

M-10 (LODGE FREEWAY) EMERGENCY RETAINING WALL PROJECTS

Peter Jansson - MDOT Bridge Field Services
Tia Klein - Fishbeck, Thompson, Carr & Huber
Peter MacAskill – Hubbell, Roth & Clark, Inc.



ftc&h



HRC

HUBBELL, ROTH & CLARK, INC
Consulting Engineers



Timeline

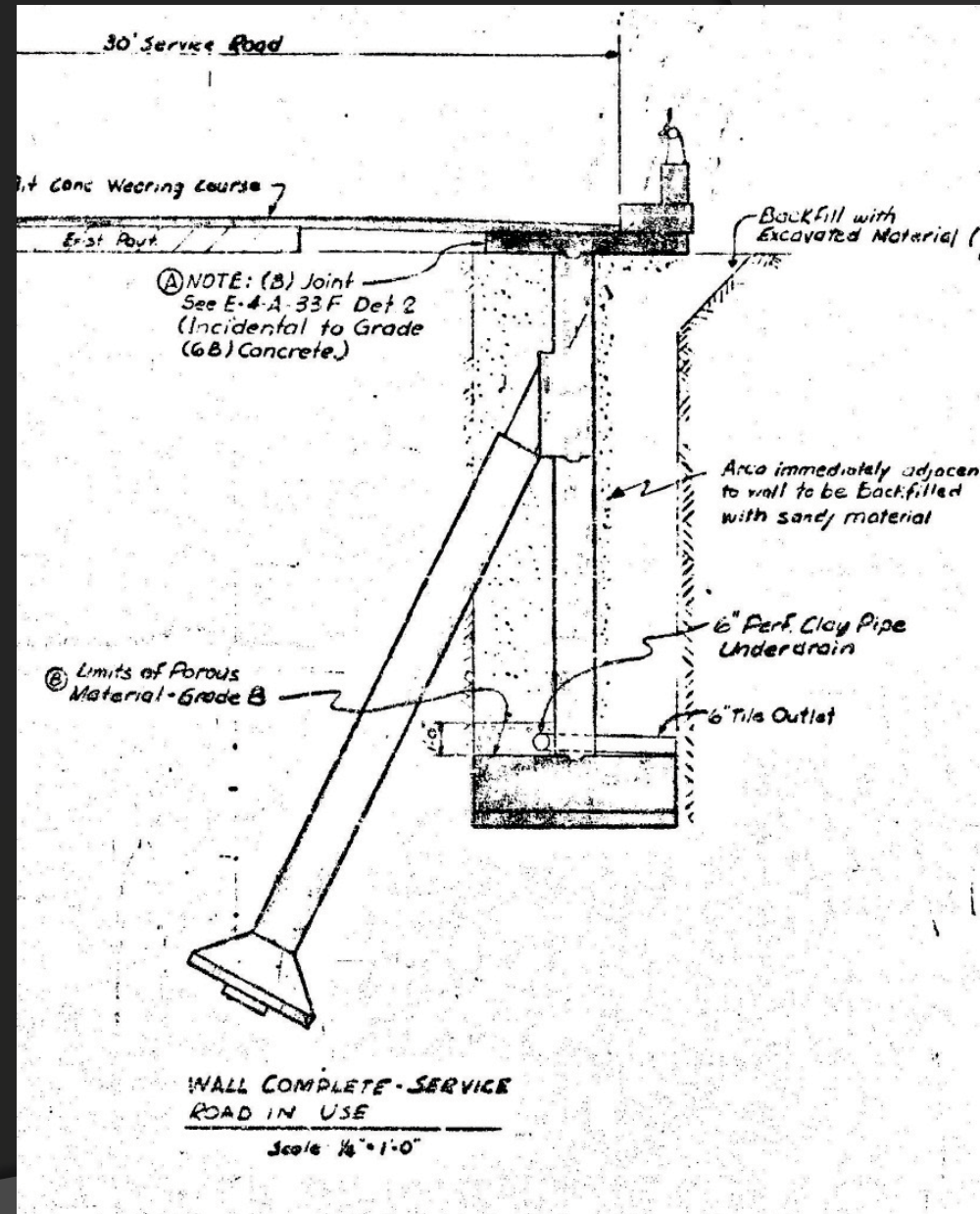
- ⦿ July 2012 – Wall movement reported
 - Initial investigation and monitoring begins
- ⦿ May 2013 – Determination of failure in progress
 - Initiate emergency maintenance and wall reconstruction projects
- ⦿ June 2013 – Emergency maintenance project begins
- ⦿ August 2013 – Wall reconstruction project begins
- ⦿ Summer 2014 – Initiate consultant contract
 - forensic analysis
 - feasible rehab/repair options & costs

