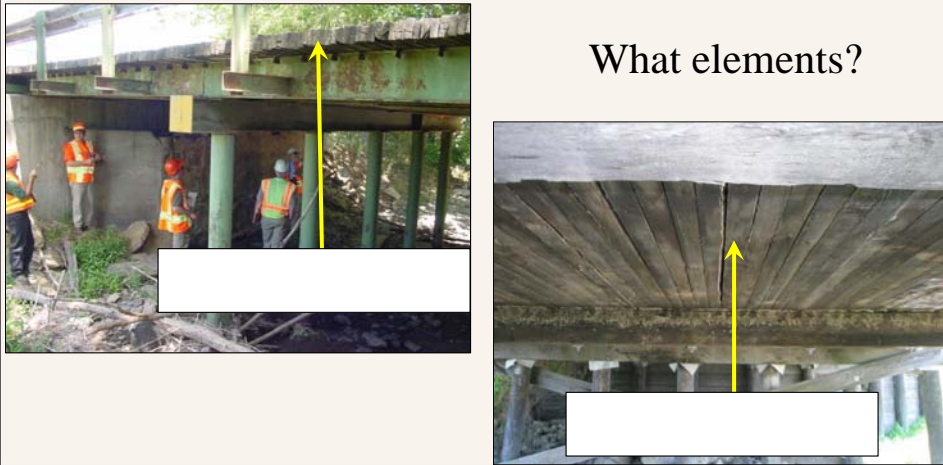
Refer to handout for defect definitions covered in prior lesson.



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Decks / Slabs – Timber

What elements?





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Decks / Slabs – Timber Defects

#	Defect	Units
1020	Connection	Area (sq. ft.)
1140	Decay / Section Loss	Area (sq. ft.)
1150	Check / Shake	Area (sq. ft.)
1160	Crack	Area (sq. ft.)
1170	Split / Delamination	Area (sq. ft.)
1180	Abrasion / Wear	Area (sq. ft.)
7000	Damage	Area (sq. ft.)


Refer to handout for defect definitions covered in prior lesson.

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Decks / Slabs – Timber Deck Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
31	Timber Deck	4500	sq. ft.				
			sq. ft.				





2 sq. ft. of decay greater than 10% of section and split length greater than member depth.

Which condition state applies?



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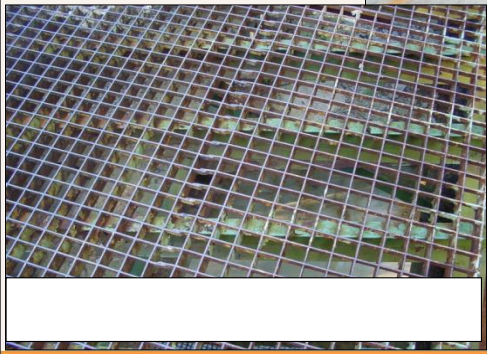

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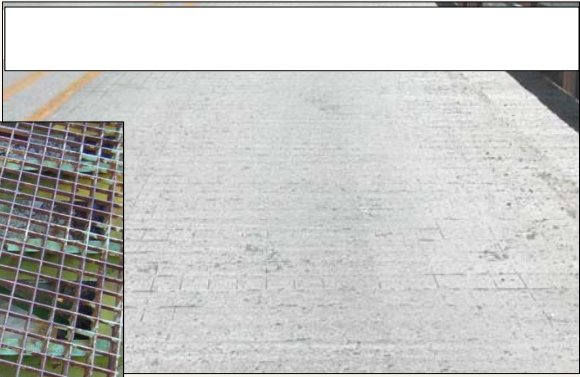
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Decks – Steel – Open/Filled Grid


What elements?









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Decks – Steel Grid (Open/Filled) – Defects




#	Defect	Units
1000	Corrosion	Area (sq. ft.)
1010	Cracking	Area (sq. ft.)
1020	Connection	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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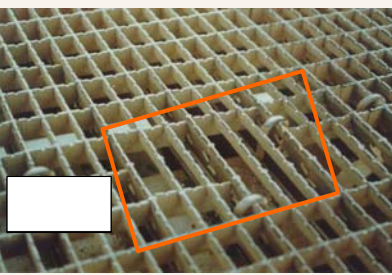
Decks – Steel Open Grid Exercise





#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
28	Steel Deck - Open Grid	4500	sq. ft.				
			sq. ft.				

4 sq. ft. of broken welds with missing sections without impact on load capacity.

Which condition state applies?




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Decks – Steel Filled Grid Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
29	Steel Deck – Filled Grid	4500	sq. ft.				
			sq. ft.				



No corrosion. Concrete fill is sound throughout.

Which condition state applies?

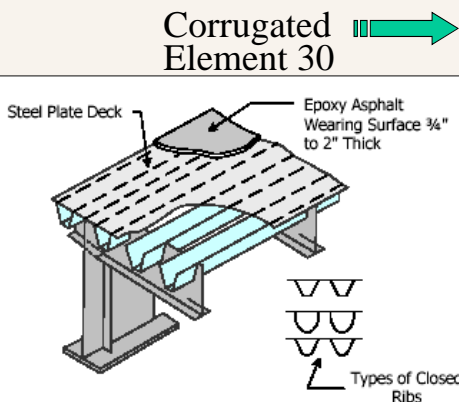


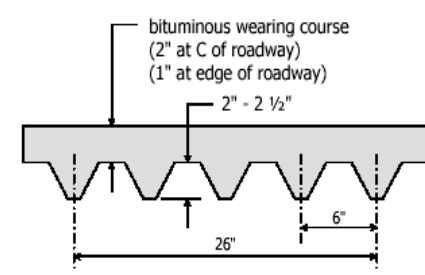
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Decks – Steel Corrugated/Orthotropic

Corrugated Element 30






Orthotropic Element 30

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Decks – Steel Corrugated / Orthotropic




#	Defect	Units
1000	Corrosion	Area (sq. ft.)
1010	Cracking	Area (sq. ft.)
1020	Connection	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Decks – Steel Corrugated Exercise





#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
30	Steel Deck – Corrugated	4500	sq. ft.				
			sq. ft.				

5 sq. ft. of surface corrosion.

Which condition state applies?





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Decks / Slabs – Other

- Element 60 – Other Deck
- Element 65 – Other Slab
- Intended for decks or slabs constructed of composite (FRP) materials, or other materials that cannot be classified using any other defined deck or slab element



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Decks / Slabs – Other

#	Defect	Units
1000	Corrosion	Area (sq. ft.)
1010	Cracking	Area (sq. ft.)
1020	Connection	Area (sq. ft.)
1080	Delamination/Spall/Patched Area	Area (sq. ft.)
1130	Cracking	Area (sq. ft.)
1220	Deterioration	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.



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Decks / Slabs – BMEs

- Wearing Surfaces and Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions



#	Element	Units
510	Wearing Surfaces	Area (sq. ft.)
515	Steel Protective Coating	Area (sq. ft.)
520	Concrete Reinforcing Steel Protective System	Area (sq. ft.)
521	Concrete Protective Coating	Area (sq. ft.)

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Decks / Slabs – Wearing Surfaces

- Element 510
 - Flexible
 - Asphalt
 - Semi-rigid
 - Epoxy, Polyester
 - Rigid (Portland cement concrete)
 - Latex, Micro-silica, High-Performance
 - Timber running planks

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Wearing Surfaces – Defects



#	Defect	Units
3210	Delamination/Spall/Patched Area/Pothole	Area (sq. ft.)
3220	Crack	Area (sq. ft.)
3230	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)


Refer to handout for defect definitions covered in prior lesson.

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Decks / Slabs – Wearing Surface Exercise





#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
510	Wearing Surface	4000	sq. ft.				
			sq. ft.				

5 sq. ft. patched area that appears to be sound.

Which condition state applies?





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Steel Protective Coatings

- Element 515
 - Paint
 - Galvanizing
 - Metalizing
 - Other top coat steel corrosion inhibitors
 - Oxide (patina) on weathering steel



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Steel Protective Coatings – Defects

#	Defect	Units
3410	Chalking	Area (sq. ft.)
3420	Peeling/Bubbling/Cracking	Area (sq. ft.)
3430	Oxide Film Degradation Color /Texture/Adherence	Area (sq. ft.)
3440	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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Concrete Protective Coatings

- Element 521
 - Silane/siloxane water proofers
 - Crack sealers
 - High Molecular Weight Methacrylate (HMWM)
 - Any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion



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Concrete Protective Coatings – Defects

#	Defect	Units
3510	Wear	Area (sq. ft.)
3520	Chalking	Area (sq. ft.)
3530	Peeling / Bubbling / Cracking	Area (sq. ft.)
3540	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Concrete Reinforcing Steel Protective Systems




Epoxy Coatings

Element 520



Cathodic Protection



Galvanic Coatings

Or similar
protective
system



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Concrete Reinforcing Steel Protective Systems – Defects


#	Defect	Units
3600	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.


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QUESTIONS



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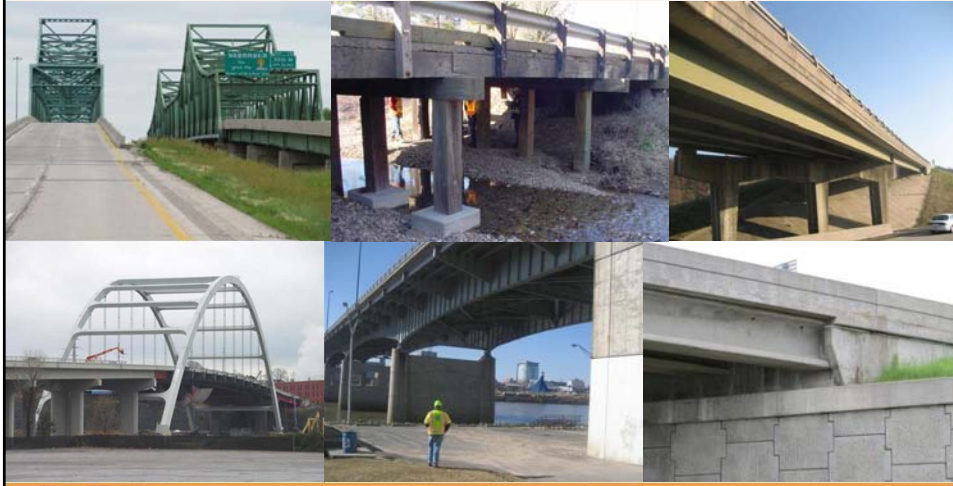
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Lesson 3b
Superstructure Elements

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Superstructure




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Superstructure – NBEs

- Elements with unit of measure Length (ft.)
 - Total quantity is a sum of the lengths
- Elements with unit of measure Each
 - Total quantity is a count of the elements
- Quantities assigned amongst 4 condition states based on existing conditions
- Additional protective systems addressed separately

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Superstructure – NBEs

- Visual evaluation is 3-Dimensional
 - Exterior and interior surfaces of box girders
 - Faces of exposed webs, top and bottom flanges
- If surface or surfaces not visible
 - Example – concrete encased
 - Assess based on available visible surface or destructive and nondestructive testing or indicators in the materials covering the surfaces

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Superstructure – Steel



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Superstructure – Steel NBEs

#	Element	Units
102	Steel Closed Web/Box Girder	Length (ft.)
107	Steel Open Girder/Beam	Length (ft.)
113	Steel Stringer	Length (ft.)
120	Steel Truss	Length (ft.)
141	Steel Arch	Length (ft.)
147	Steel Main Cables	Length (ft.)
148	Secondary Steel Cables	Each
152	Steel Floor Beam	Length (ft.)
161	Steel Pin, Pin and Hanger Assembly, or both	Each
162	Steel Gusset Plate	Each

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Superstructure – Box Girder

What element?

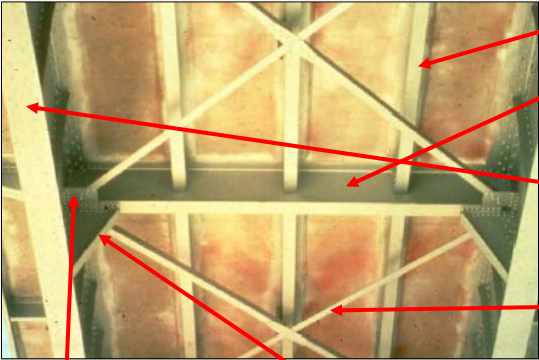




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Superstructure – Steel Floor System

What elements and units?

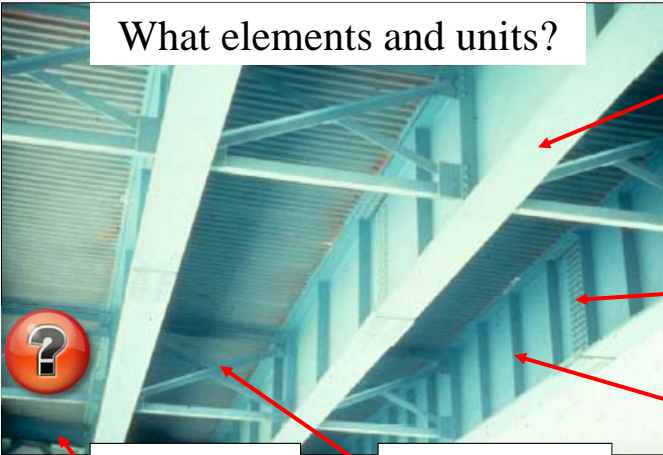


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Superstructure – Steel Open Beam/Girder

What elements and units?



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Superstructure – Steel – Defects

#	Defect	Units
1000	Corrosion	Length (ft.) or Each
1010	Cracking	Length (ft.) or Each
1020	Connection	Length (ft.) or Each
1900	Distortion	Length (ft.) or Each
7000	Damage	Length (ft.) or Each

Refer to handout for defect definitions covered in prior lesson.

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Superstructure – Steel Girder Exercise


#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
107	Steel Open Girder/Beam	200	ft.				
			ft.				



2 ft. of deep pitting.
More than 10% section loss.
Flaking steel.


Which condition state applies?



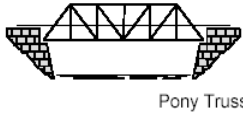

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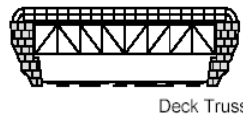
Superstructure – Steel Trusses



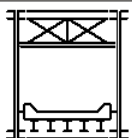
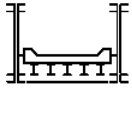

Through Truss



Pony Truss



Deck Truss






Element 120

Through, Deck and Pony trusses treated similarly.

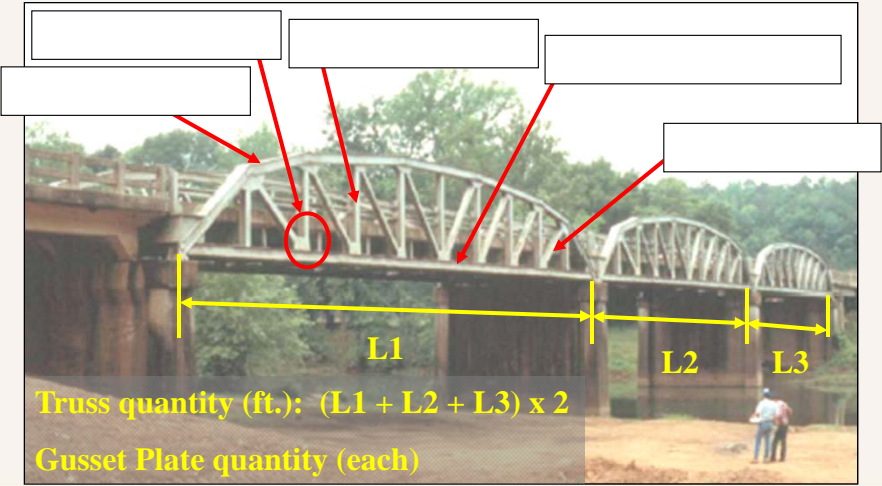
Includes all tension and compression members.

Other associated elements:
Gusset Plates, Floor Beams and Stringers.




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Superstructure – Steel Trusses

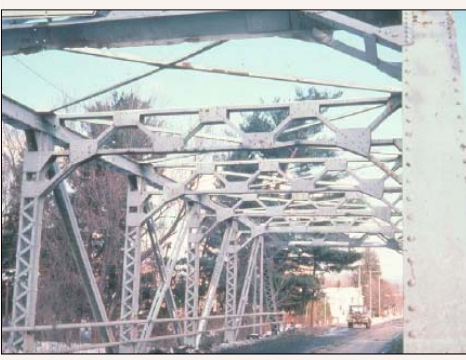


Truss quantity (ft.): $(L1 + L2 + L3) \times 2$
Gusset Plate quantity (each)

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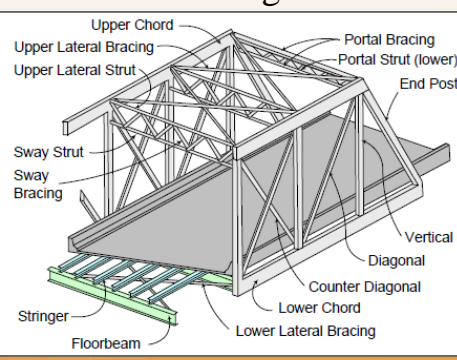
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Superstructure – Steel Trusses



Condition assessment of truss element includes verticals and diagonals.

What about bracing and struts?



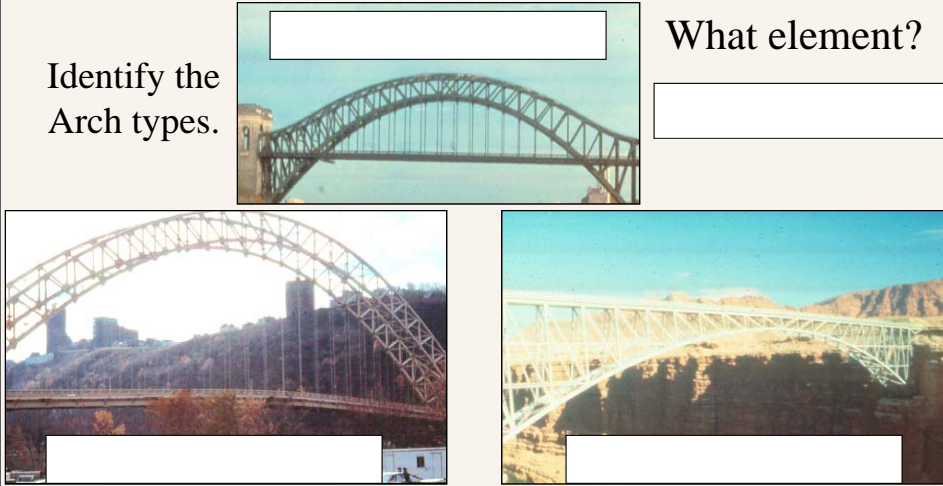
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Superstructure – Steel Arches

Identify the Arch types.

What element?

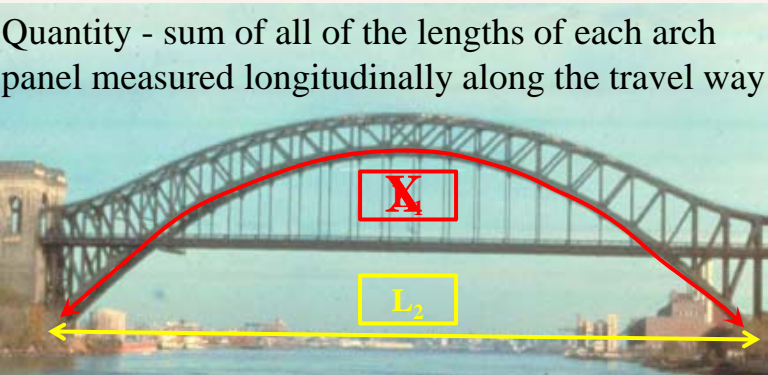


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Superstructure – Steel Arches

Quantity - sum of all of the lengths of each arch panel measured longitudinally along the travel way

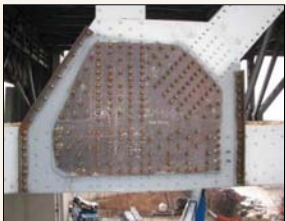


Assign quantities to condition states along the arch length (L_2). Total quantity is $L_2 \times 2$ arch ribs.


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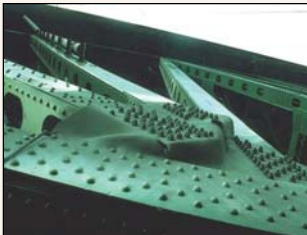

Superstructure – Steel Gusset Plates





162 – Steel Gusset Plate
For connections in main
truss/arch panels.




Units - Each
Number of primary
load path gusset
plate assemblies.
One per panel point.


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Superstructure – Steel Cables



147 – Steel Main Cables
Main suspension or cable stay cables
not embedded in concrete.




Units – Length (ft.)
Sum of the lengths measured
longitudinally along the travel way.

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Superstructure – Steel Cables



Units - Each
Sum of the individual
cable or cable groups.

148 – Secondary Steel Cables
Suspender cables or other
secondary cables not embedded
in concrete.

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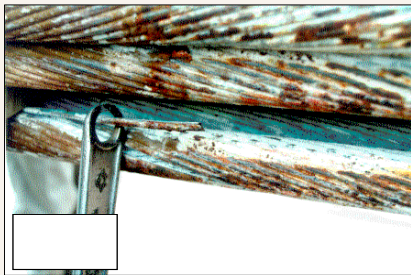
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Superstructure – Steel Cable Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
147	Steel Main Cable	200	ft.				
			ft.				

One ft. length of cable with one fractured wire in one of several multi-wire strands. Steel pitting - no impact on load capacity.


Which condition state applies?



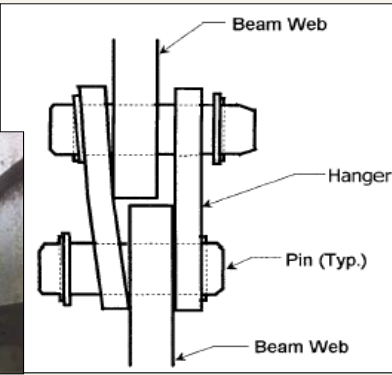
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Superstructure – Steel Pin, Pin and Hanger



161 - Steel Pin,
Pin and Hanger Assembly,
or both



Units - Each Number of pins and pin and hanger assemblies

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Superstructure – Steel Pin/Hanger Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
161	Steel Pin and Hanger	7	Each				
			Each				

Freckled rust. No cracks.
Connection sound.

Which condition state applies?



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Superstructure – Reinforced Concrete





Reinforced Concrete (RC)
(mild steel reinforcement)

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Superstructure – RC NBEs

#	Element	Units
105	Reinforced Concrete Closed Web/Box Girder	Length (ft.)
110	Reinforced Concrete Open Girder/Beam	Length (ft.)
116	Reinforced Concrete Stringer	Length (ft.)
144	Reinforced Concrete Arch	Length (ft.)
155	Reinforced Concrete Floor Beam	Length (ft.)

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Superstructure – RC – Defects



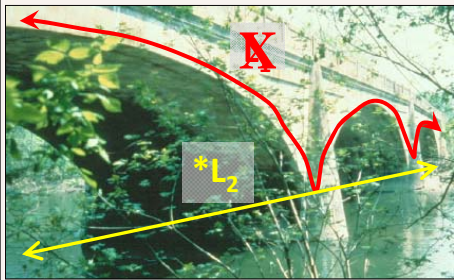
#	Defect	Units
1080	Delamination / Spall / Patched Area	Length (ft.)
1090	Exposed Rebar	Length (ft.)
1120	Efflorescence / Rust Staining	Length (ft.)
1130	Cracking	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.

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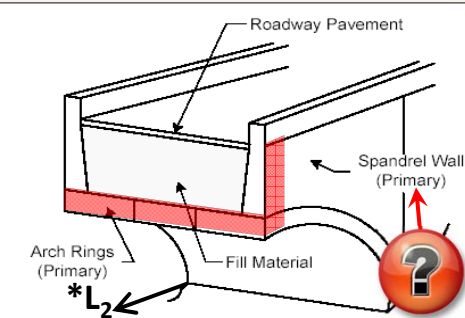
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Superstructure – RC Arch



Units – Length (ft.)
Sum of the length of each arch panel measured longitudinally along the travel way

RC Closed Spandrel Arch
144 – Reinforced Concrete Arch



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Superstructure – RC Arch

L₂ x 3 arch ribs

RC Open Spandrel Arch
144 – RC Arch

K

Units – Length (ft.)
Sum of the length of each arch panel measured longitudinally along the travel way (L₂)

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Superstructure – RC Integral Deck Girder

What element?

T-Beams

? Do you need a deck element too or just a superstructure element?

Units – Length (ft.)
Sum of all of the lengths of each girder

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Superstructure – RC Girder Exercise


#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
110	RC Open Girder/Beam	500	ft.				
			ft.				

15 ft. of spalls greater than 1 in. deep with exposed reinforcing steel near girder end. Exposed rebar has no measureable section loss.

Which condition state applies?


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Superstructure – Prestressed Concrete



Prestressed Concrete (PSC)
(Pre-tensioned and/or Post-tensioned)

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Superstructure – PSC NBEs

#	Element	Units
104	Prestressed Concrete Closed Web/Box Girder	Length (ft.)
109	Prestressed Concrete Open Girder/Beam	Length (ft.)
115	Prestressed Concrete Stringer	Length (ft.)
143	Prestressed Concrete Arch	Length (ft.)
154	Prestressed Concrete Floor Beam	Length (ft.)

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Superstructure – PSC NBEs



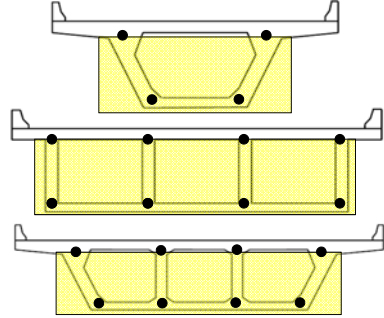
Solid Slab Beam

What element?





Voided Slab Beam

Units - Length (ft.)
Sum of all the lengths
of each girder

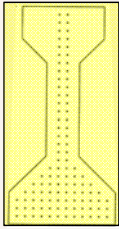


Box Beam

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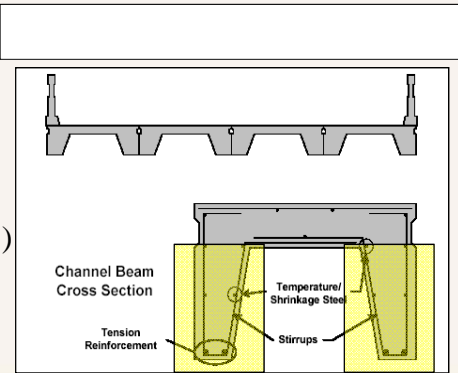
Superstructure – PSC NBEs

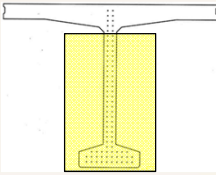


I-Beam

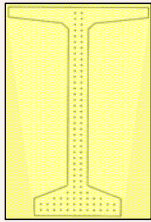
Units – Length (ft.)
Sum of all the
lengths of each
girder

What element?





Deck Bulb-Tee



Bulb-Tee

Channel Beam Cross Section

Tension Reinforcement

Temperature/Shrinkage Steel

Stirrups

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Superstructure – PSC Defects

#	Defect	Units
1080	Delamination / Spall / Patched Area	Length (ft.)
1090	Exposed Rebar	Length (ft.)
1100	Exposed Prestressing	Length (ft.)
1110	Cracking	Length (ft.)
1120	Efflorescence / Rust Staining	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.

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Superstructure – PSC Box Girder Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
104	PSC Closed Box Girder	500	ft.				
			ft.				

4 ft. of delaminations with spall greater than 1 in. deep.
No exposed steel.


Which condition state applies?






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Superstructure – Timber





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Superstructure – Timber NBEs

#	Element	Units
111	Timber Open Girder/Beam	Length (ft.)
117	Timber Stringer	Length (ft.)
135	Timber Truss	Length (ft.)
146	Timber Arch	Length (ft.)
156	Timber Floor Beam	Length (ft.)



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Superstructure – Timber – Defects

#	Defect	Units
1020	Connection	Length (ft.)
1140	Decay / Section Loss	Length (ft.)
1150	Check / Shake	Length (ft.)
1160	Crack	Length (ft.)
1170	Split / Delamination	Length (ft.)
1180	Abrasion / Wear	Length (ft.)
7000	Damage	Length (ft.)


Refer to handout for defect definitions covered in prior lesson.

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Superstructure – Timber Beam Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
111	Timber Open Beam	400	ft.				
			ft.				



10 ft. long split that is greater than the member depth. No prior structural review with this defect.

Which condition state applies?



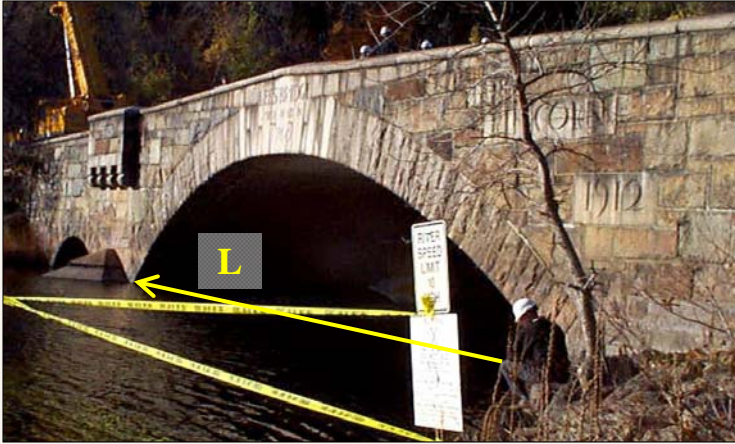
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Superstructure – Masonry

Element?

Units?





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Superstructure – Masonry – Defects

#	Defect	Units
1120	Efflorescence / Rust Staining	Length (ft.)
1610	Mortar Breakdown	Length (ft.)
1620	Split / Spall	Length (ft.)
1630	Patched Area	Length (ft.)
1640	Masonry Displacement	Length (ft.)
7000	Damage	Length (ft.)



Refer to handout for defect definitions covered in prior lesson.

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Superstructure – Other NBEs

#	Element	Units
106	Other Closed Web/Box Girder	Length (ft.)
112	Other Open Girder/Beam	Length (ft.)
118	Other Stringer	Length (ft.)
136	Other Truss	Length (ft.)
142	Other Arch	Length (ft.)
149	Other Secondary Cable	Each
157	Other Floor Beam	Length (ft.)



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Superstructure – Other – Defects

#	Defect	Units
1000	Corrosion	Length (ft.) or Each
1010	Cracking	Length (ft.) or Each
1020	Connection	Length (ft.) or Each
1080	Delamination / Spall / Patched Area	Length (ft.) or Each
1120	Efflorescence / Rust Staining	Length (ft.) or Each
1130	Cracking	Length (ft.) or Each
1220	Deterioration	Length (ft.) or Each
1900	Distortion	Length (ft.) or Each
7000	Damage	Length (ft.) or Each

Refer to handout for defect definitions covered in prior lesson.



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Superstructure – BMEs

- Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions


#	Element	Units
515	Steel Protective Coating	Area (sq. ft.)
520	Concrete Reinforcing Steel Protective System	Area (sq. ft.)
521	Concrete Protective Coating	Area (sq. ft.)


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Steel Protective Coating

Paint, galvanization, or other top coat steel corrosion inhibitor








Includes weathering steel patina

Element 515

Quantity
Entire exposed surface area of the steel element





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Steel Protective Coatings – Defects

#	Defect	Units
3410	Chalking	Area (sq. ft.)
3420	Peeling/Bubbling/Cracking	Area (sq. ft.)
3430	Oxide Film Degradation Color /Texture/Adherence	Area (sq. ft.)
3440	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Superstructure – Steel Coating Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
515	Steel Protective Coating	500	sq. ft.				
			sq. ft.				

25 sq. ft. of peeling with exposed bare metal.


Which condition state applies?



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Concrete Reinforcing Steel Protective Systems




Epoxy Coatings

Element 520




Cathodic Protection



Galvanic Coatings

Or similar protective system



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Concrete Reinforcing Steel Protective Systems – Defects

#	Defect	Units
3600	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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Concrete Protective Coating

- Element 521 Examples
 - Water proofing and crack sealers
 - Silane/siloxane
 - High Molecular Weight Methacrylate (HMWM)
 - Any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion



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Concrete Protective Coatings – Defects


#	Defect	Units
3510	Wear	Area (sq. ft.)
3520	Chalking	Area (sq. ft.)
3530	Peeling / Bubbling / Cracking	Area (sq. ft.)
3540	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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QUESTIONS




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Lesson 3c
Substructure Elements

July 2013

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Substructure



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Substructure – NBEs



- Elements with unit of measure Length (ft.)
 - Total quantity is a sum of the lengths
- Elements with unit of measure Each
 - Total quantity is a count of the elements
- Quantities assigned amongst 4 condition states based on existing conditions
- Additional protective systems addressed separately

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Substructure – Steel NBEs




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Substructure – Steel NBEs

#	Element	Units
202	Steel Column	Each
207	Steel Tower	Length (ft.)
219	Steel Abutment	Length (ft.)
225	Steel Pile	Each
231	Steel Pier Cap	Length (ft.)

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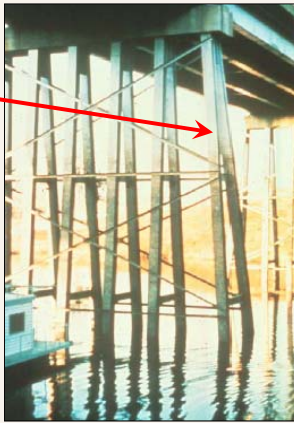
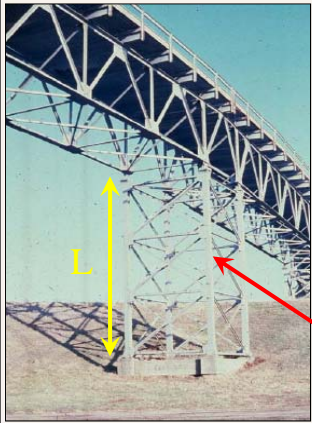
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Substructure – Steel NBEs

What element and units?



