



Sodium Hypochlorite Storage Area Rehabilitation



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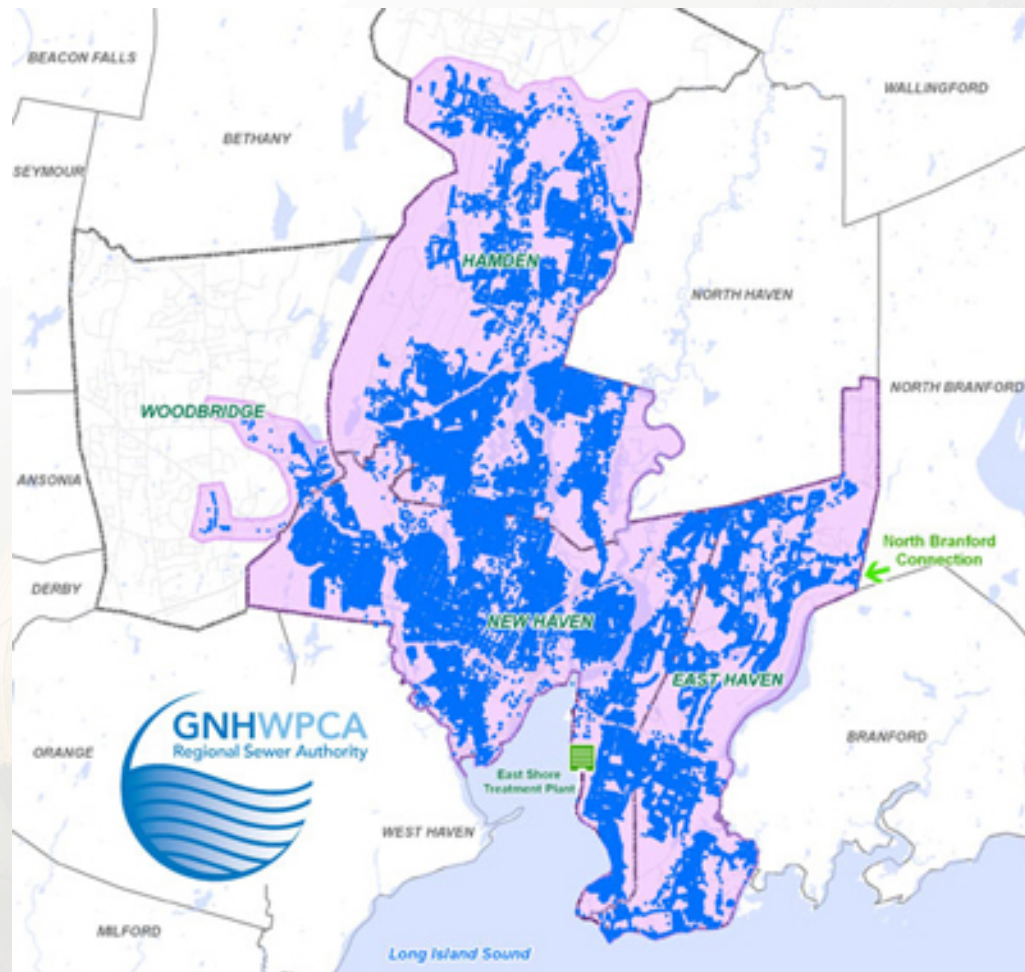
OVERVIEW

- Process and Structural System
- Deterioration
- Assessment
- Design
- Construction





Greater New Haven Water Pollution Control Authority





East Shore Water Pollution Abatement Facility

- 40-mgd secondary treatment
- 100-mgd wet weather treatment
- Secondary facilities constructed 1970s



East Shore Water Pollution Abatement Facility





Secondary Treatment Building Disinfection System

- Sodium Hypochlorite, 15% concentration
- Two 5000-gal polyethylene tanks
- FRP secondary containment wall (partial)

