
KRYSTOL INTERNAL MEMBRANE™ (KIM®) WATERPROOFING SYSTEM

SUBMITTAL PACKAGE



For	Date
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SMART CONCRETE®

Kryton International Inc.
1645 East Kent Avenue, Vancouver, British Columbia, V5P 2S8 Canada
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ABOUT KRYTON

Since inception in 1973, Kryton's guiding vision has been to build a better future. This has resulted in fully integrated concrete waterproofing systems and solutions that drive quality and durability through innovation.

Kryton is driven by our desire to offer the best performing products and systems, and provide the highest level of support. Whether it be through assisting in project design, concrete mix approvals, on-site training or inspection - Kryton's technically focused sales and services teams are there to support you every step of the way.

Only Kryton has proprietary Krystol crystalline technology that has unmatched waterproofing performance and history. When added or applied to concrete, Krystol chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.

Kryton takes the risk out of waterproofing.



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KRYSTOL INTERNAL MEMBRANE™ (KIM®) WATERPROOFING SYSTEM

Kryton's **Krystol Internal Membrane™ (KIM®)** Waterproofing System creates water-tight concrete structures that replace the need for traditional surface applied membranes. It is more reliable, lasts longer and saves time over other waterproofing methods which not only saves time and money during initial construction, but also reduces long term repair and maintenance costs.

The KIM Waterproofing System consists of:

- 1** Krystol Internal Membrane (KIM) is a hydrophilic crystalline admixture that lowers the permeability of concrete. KIM is the original waterproofing admixture and offers the highest performance in permeability reduction and self-sealing. By stopping the transmission of water through concrete, KIM also adds durability and longevity to concrete by protecting it against chemical attack and corrosion of reinforcing steel.
- 2** KIM is the only admixture with proven long term waterproofing performance and is backed by the industry's longest warranty. KIM has been used to waterproof concrete structures in over 70 countries and has undergone more testing and certifications than any other waterproofing product on the market.
- 3** Krystol Waterstop System is used to permanently waterproof concrete construction joints, penetrations, tie-holes and control joints. The Krystol Waterstop System is comprised of Krystol Waterstop Grout, Krystol Waterstop Treatment, Krytonite Swelling Waterstop and Kryton's Crack Inducing Waterstop. These products are used in a variety of ways to waterproof all construction joints and details found in concrete construction.
- 4** Krystol Leak Repair System is used in the repair of leaking cracks, holes and joints found in the concrete that are too large to self-seal. The Krystol Leak Repair System reliably stops high water flow and outperforms injection systems.



CONTENT

1	KRYSTOL INTERNAL MEMBRANE™ (KIM®)	6
	a. Technical Data Sheet	7
	b. Application Instructions (for Site Supervisor)	13
	c. Technical Validation; Independent Testing	
	i. Overview	15
	ii. Permeability	25
	iii. Self-sealing	40
	iv. Shrinkage Cracking	43
	v. Corrosion Resistance	50
	d. Product Warranty	56
2	KRYSTOL WATERSTOP SYSTEM	57
	a. Technical Data Sheets	
	i. Krystol Waterstop Treatment	58
	ii. Krystol Waterstop Grout	60
	iii. Krytonite Swelling Waterstop	62
	iv. Kryton's Crack Inducing Waterstop	58
	b. CAD Drawings / Details	66
	c. Product Warranty.....	70
3	KRYSTOL LEAK REPAIR SYSTEM	71
	a. Technical Data Sheet	72
	b. Application Instructions	76
	c. Product Warranty.....	80
4	KRYSTOL ASSURANCE PROGRAM	82
5	REFERENCES / CASE STUDIES	85



SYSTEM OVERVIEW



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NEW CONSTRUCTION OVERVIEW

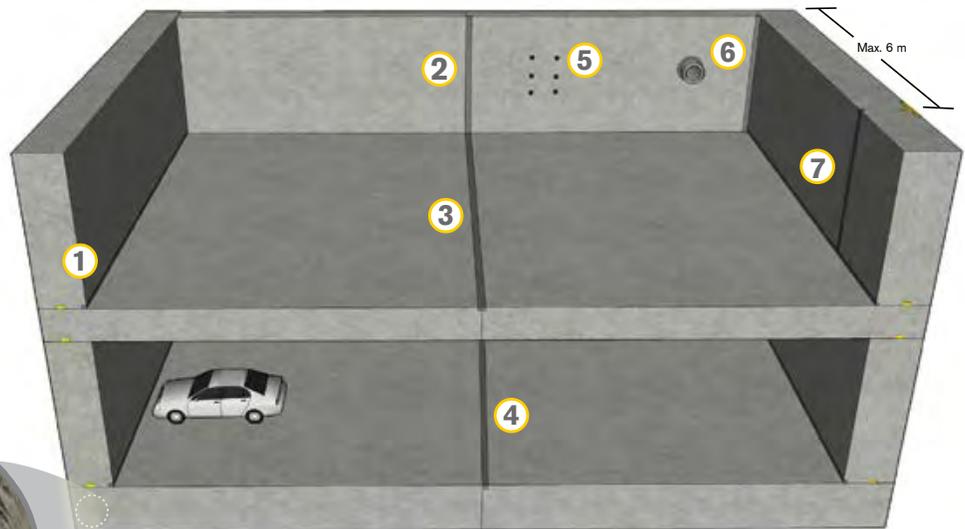
Waterproofing Parking Garages (Cast-in-Place)

Kryton's **Krytol Internal Membrane™ (KIM®)** Waterproofing System covers every construction detail to create watertight concrete structures that replace the need for traditional surface applied membranes. It is more reliable, lasts longer and saves time over other waterproofing systems. This not only saves money during initial construction but also reduces long term repair and maintenance costs.

Krytol Internal Membrane (KIM)

Add to the concrete mix to turn the concrete itself into a permanent waterproofing membrane.

KIM stops water by lowering the permeability of the concrete. Through its unmatched ability to self-seal micro cracks and stop water under the most severe hydrostatic pressure, KIM is the most effective concrete waterproofing solution available.



Krytol® chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.

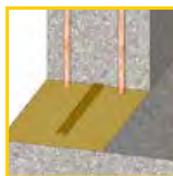
Krytol Waterstop System (KWS)

Use to permanently waterproof every concrete detail including Construction Joints, Penetrations, Tie Holes and Control Joints.

- 1 Wall to slab Construction Joints
- 2 Wall on wall Construction Joints
- 3 Expansion Joints
- 4 Slab to slab Construction Joints
- 5 Cold Joints
- 6 Penetrations
- 7 Control Joints

1 WALL TO SLAB CONSTRUCTION JOINTS

DOUBLE PROTECTION



Internal Swelling Method

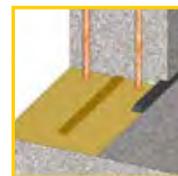


Internal Grout Method



External Grout Method

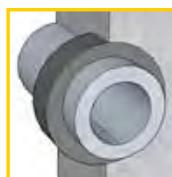
TRIPLE PROTECTION



6 PENETRATIONS



Internal Swelling Method



External Grout Method

7 CONTROL JOINTS



Crack Inducing Waterstop Method



External Grout Method



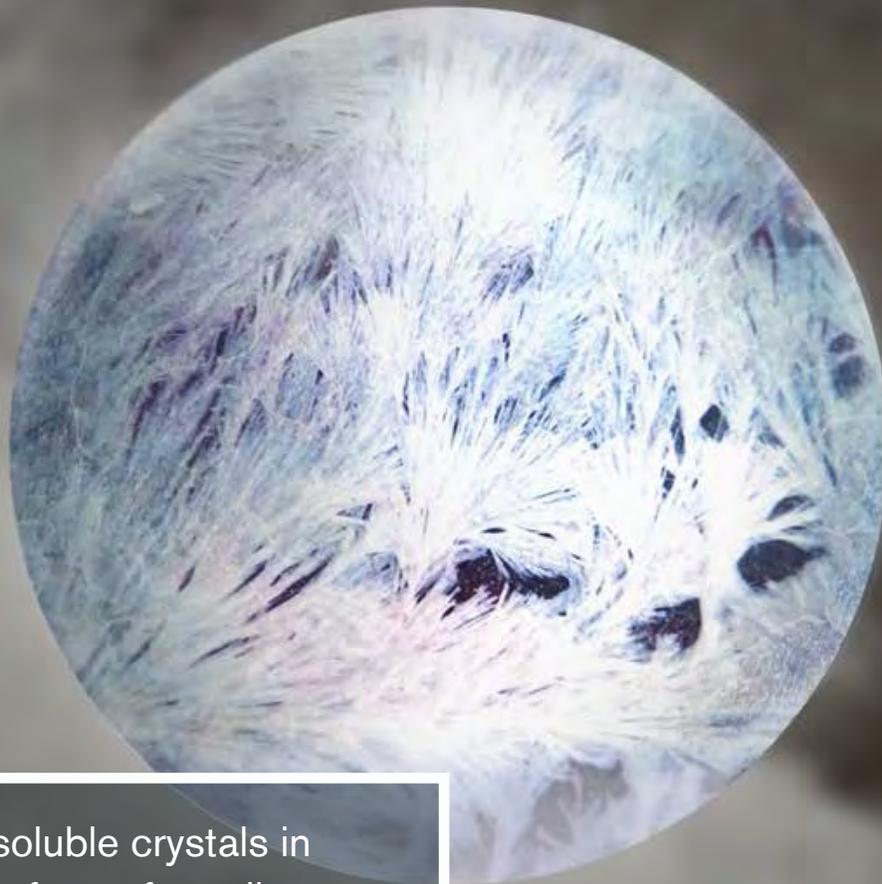
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KRYSTOL INTERNAL MEMBRANE™ (KIM®)



Insoluble crystals in
the form of needles
amplified 30 times



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TECHNICAL DATA SHEET

Concrete Waterproofing & Durability Enhancing Admixture



Krytol Internal Membrane™ (KIM®)

DESCRIPTION

Krytol Internal Membrane (KIM) is a hydrophilic crystalline admixture used to create permanently waterproof concrete.

KIM lowers the permeability of concrete and is used in place of surface applied waterproofing membranes. By stopping the transmission of water through concrete, KIM adds durability and longevity to concrete by protecting it against chemical attack and corrosion of reinforcing steel.

KIM contains Krytol technology. When added to concrete, Krytol chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.



FEATURES & BENEFITS

- KIM is a permeability reducing admixture for hydrostatic conditions (PRAH)
- Replaces unreliable exterior membranes, liners and coatings
- Easily added directly to ready-mix truck or at batch plant
- Self-seals hairline cracks up to 0.5 mm (0.02 in.)
- Effective against hydrostatic pressure up to 140 m (460 ft.) of head
- Impervious to physical damage and deterioration
- Safe for contact with potable water, certified by NSF to NSF/ANSI Standard 61
- Reduces concrete shrinkage and cracking
- Provides excellent resistance to waterborne chemicals such as sulfates, chlorides, and acids
- Compatible with self-compacting concrete (SCC)
- Permanently waterproofs concrete
- Protects concrete and reinforcement from harsh environments
- Increases the durability and lifespan of concrete
- Lowers the cost of waterproofing by up to 40%
- Significant reduction to your construction schedule
- Reduces the cost of maintenance and repairs
- Increases revenues with a larger building footprint
- Essential for blind-wall and shotcrete applications



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RECOMMENDED USES

Use KIM to provide permanent protection for all concrete that will be subject to water pressure, such as:

- Below grade parking structures, basements, elevator pits and foundations of high-rise towers
- Recreational facilities such as aquatic centers, aquariums, zoos, water parks and marinas
- Architectural water features such as fountains and waterfalls
- Water containment reservoirs, water treatment tanks, sewage and manholes
- Traffic tunnels, below grade pipelines and subway tunnels
- Bridges, dams and highway infrastructure
- Concrete homes including basements, foundations, swimming pools, decks, bathrooms, garages and exteriors
- Properly designed roof tops and plaza decks

PROPERTIES

<u>Physical Properties</u>			
Appearance		Light gray powder	
Particle size (μ)		40-150	
Bulk density g/cm ³ (lb./cu. ft)		~ 1.4 (88)	
Specific gravity		~2.8	
Compressive Strength		No change or slight increase	
<u>Plastic Properties</u>	<u>Test Reference</u>	<u>Control Concrete</u>	<u>KIM Concrete (2% wt Cement)</u>
Water/Cement Ratio		0.49	0.47
Slump (mm) - 0 min	BS EN 12350-2	70	65
Slump (mm) - 30 min	BS EN 12350-2	40	45
Plastic Density (kg/m ³)	BS EN 12350-6	2410	2420
Air Content (%)	BS EN 12350-7	1.0	0.9
<u>Hardened Properties</u>			
Coefficient of Water Permeability, Taywood/ Valenta		Reduced 70%	
Drying Shrinkage, BS 1881-5		Reduced 25%	
Freeze/Thaw Expansion, BS 5075-2		Reduced 87%	
Compressive Strength (28 Days), BS EN 12390-3		Increased 8%	
Flexural Strength (28 Days), BS EN 12390-5		Increased 7%	
Modulus of Elasticity, BS 1881-122		Increased 16%	

British Board of Agrément (2005), Certificate No 05/4217

WORKABILITY

ASTM C143 – Standard Test Method for Slump of Hydraulic Cement Concrete

KIM enhances the workability and plastic properties of concrete in many ways. KIM provides plasticizing effects at low and high slump requirements and provides better flow and consolidation even at low slumps. KIM works very well with superplasticizers to achieve high slumps for long pumping distances and unique applications without segregation.

HBT Agra Ltd., 1993



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PERMEABILITY

DIN 1048: Part 5 - Permeability of Hardened Concrete

Concrete specimens containing KIM (@ 2% cementing materials) were cast and aged for 28 days. The specimens were then subjected to hydrostatic pressure of 500 KPa (72.5 psi) for a period of 72 hours. This pressure is equal to 51 m (167 ft.) of water head pressure.

Maximum penetration of less than 3 mm (0.125 in.). The specimens exhibited no leakage or dampness.

Al-Fattaim Tarmac Laboratories, 2002

Concrete specimens containing KIM (@ 2% cementing materials) and a 0.40 water to cement ratio were cast and aged for 28 days. The specimens were then subjected to hydrostatic pressure of 500 KPa (72.5 psi) for a period of 72 hours. This pressure is equal to 51 m (167 ft.) of water head pressure. KIM performed 10x better than the control, allowing only 3.7 mm (0.146 inches) of water to penetrate the sample.

Kuwait University, Civil Engineering Testing Center, 2004

ICBO/ICC Water Percolation Test (Modified ASTM D4068 annex A2)

Concrete specimens containing KIM (@ 2% cementing materials) were cast and aged for 28 days. The specimens were then subjected to hydrostatic pressure imposed by water columns 1.22 m (48 in.) in height. The specimens met the acceptance criteria, which is no water passing through the specimens and maximum 12.5 mm (0.5 in.) of water drop in the columns after 48 hours.

Inspection Concepts California, 1993

CRD C48 - 92 – USACE Standard Test Method for Water Permeability of Concrete

Six concrete specimens containing KIM (@ 2% cementing materials) were cast and aged for 28 days. The specimens were then subjected on one side to hydrostatic pressure of 1.38 MPa (200 psi) for a period of 14 days. This pressure is equal to 140 m (460 ft.) of water head pressure. There was no leakage through any of the specimens.

UBC/Kryton, 2003

A similar test was conducted by AGRA Earth and Environmental in 1995, which compared reference concrete mixes of high strength concrete (50-60 MPa) with and without the addition of KIM. Results of permeability testing show that even for these mixes, KIM achieved 57% and 75% reductions in permeability over the reference mixes.

AGRA Earth & Environmental Ltd., 1995

RAPID CHLORIDE PERMEABILITY

ASTM C1202-97 – Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration & AASHTO T277-89 – Rapid Determination of the Chloride Permeability of Concrete

Commonly referred to as the Rapid Chloride Permeability (RCP) test, the test determines the penetration of chloride-laden water into concrete by measuring the electrical conductance (in coulombs) of the specimens. The RCP test is widely accepted as a test for concrete permeability. Lower values reveal less chloride penetration and thus lower permeability. Concrete specimens containing KIM (@ 2% cementing materials) were tested on separate occasions by The Port Authority of New York & New Jersey and by AMEC Earth and Environmental. Chloride permeability was shown to be reduced by 45% in both tests.

The Port Authority of New York & New Jersey, 1998

AMEC Earth and Environmental, 2000



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CORROSION RESISTANCE

A long-term corrosion study was conducted to evaluate the durability of reinforced concrete specimens containing various pozzolans and chemical admixtures exposed to a marine environment. Test panels were exposed in the tidal zone in Honolulu Harbor for a period of 9-10 years from 2002 to 2012. During exposure, the panels were monitored for half-cell potential, chloride concentrations, cracking and visible signs of corrosion.

Kryton KIM performed well during the field exposure, with low halfcell readings and no visible signs of corrosion after 10 years exposure. This report proves that KIM is effective at preventing corrosion over the long term under real world conditions.

University of Hawaii at Manoa, 2012

SELF SEALING PERFORMANCE

The addition of KIM will result in a considerably higher degree of automatic correction (self-sealing). Without the addition of KIM a crack in the concrete =0.3mm has automatically healed itself after 1200 hours in actual test situations. With the addition of KIM, even a crack width of 0.6 mm is automatically corrected.

The Cement and Concrete Institute, Sweden, 2003

The addition of Krystol Internal Membrane (KIM) indicates an enhancement in the concrete's natural ability to self-seal.

British Columbia Institute of Technology, 2012

SULFATE RESISTANCE

Krytol treated concrete specimens exhibited excellent sulfate resistance when tested in accordance with US Bureau of Reclamation guidelines. Specimens were alternately soaked in sodium sulfate solution and oven dried. The specimens were tested for strength loss and weight change. The Krytol treated specimens dramatically outperformed both the control specimens and the competitor's specimens.

R. M. Hardy and Associates, 1976

The lower permeability of KIM concrete will reduce the ingress of sulfates.

British Board of Agreement (BBA) Agrément certificate No 05/4217, 2005

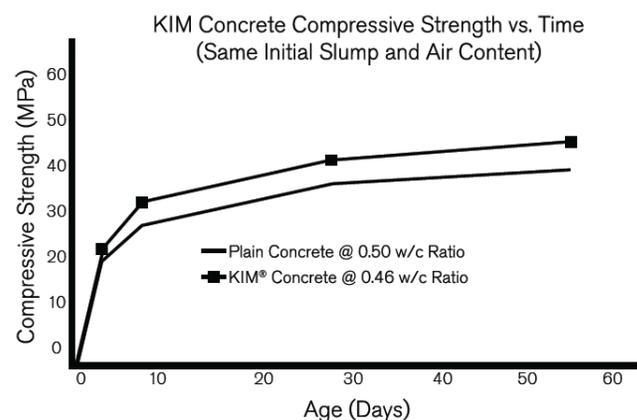
COMPRESSIVE STRENGTH

ASTM C494: Type D, CAN/CSA A266.2-M: Type WR – Chemical Admixtures for Concrete

Concrete specimens containing KIM (@ 2% cementing materials) displayed increases in compressive strength of 12% to 19% at ages 3, 7, 28 and 56 days compared to control specimens of equal slump and air. This exceeds the CAN/CSA A266.2-M requirements for a Type WR water reducing set-retarding admixture.

HBT Agra Ltd., 1993

Note: Do not assume strength increase will occur. Plan for no change to strength



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SHRINKAGE AND CRACK REDUCTION

AS 1012.13-1992 – Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory

Results have clearly shown drying shrinkage reduction and resulting crack reduction in KIM modified concrete. Evaluation of KIM concrete showed a reduction in drying shrinkage of 20-25%.

Materials Testing & Environmental Services of Boral Resources (NSW) Pty. Ltd.

ASTM C341/C341M-06 – Standard Practice for Length Change of Cast, Drilled, or Sawed Specimens of Hydraulic-Cement Mortar and Concrete

Restrained shrinkage cracking in KIM concrete with similar slump, air content and cement content is less than plain concrete by 80%.

AMEC Earth & Environmental Ltd.

ASTM C1579 – 06 Standard – Restraint Shrinkage Cracking Study

The shrinkage cracking test results indicate that Krytol Internal Membrane (KIM) admixtures can reduce plastic shrinkage cracks in younger concrete. Evaluation of KIM concrete demonstrate 53% crack reduction over control.

British Columbia Institute of Technology, 2012

NOTE: Kryton does not recommend eliminating standard shrinkage control joints. Follow ACI guidelines and Kryton's published literature for waterproofing joints

POTABLE WATER CONTAINMENT

NSF/ANSI Standard 61: Drinking Water System Components – Health Effects

KIM has been tested and certified safe for concrete drinking water containment by NSF International.

CHLORIDE ION CONTENT

DIN EN 480-10: Determination of Water Soluble Chloride Content

Concrete specimens containing KIM (@ 2% cementing materials) were tested for water soluble chlorides. KIM contains only negligible levels of chlorides (0.01 % wt/wt) and is therefore not harmful to steel reinforcement.

Kirton Concrete Services Ltd (United Kingdom), 2010

APPLICATION

Read and distribute Application Instruction 1.11 (Instructions for Mix Design & Batch Plant) through 1.22 (Instructions for Shotcrete Inspector) (as applicable) before using this product.

A pre-pour conference with the general contractor, forming contractor, finisher, concrete supplier and materials testing engineer is strongly recommended. Joints should be treated according to Application Instructions 4.11 through 4.31 (as applicable). Consult a Kryton Representative for help with selecting the appropriate joint detail. KIM dosed at 2% of cementing materials by weight, to a maximum dosage of 8 kg/m³ (13.5 lb. /cu. yd.). Dosage may be varied for specific projects in consultation with Kryton's Technical Services Department. Trial batches are required to determine actual plastic properties. Allow KIM to thoroughly mix at medium/high speed for 1 minute per cubic meter/yard in the batch and a minimum of 3 minutes. Place and finish in accordance with ACI guidelines. Proper placement and curing are essential to achieve the performance and benefits of KIM. Cure in accordance with ACI 308.1 guidelines. Tie holes and penetrations should be treated as per Application Instruction 5.31 (Waterproofing Cracks, Holes & Joints) and 5.33 (Waterproofing Pipe Penetrations).



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Concrete Waterproofing & Durability Enhancing Admixture



LIMITATIONS

KIM is an effective waterproofing system for rigid concrete structures only and may not reliably seal cracks and joints that experience variable loading or repeated movement. Consult a Kryton representative for project specific recommendations.

