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Agrément Certificate

06/4369

Product Sheet 1

COMBINED THERMAL SOLUTIONS FLOORING SYSTEMS

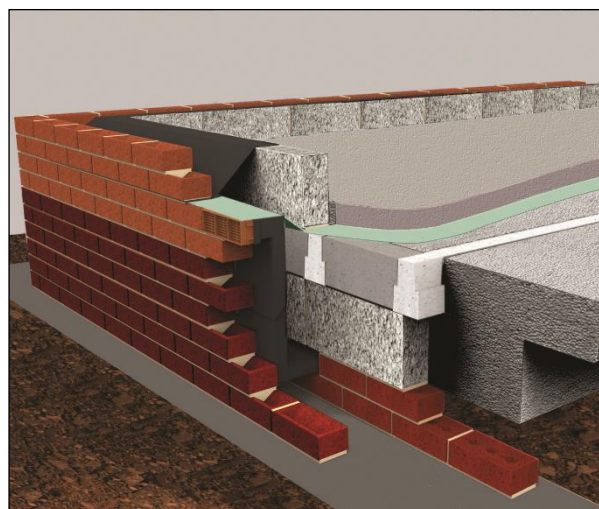
TDECK EPS PANEL SYSTEM

This Agrément Certificate Product Sheet ⁽¹⁾ relates to the Tdeck EPS Panel System, a range of expanded polystyrene (EPS) blocks and toe extension dovetail pieces, for use as thermal insulation in suspended concrete ground floors (over a sub floor void) in domestic, residential and commercial buildings within the loads specified in this Certificate. The blocks are for use in conjunction with prestressed concrete beams, masonry closure blocks and structural concrete toppings.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.



KEY FACTORS ASSESSED

Strength and stability — the system has adequate strength and stiffness to support a suitable concrete topping and can sustain and transmit the dead and imposed floor loads (see section 6).

Thermal performance — the EPS blocks can enable a floor to meet the design U values specified in the documents supporting the national Building Regulations (see section 7).

Condensation risk — the EPS blocks can contribute to limiting the risk of condensation (see section 8).

Durability — the system components (including the infill blocks, concrete beams and concrete topping reinforced with steel mesh, macro/micro-polymer fibres or steel fibres) will have a design life equivalent to that of the building in which they are incorporated (see section 10).

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 Second issue: 14 December 2017

Originally certificated on 29 November 2006

Certificate amended on 25 April 2018 to reflect changes to section 6.8 and Table 2.

Paul Valentine
Technical Excellence Director

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.

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Regulations

In the opinion of the BBA, the Tdeck EPS Panel System, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of the following Building Regulations (the presence of a UK map indicates that the subject is related to the Building Regulations in the region or regions of the UK depicted):



The Building Regulations 2010 (England and Wales) (as amended)

Requirement:	A1(1)	Loading
Comment:		The system can sustain and transmit dead and imposed floor loads to the supporting structure. See sections 6.1 and 6.6 to 6.16 of this Certificate.
Requirement:	C2(c)	Resistance to moisture
Comment:		The system can contribute to limiting the risk of surface condensation. See sections 8.1 and 8.4 of this Certificate.
Requirement:	L1(a)(i)	Conservation of fuel and power
Comment:		The system can contribute to satisfying this Requirement. See section 7.3 of this Certificate.
Regulation:	7	Materials and workmanship
Comment:		The system is acceptable. See section 10 and the <i>Installation</i> part of this Certificate.
Regulation:	26	CO₂ emission rates for new buildings
Regulation:	26A	Fabric energy efficiency rates for new dwellings (applicable to England only)
Regulation:	26A	Primary energy consumption rates for new buildings (applicable to Wales only)
Regulation:	26B	Fabric performance values for new dwellings (applicable to Wales only)
Comment:		The system can contribute to satisfying these Regulations. See section 7.3 of this Certificate.



The Building (Scotland) Regulations 2004 (as amended)

Regulation:	8(1)	Durability, workmanship and fitness of materials
Comment:		The system can contribute to a construction satisfying this Regulation. See section 10 and the <i>Installation</i> part of this Certificate.
Regulation:	9	Building standards applicable to construction
Standard:	1.1 (a)(b)	Structure
Comment:		The system can sustain and transmit dead and imposed floor loads to the supporting structure, with reference to clause 1.1.1 ⁽¹⁾⁽²⁾ . See sections 6.1 and 6.6 to 6.16 of this Certificate.
Standard:	3.15	Condensation
Comment:		The system will contribute to limiting the risk of surface and interstitial condensation, with reference to clauses 3.15.1 ⁽¹⁾⁽²⁾ , 3.15.4 ⁽¹⁾⁽²⁾ and 3.15.5 ⁽¹⁾⁽²⁾ . See sections 8.1 and 8.5 of this Certificate.
Standard:	6.1(b)	Carbon dioxide emissions
		The system can contribute to satisfying of this Standard with reference to clauses 6.1.1 ⁽¹⁾ , 6.1.2 ⁽²⁾ and 6.1.6 ⁽¹⁾ . See section 7.3 of this Certificate.

Standard: Comment:	6.2	Building insulation envelope The system will contribute to satisfying the requirements of this Standard, with reference to clauses 6.2.1 ⁽¹⁾⁽²⁾ , 6.2.3 ⁽¹⁾ , 6.2.4 ⁽²⁾ , 6.2.5 ⁽²⁾ and 6.2.13 ⁽¹⁾ . See section 7.4 of this Certificate.
Standard: Comment:	7.1(a)(b)	Statement of sustainability The system can contribute to satisfying the relevant requirements of Regulation 9, Standards 1 to 6, and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard. In addition, the system can contribute to a construction meeting a higher level of sustainability as defined in this Standard, with reference to clauses 7.1.4 ⁽¹⁾ [Aspects 1 ⁽¹⁾ and 2 ⁽¹⁾], 7.1.6 ⁽¹⁾⁽²⁾ [Aspects 1 ⁽¹⁾⁽²⁾ and 2 ⁽¹⁾⁽²⁾], 7.1.7 ⁽¹⁾ [Aspect 1 ⁽¹⁾], 7.1.9 ⁽²⁾ [Aspect 1 ⁽²⁾] and 7.1.10 ⁽²⁾ [Aspect 1 ⁽²⁾]. See section 7.3 of this Certificate.
		(1) Technical Handbook (Domestic). (2) Technical Handbook (Non-Domestic).



