

2007 Western Bridge Engineers' Seminar

Fracture Critical and Fatigue Prone Inspection of the West Fremont Bridge Approach Structures

Portland, Oregon

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HDR

Background



- 1971 – 1973
- US 30 EB/WB
& I-405 NB/SB
- 6 movements
- 7 bridges:
385 ft – 2384 ft



West Approach Willamette River (Fremont) Bridge



West Approach Bridge Characteristics

- 17,003 feet of trapezoidal steel box girders



West Approach Bridge Characteristics

- 35,396 feet of reinforced concrete box girders



West Approach Bridge Characteristics

- 139 pin and hanger assemblies at 30 hinge joints



West Approach Bridge Characteristics

- Architectural concrete piers



West Approach Bridge Characteristics

- **Architectural concrete piers**



West Approach Bridge Characteristics

- Structural steel ring beams



West Approach Bridge Characteristics

- Structural steel ring beams



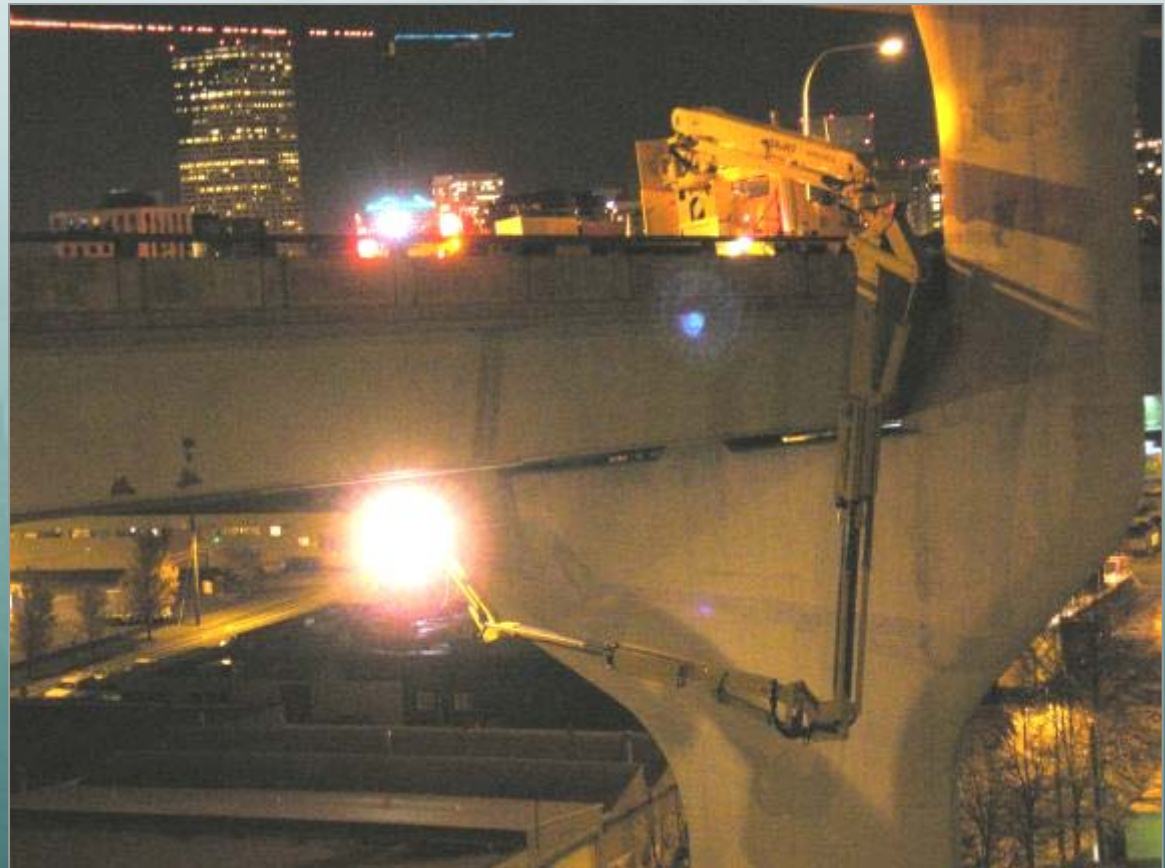
Site Conditions

- 112,600 ADT, 11% trucks (I-405)
- Superelevation + grade > 15%
- Winter in Portland = rain
- Night work
 - 8 p.m. to 5 a.m., weekdays
 - 3 p.m. to 11 a.m., weekends

