

CASE STUDY OF THE REHABILITATION AND PRESERVATION OF POST-TENSIONED (PT) COMPLEX BRIDGE 690

PRESENTED BY:

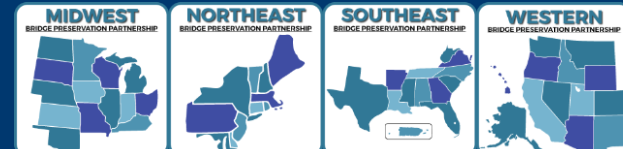
DALLAS MONTGOMERY, PE, PS, ASBI, PTI, SENIOR PROJECT MANAGER



MIKE KRONANDER, PE, ASBI, PTI, PROJECT MANAGER



BURGESS & NIPLE



TEAM EXPERIENCE

- 70+ PT Bridges
 - Segmental Box Girders
 - Cast-in-Place Box Girders
 - Straddle Bents
 - Pier Caps
 - Cable-Stay
 - Suspension
- Worked together as a team on projects for the past 18 years with an ongoing relationship.



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NATIONAL BRIDGE PRESERVATION CONFERENCE 2024
Innovation for Infrastructure Resiliency

SCOPE OF SERVICES

2021 - Phase 1 (P1)

- Visual inspection and field assessment of Bridge 690 (built 2001) for the Cincinnati Department of Transportation and Engineering (CDOTE)
- Extensive review of past construction documents
- PT inspection plan created to serve as scope for phase 2.

2021 - Phase 2 (P2)

- Risk-based NDT & IVT
- Tendon duct grout sampling
- Borescope testing of PT tendon ducts



SCOPE OF SERVICES

2021 - Phase 2-Continued (P2)

- Number of tests to perform and protocols
- Repair procedures after tests are completed
- Long term inspection and maintenance
- Develop scope for repairs

2023 - Phase 3 (P3)

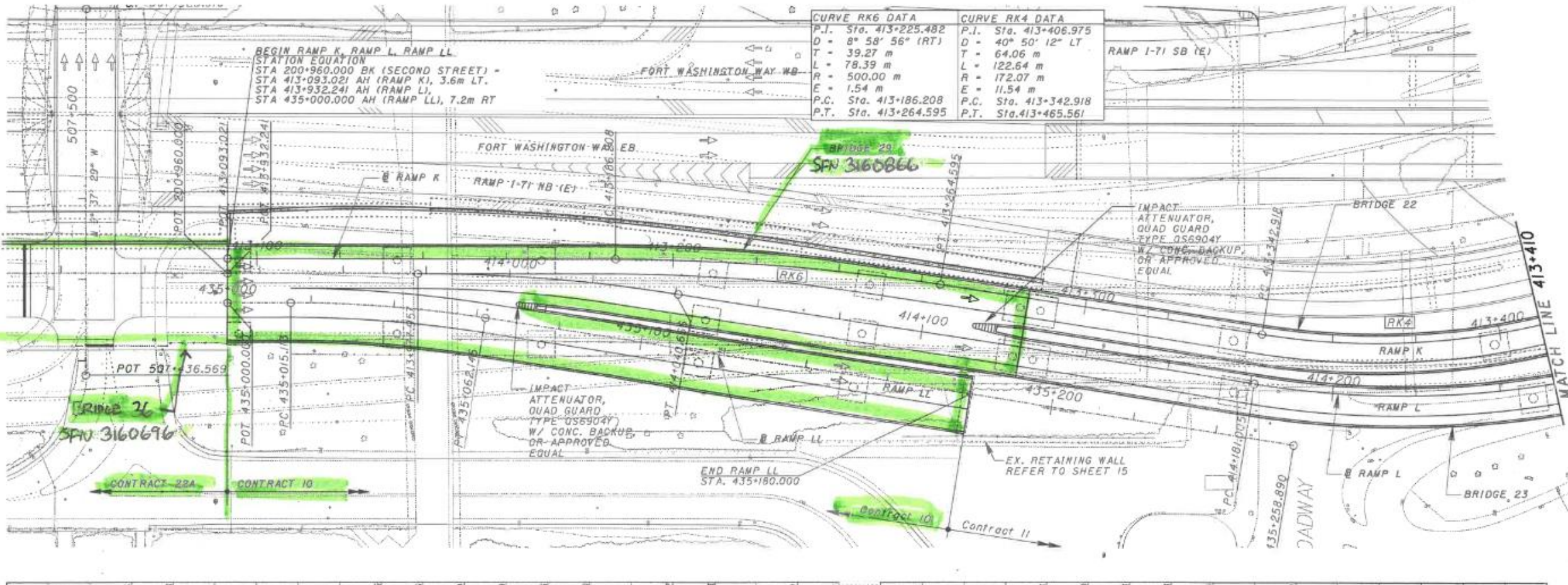
- Generation of repair plans based on findings from phases 1 & 2.

2024 - Phase 4 (Final, P4)

- Provide construction inspection expertise during remedial grouting.