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Substructure – Steel NBEs

What element and units?

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Substructure – Steel – Defects

#	Defect	Units
1000	Corrosion	Length (ft.) or Each
1010	Cracking	Length (ft.) or Each
1020	Connection	Length (ft.) or Each
1900	Distortion	Length (ft.) or Each
4000	Settlement	Length (ft.) or Each
6000	Scour	Length (ft.) or Each
7000	Damage	Length (ft.) or Each

Refer to handout for defect definitions covered in prior lesson.

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Substructure – Steel Pile Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
225	Steel Pile	5	Each				
			Each				
			Each				
			Each				

5 piles with corrosion initiated. Connections sound. 1 pile with tolerable distortion due to debris impact damage.


Which condition state applies?






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Substructure – Concrete



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Substructure – Concrete NBEs		
#	Element	Units
204	Prestressed Concrete Column	Each
205	Reinforced Concrete Column	Each
210	Reinforced Concrete Pier Wall	Length (ft.)
215	Reinforced Concrete Abutment	Length (ft.)
220	Reinforced Concrete Pile Cap/Footing	Length (ft.)
226	Prestressed Concrete Pile	Each
227	Reinforced Concrete Pile	Each
233	Prestressed Concrete Pier Cap	Length (ft.)
234	Reinforced Concrete Pier Cap	Length (ft.)

February 2015



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Substructure – Reinforced Concrete		
What element and units?		
		<p>Quantity</p> <p>Sum the width of the abutments with monolithic wingwalls and extensions</p>

July 2013



Lesson 3c



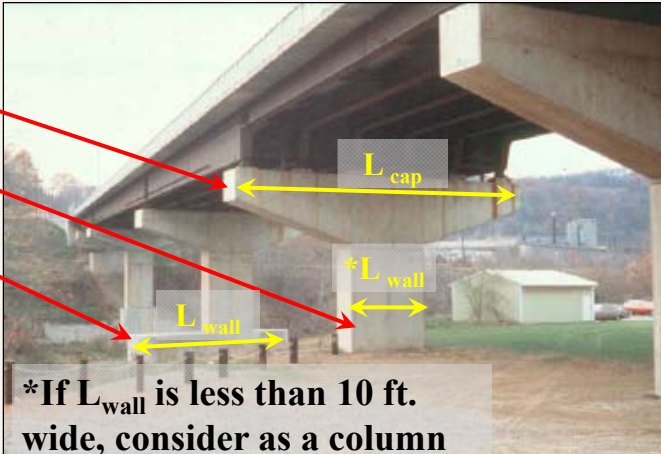
12

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Substructure – Reinforced Concrete

What elements?

What units?




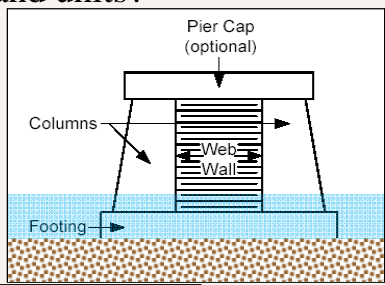
***If L_{wall} is less than 10 ft. wide, consider as a column**



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Substructure – Reinforced Concrete

What elements and units?



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Federal Highway Administration 14

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Substructure – RC – Defects

#	Defect	Units
1080	Delamination /Spall / Patched Area	Length (ft.) or Each
1090	Exposed Rebar	Length (ft.) or Each
1120	Efflorescence / Rust Staining	Length (ft.) or Each
1130	Cracking	Length (ft.) or Each
1190	Abrasion / Wear	Length (ft.) or Each
4000	Settlement	Length (ft.) or Each
6000	Scour	Length (ft.) or Each
7000	Damage	Length (ft.) or Each

Refer to handout for defect definitions covered in prior lesson.

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Lesson 3c

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Substructure – RC Column Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
205	RC Column	6	Each				
			Each				

1/32 in. (0.031 in.) wide cracks throughout at 1 ft. spacing.

Which condition state applies?








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Substructure – Prestressed Concrete

What element and units?





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Substructure – PSC – Defects



#	Defect	Units
1080	Delamination /Spall / Patched Area	Length (ft.) or Each
1090	Exposed Rebar	Length (ft.) or Each
1100	Exposed Prestressing	Length (ft.) or Each
1120	Efflorescence / Rust Staining	Length (ft.) or Each
1110	Cracking	Length (ft.) or Each
1190	Abrasion / Wear	Length (ft.) or Each
4000	Settlement	Length (ft.) or Each
6000	Scour	Length (ft.) or Each
7000	Damage	Length (ft.) or Each



Refer to handout for defect definitions covered in prior lesson.

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Substructure – Timber






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Substructure – Timber NBEs

#	Element	Units
206	Timber Column	Each
208	Timber Trestle	Length (ft.)
212	Timber Pier Wall	Length (ft.)
216	Timber Abutment	Length (ft.)
228	Timber Pile	Each
235	Timber Pier Cap	Length (ft.)



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Substructure – Timber – Defects

#	Defect	Units
1020	Connection	Length (ft.) or Each
1140	Decay / Section Loss	Length (ft.) or Each
1150	Check / Shake	Length (ft.) or Each
1160	Crack	Length (ft.) or Each
1170	Split / Delamination	Length (ft.) or Each
1180	Abrasion / Wear	Length (ft.) or Each
4000	Settlement	Length (ft.) or Each
6000	Scour	Length (ft.) or Each
7000	Damage	Length (ft.) or Each

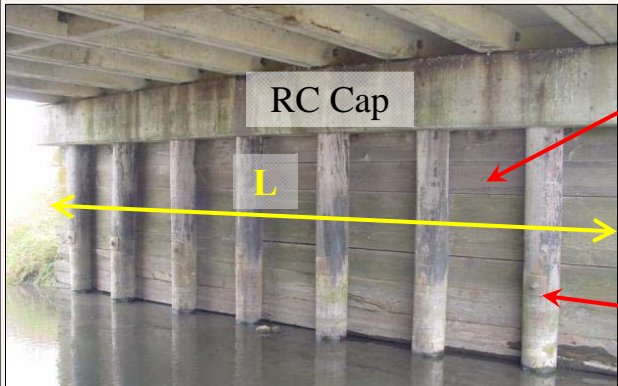
Refer to handout for defect definitions covered in prior lesson.



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Substructure – Timber

What elements and units?






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Substructure – Timber

What elements and units?



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Substructure – Timber Pile Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
228	Timber Pile	6	Each				
			Each				

1 pile with decay greater than 10% and crushing.

Which condition state applies?






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Substructure – Masonry NBEs

#	Element	Units
213	Masonry Pier Wall	Length (ft.)
217	Masonry Abutment	Length (ft.)



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Substructure – Masonry – Defects

#	Defect	Units
1120	Efflorescence / Rust Staining	Length (ft.)
1610	Mortar Breakdown	Length (ft.)
1620	Split / Spall	Length (ft.)
1630	Patched Area	Length (ft.)
1640	Masonry Displacement	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)


Refer to handout for defect definitions covered in prior lesson.

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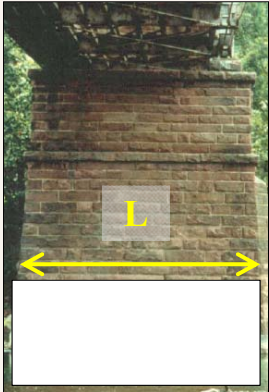
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Substructure – Masonry

What element and units?



What element and units?



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Substructure – Masonry Abutment Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
217	Masonry Abutment	40	ft.				
			ft.				

5 ft. of complete mortar loss, separation of stones and loss of bearing support.

Which condition state applies?





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Substructure – Other NBEs

#	Element	Units
203	Other Column	Each
211	Other Pier Wall	Length (ft.)
218	Other Abutments	Length (ft.)
229	Other Pile	Each
236	Other Pier Cap	Length (ft.)



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Substructure – Other – Defects

#	Defect	Units
1000	Corrosion	Length (ft.) or Each
1010	Cracking	Length (ft.) or Each
1020	Connection	Length (ft.) or Each
1080	Delamination / Spall / Patched Area	Length (ft.) or Each
1120	Efflorescence / Rust Staining	Length (ft.) or Each
1130	Cracking	Length (ft.) or Each
1220	Deterioration	Length (ft.) or Each
1900	Distortion	Length (ft.) or Each
4000	Settlement	Length (ft.) or Each
6000	Scour	Length (ft.) or Each
7000	Damage	Length (ft.) or Each

Refer to
handout for
defect
definitions
covered in prior
lesson.



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Substructure – BMEs

- Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions



#	Element	Units
515	Steel Protective Coating	Area (sq. ft.)
520	Concrete Reinforcing Steel Protective System	Area (sq. ft.)
521	Concrete Protective Coating	Area (sq. ft.)

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Steel Protective Coatings

- Element 515
 - Paint
 - Galvanizing
 - Metalizing
 - Other top coat steel corrosion inhibitors
 - Oxide (patina) on weathering steel



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Steel Protective Coatings – Defects

#	Defect	Units
3410	Chalking	Area (sq. ft.)
3420	Peeling/Bubbling/Cracking	Area (sq. ft.)
3430	Oxide Film Degradation Color /Texture/Adherence	Area (sq. ft.)
3440	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Concrete Reinforcing Steel Protective Systems



Epoxy Coatings

Element 520




Cathodic Protection



Galvanic Coatings

Or similar
protective
system


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Concrete Reinforcing Steel Protective Systems – Defects

#	Defect	Units
3600	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Concrete Protective Coatings



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Lesson 3c



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Federal Highway Administration

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Concrete Protective Coatings

- Element 521 Examples
 - Water proofing and crack sealers
 - Silane/siloxane
 - High Molecular Weight Methacrylate (HMWM)
 - Any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion



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Concrete Protective Coatings – Defects


#	Defect	Units
3510	Wear	Area (sq. ft.)
3520	Chalking	Area (sq. ft.)
3530	Peeling / Bubbling / Cracking	Area (sq. ft.)
3540	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.


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QUESTIONS



July 2013

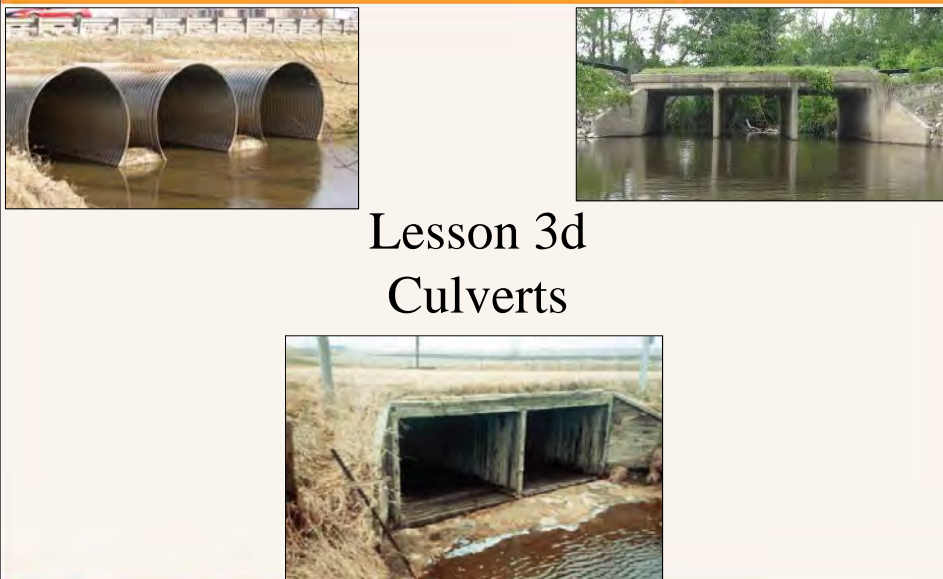
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Lesson 3d Culverts

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Culverts – NBEs



#	Element	Units
240	Steel Culvert	Length (ft.)
241	Reinforced Concrete Culvert	Length (ft.)
242	Timber Culvert	Length (ft.)
243	Other Culvert	Length (ft.)
244	Masonry Culvert	Length (ft.)
245	Prestressed Concrete Culvert	Length (ft.)

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Culverts – NBEs


- Unit of measure is Length (ft.)
- Total quantity calculated as flow line length of the barrel times number of barrels
- Quantities are assigned amongst 4 condition states based on existing conditions
- Additional protection systems addressed separately



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Culverts – NBEs


- Total Quantity: Barrel length times number of barrels





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Culverts – Steel



Element 240



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Federal Highway Administration 5

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Culverts – Steel – Defects

#	Defect	Units
1000	Corrosion	Length (ft.)
1010	Cracking	Length (ft.)
1020	Connection	Length (ft.)
1900	Distortion	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.

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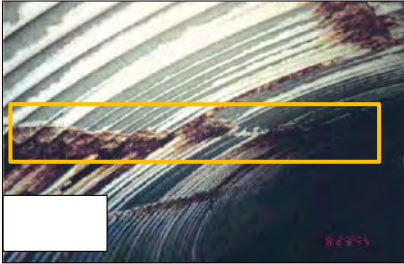
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Culverts – Steel Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
240	Steel Culvert	140	ft.				
			ft.				

30 feet of corrosion with section loss, no impact on load capacity. No distortion, cracking, or separation of seams.

Which condition state applies?

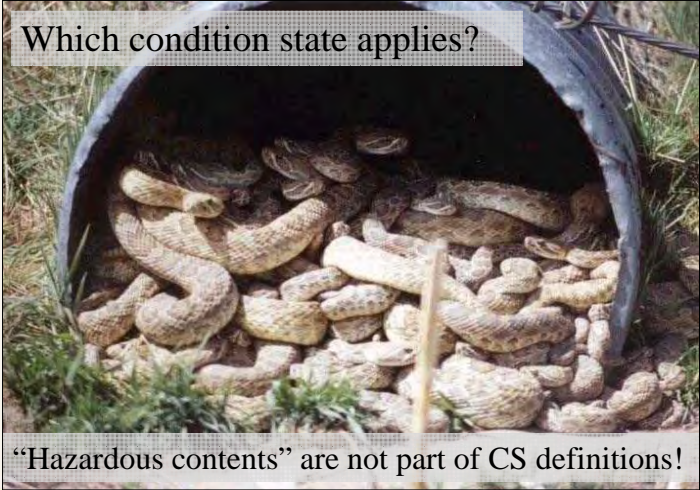


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Culverts – Steel

Which condition state applies?




“Hazardous contents” are not part of CS definitions!


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Culverts – Reinforced Concrete



Element 241




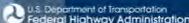
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Culverts – Reinforced Concrete – Defects

#	Defect	Units
1080	Delamination / Spall / Patched Area	Length (ft.)
1090	Exposed Rebar	Length (ft.)
1120	Efflorescence / Rust Staining	Length (ft.)
1130	Cracking (RC)	Length (ft.)
1190	Abrasion / Wear (PSC/RC)	Length (ft.)
1900	Distortion	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.

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Culverts – Reinforced Concrete Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
241	Concrete Culvert	180	ft.				
			ft.				

4 ft. length with 3 in deep spall, exposed rebar with no measureable section loss, scour and settlement within tolerable limits, and unaddressed distortion that may impact strength of the element.

Which condition state applies?


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Culverts – Timber

Not very common.

Any in your agency's inventory?



Element 242



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Culverts – Timber – Defects

#	Defect	Units
1020	Connection	Length (ft.)
1140	Decay / Section Loss	Length (ft.)
1150	Check / Shake	Length (ft.)
1160	Crack	Length (ft.)
1170	Split / Delamination	Length (ft.)
1180	Abrasion / Wear	Length (ft.)
1900	Distortion	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)


Refer to handout for defect definitions covered in prior lesson.



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Culverts – Other

- Element 243
- Materials other than concrete, steel or timber
 - Plastic (High Density Polyethylene)
 - Aluminum
 - Fiber Reinforced Polymer
- Any in your agency's inventory?





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Culverts – Other – Defects

#	Defect	Units
1000	Corrosion	Length (ft.)
1010	Cracking	Length (ft.)
1020	Connection	Length (ft.)
1080	Delamination / Spall / Patched Area	Length (ft.)
1120	Efflorescence / Rust Staining	Length (ft.)
1130	Cracking (RC and Other)	Length (ft.)
1220	Deterioration	Length (ft.)
1900	Distortion	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)


Refer to handout for defect definitions covered in prior lesson.

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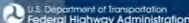
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Culverts – Masonry

Masonry block or stone culverts.



Element 244



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Culverts – Masonry – Defects

#	Defect	Units
1120	Efflorescence / Rust Staining	Length (ft.)
1610	Mortar Breakdown	Length (ft.)
1620	Split / Spall	Length (ft.)
1630	Patched Area	Length (ft.)
1640	Masonry Displacement	Length (ft.)
1900	Distortion	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.

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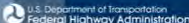
Culverts – Masonry Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
244	Masonry Culvert	110	ft.				
			ft.				

2 ft. of block has significant shifting at a masonry joint that does not impact strength or serviceability. Surface white efflorescence. Mortar and blocks intact.

Which condition state applies?






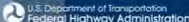
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Culverts – Prestressed Concrete

- Element 245
- Culverts made of prestressed concrete
 - Prestressed Concrete Cylinder Pipe (PCCP)
 - Precast plate arch
- Any in your agency's inventory?




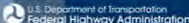
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Culverts – Prestressed Concrete – Defects

#	Defect	Units
1080	Delamination / Spall / Patched Area	Length (ft.)
1090	Exposed Rebar	Length (ft.)
1100	Exposed Prestressing	Length (ft.)
1110	Cracking (Prestressed Concrete)	Length (ft.)
1120	Efflorescence / Rust Staining	Length (ft.)
1190	Abrasion / Wear	Length (ft.)
1900	Distortion	Length (ft.)
4000	Settlement	Length (ft.)
6000	Scour	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.



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Culvert – BMEs

- Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions


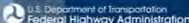
#	Element	Units
515	Steel Protective Coating	Area (sq. ft.)
520	Concrete Reinforcing Steel Protective System	Area (sq. ft.)
521	Concrete Protective Coating	Area (sq. ft.)

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Steel Protective Coatings

- Element 515
 - Paint
 - Galvanizing
 - Metalizing
 - Other top coat steel corrosion inhibitors
 - Oxide (patina) on weathering steel



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Steel Protective Coatings – Defects

#	Defect	Units
3410	Chalking	Area (sq. ft.)
3420	Peeling/Bubbling/Cracking	Area (sq. ft.)
3430	Oxide Film Degradation Color /Texture/Adherence	Area (sq. ft.)
3440	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

August 2013  **RESOURCE CENTER** Federal Highway Administration Lesson 3d  23

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Concrete Reinforcing Steel Protective Systems



Epoxy Coatings

Element 520



Cathodic Protection



Galvanic Coatings

Or similar
protective
system



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Concrete Reinforcing Steel Protective Systems – Defects

#	Defect	Units
3600	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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Concrete Protective Coatings

- Element 521 Examples
 - Water proofing and crack sealers
 - Silane/siloxane
 - High Molecular Weight Methacrylate (HMWM)
 - Any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion



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Concrete Protective Coatings – Defects


#	Defect	Units
3510	Wear	Area (sq. ft.)
3520	Chalking	Area (sq. ft.)
3530	Peeling / Bubbling / Cracking	Area (sq. ft.)
3540	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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QUESTIONS




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Lesson 4

Element Exercise - Part 1

“Identify and Quantify”

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Lesson 4  U.S. Department of Transportation
Federal Highway Administration


1

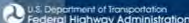
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Lesson 4 - Learning Outcomes

- Review as-built plans to identify bridge elements and determine appropriate units and quantities for elements (D)



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Bridge Element Inventory


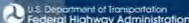
- 1st step in element level inspection
 - Inventory elements, their environments and quantities for each bridge
- Use information from
 - As-built or construction plans
 - Past inspection reports
 - Visual assessment during inspection
- Refer to Agency's policies

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Exercise 1

- 3-span painted steel beam bridge (14277)
 - Use provided form to inventory elements, environments, units and quantities
 - Use 1 structure unit for All spans
 - Use provided bridge plan sheets (14277)
 - Identify and record all deck, superstructure and substructure NBEs and their protective systems

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Introduction to Element Level Bridge Inspection
Lesson 4 - Exercise 1 & Lesson 6 - Exercise 1

Structure No.: 14277 By: _____ Date: _____

Element/ Str. Unit No.	Env.	Element/Structure Unit Description	Total Qty	Units
1		Span(s): All		
DECK (Lesson 4)				
SUPERSTRUCTURE (Lesson 4)				
SUBSTRUCTURE (Lesson 4)				
JOINTS (Lesson 6)				
APPROACH SLABS (Lesson 6)				
BRIDGE RAILINGS (Lesson 6)				
BEARINGS (Lesson 6)				

Element Quantity Calculation

Rounding Process

Conversion of plan dimensions to decimal feet (hundredth of a foot):

$$24'-4'' = 24.\underline{33} \text{ ft.}$$

Area calculation example:

$$100'-4'' \times 36'-8''$$









$$100.\underline{33} \text{ ft.} \times 36.\underline{67} \text{ ft.} = 3,679.\underline{10} \text{ sq. ft.}$$

Round up to **3,680 ft.**

SURFACE AREAS AND BOX AREAS

W shapes

Square feet per foot of length

	Case A	Case B	Case C	Case D		Case A	Case B	Case C	Case D
Designation					Designation				
W44x335	11.0	12.4	8.67	10.0	W36x256	9.02	10.0	7.26	8.27
x290	11.0	12.3	8.59	9.91	x232	8.96	9.97	7.20	8.21
x262	10.9	12.2	8.53	9.84	x210	8.91	9.93	7.13	8.15
x230	10.9	12.2	8.46	9.78	x194	8.88	9.89	7.09	8.10
W40x593	10.9	12.3	8.56	9.95	W36x182	8.85	9.85	7.06	8.07
x503	10.7	12.1	8.38	9.75	x170	8.82	9.82	7.03	8.03
x431	10.5	11.9	8.23	9.58	x160	8.79	9.79	7.00	8.00
x372	10.4	11.8	8.11	9.45	x150	8.76	9.76	6.97	7.97
x321	10.3	11.6	8.01	9.33	x135	8.71	9.70	6.92	7.92
x297	10.3	11.6	7.96	9.28	W33x354	9.66	11.0	7.27	8.61
x277	10.3	11.6	7.93	9.25	x318	9.58	10.9	7.19	8.52
x249	10.2	11.5	7.88	9.19	x291	9.52	10.8	7.13	8.46
x215	10.2	11.5	7.81	9.12	x263	9.46	10.8	7.07	8.39
x199	10.1	11.4	7.76	9.07	x241	9.42	10.7	7.02	8.34
x174	10.0	11.3	7.68	8.99	x221	9.38	10.7	6.97	8.29
W40x466	9.79	10.8	8.13	9.18	x201	9.33	10.6	6.93	8.24
x392	9.61	10.6	7.96	8.99	W33x169	8.30	9.26	6.60	7.55
x331	9.47	10.5	7.81	8.83	x152	8.27	9.23	6.55	7.51
x278	9.35	10.3	7.69	8.69	x141	8.23	9.19	6.51	7.47
x264	9.32	10.3	7.66	8.66	x130	8.20	9.15	6.47	7.43
x235	9.28	10.3	7.61	8.60	x118	8.15	9.11	6.43	7.39
x211	9.22	10.2	7.55	8.53	W30x477	9.30	10.6	7.02	8.35
x183	9.17	10.2	7.48	8.47	x391	9.11	10.4	6.83	8.13
x167	9.11	10.1	7.42	8.40	x326	8.96	10.2	6.68	7.96
x149	9.05	10.0	7.35	8.34	x292	8.88	10.2	6.61	7.88
W36x848	11.1	12.6	8.59	10.1	x261	8.81	10.1	6.53	7.79
x798	11.0	12.5	8.49	9.99	x235	8.75	10.0	6.47	7.73
x650	10.7	12.1	8.21	9.67	x211	8.71	9.97	6.42	7.67
x527	10.4	11.9	7.97	9.41	x191	8.66	9.92	6.37	7.62
x439	10.3	11.7	7.79	9.20	x173	8.62	9.87	6.32	7.57
x393	10.2	11.6	7.70	9.10	W30x148	7.53	8.40	5.99	6.86
x359	10.1	11.5	7.63	9.02	x132	7.49	8.37	5.93	6.81
x328	10.0	11.4	7.57	8.95	x124	7.47	8.34	5.90	6.78
x300	9.99	11.4	7.51	8.90	x116	7.44	8.31	5.88	6.75
x280	9.95	11.3	7.47	8.85	x108	7.41	8.28	5.84	6.72
x260	9.90	11.3	7.42	8.80	x99	7.37	8.25	5.81	6.68
x245	9.87	11.2	7.39	8.77	x90	7.35	8.22	5.79	6.66
x230	9.84	11.2	7.36	8.73					

Case A: Shape perimeter, minus one flange surface.

Case B: Shape perimeter.









Case C: Box perimeter, equal to one flange surface plus twice the depth.

Case D: Box perimeter, equal to two flange surfaces plus twice the depth.

SURFACE AREAS AND BOX AREAS

W shapes

Square feet per foot of length

Designation	Case A	Case B	Case C	Case D	Designation	Case A	Case B	Case C	Case D
									
W27x539	8.82	10.09	6.69	7.96	W21x201	6.75	7.80	4.89	5.93
x448	8.61	9.86	6.48	7.73	x182	6.69	7.74	4.83	5.87
x368	8.42	9.64	6.29	7.51	x166	6.65	7.68	4.78	5.82
x307	8.27	9.47	6.14	7.34	x147	6.61	7.66	4.72	5.76
x281	8.21	9.40	6.08	7.27	x132	6.57	7.61	4.68	5.71
x258	8.15	9.34	6.02	7.21	x122	6.54	7.57	4.65	5.68
x235	8.09	9.27	5.96	7.14	x111	6.51	7.54	4.61	5.64
x217	8.04	9.22	5.91	7.09	x101	6.48	7.50	4.58	5.61
x194	7.98	9.15	5.85	7.02					
x178	7.95	9.12	5.81	6.98	W21x93	5.54	6.24	4.31	5.01
x161	7.91	9.08	5.77	6.94	x83	5.50	6.20	4.27	4.96
x146	7.87	9.03	5.73	6.89	x73	5.47	6.16	4.23	4.92
					x68	5.45	6.14	4.21	4.90
W27x129	6.92	7.75	5.44	6.27	x62	5.42	6.11	4.19	4.87
x114	6.88	7.72	5.39	6.23					
x102	6.85	7.68	5.35	6.18	W21x57	5.01	5.56	4.06	4.60
x94	6.82	7.65	5.32	6.15	x50	4.97	5.51	4.02	4.56
x84	6.78	7.61	5.28	6.11	x44	4.94	5.48	3.99	4.53
W24x492	8.07	9.25	6.12	7.29	W18x311	6.41	7.41	4.72	5.72
x408	7.86	9.01	5.91	7.06	x283	6.32	7.31	4.63	5.62
x335	7.66	8.79	5.71	6.84	x258	6.24	7.23	4.56	5.54
x279	7.51	8.62	5.56	6.67	x234	6.17	7.14	4.48	5.45
x250	7.44	8.54	5.49	6.59	x211	6.10	7.06	4.41	5.37
x229	7.38	8.47	5.43	6.52	x192	6.03	6.99	4.35	5.30
x207	7.32	8.40	5.37	6.45	x175	5.97	6.92	4.29	5.24
x192	7.27	8.35	5.32	6.40	x158	5.92	6.86	4.23	5.17
x176	7.23	8.31	5.28	6.35	x143	5.87	6.81	4.18	5.12
x162	7.22	8.30	5.25	6.33	x130	5.83	6.76	4.14	5.07
x146	7.17	8.24	5.20	6.27					
x131	7.12	8.19	5.15	6.22	W18x119	5.81	6.75	4.10	5.04
x117	7.08	8.15	5.11	6.18	x106	5.77	6.70	4.06	4.99
x104	7.04	8.11	5.07	6.14	x97	5.74	6.67	4.03	4.96
					x86	5.70	6.62	3.99	4.91
W24x103	6.18	6.93	4.84	5.59	x76	5.67	6.59	3.95	4.87
x94	6.16	6.92	4.81	5.56					
x84	6.12	6.87	4.77	5.52	W18x71	4.85	5.48	3.71	4.35
x76	6.09	6.84	4.74	5.49	x65	4.82	5.46	3.69	4.32
x68	6.06	6.80	4.70	5.45	x60	4.80	5.43	3.67	4.30
					x55	4.78	5.41	3.65	4.27
W24x62	5.57	6.16	4.54	5.13	x50	4.76	5.38	3.62	4.25
x55	5.54	6.13	4.51	5.10					

Case A: Shape perimeter, minus one flange surface.

Case B: Shape perimeter.









Case C: Box perimeter, equal to one flange surface plus twice the depth.

Case D: Box perimeter, equal to two flange surfaces plus twice the depth.

SURFACE AREAS AND BOX AREAS

W shapes

Square feet per foot of length

Designation	Case A	Case B	Case C	Case D	Designation	Case A	Case B	Case C	Case D
									
W18x46	4.41	4.91	3.51	4.02	W14x82	4.75	5.59	3.23	4.07
x40	4.38	4.88	3.48	3.99	x74	4.72	5.56	3.20	4.04
x35	4.34	4.84	3.45	3.95	x68	4.69	5.53	3.18	4.01
					x61	4.67	5.50	3.15	3.98
W16x100	5.28	6.15	3.70	4.57					
x89	5.24	6.10	3.66	4.52	W14x53	4.19	4.86	2.99	3.66
x77	5.19	6.05	3.61	4.47	x48	4.16	4.83	2.97	3.64
x67	5.16	6.01	3.57	4.43	x43	4.14	4.80	2.94	3.61
W16x57	4.39	4.98	3.33	3.93	W14x38	3.93	4.50	2.91	3.48
x50	4.36	4.95	3.30	3.89	x34	3.91	4.47	2.89	3.45
x45	4.33	4.92	3.27	3.86	x30	3.89	4.45	2.87	3.43
x40	4.31	4.89	3.25	3.83					
x36	4.28	4.87	3.23	3.81	W14x26	3.47	3.89	2.74	3.16
					x22	3.44	3.86	2.71	3.12
W16x31	3.92	4.39	3.11	3.57					
x26	3.89	4.35	3.07	3.53	W12x336	5.77	6.88	3.92	5.03
					x305	5.67	6.77	3.82	4.93
W14x808	7.74	9.28	5.35	6.90	x279	5.59	6.68	3.74	4.83
x730	7.61	9.10	5.23	6.72	x252	5.50	6.58	3.65	4.74
x665	7.46	8.93	5.08	6.55	x230	5.43	6.51	3.58	4.66
x605	7.32	8.77	4.94	6.39	x210	5.37	6.43	3.52	4.58
x550	7.19	8.62	4.81	6.24	x190	5.30	6.36	3.45	4.51
x500	7.07	8.49	4.68	6.10	x170	5.23	6.28	3.39	4.43
x455	6.96	8.36	4.57	5.98	x152	5.17	6.21	3.33	4.37
					x136	5.12	6.15	3.27	4.30
W14x426	6.89	8.28	4.50	5.89	x120	5.06	6.09	3.21	4.24
x398	6.81	8.20	4.43	5.81	x106	5.02	6.03	3.17	4.19
x370	6.74	8.12	4.36	5.73	x96	4.98	5.99	3.13	4.15
x342	6.67	8.03	4.29	5.65	x87	4.95	5.96	3.10	4.11
x311	6.59	7.94	4.21	5.56	x79	4.92	5.93	3.07	4.08
x283	6.52	7.86	4.13	5.48	x72	4.89	5.90	3.05	4.05
x257	6.45	7.78	4.06	5.40	x65	4.87	5.87	3.02	4.02
x233	6.38	7.71	4.00	5.32					
x211	6.32	7.64	3.94	5.25	W12x58	4.39	5.22	2.87	3.70
x193	6.27	7.58	3.89	5.20	x53	4.37	5.20	2.84	3.68
x176	6.22	7.53	3.84	5.15					
x159	6.18	7.47	3.79	5.09	W12x50	3.90	4.58	2.71	3.38
x145	6.14	7.43	3.76	5.05	x45	3.88	4.55	2.68	3.35
					x40	3.86	4.52	2.66	3.32
W14x132	5.93	7.16	3.67	4.90					
x120	5.90	7.12	3.64	4.86					
x109	5.86	7.08	3.60	4.82					
x99	5.83	7.05	3.57	4.79					
x90	5.81	7.02	3.55	4.76					

Case A: Shape perimeter, minus one flange surface.

Case B: Shape perimeter.









Case C: Box perimeter, equal to one flange surface plus twice the depth.

Case D: Box perimeter, equal to two flange surfaces plus twice the depth.