M-10 Retaining walls

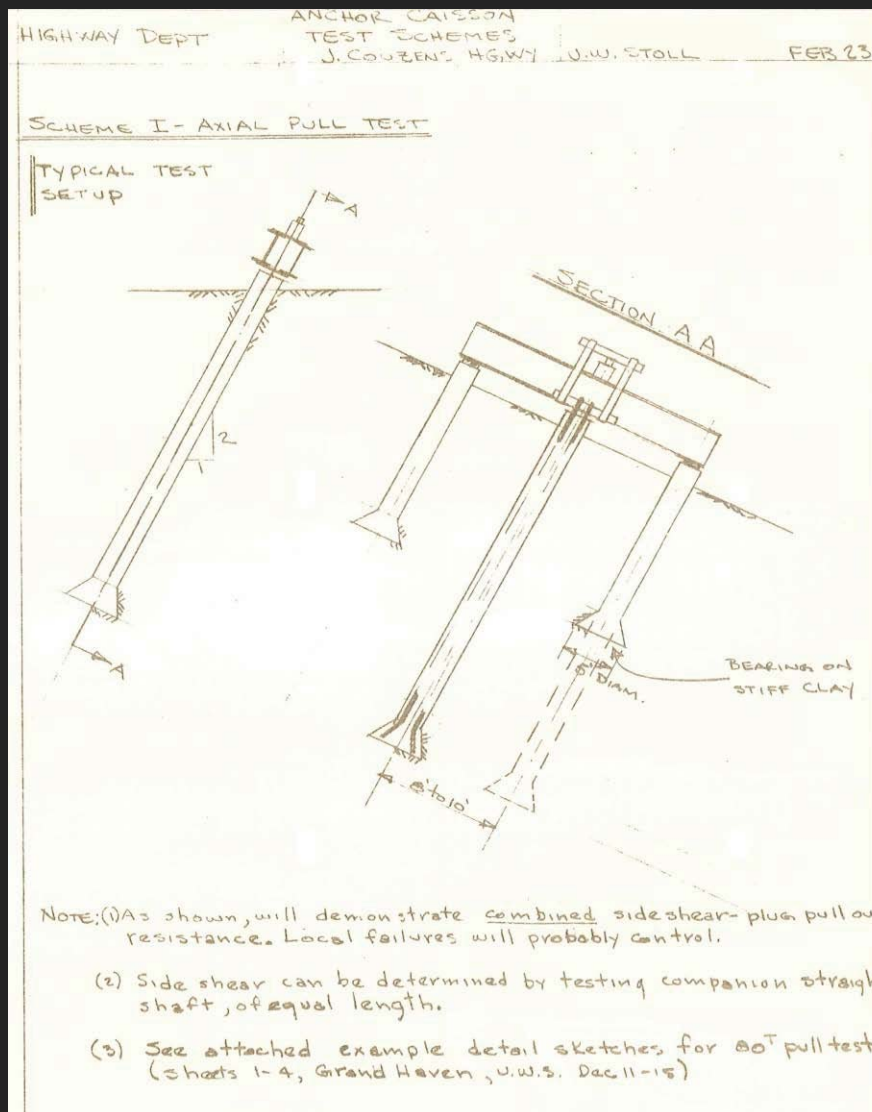
- Constructed 1960-1963?
- 8+ miles in the City of Detroit
- Corridor projects
 - 2007 Pavement Reconstruct, Bridge rehab, & Wall painting
 - 1987 Pavement Reconstruct & Bridge rehab.

Wall Design

- Unique Design - Focus on cost
 - Dr. Housel at Univ. of Mich.
 - Limited real estate
 - Steep angle PT tie backs
 - Cantilevered railing
 - Sheeted excavation
 - Narrow footings and PT ties backs resist sliding and overturning
 - Exp. Joints every 100 ft.
 - Full scale load tests to verify design



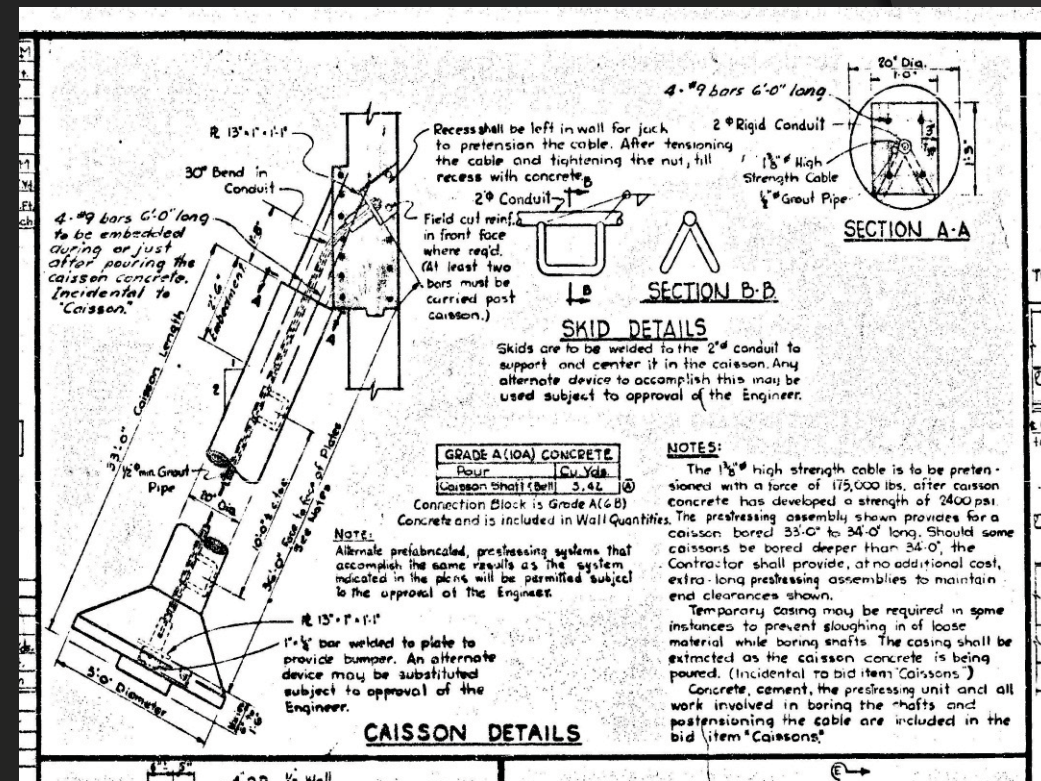
On-site load tests



Wall Details

- ⦿ Lack of PT bar material spec.
 - Alternative PT Design
- ⦿ Steep angle
- ⦿ Changes from Research

