2024 PNWS-AWWA Spring Conference

Under Pressure! Emergency Repair of Sherwood's Prestressed Concrete Tank

Matt Hickey | Consor

AGENDA

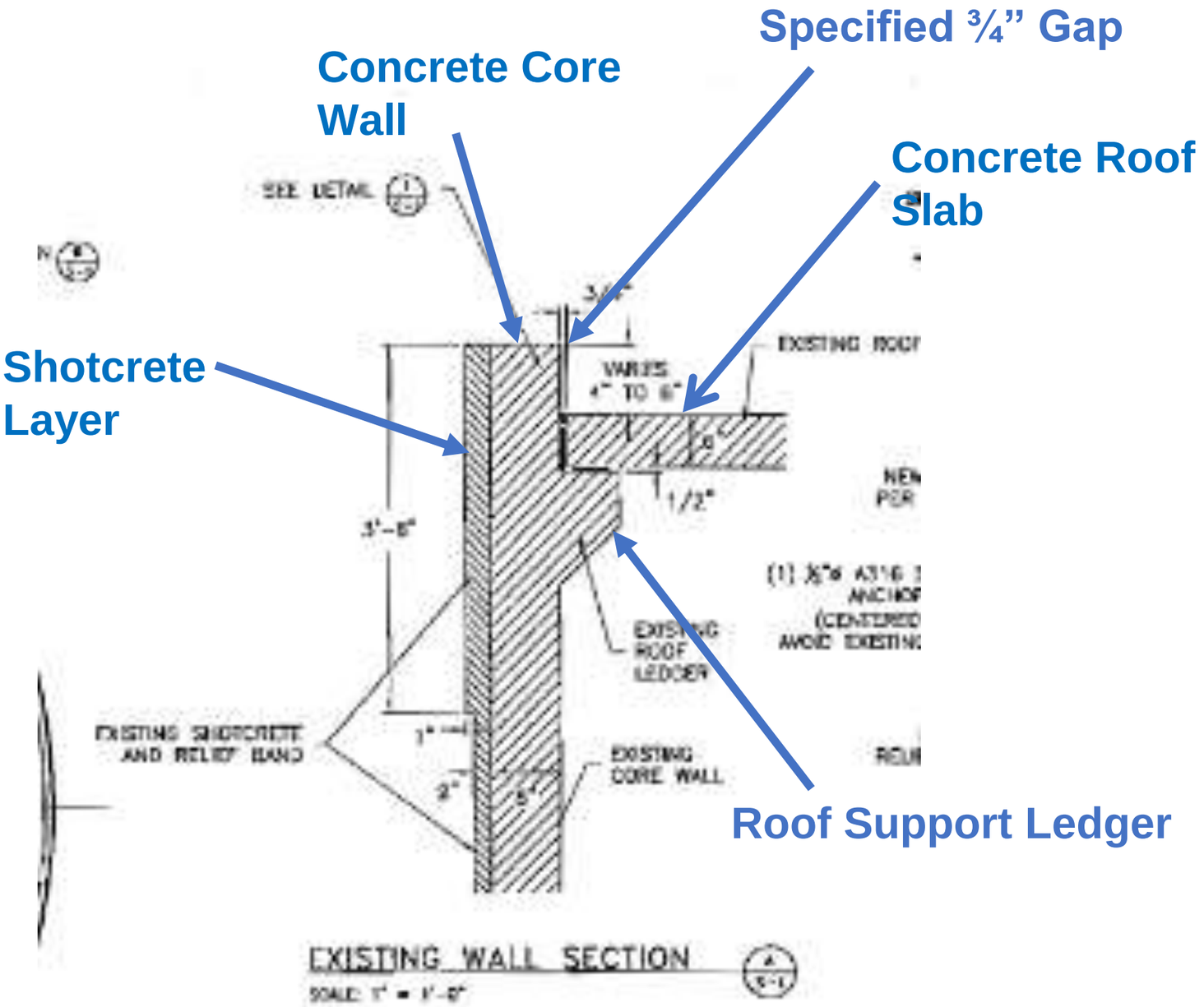
- Introduction
- Background
- The Issue
- Assessment
- Analysis
- Design
- Construction