SURFACE AREAS AND BOX AREAS

W shapes

Square feet per foot of length

Designation	Case A	Case B	Case C	Case D	Designation	Case A	Case B	Case C	Case D
									
W12x35	3.63	4.18	2.63	3.18	W8x21	2.61	3.05	1.82	2.26
x30	3.60	4.14	2.60	3.14	x18	2.59	3.03	1.79	2.23
x26	3.58	4.12	2.58	3.12					
W12x22	2.97	3.31	2.39	2.72	W8x15	2.27	2.61	1.69	2.02
x19	2.95	3.28	2.36	2.69	x13	2.25	2.58	1.67	2.00
x16	2.92	3.25	2.33	2.66	x10	2.23	2.56	1.64	1.97
x14	2.90	3.23	2.32	2.65					
W10x112	4.30	5.17	2.76	3.63	W6x25	2.49	3.00	1.57	2.08
x100	4.25	5.11	2.71	3.57	x20	2.46	2.96	1.54	2.04
x88	4.20	5.06	2.66	3.52	x15	2.42	2.92	1.50	2.00
x77	4.15	5.00	2.62	3.47					
x68	4.12	4.96	2.58	3.42	W6x16	1.98	2.31	1.38	1.72
x60	4.08	4.92	2.54	3.38	x12	1.93	2.26	1.34	1.67
x54	4.06	4.89	2.52	3.35	x9	1.90	2.23	1.31	1.64
x49	4.04	4.87	2.50	3.33					
W10x45	3.56	4.23	2.35	3.02	W5x19	2.04	2.45	1.28	1.70
x39	3.53	4.19	2.32	2.98	x16	2.01	2.43	1.25	1.67
x33	3.49	4.16	2.29	2.95					
W10x30	3.10	3.59	2.23	2.71	W4x13	1.63	1.96	1.03	1.37
x26	3.08	3.56	2.20	2.68					
x22	3.05	3.53	2.17	2.65					
W10x19	2.63	2.96	2.04	2.38					
x17	2.60	2.94	2.02	2.35					
x15	2.58	2.92	2.00	2.33					
x12	2.56	2.89	1.97	2.30					
W8x67	3.42	4.11	2.19	2.88					
x58	3.37	4.06	2.14	2.83					
x48	3.32	4.00	2.09	2.77					
x40	3.28	3.95	2.05	2.72					
x35	3.25	3.92	2.02	2.69					
x31	3.23	3.89	2.00	2.67					
W8x28	2.87	3.42	1.89	2.43					
x24	2.85	3.39	1.86	2.40					

Case A: Shape perimeter, minus one flange surface.



Case B: Shape perimeter.

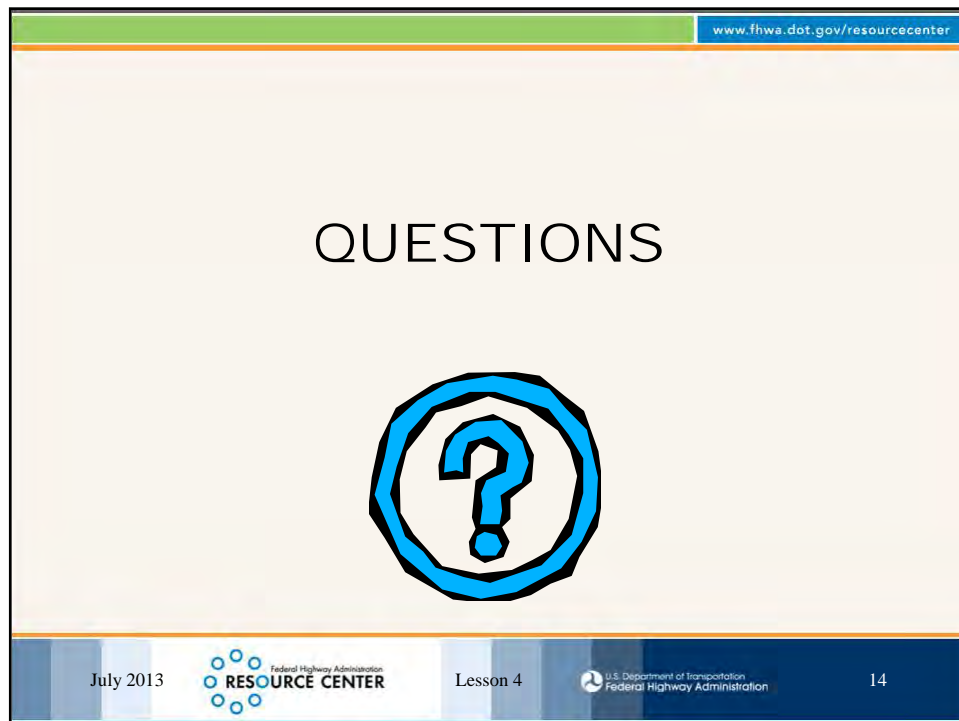
Case C: Box perimeter, equal to one flange surface plus twice the depth.

Case D: Box perimeter, equal to two flange surfaces plus twice the depth.

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Structure No.: _____ By: _____ Date: _____		Env	Element/Structure Unit Description	Total Qty	Units
1	Span(s):				
DECK (Lesson 4)					
SUPERSTRUCTURE (Lesson 4)					
SUBSTRUCTURE (Lesson 4)					
JOINTS (Lesson 6)					
APPROACH SLABS (Lesson 6)					
BRIDGE RAILINGS (Lesson 6)					
BEARINGS (Lesson 6)					


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Lesson 4 - Learning Outcomes


- Review as-built plans to identify bridge elements and determine appropriate units and quantities for elements (D)



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Lesson 5a Bridge Railings

March 2015

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Lesson 5a

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Lesson 5 - Learning Outcomes

- Explain the rules and conventions for identifying and quantifying elements (B)
- Interpret condition state definitions (C)

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Bridge Railings




- Unit of measure is Length (ft.)
- Total quantity is the number of rows of bridge rail on the bridge times the length of the bridge
- Quantities are assigned amongst 4 condition states based on existing conditions
- Additional protection systems addressed separately

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Bridge Railings - Quantity




How many rows of bridge rail are shown in each picture?



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Bridge Railings – NBEs

#	Element	Units
330	Metal Bridge Railing	Length (ft.)
331	Reinforced Concrete Bridge Railing	Length (ft.)
332	Timber Bridge Railing	Length (ft.)
333	Other Bridge Railing	Length (ft.)
334	Masonry Bridge Railing	Length (ft.)

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Metal Bridge Railing




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Metal Bridge Railing



- All types and shapes of metal bridge railing
- Includes metal, timber or concrete posts, blocking, and curb
- Quantity is the number of rows of bridge rail on the bridge times the length of the bridge



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Metal Bridge Railing – Defects


#	Defect	Units
1000	Corrosion	Length (ft.)
1010	Cracking	Length (ft.)
1020	Connection	Length (ft.)
1900	Distortion	Length (ft.)
7000	Damage	Length (ft.)



Refer to handout for defect definitions covered in prior lesson.

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Reinforced Concrete Bridge Railing






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Reinforced Concrete Bridge Railing

- All types and shapes of RC bridge railing
- All elements of the railing must be concrete
- Quantity is the number of rows of bridge rail on the bridge times the length of the bridge





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RC Bridge Railing – Defects


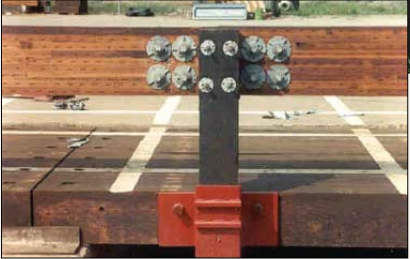

#	Defect	Units
1080	Delamination / Spall/ Patched Area	Length (ft.)
1090	Exposed Rebar	Length (ft.)
1120	Efflorescence / Rust Staining	Length (ft.)
1130	Cracking	Length (ft.)
7000	Damage	Length (ft.)



Refer to handout for defect definitions covered in prior lesson.

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Timber Bridge Railing







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Timber Bridge Railing

- All types/shapes of timber bridge railing
- Includes metal, timber or concrete posts, blocking, and curb
- Quantity is the number of rows of bridge rail on the bridge times the length of the bridge


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Timber Bridge Railing – Defects

#	Defect	Units
1020	Connection	Length (ft.)
1140	Decay / Section Loss	Length (ft.)
1150	Check / Shake	Length (ft.)
1160	Crack	Length (ft.)
1170	Split / Delamination	Length (ft.)
1180	Abrasion / Wear	Length (ft.)
7000	Damage	Length (ft.)



Refer to handout for defect definitions covered in prior lesson.

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Timber Bridge Railing – Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
332	Timber Bridge Railing	400	ft.				
			ft.				

8 ft. of decay affects more than 10% of the member and impacts strength of the element. Missing fasteners.

Which condition state applies?





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Other Bridge Railing

- Used for materials not otherwise defined
- Quantity is the number of rows of bridge rail on the bridge times the length of the bridge



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Other Bridge Railing – Defects



#	Defect	Units
1000	Corrosion	Length (ft.)
1010	Cracking	Length (ft.)
1020	Connection	Length (ft.)
1080	Delamination/Spall/Patched Area	Length (ft.)
1120	Efflorescence/Rust Staining	Length (ft.)
1130	Cracking	Length (ft.)
1220	Deterioration	Length (ft.)
1900	Distortion	Length (ft.)
7000	Damage	Length (ft.)



Refer to handout for defect definitions covered in prior lesson.



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Masonry Bridge Railing



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Masonry Bridge Railing – Defects

#	Defect	Units
1120	Efflorescence / Rust Staining	Length (ft.)
1610	Mortar Breakdown	Length (ft.)
1620	Split / Spall	Length (ft.)
1630	Patched Area	Length (ft.)
1640	Masonry Displacement	Length (ft.)
7000	Damage	Length (ft.)

Refer to handout for defect definitions covered in prior lesson.



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Bridge Railings – BMEs

- Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions

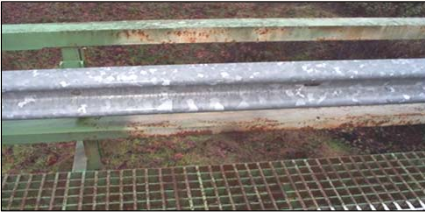
#	Element	Units
515	Steel Protective Coating	Area (sq. ft.)
520	Concrete Reinforcing Steel Protective System	Area (sq. ft.)
521	Concrete Protective Coating	Area (sq. ft.)



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Bridge Railings – Steel Protective Coating

- Element 515
 - Paint
 - Galvanizing
 - Metalizing
 - Weathering steel patina
 - Other top coat steel corrosion inhibitor





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Steel Protective Coatings – Defects


#	Defect	Units
3410	Chalking	Area (sq. ft.)
3420	Peeling / Bubbling / Cracking	Area (sq. ft.)
3430	Oxide Film Degradation, Color/Texture/Adherence	Area (sq. ft.)
3440	Effectiveness (Steel Protective Coatings)	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Metal Bridge Railing – Exercise

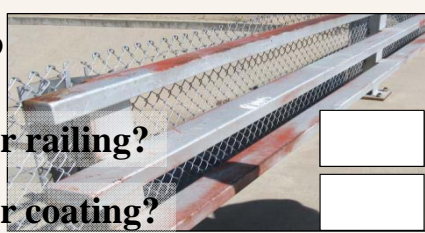




#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
330	Metal Bridge Railing	100	ft.				
515	Steel Protective Coating	350	sq. ft.				
			sq. ft.				

No railing defects. 90 sq. ft. of top coat peeling with intact primer.

Which condition state applies for railing?

Which condition state applies for coating?



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Concrete Reinforcing Steel Protective Systems




Epoxy Coatings

Element 520




Cathodic Protection



Galvanic Coatings

Or similar protective system

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Concrete Reinforcing Steel Protective Systems – Defects

#	Defect	Units
3600	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)


Refer to handout for defect definitions covered in prior lesson.



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Concrete Protective Coatings

- Element 521
 - Water proofing and crack sealers
 - Silane/siloxane
 - High Molecular Weight Methacrylate (HMWM)
 - Any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion





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Concrete Protective Coatings – Defects


#	Defect	Units
3510	Wear	Area (sq. ft.)
3520	Chalking	Area (sq. ft.)
3530	Peeling / Bubbling / Cracking	Area (sq. ft.)
3540	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)


Refer to handout for defect definitions covered in prior lesson.


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What elements and units?










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Lesson 5b Joints



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Joints – BMEs





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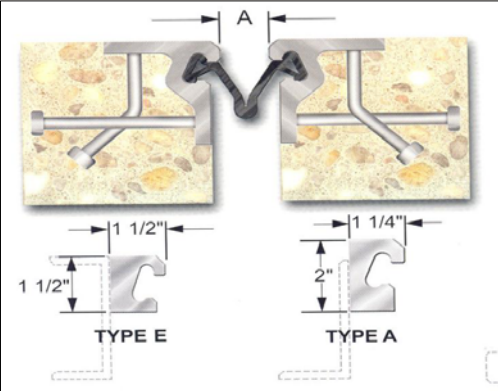
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Joints – BMEs		
#	Element	Units
300	Strip Seal Expansion Joint	Length (ft.)
301	Pourable Joint Seal	Length (ft.)
302	Compression Joint Seal	Length (ft.)
303	Assembly Joint with Seal	Length (ft.)
304	Open Expansion Joint	Length (ft.)
305	Assembly Joint without Seal	Length (ft.)
306	Other Joint	Length (ft.)

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Joints – BMEs		
<ul style="list-style-type: none"> • Unit of measure is Length (ft.) • Total quantity calculated as sum of the length of all joints measured along the skew • Quantities are assigned amongst 4 condition states based on existing conditions • Additional protective systems addressed separately 		

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Joints – Defects and Application								
#	Defect	300	301	302	303	304	305	306
2310	Leakage	X	X	X	X			X
2320	Seal Adhesion	X	X	X	X			
2330	Seal Damage	X	X	X	X			
2340	Seal Cracking	X	X	X	X			
2350	Debris Impaction	X	X	X	X	X	X	X
2360	Adjacent Deck or Header	X	X	X	X	X	X	X
2370	Metal Deterioration or Damage	X			X		X	X
7000	Damage	X	X	X	X	X	X	X
Refer to handout for defect definitions covered in prior lesson.								
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Joints – Strip Seal Expansion Joint								
<ul style="list-style-type: none"> • Element 300 • Neoprene waterproof gland with metal extrusion or other anchor system 								
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Joints – Strip Seal Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
300	Strip Seal Exp Joint	40	ft.				
			ft.				





Free flow of water through the entire length of joint.

Which condition state applies?



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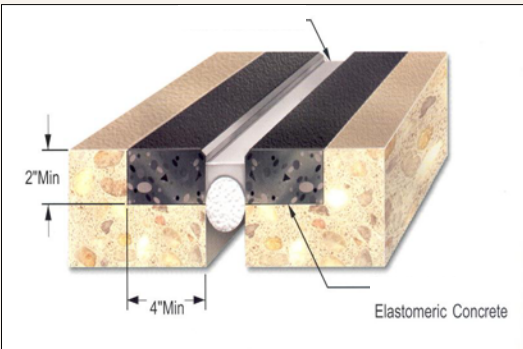

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Joints – Pourable Joint Seal

- Joints filled with a pourable seal with or without a backer
- Element 301



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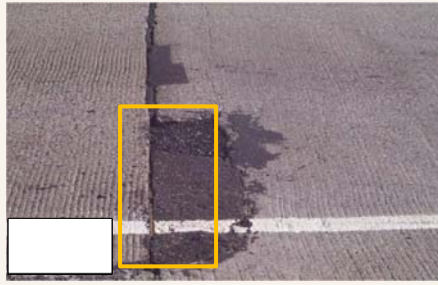
Joints – Pourable Joint Seal Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
301	Pourable Joint Seal	40	ft.				
			ft.				



Seal missing & unsound patch in adjacent deck for 3 feet.

Which condition state applies?

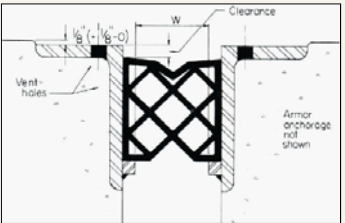



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Joints – Compression Joint Seal

- Joints filled with a preformed compression type seal
- May or may not have an anchor system to confine the seal
- Element 302





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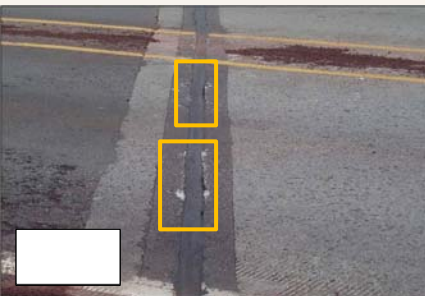

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Joints – Compression Joint Seal Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
302	Compression Joint Seal	40	ft.				
			ft.				

5 feet of the joint has top 25% of seal pulled away from header and spalls less than 1 in. deep and less than 6 in. diameter.

Which condition state applies?


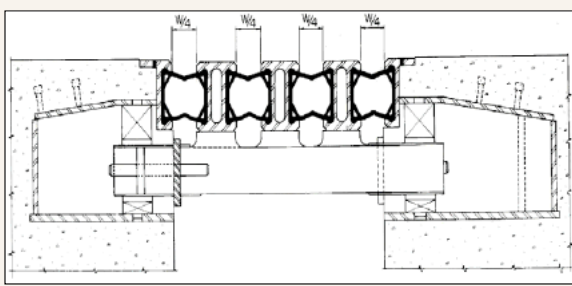





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Joints – Assembly Joint with Seal

- Joints filled with an assembly mechanism that have a seal
- Element 303

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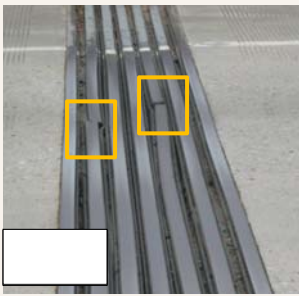
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Joints – Assembly Joint with Seal Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
303	Assembly Joint/Seal	40	ft.				
			ft.				

Two full fractures, 2 ft. apart in center beams. Seals partially pulled out & moderate leaking at fractures.

Which condition state applies?



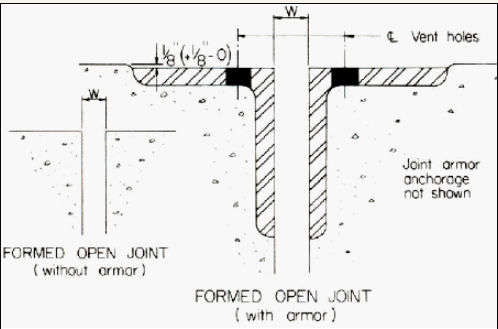




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Joints – Open Expansion Joint

- Joints that are open and not sealed
- Formed with or without armoring
- Element 304







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Joints – Assembly Joint without Seal

- Assembly joints that are open and not sealed
- Include finger and sliding plate joints
- Element 305

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Joints – Assembly without Seal Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
305	Assembly Joint w/o seal	40	ft.				
			ft.				

Four foot section is loose under live load, connectors intact.

Which condition state applies?



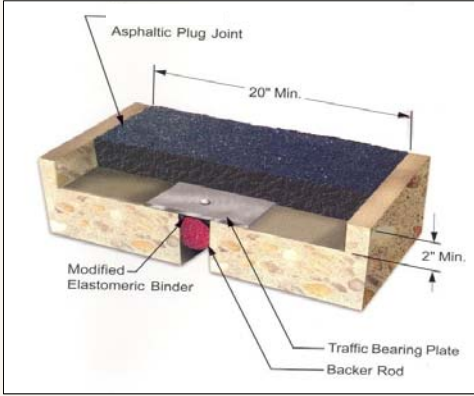
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Joints – Other Joint

- Joints that are not defined by other joint elements
- Element 306

Plug Joint
Use 306 or 301
or ADE-BME



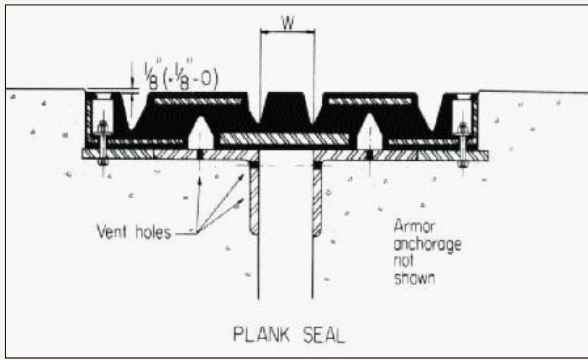
The diagram illustrates an asphaltic plug joint. It shows a cross-section of a joint where a plug of asphalt is placed between two concrete slabs. The plug is labeled 'Asphaltic Plug Joint' and has a minimum length of '20" Min.'. Below the plug, a 'Modified-Elastomeric Binder' is shown. A 'Traffic Bearing Plate' is positioned above the plug, and a 'Backer Rod' is shown below it. The thickness of the binder is indicated as '2" Min.'.

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Joints – Other Joint

Plank Seal
Use 303 or 306
or ADE-BME



The diagram illustrates a plank seal joint. It shows a cross-section of a joint where a seal is placed between two concrete slabs. The seal is labeled 'PLANK SEAL' and has a width 'W'. The seal is shown with 'Vent holes' and 'Armor anchorage not shown'. The seal is shown with a thickness of $\frac{1}{8}'' (\frac{1}{8}'' - 0)$.

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Joints – Other Joint

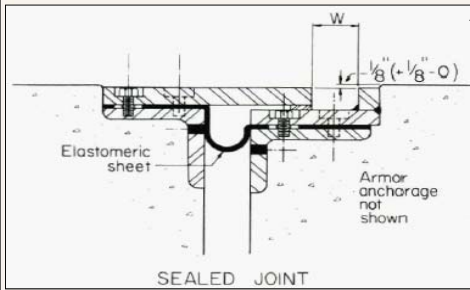


Diagram of a Sealed Joint showing an elastomeric sheet and armor anchorage. Dimensions include W and $\frac{1}{8}'' (-\frac{1}{8}'' - 0)$. Labels include "Elastomeric sheet" and "Armor anchorage not shown".

SEALD JOINT

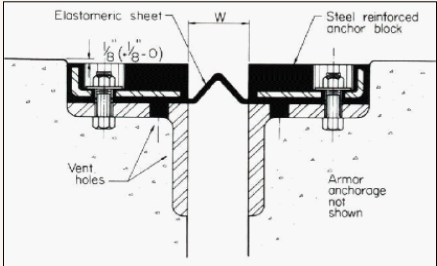




Diagram of a Sliding plate w/ elastomeric sheet showing an elastomeric sheet, steel reinforced anchor block, and vent holes. Dimensions include W and $\frac{1}{8}'' (-\frac{1}{8}'' - 0)$. Labels include "Elastomeric sheet", "Steel reinforced anchor block", "Vent holes", and "Armor anchorage not shown".

Sliding plate w/
elastomeric sheet


Sheet Seal



Use 303, 300, 306,
or ADE-BME

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Lesson 5c Bearings



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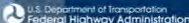
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Bearings – NBEs

#	Element	Units
310	Elastomeric Bearing	Each
311	Movable Bearing	Each
312	Enclosed/Concealed Bearing	Each
313	Fixed Bearing	Each
314	Pot Bearing	Each
315	Disk Bearing	Each
316	Other Bearing	Each

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Bearings – Defects and Application								
#	Defect	310	311	312	313	314	315	316
1000	Corrosion	x	x	x	x	x	x	x
1020	Connection	x	x	x	x	x	x	x
2210	Movement	x	x	x	x	x	x	x
2220	Alignment	x	x	x	x	x	x	x
2230	Bulging, Splitting, Tearing	x				x		
2240	Loss of Bearing Area	x	x	x	x	x	x	x
7000	Damage	x	x	x	x	x	x	x
Refer to handout for defect definitions covered in prior lesson.								
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Bearings – Elastomeric			
		<p>Element 310 - Bearings constructed primarily from elastomeric material (ex. rubber, neoprene) that may contain fabric or metal reinforcement</p>	
			
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Bearings – Elastomeric Exercise



#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
310	Elastomeric Bearing	40	Each				
			Each				



Alignment at 10 bearings is inconsistent with current temperature, but tolerable.

Which condition state applies?







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Bearings – Movable

Element 311 - Bearings primarily constructed of steel that provide for both rotation and longitudinal movement by means of roller, rocker, or sliding mechanisms

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Bearings – Movable – Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
311	Movable Bearing	40	Each				
			Each				

5 bearings with alignment beyond tolerable limits and bent anchor bolts. No defects for remainder of bearings.

Which condition state applies?

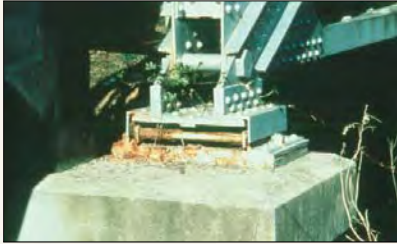





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Bearings – Enclosed/Concealed

- Element 312 - Not open/visible for detailed inspection
- Assess the condition based on
 - Alignment
 - Grade across the joint
 - Persistence of debris
 - Other indirect indicators






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Bearings – Fixed

Element 313 - Bearings that provide for rotation only (no longitudinal movement)


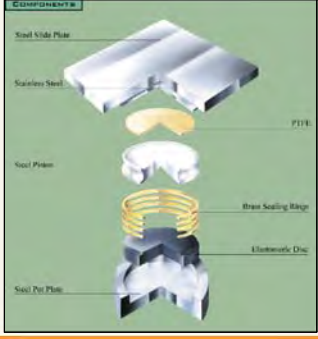



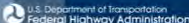
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Bearings – Pot

Element 314 - Capable of high loads, contain a confined elastomer, allow movement in multiple directions

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Bearings – Pot Bearing Exercise

#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
314	Pot Bearing	40	Each				
			Each				

Elastomer actively extruding from 3 pot bearings. No defects for remainder of bearings.

Which condition state applies?

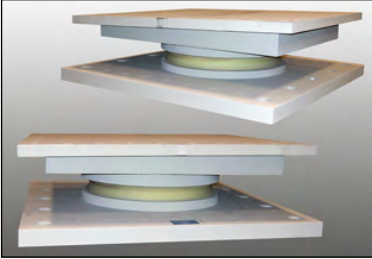






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Bearings – Disk

Element 315 - Capable of high loads, contains a hard plastic disk, allow movement in multiple directions





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Bearings – Other

Element 316 – Bearings constructed of materials that cannot be classified using other defined elements, regardless of translation or rotation constraints.




**Friction
Pendulum**
Use 316 or 311
or ADE-NBE

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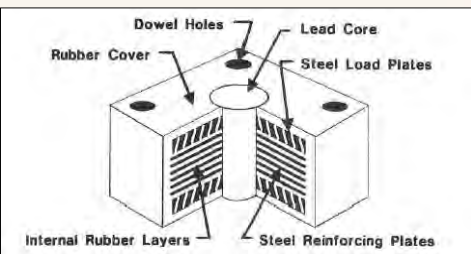
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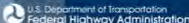
Bearings – Other



Use 310 or 316 or
ADE-NBE

Lead Core Seismic
Isolation Bearing





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Bearings – BMEs

- Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions



#	Element	Units
515	Steel Protective Coating	Area (sq. ft.)

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Steel Protective Coatings

- Element 515
 - Paint
 - Galvanizing
 - Metalizing
 - Other top coat steel corrosion inhibitors
 - Oxide (patina) on weathering steel



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Steel Protective Coatings – Defects


#	Defect	Units
3410	Chalking	Area (sq. ft.)
3420	Peeling/Bubbling/Cracking	Area (sq. ft.)
3430	Oxide Film Degradation Color /Texture/Adherence	Area (sq. ft.)
3440	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)


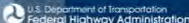
Refer to handout for defect definitions covered in prior lesson.

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Lesson 5d Approach Slabs

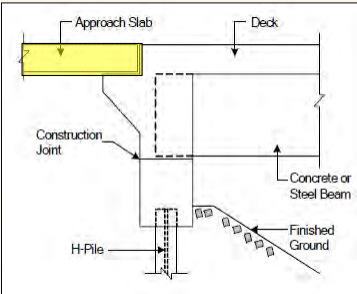




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Approach Slabs – BMEs

#	Element	Units
320	Prestressed Concrete Approach Slab	Area (sq. ft.)
321	Reinforced Concrete Approach Slab	Area (sq. ft.)







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Approach Slabs – BMEs


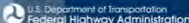
- Unit of measure is Area (sq. ft.)
- Total quantity calculated as edge-to-edge width times edge-to-edge length
- Quantities are assigned amongst 4 condition states based on existing conditions
- Additional wearing surface or protective systems addressed separately

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Approach Slabs – Prestressed Concrete

- Element 320
- Structural sections between the abutment and the approach pavement
- Constructed of prestressed concrete (pretensioned or post-tensioned)



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Approach Slabs – PSC – Defects

#	Defect	Units
1080	Delamination/Spall/Patched Area	Area (sq. ft.)
1090	Exposed Rebar	Area (sq. ft.)
1100	Exposed Prestressing	Area (sq. ft.)
1110	Cracking	Area (sq. ft.)
1190	Abrasion/Wear	Area (sq. ft.)
4000	Settlement	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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Approach Slabs – Reinforced Concrete

- Element 321
- Structural sections between the abutment and the approach pavement
- Constructed of mild steel reinforced concrete



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Approach Slabs – RC – Defects

#	Defect	Units
1080	Delamination / Spall / Patched Area	Area (sq. ft.)
1090	Exposed Rebar	Area (sq. ft.)
1130	Cracking	Area (sq. ft.)
1190	Abrasion / Wear	Area (sq. ft.)
4000	Settlement	Area (sq. ft.)
7000	Damage	Area (sq. ft.)


Refer to handout for defect definitions covered in prior lesson.

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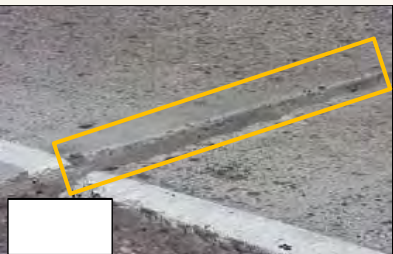
Approach Slabs – RC Exercise


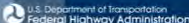
#	Description	Total Qty	Units	Condition State Qty			
				1	2	3	4
321	RC Approach Slab	600	sq. ft.				
			sq. ft.				



Tolerable settlement of 1 in.
along a 2 ft. length.

Which condition state applies?





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Approach Slabs – BMEs

- Wearing Surfaces and Protective Systems
 - Quantity is the entire protected surface area of the protected element (sq. ft.)
 - Quantities are assigned amongst 4 condition states based on existing conditions



#	Element	Units
510	Wearing Surfaces	Area (sq. ft.)
520	Concrete Reinforcing Steel Protective System	Area (sq. ft.)
521	Concrete Protective Coating	Area (sq. ft.)

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Wearing Surfaces

- Element 510
 - Flexible
 - Asphalt
 - Semi-rigid
 - Epoxy, Polyester
 - Rigid (Portland cement concrete)
 - Latex, Micro-silica, High-Performance



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Wearing Surfaces – Defects

#	Defect	Units
3210	Delamination/Spall/Patched Area /Pothole	Area (sq. ft.)
3220	Crack	Area (sq. ft.)
3230	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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Concrete Protective Coatings

- Element 521
 - Silane/siloxane water proofers
 - Crack sealers
 - High Molecular Weight Methacrylate (HMWM)
 - Any top coat barrier that protects concrete from deterioration and reinforcing steel from corrosion



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Concrete Protective Coatings – Defects

#	Defect	Units
3510	Wear	Area (sq. ft.)
3520	Chalking	Area (sq. ft.)
3530	Peeling / Bubbling / Cracking	Area (sq. ft.)
3540	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)

Refer to handout for defect definitions covered in prior lesson.

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Concrete Reinforcing Steel Protective Systems



Epoxy Coatings

Element 520



Cathodic Protection



Galvanic Coatings

Or similar
protective
system



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Concrete Reinforcing Steel Protective Systems – Defects


#	Defect	Units
3600	Effectiveness	Area (sq. ft.)
7000	Damage	Area (sq. ft.)



Refer to handout for defect definitions covered in prior lesson.

