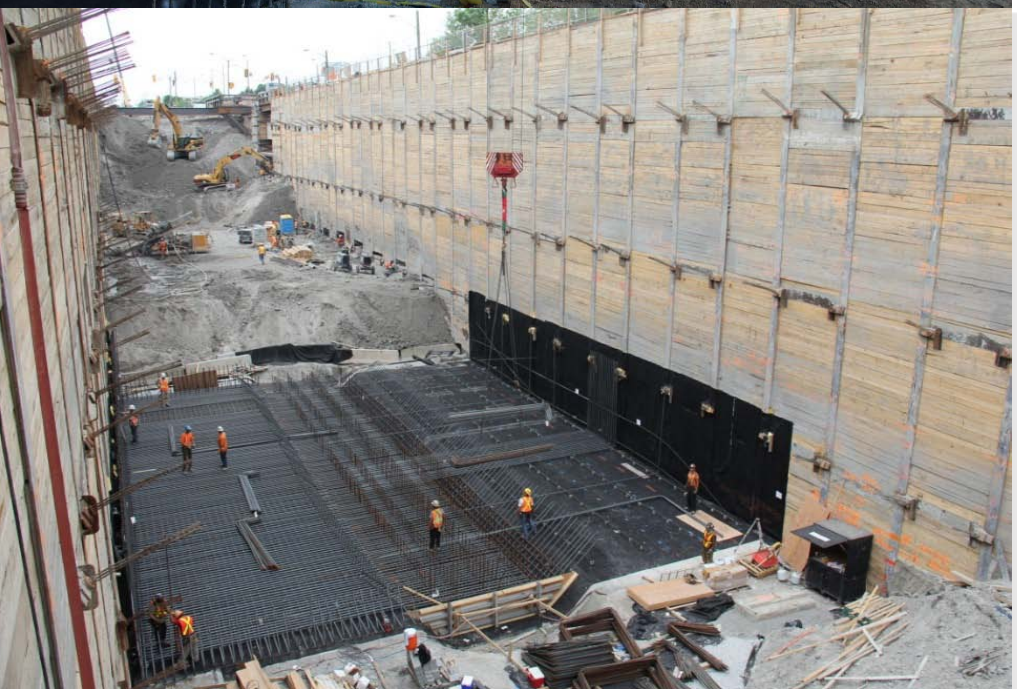

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QUALITY…SERVICE…INTEGRITY

EFFECTIVE WATERPROOFING

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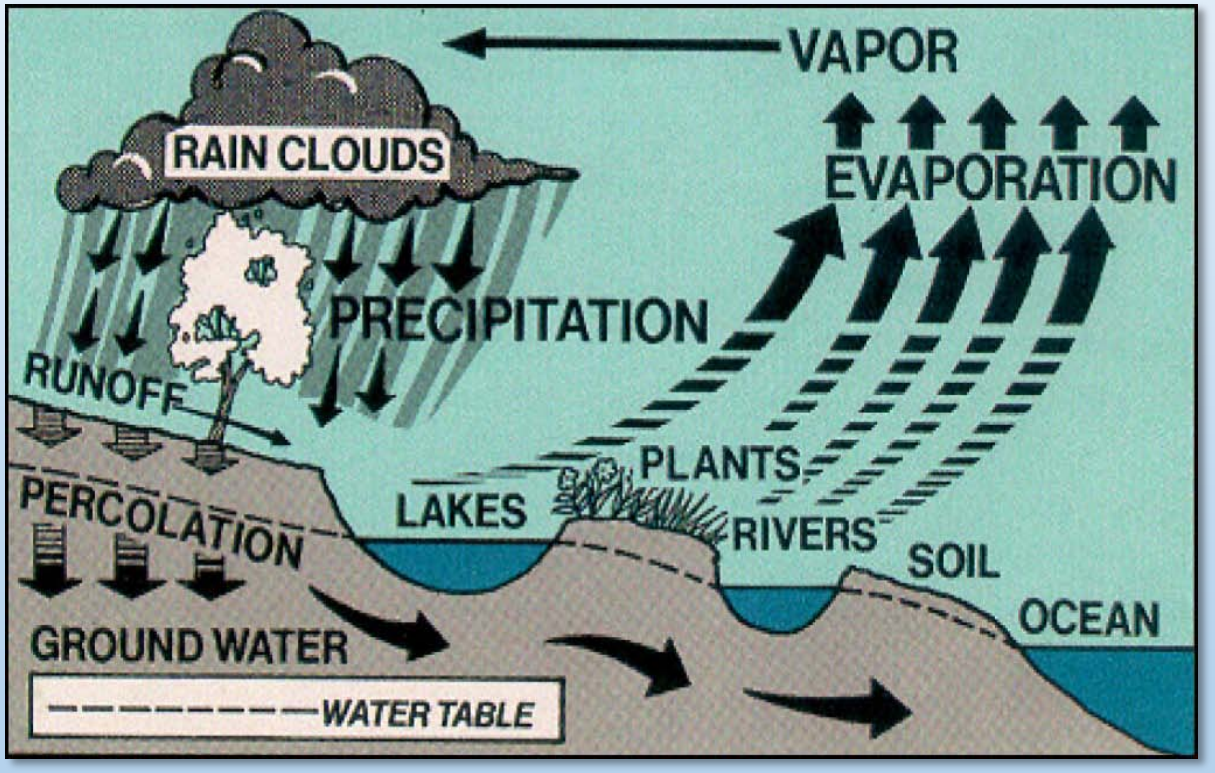
Objectives

- Discuss the mechanics of moisture movement and the resulting issues
- Explain some of the issues relating to concrete deterioration as a result of water penetration
- Differentiate between dampproofing, waterproofing and vaporproofing methods
- Differentiate between positive and negative side waterproofing
- Identify the various types of below grade systems to control moisture movement and differentiate between them

