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Roads and Bridges
Agrément Certificate
04/R137
Product Sheet 1

ANDERTON SYSTEMS FOR REINFORCED SOIL RETAINING WALLS AND BRIDGE ABUTMENTS

ANDERTON UNIVERSAL

The Highways Agency requirements to which this Certificate is subject are detailed on page 2

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to Anderton Universal, a reinforced soil retaining wall and bridge abutment system comprising concrete block facing units in combination with Tensar RE520, RE540, RE560 and RE580 geogrids.

AGRÉMENT CERTIFICATION INCLUDES:

- factors relating to compliance with Highways Agency requirements where applicable
- factors relating to compliance with Regulations 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

Mechanical properties — the following key areas have been evaluated:

- long-term connection strength (see section 6.1)
- design strength of the wall system including safety factors (see sections 6.2 to 6.7).

Durability — the wall system with concrete blocks classified as XF2 to BS 8500-1 : 2006 can achieve a design life greater than 100 years (see section 7).

The BBA has awarded this Agrément Certificate to the company named above for the systems described herein. These systems have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 4 January 2011

Originally certified on 14 June 2004

Brian Chamberlain

Head of Approvals — Engineering

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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Highways Agency Requirements

All proposals for adopting the systems shall comply with current HA design and certification procedures and relevant design data shall be submitted in accordance with the requirements of section 3 of this Certificate.

The design, materials specification and construction methods adopted shall be in accordance with HA Technical Standard BD 70/03 (DMRB 2.1.5) and the Manual of Contract Documents for Highway Works (MCHW)⁽¹⁾, Volumes 1 and 2, August 1998 (as amended).

(1) The MCHW is operated by the Overseeing Organisations: The Highways Agency (HA), Transport Scotland, the Welsh Assembly Government and The Department for Regional Development (Northern Ireland).

Regulations

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* (2.2 and 2.3) and 8 *Procedure* (8.1)

General

This Certificate relates to Anderton Universal, a reinforced soil retaining wall and bridge abutment system comprising concrete block facing units in combination with Tensar RE520, RE540, RE560 and RE580 geogrids.

The blocks and geogrids are connected by a combination of polymeric comb connectors and frictional-fill material.

The design and construction of the reinforced soil structure shall be in accordance with the requirements of the Highways Agency (HA); acting on behalf of the Department for Transport, the Scottish Executive, the Welsh Assembly Government, and the Department for Regional Development, Northern Ireland; and the conditions set out in the *Design Considerations* and *Installation* parts of this Certificate.

Technical Specification

1 Description

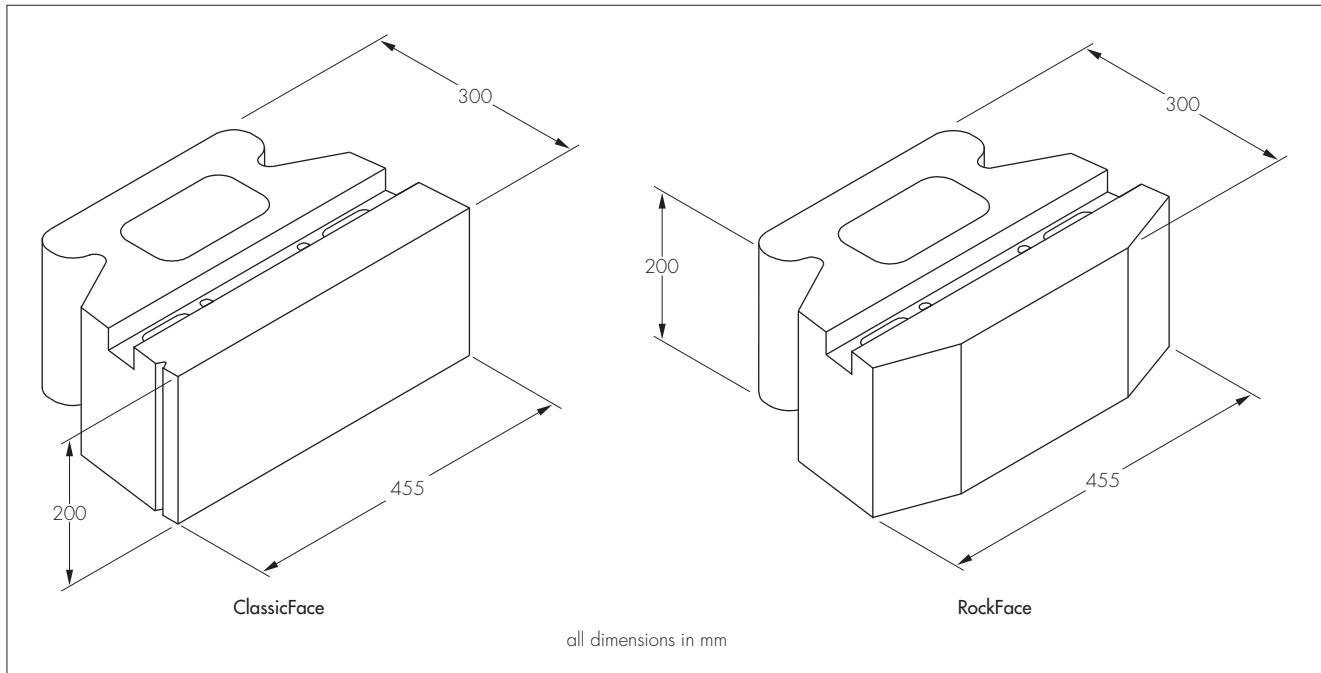
1.1 The system comprises:

- Anderton Universal concrete block facing units (Keystone)
- polymeric comb connectors
- Tensar RE520, RE540, RE560 and RE580 geogrids
- selected granular fill to all voids, in, around and behind the facing units
- pultruded GRP dowels.

Anderton Universal concrete block facing units

1.2 The concrete block facing units covered by this Certificate are the ClassicFace or RockFace types (see Figure 1). All units are manufactured to the same concrete mix specification.

Figure 1 Types of block



1.3 All pigments used for the coloration of the concrete blocks comply with BS EN 12878 : 2005.

1.4 Facing units are manufactured in block machines, where mechanical vibratory compaction and sizing is used with semi-dry concrete to achieve the specified minimum compressive strength, water absorption and block shape:

- minimum concrete strength – $40 \text{ N}\cdot\text{mm}^{-2}$ at 28 days
- water absorption – a maximum of 6% when tested in accordance with the method of BS EN 1339 : 2003
- density range – average value to be a minimum of $1925 \text{ kg}\cdot\text{m}^{-3}$ when tested in accordance with the method of BS 6073-2 : 2008.

1.5 The concrete mix specification comprises a minimum cement content of $340 \text{ kg}\cdot\text{m}^{-3}$ and a maximum water/cement ratio of 0.55 and satisfies the requirements of exposure class XF2 to BS 8500-1 : 2006.

1.6 The blocks are cured for a minimum 24-hour period in a temperature- and humidity-controlled internal environment.

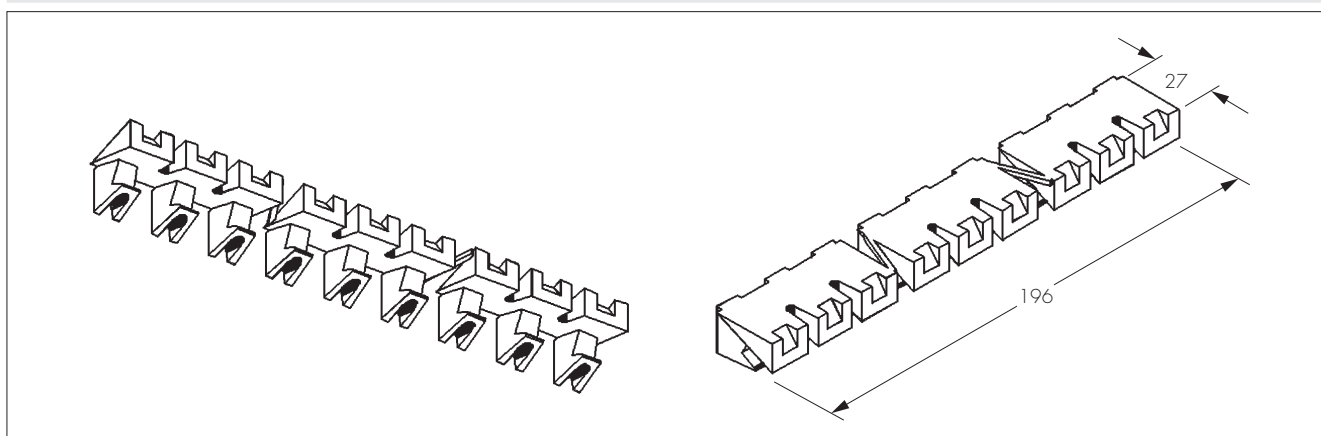
1.7 Factory production control is undertaken throughout all stages of manufacture including:

- formalised daily patrol checks
- formalised recording of use of correct concrete mix specification
- visual checks on appearance of demoulded units and hourly measurements of block heights
- recording of compressive strength and measured density of two cubes tested at seven days and two cubes tested at 28 days taken from mixes produced each day
- formalised acceptance of product after completion of all quality control checks (minimum period before products released for use is seven days).

Polymeric comb connectors

1.8 The polymeric comb connectors (see Figure 2) are manufactured from polyethylene, to one specification, by a sub-contractor approved by the Certificate holder.

Figure 2 Polymeric connectors



Tensar RE520, RE540, RE560 and RE580 geogrids

1.9 The technical specification must comply with BBA Certificate 99/R109, Product Sheet 1.

Pultruded GRP dowels

1.10 The GRP dowels are manufactured by a pultrusion process to achieve both the required durability and long-term mechanical properties. They are 132 mm in length and have a diameter of 12 mm.

Selected granular fill to all voids in, around and behind the facing units

1.11 The granular fill material to all voids must be a crushed, coarse aggregate graded 4 mm to 20 mm in accordance with BS EN 12620 : 2002. Pea gravel or other rounded aggregates must not be used.

Fill

1.12 The fill material used in the structure should comply with the requirements of one of the class 6I, 6J, 7B, 7C and 7D of the HA specification (MCHW, Volumes 1 and 2) and with BD 70/03.

2 Delivery and site handling

Facing units

2.1 The facing units are delivered to site on shrink-wrapped pallets. They carry a manufacturer's label or marking identifying the product type and batch code. Pallets should not be stacked more than two high.

2.2 To prevent damage, care should be taken in transit and handling. During prolonged periods of storage on site the units should remain covered on pallets.

Polymeric comb connectors

2.3 The polymeric connectors are delivered to site in polyethylene bags containing 250 units. The bags are labelled, to show the manufacturer, product type and batch code. The connectors should remain within their packaging until use is imminent, since any damage or dirt accumulation will compromise the structural integrity of the connection.

Tensar RE520, RE540, RE560 and RE580 geogrids

2.4 The geogrids should be handled and stored generally in accordance with HA requirements and BBA Certificate 99/R109, Product Sheet 1.

Pultruded GRP dowels

2.5 The GRP dowels are delivered to site in boxes. Care should be taken in storage, transit and handling on site.

Assessment and Technical Investigations

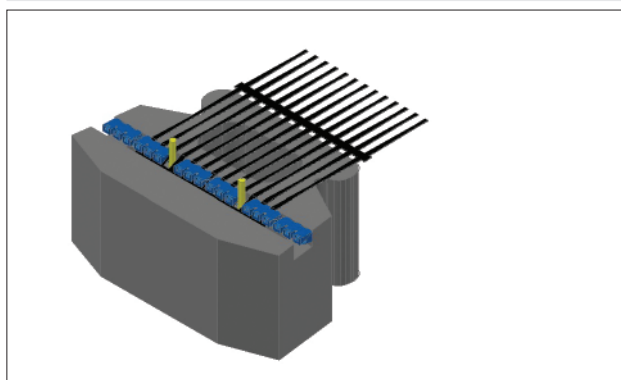
The following is a summary of the assessment and technical investigations carried out on Anderton Universal.