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QUESTIONS





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Lesson 6

Element Exercise - Part 2


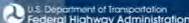
“Identify and Quantify”

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Session 6 - Learning Outcomes



- Review as-built plans to identify bridge elements and determine appropriate units and quantities for elements (D)

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Bridge Element Inventory – Continued


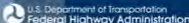
- 1st step in element level inspection
 - Inventory elements, their environments and quantities for each bridge
- Use information from
 - As-built or construction plans
 - Past inspection reports
 - Visual assessment during inspection
- Refer to Agency's policies

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Exercise 1

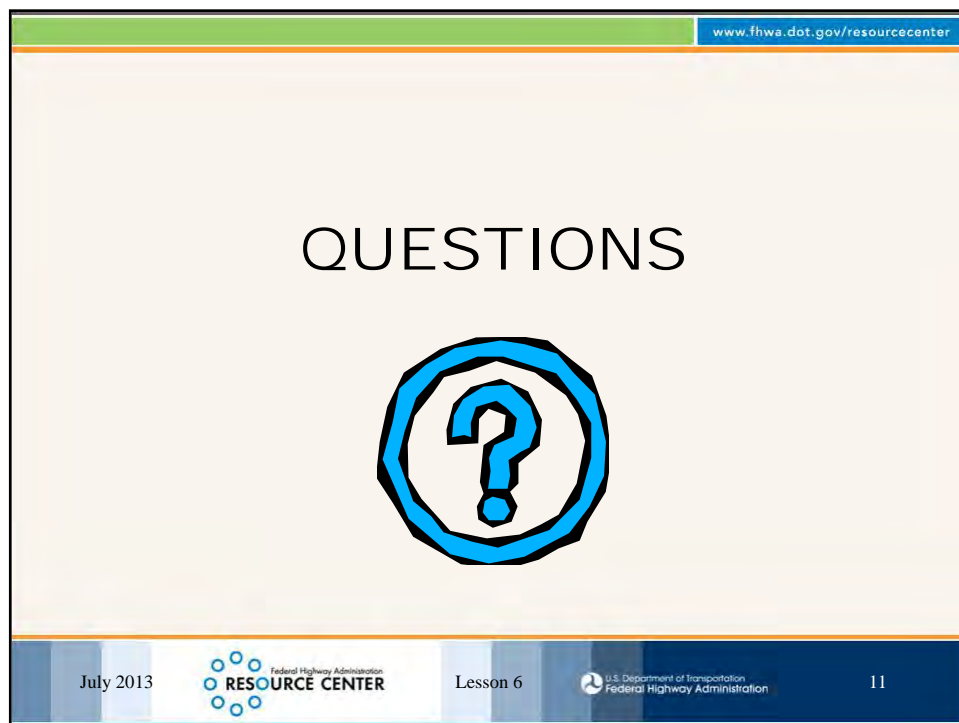
- 3-span painted steel beam bridge (14277)
 - Use provided form to inventory elements, environments, units and quantities
 - Use 1 structure unit for All spans
 - Use provided bridge plan sheets (14277)
 - Identify and record all Joints, Approach Slabs, Bridge Rails, and Bearings

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Structure No.: _____		By: _____		Date: _____	
Element/ Str. Unit No.	Env	Element/Structure Unit Description	Total Qty	Units	
1		Span(s):			
DECK (Lesson 4)					
SUPERSTRUCTURE (Lesson 4)					
SUBSTRUCTURE (Lesson 4)					
JOINTS (Lesson 6)					
APPROACH SLABS (Lesson 6)					
BRIDGE RAILINGS (Lesson 6)					
BEARINGS (Lesson 6)					

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Session 6 - Learning Outcomes

- Review as-built plans to identify bridge elements and determine appropriate units and quantities for elements (D)

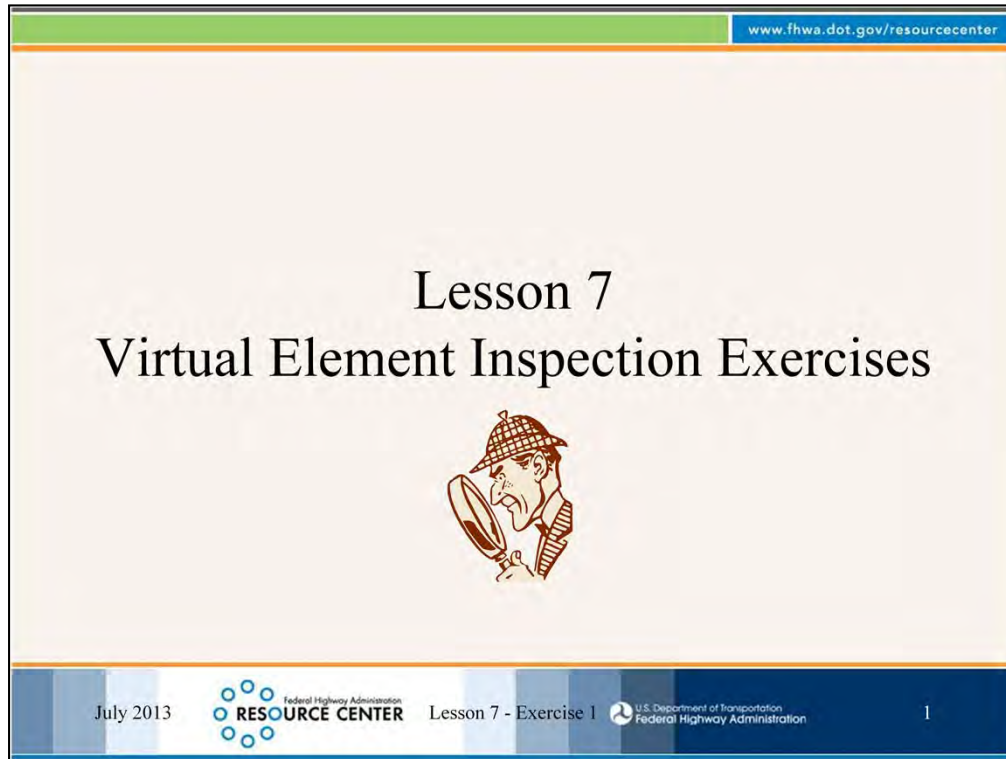
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Lesson 6

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Federal Highway Administration

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Participants will need a pen or pencil, element inventory and assessment form, calculator and element condition state definitions handout.


Participant can work alone or consult with their neighbor.

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Lesson 7 - Learning Outcomes

- Interpret condition state definitions based on visual observations and quantify and record observations (E)

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Lesson 7 - Exercise 1

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Lesson 7 – Exercise Instructions

- Use the provided form and record:
 - The applicable defects for each element
 - Only record the predominate defect if there are overlapping defects
 - The condition state quantities for each defect
 - The total condition state quantities for each element
- Exercises use just one structure unit

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Lesson 7

Virtual Element Inspection Exercises


Exercise 1

Steel Multi-Beam


2 Spans



July 2013

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Lesson 7 - Exercise 1

 U.S. Department of Transportation
Federal Highway Administration

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Introduction to Element Level Bridge Inspection

Lesson 7 - Exercise 1: Two Span Steel Beam

Element/ Str. Unit No.	Element/Structure Unit Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
1	Span(s) - All						
DECK/SLAB							
12	RC Deck	4500	sq. ft.				
JOINTS							
300	Strip Seal Expansion Joint	60	ft.				
APPROACH SLABS							
BRIDGE RAILINGS							
330	Metal Bridge Railing	300	ft.				
331	RC Bridge Railing	300	ft.				
SUPERSTRUCTURE							
107	Steel Open Girder/Beam	864	ft.				
515	Steel Protective Coating	8640	sq. ft.				
BEARINGS							
311	Movable Bearing	12	each				
515	Steel Protective Coating	48	sq. ft.				
313	Fixed Bearing	12	each				
515	Steel Protective Coating	48	sq. ft.				
SUBSTRUCTURE							
210	RC Pier Wall	30	ft.				
215	RC Abutment	60	ft.				

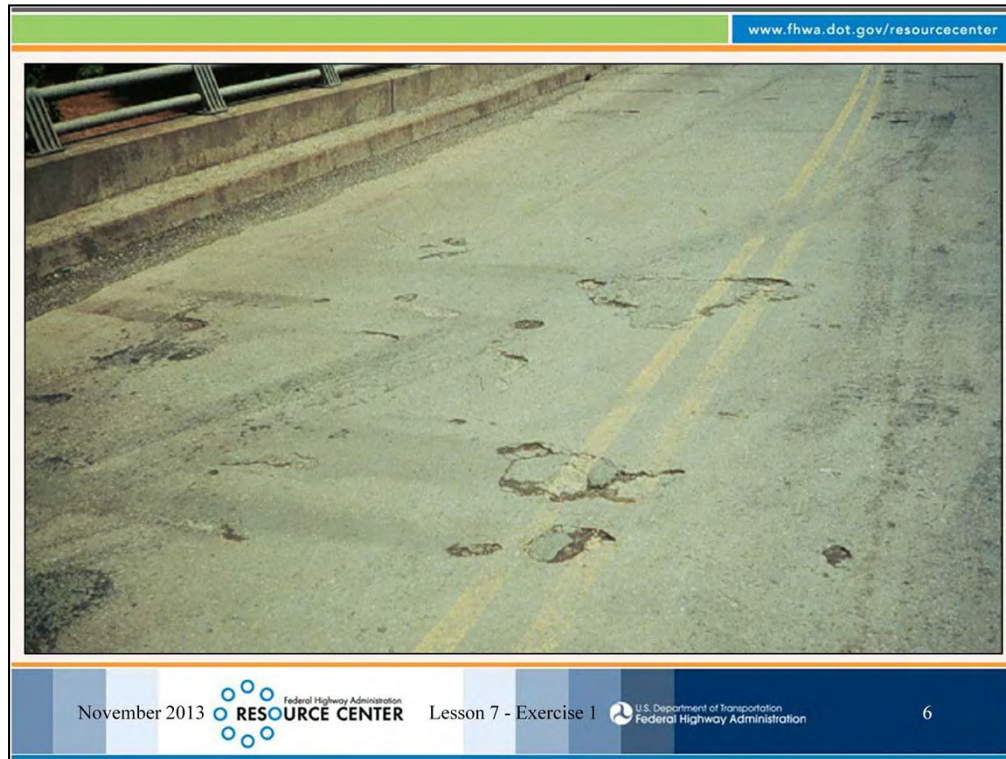


Make note of element defects and defect quantities.

Deck: The deck is continuous across the pier. The bridge has a reinforced concrete deck with an out-to-out width of 30 ft. and length of 150 ft. The deck has no additional wearing surface.

Superstructure: This is a two span, painted steel multi-beam bridge, with each span consisting of six beams having a length of 72 ft.

Substructure: The two simple spans (fixed at pier, expansion at abutments) are supported by one 30 ft. long pier and two 30 ft. long abutments constructed of reinforced concrete.



Make note of element defects and defect quantities.

Deck: The top side of the deck in span 1 has 450 sq. ft. of delaminated concrete and 25 sq. ft. of spalls greater than 1 in. deep with exposed rebar having no measureable section loss. There are transverse cracks less than 0.012 in. wide at spacing greater than 3 ft. throughout spans 1 and 2.

Bridge Railing: The bridge railing is a combination of tubular aluminum (no protective coating) on reinforced concrete and has no noteworthy deficiencies.

Joints: The strip seal expansion joints are clean and functional.

Approach Slab: There are no approach slabs.

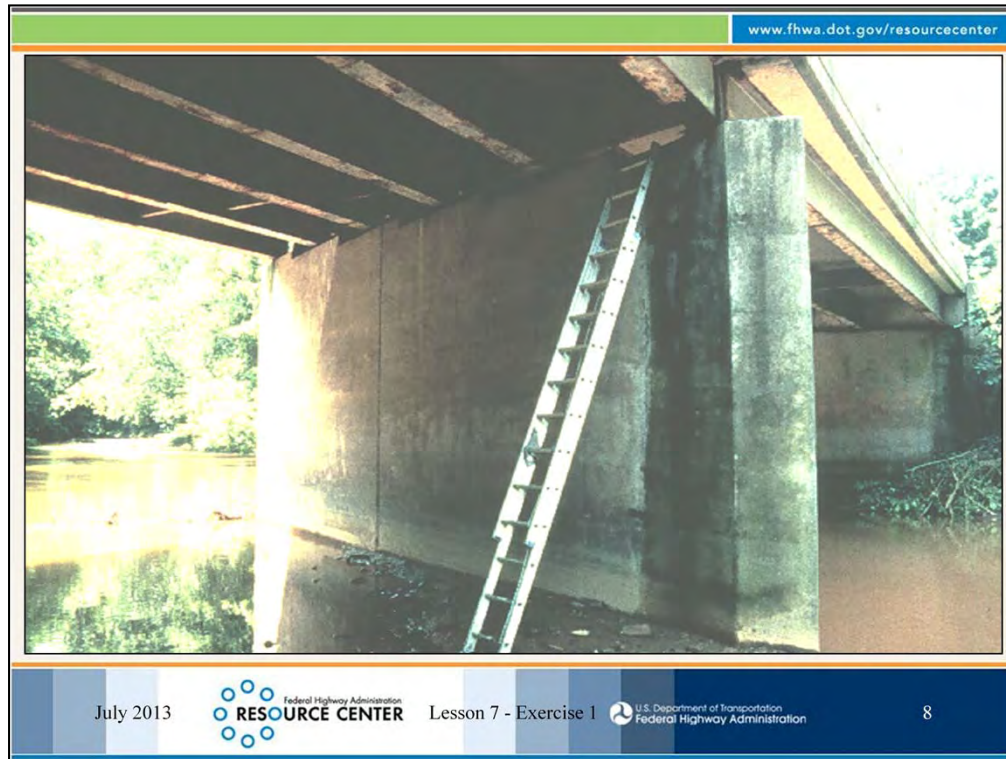


Make note of element defects and defect quantities.

Deck: The underside of the deck in span 2 has cracks less than 0.012 in. wide throughout and 400 sq. ft. with heavy efflorescence and rust stains.

Superstructure: The steel beams have pitting to a depth of 1/16 in. on all bottom flanges throughout their entire length. The coating system is no longer effective for 10% of the steel beam coating and the rest is chalking with surface dulling, but still substantially effective. Coating area for steel beams is 10 sq. ft. per ft. length of beams. The web and top flanges have no noteworthy deficiencies. There is a 4 in. long crack in the cover plate end welds of 3 beams that were discovered during this inspection. All diaphragms are generally pitted to 1/16 in. depth with surface rust.

Bearings: All bearings are functioning as intended. All movable bearings have surface rust throughout and the paint system is no longer effective. All fixed bearings have surface rust on the masonry plates representing 25% of the coating area that is not effective. The remaining coating area is chalking with surface dulling, but still substantially effective. Coating area for bearings is 4 SF per bearing.



Make note of element defects and defect quantities.

Substructure: The far abutment has a full height vertical crack between Beam No. 3 and No. 4 that has been present and unchanged for many years. This crack varies in width from 1/16 in. to 1/8 in. (0.06 in. to 0.12 in.)



There is scour that exceeds tolerable limits along the front face of the near abutment for a length of 28 ft. x 7 ft. wide to a depth of 4 ft. There is no undermining, the footing is not exposed, and the structure is stable.

The upstream end of the pier has sediment and debris build-up measuring 40 ft. long x 7 ft. wide x 4 ft. high. The pier has two, 1/16 inch (0.06 in.) wide vertical cracks that are full-height with efflorescence that is surface white without build-up.

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Total Element Quantity Explanation



- Deck: 150 ft. x 30 ft. = 4500 sq. ft.
- Strip Seal: 2 x 30 ft. = 60 ft.
- Bridge Railing: 2 x 150 ft. = 300 ft.
- Steel Beams: 2 spans at 72 ft. x 6 beams = 864 ft.*
- Movable Bearings: 6 at each abut. x 2 = 12 each**
- Fixed Bearings: 12 at pier = 12 each**
- RC Pier: 1 pier x 30 ft. = 30 ft.
- RC Abutments: 2 abuts. x 30 ft. = 60 ft.

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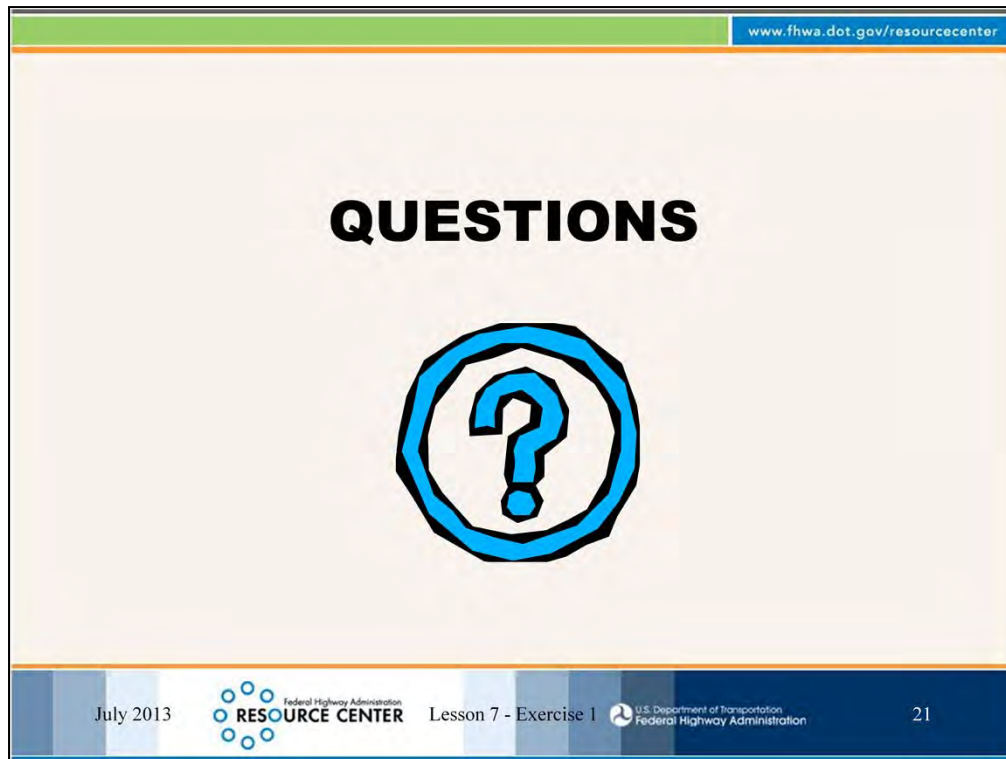
*Steel Protective Coating – Steel Beams: 864 ft. x 10 sq. ft./ft. = 8,640 sq. ft.

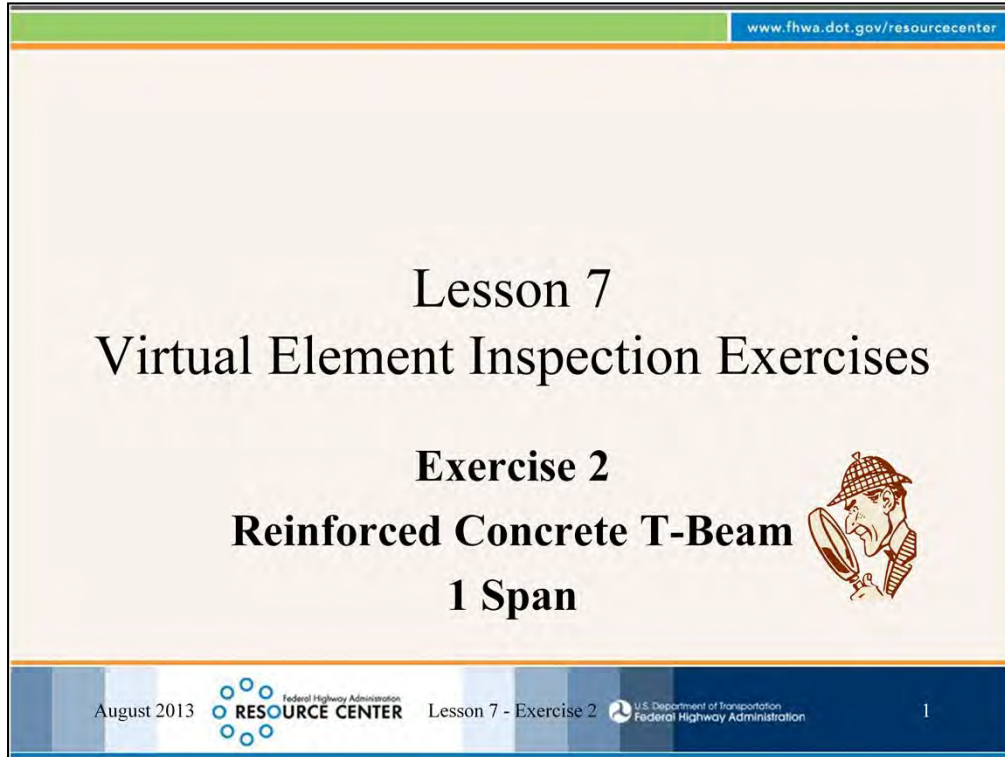
**Steel Protective Coating – Bearings: Movable (12 EA x 4 sq. ft./EA = 48 sq. ft.); Fixed (12 EA x 4 sq. ft./EA = 48 sq. ft.)

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Elements, Units and Quantities							
Element No.	Element Description	Total QTY	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
12	RC Deck	4500	sq. ft.				
300	Strip Seal Expansion Joint	60	ft.				
330	Metal Bridge Railing *	300	ft.				
331	RC Bridge Railing *	300	ft.				
107	Steel Open Girder/Beam	864	ft.				
515	Steel Protective Coating	8640	sq. ft.				
311	Movable Bearing	12	each				
515	Steel Protective Coating	48	sq. ft.				
313	Fixed Bearing	12	each				
515	Steel Protective Coating	48	sq. ft.				
210	RC Pier Wall	30	ft.				
215	RC Abutment	60	ft.				

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* The redirective elements of the bridge railing are a combination of concrete bridge rail and metal bridge rail, therefore both the metal and reinforced concrete bridge railing elements were used to better track element material defects. However, only element 330-Metal Bridge Railing could have been used as an alternative.





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Lesson 7

Virtual Element Inspection Exercises

Exercise 2

Reinforced Concrete T-Beam

1 Span

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Federal Highway Administration

1

Participants will need a pen or pencil, element inventory and assessment form, calculator and element condition state definitions handout.

Participant can work alone or consult with their neighbor.

Use the provided form and record:

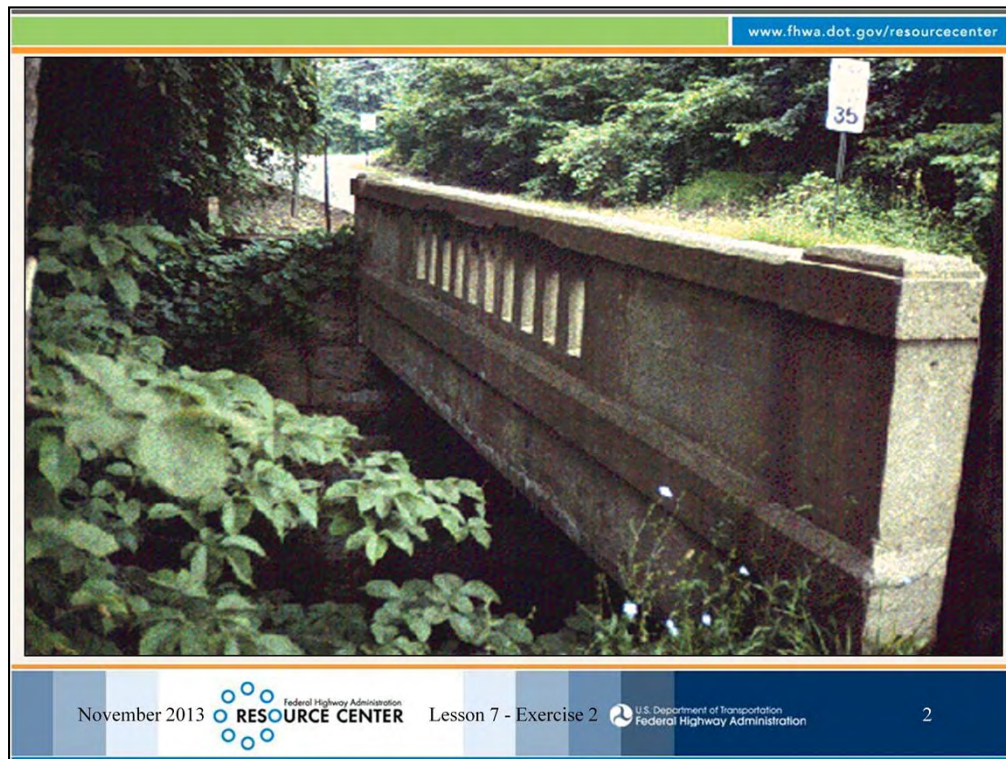
- The applicable defects for each element.
 - Only record the predominate defect if there are overlapping defects.
- The condition state quantities for each defect.
- The total condition state quantities for each element.

Exercise uses just one structure unit.

Introduction to Element Level Bridge Inspection

Lesson 7 – Exercise 2: One Span RC Tee Beam

[illegible]



Superstructure: One span, reinforced concrete T-Beam. Structure length 30 ft. Width 24 ft. out-to-out.

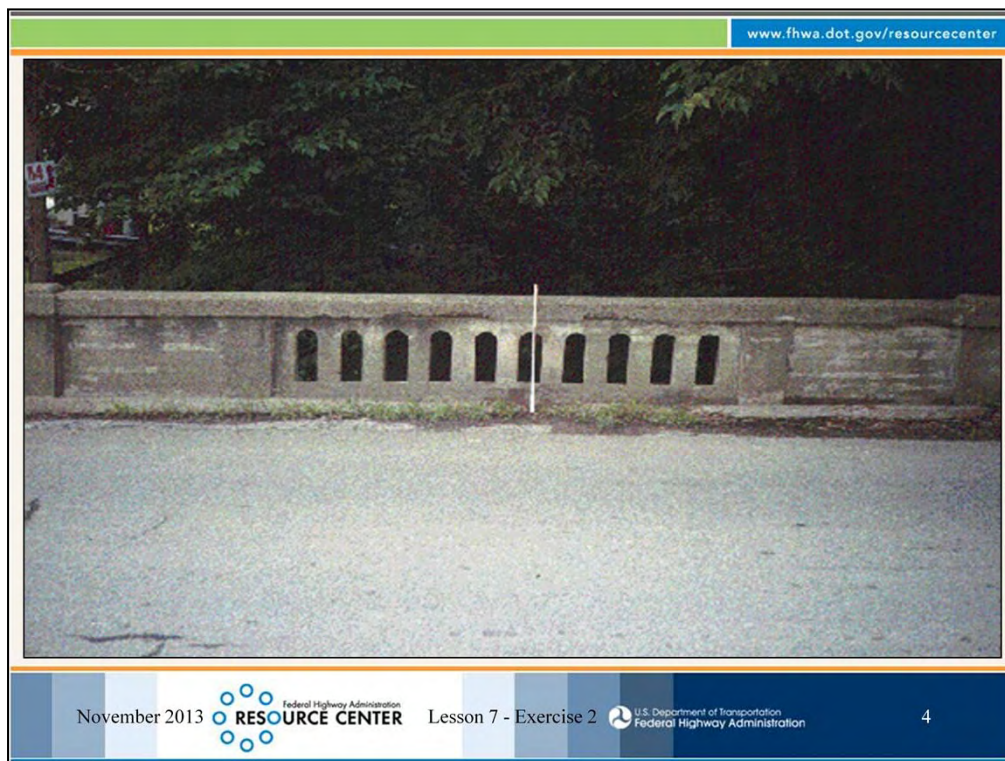
Bridge Railing: Reinforced concrete bridge rail.

Element Quantities: The element quantity calculations are shown on slide 15.



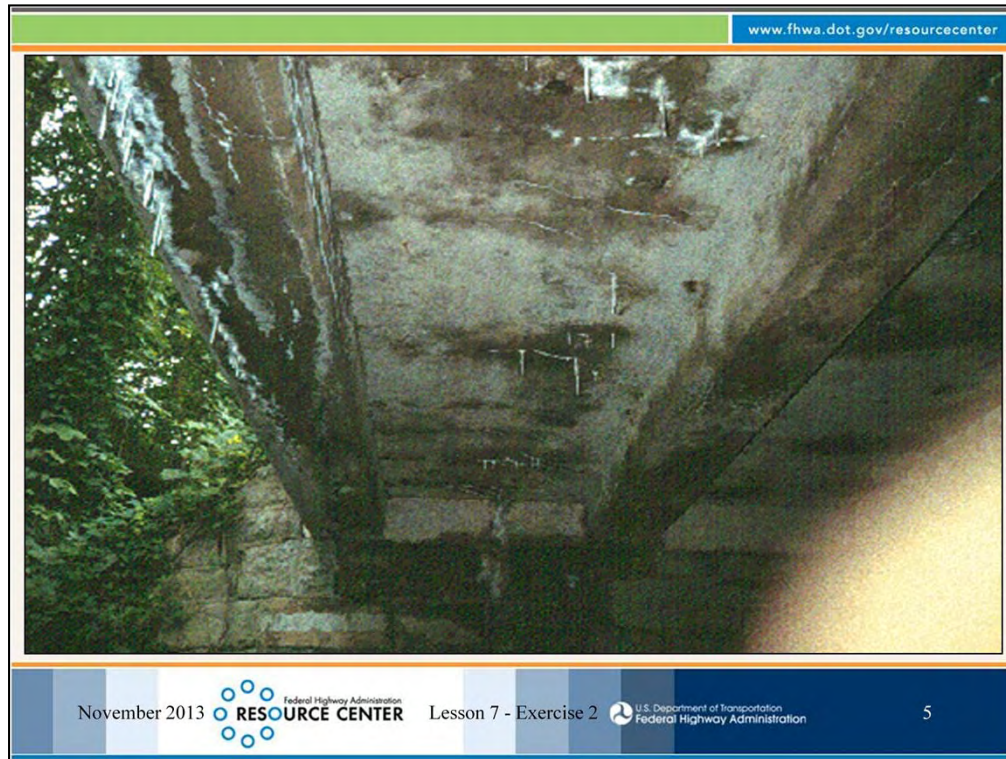
Make note of element defects and defect quantities.

Wearing Surface: Asphalt wearing surface 20 ft. wide by 30 ft. long with random transverse and longitudinal cracks that vary from 1/4 in. to 3/4 in. wide over a 180 sq. ft. area. Remaining area has no noteworthy deficiencies.



Make note of element defects and defect quantities.

Bridge Railing: RC bridge railing on upstream side. Spalls less than 1 in. deep for 20 ft. with no exposed reinforcing steel. Downstream bridge rail has 15 ft of spalls less than 1 in. deep with no exposed reinforcing steel.

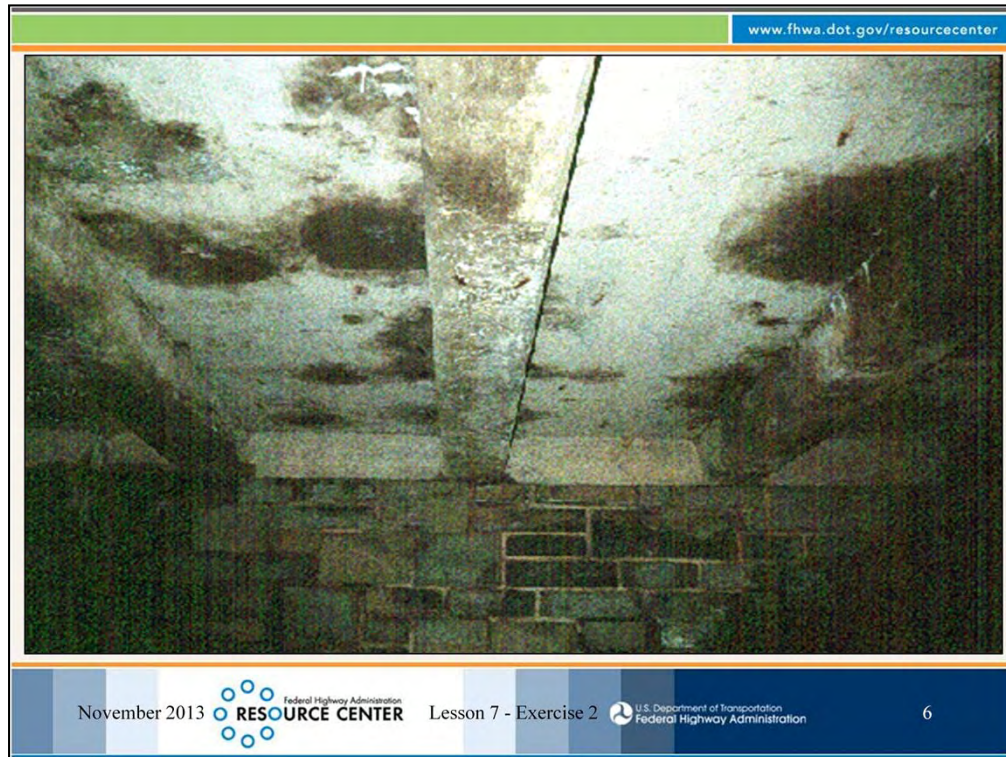


Make note of element defects and defect quantities.

Deck: Underside of deck between Beams 1 and 2. Dark stained areas (80 sq. ft.) are delaminations with cracks less than 0.012 in. wide and efflorescence without rust staining.

Superstructure, Beam 1: Longitudinal 1/16 in. (0.06 in.) wide cracks throughout with heavy efflorescence and rust staining. Dark stained areas are delaminations that exist for the full length. No exposed reinforcing steel.

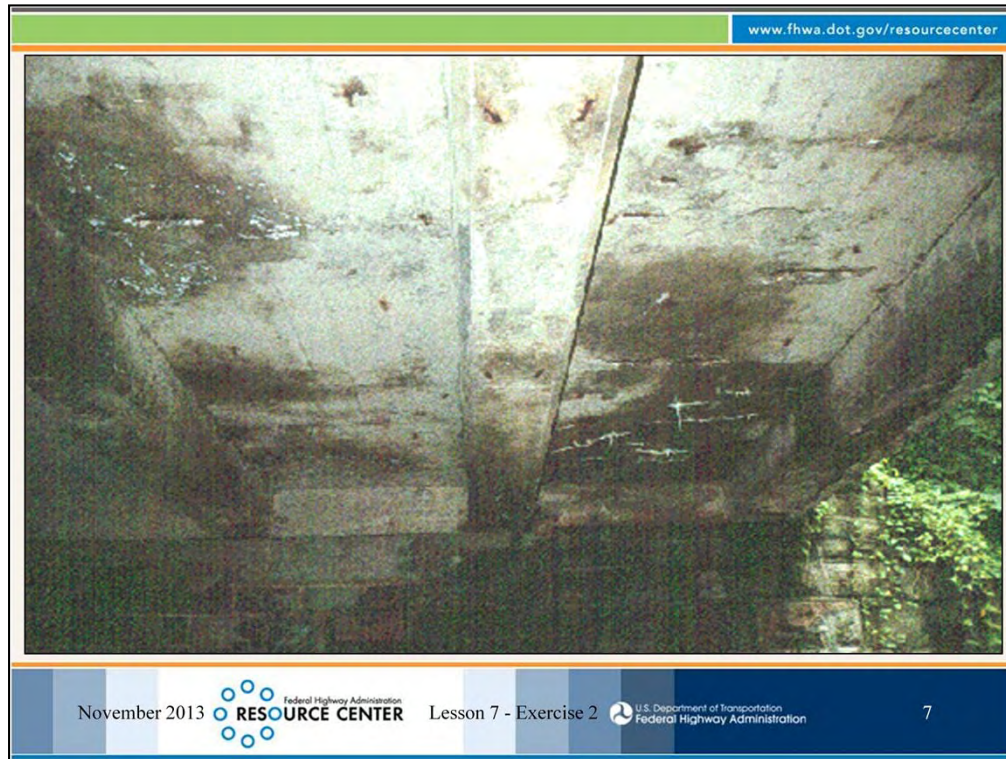
Superstructure, Beam 2: Longitudinal cracks up to 0.05 in. wide throughout with efflorescence and no rust staining. Dark stained areas are delaminations that exist for the full length. No exposed reinforcing steel.