- Takeaways and Q&A

Background

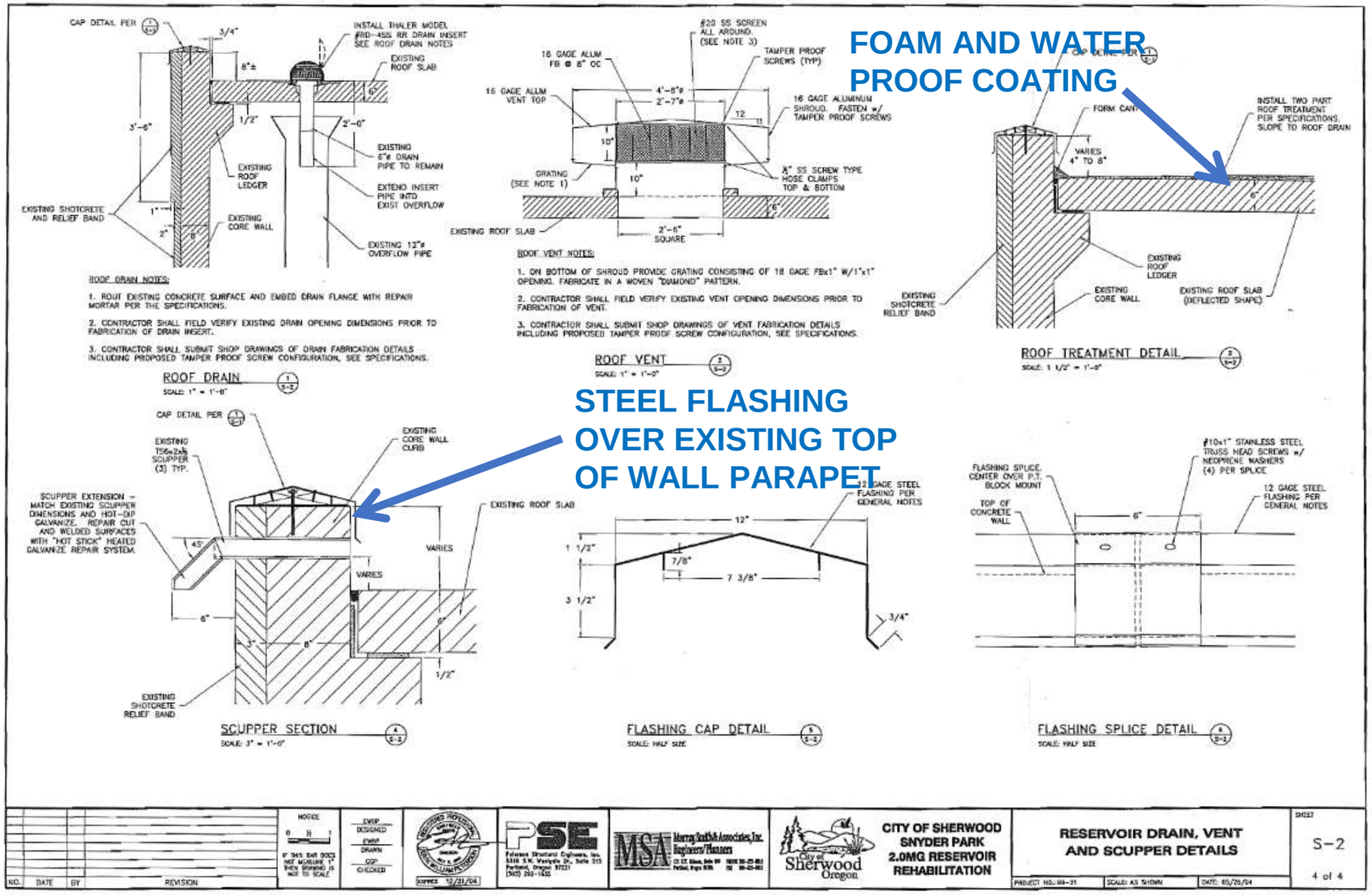
- Constructed in 1973
- First D110 Type I strand wrapped tank in Oregon
- Early technology/early design concepts
- Designs evolved to improve performance and reduce maintenance