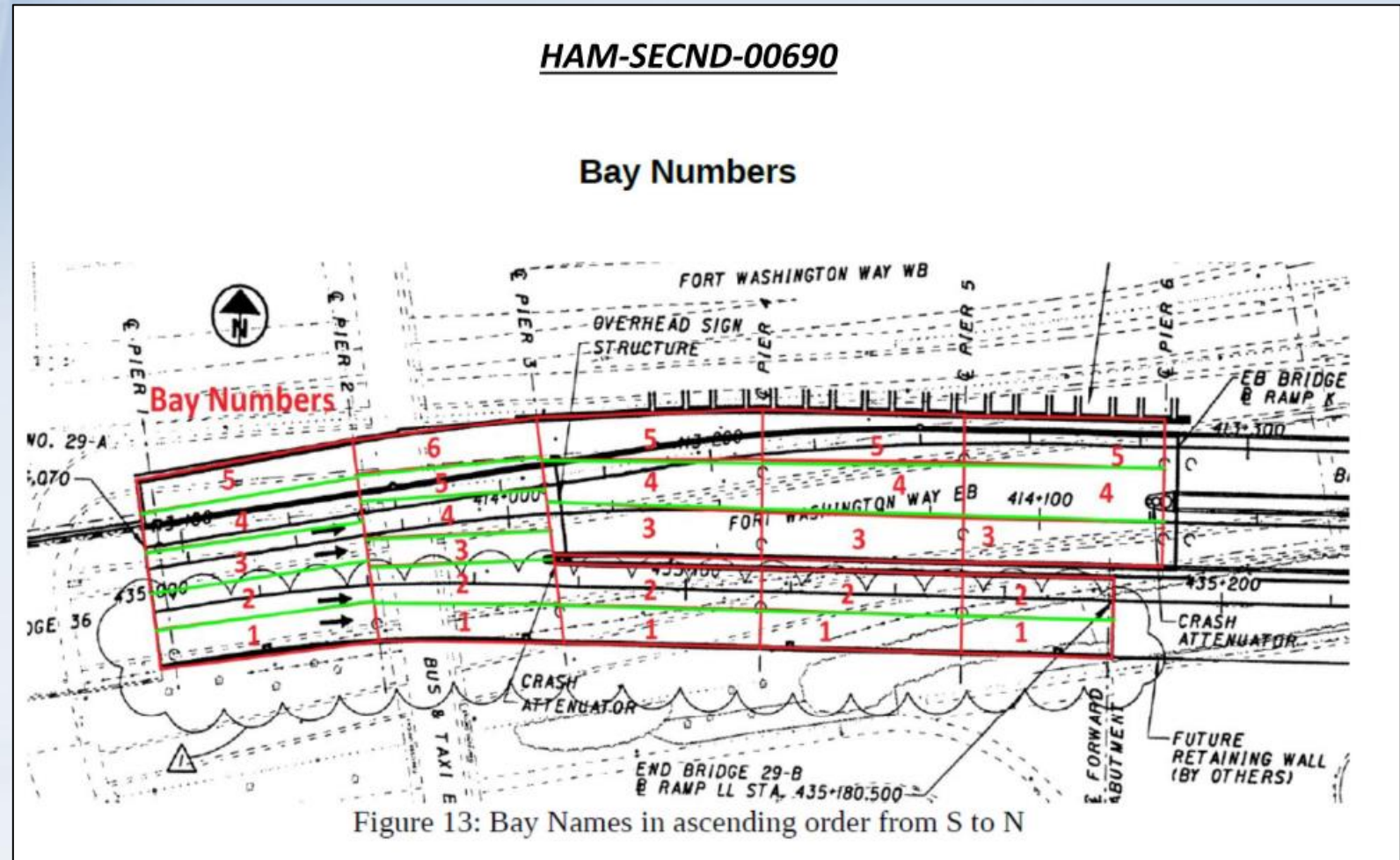
PROJECT LOCATION/SITE PLAN (P1)



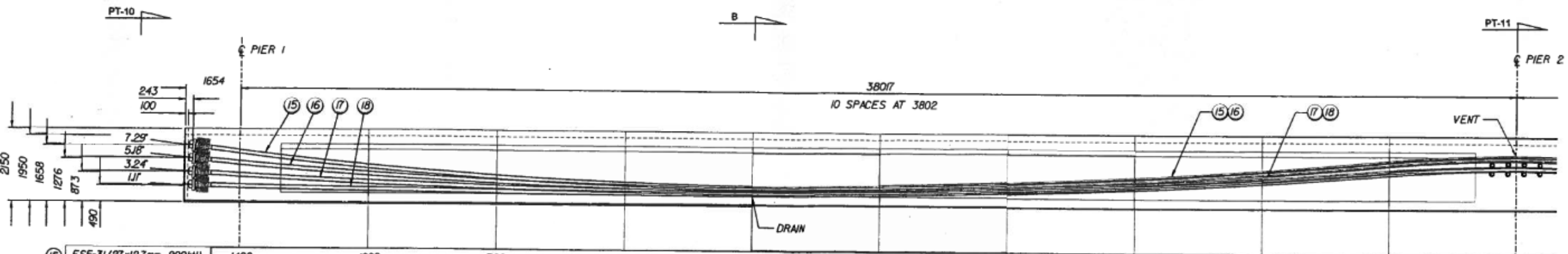
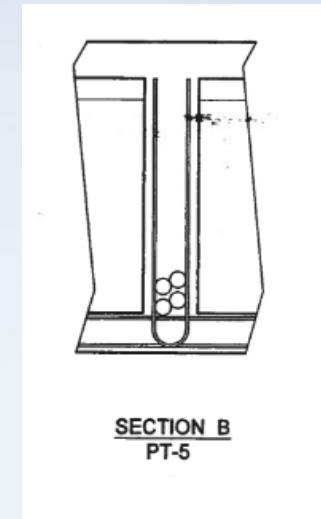
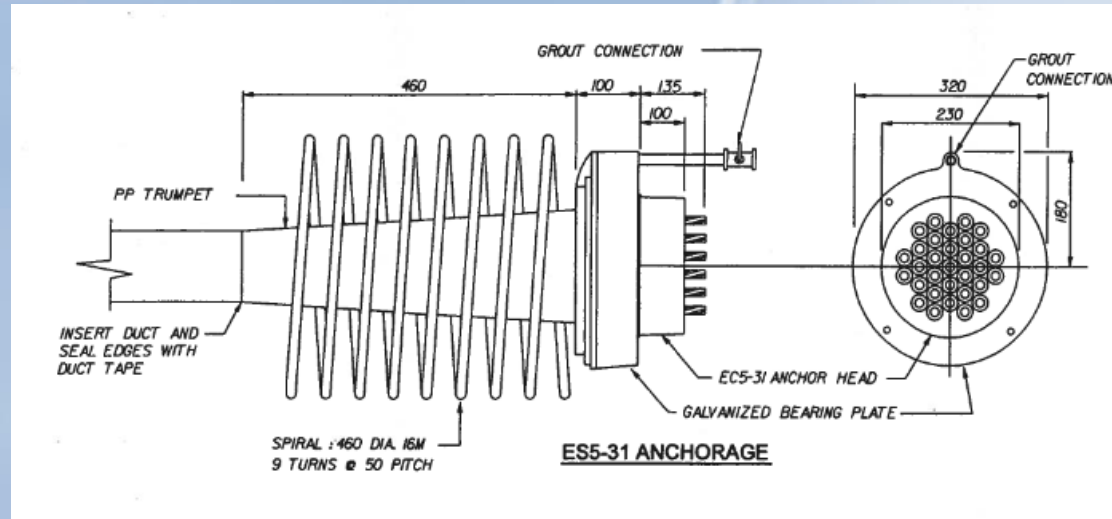
SPAN AND CELL LAYOUT (P1)