SAFETY

Read the Safety Data Sheet (SDS) for this product. For professional use only. Avoid contact with skin or eyes. Avoid breathing dust. Wear a dust mask, long sleeves, safety goggles and impervious gloves.

PACKAGING

KIM is available in 5 kg (11 lb.) and 25 kg (55 lb.) resealable pails as well as pulpable mixer-ready bags in custom sizes to match your mix design.

SHELF LIFE

When stored in a dry enclosed area, KIM has a shelf life of 5 years for unopened pails and 4 months for properly resealed pails. When packaged in mixer ready bags, KIM has a shelf life of 4 years when kept in the original pallet wrapping and must be used within 4 months of opening the original pallet wrapping.

WARRANTY

Kryton International Inc. (Kryton) warrants that Kryton products are free from manufacturing defects and comply with the specifications given in their respective technical data sheet. Because conditions of use, such as site conditions, surface preparations, workmanship, concrete ingredients, weather, structural issues and other factors are beyond the control of Kryton, no warranty can be given as to the results of use. Purchaser agrees to seek the advice of qualified professionals and to determine for themselves the suitability of the products for their intended purpose and assumes all risks. Purchaser's sole remedy is limited to replacement of any product proven defective or at Kryton's option refund of the purchase price paid. THIS LIMITED WARRANTY CONTAINS THE ENTIRE OBLIGATION OF KRYTON. NO OTHER WARRANTIES, EXPRESS OR IMPLIED, SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. KRYTON SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. No representative of Kryton has the authority to make any representations or provision except as stated herein. Kryton reserves the right to change the properties of its products without notice.



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APPLICATION INSTRUCTION 1.13

Concrete Waterproofing Admixture

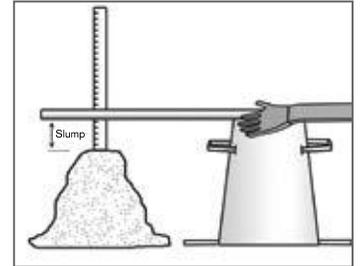
Krytol Internal Membrane™ (KIM®)

Instructions for Site Superintendent

DESCRIPTION

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 to protect against moisture transmission, chemical attack, and corrosion of reinforcing steel.

IMPORTANT: You are making a waterproof membrane out of the concrete. This is different from traditional construction where the concrete just forms the structure. The KIM concrete you are placing will be the only barrier to water penetration. This means that common defects found in typical concrete cannot be tolerated. Poor consolidation, unplanned cold joints, cracks, penetrations, contaminations, etc. will all result in a leaking structure. To avoid leakage and to achieve success, you must follow the critical instructions outlined in this document.



EFFECT ON PLASTIC CONCRETE

KIM admixture has been specially formulated to meet the requirements of projects in different climate conditions as follows:

- KIM-HS: This version of KIM is used for most common applications. KIM-HS is compatible with common admixtures, such as plasticizers, accelerators, retarders and air-entrainers.
- KIM-AE: This version of KIM is specially designed for concrete requiring air-entrainment to resist freezing and thawing cycles. KIM-AE will increase air content by 3-5 %. Adjust or remove any air-entraining admixtures accordingly.
- KIM-ES: This version of KIM is specially designed for use in hot climates and mass concrete. KIM-ES will prolong the slump retention of the concrete and delay the initial setting time. Adjust or remove set retarding admixtures accordingly.

All versions will typically delay the setting times of concrete. Consult your Kryton representative for the most appropriate grade of KIM admixture for your project. Be aware of the differences in air entrainment and retardation between KIM-HS, KIM-AE & KIM-ES.

General influence of KIM admixture on concrete plastic properties at standard laboratory conditions (actual field setting times may be shorter):

Type of KIM	Plastic Properties	
	Initial Setting Time* (hh:mm)	Air Content* (%)
Plain	3:00	1.5
KIM-HS (2% wt/wt cementing material)	4:30	1.6
KIM-AE (2% wt/wt cementing material)	4:00	6.0
KIM-ES (2% wt/wt cementing material)	6:00	1.6

* This table is to be used as a guide only. Actual setting times and air contents depend on mix design, temperature, and the influence of other chemical admixtures. Perform trial batches.

*KIM doses at 2% of cementing materials

1 of 2



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APPLICATION INSTRUCTION 1.13

Concrete Waterproofing Admixture

PRE-POUR SITE MEETING

The Site Superintendent must arrange a meeting that includes himself, a Kryton representative, the concrete supplier and applicable representatives of the forming, placing, finishing, or shotcreting contractors. The meeting needs to be scheduled well in advance of the initial concrete pour in order to communicate any modifications required for a successful concrete project.

Discussion will include the following:

- Delayed setting times of KIM concrete, particularly in cold weather.
- Review of how set delay may affect form pressure or stripping schedules.
- Review of how set delay and air content may affect the slab finishing.
- Importance of controlling water content of the concrete.
- Importance of proper curing procedures.
- Review of KIM Application Instructions 1.11 to 1.14 — Use of KIM Admixture (plus 1.21 and 1.22 – Use of KIM Admixture for shotcrete).
- Review of Application Instructions 4.11 to 4.16 — Use of Krystol® Waterstop System installation at all construction joints.
- Review of spacing and treatment of shrinkage control joints.
- Review of Application Instructions 5.12 to 5.32 — Use of Krystol Leak Repair System for crack repair, tie holes and penetrations.
- Review of Krystol Assurance Program documents (if applicable).

CONSTRUCTION JOINTS & THE KRYSTOL WATERSTOP SYSTEM

- Construction joints should be treated with the Krystol Waterstop System:
 - Cast-in-Place: Application Instruction 4.11 and 4.12 — Use of Krystol Waterstop System. This may require minor modifications to concrete forms.
 - Shotcrete: Application Instructions 4.21 and 4.22 — Use of Krystol Waterstop System.
 - Shrinkage control joints: Application Instruction 4.14 — Waterproofing Horizontal & Vertical Construction Joints.
 - Suspended Slabs: Application Instruction 4.31 — Waterproofing Suspended Slab Joints.
- Tie holes and penetrations should be treated as per Application Instruction 4.17 — Waterproofing Tie Holes and Pipe Penetrations
- Shrinkage control joints should be spaced to ACI requirements. Typical wall sections should have a shrinkage control joint every 6 m (20 ft.) or less.
- Consult a Kryton Representative for help with selecting the appropriate joint detail.

PLACING AND FINISHING

- Proper consolidation of the concrete is essential to achieve the performance and benefits of KIM.
- It is very important that there be no water or debris in forms when pouring a joint that must be watertight.
- Place and finish in accordance with ACI guidelines.
- KIM treated concrete will typically delay the initial and final setting times of the concrete. Adjust your finishing or stripping schedule accordingly. Evaporation retarder may be needed.

CURING AND PROTECTION

- KIM improves the internal cure of concrete. However, KIM is not a replacement for proper curing procedures.
- Proper curing is essential to achieve the performance and benefits of KIM. Cure in accordance with ACI 308.1 guidelines.
- Wet curing the concrete with a fog mist spray, sprinkler or wet burlap for 5 to 7 days is recommended. Protect from rain, excessive wind, and sun.
- Alternatively, use a curing compound conforming to ASTM C309.
- Alert the manufacturer immediately of any concerns.



TECHNICAL REPORTS

TEST REPORTS FOR KEY PROPERTIES

When waterproofing concrete using crystalline technology, key performance properties are critical to understand and testing of these properties helps end users make informed decisions.

Key performance properties for integral waterproof concrete treatments, which are typically supplied as admixtures like **Krytol Internal Membrane™ (KIM®)**:

- 1 Water Permeability:** The reduction of permeability in concrete is a critical performance attribute when integrally waterproofing concrete. The products ability to withstand hydrostatic pressure, which applies pressurized water to a concrete sample for a specified period of time and measures the depth of penetration, provides the closest thing to real world testing. Relevant water permeability tests include: DIN 1048-5/BS EN 12390-8 (72.5 psi for 3 days), Taywood-Valenta (150 psi for 4 days) and USACE C48 (200 psi for 14 days).
- 2 Self-Sealing:** The ability to self-seal minor cracks that occur throughout the concretes lifecycle is a critical performance factor. Without the ability to self-seal, water passes freely through the concrete resulting in leaks, as well as increases corrosion of the reinforcing steel. The capability to self-seal is typically determined by the size of the crack in which water flow stops naturally. Self-sealing typically correlates to the products ability to reduce permeability, and can dramatically reduce the long-term maintenance and repair costs of a concrete structure.
- 3 Shrinkage / Crack Reduction:** Reducing the size and number of cracks in concrete is enormously beneficial to waterproofing performance. Reducing plastic shrinkage cracking minimizes early cracking and minimizes water entering the structure from day 1, which increases life cycle of infrastructure.
- 4 Corrosion:** Corrosion of reinforcing steel used in concrete, is the leading cause of premature deterioration in concrete infrastructure. Durability, and resistance to corrosion, is fundamentally based on the permeability of concrete and is typically measured through Rapid Chloride Penetration testing, in which Coulombs are counted. The better the concrete waterproofing, the greater resistance to corrosion. That said, the most effective way to show resistance to corrosion is through long term evaluation in real world applications.

The following test reports have been compiled from around the world to help make an informed choice on Kryton products. Test reports, along with summaries of these test reports, are available upon request.



SUMMARIZED TEST RESULTS

NAME: BRITISH BOARD OF AGREEMENT (BBA) CERTIFICATION FOR KIM-HS

BY: British Board of Agreement (BBA)

PRODUCTS: **Krytol Internal Membrane™ (KIM®) - HS**

DATE: November 2011

REF #: 247

PROPERTIES: Permeability, Shrinkage / Crack Reduction, Strength

During technical investigations for approval, the British Board of Agreement tested **Krytol Internal Membrane (KIM)**, and its usage in concrete over an untreated concrete sample (control). This portion of the assessment included a testing regimen on a number of plastic properties, as well as water permeability under hydrostatic pressure, drying shrinkage, wetting expansion, freeze/thaw expansion, compressive and flexural strength, modulus of elasticity and water vapor permeability (MVT).

The study's findings yielded the following key points:

- 1** **KIM** reduced water permeability of the concrete by 70% when using Taywood-Valenta method of testing (150 psi for 496 hours).
- 2** **KIM** lowered water vapor permeability in the concrete by 17%.
- 3** **KIM** improved the resistance of concrete to freeze / thaw expansion by 87%. This is a direct correlation to durability.
- 4** **KIM** reduced drying shrinkage by 25%.
- 5** **KIM** increased compressive strength by 9% and flexural strength by 7% over the control.
- 6** Adding **KIM** to the concrete had no detrimental effects on the properties of the concrete



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Agrément Certificate
05/4217
Product Sheet 1

KRYSTOL WATERTIGHT CONCRETE SYSTEM

KRYSTOL INTERNAL MEMBRANE — HS (KIM-HS)

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to Krytol Internal Membrane — HS (KIM-HS), a reactive crystalline admixture for use in concrete mixes to provide watertight concrete suitable for basements, roofs, swimming pools, tunnels, and culverts, without the requirement for additional applied protection.

AGRÉMENT CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.



KEY FACTORS ASSESSED

Resistance to water penetration — concrete containing the product has reduced permeability when compared to the equivalent plain concrete (see sections 5 and 6).

Reinforcement protection — concrete containing the product has enhanced resistance to reinforcement corrosion when compared to the equivalent plain concrete (see section 7).

Mechanical properties — the mechanical properties of concrete are not adversely affected by the incorporation of the product (see section 8).

Durability — concrete containing the product is more durable than the equivalent plain concrete mix due to its reduced permeability (see section 17).

The BBA has awarded this Agrément Certificate to the company named above for the product described herein. The product has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Simon Wroe
Head of Approvals — Materials

Greg Cooper
Chief Executive

Date of Fifth issue: 18 November 2011

Originally certificated on 30 March 2005

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

British Board of Agrément

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Regulations

In the opinion of the BBA, Krystol Internal Membrane — HS (KIM-HS) is not subject to these Regulations:



The Building Regulations 2010 (England and Wales)



The Building (Scotland) Regulations 2004 (as amended)



The Building Regulations (Northern Ireland) 2000 (as amended)

Construction (Design and Management) Regulations 2007

Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections: 2 *Delivery and site handling* (2.1, 2.4 and 2.5) and 21 *Placing* (21.1) of this Certificate.

Additional Information

NHBC Standards 2011

In the opinion of the BBA, the use of Krystol Internal Membrane — HS (KIM-HS), in relation to this Certificate, is not subject to the requirements of these Standards.

Technical Specification

1 Description

1.1 Krystol Internal Membrane — HS (KIM-HS) is a powder admixture, consisting of blended Portland cement and proprietary chemicals. When incorporated in concrete mixes it enhances the water resistance and durability of the concrete.

1.2 The product is manufactured by a blending process. Quality control is exercised over raw materials, during manufacture and on the final product.

2 Delivery and site handling

2.1 The product is supplied on shrink-wrapped pallets in the packaging and weights given in Table 1.

Table 1 Packaging and weights

Packaging type	Weight (kg)	No per pallet	Pallet weight (kg)
Pails	5	96	480
	25	36	900
Bag	5–10	96–192	960

2.2 Each container bears the manufacturer's and product name, batch number, health and safety information and the BBA identification mark incorporating the number of this Certificate.

2.3 The product must be stored in sealed containers in a dry environment and protected from rain or other sources of moisture. The product has a shelf-life of two years, when stored under these conditions.

2.4 The product is classified as 'corrosive' and 'irritant' under *The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP4)/Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation) 2009*.

2.5 When handling, the normal health and safety procedures associated with cementitious materials should be observed.



Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Krystol Internal Membrane — HS (KIM-HS).

Design Considerations

3 Use

3.1 Krystol Internal Membrane — HS (KIM-HS) is satisfactory for use in concrete mixes at an addition rate of 2% by weight of the total cementitious content. It produces watertight concrete suitable for use in basements, roofs, swimming pools, tunnels, and culverts, without the requirement for additional applied protection.

3.2 Concrete containing the product should be designed in accordance with BS EN 206-1 : 2000 and BS 8500-2 : 2006 for use as all normal types, including precast, pre-stressed, post tensioned, ready-mixed, reinforced, slip formed, sprayed and pumped concretes.

3.3 The product is compatible with cement blends containing pulverized-fuel ash, ground granulated blastfurnace slag and silica fume blends as defined in BS EN 197-1 : 2011.

3.4 The use of the product with an air-entraining agent is outside the scope of this Certificate.

3.5 Concrete containing the product is suitable for use in contact with potable water and has been approved by the Drinking Water Inspectorate for this purpose.

4 Practicability of installation

Concrete mixes containing the product can be placed, compacted and cured by operatives with experience of using conventional concreting methods and equipment.

5 Water penetration

Concrete containing the product has greater resistance to water penetration than the equivalent plain concrete.

6 Water vapour permeability

6.1 Concrete containing the product has a lower permeability to water vapour than the equivalent plain concrete.

6.2 Concrete made with a high water/cement ratio can have a water vapour permeability above $3000 \times 10^{-12} \text{ gm(Ns)}^{-1}$. The permeability of concrete is strongly dependent on the exact mix design, and the figures given in the *Technical Investigations* section, Table for *Effects of KIM-HS on the hardened properties of concrete* indicate the levels that can be obtained using the product.

6.3 The appropriate thickness for concrete with a specific permeability to achieve a water vapour resistance of $200 \text{ MN}\cdot\text{s}\cdot\text{g}^{-1}$ or $550 \text{ MN}\cdot\text{s}\cdot\text{g}^{-1(1)}$ (suitable for grade 3 of BS 8102 : 2009) is given by:

For $200 \text{ MN}\cdot\text{s}\cdot\text{g}^{-1}$, $t = 0.2 \times 10^{12} \times p$

For $550 \text{ MN}\cdot\text{s}\cdot\text{g}^{-1}$, $t = 0.55 \times 10^{12} \times p$

where t = concrete thickness in mm and p = water vapour permeability in gm(Ns)^{-1} (from BS 3177 : 1959 test).

(1) This figure may be used where a high resistance to water vapour is required.

7 Reinforcement protection

7.1 The level of alkalinity required to prevent corrosion of the reinforcement ($\text{pH} > 13$) will not be adversely affected by the incorporation of the product into concrete.

7.2 Corrosion of reinforcement is normally caused by the ingress of chloride to the steel or by the reduction in alkalinity of the concrete by the diffusion of carbon dioxide. The reduced permeability of concrete containing the product will slow down diffusion of aggressive agents into the concrete and so confer improved protection against reinforcement corrosion.

8 Mechanical properties

8.1 The compressive strength of concrete containing the product will be higher than the equivalent plain concrete with the same slump.

8.2 The flexural strength of concrete containing the product is similar to the equivalent plain concrete.

8.3 The static modulus of elasticity of concrete containing the product is higher than the equivalent plain concrete.

9 Drying shrinkage and wetting expansion

The drying shrinkage and wetting expansion of concrete containing the product is reduced compared to that of an equivalent plain concrete.



10 Setting characteristics

10.1 The setting time of concrete mixes containing the product will be retarded when compared to an equivalent plain concrete. The amount of retardation will depend on the concrete mix design used and ambient temperature during placing and curing.

10.2 The effect of the product on a specific mix and site conditions should be evaluated through site trials prior to use.

11 Carbonation resistance

Concrete containing the product has a greater resistance to carbon dioxide diffusion than an equivalent plain concrete.

12 Frost resistance

Concrete containing the product has a greater freeze/thaw resistance than equivalent plain concrete.

13 Sulfate resistance

The lower permeability of concrete containing the product will reduce the ingress of sulfates. However, if sulfate-resistant concrete is required the advice of the Certificate holder should be sought.

14 Alkali silica reaction (ASR)

14.1 Concrete mixes containing the product should be designed according to BS EN 206-1 : 2000, Section 5.2.3.4 and BS 8500-2 : 2006, Section 5.2.

14.2 The sodium oxide equivalent of the product when measured in accordance with BS EN 480-12 : 1998 was 7.15% by mass of admixture. This figure should be used when calculating the contribution of the product to the total alkali content of a given concrete mix. In turn, this can be used to assess the susceptibility of that concrete to alkali-silica reaction.

15 Resistance to leaching

Use of the product will reduce the leaching of lime from the hydrated cement in the concrete.

16 Maintenance

For a specific installation, the maintenance regime should be considered to ensure that the required design life of the concrete is achieved.

17 Durability

17.1 Under normal conditions of service, concrete containing the product is more durable than equivalent plain concrete due to its reduced permeability.

17.2 Where exposure to aggressive soil conditions or chemicals is anticipated, a full assessment of the site should be made. In these situations the Certificate holder should be consulted on the suitability of the concrete.

Installation

18 General

18.1 When the product is used in concrete mixes it enhances durability and improves protection against reinforcement corrosion by providing a physical pore-blocking action that protects the resulting concrete structure against water ingress via hydrostatic pressure.

18.2 The use of the product in concrete mixes will produce a concrete with the following enhanced properties relative to a control:

- reduced porosity
- reduced permeability
- increased water resistance
- increased corrosion resistance.

18.3 The product has no known detrimental effect on the properties of the concrete.

18.4 Structures built incorporating Kryton Internal Membrane — HS (KIM-HS) should be designed to the relevant Sections of BS 8007 : 1987, BS 8102 : 2009, BS 8110-1 : 1997, BS EN 1992-1-1 : 2004, BS EN 1992-1-2 : 2004, BS EN 1992-3 : 2006 and their respective UK National Annexes.

18.5 Concrete mixes containing the product are suitable for Type B constructions as defined in BS 8102 : 2009, and can meet the requirements for all grades defined in Table 2 of this Standard. For Grade 3 (where control of water vapour is required), it will be necessary to provide a mix with a sufficiently low vapour permeability in combination with an adequate section thickness (see sections 6.2 and 6.3). The use of suitable ventilation, dehumidification or air-conditioning, appropriate to the intended use, must also be considered.

18.6 Basements for dwellings should be designed in accordance with the guidance given in the Approved Document Basement for dwellings⁽¹⁾.

(1) Published by the British Cement Association, Document No 48.062.



19 Mix design

19.1 Concrete containing the product is normally supplied as ready-mixed concrete but may be prepared on sites where there is adequate mix control. Concrete prepared on site should be carried out in accordance with BS 8000-2.1 : 1990, the Certificate holder's instructions and this Certificate.

19.2 Concrete mixes must have a minimum cement content of 325 kg·m⁻³ and be batched with a maximum water/cement ratio of 0.5. Further details of suitable mixes can be obtained from the Certificate holder or their approved representatives.

19.3 Once mixed, further materials must not be added to the fresh concrete.

19.4 The workability of concrete mixes can be adjusted using a suitable⁽¹⁾ water reducing or superplasticising admixture complying with BS EN 934-2 : 2009, Tables 3.1 and 3.2 to ensure the maximum water/cement ratio given in section 19.2 of this Certificate is not exceeded. Specific admixtures have not been considered and are outside of the scope of this Certificate.

(1) The Certificate holder's advice should be sought regarding the suitability and compatibility of water reducing or superplasticising admixtures. Admixtures should be evaluated before use and site trials should be carried out to establish the appropriate dose required.

20 Site mixing

20.1 The product is added at the correct dose to the mixed wet concrete (see section 3.1).

20.2 When a superplasticiser is required, it should be added after the addition of the product.

20.3 The resulting concrete should be mixed for a further ten minutes to ensure even distribution of the product throughout the concrete.

21 Placing

21.1 Concrete mixes containing the product should be placed in the same way as normal concrete, in accordance with BS 8000-2.2 : 1990, BS EN 13670 : 2009, the Certificate holder's health and safety guidance and the normal routine precautions for handling concrete.

21.2 Concrete mixes containing the product should not be placed at temperatures of 5°C or below.

21.3 Concrete mixes containing the product must be fully compacted.

22 Curing

The concrete should be cured strictly in accordance with BS EN 13670 : 2009, BS EN 1992-1-1 : 2004, its UK National Annex and the Certificate holder's recommendations where site specific information exists.

23 Joints

23.1 Joints should be designed with waterstops as recommended in BS 8102 : 2009, to maintain watertightness of the whole structure. The advice of the Certificate holder should be sought on particular applications.

23.2 Penetrations of the concrete, such as pipe entries or formwork ties, must also be securely sealed to maintain watertightness. The advice of the Certificate holder should be sought on suitable systems.

24 Finishes

When water-based products are used to coat concrete containing the product, a bonding agent may be needed. For specific cases, advice should be sought from the Certificate holder.

Technical Investigations

25 Tests

25.1 Tests were conducted to determine the effect of the product on the properties of concrete mixes designed to BS EN 480-1 : 1998, Reference concrete 1. The results are given in Tables 2 and 3.



