Onsite | 2024 Spokane, WA
Wastewater
Mega-Conference
Celebrating Tomorrow's Environment
Clean Water for the Future

NOWRA NAWT FOWA OWA

COATINGS AND SEALERS FOR PRECAST CONCRETE WASTEWATER TANKS – WHAT TO USE WHERE AND WHY?

NPCA

DISCLAIMER

The materials being presented represent our own opinions, and do NOT reflect the opinions of NOWRA.

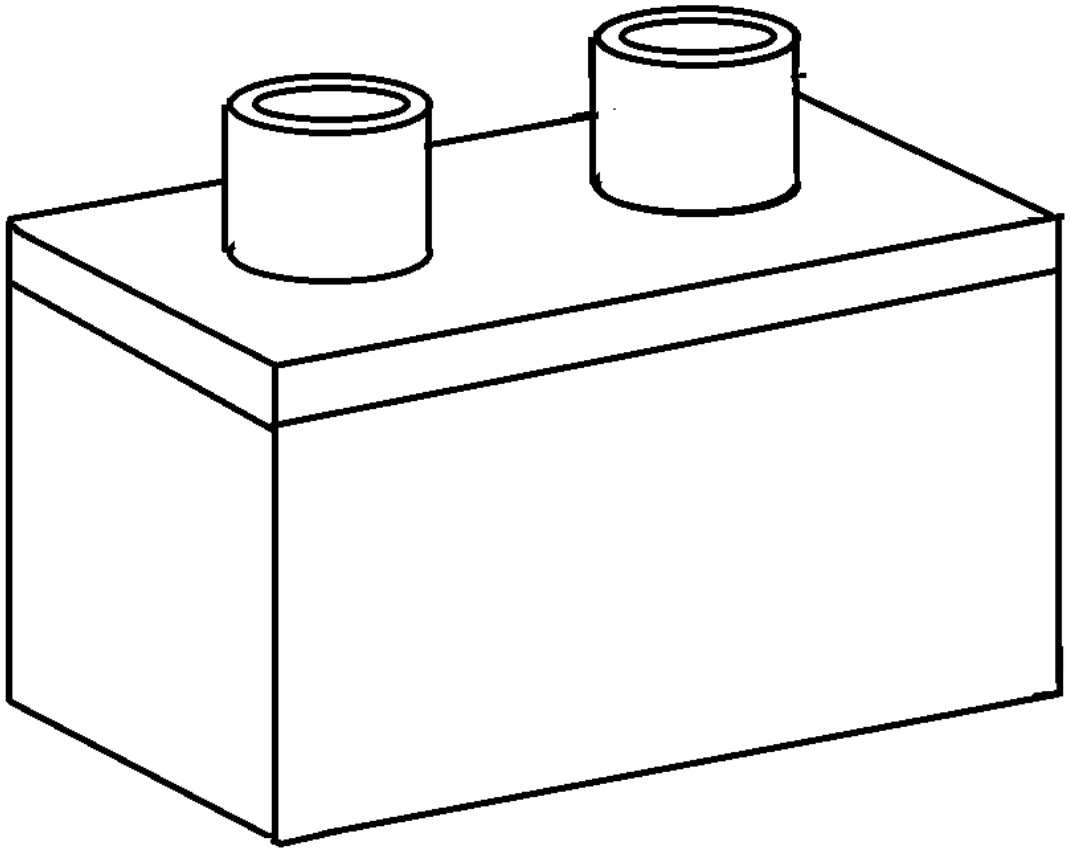
LEARNING OBJECTIVES

- Differentiate between coatings and sealers and describe similarities and differences in their uses.
- Define damp-proofing and waterproofing and explain applications for each.
- List protection measures for concrete exposed to environments including water, salts, hydrocarbons, acids, and bacteria.
- Explain the role of concrete primers.
- Describe the significance of waterborne vs. solvent-borne coatings, factors impacted by the coatings' percentage of solids, outgassing, and corresponding installation considerations.
- List best practices for concrete surface preparation prior to coating and sealer application.

COATINGS & SEALERS

COATINGS & SEALERS WITH CONCRETE

COATINGS & SEALERS WITH PRECAST CONCRETE WASTEWATER TREATMENT STRUCTURES



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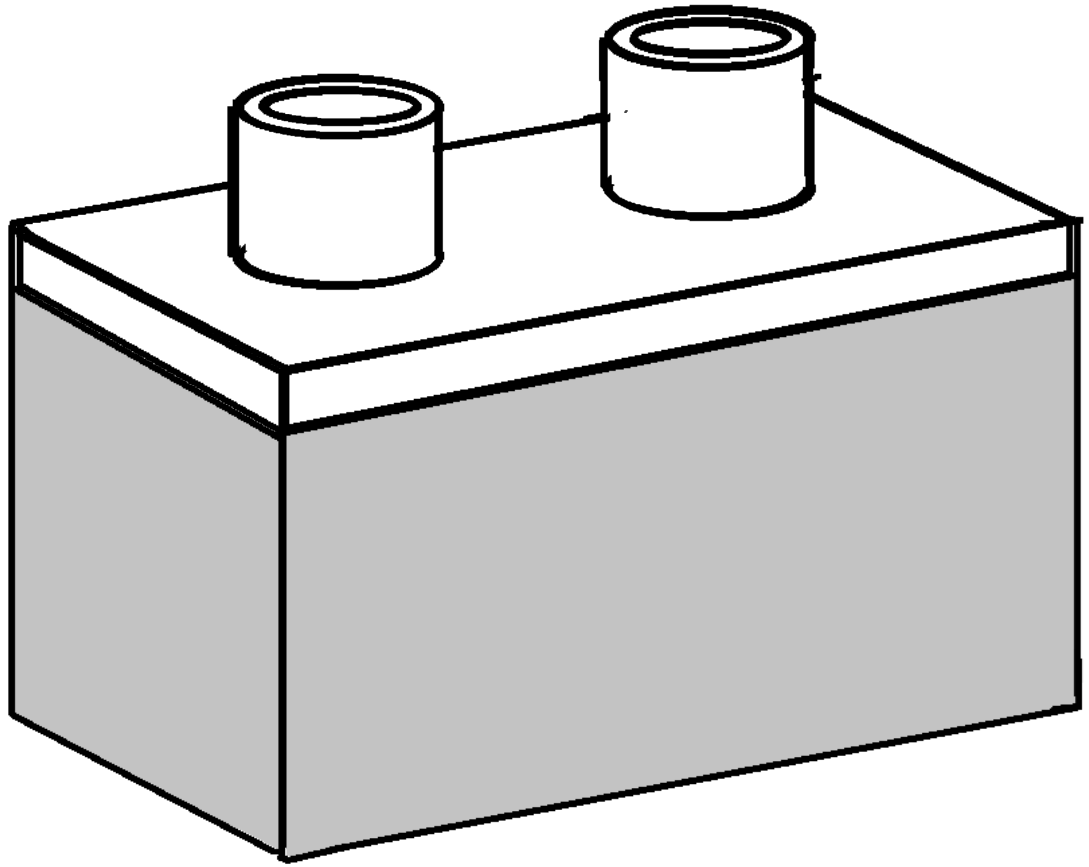

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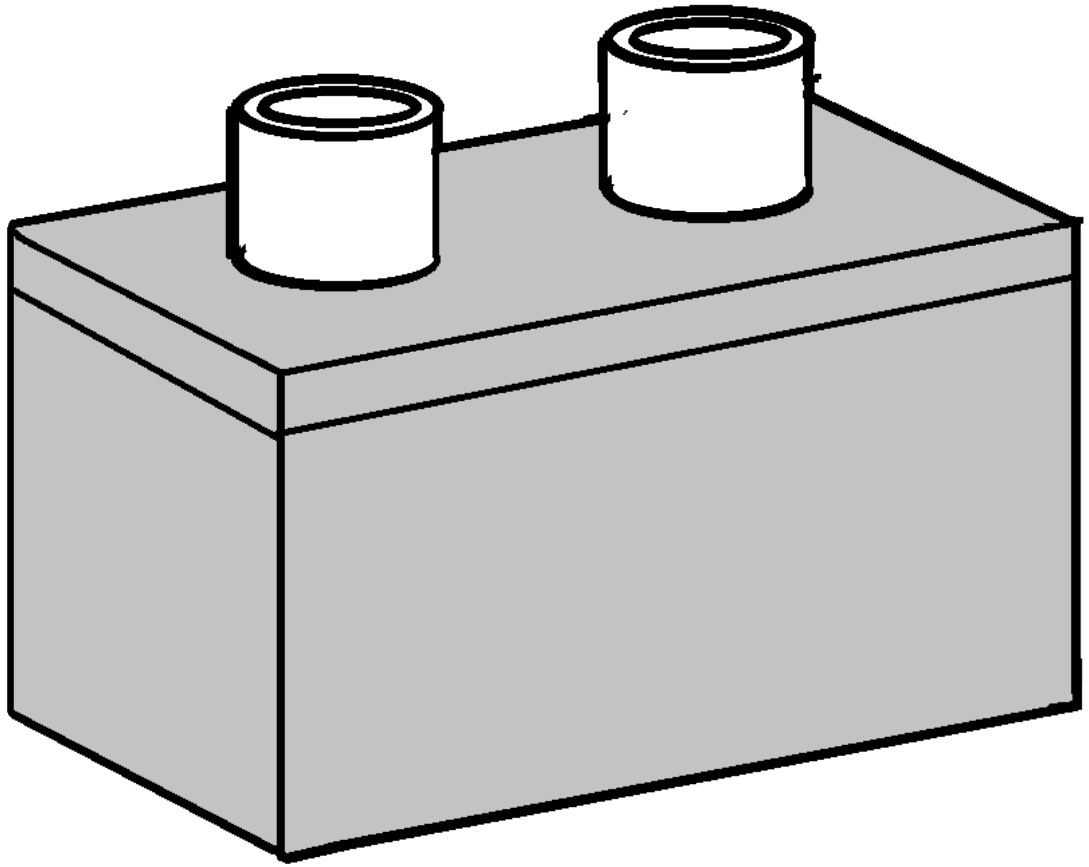

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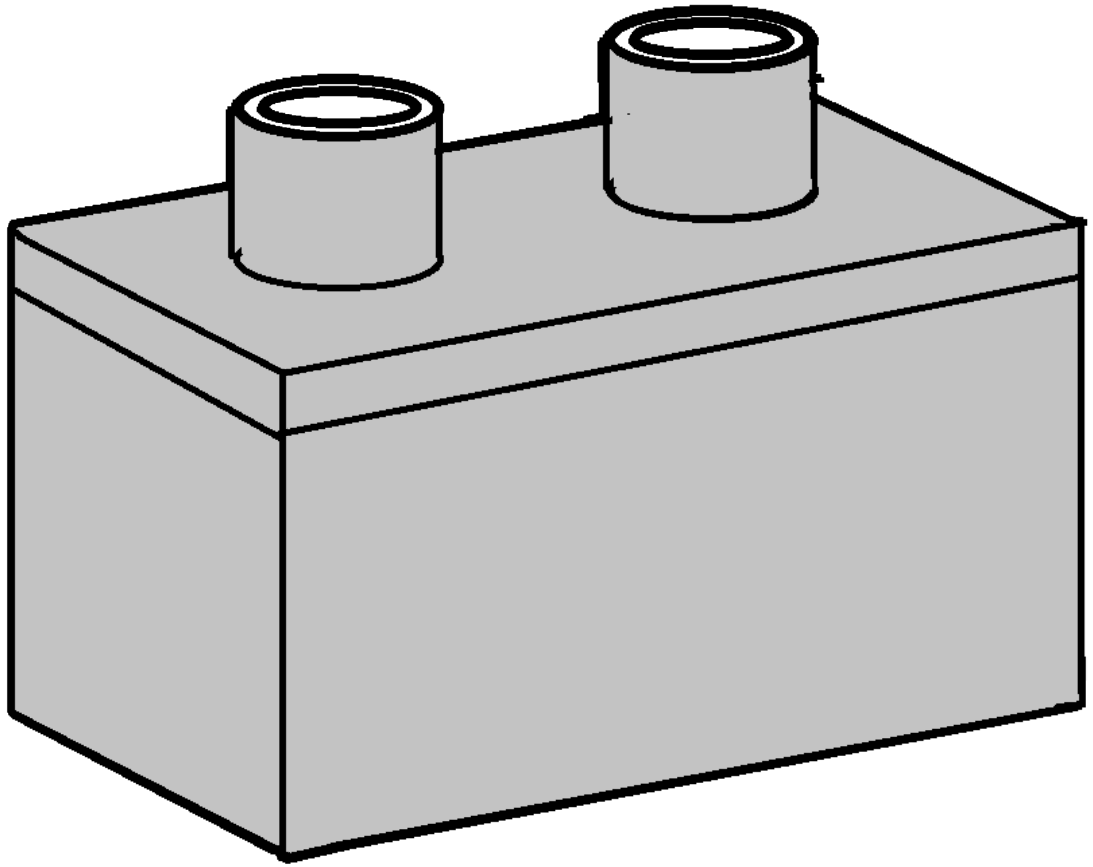

