

CSI SPECIFICATIONS

CRYSTALLINE WATERPROOFING ADMIXTURE FOR SHOTCRETE

Section 03 05 15



Krytol Internal Membrane (KIM) is a chemical admixture in powder form 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.

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 SECTION INCLUDES

- A. Integral crystalline waterproofing admixture for shotcrete.
- B. Crystalline waterproofing compounds for leak repair.

1.3 RELATED SECTIONS

In this article, indicate those sections that inter-rely on this section. The listing below is only partial and should be edited to include those sections specific to the project that describes subjects or products that affect this section directly.

- A. [Section 03 01 30 - Maintenance of Cast-in-Place Concrete: Patching compounds for substrate repair.]
- B. Section 03 37 13 - Shotcrete.
- C. [Section 03 15 16 - Concrete Construction Joints.]

1.4 REFERENCES

Edit this article after editing the rest of this section. Only list reference standards below, that are included within the text of this section, when edited for a project specification - delete other references that do not apply. Comparable Canadian and US are listed for some products.

- A. American Concrete Institute (ACI).
 1. ACI 212.3R-10 - Report on Chemical Admixtures for Concrete; Chapter 15-Permeability-reducing admixtures.
 2. ACI 224R-01 - Control of Cracking in Concrete Structures (Reapproved 2008).
 3. ACI 301-16 - Specifications for Structural Concrete.
 4. ACI 305R-10 - Guide to Hot Weather Concreting.
 5. ACI 306R-10 - Guide to Cold Weather Concreting.

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6. ACI 308.1-11 - Specification for Curing Concrete.
 7. ACI 309R-05 - Guide for Consolidation of Concrete.
 8. ACI 506R-16 - Guide to Shotcrete.
 9. ACI 506.2-13 - Specification for Shotcrete.
- B. American Society of the International Association for Testing and Materials (ASTM).
1. ASTM C39/C39M-16 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 2. ASTM C94/C94M – Standard Specification for Ready Mix Concrete.
 3. ASTM C143/C143M-15a - Standard Test Method for Slump of Hydraulic-Cement Concrete.
 4. ASTM C157/C157M-08(2014) - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 5. ASTM C231/C231M-14 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 6. ASTM C309-11 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 7. ASTM C494/C494M-15a - Standard Specification for Chemical Admixtures for Concrete.
- C. British Board of Agrément (BBA).
- D. British Standard Institution.
1. BS EN 206-1:2000 - Concrete. Specification, Performance, Production and Conformity.
 2. BS EN 480-12:1998 - Admixtures for Concrete, Mortar and Grout. Test Methods. Determination of the Alkali Content of Admixtures.
 3. BS EN 934-2:2009+A1:2012 - Admixtures for concrete, mortar and grout. Concrete admixtures. Definitions, requirements, conformity, marking and labelling.
 4. BS 8500-2:2006 - Concrete – Complementary British Standard to BS EN 206 Part 2: Specification for constituent materials and concrete.
 5. BS EN 12390-8:2009 - Testing Hardened Concrete: Depth of Penetration of Water Under Pressure.
- E. Canadian Standards Association (CSA).
1. CSA A23.1-09/A23.2-09 (R2014) - Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 2. CAN/CSA A23.3-04 (R2010) - Design of Concrete Structures.
 3. CAN/CSA A266.2-M78 - Chemical Admixtures for Concrete.
- F. German Institute for Standardization (DIN).
1. DIN 1048 Part 5, Testing Concrete: Testing of Hardened Concrete Water Permeability.
- G. NSF International.
1. NSF/ANSI Standard 61 - Drinking Water System Components, Health Effects.
- H. U.S. Army Corps of Engineers (USACE).
1. CRD C48-92 – Standard Test Method for Water Permeability of Concrete.

1.5 PERFORMANCE REQUIREMENTS

- A. Permeability:

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1. When tested to BS EN 12390-8 or DIN 1048-5 at <0.5 MPa><<72.5 psi>> for 72 hours, permeability of treated concrete will be reduced by 70% over untreated concrete.
 2. When using the Taywood / Valenta method of testing to modified BS EN 12390-8 at <1 MPa><<150 psi>> for 96 hours and then measuring and calculating the coefficient of permeability, the permeability of treated concrete will be reduced by a minimum of 70% over untreated concrete.
 3. When tested to USACE CRD C48, no passage of water through treated samples when exposed to a vertical water head equal to 200 psi (460 foot head pressure) 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 when 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. Chemical Resistance: The waterproofing admixture shall improve sulphuric acid resistance of cement-based materials by blocking capillary pores to reduce acid penetration.
- F. Corrosion of Reinforcing Steel: The waterproofing admixture shall provide enhanced corrosion resistance to embedded steel such that no noticeable signs of corrosion shall be evident after 10 years exposure to corrosive environment.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Section [01 31 00]: Project management and coordination procedures.
- B. Pre-Installation Conference:
1. A meeting shall be held prior to placement of waterproof shotcrete with the Contractor, [forming contractor,] shotcrete subcontractor, [finisher,] concrete supplier and Owner's testing agency and the Consultant in attendance.
 2. Review schedule, testing requirements, batching, construction methods, jointing, and placement, finishing and curing.

1.7 SUBMITTALS FOR REVIEW

- A. Section [01 33 00]: Submission procedures.
- B. Product Data: Provide technical data on waterproofing admixtures certifying compliance with specified performance requirements, storage and handling recommendations and application instruction method.
- C. Independent Test Reports:
1. Provide reports certifying compliance of waterproofing admixtures with specified performance requirements.
 2. Reports shall include dosage rate for admixtures.
- D. 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.

1.8 SUBMITTALS FOR INFORMATION

The following submittals are for information only.