Table 2 Effects of KIM-HS on the properties of fresh wet concrete⁽¹⁾

Property	Control concrete	KIM-HS	Test reference
KIM-HS (% wt/wt PC)	–	2.00	
Water/cement ratio	0.49	0.47	
Slump (mm)			BS EN 12350-2
0 min	70	65	
30 min	40	45	
Plastic density (kg·m ⁻³)	2410	2420	BS EN 12350-6
Air content (%)	1.0	0.9	BS EN 12350-7
Setting time (min)			BS 5075-1
initial set	150	200	
final set	250	700	

(1) The specific effect of the product on these properties, for a particular mix and site conditions should be evaluated through site trials prior to use.

Table 3 Effects of KIM-HS on the hardened properties of concrete⁽¹⁾

Property	Control concrete	KIM-HS	Test reference
Water permeability (m·s ⁻¹)	4.29 x 10 ⁻¹⁴	1.28 x 10 ⁻¹⁴	Taywood/Valenta
Drying shrinkage (%)	0.040	0.030	BS 1881-5
Wetting expansion (%)	0.030	0.020	
Freeze/thaw expansion (%)	0.742	0.099	BS 5075-2
Compressive			BS EN 12390-3
24 hours	18.0	13.0	
28 days	54.3	59.0	
Flexural strength (N·mm ⁻²)			BS EN 12390-5
24 hours	2.5	2.0	
28 days	5.5	5.9	
Modulus of elasticity (N·mm ⁻²)			BS 1881-122
28 days	35000	40500	
Water vapour permeability [g·m(N·s) ⁻¹]	561 x 10 ⁻¹²	463 x 10 ⁻¹²	BS 3177

(1) The specific effect of the product on these properties, for a particular mix and site conditions should be evaluated through site trials prior to use.

25.2 Tests were conducted and the results evaluated by the BBA to determine:

- characteristics of the admixture including:
 - conventional dry material content
 - total chlorine
 - IR trace
 - pH
 - water soluble chloride
 - alkali content
 - setting time in cement blended mortars
- fresh concrete
 - setting time
 - slump
 - workability
 - density
 - air content
- hardened concrete
 - compressive strength
 - bond to steel
 - wetting expansion
 - liquid water permeability
 - flexural strength
 - freeze/thaw resistance
 - water vapour permeability
 - efflorescence.
 - modulus of elasticity
 - drying shrinkage

26 Investigations

26.1 The manufacturing process and quality control procedures were evaluated and details were obtained of the quality and composition of the materials used.

26.2 A postal user survey was conducted to investigate the performance of the product in service.



Bibliography

- BS 1881-5 : 1970 *Testing concrete — Methods of testing hardened concrete for other than strength*
BS 1881-122 : 1983 *Testing concrete — Method for determination of water absorption*
BS 3177 : 1959 *Method for determining the permeability to water vapour of flexible sheet materials used for packaging*
BS 5075-1 : 1982 *Concrete admixtures — Specification for accelerating and retarding water reducing admixtures*
BS 5075-2 : 1982 *Concrete admixtures — Specification for air-entraining admixtures*
BS 8000-2.1 : 1990 *Workmanship on building sites — Code of practice for concrete work — Mixing and transporting concrete*
BS 8000-2.2 : 1990 *Workmanship on building sites — Code of practice for concrete work — Sitework with in-situ and precast concrete*
BS 8007 : 1987 *Code of practice for design of concrete structures for retaining aqueous liquids*
BS 8102 : 2009 *Code of practice for protection of below ground structures against water from the ground*
BS 8110-1 : 1997 *Structural use of concrete — Code of practice for design and construction*
BS 8500-2 : 2006 *Concrete — Complementary British Standard to BS EN 206-1 — Specification for constituent materials and concrete*
BS EN 197-1 : 2011 *Cement — Composition, specifications and conformity criteria for common cements*
BS EN 206-1 : 2000 *Concrete — Specification, performance, production and conformity*
BS EN 480-1 : 1998 *Admixtures for concrete, mortar and grout — Test methods — Reference concrete and reference mortar for testing*
BS EN 480-12 : 1998 *Admixtures for concrete, mortar and grout — Test methods — Determination of the alkali content of admixtures*
BS EN 934-2 : 2009 *Admixtures for concrete, mortar and grout — Concrete admixtures — Definitions and requirements, conformity, marking and labelling*
BS EN 12350-2 : 2000 *Testing fresh concrete — Slump-test*
BS EN 12350-6 : 2000 *Testing fresh concrete — Density*
BS EN 12350-7 : 2000 *Testing fresh concrete — Air content — Pressure methods*
BS EN 12390-3 : 2002 *Testing hardened concrete — Compressive strength of test specimens*
BS EN 12390-5 : 2009 *Testing hardened concrete — Flexural strength of test specimens*
BS EN 1992-1-1 : 2004 *Eurocode 2 : Design of concrete structures — General rules and rules for buildings*
NA to BS EN 1992-1-1 : 2004 *UK National Annex to Eurocode 2 : Design of concrete structures — General rules and rules for buildings*
BS EN 1992-1-2 : 2004 *Eurocode 2 : Design of concrete structures — General rules — Structural fire design*
NA to BS EN 1992-1-2 : 2004 *UK National Annex to Eurocode 2 : Design of concrete structures — Structural fire design*
BS EN 1992-3 : 2006 *Eurocode 2 : Design of concrete structures — Liquid retaining and containing structures*
NA to BS EN 1992-3 : 2006 *UK National Annex to Eurocode 2 : Design of concrete structures — Liquid retaining and containing structures*
BS EN 13670 : 2009 *Execution of concrete structures*



Conditions of Certification

27 Conditions

27.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page — no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

27.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

27.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

27.4 The BBA has used due skill, care and diligence in preparing this Certificate, but no warranty is provided.

27.5 In issuing this Certificate, the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- individual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal.

27.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

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SUMMARIZED TEST RESULTS

NAME: UBC – USACE C48

BY: UBC

PRODUCTS: **Krytol Internal Membrane™ (KIM®)**

DATE: December 2003

REF #: 024

PROPERTIES: Permeability Reduction. Hydrostatic Pressure Resistance

Krytol Internal Membrane (KIM) treated concrete was measured over control to evaluate permeability reduction when exposed to extreme hydrostatic pressure. Test method USACE-C48 was used which applied 200 psi (1.38 MPa), or 460 ft (140 m) of hydrostatic pressure to the concrete samples for 14 days or until failure was observed. Failure of a particular sample was determined to be at the time when water is observed flowing from the open end of the sample.

- 1** Concrete treated with **KIM** and cured for only 7 days passed testing and showed no water passing after 14 days.
- 2** Control samples cured for 7 days failed within the first day after only 8-12 hours of exposure.
- 3** Concrete treated with **KIM** and cured for 28 days passed testing and showed no water passing after 14 days exposure.
- 4** Control samples cured for 28 days failed within 2 days of exposure after only 45 hours of exposure.

Testing shows that **Kryton KIM** greatly reduced permeability and had a tremendous effect on the stopping water from passing through the concrete.



REPORT ON THE CONCRETE WATERPROOFING PERFORMANCE
OF
KRYSTOL INTERNAL MEMBRANE (KIM)

US ARMY CORPS OF ENGINEERS Standard Test Method for Permeability of
Concrete (USACE CRD C48-92)

PREPARED FOR:
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CANADA

BY:
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UNIVERSITY of BRITISH COLUMBIA
FACULTY OF ENGINEERING
COOPERATIVE EDUCATION PROGRAM
DECEMBER 2003



1.0 INTRODUCTION

Krytol Internal Membrane (KIM) is a concrete admixture that is designed to reduce the permeability of treated concrete. This testing program was initiated by Kryton to provide additional quantitative evidence in support of existing permeability test results and positive field data. The test goal is to show that KIM is effective at significantly reducing the permeability of concrete.

2.0 TEST METHODOLOGY

The US Army Corps of Engineers CRD C48-92, “*Standard Test Method for Water Permeability of Concrete*” was used to compare KIM-treated concrete samples with untreated control concrete samples. A standard mix design (refer to Appendix I) was used to produce both control concrete and KIM treated concrete. The KIM treated concrete contained KIM, added at 2% w/w cementitious content.

Concrete specimens were cast in cylindrical moulds. After a set period of curing, the specimens were sealed into cylindrical steel sample holders. The sample holders were open at both ends. One open end of the sample was subjected to hydrostatic pressure of 200 psi (1.38 MPa). This is equal to 460 vertical feet (140m) of direct water column. The pressure was maintained for a period of 14 days or until failure was observed. Failure of a particular sample was determined to be at the time when water is observed flowing from the open end of the sample.

3.0 TEST RESULTS

Five series of tests were run. Each series contained three KIM treated samples and three control samples. Three series were performed using samples that had cured for seven days, and two series were performed using samples that had cured for 28 days. Plastic properties can be found in Appendix II.

Time to Failure of Samples Cured for 7 days

Parameter	KIM-treated concrete	Control Concrete
Series One: Average Time to failure (hr)	DNF	8.67
Series Two: Average Time to failure (hr)	DNF	12.75
Series Three: Average Time to failure (hr)	DNF	8.69
Overall Average Time to Failure (hr)	DNF	10.04



Time to Failure of Samples Cured for 28 days

Parameter	KIM-treated concrete	Control Concrete
Series Four: Average Time to failure (hr)	DNF	45.29
Series Five: Average Time to failure (hr)	DNF	44.87
Overall Average Time to Failure (hr)	DNF	45.08

DNF = Did Not Fail

4.0 CONCLUSIONS

On average, the control samples failed in approximately 10 hours for samples cured seven days, and 45 hours for samples cured 28 days. All of the KIM treated samples in every series run did not fail at any time during the test periods of 14 days. There was no leakage through any of the KIM-treated specimens.

Leakage observed in each of the control samples contrasts with the absence of leakage in any of the KIM treated samples and indicates that water permeability of the KIM treated samples has been significantly reduced.



5.0 APPENDICES

Appendix I - Mix Design

Raw Material	KIM treated samples	Control samples
Type 10 Cement	4.18	4.18
14mm Aggregate	13.79	13.79
Concrete Sand	10.28	10.28
Water	1.92	1.92
KIM	0.084	0
AEA (as required in control)	0	As required
water/cement	0.46	0.46

Note: KIM added @ 2% of cementitious in KIM-treated samples

Appendix II - Plastic Properties

Series #	Curing Period (days)	w/c	Slump (mm)		Air Content (%)		Compressive Strength @ 28d (MPa)	
			KIM	Control	KIM	Control	KIM	Control
1	7	0.46	130	60	9.0	6.4	37.2	35.9
2	7	0.46	130	60	9.2	6.4	31.0	31.8
3	7	0.46	60	60	6.6	6.6	31.5	37.3
4	28	0.46	130	60	9.0	6.4	37.2	35.9
5	28	0.46	110	50	8.0	5.6	32.2	31.7



SUMMARIZED TEST RESULTS

NAME: AL FUTTAUM –TESTING ON KIM AND CONTROL CONCRETE

BY: Al Futtain Exava LLC

PRODUCTS: **Krytol Internal Membrane™ (KIM®)**

DATE: August 2010

REF #: 413

PROPERTIES: Permeability, Compressive Strength, Water Absorption, Corrosion

This test report summarizes a tests evaluating KIM treated and control concrete for water permeability using BS EN 12390 Part 8: 2000.

The results of the report indicate KIM treated concrete performed better in the reduction of water penetration depth relative to the untreated (control).

The study's findings yielded the following key points:

- 1** **KIM** treated concrete showed a small, immeasurable amount depth of water penetration (NIL) against hydrostatic water pressure while the control penetration was at a depth of 8.3mm.



Trading, Advising, Assisting,

DEPTH OF PENETRATION OF WATER UNDER PRESSURE

(Page 1 of 1)

Client	Crystalline Water Proofing Trading P.O. Box. 91280, Dubai, U.A.E.	Lab Report No.	WR10-10565
Client's ref.	LTM # 1490710	Request No.	WQ10-06268
Project No.	N.G	Sample No.	W10-008268
Project Name	N.G	Date reported	21.08.2010
Location	N.G	Consultant	N.G
Sample Description	Concrete Cube	Contractor	N.G
Date of sampling	19.07.2010	Source	N.G
Time of sampling	N.G.	Mlx grade	440CC (OPC+30% PFA + 6% MS)
Lot Size	N.G.	Date Received	16.08.2010
Sample prepared by	TG RMC.C	Time Received	13:30 hrs
Unit sample from	Trans Gulf Batching Plant (DXB)	Size of sample	3
Nominal size (mm)	150x150x150	Method of compaction	Hand using comp. bar
Curing condition at lab	BS 1881:Part 111:1983	Date cast	N.G
Method of surface treatment	By Grinding	Date test started	16.08.2010
Surface treatment done by	AFE	Date test finished	19.08.2010
Sampling method	BS 1881 Part 120 : 1983	Sampling report No.	N.G
Curing condition and storage at site	BS 1881:Part 111:1983	Sampled by	TG RMC.C
Test Method	BS EN 12390 Part 8: 2000	Sample brought in by	Client
Test method variation	None	Tested by	RMH

Client Cube No.	7	8	9
Lab Sample No.	W10-006268/07	W10-006268/08	W10-006268/09
Actual test age (days)	28	28	28
Reqd. test age (days)	28	28	28
Direction of application of water pressure with respect to the casting direction	Normal	Normal	Normal
Maximum depth of water penetration (mm)	8	10	7

Remarks: Specimen area subject to water pressure were prepared by AFE prior to testing.

For and on behalf of Al Futtaim Exova (L.L.C)

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- The test results relate only to the samples tested.
- "NOTE: This test is accredited by DAC"

Testing, Advising, Assuring.

DEPTH OF PENETRATION OF WATER UNDER PRESSURE

(Page 1 of 1)

Client	Crystalline Water Proofing Trading P.O. Box. 91280, Dubai, U.A.E.	Lab Report No.	WR10-10589
		Request No.	WQ10-06269
Client's ref.	LTM # 150710 (with KIM)	Sample No.	W10-006269
Project No.	N.G	Date reported	21.08.2010
Project Name	N.G	Consultant	N.G
Location	N.G	Contractor	N.G
Sample Description	Concrete Cube	Source	N.G
Date of sampling	19.07.2010	Mix grade	440CC (OPC+30% PFA + 6% MS, with KIM)
Time of sampling	N.G.	Date Received	16.08.2010
Lot Size	N.G.	Time Received	13:30 hrs
Sample prepared by	TG RMC.C	Size of sample	3
Unit sample from	Trans Gulf Batching Plant (DXB)		
Nominal size (mm)	150x150x150	Method of compaction	Hand using comp. bar
Curing condition at lab	BS 1881:Part 111:1983	Date cast	N.G
Method of surface treatment	By Grinding	Date test started	16.08.2010
Surface treatment done by	AFE	Date test finished	19.08.2010
Sampling method	BS 1881 Part 120 : 1983	Sampling report No.	N.G
Curing condition and storage at site	BS 1881:Part 111:1983	Sampled by	TG RMC.C
Test Method	BS EN 12390 Part 8: 2000	Sample brought in by	Client
Test method variation	None	Tested by	RMH

Client Cube No.	7	8	9
Lab Sample No.	W10-006269/07	W10-006269/08	W10-006269/09
Actual test age (days)	28	28	28
Reqd. test age (days)	28	28	28
Direction of application of water pressure with respect to the casting direction	Normal	Normal	Normal
Maximum depth of water penetration (mm)	Nil	Nil	Nil

Remarks: Specimen area subject to water pressure were prepared by AFE prior to testing.



For and on behalf of Al Futtaim Exova (L.L.C)

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- The test results relate only to the samples tested.
- "NOTE: This test is accredited by DAC"

Company Commercial License No: 546636



SUMMARIZED TEST RESULTS

NAME: KUWAIT UNIVERISTY – DIN 1048 TESTING ON KIM & CONTROL CONCRETE

BY: Civil Engineering Testing Center (CETC), Kuwait University

PRODUCTS: **Krystol Internal Membrane™ (KIM®)**

DATE: December 2003

REF #: 83

PROPERTIES: Permeability

Water permeability of concrete treated with **Krystol Internal Membrane (KIM)** was tested in accordance to the German Standard DIN 1048: Part 5, in which cast samples are aged for 28 days then subjected to 72.5 psi (500 KPA) of pressurized water for a period of three days. Samples are then split and depth of water penetration is measured.

The study's findings yielded the following key points:

- 1** **KIM** treated concrete exhibited a 89.9% reduction in permeability over the same untreated concrete mix design (control) with an average depth of water penetration of 3.7 mm for the KIM treated sample and 36.7 mm for the control.





Civil Engineering Testing Center
College of Engineering & Petroleum
Kuwait University

P.O. Box 5969 Safat, 13060 Kuwait
Tel/ Fax : 4818495

Report: CETC1482/11/2003

Date : 1/12/2003

Page : [1/2]

To : National Industries Co.
From : Civil Engineering Testing Center (CETC)
College of Engineering
Kuwait University

Dear Sir

We here by report the results requested by you according to the following information :

REPORT : CETC1482/11/2003
TEST : Water Permeability
TEST CODE : N. A.
STANDARD : As Enclosed
CLIENT NAME : National Industries Co.
TESTED FOR : National Industries Co.
PROJECT NAME : Trial Mixes
CONTRACT NO. : Trial Mixes
NO OF PAGES : 2

SAMPLES DELIVERED, STATE AND NUMBER:

6 200mm concrete cubes

INFORMATION PROVIDED BY SUPERVISION :

Concrete Mixes: -K300V+KIM
-K300V

Best regards

Eng. Moh'd Rabi Morelly
CETC Manager



Kuwait University, the College of Engineering & Petroleum, and the Civil Engineering Testing Center will not be held liable for any consequent actions based upon the results so obtained in this report. Test results represent the samples submitted for testing only. The CETC assumes that samples supplied by clients are prepared according to the requirements of the relevant technical procedures.



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Tests on Hardened Concrete Cubes

Water Permeability - DIN 1048 (K300V+KIM)

Item	Specimen 1	Specimen 2	Specimen 3
Casting Date	16/10/2003	16/10/2003	16/10/2003
Age (Days)	28	28	28
Water Penetration (mm)	4.0	3.0	4.0
Average	3.7		

Water Permeability - DIN 1048 (K300V)

Item	Specimen 1	Specimen 2	Specimen 3
Casting Date	22/10/2003	22/10/2003	22/10/2003
Age (Days)	28	28	28
Water Penetration (mm)	34.0	39.0	37.0
Average	36.7		



Kuwait University, the College of Engineering & Petroleum, and the Civil Engineering Testing Center will not be held liable for any consequent actions based upon the results so obtained in this report. Test results represent the samples submitted for testing only. The CETC assumes that samples supplied by clients are prepared according to the requirements of the relevant technical procedures.



SULAIBIYAH FACTORYS GROUP
QUALITY CONTROL DEPARTMENT
Trial Test Report

Concrete Grade: K-300 + KIM
Cement Type : V

Trial Date: 01/10/2003

Test Type	Result النتائج	نوع الفحص
Cement Temperature .	68	درجة حرارة الاسمنت العنوية .
Starting Time For Weighting Materials.	08:00	ساعة بدء وزن المواد الاولية.
Time Of Materials Dry Mixing.	08:10	ساعة بدء خلط المواد الاولية ناشفة.
Time Of Adding Water To The Mix.	11:06	ساعة بدء الخلط باضافة الماء.
Concrete Temperature .	32	درجة حرارة الخلطة الابتدائية العنوية .
Mixing Water Temperature.	7	درجة حرارة ماء الخلط العنوية .
Air Temperature.	31	درجة حرارة الجو العنوية .
Mixing Time Limit - min.	2.5	مدة الخلط الابتدائي - دقيقة .
Initial Slump - Cm.	Collapse	مقدار التهدل الابتدائي .
Slump After 15 min.	Collapse	مقدار التهدل بعد 15 دقيقة .
SLump After 30 min.	22	مقدار التهدل بعد 30 دقيقة .
SLump After 45 min.	19	مقدار التهدل بعد 45 دقيقة .
SLump After 1:00 hr.	17	مقدار التهدل بعد 1:00 ساعة .
SLump After 1:15 hr.	12	مقدار التهدل بعد 1:15 ساعة .
SLump After 1:30 hr.	10	مقدار التهدل بعد 1:30 ساعة .
SLump After 1:45 hr.	6	مقدار التهدل بعد 1:45 ساعة .
SLump After 2:00 hr.	-	مقدار التهدل بعد 2:00 ساعة .
Air Entrained %	1.5	محتوى الهواء المحبوس %
Moisture Content In Sand %	5.5	نسبة الرطوبة بالرمل %
Absorption of Sand %	0.5	نسبة امتصاص الرمل %
Absorption of Agg. %	0.5	نسبة امتصاص الصليوخ %
Water/ Cement Ratio - W/C.	0.4	نسبة الماء / الاسمنت .
Admixture/ Cement Ratio.	1.00%	نسبة المادة المضافة / الاسمنت .
Admixture Type .	S.P 2000	نوع المادة المضافة.
Fresh Unit Weight - Kg/m ³ .	2429	كثافة الخرسانة الطرية - كجم / م ³ .
No. Of Cubes Made.	6	عدد المكعبات التي تم عملها .

Materials Of One Cubic Meter 1/ m ³ Mix Design (Kg)	Cement	Sand	3/4"	3/8"	Water	Admix.
		392+8Kim	660	695	460	160

Cubes Test Result	Age 7 Days			Age 28 Days		
		493	517	476	544	528

Remark

With KIM Concrete + Cylinder wt. = 20.700 Kg. (20.700 - 3.5 = 17.200 Kg.) 17.200 + 0.00708 = 2429 Kg.
Add. KIM Only To Wet Mix.

Lab. Tech.

