# TensarTech® TW3 Earth Retaining Wall System: Model Specification

**This document is intended to form a basis for Tender documents where the TensarTech® TW3 reinforced soil system is required.**

## 1. GENERAL

This work shall consist of constructing retaining walls using a proprietary modular block faced, reinforced soil wall system, constructed in accordance with the suppliers drawings and specifications and in conformity with the alignment, grades and dimensions shown on the contract documents or as established by the Engineer. The Contractor shall provide complete set of drawings issued for construction and complete specifications of the proposed wall system for the approval of the Engineer 60 days prior to ordering materials to construct said walls. Any particular requirements of approved detailed specifications for the approved proprietary system shall override any conflicting or incompatible requirement contained within this section.
The proposed system must demonstrate previous use for reinforced soil walls with a minimum height of 20.0m and a minimum in-service life of 20 years.
The wall system as a whole shall have a current British Board of Agrèment (BBA) HAPAS certificate, demonstrating suitability for use in highways walls and abutments with a minimum 100 year design life.

## 2. DESIGN

The design, materials specification and construction methods adopted shall be in accordance with DETR, HA Technical Standard BD70 Strengthened Reinforced Soils and other Fills for Retaining Walls and Bridge Abutments (DMRB 2.1.5) and Manual of Contract Documents for Highway Works (MCHW), Volume 1 Specification for Highway Works (MCHW1) November 2009 Edition or BS8006 : 2010 Code of Practice for Strengthened/Reinforced soils and other fills, whichever is appropriate. The design must be performed by the supplier of the wall system, who shall submit proof of professional indemnity insurance coverage. The specifications as presented to the Engineer shall state any requirements for or limitations on the backfill used in the structure to ensure the design life. The tender submission shall be accompanied by:

A. A copy of the current BBA certificate
B. Sample design calculations for the proposed walls in compliance with the appropriate Design Standard
C. Soils test information of the proposed reinforced soil fill
D. Method statement for construction
E. Confirmation of both the Professional Indemnity and Product Liability insurance cover provided by the Wall System Supplier

## 3. STANDARDS

The following standards and codes in their latest edition shall be particularly applied to work covered by this specification where applicable; together with any further standards or codes as described within the approved Specification for the approved reinforced soil wall system.

### 3.01 Modular Block Retaining Wall Units

| | | |
|---|---|---|
| A | **BS EN 12878 : 2005** | Pigments for the colouring of building materials based on cement and/or lime |
| B | **BS 6073-2 : 2008** | Precast concrete masonry units. Specification for precast concrete masonry units |

### 3.02 Geogrid Reinforcement

| | | |
|---|---|---|
| A | **ISO 2602: 1980** | Statistical Interpretation of Test Results |
| B | **BS EN ISO 9001: 2000** | Quality Systems – Model for Quality Assurance in Production, design and development Installation & Servicing |
| C | **BS 2782: Part 4** | Methods of Testing Plastics. Part 4: Chemical Properties |
| D | **GRI GG2 - 87** | Geogrid Junction Strength |
| E | **BS EN ISO 10321: 1996** | Geotextiles – Tensile Test for Joints-Seams by Wide-Width Method |
| F | **BS EN ISO 10319: 1996** | Wide-Width Tensile Test |
| G | **BS EN ISO 13431: 1999** | Geotextiles and geotextiles related products. Determination of tensile creep and creep rupture behaviour |

### 3.03 Soils

| | | |
|---|---|---|
| A | **BS1377: 1990** | Moisture Density Relationship for Soils, Standard Method |

B **BS1377*: 1990*** Gradation of Soils

C **BS1377*: 1990*** Atterberg Limits of Soil
D **BS1377*: 1990*** Shear Box Test

## 4. MATERIALS

The wall system will comprise interlocking concrete block facing units, uniaxially orientated high density polyethylene geogrids and connectors designed to ensure a high efficiency mechanical connection between wall face and geogrid. The independent approval certificate will have assessed this connection efficiency.

### 4.01 Modular Block Facing Units

A. The blocks shall be machine manufactured from Portland cement concrete specifically designed for use in a reinforced soil retaining wall system.

B. Colour of the facing units shall be as specified by the engineer/client

C. The blocks shall have a straight split/textured face finish, smooth or sculptured rock face in angular tri-planer configuration as detailed on the contract drawings

D. In elevation the block height should be 200mm and length 450mm

E. Horizontal shear connection between block courses shall be by 12 mm diameter thermoset isopthalic polyester resin-pultruded fibreglass reinforcement pins or equivalent. Strength of shear connectors between vertical adjacent units shall be applicable over a design temperature of -10 to 40 degrees C.