Original Tank Design and Construction



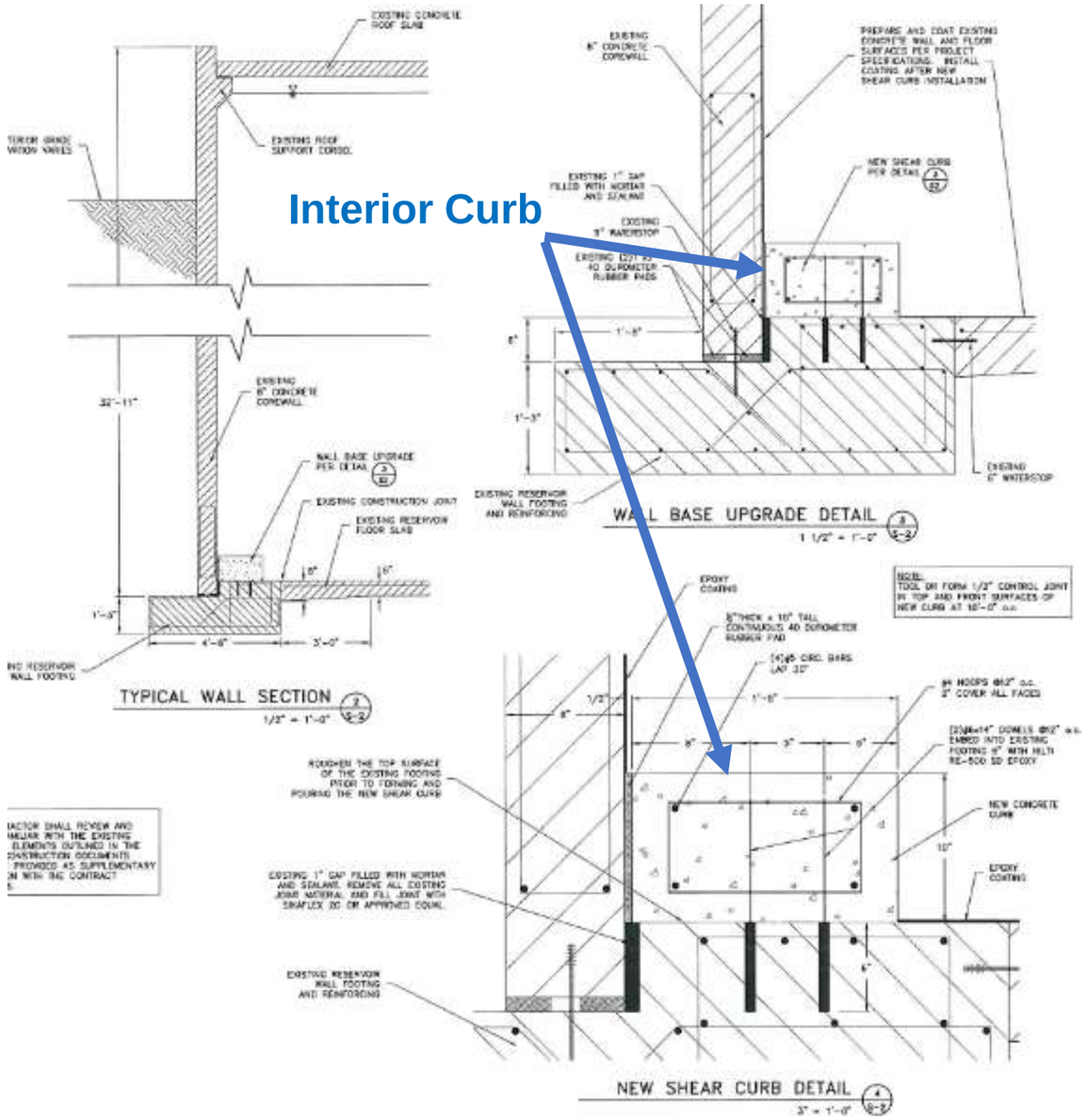
1998 Roof Improvements

- 1 ½” gap at edge of wall
- Overstressing columns
- Shims at roof perimeter
- Flashing added at top of wall
- Foam on roof to increase slope for drainage
- New drain, vents, hatch
- Contractor cut flashing to deal with curved tank wall
  - Possible path for water intrusion

