Waterproofing Concrete Structures

A Dynamic Systems Approach

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AIA CES Program #CRP-02

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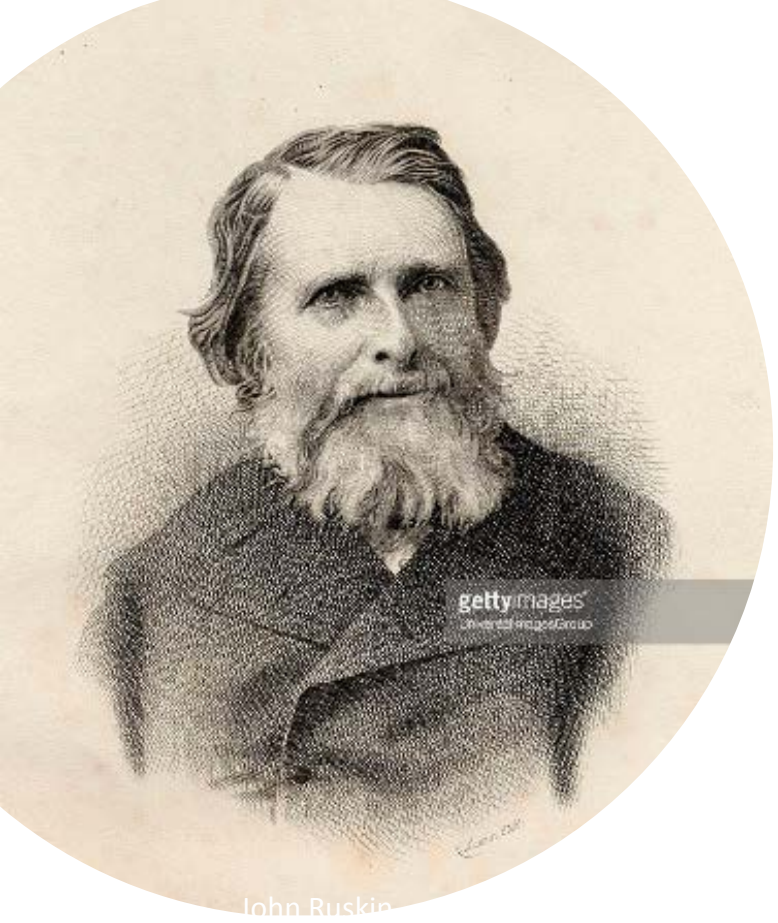


John Ruskin
1819-1900

The Common Law of Business Balance

“It's unwise to pay too much, but it's worse to pay too little.

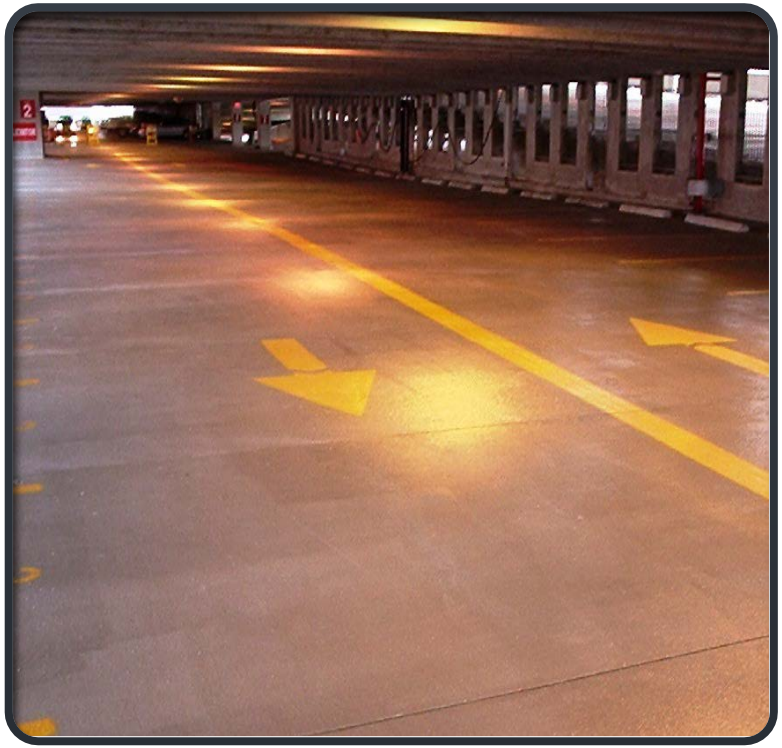
When you pay too much, you lose a little money - that's all.

When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do.

The common law of business balance prohibits paying a little and getting a lot - it can't be done.

If you deal with the lowest bidder, it is well to add something for the risk you run, and if you do that you will have enough to pay for something better.”