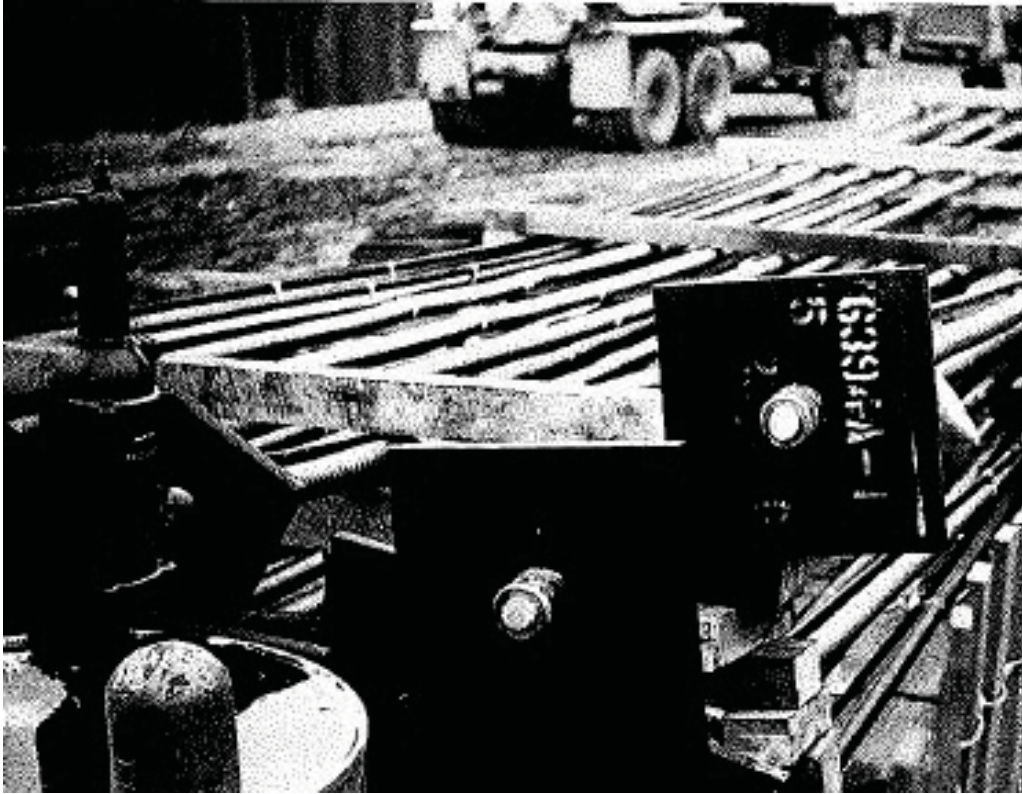
- Limited caisson reinforcement



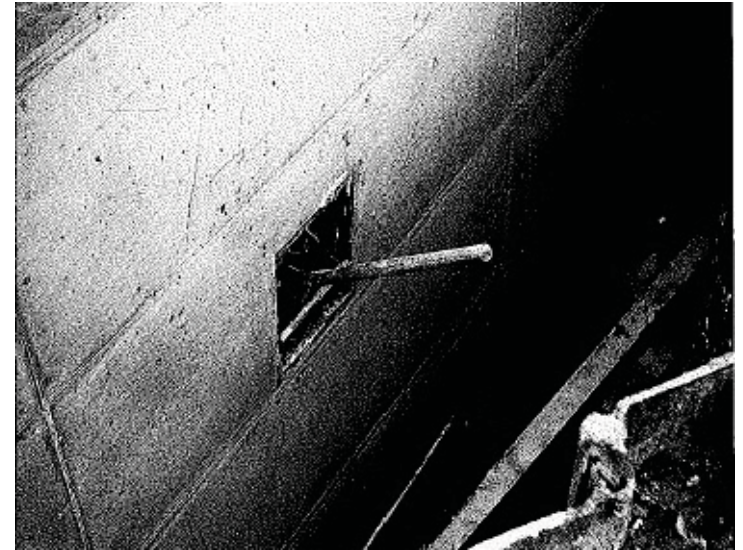


Wall reinforcement and top of caisson





Anchorage plate at end of caisson



PT bar prior to tensioning and cut off

NB Service Dr. at Schaefer



NB Service Dr. at Schaefer



Wall movement = pavement movement



Investigation and Monitoring



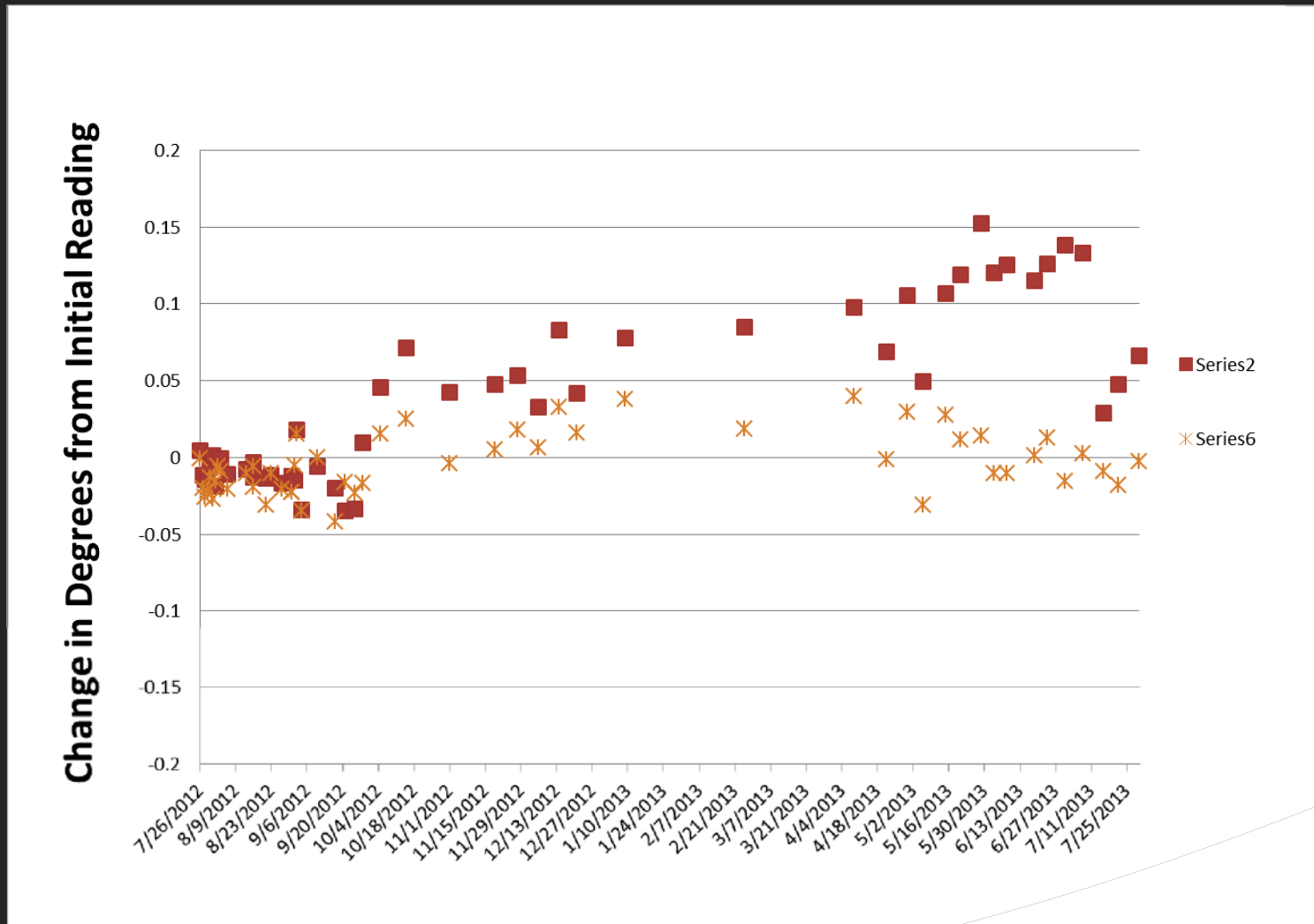
Load > Capacity (Initial thoughts?)

- ⦿ Fractured PT Bar at wall connection
- ⦿ Fracture of caisson “bell”