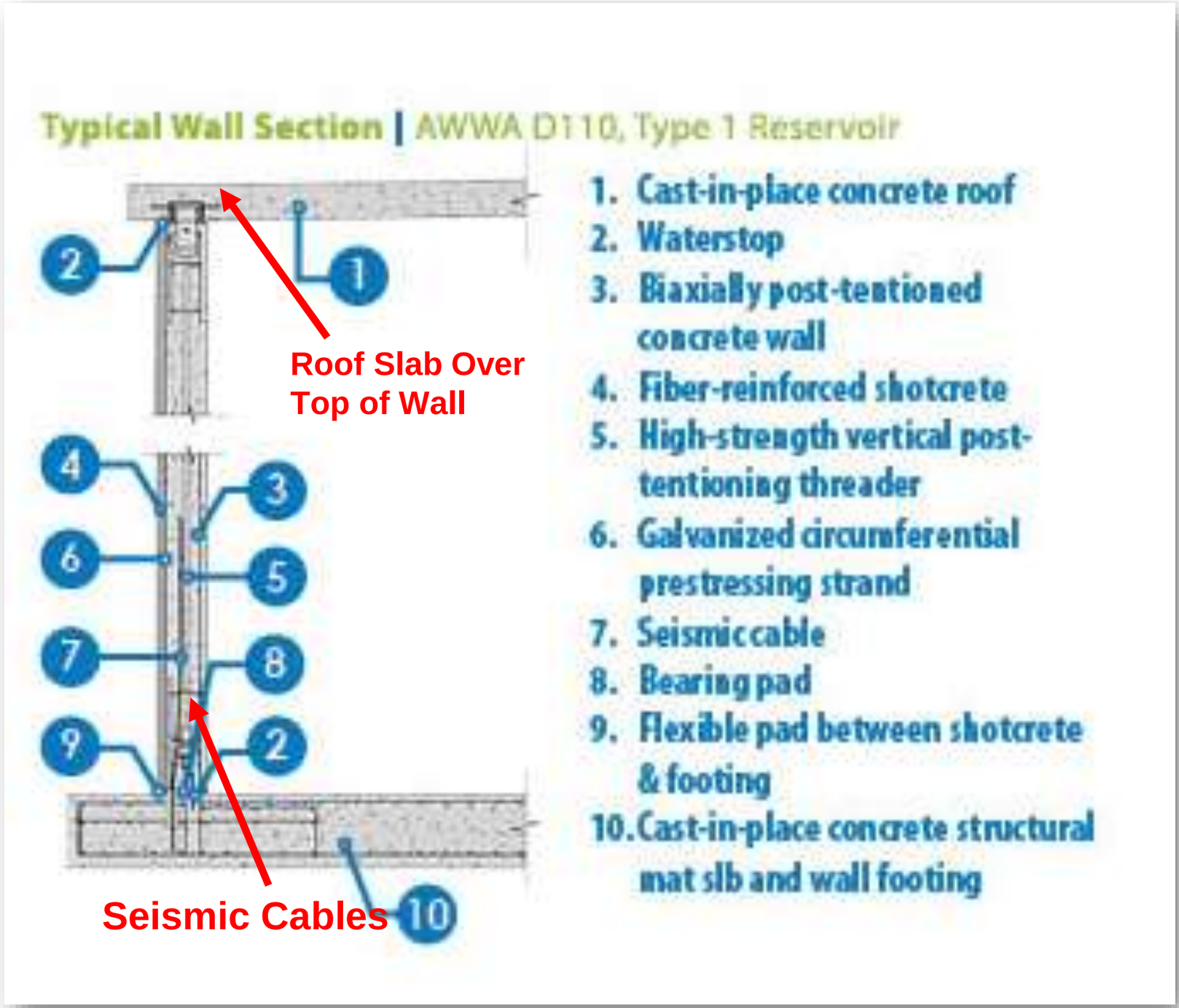


2010 Seismic and Maintenance Upgrades

- With the new 4 MG tank in place, interior improvement could be made
- Interior curb to address wall to floor sliding
- Epoxy liner to address degraded concrete due to chemical attack
- Piping Upgrades



AWWA D110 Type I – Current Wall Design



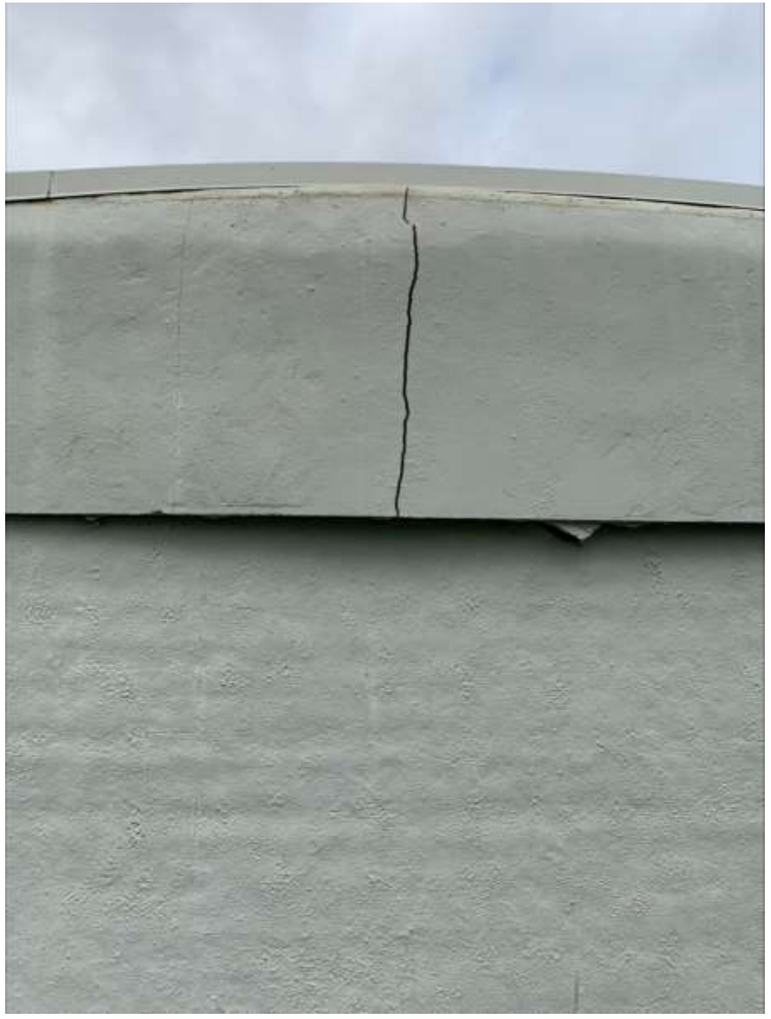
AWWA D110 Type I – Current Wall Construction

Typical Wrapping Machine

Typical Type I Wall Construction

The Issue

What Happened?!!!!



March 5, 2023, Site Visit

Investigation

City wanted the tank in service by end of May!

Assessment

Assessment

- Corroded Strands
- Isolated to this area?

