HAPAS

Allan Block Corporation
7424 West 78th Street
Bloomington
Minnesota 55439
USA
Tel: 00 1 952 835 5309 Fax: 00 1 952 835 0013
e-mail: info@allanblock.com
website: www.allanblock.com

BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

HAPAS Certificate
13/H203
Product Sheet 1

ALLAN BLOCK RETAINING WALL SYSTEM

AB MODULAR STACKABLE CONCRETE BLOCK WALL SYSTEM FOR REINFORCED SOIL RETAINING WALLS AND BRIDGE ABUTMENTS

This HAPAS Certificate Product Sheet(1) is issued by the British Board of Agrément (BBA), supported by the Highways Agency (HA) (acting on behalf of the Overseeing Organisations of the Department for Transport; Transport Scotland; the Welsh Assembly Government and the Department for Regional Development, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers' Group and industry bodies. HAPAS Certificate Product Sheets are normally each subject to a review every five years.

(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to the AB Modular Stackable Concrete Block Wall System for Reinforced Soil Retaining Walls and Bridge Abutments for use up to a maximum height of 10 metres. The system comprises concrete block facing units, Fortrac MP and Fortrac T geogrids and compacted fill.

CERTIFICATION INCLUDES:

- factors relating to compliance with HAPAS requirements
- 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 five-yearly review.

KEY FACTORS ASSESSED

Mechanical properties — the method of connection between the geogrids and concrete block facing units has been assessed and long-term connection strength values determined for various wall heights and concrete block/geogrid combinations (see Table 6). The interface shear capacity between adjacent concrete block facing units in between layers of geogrid reinforcement has been assessed and is satisfactory (see section 7.8).

Performance of geogrids — the short- and long-term tensile strength of the geogrids, resistance to installation damage, weathering and environmental effects and soil/geogrid interaction have been assessed(1) (See section 7).

Durability — when designed and installed in accordance with the provisions of this Certificate, the system will have adequate durability for its intended use as a retaining wall or bridge abutment (see section 9).

(1) Data and reduction factors for use in design are given in BBA Certificate 13/H197.

The BBA has awarded this Certificate to the company named above for the system described herein. This system 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

Date of First issue: 30 July 2013

Brian Chamberlain
Head of Approvals — Engineering

Claire Curtis-Thomas
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.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA
tel: 01923 665300
fax: 01923 665301
e-mail: mail@bba.star.co.uk
website: www.bbacerts.co.uk

Requirements

In the opinion of the BBA, the AB Modular Stackable Concrete Block Wall System for Reinforced Soil Retaining Walls and Bridge Abutments, when designed and installed in accordance with the provisions of this Certificate, will meet the requirements of the Highways Agency and local Highway Authorities for the design and construction of reinforced soil retaining walls and bridge abutments.

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: 1 *Description* (1.2) 3 *Delivery and site handling* (3.1, 3.3, 3.7 and 3.8) and the *Installation* part of this Certificate.

Additional Information

CE marking

The Certificate holder's nominated supplier for the concrete block facing units has taken the responsibility of CE marking the blocks in accordance with harmonised European Standard BS EN 771-3 : 2011. An asterisk (*) appearing in this Certificate indicates that data shown is given in the manufacturer's Declaration of Performance.

The manufacturer has taken the responsibility of CE marking the geogrids in accordance with harmonised European Standard BS EN 13251 : 2001. An asterisk (*) appearing in this Certificate indicates that data shown is given in the manufacturer's Declaration of Performance.

Technical Specification

1 Description

1.1 The AB Modular Stackable Concrete Block Wall System for Reinforced Soil Retaining Walls and Bridge Abutments comprise:

- AB Classic, AB Stones, AB One Degree and AB Vertical modular dry jointed, hollow, concrete block facing units
- AB Capstone
- Fortrac MP and Fortrac T geogrids(1)
- fill material.

(1) covered under BBA Certificate 13/H197.

Concrete block facing units

1.2 The blocks are manufactured from concrete conforming to the following minimum specification, satisfying the Highways Agency's requirements for durability of class XF2 exposure to BS 8500-1 : 2006 (see Table 1).

Table 1 Concrete characteristics

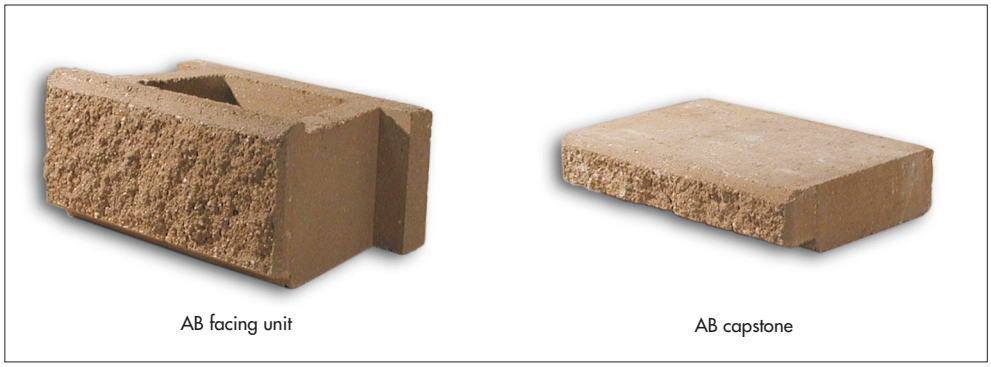
Property	Value
Minimum concrete cube strength at 28 days ($N \cdot mm^{-2}$)	40
Minimum cement content ($Kg \cdot m^{-3}$)	340
Maximum water/cement ratio	0.55