- ⦿ Relaxation of PT bar and fracture of caisson
- ⦿ Plastic hinge at footing vs. footing failure
- ⦿ Excessive hydrostatic pressure
 - Leaky water main
 - Non-functional drains

Preliminary Analysis

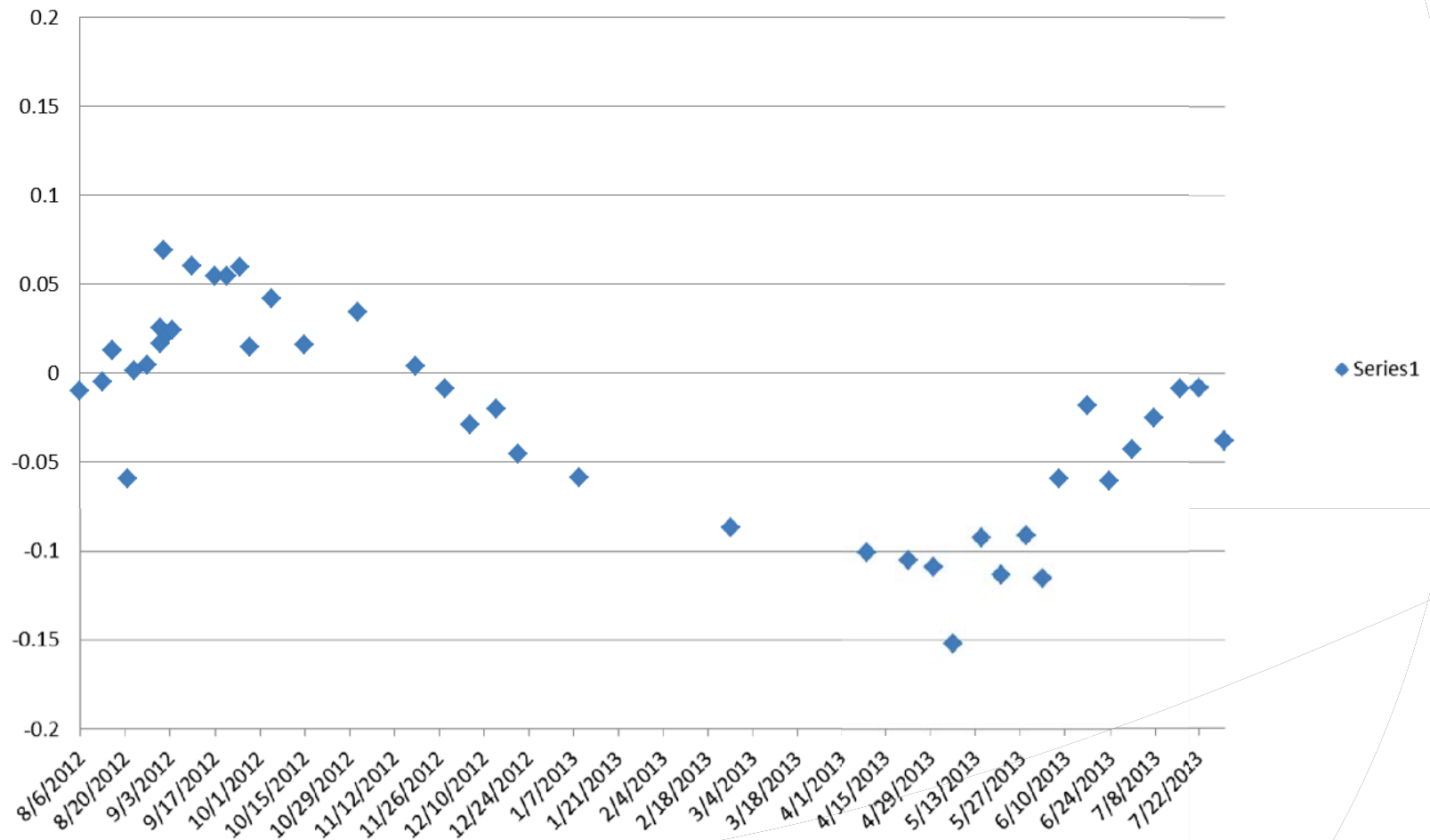
- ⦿ Factor of Safety – Over-turning
 - *Approx. 1.0*
- ⦿ Factor of Safety – Resistance to sliding
 - *Approx. 1.4* (without tie-back, *approx. 1.0*)
- ⦿ Alternative analysis –
 - Footing eccentricity outside footing limits
 - *Tiebacks must work!*