Assessment

- Removed Additional Shotcrete
- Issue with stands appeared to be isolated to the one area

Assessment – Shotcrete Sounding

- Issues only in the architectural relief band
- Assessed the rest of the shotcrete
- Rest of shotcrete appeared to be in good shape

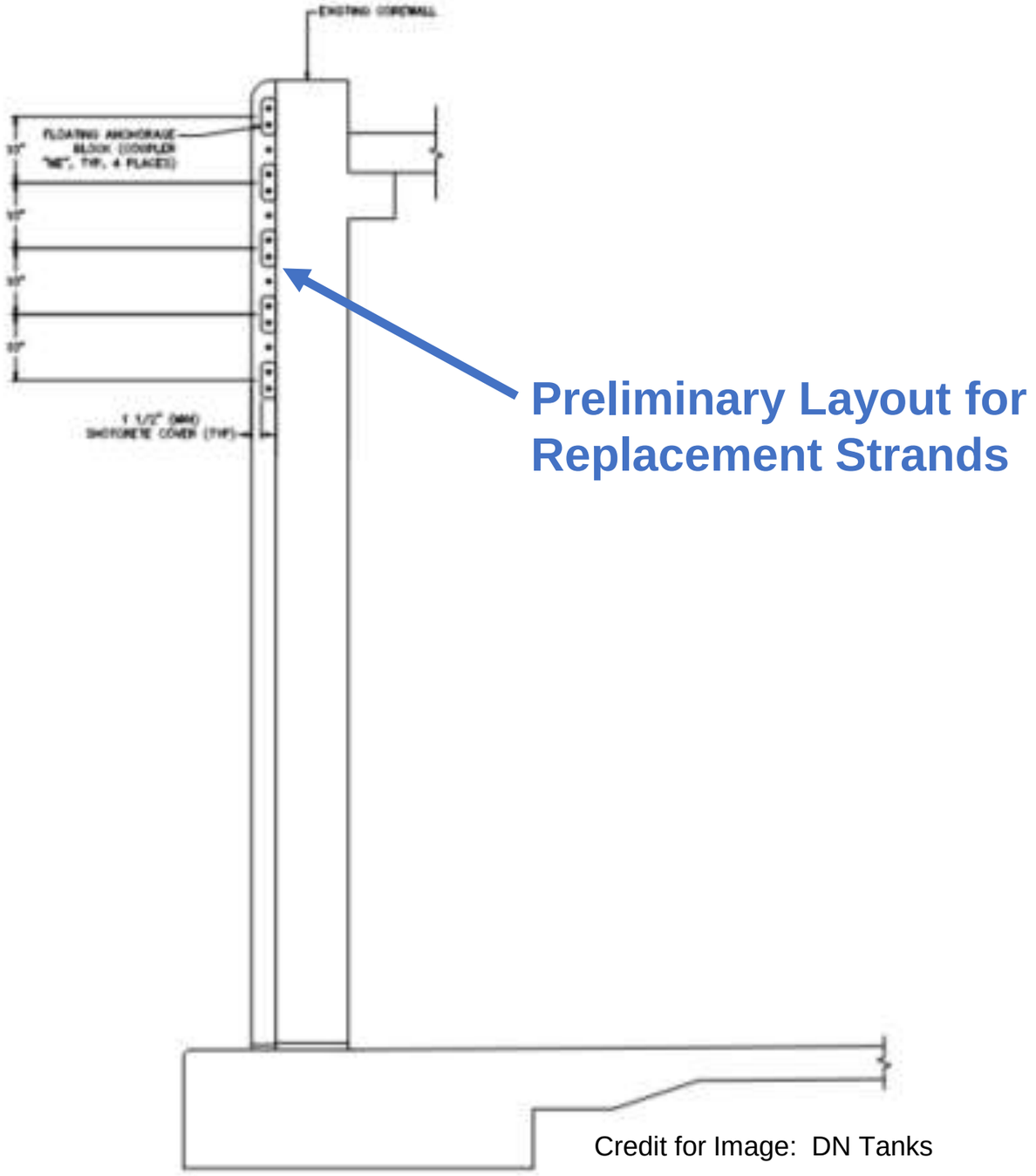
Analysis

Preliminary Analysis and Additional Investigation

- In mid-March we Contacted DN tanks to discuss concepts and detailing for the repairs
- City contracted with DN in late April and they assisted with the assessment
- As part of the analysis DN checked condition of strands in lower shotcrete section – early May
- Chipped windows in shotcrete at 4 locations
- Strands and shotcrete were in good condition

Structural Analysis

- Conducted analysis of the tank without the top strands
- ASCE 7 AND ACI 350.3R Standards
- Found it was still structurally sound
- Water level needed to be dropped
- Allowed the City to keep the reservoir in operation