OTHER LOCATION DETAILS:

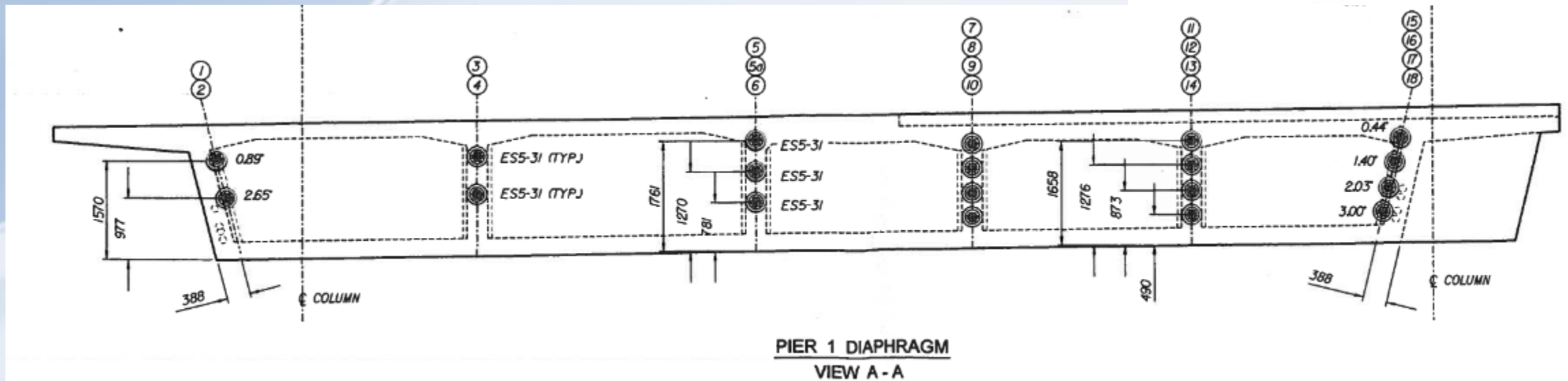
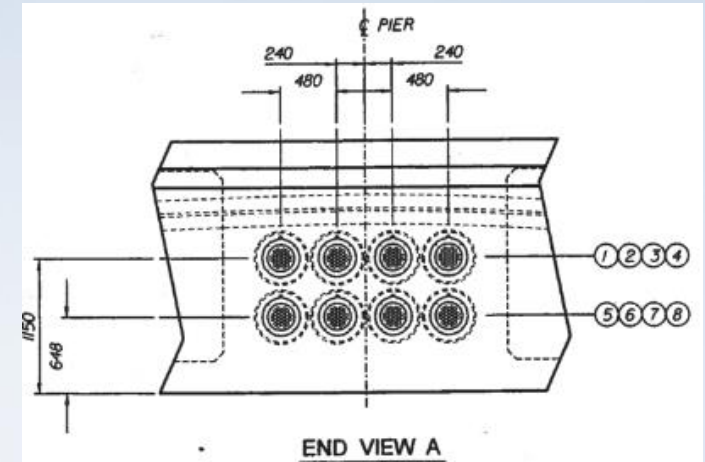
- Downtown Cincinnati, OH near Reds Stadium
- Included on-ramps to I-71 North and US-50 East
- Exit onto Johnny Bench way
- Bifurcated Deck
- Bridge is over vacant lot and parking area near transit center.