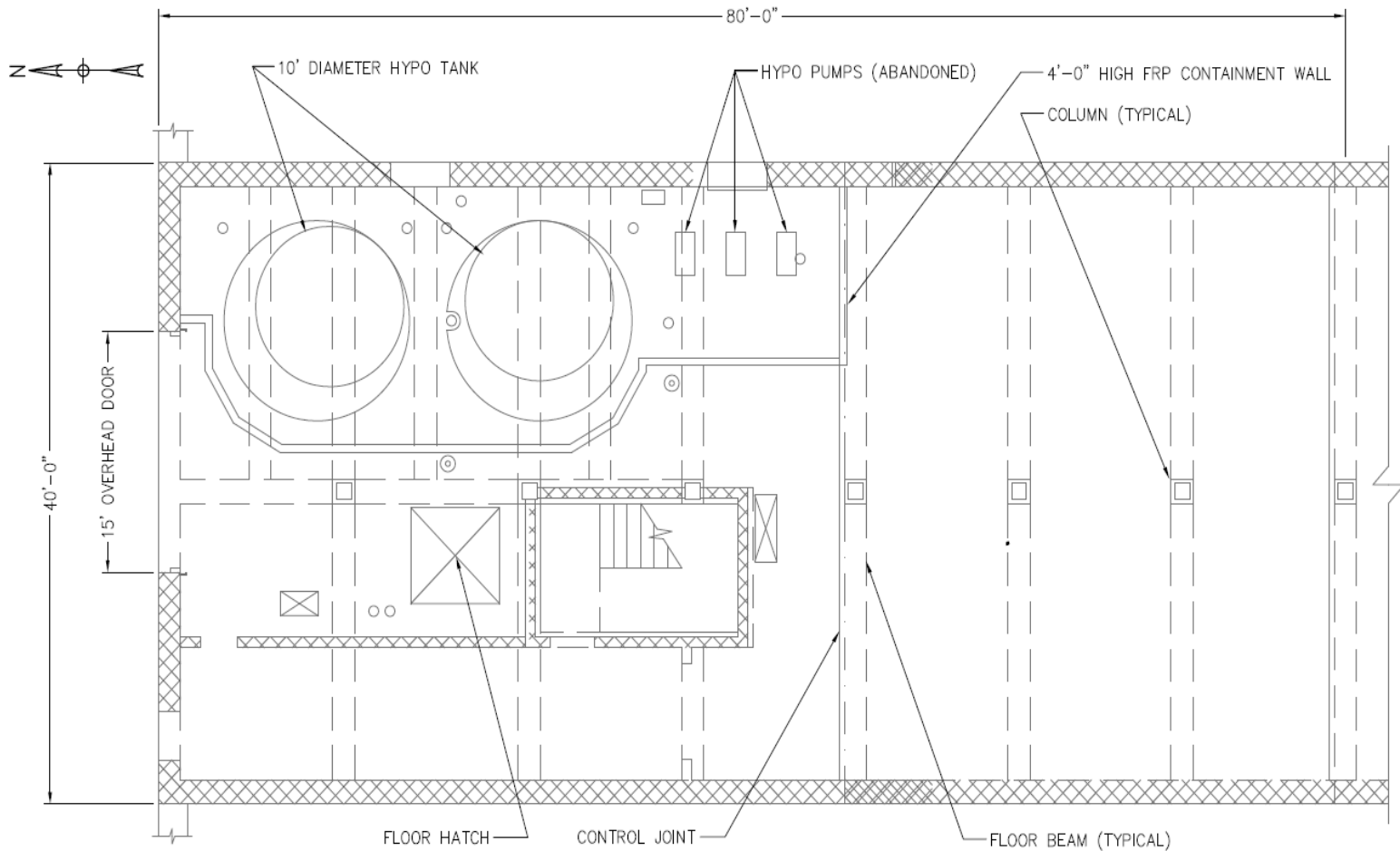


Secondary Clarifiers and Secondary Treatment Building



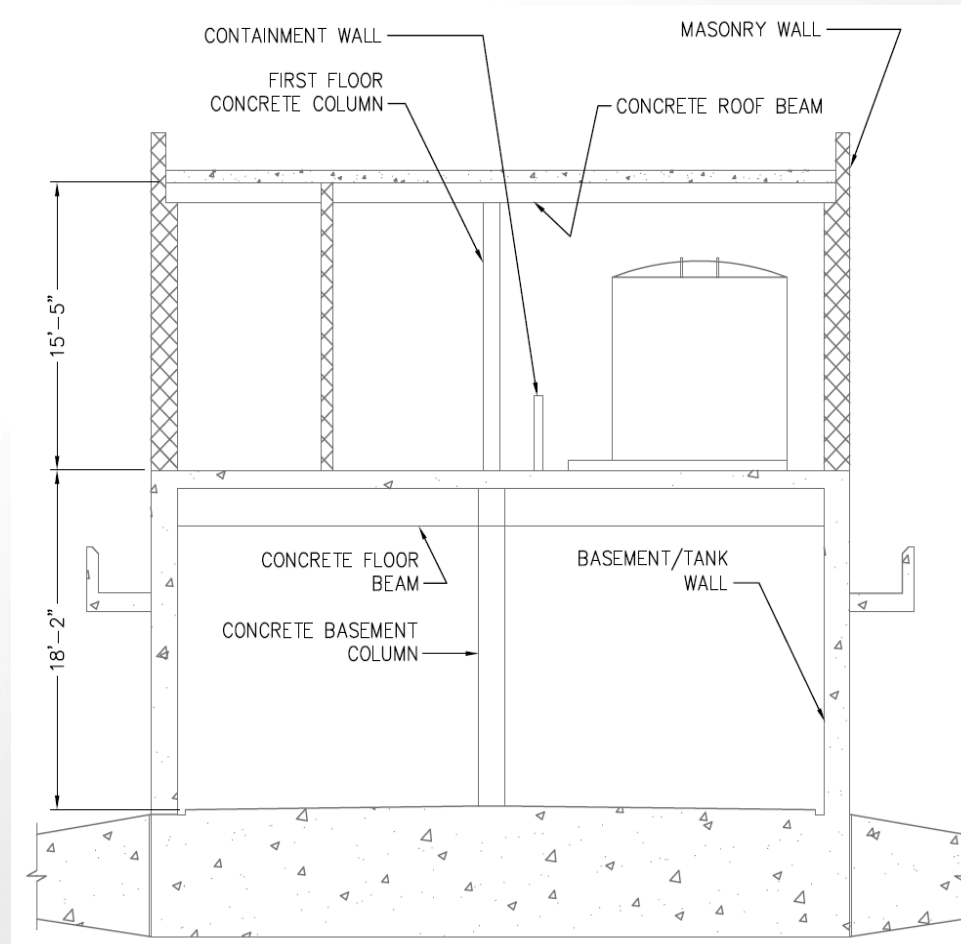


Hypo Area Existing Floor Plan





Hypo Area Existing Building Section



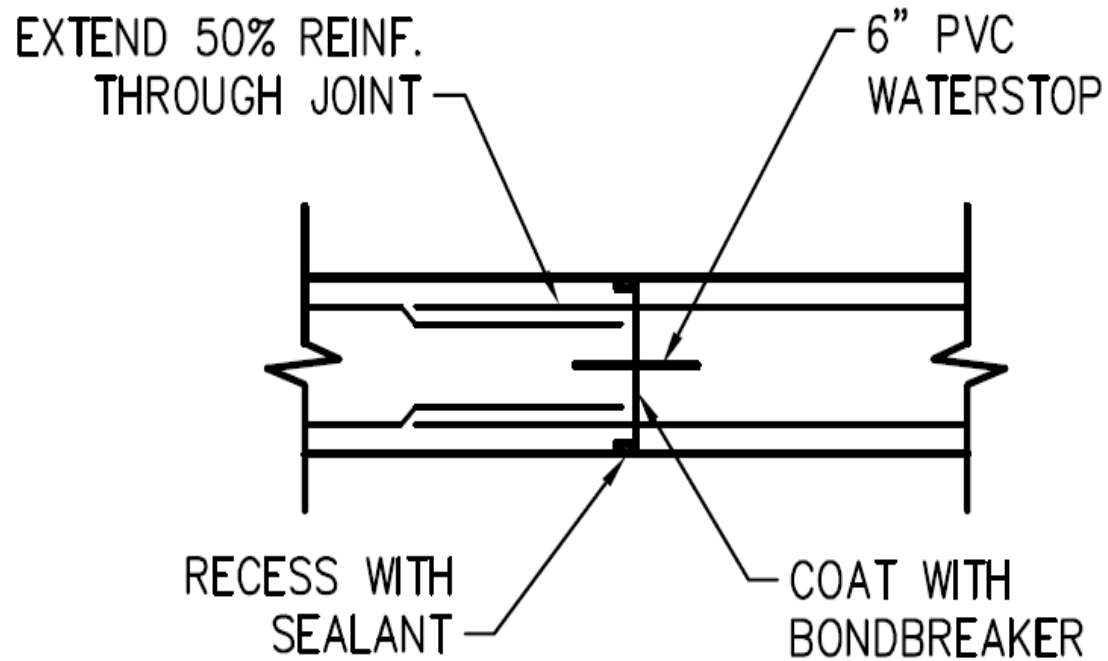


Control Joint Environmental Structures

- Formed joint between placements
- Controlled discontinuity
- Promotes controlled crack for shrinkage relief
- Spacing related to minimum reinforcing