1.3 The concrete block facing units covered by this Certificate are shown in Table 2 and Figure 1.

Table 2 AB facing units and AB Capstone

Unit type	Height (*) (mm)	Depth (*) (mm)	Width (*) (mm)	Setback (°)	Weight (kg)
AB Stones	200	300	450	12	35
AB Classic	200	300	450	6	35
AB Vertical	200	300	450	3	35
AB One Degree	200	300	450	1	35
AB Capstone	100	300	450	–	27

Figure 1 AB facing units and AB Capstone



1.4 The blocks conform to BS EN 771-3 : 2011. The performance characteristics given in Table 3 have been declared by the manufacturer in accordance with this Standard.

Table 3 Performance values in accordance with BS EN 771-3

Property	Test method	Manufacturer's declared values (*)
Dimensional tolerances		Category D2
Compressive strength (mean) ($N \cdot mm^{-2}$)		>40
Density ($kg \cdot m^{-3}$)		2350
Maximum water Absorption (%)	BS EN 1338: 2003 Annex E	6

1.5 The concrete block facing units are available in a range of colours, including: Limestone Blend, Cinder Blend, Slate Blend, Abbey Blend, Pewter and Cotswold. All pigments used for the coloration of the concrete units comply with BS EN 12878 : 2005.

Geogrids

1.6 Fortrac MP and T Geogrids are planar structures consisting of a regular open network of woven or knitted, integrally-connected tensile elements of yarn coated with a protective layer of black polymer. The MP Geogrid yarn is manufactured from high modulus polyvinyl alcohol (PVA) multifilament fibres in the warp direction and high tenacity polyamide (PA) fibres in the cross machine direction. The Fortrac T Geogrid yarn is manufactured from polyester fibres. The grades(1) covered by this Certificate are:

- Fortrac 20/13-20/30 MP
- Fortrac 35/20-20/30 MP
- Fortrac 55/25-20/30 MP
- Fortrac 80/25-20/30 MP
- Fortrac 35/20-20T
- Fortrac 55/30-20T
- Fortrac 80/30-20T
- Fortrac 110/30-20T

(1) Full product details are given in BBA Certificate 13/H197

Wall Rock Fill Material

1.7 Crushed coarse aggregate is used to infill the hollow cores of the AB facing units and a 300 mm wide layer immediately behind the wall. The aggregate must be well-graded granular fill ranging in diameter from 6 mm to 38 mm and containing less than 10% passing the 0.075 mm sieve size.

Fill material

1.8 Fill materials must comply with the requirements set out in BS 8006-1 : 2010 and the MCHW, Volume 1.

2 Manufacture

2.1 The concrete block facing units are manufactured to an agreed specification by the Certificate holder's nominated supplier. Ingredients for the concrete are weighed by a computer-controlled weigh-batcher system and the blocks cast in block machines.

2.2 The geogrids are manufactured from yarn woven or knitted into grids and coated with a protective layer of black polymer.

2.3 As part of the assessment and ongoing surveillance of product quality, the BBA has:

- agreed with the respective manufacturers the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.4 The manufacturer's management system for the concrete block facing units has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by BM TRADA (Certificate No 6593).

2.5 The manufacturer's management system for the geogrids has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by TÜV NORD CERT GmbH (Certificate No 04 100 970084).

3 Delivery and site handling

3.1 The concrete block facing units and capstones are tied together with steel straps and delivered to site on shrink-wrapped pallets. The pallets carry a manufacturer's label bearing the product type and batch code. Pallets should not be stacked more than two high.

3.2 To avoid damage, care should be taken in transit and handling. Damaged materials must not be used. During prolonged periods of storage on site, the blocks should remain covered on pallets.

3.3 The geogrids are delivered to site in 5.0 metre wide rolls between 0.5 m to 0.9 m (Fortrac T) or 0.5 m to 0.6 m (Fortrac MP) diameter, giving approximately 100 m or 200 m of length.

3.4 Each roll is wrapped for transit and site protection in black polythene film and stacked/strapped in timber pallets for distribution.

3.5 Each bag is labelled with the geogrid grade and identification

3.6 The ends of the rolls are sprayed with colour-coded paint to assist identification of a particular grade of geogrid on site in accordance with BS EN ISO 10320 : 1999.

3.7 The geogrids should be stored in clean, dry conditions and protected from mechanical or chemical damage, exposure to direct sunlight and extreme temperatures. When laid horizontally, the rolls may be stacked up to five high. No other loads should be stored on top of the stack. The packaging should not be removed until immediately prior to installation.

3.8 Toxic fumes are given off if the geogrids catch fire and therefore, the necessary precautions should be taken, following the instructions of the material safety data sheet for the product.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on AB Modular Stackable Concrete Block Wall System for Reinforced Retaining Walls and Bridge Abutments.