The Building Regulations (Northern Ireland) 2012 (as amended)

Regulation: Comment:	23(a)(i)(iii)(b)	Fitness of materials and workmanship The blocks are acceptable. See section 10 and the <i>Installation</i> part of this Certificate.
Regulation: Comment:	29	Condensation The system can contribute to limiting the risk of interstitial condensation. See section 8.1 of this Certificate.
Regulation: Comment:	30	Stability The system can sustain and transmit dead and imposed floor loads to the supporting structure. See sections 6.1 and 6.6 to 6.16 of this Certificate.
Regulation: Regulation: Comment:	39(a)(i) 40(2)	Conservation measures Target carbon dioxide emission rate The system can contribute to satisfying these Regulations. See section 7.3 of this Certificate.

Construction (Design and Management) Regulations 2015

Construction (Design and Management) Regulations (Northern Ireland) 2016

Information in this Certificate may assist the client, designer (including Principal Designer) and contractor (including Principal Contractor) to address their obligations under these Regulations.

See sections: 3 *Delivery and site handling* (3.2 and 3.5), 6 *Strength and stability* (6.4) and 14 *Procedure* (14.3, 14.5, 14.6 and 14.7) of this Certificate.

Additional Information

NHBC Standards 2017

In the opinion of the BBA, the Tdeck EPS Panel System with macro-polymer⁽¹⁾ fibres, steel fibres or steel mesh concrete toppings, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements of *NHBC Standards*, Chapter 5.2 *Suspended ground floors*.

(1) NHBC do not accept micro-polymer fibre structural concrete toppings (see Table 2, footnote 9).

CE marking

The Certificate holder has taken the responsibility of CE marking the product in accordance with harmonised European Standard BS EN 15037-4 : 2010

Technical Specification

1 Description

1.1 The Tdeck EPS Panel System comprises a range of grey expanded polystyrene (EPS) blocks including full, half, starter and end blocks and toe extension dovetail pieces (see Table 1 and Figure 1 of this Certificate).

1.2 The toe extension dovetail pieces are used to increase the toe length where required (ie multiple beam situations) and incorporate 'dovetail' profiles.

Table 1 EPS block properties

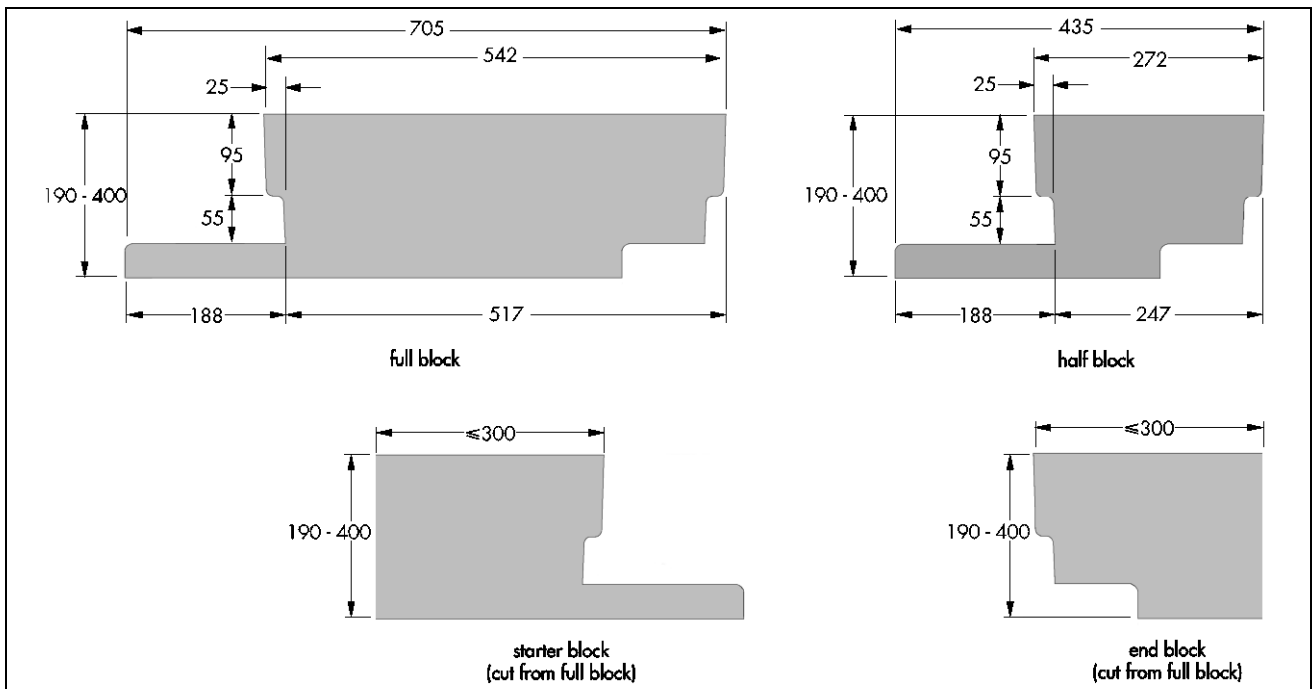
Property	Value
Length (mm)	1200 ⁽¹⁾
– full blocks	
top width (mm)	542
overall thickness (mm)	190 to 400
bottom width (mm)	680
toe thickness (mm)	40 to 250
– half blocks	
top width (mm)	271
overall thickness (mm)	190 to 400
bottom width (mm)	409
toe thickness (mm) ⁽²⁾	40 to 200
– starter and end blocks ⁽³⁾	
top width (mm)	≤ 300
– toe extension dovetail piece	various (to suit multiple beam situations)
Thermal conductivity ($W \cdot m^{-1} \cdot K^{-1}$) λ_D value	0.031
Type and class of EPS according to BS EN 15037-4 : 2010	Type R1 and Class R1a
Declared level of compression stress at 10% deformation	70 kPa
Moisture diffusion coefficient (μ)	20 to 40

(1) Other lengths (from a minimum of 275 mm) can be used, as specified by the Certificate holder – see section 6.4 of this Certificate.

(2) All available with toe widths to cover single, double and triple beams

(3) Starter and end blocks are used between the first and last prestressed concrete beam and the inner leaf of the external walls and party walls. These are formed by cutting a full-width block lengthways on site.

Figure 1 Example EPS blocks dimensions (measurements in mm)



1.2 Polystyrene edge strips (30 mm thick) are used in conjunction with standard and aerated concrete perimeter blocks to provide continuous insulation cover of the floor.