LEARNING OBJECTIVES



- What is Waterproofing
- Most Common Problems
- Mechanisms that Influence Integrity & Resiliency
- Dynamic Systems Approach
- Two Lines of Defense

1st Learning Objective

Waterproofing versus Dampproofing

As Per ACI 515.1R (1985) - Retired

"A Guide to the Use of Waterproofing, Dampproofing, Protective, and Decorative Barrier Systems for Concrete"

WATERPROOFING: *"THE TREATMENT OF A SURFACE OR STRUCTURE TO RESIST THE PASSAGE OF WATER IN THE PRESENCE OF HYDROSTATIC PRESSURE."*

DAMPPROOFING: *"THE TREATMENT OF A SURFACE OR STRUCTURE TO RESIST THE PASSAGE OF WATER IN THE ABSENCE OF HYDROSTATIC PRESSURE."*

Waterproofing versus Dampproofing

As Per ICRI

"Concrete Repair Terminology"

WATERPROOF: "*IMPERVIOUS TO WATER EITHER IN A LIQUID OR VAPOR STATE. (SINCE NOTHING CAN BE COMPLETELY "IMPERVIOUS" TO WATER UNDER INFINITE PRESSURE OVER INFINITE TIME, THIS TERM SHALL NOT BE USED.)*"

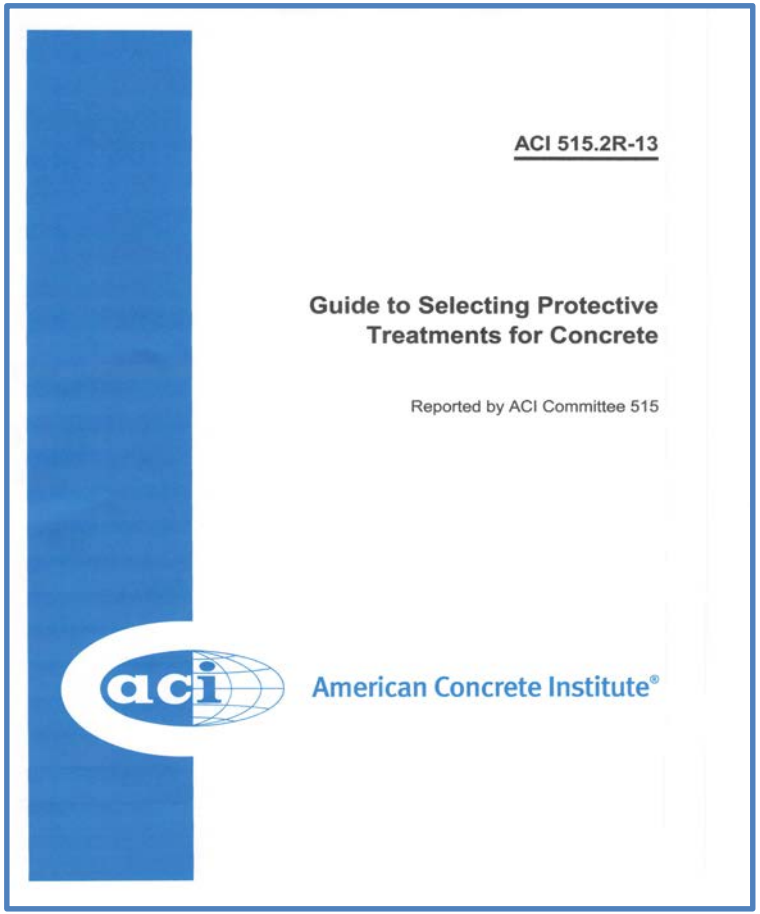
DAMPPROOFING: "*THE TREATMENT OF CONCRETE OR MORTAR TO RETARD THE PASSAGE OR ABSORPTION OF WATER, OR WATER VAPOR, EITHER BY APPLICATION OF A SUITABLE COATING TO EXPOSED SURFACES, OR BY USE OF A SUITABLE ADMIXTURE OR TREATED CEMENT .*"

Waterproofing versus Dampproofing

ACI 515.1R
Has Been Retired and Replaced by
ACI 515.2R
Neither Terms Dampproofing or Waterproofing Mentioned

Some industry professionals promoting “Watertight” as a replacement

“WATERPROOFING” HAS REMAINED THE PREVALENT AND MORE WIDELY USED TERM REGARDLESS OF THE ABSENCE OR PRESENCE OF HYDROSTATIC PRESSURE


ACI 515.2R-13
Guide to Selecting Protective Treatments for Concrete
Reported by ACI Committee 515
aci
American Concrete Institute®