Make note of element defects and defect quantities.

Deck: Underside of deck between Beams 2, 3 and 4. Dark stained areas (40 sq. ft.) are delaminations with cracks less than 0.012 in. wide and efflorescence without rust staining.

Superstructure, Beams 3 and 4: Spalling with exposed reinforcing steel (3 ft.), no section loss. Dark stained areas (40 ft.) are delaminations with cracks less than 0.012 in. wide and efflorescence without rust staining.

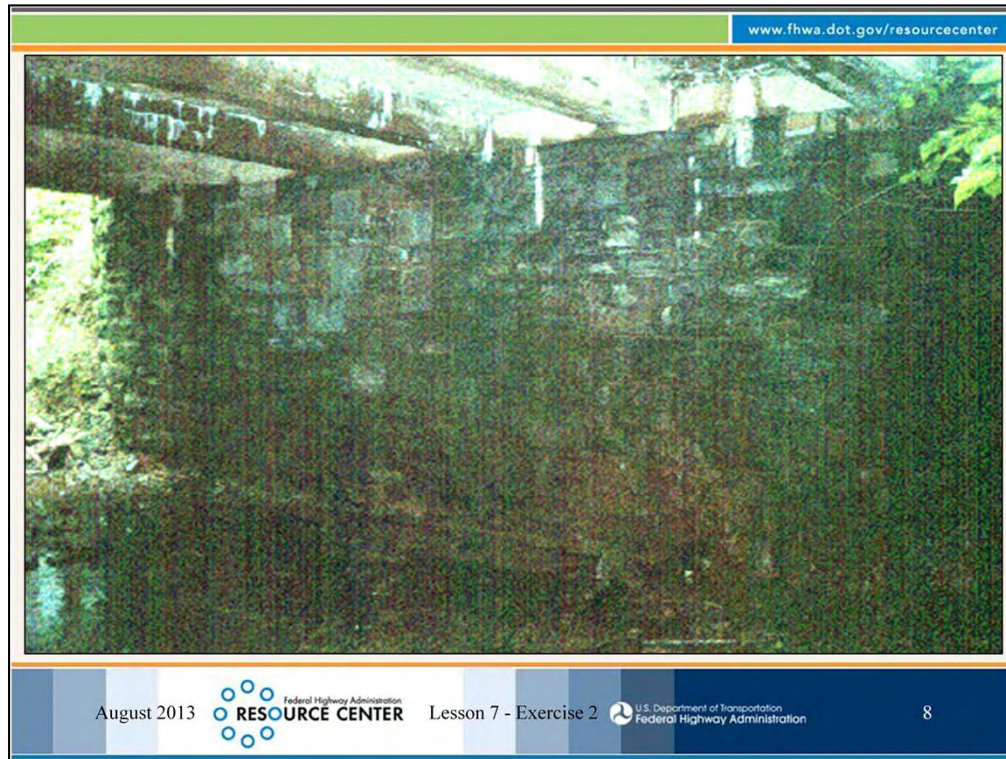


Make note of element defects and defect quantities.

Deck: Underside of deck between Beams 4, 5 and 6. 1 in. to 1.5 in. deep spalls with exposed reinforcing steel (20 sq. ft.). Dark stained areas (80 sq. ft.) are delaminations with cracks less than 0.012 in. wide and efflorescence without rust staining.

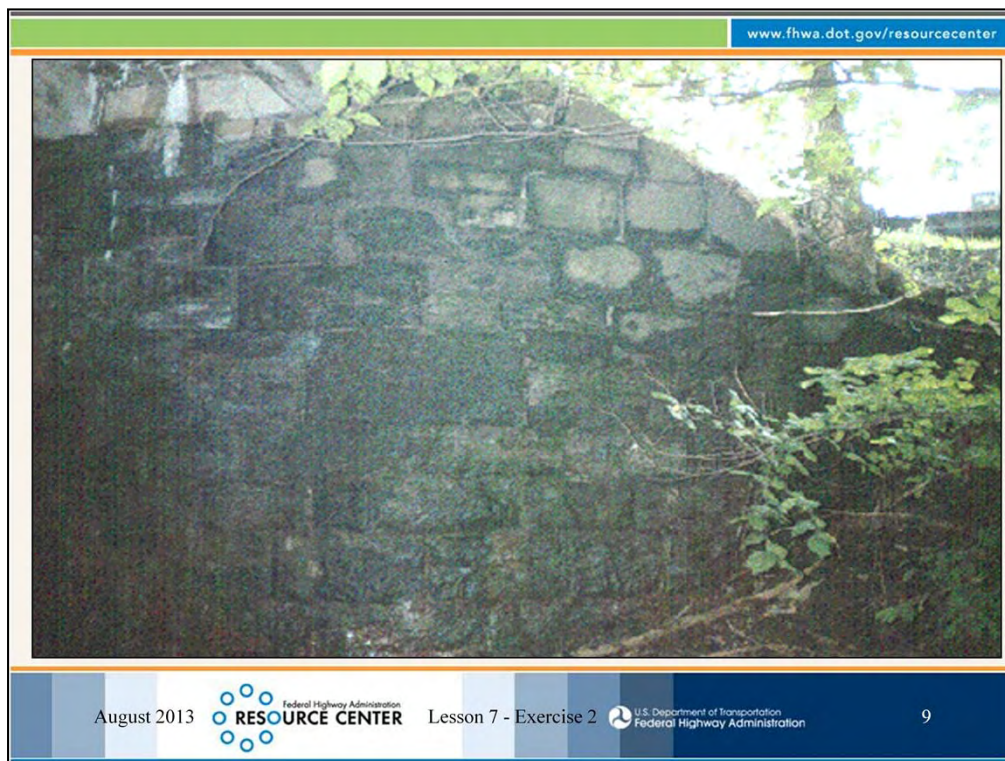
Superstructure, Beam 5: Spalling with exposed reinforcing steel, but no section loss (5 ft.). Dark stained areas (20 ft.) are delaminations with cracks less than 0.012 in. wide and efflorescence without rust staining.

Superstructure, Beam 6: Longitudinal 1/16 in. (0.06 in.) wide cracks throughout with heavy efflorescence and rust staining. Dark stained areas are delaminations that exist for the full length. No exposed reinforcing steel.



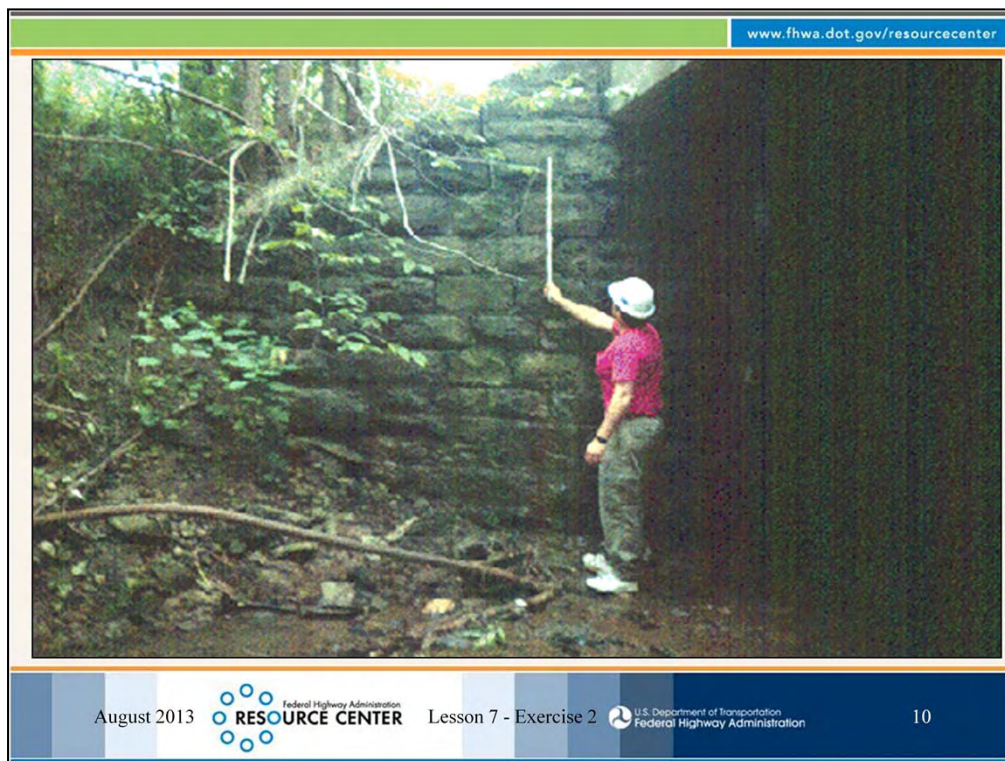
Make note of element defects and defect quantities.

Substructure, Abutment 1: Near abutment looking downstream. Abutment face is 30 ft. long. Top half of the masonry is intact. 20 ft. of the bottom half exhibits moderate disintegration of the stone surface 4 in. to 6 in. deep with loss of mortar in more than 10% of joints. No stones are displaced. No undermining.



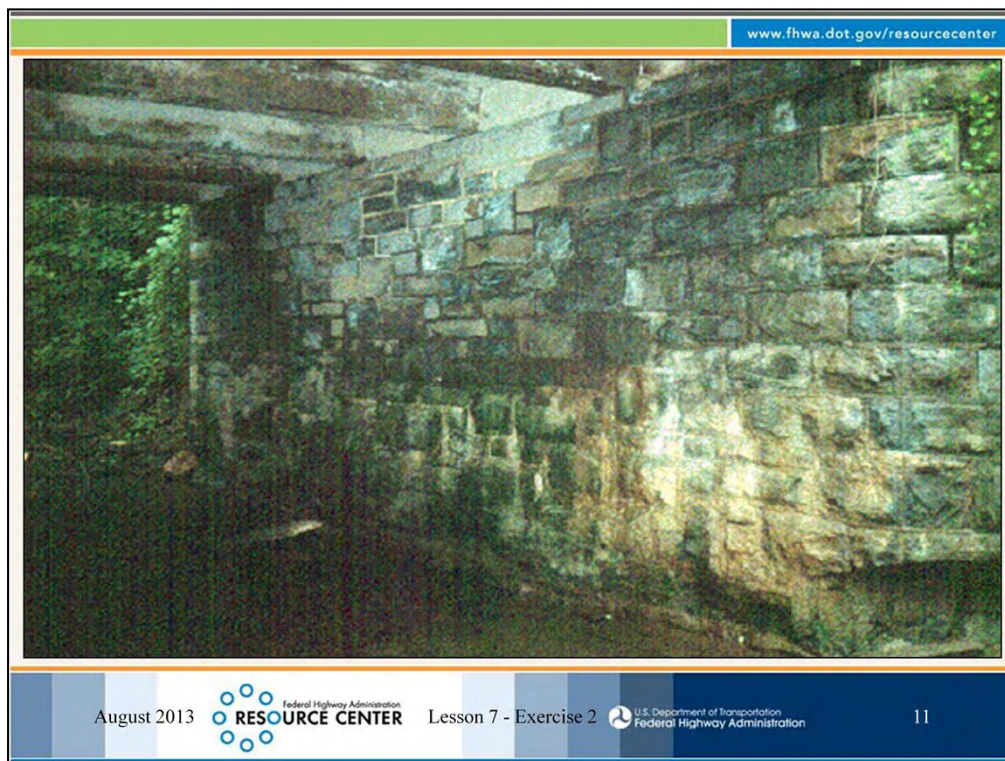
Make note of element defects and defect quantities.

Substructure, Abutment 1: Near upstream wingwall. Wingwall is 10 ft. long and integral with abutment. 10 ft. of the bottom half exhibits moderate disintegration of the stone surface 4 in. to 6 in. deep with loss of mortar in more than 10% of joints. No stones are displaced. No undermining.



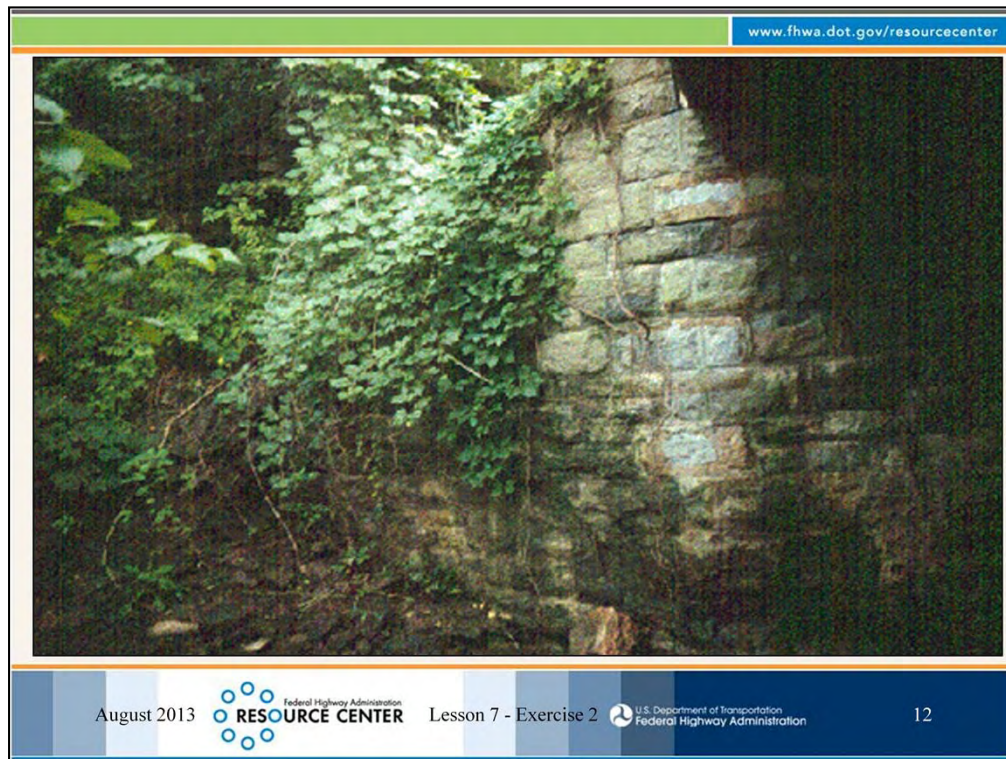
Make note of element defects and defect quantities.

Substructure, Abutment 1: Near downstream wingwall. Wingwall is 10 ft. long and integral with abutment. Some missing joint mortar, less than 10% of total, is typical throughout. No displacement of stones.



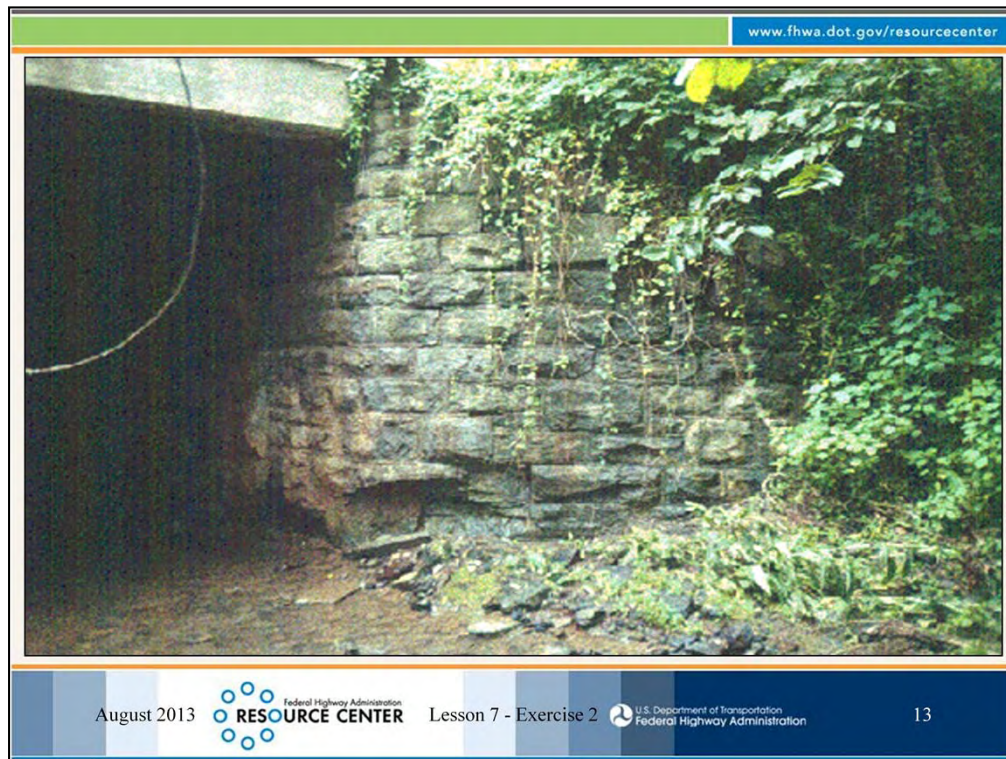
Make note of element defects and defect quantities.

Substructure, Abutment 2: Far abutment looking upstream. Disintegration of stone at streambed level 6 in. to 10 in. deep for 3 ft. No displacement of stones.



Make note of element defects and defect quantities.

Substructure, Abutment 2: Far upstream wingwall. Wingwall is 10 ft. long and integral with abutment. Masonry intact.



Make note of element defects and defect quantities.

Substructure, Abutment 2: Far downstream wingwall. Wingwall is 10 ft. long and integral with abutment. Failure of stone with portions missing at streambed level for a 2 ft. length.





Make note of element defects and defect quantities.

Substructure, Abutment 2: Far downstream wingwall. Complete loss of mortar in top courses throughout.

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Total Element Quantity Explanation

- Deck: 24 ft. x 30 ft. = 720 sq. ft.
- Wearing Surface: 20 ft. x 30 ft. = 600 sq. ft.
- Bridge Railing: 30 ft. x 2 rails = 60 ft.
- Beams: 30 ft. long x 6 beams = 180 ft.
- Abutment: (30 ft.+10 ft.+ 10 ft.) x 2 = 100 ft.

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Abutment quantity includes integral wingwalls.

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Elements, Units and Quantities

Element No.	Element Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
DECK/SLAB							
16	RC Top Flange *	720	sq. ft.				
510	Wearing Surface	600	sq. ft.				
BRIDGE RAILINGS							
331	RC Bridge Railing	60	ft.				
SUPERSTRUCTURE							
110	RC Open Girder/Beam	180	ft.				
SUBSTRUCTURE							
217	Masonry Abutment	100	ft.				

November 2013

Federal Highway Administration
RESOURCE CENTER

Lesson 7 - Exercise 2

U.S. Department of Transportation
Federal Highway Administration

16

*Element 16 – RC Top Flange applies since traffic rides directly on the girder flanges regardless of the wearing surface or protection systems used. These bridge types include tee-beams, box girders, and girders that require traffic to ride on the top flange.

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Lesson 7

Virtual Element Inspection Exercises

Exercise 3

Steel Truss

1 Span

November 2013 Federal Highway Administration Lesson 7 - Exercise 3 U.S. Department of Transportation Federal Highway Administration 1

Participants will need a pen or pencil, element inventory and assessment form, calculator and element condition state definitions handout.

Participant can work alone or consult with their neighbor.

Use the provided form and record:

- The applicable defects for each element.
 - Only record the predominate defect if there are overlapping defects.
- The condition state quantities for each defect.
- The total condition state quantities for each element.

Exercise uses just one structure unit.

Introduction to Element Level Bridge Inspection

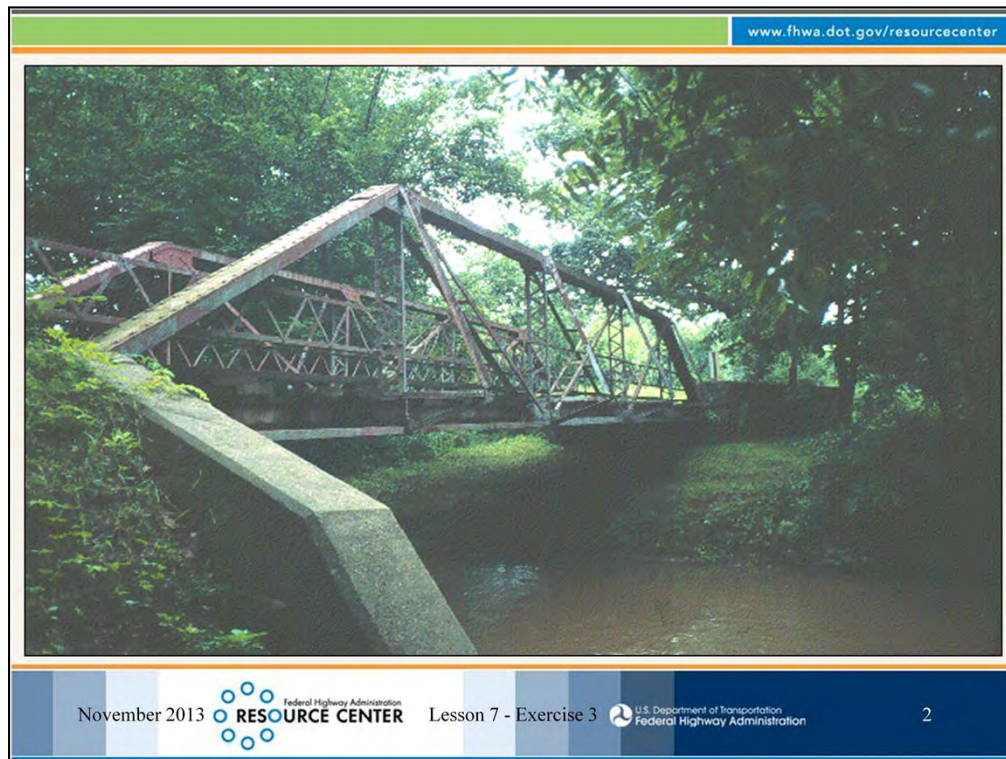
Lesson 7 – Exercise 3: One Span Steel Truss

Element/ Str. Unit No.	Element/Structure Unit Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
1	Span(s) - All						
DECK/SLAB							
31	Timber Deck	960	sq. ft.				
JOINTS							
304	Open Expansion Joint	12	ft.				
APPROACH SLABS							
BRIDGE RAILINGS							
330	Metal Bridge Railing	160	ft.				
515	Steel Protective Coating	320	sq. ft.				
SUPERSTRUCTURE							
120	Steel Truss	160	ft.				
515	Steel Protective Coating	4800	sq. ft.				
162	Gusset Plate	20	each				
515	Steel Protective Coating	120	sq. ft.				
113	Steel Stringer	375	ft.				
515	Steel Protective Coating	1200	sq. ft.				
152	Steel Floor Beam	90	ft.				
515	Steel Protective Coating	450	sq. ft.				

Introduction to Element Level Bridge Inspection

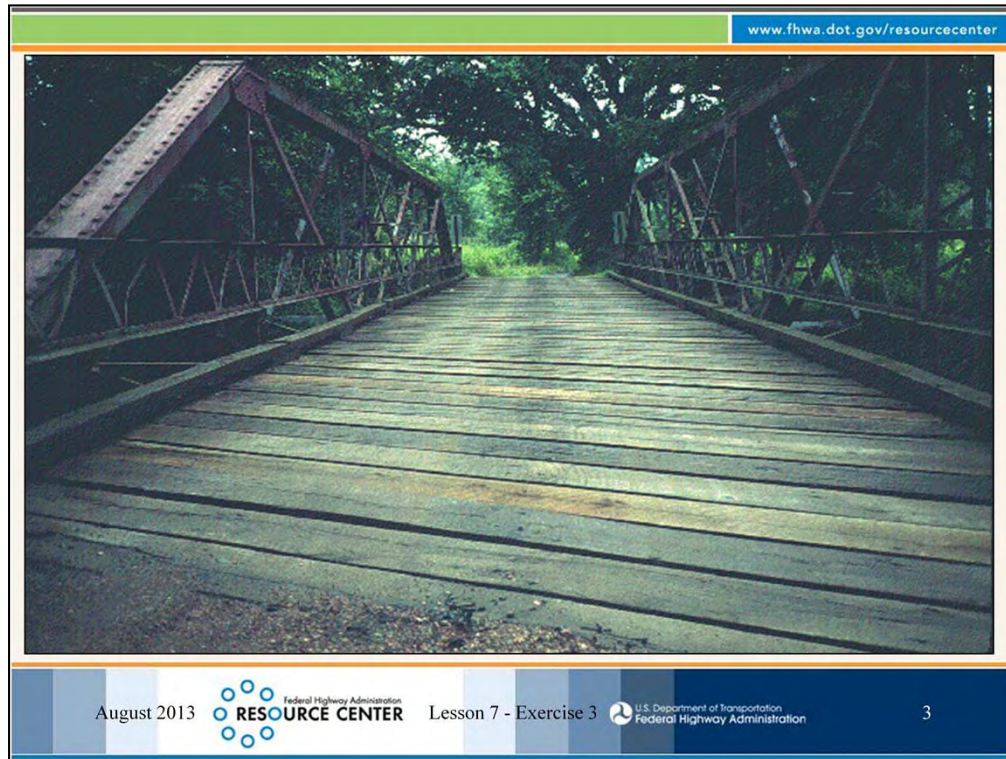
Lesson 7 – Exercise 3: One Span Steel Truss

[illegible]



Superstructure: Simple span painted steel through truss 80 ft. long.

Element Quantities: The element quantity calculations are shown on slides 25 and 26.

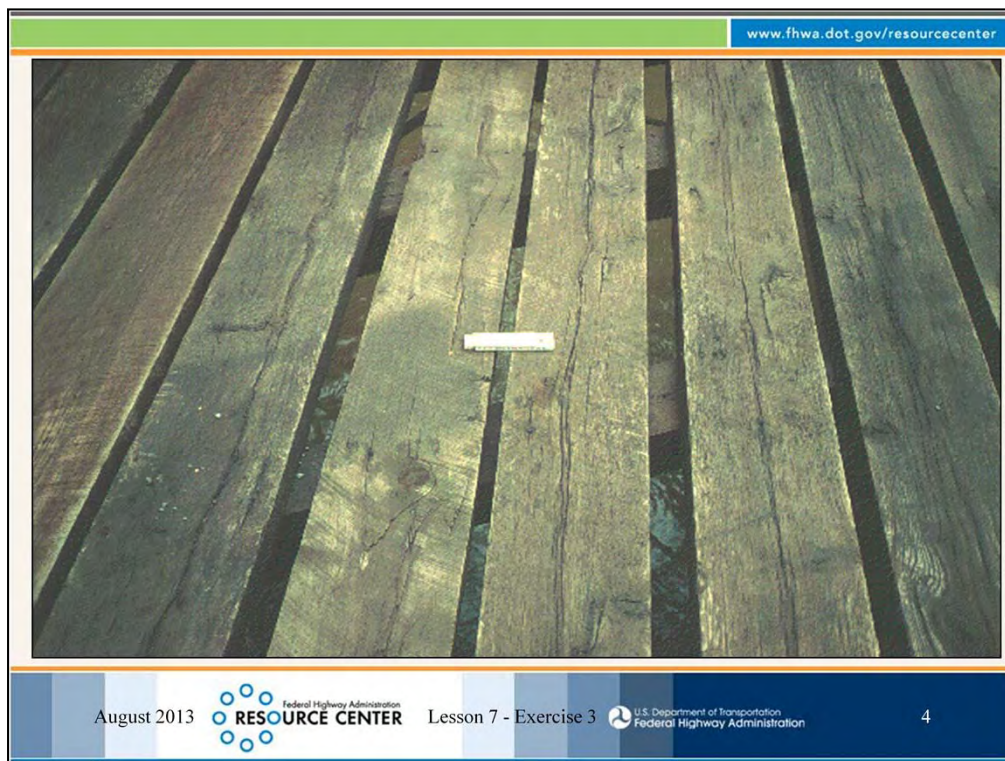


Make note of element defects and defect quantities.

Deck: General view of timber deck as seen from far approach. Deck width out-to-out is 12 ft.

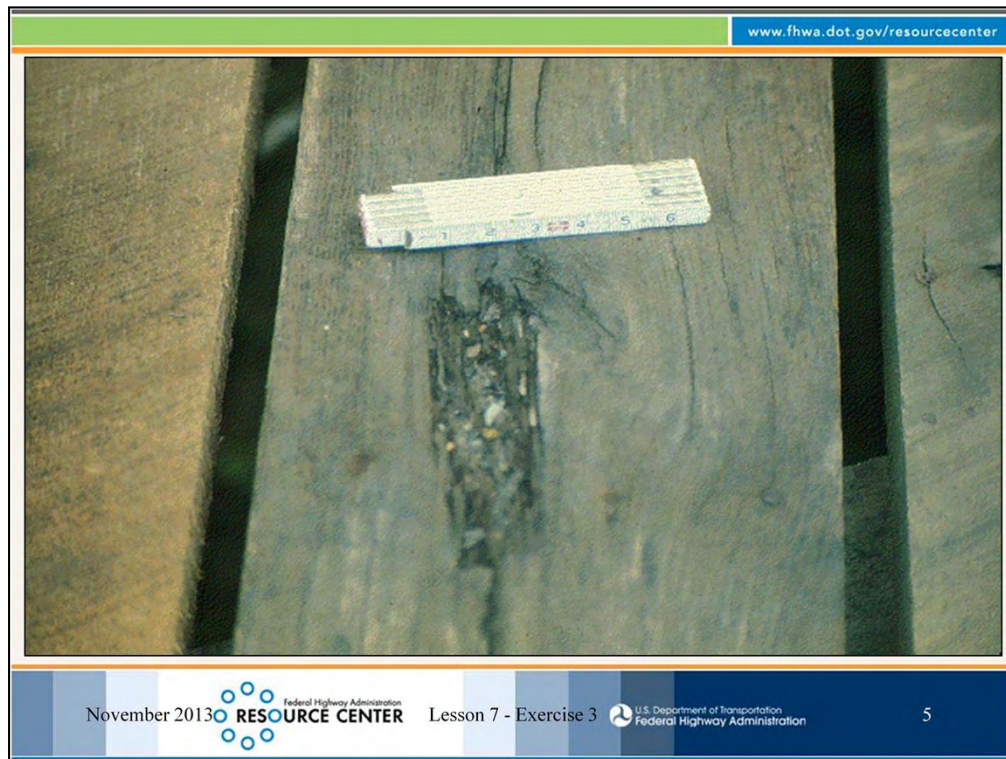
Bridge Rail: Painted metal bridge rail.

Joints: Open joint has severe debris impact over entire length preventing movement at joint.



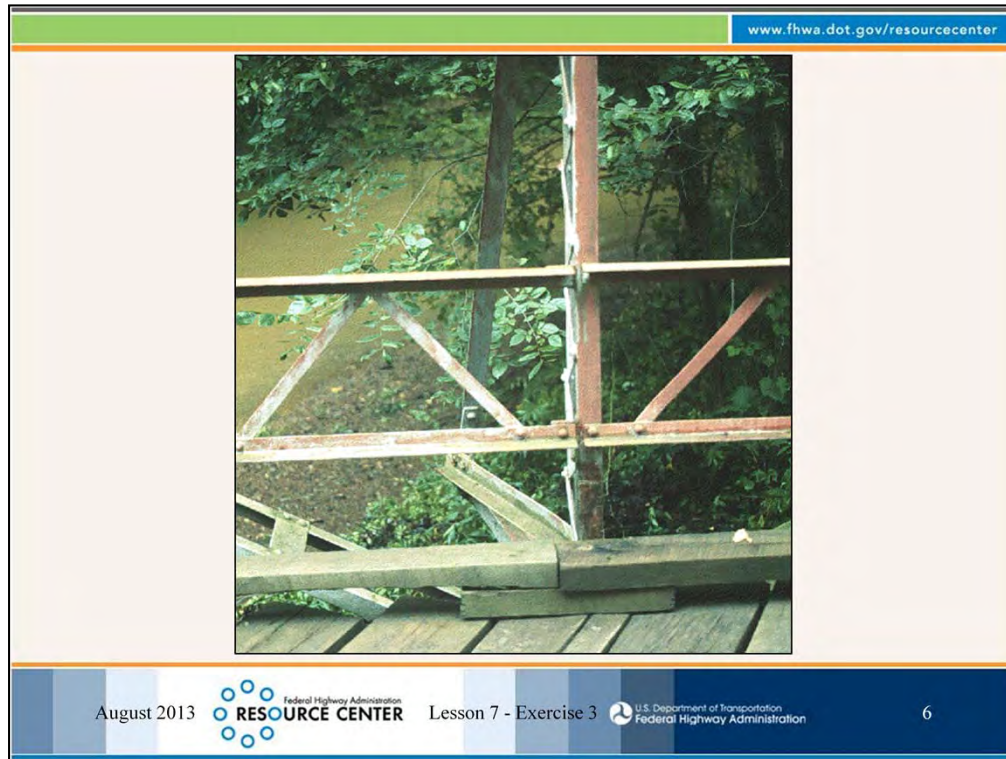
Make note of element defects and defect quantities.

Deck: Typical longitudinal splitting of timber deck planks. 54 sq. ft. of deck area is affected by splits up to 3 ft. long, but deck and connections to stringers are sound under live load. Shallow checks (less than 5% depth of planks) present throughout the deck surface at spacing less than 12 in.