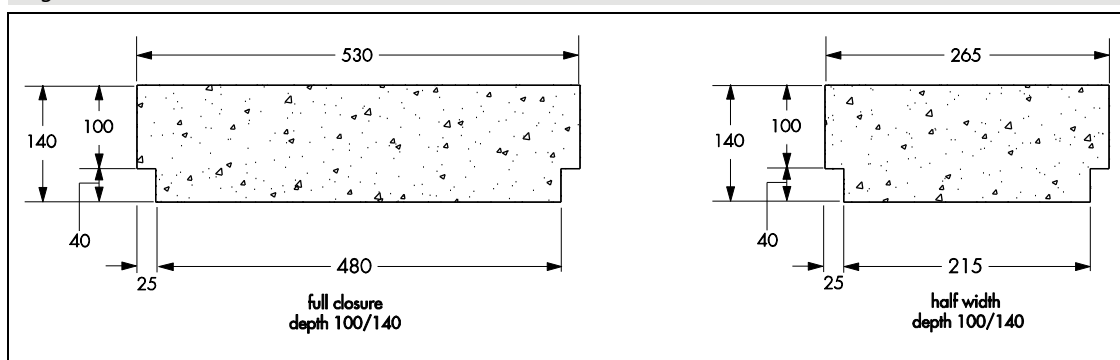
1.3 The Certificate holder's specifications for ancillary items used in conjunction with the EPS blocks include:

- concrete topping⁽¹⁾ reinforced with steel mesh to the specifications given in Table 2, depending on the proposed floor usage. The concrete topping must be designed in accordance with BS EN 1990 : 2002, BS EN 1991-1-1 : 2002 and BS EN 1992-1-1 : 2004 and their respective UK National Annexes, with a maximum aggregate size of 20 mm
- concrete topping⁽¹⁾ reinforced with macro-polymer or steel fibres, to the specifications given in Table 2, in accordance with TR34 fourth edition, with a maximum aggregate size of 10 to 20 mm
- concrete topping⁽¹⁾ reinforced with micro-polymer fibres to the specifications given in Table 2, with a maximum aggregate size of 20 mm

(1) The specification of concrete used for toppings must be in accordance with BS EN 206: 2013, BS 8500-1: 2015 and BS 8500-2 : 2015

- concrete closure blocks manufactured in accordance with BS EN 771-3 : 2011. The blocks should have BBA (or other third party) certification and must have a minimum compressive strength equal to, or greater than, that of the blocks used to form the inner leaf of the wall. Dimensions of concrete closure blocks are given in Figure 2.

Figure 2 Concrete closure blocks



- insulation strips (width 25 or 30 mm) — for perimeter of structural concrete toppings

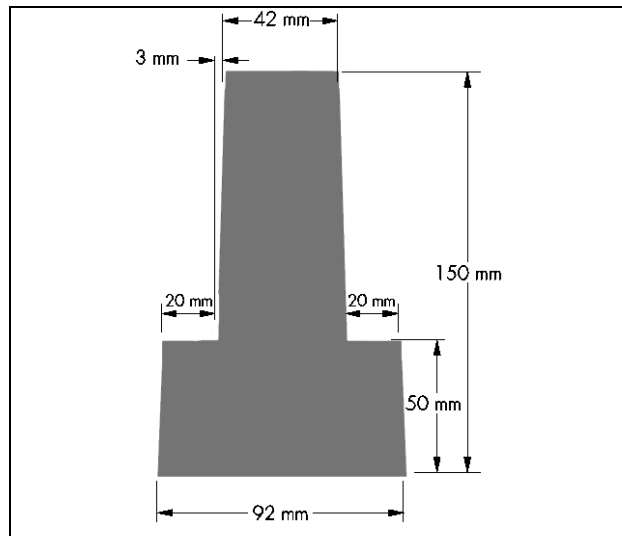
1.4 Ancillary items outside the scope of this Certificate include:

- prestressed concrete beams⁽¹⁾ of the type and size shown in Figure 3 of this Certificate, which must be CE marked and designed in accordance with BS EN 15037-1 : 2008. The beams should also be designed in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex. See sections 6.11 to 6.16 of this Certificate
- where required, gas barrier membranes⁽¹⁾ with third-party approval
- vapour control layer (VCL)⁽²⁾
- damp-proof membranes (dpm)⁽²⁾ with third-party approval.

(1) The specification of concrete used for the concrete beams must be in accordance with BS EN 206: 2013, BS 8500-1: 2015 and BS 8500-2 : 2015

(2) Must be compatible with EPS

Figure 3 typical pre-cast prestressed concrete beam⁽¹⁾



(1) This beam was used for the full-scale tests.

2 Manufacture

2.1 The EPS blocks are manufactured using conventional moulding techniques from expanded polystyrene beads.

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

- agreed with the manufacturer 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 non-conformities
- 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

2.3 The management system of Combined Thermal Solutions Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001: 2015 by the SGS (Certificate No GB11/83916).

3 Delivery and site handling

3.1 Care must be taken when unloading, stacking and storing the concrete beams to prevent damage. They should be lifted as near as possible to each end and must remain the correct way up at all times. On site, concrete beams must be stored on timber bearers on suitable level ground.

3.2 The concrete beams should be stacked horizontally, one above the other. Timber bearers should be placed close to the beam ends (within 300 mm) and vertically aligned.

3.3 The EPS components are shrink-wrapped and bonded in cube packs. Reasonable care must be taken during transit and storage to avoid damage to the blocks.

3.4 The blocks should be stacked on a flat base clear of the ground, and protected against direct sunlight and secured to avoid wind damage. Care must be taken to avoid contact with solvents and with materials containing volatile organic components.

3.5 The EPS blocks must not be exposed to flame or ignition sources.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the Tdeck EPS Panel System.

Design Considerations

4 General

4.1 The Tdeck EPS Panel System is satisfactory for use as part of a suspended ground floor in buildings where the loads do not exceed those specified in Table 3 and defined in section 6.8 of this Certificate.