Q.C.Eng

Trial Test Report

Concrete Grade: K-300
Cement Type : V

Trial Date: 01/10/2003

Test Type	Result النتائج	نوع الفحص
Cement Temperature .	55	درجة حرارة الاسمنت المنوية .
Starting Time For Weighting Materials.	14:00	ساعة بدء وزن المواد الاولية.
Time Of Materials Dry Mixing.	14:15	ساعة بدء خلط المواد الاولية ناشفة.
Time Of Adding Water To The Mix.	14:16	ساعة بدء الخلط باضافة الماء.
Concrete Temperature.	35	درجة حرارة الخلطة الابتدائية المنوية .
Mixing Water Temperature.	11	درجة حرارة ماء الخلط المنوية .
Air Temperature .	29	درجة حرارة الجو المنوية .
Mixing Time Limit - min.	2	مدة الخلط الابتدائي - دقيقة .
Initial Slump - cm.	Collapse	مقدار التهدل الابتدائي.
Slump After 15 min.	Collapse	مقدار التهدل بعد 15 دقيقة .
SLump After 30 min.	23	مقدار التهدل بعد 30 دقيقة .
SLump After 45 min.	20	مقدار التهدل بعد 45 دقيقة .
SLump After 1 hr.	17	مقدار التهدل بعد 1:00 ساعة .
SLump After 1:15 hrs.	14	مقدار التهدل بعد 1:15 ساعة .
SLump After 1:30 hrs.	11	مقدار التهدل بعد 1:30 ساعة .
SLump After 1:45 hrs.	9	مقدار التهدل بعد 1:45 ساعة .
SLump After 2:00 hrs.	8	مقدار التهدل بعد 2:00 ساعة .
Air Entrained %	2	محتوى الهواء المحبوس %
Moisture Content In Sand %	5	نسبة الرطوبة بالرمل %
Absorption of Sand %	0.5	نسبة امتصاص الرمل %
Absorption of Agg. %	0.5	نسبة امتصاص الصلبيخ %
Water/ Cement Ratio W/C	0.4	نسبة الماء / الاسمنت .
Admixture/ Cement Ratio.	1.00%	نسبة المادة المضافة / الاسمنت .
Admixture Type.	S.P 2000	نوع المادة المضافة.
Fresh Unit Weight - Kg/m ³	2458	كثافة الخرسانة الطرية - كجم / م ³
No. Of Cubes Made.	6	عدد المكعبات التي تم عملها .

Materials Of One Cubic Meter 1/ m ³ Mix Design (Kg.)	Cement	Sand	3/4"	3/8"	Water	Admix.
		400	660	695	460	160

Cubes Test Result	Age 7 Days			Age 28 Days		
		560	553	535	569	557

Remark Concrete + Cylinder wt. = 20.900 Kg. (20.900 - 3.5 = 17.400 Kg.) 17.400 + 0.00708 = 2458Kg.

Lab. Tech.

Q.C.Eng



BRITISH COLUMBIA
INSTITUTE OF TECHNOLOGY

CIVIL ENGINEERING
3700 WILLINGDON AVENUE
BURNABY, BRITISH COLUMBIA
CANADA V5G 3H2

bcit.ca/civil

Report Summary: Permeability

Date: April 12, 2012

Kryton International Inc.
1645 East Kent Avenue
Vancouver BC
V5P 2S8 Canada

RE: Permeability Testing

Introduction:

Krytol Internal Membrane (KIM) is a concrete admixture that is used to reduce the permeability of concrete. The DIN-1048 Part 5 test was used to compare the permeability of KIM-Treated concrete samples with untreated concrete samples. It was observed from the test results that KIM is effective at reducing the permeability of concrete.

Experiment:

The mix-design used for this study was based on results from a series of trial mixes. Refer to the table below for the final concrete mix design. Three permeability cylinders were cast at BCIT for each batch and cured in plastic bags until the date of testing.

Table 1. Mix Proportions

Ingredient	Quantity [kg/m ³]	
	Untreated	Treated
Cement	325	325
Coarse aggregate	1100	1100
Fine aggregate	850	850
w/c ratio	0.5	0.5
Waterproofing admixture (KIM)	0	6.5

The samples were tested as per DIN1048 – Part 5. In accordance with DIN standards, samples were subjected to 0.5 MPa of hydrostatic pressure for 72hrs. After the testing was completed, the samples



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were split in half and depth of penetration in each sample was measured. The mean value of three samples for each mix was considered as penetration results.

Conclusion:

In this study, it was observed that the control samples had an average penetration of 12.5 cm; in contrast, KIM treated samples had an average penetration of 3.5 cm. These results are based on an average of three specimens. Overall, the KIM-treated concrete exhibited around 70% improvement as compared to the reference specimens.

Dr. Rishi Gupta, P.Eng.
Faculty, Program Coordinator - Department of Civil Engineering
School of Construction and the Environment
British Columbia Institute of Technology
SW3-2084, 3700 Willingdon Ave,
Burnaby, B.C. V5G 3H2
T: (604) 456-1064 F: (604) 436-6113



Date: April 12, 2012

**Kryton International Inc.
1645 East Kent Avenue
Vancouver BC
V5P 2S8 Canada**

RE: Krystol Internal Membrane Evaluation through research projects

BCIT has conducted various technical evaluations of the Krystol Internal Membrane (KIM) when used in concrete over the past 3 years. Studies conducted include the following:

- Evaluation of permeability of KIM modified concrete
- Restrained Shrinkage Cracking Study
- Self-sealing characteristics of KIM Concrete

In these studies it was observed that:

1. KIM is effective in reducing the water permeability of concrete. Reduction in permeability of concrete was observed from permeability tests and SEM study indicated modification of crystal structure in some specimens.
2. Concrete made with KIM was found to have less of a tendency to crack at an early age.
3. Initial studies conducted using the newly developed “self-sealing test” indicated that adding Krystol Internal Membrane (KIM) as an admixture increased self-sealing properties of some specimens.

More information regarding the testing procedures used and test results are detailed in the following report summaries. Other details such as test variability and future scope of work is presented in the detailed student reports submitted to Kryton previously.

Dr. Rishi Gupta, P.Eng.
Faculty, Program Coordinator - Department of Civil Engineering
School of Construction and the Environment
British Columbia Institute of Technology
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T: (604) 456-1064 F: (604) 436-6113



Report Summary: Self-Sealing

Date: April 12, 2012

Kryton International Inc.
1645 East Kent Avenue
Vancouver BC
V5P 2S8 Canada

RE: SELF-SEALING Of KIM CONCRETE

Summary:

The scope of this British Columbia Institute of Technology (BCIT) study was to investigate the effects of Krystol Internal Membrane (KIM) on the self-sealing properties of concrete. A patent pending test method was used to compare and quantify the ability of treated and untreated concrete to self-seal under a constant water head. Preliminary tests indicate that this admixture can improve the self-sealing properties of concrete.

Experiment:

The mix proportions of concrete used in this test program are given in Table 1.

Table 1. Mix Proportions

Ingredient	Quantity [kg/m ³]	
	Untreated	Treated
Portland Cement (CSA Type GU/ASTM Type I)	340	340
Aggregate (with a maximum aggregate size of 10 mm)	1120	1120
Sand (river sand)	820	820
Water (tap water)	190	190
KIM (2% of weight of cementitious materials)	0	6.8

The mixes were cast into 4" x 6" cylinders. The samples were moist-cured and cracked at the optimum age and loading rate. Then the samples with comparable crack sizes were identified and later fitted into jackets developed for this test. During the test, one end of the sample was subjected to a constant pressure head while the other remained at atmospheric pressure. The flow rate of water through the

cracked concrete specimen under constant head was monitored over time. Reduction of flow rate indicates that self-sealing is occurring.

Results:

Figure 1 illustrates the process of completing self-sealing on two series of experiments. First series had an initial flow of approximately 0.4l/min with an average crack size of 0.7mm. The second series had an initial flow of approximately 0.27l/min with an average crack size of 0.6mm. It can be observed that with cracks of comparable sizes, the treated samples containing the crystalline admixture reduced flow at a faster rate when compared to the untreated samples. The flow rate through the treated sample dropped more rapidly than the untreated sample, reducing the time required to achieve complete sealing (Fig. 1).

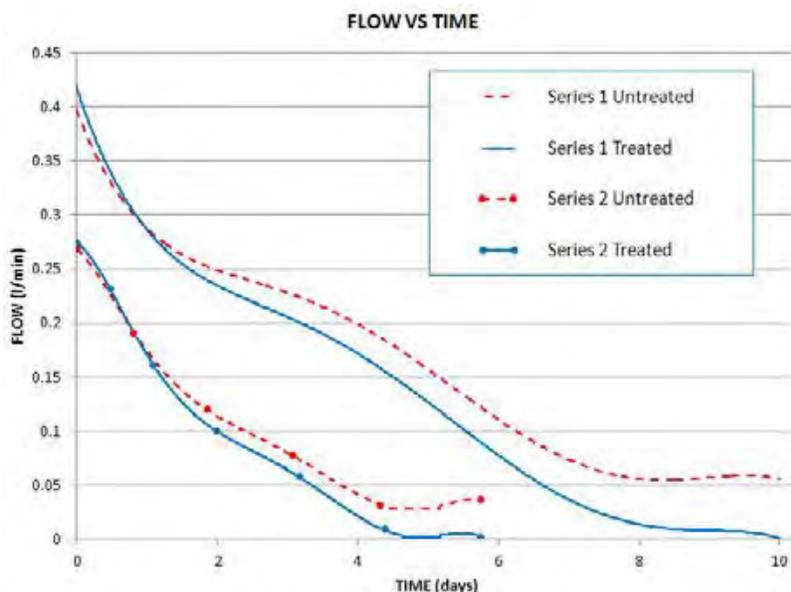


Fig. 1 Flow rate against time for representative samples

Conclusion:

Based on the mix used in this report and the limited number of samples tested, the addition of Krytol Internal Membrane (KIM) indicates an enhancement in the concrete's natural ability to self-seal. This ability of self-sealing could be possibly used in design to allow larger permissible crack width.

Dr. Rishi Gupta, P.Eng.
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Date: April 12, 2012

**Kryton International Inc.
1645 East Kent Avenue
Vancouver BC
V5P 2S8 Canada**

RE: Krytol Internal Membrane Evaluation through research projects

BCIT has conducted various technical evaluations of the Krytol Internal Membrane (KIM) when used in concrete over the past 3 years. Studies conducted include the following:

- Evaluation of permeability of KIM modified concrete
- Restrained Shrinkage Cracking Study
- Self-sealing characteristics of KIM Concrete

In these studies it was observed that:

1. KIM is effective in reducing the water permeability of concrete. Reduction in permeability of concrete was observed from permeability tests and SEM study indicated modification of crystal structure in some specimens.
2. Concrete made with KIM was found to have less of a tendency to crack at an early age.
3. Initial studies conducted using the newly developed “self-sealing test” indicated that adding Krytol Internal Membrane (KIM) as an admixture increased self-sealing properties of some specimens.

More information regarding the testing procedures used and test results are detailed in the following report summaries. Other details such as test variability and future scope of work is presented in the detailed student reports submitted to Kryton previously.

Dr. Rishi Gupta, P.Eng.
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bcit.ca/civil

Report Summary: Shrinkage Cracking

Date: April 12, 2012

Kryton International Inc.
1645 East Kent Avenue
Vancouver BC
V5P 2S8 Canada

RE: Restrained Shrinkage Cracking Study

Summary:

The project objective was to investigate the effects of Krystol Internal Membrane (KIM) on the restrained shrinkage cracking of concrete. Treated samples were compared with untreated concrete specimens as per ASTM C1579 – 06 Standard. Preliminary test results demonstrate that treating concrete with KIM can reduce the chance of cracking at an early age.

Experiment:

The restrained shrinkage test was done in the BCIT environmental chamber from June 29 to 30 2011. The mix proportions are outlined in table 1 below.

Table 1. Mix Proportions Used (kg)

Untreated Mix				
Water	Cement	KIM	14mm Agg.	Sand
10.8	21.6	-	45.36	30.24
KIM Treated Mix				
Water	Cement	KIM	14mm Agg.	Sand
10.8	21.6	.432	45.36	30.24



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In total, four specimens were made for this study, two untreated samples as references and two KIM treated samples. Immediately after batching, the samples were placed in the chamber for a 24-hour period. After 24hrs the samples were removed from the chamber and crack width was measured. Listed below are the results and comparison between the KIM concrete and control mix.

Table 2. Crack widths and Crack Reduction Ratio (CRR)

MIX	Average Crack Width (mm)	CRR over control (%)
Untreated	1.02	–
KIM Treated	0.48	53%

Figure 1 below showcases four comparable samples and their respective cracks.

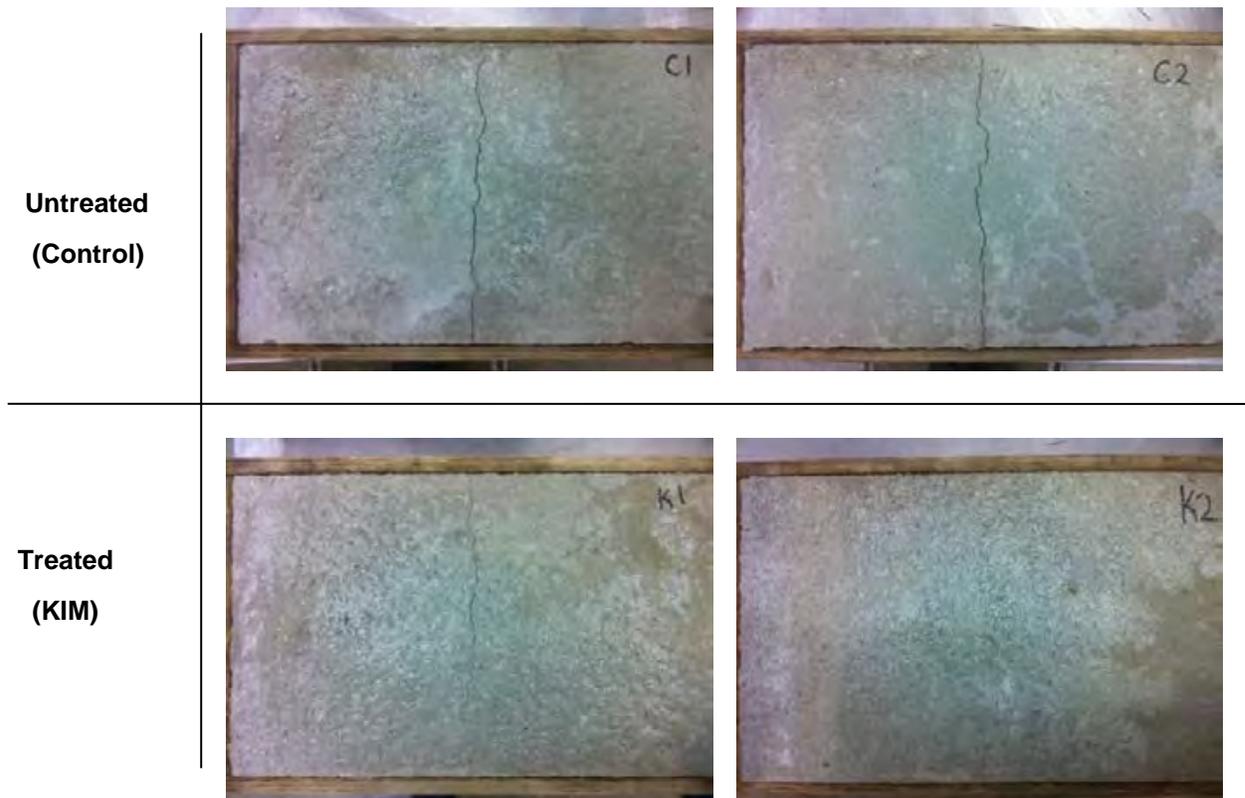


Figure 1. Crack widths of Un-treated (C1 & C2) and Treated (K1 & K2).



Conclusion:

The shrinkage cracking test results indicate that Krytol Internal Membrane (KIM) admixtures can reduce plastic shrinkage cracks in younger concrete.

Dr. Rishi Gupta, P.Eng.
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SUMMARIZED TEST RESULTS

NAME: KIM DRYING SHRINKAGE REPORT

BY: Boral Concrete & Quarries

PRODUCTS: Krystol Internal Membrane™ (KIM®)

DATE: December 1994

REF #: 51

PROPERTIES: Drying Shrinkage

This test report provides results of drying shrinkage measurements of **KIM** treated samples and untreated (control) samples. Both samples were cast, cured and tested in accordance with AS1012.13 and measurements were taken on the 75 mm x 75 mm x 285 mm prisms.

The study's findings yielded the following key points:

- 1** **KIM** had a reduction in drying shrinkage of 20-25% compared to concrete containing water reducing and air entraining admixtures.



BORAL CONCRETE & QUARRIES



WITH
KIM

Materials Testing & Environmental Services
 Boral Resources (NSW) Pty. Ltd.
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 Wentworthville NSW 2145 Australia
 Telephone: (02) 688 9901 Facsimile (02) 688 9813

Registration No: 547

CONCRETE DRYING SHRINKAGE TEST REPORT

CLIENT: Plugge Construction Products FILE NO: 265/94
 PROJECT: Evaluation of Krystol Internal Membrane - K.I.M.
 TEST METHOD: AS1012.13-1992 LAB. SAMPLE NO: 6888

Results of Drying Shrinkage measurements taken on nominal 75 x 75 x 285mm prisms, prepared in this laboratory, are shown below.

Specimen No.	2780	2781	2782	Average
Casting Date	21.12.94			
Starting Date	28.12.94			
Days Drying	DRYING SHRINKAGE (microstrain)			
7	164	176	180	170
14	228	244	236	240
21	280	300	300	290
28	328	352	344	340
56	440	472	464	460

Curing History: Specimens prepared in this laboratory 21.12.94 from 350kg/m³ SL with 1.5% K.I.M. additive. Cast, cured and tested in accordance with AS1012.13.

J. Rogers, I. Dumitru, File 5698. File. Ref: 530.Res

KIM TREATED CONCRETE HAS A 20% - 25%
 REDUCTION IN DRYING SHRINKAGE IN
 COMPARISON TO CONCRETE CONTAINING WATER
 REDUCING AND AIR ENTRAINING ADMIXTURES

Authorised Signatory _____

G. Smorchevsky

Date _____ Serial No. _____



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Registration No: 547

CONCRETE DRYING SHRINKAGE TEST REPORT

CLIENT: Plugge Construction Products FILE NO: 265/94
PROJECT: Evaluation of Krystol Internal Membrane - K.I.M.
TEST METHOD: AS1012.13-1992 LAB. SAMPLE NO: 6889

Results of Drying Shrinkage measurements taken on nominal 75 x 75 x 285mm prisms, prepared in this laboratory, are shown below.

Specimen No.	2810	2811	2812	Average
Casting Date	21.12.94			
Starting Date	28.12.94			
Days Drying	DRYING SHRINKAGE (microstrain)			
7	220	216	220	220
14	312	320	320	320
21	392	400	396	400
28	444	456	456	450
56	556	576	564	570

Curing History: Specimens prepared in this laboratory 21.12.94 from 330kg/m³ SL Control Mix with WR and AEA admixtures. Cast, cured and tested in accordance with AS1012.13.

J. Rogers, I. Dumitru, File 5698, File, Ref: 530.Res

Authorised Signatory _____

G. Smorchevsky

Date _____ Serial No. _____



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SUMMARIZED TEST RESULTS

NAME: PERFORMANCE OF CORROSION INHIBITING ADMIXTURES
IN A MARINE ENVIRONMENT

BY: University of Hawaii

PRODUCTS: **Krytol Internal Membrane™ (KIM®)**

DATE: September 2012

REF #: 425

PROPERTIES: Water Penetration

A long-term corrosion study was conducted to evaluate the durability of reinforced concrete specimens containing various pozzolans and chemical admixture exposed to marine environment. Test panels were exposed in the tidal zone of Honolulu Harbor for a period of 9-10 years from 2002-2012. During exposure, the panels were monitored for half-cell potential, chloride concentrations, cracking and visible signs of corrosion.

The study's findings yielded the following key points:

- 1 "The panel using 2% **KIM** performed well, with low half-cell readings and no visible signs of corrosion after 10 years of exposure."
- 2 Control panels (no admixture or Pozzolan) with a water-cement ratio of 0.40 experienced corrosion-induced cracking and rust residue.

These findings are particularly relevant because they are based on field exposure in a harsh coastal environment. Many products perform well in short term laboratory experiments, but perform poorly over the long term in real world conditions.



**PERFORMANCE OF CORROSION INHIBITING ADMIXTURES
IN HAWAIIAN CONCRETE IN A MARINE ENVIRONMENT**



**FINAL PROJECT REPORT
to
Hawaii Department of Transportation, Harbors Division**

by

**Joshua Ropert, MS
and
Ian N. Robertson, Ph.D., S.E., Professor**

University of Hawaii at Manoa



**UNIVERSITY OF HAWAII
COLLEGE OF ENGINEERING**

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

**Research Report UHM/CEE/12-04
September 30, 2012**



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EXECUTIVE SUMMARY

A long-term field exposure study was conducted to evaluate the durability of reinforced concrete specimens exposed to a marine environment made with Hawaiian aggregates. Twenty five field panels were constructed and placed in the tidal zone at Pier 38 in Honolulu Harbor on the island of Oahu in 2002 and 2003. The panels were removed from Pier 38 in 2012, after 9 to 10 years of exposure. In addition to control specimens, these panels including various corrosion inhibiting admixtures and pozzolans intended to reduce the chloride penetration rates through the concrete and delay the onset of chloride induced corrosion of the reinforcing steel. The panels were monitored for half-cell potential and chloride concentration through the cover concrete at various intervals during field exposure. This report provides an overview of the results of this study, including evaluation of the ability of the computer program Life-365 to predict the chloride penetration rates. Recommendations are provided for design of future concrete exposed to a marine environment in Hawaii and application of Life-365 to life cycle estimation for such concrete. Suggestions are also given for future research needs in this important field of study.

The concrete mixtures used in this study were based on typical mixtures used by the Harbors Division of the Hawaii Department of Transportation. Water-cement ratios range from 0.35 to 0.40. All coarse and fine aggregates were obtained from either Halawa quarry (Hawaiian Cement) or Kapaa quarry (Ameron), both located on the island of Oahu. The corrosion inhibiting admixtures included in the field panel mixtures were Darex Corrosion Inhibitor (DCI), Rheocrete CNI, Rheocrete 222+, FerroGard 901, Xypex Admix C-2000, latex modifier, and Kryton KIM. The pozzolanic admixture materials included fly ash and silica fume.

Observations and Conclusions

Half-cell readings were taken on the top surface of the panels at various intervals during the field exposure. These readings provided an indication of the probability that corrosion had initiated on the reinforcing steel in the panel. Field observations confirmed the presence of surface cracks and rust products on some of the panels after as little as 7 years exposure in the tidal zone.

Table E-1-1 shows the results of analysis of the half cell readings and visual inspection of the field panels. The panel mixture details are listed in columns 2 to 5. Column 6 lists the number of months before the half-cell readings indicated a 50% probability that corrosion had initiated somewhere in the panel, while column 7 lists the months before the half-cell readings indicated a 90% probability that corrosion had initiated. Columns 8 and 9 provide the type of observed damage due to corrosion and the number of months exposure at which the damage was observed, respectively. The cell coloring indicates whether the panel performance was good (green), fair (orange) or poor (red) based on the half-cell and visual inspections.