2nd Learning Objective

Most Common Problems #1

Delamination failures on the negative side

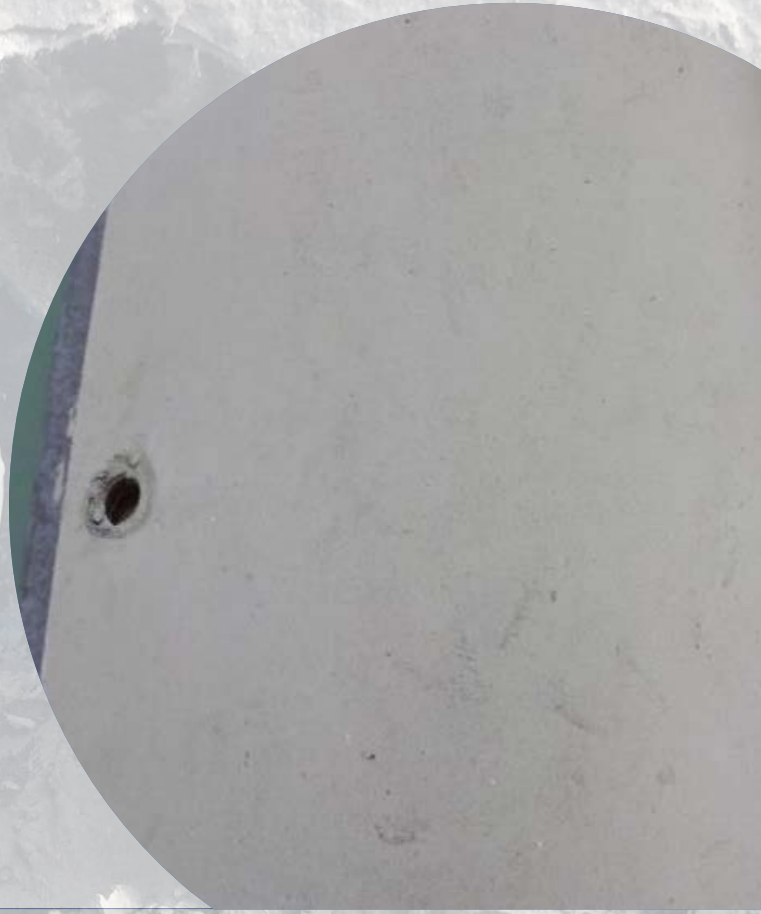
Most Common Problems #2

Water leakage into or out of structure

The corrosion cycle of steel begins with the rust expanding on the surface of the bar and causing cracking near the steel/concrete interface. As time marches on, the corrosion products build up and cause more extensive cracking until the concrete breaks away from the bar, eventually causing spalling.

Most Common Problems #3

Concrete spalling due to corrosion of steel



Most Common Problems #4

Waterproofing compromised by others

Most Common Problems #5

Failure of cementitious flexible membranes

Most Common Problems #6

Failure of vapor impermeable elastomeric membranes

Failure of Vapor Impermeable Elastomeric Membranes

Guide to Specification Issues for Architects and Engineers
Concrete International - April 2003

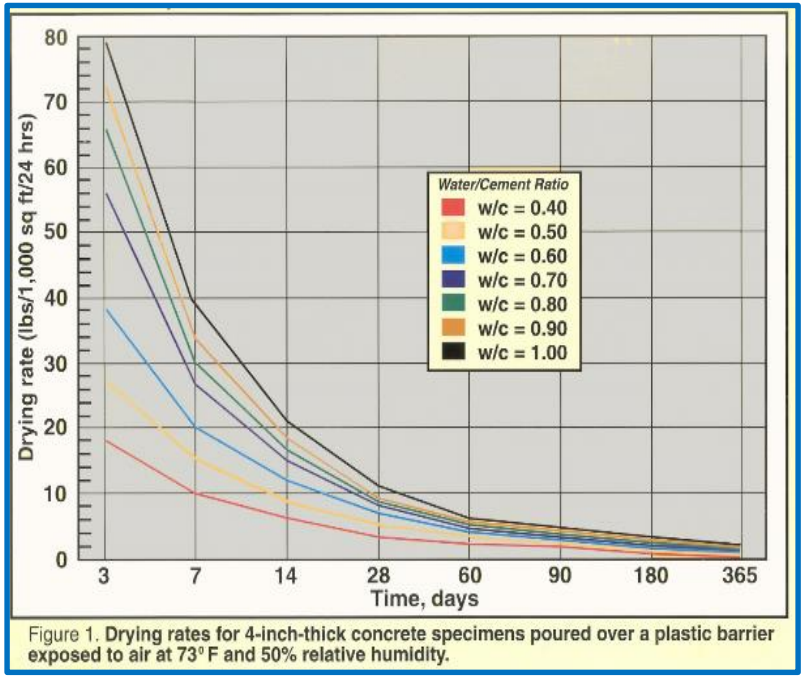


Figure 1. **Drying rates for 4-inch-thick concrete specimens poured over a plastic barrier exposed to air at 73° F and 50% relative humidity.**

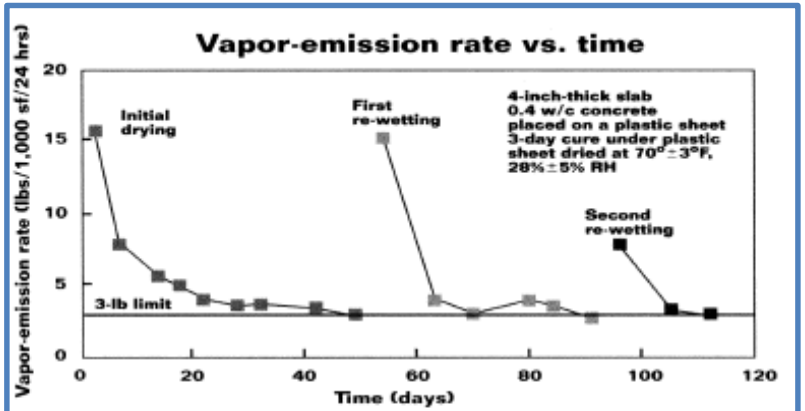
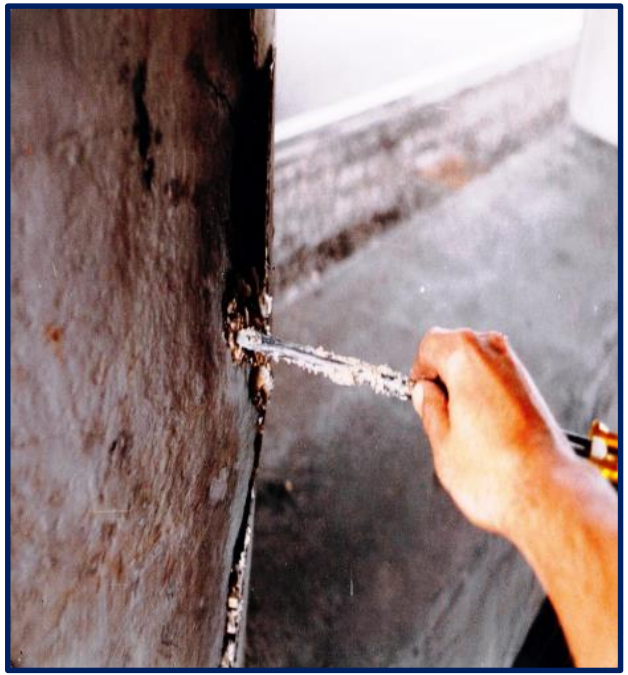