4.2 A suitably experienced/qualified engineer should carry out/produce a site-specific assessment/design to ensure:

- the EPS blocks, concrete beams and structural concrete toppings are in accordance with the recommendations in this Certificate and the relevant parts of BS EN 15037-1 : 2008 and BS EN 15037-4 : 2010
- for concrete toppings reinforced with steel mesh, macro-polymer and steel fibre, the concrete beam meets the requirements of section 1.4 of this Certificate
- for micro-fibre concrete topping, if the concrete beam other than that shown in Figure 3 is specified, then the requirements of section 6.14 of this Certificate are also be satisfied
- the floor is not loaded by construction materials until the structural concrete topping has reached its design strength
- the natural frequency of the floor is greater than 4.0 Hz. Use of the system where vibration due to rhythmic activity (such as dancing) and external sources (eg building construction or rail traffic) may be encountered are outside the scope of this Certificate
- adequate ties between the floor and its supporting elements are provided, to comply with the requirements of the national Building Regulations and BS EN 1997-1-7: 2006 in respect of structural robustness. The appropriate building class/risk group/consequence class (refer to national Building Regulations and BS EN 1997-1-7 : 2006) of the building should be established to ensure that:
 - the buildings designated as building class/risk group/consequence class 1 meet the requirements of BS 8103-1: 2011, BS 8103-3 : 2009 or PD 6697 : 2010
 - the buildings designated as building class/risk group/consequence class 2a, 2b and 3 meet the requirements of the national Building Regulations, BS EN 1991-1-7 : 2006 and its UK National Annex, and PD 6697 : 2010.

4.3 A void of at least 150 mm deep for the system must be provided between the underside of the floor and the ground surface.

4.4 In locations where clay heave is anticipated, a greater void depth may be required to accommodate the possible expansion of the ground below the floor. In such cases where the risk of clay heave has been confirmed by geotechnical investigations, a total void of up to 300 mm may be required (refer to *NHBC Standards 2017*), as follows:

- high volume change potential (300 mm total void)
- medium volume change potential (250 mm total void)
- low volume change potential (200 mm total void).

4.5 On sites which may be subject to emissions of gas or volatile organic compounds (VOCs), a suitably experienced and qualified person must assess the compatibility of the insulation with any potential emissions.

4.6 The selected structural concrete toppings must be designed and installed strictly in accordance with this Certificate and the Certificate holder's instructions (see section 6 of this Certificate). The dosage rate for micro/macro-polymer fibres and steel fibres must be in accordance with Table 2.

4.7 The tolerance for the batching process and criteria for acceptability of steel fibres and macro/micro polymer fibres content must be in accordance with Tables 27 and B.2 of BS EN 206 : 2013.

4.8 For macro-polymer and steel fibres, the maximum allowed deviation of single test results from limit values, from tolerance on a target value or from the limits of the specified class should be in accordance with Table 22 of BS EN 206 : 2013.

4.9 Electrical cables running below the EPS should be enclosed in a suitable conduit.

4.10 The system can be used in floors with suitable underfloor heating systems. Care must be taken to ensure that the minimum design thickness of structural concrete topping is maintained, eg above pipes.

5 Practicability of installation

The system is designed to be installed by a competent general builder, or contractor, experienced with this type of product.

6 Strength and stability



6.1 A suitably experienced/qualified engineer must ensure that the concrete beams, edge strips, beam spacer, closure blocks and concrete structural topping are suitable for the intended use (see section 4.2).

EPS blocks

6.2 The EPS blocks provide a permanent formwork to the structural concrete topping. They make no further contribution to the long-term structural performance of the floor once the structural concrete topping has been placed and has obtained its full design strength.

6.3 Subject to compliance with the design and installation requirements of this Certificate, the EPS blocks have adequate strength to carry the normal temporary loads expected during the construction phase of the floor system including the weight of the structural concrete topping when poured.

6.4 EPS blocks can be cut on site to accommodate the varying beam lengths but must at least 275 mm long. Once cut, they should be positioned at the floor edges. Starter and end blocks should not be more than 300 mm wide at the top (see section 14.5 of this Certificate).

6.5 The EPS blocks are designed to have a normal bearing of 20 mm with a 5 mm allowance for misalignment and manufacturing tolerances in the straightness of the beam. A minimum bearing width of 15 mm must therefore be ensured.



6.6 Spacers for supporting steel mesh reinforcement should be located along the beams or on spreader plates over the EPS blocks. This will reduce the risk of accidental penetration of the EPS during the construction phase and the resulting misalignment of the reinforcement within the structural concrete topping depth. The spacer dimensions must not be less than 50 by 50 mm; and a minimum of four spacers per m² are required.

Structural concrete toppings

6.7 The concrete forming the topping must be in accordance with BS 8500-1 : 2015, BS 8500-2 : 2015. Concrete should be manufactured in plants covered by the Quality Scheme for Ready Mixed Concrete (QSRMC scheme) and laid by personnel with the appropriate skill and experience.

6.8 Table 2 of this Certificate defines the method of suitability of each concrete topping reinforced with various reinforcements corresponding to appropriate characteristic loads defined in Table 3 in conjunction with the EPS infill blocks as specified in Table 1 and Figure 1 of this Certificate.

Table 2 Specification of structural concrete topping, load category and method of verification ⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾⁽⁵⁾

Ref no.	Reinforcement of concrete topping	Applicable load category	Method of verification of concrete topping
1	One layer of A142 mesh to BS 4483: 2005 with a characteristic yield strength (fyk) of 500 N·mm ⁻² . Reinforcement should be placed at mid height of the concrete slab	All of characteristic loads defined in Table 3	Calculation to BS EN 1992-1-1 : 2004 and its UK National Annex
2	Durus S400 ⁽⁶⁾⁽⁷⁾ (macro-polymer fibre), dosage rate 4.0 kg·m ⁻³ , 45 mm long, 0.9 mm diameter, tensile strength 465 N·mm ⁻² and modulus of elasticity 3350 N·mm ⁻²	All of characteristic loads defined in Table 3 of this Certificate	Full-scale test
3	Novomesh B&BA ⁽⁶⁾⁽⁸⁾⁽⁹⁾ (steel fibre), dosage rate 17.5 kg·m ⁻³ , steel flat end, steel fibres, fibre length 50 mm, diameter 1.0 mm, tensile strength 1150 N·mm ⁻²	Characteristic loads for single-family dwellings defined in Table 3 of this Certificate only	Structural calculation of the ultimate bending moment capacity in accordance with 'equation 6' of TR34 (fourth edition, March 2016)
4	Novomesh B&BA ⁽⁶⁾⁽⁷⁾⁽⁸⁾ (macro-polymer and micro polyolefin fibre), dosage rate 3.84 kg·m ⁻³ , shape of macro fibre: continuously deformed, 60 mm long, 0.56 mm diameter, tensile strength 600 N·mm ⁻² , modulus of elasticity 7000 N·mm ⁻²		
5	Adfil SF86 ⁽⁶⁾⁽⁸⁾⁽⁹⁾ (steel fibre), dosage rate 13.33 kg·m ⁻³ , 60 mm long, diameter 0.75 mm, tensile strength 1225 N·mm ⁻² , modulus of elasticity 200000 N·mm ⁻²		
6	Durus Easy Finish ⁽⁶⁾⁽⁷⁾⁽⁸⁾ (macro-polymer fibre), dosage rate 3.00 kg·m ⁻³ , 40 mm long, 0.7 mm equivalent diameter, tensile strength 470 N·mm ⁻² , modulus of elasticity 6000 N·mm ⁻²		
7	Fibrin X-T ⁽⁶⁾⁽¹⁰⁾ (monofilament polypropylene micro fibre), minimum dosage rate 0.91 kg·m ⁻³ , 12 mm long, 22 microns diameter, tensile strength 280 N·mm ⁻²		Full-scale test
8	Fibrin 23 ⁽⁶⁾⁽¹⁰⁾ (polypropylene micro fibre), dosage rate 0.90 to 0.91 kg·m ⁻³ , 12 mm long, 19.5 microns diameter, tensile strength 312 N·mm ⁻²		Alternative acceptable micro fibre