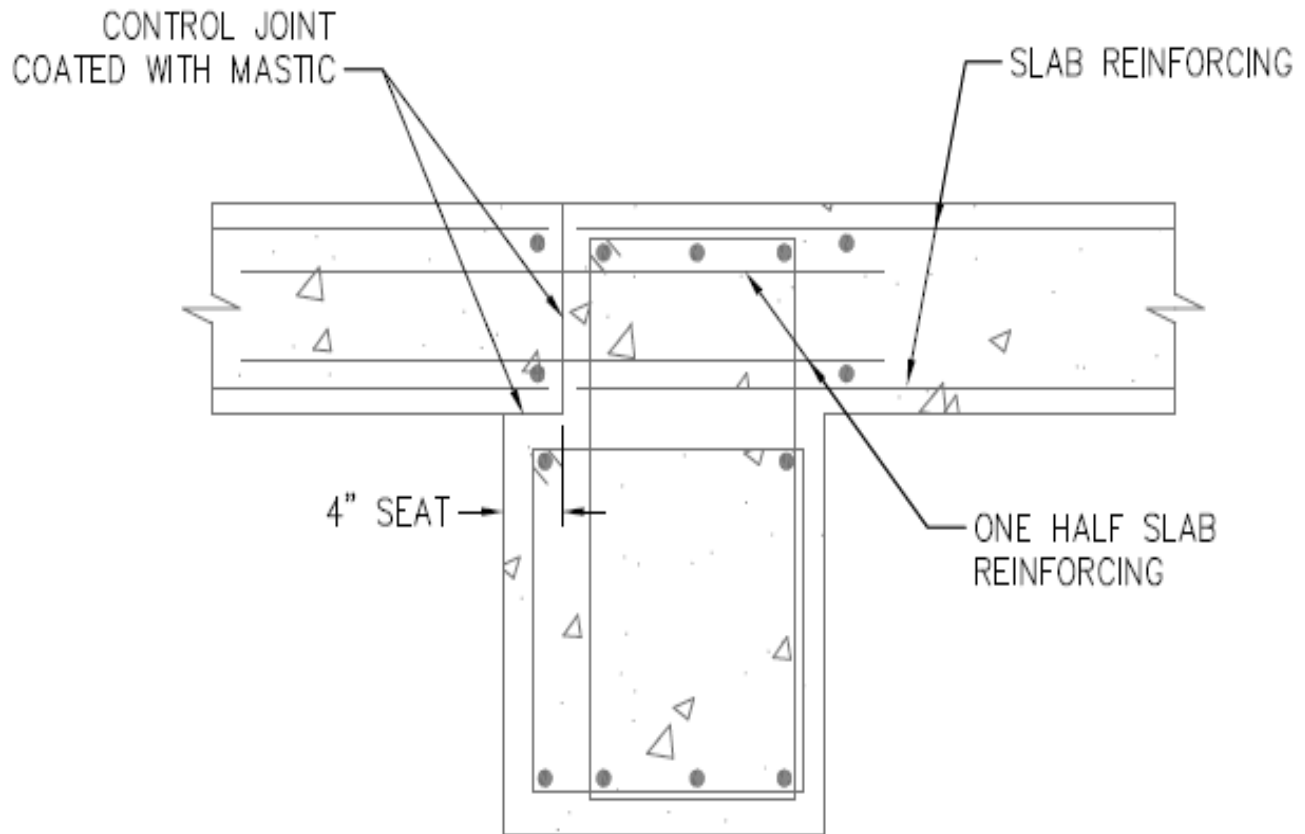


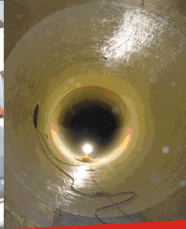
Typical Environmental Control Joint

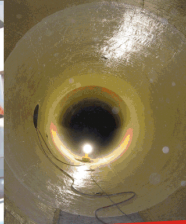




Existing Seated Control Joint











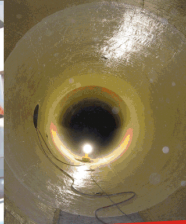






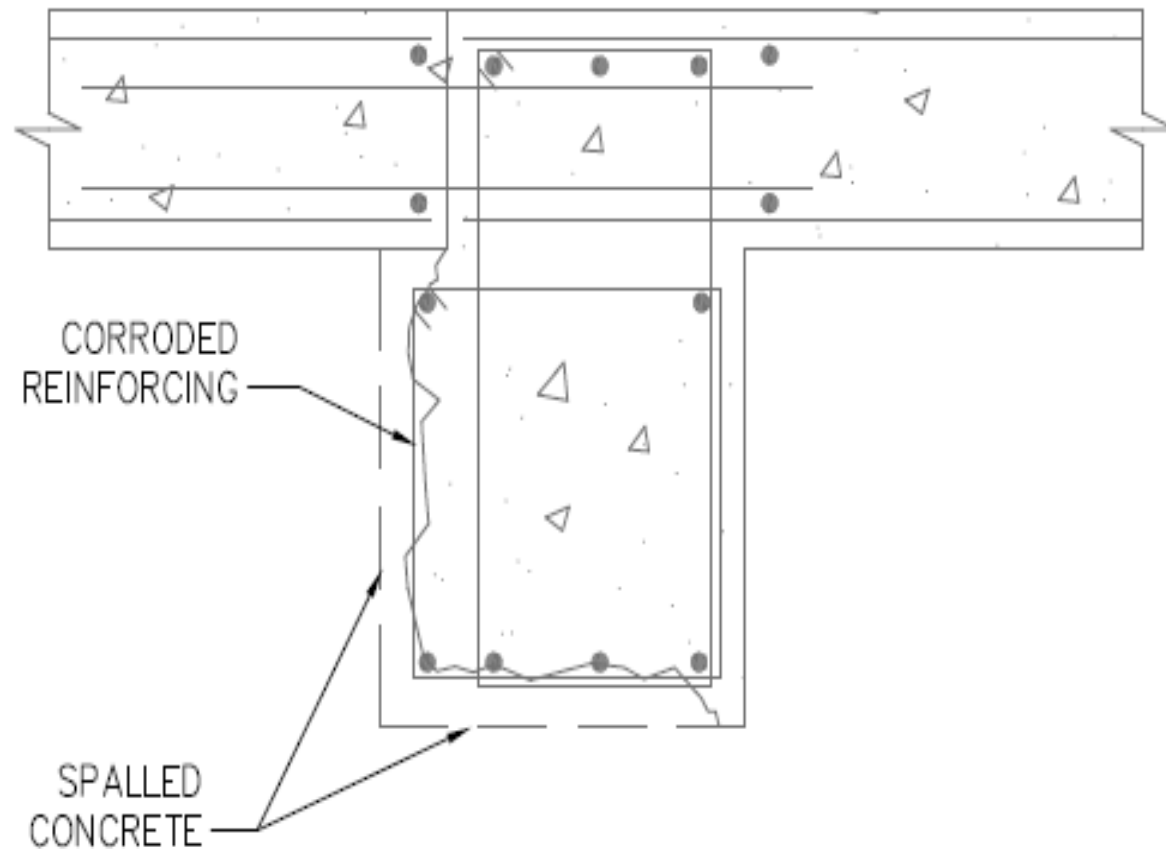


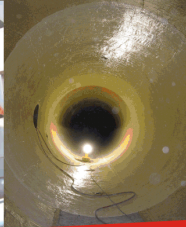
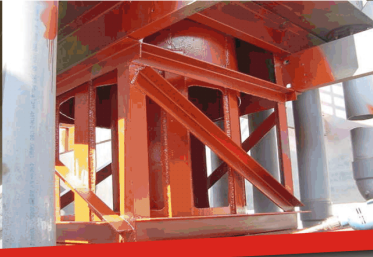






Seated Control Joint Deterioration









Assessment

- Deterioration nature and extent
- Deterioration mechanism
- Repair materials, methods, and details
- Repair quantity for bid



Assessment

Resist premature conclusions.



Deterioration Nature

- Localized
- Discontinuities (joints, cracks, penetrations)
- Concrete cover spalling
- Reinforcing corrosion
- Corrosive agent: Sodium hypochlorite



Wastewater Corrosive Mechanisms (*The Usual Suspects*)

- Acid attack
- Hydrogen sulfide attack
- Sulfate attack
- Carbonation
- Erosion/cavitation
- ***Chloride corrosion***



Chloride Corrosion

Concrete properties

- Pore network
- Permeable to water and ions
- 25% calcium hydroxide
- pH 12 to 13



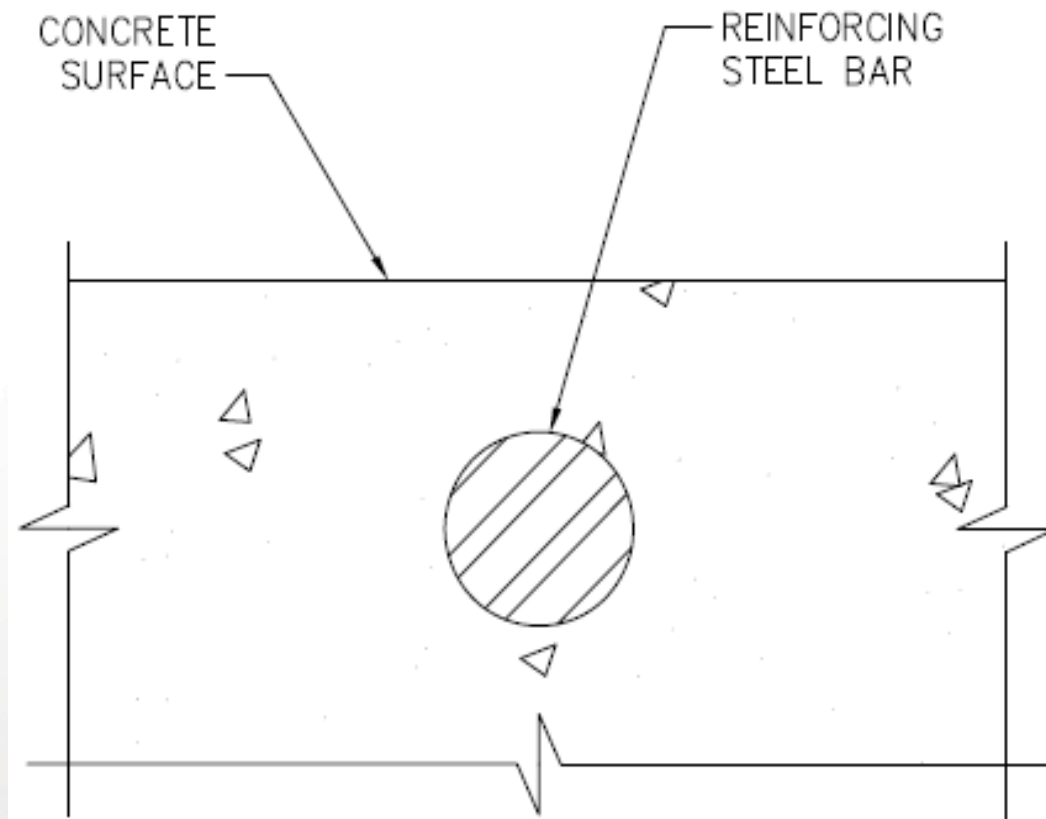
Chloride Corrosion Mechanism

Reinforcing corrosion

- Passive oxide film at $\text{pH} > 10$
- Chlorides breakdown passive layer
- Concrete acidification