Moisture Movement

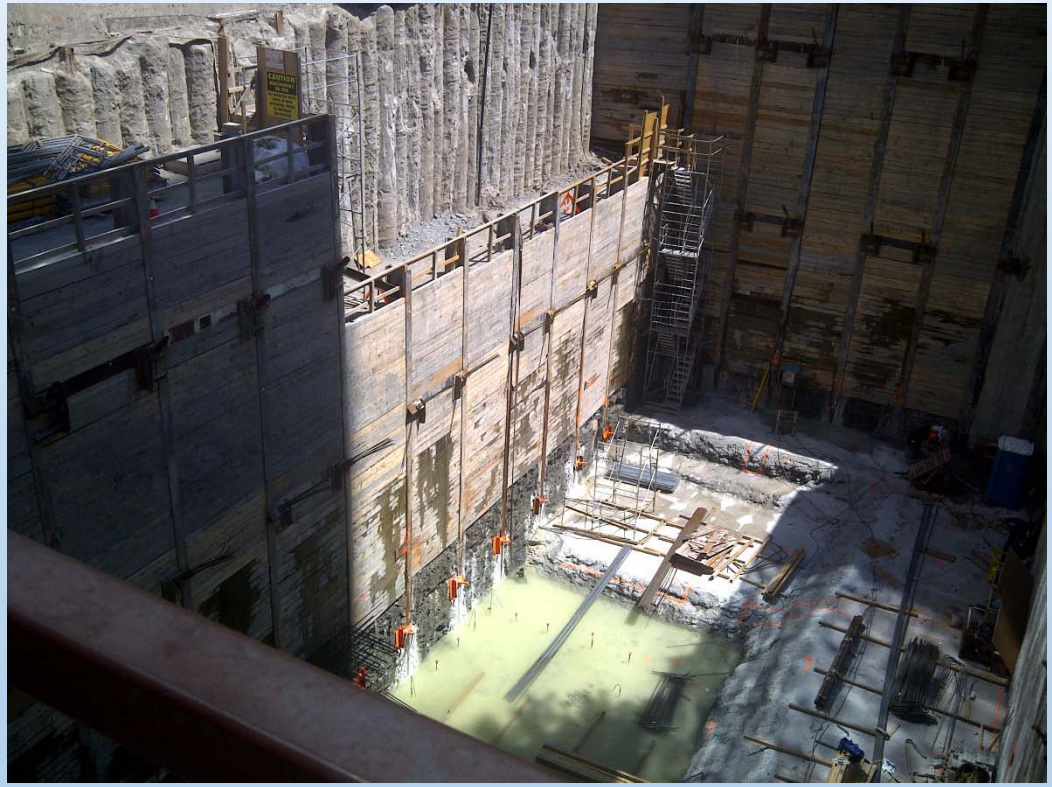
- Hydrologic Cycle
- Gravity
- Capillarity
- Diffusion Through a Material
- Air Transport
- Dew Point



How does Moisture Enter the Structure?

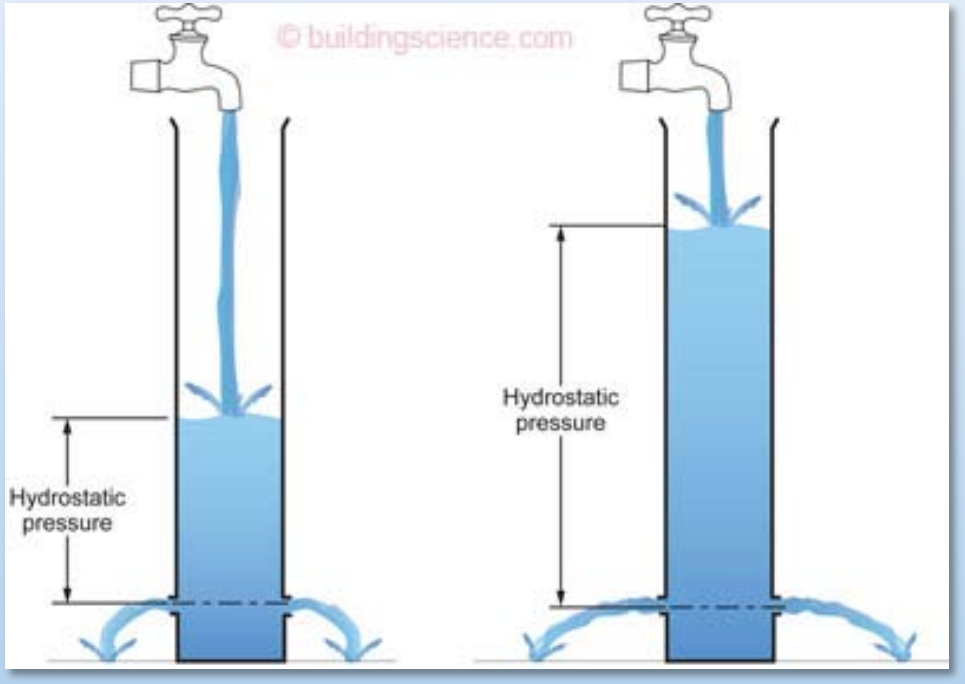
Liquid Water

- Water table
- Site drainage
- Irrigation - sprinkler systems
- Cracks
- Improper waterproofing details



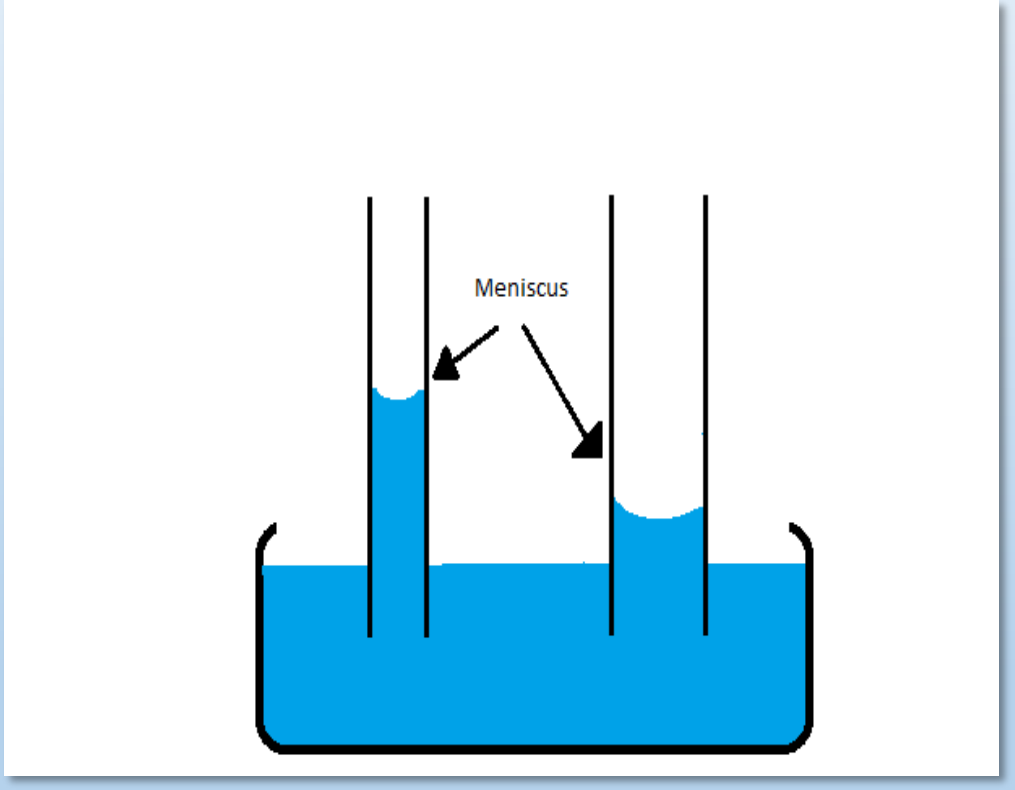
Hydrostatic Pressure

- Hydrostatic pressure is the pressure coming from the weight of the liquid
- Its value is directly proportional to the height of the liquid and to the density of the liquid
- Increases in proportion to depth measured from the surface because of the increasing weight of fluid exerting downward force from above