Table E-1-1: Results of half-cell and visual inspection of field corrosion specimens

Field Panel Details					Field Half-cell		Field Panel Damage	
Field Panel	w/c Ratio	Aggregate Source	Inhibiting Admixture	Admixture Dosage	50% Months	>90% Months	Panel Damage	Months
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	0.4	Kapaa	None	Control	40	40	Crack	84
7	0.35	Kapaa	None	Control	24	62	None	-
2	0.4	Halawa	None	Control	40	40	Cracks and Rust	84
3	0.4	Kapaa	DCI	10l/m ³	-	-	None	-
3A	0.4	Kapaa	DCI	20l/m ³	-	-	None	-
5	0.4	Kapaa	CNI	10l/m ³	24	24	None	-
6	0.4	Kapaa	CNI	10l/m ³	24	46	Rust	80
5A	0.4	Kapaa	CNI	20l/m ³	58	-	None	-
4	0.4	Halawa	CNI	10l/m ³	40	40	Crack and rust	84
15	0.4	Kapaa	Rheocrete	5l/m ³	62	62	Crack and rust	84
16	0.4	Kapaa	Rheocrete	5l/m ³	24	24	None	-
17	0.4	Halawa	Rheocrete	5l/m ³	24	40	Rust	84
17A	0.4	Halawa	Rheocrete	5l/m ³	58	-	None	-
20	0.4	Kapaa	FerroGard	15l/m ³	37	60	Crack and rust	80
18	0.4	Halawa	FerroGard	15l/m ³	40	62	Crack and rust	84
19	0.4	Halawa	FerroGard	15l/m ³	49	62	Rust	84
21	0.4	Kapaa	Xypex	2%	20	37	Crack and rust	84
14	0.4	Kapaa	Latex Mod.	5%	30	38	Crack and rust	74
22	0.4	Kapaa	Kryton Kim	2%	24	-	None	-
8	0.36	Kapaa	Silica Fume	5%	20	-	None	-
9	0.36	Kapaa	Silica Fume	5%	13	52	Crack and rust	74
10	0.36	Kapaa	Silica Fume	5%	64	-	None	-
11	0.36	Kapaa	Fly Ash	15%	20	80	None	-
12	0.36	Halawa	Fly Ash	15%	84	-	None	-
13	0.36	Halawa	Fly Ash	15%	-	-	None	-

Based on the results summarized in Table E-1-1, it was concluded that control mixtures with a lower water-cement ratio (0.35) performed better than those made with higher ratio (0.40) as would be expected. The calcium nitrite based admixtures, DCI and Rheocrete CNI, indicated better corrosion resistance with a higher dosage of 4 gal/yd³ (20 l/m³) compared to mixtures with 2 gal/yd³ (10 l/m³). Panels with 15% cement replaced with fly ash provided consistently good results. Panels with 5% cement replaced with silica fume showed good performance except for one panel where it appeared that poor dispersion of the silica fume during mixing led to pockets of silica fume powder in the final specimen. The panel using 2% Kryton Kim performed well during the field exposure. Panels using the remaining admixtures, Rheocrete 222+, FerroGard 901, Xypex Admix C-2000 and latex modifier exhibited inconsistent to poor results.



Another focus of this study was to compare the chloride concentration results measured in the field panels to those obtained from the computer program Life-365 which is designed to predict chloride concentrations in reinforced concrete. Since Life-365 only provides predictions for certain admixtures, this portion of the study was limited to the control panels and those with DCI, Rheocrete CNI, Rheocrete 222+, fly ash and silica fume.

Modified parameters were needed for all of the predicted chloride concentrations of Life-365 as most of the program default parameters overestimated the concentrations through the depth of the specimen when compared to the field panel results. In order to improve predictions of chloride ingress provided by Life-365, the default parameters used in the program should be replaced with those shown in Table E-2. These proposed parameters were shown to provide much closer agreement with the measured chloride concentrations through the cover concrete, but particularly at the top surface of the steel reinforcement.

Table E-2: Life-365 default and proposed parameters.

Specimen	Life-365 Default Parameters		Proposed Parameters	
	Diffusion Coefficient	Diffusion Decay Index	Diffusion Coefficient	Diffusion Decay Index
	D_{28}	m	D_{28}	m
Control panels with 0.40 w/c ratio	7.94×10^{-12}	0.20	5.50×10^{-12}	0.38
Panels with DCI or CNI and 0.40 w/c ratio	7.94×10^{-12}	0.20	5.50×10^{-12}	0.38
Panels with Rheocrete 222+ and 0.40 w/c ratio	7.94×10^{-12}	0.20	5.50×10^{-12}	0.38
Control panel with 0.35 w/c ratio	6.03×10^{-12}	0.20	6.50×10^{-12}	0.53
Panels with 15% Fly Ash and 0.36 w/c ratio	6.37×10^{-12}	0.32	3.00×10^{-12}	0.35
Panels with 5% silica fume and 0.36 w/c ratio	2.71×10^{-12}	0.20	2.50×10^{-12}	0.30

Recommendations

Design of concrete using Hawaiian aggregates for exposure in a marine or coastal environment should observe the following recommendations based on this study:

1. Use a water to cementitious material ratio as low as possible, but not greater than 0.40.
2. Include fly ash with at least 15% replacement of cement, or silica fume with at least 5% replacement of cement. Mixing must ensure that the fly ash and silica fume, in particular, are well distributed throughout the concrete.
3. Include Darex DCI or Rheocrete CNI at minimum dosages of 4 gal/cuyd (20 l/m^3).
4. As added protection, consider including Kryton Kim at 2% by weight of cement.



Future Research Needs

Based on the results of this and other similar studies of the effect of reinforcing steel corrosion on reinforced concrete exposed to a marine environment, the following future research needs were identified:

1. Perform long-term field exposure studies on concrete mixtures using a combination of corrosion inhibiting measures to observe the combined effect. For example, combining fly ash and effective corrosion inhibitors like DCI, CNI and Kryton Kim to determine how much the combination improves performance compared with each individual admixture and the original control mixture.
2. Consider new corrosion inhibiting admixtures that have become available since initiation of this project, for example Cortec MCI-2000 which is currently being used by HDOT harbors division without local tests to verify its performance with concretes based on Hawaiian aggregates.
3. Longer term field monitoring of successful admixtures. The current study has identified which corrosion inhibiting admixtures appear to work and which do not. However, after 10 years of exposure (on only 5 years of funding), a number of the specimens with fly ash, silica fume, and DCI or CNI, have not started to corrode. Ideally, specimens should be kept in the field exposure until corrosion initiates to determine the true performance of these admixtures.
4. The specimens in this study consisted of uncracked concrete, at least until corrosion initiated cracks. This is unrealistic for most in-place concrete which will crack due to shrinkage, temperature, construction loads, etc. In order to evaluate the successful admixtures for true field conditions, it is necessary to fabricate specimens that simulate the types of cracks most common in field construction. These specimens would then be exposed to the same tidal zone conditions as the original un-cracked specimens to determine whether or not the admixtures can still delay the onset of corrosion.
5. For the current study, all specimens were placed in the tidal zone. This meant there were no panels that were in a coastal environment, but not in the tidal zone, and no specimens that were completely submerged. The tidal zone is known to be the most corrosive environment, hence it was chosen for this study. However, most harbor facilities and coastal structures are predominantly out of the water, or continuously submerged, both of which are less corrosive environments. A better understanding of the performance of the successful admixtures in these environments is also important for future coastal construction. It would be uneconomical to design all harbor and coastal structures assuming the worst case of tidal zone exposure.



LIMITED PRODUCT WARRANTY

Krytol Internal Membrane™ (KIM®)

Limited Warranty Coverage: Subject to the limitations set forth below, the MANUFACTURER warrants to the BUYER that the Krytol Internal Membrane (KIM) product is free from any and all defects of manufacture for a warranty period of **twenty-five (25)** years from the date of purchase. If the KIM product is proven defective during the warranty period, the MANUFACTURER will replace the defective product or supply Kryton products needed to make waterproofing repairs to the affected area or refund the BUYER's purchase price, at MANUFACTURER's option.

Limited Warranty Coverage: This Limited Warranty does not include or cover leakage of the structure resulting from the penetration of water through poorly consolidated concrete, contaminations within the concrete, construction joints, openings, penetrations or open cracks that occur as a result of shrinkage, settling or other movement of the concrete. Further, this Limited Warranty does not include or cover damage or failure caused by fire, explosion, vibration, structural movement, lightning, earthquake, civil disturbance, structural design, or any other cause not the fault of Kryton, nor for damage caused directly or indirectly by the BUYER's negligence or failure to comply with the MANUFACTURER's specifications or requirements, including installation according to the MANUFACTURER's printed instructions. This Limited Warranty does not cover, and MANUFACTURER makes no Warranty with respect to the quality or performance of the concrete or to related materials, such as reinforcement, vapor retarder, drains and vents. This Limited Warranty does not cover claims related to mold or mildew regardless of cause. This Limited Warranty is valid only when the MANUFACTURER has received payment in full for the KIM product covered by this warranty and the amount paid is the value limit of this warranty. This Limited Warranty contains the entire obligation of the MANUFACTURER in connection with the KIM product covered by this warranty.

BUYER's Responsibility: It is expressly acknowledged and agreed that it is the BUYER'S responsibility to independently evaluate and determine the suitability of KIM for the purpose intended and to design and construct the structure in compliance with the product requirements. BUYER agrees to seek the advice of qualified professionals, as appropriate, regarding the evaluation of KIM and any related materials. Under no circumstance will the MANUFACTURER be liable or responsible for any loss or damage caused by BUYER'S determination of usefulness and use of the products in a particular application, project or specification.

Project Description:

Issuing Distributor:

Date:

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Sole Remedy: BUYER agrees to accept the refund or Kryton Products referred to herein as BUYER's exclusive remedy and as the limit of the MANUFACTURER'S liability regardless of BUYER's legal theory, including tort, contract and strict liability, and regardless of whether resulting from or arising out of or in connection with any failure of the KIM product. BUYER must notify MANUFACTURER in writing of any and all proposed repairs to, modification of, or alteration or addition to the structure occurring after the effective date of this Limited Warranty. Any claim shall be waived unless BUYER shall have given MANUFACTURER written notice within fifteen (15) days following occurrence of leakage. Notification shall be by certified or registered mail. Warranty service shall be provided by the distributor.

Indemnification: BUYER agrees, in consideration of MANUFACTURER agreeing to refund the purchase price or supply material to make repairs under this agreement for the period specified, to indemnify and hold harmless MANUFACTURER from any loss, damage or liability resulting from or arising out of any leaks or failures of the **KIM** product.

IN NO EVENT SHALL BUYER BE ENTITLED TO RECOVER INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR DELAY, INCONVENIENCE, LOSS OF USE, LOSS OF PROFITS, COST TO PROCURE SUBSTITUTE GOODS OR SERVICES, OR OTHER COMMERCIAL LOSS.

Governing Law: This Limited Warranty shall be governed and construed in accordance with the laws of the Province of British Columbia, Canada and the parties hereto, on their own behalf and on behalf of their agent's, heirs, successors, permitted assigns, subcontractors, trustees in bankruptcy and successor companies, hereby attorn to the jurisdiction of the Courts of British Columbia. If any part of this document is determined to be unenforceable by a court of competent jurisdiction, it shall be stricken and the remainder shall be retained and enforced.



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KRYSTOL WATERSTOP SYSTEM



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TECHNICAL DATA SHEET

Construction Joints & Details



Krystol Waterstop Treatment™

Product Code: K-321

DESCRIPTION

Krystol Waterstop Treatment is a cementitious crystalline slurry that is applied to horizontal and vertical construction joints to provide additional waterproofing protection, and protect rebar from corrosion.

Krystol Waterstop Treatment is used in conjunction with Krystol Waterstop Grout and/or Krytonite, as part of the Krystol Waterstop System, wherever water penetration through static concrete-to-concrete joints is a concern. Krystol Waterstop Treatment can also be used by itself as a dampproofing treatment.

Krystol Waterstop Treatment contains Krystol technology. When applied to concrete, Krystol chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.



FEATURES & BENEFITS

- Easy to install
- Provides a permanent waterstop treatment as part of the Krystol Waterstop System
- Durable; resistant to rain and foot traffic once hardened
- Safe for contact with potable water; certified to NSF/ANSI Standard 61
- Easy to inspect; distinctive yellow color increases reliability and quality control

RECOMMENDED USES

Krystol Waterstop Treatment is used in conjunction with Krystol Waterstop Grout and/or Krytonite as part of the Krystol Waterstop System at all static concrete-to-concrete joints where water penetration is a concern. Krystol Waterstop Treatment can also be used by itself as a dampproofing treatment.

PROPERTIES

Physical Properties	
Appearance	Buff / Yellow powder
Bulk density	1.2 g/cm ³ (75 lb. /cu. ft.)
pH (when mixed with water)	13
Plastic Properties	
Working time (20°C / 68°F, 50% RH)	35 minutes
Hardening time (20°C / 68°F, 50% RH)	2.5 Hours



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TECHNICAL DATA SHEET

Construction Joints & Details



APPLICATION

Refer to **Krytol Waterstop Application Instruction 4.11 to 4.22 (as applicable)** before using this product. Consult a Kryton Representative for help with selecting the appropriate joint detail.

Mix approximately 3 parts Krytol Waterstop Treatment to 1 part clean water (by volume) to a thick slurry consistency. Apply Treatment at construction joints prior to pouring next subsequent concrete. Protect from rain, rapid drying or freezing for at least 24 hours.

LIMITATIONS

Krytol Waterstop Treatment is effective for rigid structures only and may not reliably seal joints that experience variable loading or repeated movement. Consult a Kryton representative for project specific recommendations.

SAFETY

Read the Safety Data Sheet (SDS) for this product. For professional use only. This product becomes caustic when mixed with water or perspiration. Avoid contact with skin or eyes. Avoid breathing dust. Wear long sleeves, safety goggles and impervious gloves.

PACKAGING

Krytol Waterstop Treatment is available in 5 kg (11 lb.) and 25 kg (55 lb.) resealable pails.

SHELF LIFE

When stored in a dry enclosed area, Krytol Waterstop Treatment has a shelf life of 3 years for unopened pails and 4 months for properly resealed pails.

WARRANTY

Kryton International Inc. (Kryton) warrants that Kryton products are free from manufacturing defects and comply with the specifications given in their respective technical data sheet. Because conditions of use, such as site conditions, surface preparations, workmanship, concrete ingredients, weather, structural issues and other factors are beyond the control of Kryton, no warranty can be given as to the results of use. Purchaser agrees to seek the advice of qualified professionals and to determine for themselves the suitability of the products for their intended purpose and assumes all risks. Purchaser's sole remedy is limited to replacement of any product proven defective or at Kryton's option refund of the purchase price paid. THIS LIMITED WARRANTY CONTAINS THE ENTIRE OBLIGATION OF KRYTON. NO OTHER WARRANTIES, EXPRESS OR IMPLIED, SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. KRYTON SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. No representative of Kryton has the authority to make any representations or provision except as stated herein. Kryton reserves the right to change the properties of its products without notice.



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TECHNICAL DATA SHEET

Construction Joints & Details



SMART CONCRETE®

Krystol Waterstop Grout™

Product Code: K-322X

DESCRIPTION

Krystol Waterstop Grout is a crystalline grout used to create an internal or external waterstop at construction joints, pipe penetrations, tie-holes and control joints.

Krystol Waterstop Grout contains fiber reinforcements that reduce shrinkage and limit cracking. It is typically used in conjunction with Krystol Waterstop Treatment™ as part of the Krystol Waterstop System.

Krystol Waterstop Grout contains Krystol technology. When applied to concrete, Krystol chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.



FEATURES & BENEFITS

- Multi use –internal or external waterstop
- Permanent crystalline waterproofing and protection
- Crack Resistant
- NSF 61 certified; safe for contact with potable water,
- Durable; resistant to rain, foot traffic and shifting
- Allows for flexible scheduling; Concrete can be placed / keyways can be filled days or weeks after installation

RECOMMENDED USES

Use with Krystol Waterstop Treatment as part of the Krystol Waterstop System as either an internal or external waterstop at all static concrete-to-concrete joints, and as an external waterstop at all pipe penetrations, tie holes and control joints where water penetration is a concern.

PROPERTIES

Physical Properties	
Appearance	Gray powder
Bulk density	1.3 g/cm ³ (81lb. /cu. ft.)
pH (when mixed with water)	12
Plastic Properties	
Working time (20°C, 50% RH)	30 minutes
Hardening time (20°C, 50% RH)	1 hour



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TECHNICAL DATA SHEET

Construction Joints & Details



Hardened Properties	
Hydrostatic head pressure resistance	140 m (460 ft.)
Compressive strength (ASTM C109)	24 MPa (3480 psi) @ 24 hrs 30 MPa (4351 psi) @ 7 days 35 MPa (5076 psi) @ 28 days 40 MPa (6700 psi) @ 56 days
Pull off Strength (ASTM C1583)	400 psi

APPLICATION

Refer to Application Instruction: 4.11, 4.12, 4.14, 4.16, 4.17, or 4.21 (as applicable) before using this product.

Consult a Kryton Representative for help with selecting the appropriate joint detail.

Mix approximately 4.5 parts of Krystol Waterstop Grout to 1 part clean water (by volume) to a non sag putty consistency.

Internal Method: Apply the mixed grout to the center of the construction joint using Kryton's triangle shaping trowel. Form a continuous and seamless triangular shaped strip that measures 50 mm (2 in.) wide by at least 30 mm (1.25 in.) high.

External Method: Tightly pack mixed grout to pre formed, clean concrete keyway or tie hole while in a Saturated, Surface Dry (SSD) condition. Protect the grout application from damage by rain, rapid drying or freezing for at least 24 hours.

LIMITATIONS

Krystol Waterstop Grout is effective for rigid structures only and may not reliably seal joints that experience variable loading or repeated movement. Consult a Kryton representative for project specific recommendations.

SAFETY

Read the Safety Data Sheet (SDS) for this product. For professional use only. This product becomes caustic when mixed with water or perspiration. Avoid contact with skin or eyes. Avoid breathing dust. Wear long sleeves, safety goggles and impervious gloves.

PACKAGING

Krystol Waterstop Grout is available in 5 kg (11 lb.) and 25 kg (55 lb.) resealable pails.

SHELF LIFE

When stored in a dry enclosed area, Krystol Waterstop Grout has a shelf life of 3 years for unopened pails and 4 months for properly resealed pails.

WARRANTY

Kryton International Inc. (Kryton) warrants that Kryton products are free from manufacturing defects and comply with the specifications given in their respective technical data sheet. Because conditions of use, such as site conditions, surface preparations, workmanship, concrete ingredients, weather, structural issues and other factors are beyond the control of Kryton, no warranty can be given as to the results of use. Purchaser agrees to seek the advice of qualified professionals and to determine for themselves the suitability of the products for their intended purpose and assumes all risks. Purchaser's sole remedy is limited to replacement of any product proven defective or at Kryton's option refund of the purchase price paid. THIS LIMITED WARRANTY CONTAINS THE ENTIRE OBLIGATION OF KRYTON. NO OTHER WARRANTIES, EXPRESS OR IMPLIED, SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. KRYTON SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. No representative of Kryton has the authority to make any representations or provision except as stated herein. Kryton reserves the right to change the properties of its products without notice.



SMART CONCRETE®

Kryton International Inc.

1645 East Kent Avenue, Vancouver, British Columbia, V5P 2S8 Canada

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TECHNICAL DATA SHEET

Construction Joints & Details



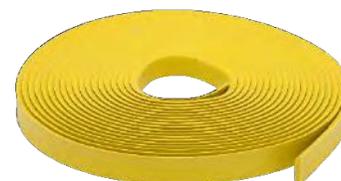
Krytonite™ Swelling Waterstop

Product Code: K-325-Y-5

DESCRIPTION

Krytonite Swelling Waterstop is a synthetic rubber waterstop that uses swelling pressure to seal concrete construction joints and stop water.

Krytonite has superior swelling pressure and performance that stops water better than bentonite and competing swelling waterstops. It is suitable for use with regular ground water as well as salt and sulfate contaminated water. Krytonite is extremely durable and will not deteriorate over time. It can be used by itself as a single protection waterstop, or with other components of the Krystol Waterstop System as a double or triple protection option for construction joints.



FEATURES & BENEFITS

- High-performance swelling – even in contaminated water
- Flexible and easy to install
- Resistant to high hydrostatic pressure
- Extremely durable – will not deteriorate even with repeated wetting and drying cycles
- Innovative trapezoid shape resists dislodgement and allows better concrete consolidation
- Controlled swelling allows for concrete strength development in advance of swelling pressure

RECOMMENDED USES

Use Krytonite Swelling Waterstop to permanently waterproof horizontal or vertical construction joints, pipe penetrations, between precast elements and other concrete joints. Not for use at expansion joints. Suitable for use in sewage and containment structures. May be used in areas with chloride or sulfate contaminated soils and in contact with sea water. Use in conjunction with Krystol Waterstop Treatment or as a replacement for bentonite strips.

PROPERTIES

Physical Properties	
Appearance	Yellow, trapezoid, flexible rubber strip
Dimensions	5 x 20mm (approximately .2" x .8")
Density	1.2 - 1.25 g/cm
Hardness (Shore A)	24 +/- 3
Tensile Strength	>3 MPa
Performance Properties	
Swelling Performance – Clean Water	≥ 1000%
Swelling Performance – Concrete Water (high pH)	≥ 800%
Swelling Performance – Salt Water (3%)	> 300%



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TECHNICAL DATA SHEET

Construction Joints & Details



APPLICATION

Before using this product, refer to Application Instruction 4.11, 4.15 or 4.16 (as applicable).

Basic Application Procedure: Using Krytonite Adhesive, or other approved fastening device, adhere Krytonite Swelling Waterstop at or near the center of the construction joint to clean dry concrete surface. For added long-term protection of the outboard reinforcing steel, apply Krystol Waterstop Treatment to the concrete surface first and adhere Krytonite to the treatment when it is dry. Strip-ends should be tightly butted and not overlapped. Avoid rain or immersion in water as this may cause premature swelling. If premature swelling occurs, dry the Krytonite sufficiently to restore its original dimensions and ensure material is properly affixed to the surface before pouring concrete.

LIMITATIONS

Minimum joint cross section is 200 mm (8 in.). Minimum concrete strength is 27.5 MPa (3000 PSI). Apply in dry conditions and keep dry. Do not place near edge. Leave a minimum of 75 mm (3 in.) of concrete cover.