Fig. 2.12—Even with a low w/cm *and a 3-day cure under plastic sheeting, these slabs took approximately 7 weeks to dry to a 3 lb/1000 ft^2/24 h (1.5 kg/100 m^2/24 h) emission rate. After rewetting, the slabs took several weeks to again reach the 3 lb/1000 ft^2/24 h (1.5 kg/100 m^2/24 h) emission rate (Suprenant and Malisch 1998c).*

3rd Learning Objective

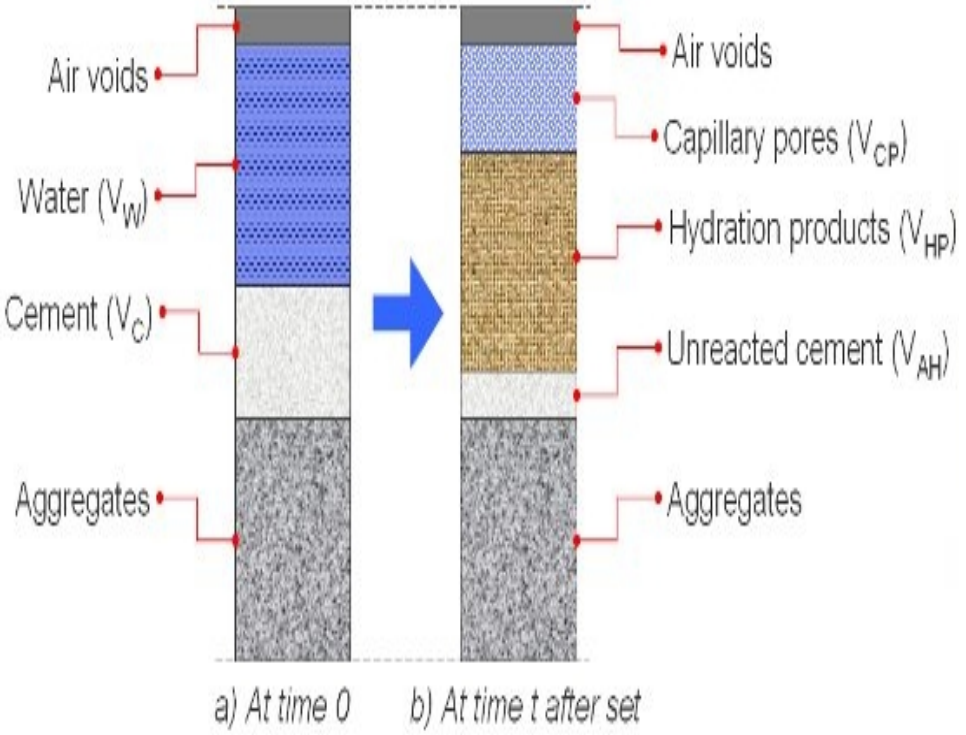


Mechanisms that Influence Integrity & Resiliency

Concrete: Two key hydration products	Capillary action	Osmosis
Calcium Hydrate	Osmotic pressure	Efflorescence

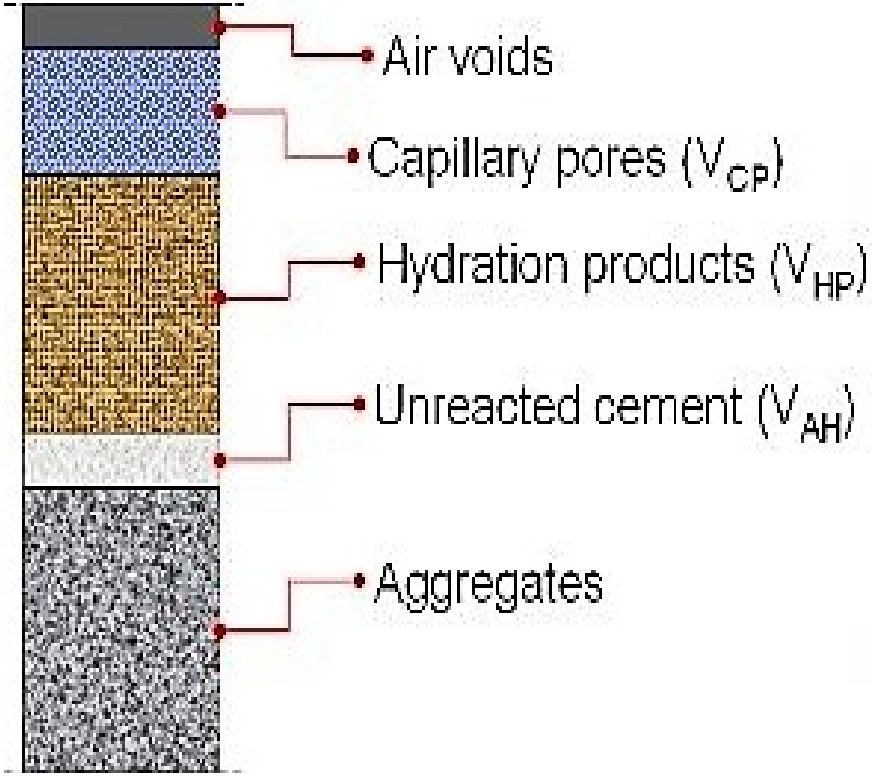
Mechanisms that Influence Integrity & Resiliency