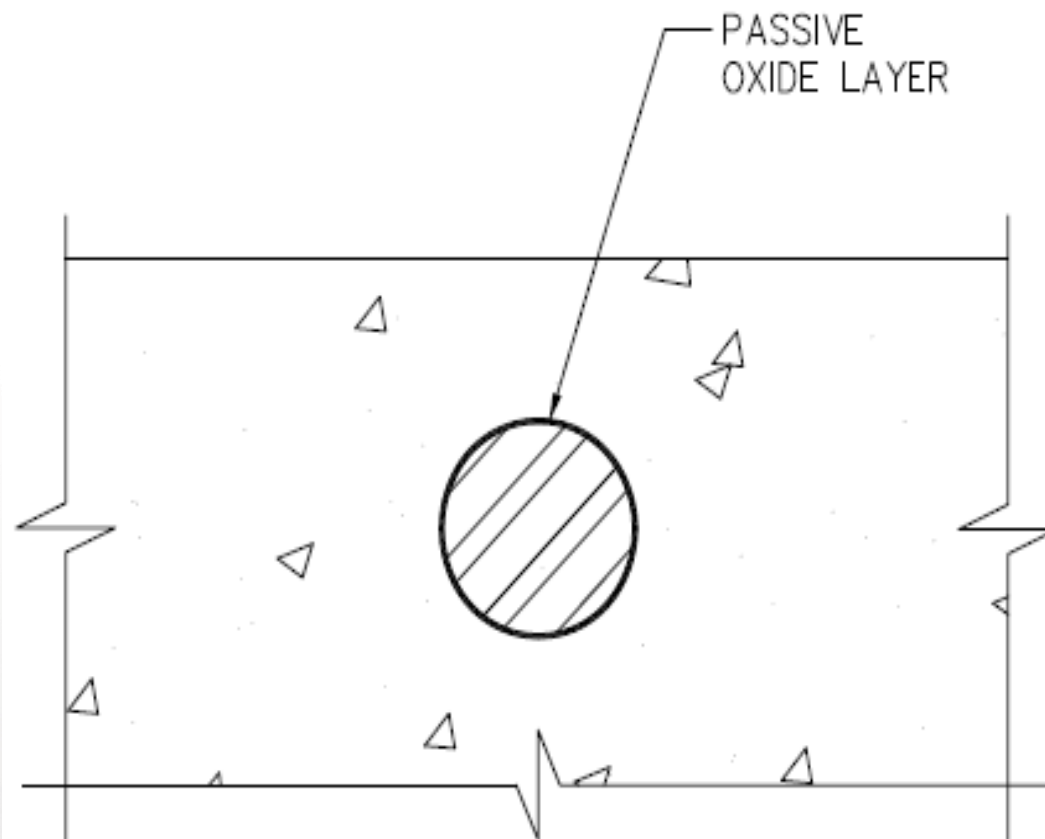


Chloride Corrosion Mechanism



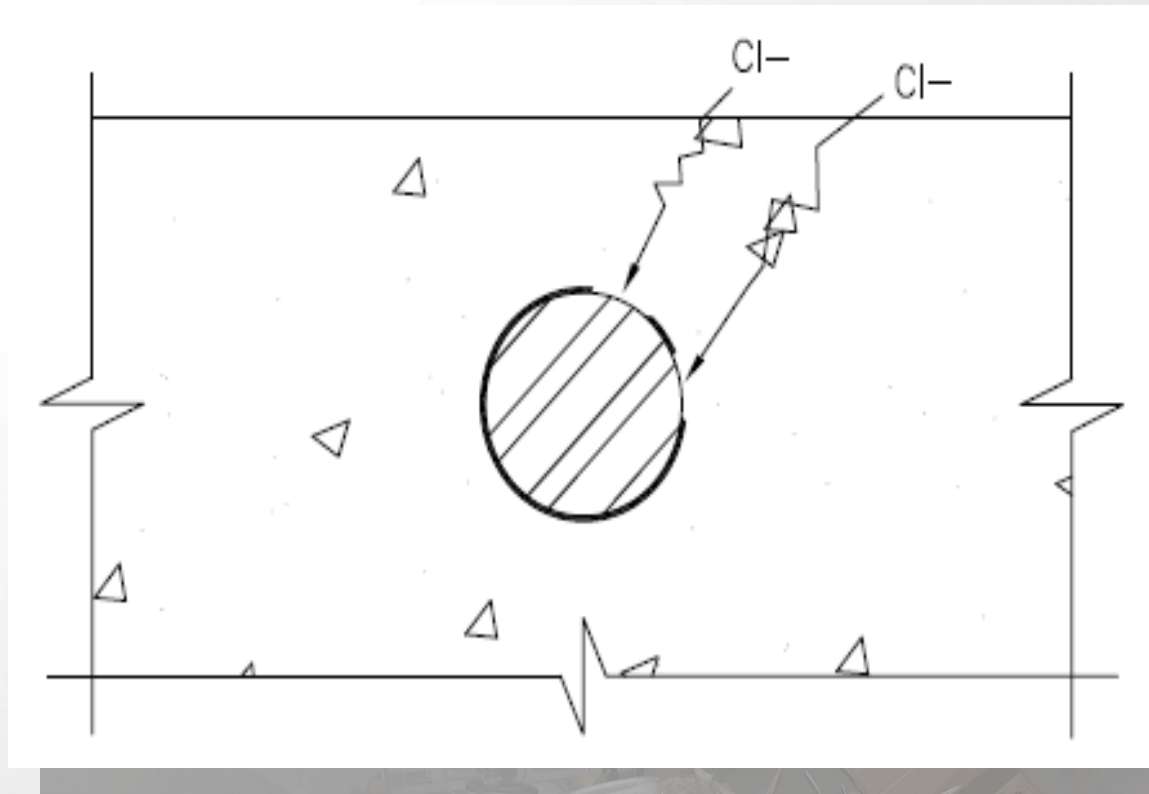


Chloride Corrosion Mechanism



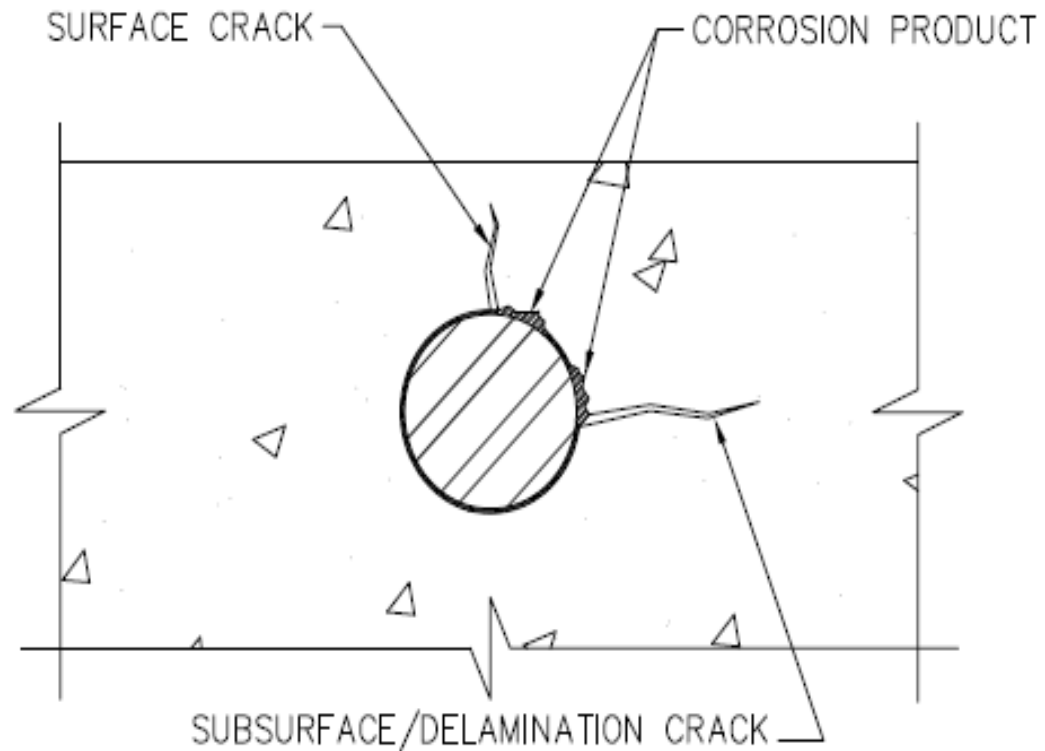


Chloride Corrosion Mechanism



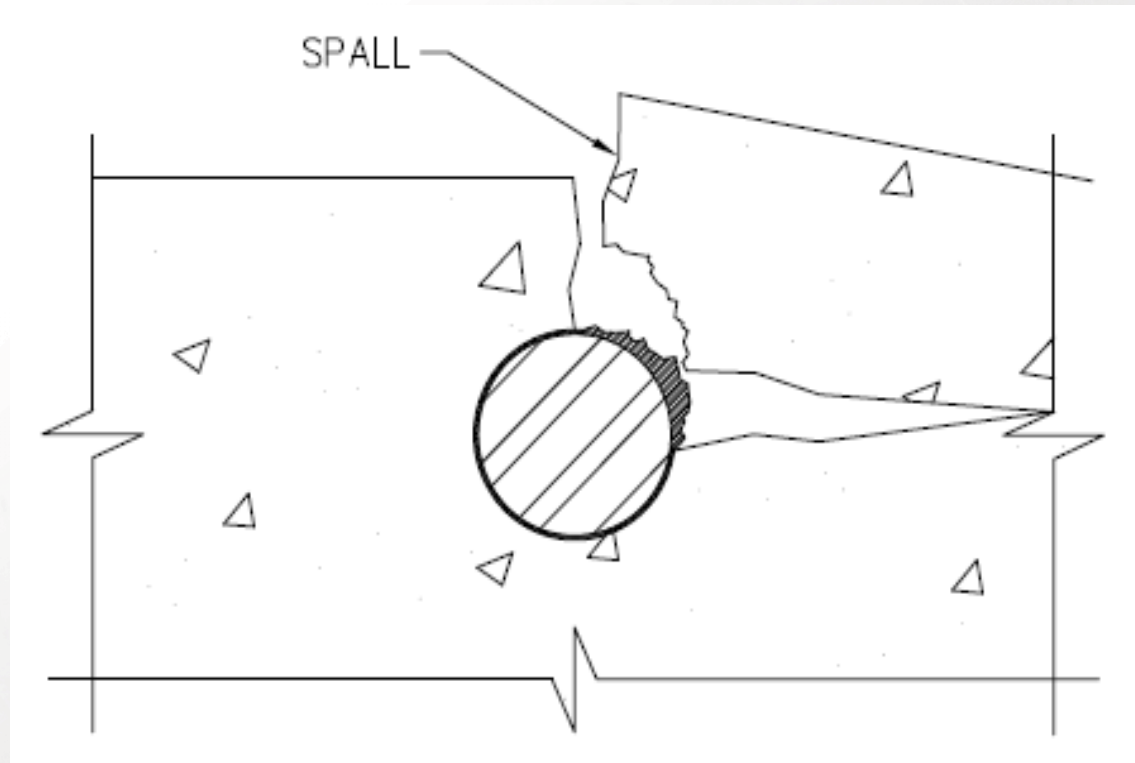


Chloride Corrosion Mechanism





Chloride Corrosion Mechanism





Diagnosis: Chloride Corrosion

- Source: Sodium hypochlorite spillage/leakage
- Path
 - Control joint
 - Pipe penetrations
 - Cracks
- Deterioration
 - Concrete spalling
 - Reinforcing corrosion

