# Coatings for Underground Concrete Structures

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Concrete Sealants

# Learning Objectives

- Describe different situations where coatings improve concrete's performance and durability, including where damp-proofing, waterproofing, sulfate resistance, or acid resistance are needed.
- List which types of coatings are appropriate for those scenarios.
- Explain why a coal tar epoxy coating is requested on the exterior of structures, issues associated with coal tar epoxy, and what alternatives are available.
- Outline best practices for concrete surface preparation and coating application.

# Resilience

- Resilience is a combination of durability and sustainability, and optimizes:
  - **Resources:** materials, manpower, capital, time
  - **Design:** material selection, system and structural design, installation
  - **Operation and maintenance:** lower maintenance options, predictability
  - **Production:** lean manufacturing, waste reduction, use of recycled materials


# Resilience

- We want structures and systems to be designed to **stand the test of time**
- If these systems do experience deterioration over time, it **shouldn't disrupt service**
- We want the behavior and performance to be **predictable**
- We want to **make the most of the materials and resources** we put into these structures and systems

# Concrete Basics

- Composite material made of natural ingredients, manufactured materials, and industrial byproducts
- New concrete has a pH of about 13
- Strong and durable in myriad conditions
- Raw materials, their proportions, manufacturing, and curing play a significant role in hardened concrete performance

# Potentially Detrimental Substances

- Water
- Ice
- Sulfates
  - Sodium sulfate
  - Magnesium sulfate
  - Calcium sulfate
- Salts
  - Sodium chloride
  - Magnesium chloride
  - Calcium chloride

# What Could Cause Degradation?

- **Water** – could carry potentially detrimental substances into concrete; abrades concrete
- **Ice** – expands in concrete's pores and can cause cracking
- **Sulfates** – react with CH and CA3 to produce gypsum and ettringite; ettringite's volume is greater than CH and CA3 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