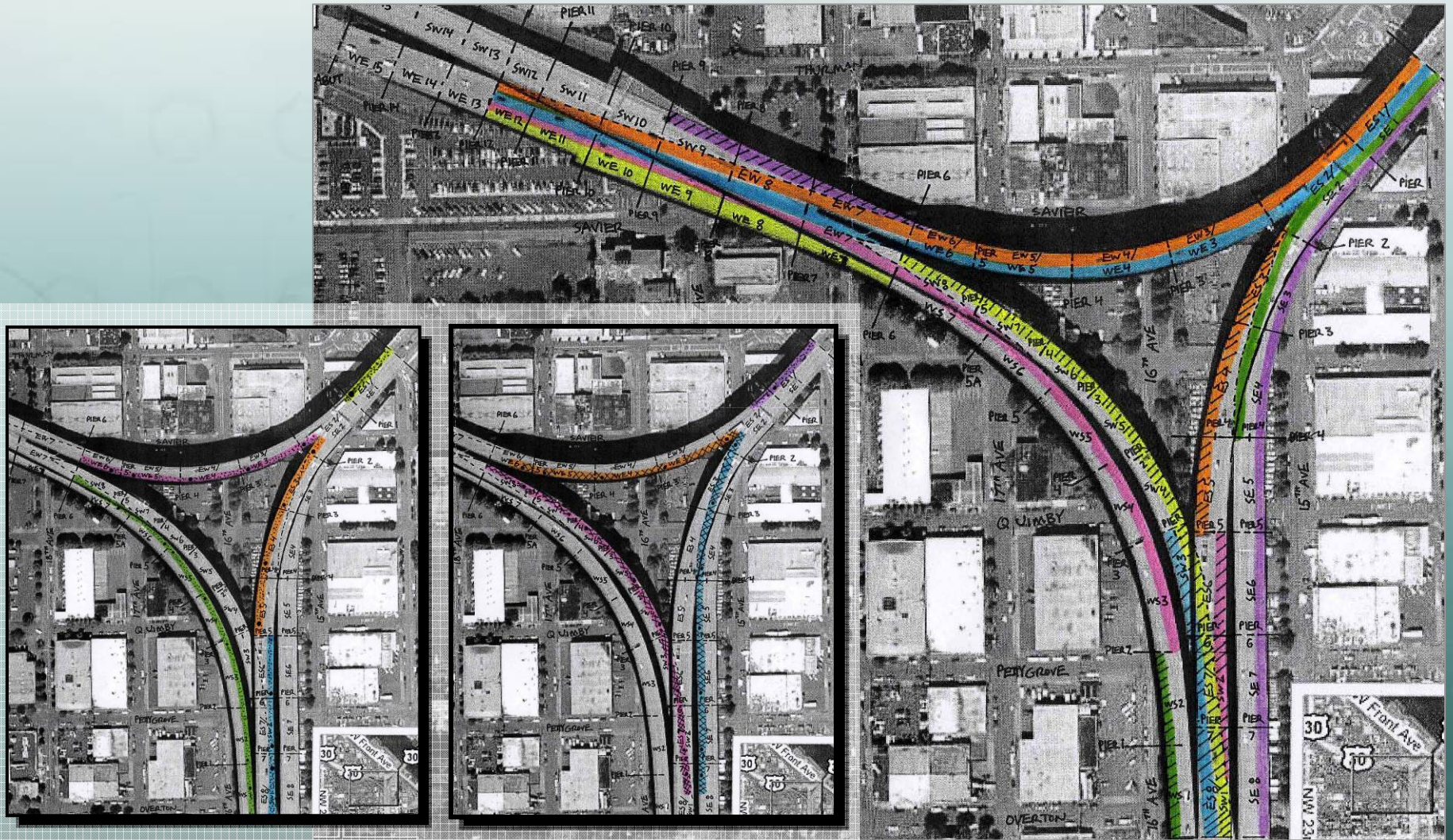


Access Equipment

- 2 ODOT snooper trucks
- 45-ft. bucket truck
- 80-ft. aerial lift



Traffic Control / Staging of Work

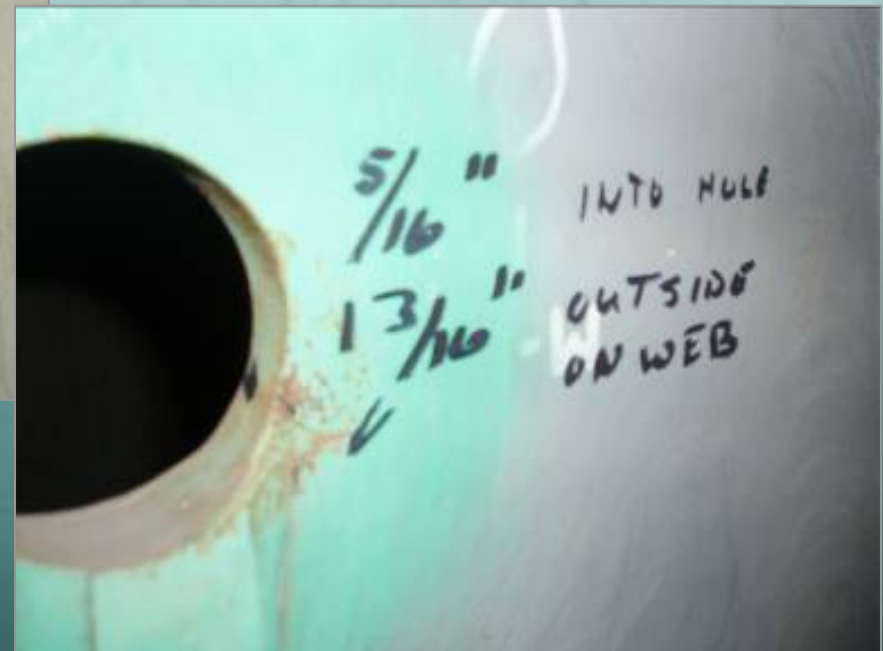


Field Inspection Topics

- Significant findings
- Fracture critical, fatigue prone, and intersecting weld details
- Pin and hanger assemblies
- Fracture critical and fatigue prone detail reports
- Other inspection findings
- Field notes



Significant Findings



- Crack propagating from arrest hole

Significant Findings



- Crack in weld between cross beam web and girder connection plate

Significant Findings



- Crack in weld between cross beam web and girder connection plate

Significant Findings

- Crack in weld between longitudinal stiffener and girder web near intersecting weld detail



Significant Findings

- **Failing expansion joints throughout west approach structures**



Significant Findings

- 40" section of rail and gland missing



- Maintenance crews respond quickly

Significant Findings



- Broken joint hardware accumulates on pigeon screens

Typical Fatigue Prone, Intersecting Welds and Fracture Critical Details

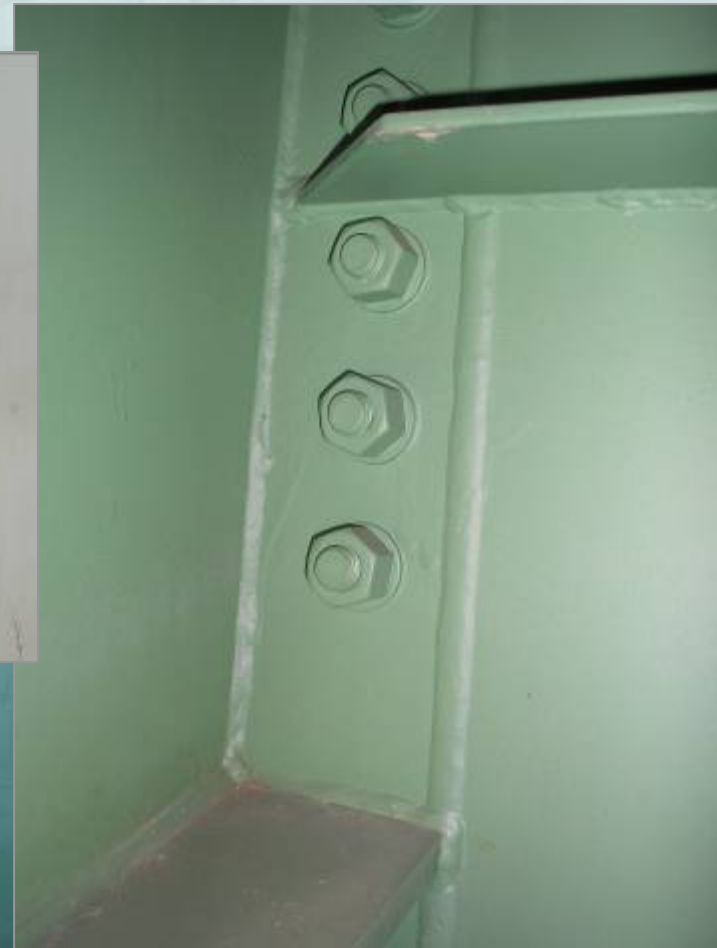
- **Fracture critical members**
 - Ring beams
 - Cross beams
 - Bottom flange and lower web in dual-girder spans
- **Intersecting welds and intermittent piggy-back welds are common**



Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Web splice at floorbeam connection



Fracture Critical, Fatigue Prone, and Intersecting Weld Details



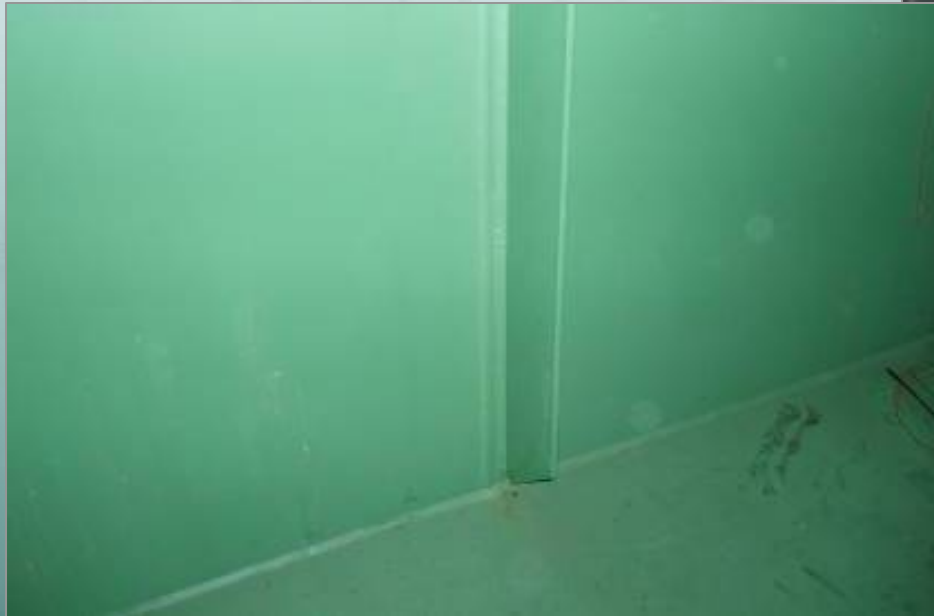
- Web splice at floorbeam connection

Fracture Critical, Fatigue Prone, and Intersecting Weld Details

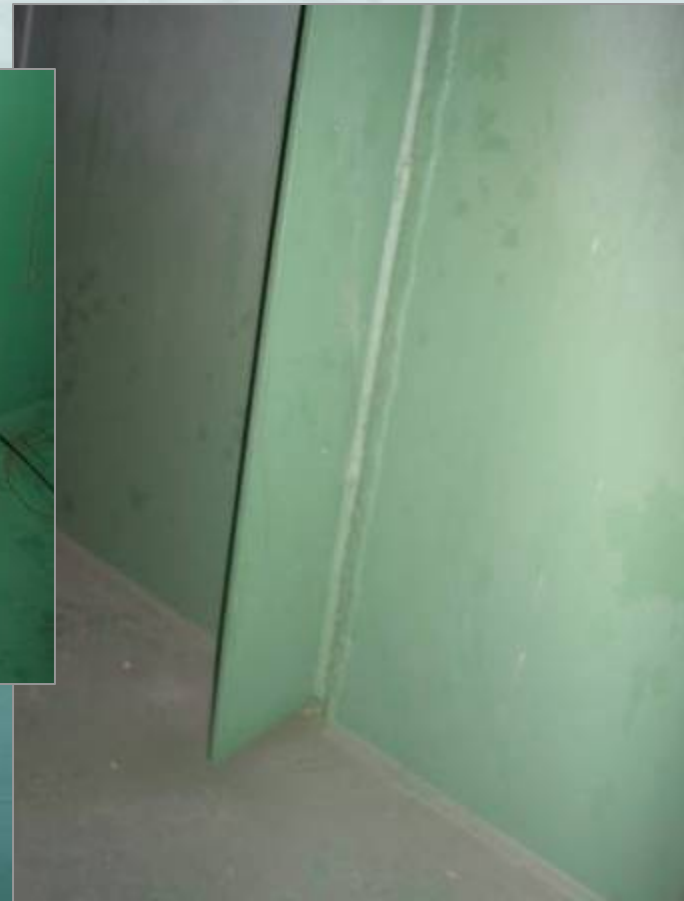


- Web splice at internal diaphragm

Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Web splice at transverse stiffener



Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Web splice, transverse stiffener, longitudinal stiffener

Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Intermittent piggy-back welds

Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Intermittent piggy-back welds

Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Weld defects present at several locations

Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Previously arrested fatigue cracks in ring beams