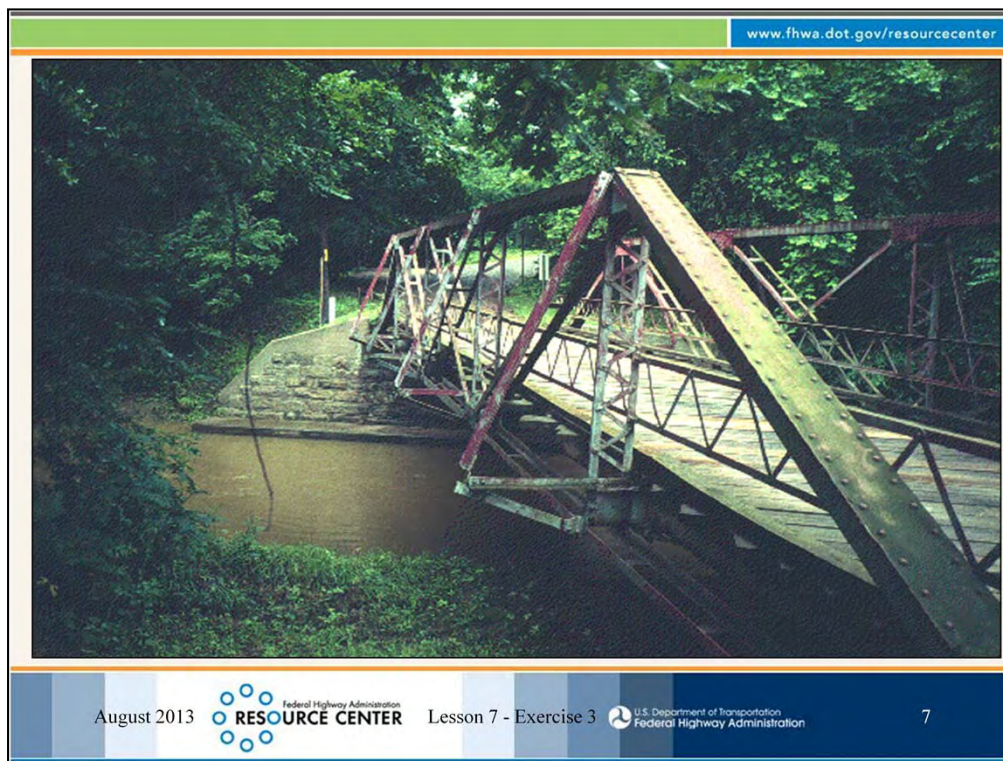
Make note of element defects and defect quantities.

Deck: Decay less than 10% of the timber plank cross section adjacent to a knot hole (1 sq. ft.). This condition was the only spot observed on the entire deck.



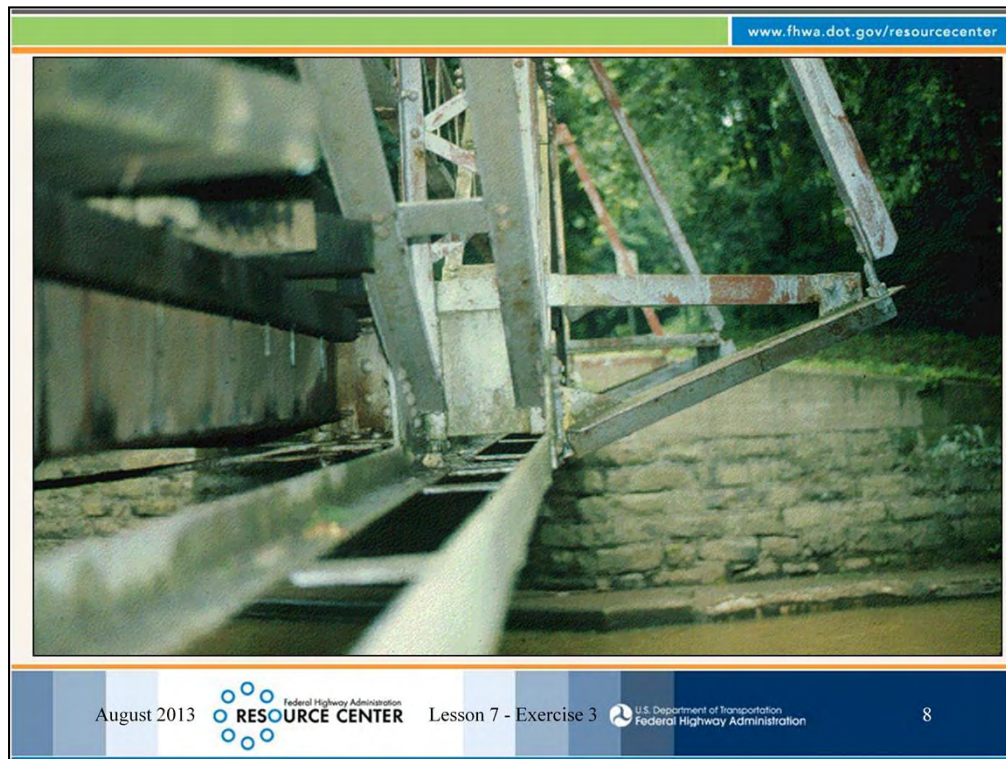
Make note of element defects and defect quantities.

Bridge Rail: Painted metal bridge rail has 20 ft of freckled rust where the coating system is no longer effective. Elsewhere, the metal rail coating system has chalking, without loss of pigment, of the top coat and is substantially effective. Bridge rail coating is 2 sq. ft. per ft.



Make note of element defects and defect quantities.

Superstructure, Truss: Truss coating system area is 30 sq. ft. per ft. There is 640 sq. ft. where the coating is no longer effective at protecting the steel. The remaining area of coating is substantially effective.



Make note of element defects and defect quantities.

Superstructure, Truss: Truss bottom chords have 100 ft. of freckled rust.



Make note of element defects and defect quantities.

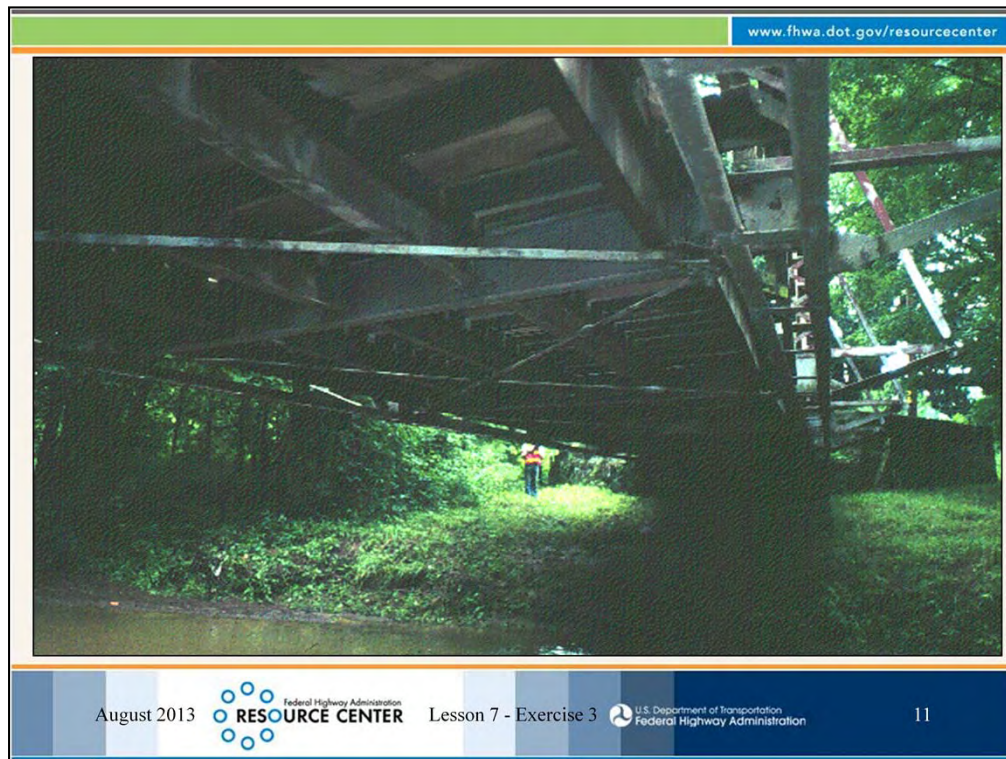
Superstructure, Truss: There is corrosion and section loss of the top chords and end posts with rust packing between channel member and top plate. Typical for entire length of trusses.



Make note of element defects and defect quantities.

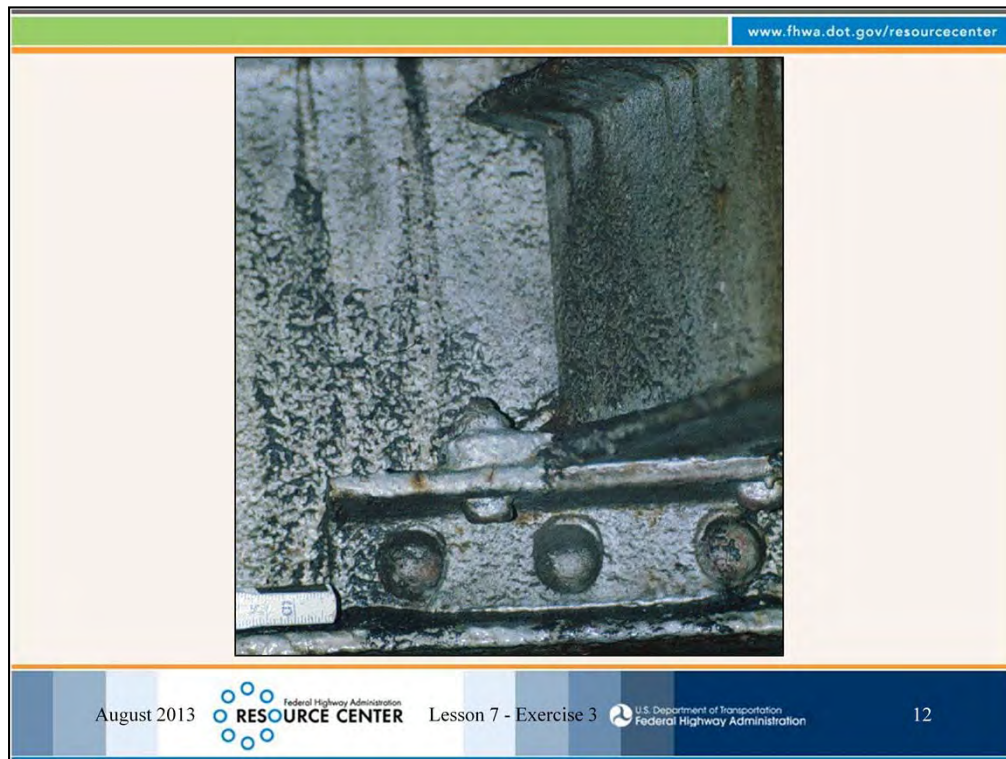
Superstructure, Gusset Plates: There are 10 gusset plate assemblies per truss. Panel point L₃, upstream truss, field welded repair of gusset plate connection has isolated broken welds and missing connectors. All gusset plates have areas of freckled rust, but are otherwise sound.

Coating system for gusset plates has 10 sq. ft. that is no longer effective and the remaining area is substantially effective. Each gusset plate assembly has a coating area of 6 sq. ft.



Make note of element defects and defect quantities.

Deck: No additional noteworthy deficiencies on bottom side.



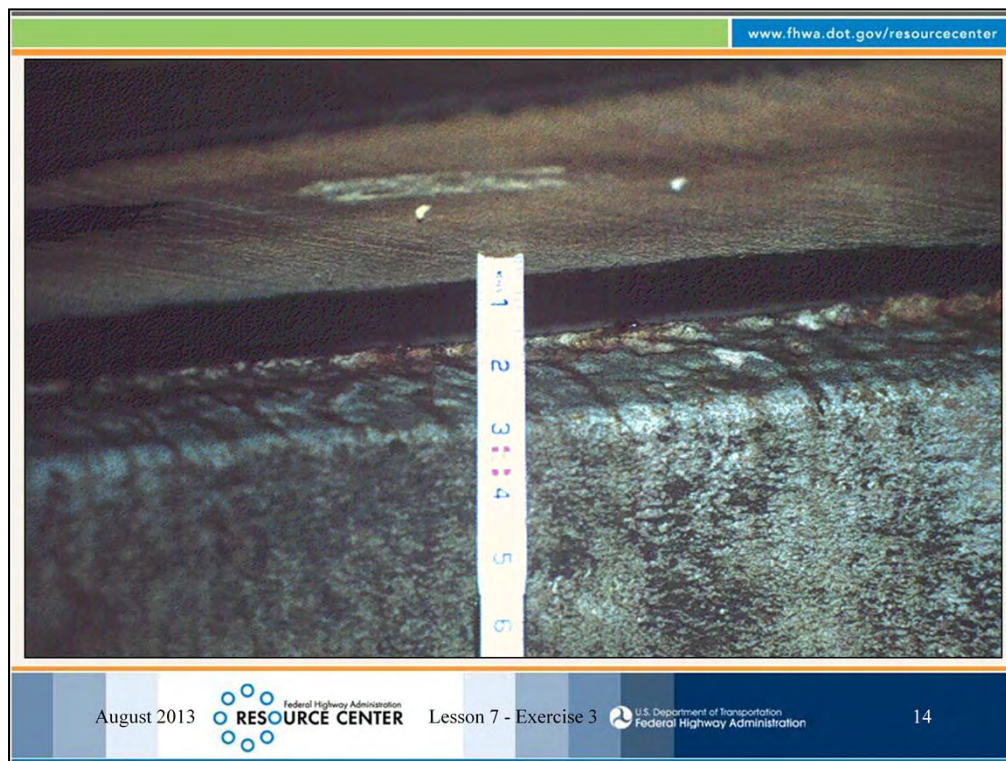
Make note of element defects and defect quantities.

Superstructure , Stringers: Typical stringer to floorbeam connection. All connections are sound.



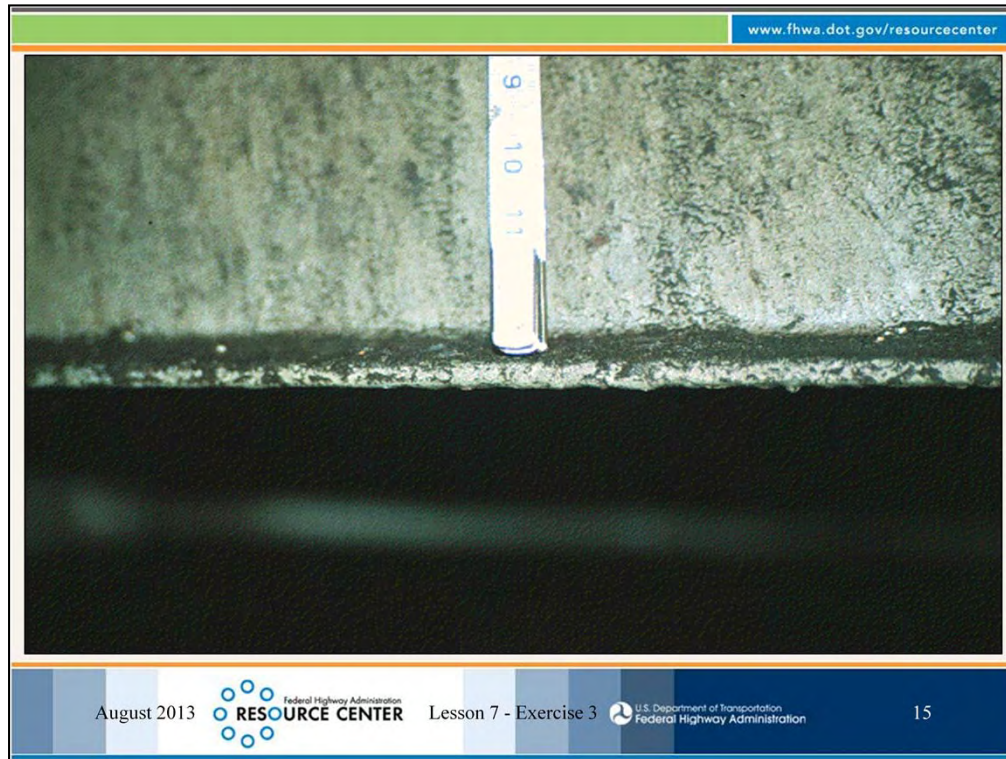
Make note of element defects and defect quantities.

Superstructure, Stringer: Typical stringer condition. 1/16 in. section loss of top flange, on all stringers, full length. Coating system is no longer effective for 375 sq. ft. The remainder of the coating system area is substantially effective.



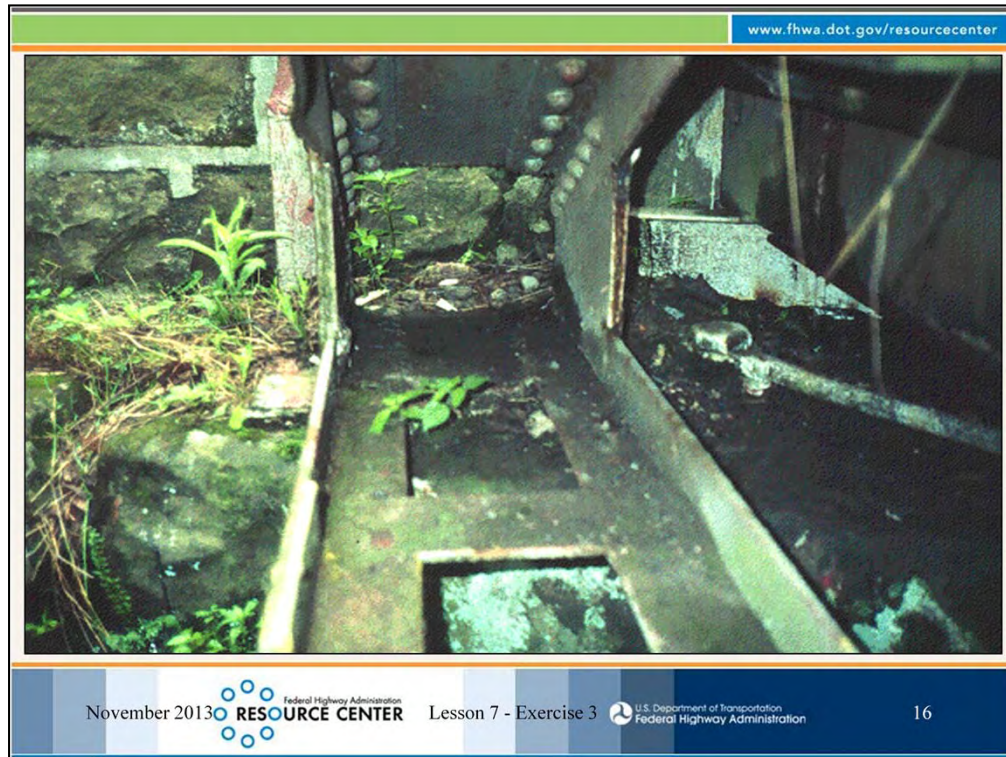
Make note of element defects and defect quantities.

Superstructure, Floor beams: Floorbeam #0 has 1/8 in. section loss of top flange, full length. Floorbeam #5 the same. There is 30 sq. ft. of the coating that is no longer effective. There is 60 sq. ft. of the coating that is substantially effective.



Make note of element defects and defect quantities.

Superstructure, Floor beams: Floorbeam #4 has 1/16 in. pitting on bottom flange, full length. Floorbeams #1, 2 & 3 are the same. There is 60 sq. ft. of coating that is no longer effective and there is 300 sq. ft. that is substantially effective.



Make note of element defects and defect quantities.

Movable Bearings: Near abutment upstream sliding plate expansion bearing has corrosion with section loss and coating is no longer effective. Typical condition both bearings. Coating system area for bearings is 2 sq. ft. per bearing.



Make note of element defects and defect quantities.

Fixed Bearings: Far abutment upstream fixed steel plate bearing. No noteworthy deficiencies. Coating system area for bearings is 2 sq. ft. per bearing. Coating system is substantially effective.



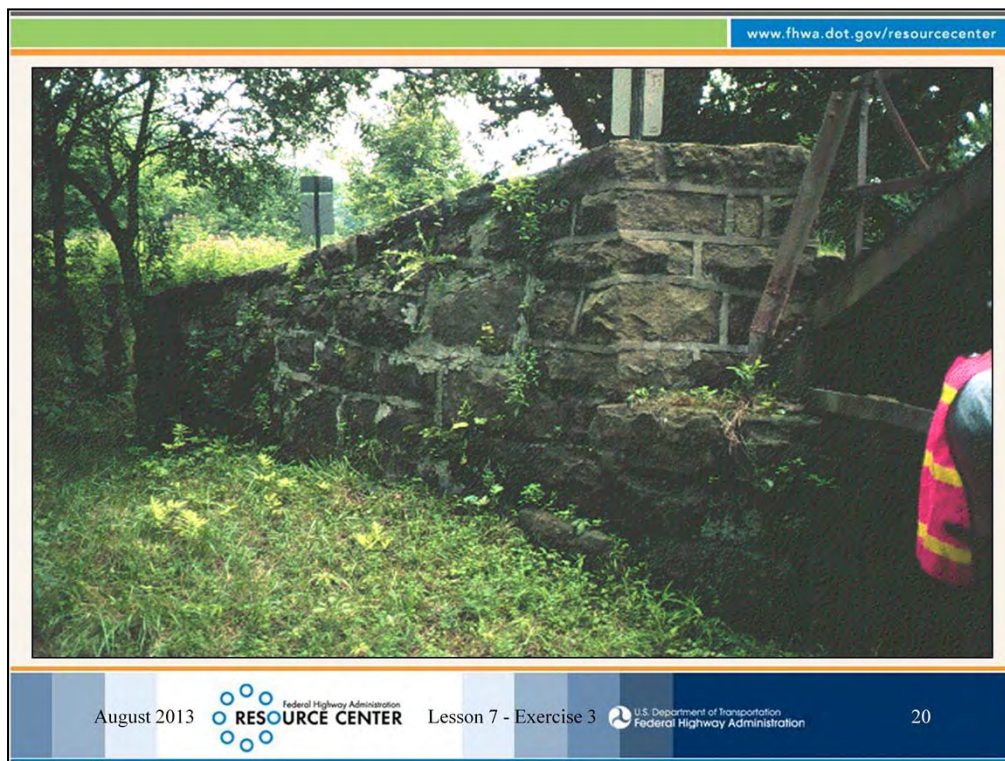
Make note of element defects and defect quantities.

Substructure, Abutment 1: General view of near abutment. Stone masonry construction. Abutment face measures 19 ft. long. All stones and mortar joints are sound.



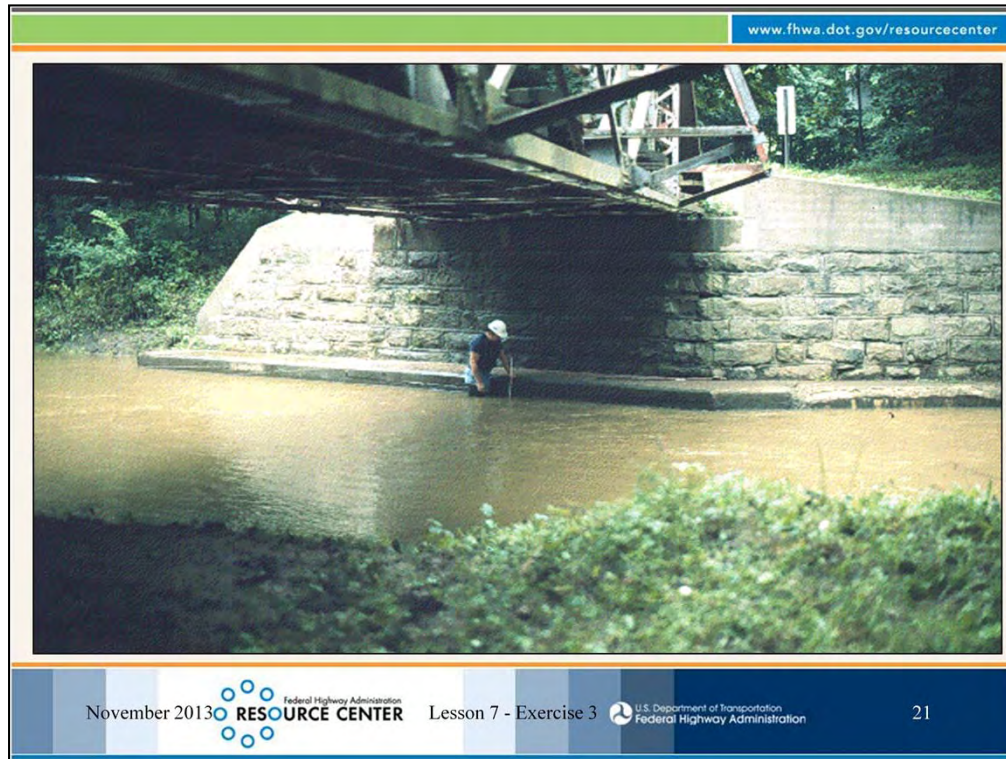
Make note of element defects and defect quantities.

Substructure, Abutment 1: General view of left wingwall (upstream) at near abutment. Wingwall is 15 ft. long and integral with abutment. All stones and mortar joints are sound.



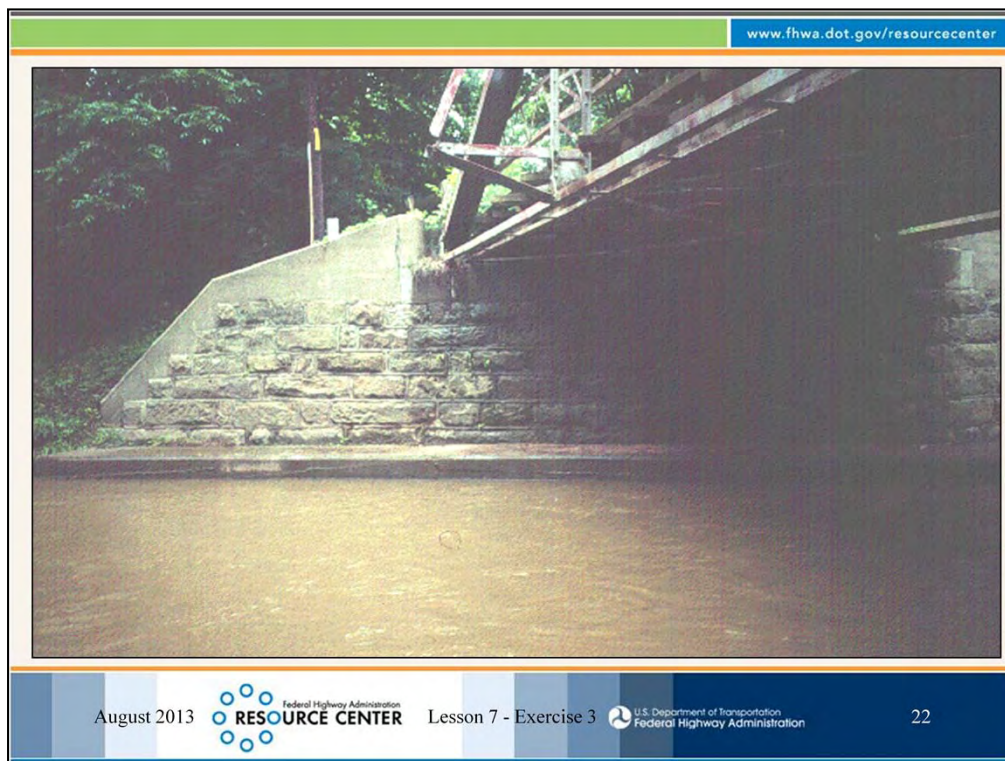
Make note of element defects and defect quantities.

Substructure , Abutment 1: General view of right wingwall (downstream) at near abutment. Wingwall length is 20 ft. and is integral with the abutment. All stones and mortar joints are sound.



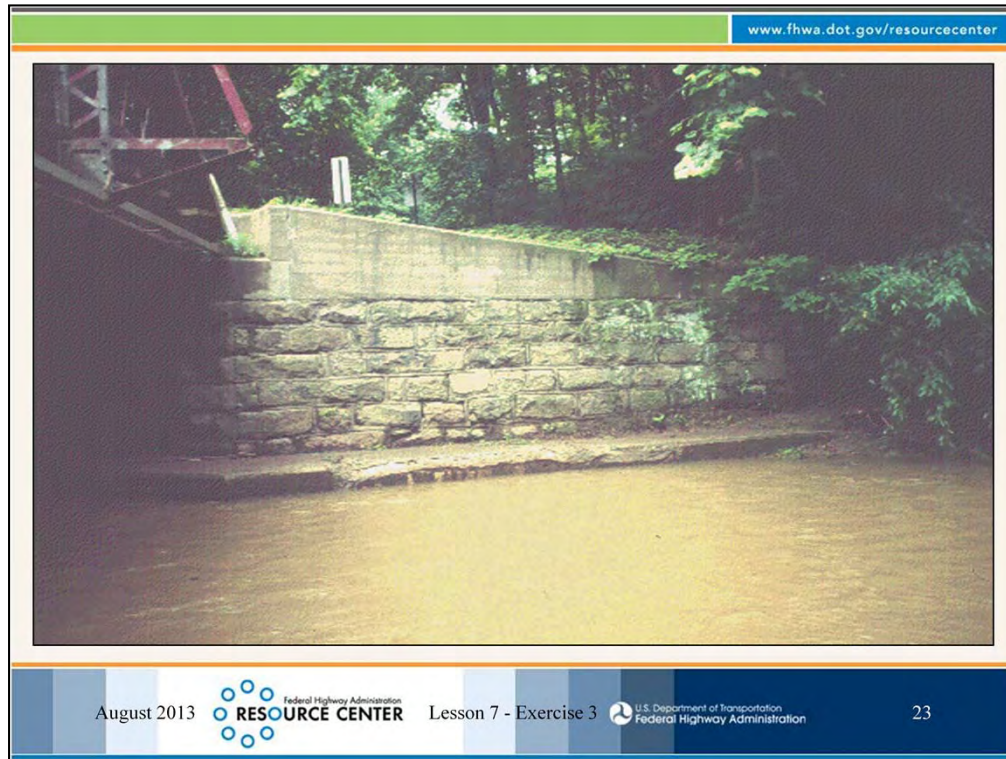
Make note of element defects and defect quantities.

Substructure, Abutment 2: General view of far abutment. Abutment face measures 19 ft. long. Bearing seat and tops of wingwalls have been reconstructed of reinforced concrete with no noteworthy deficiencies. A concrete footing apron has been added along front face of abutment and each wingwall. Scour of the streambed for 30 ft. along the abutment and far right wingwall. No undermining and no indication of structure instability.



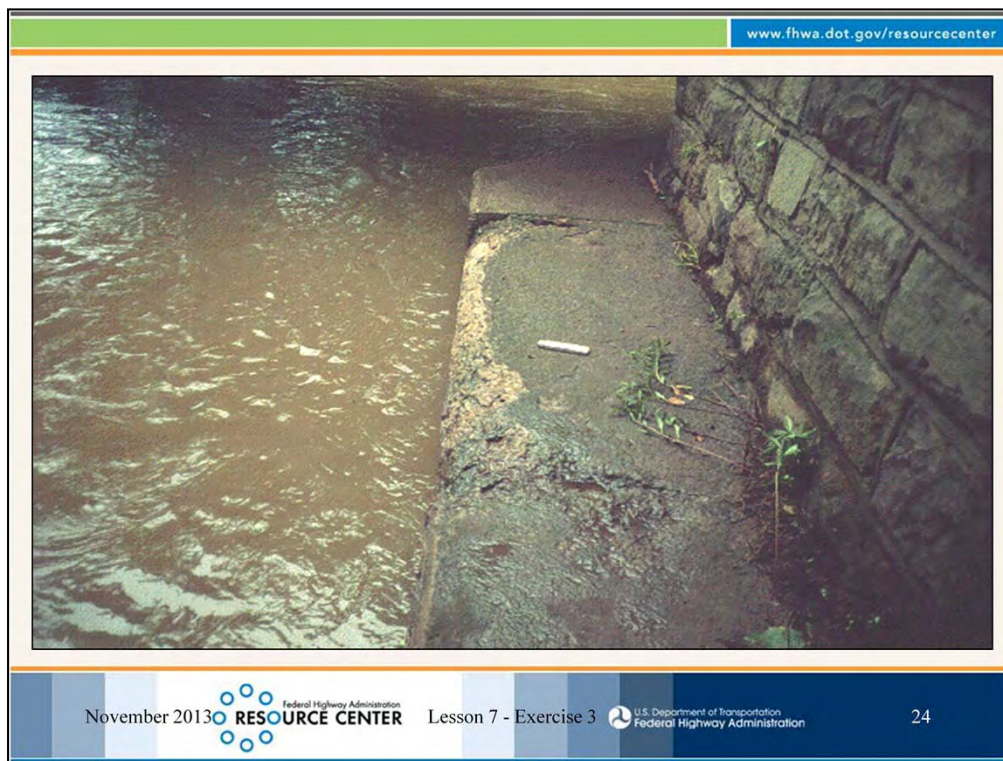
Make note of element defects and defect quantities.

Substructure, Abutment 2: General view of left wingwall (upstream) for far abutment. Wingwall is 15 ft. long and integral with the abutment. All stones and mortar joints are sound. No scour was observed for this wingwall.



Make note of element defects and defect quantities.

Substructure, Abutment 2: General view of right wingwall (downstream) for far abutment. Wingwall is 20 ft. long and integral with the abutment. Mortar joints are deteriorated and missing for a 5 ft. length. All stones are sound and not displaced. Spalling of the footing apron for 10 ft. length.



Make note of element defects and defect quantities.


Substructure, Abutment 2: Close-up view of footing apron along front face of far abutment. Spalling greater than 6 in. diameter of footing apron for 10 ft. along the front edge. No exposed reinforcing steel.

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Total Element Quantity Explanation

- Deck: 80 ft. x 12 ft. = 960 sq. ft.
- Open Joint: 12 ft. long = 12 ft.
- Bridge Railing: 80 ft. x 2 rails = 160 ft.
 - Coating System: 2 sq. ft. /ft. x 160 ft. = 320 sq. ft.
- Truss: 80 ft. x 2 trusses = 160 ft.
 - Coating system: 30 sq. ft. / ft. x 160 ft. = 4800 sq. ft.
- Gusset Plates: 10 per truss x 2 trusses = 20 each
 - Coating System: 6 sq. ft. / gusset plate x 20 = 120 sq. ft.
- Stringers: 80 ft. x 5 stringer lines = 400 ft.
 - Coating System: 3 sq. ft. / ft. x 400 ft. = 1200 sq. ft.