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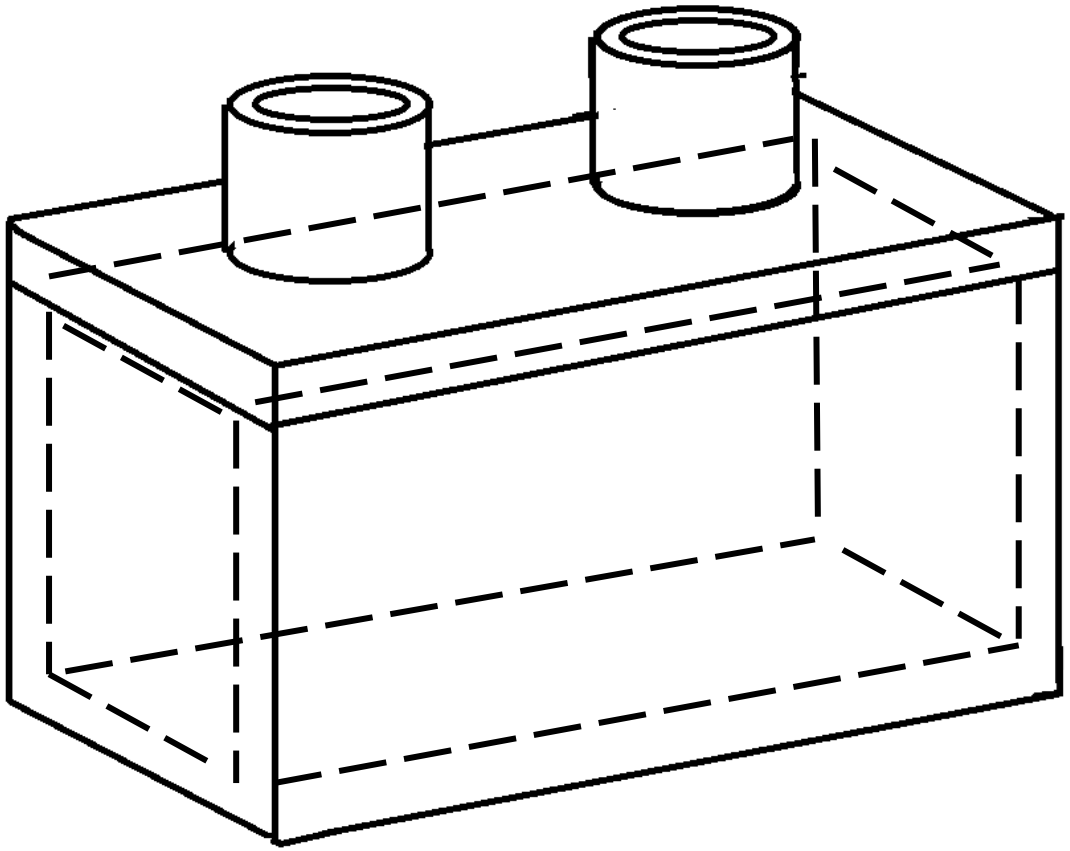

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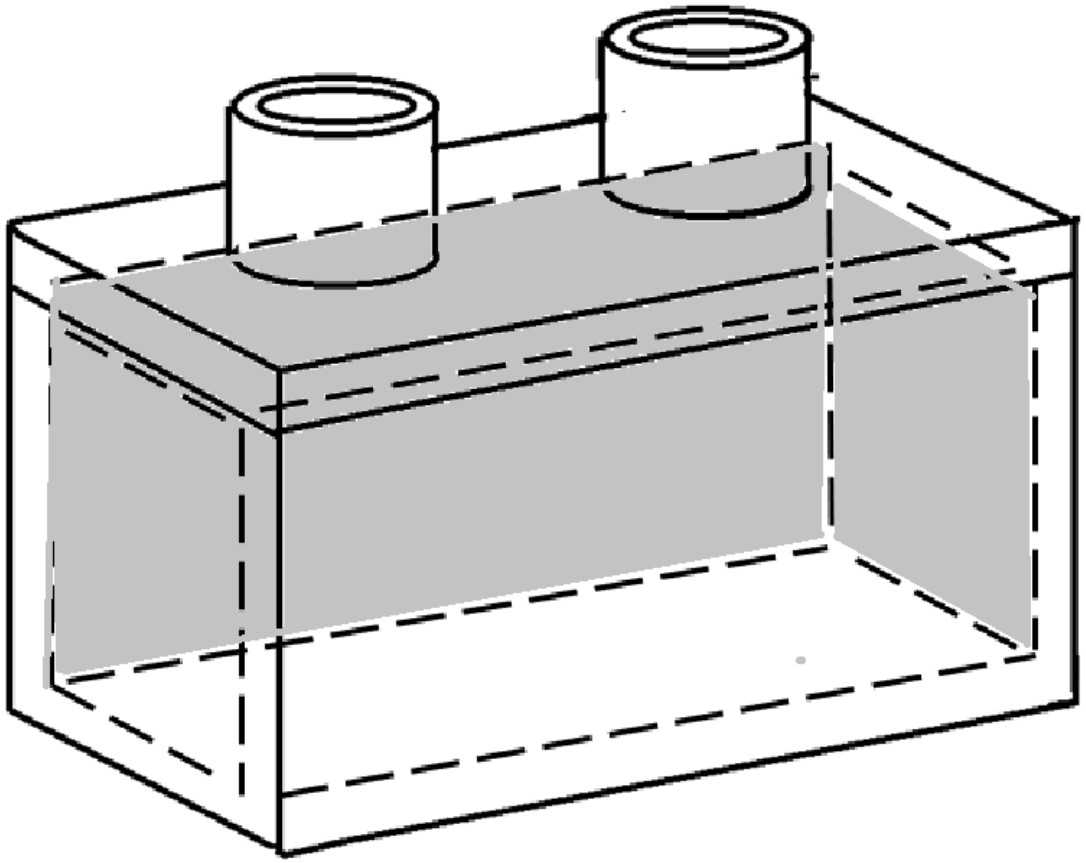

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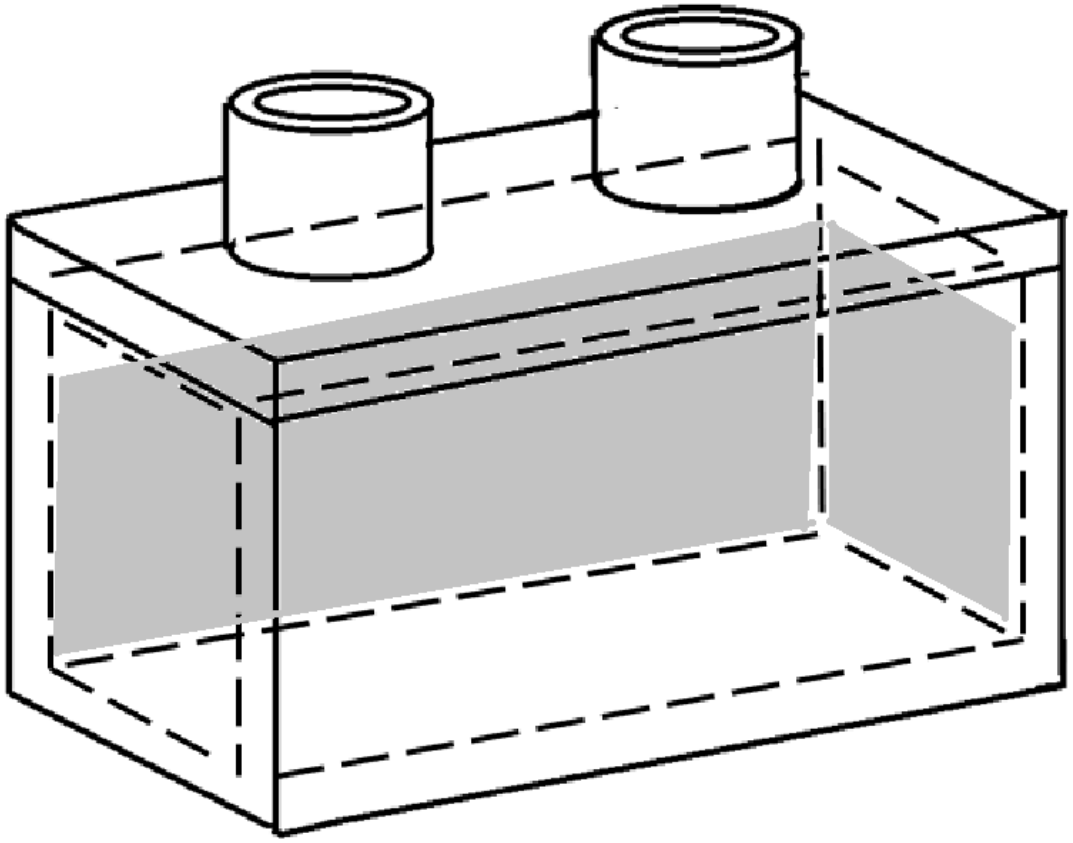

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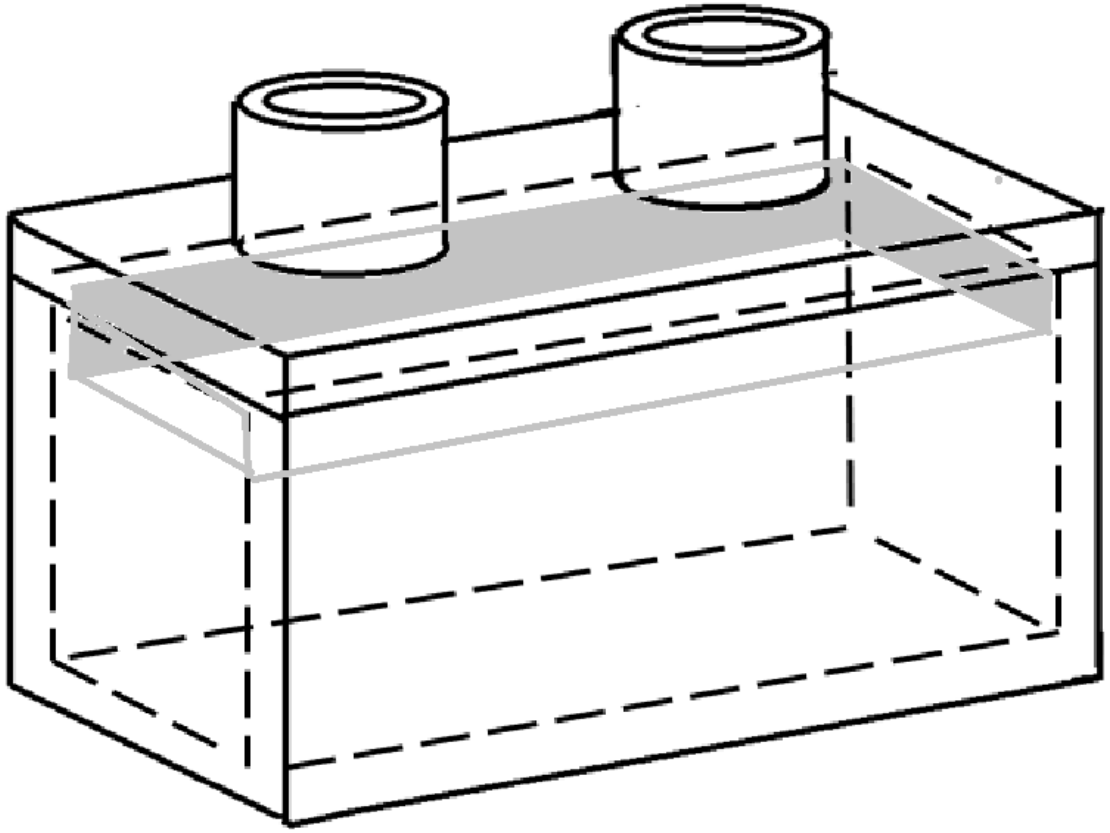
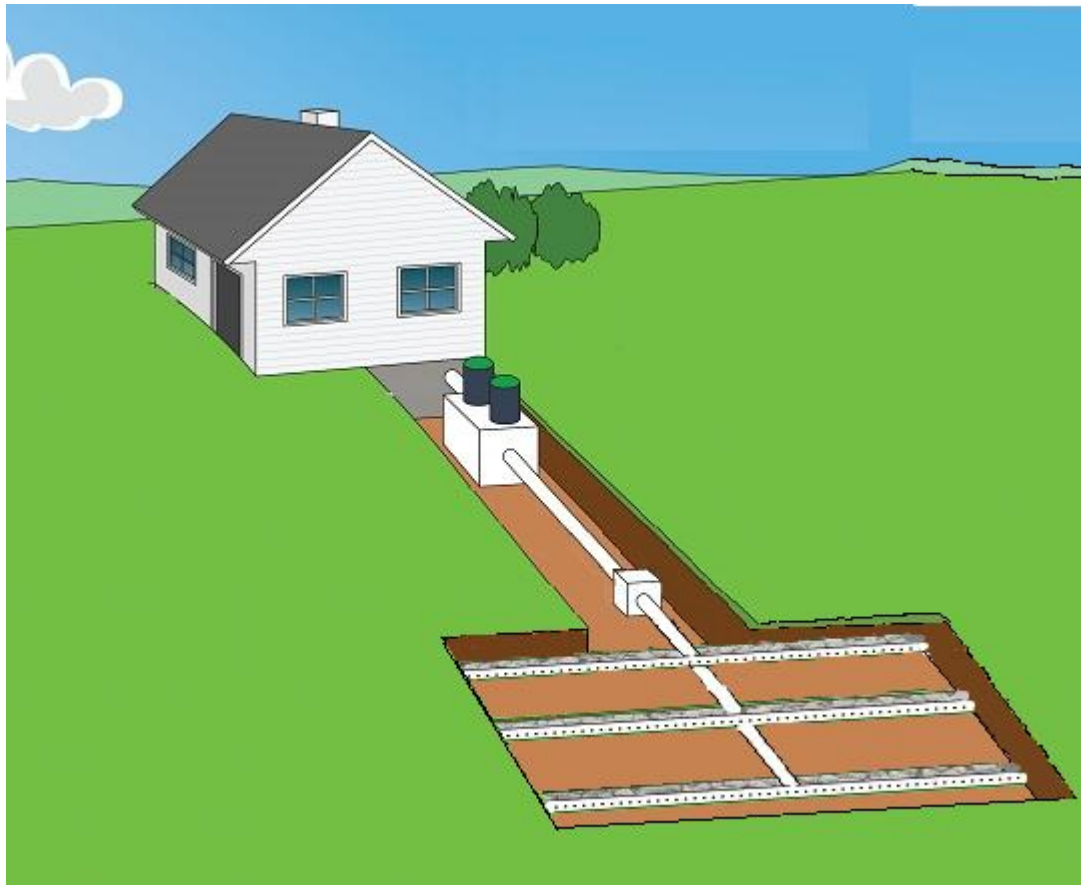