- (1) The overall depth of concrete topping above the services is 75 mm (above the header of the beam) and 80 mm between the concrete beams (refer to Figure 4 of this Certificate).
- (2) All of the fibres in Table 2 can be used within a C28/35 standard concrete (see note 3, below) with maximum 20 mm aggregate (see note 5, below) or C28/35 self-compacting (see note 4, below) concrete with maximum 10 mm aggregate (see note 5, below).
- (3) For standard concrete, the slump should be Class S3 (100 to 150 mm) or S4 (for spot samples taken from initial discharge, 140 to 230 mm).
- (4) For self-compacting concrete, the slump flow class should be SF1 (550 to 650 mm) or SF2 (660 to 750 mm). The sand content should be greater than 45%.
- (5) The aggregate for concrete must comply with BS EN 12620 : 2013.
- (6) The steel and polymer fibres for concrete topping must comply with BS EN 14889-1: 2006 and BS EN 14489-2: 2006 respectively.
- (7) For fresh concrete, macro-polymer fibres content should be measured in accordance with BS EN 14488-7 : 2007
- (8) The dosage rates of steel and polymer fibres defined in Table 2 include 15% additional fibres and are designed to give the minimum required residual flexural tensile strength of concrete toppings with steel and macro-polymer fibres. See also section 6.8 of this Certificate.
- (9) For fresh and hardened concrete, steel fibres content should be measured in accordance with BS EN 14721 : 2005.
- (10) Micro-polymer fibre-only structural concrete toppings are not accepted on NHBC sites.

Table 3 Characteristic imposed and partition loads

Description	Maximum characteristic loads for single-family dwellings	Maximum characteristic loads for communal areas in blocks of flats	Maximum characteristic loads for non-domestic
Imposed uniformly distributed load (UDL) ($\text{kN}\cdot\text{m}^{-2}$)	1.5 ⁽¹⁾	3.0 ⁽¹⁾	5.0 ⁽¹⁾
Imposed concentrated load (kN)	2.0 ⁽¹⁾⁽²⁾	4.0 ⁽¹⁾⁽²⁾	4.5 ⁽¹⁾⁽²⁾
Line load partition, parallel and perpendicular to the beam ($\text{kN}\cdot\text{m}^{-1}$)	1.0 ⁽³⁾⁽⁴⁾ , 3 ⁽⁵⁾	5.0 ⁽³⁾⁽⁵⁾	5.0 ⁽³⁾⁽⁵⁾⁽⁶⁾
Allowance for moveable partition ($\text{kN}\cdot\text{m}^{-2}$)	1.0 ⁽³⁾	1.0 ⁽³⁾	1.0 ⁽³⁾
Finishes ($\text{kN}\cdot\text{m}^{-2}$)	0.5	0.5	0.5

(1) Imposed concentrated load must not be combined with the uniformly distributed load or other variable actions.

(2) Imposed concentrated load for residential buildings is assumed to be applied over a square plate not less than 50 by 50 mm.

(3) Either the imposed load for lightweight partitions (moveable) or line load partition must be considered.

(4) For concrete toppings reinforced with micro-polymer fibres, non-load bearing partition walls heavier than $1 \text{ kN}\cdot\text{m}^{-1}$ parallel to the beams must either be supported by the foundation or be directly on the concrete beams.

(5) For concrete toppings reinforced with macro-polymer fibres, steel fibres and steel mesh, non-load bearing partition walls heavier than $3 \text{ kN}\cdot\text{m}^{-1}$ parallel to the beams must either be supported by the foundation or be directly on the concrete beams.

(6) Steel reinforcement required for loads other than those stated above must be designed by a suitably experienced/qualified engineer.

6.9 The maximum length of the cantilever slab from the top face of the concrete beam should not exceed 303 mm for the concrete beam shown in Figure 3 of this Certificate.

6.10 The maximum distance of the concentrated load applied on the cantilever load from the top face of the concrete beam should not exceed 236 mm ($303^{(1)} - 42^{(2)} - 25^{(3)} = 236$).

(1) Length of cantilever slab (see Figure 4).

(2) Width of plasterboard, skirting board and skim.

(3) Half of width of a 50 mm square plate (imposed concentrated load is assumed to be applied over a square plate not less than 50 by 50 mm).

6.11 The EPS blocks are for use with self-bearing pre-stressed concrete beams (of normal weight concrete) which provide the final strength of the floor system independently of any other constituent part of the floor system.

6.12 The dimensions and specification of the pre-stressed concrete beam that was used in the full-scale structural testing is shown in Figure 3 and Table 4.