Capillarity

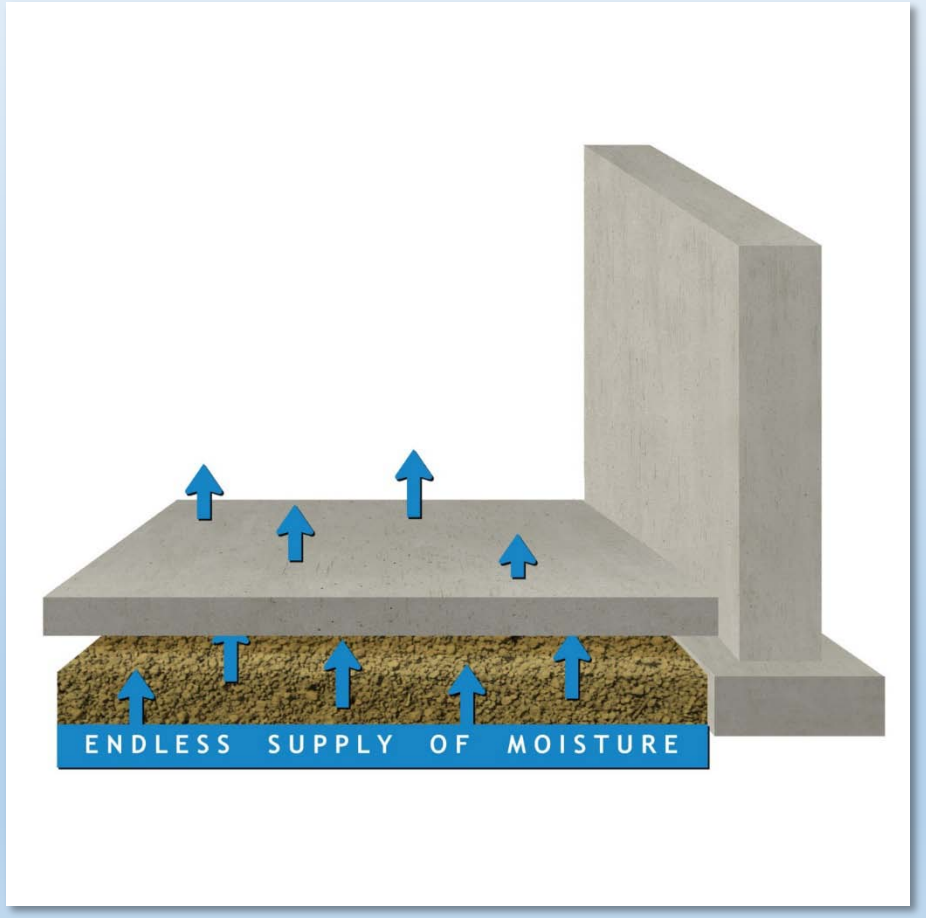
- The force that results from greater adhesion of a liquid (water) to a solid surface than internal cohesion of the liquid itself and is therefore able to literally rise along vertical surfaces
- Liquid rises against gravity
- Smaller diameter, greater rise



How Does Moisture Enter The Structure?

Water Vapor

- Below grade diffusion into the structure
- Concrete is not a good vapor barrier



Vapor Diffusion

- Vapor diffusion can be defined as the transmission of water vapor, independent of air pressure, as a result of a difference in vapor pressure

- Dependent on differences in temperature and relative humidity

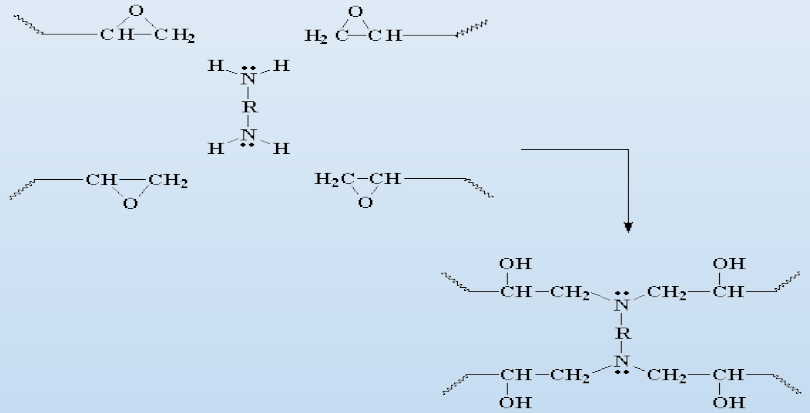
Description of Concrete

- What is concrete ?
- Composition of concrete
- Origin of concrete ?
- Advantages - low cost, high stiffness, high compressive strength, non-flammable, and ease of fabrication
- Disadvantages - low tensile strength, brittle, and to some extent long term durability

Chemistry of Concrete

- **Hydration**

- **Formation of:**
  - Calcium Silicate Hydrate
  - Calcium Hydrate
  - Calcium Aluminate Hydrate
  - Calcium Ferrite



- **Water / Cement Ratio** – determines concrete strength

- **Water** - also affects the workability and consistency of the concrete mix.

Limitations of Concrete

Although very durable, concrete will eventually deteriorate from natural weathering

Degree of deterioration dependent on:

- exposure to moisture, temperature, aggressive chemicals
- inadequate mix design and materials selection
- inadequate design for deterioration
- poor construction practices

Even good concrete can be described as permeable and porous

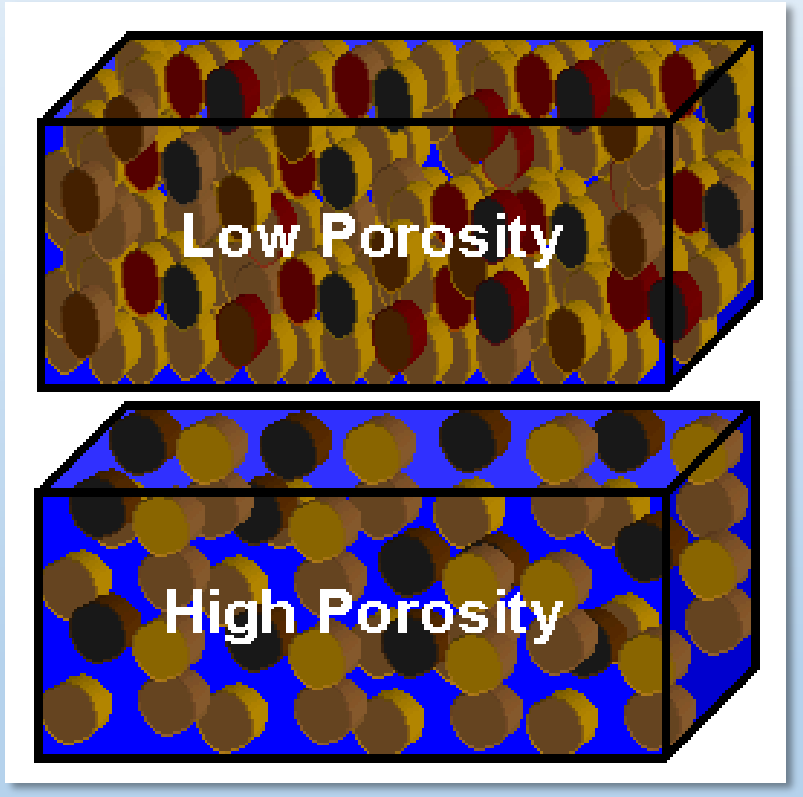
Permeability

- A measure of the ease with which fluids will flow though a material

- Trapped air pockets from inadequate compaction
- Empty space due to lack of mixing water by evaporation
- Age of the concrete
- Condition of the concrete
- Finer grades of cement particles

