

CSI SPECIFICATIONS

CRYSTALLINE WATERPROOFING ADMIXTURE FOR SHOTCRETE

Section 03 37 00



Note to Specifier: Krystol Internal Membrane (KIM) is a chemical admixture used to create waterproof concrete. KIM is used in place of externally applied surface membranes for water containment or waterproofing protection of structures exposed to hydrostatic conditions. KIM is also used to add durability as it protects against moisture transmission, chemical attack, and corrosion of reinforcing steel. This section is intended to be used in conjunction with applicable Division 03 - Concrete technical specifications for shotcrete to suit project requirements. Edit this section as required to suit concreting procedures.

Part 1 General

1.1 SUMMARY

- A. Hydrophilic crystalline concrete admixture to provide permanently waterproof concrete. The admixture reacts chemically with water and un-hydrated cement particles to form insoluble microscopic needle-shaped crystals that fill capillary pores and self-seal micro-cracks in the concrete and block the pathways for water and waterborne contaminants. The admixture significantly lowers the permeability of concrete, adds durability and longevity to concrete by protecting against chemical attack and corrosion of reinforcing steel and is used as a more reliable and long-term waterproofing solution compared to surface applied waterproofing membranes and coatings.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-In-Place Concrete
- B. Section 03 15 16 - Concrete Construction Joints
- C. Section 03 37 13- Shotcrete
- D. Section 03 40 00- Precast Concrete Section
- E. Section 03 01 30 - Maintenance of Cast-in-Place Concrete

1.3 REFERENCES

- A. The following agencies and standards are applicable to this section.
 - 1. American Concrete Institute (ACI)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. British Board of Agrément (BBA)
 - 4. British Standard Institution (BSI)
 - 5. Canadian Standards Association (CSA)
 - 6. German Institute for Standardization (DIN)
 - 7. NSF International
 - 8. U.S. Army Corps of Engineers (USACE)

1.4 PERFORMANCE REQUIREMENTS

- A. Permeability:
 - 1. Permeability reduced minimum 70% over untreated concrete tested to BS EN 12390-8 or DIN 1048-5 at <0.5 MPa><<72.5 psi>> for 72 hours.
 - 2. Permeability reduced 70% over untreated concrete tested to Taywood / Valenta method (BS EN 12390-8 modified to <1 MPa><<150 psi>> for 96 hours.

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3. No leakage from samples tested to USACE CRD C48 at 200 psi (460-feet of head) for 14 days.
4. Permeability reduced 97% tested to USACE CRD C48 at 200 psi (460 feet of head) for 14 days.
- B. **Compressive Strength:** Treated concrete must have compressive strength equal or higher than plain concrete when tested to ASTM C39/C39M at 28 days.
- C. **Drying Shrinkage:** Minimum 20% reduced drying shrinkage for treated concrete tested to ASTM C157.
- D. **Self-Sealing:** Autogenous crack sealing of treated concrete for cracks with width of <0.5mm><<0.02 inches>> or greater; verified by independent testing.
- E. **ASR Protection:** Reduce ASR kinetics and reduced ASR damage due to microcrack sealing, verified by independent testing.
- F. **Chemical Resistance:** The waterproofing admixture shall improve sulphuric acid resistance of cement-based materials by blocking capillary pores to reduce acid penetration.
- G. Corrosion of Reinforcing Steel:
 1. Field Performance - The admixture must provide enhanced corrosion resistance to embedded steel such that low half-cell readings and no noticeable signs of corrosion are evident after 10 years exposure directly in the corrosive marine tidal zone; untreated panels show evidence of corrosion.
 2. Testing following ASTM G109 and ASTM C876, and assessed using half-cell measurements, macro cell corrosion rate, and linear polarization resistance (LPR) after exposure to severe corrosive conditions, must demonstrate that the waterproofing admixture significantly delays the onset of corrosive conditions and reduces corrosion rates.
- H. Evidence of Crystallization:
 1. Manufacturer must present independent evidence of waterproofing crystals using both optical and scanning electronic microscope (SEM) to verify waterproofing crystals are needle shaped.
 2. Manufacturer must present independent evidence using Energy Dispersive X-Ray Spectroscopy (EDS) that waterproofing crystals are distinct from ettringite crystals.
- I. **Bonding of coatings and finishes** – Manufacturer must present tensile pull-off testing showing that the waterproofing admixture does not reduce the bond strength of subsequent coatings or finishes, with examples of using four different coatings (acrylic coating, rubber coating, epoxy coating, and tile thin-set).