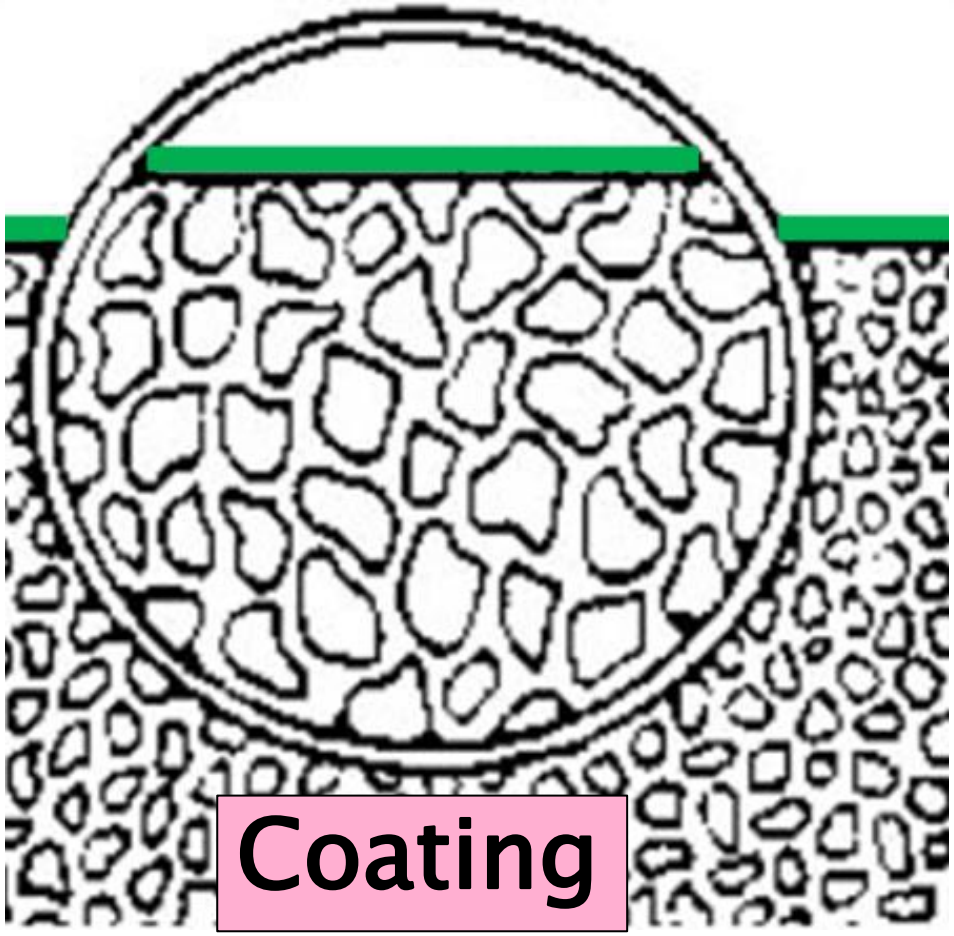
# Potentially Detrimental Substances

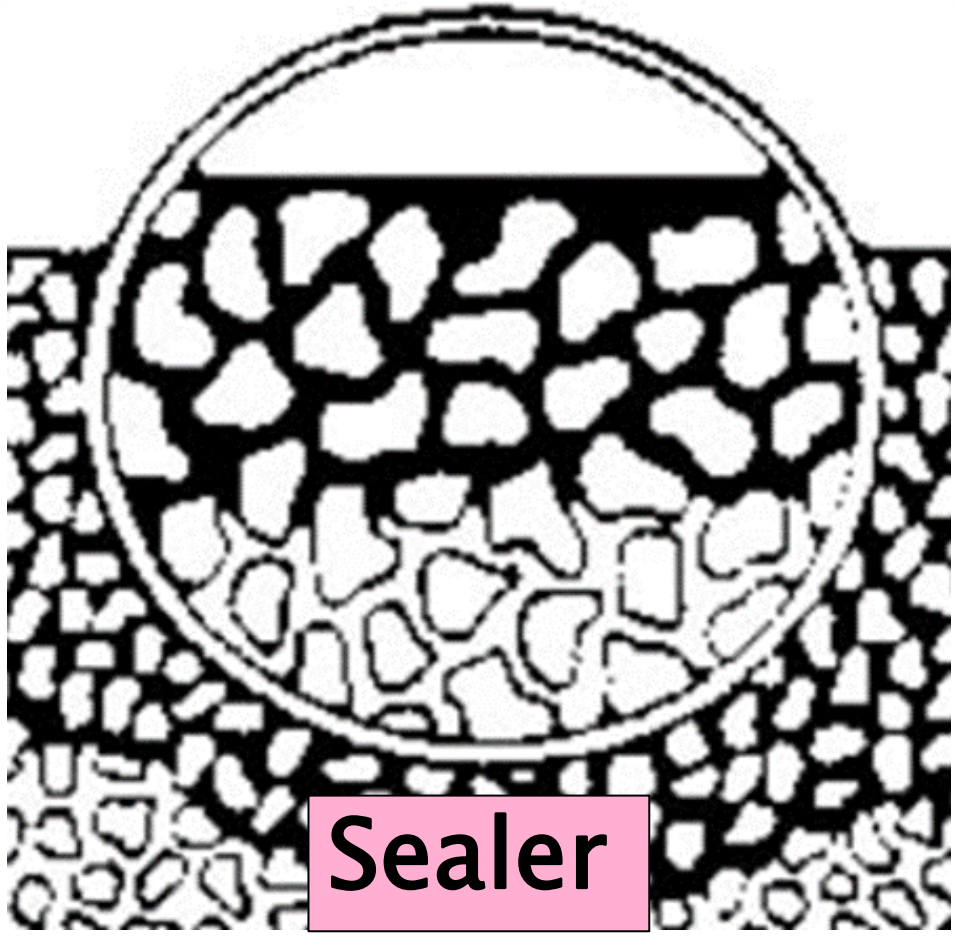
- $CO_2$
- Sugar
- Acids
  - Hydrochloric acid
  - Sulfuric acid
  - Lactic acid
  - Some cleaning agents


# What Could Cause Degradation?

- **$CO_2$** – causes carbonation which produces $CaCO_3$ and contributes to steel corrosion
- **Sugar** – sugar carried in water can cause slow degradation
- **Acids** – react with CH and CSH and produce gypsum, also eventually produce ettringite, and lowers the concrete's pH

# Coatings vs. Sealers



# Coatings Overview


- **Common types:**
  - Acrylic, epoxy, urethane, modified silicone, asphalt, coal tar
- **Typical uses:**
  - Waterproofing, damp-proofing, protection against harsh substances like chemicals, oil, gas, or acids
- **Note:**
  - Just because two coatings made from the same material doesn't mean they work the same way, can be used in the same service conditions, have the same application rate, have the same curing rate, etc.