Design Considerations

4 General

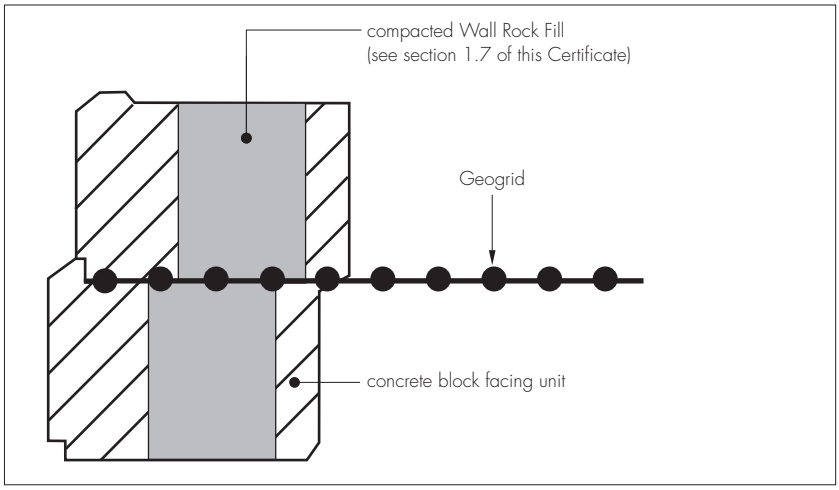
4.1 When designed and installed in accordance with this Certificate, the AB Modular Stackable Concrete Block Wall System is satisfactory for the construction of reinforced soil retaining walls and bridge abutments up to a maximum height of 10 metres. Walls above this height require special consideration and are outside this scope of the Certificate.

4.2 Structural stability of the wall system is achieved through:

- interface shear capacity between adjacent rows of blocks
- the connection strength between the blocks and geogrid layers (see Figure 2) at each layer of geogrid
- the tensile strength of the geogrids, and
- the embedment and resistance to sliding and pull out of the geogrids from the fill material.

4.3 The connection between the geogrids and concrete block facing units is formed by the interaction between the geogrids and the Wall Rock Fill material placed and compacted into the hollows of the concrete blocks (see Figure 2). It is critical that construction of the connection is carried out carefully and is closely supervised (see the *Installation* part of this Certificate).

Figure 2 Connection of geogrids to facing units



4.4 Prior to the commencement of work, the designer must satisfy the design approval and certification procedures of the relevant Highway Authority.

4.5 The BBA has not assessed the structures for supporting parapet loading caused by vehicle collision at the top of the facing units.

4.6 Reinforced soil structures constructed using the AB Modular Stackable Concrete Block Wall System should be protected with suitable barriers, to protect the structure against potential damage from vehicle impact and vehicle fires.

4.7 In addition to those factors covered in section 6 of this Certificate, attention must also be paid in design to:

- site preparation
- fill material properties
- the specification for placing and compaction of the fill material
- drainage behind the wall
- protection of the geogrid against damage during installation.

4.8 It is considered that with correct design and workmanship and by following the recommendations of this Certificate, normally accepted tolerances of line and level 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 wall units.

4.9. Particular attention should be paid to changes in direction of walls where overlapping of the geogrids may occur. Detailed guidance is given in the Certificate holder's technical literature. BS 8006-1 : 2010 also gives guidance on typical layout plans for the geogrids (reinforcing elements) in bridge abutments.

5 Practicability of installation

The system is designed to be installed by trained contractors in accordance with the specifications and construction drawings (see the *Installation* part of this Certificate). Close supervision is required to ensure the integrity of the connection between the geogrids and concrete block facing units.

6 Design

Design methodology

6.1 Reinforced soil retaining walls and bridge abutments constructed using the AB Modular Stackable Concrete Block Wall System must be designed in accordance with BS 8006-1 : 2010 and the Specification for Highway Works.

6.2 In accordance with BS 8006-1 : 2010 Annex B, the required design life for permanent walls and bridge abutments is 120 years.

6.3 To evaluate the overall stability of the wall system, it is necessary to consider:

- the design strength and length of embedment of the geogrid,
- the connection strength between the geogrid and concrete block facing units
- the interface shear capacity of the blocks between layers of geogrid reinforcement.

Design strength of geogrids (ultimate limit state)

6.4 The design methodology for determination of the ultimate limit state (ULS) design strength of the geogrids is given in BS 8006-1 : 2010 and in the design sections of BBA HAPAS Certificate 13/H197 Product Sheets 2 and 3 (see also section 7.1 of this Certificate).

6.5 The ultimate limit state design strength of the geogrid ($T_{D\,(ULS)}$), should be taken as:

$T_{CR}/f_m \times f_n$, where:

T_{CR} = the long-term tensile creep strength of the geogrid, at the appropriate design life and design temperature

f_m = the partial material factor

f_n = the partial factor for ramification of failure in accordance with BS 8006-1 : 2010, Table 9.

6.6 For the ultimate limit state, the design load (T_i) at each level that the geogrid must resist is calculated using prescribed load factors in accordance with BS 8006-1 : 2010. In all cases, T_i must be $\leqslant T_{D\,(ULS)}$.