Fracture Critical, Fatigue Prone, and Intersecting Weld Details



- Tack welds between the ring beam bottom flanges and splice fill plates

Fracture Critical, Fatigue Prone, and Intersecting Weld Details

- Torch-cut drain holes and plugged coupon samples



Pin and Hanger Assemblies



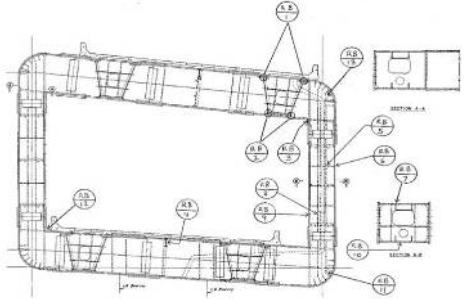
Fracture Critical Member Report

- Formatted to link detailed descriptions and locations

Inspection date: December 6, 2006

Ring Beam Typical Fatigue Prone & Intersecting Weld Details

Detail	Category	Description
RB1	IW	Ring beam web/girder web weld intersects girder top flange weld
RB2	IW	Ring beam web/girder web weld intersects girder bottom flange weld
RB3	IW	Top strut bottom flange weld intersects column flange weld
RB4	IW	Strut web/interior support beam web weld intersects strut web/interior support beam flange welds
RB5	IW	Column vertical stiffener weld intersects horizontal stiffener weld
RB6	IW	Column web/flange weld intersects horizontal stiffener weld
RB7	IW	Column vertical stiffener/column web weld intersects diaphragm/column web weld
RB8	IW	Column butt splice weld intersects vertical stiffener/column web weld
RB9	IW	Column butt splice weld intersects column web/flange weld
RB10	E	Angle support bracket for drain pipe welded all-around to column web
RB11	E	Vertical stiffener weld termination
RB12	IW	Bottom strut top flange weld intersects column flange weld
RB13	IW	Vertical stiffener weld termination intersects radial stiffener/column web weld



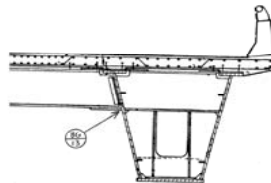
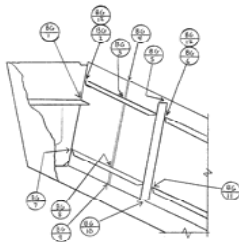
NOTE: Ring beam for EW/WE ramps shown. Fatigue prone and intersecting weld details for other Fremont West Approach ramps similar.

- Documented typical details to reduce repetition
- Recorded span, member, fatigue category, intersecting weld type, inspection method, and brief description

Fatigue Prone Detail Report

Box Girder Typical Fatigue Prone & Intersecting Weld Details

Detail	Category	Description
BG1	IW	Intersecting weld detail between diaphragm web/flange weld, diaphragm web/girder web weld, and diaphragm flange/girder web weld
BG2	IW	Upper longitudinal stiffener weld intersects girder web/diaphragm weld
BG3	IW	Web butt splice weld intersects upper longitudinal stiffener weld
BG4	IW	Web butt splice weld intersects girder top flange weld; butt weld not ground smooth (similar detail on exterior web)
BG5	IW	Transverse stiffener weld intersects girder top flange weld
BG6	IW	Upper longitudinal stiffener weld intersects transverse stiffener weld
BG7	IW	Lower longitudinal stiffener weld intersects girder web/diaphragm weld
BG8	IW	Web butt splice weld intersects lower longitudinal stiffener weld
BG9	IW	Web butt splice weld intersects girder bottom flange weld; butt weld not ground smooth (similar detail on exterior web)
BG10	IW	Transverse stiffener weld intersects girder bottom flange weld
BG11	IW	Lower longitudinal stiffener weld intersects transverse stiffener weld
BG12	E	Longitudinal stiffener weld termination
BG13	E	Floorbeam shelf plate welded to girder web



Br. 09268B 06-Dec-2006 Inspection Report

SPAN/BENT	MEMBER	LENGTH/WIDTH	TYPE OF MEMBER	FPDIW	INSP. MTHD.	INSPECTION RESULTS, REMARKS, OR RECOMMENDATIONS	SKETCH/PHOTO
Pier 1	Cross Beam	40'-00"	Cross Beam: Full Length	XG 1-7	VT	See typical FPD/W sketch above	Typ FPD/W
Pier 2	Cross Beam	40'-00"	Cross Beam: Full Length	XG 1-7	VT	See typical FPD/W sketch above	Typ FPD/W
				IW	VT	Crossbeam bearing stiffener near Girder A: 1" crack in weld between bearing stiffener and web; crack is adjacent to intersecting weld detail between bearing stiffener weld and bottom flange weld	IM09268BA4
Pier 3	Cross Beam	40'-00"	Cross Beam: Full Length	XG 1-7	VT	See typical FPD/W sketch above	Typ FPD/W
Pier 4	Cross Beam	40'-00"	Cross Beam: Full Length	XG 1-7	VT	See typical FPD/W sketch above	Typ FPD/W
Pier 5	Cross Beam	40'-00"	Cross Beam: Full Length	XG 1-7	VT	See typical FPD/W sketch above	Typ FPD/W
Pier 5A	Cross Beam	40'-00"	Cross Beam: Full Length	XG 1-7	VT	See typical FPD/W sketch above	Typ FPD/W
				D*	VT	Backer rod welded along the bottom flange-to-girder web interface near Girder A	IM09268BA5
WS 1	Girder A	161'-0.25'	Steel box girder Top flange/upper web - FP Bot flange/lower web - FC Pin & hanger assemblies - FP	BG 1-13	VT	See typical FPD/W sketch above	Typ FPD/W
				B	VT	Bottom flange transition welds near FB 11: Circular steel samples taken, holes plugged	
				D*	VT	Girder web near FB 1: Transverse stiffener weld piggly-backed onto web butt splice weld	IM09268BA6
WS 1	Girder B	161'-0.25'	Steel box girder Top flange/upper web - FP Bot flange/lower web - FC Pin & hanger assemblies - FP	E	VT	Pin & hangers: No signs of distress	
				BG 1-13	VT	See typical FPD/W sketch above	Typ FPD/W
WS 2	Girder A	175'-00"	Steel box girder Top flange/upper web - FP Bot flange/lower web - FC	BG 1-13	VT	See typical FPD/W sketch above	Typ FPD/W
				IW	VT	Girder Web A1 at Pier 2 bearing stiffener: 1" crack in weld between bearing stiffener and girder web; crack is adjacent to intersecting weld detail between bearing stiffener weld and bottom flange weld	
WS 2	Girder B	175'-00"	Steel box girder Top flange/upper web - FP Bot flange/lower web - FC	BG 1-13	VT	See typical FPD/W sketch above	Typ FPD/W