Porosity

- Ratio of the volume of openings (voids) to the total volume of material
- Most important factor is the water/cement ratio of the concrete
- Greater w/c ratio, greater porosity



Moisture Control

- "Except for structural errors, about 90 percent of all building construction problems are associated with water in some way".(Moisture Migration in Buildings Publication #779, ASTM, 1982)

- US EPA BASE study
  - 4 year study – 1994-1998
  - 100 selected public and private office buildings in the 10 U.S. climatic regions.
  - 85 percent of the buildings had been damaged by water at some time and 45 percent had leaks at the time the data were collected

Moisture Control

Is essential…

- For the function of a building
- For occupant health and safety
- For efficient operation of the mechanical system
- To protect building from damage

Essential Elements of Effective Moisture Protection

- Continuity
- Durability
- Structural integrity
- Resilient

Factors Influencing This Effectiveness

- Design
- Materials
- Workmanship
- Quality assurance

Waterproofing System Selection

- There is not one waterproofing system for every situation
- It is important to differentiate between dampproofing, waterproofing, and vaporproofing

Waterproofing

- Waterproofing is defined as the resistance of the passage of water under hydrostatic head pressure.

Dampproofing

- Dampproofing is defined as the resistance of water in the absence of hydrostatic head pressure.

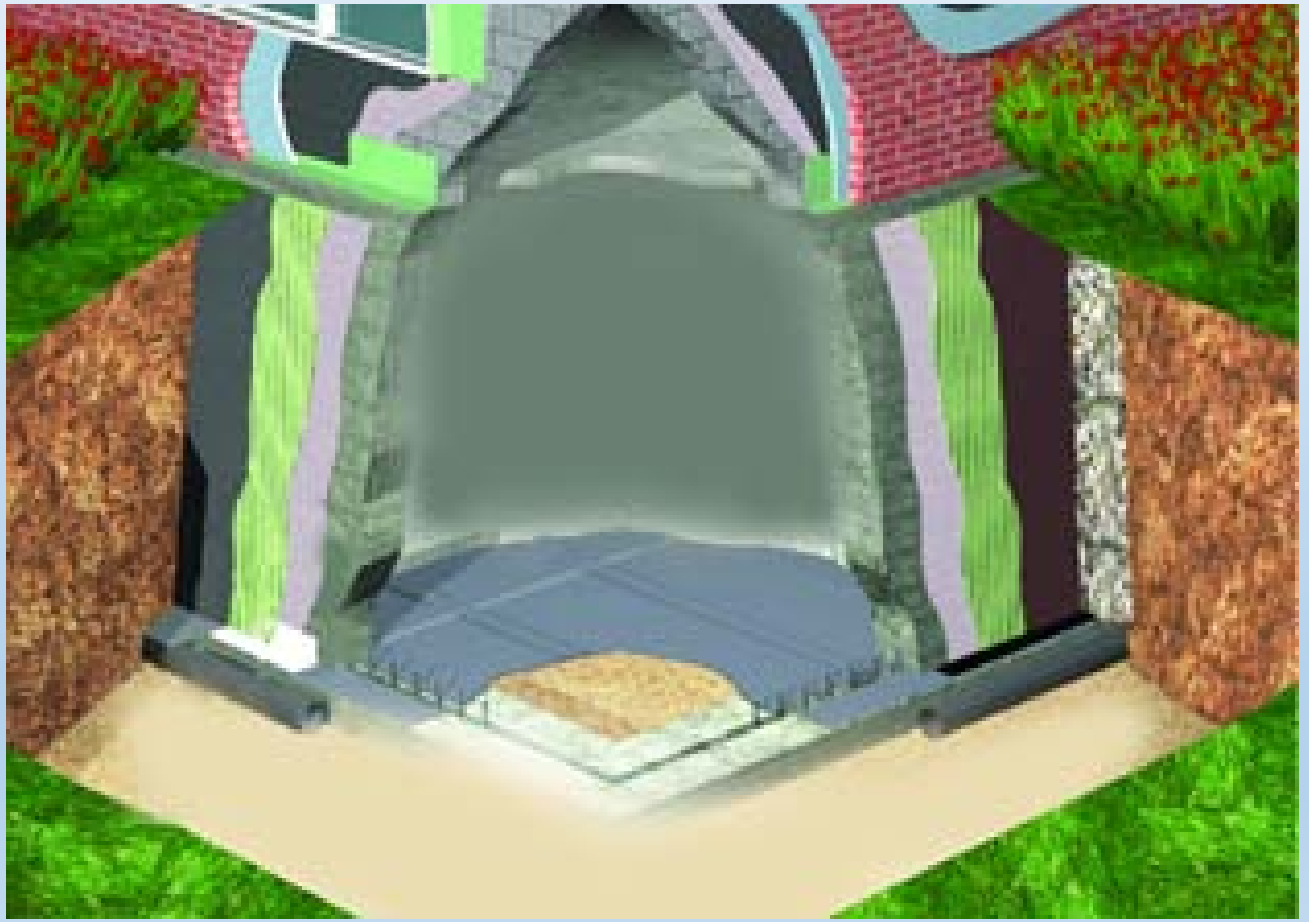
- Dampproofing materials typically will not bridge cracks in concrete that may occur during the life of a building.

Vaporproofing

- A material that is totally immune to the passage of a gas under pressure
- Vapor diffusion - transmission of water vapor, independent of air pressure, as a result of a difference in vapor pressure
- Limitations using waterproofing coatings