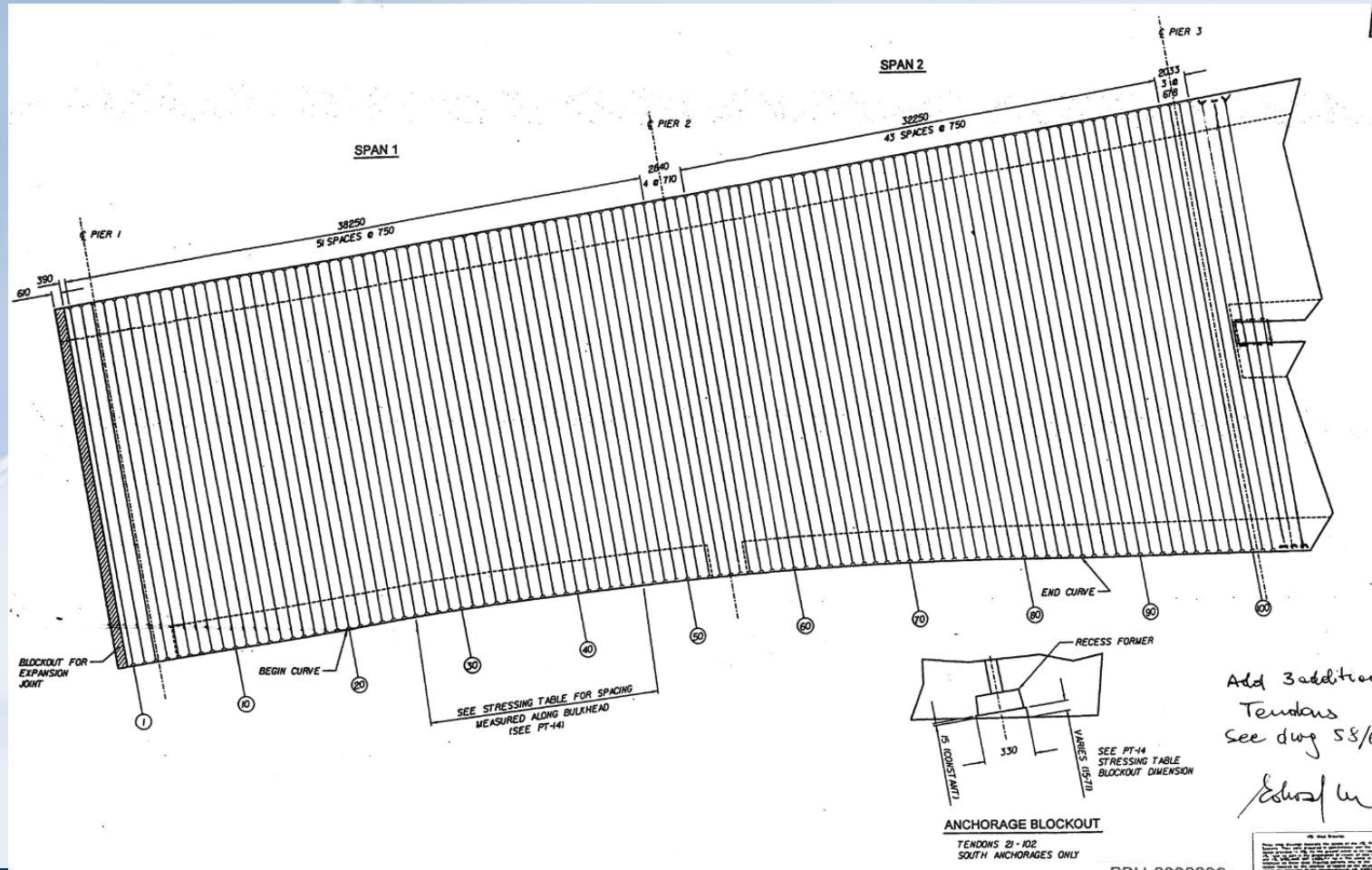
PT DETAILS/DRAWINGS (P1) LONGITUDINAL GIRDERS



PT DETAILS/DRAWINGS (P1) AT DIAPHRAGMS



PT DETAILS/DRAWINGS (P1) DECK



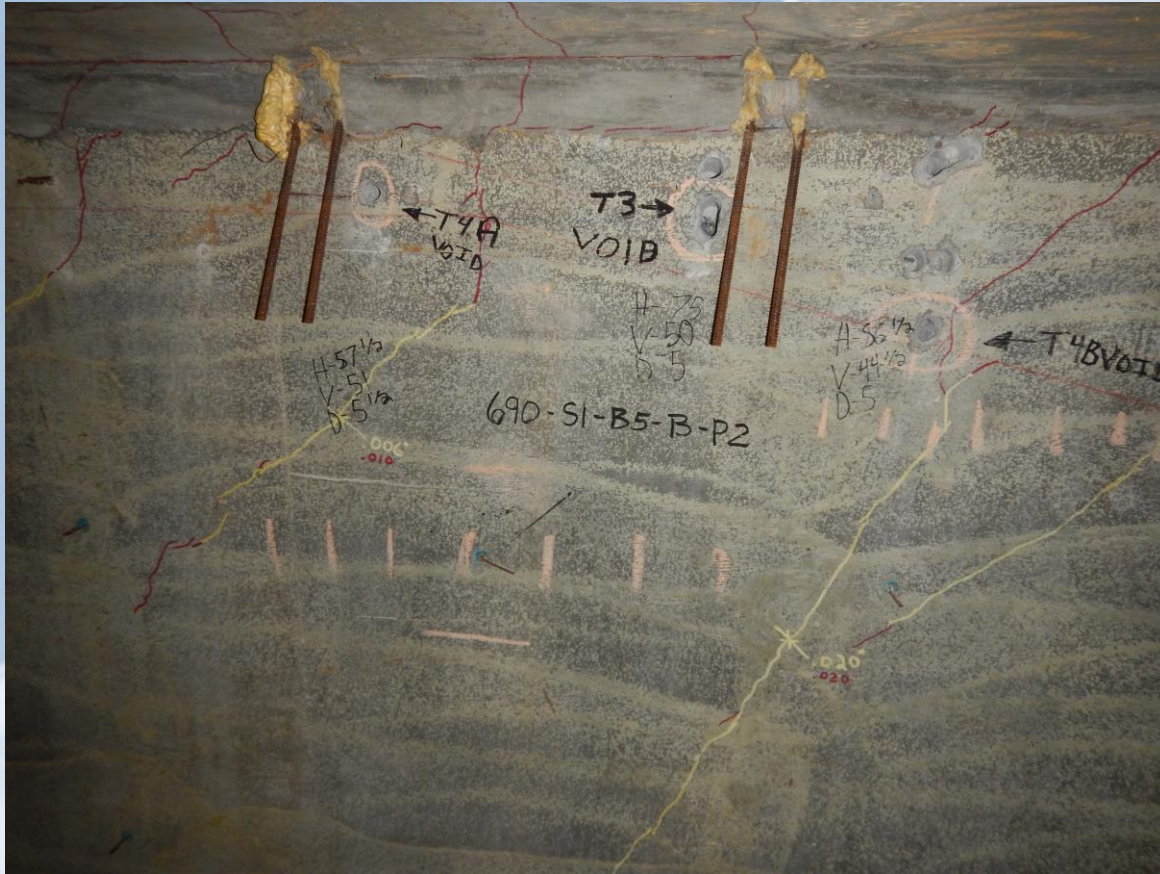
TESTING/INVESTIGATION (P2)

GPR SCANNING/LAYOUT & DRILLING

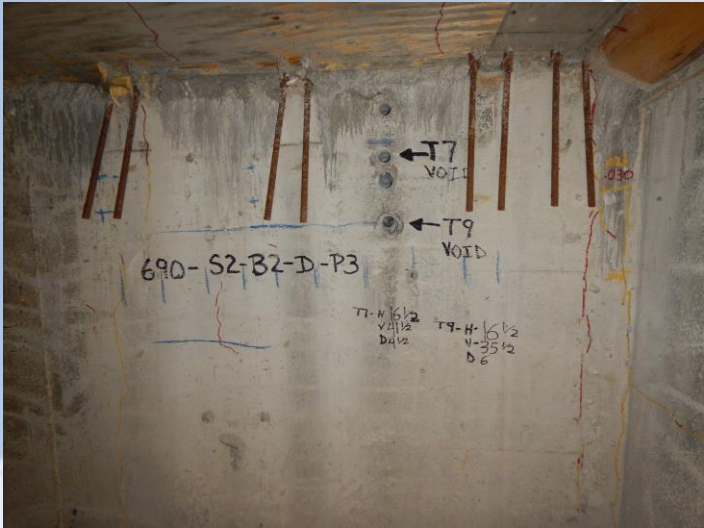
- Phase 2 was broken into two parts (also called phases):
 1. Borescope testing of 40 longitudinal tendon duct locations, two diaphragm tendon ducts, and 3 corrosion rate testing sites.
 2. If a significant number of voids were discovered (**yes this was the case**), the remaining 128 longitudinal tendon duct locations and 6 corrosion rate testing sites were to be investigated.



TESTING/INVESTIGATION (P2) GPR SCANNING/LAYOUT & DRILLING



TESTING/INVESTIGATION (P2) ID & REPAIR







TESTING/INVESTIGATION (P2) INVESTIGATION/BORESCOPE



TESTING/INVESTIGATION (P2) INVESTIGATION/BORESCOPE





TESTING/INVESTIGATION (P2) CORROSION RATE TESTING/GROUT SAMPLING



TESTING/INVESTIGATION (P2)
CORROSION RATE TESTING/GROUT SAMPLING



TESTING/INVESTIGATION (P2)
CORROSION RATE TESTING/GROUT SAMPLING

TESTING/INVESTIGATION (P2) REPAIR OF TESTING SITES



TESTING/INVESTIGATION (P2)

SUMMARY OF FINDINGS

- Voids were encountered at 100 of 170 borescope locations (59%). Void depths ranged from 0.25 inches to 4 inches (no grout).
- Six locations had visible water. 4 of 6 had standing water which exited during the drilling process.
- Fifty-one locations contained exposed strands.
- Sixty locations contained white/chalky grout pieces (**chunky**).
- Thirty-eight test locations contained white/chalky colored grout (**smooth**).
- Seventy-two locations contained hard, gray colored grout (**hard**).
- Strands were in fair-to-good condition with light corrosion.
- Ducts were in poor-to-fair condition with light to heavy corrosion on the insides.



