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Engineers and Planners

Waterproofing Below Grade in High Water Table Conditions

ICRI 2013 Spring Convention

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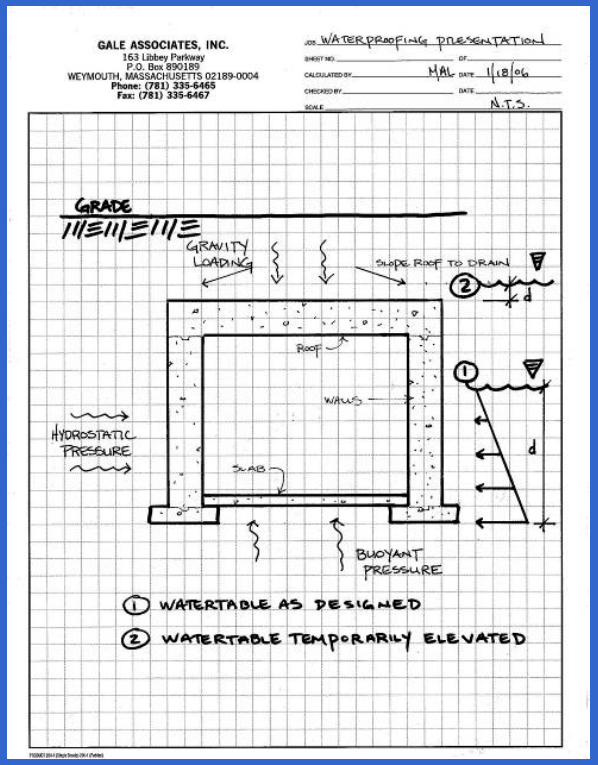
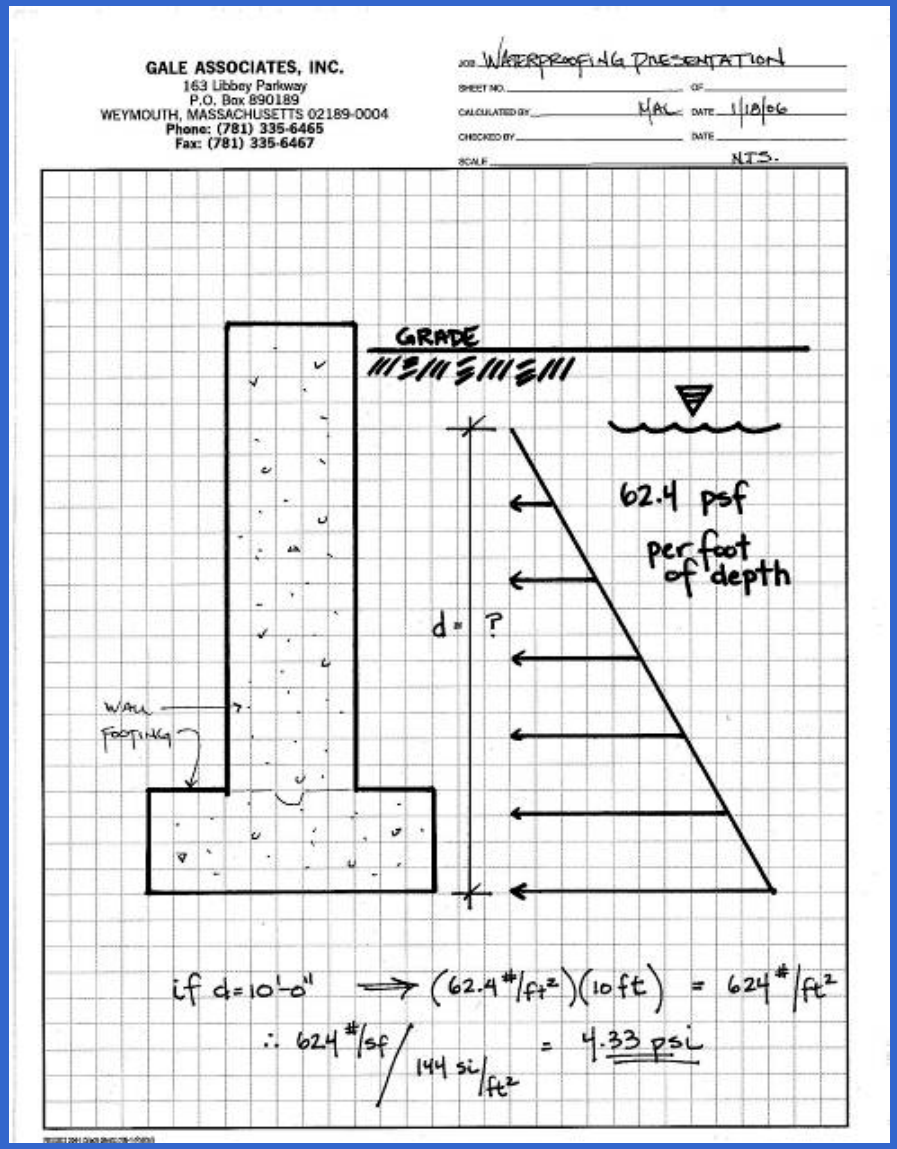
Presentation Outline