SAFETY

Read the Safety Data Sheet (SDS) before using this product. For professional use only.

PACKAGING

Krytonite Swelling Waterstop is available in 50 m (164 ft.) per box; 5 rolls @ 10 m (32.8 ft.) Up to 60 boxes per pallet.

SHELF LIFE

When stored in a dry enclosed area, Krytonite Swelling Waterstop has a shelf life of 2 years. Protect the materials from all sources of moisture and frost.

WARRANTY

Kryton International Inc. (Kryton) warrants that Kryton products are free from manufacturing defects and comply with the specifications given in their respective technical data sheet. Because conditions of use, such as site conditions, surface preparations, workmanship, concrete ingredients, weather, structural issues and other factors are beyond the control of Kryton, no warranty can be given as to the results of use. Purchaser agrees to seek the advice of qualified professionals and to determine for themselves the suitability of the products for their intended purpose and assumes all risks. Purchaser's sole remedy is limited to replacement of any product proven defective or at Kryton's option refund of the purchase price paid. THIS LIMITED WARRANTY CONTAINS THE ENTIRE OBLIGATION OF KRYTON. NO OTHER WARRANTIES, EXPRESS OR IMPLIED, SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. KRYTON SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. No representative of Kryton has the authority to make any representations or provision except as stated herein. Kryton reserves the right to change the properties of its products without notice.



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TECHNICAL DATA SHEET

Construction Joints & Details



SMART CONCRETE®

Kryton Crack Inducing Waterstop

Product Code: K-341

DESCRIPTION

Kryton Crack Inducing Waterstop is specially engineered to produce a waterproof crack control joint.

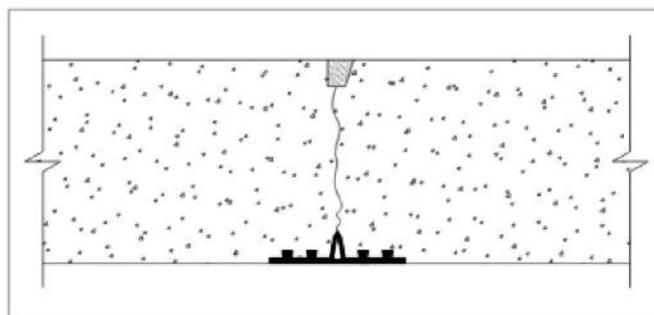
Used as part of the Krystol Waterstop System and in conjunction with Krystol Waterstop Grout, Kryton Crack Inducing Waterstop is resistant to waterborne chemicals and is perfect for blindside applications where access is limited. It is placed in a predetermined location to isolate cracking to a controlled area in order to eliminate water entry through uncontrolled shrinkage cracking.

Kryton Crack Inducing Waterstop is fastened to the concrete form or shoring wall. A keyway is measured and formed directly opposite the waterstop. After the concrete is placed, a controlled crack develops from the Crack Inducing Waterstop through to the keyway. Krystol Waterstop Grout is then tightly packed in the keyway for added protection.



FEATURES & BENEFITS

- Accurate placement of control joints
- Ideal for blind walls
- Easy to form and install
- Extremely durable
- Heat weld-able
- Highest quality PVC



RECOMMENDED USES

Use Kryton Crack Inducing Waterstop to create crack control joints in cast-in-place concrete and shotcrete walls.

PROPERTIES

Color	Bright Yellow
Standard Weight	1.5 kg/m (1.0 lb/ft)
Dimensions	150mm x 40mm (6" wide x 1-5/8")
Water absorption (ASTM D5)	0.15% max.
Tear resistance (ASTM D624)	5.4 kg/mm (300 lb/in) min.
Ultimate elongation (ASTM D638)	350% min.
Tensile strength (ASTM D638)	2000 psi min.
Low temperature brittleness (ASTM D746)	Passes at -35°F / -37°C
Stiffness in flexure (ASTM D747)	700 psi min.



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Construction Joints & Details



APPLICATION

Before using this product, must refer to **Application Instruction 4.14 – Waterproofing Horizontal & Vertical Control Joints.**

Fasten Kryton Crack Inducing Waterstop to the exterior concrete form at the required control joint location. Directly opposite the waterstop, form a 4 cm (1.5 in.) keyway. After concrete has hardened, mix Krystol Waterstop Grout to a dry putty consistency and tightly pack keyway flush to the surface. Protect the Grout application from damage by rain, rapid drying or freezing for at least 24 hours.

LIMITATIONS

Some restrictions with transitions and intersections. Always maintain adequate clearance between reinforcing steel and Kryton's Crack Inducing Waterstop. Any discontinuity in the waterstop system can be a point of leakage.

SAFETY

Kryton Crack Inducing Waterstop is non-reactive and fully cured. For professional use only. Keep out of reach of children.

PACKAGING

Kryton Crack Inducing Waterstop is available in 15.24 m (50 ft.) rolls: 10 rolls per pallet.

SHELF LIFE

Kryton Crack Inducing Waterstop has a shelf life of 2 years when protected from UV light.

WARRANTY

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KRYSTOL WATERSTOP SYSTEM

CAD DRAWINGS

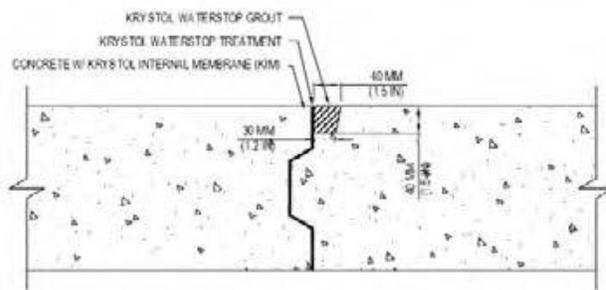
Details shown are to provide an understanding of Construction Joints and Details. Specific CAD Drawings and Application Instructions are available at www.kryton.com.

CONSTRUCTION JOINTS:

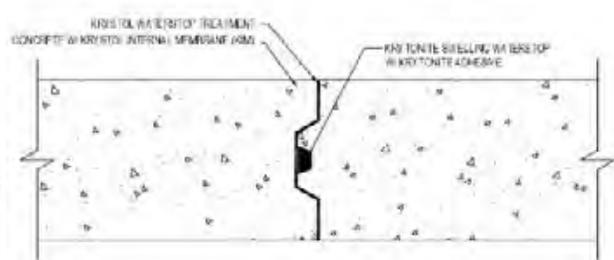
All construction joints (cold joints), in which a joint is created from installing concrete in more than a single pour, will need waterproofing.

Slab to Slab Construction Joints

Double Protection options:

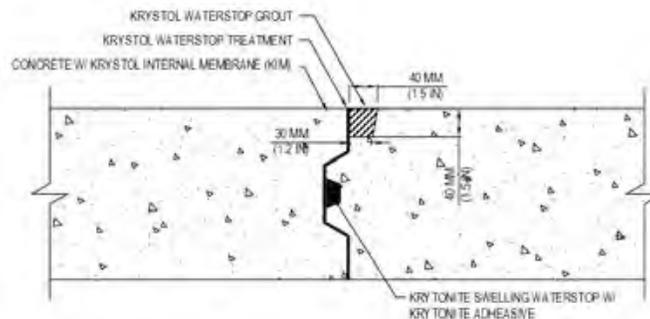


SLAB TO SLAB CONSTRUCTION JOINTS
DUAL PROTECTION EXTERNAL METHOD



SLAB TO SLAB CONSTRUCTION JOINTS
DUAL PROTECTION INTERNAL SWELLING METHOD

Triple Protection (high risk) options:



SLAB TO SLAB CONSTRUCTION JOINTS
TRIPLE PROTECTION



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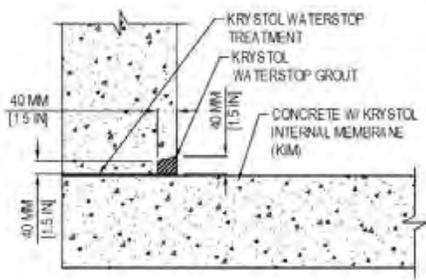
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KRYSTOL WATERSTOP SYSTEM

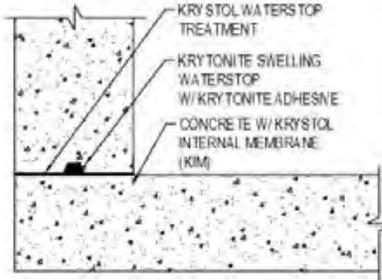
CAD DRAWINGS

Slab to Wall Construction Joints

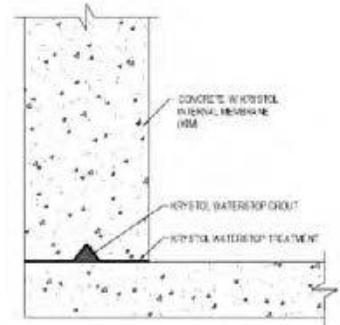
Double Protection options:



WALL TO SLAB CONSTRUCTION JOINTS
DUAL PROTECTION, INTERNAL SWELLING METHOD

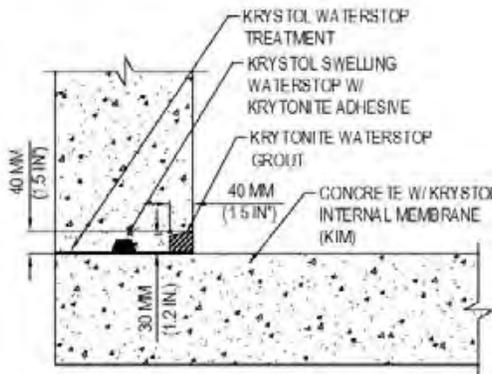


WALL TO SLAB CONSTRUCTION JOINTS
DUAL PROTECTION, EXTERNAL GROUT METHOD



WALL TO SLAB CONSTRUCTION JOINTS
DUAL PROTECTION, INTERNAL GROUT METHOD

Triple Protection (high risk) options:



WALL TO SLAB CONSTRUCTION JOINTS
TRIPLE PROTECTION



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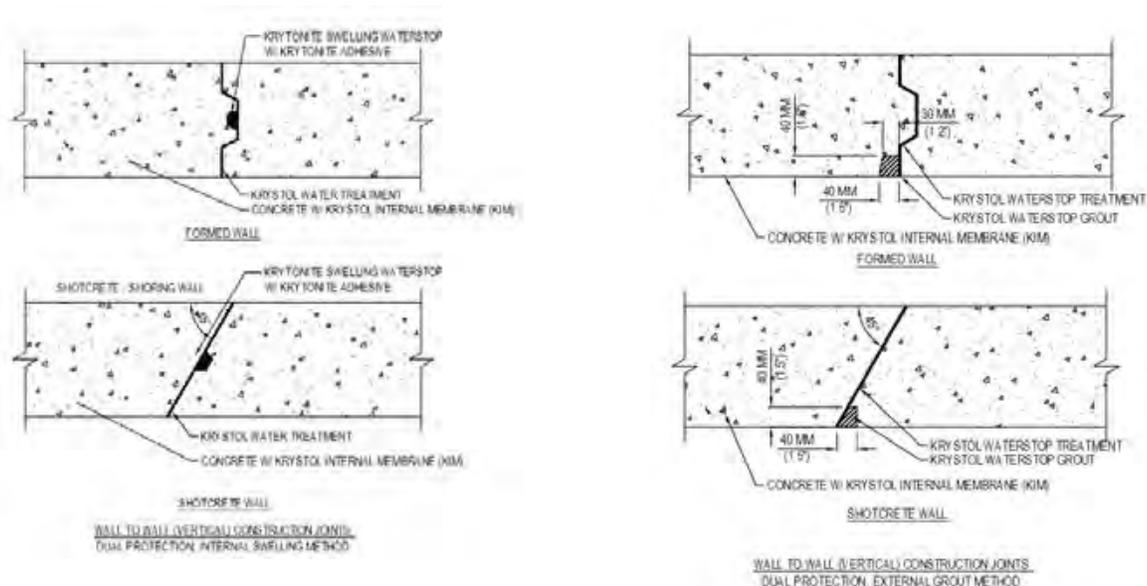
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KRYSTOL WATERSTOP SYSTEM

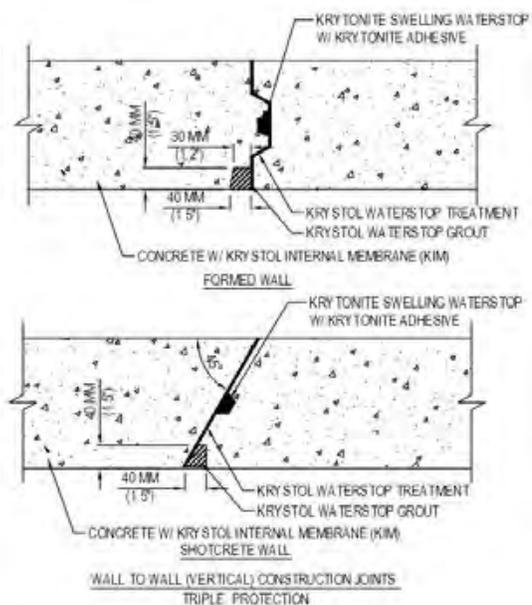
CAD DRAWINGS

Wall to Wall Construction Joints

Double Protection options:



Triple Protection (high risk) options:



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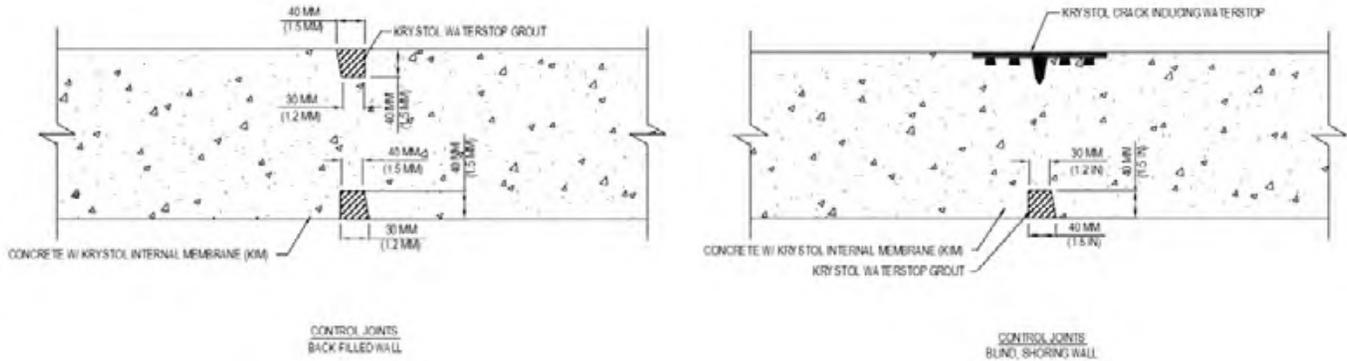
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KRYSTOL WATERSTOP SYSTEM

CAD DRAWINGS

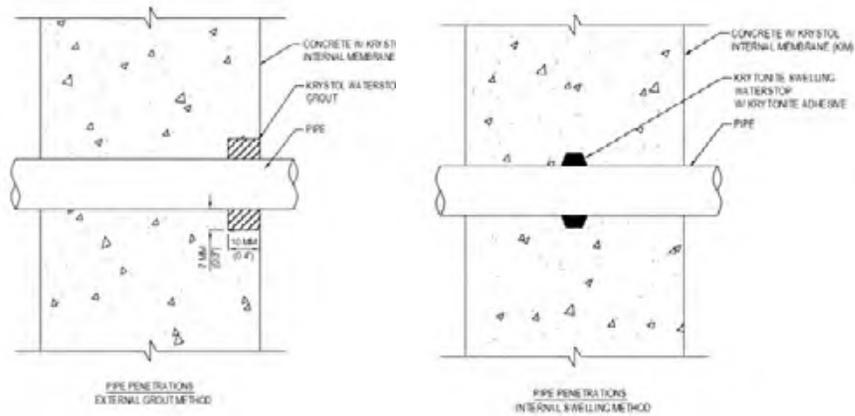
CONTROL JOINTS:

Controlling the cracking through a waterproof crack control joint will minimize repairs and ensure a watertight structure.

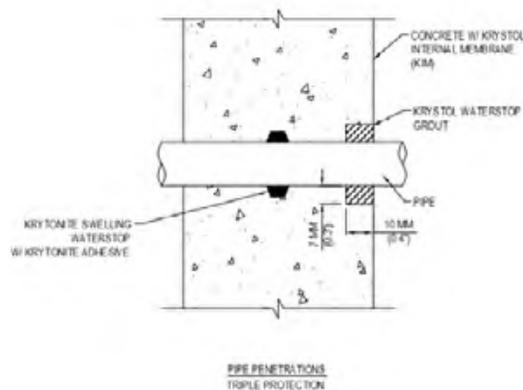


PENETRATIONS:

Double Protection options:



Triple Protection (high risk) options:



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LIMITED PRODUCT WARRANTY

Krytol® Waterstop System

Limited Warranty Coverage: Subject to the limitations set forth below, the MANUFACTURER warrants to the BUYER that the **Krytol Waterstop System (KWS)** product is free from any and all defects of manufacture for a warranty period of **ten (10)** years from the date of purchase. If the KWS product is proven defective during the warranty period, the MANUFACTURER will replace the defective product or supply Kryton products needed to make waterproofing repairs to the affected area or refund the BUYER's purchase price, at MANUFACTURER's option.

Warranty Limitations: This Limited Warranty does not include or cover leakage of the structure resulting from the penetration of water through poorly consolidated concrete, contaminations within the concrete, construction joints, openings, penetrations or open cracks that occur as a result of shrinkage, settling or other movement of the concrete. Further, this Limited Warranty does not include or cover damage or failure caused by fire, explosion, vibration, structural movement, lightning, earthquake, civil disturbance, structural design, or any other cause not the fault of Kryton, nor for damage caused directly or indirectly by the BUYER's negligence or failure to comply with the MANUFACTURER's specifications or requirements, including installation according to the MANUFACTURER's printed instructions. This Limited Warranty does not cover, and MANUFACTURER makes no Warranty with respect to the quality or performance of the concrete or to related materials, such as reinforcement, vapor retarder, drains and vents. This Limited Warranty does not cover claims related to mold or mildew regardless of cause. This Limited Warranty is valid only when the MANUFACTURER has received payment in full for the KWS product covered by this warranty and the amount paid is the value limit of this warranty. This Limited Warranty contains the entire obligation of the MANUFACTURER in connection with the KWS product covered by this warranty.

BUYER'S Responsibility: It is expressly acknowledged and agreed that it is the BUYER'S responsibility to independently evaluate and determine the suitability of KWS for the purpose intended and to design and construct the structure in compliance with the product requirements. BUYER agrees to seek the advice of qualified professionals, as appropriate, regarding the evaluation of KIM and any related materials. Under no circumstance will the MANUFACTURER be liable or responsible for any loss or damage caused by BUYER'S determination of usefulness and use of the products in a particular application, project or specification.

Project Description:

Issuing Distributor:

Date:

MANUFACTURER MAKES NO REPRESENTATIONS OR WARRANTIES (EXPRESS, IMPLIED, STATUTORY OR OTHERWISE) OTHER THAN THE EXPRESS WARRANTY AS SET OUT IN THESE TERMS. MANUFACTURER EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES (EXPRESS, IMPLIED, STATUTORY OR OTHERWISE) INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Sole Remedy: BUYER agrees to accept the refund or Kryton Products referred to herein as BUYER's exclusive remedy and as the limit of the MANUFACTURER'S liability regardless of BUYER's legal theory, including tort, contract and strict liability, and regardless of whether resulting from or arising out of or in connection with any failure of the KWS product. BUYER must notify MANUFACTURER in writing of any and all proposed repairs to, modification of, or alteration or addition to the structure occurring after the effective date of this Limited Warranty. Any claim shall be waived unless BUYER shall have given MANUFACTURER written notice within fifteen (15) days following occurrence of leakage. Notification shall be by certified or registered mail. Warranty service shall be provided by the distributor.

Indemnification: BUYER agrees, in consideration of MANUFACTURER agreeing to refund the purchase price or supply material to make repairs under this agreement for the period specified, to indemnify and hold harmless MANUFACTURER from any loss, damage or liability resulting from or arising out of any leaks or failures of the **KWS** product.

IN NO EVENT SHALL BUYER BE ENTITLED TO RECOVER INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR DELAY, INCONVENIENCE, LOSS OF USE, LOSS OF PROFITS, COST TO PROCURE SUBSTITUTE GOODS OR SERVICES, OR OTHER COMMERCIAL LOSS.

Governing Law: This Limited Warranty shall be governed and construed in accordance with the laws of the Province of British Columbia, Canada and the parties hereto, on their own behalf and on behalf of their agent's, heirs, successors, permitted assigns, subcontractors, trustees in bankruptcy and successor companies, hereby attorn to the jurisdiction of the Courts of British Columbia. If any part of this document is determined to be unenforceable by a court of competent jurisdiction, it shall be stricken and the remainder shall be retained and enforced.



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KRYSTOL LEAK REPAIR SYSTEM



SMART CONCRETE®

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TECHNICAL DATA SHEET

Concrete Repair



SMART CONCRETE®

Krystol Plug™

Product Code: K-620

DESCRIPTION

As part of the Krystol Leak Repair System, Krystol Plug is a rapid-setting hydraulic cement product that when mixed with water is used to stop flowing water and repair leaking cracks, holes and joints in concrete.

Krystol Plug sets hard within 2 minutes and has high-compressive strength, which allows it to stop water even under high-hydrostatic pressure. Stopping water flow then allows permanent repair of the leak using Krystol technology.

Krystol Plug is mixed with water and immediately, and firmly, pressed into a prepared chase to stop flowing water. After stopping the water, Krystol Repair Grout is used to introduce Krystol technology to the leak repair. When applied to concrete, Krystol chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.