Design strength of geogrids (serviceability limit state)

6.7 The serviceability limit state design strength of the geogrid ($T_{D\,(SLS)}$), should be taken as:

T_{CS}/f_m,

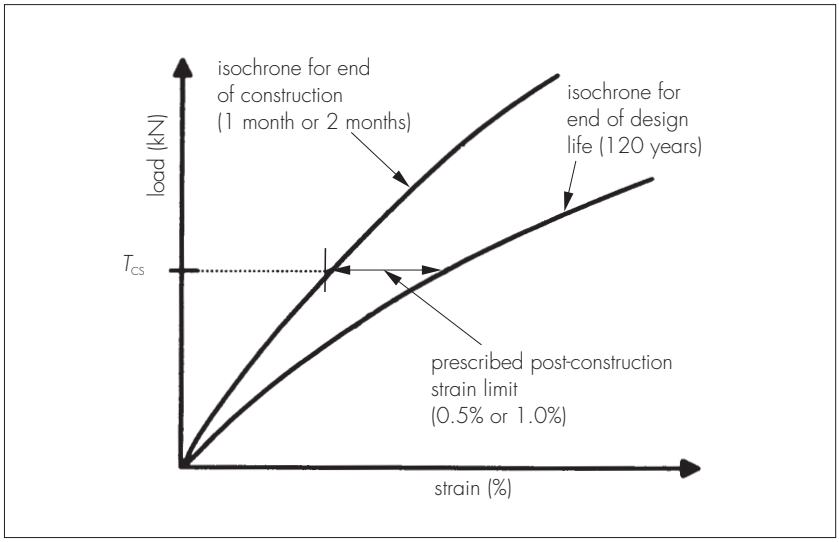
where:

T_{CS} is the tensile load in the reinforcement which induces the prescribed limit value of post-construction strain in the geogrid

f_m = the partial material factor

6.8 The definitions of prescribed post-construction strain limit and T_{CS}, the tensile load that would create the prescribed post-construction strain, are explained in Figure 3.

Figure 3 Definition of T_{CS}



6.9 The prescribed maximum allowable post-construction creep strains allowed by BS 8006-1 : 2010 for the serviceability limit state of reinforced soil retaining walls and bridge abutments are shown in Table 4.

Table 4 Serviceability limits on post-construction internal strains for bridge abutments and retaining walls

Structure	Strain (%)	Design period for the purposes of determining limiting strain
Bridge abutments and retaining walls with permanent structural loading	0.5	2 months – 120 years
Retaining walls, with no applied structural loading i.e. transient live loadings only	1.0	1 month – 120 years

6.10 Post-construction strain can be related to the average load in the reinforcement. The average serviceability limit state design loads (T_{avj}) that the geogrid must resist is to be calculated in accordance with BS 8006-1 : 2010. The average load in the *j*th level (T_{avj}), is related to the maximum load in the reinforcement (T_j) by a factor *k* such that $T_{avj} = T_j/k$. The factor *k* has a minimum value of unity and generally falls in the range of 1.0 to 2.0. Where the distribution of tensile load along the loaded length of the reinforcement is not proven by field measurements, the factor *k* should be taken as unity. In all cases, $T_{avj} \leqslant T_{D(SLS)}$.

6.11 Isochronous curves, design values for T_{cs} and reduction factors for determination of $T_{D(SLS)}$ are given in Sections 7.2 to 7.5 of this Certificate.

Design of geogrids (determination of resistance to direct sliding and pull out)

6.12 The design methodology for determination of resistance to pull out and direct sliding, and therefore, the required length of embedment of the geogrids is given in BS 8006-1 : 2010 and in the design sections of BBA HAPAS Certificates 13/H197 Product Sheets 2 and 3.

Connection strength between the geogrids and concrete block facing units

6.13 The design connection strength between the geogrids and concrete block facing units (T_{Dconn}) should be determined for the ULS and checks should be made to ensure that it is not exceeded by the design load (T_j) at each level i.e. $T_j \leq T_{Dconn}$. Particular care should be taken during the design of bridge abutments to ensure that adequate reinforcement is provided and adequate connection strengths are achieved at the top of the wall and in front of bank seats.

6.14 The design connection strength (T_{Dconn}) is determined using the following formula:

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

Where:

T_{conn} = the long-term connection strength derived from testing (See Section 7.6)

f_m = the material safety factor for the geogrid (see Section 7.7)

f_n = the partial factor for ramification of failure in accordance with BS 8006-1 : 2010 Table 9.

Interface shear capacity between concrete block facing units

6.15 The interface shear capacity between the concrete block facing units should be checked for the ultimate limit state and checks should be made to ensure that it is not exceeded by the design load (T_j) at each level (see section 7.8).

Specification of fill material

6.16 The designer should specify the relevant properties of the fill material for the reinforced soil structure deemed acceptable for the purposes of the design. Acceptable materials should meet the requirements of BS 8006-1 : 2010 and the MCHW, Volume 1, Series 600.

6.17 Where concrete wall units are to be embedded in potentially aggressive soils, the guidance given in BRE Special Digest 1 : 2005 *Concrete in aggressive ground* should be followed.