# Common Scenarios Where Coatings are Specified

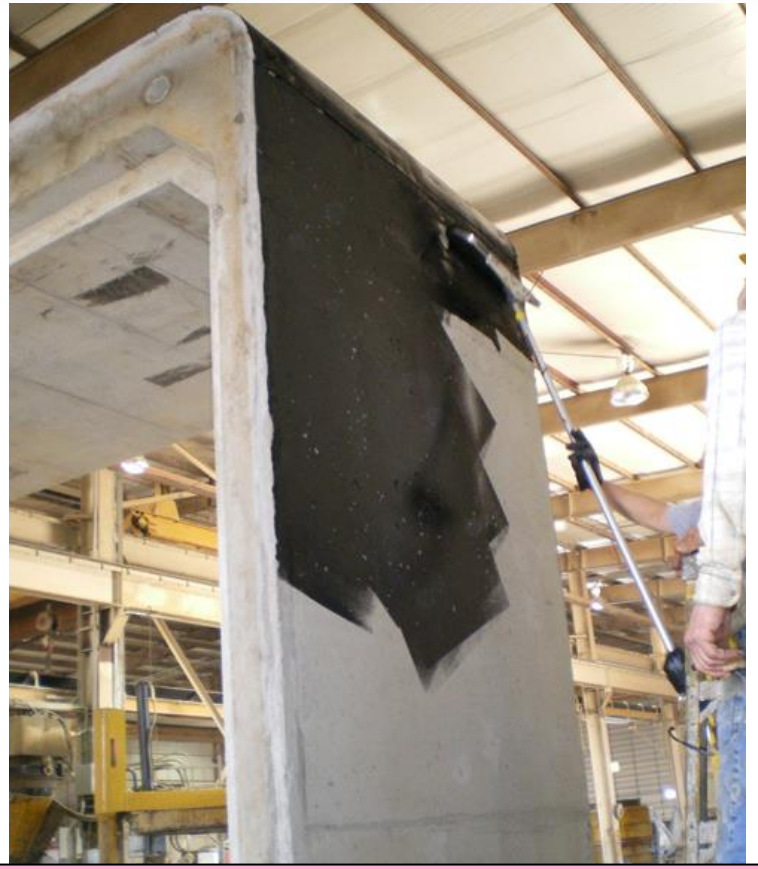
- Damp-proofing
- Waterproofing
- Bases/high pH exposure
- Acids/low pH exposure
- Sulfate exposure

# Waterproofing vs. Damp-Proofing

- **Waterproofing coatings:**
  - Typically 40 mils dry film thickness (0.040 in.) or greater in total thickness
  - Resistant to hydrostatic pressure
- **Damp-proofing coatings:**
  - Typically 12 mils dry film thickness (0.012 in.) or less in thickness
  - Not resistant to hydrostatic pressure

# Waterproofing vs. Damp-Proofing

Waterproof Coating



Damp-Proof Coating

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# 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, acid, or bases

# Asphalt Coatings

- Used for damp-proofing
- Can degrade over time

# Urethane Coatings

- Rigid
- Good weatherability
- Good abrasion resistance
- Water-repellent

# Hybrid Coatings

- Flexible
- Water-repellent
- Good weatherability
- Excellent acid-resistance
- Waterproof

# Coal Tar Coatings

- Damp-proofing
- Protection against sulfate attack

# Coal Tar Coatings

- Coal is distilled to produce coal tar pitches
- Coal tar pitches can be further modified by undergoing additional processing or incorporating additives to change the material properties
- Consistency ranges from thin liquids to semi-solids
- Coal tar epoxy exhibits intermediate properties between coal tar and epoxy, and contain:
  - Coal tar, filler, solvent, epoxy resin, curing agent

# Disadvantages of Coal Tar Coatings

- Why is coal tar being **restricted and removed** from specifications?
  - It's toxic! Coal tar is a known **carcinogen**.
  - It requires **significant personal protective equipment** during application because of its toxic nature and because it's a skin irritant.
  - **Pinholes** are difficult to avoid.
  - It typically requires multiple coats, so it requires **more labor**.