Tilt Sensor Data – Service Dr. at top of wall



Tilt Sensor Data – M10 at base of wall

Change in Degrees from Initial Reading



Risk management

Risk = Likelihood x Consequence

Comparitive Risk matrix

Likelihood		Consequences (Level/Description)				
		1	2	3	4	5
Level	Descriptor	Negligible	Minor	Major	Critical	Catastrophic
1	Rare	1	2	3	4	5
2	Remote	2	4	6	8	10
3	Occasional	3	6	9	12	15
4	Probable	4	8	12	16	20
5	Frequent	5	10	15	20	25

Risk Level	Descriptor	Risk Management Approach
1 to 5	Very Low Risk	Maintain and/or monitor for deterioration to higher risk
5 to 10	Low Risk	Remedial repair, monitor for detrioration to high risk
10 to 15	Moderate Risk	Low safety hazzard; repair/replace to reduce risk
15 to 20	High Risk	Moderate safety Hazard; repair/replace to reduce risk
>20	Very High Risk	High safety hazzard; or failure repair/replace to reduce risk

Emergency Maintenance Contract

- ⦿ Advertised 5/30/13
- ⦿ Reduce / Stop tilting movement
 - Excavation to unload wall
 - Reduce forces to maintain stability
- ⦿ Investigate conditions to design repairs
 - Expose caissons
 - Expose footing

Excavation Begins

- ⦿ Saturday June 8, 2013
- ⦿ Closed Service Drive
- ⦿ M10 Lane Closures for safety
- ⦿ Excavated behind 200 ft. of wall 10 ft. + depth
- ⦿ Exposed Footing
- ⦿ Hand Exposed Caissons



Emergency Maintenance Contract

⦿ Contractor Forces

- Only non-vibratory and non-impact pavement removal and excavation methods allowed
- Haul out excavated material

⦿ MDOT Forces

- Inspect during demolition
- Continue to monitor tilt and displacement
- Chipping of caissons to expose PT bars

Emergency Maintenance Contract

- Service Drive Pavement removed approximately 20' from back of wall for 200' length
- Left wall unloaded to 10' depth +/-
- Temporary aluminum fence and barrier wall installed to protect excavation
- Full service drive closure left in place

Caisson exposure and chipping



Findings:

- Cracked anchor blocks
- Fractured PT bar
- Deteriorated grout in PT ducts
- Deteriorated caisson concrete
- Caisson voids