- Cement/Water Combine to Form Two Main Hydration Products
- Calcium Silicate Hydrate Gel - CSH
- Calcium Hydrate - Ca(OH)2



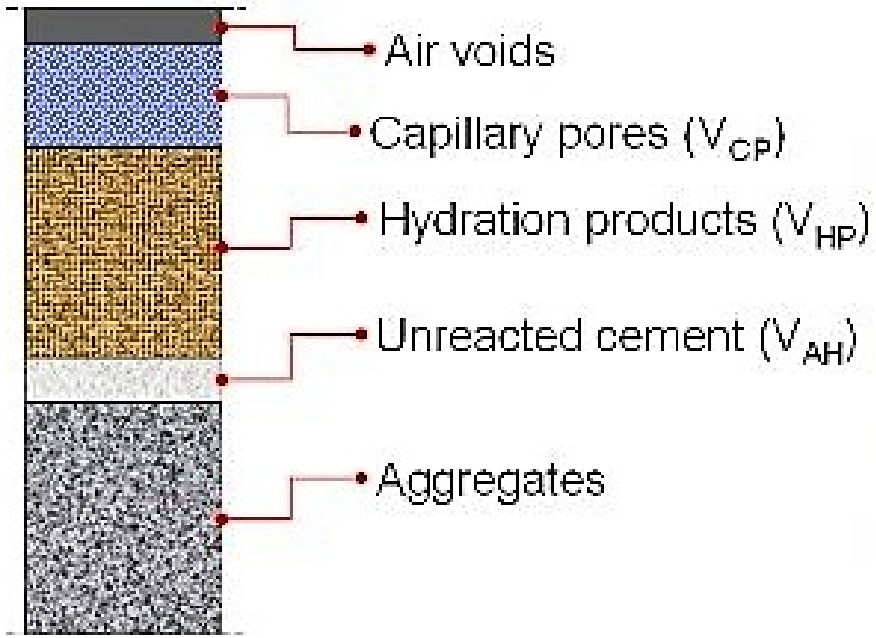
Calcium Silicate Hydrate Gel

- 50% by mass of the cement matrix
- The backbone of concrete
- Contributes strength and integrity
- CSH is water insoluble



Calcium Hydrate

- 25% by mass of the cement matrix
- The weakness of concrete
- Detracts from strength and integrity
- Ca(OH)2 is water soluble
- Problematic – causes efflorescence

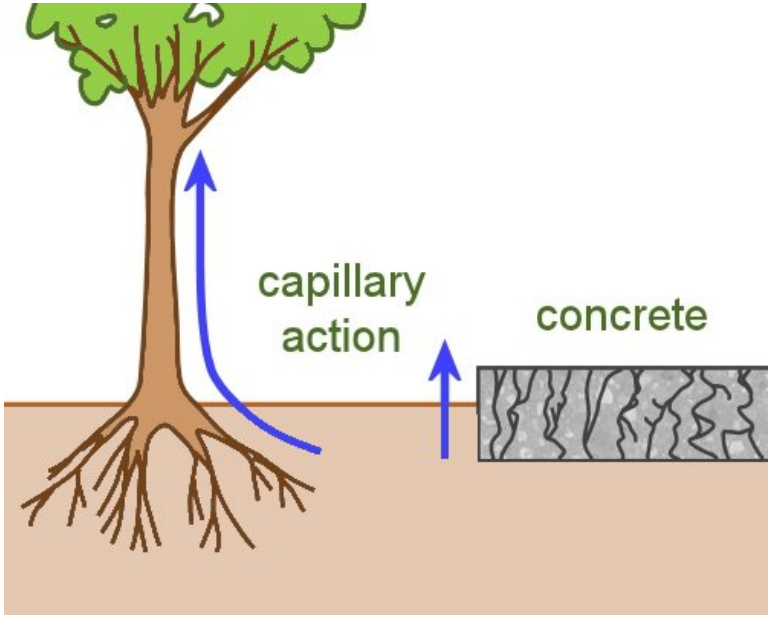


Capillary Action

The ability of a liquid to flow through narrow spaces without the assistance of, and even in opposition to, external forces like gravity.

Surface tension + adhesive forces between the liquid and capillary wall causes lift and migration for long distances.