August 2013

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“Gusset Plates” refers to gusset plate assemblies. The quantity for this element is the number of primary load path gusset plate assemblies. At a single panel point the quantity is one gusset plate assembly regardless of the number of individual plates at the connection point. There are 10 panel points per truss on this bridge.

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Total Element Quantity Explanation

- Floorbeams: 15 ft. long x 6 floorbeams = 90 ft.
 - Coating system: 5 sq. ft. / ft. x 90 ft. = 450 sq. ft.
- Movable Bearings: 1 each truss x 2 trusses = 2 each
 - Coating System: 2 sq. ft. per bearing x 2 bearings = 4 sq. ft.
- Fixed Bearings: 1 each truss x 2 trusses = 2 each
 - Coating System: 2 sq. ft. per bearing x 2 bearings = 4 sq. ft.
- *Abutments:
 - Masonry: (19 ft. + 20 ft. + 15 ft.) x 2 abut's = 108 ft.
 - Reinforced Concrete: 19 ft. + 20 ft. + 15 ft. = 54 ft.
 - Footing: 19 ft. + 20 ft. + 15 ft. = 54 ft.

November 2013

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*Abutment-2 has a reinforced concrete addition to the top of the stone masonry. In this example both the Masonry and RC Abutment elements are used to record the conditions for each of these materials. In this case there is 108 ft. of Masonry Abutment (abutments 1 & 2) and 54 ft. of RC Abutment (abutment 2 only). Also, a RC apron has been added to the base of Abutment-2. In this example the Pile Cap/Footing element is used to record the condition of the apron.

As an alternative, an agency may elect to use an agency developed element (ADE) for the apron.

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Elements, Units and Quantities

Element No.	Element Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
DECK/SLAB							
31	Timber Deck	960	sq. ft.				
JOINTS							
304	Open Expansion Joint	12	ft.				
BRIDGE RAILINGS							
330	Metal Bridge Railing	160	ft.				
515	Steel Protective Coating	320	sq. ft.				
SUPERSTRUCTURE							
120	Steel Truss	160	ft.				
515	Steel Protective Coating	4800	sq. ft.				
162	Gusset Plate	20	each				
515	Steel Protective Coating	120	sq. ft.				



November 2013

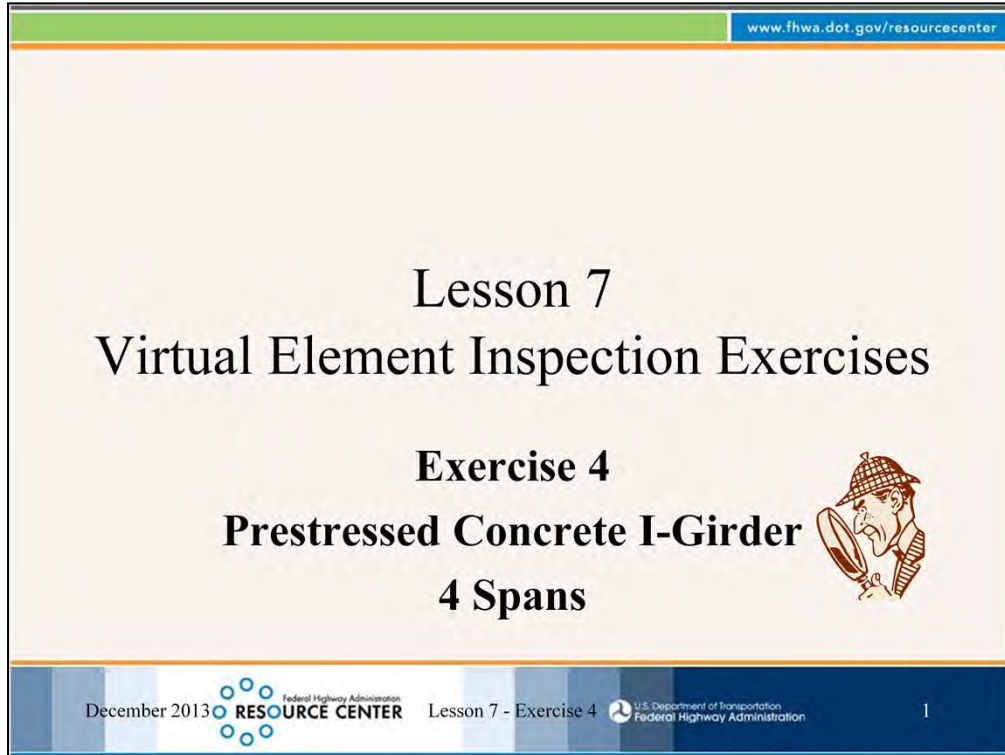
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Elements, Units and Quantities							
Element No.	Element Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
113	Steel Stringer	375	ft.				
515	Steel Protective Coating	1200	sq. ft.				
152	Steel Floor Beam	90	ft.				
515	Steel Protective Coating	450	sq. ft.				
BEARINGS							
311	Movable Bearing	2	each				
515	Steel Protective Coating	4	sq. ft.				
313	Fixed Bearing	2	each				
515	Steel Protective Coating	4	sq. ft.				
SUBSTRUCTURE							
217	Masonry Abutment	108	ft.				
215	RC Abutment	54	ft.				
220	RC Pile Cap/Footing	54	ft.				
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Lesson 7



Virtual Element Inspection Exercises

Exercise 4

Prestressed Concrete I-Girder

4 Spans



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Federal Highway Administration 1

Participants will need a pen or pencil, element inventory and assessment form, calculator and element condition state definitions handout.

Participant can work alone or consult with their neighbor.

Use the provided form and record:

- The applicable defects for each element.
 - Only record the predominate defect if there are overlapping defects.
- The condition state quantities for each defect.
- The total condition state quantities for each element.

Exercise uses just one structure unit.

Introduction to Element Level Bridge Inspection

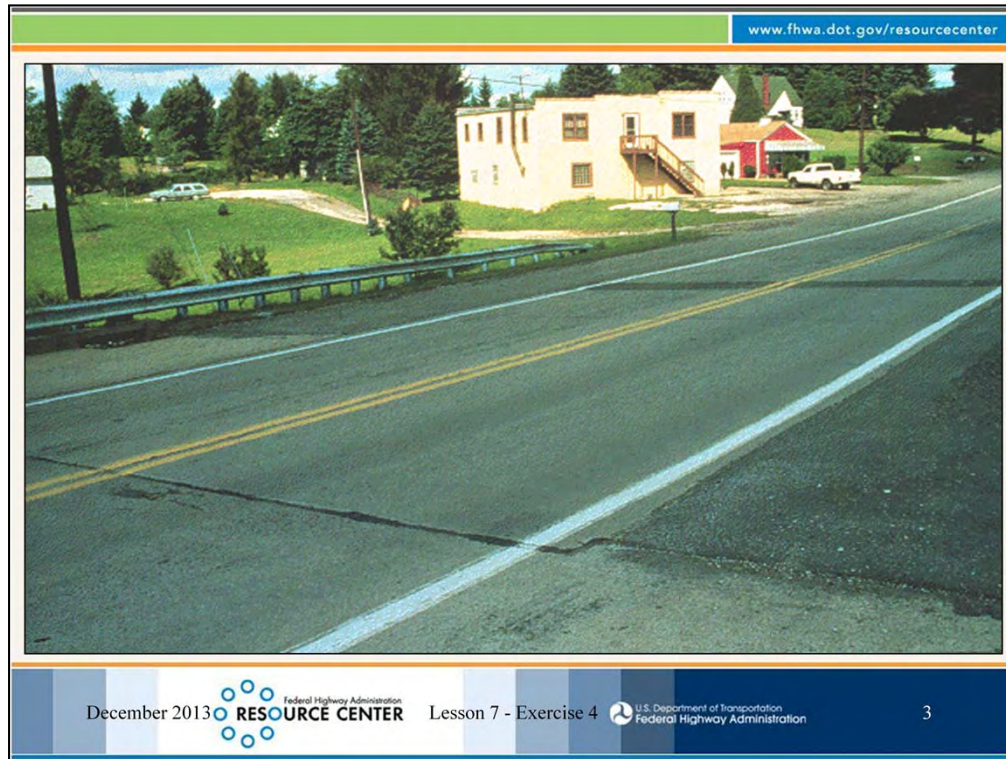
Lesson 7 – Exercise 4: Four Span PSC Girder

Element/ Str. Unit No.	Element/Structure Unit Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
1	Span(s) - All						
DECK/SLAB							
12	RC Deck	11880	sq. ft.				
JOINTS							
301	Pourable Joint Seal	88	ft.				
302	Compression Joint Seal	132	ft.				
APPROACH SLABS							
321	RC Approach Slab	1440	sq. ft.				
BRIDGE RAILINGS							
330	Metal Bridge Railing	540	ft.				
331	RC Bridge Railing	540	ft.				
SUPERSTRUCTURE							
109	PSC Open Girder/Beam	2160	ft.				
BEARINGS							
310	Elastomeric Bearing	64	each				
SUBSTRUCTURE							
205	RC Columns	9	each				
234	RC Pier Cap	149	ft.				
215	RC Abutment	98	ft.				



Elevation view. 4 simple spans, 8 girder lines, structure length is 270 ft.

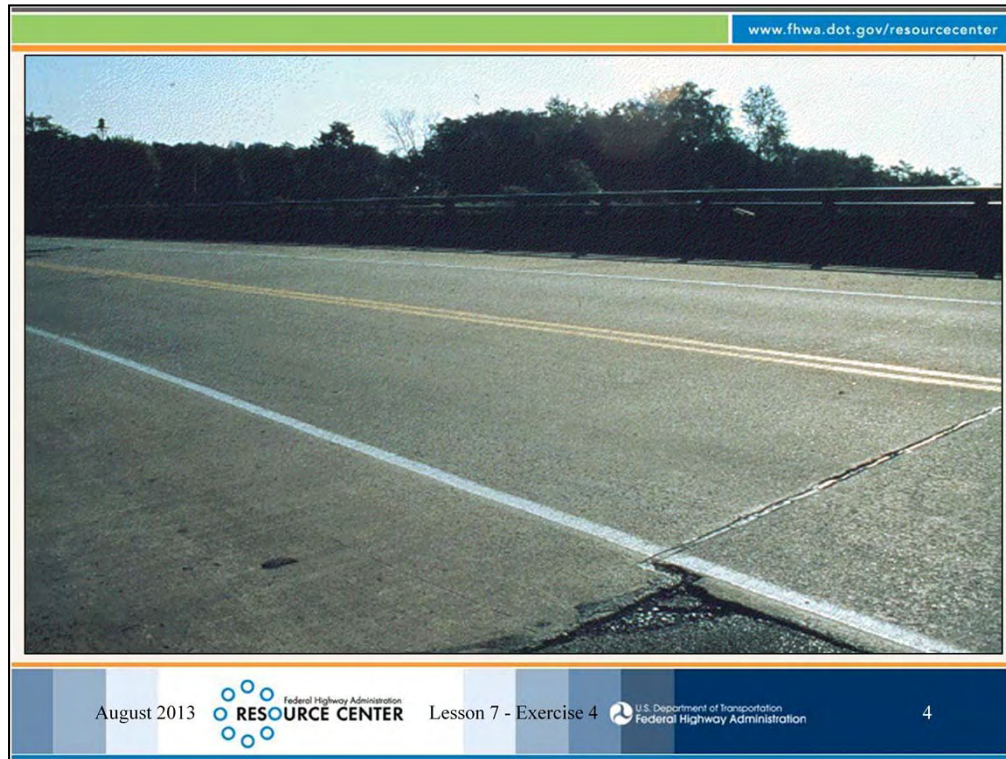
Element Quantities: The element quantity calculations are shown on slide 27.



Make note of element defects and defect quantities.

Approach Slabs: View of RC approach slab that is 24 ft wide by 30 ft long. There are no noteworthy deficiencies.

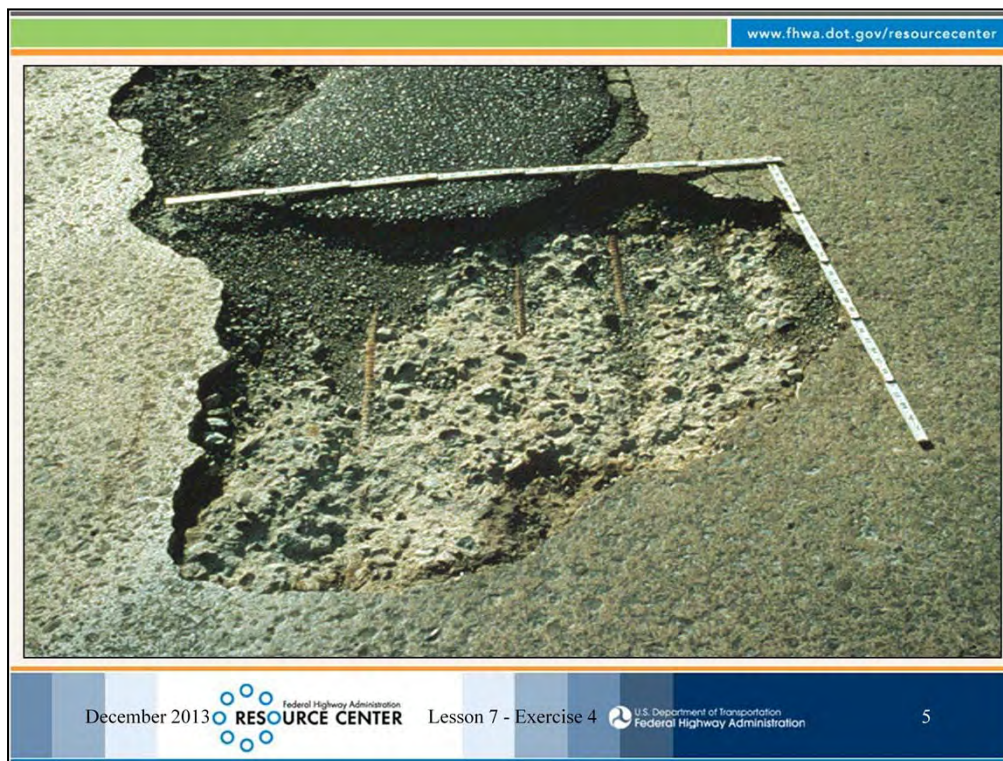
Joints: Joint at the bridge/approach slab interface has a poured sealant that is 44 ft. long. Same at other approach. There is debris partially filling 40 ft. of the joints but not effecting movement.



Make note of element defects and defect quantities.

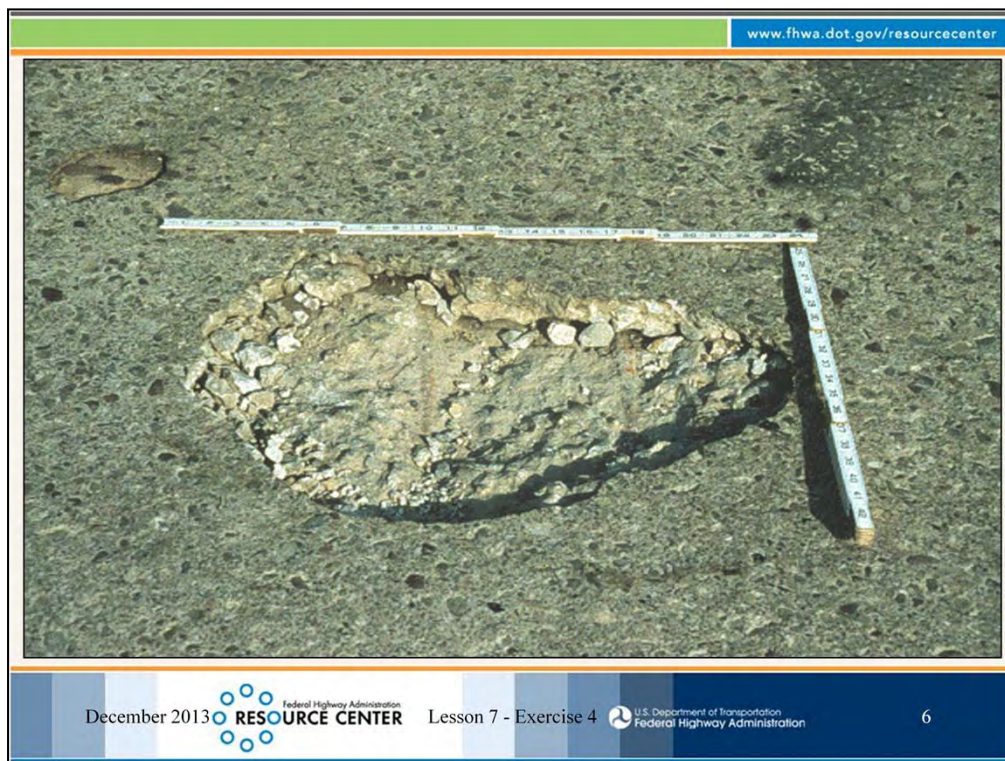
Deck: General view of reinforced concrete deck - Span 1. Deck width is 44 ft. out-to-out. Transverse cracks less than 0.012 inches wide at variable spacing greater than 3 ft. throughout the entire deck in all spans.

Bridge Railing: Combination bridge rail, reinforced concrete with aluminum top rails, no protective coating. Reinforced concrete has cracks less than 0.012 inches wide at 4 ft. spacing throughout.



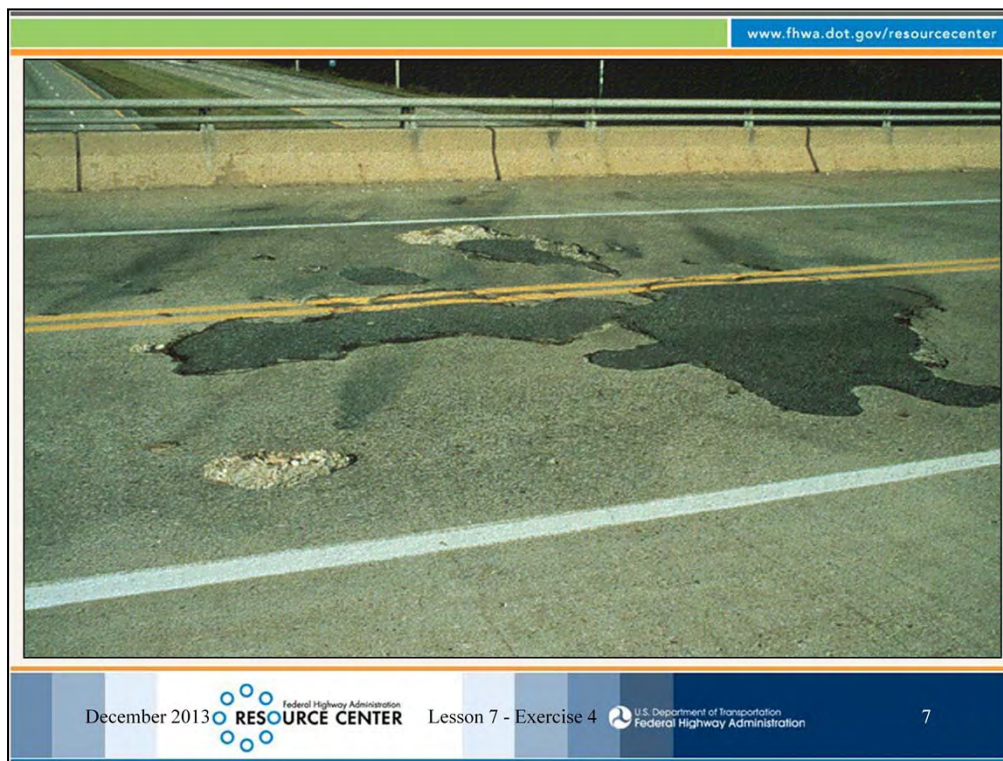
Make note of element defects and defect quantities.

Deck: Spall and patch at mid-span of Span 2 left lane. Spalls greater than 1 in. deep with exposed reinforcing steel (8 sq. ft.). There is no measurable section loss on exposed reinforcing steel. Distressed patches (10 sq. ft.).



Make note of element defects and defect quantities.

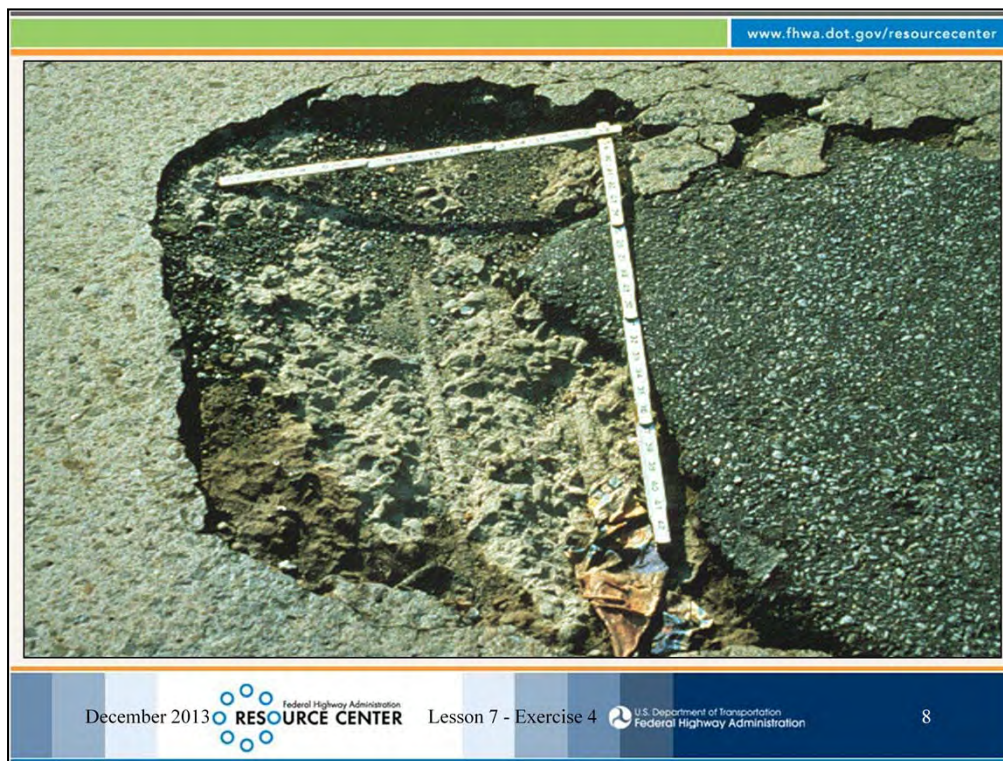
Deck: Spall greater than 1 in. deep with exposed reinforcing steel (4 sq. ft.) on Span 2 at mid-span right lane. There is no measurable section loss on exposed reinforcing steel.



Make note of element defects and defect quantities.

Deck: Spalls greater than 6 inches in diameter and distressed patches on deck Span 2. Total area of spalls is 12 sq. ft. Total area of distressed patches is 100 sq. ft.

Bridge Railing: Spalls greater than 1 in. deep with exposed reinforcing steel (10 ft.). There is no measurable section loss on exposed reinforcing steel.



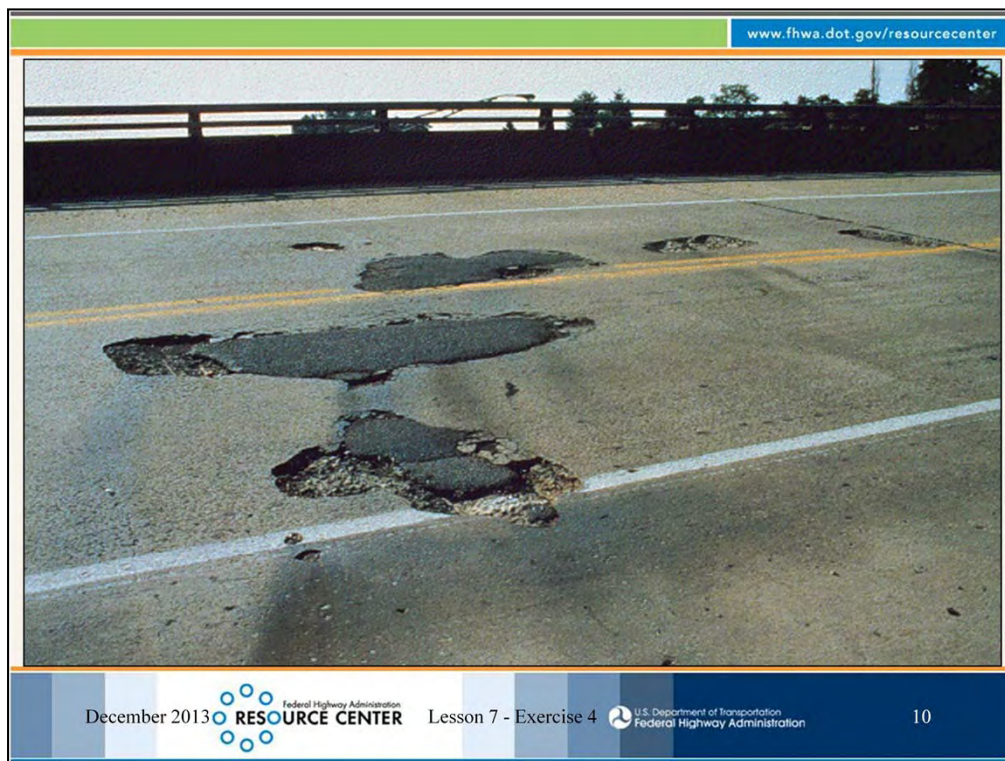
Make note of element defects and defect quantities.

Deck: Span 4 at mid-span of the left lane. Spall greater than 6 in. diameter with exposed reinforcing steel (5 sq. ft.). There is no section loss of the exposed reinforcing steel. Distressed patch (7 sq. ft.)



Make note of element defects and defect quantities.

Deck: Span 4 at mid-span of the right lane. Spall greater than 6 in. diameter with exposed reinforcing steel (10 sq. ft.). There is no section loss of the exposed reinforcing steel.



Make note of element defects and defect quantities.

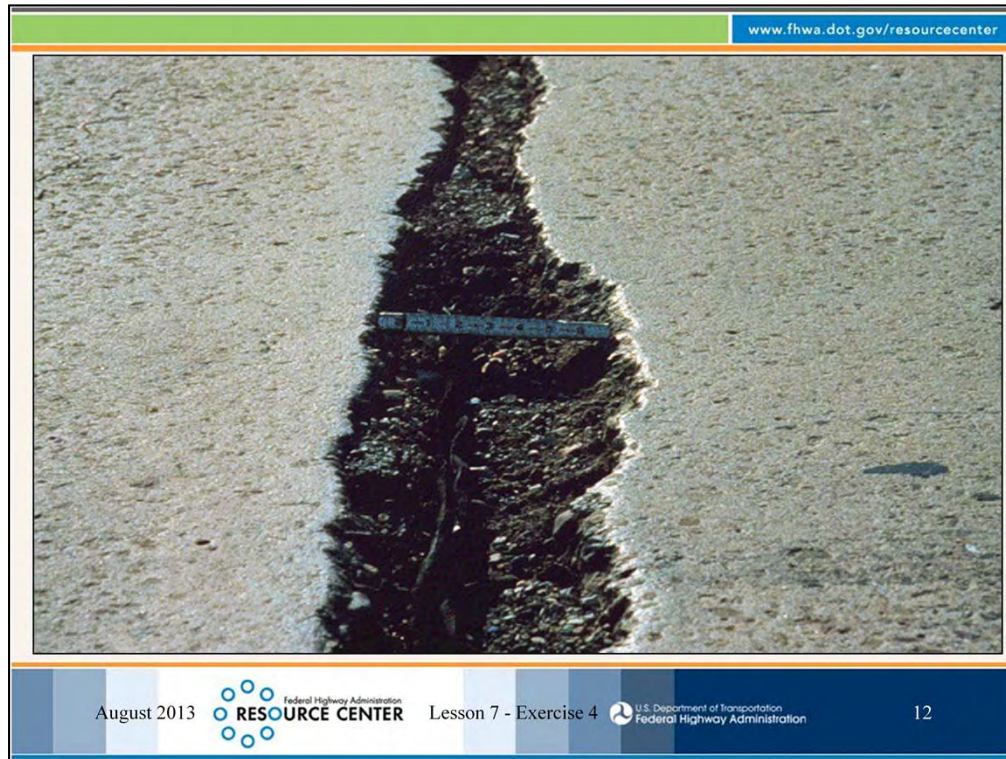
Deck: General view of deck Span 4. Spalls greater than 1 in. deep with exposed reinforcing steel (40 sq. ft.). There is no measurable section loss on exposed reinforcing steel. Distressed patches (60 sq. ft.).



Make note of element defects and defect quantities.

Deck: Spall greater than 6 in. diameter (2 sq. ft.) located at left side of deck at Bent 1 expansion joint.

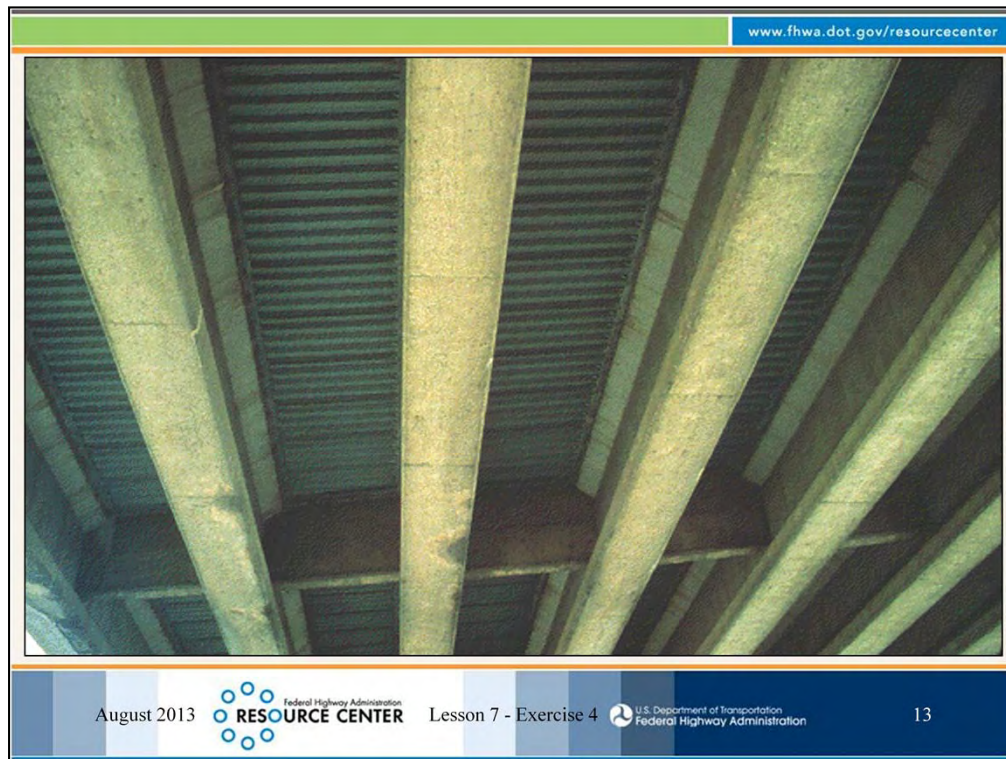
Joints: Compression seal joint over each bent (pier) at 44 ft. long each. At left curb over Bent 1 exposed compression seal due to greater than 6 in. diameter spall extending 2 ft. from left curb. Debris build-up and moderate leakage for 10 ft. from the left curb.



Make note of element defects and defect quantities.

Deck: Spalling 2 inches deep along full length of Bent 3 expansion joint, 44 sq. ft.

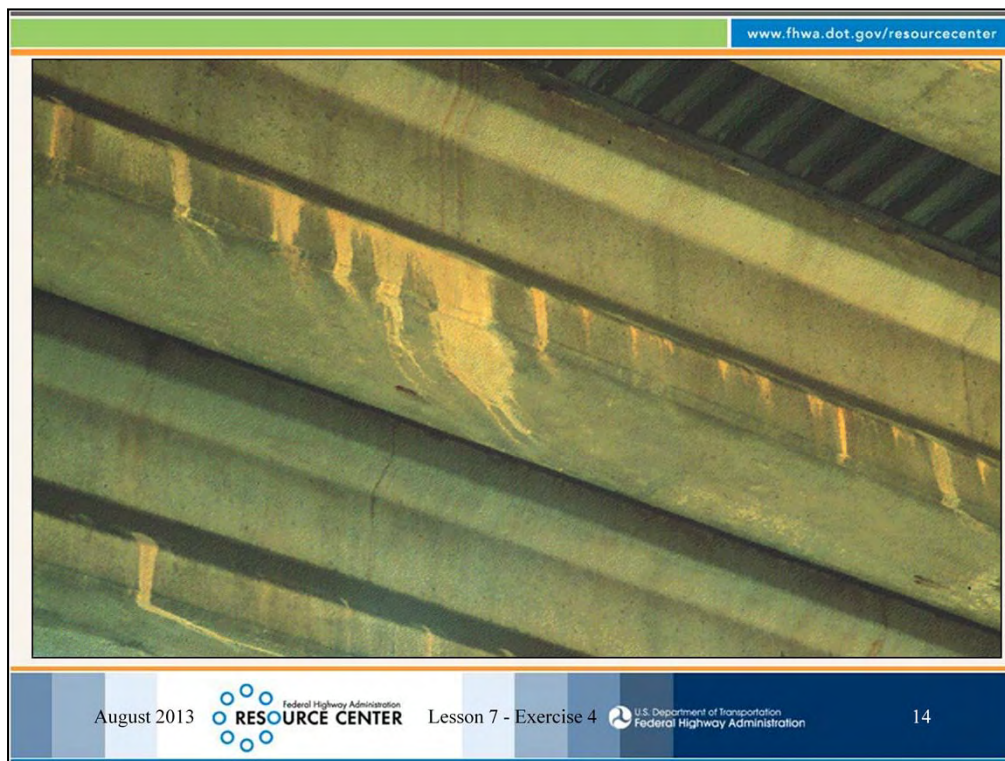
Joints: Compression seal joint at Bent 3. Adjacent deck spalls 2 inches deep along full length of joint (44 ft.). Compression seal partially pulled out for 4 ft., allowing a free flow of water. Remainder adequately adhered for at least 50% of seal height and not leaking.