# Safe and Effective Coal Tar Alternatives

- Waterborne coatings that:
  - Are non-toxic and don’t require special PPE
  - Provide waterproofing, acid protection, and sulfate protection
  - Are fast-drying
  - Have high solids content
  - Create tack-free surface in minutes
  - Are freeze-thaw stable
  - Are mildew resistant and bacterial stable
  - Are appropriate for indoor/outdoor application
  - Are brush, roller, or spray applied
  - Create a flexible film with excellent impact resistance

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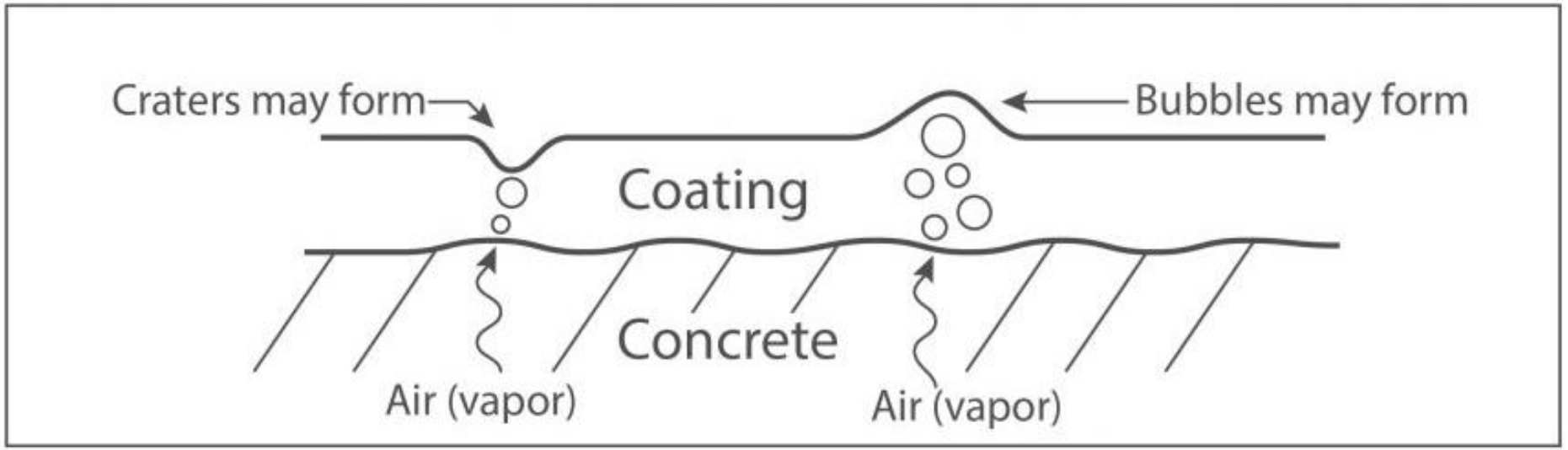
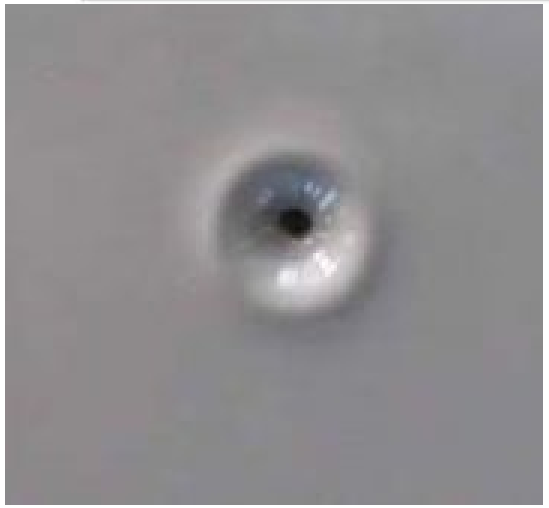
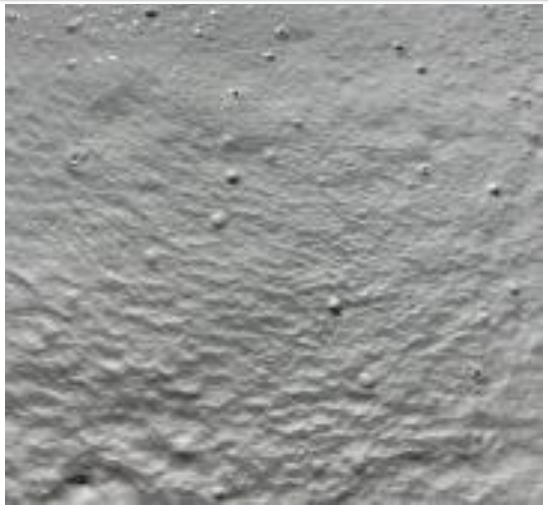
# Why does solids content matter?