Exposed wall joint and cracked anchor block



Fractured PT Bar



Deteriorated Concrete



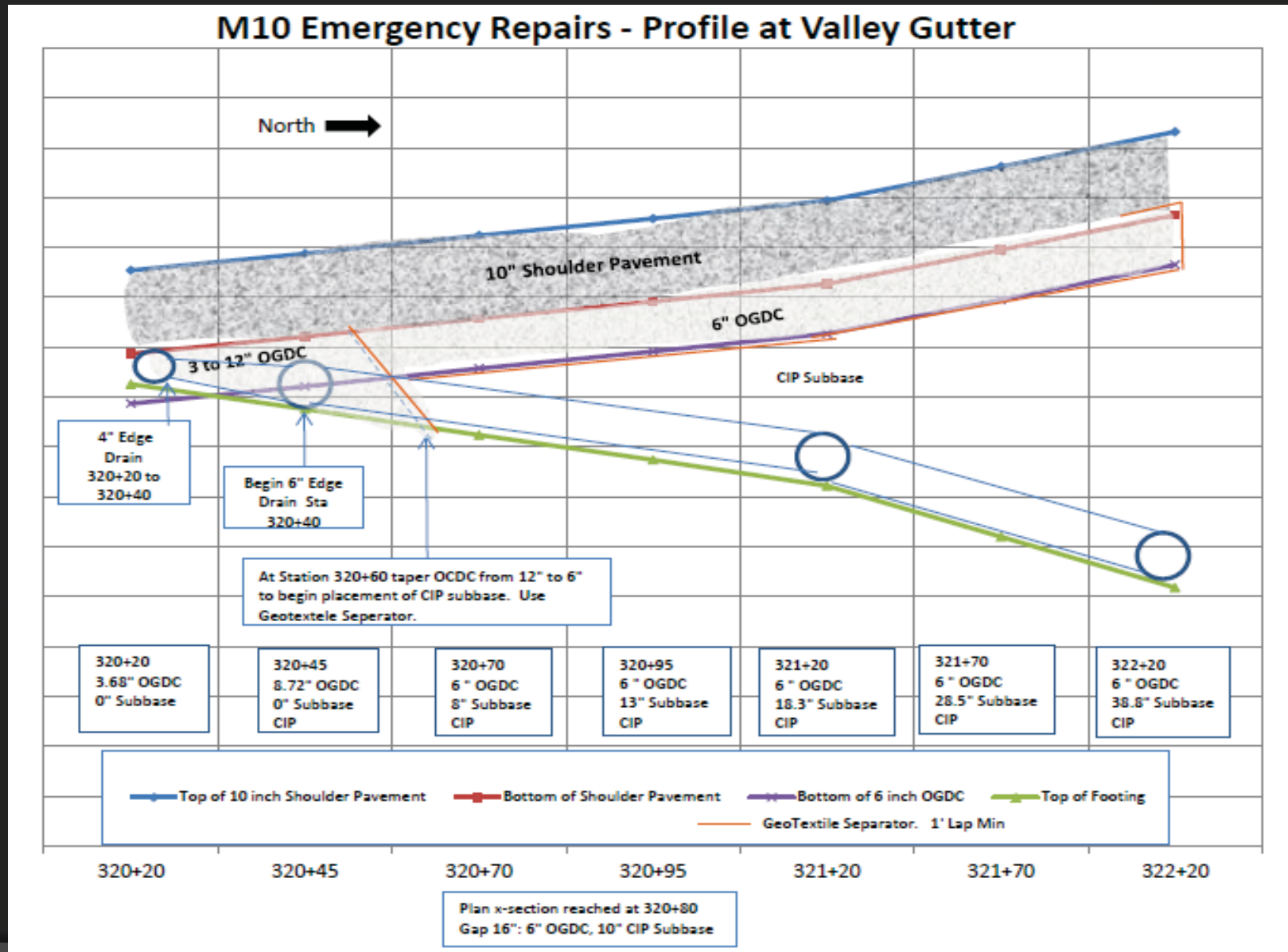
Prior to Wall Replacement



Wall Replacement Contract

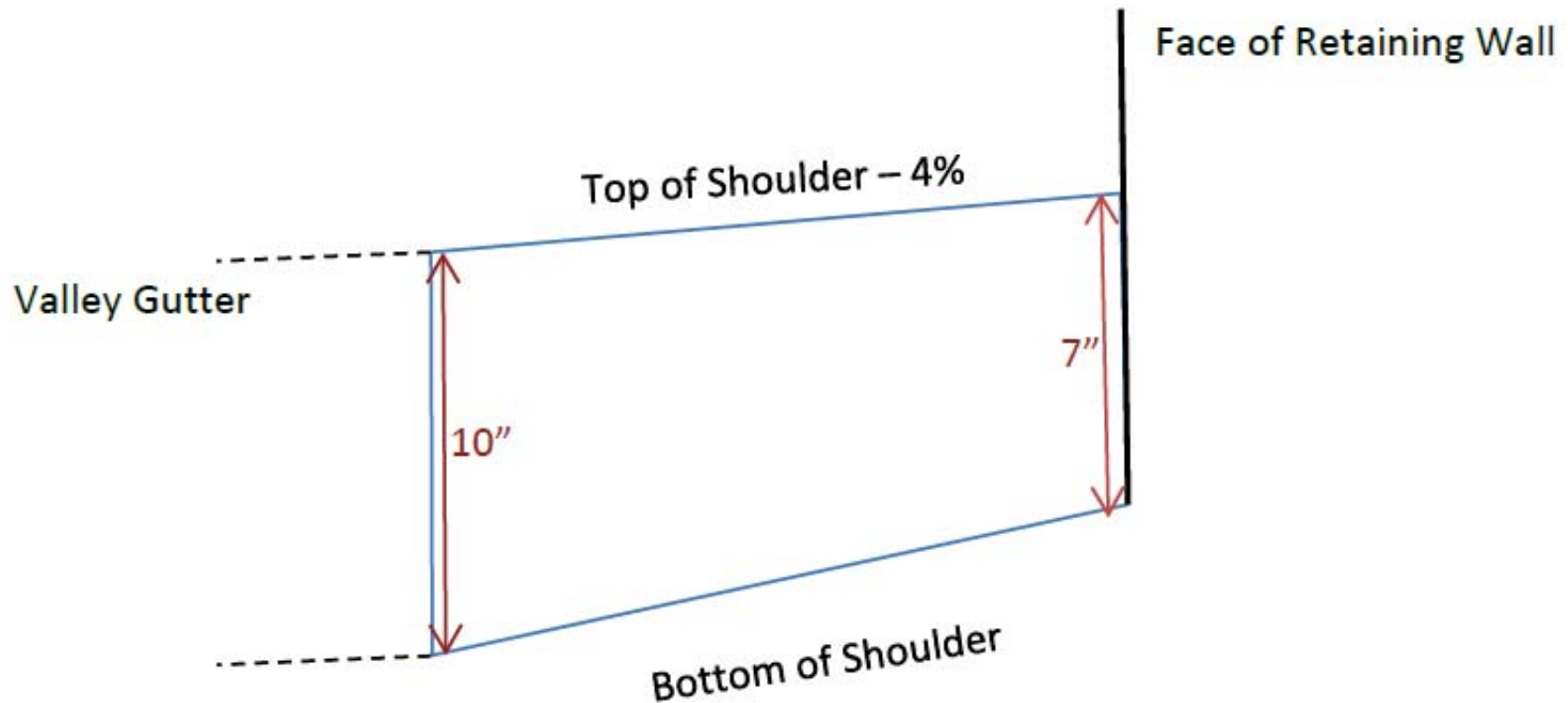
- Remove 200 LFT of wall and footings
- Allow for inspection during removal
- Unload PT bars
- Salvage three caissons from wall anchorage to a distance of 8 ft
- Awarded to Z Contractors
- Construction began August 2013
- New wall completed October 2013