Br. 09268B 06-Dec-2006 Inspection Report

Other Inspection Findings



- Peeling paint and light surface rust

Other Inspection Findings



- Significant accumulations of pigeon debris

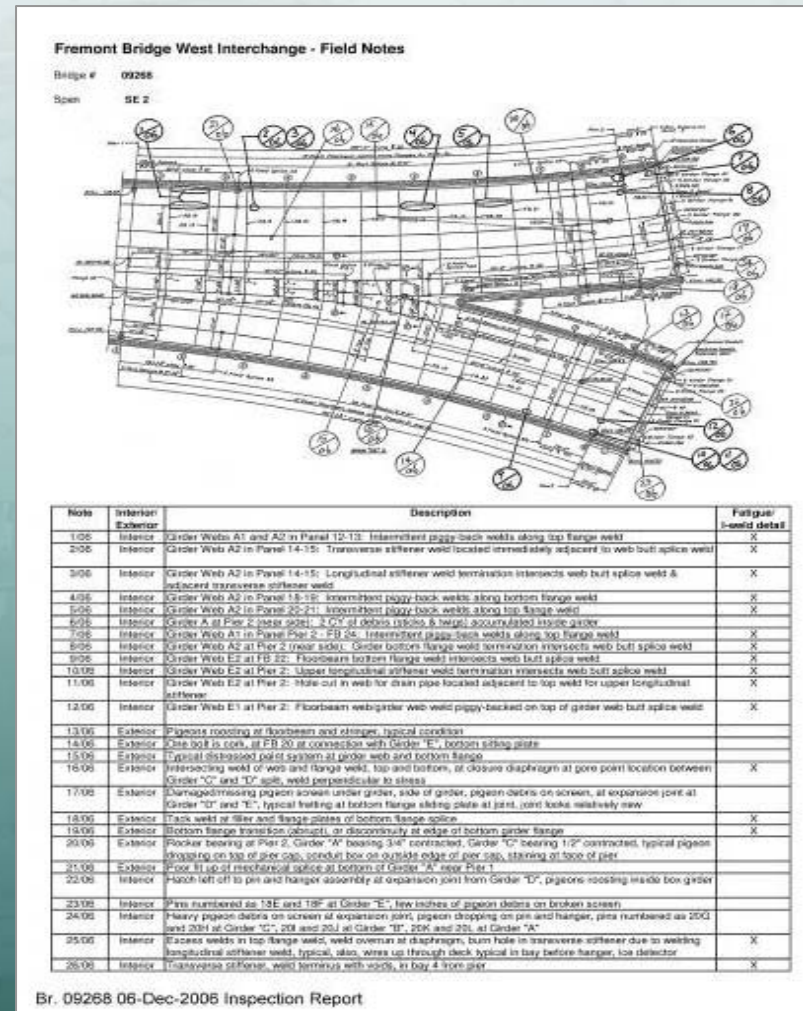
Other Inspection Findings



- Roadway debris and standing water

Field Notes

- Used to document defects, noteworthy conditions, fatigue prone details, and intersecting weld details
- As-constructed plans used as maps to document defect locations
- Unique identifier assigned to each field note

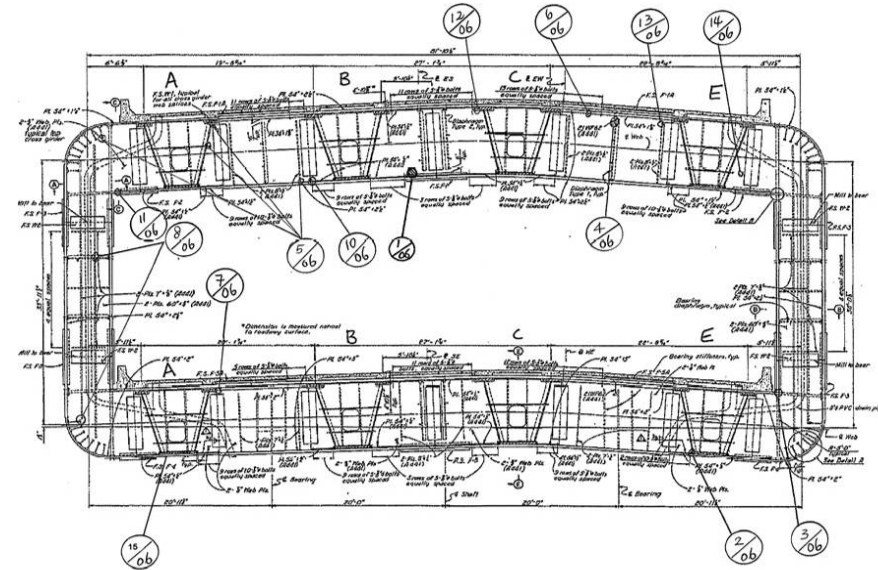


Field Notes

Fremont Bridge West Interchange - Field Notes

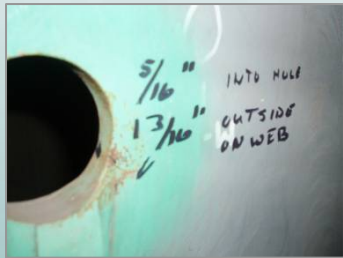
Bridge # 09268

Ring Beam 1

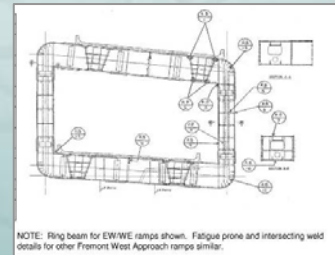


Note	Interior/ Exterior	Description	Fatigue/ I-weld detail
1/06	Exterior	Top strut, far web between Girders B and C. 1" diam torch-cut drain hole in web	
2/06	Exterior	Tack weld between ring beam bottom flange and Girder E fill plate	X
3/06	Exterior	Typical ring beam corner intersecting welds	X
4/06	Interior	Typical intersecting welds where rolled shape cross member connects to the web (between girders)	X
5/06	Interior	Typical intersecting welds at bearing stiffener and flange weld, web stiffener and flange weld, longitudinal stiffener weld and web weld, girder flange weld and ring beam web weld, corner stiffener weld to web of ring beam, crossgirder web weld and girder top flange weld	X
6/06	Interior	Typical water condensation and speckled rust inside ring beam	
7/06	Interior	Multiple passes of improperly built up weld at inside wall of ring beam, typical with bad weld and weld overruns	X
8/06	Interior	Typical intersecting welds, vertical and horizontal stiffeners at diaphragm, between all around weld of vertical stiffener and all around weld of corner stiffener	X
10/06	Interior	Flame cut hole in stiffener at web and near bottom flange of Girder "B" after welding (weld still in place)	X
11/06	Interior	Typical, water leaking thru ringbeam splice location, and pooling around drain hole	X
12/06	Interior	Rust on weld overruns, weld between web and top flange, Girder "C"	X
13/06	Interior	Ring beam diaphragm, between Girder "C" and "E", severely undercut weld at top	X
14/06	Interior	Small piece of angle iron welded to the web of the crossgirder	X
15/06	Exterior	Tack weld between ring beam bottom flange and Girder A fill plate	X