DURABILITY AND RESILIENCE OF ONSITE WASTEWATER TREATMENT SYSTEMS

LIFE OF THE WASTEWATER TREATMENT SYSTEM

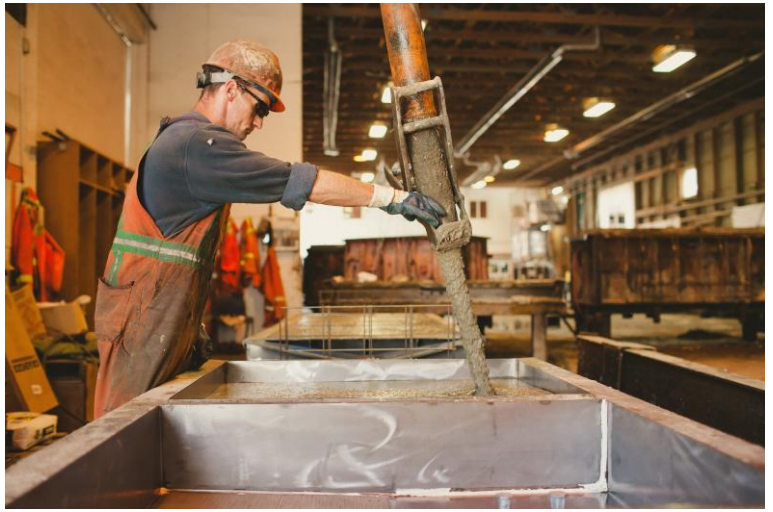
- Durability & functionality of the system on:

  - **Design of the entire system**
  - **Design and manufacturing of individual components**
  - **Installation**
  - **Use & Maintenance**

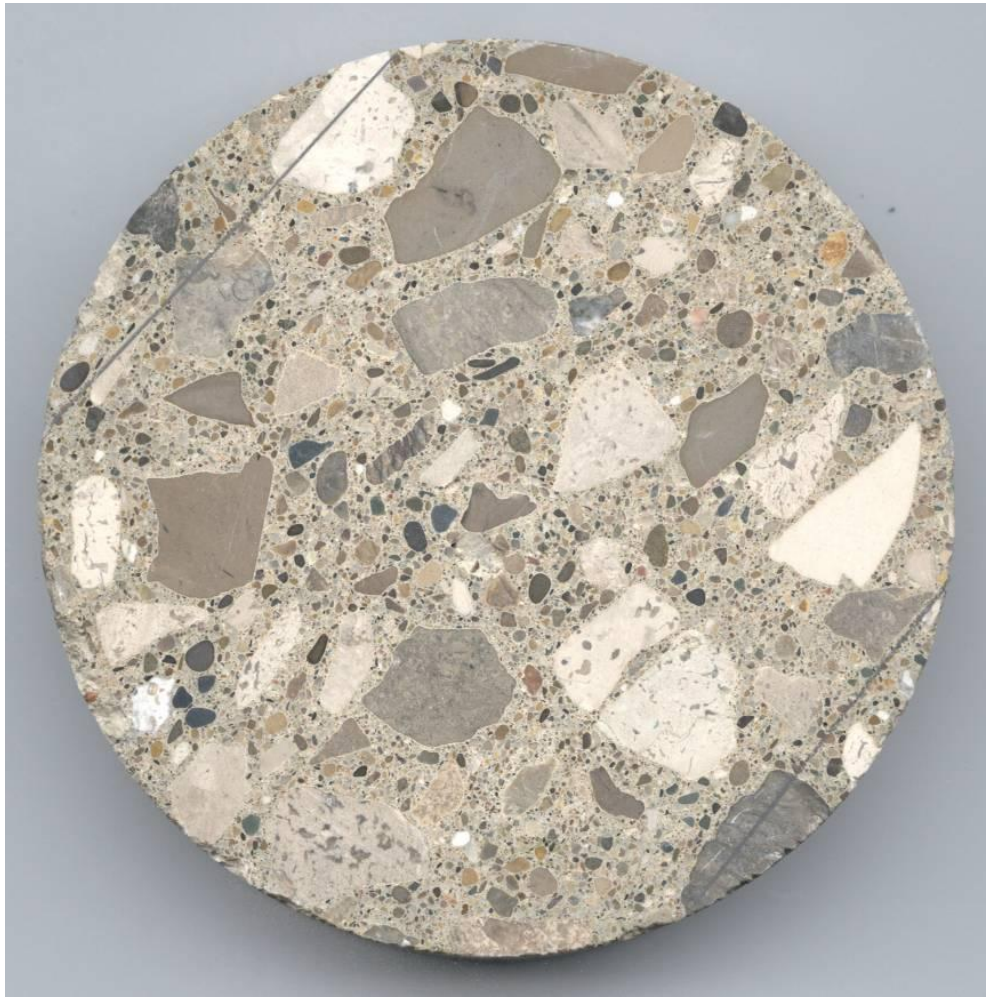


DURABILITY OF TANKS

- Durability of precast concrete tanks depends on:
  - **Design:** material selection, system and structural design,
  - **Manufacturing:** materials, processes, quality control
  - **Delivery and Installation:** Proper site preparation, handling and placement, backfilling.
  - **Use & Maintenance:** Best practices on disposal, proper maintenance, periodic inspections.



LET'S GEEK OUT ON CONCRETE!

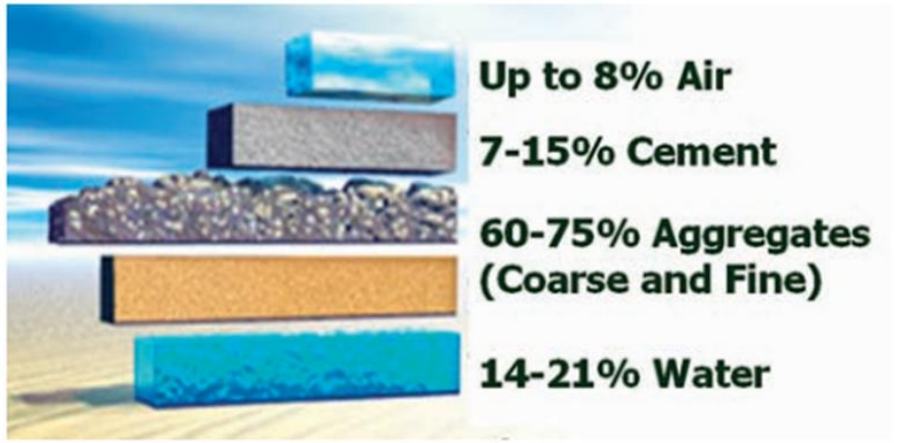


- Composite material made of natural ingredients, manufactured materials, and industrial byproducts
- Raw materials, raw material proportions, manufacturing, and curing play a significant role in hardened precast concrete performance

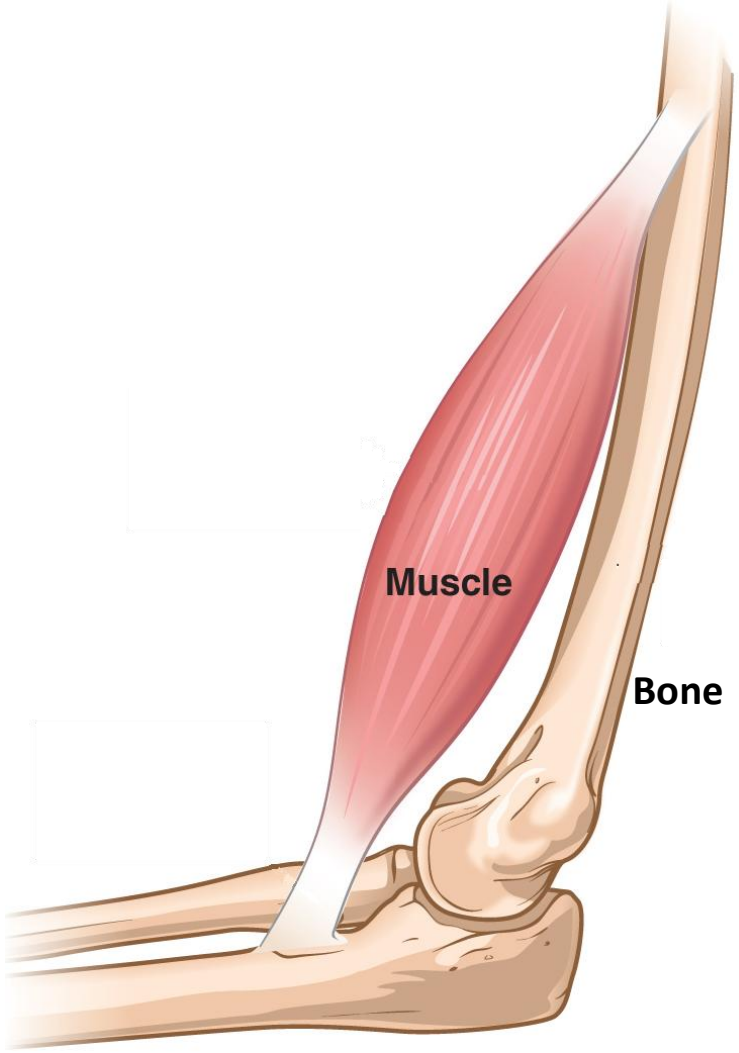
RAW MATERIALS IN CONCRETE

- Cement
- Supplementary cementitious materials (SCMs)
- Water
- Fine aggregates
- Coarse aggregates
- Admixtures

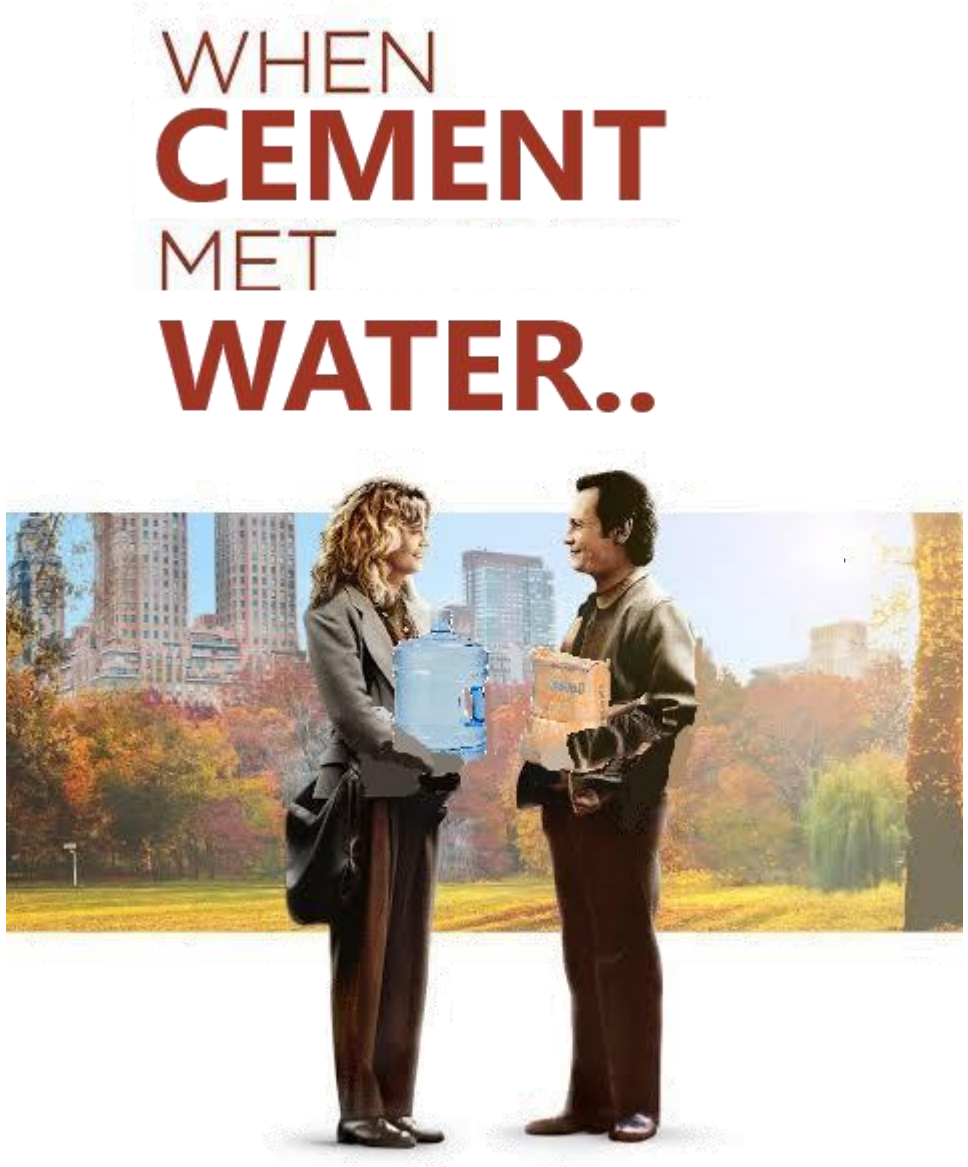
RAW MATERIALS IN CONCRETE



- Binder/glue/paste:
  - Cement
  - Supplementary cementitious materials (SCMs)
  - Water
  - Admixtures
- Filler:
  - Coarse and fine aggregates



