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BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

Agrément Certificate
No 05/4217

PRODUCT SHEET 1 — 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 used to provide watertight concrete.

THIS CERTIFICATE INCLUDES:

- factors relating to compliance with UK 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 will have reduced permeability when compared to the equivalent plain concrete (see sections 4 and 5).

Reinforcement protection — concrete containing the product will have enhanced resistance to reinforcement corrosion when compared to the equivalent plain concrete (see section 6).

Mechanical properties — the mechanical properties of the concrete will not be adversely affected by the incorporation of the product (see section 7).

Durability — concrete containing the product is more durable than the equivalent plain concrete mix due to its reduced permeability (see section 15).

The BBA has awarded this Agrément Certificate for Krystol Internal Membrane – HS (KIM-HS) to Kryton International Inc as fit for its intended use provided it is installed, used and maintained as set out in this Agrément Certificate.

On behalf of the British Board of Agrément

Date of First issue: 30 March 2005
Date of Fourth issue: 31 October 2007

Greg Cooper: Chief Executive

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.

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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 2000 (as amended) (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 19 *Placing* (19.1).

Non-regulatory Information

NHBC Standards 2007

In the opinion of the BBA, there are no requirements in the above Standards relating to Krystol Internal Membrane – HS (KIM-HS).

Zurich Building Guarantee Technical Manual 2007

In the opinion of the BBA the use of Krystol Internal Membrane – HS (KIM-HS) when installed and used in accordance with this Certificate is capable of satisfying the requirements of the *Zurich Building Guarantee Technical Manual* Section 5 *Internal/external works, services & finishes*, Sub-sections *External works, Concrete mixes – General.*

General

This Certificate relates to Krystol Internal Membrane – HS (KIM-HS), a reactive crystalline admixture used to provide watertight concrete. The product produces concrete with enhanced durability and improved protection against reinforcement corrosion by providing a physical pore-blocking action that protects resulting concrete against water ingress via hydrostatic pressure. The use of the product will therefore produce a concrete with the following properties relative to a control:

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

The product has no detrimental affect on the properties of the concrete.

Technical Specification

1 Description

1.1 Krystol Internal Membrane – HS (KIM-HS) is a powder admixture, consisting of blended Portland cement and proprietary chemicals, that when incorporated in concrete enhances the water resistance and durability of the hardened 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	10	96	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* (CHIP3).

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 to provide watertight concrete for 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 : 2000.

3.4 The use of the product with an air-entraining agent is not covered by this Certificate.

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

4 Water penetration

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

5 Water vapour permeability

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

5.2 Concrete made with a high water/cement ratio can have a water vapour permeability above 3000×10^{-12} gm(Ns)$^{-1}$. The permeability of concrete is strongly dependent on the exact mix design and the figures given in Table 3 indicate the levels that can be obtained using the product.

5.3 The appropriate thickness for concrete with a specific permeability to achieve a water vapour resistance of 200 MNsg^{-1} or 550 MNsg^{-1} (suitable for grades 3 and 4 respectively of BS 8102 : 1990) is given by:

For 200 MNsg^{-1}, $t = 0.2 \times 10^{12} \times p$

For 550 MNsg^{-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).

6 Reinforcement protection

6.1 The high alkalinity (pH>13) of concrete necessary to prevent corrosion of the reinforcement will not be adversely affected by the incorporation of the product into concrete.

6.2 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.

7 Mechanical properties

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

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

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

8 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.

9 Setting characteristics

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

9.2 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 Carbonation resistance

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

11 Frost resistance

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

12 Sulfate resistance

The lower permeability of the 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.

13 Alkali silica reaction (ASR)

13.1 Concrete 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.

13.2 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.

14 Resistance to leaching

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

15 Durability

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

15.2 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 product.