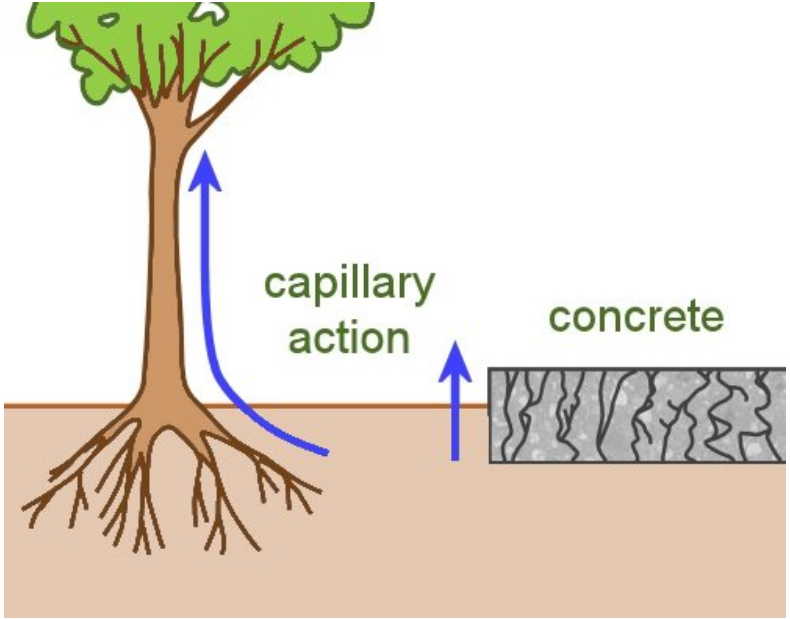
Capillary pressures = 300 to 500 psi



Osmosis

The process of migrating capillary water dissolving free soluble hydrate and other mineral salt compounds bringing them in solution to the surface.

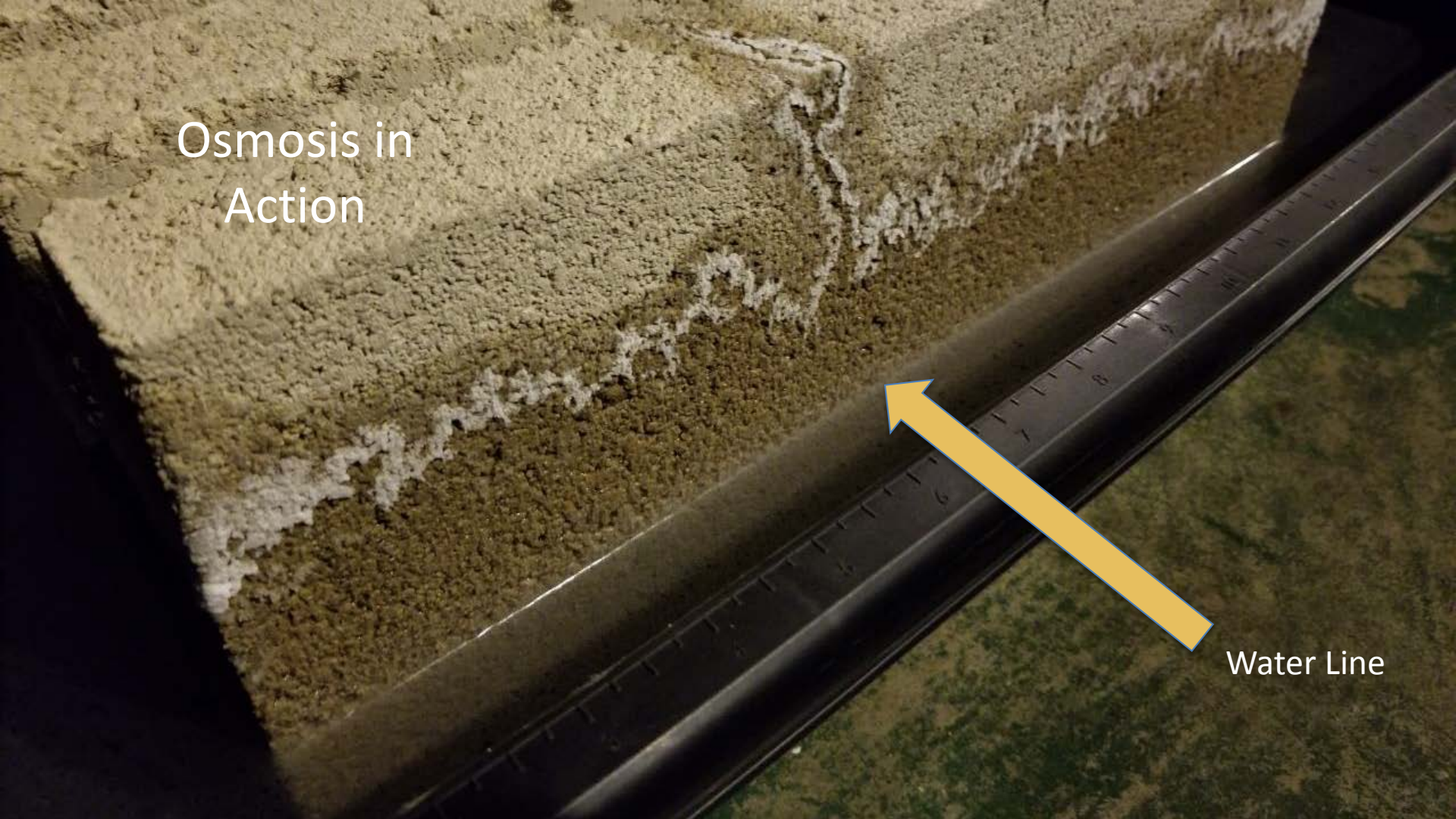
Upon evaporation of water, these salt solids are left behind in the form of efflorescence to accumulate on the surface or behind membranes, coatings and other finishes such as plaster and tile.