F. Block units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the structure. Cracking or excessive chipping may be grounds for rejection. Units showing cracks longer than 13mm shall not be used within the wall. Units showing chips visible at a distance of 10 metres from the wall shall not be used within the wall.

G. Concrete used to manufacture block units shall have a minimum 28 days compressive strength of 40Nmm$^{-2}$ and a maximum moisture absorption rate, by weight, of 6% as determined in accordance with BS 7263-1:1994.

H. Minimum density is 2100 kg/m$^3$ when tested in accordance with the method of BS 6073-2 : 1981, Appendix C

I. Modular block facing dimensions shall not differ more than ± 2mm from the dimensions specified in the current BBA certificate.

### 4.02 Geogrid Reinforcement

A. The reinforcing element shall be a geogrid manufactured in accordance with a Quality Management System which complies with the requirements of BS EN ISO 9001:2000. If required by the Engineer, the Contractor shall provide evidence that the manufacturer's Quality Assurance System has been certified to conform with BS EN ISO 9001:2000 by an external authenticating authority approved by the Department of Trade and Industry.

B. The reinforcing element shall be a geogrid manufactured from punched high density polyethylene sheet, oriented in one direction so that the resulting ribs shall have a high degree of molecular orientation, which is continued through the integral transverse bar.

C. The long term creep rupture strength $P_C$ (Ultimate Limit State), for a design life of 120 years, shall be in accordance with the following table at a mean temperature for design country (10°C, 20°C or 30°C). This shall be determined by application of standard extrapolation techniques to creep data obtained in accordance with BS EN ISO 13431:1999 and shall be a lower bound value. Values shall be based on a minimum 100,000 hour of continuous creep testing.

| | | Geogrid Type - design life of 120 years | | | | | |
|---|---|---|---|---|---|---|---|
| | Units | RE510 | RE520 | RE540 | RE560 | RE570 | RE580 |
| $P_{C\ 10°C}$ | kN/m | 20.71 | 27.34 | 33.40 | 45.93 | 61.31 | 71.09 |
| $P_{C\ 20°C}$ | kN/m | 19.01 | 25.10 | 30.66 | 42.16 | 56.28 | 65.27 |
| $P_{C\ 30°C}$ | kN/m | 17.24 | 22.76 | 27.80 | 38.23 | 51.03 | 59.17 |

D. The geogrid shall have an appropriate partial factor for site installation and construction damage, determined by the particle size distribution of the reinforced fill and in accordance with the values used in the design. This factor shall be based on full-scale tests carried out in accordance with BS8006 Annex D and witnessed by an independent Approval Authority. If required by the Engineer, the Contractor shall provide supporting documented evidence of testing for this and any other partial factors assumed in the design. Partial factors for site installation and construction damage based on limited laboratory based testing are not acceptable.

E. The strength of the junctions between the longitudinal ribs and transverse bars, as determined by the Geosynthetics Research Institute, Drexel University, USA, Test Method GG2-87, shall be not less than 95% of the Quality Control Strength.

F. Any site joints in the reinforcement roll length shall be capable of carrying 100% of the geogrid Long Term Creep Rupture Strength. If required by the Engineer, the Contractor shall provide evidence of this.

G. The geogrid shall be inert to all chemicals naturally found in soils and shall have no solvents at ambient temperature. It shall not be susceptible to hydrolysis, shall be resistant to aqueous solutions of salts, acids and alkalis, shall be non-biodegradable and shall have a minimum of 2% finely divided carbon black, as determined by BS 2782 Part 4, Method 452B 1993, to inhibit attack by ultraviolet light.

H. The geogrid shall have an independent test certificate proving resistance and durability in a pH range of 2.0 to 12.5. Specifically, 'The a sample of the geogrid classification chosen shall have a test certificate from a recognised independent test authority, showing that when tested to ENV ISO 12960, March 1998, they can withstand immersion in a saturated solution of calcium hydroxide with a pH of 12.5, at 60 deg C for 3 days with no loss of tensile strength.

I. The geogrid shall be CE Marked by an independent, authorised Certification Body to demonstrate that the product has been tested in accordance with the relevant European Standard relating to its specific use in construction, in accordance with the EU Construction Products Directive.