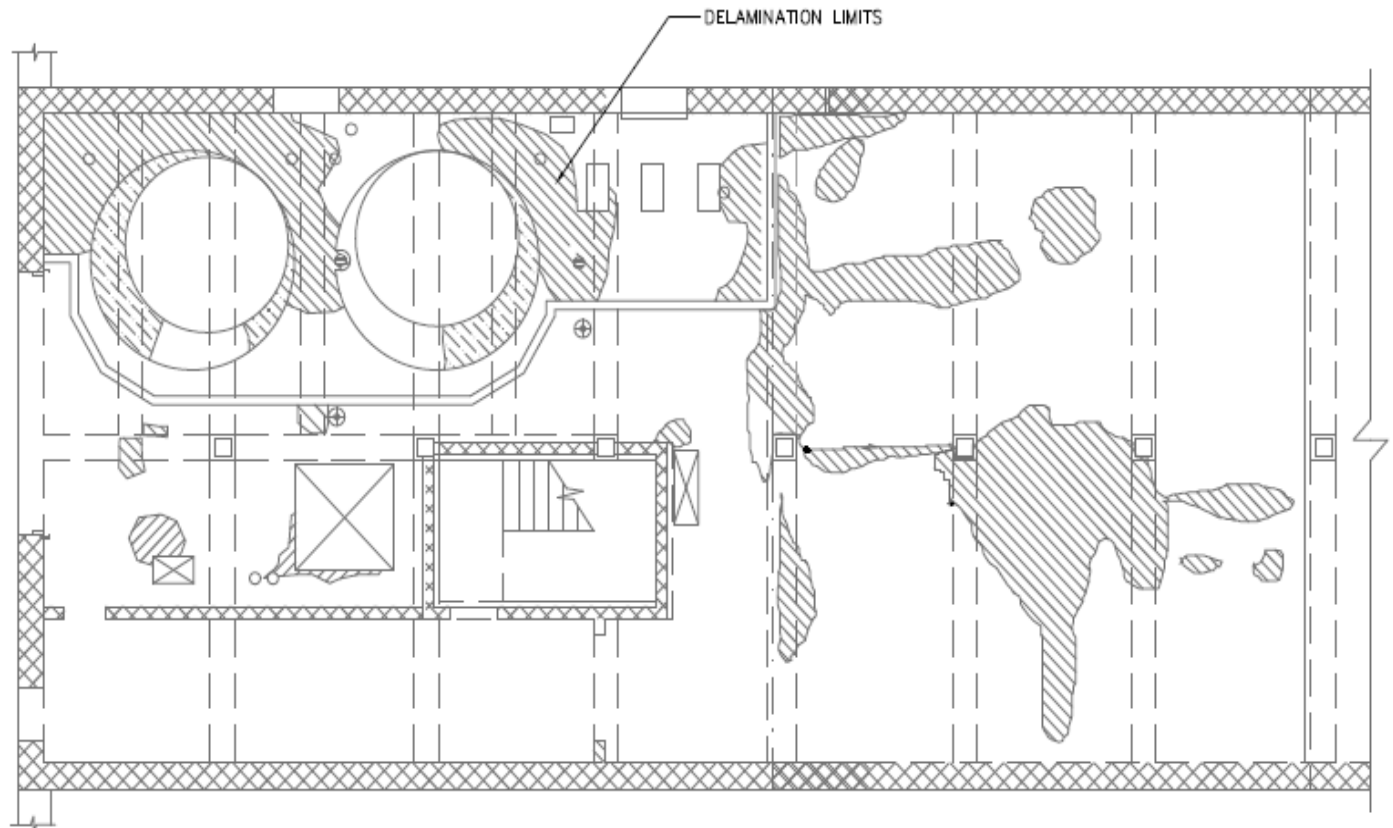
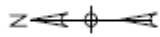


Assessment

- Percussion testing (hammer sounding)
 - Delamination extent
- Coring
 - Chemical Testing
 - Delamination depth
- Drilled powder sampling
 - Chemical testing
- Excavation
 - Subsurface conditions



Percussion Testing Survey





Core Extraction





Drilled Powder Samples





Powder Sample Analysis

- Slab chloride content (% weight of cement):
 - 0.06% minimum
 - 0.90% maximum
- Limit for corrosion prevention (ACI)
 - 0.08% to 0.15%



Excavation





Excavation





pH Testing





Design Considerations

- Structural integrity restoration
- Secondary containment (110% one tank)
- Protection against hypo exposure
- Tank installation and replacement



Repair Design Concept

- Remove deteriorated/contaminated concrete
- Remove severely corroded reinforcing
- Protect remaining reinforcing
- Splice replacement reinforcing
- Install repair mortar



Replacement HDPE Tanks

- Linear Polyethylene (ASTM D1998)
- 10' diameter by 12' high
- Furnished, installed by plant operator



Design Materials

- Slab repair: Packaged repair mortar
 - Portland cement based
 - Fiber reinforced, Silica fume modified
 - Underside spray applied (contractor request)
- Containment walls: Batched concrete
 - 4,000 psi
 - 0.44 max w/c ratio
 - Fly ash, Class F, 20% - 25% replacement



Design Materials

- Reinforcing
 - Epoxy coated new
 - Epoxy primer with zinc on existing
 - Minimum reinforcing by ACI 350

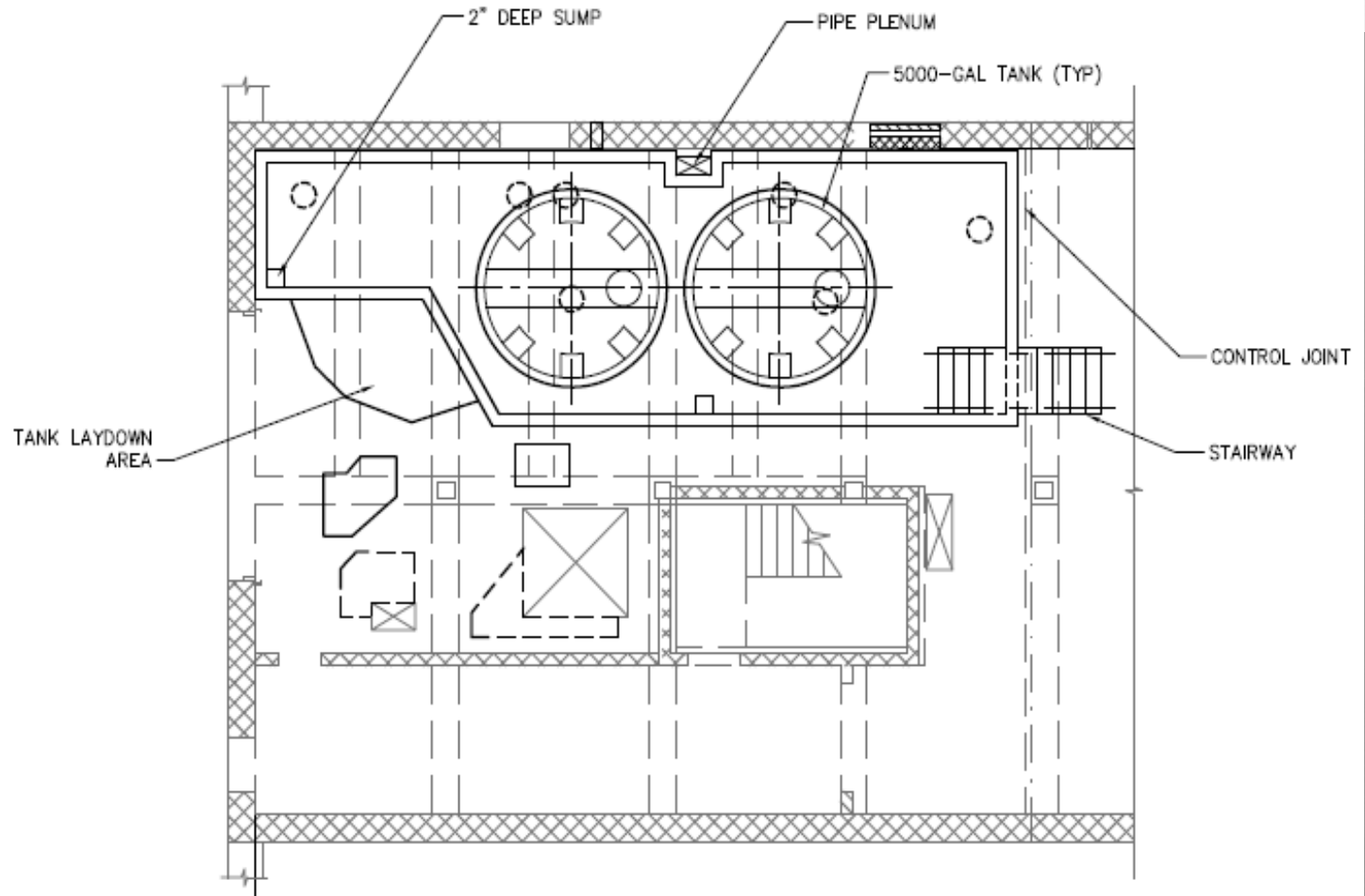


Design Materials

- Containment flooring
 - Epoxy, 3/16-inch, broadcast aggregate
 - Novolac topcoat
- Containment wall coating
 - Epoxy, 16 mil
 - Novolac topcoat
- Non-containment flooring
 - Epoxy, 1/8-inch, broadcast aggregate
 - Polyurethane topcoat