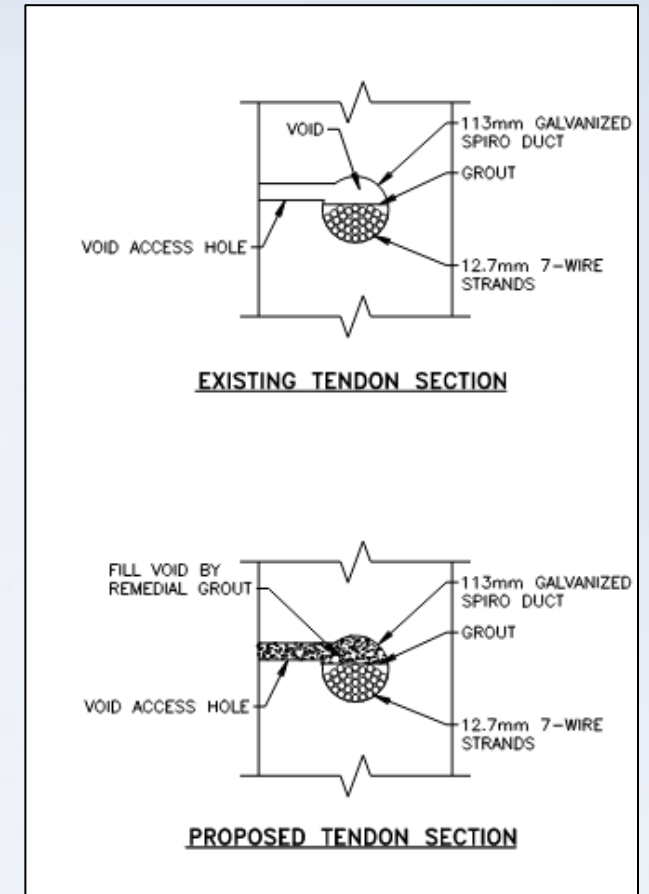
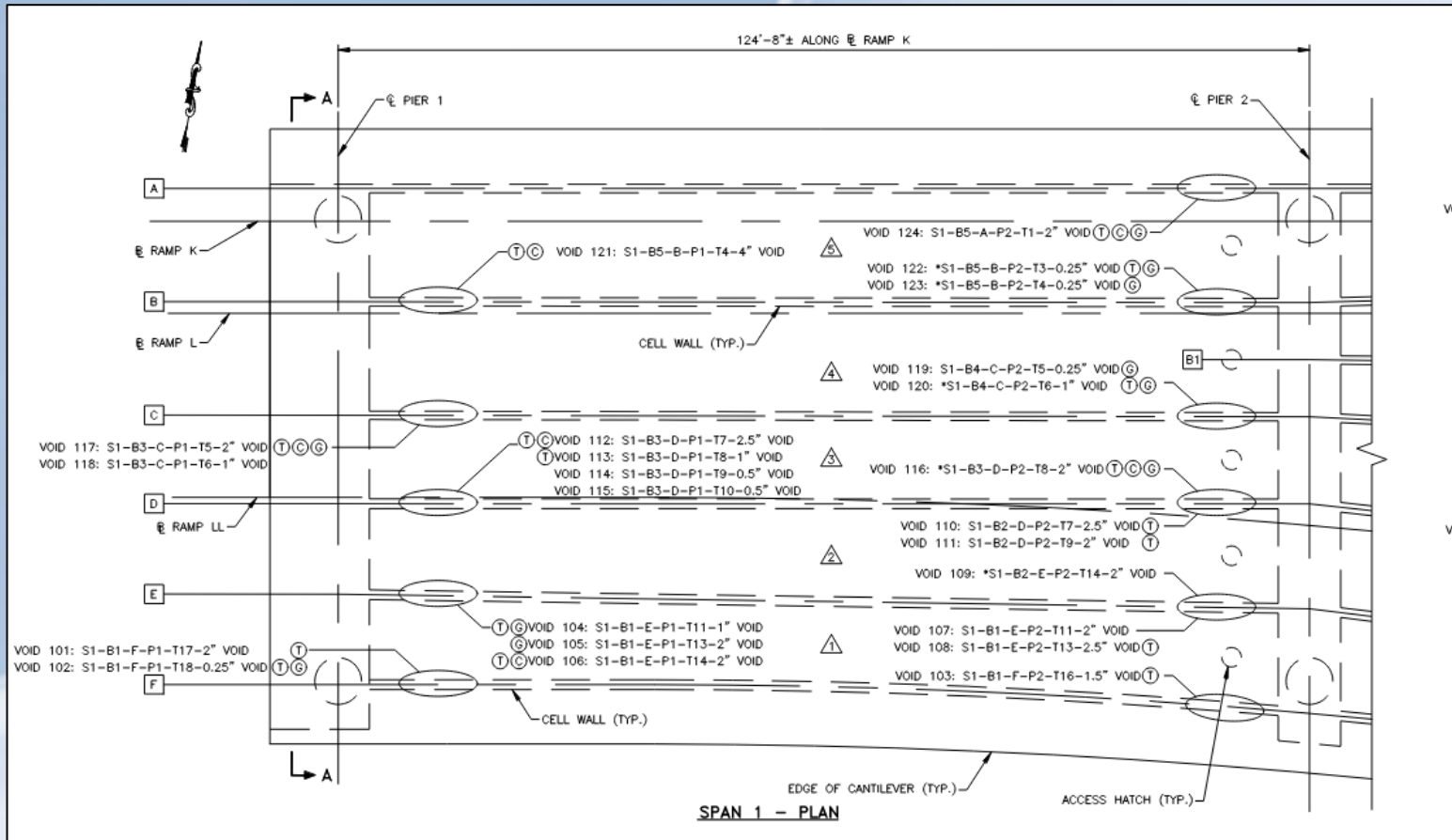
TESTING/INVESTIGATION (P2)