- A. Section [01 33 00]: Submission procedures.

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- B. Installation Data: Manufacturer's special installation requirements and best practices recommendations.
- C. Qualification Statements:
 - 1. Written notice from shotcrete subcontractor confirming project experience and qualifications of nozzle men.
 - 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.

1.9 CLOSEOUT SUBMITTALS

The following submittals are for project close-out purposes.

- A. Section [01 78 10]: Submission procedures.
- B. Warranty Documents: Manufacturer's warranty documentation for specified coverage executed in the Owner's name.

1.10 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. Conform to [ACI 305R] [CSA-A23.1/A23.2] when concreting during hot weather.
- D. Conform to [ACI 306R] [CSA-A23.1/A23.2] when concreting during cold weather.
- E. Product Certifications:
 - 1. NSF/ANSI Standard 61 certified for use with potable water.
 - 2. Product packaging must bear CE mark certifying compliance with EN 934-2:2009 A1:2012.
 - 3. BBA Certified for compliance with EN 934-2:2009 A1:2012.
- F. Shotcrete Subcontractor:
 - 1. Nozzle men 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. Nozzle men shall be prequalified based on assessment of job-specific mock-up.
- G. Manufacturer:
 - 1. The admixture manufacturer shall have a minimum 25 years' experience in supplying crystalline admixtures.
- H. Dosage Rate:
 - 1. Dosage rate for this Project will be the same dosage that is used in the submitted Independent Test Reports to meet specified performance requirements.
- I. 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.
- J. Testing: The following data must be recorded to comply with the manufacturer's warranty requirements:

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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 called for in the job specifications.

1.11 MOCK-UP

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

- A. Section [01 43 00]: Requirements for mock-up.
- B. Provide [\llbracket] m>><[] ft>>] long by [\llbracket] m>><[] ft>>] wide mock-up area under conditions similar to those which will exist during actual placing.
- C. Locate [where directed by Consultant].
- D. Mock-up will be used to assess the abilities of the shotcrete subcontractor's nozzlemen to perform the Work.
- E. Approved mock-up [may] [may not] remain as part of the Work.

1.12 DELIVERY, STORAGE, AND PROTECTION

- A. Section [01 61 00]: Transport, handle, store, and protect products.
- B. Deliver packaged waterproofing admixture materials in original undamaged containers, with manufacturer's labels and seals intact.
- C. Store materials in dry environment at a temperature above 7 degrees C (45 degrees F).

1.13 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-77 (Hot Weather Concreting) and ACI 306R-78 (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).

1.14 WARRANTY

- A. Section [01 78 10]: Warranties.
- B. Provide 25-year manufacturer's standard limited product warranty for the waterproofing admixture.

Part 2 Products

2.1 CONCRETE MATERIALS

- A. Cementitious Materials and Aggregates: Refer to Section 03 37 13.

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2.2 ADMIXTURES

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.

- *KIM admixture, Type B admixtures (set retarding), Type D admixtures (water reducing and set retarding), fly ash and slag may all retard the setting time of concrete. Avoid using all of these materials in the same mix design without first testing for compatibility. Accelerating admixtures may be used in cold weather to help maintain normal setting times.*
- *Type A (water reducing) and Type F (water reducing, high range) admixtures are preferred for slump control when using KIM.*

- 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.

ASTM C494/A494M lists the following types of admixtures: Type A - Water-reducing admixtures; Type B - Retarding admixtures; Type C - Accelerating admixtures; Type D - Water-reducing and retarding admixtures; Type E - Water-reducing and accelerating admixtures; Type F - Water-reducing, high range admixtures; Type G - Water-reducing, high range, and retarding admixtures; Type S - Specific performance admixtures.

ASTM C1017/C1017M lists the following two types of admixtures: Type I - Plasticizing; Type II - Plasticizing and retarding.

1. Type: [WR water reducing admixture to CAN/CSA A266] [Type D water reducing and set retarding admixture to ASTM C494].
 2. Shape of crystal: The shape of the crystal when observed under 30x magnification will be long and needle shaped allowing them to grow deeper and pack more tightly.
 3. Certifications:
 1. NSF/ANSI Standard 61 certified for use with potable water.
 2. [CE][,BBA][,BRANZ] certifying compliance with EN 934-2:2009 A1:2012.
 4. Product: Krystol Internal Membrane (KIM).
 5. 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.

2.3 ACCESSORIES

- A. Joint Devices and Filler Materials: Admixture manufacturer's recommended product for waterproofing construction joints and details.
1. Acceptable Products: Krystol Waterstop System
- B. Leak Repair Products: Admixture manufacturer's recommended products for leaking and defective concrete assemblies.
1. Acceptable Products: Krystol Leak Repair System.

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Part 3 Execution

3.1 EXAMINATION

- A. Section [01 70 00]: Verify existing conditions before starting work.
- B. Verify the joints are treated according to the requirements of the waterproofing manufacturer's instructions.
- C. 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 placement of 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.

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.
 - 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.

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3.4 FIELD QUALITY CONTROL

Only include this article if special field inspection services are required.

- A. Section 01 45 00: Field [inspection] [and testing].
- B. Provide free access to Work and cooperate with appointed firm.
- C. Submit proposed mix design [of each class of concrete] to [inspection] [testing] firm for review prior to commencement of Work.
- D. Site Tests and Inspections:

The following paragraphs describe flood testing of water containment structures. Revise to describe testing for other types of assemblies treated with waterproofing admixtures 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.

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.

- E. 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. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by the Consultant.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Consultant for each individual area.

3.7 PROTECTION OF FINISHED WORK

- A. Section [01 78 40]: Protecting installed work.
- B. Protect completed waterproof assemblies from damage after application.

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3.8 SCHEDULES

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