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Agrément Certificate  
**05/4217**  
Product Sheet 1

### KRYSTOL WATERTIGHT CONCRETE SYSTEM

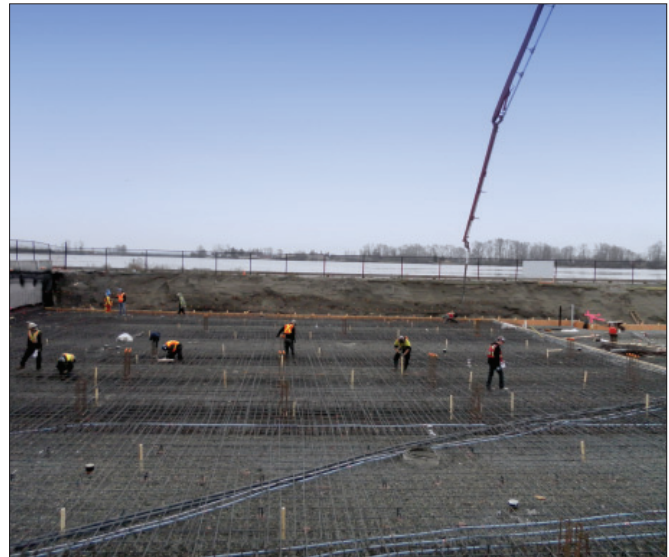
### KRYSTOL INTERNAL MEMBRANE — HS (KIM-HS)

#### PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to Krystol 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 certified on 30 March 2005

*The BBA is a UKAS accredited certification body — Number 1113. 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](http://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.*

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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  $\text{gm(Ns)}^{-1}$  (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 Krystol 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<sup>(1)</sup>.

(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  $325 \text{ kg}\cdot\text{m}^{-3}$  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<sup>(1)</sup> 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  $5^{\circ}\text{C}$  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<sup>(1)</sup>

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 <sup>-3</sup> )	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<sup>(1)</sup>

Property	Control concrete	KIM-HS	Test reference
Water permeability (m·s <sup>-1</sup> )	4.29 x 10 <sup>-14</sup>	1.28 x 10 <sup>-14</sup>	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 <sup>-2</sup> )			BS EN 12390-5
24 hours	2.5	2.0	
28 days	5.5	5.9	
Modulus of elasticity (N·mm <sup>-2</sup> )			BS 1881-122
28 days	35000	40500	
Water vapour permeability [g·m(N·s) <sup>-1</sup> ]	561 x 10 <sup>-12</sup>	463 x 10 <sup>-12</sup>	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*

## 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.