- Type of Structures and Specific Concerns
- Approaches to Sub-grade Waterproofing
- Design and Product Considerations
- Case Study Examples

Sub-grade Structures and Concerns

- Hydrostatic pressure – weight of water
- Storm water
- Capillary action





Sub-Grade Structures and Concerns

- Foundation walls and footings
- Slabs on grade / split / mud
- Sump / elevator pits
- Pile and matt slab foundations
- Retaining walls
- Tunnels
- Parking garages / slurry walls
- Occupied below grade spaces

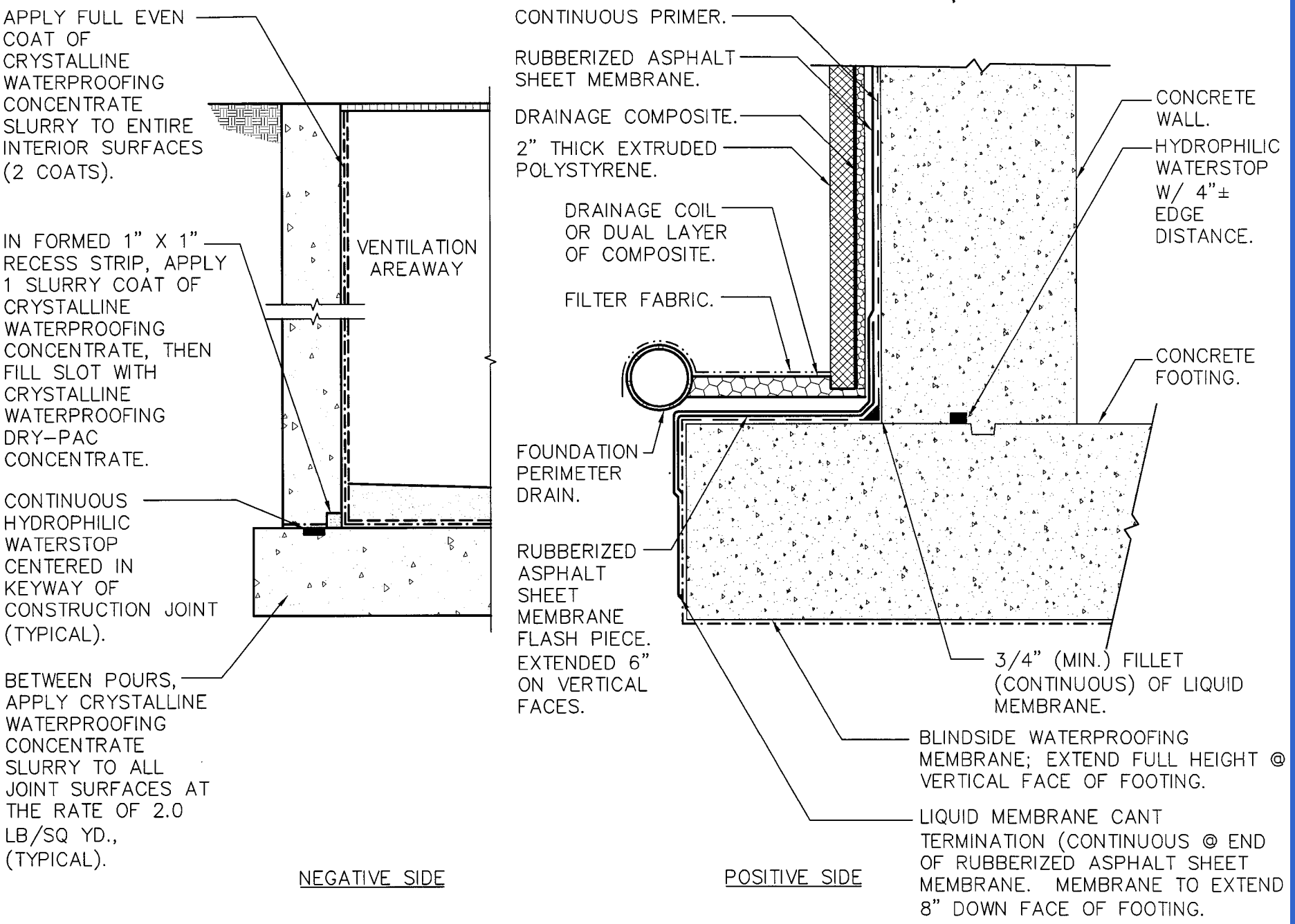
Key Concepts

- Code requirements
- Tolerance to moisture
- Risk of leakage
- Redundancy in system

Approach to Sub-Grade Waterproofing

Control of Ground and Storm Water

- Footing drains
- Under slab drains
- Dewatering during excavation
- Pumps and wells
- Back up power for pumps



GALE

POSITIVE AND NEGATIVE SIDE WATERPROOFING

Approach to Sub-Grade Waterproofing

Positive Side

- Bentonite clay
- Composite polymers
- Reinforced fluid
- Sheet membrane
- Cementitious
- Soil injection


MAY 8 20

Approach to Sub-Grade Waterproofing

Blindside (positive side)

- Slabs
- Waste forms (walls and footings)
- Soldier pile and lagging / tie-backs
- Property line construction
- Shotcrete

Approach to Sub-Grade Waterproofing

Negative Side

- Crystalline
- Metallic oxide
- Cementitious
- Injection

Approach to Sub-Grade Waterproofing

Integral Concrete Waterproofing

- Secondary / tertiary redundancy
- Primary waterproofing for duct banks
- Dams, waterways, containment tanks
- .002” crack bridging capability

Approach to Sub-Grade Waterproofing

Joint Water Stops

- Hydrophilic
- Bulb
- Consider joint movement
- Retrofit applications
- New to existing building transitions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Design Considerations

Code Requirements

- MA Building Code (5th edition): 1224.4; Groundwater Investigation
- 2010 Florida Building Code
- IBC/CT Building Code – not less than 12” above the maximum elevation of the groundwater table
- Dampproofing vs. waterproofing
- Occupied spaces

Design Considerations

Geotechnical Data

- Design groundwater elevation – seasonal highs and lows
- Backfill type and acceptability
- Soil backfill requirements
- Controlled compaction requirements
- Damage control

Design Considerations

Soil / Water Contamination and Testing

- Saltwater
- Brackish water / sulfates
- Petroleum
- Other chemicals (dry cleaning PCE, high alkaline, hard and soft water)
- PH testing

Design Considerations

Structural Configuration and Behavior

- Active
- Passive
- System transitions

Design Considerations

Environmental Conditions

- Minimum application temperatures
- Freezing temperature; surface and ambient
- Precipitation
- Dust control