1.5 ADMINISTRATIVE REQUIREMENTS

- A. A meeting shall be held prior to placement of waterproof shotcrete with the Contractor, shotcrete subcontractor [finisher,] concrete supplier and Owner's testing agency and the Consultant.
- B. Review schedule for testing, batching, construction methods, jointing, placement, finishing and curing.

1.6 SUBMITTALS FOR REVIEW

- A. Product Data: Provide technical data on waterproofing admixtures certifying compliance with specified performance requirements, storage and handling recommendations and application instruction method.
- B. Independent Test Reports:
 1. Provide reports certifying compliance of waterproofing admixtures with performance requirements.
 2. Reports shall include dosage rate for admixtures.
- C. Batching Test Reports:
 1. Provide reports from testing; identify admixture dosage rate, air content, plastic and hardened properties, slump and other properties as requested by Consultant.

1.7 SUBMITTALS FOR INFORMATION

- A. Installation Data: Manufacturer's special installation requirements and best practices recommendations.

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B. Qualification Statements:

1. Written notice from shotcrete subcontractor confirming project experience and qualifications of nozzlemen.
2. [Written notice from manufacturer confirming applicator is qualified and approved to install the materials.]
3. Written notice from manufacturer confirming manufacturing and project experience.

1.8 CLOSEOUT SUBMITTALS

- A. Warranty Documents: Manufacturer's warranty documentation executed in the Owner's name.

1.9 QUALITY ASSURANCE

- A. Perform Work in accordance with [ACI 506R][CSA-A23.1/A23.2].
- B. Source Quality Control: Obtain all crystalline integral waterproofing products from a single manufacturer, including jointing and leak repair products.
- C. Product Certifications:
1. NSF/ANSI/CAN Standard 61 certified for use with potable water.
 2. CE and UKCA mark certifying compliance with EN 934-2:2009 A1:2012.
 3. BBA Certified 05/4217.
- D. Shotcrete Subcontractor:
1. Nozzlemen must be ACI certified in category specific to the installation method to be used, including; wet-mix vertical, wet-mix overhead, dry-mix vertical or dry-mix overhead.
 2. Nozzlemen shall be prequalified based on assessment of job-specific mock-up.
- E. Manufacturer:
1. Manufacturer shall have a minimum 25 years' experience in supplying crystalline admixtures.
- F. Admixture Dosage Rate:
1. Dose at the rate recommended by the manufacturer to meet specified performance requirements.
- G. Test Batches:
1. Provide test batches as recommended by the waterproofing admixture manufacturer to determine air content, plastic and hardened properties, and slump.
 2. Include admixture manufacturer's lot number for products used in test mix.
 3. Provide test results to the Consultant.
- H. Testing: The following data must be recorded to comply with the manufacturer's warranty requirements:
1. Slump using CAN/CSA A23.3-5C or ASTM C143.
 2. Air content using CAN/CSA A23.2-4C or ASTM C231.
 3. Temperature of concrete and of ambient air.
 4. Time of batching, testing and placement.
 5. Cylinders: Take compressive test cylinders from each load tested or as per job specifications.

1.10 MOCK-UP

Note to Specifier: Use this article for assessing abilities of shotcrete nozzlemen, for review of construction, coordination of work of several sections, testing, or observation of operation.

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- A. Provide [] m><<[] ft>>] long by [] m><<[] ft>>] wide mock-up area under conditions similar to those which will exist during actual placing.
- B. Locate [where directed by Consultant].
- C. Mock-up will be used to assess the abilities of the shotcrete subcontractor to perform the Work.
- D. Approved mock-up [may] [may not] remain as part of the Work.