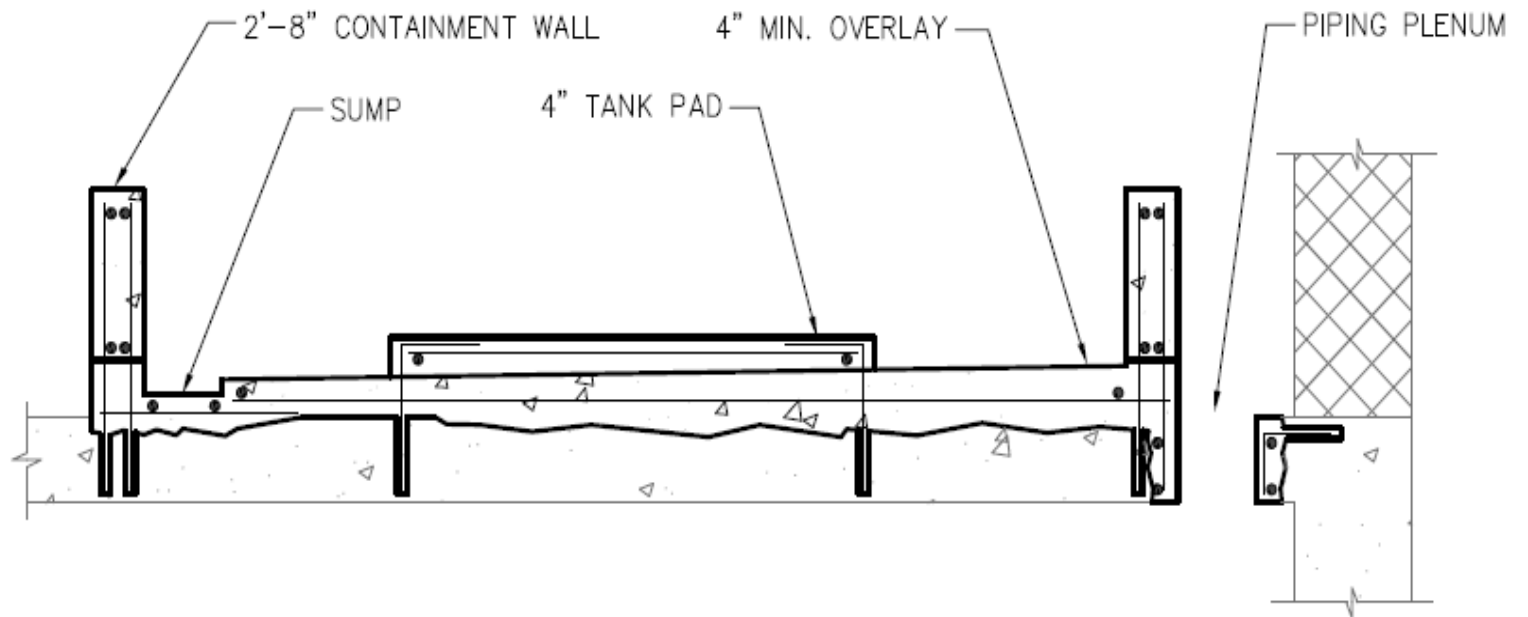


Containment Area Plan



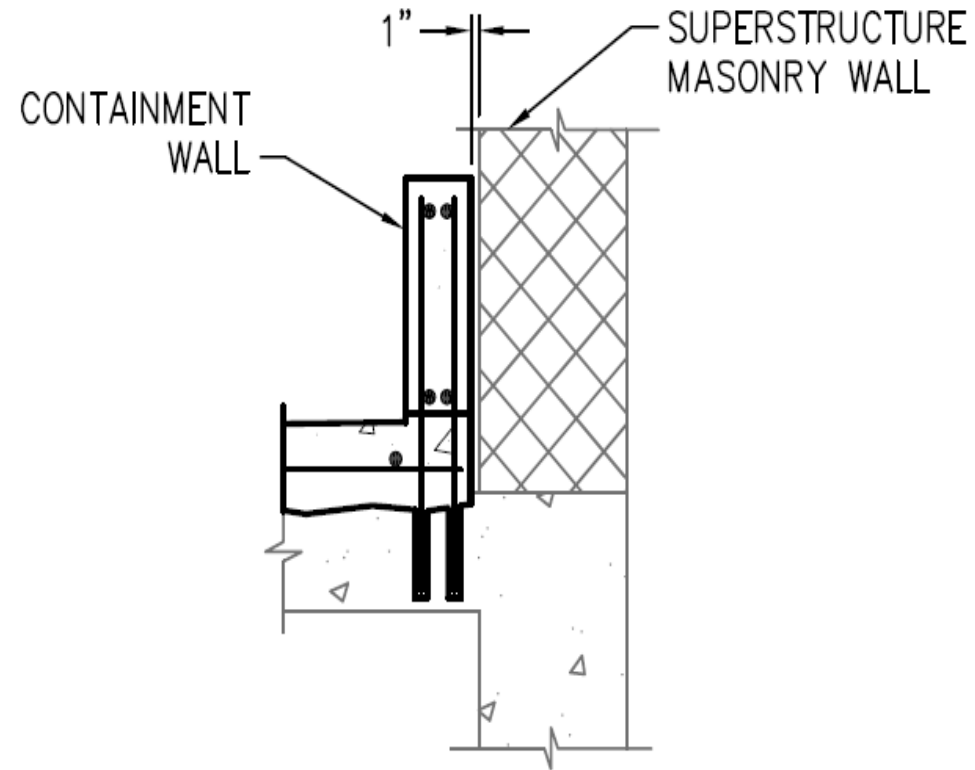


Containment Area Section



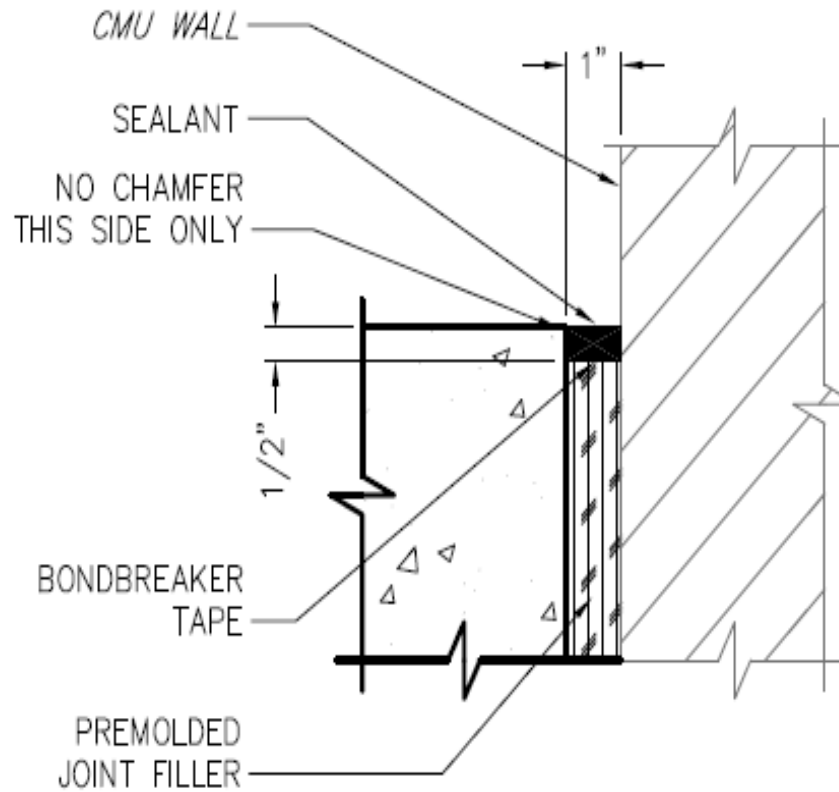


Containment Wall Section



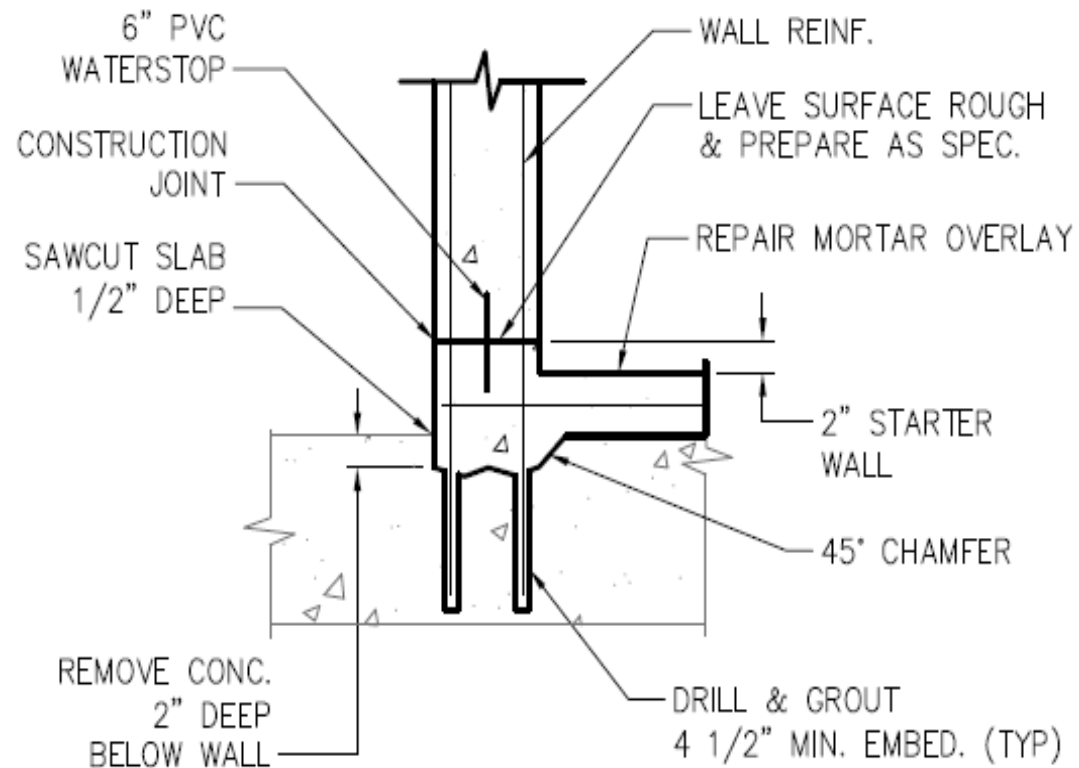


Isolation Joint Detail



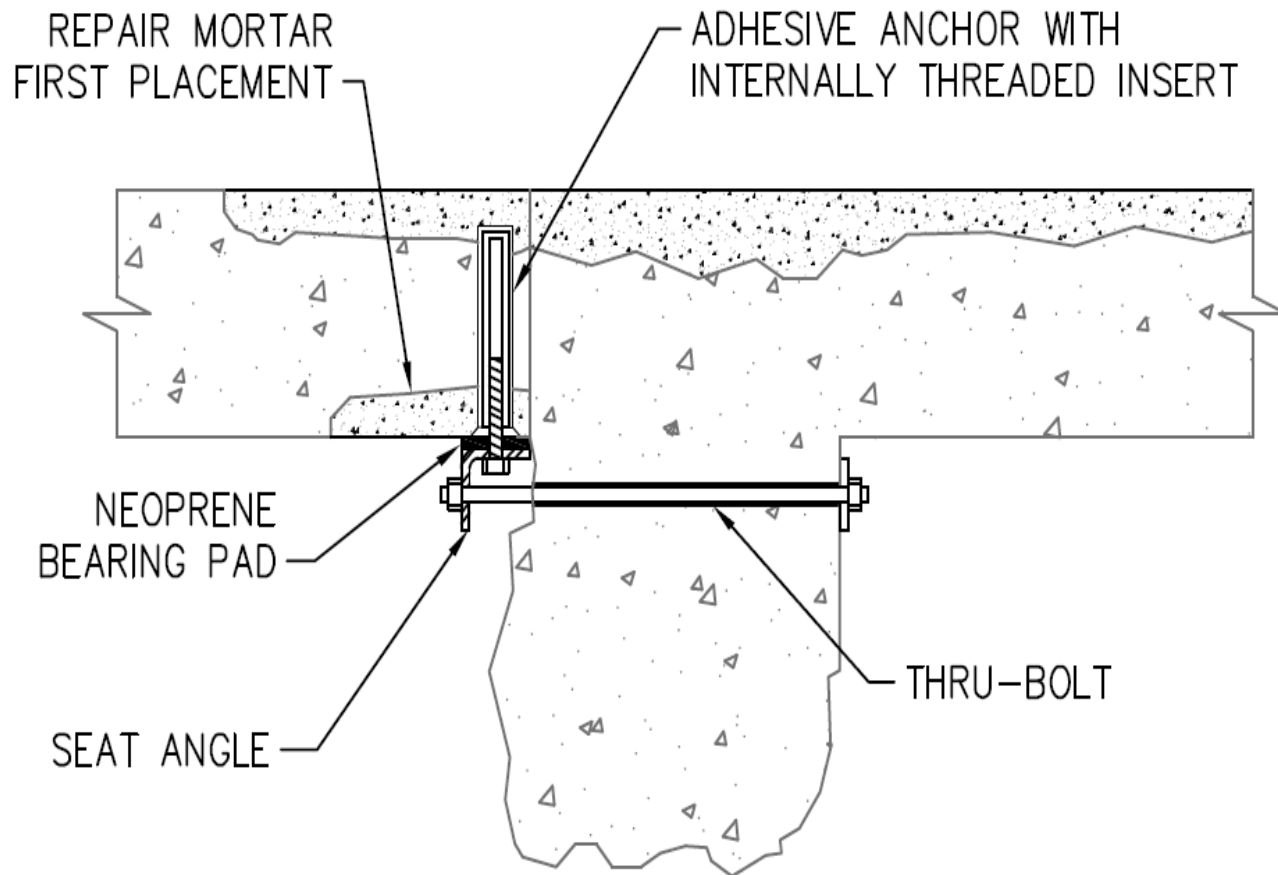


Containment Wall Detail



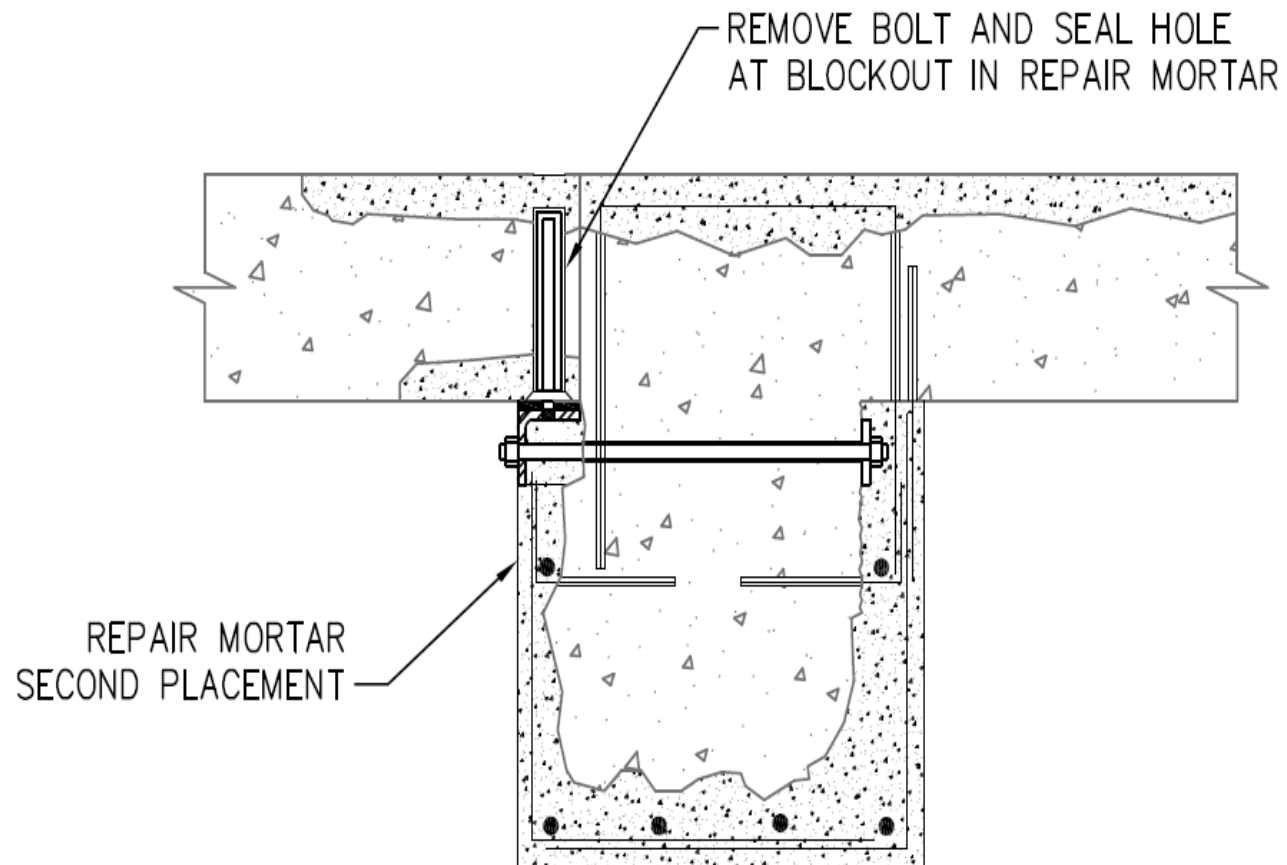


Control Joint Repair – Phase I



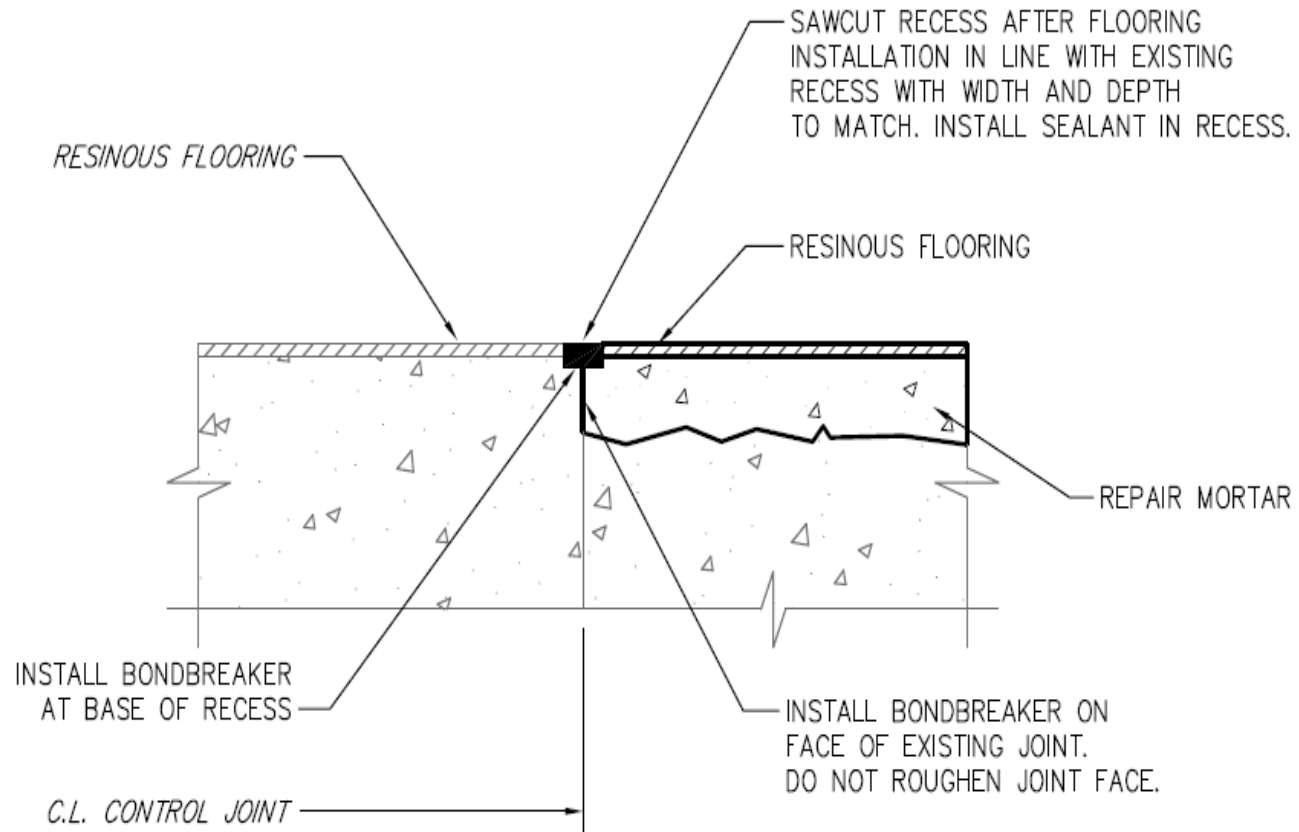


Control Joint Repair – Phase II





Control Joint Flooring Detail





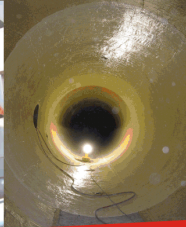
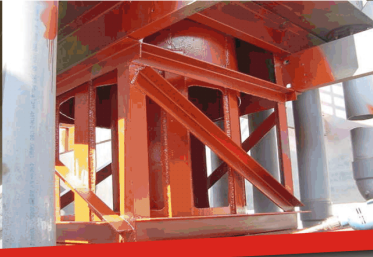
Construction Considerations