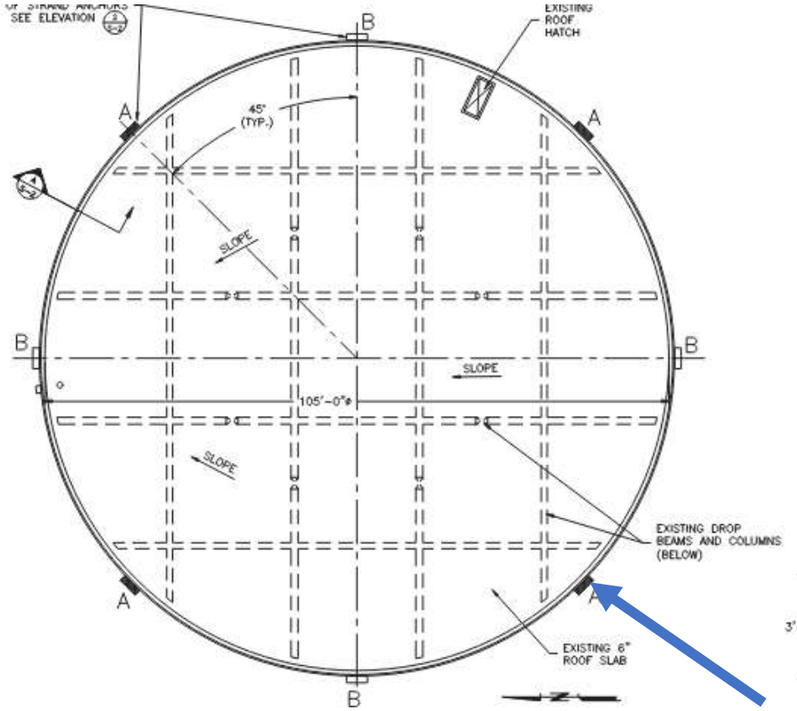
Preliminary Layout for Replacement Strands

Credit for Image: DN Tanks

Design

Design of Repairs – Wrapping Details

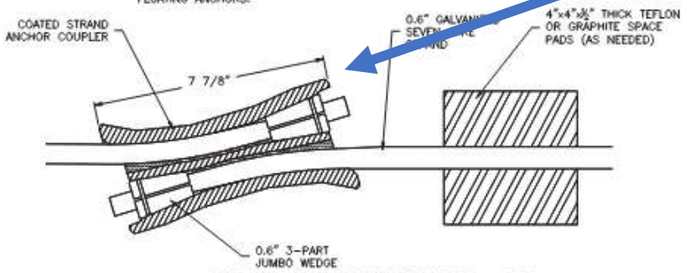
- Plan to replace strands
- No wrapping machine
- Hydraulic rams to be used for stressing
- stressed less than typical machine rapping



ROOF PLAN WITH ANCHOR LOCATIONS

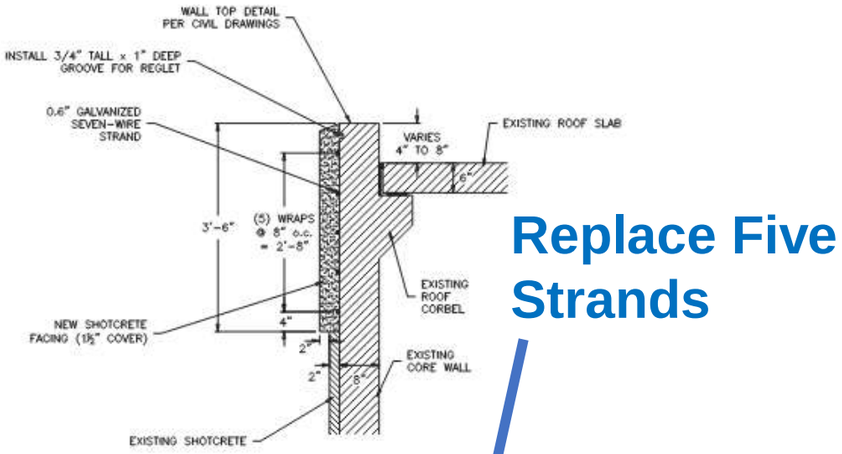
SCALE: 1" = 10'

"A" AND "B" REPRESENT THE POSITION OF THE FLOATING ANCHORS.



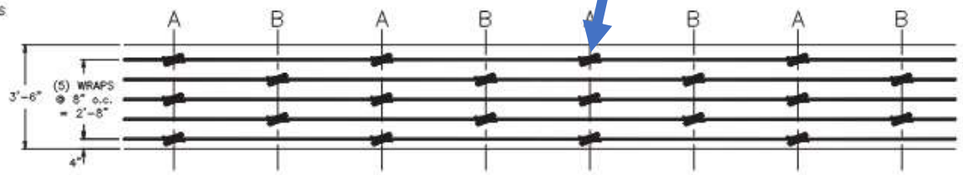
STRAND ANCHOR ELEVATION

SCALE: HALF SIZE



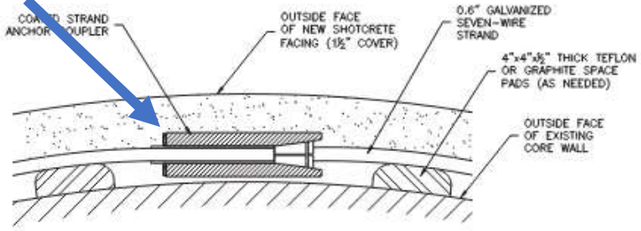
EXISTING WALL & NEW WRAPS SECTION

SCALE: 1" = 1'-0"