J. The product labelling must show the CE Mark, together with the Certification Body Number and the FPC (factory production control) number. 'Accompanying Documentation' indicating the relevant testing 'declared values', should be available on request.

### 4.03 Face to geogrid connection

A. The connection between the modular block facing unit and the geogrid shall be a mechanical continuous connection manufactured using an approved High Density Polyethylene. The allowable connection strength at the face ($T_{conn}$) to be used in the design shall have been tested and independently assessed for each grade of geogrid reinforcement used in the design and published in the relevant BBA Roads and Bridges certificate. Reliance on a pin or frictional connections between block and geogrid shall not be allowed.

### 4.04 Drainage Aggregate

A. The granular fill material to all voids and behind the block face shall be a crushed coarse aggregate 4/20mm in accordance with BS EN 12620 : 2013. Pea gravel or other rounded aggregates must not be used.

### 4.05 Reinforced (Infill) Soil

The reinforced soil material proposed should comply with the specification for 6I/6J material as detailed in Tables 6/1 and 6/2 of the 'MANUAL OF CONTRACT DOCUMENTS FOR HIGHWAY WORKS (MCHW) VOLUME 1 SPECIFICATION FOR HIGHWAY WORKS (MCHW1) – Series 600 for Earthworks, Highways Agency document November 2009' This material should be well graded crushed and granular not sub-rounded, and should also comply with the following:

A. Minimum angle of friction ($ø_p'$) of 30 degrees unless otherwise agreed by the Engineer

B. The contractor should provide the Wall System supplier and the Engineer/Client with Effective Stress Parameters soil test information including soil density to allow completion and checking of the final design.

## 5. CONSTRUCTION

### 5.01 Excavation

A. Contractor shall excavate to the lines and grades shown on the project grading plans. Contractor shall take precautions to minimize over-excavation. Over-excavation shall be filled with compacted approved infill material, or as directed by the Engineer.

B. Contractor shall verify the location of existing structures and utilities prior to excavation. Contractor shall ensure all surrounding structures are protected from the effects of wall excavation. Excavation support, if required, is the responsibility of the Contractor.

### 5.02 Foundation Preparation

A. Following the excavation, the foundation soil shall be examined by the Owner's Engineer to assure actual foundation soil strength meets or exceeds the design bearing strength. Soils not meeting the required strength shall be removed and replaced with compacted approved infill soils, as directed by the Engineer.

B. Foundation soil shall be proof rolled and compacted to 95% standard Proctor density and inspected by the Engineer prior to placement of levelling pad materials.

### 5.03 Levelling Pad Construction

A. Levelling pad shall be placed as shown on the construction drawings with a minimum thickness of 150mm. Material for levelling pad shall consist of mass concrete with a minimum 28 days compressive strength of $30Nmm^{-2}$ The levelling pad should extend laterally at least a distance of 150mm min from the toe and heel of the lower most course of blocks.

### 5.04 Modular Block Facing and Geogrid Installation

A. The retaining walls shall be installed at the proper elevation and orientation as shown on the wall profiles and details on the construction plans or as directed by the Engineer. The wall system shall be installed in general accordance with the manufacturer's recommendations. The specifications and drawings shall govern in any conflict between the two requirements.

B. The first course is critical for accurate and acceptable construction.

C. Bed the first course of concrete facing blocks side by side on the levelling pad setting pinholes in adjoining blocks 305mm centre to centre, on a cement:sand mortar (1:3 ratio) ensuring that the top of the block is uppermost. The top of the block has continuous grooved recess and two pin holes. A lifting tool is available to assist in the placing and handling of the blocks.

D. Allow the mortar bed to cure before laying additional courses.

E. Ensure that the blocks are level front to back, side to side and to the correct alignment. Align the blocks with a string line placed on the back of the block, or for curved walls to the appropriate radius, but using the back of the block as the datum.

F. Place the fibreglass pins into the pinholes. This facing block is designed for use with the polymeric connector and has only two holes forming a finished wall face at a nominal face angle of 89.6° (1:128).

G. Fill all voids within, between and immediately behind the blocks with an angular drainage medium hand tamped to avoid settlement. This granular fill material to fill all voids must be a crushed coarse aggregate 4/20mm in accordance with BS EN 12620 : 2013. Pea gravel or other rounded aggregates must not be used. The drainage zone should extend a minimum of 300mm behind the blocks.

H. Approved backfill according to the specification may then be placed and compacted in layers corresponding with the height of the blocks, (200 mm) and to the requirements of the design.