Table 4 Properties of the concrete beam used for full-scale test

Property	Value
Characteristic compressive strength of the concrete beam at 28 days — (f_{ck}) cylinder ($\text{N}\cdot\text{mm}^{-2}$) according to DoP for each concrete beam	55
Area of concrete (mm^2)	9000
Secant modulus of elasticity of concrete (E_{cm}) ($\text{N}\cdot\text{mm}^{-2}$)	38,214
Second moment of area (I) (mm^4)	17,028,000
Aggregate	Granite
Number of 5 mm diameter wires ⁽¹⁾	4
Characteristic tensile strength of pre-stressing steel (f_{pk}) ($\text{N}\cdot\text{mm}^{-2}$)	1770
Characteristic tensile strength 0.1% proof stress of pre-stressing steel ($f_{p0,1k}$) ($\text{N}\cdot\text{mm}^{-2}$)	1556
Service moment resistance ($\text{kN}\cdot\text{m}$)	5.46
Ultimate moment resistance ($\text{kN}\cdot\text{m}$)	7.34
Ultimate shear resistance (kN)	12.20
Initial pre-stress force (kN)	104.24
Pre-stress force after losses (kN)	73.56
Eccentricity (mm)	21.90
Mass of beam per metre ($\text{kg}\cdot\text{m}^{-1}$)	22.94

(1) The indented pre-stressing steel wire must be in accordance with BS 5896 : 2012.

6.13 The natural frequency⁽¹⁾ (f) of the concrete beam used in the test assemblies was greater than 4 Hertz (Hz) , as defined below. A suitably experienced/qualified engineer and experienced individual must ensure that the following criteria are met for other beams under the specified loading conditions:

- (a) The concrete beam should have a natural frequency greater than 4 Hz when loaded with full dead load plus 0.1 x imposed load (UDL).
- (b) The natural frequency in Hz of a simply supported concrete beam under UDL loading is determined from equation $f=18/\Delta^{0.5}$, where Δ is the deflection of the concrete beam in mm for imposed UDL, as defined in item (a) above and UDL dead loads.

(1) The vibration due to rhythmic activity (such as dancing) and the external sources (such as building construction or rail traffic) will be excluded for the beam and block floor systems.

6.14 Other pre-stressed concrete beams (other than those used for full scale tests — see Figure 3) for micro-fibre concrete specifications (with reference number 7 and 8 in Table 2 of this Certificate) can be considered as acceptable alternatives if a suitably experienced/qualified engineer confirms that the following conditions for the tested beam are met:

- the pre-stressed concrete beams are designed in accordance with BS EN 1992-1-1 : 2004 (Eurocode 2) and its UK National Annex by a suitably experienced/qualified engineer to ensure that the beams are adequate to resist the applied loading
- the proposed pre-stressed concrete beam is CE marked and manufactured and designed in accordance with the requirements of BS EN 15037-1 : 2008
- the serviceability deflection limit of the proposed concrete beam is in accordance with BS EN 1992-1-1 : 2004, as summarised in Table 5 of this Certificate.

Table 5 Deflection limitation of pre-stressed concrete beams

Description	Limit for deflection
Camber at transfer (upward deflection) of pre-stressed force under the self-weight of the beam	span/250
Deflection at application of finishes – downward from the level of the bearings	span/250
Deflection for long-term quasi permanent loading (M_{QP}) ⁽¹⁾ after losses in pre-stress force and creep measured from below the level of the bearings. $E_{c,eff}$ ^(2,3) should be used, to account for the effect of creep in the concrete	span/250
Movement after application of finishes – increase in deflection due to pre-stress loss and creep	span/500

(1) M_{QP} is the moment under the quasi-permanent load combination (refer to equation 6.16a of BS EN 1990 : 2002).

(2) Effective modulus of elasticity of concrete obtained from equation $E_{cm}/(1+\Psi)$, where Ψ is the long-term creep coefficient of the concrete beam and assumed to be equal to 2.

(3) The value of E_{cm} should be reduced by 10% as the aggregate for the concrete beams is limestone.

- the deflection of the proposed pre-stressed concrete beam for the same length and loads at each stage (defined in Table 5 of this Certificate) is equal to or less than the concrete beam shown in Figure 3
- the value of E_{cm} for limestone and sandstone aggregates are reduced by 10% and 30% respectively
- the natural frequency of the concrete beam is greater than 4 Hz, as defined in section 6.13 for floor vibration
- the concrete beam is self-bearing and no account should be made for possible composite action between the beams and the EPS in-fill blocks or the concrete topping
- the maximum length of the cantilever slab from the top face of the concrete beam does not exceed 303 mm
- the maximum distance of the concentrated load applied on the cantilever load from the top face of the beam does not exceed 236 mm ($303^{(1)}-42^{(2)}-25^{(3)} = 236$)
- the imposed loads (UDL and concentrated load) are in accordance with BS EN 1991-1-1: 2002 and its UK National Annex, and not exceeding the values shown in the Tables 6, 7 and 8 of this Certificate
- the minimum bearing width to support the concrete beam is 90 mm.

(1) Length of cantilever slab (see Figure 4).

(2) Width of plasterboard, skirting board and skim.

(3) Half of width of a 50 mm square plate (imposed concentrated load for residential buildings is assumed to be applied over a square plate not less than 50 by 50 mm).

6.15 The maximum effective span of the concrete beam (assumed to be a simply supported and self-bearing beam) must be calculated using the equations from BS EN 1990 : 2002 (6.10 and 6.14a or the less favourable equations 6.10a, 6.10b and 6.14b). The lowest effective span obtained from these equations are considered to be the maximum effective span of the concrete beam.

6.16 Where two or more concrete beams are placed side by side, eg beneath load bearing walls, the spaces between the beam webs should be in-filled with concrete with a minimum strength class of C25/30 to give unity of action.

7 Thermal performance

7.1 The overall floor U value will depend significantly on the deck U value, the ratio of the exposed (and semi-exposed) floor perimeter length to floor area (p/a), the amount of underfloor ventilation and the ground thermal conductivity. Each floor U value should therefore be calculated to BS EN ISO 13370 : 2017 and BRE Report 443 : 2006.

7.2 The floor deck U value (from inside to the underfloor void) will depend significantly on the size and number of precast concrete beams, the EPS block's toe thickness and the width of any gap between adjacent EPS blocks in the toe layer. The thermal resistance of each beam and EPS block configuration should be numerically modelled to BS EN ISO 10211 : 2017 and BS EN 15037-4 : 2010. The floor deck U value may then be taken as an area-weighted average, and the overall floor U value calculated as described in section 7.1.



7.3 Example floor U values given in Table 6 indicate that the EPS blocks can enable a floor to meet, or improve upon, the design floor U values of 0.13 to 0.25 $W \cdot m^{-2} \cdot K^{-1}$ as specified in the documents supporting the national Building Regulations.