WRAPPING ANCHOR LAYOUT ELEVATION

SCALE: 1/2" = 1'-0"



STRAND ANCHOR PLAN

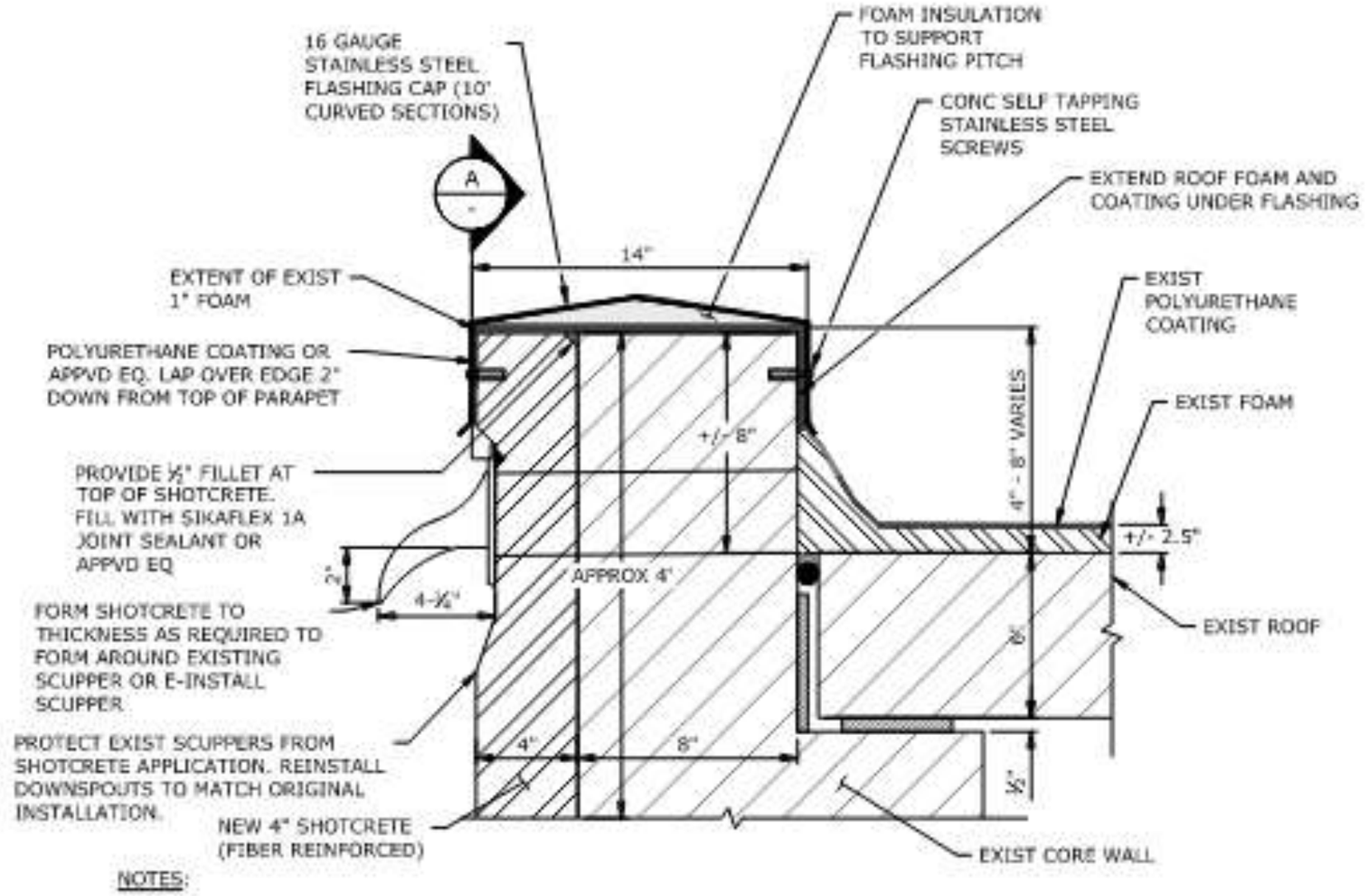
SCALE: HALF SIZE

Replace Five Strands

Dog Bones

Design of Repairs – Top of Wall Detail

- Provide water tight cover over wall
- Prevent future water intrusion
- Curved flashing specified
- Anchored through sides of flashing



Construction

Schedule – Phase 1

- DN began procuring materials and getting crews ready to mobilize in May
- DN planned on a 4-5 days for removal of the shotcrete – Demo Phase 1
- Due to challenges in moving portions it took over 3 weeks – Done by June 6
- The design team completed designs during May
- Design work and demolition occurred simultaneously