FEATURES & BENEFITS

- Can stop extreme leaks
- Works where all other products fail
- Stops flowing water immediately
- Sets fast, in one to two minutes
- Easy to mix and apply
- Will set up and harden under water
- Has exceptional strength
- Does not contain any chlorides
- Safe for drinking water applications

RECOMMENDED USES

- Use as part of the Krystol® Leak Repair System to repair leaking cracks, joints and holes
- Provides impervious, non-shrinking seal to prevent seepage around pipes and metal fixtures in masonry and concrete

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TECHNICAL DATA SHEET

Concrete Repair



PROPERTIES

<u>Physical Properties</u>	
Appearance	Dark gray powder
Bulk density g/cm ³ (lb. /cu. ft.)	1.4 (88)
pH (when mixed with water)	12
<u>Plastic Properties</u>	
Working time (20°C/ 68°F, 50% RH)	1 minute
Hardening time (20°C/ 68°F, 50% RH)	2 minutes
<u>Hardened Properties</u>	
Compressive strength	50 MPa (7250 psi) @ 7 days

APPLICATION

For use as part of the Krystol Leak Repair System, read and distribute Application Instruction 5.12 — Waterproofing Cracks, Holes and Joints before using this product. Mix Krystol Plug to a suitable putty consistency that can be held in your hand (wear gloves) -approximately 4 parts powder to 1 part clean water by volume. Mix only the amount of material that can be applied within one minute. After the Krystol Plug putty has been adequately kneaded into a uniform texture, immediately press it firmly into the cracks and crevices to be sealed using maximum pressure but with minimum back and forth motion or rubbing. Air and surface temperatures must be at least 4 °C (40 °F).

LIMITATIONS

Krystol Plug is effective for rigid structures only and may not reliably seal cracks that experience variable loading or repeated movement. Consult a Kryton representative for project specific recommendations.

SAFETY

Read the Safety Data Sheet (SDS) for this product. For professional use only. This product becomes caustic when mixed with water or perspiration. Avoid contact with skin or eyes. Avoid breathing dust. Wear long sleeves, safety goggles and impervious gloves.

PACKAGING

Krystol Plug is available in 5 kg (11 lb.) and 25 kg (55 lb.) resealable pails.

SHELF LIFE

When stored in a dry enclosed area, Krystol Plug has a shelf life of 2 years for unopened pails and 4 months for properly resealed pails

WARRANTY

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TECHNICAL DATA SHEET

Concrete Repair



SMART CONCRETE®

Krystol Repair Grout™

Product Code: K-510

DESCRIPTION

As part of the Krystol Leak Repair System, Krystol Repair Grout is a crystalline concrete waterproofing product that stops the flow of water to permanently repair leaking cracks, holes and joints in concrete, and can also be used to resurface and waterproof defective, damaged or deteriorating concrete. The grout employs advanced fiber technology and shrinkage controlling additives to prevent cracking.

Krystol Repair Grout contains Krystol technology. When applied to concrete, Krystol chemically reacts with water and un-hydrated cement particles to form insoluble needle-shaped crystals that fill capillary pores and micro-cracks in the concrete and block the pathways for water and waterborne contaminants. Any moisture introduced over the lifespan of the concrete will initiate crystallization, ensuring permanent waterproofing protection.



FEATURES & BENEFITS

- Crystalline waterproofing technology
- Simple and easy to use
- Non-shrink crack resistant
- NSF 61 Certified; safe for contact with potable water
- Color matches concrete

RECOMMENDED USES

Use in conjunction with Krystol Plug to repair any leaking crack, joint or other defect in concrete, or by itself to repair spalled or honeycombed concrete.

PROPERTIES

Physical Properties	
Appearance	Gray powder with fiber additive
Bulk density	1.3 g/cm ³ (81 lb. / cu. ft.)
pH (when mixed with water)	12
Plastic Properties	
Working time (20°C / 68°F, 50% RH)	30 minutes
Hardening time (20°C / 68°F, 50% RH)	1 hour

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TECHNICAL DATA SHEET

Concrete Repair



Hardened Properties	
Hydrostatic head resistance	140 m (460 ft.)
Compressive strength (ASTM C109)	24 MPa (3480 psi) @ 24 hrs 30 MPa (4351 psi) @ 7 days 35 MPa (5076 psi) @ 28 days 40 MPa (5801 psi) @ 56 days
Pull off Strength (ASTM C1583)	2.75 MPa (400 psi)

COVERAGE

Krytol Repair Grout covers approximately 15 m per 25 kg pail (50 ft. per 55 lb. pail) when used with Krytol Plug, and 10 m per 25 kg pail (33 ft. per 55 lb. pail) when used without Krytol Plug. Coverage based on filling a 40 mm x 30 mm (1.5 in x 1 in) chase.

APPLICATION

Refer to Application Instruction 5.12 - Waterproofing Cracks, Holes and Joints or 5.32 - Waterproofing Pipe Penetrations before using this product. First, stop any flowing water with Krytol Plug. Mix Krytol Repair Grout to a dry putty consistency (approximately 4 parts of powder to 1 part clean water by volume) and pack the keyway. Additional powder may be used to produce a thicker grout suitable for vertical repairs. Protect application from damage by rain, rapid drying or freezing for at least 24 hours.

LIMITATIONS

Krytol Repair Grout is effective for rigid structures only and may not reliably seal crack or joints that experience variable loading or repeated movement. Consult a Kryton representative for project specific recommendations.

SAFETY

Read the Safety Data Sheet (SDS) for this product. For professional use only. This product becomes caustic when mixed with water or perspiration. Avoid contact with skin or eyes. Avoid breathing dust. Wear long sleeves, safety goggles and impervious gloves.

PACKAGING

Krytol Repair Grout is available in 5 kg (11 lb.) and 25 kg (55 lb.) resealable pails.

SHELF LIFE

When stored in a dry enclosed area, Krytol Repair Grout has a shelf life of 3 years for unopened pails and 4 months for properly resealed pails.

WARRANTY

Kryton International Inc. (Kryton) warrants that Kryton products are free from manufacturing defects and comply with the specifications given in their respective technical data sheet. Because conditions of use, such as site conditions, surface preparations, workmanship, concrete ingredients, weather, structural issues and other factors are beyond the control of Kryton, no warranty can be given as to the results of use. Purchaser agrees to seek the advice of qualified professionals and to determine for themselves the suitability of the products for their intended purpose and assumes all risks. Purchaser's sole remedy is limited to replacement of any product proven defective or at Kryton's option refund of the purchase price paid. THIS LIMITED WARRANTY CONTAINS THE ENTIRE OBLIGATION OF KRYTON. NO OTHER WARRANTIES, EXPRESS OR IMPLIED, SHALL APPLY INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. KRYTON SHALL NOT BE LIABLE UNDER ANY LEGAL THEORY FOR SPECIAL OR CONSEQUENTIAL DAMAGES. No representative of Kryton has the authority to make any representations or provision except as stated herein. Kryton reserves the right to change the properties of its products without notice.

V2018-06



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APPLICATION INSTRUCTIONS 5.12

Repairs

Krystol® Leak Repair System

Waterproofing Cracks, Holes & Joints

DESCRIPTION

The Krystol Leak Repair System is used to permanently waterproof leaking cracks, joints, and holes in concrete. It is installed in place of other less reliable crack repair systems and allows the concrete to be protected from any direction, even under high hydrostatic pressure. The Krystol Leak Repair System uses Krystol crystalline technology which reacts with water and un-hydrated cement particles to grow insoluble needle-shaped crystals that fill capillaries, micro-cracks and pores in concrete to reduce permeability and stop water. The following application instructions are used for the repair of leaking cracks, holes & joints from either the positive or negative side.

LIMITATIONS

Krystol leak repair is effective for rigid structures only and may not reliably repair cracks or joints that are subject to movement. Moving cracks can only be repaired using a flexible system such as urethane injection. Consult a Kryton representative for project specific recommendations. Use typical cold weather practices if applying in cold climatic conditions. Installation during heavy rain must be avoided.

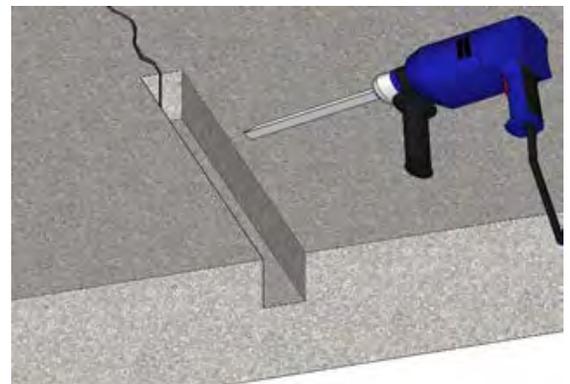
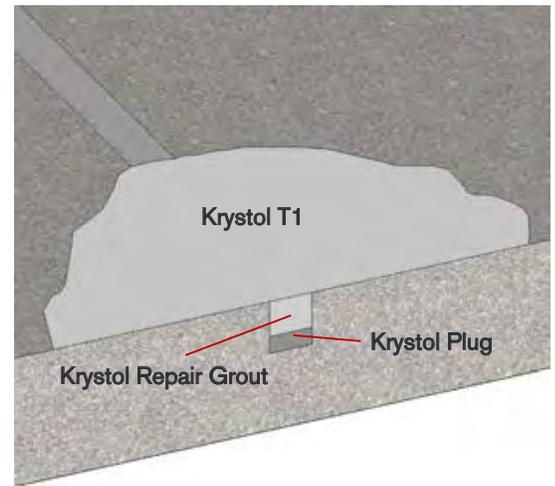
SAFETY PRECAUTIONS

Read and follow the Safety Data Sheets (SDS) for these products (available at www.Kryton.com). For professional use only. These products become highly caustic when mixed with water or perspiration. Avoid contact with skin or eyes. Avoid breathing dust. Wear long sleeves, safety goggles and impervious gloves.

STEP 1: PREPARE THE LEAKING CRACK OR JOINT

1. Using a sharp 25 mm (1 in.) square chisel, chip a 25 mm (1 in.) wide chase along the entire length of the crack to a minimum depth of 40 mm (1.5 in.). The shape of the chase is critical to your success. The chase must be rectangular shaped and deeper than it is wide. If the concrete breaks apart near the surface, you must chisel deeper to obtain the required 25 mm by 40 mm (1 in. by 1.5 in.) size and shape.

When chiseling, do not place the chisel inside the chase. Instead, place the chisel on the concrete surface over the leaking crack or joint about one inch ahead of the chase and direct chisel pressure back towards the chase so that the piece being removed falls into the chase. Chisel to the full



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APPLICATION INSTRUCTIONS 5.12

Repairs

depth of 40 mm (1.5 in.) before moving on. This method is proven to be most productive, requires the least effort and will result in a chase that is the proper shape.

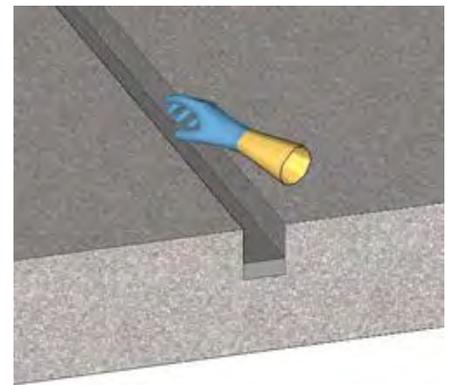
2. Wash the chase with water until it is clean and water runs clear. If necessary, use a vacuum to remove dust, debris or water.
3. Grind or wire brush the concrete 6 inches on either side of the repair to expose clean, sound concrete. This will provide better adhesion for the Krystol T1® coating (Step 4).

IMPORTANT: Be sure to repair the full length of the crack or joint. If you repair only the area that is currently leaking, the water will likely migrate to the un-repaired section and you will be back to repair a new leak.

STEP 2: STOP FLOWING OR SEEPING WATER

If there is no active leaking at this time, you may skip to step 3.

1. Quickly mix four (4) parts Krystol Plug™ to one (1) part clean water by volume to a putty consistency. Mix only enough material as can be placed in 1 minute.
2. Using a gloved hand, immediately press the Krystol Plug firmly into the leaking chase while it is in a pliable form and hold still until it has set. Compact the Krystol Plug so there are no voids.
3. Repeat, working from one end of the crack to the other until the entire chase has been plugged and all water has been completely stopped.



IMPORTANT:

- To avoid early water exposure, use separate measuring cups when portioning Krystol Plug Powder and water.
- In hot weather, use cold water to slightly extend setting time.
- In cold weather, use hot water to accelerate setting time.
- Do not move or work the plug after it has started to set or it will break apart.
- The Krystol Plug must not fill more than one-third of the chase. The maximum thickness of Krystol Plug is 13 mm (0.5 inches). Use a trowel or chisel to scrape out any excess Krystol Plug so that at least 25 mm (1 in.) of space remains in the chase.
- Do not allow Krystol Plug to build up on the walls of the chase. Wire brush the chase to remove excess Krystol Plug from the walls so the remaining materials can bond directly to clean concrete.
- All leaking water must be stopped before proceeding. Touch up work may be needed to stop all the water.

TIP: In areas of very high water flow, insert a rubber hose at the highest flow area to direct water and install Krystol Plug around it. Removing the hose will leave a deep narrow hole that is much easier to plug with a single ball of material. Fill the chase leaving the highest flow area to the end.



APPLICATION INSTRUCTIONS 5.12

Repairs

STEP 3: INSTALL KRYSTOL REPAIR GROUT

1. Wash the chase with water until it is clean and water runs clear. Ensure that the chase is in Saturated, Surface Dry (SSD) condition; saturate with water, then remove any standing water before proceeding.
2. Mix Krystol Repair Grout to a stiff putty consistency as follows: Start by mixing four (4) parts Krystol Repair Grout with one (1) part clean water by volume until smooth. Add up to an additional half (0.5) part of powder for a total of approximately 4.5 to 1 and continue mixing to obtain a sag free paste. The mixture will appear dry at first, but with mixing will become smooth and workable.. If the grout sags during installation, mix in extra powder until the grout holds in place.



4. **NOTE:** The mix ratio is only approximate and intended only as a guide since jobsite conditions may vary affecting the actual powder to water required

For large repairs with a minimum repair cross section of **50 x 50 mm (2x2 inches) to a maximum 100 x 100 mm (4 x 4 inches)**, mix Krystol Repair Grout with clean 5 mm minus gravel (1/4 inch). For large repairs with a minimum repair cross section of **75 x 75 mm (3 x 3 inches)**, mix Krystol Repair Grout with clean 10 mm minus gravel (3/8 inch). Mix 4 parts Krystol Repair Grout with 2 parts clean gravel. Slowly add a maximum of 1 part clean water until the desired consistency is obtained. Work Krystol Repair Grout into the prepared surface and ensure good bonding.

NOTE: Because sources of gravel vary, trial batches may be needed to determine the optimal mix.

3. Tightly pack the Krystol Repair Grout into the keyway so that it is flush with the surface. Do not leave any voids.
4. Protect the Krystol Repair Grout application from damage by rain, rapid drying or freezing for at least 24 hours.

IMPORTANT: Mix only as much material as can be placed in 20 minutes. Warm temperatures will reduce working time. Note that material left standing will stiffen, but mixing will restore plasticity. Do not add water to the material once it has started to set. Over-watering will result in cracking.



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APPLICATION INSTRUCTIONS 5.12

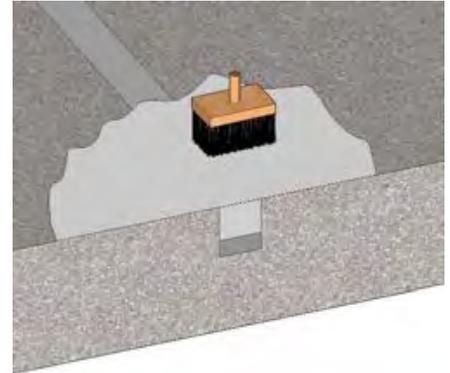
Repairs

STEP 4: APPLY KRYSTOL T1 COATING (RECOMMENDED)

1. Mix Krystol T1 to a fluid paste like coating, three (3) parts powder to one (1) part clean water by volume. Mix only as much as can be placed in 30 minutes.
2. Ensure that the concrete is in SSD condition.
3. With a concrete brush, use an aggressive, circular scrubbing motion to apply the Krystol T1 coating over the repair, extending at least 15 cm (6 in.) on either side. Apply at 0.8 kg/m² (1.5 lb./sq. yd.). The coating should be a 1-2 mm finish with a lighter pressure to achieve the correct thickness.

TIP: It is highly recommended that the entire wall, floor and/or ceiling be coated with Krystol T1. For more information, see Application Instruction 2.11 — Waterproofing with Surface Application (Brush Method) or 2.12 — Waterproofing with Surface Application (Spray Method).

4. Protect the repair from drying out. Cover the repair with tarps or plastic to prevent water loss due to evaporation. Once the Krystol T1 coating has hardened, mist the surface with water as needed to keep the repair damp for at least 3 days. Protect the repair from frost, rain and traffic for at least 24 hours.



MATERIALS AND COVERAGE

Material	Coverage
Krystol Plug	Approximately 30 m per 25 kg pail (100 ft. per 55 lb. pail)
Krystol Repair Grout	Approximately 10 m per 25 kg pail (33 ft. per 55 lb. pail) when used without Krystol Plug
	Approximately 15 m per 25 kg pail (50 ft. per 55 lb. pail) when used with Krystol Plug
Krystol T1	Approximately 31 m ² per 25 kg pail (330 sq. ft. per 55 lb. pail)

TOOLS

- Clean water supply
- Mixing bucket, drill and mortar paddle
- Natural bristle concrete brush
- Margin trowel
- Chipping Hammer or scabbler



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LIMITED PRODUCT WARRANTY

Krytol Plug™

Limited Warranty Coverage: Subject to the limitations set forth below, the MANUFACTURER warrants to the BUYER that the **Krytol Plug™** product is free from any and all defects of manufacture for a warranty period of **ten (10)** years from the date of purchase. If the Kryton product is proven defective during the warranty period, the MANUFACTURER will replace the defective product or supply Kryton products needed to make waterproofing repairs to the affected area or refund the BUYER's purchase price, at MANUFACTURER's option.

Warranty Limitations: This Limited Warranty does not include or cover leakage of the structure resulting from the penetration of water through poorly consolidated concrete, contaminations within the concrete, construction joints, openings, penetrations or open cracks that occur as a result of shrinkage, settling or other movement of the concrete. Further, this Limited Warranty does not include or cover damage or failure caused by fire, explosion, vibration, structural movement, lightning, earthquake, civil disturbance, structural design, or any other cause not the fault of Kryton, nor for damage caused directly or indirectly by the BUYER's negligence or failure to comply with the MANUFACTURER's specifications or requirements, including installation according to the MANUFACTURER's printed instructions. This Limited Warranty does not cover, and MANUFACTURER makes no Warranty with respect to the quality or performance of the concrete or to related materials, such as reinforcement, vapor retarder, drains and vents. This Limited Warranty does not cover claims related to mold or mildew regardless of cause. This Limited Warranty is valid only when the MANUFACTURER has received payment in full for the Kryton product covered by this warranty and the amount paid is the value limit of this warranty. This Limited Warranty contains the entire obligation of the MANUFACTURER in connection with the Kryton product covered by this warranty.

BUYER'S Responsibility: It is expressly acknowledged and agreed that it is the BUYER'S responsibility to independently evaluate and determine the suitability of Krytonite for the purpose intended and to design and construct the structure in compliance with the product requirements. BUYER agrees to seek the advice of qualified professionals, as appropriate, regarding the evaluation of Krytonite and any related materials. Under no circumstance will the MANUFACTURER be liable or responsible for any loss or damage caused by BUYER'S determination of usefulness and use of the products in a particular application, project or specification.

Project Description:

Issuing Distributor:

Date:

MANUFACTURER MAKES NO REPRESENTATIONS OR WARRANTIES (EXPRESS, IMPLIED, STATUTORY OR OTHERWISE) OTHER THAN THE EXPRESS WARRANTY AS SET OUT IN THESE TERMS. MANUFACTURER EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES (EXPRESS, IMPLIED, STATUTORY OR OTHERWISE) INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Sole Remedy: BUYER agrees to accept the refund or Kryton Products referred to herein as BUYER's exclusive remedy and as the limit of the MANUFACTURER'S liability regardless of BUYER's legal theory, including tort, contract and strict liability, and regardless of whether resulting from or arising out of or in connection with any failure of the Kryton product. BUYER must notify MANUFACTURER in writing of any and all proposed repairs to, modification of, or alteration or addition to the structure occurring after the effective date of this Limited Warranty. Any claim shall be waived unless BUYER shall have given MANUFACTURER written notice within fifteen (15) days following occurrence of leakage. Notification shall be by certified or registered mail. Warranty service shall be provided by the distributor.

Indemnification: BUYER agrees, in consideration of MANUFACTURER agreeing to refund the purchase price or supply material to make repairs under this agreement for the period specified, to indemnify and hold harmless MANUFACTURER from any loss, damage or liability resulting from or arising out of any leaks or failures of the Kryton product.

IN NO EVENT SHALL BUYER BE ENTITLED TO RECOVER INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR DELAY, INCONVENIENCE, LOSS OF USE, LOSS OF PROFITS, COST TO PROCURE SUBSTITUTE GOODS OR SERVICES, OR OTHER COMMERCIAL LOSS.

Governing Law: This Limited Warranty shall be governed and construed in accordance with the laws of the Province of British Columbia, Canada and the parties hereto, on their own behalf and on behalf of their agent's, heirs, successors, permitted assigns, subcontractors, trustees in bankruptcy and successor companies, hereby attorn to the jurisdiction of the Courts of British Columbia. If any part of this document is determined to be unenforceable by a court of competent jurisdiction, it shall be stricken and the remainder shall be retained and enforced.



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LIMITED PRODUCT WARRANTY

Krytol Repair Grout

Limited Warranty Coverage: Subject to the limitations set forth below, the MANUFACTURER warrants to the BUYER that the **Krytol Repair Grout (Krytol)** product is free from any and all defects of manufacture for a warranty period of **ten (10)** years from the date of purchase. If the Krytol product is proven defective during the warranty period, the MANUFACTURER will replace the defective product or supply Kryton products needed to make waterproofing repairs to the affected area or refund the BUYER's purchase price, at MANUFACTURER's option.

Warranty Limitations: This Limited Warranty does not include or cover leakage of the structure resulting from the penetration of water through poorly consolidated concrete, contaminations within the concrete, construction joints, openings, penetrations or open cracks that occur as a result of shrinkage, settling or other movement of the concrete. Further, this Limited Warranty does not include or cover damage or failure caused by fire, explosion, vibration, structural movement, lightning, earthquake, civil disturbance, structural design, or any other cause not the fault of Kryton, nor for damage caused directly or indirectly by the BUYER's negligence or failure to comply with the MANUFACTURER's specifications or requirements, including installation according to the MANUFACTURER's printed instructions. This Limited Warranty does not cover, and MANUFACTURER makes no Warranty with respect to the quality or performance of the concrete or to related materials, such as reinforcement, vapor retarder, drains and vents. This Limited Warranty does not cover claims related to mold or mildew regardless of cause. This Limited Warranty is valid only when the MANUFACTURER has received payment in full for the Krytol product covered by this warranty and the amount paid is the value limit of this warranty. This Limited Warranty contains the entire obligation of the MANUFACTURER in connection with the Krytol product covered by this warranty.