Construction Issues – Shoulder / Footing Conflict



Construction Issues – Shoulder / Footing Conflict

120697A Shoulder Width 320+20 to 320+80



Construction Issues – Sheet Piling

- Contractor stated they could not drive pile to full depth per-plan due to non-vibratory methods
- Submitted revised sheet piling plan with cross bracing
- Revised plan approved
- Water main break occurred prior to cross brace installation

Construction Issues – Water Main Break



Construction Issues – Water Main Break

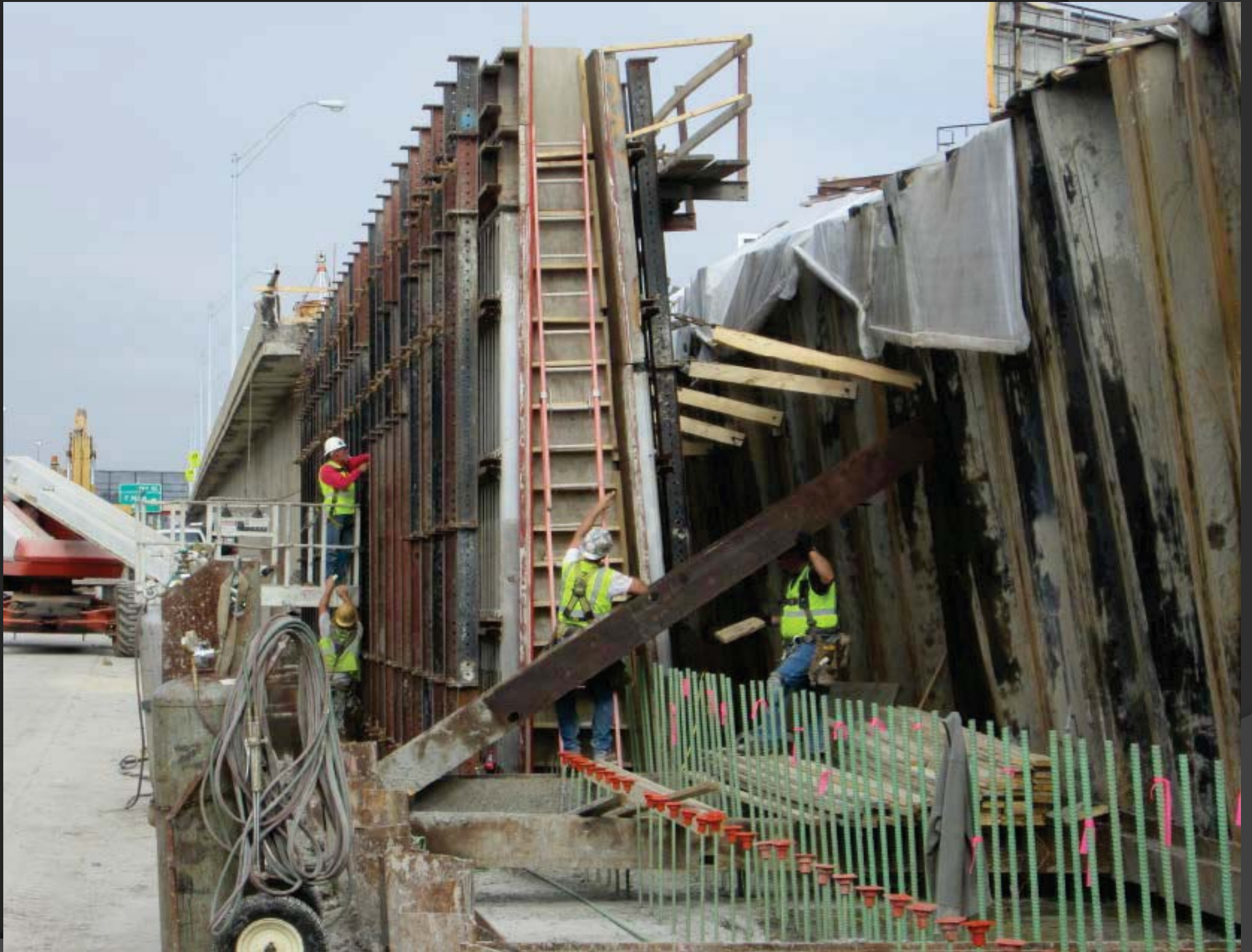


Sheet Piling Cross Bracing



Sheet Piling Cross Bracing























- ◎ Unloading of PT bars
 - 150 kips?
- ◎ Audible noise and displacement when unloaded
 - Caissons 1, 9, 12, 13
- ◎ No noise or displacement
 - Caissons 2-8, 10-11, 14-15