Osmotic pressures = Can reach up to 3,000 to 5,000 psi when restrained

Efflorescence – It's Everywhere

- Efflorescence requires the presence of water
- Capillary action or evaporation must be present
- Causes extreme internal pressure if restrained
- Chemically aggressive in the wet state


Osmosis in Action
Water Line

"1st Line of Defense"

Internal (Integral) Waterproofing

Penetration Based

Colloidal Silicate

Hydrophilic

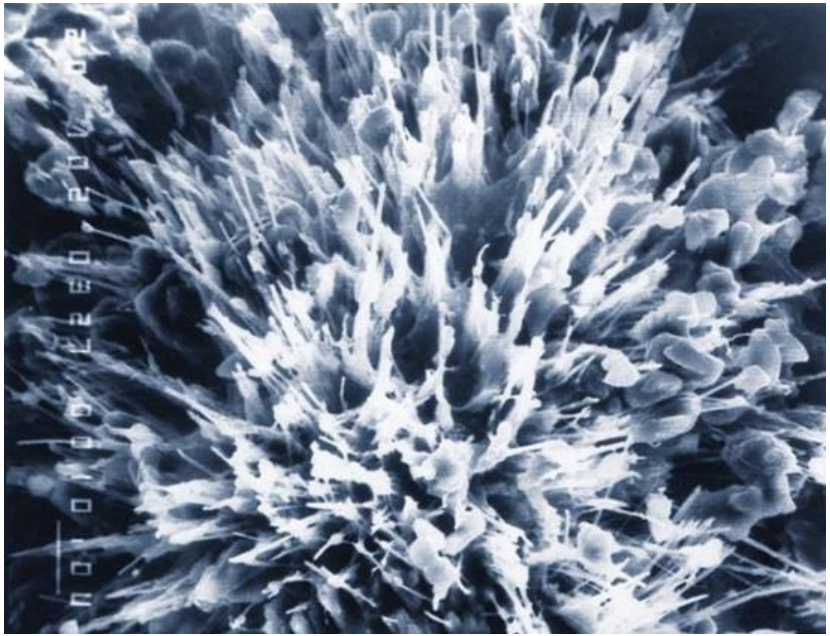
Hydro Gel

Dynamic Systems Solution Approach

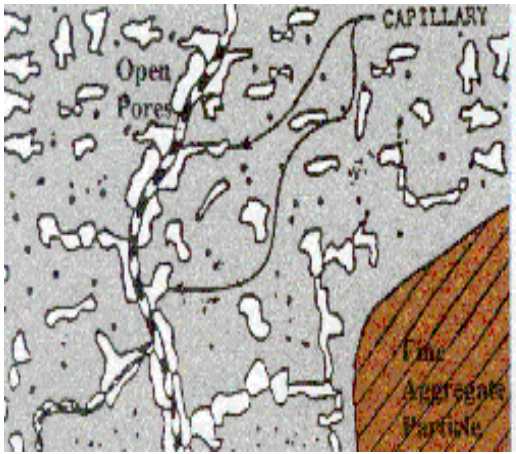
4th Learning Objective

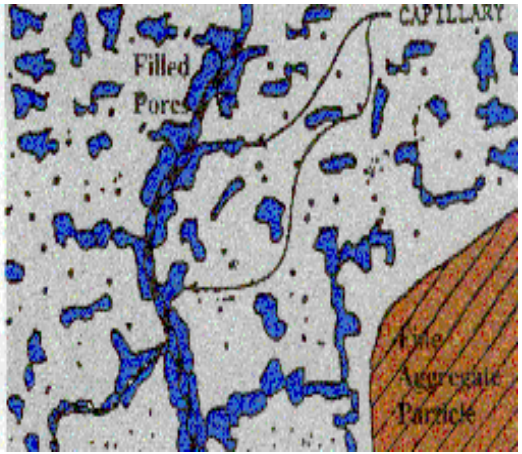
What is a Colloidal Silicate

- ***Colloidal*** always refers to a liquid material.
- Contains suspended particles of ***solid silica***. Will not settle.
- ***Nano-size*** (5 nm) solids in permanent liquid suspension.
- Colloidal Silicates – ***Not to be Confused*** with Crystalline Powder Formulations.
- ***Powder*** Formulations – ***Hydrophobic*** and exhibit ***Shallow Penetration.***
- ***Colloidal Silicates*** – ***Hydrophilic and Migrate Deep*** into the Concrete.



PROCESS OF MIGRATION & CHEMICAL REACTION





CRYSTALLINE COLLOIDAL SILICATES


HYDRION®
pH Pencil
Surface pH Pencil 0.0 - 13.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13
See reverse side for instructions
www.MicroEssentialLab.com
4224 Avenue H, Brooklyn, New York 11210
ph: 718.338.3618 | fax: 718.692-4491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MITIGATING CORROSION OF STEEL REINFORCEMENT U.S. BUREAU OF RECLAMATION M82

- Substantially reduces corrosion at a 95% C.L.
- Purged imbedded chlorides within 24 hrs.
- Equivalent to 40#’s per cubic yard.
- Significant reductions in chloride ingress.
- Corrosion rates significantly lowered.