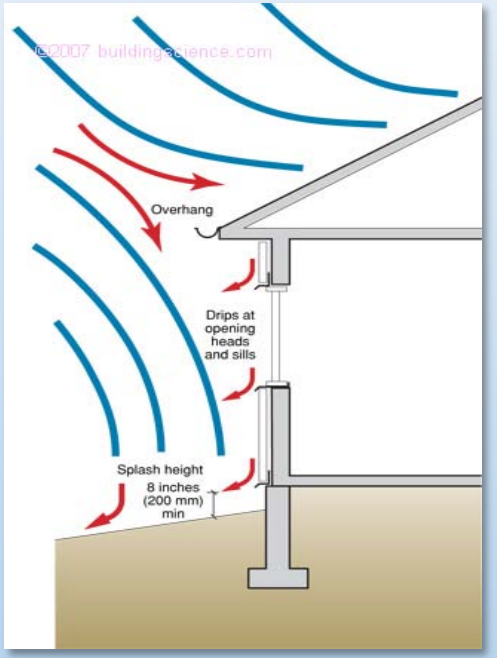
Below Grade Systems

- Waterproofing
- Vaporproofing
- Drainage



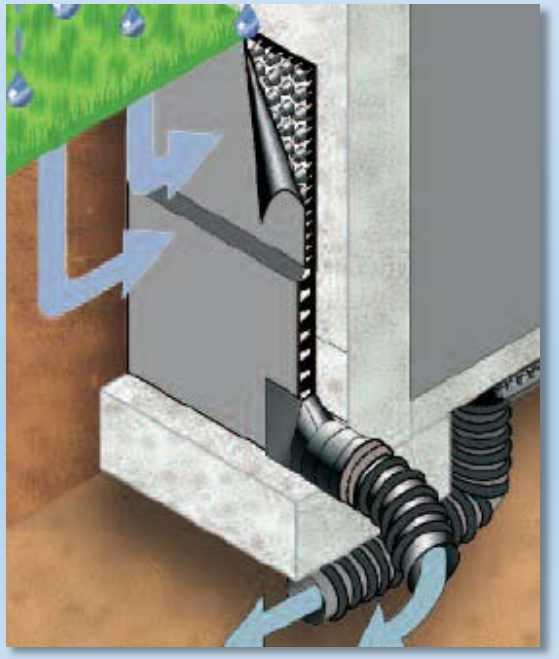
Water Control System

- Deflection – shed water – site planning, landscaping
- Drainage
- Provide capillary breaks
- Provide waterproofing systems

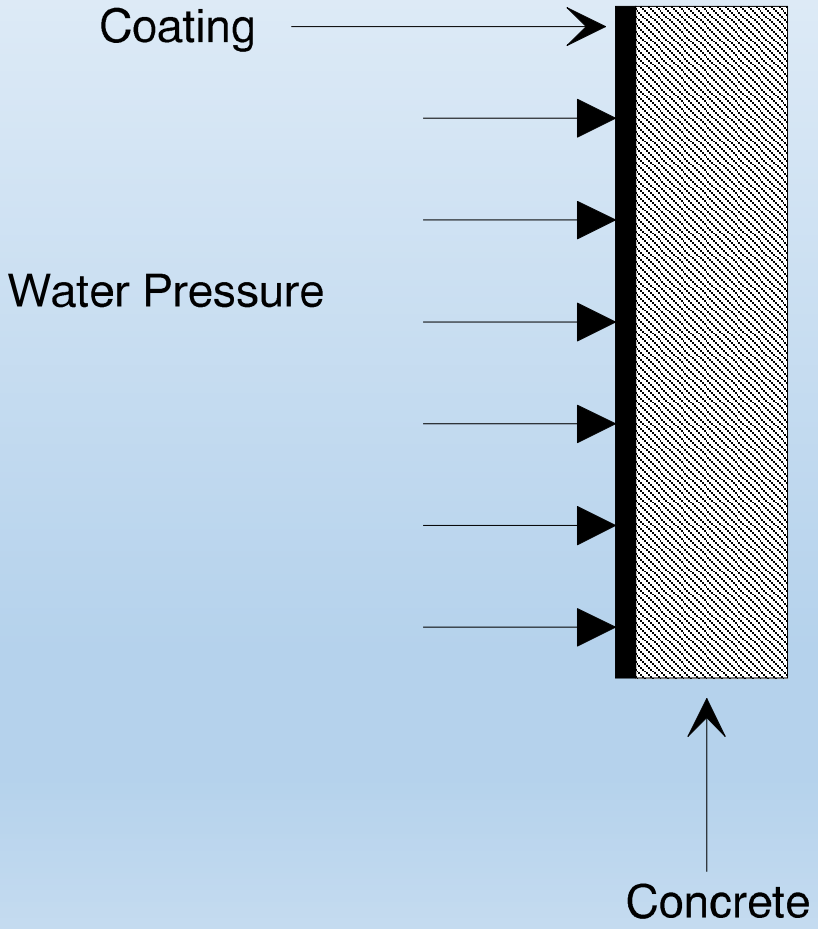


deflection

drainage



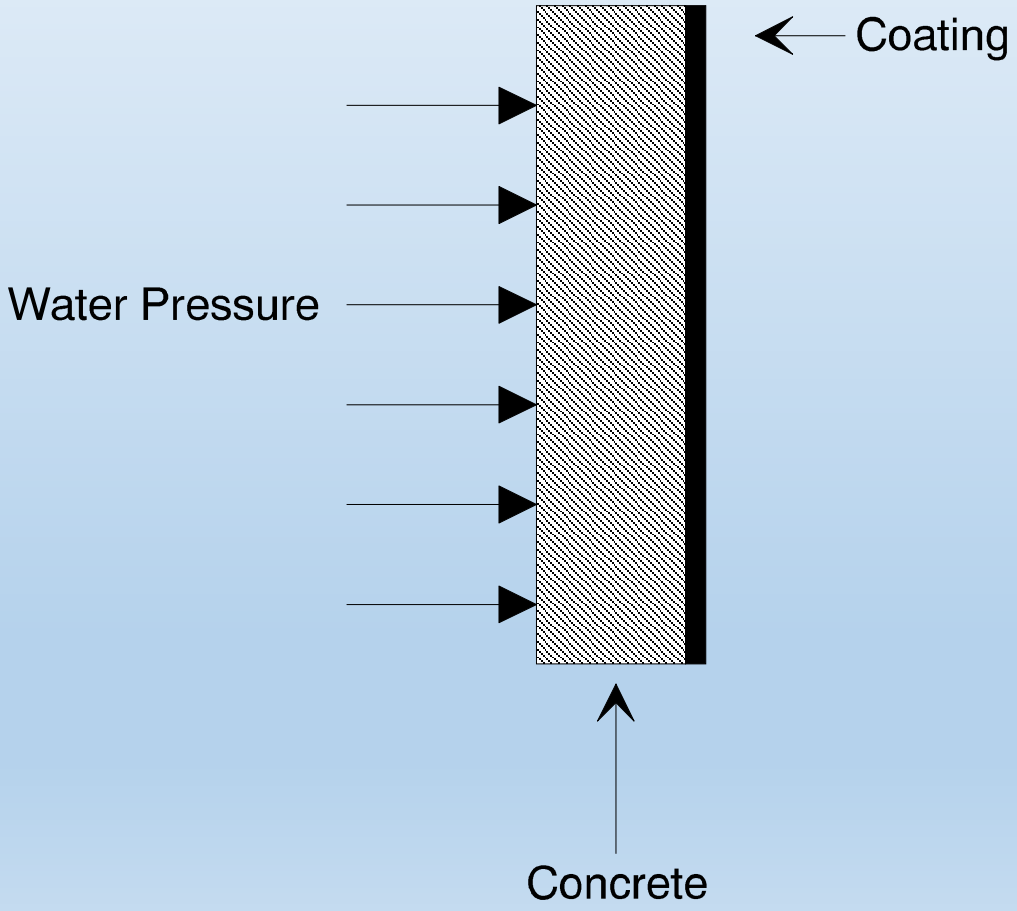
Positive Side Waterproofing Systems



- Sheet membrane waterproofing
- Fluid applied membranes
- Cementitious waterproofing
- Flexible cementitious coatings