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

7 Mechanical properties

Ultimate Limit State (ULS) design strength of geogrids ($T_{D(ULS)}$)

7.1 The characteristic short-term tensile strength (T_{char}) and the associated reduction factors for creep (RF_{CR}), installation damage (RF_{ID}), weathering (RF_W), environmental degradation (RF_{CH}) and extrapolation of data (f_s) required for determination of the ultimate limit state (ULS) design strength of the geogrids ($T_{D(ULS)}$) are given in HAPAS Certificate 13/H197 Product Sheets 2 and 3.

Serviceability Limit State (SLS) design strength of geogrids (T_{CS})

7.2 Isochronous curves for the Fortrac MP and Fortrac T geogrids have been derived from long-term creep strain tests and are shown in Figure 4 and Figure 5.

Figure 4 Isochronous curves for Fortrac MP geogrids

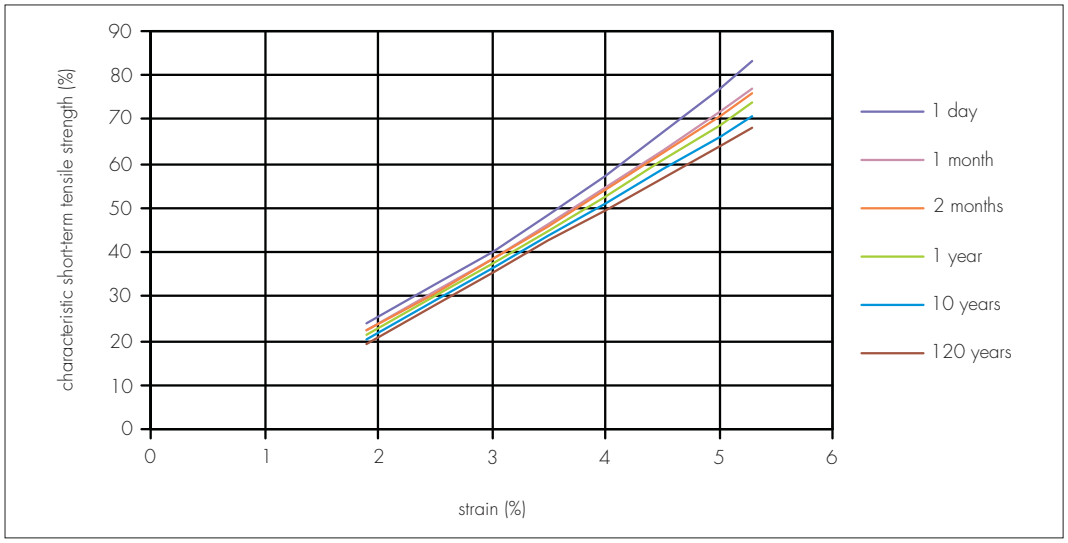
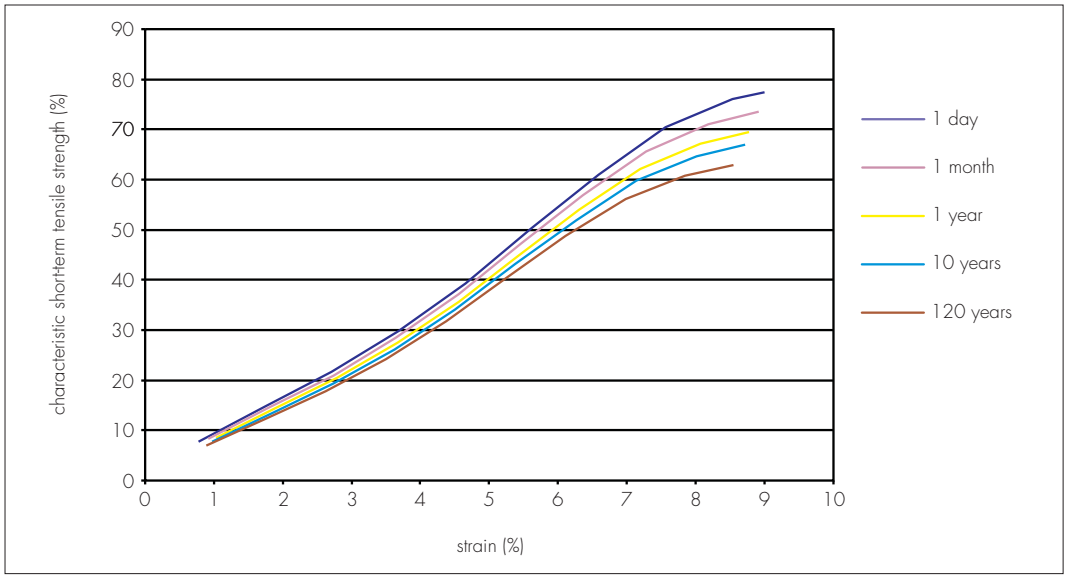


Figure 5 Isochronous curves for Fortrac T geogrids



7.3 For the Fortrac MP geogrids, creep rupture governs the long-term performance of the geogrid, as opposed to creep strain. T_{CS} should therefore be taken as the corresponding T_{CR} value for Fortrac MP geogrids, (see section 7.1).