I. Care should be taken to avoid contact with the facing blocks by any of the compaction plant and the following restrictions should apply:

J. All construction plant, including compaction equipment with a mass exceeding 1000kg should be kept at least 2m from the face of the wall. Compaction plant within 2m of the wall should be restricted to vibrating rollers having a mass per metre width not exceeding 1300kg or plate compactors with a mass less than 1000kg.

K. Compaction should always commence nearest the facing blocks working away towards the free end of the geogrid.

L. The specified type of geogrid is to be incorporated at the locations specified in the design.

M. Ensure that the compacted fill is generally level to receive the geogrid.

N. Sweep the blocks clean to remove all debris.

O. A suitable length of geogrid is cut from the roll and any protruding ribs trimmed back to the transverse bar. Place the prepared end of the geogrid over the rebate in the block and locate the blue moulded connectors around the transverse bar. Ensure that a connector covers each aperture of the geogrid. The connectors may be split where necessary and trimmed to fit around the pin in the recess.

P. Please note that when constructing with stiffer geogrids it may be necessary to cut the transverse bar locally around the fibreglass pins in order for it to sit neatly in the recess.

Q. Position the assembly neatly into the rebate and push down firmly. The next course of blocks is placed over the fibreglass pins, locating the kidney-shaped recesses over the pins taking care not to disturb the geogrid and connector in the block below. Repeat this procedure for the whole course ensuring that adjacent lengths of geogrid are abutted at the wall face.

R. The facing block is centred over underlying block and is then pushed towards the front of the structure until it makes full contact with both pins. During construction it will be necessary to regularly check and correct both horizontal and vertical alignment. The line and level of the wall overall should be checked every 3rd course. Any adjustment necessary may be made using ribs cut from the geogrid or approved shims, placed in between blocks.

S. To avoid the need for shimming it is acceptable to trim the ribs so that they project 50mm in front of the transverse bar that runs across the 1.3m width of geogrid. Further advice should be sought from the geogrid supplier.

T. The geogrid should be lightly tensioned using the tensioning beam supplied so that the moulded geogrid connectors are up against the rear of the rebate. The backfill is placed by mechanical plant, with an opening bucket, such that it causes the fill to cover the geogrid in a uniform manner.

U. Repeat steps E to S to construct the wall to the required height. The top course of blocks should be bonded to the course below using adhesive supplied. Extrude a bead of adhesive either side of the rebate of the lower blocks & place the top course, pressing firmly to locate.

V. Complete the wall with caps. Sweep the wall clean to remove debris. Place the cap over the pins in the underlying blocks on a bed of four spots of adhesive (supplied with the caps) then push forward onto the pin. Make minor adjustments to the alignment as necessary.

W. The Contractor must fully assess the safety risk associated with working at height and where appropriate install the necessary temporary edge protection.

**5.05 Drainage Materials**

A. Drainage aggregate shall extend to the minimum thickness shown behind the facing units or to the line, grades, and sections shown on the final Contract Drawings.

### 5.06 Construction Adjacent to Completed Wall

A. The Contractor is responsible for ensuring that construction adjacent to the wall by others does not disturb the wall or place temporary construction loads on the wall that exceed design loads, including loads such as water pressure, temporary grades, or equipment loading. Heavy paving or grading equipment shall be kept a minimum of 1m behind the back of the wall face. Equipment with equivalent loading in excess of 15kN/m$^2$ live load shall not be operated within 3m of the face of the retaining wall during construction. Care should be taken by the General Contractor to ensure water runoff is directed away from the wall structure until final grading and surface drainage collection systems and erosion protection measures are completed.

## 6. SUBMISSION OF ALTERNATIVES

6.01 Any alternative to the specified system for Reinforced Soil Structure proposed by the Tenderer shall be submitted with the tender and shall include:

- the names of the supplier and designer
- a full set of calculations
- outline drawings
- product samples and specifications
- test certificates for the reinforcing elements

The outline drawings must be sufficient to indicate the details of the construction of the Reinforced Soil Structure including:

- typical plans
- elevations and section drawings
- foundations
- facing details (including vegetation if appropriate)
- anchoring reinforcing elements at the face
- reinforcing element joints and overlaps

The width and length of the soil reinforcing elements should be clearly shown along with details of their orientation in the work

**This document is drafted on an entirely generic basis and its use in any contract or tender documentation in any way must be reviewed by the user and made specific to their project**



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