Design Considerations

3 General

3.1 The Anderton Universal Reinforced Soil Retaining Wall and Bridge Abutment System is satisfactory for use in providing reinforced soil retaining walls. Walls up to a maximum height of 10 metres are covered by this Certificate. Structural stability is achieved through the frictional interaction and interlock of the soil particles and the geogrid and by the mechanical connection of the geogrid to the facing units via the polymeric comb connectors (see Figure 3).

Figure 3 Method of connecting geogrid to facing unit



3.2 The BBA has not assessed this system for supporting parapet loading caused by vehicle collision at the top of the facing units. When applicable, this aspect of a design would require separate consideration and approval by the HA.

3.3 In common with all retaining walls of this type, supplementary details are required if there is a risk of dislodgement of the top courses.

3.4 The system should be protected against horizontal impact loads caused by possible vehicle collision with the lower facing units of the wall.

3.5 Design of the reinforced soil wall must be in accordance with HA requirements and carried out by a suitably qualified engineer.

3.6 Prior to the commencement of the work, the designer shall submit to the HA nominee via the main contractor, relevant design and check certificates in accordance with current HA requirements and, as required, details:

- working drawings
- calculations
- source of fill material
- acceptable moisture content of fill material at time of placement
- method of tightening geogrids prior to fill placing
- sequence of placing fill material
- estimated movements of facing units during filling and compaction operations
- tolerance on the position of finished line of the wall.

4 Practicability of installation

4.1 The system is designed to be installed by contractors experienced with this type of product and can be installed easily provided all requirements of BBA Certificate 99/R109, Product Sheet 1, and section 8 of this Certificate are complied with.

4.2 It is important that the first course of concrete block units is laid accurately to the correct line and level to avoid compounding errors in alignment as the wall is built.

4.3 Where accurate cutting of facing units is required on site, this should be carried out by disc-cutting techniques.

4.4 To avoid problems with the level of the facing units, the geogrid should not be lapped when attached to the GRP dowels. Adjacent strips of geogrids should be positioned to abut.

5 Design considerations

5.1 Walls utilising the system must be designed in accordance with BD 70/03.

5.2 Adequate consideration must be given to the provision of drainage to the wall in accordance with HA requirements.

5.3 It is considered that with correct design and workmanship, and by following the recommendations of this Certificate, normally accepted tolerances for the construction of retaining walls, as defined in BS 8006-1 : 2010, Table 18, can be achieved. However, where the alignment of the vertical face is critical, consideration may be given to providing a brickwork skin, or similar, to the facing units.

5.4 The design of the retaining wall as a whole unit must ensure that the facing units can provide adequate anchorage to the geogrid and provide local support to the soil between the layers of geogrid.

5.5 To prevent interface shear, all blocks must be interconnected with the glassfibre dowels, whether or not a reinforcing layer is to be used.

6 Mechanical properties

Long-term connection strength (T_{conn})

6.1 A value for the long-term connection strength of the wall system (see Table 1) has been derived by performing a series of short-term tests in line with the National Concrete Masonry Association *Design Manual for Segmental Retaining Walls* (Second Edition, 1997). From the results of these tests, a connection efficiency, expressed as a percentage, has been applied to the values of tensile creep rupture strength (T_{cr}) of the grid (as given in BBA Certificate 99/R109, Product Sheet 1).

Table 1 Long-term connection strength (T_{conn})