Design Considerations

Surface Preparation

- Concrete (honeycombing, form oils, form ties and tie wires, curing compounds, finish considerations, cold joints)
- Soil / fills (compaction, correct aggregate size, free draining, no clay in sub-base)
- Forms (soldier pile and lagging, sheet piling joints, tie-backs)
- Priming requirements

Design Considerations

Construction Sequence

- Pits prior to slabs
- Footings / mats prior to walls
- Membrane laps and transitions
- Open time and exposure subject to damage

Design Considerations

Remedial Techniques

- Drill and pressure injection (high pressure)
- Exterior soil injection / curtain walling (low pressure)
- Negative side cementitious and crystalline
- Water plugs / patches
- Positive side (Extensive)

Case Study Example – Florida Courthouse Basement

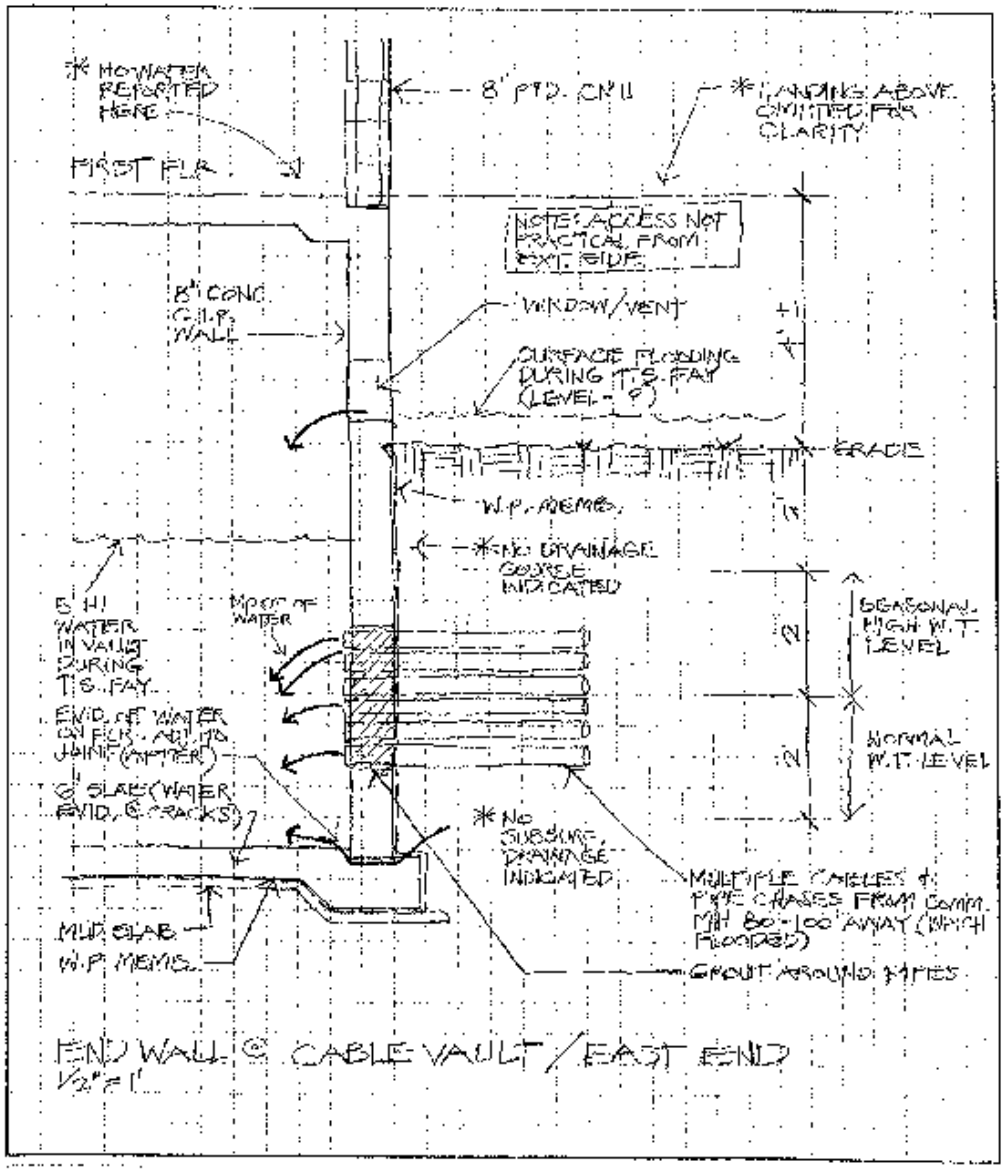
- Leak sources: slab penetrations and wall/floor joints
- Buoyant pressures caused heaving and buckling during storm related rising water tables
- Existing system: composite HDPE/Bentonite on positive/blind side, well point system