SUMMARY OF FINDINGS

- Upper limit of normal moisture content is 25%. Some of the chunky and smooth grout had up to 36.2%!
- Chloride content ranged from 0.011% to 0.042% below the upper threshold of 0.08% for new PT structures.
- Sulfate content ranged from 2.0% to 2.8% within upper threshold limits (3% typically).
- Six of nine locations exhibited a 90% probability of active corrosion (potential), 5 of 6 locations exhibited corrosion on duct interiors and/or strands. Remaining locations had inconclusive results.
- Four of seven locations exhibited moderate corrosion rates.
- Petrographic analysis indicated high pHs of 12 and above while within the duct. When exposed to air, carbonation took effect reducing the pH.
- Of the two borescope tests performed for the diaphragm tendons of pier 3, no deficiencies were found.



REPAIR PLANS (P3) PLAN SETS



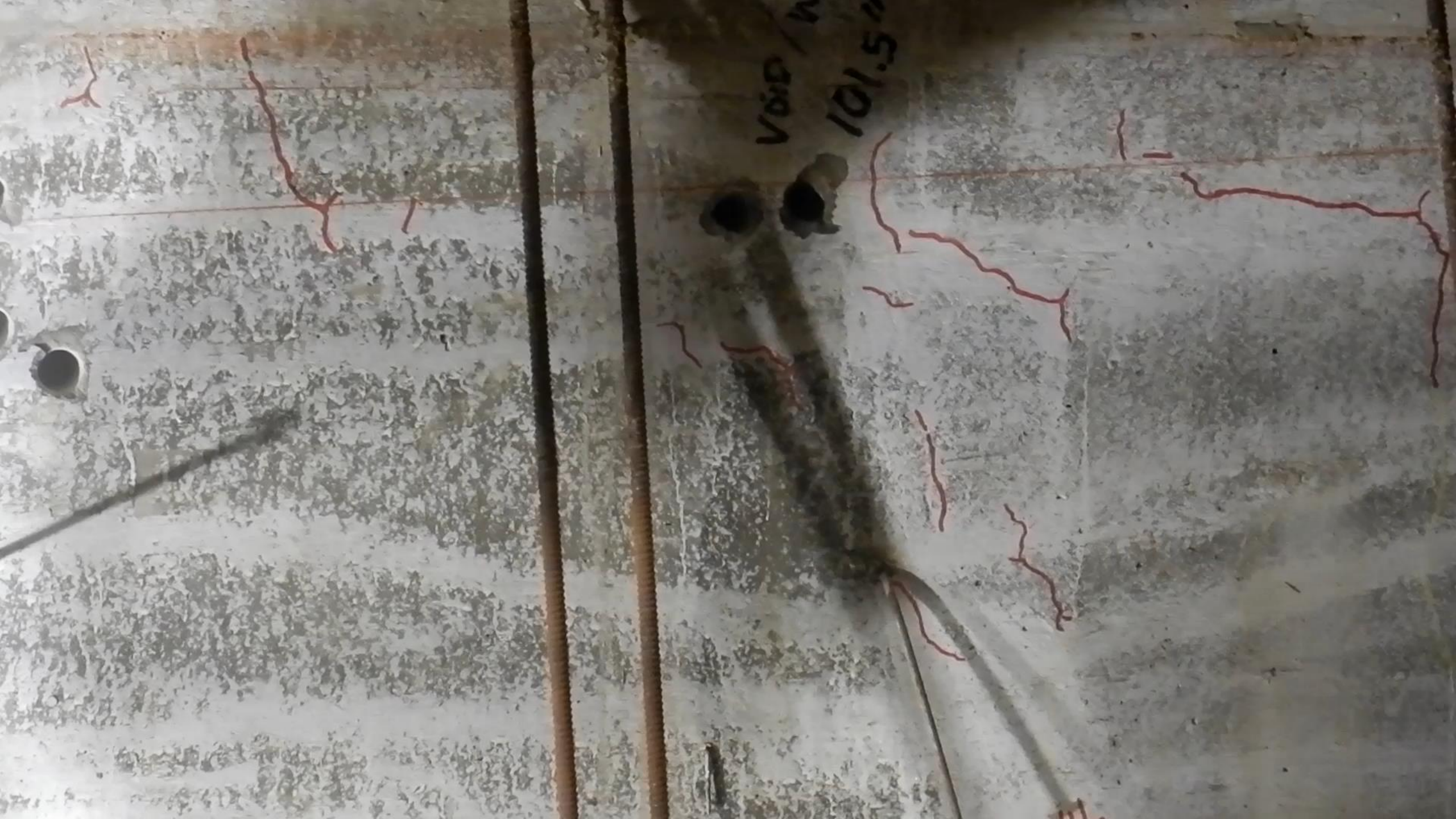
REPAIR PLANS (P3) PLAN SETS

- Void ID
- Dimensions/Location of to perform grouting.
- Void depths
- Continuous voids
- Exposed tendons
- Chunky grout (locations with pieces of grout in duct).
- Water/moisture
- Corrosion present