Summary



Significant findings



Fracture Critical and Fatigue Prone Detail Reports



Fracture Critical, Fatigue Prone, and Intersecting Weld Details



Other Inspection Findings



Pin and Hanger Assemblies



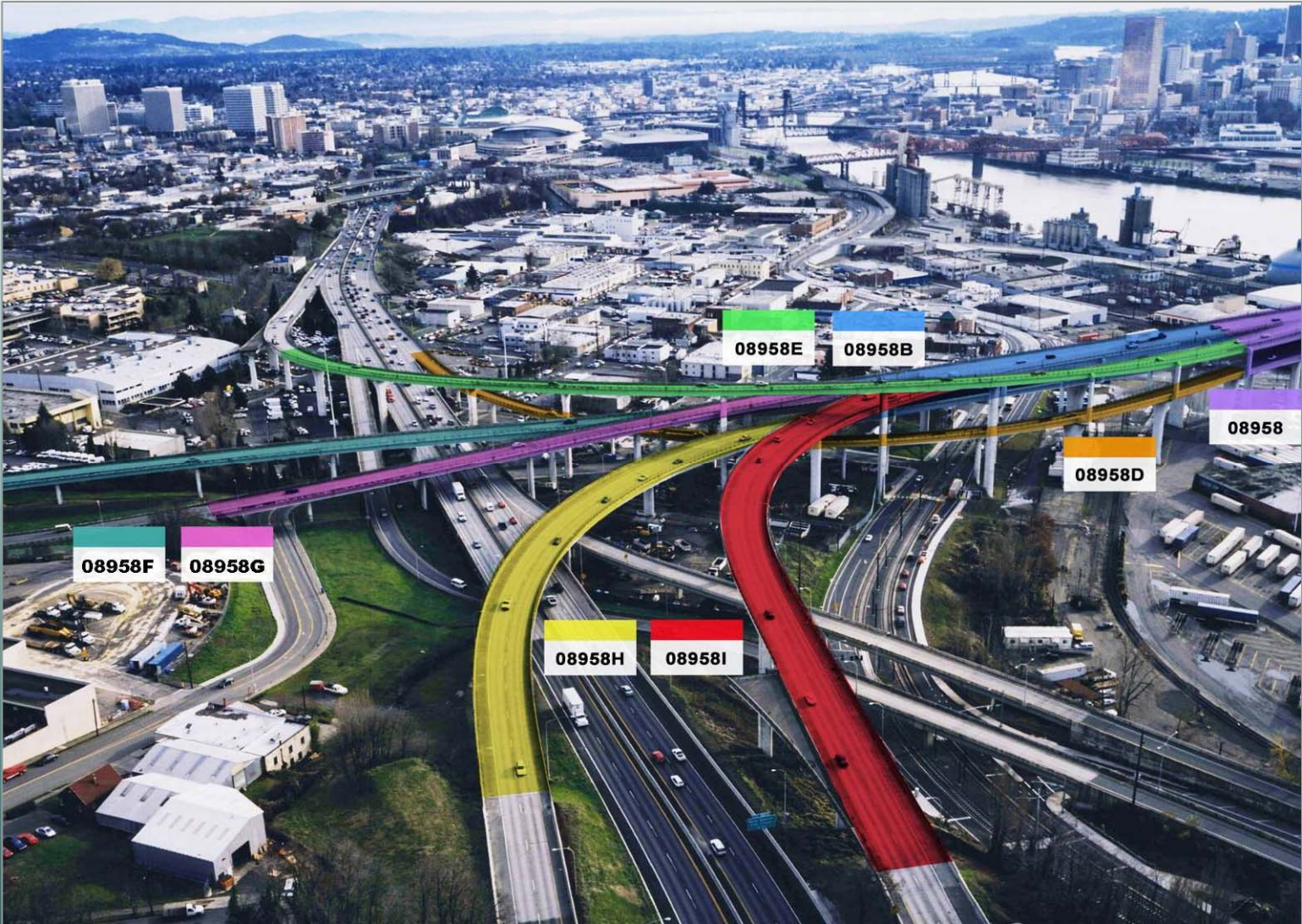
Field Notes

East Approach Interchange



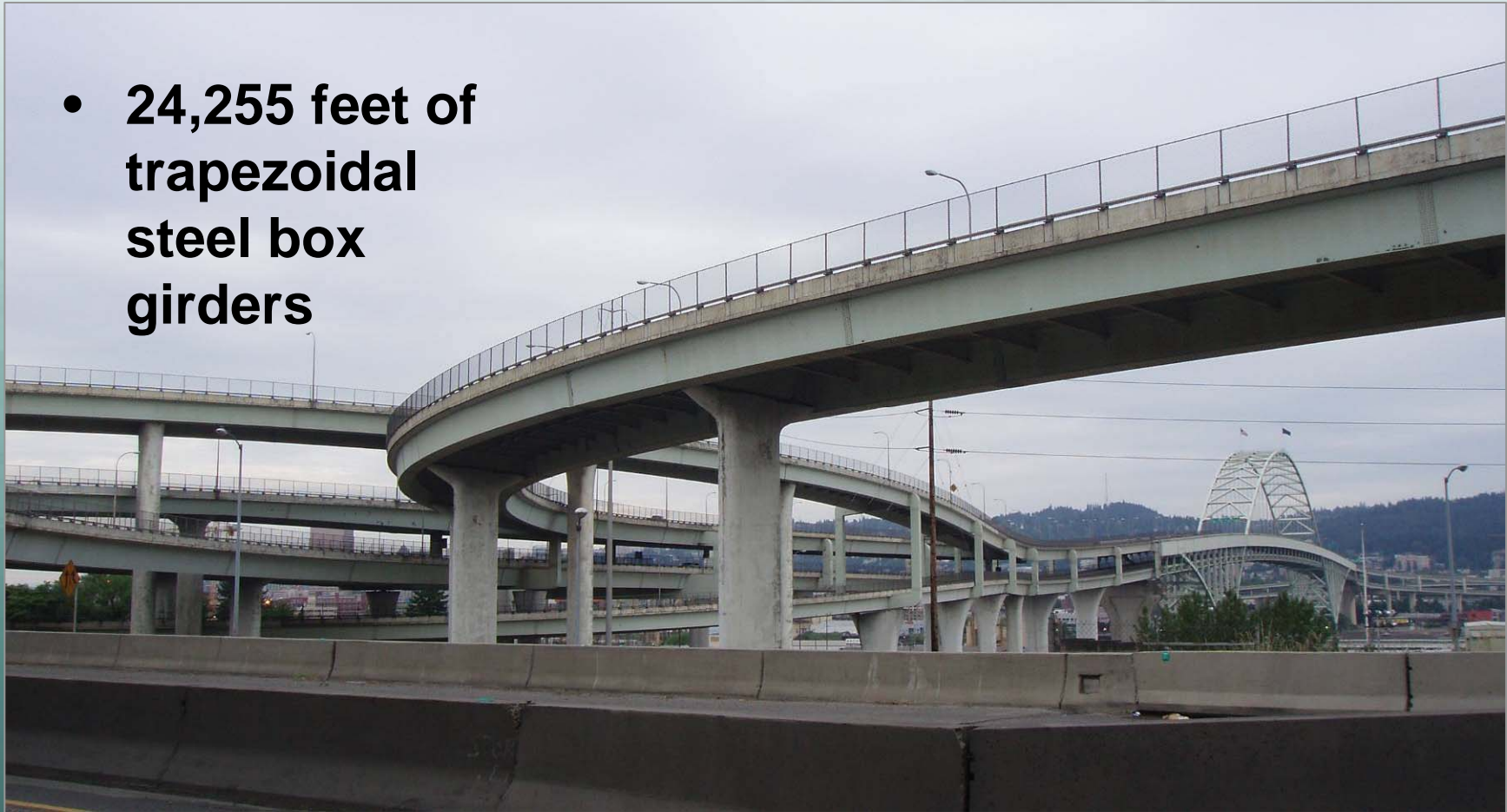
- I-5 NB/SB & I-405 NB/SB
- 6 movements
- 8 bridges:
655 ft – 2457 ft