7.4 For Fortrac T geogrids design values for T_{CS} are given in Table 5.

Table 5 Maximum tensile load inducing prescribed post-construction strain limits for Fotrac T geogrids

Geogrid grade	T_{CS} (kN·m^{-1})	
	Prescribed post-construction strain limits	
	0.5%	1.0%
Fortrac 35/20-20T	17.7	20.8
Fortrac 55/30-20T	27.8	32.7
Fortrac 80/30-20T	40.5	47.5
Fortrac 110/30-20T	55.7	65.3

7.5 Reductions factors for installation damage, weathering and environmental degradation (RF_{ID} , RF_{W} and RF_{CH}) and factors of safety for the extrapolation of data (f_s) required for determination of the serviceability design strength of the geogrids ($T_{D(SLS)}$) are given in HAPAS Certificate 13/H197 Product Sheets 2 and 3.

Design connection strength between the geogrids and concrete blocks facing units (T_{Dconn})

7.6 Long-term connection strength values (T_{conn}) for the wall system, for use in determining the design connection strength (T_{Dconn}), have been derived from short-term tests in line with the National Concrete Masonry Association *Design Manual for Segmental Retaining Walls* 1997) and ASTM D6638 Connection efficiencies determined from these tests have been applied to the long-term creep rupture strength (T_{CR}) values for the geogrids, to determine the relevant long-term connection strengths (T_{conn}). The results are shown in Table 6.

Table 6 Long-term connection strength values (T_{conn}) for use in determining design connection strength (T_{Dconn})

Concrete block facing unit type	Geogrid grade	T_{CR} [1] ($kN \cdot m^{-1}$)	Wall height – H [2] (m)	T_{conn} [3] ($kN \cdot m^{-1}$)
AB Classic and AB Stones	Fortrac 20 MP	14.08	$0.8 \leqslant H \leqslant 10.0$	2.8
	Fortrac 35 MP	24.64	$0.9 \leqslant H \leqslant 10.0$	8.1
	Fortrac 55 MP	38.72	$2.5 \leqslant H < 4.9$	9.7
			$4.9 \leqslant H < 5.8$	10.9
			$5.8 \leqslant H < 7.4$	12.3
			$7.4 \leqslant H \leqslant 10.0$	13.1
	Fortrac 80 MP	56.32	$2.5 \leqslant H < 5.8$	13.3
			$5.8 \leqslant H < 7.4$	14.3
			$7.4 \leqslant H < 8.2$	14.9
			$8.2 \leqslant H \leqslant 10.0$	16.0
	Fortrac 35/20-20T	23.10	$1.5 \leqslant H < 3.5$	8.9
			$3.5 \leqslant H < 9.3$	9.9
			$9.3 \leqslant H \leqslant 10.0$	10.6
	Fortrac 55/30-20T	36.30	$1.5 \leqslant H < 3.5$	9.2
			$3.5 \leqslant H < 9.3$	14.6
			$9.3 \leqslant H \leqslant 10.0$	15.7
	Fortrac 80/30-20T	52.80	$1.5 \leqslant H < 3.5$	9.8
			$3.5 \leqslant H < 5.2$	17.8
			$5.2 \leqslant H < 7.3$	18.3
			$7.3 \leqslant H < 9.3$	20.6
			$9.3 \leqslant H \leqslant 10.0$	26.3
	Fortrac 110/30-20T	72.60	$1.5 \leqslant H < 3.5$	9.9
			$3.5 \leqslant H < 7.3$	19.6
			$7.3 \leqslant H < 9.3$	25.4
			$9.3 \leqslant H \leqslant 10.0$	27.2
AB One Degree and AB Vertical	Fortrac 35/20-20T	23.10	$1.5 \leqslant H < 3.5$	10.3
			$3.5 \leqslant H \leqslant 10.0$	11.2
	Fortrac 55/30-20T	36.30	$1.5 \leqslant H < 3.5$	14.1
			$3.5 \leqslant H < 9.3$	17.3
			$9.3 \leqslant H \leqslant 10.0$	18.0
	Fortrac 80/30-20T	52.80	$1.5 \leqslant H < 3.5$	12.7
			$3.5 \leqslant H < 7.3$	17.2
			$7.3 \leqslant H < 9.3$	19.3
			$9.3 \leqslant H \leqslant 10.0$	21.0
	Fortrac 110/30-20T	72.60	$1.5 \leqslant H < 3.5$	13.5
			$3.5 \leqslant H < 7.3$	19.2
			$7.3 \leqslant H < 9.3$	22.0
			$9.3 \leqslant H \leqslant 10.0$	22.3

(1) Assumes a design life of 120 years and a design temperature of 20°C.

(2) Assumes a density of 1900 $kg \cdot m^{-3}$ of the fill in the hollow core of AB units and the weight of the whole wall height above the connection

(3) In situations where fire can occur adjacent to a structure, connection strength values should be reduced by:

- a factor of 1.25 for Fortrac 20 MP, 35 MP and 55 MP and Fortrac 35/20-20T and Fortrac 55/30-20T grades, and
- a factor of 1.11 for Fortrac 80 MP and Fortrac 80/30-20T and 110/30-20T grades.