Case Study Example – Florida Courthouse Basement

- Restoration options: injection, internal trench, raised floor, eliminate floor penetrations
- Lessons learned: design buoyant slab, detail slab penetrations, well-points needed back-up, continuity of waterproofing system

Case Study Example – Electrical Vault Florida

- Leak sources: wall and floor joints, penetrations and openings
- Issues: storm impact on rising water table, age of existing construction and impractical positive-side solutions
- Existing system: multi-ply membrane without sub-surface drainage, urethane foam seals at penetrations

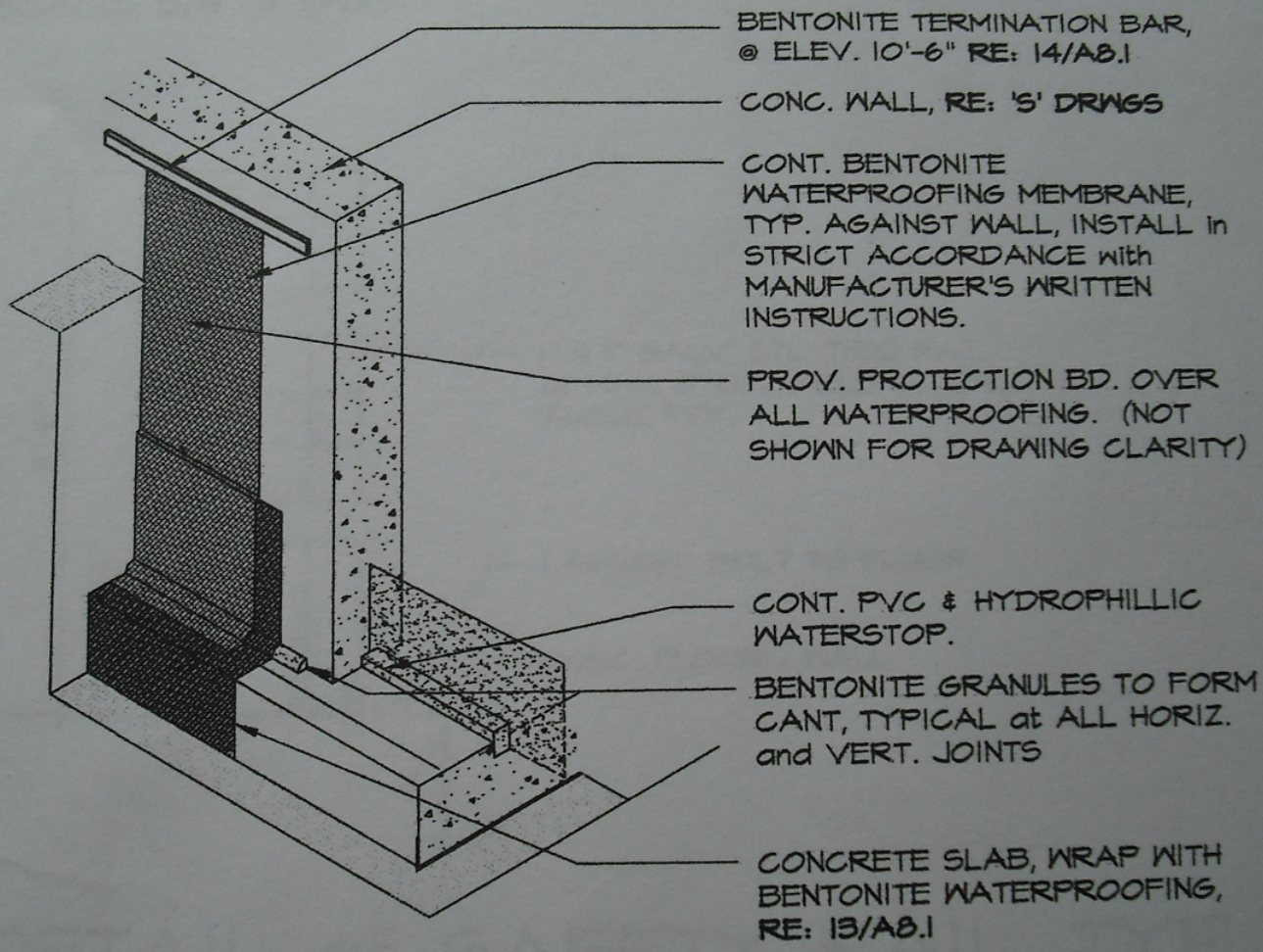

* NO WATER REPORTED HERE
8' PTD. CMU
* LANDING ABOVE OMITTED FOR CLARITY
FIRST FLR.
NOTE: ACCESS NOT PRACTICAL FROM EXT. SIDE
8" CONC. C.I.P. WALL
WINDOW/VENT
SURFACE FLOODING DURING T.S. FAY (LEVEL - ?)
GRADE
W.P. MEMB.