Design	**Mid March to end of May**
Shotcrete Investigation	**Mid May**
Demolition	**May 11 to June 6**

Schedule – Phase 2

- DN provided a proposal and schedule for construction – Phase 2
- Supply issues, mobilization time, crew availability
- It wasn’t quite going to be ready by end of May
- Prestressing done for August/September high demand time

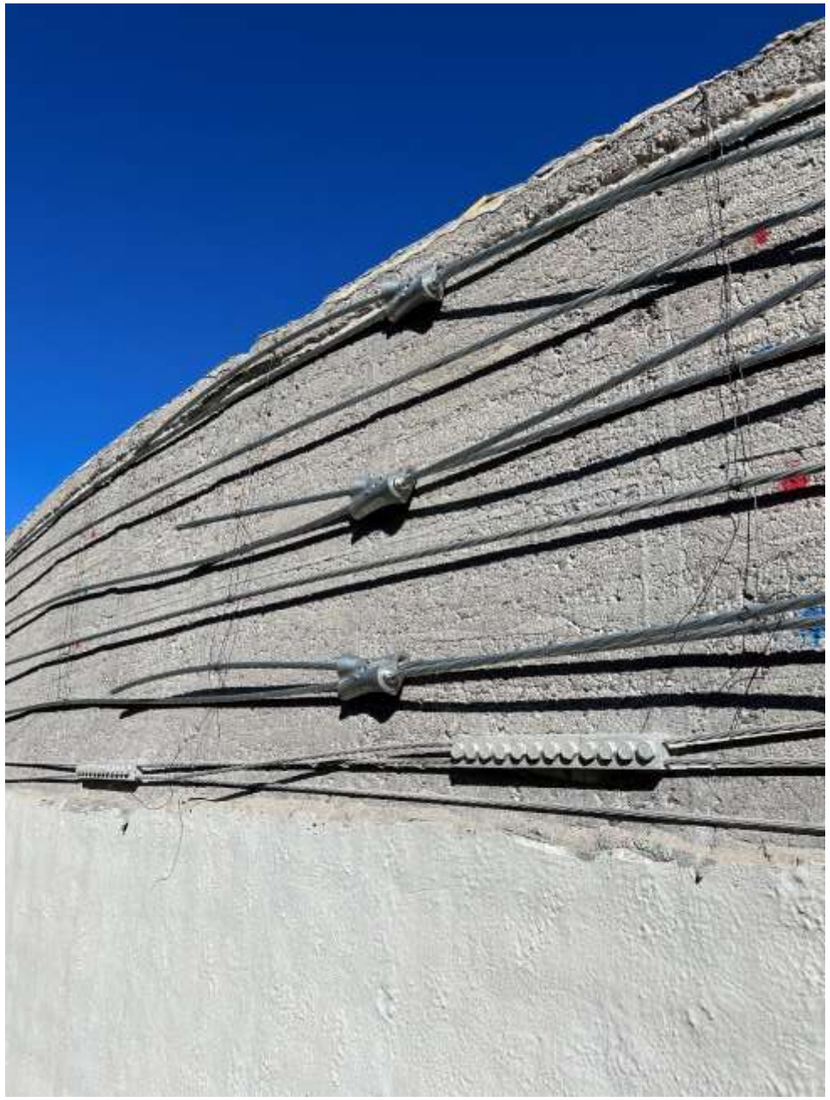
Mobilization	**July 17 to July 18**
Surface Preparation (Hydroblasting, Reglet)	**July 18 to July 28**
Prestressing	**July 31 to August 4**
Shotcrete	**August 7 to Augst 11**
Misc & Roof Curb	**August 14 to August 22**

Start of Construction – Hydroblasting

Started July 17, 2023

Construction -- Strand Installation

Hydraulic Ram



Prestressing Strand, Lock offs, and Dog Bones

Prestressing Strand Installation

Dog bones installed at 4 locations

Completed Prestressing Strand Installation

City could fill the tank at this point

Shotcrete Application

Shotcrete Application and Finishing

Curing the Shotcrete

Finishing the Shotcrete and Top of Wall

Top of Wall Foam Replacement & Flashing Materials

Foam filler at outside edge of wall

Top of wall flashing

Flashing Installation

The Completed Repairs

- Painted to match
- Cost of Repairs $350,000
- Main portion of repairs took about 6 weeks
- Time factors
- *Assessment*
- *Contracting*
- *Crew availability*
- *Material availability*
- Overall successful process

Takeaways

1. Regular Inspection is Important – AWWA D110 Section 6.4 covering routine inspection requirements

2. Assessing potential issues with older tanks

3. Systemwide high-level inspection and prioritization

4. Qualified contractors to complete repairs

5. Thorough construction observation is key as it can reduce future issues

6. Cost effective approaches to keep these operational and resilient

7. Maintaining these valuable assets is important – Large cost to replace & sustainable approach

Questions?

Matt Hickey | Consor
Matt.Hickey@consoreng.com

Thank You

Structuring a better way