- Protection boards
- Composite drainage boards

Negative Side Waterproofing Systems



- Crystalline waterproofing
- Flexible cementitious coatings

Material Selection

- Working life of product
- Cost
- Adherence to substrate
- Puncture resistance
- Resealability
- Flexibility
- Ease of application
- Installation costs
- Credibility of manufacturer
- Warranty program

Types of Materials

- Sheet membranes
- Fluid-applied membranes
- Cementitious membranes
- Conventional and Blindside Applications

Self-Adhesive Membranes

- Consist of SBS modified bitumen
- High density polyethylene carrier sheet
- Horizontal and vertical substrates
- Application includes a substrate primer

Thermofusible (Torch-On) Membranes

- Consist of SBS modified bitumen membrane
- Reinforced with non-woven fibreglass
- Horizontal and vertical substrates
- Application requires use of an open flame propane torch to heat the lower side, allowing membrane to fuse with substrate

Fluid-Applied Membranes

- Hot Applied Systems
- Cold Applied Systems

Hot Applied Systems

- Rubberized asphalt compound
- Adheres to virtually any structural surface
- Built up system – can provide good waterproofing protection
- Lower elasticity compared to other systems due to reinforcing sheet
- Safety during application could be a factor – experienced installer with specialized equipment

Cold Applied Systems

- One component and two component
- Polymer modified
- Water-based products
- Multiple applications
- Provides a seamless membrane
- Can be applied to “green” concrete **

Blindside Waterproofing Systems

- Drainage and waterproofing membranes are installed before the concrete structure is poured
- Typical projects include jobs where property lines and/or nearby structures limit excavation and access
- Membrane is installed over a soil retention system and not the concrete

Bentonite Sheets

- Ability to heal itself if ripped, punctured, or cracked
- Works in the presence of water
- Form a tenacious mechanical bond
- Get wet prematurely

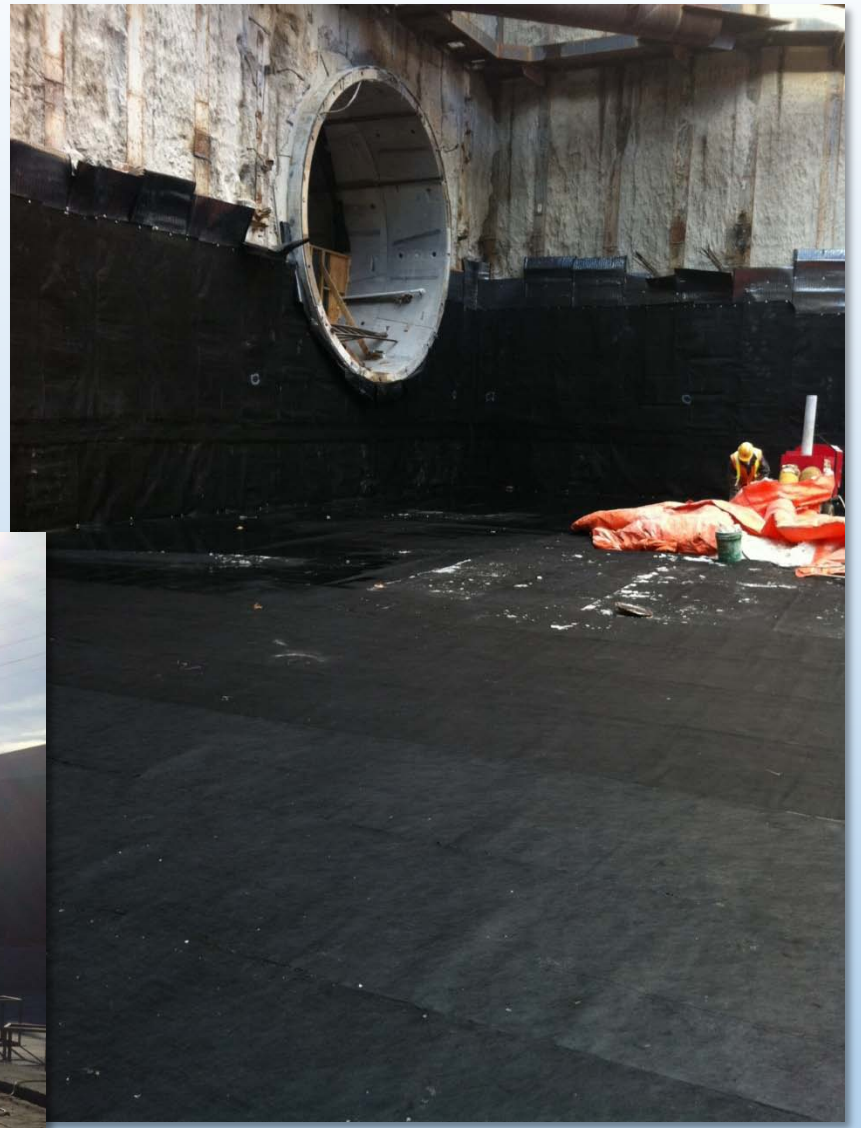
Spray Applied Membranes

- Chemically bonds to concrete once poured
- Used in conjunction with a drainage board
- Very dependent upon the details over the soil retention system

Sheet Membranes

- HDPE membrane with pressure-sensitive adhesive and a weather-resistant protective coating.

- Bituminous membranes that incorporate the embedment of membrane into concrete once poured as it contains nylon fibres



Difficult Details

Two Most Important Waterproofing Principles – Michael Kubal

- First Principle
  - 90%/1% principle – most of the leaks result from 1% of an envelopes total exterior surface area
- Second Principle
  - 99% of leaks are attributable to causes other than material or system failures

Membrane Protection

- Protection Boards
- Prefabricated Drainage Layers

Protection Boards

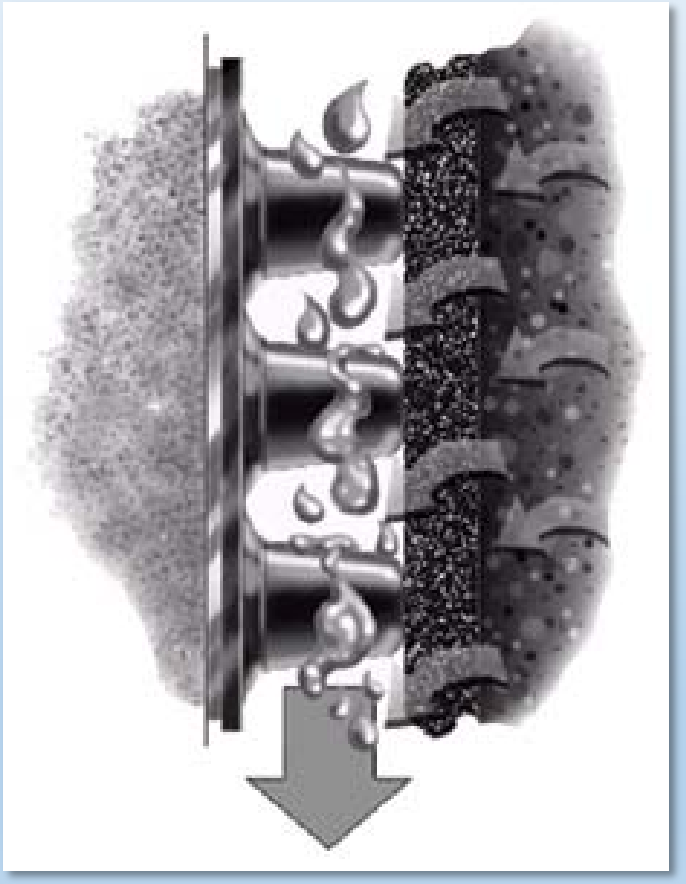
Designed to protect membrane from construction damage