Make note of element defects and defect quantities.

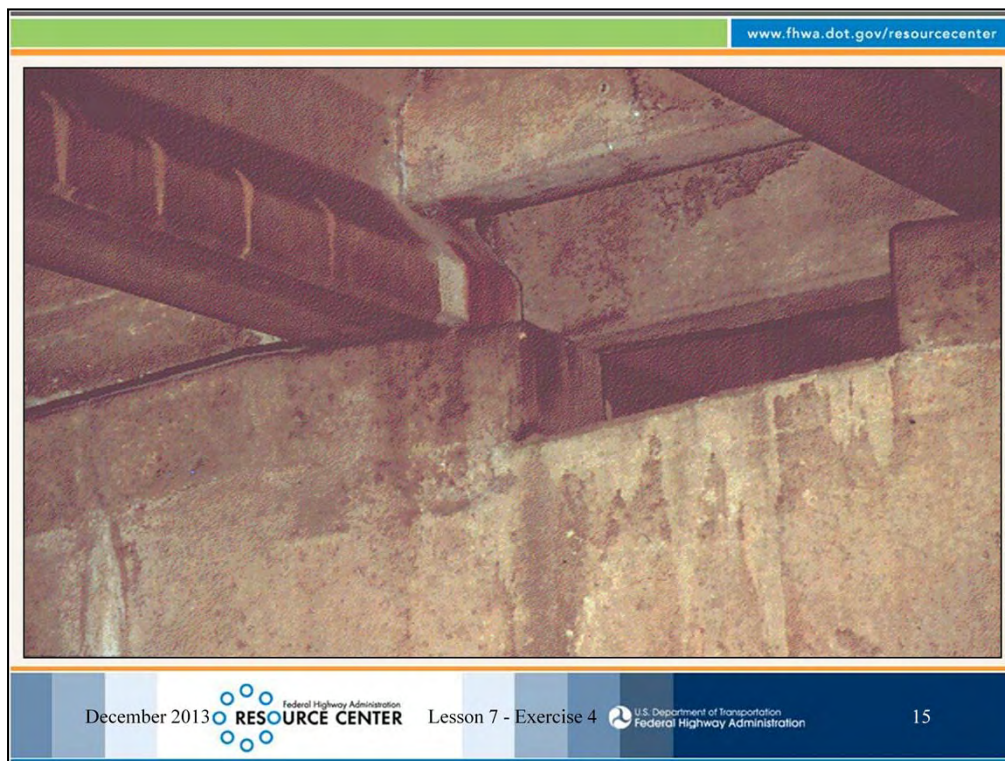
Deck: Typical deck underside view. Note stay-in-place forms.

Superstructure: Precast, prestressed concrete girders.



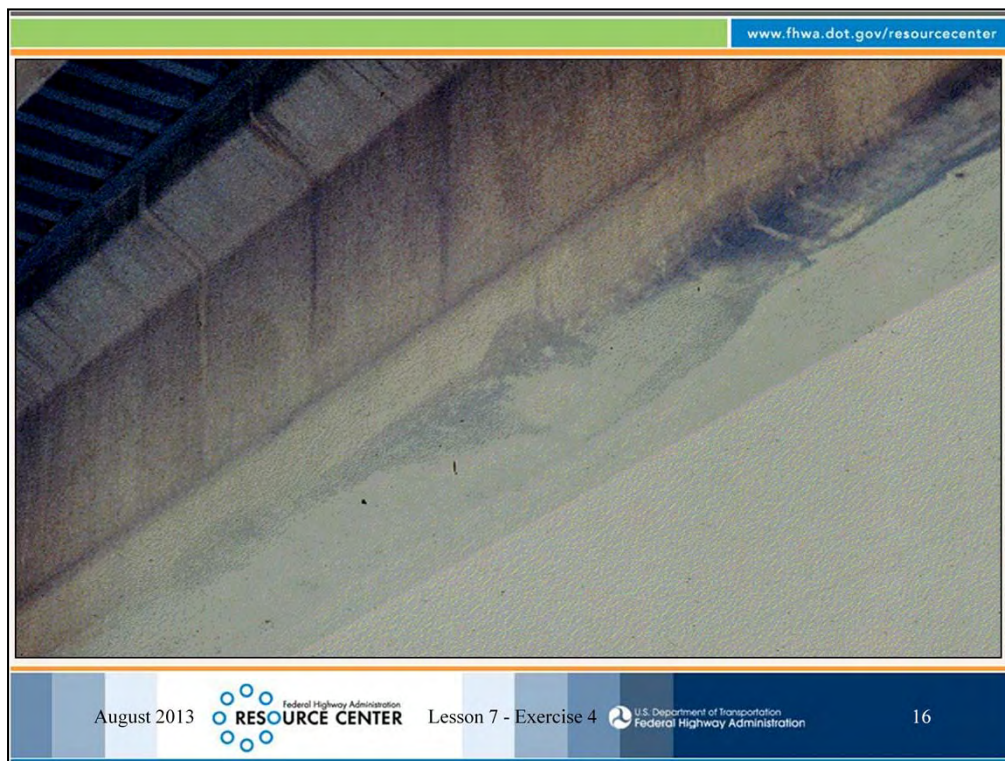
Make note of element defects and defect quantities.

Superstructure: Staining of Beam 6, Span 3. Staining due to water running along the deck forms. No deterioration or efflorescence. Condition is typical for all beams in all spans.



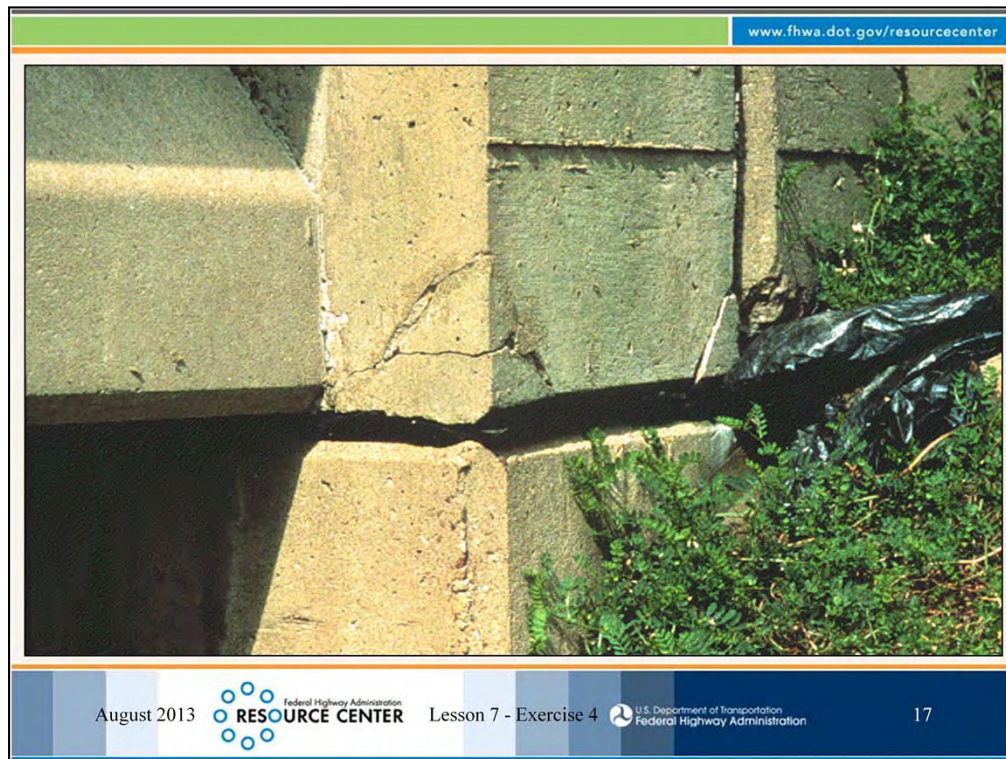
Make note of element defects and defect quantities.

Superstructure: Exposed rebar without section loss at all girder ends (1 ft. for each girder end = 8 ft.) in bearing area at Bent 2. Associated spalling is 1 to 2 inches deep.



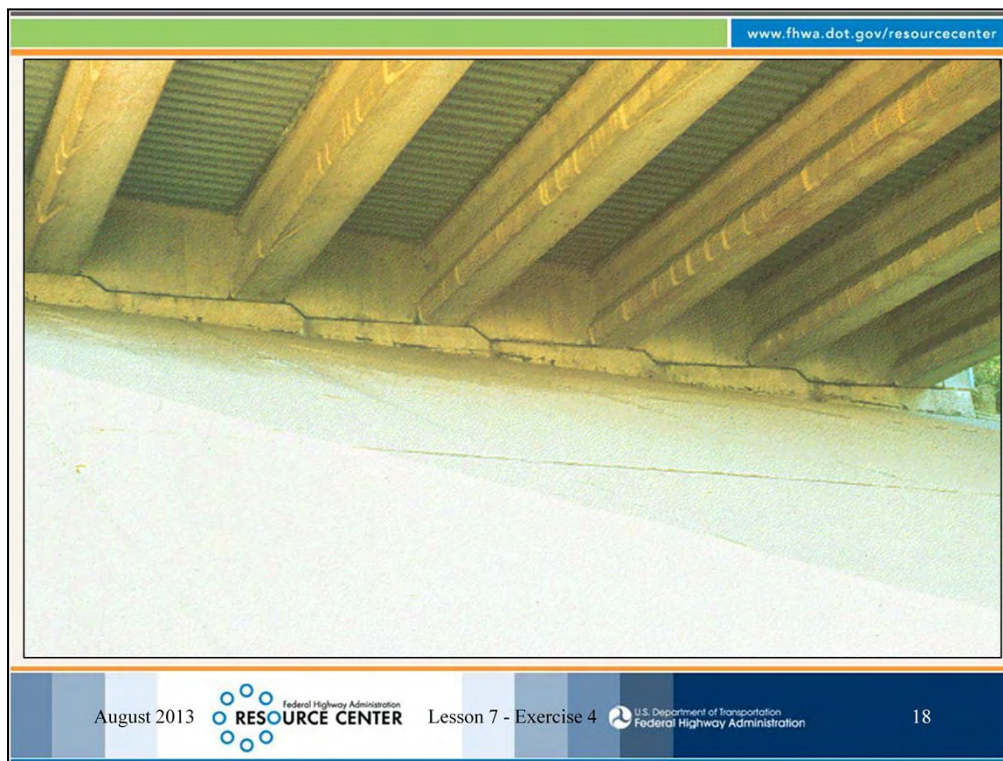
Make note of element defects and defect quantities.

Superstructure: Collision damage of Beam 1 Span 3. Inside corner of beam has been broken off (less than 1 inch deep and less than 6 inches wide spall). There are no exposed strands. The affected length is 2 ft.



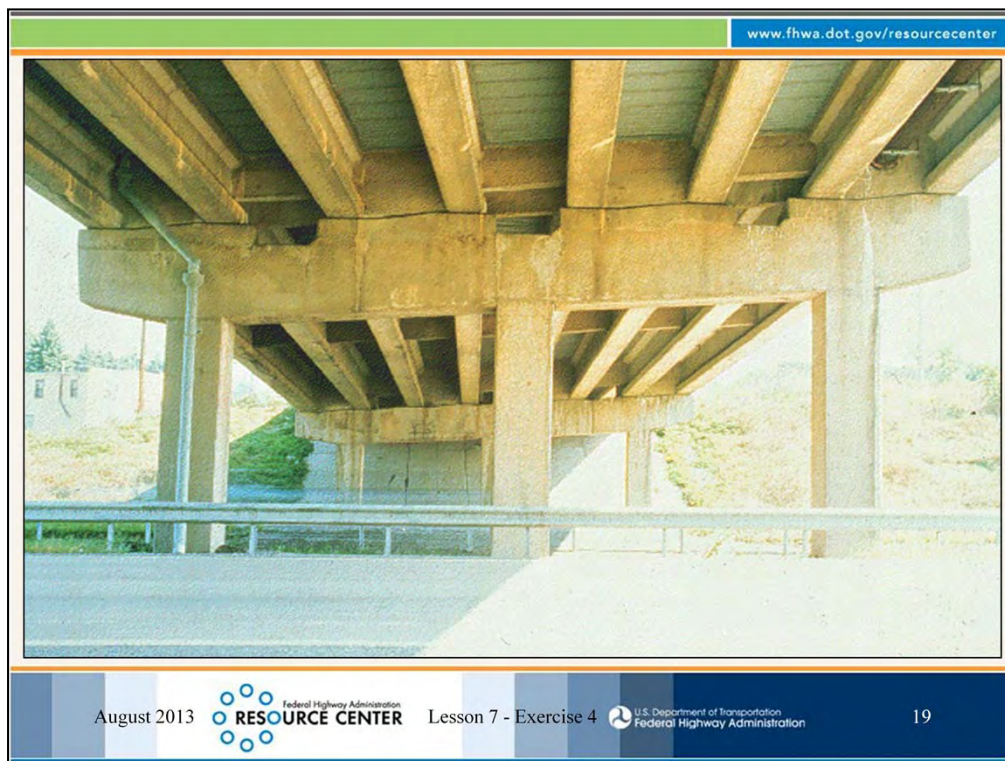
Make note of element defects and defect quantities.

Bearings: Bearing area of Beam 8 at the far (east) abutment. There is minor bulging, less than 15% of thickness, of the neoprene bearing.



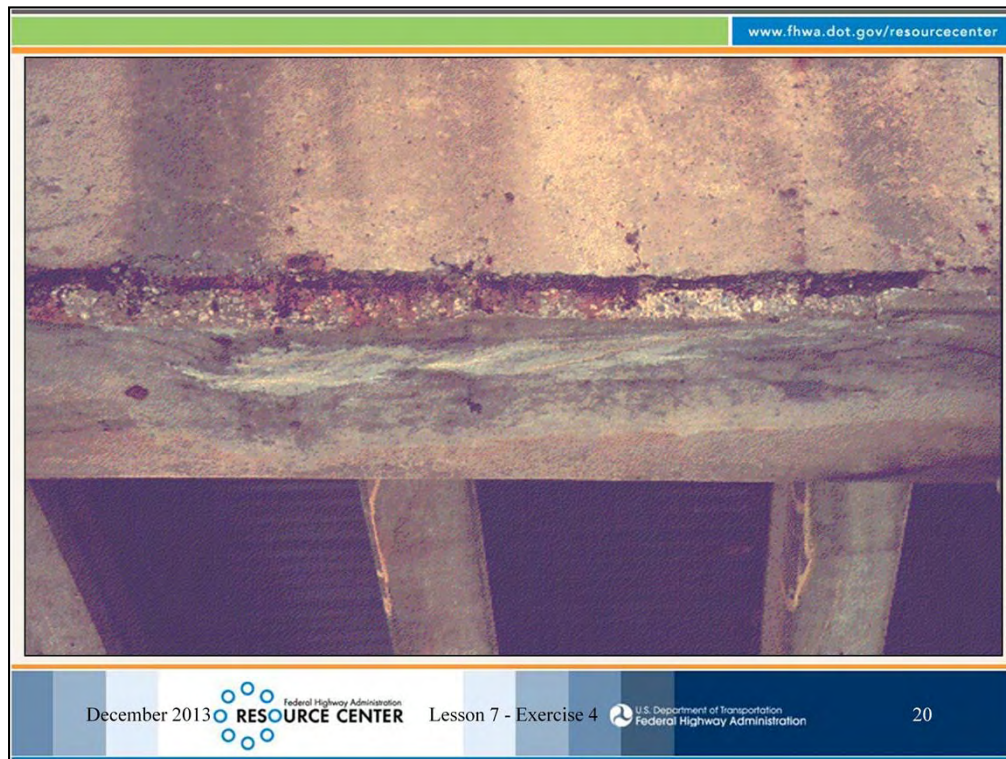
Make note of element defects and defect quantities.

Substructure, Abutments: General view of near (west) abutment and embankment slope paving. Abutment is plumb and sound with no cracks. Far (east) abutment is similar. Both abutments are 49 ft. long.



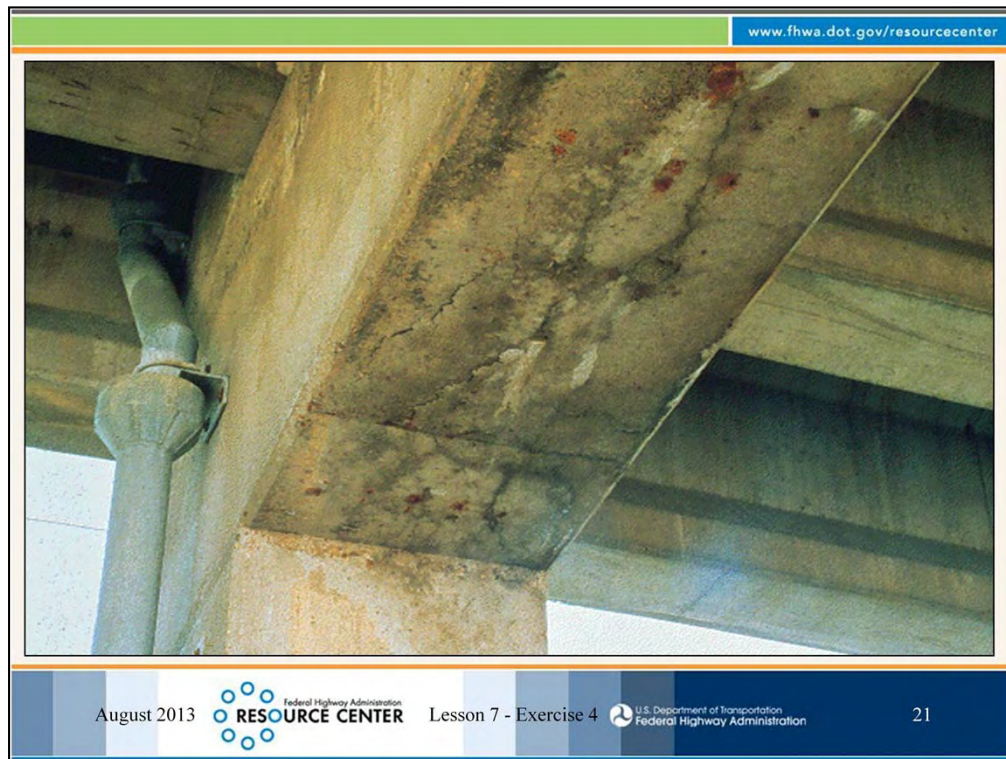
Make note of element defects and defect quantities.

Substructure, Bents: General view of near (west) face of Bent 2. Bents 1 and 3 are similar. The bent cap of Bent 2 is 49 ft. long. The bent cap of Bents 1 and 3 are 50 ft. long.



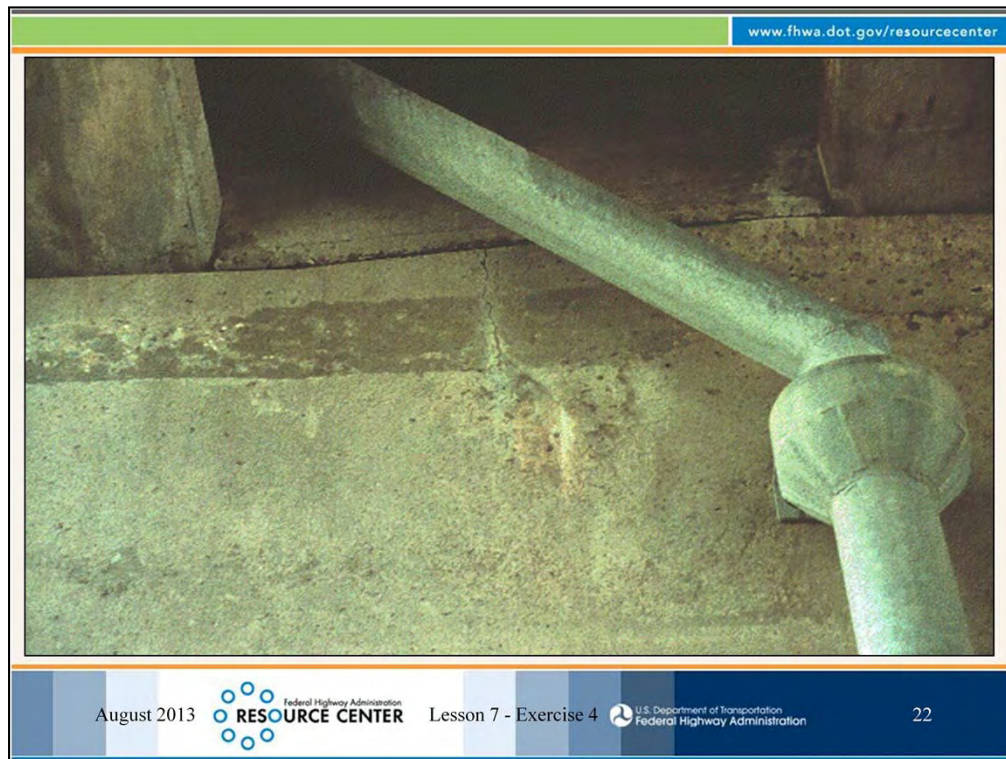
Make note of element defects and defect quantities.

Substructure, Bent 1: The underside of Bent Cap 1 has a delaminated area 14 ft. long. There are also spalls greater than 1 in. deep over a 12 ft. length with exposed rebar. The exposed #8 rebar has 1/16 in. section loss. There are cracks less than 0.05 in. wide with light efflorescence over the same 12 ft. length.



Make note of element defects and defect quantities.

Substructure, Bent 2: Bent cap has 1/16 (0.06) in. wide cracks and rust staining near the left column of bent 2. Cracking extends for 6 ft. from the bent column.



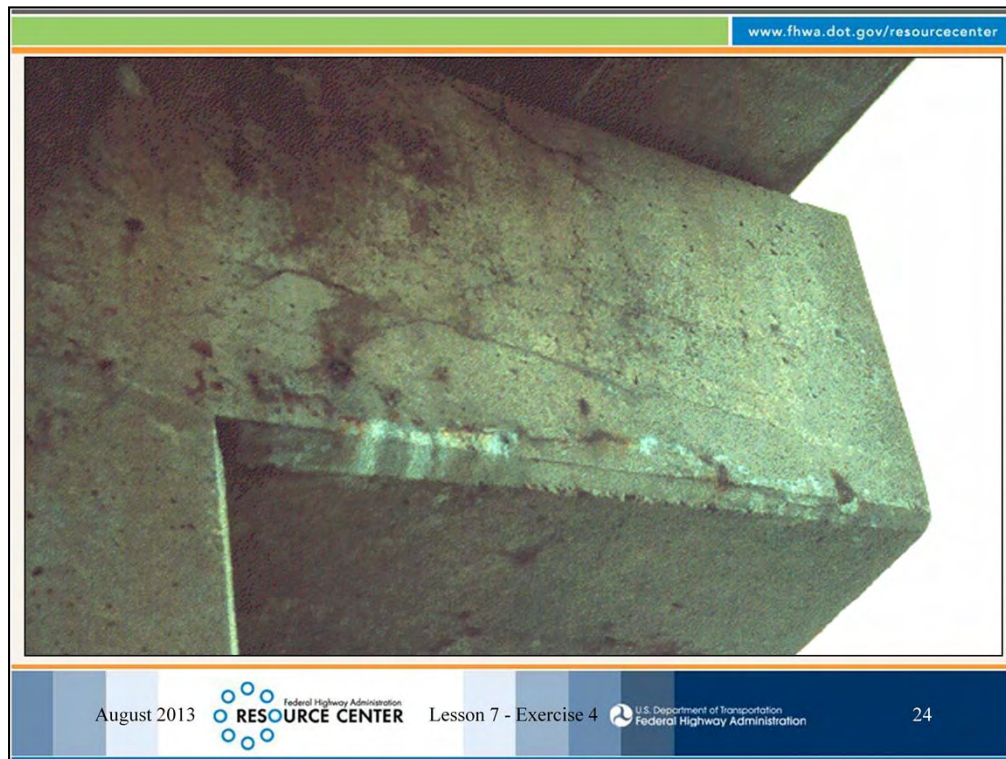
Make note of element defects and defect quantities.

Substructure, Bent 2: Bent cap has 1/16 (0.06) in. width crack, 10 in. long above the left column of bent 2 on the near (west) face.



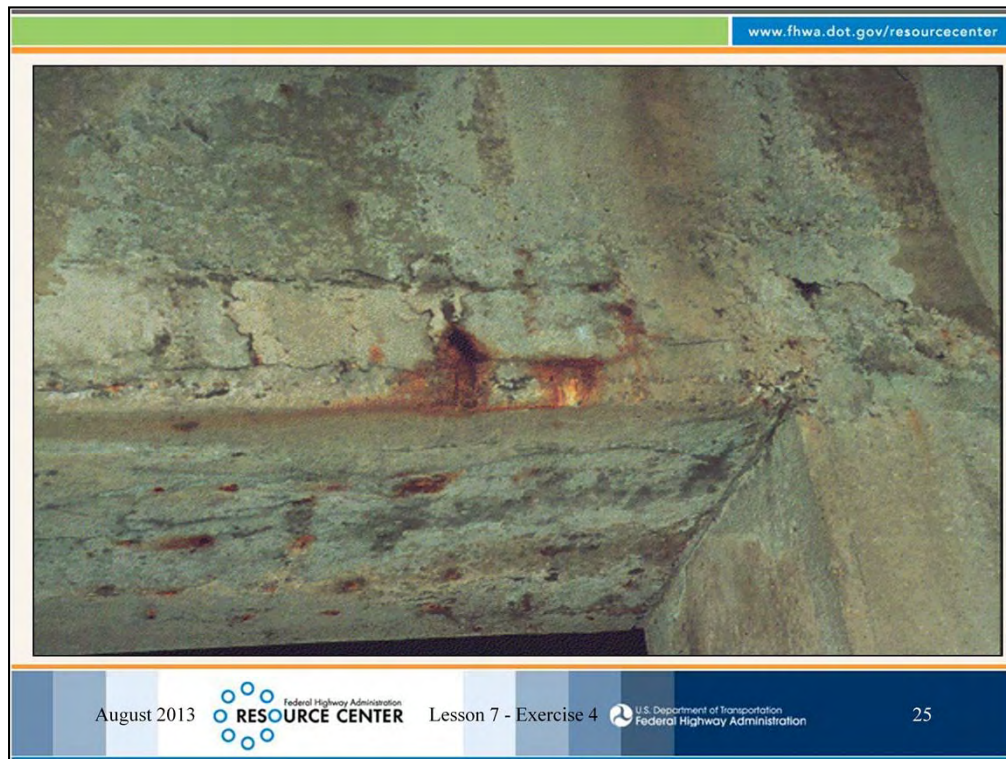
Make note of element defects and defect quantities.

Substructure, Bent 3: Bent cap has 2 ft. long 0.04 in. wide crack and rust staining at Bent 3 on the left side of the near (west) face.



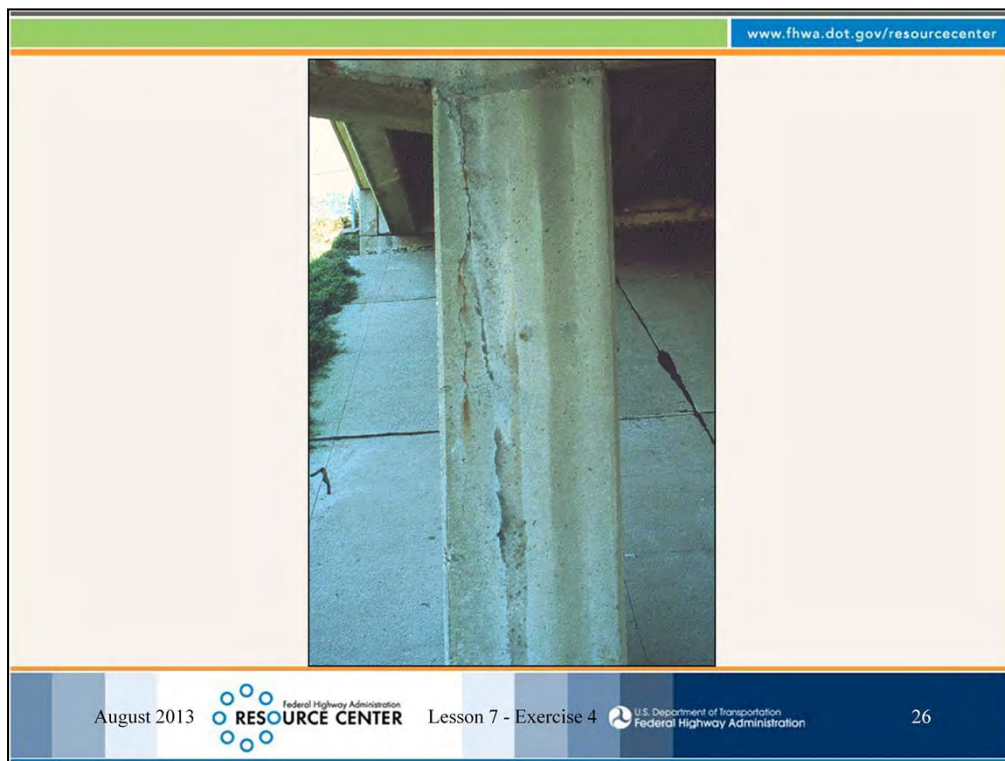
Make note of element defects and defect quantities.

Substructure, Bent 3: Bent cap has cracks less than 0.05 inches wide and rust staining of Bent 3 for 4 ft. on the right cantilever of the near (west) face.



Make note of element defects and defect quantities.

Substructure, Bent 3: Bent cap has cracks less than 0.05 inches wide and rust staining of Bent 3 for 2 ft. at the near (west) face of the center column.





Make note of element defects and defect quantities.

Substructure, Bent 3: Column has a 3/16 (0.19) in. wide x 11 ft. long vertical crack with rust staining on the left column of Bent 3. A previous structural review found that this crack does not effect strength or serviceability.

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Total Element Quantity Explanation



- Deck: 270 ft. x 44 ft. = 11,880 sq. ft.
- Pourable Joint Seal: 44 ft. x 2 joints = 88 ft.
- Compression Joint Seal: 44 ft. x 3 joints = 132 ft.
- Bridge Railing: 270 ft. x 2 = 540 ft.
- Girders: 270 ft. long x 8 girder lines = 2160 ft.
- Elastomeric Bearings: 8 Girders x 2 brgs. x 4 spans = 64 each
- RC Columns: 3 bents x 3 columns/bent = 9 each
- RC Cap: 50 ft. + 49 ft. + 50 ft. = 149 ft.
- RC Abutment: 49 ft. long x 2 abuts. = 98 ft.
- RC Approach Slabs: 24 ft. x 30 ft. x 2 = 1440 sq. ft.

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The pourable joint seals are located between the abutments and approach slabs.

The compression joint seals are located in the deck over the piers.

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Elements, Units and Quantities							
Element No.	Element Description	Total Qty	Units	Condition State Quantity			
				CS 1	CS 2	CS 3	CS 4
12	RC Deck	11880	sq. ft.				
301	Pourable Joint Seal	88	ft.				
302	Compression Joint Seal	132	ft.				
321	RC Approach Slab	1440	sq. ft.				
330	Metal Bridge Railing *	540	ft.				
331	RC Bridge Railing *	540	ft.				
109	PSC Open Girder/Beam	2160	ft.				
310	Elastomeric Bearing	64	each				
205	RC Columns	9	each				
234	RC Pier Cap	149	ft.				
215	RC Abutment	98	ft.				


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* The redirective elements of the bridge railing are a combination of concrete and metal components, therefore both the metal and reinforced concrete railing elements are used.


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Lesson 11
Wrap-up

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Course Learning Outcomes


A. Explain the following terms:

– Component vs. Element vs. Safety Inspection Data


– Elements (NBE, BME, ADE)

- Element Environments
- Element Condition States
- Element Defects


– Structure Units



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Course Learning Outcomes

- B. Explain the rules and conventions for identifying and quantifying elements
- C. Interpret condition state definitions
- D. Review as-built plans to identify bridge elements and determine appropriate units and quantities for elements

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Course Learning Outcomes

- E. Interpret condition state definitions based on visual observations and quantify and record observations
- F. Identify areas of inconsistency and/or differing interpretations
- G. Suggest areas for clarification or further guidance

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Course Evaluation

- Please complete MS Forms course evaluation
 - <https://forms.office.com/g/g4mWjcnAah>
 - Evaluation statement rating scale
 - Strongly agree (best rating)
 - Agree
 - Neither agree or disagree (neutral)
 - Disagree
 - Strongly disagree (worst rating)


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QUESTIONS



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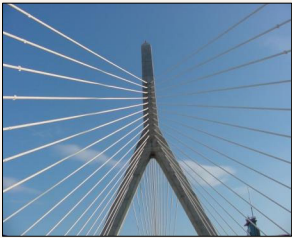
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Thank You!



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End of Course Assessment

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Instructions

- 20 questions to answer
 - Some questions are multiple choice (select one answer), True or False, and multiple answer (select multiple answers)
- 30 minutes to complete
- May use your 5-page AASHTO Elements, Defects, and Condition States hand-out
- We will review responses as time permits

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Start End of Course Assessment

- MS Forms web-link or QR code below
 - <https://forms.office.com/g/qrBNLeazgz>
- You may begin


End of Course Assessment FHWA-RC Introduction to Element-level Bridge Inspection Training



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