WHEN CEMENT MEETS WATER



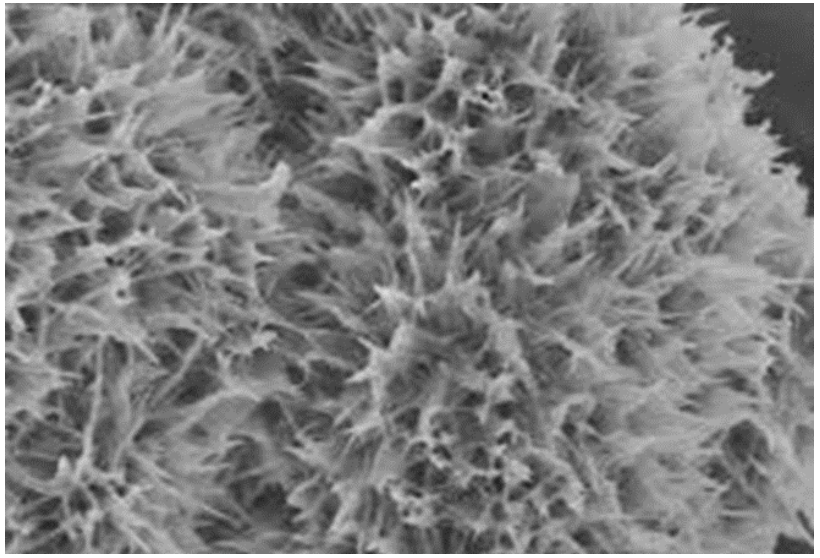
2 MAIN PRODUCTS OF CEMENT HYDRATION

Calcium Silicate Hydrate (CSH)

Primary cementitious binder.

Greatest contributor to strength.

Strongest part of concrete.



Calcium Hydroxide (CH)

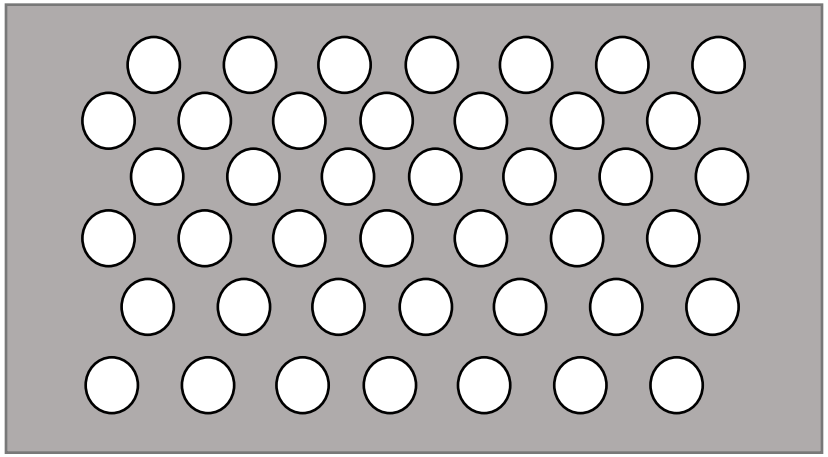
Little to no cementitious properties.

Contributes little to strength.

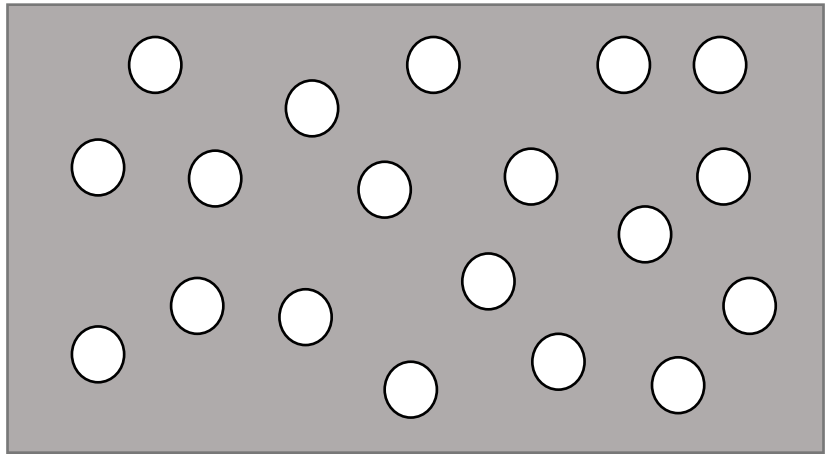
Helps maintain high pH of concrete.

POROSITY

- Porosity is the ratio of the volume of openings (or voids) to the total volume of the material. It basically represents the storage capacity of the material. Porosity is expressed in volume per volume ($in.^3/in.^3$ or mm^3/mm^3).



MORE POROUS

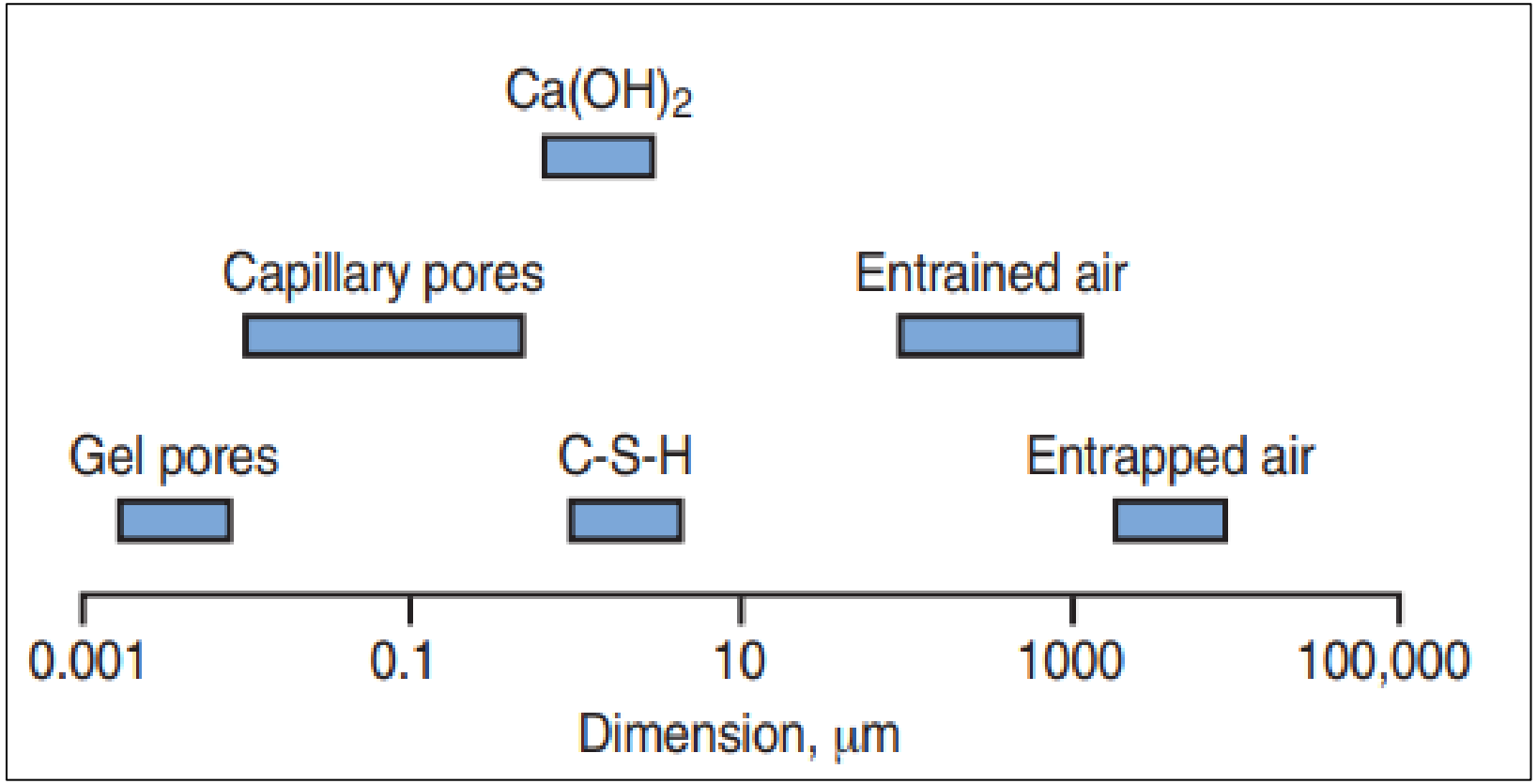


LESS POROUS

CONCRETE IS A POROUS MATERIAL

WHAT CAUSES PORES?

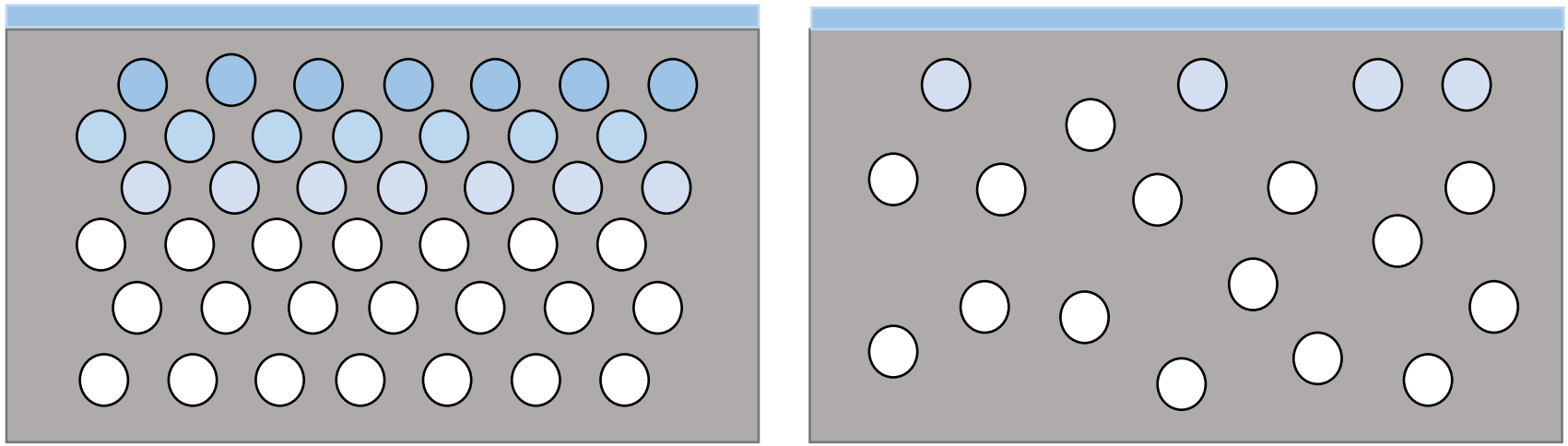
- Concrete mixing
- Placing concrete
- Improper concrete consolidation
- Excess mix water
- Cement hydration reactions



PCA Design and Control of Concrete Mixtures, 15th Edition

PERMEABILITY

- Permeability is the measure of the ease with which fluids can flow through a porous material. Permeability is expressed in terms of speed (in./s or mm/s)