East Approach Willamette River (Fremont) Bridge



East Approach Bridge Characteristics

- 24,255 feet of trapezoidal steel box girders



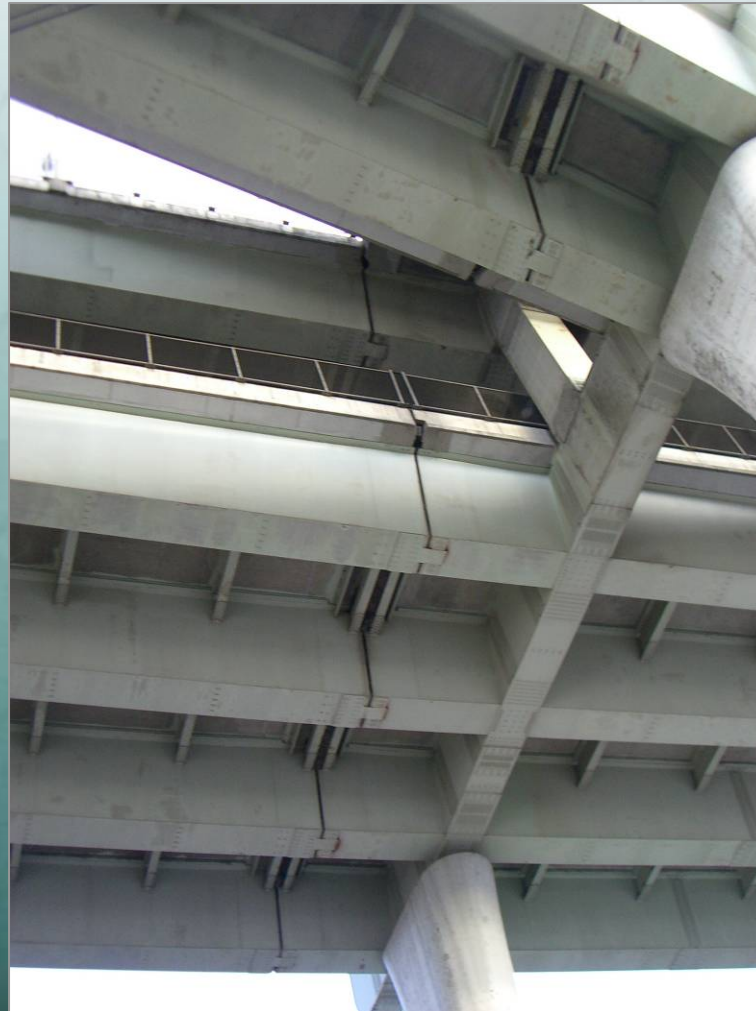
East Approach Bridge Characteristics



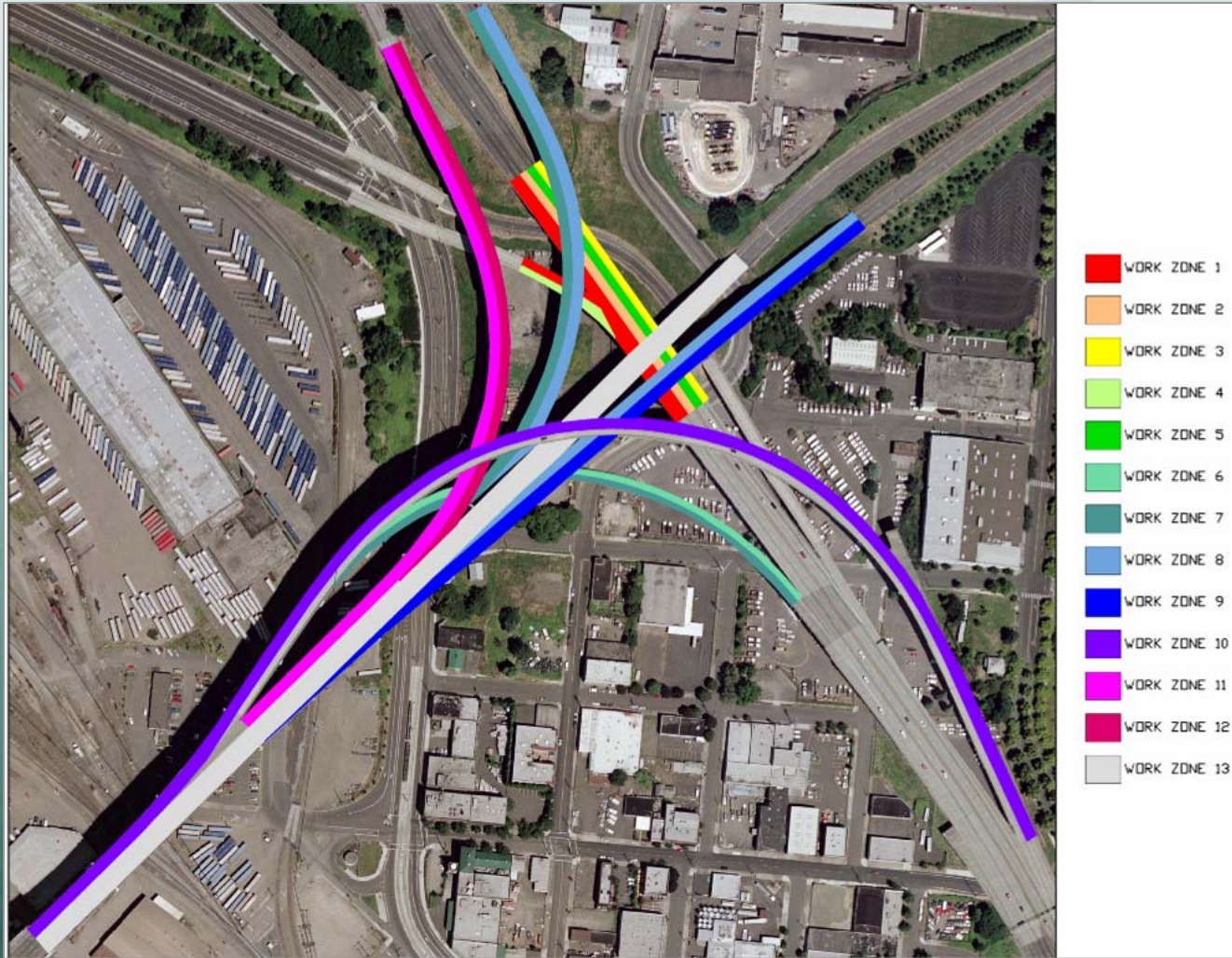