- Structural stability – shorter schedule
- Maintenance of operation – longer schedule
- Containment integrity
- Accessibility (conduits and piping)

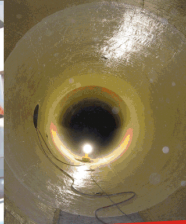
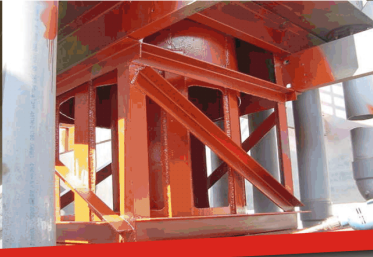


Construction Concept

- Two phases
 - I. Beam at control joint and southward
 - II. Containment area
- Watertightness test prior to lining
 - ACI 350.1
 - Hydrostatic test – Visual inspection only (HST-VIO)
- Mechanical pre-work – utility relocation

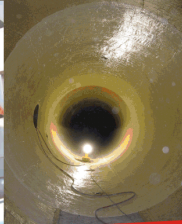
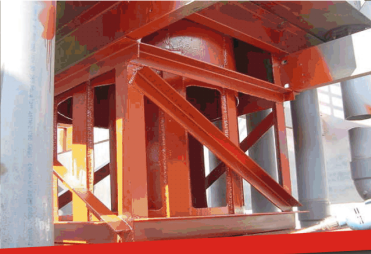


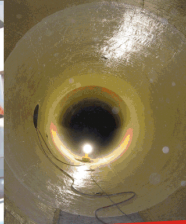


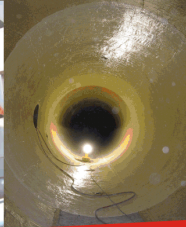
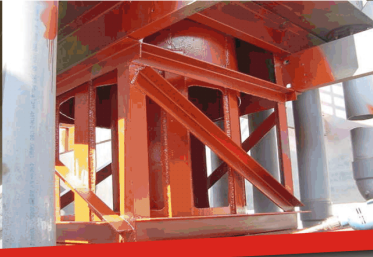