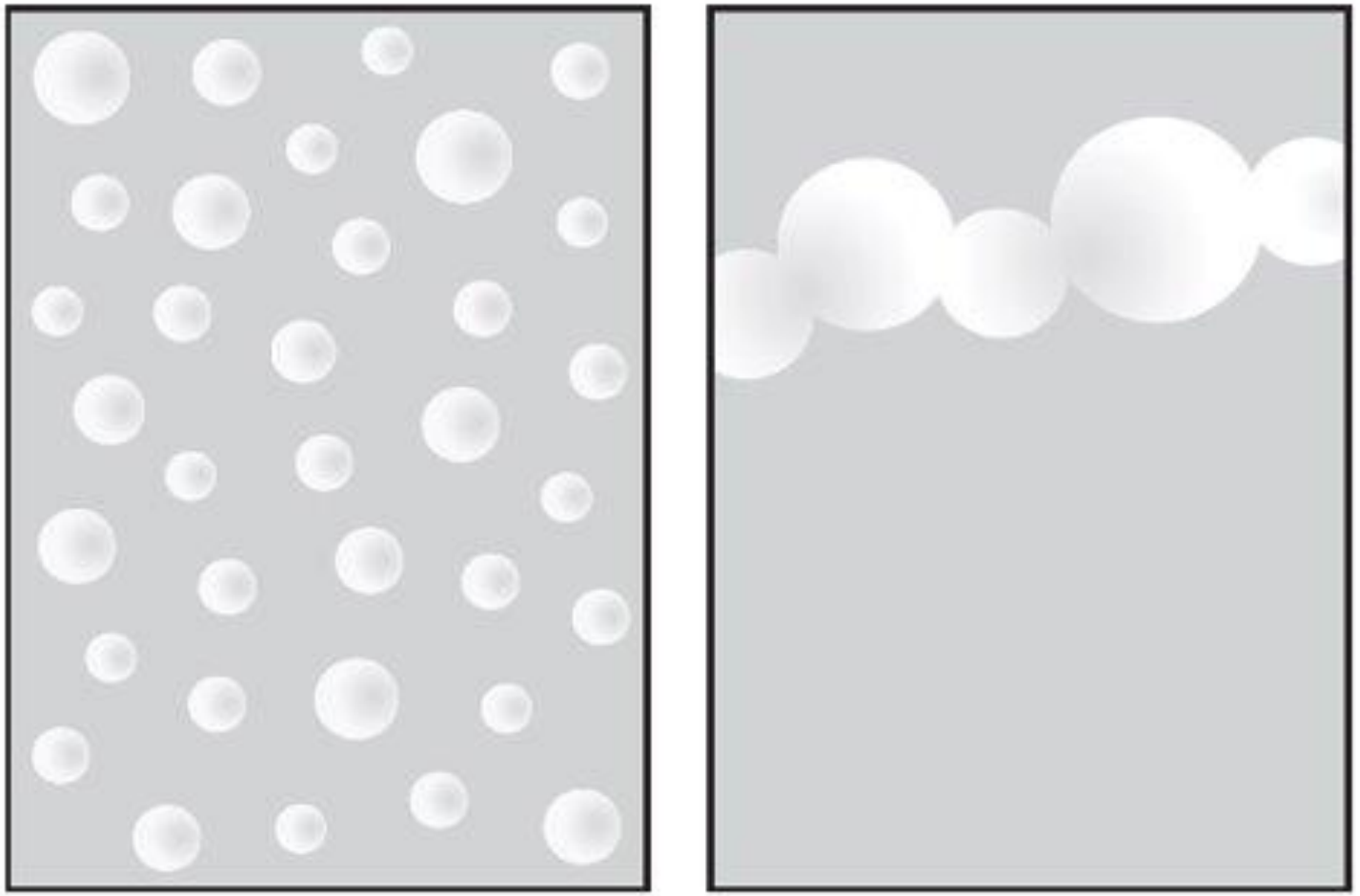


MORE PERMEABLE

LESS PERMEABLE

PORES AND PERMEABILITY

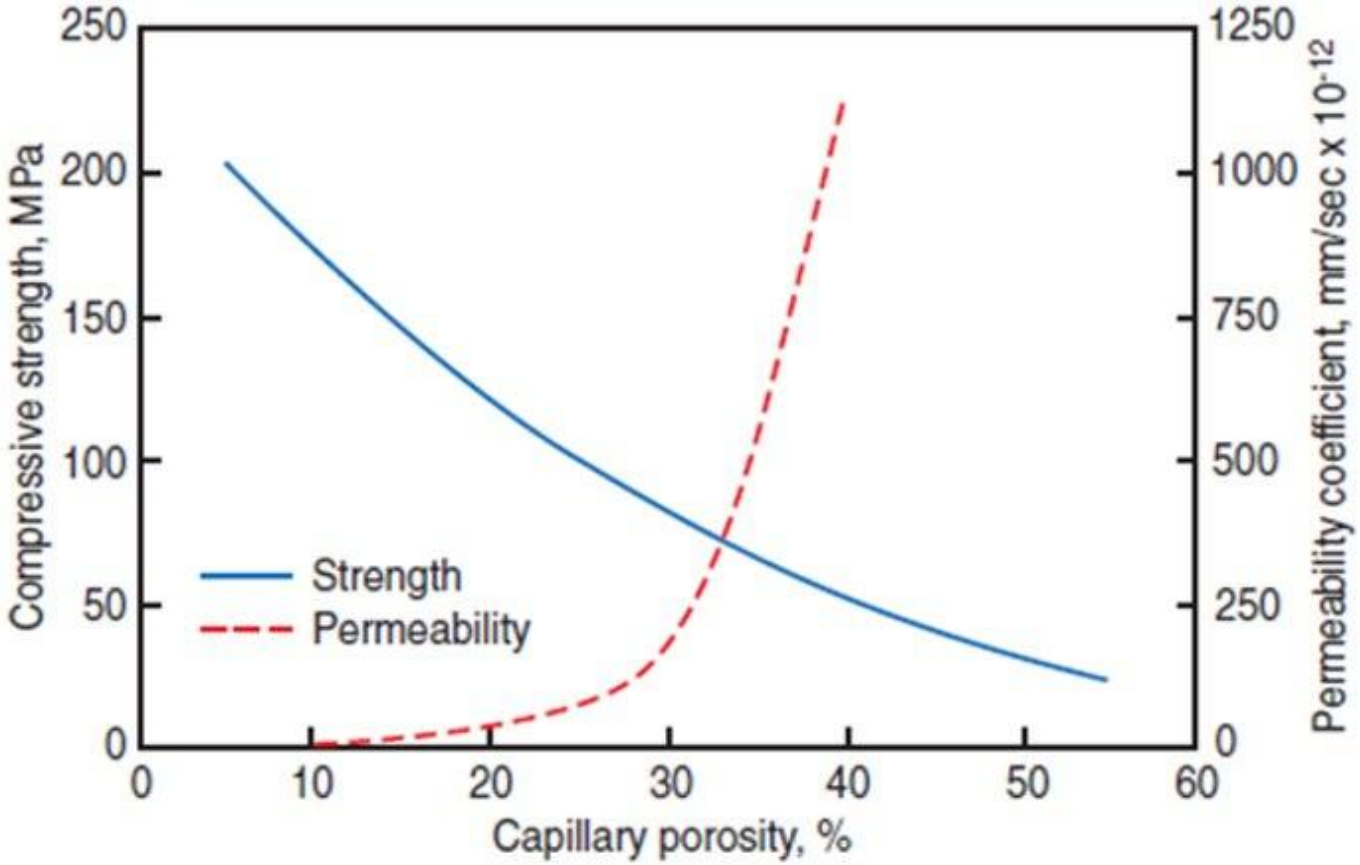
Discrete pores have less impact on permeability while interconnected pores increase permeability



PCA Design and Control of Concrete Mixtures, 15th Edition

PERMEABILITY

- When properly proportioned, designed, manufactured, cured, and installed, concrete is an extremely durable material



PCA Design and Control of Concrete Mixtures, 15th Edition

POTENTIALLY DETRIMENTAL SUBSTANCES

- Sulfates
  - Sodium sulfate
  - Magnesium sulfate
  - Calcium sulfate
- Salts
  - Sodium chloride
  - Magnesium chloride
  - Calcium chloride
- Acids
  - Sulfuric acid
  - Lactic acid

WHAT CAN CAUSE DEGRADATION?

- **Sulfates** – react with CH and CA_3 to produce gypsum and ettringite; ettringite's volume is greater than CH and CA_3 and can cause cracking
- **Salts** – react with CH to produce CAOXY which is larger than CH so causes cracking; draws water into concrete which is problematic for areas with freeze/thaw cycles
- **Acids** – react with CH and CSH and produce gypsum, also eventually produce ettringite, and lowers the concrete's pH

WAYS TO MINIMIZE PERMEABILITY

- Good Quality Concrete
- Good Quality Concrete
- Permeability Reducing Admixtures/Additives
- Coatings
- Sealers

TERMINOLOGY

Concrete Coating: liquid or semi-solid that is applied to the surface of hardened concrete that will bond to and preserve, protect, decorate, or smooth the substrate

Used to create a membrane/protective **barrier**

TERMINOLOGY

Sealer: liquid that is applied to the surface of hardened concrete to prevent or decrease the penetration of liquids or gases during service

- Can be reactive or non-reactive
- Penetrating treatment

TERMINOLOGY

Sealant: Material used to fill voids, gaps, and joints. For onsite wastewater structures, sealants would be pliable bitumen or elastomeric polymer (butyl) material, formed into a defined cross section, that is applied to the section joint surface of a tank or riser section.

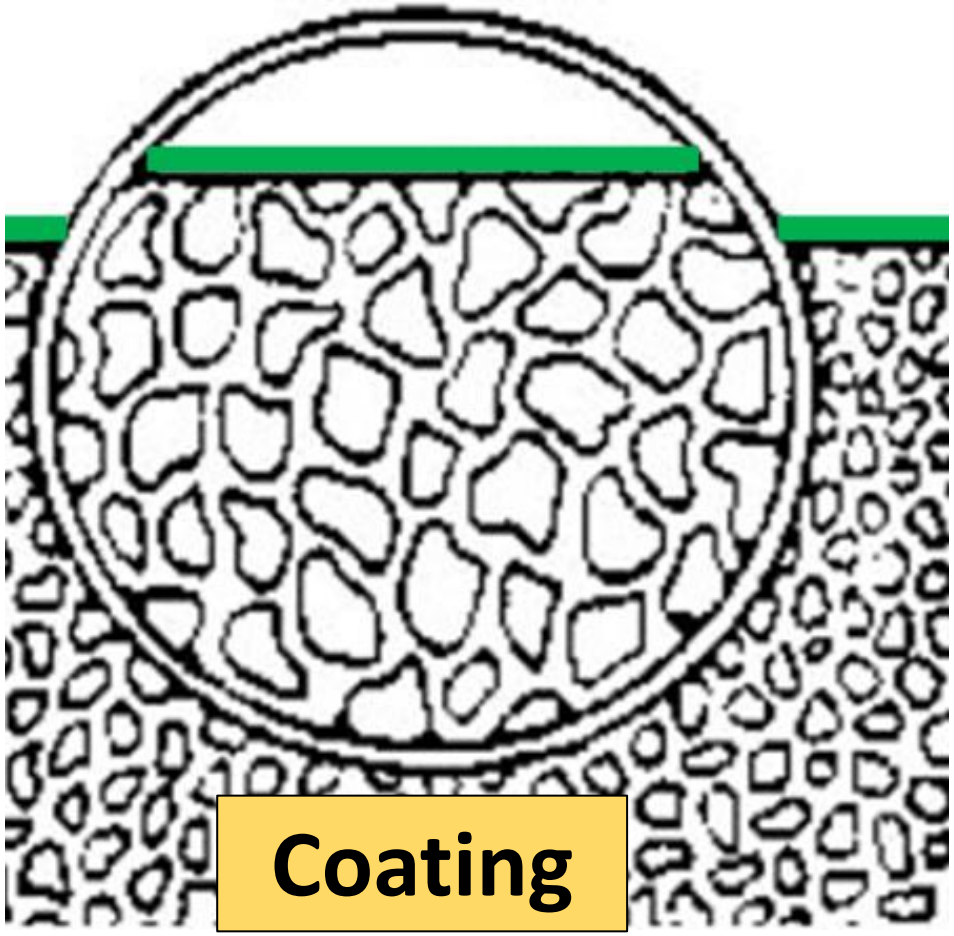
TERMINOLOGY

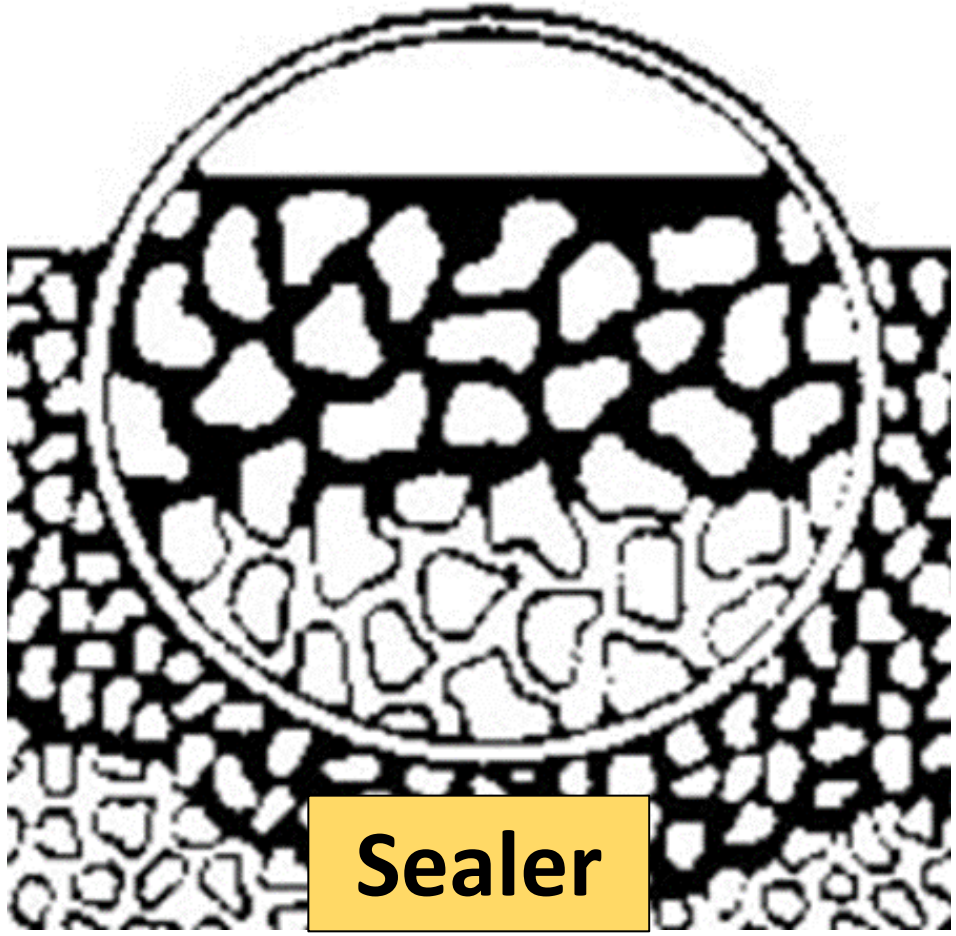
- **Mils:** One thousandth of an inch (0.001”). Unit often used when describing coating application thickness

- **Wet Film and Dry Film Thickness (WFT/DFT):** Thickness of coating before and after drying.

- **High Build**: Thicker coatings applied in one or two coats to enhance surface protection.