* NO DRAINAGE SOURCE INDICATED
5' HI WATER IN VAULT DURING T.S. FAY.
MIST OF WATER
EVID. OF WATER ON FLR. AT MID JOINT (WATER)
SLAB (WATER EVID. & CRACKS)
* NO SUBSURF. DRAINAGE INDICATED
MULTIPLE CABLES & PIPE CHASES FROM COMM. MH 80-100' AWAY (WHICH FLOODED)
MUD SLAB
W.P. MEMB.
GROUT AROUND PIPES
SEASONAL HIGH W.T. LEVEL
NORMAL W.T. LEVEL
END WALL @ CABLE VAULT / EAST END
1/2" = 1'

Case Study Example – Electrical Vault Florida

- Restoration options: negative-side crystalline slurry, seal open penetrations with hydrophilic sealant, manage water intrusion
- Lessons Learned: sub-surface drainage, pump system needed as back-up

Case Study Example – Connecticut Beach Foundation

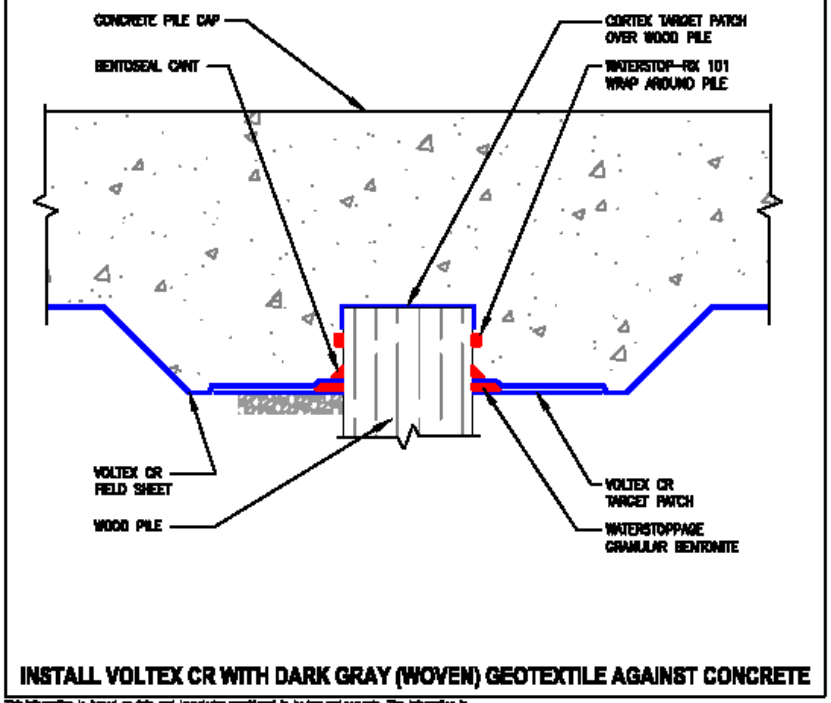
- Leak sources: slab and wall condensation
- Conditioning and condensate on poorly insulated concrete
- Specified system: bentonite sheet and dual waterstop