Act as a separator with some membranes to prevent “dragging” due to settlement

Protection of the membrane from UV exposure prior to backfill

Prefabricated Drainage Layers

- Dimple-raised, molded polystyrene sheet
- High strength polypropylene fabric
- Part of a COMPLETE WATERPROOFING SYSTEM



Prefabricated Drainage Layers

- Most Specs Show 1/2” Thickness
- Prior to ASTM D 4716 Testing
- Early Drainage Boards Were Over Designed
- Selection to be based on
  - Flow rate
  - Strength
  - Soil retention

For example:

- U.S. Weather Bureau states that in North America, maximum 1-hour rainfall is 5” per hour
- 5” per hour = .05GPM

- 1/4” Thick Core - has A 9 GPM Flow Rate [Equal to a garden hose every lineal foot of wall]
- 150 GPM on Fabric
- 10,800 psi Compressive Strength

Cementitious Waterproofing

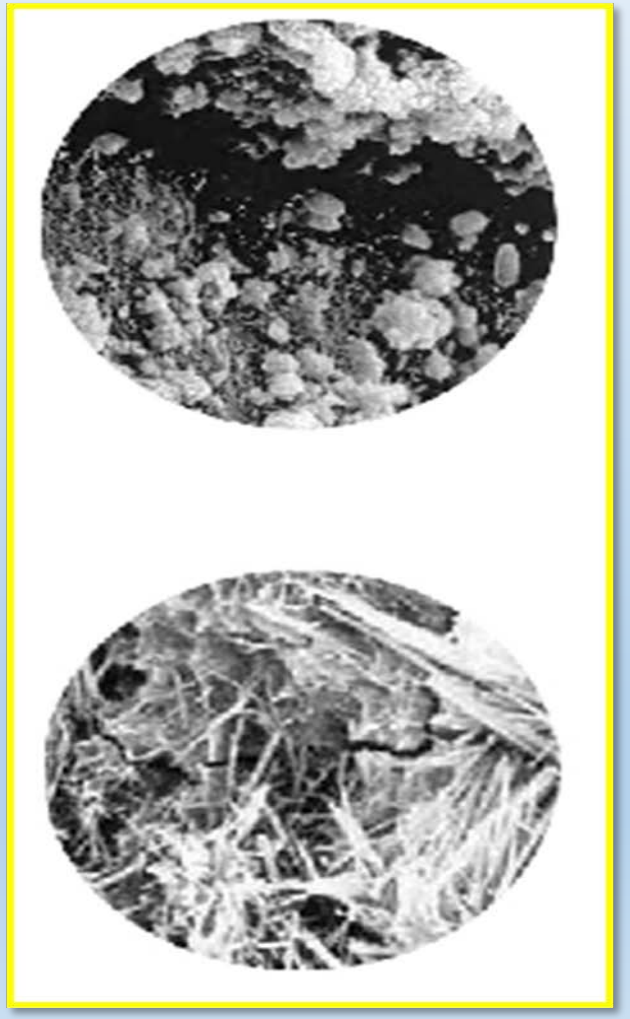
- Crystalline Waterproofing
- Flexible Cementitious Waterproofing

Uses For Cementitious Waterproofing

- Waterproofing of foundations, slabs and walls
- Water and wastewater storage
- Potable water tanks & facilities
- Elevator shafts
- Parking garages
- Basements
- Secondary containment structures
- Swimming pools

Crystalline Waterproofing

- Cement, silica and proprietary chemicals
- Form a crystalline structure in the presence of water and plugs pores, capillaries, micro-cracks and other voids
- Becomes integral with the concrete
- Questions arise due to waterproofing of cracks
- Can be surface applied, added directly to the mix, or sprinkled on fresh slab

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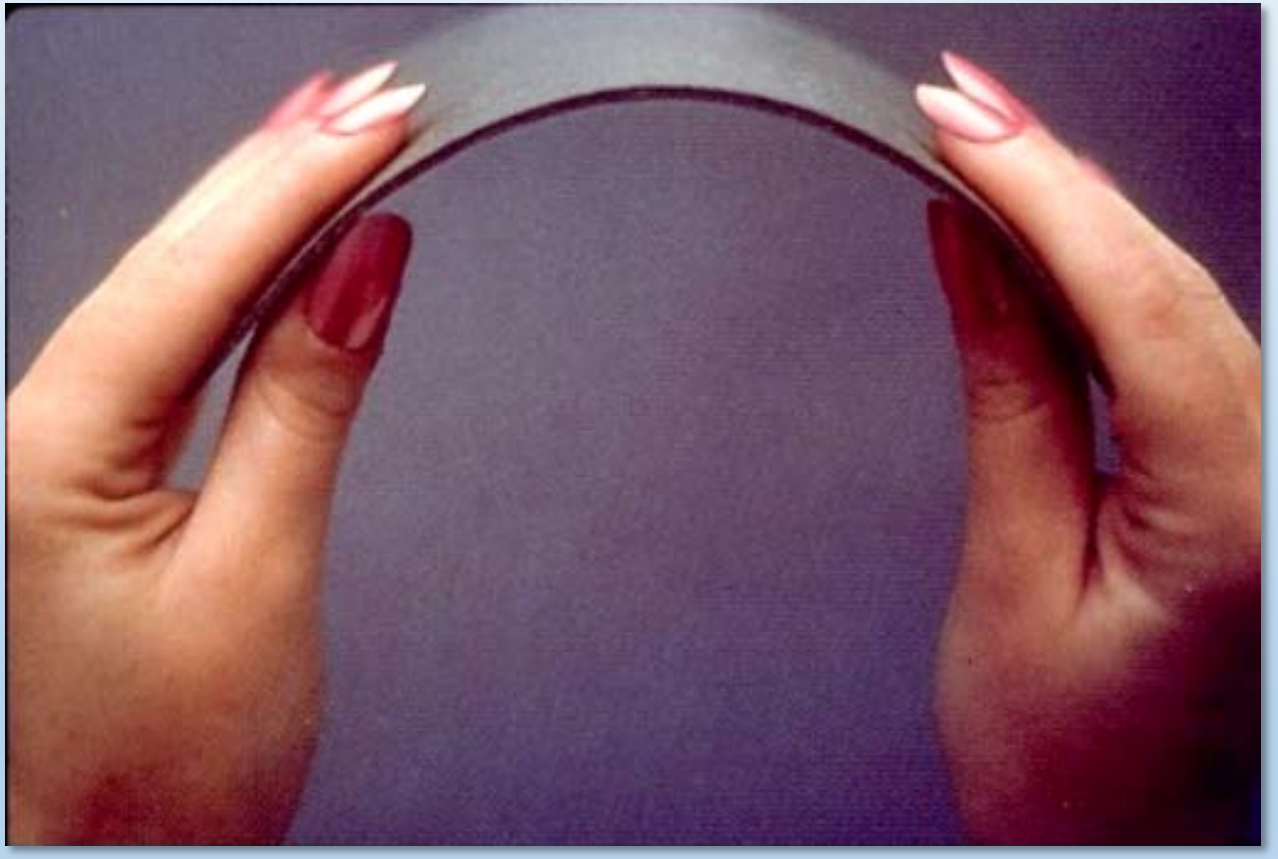
Limitations