1.11 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver packaged waterproofing admixture materials in original undamaged containers, with manufacturer's labels and seals intact.
- B. Store materials in dry environment at a temperature above 7 degrees C (45 degrees F).

1.12 PROJECT CONDITIONS

- A. Structural Design: The concrete structure shall be designed to meet local building codes and in addition shall be designed to minimize and control any occurrence of cracks within the concrete mass. Follow ACI 224R, ACI 301 and ACI 506R regarding the placement of reinforcement and crack control joints.
- B. Weather Conditions:
 - 1. For mixing, transporting and placing shotcrete under conditions of high temperature or low temperature, follow ACI 305R (Hot Weather Concreting) and ACI 306R (Cold Weather Concreting).
 - 2. For flatwork being placed in hot, dry or windy conditions, surface humidity must be maintained by fogging or use of monomolecular film (evaporation retardant).

1.13 WARRANTY

- A. Provide 25-year manufacturer's standard limited product warranty for the waterproofing admixture.

Part 2 Products

2.1 ADMIXTURES

Note to Specifier: KIM is compatible with other concrete admixtures, such as accelerators, air-entrainers and plasticizers. However, care must be taken when using water reducers or plasticizers that may delay the setting time.

- *Type B admixtures (set retarding) and Type D admixtures (water reducing and set retarding) - these should be removed when using KIM unless they are needed due to high ambient temperatures or mass concrete. Accelerating admixtures may be used in cold weather to maintain normal setting times. Field trials are recommended to assess setting performance.*
- *Type A (water reducing) and Type F (water reducing, high range) admixtures are preferred for most conditions. .*

- A. Crystalline Waterproofing Admixture: Permeability-reducing admixture for hydrostatic conditions (PRAH) as defined by ACI 212.3R-10 Chapter 15; Provide as a powdered waterproofing admixture for use in ready-mix concrete.
 - 1. Shape of crystal: Manufacturer must present independent evidence of waterproofing crystals using both optical imaging and scanning electronic microscope (SEM) to verify waterproofing crystals are needle shaped end evidence using Energy Dispersive X-Ray Spectroscopy (EDS) that waterproofing crystals are distinct from ettringite crystals.
 - 2. Certifications:
 - 1. NSF/ANSI/CAN Standard 61 certified for use with potable water.
 - 2. [CE],[BBA],[UKCA] certifying compliance with EN 934-2:2009 A1:2012.
 - 3. BBA 05/4217
 - 3. Product: Krystol Internal Membrane (KIM).

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4. Manufacturer - Basis of Design:
 1. Kryton International Inc.
Toll Free: 1.800.267.8280
E-mail: info@kryton.com
Website: www.kryton.com

B. Substitutions: Not permitted.

2.2 ACCESSORIES

- A. Joints and Penetrations: Admixture manufacturer's recommended products for waterproofing construction joints, control joints and penetrations.
 1. Acceptable Products: Krytol Waterstop System
- B. Repair Products: Admixture manufacturer's recommended products for leaking and defective concrete.
 1. Acceptable Products: Krytol Leak Repair System.

Part 3 Execution

3.1 EXAMINATION

- A. Verify the joints are treated according to the requirements of the waterproofing manufacturer's instructions prior to placing shotcrete.
- B. Verify that existing concrete surfaces, lift breaks and unintended cold joints are treated according to the requirements of the waterproofing manufacturer's instructions.

3.2 PREPARATION

- A. Coordinate the placement of joint devices with erection of concrete formwork and form accessories.
- B. Verify that formwork, reinforcing steel and embedded items are braced to avoid vibration, resist rebound and designed to allow compressed air to escape.
- C. Verify that earth, rock, concrete and masonry surfaces are prepared in accordance with ACI 506.2.
- D. Verify that surfaces to be shot are dampened to a saturated-surface-dry (SSD) condition immediately prior to shotcrete application.
- E. Verify that groundwater leaking through shoring will not interfere with shotcrete placement. Plug or redirect groundwater as necessary.