- The solids content of a coating impacts:
  - Coating or sealer coverage rate (square feet per gallon)
  - The variation between the coating's wet film thickness and dry film thickness

# Outgassing-slow escape of air from concrete slab





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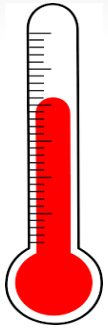
# Holiday Test / Spark Test

- 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
- Prime the substrate
- Ensure the substrate is sufficiently dry
- Ensure the substrate has cooled to ambient temperature
- 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.

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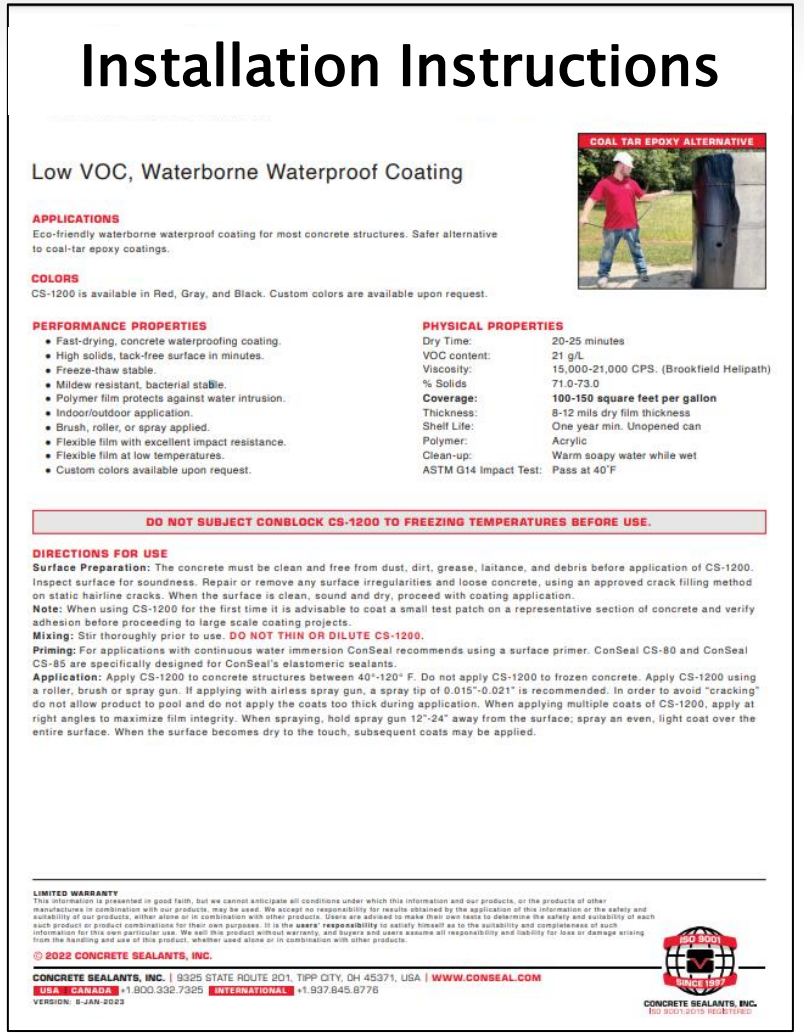
# For Best Results

- If applying multiple coats, **use alternating colors** (if available) to help see proper coverage
- If coating a slab on grade, **use a moisture barrier** under the slab and/or seal the substrate to prevent moisture wicking into the concrete

# For Best Results

- **Follow manufacturer's recommendations** for:
  - Compatibility with service conditions
  - Curing
  - Re-coat time and procedures
  - Waiting period prior to putting into service
  - Everything, really ☺



## Installation Instructions

COAL TAR EPOXY ALTERNATIVE

Low VOC, Waterborne Waterproof Coating

**APPLICATIONS**
Eco-friendly waterborne waterproof coating for most concrete structures. Safer alternative to coal-tar epoxy coatings.