SPAN 1 VOID TABLE														
VOID	FIELD DESIGNATION	INSPECTION HOLE	DIST FROM BOTTOM SLAB (IN.)	HORIZONTAL DISTANCE FROM DIAPHRAGM (IN.)	DEPTH OF COVER (IN.)	VOID DEPTH (IN.)	CONT. OVER DIAPHRAGM	DUCT DIAMETER (IN.)	EXPOSED TENDONS (T)	CHUNKY GROUT (G)	CORROSION IN DUCT OR STRAND (C)	MOISTURE (M)	WATER (W)	NOTES
101	S1-B1-F-P1-T17	A	20.5	7	4	2		4	T					
102	S1-B1-F-P1-T18	A	11	14	4.5	0.25		4	T	G				
103	S1-B1-F-P2-T16	A	50	6.5	5.5	1.5		4	T					
104	S1-B1-E-P1-T11	A	41	11	8.5	1		4	T	G				
105	S1-B1-E-P1-T13	A	21	11	9	2		4		G				
106	S1-B1-E-P1-T14	A	6	11	9.5	2		4	T		C			
107	S1-B1-E-P2-T11	A	47.5	7	5	2		4						
108	S1-B1-E-P2-T13	A	39	5	5	2.5		4	T					
109	S1-B2-E-P2-T14	A	42	6.5	6.5	2	*	4						
110	S1-B2-D-P2-T7	A	47.5	5	3.5	2.5		4	T					
111	S1-B2-D-P2-T9	A	40	5	4.5	2		4	T					
112	S1-B3-D-P1-T7	A	40.5	12	5.5	2.5		4	T		C			
113	S1-B3-D-P1-T8	A	31.5	11	8	1		4	T					
114	S1-B3-D-P1-T9	A	20.5	10.5	6.5	0.5		4						
115	S1-B3-D-P1-T10	A	9.5	10	8.5	0.5		4						
116	S1-B3-D-P2-T8	A	42.5	6	5	2	*	4	T	G	C			
117	S1-B3-C-P1-T5	A	42	9.5	8	2		4	T	G	C			
118	S1-B3-C-P1-T6	A	16	7	8.5	1		4						
119	S1-B4-C-P2-T5	A	50	6.5	9	0.25		4		G				
120	S1-B4-C-P2-T6	A	45	6.5	6	1	*	4	T	G				
121	S1-B5-B-P1-T4	A	20	19	7	4		4	T		C			
		B	17.5	41	6	4		4	T		C			
122	S1-B5-B-P2-T3	A	50	75	5	0.25	*	4	T	G				
123	S1-B5-B-P2-T4	A	51	57.5	5.5	0.25	*	4		G				
		B	44.5	86.5	5	0.25	*	4		G				
124	S1-B5-A-P2-T1	A	55	91	5.5	2		4	T	G	C			
		B	52.5	105	5.5	2		4	T	G	C			



*500.0



VOID / W
101.5







EJCO CABLE GRADUATED



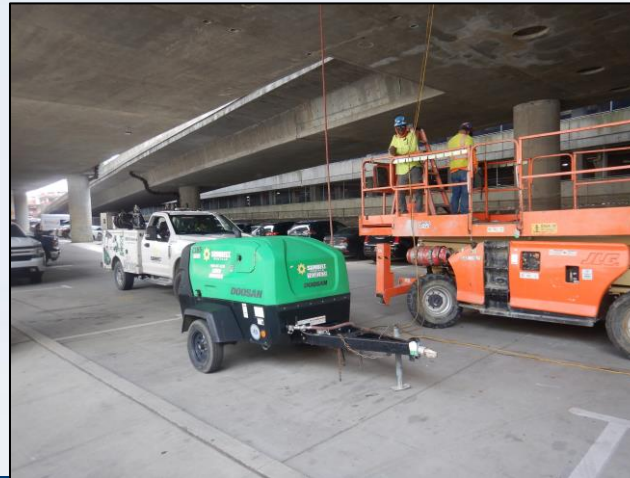
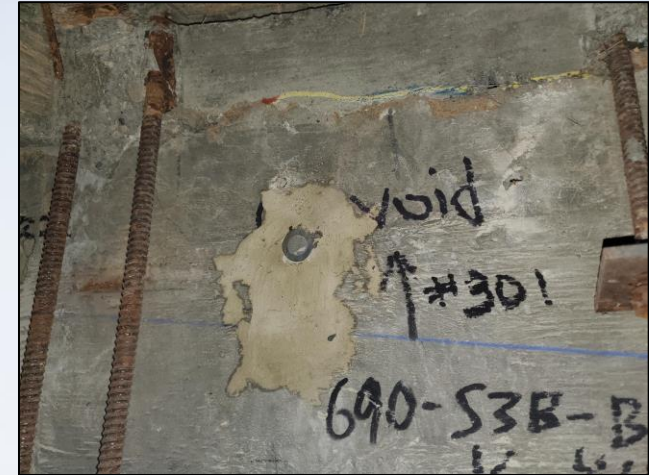
CI/REPAIRS (P4) EQUIPMENT



CI/Repairs (P4)

FINISHING REMARKS

- Cleaning ducts proved more difficult than expected.
- Hard to determine lengths of voids and volume of grout needed with continuous tendons.
- All plastic valves cut and ground flush with existing concrete web after remedial grouting was performed.
- All equipment was removed from project site.
- The top of the bridge was flood coated during the duration of project.
- Epoxy injection did not occur, cracks in the girder web exteriors were determined to be too narrow.



Questions???

DALLAS MONTGOMERY, PE, PS, ASBI, PTI, SENIOR PROJECT MANAGER
Dallas.Montgomery@burgessniple.com



MIKE KRONANDER, PE, ASBI, PTI, PROJECT MANAGER
Mike.Kronander@burgessniple.com



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