Table 6 Example U value⁽¹⁾ ($W \cdot m^{-2} \cdot K^{-1}$) for single beam configuration⁽²⁾

Beam size (mm)	p/a ratio	EPS block thickness (mm) and beam configuration (A)						
		190	210	245	285	315	360	400
150	0.4	0.19	0.17	0.14	0.12	0.11	0.10	0.09
x	0.6	0.20	0.18	0.15	0.12	0.11	0.10	0.09
92	0.7	0.21	0.18	0.15	0.13	0.11	0.10	0.09
	0.9	0.21	0.18	0.15	0.13	0.12	0.10	0.09

(1) These calculations are in accordance with sections 7.1 and 7.2 of this Certificate and assume:

- The beam dimensions shown in Figure 3 and beam straightness of < 5 mm.
- The beam λ is 2.0 $W \cdot m^{-1} \cdot K^{-1}$ and the 75 mm concrete screed λ is 1.15 $W \cdot m^{-1} \cdot K^{-1}$
- A 300 mm thick perimeter wall with a U value of 0.35 $W \cdot m^{-2} \cdot K^{-1}$
- Underfloor ventilation area is 0.0015 $m^2 \cdot m^{-1}$
- Ground conductivity is 1.5 $W \cdot m^{-1} \cdot K^{-1}$
- All other parameters are default values from BRE Report 443 : 2006.

(2) Configuration used: 100% single beam configuration.

Junction Ψ values

7.4 Care must be taken in the overall design and construction of junctions between the floor and external, internal and party walls, to limit excessive heat loss and air infiltration.

7.5 For the purpose of Standard Assessment Procedure (SAP) or SBEM calculations, junction psi values for the product can be taken from:

- Book 6 on the Constructive Details website (www.constructivedetails.co.uk), or
- Table 7 of this Certificate, or can be
- modelled in accordance with the requirements and guidance in: BRE Report 497; BRE Information paper IP01/06; and the provisions in the documents supporting the national Building Regulations relating to competency to perform calculations, determine robustness of design/construction and limiting heat loss by air infiltration.

Table 7 Junction Ψ values

Junction	Ψ ($\text{W}\cdot\text{m}^{-1}\text{K}^{-1}$)
External wall	
— ⁽¹⁾	0.06
— ⁽²⁾	0.32
Party wall ⁽²⁾	0.16

(1) beams parallel to the external wall with uncut starter or end blocks (285 mm thick) and full fill masonry wall (U value $0.15 < 0.20 \text{ W}\cdot\text{m}^{-1}\text{K}^{-1}$) with 100 mm inner block leaf at $< 0.19 \text{ W}\cdot\text{m}^{-1}\text{K}^{-1}$ and edge insulation ($R = 1.2 \text{ m}^2\cdot\text{K}\cdot\text{W}^{-1}$) to a 75 mm thick structural concrete topping. The cavity wall insulation is continued not less than 450 mm below the top of the edge insulation to the concrete topping.

(2) Conservative defaults from SAP Conventions Document.

8 Condensation risk

Interstitial condensation



8.1 Floors will adequately limit the risk of interstitial condensation when they are designed and constructed in accordance with BS 5250 : 2011 and this Certificate.

8.2 To help minimise the risk of condensation, the void space beneath the lowest point of the floor construction should be at least 150 mm high, with provision for adequate through ventilation in the form of ventilation openings provided in two opposing external walls. The ventilation openings should be sized at not less than $1500 \text{ mm}^2\cdot\text{m}^{-1}$ per run of external wall or $500 \text{ mm}^2\cdot\text{m}^{-2}$ of floor area, whichever is greater. Where pipes are used to carry ventilating air, these should be at least 100 mm in diameter.

8.3 To minimise the risk of condensation at junctions with external walls, specifiers should ensure that wall insulation extends to at least 150 mm below the top of the EPS blocks.

Surface condensation



8.4 Floors will adequately limit the risk of surface condensation when the thermal transmittance (U value) does not exceed $0.7 \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$ at any point and the junctions with walls are in accordance with the relevant requirements of *Limiting thermal bridging and air leakage : Robust construction details for dwellings and similar buildings* TSO 2002 or BRE Information Paper IP 1/06.



8.5 Floors will adequately limit the risk of surface condensation when the thermal transmittance (U value) does not exceed $1.2 \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$ at any point and the floors are designed and constructed to BS 5250 : 2011. Additional guidance can be found in BRE Report 262 : 2002.

8.6 To minimise the risk of surface condensation at service penetrations, care should be taken to minimise gaps in the insulation layer (for example, with expanding foam insulation).

9 Maintenance

The blocks are designed to be installed within the floor structure; therefore, they do not require maintenance.

10 Durability



10.1 The EPS blocks are protected in service from agents liable to cause deterioration and will be effective as insulation for the life of the building in which they are installed.

10.2 The exposure condition beneath a suspended ground floor over a ventilated void and soil is class XC3, in accordance with BS EN 1992-1-1: 2004. The concrete beam will have adequate durability for this exposure condition.

10.3 The durability of concrete topping reinforced with micro-polymer, macro-polymer or steel fibres will be at least equivalent to that of plain concrete of the same grade.