Caisson Inspection



Caisson Inspection Con't



Salvaged Caissons



Rebar from wall into footing





Conclusions from Preliminary Investigation

- ① One (or more) PT bars fractured
 - examination of the fracture surface suggests that fracture occurred years ago.
- ① Some PT duct grout was missing or deteriorated
- ① Some concrete anchor blocks exhibited active cracking
- ① Most concrete caissons exhibited circumferential cracking close to the wall

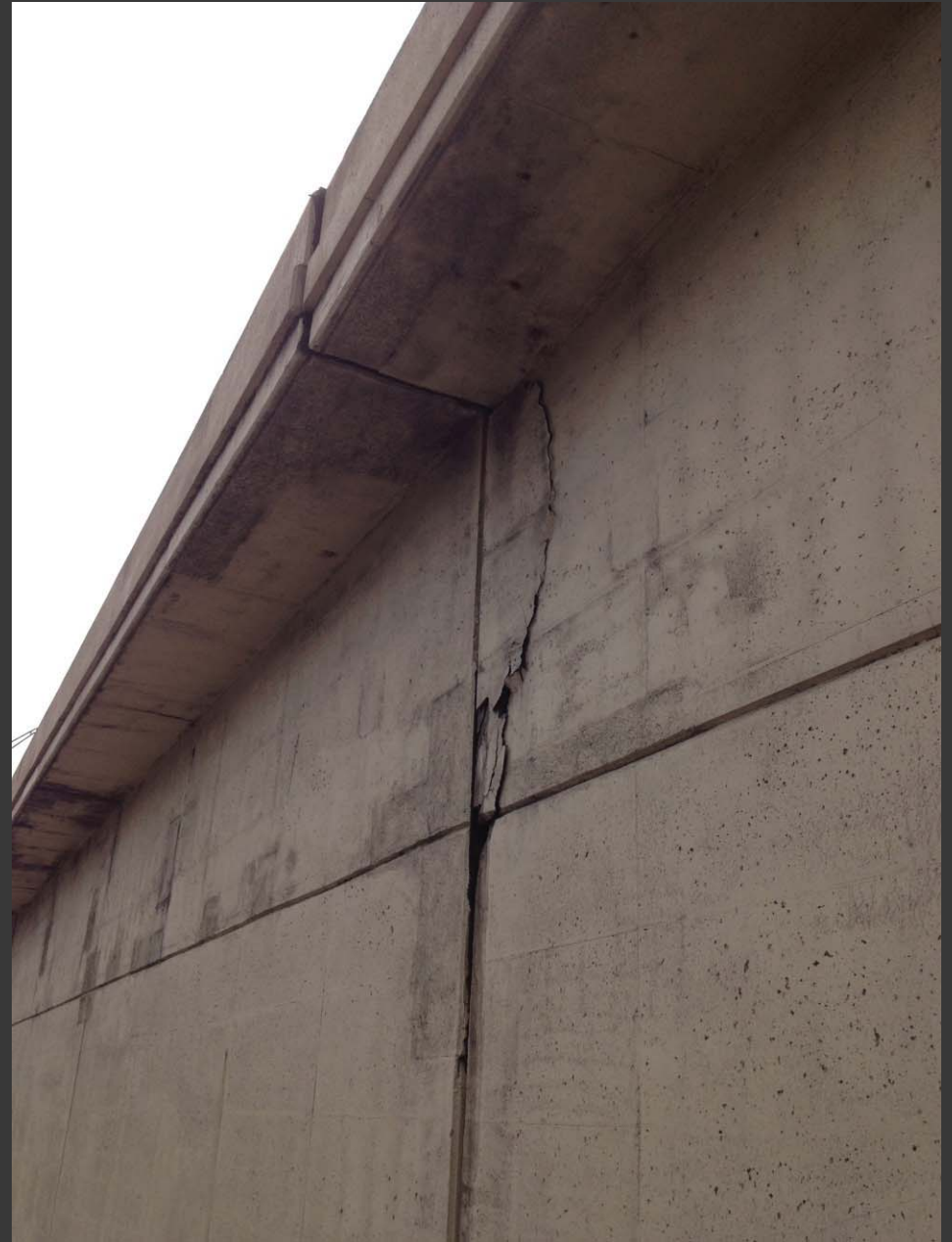
Conclusions from Preliminary Investigation

- Some of the caisson concrete appeared deteriorated or had been poorly mixed/consolidated
 - water was present on the interior of several caissons.
- Torch cutting of the PT bar wall anchorages to the wall suggested some bars had already relaxed/unloaded
- Significant corrosion and loss of section was found in the footing to wall rebar

Monitoring continues – at Outer Dr.



At Myers Rd.



And South of Schaeffer Rd.



Next Steps

- ◎ Consultant contract – Summer 2014 start
 - Review existing data, plans, utilites
 - New data – soil borings, materials testing, corrosion and electrical resistivity assessment
 - Model existing wall and loadings
 - LiDAR of corridor
 - Propose monitoring plan
 - Develop strengthening options and estimate costs
- ◎ The importance of asset management
 - Bridges, Sign structures, ***retaining walls, light standards***