7.7 The reduction factors given in Table 7 should be applied to the long-term connection strength values given in Table 6, in order to determine the design connection strength (T_{Dconn}) (see section 6.13).

Table 7 Reduction factors for determination of f_m

Material factor	Reduction factor and conditions of use/limitations
RF_{ID}	A value of 1.00 can be used for all grades of geogrid as short-term installation damage at the point of connection is already taken into account during the connection strength tests.
RF_W, RF_{CH}, f_s	As set out in BBA HAPAS Certificate 13/H197 Product Sheet 2 and 3 respectively, according to geogrid specification selected and conditions of use [1].

(1) pH levels within and immediately behind the wall assumed to be the same as those in the main fill material.

Interface shear capacity between concrete block facing units

7.8 Interface shear capacity between the concrete block facing units is provided by the upper concrete lip of the blocks, the friction between the concrete surfaces and the interlock between the particles of fill material. For the AB Modular Stackable Concrete Block Wall System, the interface shear capacity of the blocks is higher than the corresponding connection strength values, due to the concrete lip. Therefore, the connection strength values govern the design.

8 Maintenance

The exposed faces of the concrete block facing units may require periodic maintenance, to remove dirt build up, mould and moss growth. All other components of the system are confined within the wall and/or fill and do not require maintenance.

9 Durability

9.1 When designed and installed in accordance with this Certificate, the system will have adequate durability for the required 120 year design life of a retaining wall and bridge abutment in conditions encountered in the UK.

9.2 Where the blocks are to be embedded in potentially aggressive soils, the guidance given in BS 8005-1 : 2006 and BRE Special Digest 1 : 2005 should be followed.

10 Reuse and recyclability

The concrete facing units can be crushed and re-used as aggregate. The fill material can also be re-used.

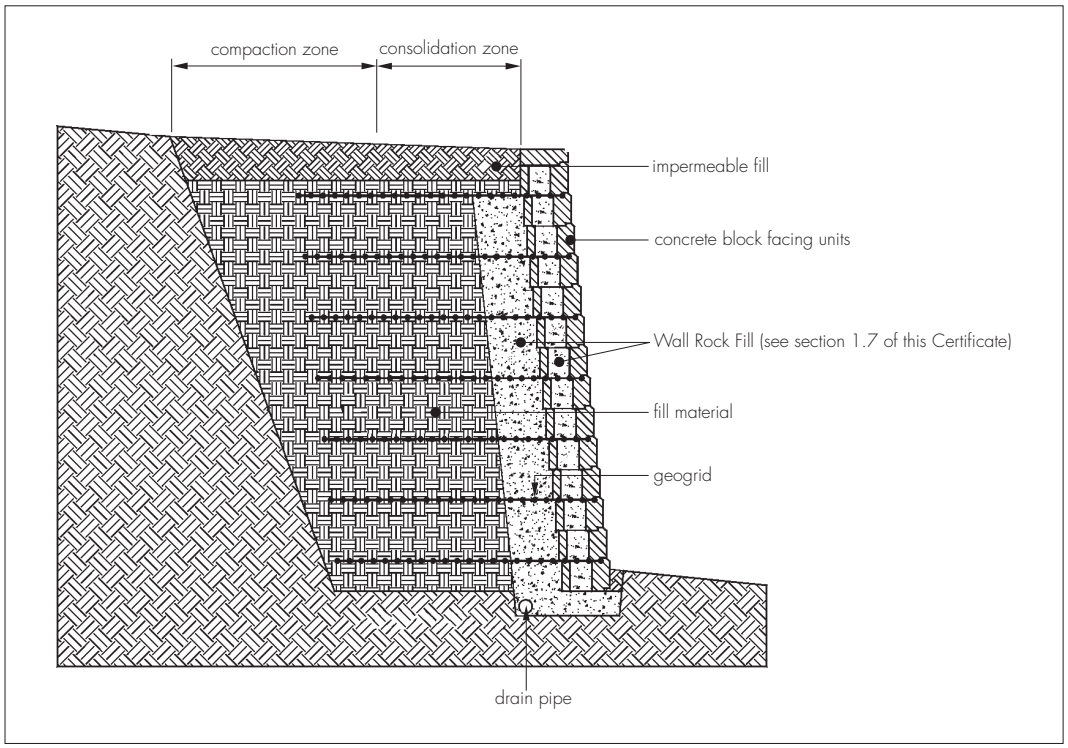
Installation

11 General

11.1 Detailed information on installation of the AB Modular Stackable Concrete Block Wall System for Reinforced Soil Retaining Walls and Bridge Abutments can be found in the Certificate holder's Installation Guide.

11.2 A typical cross-section of a reinforced soil retaining wall constructed using the AB Modular Stackable Concrete Block Wall System is shown in Figure 6.

Figure 6 Typical cross-section of reinforced soil wall



11.3. Installation should also comply with the requirements of BS 8006-1 : 2010 and BS EN 14475 : 2006.

11.4 Close supervision is required particularly during construction of the geogrid to concrete block facing unit connection.

11.5 Detailed guidance on forming curves and corners, including the placement of geogrids, can be found in the Certificate holder's Installation Guide.