East Approach Bridge Characteristics



East Approach Bridge Characteristics



Traffic Control / Work Access



Traffic Control / Work Access

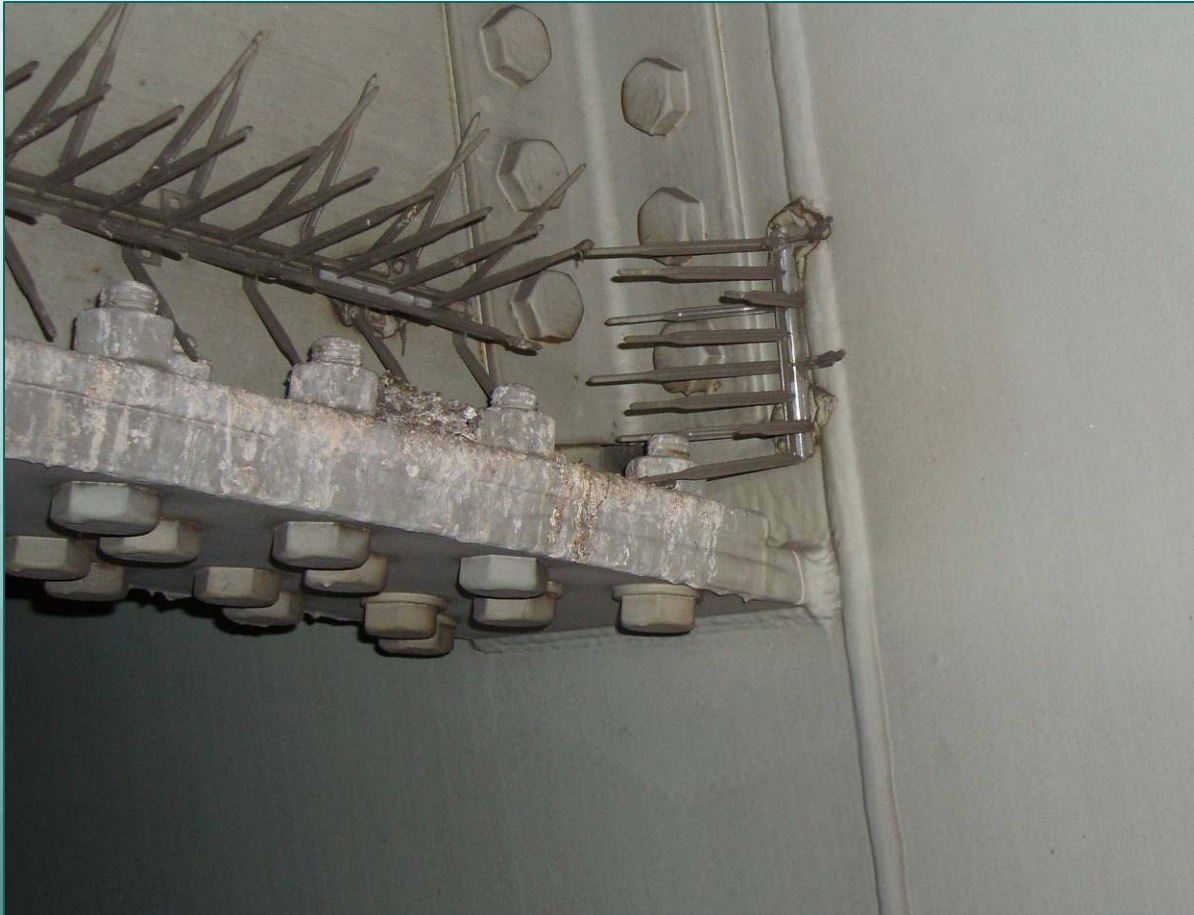


Traffic Control / Work Access



Traffic Control / Work Access





Questions?