COATINGS VS. SEALERS





WHY COATINGS OR SEALERS ARE SPECIFIED

- Damp-proofing
- Waterproofing
- Acid exposure
- Sulfate exposure
- Deicer protection
- Secondary containment
- Microbial induced corrosion
- Repair/reliner applications

COATING AND SEALER CHEMISTRIES

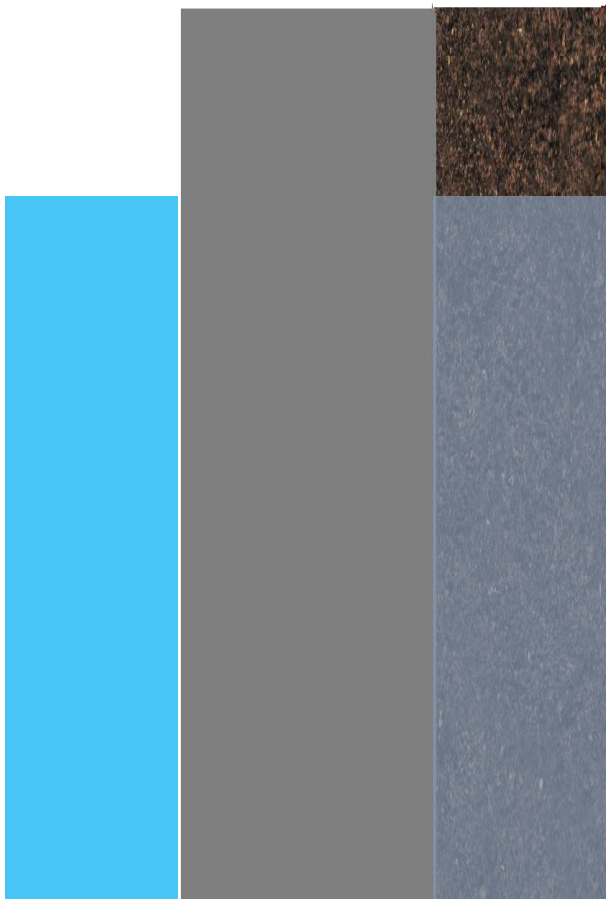
- Acrylic
- Epoxy
- Urethane
- Modified silicone
- Bitumen
- Coal tar
- Neoprene
- Chlorinated rubber
- Silane
- Siloxane
- Silane-siloxane
- Silicate

DAMP-PROOFING VS. WATERPROOFING

- **Damp-proofing coatings**:
  - Designed to prevent concrete from absorbing water that is not under hydraulic pressure (prevents capillary absorption via wicking)

DAMP-PROOFING VS. WATERPROOFING

- **Damp-proofing coatings**:
  - Designed to prevent concrete from absorbing water that is not under hydraulic pressure (prevents capillary absorption via wicking)
- **Waterproofing coatings**:
  - Designed to prevent concrete from absorbing water in hydrostatic pressure conditions (prevents direct ingress of water under pressure)
- Primary differences between waterproofing and damp-proofing coatings is the coating thickness and the material chemistry



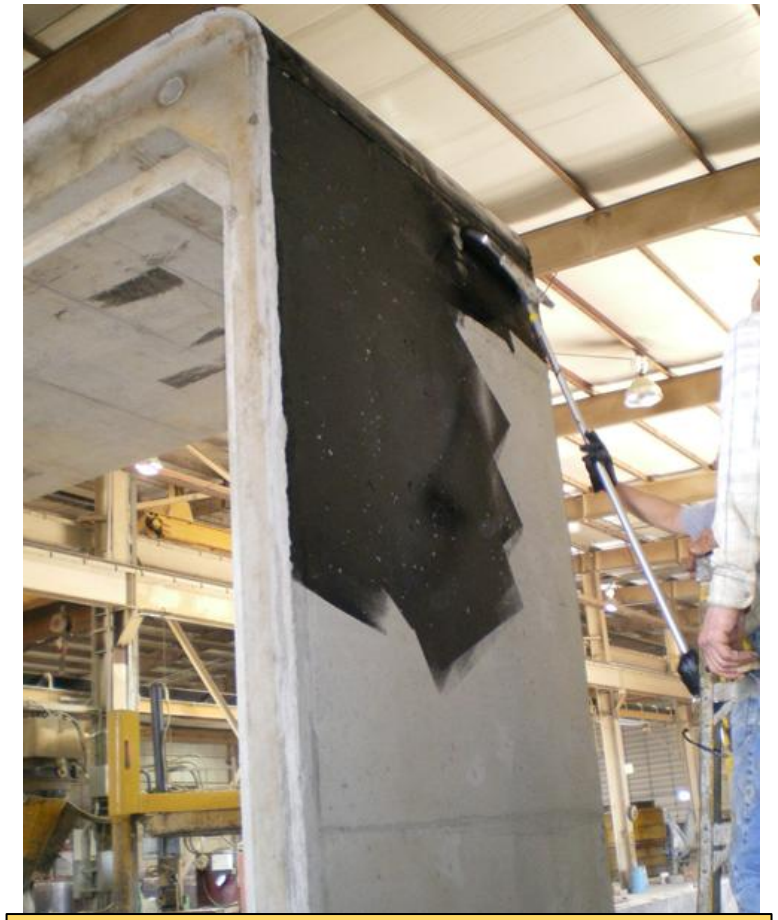
DAMP-PROOFING COATINGS

- Resistance to hydrostatic pressure: unable to permanently resist flow under hydrostatic conditions
- Application: usually on structure's exterior
- Thickness: typically 12 mils dry film thickness (0.012 in.) or less
- Crack bridging: little to none
- Notes: not intended to keep all water and moisture out, rather intended to retard moisture infiltration; more care needed during backfill

WATERPROOFING COATINGS

- Resistance to hydrostatic pressure: designed specifically for moisture protection
- Application: either on the structure's interior or exterior depending on goals
- Thickness: typically 40 mils dry film thickness (0.040 in.) or greater
- Crack bridging: some can span cracks measuring 0.0625 in.
- Notes: usually are elastomeric/flexible

DAMP-PROOFING VS. WATERPROOFING



Damp-proof Coating

Waterproof Coating

SOLIDS CONTENT

- The solids content of a coating or sealer impacts:
  - Coating or sealer coverage rate (square feet per gallon)
  - The variation between the coating's wet film thickness and dry film thickness (not applicable to sealers)

	Damp-proofer	Coal Tar Epoxy Alternative & Waterproofer	Waterproofer
Base	Waterborne acrylic	Waterborne acrylic	Hybrid
% solids	48% min.	72%	100%
Wet film thickness per coat (mils)	4-6	10-15	28-30
Dry film thickness per coat (mils)	2-3	8-12	28-30
# of coats needed	1 or more, depending on specifications	1 or more, depending on specifications	1 or 2, depending on specifications
Coverage per coat	225-300 SF per gal.	100-150 SF per gal.	50 SF per gal.

ASPHALT COATINGS

- Used for damp-proofing
- Can degrade over time
- 2 coats usually needed

COAL TAR COATINGS

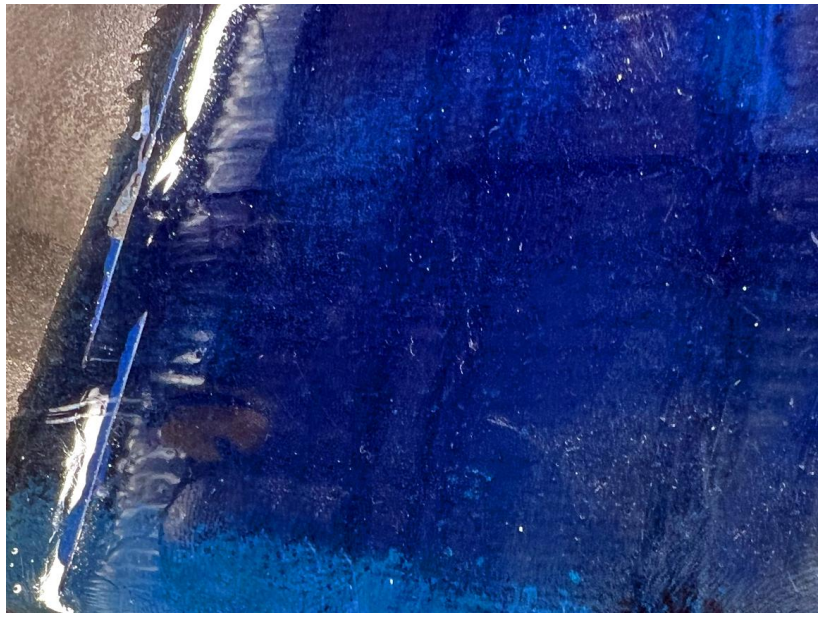
- Used for damp-proofing and protection against sulfate attack
- Can take a long time to cure
- Adhesion issues
- Moving away from coal tar-based coatings due to toxicity

ACRYLIC COATINGS

- Varying levels of flexibility
- Typically used for damp-proofing but some are capable of waterproofing
- Some offer moderate acid resistance

EPOXY COATINGS

- Typically rigid but some flexible options exist
- Used to protect concrete in harsher environments like exposure to hydrocarbons, chemicals, or acids
- Often not UV-stable



MODIFIED SILICONE COATINGS

- Flexible/elastomeric
- Water-repellent
- Good weatherability

SEALERS

Sealers protect concrete in different ways. Primarily by preventing water infiltration, creating water repellency, and hardening or densifying the concrete surface.

Penetrating and barrier types

Sealers typically don’t create a visible, noticeable physical barrier.

COMMON TYPES OF PENETRATING SEALERS

- **Silane:** penetrate further into concrete
- **Siloxane:** provide surface-level water repellency
- **Silane-siloxane:** blends the benefits of both silanes and siloxanes
- **Silicate:** reacts with CH to block pores

COMMON USES FOR SEALERS

- Prevent moisture absorption
- Reduce dusting
- Improve freeze-thaw scaling resistance
- Improve abrasion resistance
- Create a water-repellent surface
- Create an antimicrobial surface

PERMEABILITY REDUCING ADMIXTURES

- **Added to the concrete mix during batching.**
- **Can be in powder or liquid form.**
- **Two categories:**
  - **PRAN**. **P**ermeability **R**educing **A**dmixtures – **N**on-hydrostatic.
    - also referred to as damp-proofers,
    - most PRANs consist of a hydrophobic or water-repellant material.
  - **PRAH**. **P**ermeability **R**educing **A**dmixtures – **H**ydrostatic.
    - often called water-proofers and are designed for hydrostatic pressure conditions.
    - Many are crystalline based while some rely on other technologies to densify the concrete.

PRIMERS

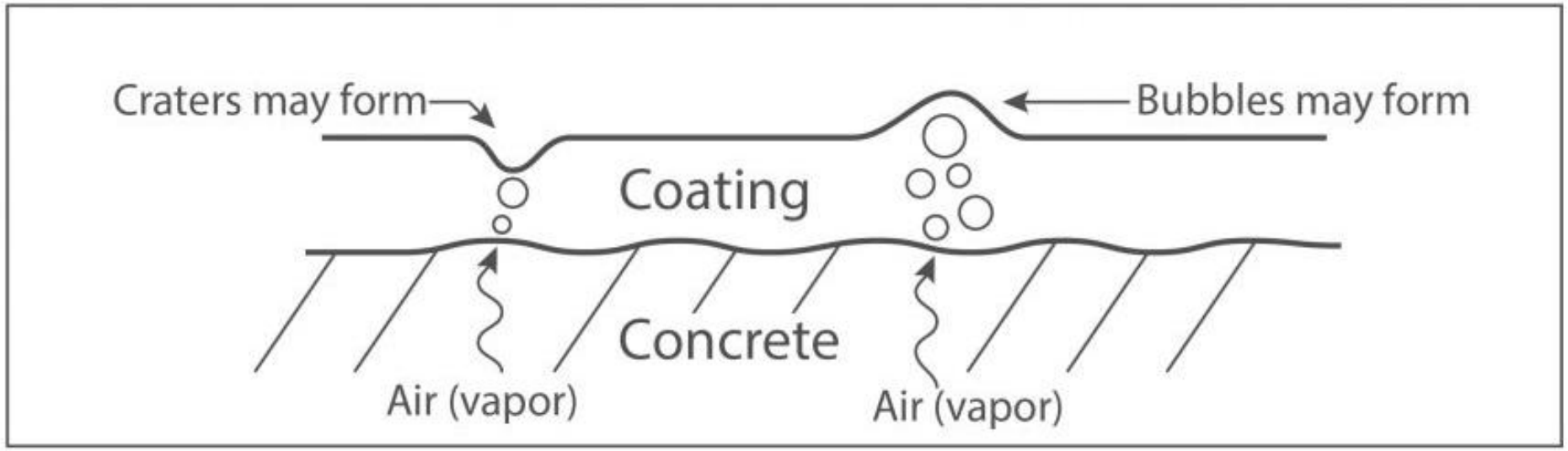
- Primers serve two key purposes:
  - Help coatings and sealants adhere to concrete (remember, concrete is alkaline)
  - Seal the concrete surface to prevent water intrusion

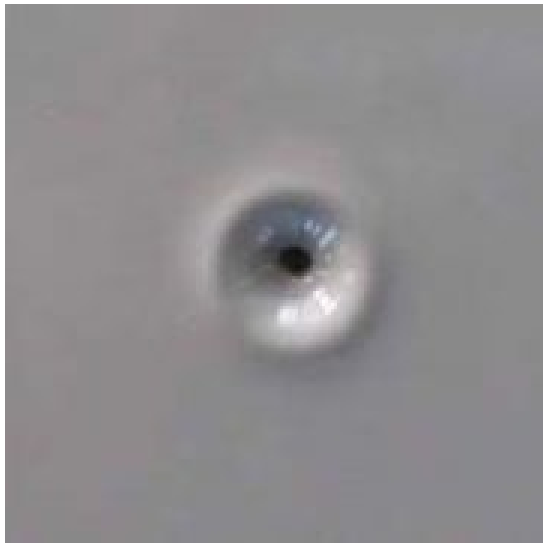
PROPER APPLICATION

Proper application of coatings and sealers include 3 major considerations:

Proper surface preparation
Proper coatings preparation / mixing
Proper application

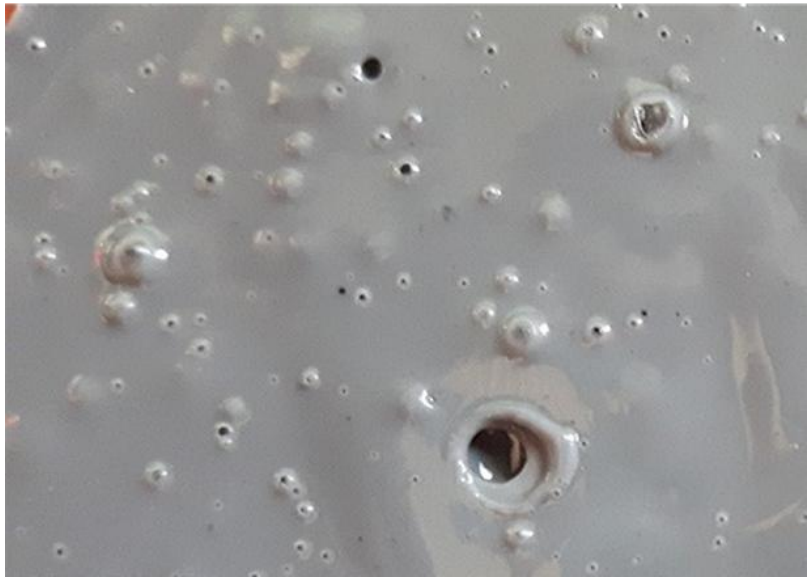
Coating Outgassing



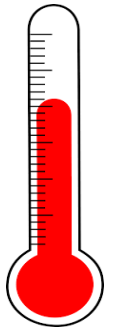


HOLIDAY TEST / SPARK TEST

- Spark testing shows points of discontinuity (holidays) in coatings
- Relies on conductivity of the substrate
- Discontinuities in the coating allow the current to pass from the brush to the substrate and create a spark

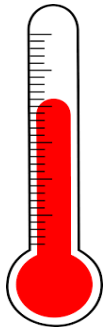


FOR BEST RESULTS



- Review the product data sheet and consult with a technical representative regarding appropriateness of application
- Ensure the substrate is sufficiently dry and clean
- Follow the necessary substrate preparation steps
- Ensure the substrate has cooled to ambient temperature
- Prime the substrate with a compatible and recommended primer
- Apply the coating within 20°F of the warmest part of the day
  - Ex. If the high temperature for the day is 70°F, apply the coating when it's between 50°F and 70°F.

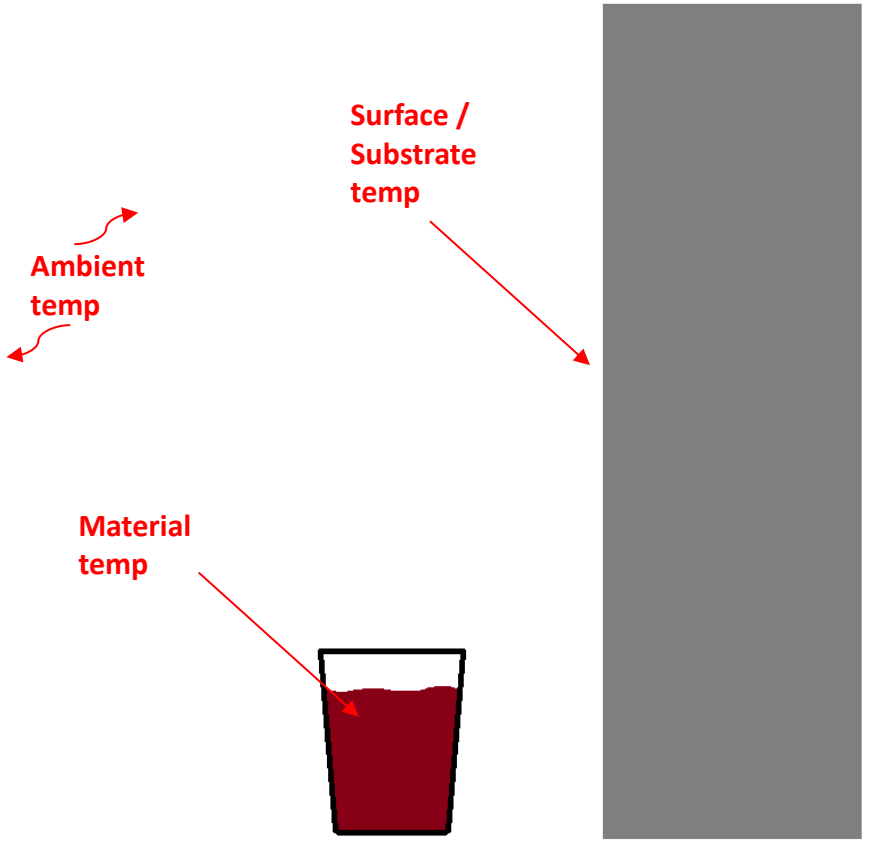
FOR BEST RESULTS



Temperature

- Ambient, Substrate, Materials
- Induction Time
- Cure time vs. Temperature

Generally, every 15º F change halves or doubles cure time



FOR BEST RESULTS

- If applying multiple coats, use alternating colors (if available) to help see proper coverage
- Follow manufacturer’s recommendations for:
  - Curing
  - Re-coat time and procedures
  - Waiting period prior to putting into service

CONCRETE SURFACE PREPARATION STEPS

- Surfaces should be free of:
  - Dust and dirt
  - Laitance
  - Loose concrete or cement paste

CONCRETE SURFACE PREPARATION STEPS

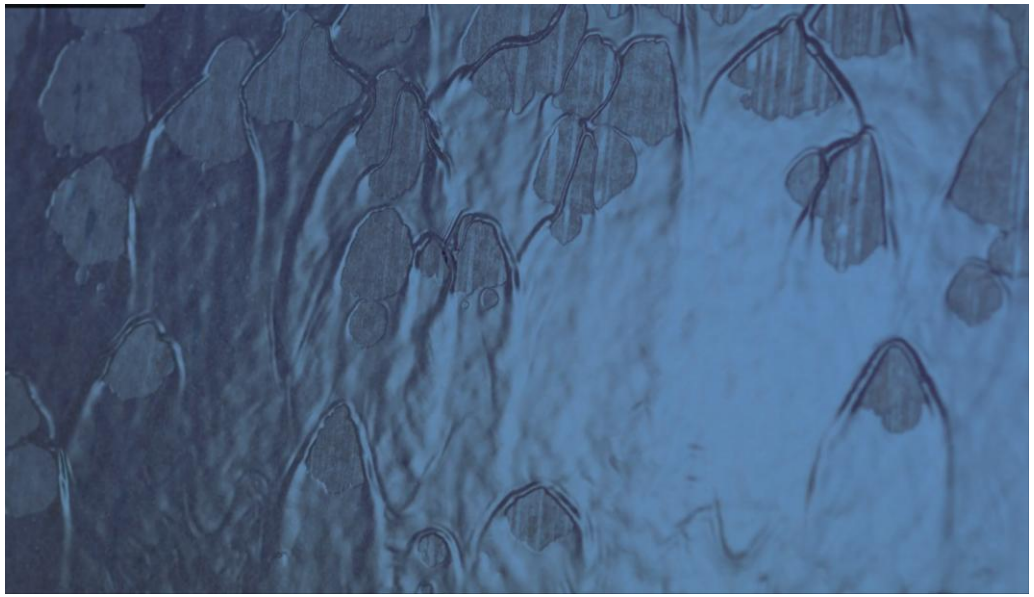
- Use extra care for structures that have already been in service
  - Thoroughly clean and dry the surface
  - May need to use solvents or other substances to remove previous coatings first
    - Check for compatibility with solvents!
  - Power washing, acid washing, wire brushing, or other procedures may be necessary
  - An engineer's assessment may also be required

COATING AND SEALER APPLICATION CONSIDERATIONS

- Sealer and/or coating application is critical to its long-term effectiveness
  - Substrate preparation
  - Primer needs
  - Weather and temperature conditions at time of application
  - Curing needs
  - Reapplication time if using more than one coat
  - Application method (spray, roll, brush, sponge mop)

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

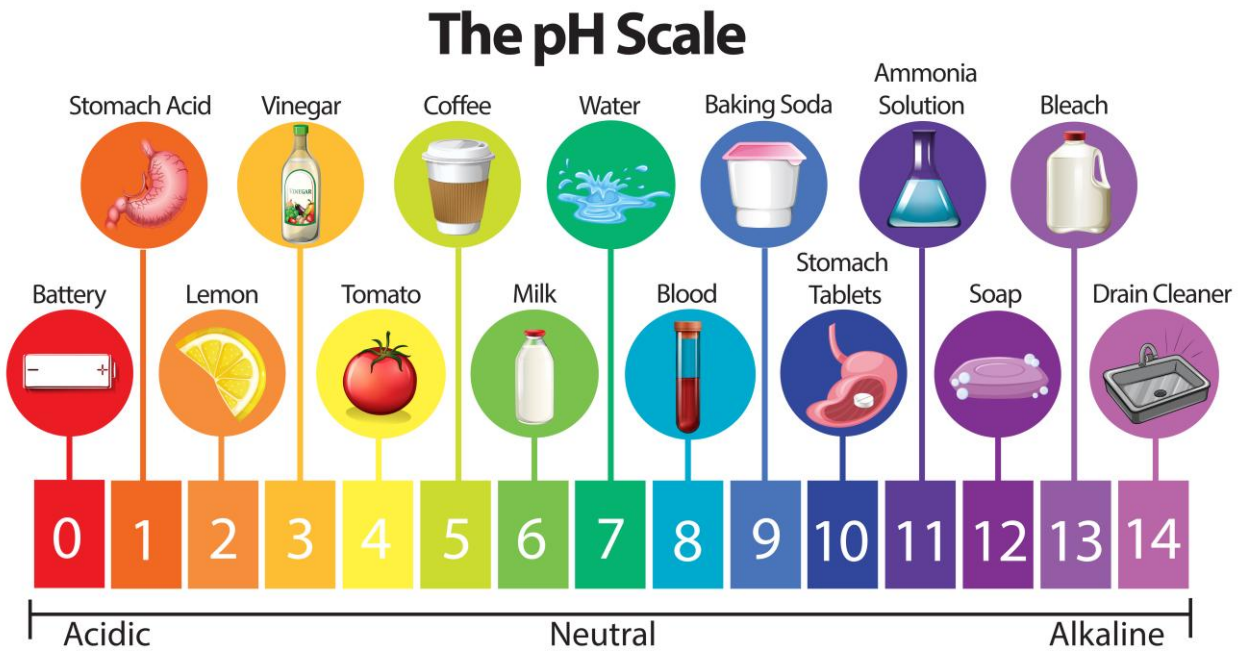
1. **What are the goals?**
   - Waterproofing, damp-proofing, protection against harsh chemicals, protection against acid developed in sewers..



10 CONSIDERATIONS FOR COATING & SEALER SELECTION

2. **What substances will the coating be in contact with or exposed to during service, if any, and what is the pH of the substances?**
   - chemicals, cleaners, water, wastewater, H_2S gas, acids, sulfates, etc.

FUN FACTS ABOUT PH WITH RESPECT TO COATINGS



- High pH:
  - Concrete is *generally* unaffected by alkaline solutions, unless they're hot!
- Low pH:
  - Low pH values do not always correlate to the aggressiveness of an acidic solution and its ability to deteriorate cement paste
  - The aggressiveness of the acid depends on the solubility of the calcium salts formed when the acid reacts with CH
  - The higher the solubility of the calcium salt, the more severe the acid attack

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

3. **Will the coating have intermittent or prolonged/consistent exposure to the substances with which it will be in contact? Will there be wetting and drying cycles?**
   - Secondary containment system, holding tank, conveyance structure, etc.

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

4. **What kind of environment will the coating be exposed to during service?**
   - Abrasion or scouring, foot traffic, vehicular traffic, direct bury/soil, paved-over, turbulent flow

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

5. **Is the structure already in service?**
   - Structures already in service have significantly more unknowns; will require thorough cleaning, drying, and other substrate preparation; and will likely require engineering assessment if it's a repair application.

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

6. **Are there any environmental/situational factors that could be limiting to the installation?**
   - Different coating materials dry and cure differently, some dry faster in low relative humidity while others cure faster in more humid environments, some will not cure in temperatures lower than 40°F, etc. Also be mindful of backfilling.

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

7. **Will the application require considerations for a confined space?**
   - Installer/applicator safety is critical. Determine whether the primer and coating are waterborne, solvent-borne, or 100% solids and incorporate any necessary safety precautions, or choose a waterborne option if possible.

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

8. **What are the desired finish characteristics of the sealer, primer, and coating?**
   - Rigid vs. flexible or elastomeric, hard vs. tacky (pressure-sensitive)

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

9. **Can the primer and coating be applied ahead of time?**
   - Applying the primer and coating before the structures arrive on the jobsite will save time and labor and can eliminate any jobsite curing environment concerns, but this is not always an option. Be mindful of the coating type, thickness, and dried texture, as well as backfill procedures if the structure will be buried.