11.6 Where accurate cutting of facing units is required on site, disc-cutting techniques may be used, for which appropriate precautions must be taken to mitigate against hazards associated with dust.

11.7 During construction it is particularly important to ensure that:

- fill is properly compacted, especially close to facing units
- at each construction stage, the level of the compacted fill coincides with the level of the facing unit connection to prevent the risk of voids occurring below the geogrid
- the geogrid is tensioned at right angles to the plane of the facing, within a tolerance of ± 50 mm in a five-metre length, and the geogrid is pulled tight to ensure that all slack is removed
- regular checks are made to confirm the alignment of the face and to ensure that any disturbance from compaction process is promptly corrected.

12 Procedure

12.1 The first row of blocks is laid on a levelling pad comprising either well-graded, good compactable material ranging in diameter from 6 mm to 38 mm, or a suitable concrete foundation laid to the correct level. 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.

12.2 Selected crushed coarse granular Wall Rock Fill aggregate (see section 1.7) is placed and compacted in the hollow cores of the concrete block facing units up to the top of the blocks and to a thickness of 300 mm width behind the blocks. Suitable fill soil is then placed and compacted behind the granular fill.

12.3 A drain pipe is installed at the back of the wall and should be vented to a daylight or a stormwater system.

12.4 The compaction requirements for the main fill material depend on the fill type selected and can be found in the MCHW, Volume 1, Clause 612. Heavy plant exceeding one tonne should not be allowed within two metres of the face of the wall (MCHW, Volume 1, Clause 622.7). A vibrating plate compactor of less than one tonne must carry out compaction within this zone.

12.5 The next course of concrete blocks facing units is laid, ensuring that the vertical seams are offset by at least 75 mm. The filling and compaction process is repeated as detailed in sections 12.2 and 12.4.

12.6 Geogrids are placed at the levels shown on the project construction drawings. A suitable length of geogrid is cut from the roll and laid with the cut edge tight against the back edge of the raised front lip of the concrete block facing units. The geogrid is placed with the machine direction perpendicular to the wall face and pulled back over the compacted area.

12.7 The next row of concrete block facing units is placed carefully into position on top of the geogrid, checking regularly that the geogrid remains in its correct position as each block is laid. Once the blocks are in place, the geogrid is pulled back, hand tight, to remove any slack and the corners staked in position. Further checks must be made at this stage, by observation through the hollows in the concrete blocks to ensure that the geogrid is still correctly embedded within the blockwork wall.

12.8 Wall Rock Fill is then placed into the hollow cores of the concrete blocks up to the top of the blocks and to 300 mm width behind the blocks. Suitable fill soil is also placed behind the granular Wall Rock Fill. The fill should be placed by mechanical plant with an opening bucket, avoiding trafficking of unprotected grids, and should cover the grid reasonably uniformly.

12.9 The fill materials are compacted as detailed in section 12.4, starting with the Wall Rock Fill placed in the hollow cores of the concrete block facing units, so forming the geogrid/block connection and then behind the wall, working away from the wall.

12.10 The general construction procedure described is repeated until the required coping is reached.

12.11 The coping units include a concrete lip to prevent them sliding forward over the wall and can be additionally secured using a high grade, flexible, waterproof masonry adhesive (outside the scope of this Certificate).

Technical Investigations

13 Investigations

13.1 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.

13.2 An examination was made of test data relating to:

- strength of concrete block facing units
- durability
- performance of the retaining wall system under fire test conditions
- the connection strength between the geogrids and facing units.

13.3 An assessment was made of the method of installation to assess the practicability and ease of construction of the system.

13.4 Research papers and test reports regarding the performance of the System during seismic activity were examined.

13.5 Case studies relating to use of the the AB Modular Stackable Concrete Block Wall System for Reinforced Soil Retaining Walls and Bridge Abutments in projects around the world were examined.

13.6 Dimensional check tests were carried out on the concrete block facing units and capstone units.

Bibliography

BBA HAPAS Certificate 13/H197 Product Sheet 2 *Fortrac Geosynthetics — Fortrac MP Geogrids*

BBA HAPAS Certificate 13/H197 Product Sheet 3 *Fortrac Geosynthetics — Fortrac T and R-T Geogrids*

BRE Special Digest 1 : 2005 *Concrete in aggressive ground*

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 12878 : 2005 *Pigments for the colouring of building materials based on cement and/or lime — Specifications and methods of test*

BS EN 14475 : 2006 *Execution of special geotechnical works — Reinforced fill*

BS EN ISO 9001 : 2008 *Quality Management systems — Requirements*

ASTM D6638 *Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units*

Manual of Contract Documents for Highway Works, Volume 1 *Specification for Highway Works, August 1998* (as amended)

Manual of Contract Documents for Highway Works, Volume 2 *Notes for Guidance on the Specification for Highway Works, August 1998* (as amended)

Conditions of Certification

14 Conditions

14.1 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.

14.2 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.

14.3 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.

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

14.5 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
- actual 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
- any claims by the manufacturer relating to CE marking.

14.6 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.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA

tel: 01923 665300
fax: 01923 665301
e-mail: mail@bba.star.co.uk
website: www.bbacerts.co.uk