**COLORS**
CS-1200 is available in Red, Gray, and Black. Custom colors are available upon request.

**PERFORMANCE PROPERTIES**
- Fast-drying, concrete waterproofing coating.
- High solids, tack-free surface in minutes.
- Freeze-thaw stable.
- Mildew resistant, bacterial stable.
- Polymer film protects against water intrusion.
- Indoor/outdoor application.
- Brush, roller, or spray applied.
- Flexible film with excellent impact resistance.
- Flexible film at low temperatures.
- Custom colors available upon request.

**PHYSICAL PROPERTIES**

| | |
|---|---|
| Dry Time: | 20-25 minutes |
| VOC content: | 21 g/L |
| Viscosity: | 15,000-21,000 CPS. (Brookfield Helipath) |
| % Solids | 71.0-73.0 |
| **Coverage:** | **100-150 square feet per gallon** |
| Thickness: | 8-12 mils dry film thickness |
| Shelf Life: | One year min. Unopened can |
| Polymer: | Acrylic |
| Clean-up: | Warm soapy water while wet |
| ASTM G14 Impact Test: | Pass at 40˚F |

**DO NOT SUBJECT CONBLOCK CS-1200 TO FREEZING TEMPERATURES BEFORE USE.**

**DIRECTIONS FOR USE**
**Surface Preparation:** The concrete must be clean and free from dust, dirt, grease, laitance, and debris before application of CS-1200. Inspect surface for soundness. Repair or remove any surface irregularities and loose concrete, using an approved crack filling method on static hairline cracks. When the surface is clean, sound and dry, proceed with coating application.
**Note:** When using CS-1200 for the first time it is advisable to coat a small test patch on a representative section of concrete and verify adhesion before proceeding to large scale coating projects.
**Mixing:** Stir thoroughly prior to use. **DO NOT THIN OR DILUTE CS-1200.**
**Priming:** For applications with continuous water immersion ConSeal recommends using a surface primer. ConSeal CS-80 and ConSeal CS-85 are specifically designed for ConSeal's elastomeric sealants.
**Application:** Apply CS-1200 to concrete structures between 40°-120° F. Do not apply CS-1200 to frozen concrete. Apply CS-1200 using a roller, brush or spray gun. If applying with airless spray gun, a spray tip of 0.015"-0.021" is recommended. In order to avoid "cracking" do not allow product to pool and do not apply the coats too thick during application. When applying multiple coats of CS-1200, apply at right angles to maximize film integrity. When spraying, hold spray gun 12"-24" away from the surface; spray an even, light coat over the entire surface. When the surface becomes dry to the touch, subsequent coats may be applied.



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# Concrete Surface Preparation

- Proper 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
  - Application thickness vs. DFT
  - Reapplication time if using more than one coat
  - Application method

# Concrete Surface Preparation

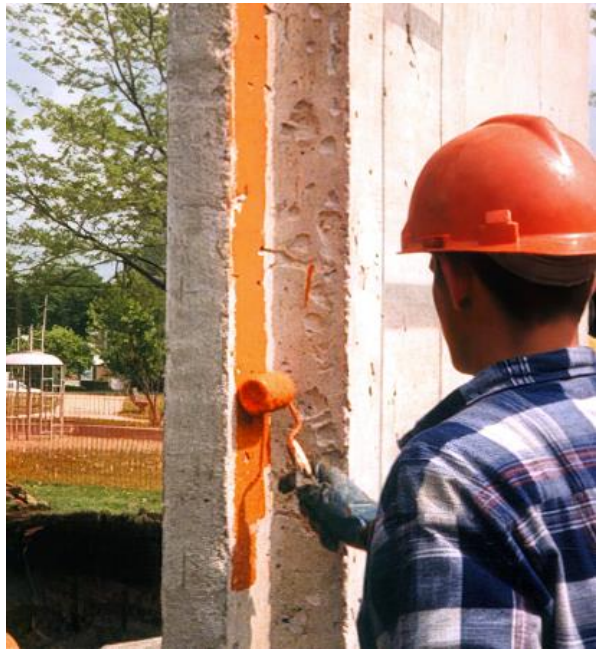
- Surfaces should be free of:
  - Dust and dirt
  - Laitance
  - Form release agent
  - Loose concrete or cement paste

# Concrete Surface Preparation

- Ensure surfaces are sufficiently dry (typically saturated surface dry or dryer) prior to primer or coating application
  - Use the “tissue test” if you’re unsure

# Concrete Surface Preparation

- Primers serve two key purposes:
  - Help coatings and sealants adhere to concrete
  - Seal the concrete surface to enhance durability and watertightness



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# Concrete Surface Preparation

- A properly primed substrate performs better than an unprimed substrate
- Some primers dry hard while some dry tacky
  - Primers that dry tacky can be advantageous when installing sealant to vertical faces or installing joint wrap
  - Primers that dry tacky should not be used with coatings
- Primers are typically optional, but some coatings *require* primers

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# What about structures that have already been in service?