10 CONSIDERATIONS FOR COATING & SEALER SELECTION

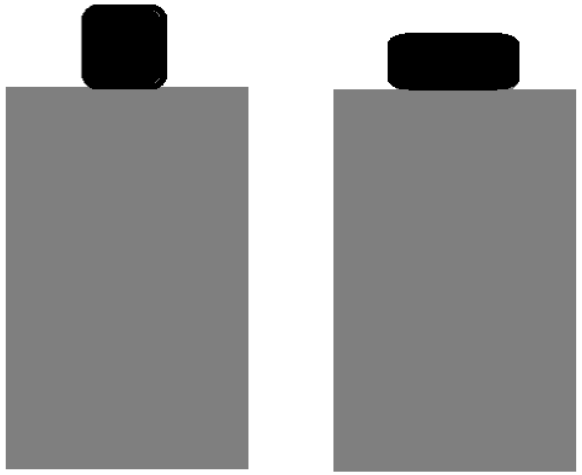
10. What is the desired service life?

- Some coating materials degrade over time and need to be re-applied, which adds maintenance costs and considerations.

SEALANTS

Should conform to

ASTM C990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants



PROPER SEALANT PLACEMENT

PROPER SEALANT PLACEMENT

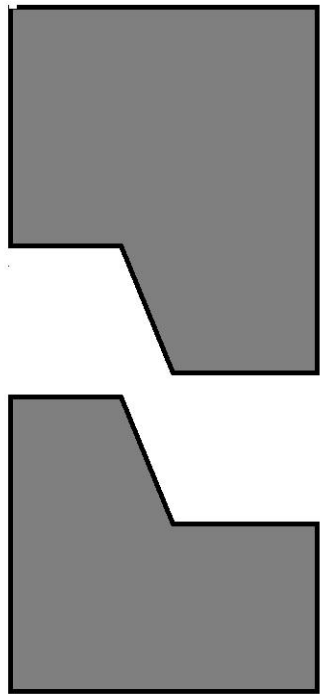
1. Clean the upper and lower joint surface with a brush. Remove any dirt and debris. Surface should be dry.

2. A primer can be used to improve sealant adhesion. When using a primer, let it dry before applying sealant.

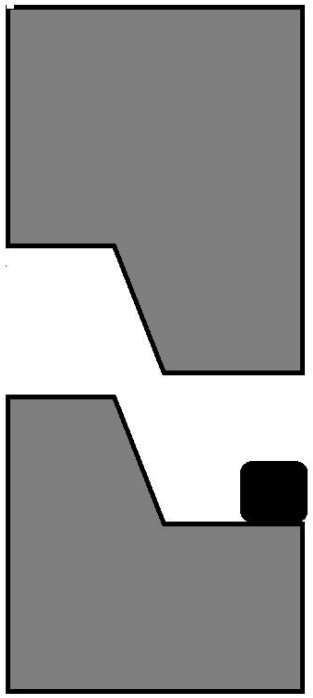
3. Place sealant so that it continuous at corners and knead joints. Do not stretch sealant.

4. Keep sealant clean under upper section is installed and remember to remove plastic sheeting

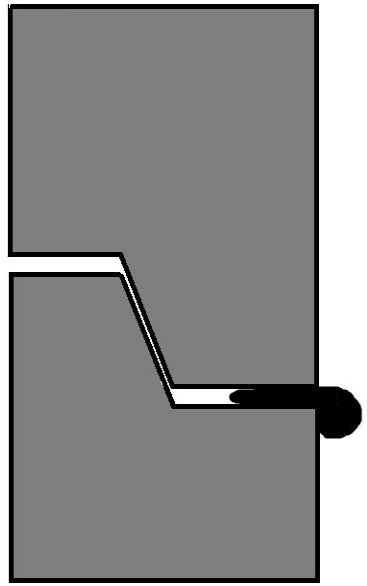
PROPER SEALANT PLACEMENT



PROPER SEALANT PLACEMENT



PROPER SEALANT PLACEMENT



PROPER SEALANT PLACEMENT

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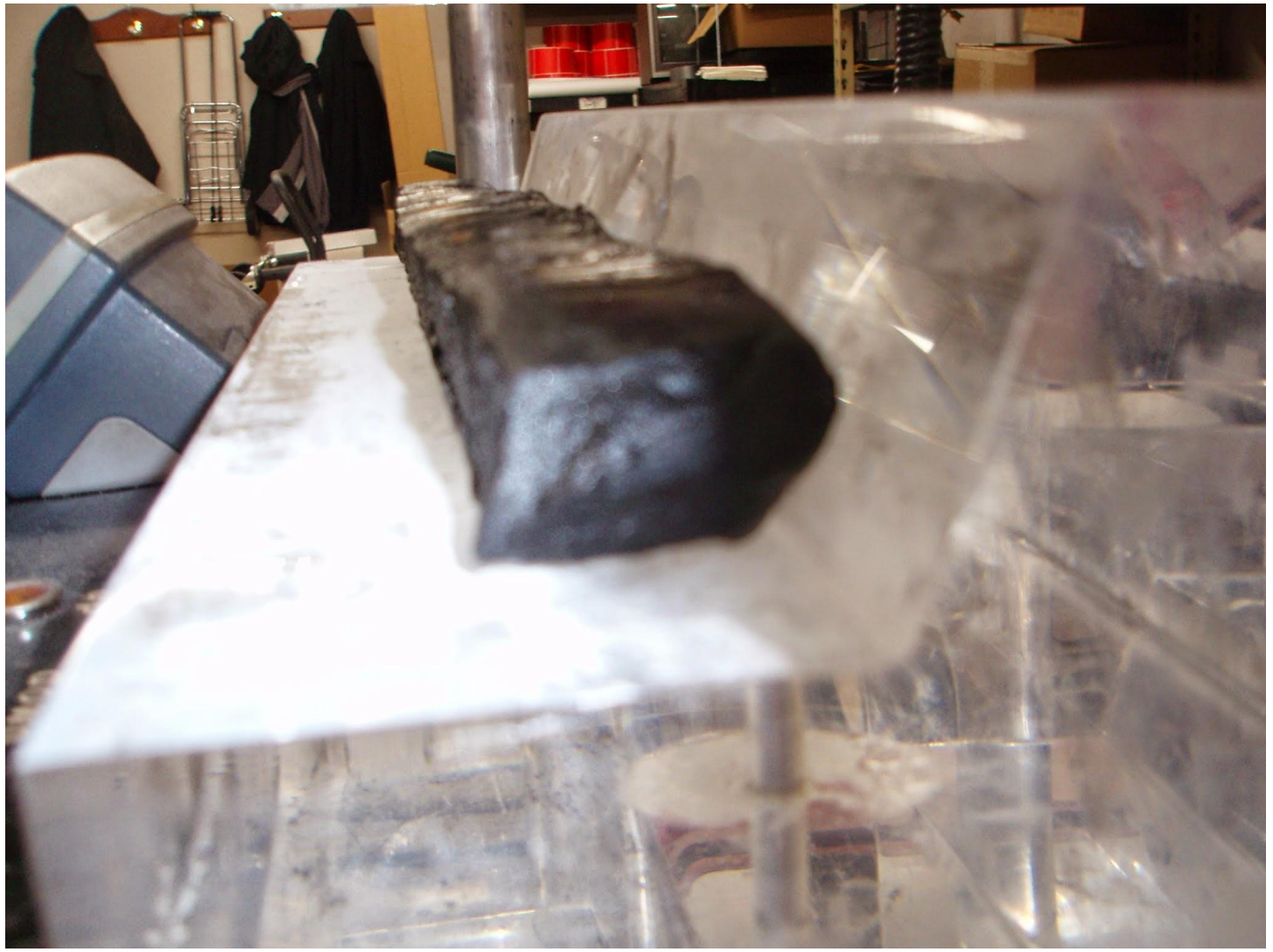
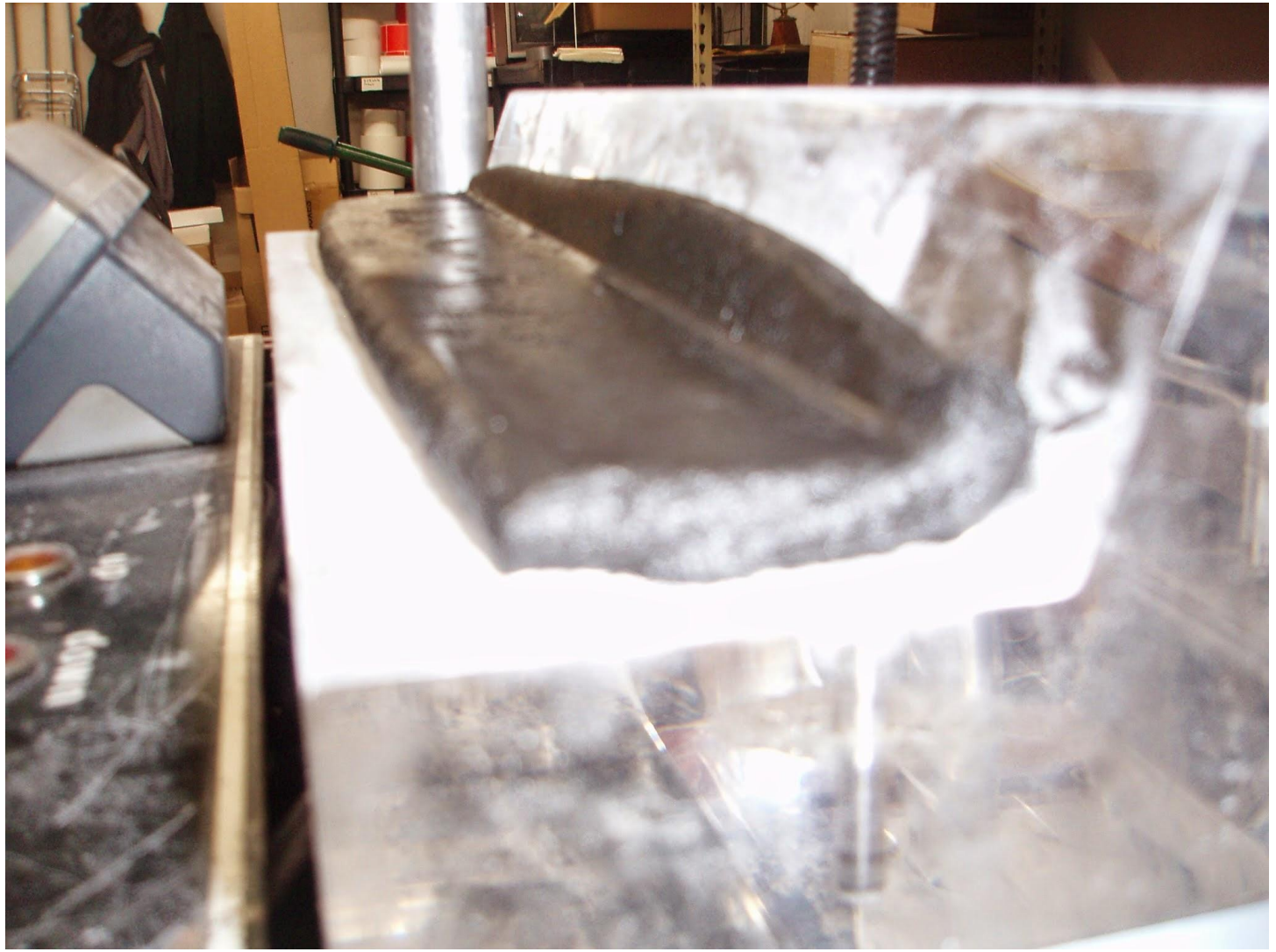


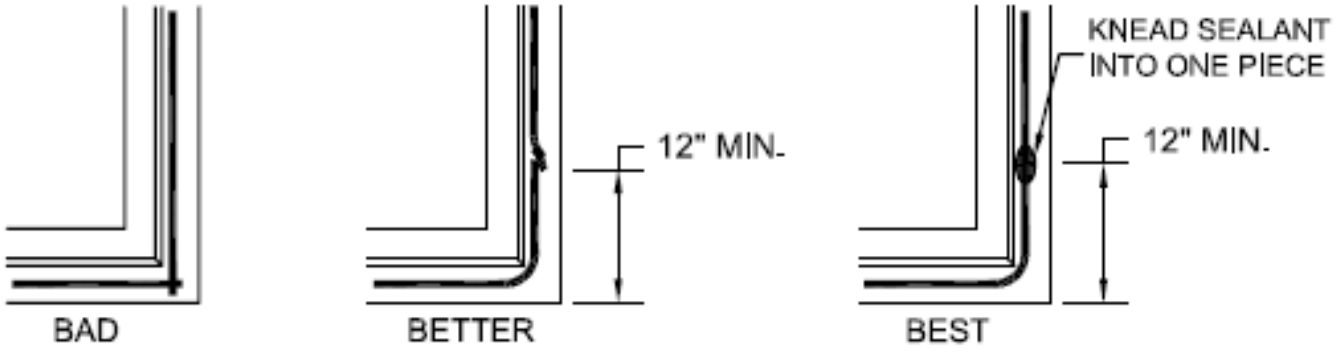
PROPER SEALANT PLACEMENT



PROPER SEALANT PLACEMENT

PROPER SEALANT PLACEMENT

Recommended Practice



PROPER SEALANT PLACEMENT

PROPER SEALANT PLACEMENT

FAQS

- Would there ever be a situation where you would want a coating to be applied on both the interior and exterior sides of a structure?
- Can a coating be applied to a repaired area?
- Is a primer absolutely necessary?

QUESTIONS?

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