BUYER'S Responsibility: It is expressly acknowledged and agreed that it is the BUYER'S responsibility to independently evaluate and determine the suitability of Krytonite for the purpose intended and to design and construct the structure in compliance with the product requirements. BUYER agrees to seek the advice of qualified professionals, as appropriate, regarding the evaluation of Krytonite and any related materials. Under no circumstance will the MANUFACTURER be liable or responsible for any loss or damage caused by BUYER'S determination of usefulness and use of the products in a particular application, project or specification.

Project Description:

Issuing Distributor:

Date:

MANUFACTURER MAKES NO REPRESENTATIONS OR WARRANTIES (EXPRESS, IMPLIED, STATUTORY OR OTHERWISE) OTHER THAN THE EXPRESS WARRANTY AS SET OUT IN THESE TERMS. MANUFACTURER EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES (EXPRESS, IMPLIED, STATUTORY OR OTHERWISE) INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Sole Remedy: BUYER agrees to accept the refund or Kryton Products referred to herein as BUYER's exclusive remedy and as the limit of the MANUFACTURER'S liability regardless of BUYER's legal theory, including tort, contract and strict liability, and regardless of whether resulting from or arising out of or in connection with any failure of the Kryton product. BUYER must notify MANUFACTURER in writing of any and all proposed repairs to, modification of, or alteration or addition to the structure occurring after the effective date of this Limited Warranty. Any claim shall be waived unless BUYER shall have given MANUFACTURER written notice within fifteen (15) days following occurrence of leakage. Notification shall be by certified or registered mail. Warranty service shall be provided by the distributor.

Indemnification: BUYER agrees, in consideration of MANUFACTURER agreeing to refund the purchase price or supply material to make repairs under this agreement for the period specified, to indemnify and hold harmless MANUFACTURER from any loss, damage or liability resulting from or arising out of any leaks or failures of the the Krytol product.

IN NO EVENT SHALL BUYER BE ENTITLED TO RECOVER INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR DELAY, INCONVENIENCE, LOSS OF USE, LOSS OF PROFITS, COST TO PROCURE SUBSTITUTE GOODS OR SERVICES, OR OTHER COMMERCIAL LOSS.

Governing Law: This Limited Warranty shall be governed and construed in accordance with the laws of the Province of British Columbia, Canada and the parties hereto, on their own behalf and on behalf of their agent's, heirs, successors, permitted assigns, subcontractors, trustees in bankruptcy and successor companies, hereby attorn to the jurisdiction of the Courts of British Columbia. If any part of this document is determined to be unenforceable by a court of competent jurisdiction, it shall be stricken and the remainder shall be retained and enforced.



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KRYSTOL ASSURANCE PROGRAM

(OPTIONAL COVERAGE)



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KRYSTOL[®] ASSURANCE PROGRAM[™]

10 YEARS MATERIALS AND LABOUR WARRANTY



TAKING THE RISK OUT OF CONCRETE WATERPROOFING



All Kryton products are covered by our standard warranty, which guarantees every product is free from defects of manufacture. Our extended Krystol Assurance Program is a 10-year warranty that covers all labor and materials required to repair any leaks that occur at no costs to the owner or builder.



Be sure & build with Kryton.

The Krytol Assurance Program is a performance-based guarantee that includes a robust, all-inclusive material and labor warranty as well as a premium quality control service.

The warranty period is 10 years starting from the day the waterproofing system is completed and dry. From there, Kryton will supply all materials and labor required to repair any leaks that occur at no cost.*

The Krytol Assurance Program

- Guarantees Krytol® treated areas remain watertight
- Enhanced quality control and supervision
 - Mix Design review
 - Construction detail review
 - Supervision during placement of KIM® treated concrete
 - On-site training for Kryton's Krytol® Waterstop Joint System
 - Quality Assurance



Kryton: The Most Effective Concrete Waterproofing System in the World

1. Proven Crystalline Technology
2. Step-by-Step Installation
3. 24/7 Field Level Support
4. Industry Experts
5. Best-in-industry Warranty

Offices in Canada, USA, UK, Singapore, China, India, and Dubai. Plus, with over 50 distributors worldwide, there is a Kryton distributor near you.

Find yours today: www.kryton.com

* This warranty is subject to limitations, which are detailed in the warranty documents.

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REFERENCES

(SEE ONLINE FOR CASE STUDIES)



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PROJECT	YEAR	COUNTRY	LOCATION OF CASE STUDY
KIMA Aswan Chemical Factory	2017	Egypt	http://www.kryton.com/projects/kima-aswan-chemical-factory/
Cadbury Food Factory	2017	Egypt	http://www.kryton.com/projects/cadbury-food-factory/
Smouha Heights Residence	2017	Egypt	http://www.kryton.com/projects/smouha-heights-residence/
Aster Private Hospital	2017	Qatar	http://www.kryton.com/projects/aster-private-hospital/
YMCA Beech House Condos and Swimming Pool	2017	Canada	http://www.kryton.com/projects/ymca-beech-house-condos-and-swimming-pool/
Whampoa MTR Station	2017	China	http://www.kryton.com/projects/whampoa-mtr-station-waterproofing-repair/
Hanlan Feedermain Water Project	2017	Canada	http://www.kryton.com/projects/hanlan-feedermain-water-project/
Motion Gate Theme Park	2016	United Arab Emirates	http://www.kryton.com/projects/motiongate-theme-park/
633 Alton Road Self Storage	2016	United States	http://www.kryton.com/projects/633-alton-road-self-storage/
Domino Sugar Refinery Redevelopment	2016	United States	http://www.kryton.com/projects/domino-sugar-refinery-redevelopment/
Pier 57 Super Pier	2016	United States	http://www.kryton.com/projects/pier-57-super-pier/
199 Watling Street	2016	United Kingdom	http://www.kryton.com/projects/199-watling-street/
Westbourne Place	2016	United Kingdom	http://www.kryton.com/projects/westbourne-place/
One57	2015	United States	http://www.kryton.com/projects/one57/
Whitney Museum of American Art	2015	United States	http://www.kryton.com/projects/whitney-museum-of-american-art/
Women and Children Hospital	2015	Brunei Darussalam	http://www.kryton.com/projects/women-and-children-hospital/
Double Tree by Hilton	2015	United Arab Emirates	http://www.kryton.com/projects/double-tree-by-hilton/
Kent State University	2015	United States	http://www.kryton.com/projects/kent-state-university/
Seylynn Village - Beacon Tower	2015	Canada	http://www.kryton.com/projects/seyllynne-village-beacon-tower/
Olympic Cauldron	2015	Canada	http://www.kryton.com/projects/olympic-cauldron/
Governors Island Seawall	2015	United States	http://www.kryton.com/projects/governors-island-seawall/
Alakanada Dam	2014	India	http://www.kryton.com/projects/alakanada-dam-new-construction/
Kiaora Lands Redevelopment	2014	Australia	http://www.kryton.com/projects/kiaora-lands-redevelopment/
Penguin Encounter at Sea World	2014	Australia	http://www.kryton.com/projects/penguin-encounter-sea-world/
Bandung Electronic Centre Extension	2014	Indonesia	http://www.kryton.com/projects/bandung-electronic-centre-extension/
Windsor Park	2014	India	http://www.kryton.com/projects/windsor-park/
Optus Sarovar Premiere Hotel	2014	India	http://www.kryton.com/projects/optus-sarovar-premiere-hotel/
TELUS Gardens	2014	Canada	http://www.kryton.com/projects/telus-gardens/
La Capital	2014	Mexico	http://www.kryton.com/projects/la-capital/
Mount Pleasant Sub-Station	2013	Canada	http://www.kryton.com/projects/mount-pleasant-sub-station/
Bloomberg Server Building	2013	United States	http://www.kryton.com/projects/bloomberg-server-building/
Georgetown Grade Separation Upgrade	2013	Canada	http://www.kryton.com/projects/georgetown-grade-separation-upgrade/
Capri on Via Roma	2013	Australia	http://www.kryton.com/projects/capri-via-roma/
Royal Brunei Police Force HQ	2013	Brunei Darussalam	http://www.kryton.com/projects/royal-brunei-police-force-hq/
East Pier Condominium	2013	United States	http://www.kryton.com/projects/east-pier-condominium/
SABAH SPORTS SCHOOL	2012	Malaysia	http://www.kryton.com/projects/sabah-sports-school/
Jameson House	2012	Canada	http://www.kryton.com/projects/jameson-house/
Clos de la Tech	2012	United States	http://www.kryton.com/projects/clos-de-la-tech-winery/



Edmunds Aquatic and Community Centre	2012	Canada	http://www.kryton.com/projects/edmunds-aquatic-and-community-centre/
Private Home – Hemingfield Road	2012	United Kingdom	http://www.kryton.com/projects/private-home-hemingfield-road/
Blessed Church Kuching	2012	Malaysia	http://www.kryton.com/projects/blessed-church-kuching/
Riverport Flats	2012	Canada	http://www.kryton.com/projects/riverport-flats/
Private Home	2012	United Kingdom	http://www.kryton.com/projects/private-home/
Trump International Hotel & Tower Toronto	2012	Canada	http://www.kryton.com/projects/trump-international-hotel-tower-toronto/
Terraces on the Park	2012	Canada	http://www.kryton.com/projects/terraces-on-the-park/
Gibson Square	2012	Canada	http://www.kryton.com/projects/gibson-square/
Briardale Gardens	2012	United Kingdom	http://www.kryton.com/projects/briardale-gardens-private-home/
60 West Cordova Street	2012	Canada	http://www.kryton.com/projects/60-west-cordova/
Belgravia Basement	2012	England	http://www.kryton.com/projects/belgravia-basement/
Te Raukura Building	2011	New Zealand	http://www.kryton.com/projects/te-wharewaka-o-poneke-building-new-construction/
Tung Ho Steel Plant	2011	Taiwan	http://www.kryton.com/projects/tung-ho-steel-plant/
Westfield Sydney Shopping Centre	2011	Australia	http://www.kryton.com/projects/westfield-sydney-shopping-centre/
Batu Kitang Module 8 Water Treatment Plant	2011	Malaysia	http://www.kryton.com/projects/batu-kitang-module-8-water-treatment-plant/
Shinsegae Tunnel	2011	South Korea	http://www.kryton.com/projects/shinsegae-tunnel/
Dammam Underpass	2011	Saudi Arabia	http://www.kryton.com/projects/dammam-underpass-repair/
Home plus Hypermarkets	2011	South Korea	http://www.kryton.com/projects/homeplus-hypermarkets/
Big Multinational Supermarket	2011	Greece	http://www.kryton.com/projects/big-multinational-supermarket-infrastructure-upgrades/
IKEA	2011	Australia	http://www.kryton.com/projects/ikea-store/
Hillcrest High School	2011	United States	http://www.kryton.com/projects/hillcrest-high-school/
VanDusen Botanical Garden Visitor Centre	2011	Canada	http://www.kryton.com/projects/vandusen-botanical-garden-visitor-centre/
Bajo de Mina Hydroelectric Project	2011	Panama	http://www.kryton.com/projects/bajo-de-mina-hydroelectric-project/
Crystal Pavilions at Marina Bay Sands	2011	Singapore	http://www.kryton.com/projects/crystal-pavilions-at-marina-bay-sands/
Brewery District	2011	Canada	http://www.kryton.com/projects/brewery-district/
Vancouver Forest	2011	China	http://www.kryton.com/projects/vancouver-forest/
Marina Coastal Expressway Contract 485	2011	Singapore	http://www.kryton.com/projects/marina-coastal-expressway-undersea-vehicular-tunnel-contract-485-phase-1/
Auckland District Health Board Car Park	2011	New Zealand	http://www.kryton.com/projects/auckland-district-health-board-car-park/
Central Square EC1	2011	United Kingdom	http://www.kryton.com/projects/central-square-ec1/
700 West 8th	2011	Canada	http://www.kryton.com/projects/700-west-8th/
Guelph Market Square	2011	Canada	http://www.kryton.com/projects/guelph-market-square/
Radio Television Malaysia (RTM)	2011	Malaysia	http://www.kryton.com/projects/radio-television-malaysia-rtm/
Coral International Hotel Apartments	2010	United Arab Emirates	http://www.kryton.com/projects/coral-international/
Sydney Desalination Plant - Pump Station	2010	Australia	http://www.kryton.com/projects/sydney-desalination-plant-pump-station/



Serangoon Shopping Complex & Bus Interchange	2010	Singapore	http://www.kryton.com/projects/serangoon-shopping-complex-bus-interchange/
Sunset Gardens	2010	Lebanon	http://www.kryton.com/projects/sunset-gardens/
Royal Mills Riverpoint Apartments	2010	United States	http://www.kryton.com/projects/royal-mills-riverpoint-apartments/
Casa Bella Verde	2010	United States	http://www.kryton.com/projects/casa-bella-verde/
Marina Bay Sands Integrated Resort	2010	Singapore	http://www.kryton.com/projects/marina-bay-sands-integrated-resort/
CityCenter	2010	United States	http://www.kryton.com/projects/citycenter/
Eden Gardens	2010	Lebanon	http://www.kryton.com/projects/eden-gardens/
Lebanese Canadian Bank	2010	Lebanon	http://www.kryton.com/projects/lebanese-canadian-bank/
Solaris Meadows Gate	2010	Canada	http://www.kryton.com/projects/solaris-meadows-gate/
Retama Condominio Residential Pool	2010	Mexico	http://www.kryton.com/projects/retama-condominio-residencial-pool/
Sherbourne Common	2010	Canada	http://www.kryton.com/projects/sherbourne-common-water-feature/
Zenith Corporate Park	2009	Malaysia	http://www.kryton.com/projects/zenith-corporate-park/
The Carlyle Residences	2009	United States	http://www.kryton.com/projects/the-carlyle-residences/
Riverfront Residences	2009	United States	http://www.kryton.com/projects/napa-river-project/
Wyly Theater (AT&T Performing Arts Center)	2009	United States	http://www.kryton.com/projects/att-performing-arts-center-wyly-theater/
Al Mashfa Hospital	2008	Saudi Arabia	http://www.kryton.com/projects/al-mashfa-private-hospital/
The Mira Hotel, Podium Gardens	2008	China	http://www.kryton.com/projects/the-mira-hotel-podium-gardens/
Private Residence, Georgia	2008	United States	http://www.kryton.com/projects/buckhead-residence/
University of Massachusetts Amherst - Boyden Tunnel	2008	United States	http://www.kryton.com/projects/university-of-massachusetts-amherst-boyden-tunnel/
Tiger Den, Bronx Zoo	2008	United States	http://www.kryton.com/projects/bronx-zoo-tiger-den/
Hotel Bellwether	2008	United States	http://www.kryton.com/projects/bellweather-hotel/
Emirates Airlines Call Centre	2008	United Arab Emirates	http://www.kryton.com/projects/emirates-airlines-call-centre/
Norwest Private Hospital	2008	Australia	http://www.kryton.com/projects/norwest-private-hospital/
Kingsford Substation	2008	Australia	http://www.kryton.com/projects/kingsford-substation/
Kambala Bayview Center Stage One	2008	Australia	http://www.kryton.com/projects/kambala-bayview-center-stage-one/
Bahri Gardens	2008	Lebanon	http://www.kryton.com/projects/bahri-gardens/
Grain Tunnel at Ensenada International Terminal	2008	Mexico	http://www.kryton.com/projects/ensenada-international-terminal-grain-tunnel/
Santa Lucia Riverwalk	2008	Mexico	http://www.kryton.com/projects/canal-santa-lucia/
KK Times Square	2007	Malaysia	http://www.kryton.com/projects/kk-times-square/
Sakura Hot Spring Hotel	2007	Taiwan	http://www.kryton.com/projects/sakura-hot-spring-hotel/
Vancouver International Airport (YVR) Airport Tunnel	2007	Canada	http://www.kryton.com/projects/yvr-vancouver-airport-tunnel/
Vancouver Airport (YVR) Aquarium	2007	Canada	http://www.kryton.com/projects/yvr-vancouver-airport-aquarium/
Kaiser Sunnyside Medical Center	2007	United States	http://www.kryton.com/projects/kaiser-sunnyside-medical-center/
Terminus 100	2007	United States	http://www.kryton.com/projects/terminus-100/
Shangri-La Rasa Ria Resort Hotel	2007	Malaysia	http://www.kryton.com/projects/shangri-la-rasa-ria-resort-hotel/
55 Allen Plaza	2007	United States	http://www.kryton.com/projects/55-allen-plaza/
Scottsdale Waterfront	2007	United States	http://www.kryton.com/projects/scottsdale-waterfront/
Singapore Condominium Projects	2006	Singapore	http://www.kryton.com/projects/singapore-condominium-projects/
Museo Del Centro Cultural Polyforum	2006	Mexico	http://www.kryton.com/projects/museo-del-centro-cultural-polyforum/



Aura Tower No.1 Swimming Pool and Infinity Channel	2006	Mexico	http://www.kryton.com/projects/aura-tower-no-1-swimming-pool-and-infinity-channel/
Manukau Police Hub Tunnel	2006	New Zealand	http://www.kryton.com/projects/manukau-police-hub-tunnel/
Thalaso Terapija	2005	Croatia	http://www.kryton.com/projects/thalaso-terapija/
Children's Healthcare of Atlanta at Egleston	2005	United States	http://www.kryton.com/projects/egleston-childrens-hospital/
St. Petersburg Wastewater Treatment Plant	2005	Russia	http://www.kryton.com/projects/st-petersburg-wastewater-treatment-plant/
Odlins Building	2005	New Zealand	http://www.kryton.com/projects/odlins-building/
Couples Swept Away Resort	2005	Jamaica	http://www.kryton.com/projects/couples-swept-away-resort/
Knowledge Village Office Building	2005	United Arab Emirates	http://www.kryton.com/projects/knowledge-village-office-building/
Republic Polytechnic - Woodlands Campus	2004	Singapore	http://www.kryton.com/projects/republic-polytechnic-woodlands-campus/
The House on the Hill	2004	United States	http://www.kryton.com/projects/the-house-on-the-hill-private-residence/
Shaw Tower Parkade	2004	Canada	http://www.kryton.com/projects/shaw-tower-parkade/
Al-Falak Residential Building	2004	Saudi Arabia	http://www.kryton.com/projects/al-falak-residential-building/
Crowne Plaza Hotel	2004	India	http://www.kryton.com/projects/crowne-plaza-today-hotel/
Northfield Wastewater Tank	2003	United States	http://www.kryton.com/projects/northfield-wastewater-tank/
Intrawest Sandestin Golf Resort	2003	United States	http://www.kryton.com/projects/intrawest-sandestin-golf-resort/
Orlando International Airport	2003	United States	http://www.kryton.com/projects/orlando-international-airport/
Russian Orthodox Church of the Holy Trinity	2003	United States	http://www.kryton.com/projects/russian-orthodox-church-of-the-holy-trinity/
TreePeople Center Underground Cistern	2003	United States	http://www.kryton.com/projects/treepeople-center-underground-cistern/
Palm Islands	2002	United Arab Emirates	http://www.kryton.com/projects/palm-islands/
Precast Water and Septic Tanks	2002	United States	http://www.kryton.com/projects/precast-water-and-septic-tanks/
La Cite	2001	Lebanon	http://www.kryton.com/projects/la-cite/
Fire Vehicle Repair Facility	2001	Canada	http://www.kryton.com/projects/fire-vehicle-repair-facility/
Skarholmen Parking Deck	2001	Sweden	http://www.kryton.com/projects/skarholmen-parking-deck/
St. Kilda Beach	2000	Australia	http://www.kryton.com/projects/st-kilda-beach/
Hyatt Hotel & Sheraton Hotel Pools	2000	Canada	http://www.kryton.com/projects/hyatt-sheraton-hotel-aquatic-centers/
Argentina Wastewater Treatment Plant	2000	Argentina	http://www.kryton.com/projects/argentina-wastewater-treatment-plant/
Argentina Pedestrian Tunnel	2000	Argentina	http://www.kryton.com/projects/argentina-pedestrian-tunnel/
Shanghai Subway	2000	China	http://www.kryton.com/projects/shanghai-subway/
Mundo Marino S.A. Oceanarium	2000	Argentina	http://www.kryton.com/projects/mundo-marino-s-a-oceanarium/
SEA LIFE Melbourne Aquarium	2000	Australia	http://www.kryton.com/projects/underwater-world-aquarium/
Bayside Grand Apartments	2000	Australia	http://www.kryton.com/projects/bayside-grand-apartments/
Point Robert's Border Crossing	1999	United States	http://www.kryton.com/projects/point-roberts-border-crossing/
Above-Grade Water Containment Tank	1999	United States	http://www.kryton.com/projects/above-grade-water-containment-tank/
Cathleens Fall Hydro Dam	1999	Ireland	http://www.kryton.com/projects/cathleens-fall-hydro-dam/
Water Reclamation Plant	1999	Singapore	http://www.kryton.com/projects/water-reclamation-plant/
BMW Building	1999	Australia	http://www.kryton.com/projects/bmw-building-extension/
Intrawest Employee Services Building	1998	Canada	http://www.kryton.com/projects/intrawest-employee-services-building/



Mrazovka Tunnel	1998	Czech Republic	http://www.kryton.com/projects/mrazovka-tunnel-connecting-bridge/
Parking Deck Raft Slab	1997	Canada	http://www.kryton.com/projects/parking-deck-raft-slab/
JFK Pumping Station	1997	United States	http://www.kryton.com/projects/jfk-pumping-station/
Park Hyatt Hotel	1997	Australia	http://www.kryton.com/projects/park-hyatt-hotel/
Bode's Precast Water and Septic Tanks	1997	United States	http://www.kryton.com/projects/bodes-precast-water-and-septic-tanks/
Richmond Aquatic Center - Watermania	1996	Canada	http://www.kryton.com/projects/richmond-aquatic-center-watermania/
Annacis Island Wastewater Treatment Plant (Upgrades)	1996	Canada	http://www.kryton.com/projects/annacis-island-wastewater-plant-upgrade/
Talent Irrigation Shotcrete Canal	1995	United States	http://www.kryton.com/projects/talent-irrigation-shotcrete-canal/
Suspended Pool	1992	Australia	http://www.kryton.com/projects/suspended-pool-with-shotcrete/
Fresh Water Pipeline	1986	Mexico	http://www.kryton.com/projects/fresh-water-pipeline/
Boeing Developmental Center	1983	United States	http://www.kryton.com/projects/boeing-development-center/