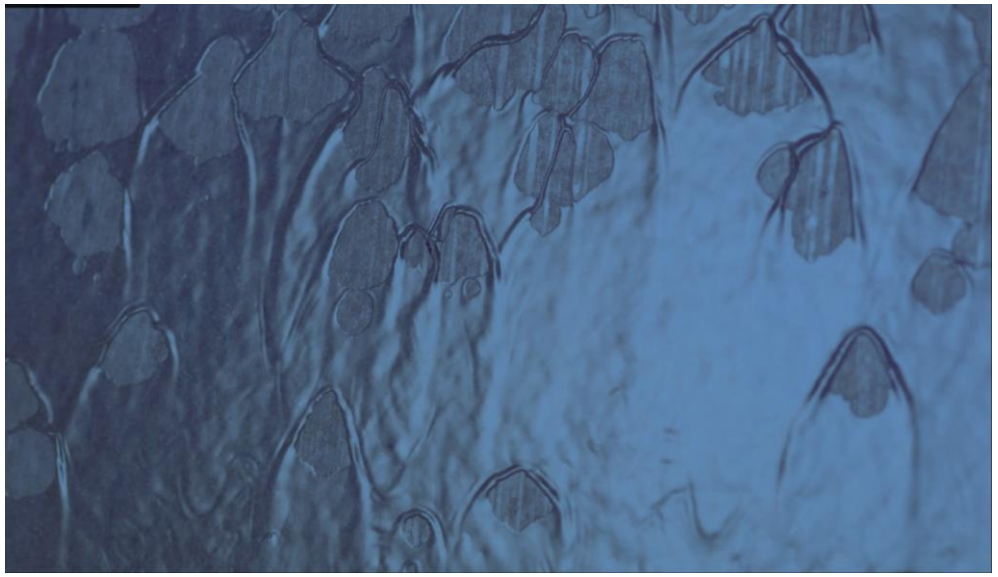
- Use extra care for structures that have already been in service
  - Thoroughly clean and dry the surface
  - May need to use solvents* or other substances to remove previous coatings first
  - Power washing or using a wire brush may be necessary

| | 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. |

# Top 10 Considerations for Coating Selection

- **What are the goals?**
  - Waterproofing, damp-proofing, protection against harsh chemicals, etc.

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



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# Top 10 Considerations for Coating Selection

- **Will the coating have intermittent, prolonged, or consistent exposure?**
  - Secondary containment, holding tank, conveyance structure, wetting and drying cycles, etc.

- **What kind of environment will the coating be exposed to during service?**
  - Sunlight, abrasion, scouring, foot traffic, vehicular traffic, direct bury, paved over, etc.

# Top 10 Considerations for Coating Selection

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

- **Are there any environmental factors that could be limiting to the installation?**
  - Different chemistries dry and cure differently; some dry faster in low RH, some will not cure in temperatures lower than 40°F

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# Top 10 Considerations for Coating Selection

- **Will the application require considerations for a confined space?**
  - Installer/applicator safety is critical; choose waterborne, 100% solids, and non-toxic options whenever possible

- **What are the desired finish characteristics?**
  - Rigid vs. flexible, hard vs. tacky

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# Top 10 Considerations for Coating Selection

- **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 jobsite curing environment concerns

- **What is the desired service life?**
  - Some coating materials degrade over time and need to be re-applied, which adds maintenance costs and considerations

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# Summary / Learning Objectives

- Describe different situations where coatings improve concrete's performance and durability, including where damp-proofing, waterproofing, sulfate resistance, or acid resistance are needed.
- List which types of coatings are appropriate for those scenarios.
- Explain why a coal tar epoxy coating is requested on the exterior of structures, issues associated with coal tar epoxy, and what alternatives are available.
- Outline best practices for concrete surface preparation and coating application.

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