3.3 APPLICATION

- A. Apply crystalline waterproofing admixture to concrete mix at ready-mix plant in accordance with manufacturer's written instructions and approved test batches.
 1. Batching and mixing of materials shall be in accordance with ASTM C94/C94M
 2. Mix at least 5 minutes after the addition of crystalline waterproofing admixture.
- B. Placing Shotcrete: Refer to Section 03 37 13, supplemented as follows:
 1. Place shotcrete in accordance with [CSA-A23.1/A23.2 and] ACI 506R.
 2. Notify Consultant minimum twenty-four (24) hours prior to commencement of operations.
 3. Ensure reinforcement, [embedded parts] [formed expansion/contraction joints] [inserts] are not disturbed during concrete placement.
 4. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

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5. Place concrete continuously between predetermined expansion, control, and construction joints.
 6. Do not interrupt successive placement; do not permit cold joints to occur.
 7. Cut out defects while the shotcrete is still plastic and reshoot the affected areas. Defects include:
 1. Sloughs, delamination, plastic shrinkage cracks.
 2. Entrapped rebound and overspray
 3. Voids of incomplete consolidation, including shadows behind rebar.
 8. Remove excess water and debris, and rebound and overspray using air lance.
 9. Remove all overspray from exposed reinforcement at construction joints.
- C. Curing: Cure in accordance with Section 03 37 13, supplemented as follows:
1. Wet cure waterproof concrete [to ACI 308.1] using fog mist spray, sprinkler or wet burlap for 5 to 7 days. Alternatively; use curing compound conforming to ASTM C309.

3.4 FIELD QUALITY CONTROL

Note to Specifier: Only include this article if special field inspection services are required.

- A. Provide free access to Work and cooperate with appointed firm.
- B. Submit proposed mix design [of each class of concrete] to [inspection] [testing] firm for review prior to commencement of Work.
- C. Site Tests and Inspections:

Note to Specifier: The following paragraphs describe flood testing of water containment structures. Revise to describe testing for other types of structures as applicable. Consult with manufacturer for specific testing.

1. Perform flood test on completed waterproofing installation before placement of other adjacent construction.
2. Plug or dam drains and fill area with water to a depth of [$<50\text{ mm}><<2\text{ inches}>>$] or to within [$<13\text{ mm}><<1/2\text{ inches}>>$] of top of waterproofing treatment.
3. Let water stand for twenty-four (24) hours.

Note to Specifier: Due to the self-sealing properties of the admixture, leaks that occur may self-seal within a few days or weeks. Consult with manufacturer whenever leaks are discovered for recommended remedial course of action.

- D. If leaks are discovered, verify with admixture manufacturer whether time period for self-sealing properties of the treated concrete has been exceeded. Make repairs as recommended by the admixture manufacturer and repeat test until no leaks are observed.

3.5 PATCHING

- A. Repair leaking cracks or joints having width greater than $<0.5\text{ mm}><<0.02\text{ inch}>>$ in accordance with waterproofing admixture manufacturer's written instructions and as follows:
 1. Chase the length of joints and cracks to a minimum depth of $<40\text{ mm}><<1.5\text{ inch}>>$. Provide rectangular-shaped chase that is deeper than wide.
 2. Use waterproofing admixture manufacturer's recommended water stop plug to stop water leakage.
 3. Use waterproofing admixture manufacturer's recommended repair grout to completely fill the chase flush with adjacent surfaces.

3.6 DEFECTIVE CONCRETE

- A. Repair or replacement of defective concrete will be determined by the Consultant.
- B. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Consultant for each individual area.

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3.7 PROTECTION OF FINISHED WORK

- A. Protect completed waterproof assemblies from damage after application.

3.8 SCHEDULES

Note to Specifier: The following article will assist in preparing a schedule for crystalline waterproofing locations for the project. The following schedule includes are EXAMPLES only. Edit the paragraphs below to create a project specific schedule. Do not repeat statements that may exist on drawings.

- A. Provide crystalline waterproofing in the following locations:
 1. Below grade parking.
 2. Elevator pits, [sump pits].
 3. Tunnels, underground vaults, dry wells and manholes.
 4. Water tanks, flumes, clarifier tanks, digester sections, reservoirs and wet wells.
 5. Planters and swimming pools.

END OF SECTION

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