| Geogrid grade | T_{cr} (kN·m ⁻¹) | Wall height (mm) | T_{conn} (kN·m ⁻¹) |
|---------------|-----------------------------------|---------------------|-------------------------------------|
| RE520 | 27.3 | 0.0–1.0 | 17.3 |
| | | 1.1–1.9 | 20.0 |
| | | 2.0–2.8 | 21.1 |
| | | 2.9–3.6 | 20.9 |
| | | 3.7–4.6 | 21.7 |
| | | 4.7–6.1 | 21.3 |
| | | 6.2–9.1 | 23.0 |
| RE540 | 33.4 | 0.0–1.4 | 27.5 |
| | | 1.5–3.8 | 28.2 |
| | | 3.9–6.2 | 26.6 |
| | | 6.3–8.1 | 27.4 |
| | | 8.2–10.0 | 24.3 |
| RE560 | 45.9 | 0.0–1.0 | 38.1 |
| | | 1.1–2.1 | 36.8 |
| | | 2.2–3.1 | 38.7 |
| | | 3.2–5.2 | 37.9 |
| | | 5.3–7.0 | 38.8 |
| | | 7.1–8.7 | 37.0 |
| | | 8.8–10.0 | 32.2 |
| RE580 | 71.1 | 0.0–2.0 | 64.9 |
| | | 2.1–4.0 | 64.5 |
| | | 4.1–5.9 | 64.8 |
| | | 6.0–7.8 | 65.8 |
| | | 7.9–9.6 | 62.6 |
| | | 9.7–10.0 | 58.4 |

Design strength of Anderton wall system

6.2 To evaluate the overall design strength of the wall system, it is necessary to consider both the design strength of the grid (T_{Dgrid}) and the design strength of the connection (T_{Dconn}).

Design strength (T_{Dgrid})

6.3 T_{Dgrid} should be calculated for both ultimate and serviceability limit states using the information contained in BBA Certificate 99/R109, Product Sheet 1.

Design strength (T_{Dconn})

6.4 For the ultimate limit state, the connection design strength should be calculated by using:

$$T_{Dconn} = T_{conn} / f_m f_n$$

6.5 For all designs involving the use of the wall system, the value of the partial factor for ramification of failure (f_n), should be in accordance with BD 70/03.

6.6 The values of the partial material factor (f_m), sub-components should be taken from Table 2.

Table 2 Partial material factor (f_m) sub-component factors for evaluating T_{Dconn}

| Partial material factor component | Value |
|-----------------------------------|---|
| f_{m11} | 1.00 |
| f_{m121} | 1.00 |
| f_{m122} | 1.00 |
| f_{m211} | 1.00 ⁽¹⁾ |
| f_{m212} | 1.05 ⁽¹⁾ |
| f_{m22} | 1.00 ⁽²⁾ , 1.05 ⁽³⁾ |

(1) Short-term installation damage effects are deemed to have been taken into account through the method of deriving the value T_{conn} .

(2) Soil pH range 4.0 to 12.5 for Tensor RE500 geogrids as Certificate 99/R109, Product Sheet 1.

(3) Soil pH range 2.0 to 4.0 for Tensor RE500 geogrids as Certificate 99/R109, Product Sheet 1.

6.7 The design load the connection must resist (T_i) is to be calculated using prescribed load factors recommended in BD 70/03. For all designs, including the wall system, the minimum value of load factor is to be 1.5. In all cases T_i must be $\leq T_{Dconn}$.

7 Durability

7.1 In the opinion of the BBA, when used and installed in accordance with this Certificate, the wall system results in a reinforced soil structure that can achieve a design life of greater than 100 years. This is based on the assumption that the exposure environment for the concrete has a Class designation of XF2 in accordance with BS 8500-1 : 2006, Table A.1.

7.2 Where concrete facing units are to be embedded in soils which could potentially be aggressive, the guidance in BRE Special Digest 1 : 2005 *Concrete in aggressive ground* should be followed.

7.3 Durability properties of the Tensar RE500 geogrids are contained in BBA Certificate 99/R109, Product Sheet 1.

7.4 Fill materials classified as 6I, 6J, 7B, 7C and 7D should comply with the limits of Table 6/3 of the 600 series of the MCHW1 regarding maximum water soluble sulfate content and maximum oxidisable sulfides content.

Installation

8 Procedure

8.1 Formation levels are prepared and a suitable concrete foundation is laid to the correct level for the first course of facing units. The first course of facing units should always be laid on a mortar bed, or bedded into the fresh concrete, to achieve the required accuracy in line and level. Facing units should be lifted and located by two men using appropriate lifting equipment.