10 DETAIL - WATERPROOFING

SCALE: 3" = 1'-0"

CETCO WATERPROOFING	DETAIL
FOUNDATION SLAB Wood Pile	**WP-2** NO SCALE - 03/30/09



INSTALL VOLTEX CR WITH DARK GRAY (WOVEN) GEOTEXTILE AGAINST CONCRETE

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Case Study Example – Connecticut Beach Foundation

- Restoration options: ventilation, cementitious or crystalline
- Lessons learned: peer review and dew point analysis could have identified potential issues, add vapor retarder

Case Study Example – Boston School Parking Garage

- Potential leak sources: pile and matt slab foundation, wall to slab transitions
- Water cut off wall did not function as intended
- Specified system: dual slab Bentonite at blindside, PVC/Bentonite composite on walls and Bentonite/HDPE on plaza

VOLCLAY WATERPROOFING

FOUNDATION SLAB

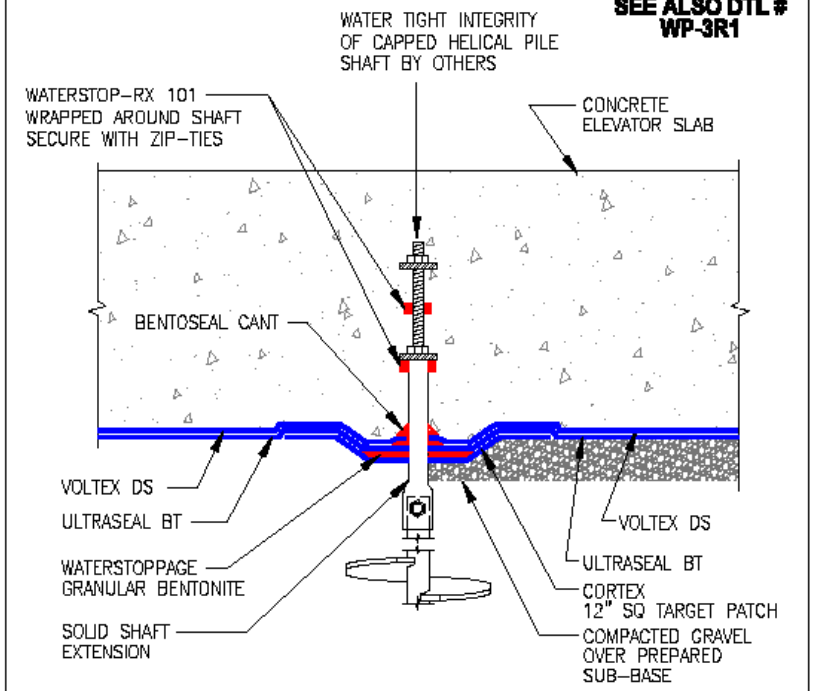
Helical Pile in Elevator Pit

DETAIL

WP-9

NO SCALE - 03/07/08

SEE ALSO DTL # WP-3R1



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Case Study Example – Boston School Parking Garage

- Restoration options: injection or negative side
- Lessons learned: prepare for worst case and potential movement, on-site construction monitoring required

Summary

- Manage Storm and Groundwater
- Code, Tolerance, Risk and Redundancy
- Design Details
- Construction Monitoring

Negligence