Installation

16 General

16.1 Structures built incorporating Krystol Internal Membrane — HS (KIM-HS) should be designed to the relevant sections of BS 8007 : 1987, BS 8102 : 1990, BS 8110-1 : 1997, BS EN 1992-1-1 : 2004 and BS EN 1992-1-2 : 2004.

16.2 Concrete containing the product is suitable for Type B constructions as defined in BS 8102 : 1990, and can meet the requirements for all grades defined in Table 1 of this Standard. For Grades 3 and 4 (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 5.2 and 5.3).

16.3 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.

17 Mix design

17.1 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.

17.2 The concrete must have a minimum cement content of 325 kgm^{-3} and be batched with a maximum water/cement ratio of 0.45. Further details of suitable mixes can be obtained from the Certificate holder or their approved representatives.

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

17.4 The workability of concrete can be adjusted using a suitable[1] water reducing or superplasticising admixture complying with BS EN 934-2 : 2001 to ensure the maximum water/cement ratio given in section 17.2 is not exceeded.

(1) The suitability and compatibility of a water reducing or superplasticising admixture should be evaluated before use and site trials should be carried out to establish the appropriate dose required.

18 Site mixing

18.1 The product is added at the correct dose (see section 17.2) to the mixed wet concrete.

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

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

18.4 Where the product is to be prepared on site, care must be taken to ensure that adequate mix control is available.

19 Placing

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

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

19.3 Concrete containing the product concrete should be fully compacted.

20 Curing

The concrete should be cured strictly in accordance with BS 8110-1 : 1997 and the Certificate holder's recommendations where site specific information exists.

21 Joints

21.1 Joints should be designed with waterstops as recommended in BS 8102 : 1990, to maintain watertightness of the whole structure. The advice of the Certificate holder should be sought on particular applications.

21.2 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.

22 Finishes

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

Technical Investigations

23 Tests

23.1 The effect of the product on the properties of concrete designed to BS EN 480-1 : 1998, Reference concrete 1, are given in Tables 2 and 3.

Table 2 Effects of KIM-HS on the properties of fresh wet concrete[1]

Property	Test reference	Control concrete	KIM-HS
KIM-HS (% wt/wt PC)		—	2.00
Water/cement ratio		0.49	0.47
Slump (mm)	BS 12350-2		
0 min		70	65
30 min		40	45
Plastic density (kgm^{-3})	BS EN 12350-6	2410	2420
Air content (%)	BS EN 12350-7	1.0	0.9
Setting time (min)	BS 5075-1		
Initial set		150	200
Final set		250	700

Table 3 Effects of KIM-HS on the hardened properties of concrete[1]

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

(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.

23.2 Tests were carried out by the BBA to determine:

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

24 Investigations

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

24.2 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 : 1990 *Code of practice for protection of 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 : 2000 *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 : 2001 *Admixtures for concrete, mortar and grout — Concrete admixtures — Definitions, 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 : 2002 *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*
BS EN 1992-1-2 : 2004 *Eurocode 2 : Design of concrete structures. General rules and rules for buildings. General rules. Structural fire design*

25 Conditions

25.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is granted only to the company, firm or person named on the front page — no other company, firm or person may hold or claim any entitlement to this Certificate
- 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.

25.2 References in this Certificate to any Act of Parliament, Statutory Instrument, Directive or Regulation of the European Union, British, European or International Standard, Code of Practice, manufacturers' instructions or similar publication, are references to such publication in the form in which it was current at the date of this Certificate.

25.3 This Certificate will remain valid for an unlimited period provided that the product/system and the manufacture and/or fabrication including all related and relevant 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.

25.4 In granting this Certificate, the BBA is not responsible for:

- 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 the nature, design, methods and workmanship of or related to the installation
- the actual works in which the product/system is installed, used and maintained, including the nature, design, methods and workmanship of such works.

25.5 Any information relating to the manufacture, supply, installation, use and maintenance 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 and maintained. It does not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date 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. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the manufacture, supply, installation, use and maintenance of this product/system.

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