8.2 The GRP dowels should be securely inserted to over half their length into the appropriate paired holes in the facing units (see Figure 1). All blocks must be inter-connected with glassfibre dowels, whether or not a geogrid layer is to be inserted.

8.3 Facing units should be laid until the required level of the first layer of geogrid. All voids, in, between and immediately behind the facing units, are filled with the granular fill material. The drainage zone should extend a minimum of 300 mm behind the facing units. Backfill may then be placed and compacted to the level of the first layer of geogrid.

8.4 Fill should be placed by mechanical plant but, to avoid excessive movement of the wall facing, heavy compaction plant should not be employed within two metres of the facing units, where the depth of fill before each pass may be less than 150 mm to suit the compaction plant used (MCHW1, Clause 622.7). Outside this area, installation and compaction of Tensar RE500 geogrids should be as described in BBA Certificate 99/R109, Product Sheet 1.

8.5 In general, the compacted fill should be level to receive the geogrid and the blocks swept to remove all debris. A suitable length of geogrid should be cut from the roll and any protruding ribs trimmed back to within 10 mm of the transverse bar. The prepared end of the grid is placed over the rebate in the block and the polymeric connectors located around the transverse bar. Each aperture of the geogrid must be covered by a connector.

8.6 The assembly is positioned neatly into the rebate of the facing unit and pushed down firmly. The next course of blocks is placed over the GRP dowels, locating the kidney-shaped recesses over the pins, and pushed towards the front of the structure until it makes full contact with both pins.

8.7 Depending upon the design, up to three courses of facing units may be laid before inserting a further layer of geogrid (606 mm maximum vertical spacing).

8.8 The geogrid should be lightly tensioned using the tensioning beam supplied, so that the polymeric connectors are up against the rear of the rebate.

8.9 The procedure is repeated until the required level for a coping facing unit is reached.

8.10 Connection of lengths of geogrid (other than at the facing units) should be by Tensar Bodkins as described and detailed in BBA Certificate 99/R109, Product Sheet 1.

Technical Investigations

9 Investigations

9.1 The manufacturing process for the concrete facing units was examined, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

9.2 An examination was made of test data relating to:

- compressive strength of concrete block facing units
- durability
- performance of the retaining wall system under fire test conditions
- assessment, including product specific testing, of the connection strength between the Tensar RE geogrids and facing units using the polymeric connector.

9.3 Visits were made to installations in progress to assess the practicability and ease of construction of the system.

9.4 Proposed design methods were assessed in relation to the requirements of BD 70/03 and the *Design Manual for Segmental Retaining Walls* (Second Edition 1997) National Concrete Masonry Association, Herndon, Virginia, USA.

Bibliography

- BS 6073-2 : 2008 *Precast concrete masonry units — Guide for specifying precast concrete masonry units*
- BS 8006-1 : 2010 *Code of practice for strengthened/reinforced soils and other fills*
- BS 8500-1 : 2006 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier*
- BS EN 1339 : 2003 *Concrete paving flags — Requirements and test methods*
- BS EN 12620 : 2002 *Aggregates for concrete*
- BS EN 12878 : 2005 *Pigments for the colouring of building materials based on cement and/or lime — Specifications and methods of test*
- BD 70/03 *Design Manual for Roads and Bridges (DMRB), Volume 2 Highway Structures : Design (Substructures and Special Structures), Materials, Section 1 Substructures — Part 5 Strengthened/Reinforced Soils and other Fills for Retaining Walls and Bridge Abutments*
- Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works*
- Manual of Contract Documents for Highway Works, Volume 2 *Notes for Guidance on the Specification for Highway Works*

Conditions of Certification

10 Conditions

10.1 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.

10.2 Publications and documents referred to in this Certificate are those that the BBA deems to be relevant at the date of issue or re-issue of this Certificate and include any: Act of Parliament; Statutory Instrument; Directive; Regulation; British, European or International Standard; Code of Practice; manufacturers' instructions; or any other publication or document similar or related to the aforementioned.

10.3 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
- remain in accordance with the requirements of the Highways Agency.

10.4 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.

10.5 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.