It will not waterproof…

- Construction joints
- Expansion joints
- Larger, dynamic cracks
- Failing waterstops
- Areas of poor concrete consolidation
- Penetrations through concrete sections

Flexible Cementitious Waterproofing

- Polymer-modified cementitious coating
- Breathable and flexible
- Various formulations based on application
- Positive or negative
- Chemically-resistant versions available
- Crack bridging capabilities – 1/16”



Flexible Cementitious Waterproofing

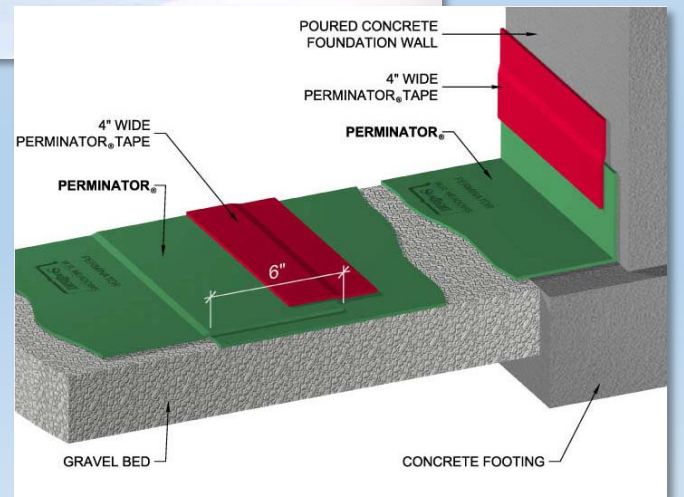
- Surface preparation
  - Sound concrete surface
  - Thorough cleaning, high pressure water
  - Treatment of inside corners
  - Patching and joint/crack treatment
  - Penetration treatment
- Saturated, surface dry condition

Flexible Cementitious Waterproofing

- Application
  - Brush or spray apply
  - Two coat application
  - If concrete is less than 6 weeks old, embed woven reinforcing fabric throughout application
  - If concrete is older than 6 weeks, just use fabric over any existing cracks
  - Air cure for 48 hours

Vapor Barriers / Vapor Retarders

- Designed with low water vapor permeance
- Superior Puncture resistance
- Compatible with surrounding soil
- Robust and durable over the life of the building
- Can serve a dual role as a waterproofing (dependent on material)



Features

- Polyolefin-based resin/chemical technology.
- Economical
- Water vapor and Radon
- Very low vapor permeance
- High puncture resistance and tensile strength

Industry Standards

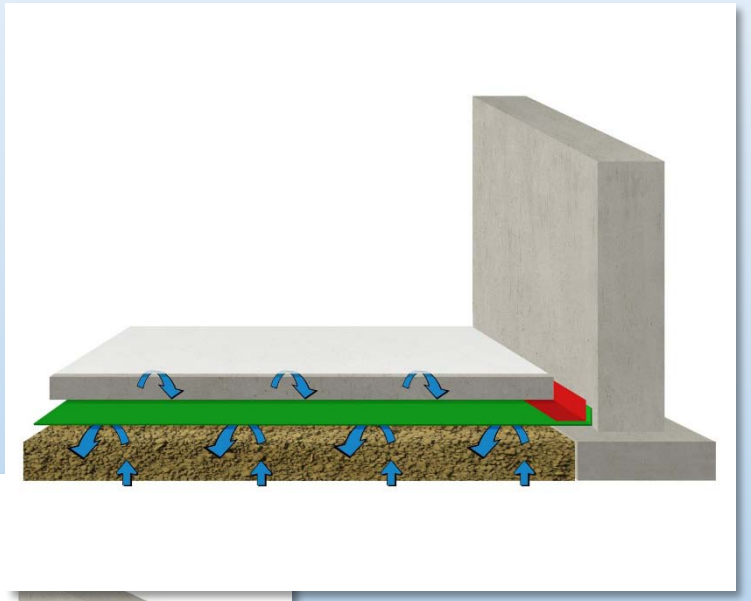
- **American Society For Testing Materials (ASTM)**
  - ASTM E 1993 - 98: Bituminous Vapor Retarders
  - ASTM E 1745 - 11: Plastic Vapor Retarders
  - ASTM E 1643 - 98 Standard Practice For Vapor Retarders

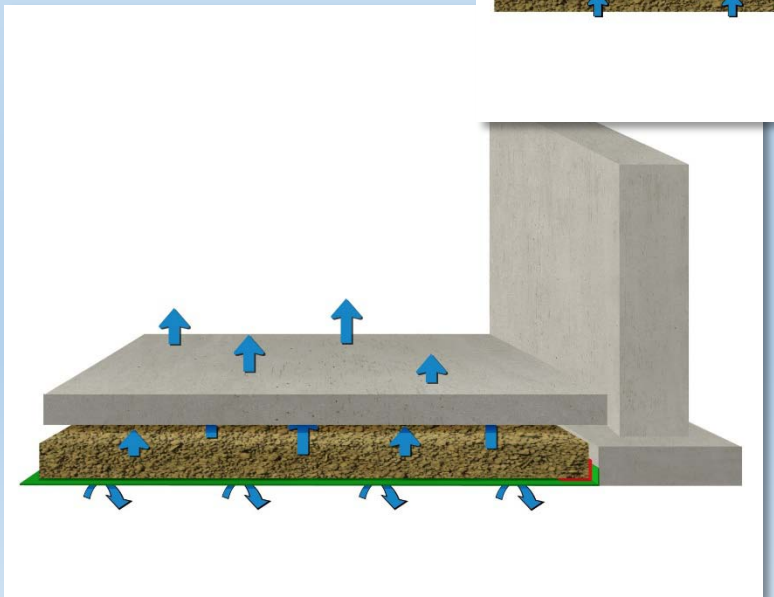
- **American Concrete Institute (ACI)**
  - ACI 302.1R-04 – Guide For Concrete Floor and Slab Construction
  - ACI 302.2R-06 – Guide For Concrete Slabs that Receive Moisture Sensitive Flooring Materials

Vapor Retarder Placement

- Cushion or Blotter Layer

- Arguments for and against this layer
  - Possible Curling
  - Possible flooring failure



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Summary

- Number of different types of systems available
- Not one system for every project
- Determine project requirements
- Select systems accordingly
- Utilize proper application techniques