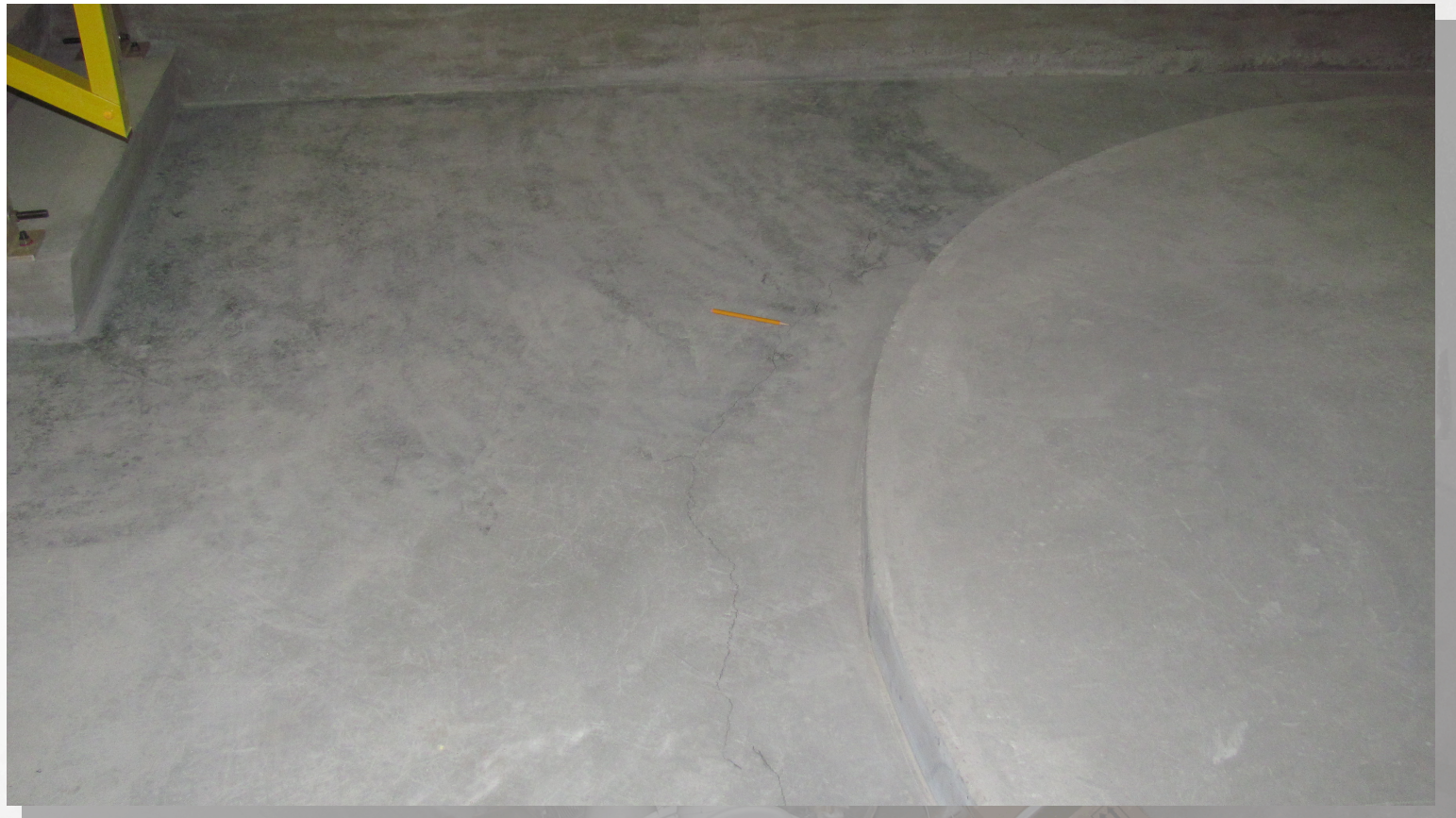












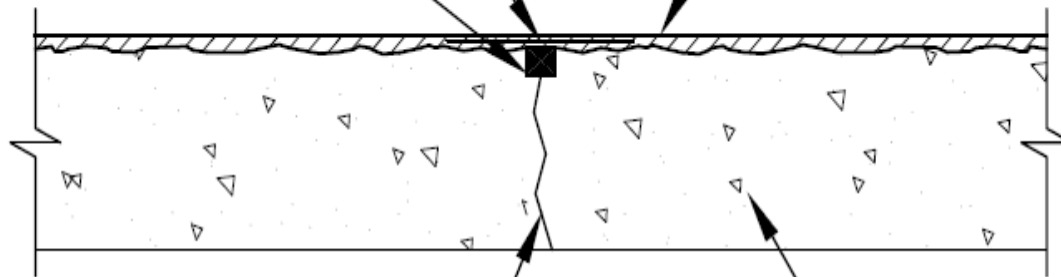


Crack Repair

6" WIDE FIBERGLASS
REINFORCING FABRIC
CENTERED ON CRACK
IN PRIMER COAT

1/4" SQ. SAWCUT
RECESS W/ SEALANT

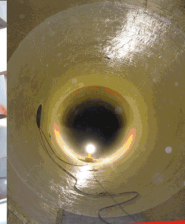
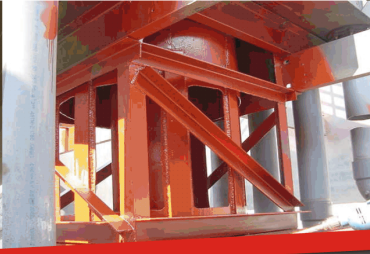
RESINOUS LINING



CRACK

REPAIR MORTAR OVERLAY

















Thanks to:

- Owner: Greater New Haven Water Pollution Control Authority
- Facility Operator: CH2M Hill – OMI
- Phase I Contractor: The Aulson Company, Methuen, MA
- Phase II Contractor: Joseph F. Kelley Company, West Haven, CT



Sodium Hypochlorite Storage Area Rehabilitation

Questions