MITIGATING CORROSION OF STEEL REINFORCEMENT U.S. BUREAU OF RECLAMATION M82

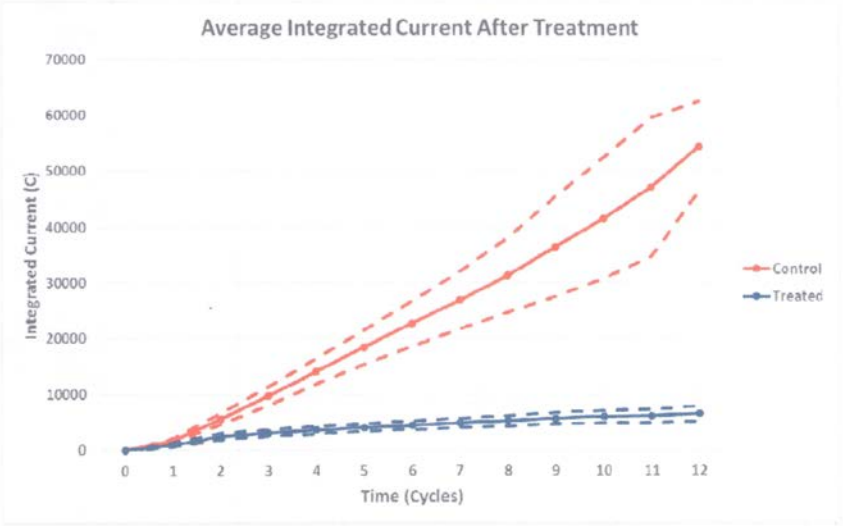

Figure 4 – Average Integrated Current after Treatment

The results in Figure 4 show that all the repair treatment tested was effective in mitigating corrosion at the 95% C.L. Both the macrocell current and the average integrated current after treatment were significantly lower for the treated slabs at the 95% C.L. at 2 cycles. The corrosion rate in the treated slabs was significantly lowered. This can be seen by the slope of the curves in Figure 4.

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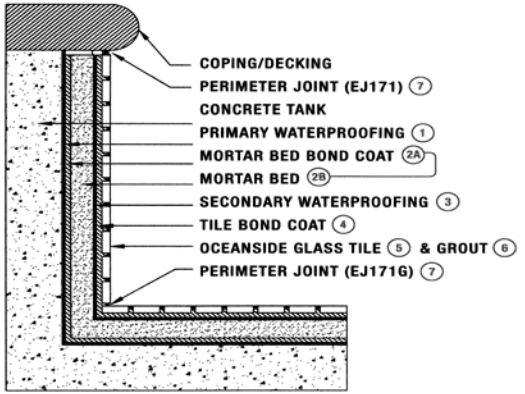
TILE COUNCIL OF NORTH AMERICA, INC.

AMENDS 2017 TILE HANDBOOK

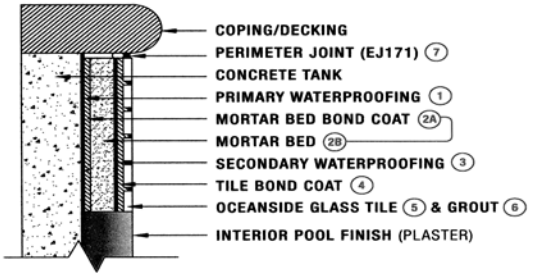
FULL COVERAGE

Full Coverage applications are those completely covered with tile.



PARTIAL COVERAGE

Partial Coverage applications are those in which the tile is used in conjunction with another pool finish (e.g. plaster).



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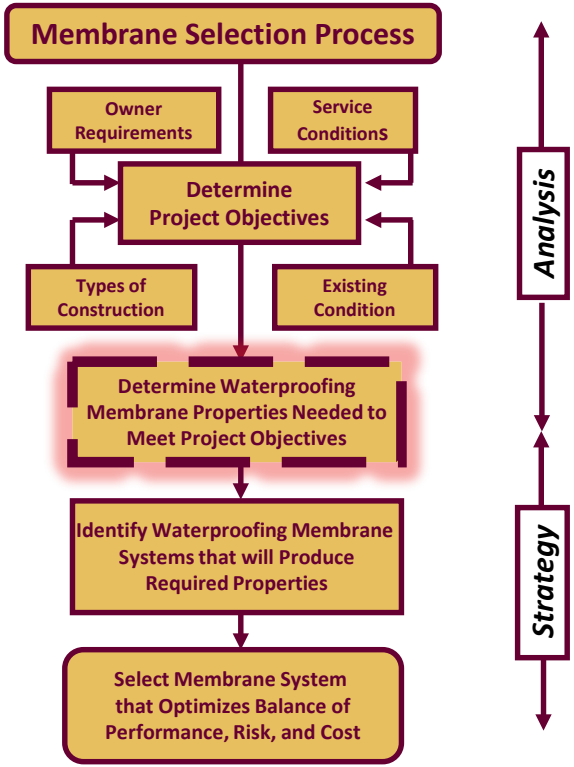
NATIONAL PLASTERERS COUNCIL

PLASTER PUCK TESTING

- 24 Plaster pucks treated with colloidal silicate
- Beginning average net oven dry weight – 107.3 g
- Beginning average saturation weight – 114.3 g
- Average weight gain – 7.0 g
- After 28 days of cure time plaster pucks re-weighed
- Average net oven dry weight – 111.5 g
- Average saturation weight – 112.9 g
- Average weight gain – 1.4 g

SYSTEM DESIGN CONSIDERATIONS



Thank You!!