31st NPC Annual Conference

February 12-14, 2020
Houston, TX

Waterproofing Pool Structures
“A DYNAMIC SYSTEMS APPROACH”
“What to do, how to do it and what happens if you don’t”

PRESENTER:
TREVOR FOSTER
TREVORF@MIRACOTE.COM
310.766.1784
WESTERN SALES MANAGER
MIRACOTE PRODUCTS
Waterproofing Concrete Structures
"A Dymanic Systems Approach"
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2/26/2020

NPC Annual Conference 2017
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."

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Learning Objectives

- Common Problems in Pools/Spas & Water Containment Structures
- Forensics – Differentiate Between Damage and Root Cause(s)
- Mechanisms that Influence Integrity & Sustainability
- Dynamic Systems Solution Approach
- Waterproofing - Key Material Properties to Consider
- Preparation, Installation, and Testing
Most Common Problems
1st Learning Objective

- Delamination Failures on Negative Side
- Raised Spas, Infinity/Vanishing Edge's
- Water leakage out of structure
- Corrosion of Steel Reinforcement – Spalling
- Failure of vapor impermeable membranes
- Waterproofing compromised by others
- Improperly applied waterproofing membranes

Forensics:
Differentiating Between Damage and Root Cause
2nd Learning Objective
Mechanisms that Influence Integrity & Sustainability

3rd Learning Objective

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

Mechanisms that Influence Integrity & Sustainability

- Cement/Water Form Two Main Hydration Products
  - Air voids
  - Water ($V_{w}$)
  - Cement ($V_{c}$)
  - Aggregates
  - Capillary pores ($V_{CP}$)
  - Hydration products ($V_{HP}$)
  - Unreacted cement ($V_{RC}$)

- Calcium Silicate Hydrate Gel (CSH)
- Calcium Hydrate Ca(OH) 2
Mechanisms that Influence Integrity & Sustainability

- **Calcium Silicate Hydrate Gel - CSH**
  - Equals 50% by mass of the cement matrix
  - Considered the backbone of concrete
  - Contributes strength and integrity
  - CSH is water insoluble

- **Calcium Hydrate - Ca(OH)2**
  - Equals 25% by mass of the cement matrix
  - Considered the weakness of concrete
  - Detracts from strength and integrity
  - Ca(OH)2 is water soluble
  - Also often referred to as calcium hydroxide
  - Ca(OH)2 is problematic – causes efflorescence
Mechanisms that Influence Integrity & Sustainability

• 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.

Mechanisms that Influence Integrity & Sustainability

• 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 pool finishes.
Mechanisms that Influence Integrity & Sustainability
Mechanisms that Influence Integrity & Sustainability

- Efflorescence – It’s Everywhere in Concrete

  - Primary efflorescence emerges with bleed water
  - Secondary efflorescence emerges post hardening
  - 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

So What is the Solution?
Dynamic Systems Solution Approach

4th Learning Objective

• "1st Line of Defense"

• Internal (Integral) Waterproofing
• Penetration Based
• Colloidal Silicate
• Hydrophilic
• Hydro Gel

CRYSTALLINE COLLOIDAL SILICATES
PROCESS OF MIGRATION & CHEMICAL REACTION
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"A Dymanic Systems Approach"

Chip Outs or Older Vessels?
Crystalline Colloidal Silicates

Product advantages

- Clear, odorless, non-toxic, zero voc’s.
- Unique molecular size and shape results in excellent lubricity to penetrate quickly.
- Ultra-Low Viscosity – Aqueous
- Depending on manufacturer, special application equipment may be required.

Crystalline Powder Formulations

Hydrophobic Topically Applied Waterproofing or Admixtures

Crystalline Technology – Powder Formulations or Admixtures

- Hydrophobic - “No affinity for water; readily repels moisture”. Problematic!
- Surface Preparation is complex & critical.
- Can be a bond breaker for secondary coatings.
- Should be removed prior to the application of thin set, tile or pool plaster.
- Manufacturers emphatically state and accept no responsibility for adhesion of subsequently applied materials.
- Material warranties exclude compatibility with plaster, stuccos, tile and other surface-applied materials.
- Some crystalline-based concrete admixtures may also result in compatibility issues with applied coatings.
Purpose of Mortar Beds for Waterproofing Applications:

- Level out unevenness in the substrate.
  - Save Labor $$$
  - Faster installation of Membrane
- Create an ideal surface to apply waterproofing membranes.
Dynamic Systems Solution Approach
4th Learning Objective

• “2nd Line of Defense”
  External Waterproofing – Surface Applied Membrane’s
  • Single Component Cementitious – BC Pro, Super Blockade, Thoroseal
  • Dual Component Cementitious – Membrane C, Flexcrete,
  • Single Component SBR - Membrane A, Hydroban, Multilasticcoat, Red Guard
  • Elastomeric Urethane – CIM 1000, UB64, LM60

Dynamic Systems Solution Approach

• “2nd Line of Defense”
  External Waterproofing – Surface Applied Membrane’s
  • Single Component Cementitious
    • Common use – Reducing Negative Side Hydrostatic Pressure
    • Rigid – little or no crack bridging
    • Still susceptible to Osmotic Pressure/attack
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"A Dynamic Systems Approach"

Dynamic Systems Solution Approach

- "2nd Line of Defense"
  - External Waterproofing – Surface Applied Membrane’s
    - Dual Component Cementitious
      - Not all are created equally
        - Rigid, semi rigid, flexible – all in the polymer
      - Can have crack bridging abilities
      - Negative side permeability
      - Can be left exposed to UV
      - Susceptible to Osmotic Pressure/attack

Process
Process

Process - Vertical
Dynamic Systems Solution Approach

• “2nd Line of Defense”
  External Waterproofing – Surface Applied Membrane’s
  • Single Component SBR’s
    • Highly Flexible – 300%+ elongation
    • Non permeable – cannot do partial areas i.e., tile lines
    • Shell must be completely dry
    • Cannot be left exposed to UV
      • Protection coat required
    • Susceptible to Osmotic Pressure & pH attack

Dynamic Systems Solution Approach

• “2nd Line of Defense”
  External Waterproofing – Surface Applied Membrane’s
  • Elastomeric Urethane
    • Highly Flexible – 500%+ elongation
    • Non permeable – cannot do partial areas
    • Shell must be completely dry
    • Cannot be left exposed to UV
      • Protection coat required or sand broadcast
    • Susceptible to Osmotic Pressure & pH attack
    • Adhesion issue’s – adhering to small bonding surface area – Sand broadcast
Where do we place membranes? TCNA P602-19
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TCNA P602-19

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Elevated Over Occupied Space or Cantilevered
Full encapsulation – from trough to bond beam

Tile Lines
Partial encapsulation over float mortar and structural shell
Partial Areas - Raised Spas and Negative Edge’s

Why do we Waterproof Negative Edges?
Surface Preparation/Details/Testing

5th Learning Objective

Check
Check all pipe penetrations, including skimmers and light niches for voids.

Chip out
Chip out loose material and fill as needed.
- Use modified mortar or Water Plug (Hydraulic Cement)

Mechanical
Sandblast, grind, bushhammer, and/or power wash as needed.

Be
Be aware of ambient and surface temperatures. Apply to an SSD surface if needed. Control environment as needed too.

Reference
Reference detailed drawings.

Surface Preparation
Elastomeric Cementitious Membranes

Don't Forget - The details

CHANGE-IN-PLANE DETAIL

- Elastomeric Cementitious Membranes
- Don't Forget - The details
- Change in plane detail
- Typical membrane detail
- Crack treatment detail
- NTS
- MIR-MEMC-PPP-CPD-2
- Pool Master Finishes
- NPC

CRACK TREATMENT DETAIL

- Crack treatment detail
- NTS
- MIR-MEMC-PPP-CPD-2
- Pool Master Finishes
- NPC
Pipe Penetration detail

- Pay close attention to detail.
- Create bevel around pipe.
  - Harmonic vibration
  - Polyether vs. Polyurethane
  - Sand Broadcast
- Membrane and reinforcing fabric
- Water Plug

Process
Site visits - Details
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Cementitious Membranes
Troughs – Exposed
Integral Coloring

Cementitious Membranes
Water test – 48 hours
Value Engineered?

Cementitious Bond Coat
Surface Profile and Protection

• Single component or Dual Component.
• Protects cementitious membrane from the plaster application.
• Allow plaster to hydrate properly.
• Create a surface profile for plaster to achieve superior mechanical adhesion.
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Questions, Comments, Discussion

Where do we need waterproofing????
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