10.4 The concrete topping reinforced with steel mesh will have adequate durability for exposure class XC1.

11 Re-use and recyclability

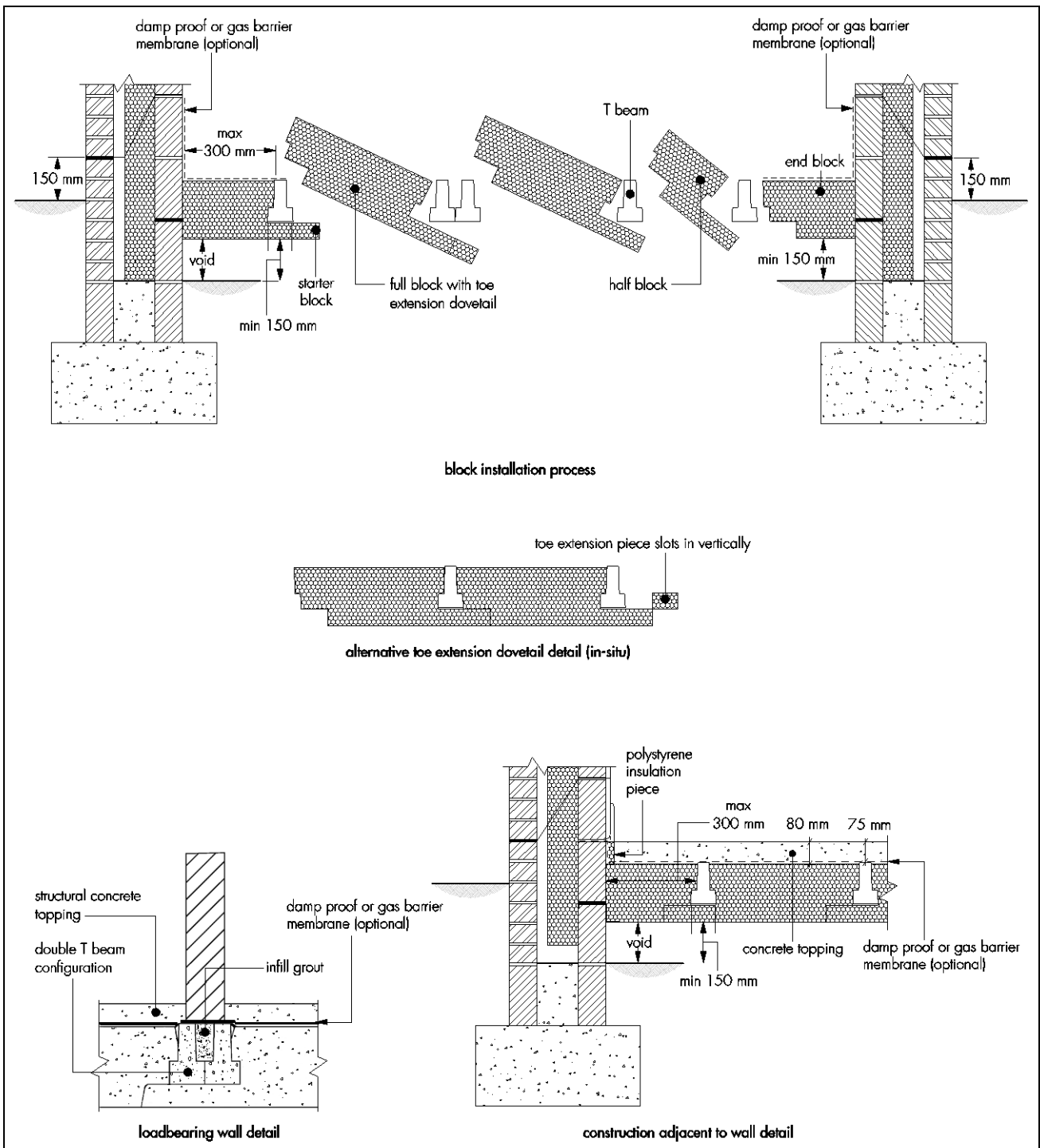
EPS material can be recycled.

Installation

12 General

Details of typical prestressed concrete beams and EPS block assemblies are shown in Figure 4 and the Certificate holder's literature, design drawings and installation guidelines. Also see the *Code of Practice for Safe Erection of Precast Concrete Flooring*.

Figure 4 Basic system layouts



13 Site preparation

13.1 A void at least 150 mm deep must be provided between the underside of the polystyrene floor construction and the ground surface. Where clay soil of low- medium- or high-volume change potential exists, the final minimum void depth should be increased appropriately to prevent problems associated with heave (see section 4.4 of this Certificate). The sub-floor void should have good natural drainage or land drains should be provided to prevent standing water within the sub-floor void when this is below external ground level. Where the levels differ, the ability of the perimeter walls to act as retaining walls must be checked.

13.2 The ground beneath the floor should be free of topsoil and vegetation. Oversite concrete or other surface seal are not required.

13.3 Damp-proofing and ventilation arrangements must be in accordance with normal good practice and the Certificate holder's instructions (for example, provision of damp-proof sleeves to ventilators and adequate drainage of the sub-floor).

13.4 A continuous damp-proof course (dpc) should be laid along the supporting wall below the beam and block bearing, in accordance with BS 8102 : 2009.

13.5 All bearings should be level and true: care should be taken to ensure that a minimum bearing on blockwork of 90 mm is maintained.

13.6 The blockwork should be brought up to finished floor level where running parallel to the beams.

14 Procedure

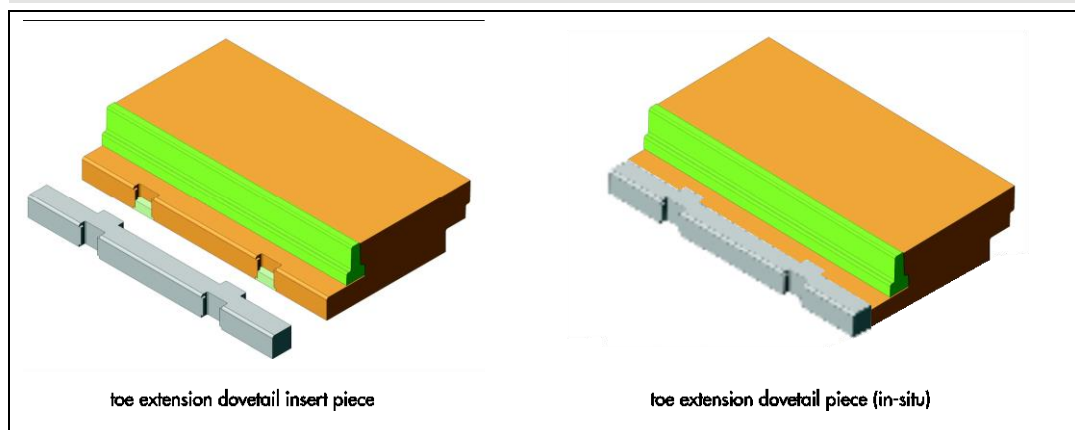
14.1 The beams are first laid in an approximate position (the exact position is detailed on the floor plan drawings). An offcut of an EPS block can be used as a template to space the beams accordingly.

14.2 The first beam is accurately positioned and a starter block (as shown in Figure 4) with a top width not exceeding 300 mm is installed; the beam is manually butted tightly against the EPS block to ensure a snug fit.

14.3 Care must be taken to cut the polystyrene accurately to size and to push the beam up tight to ensure that the polystyrene achieves its full 20 mm bearing on the beam.

14.4 If necessary, to ease the process of inserting the EPS blocks, the beams can be splayed slightly and pushed up tight to ensure the EPS blocks are locked tight as installation progresses. The blocks are installed in this way row by row, rotating into place and taking care not to damage the toe extension as it slips under the beam. If there is a risk that the toe extension will foul (touch) the ground and/or services, toe extension jointing pieces can be vertically inserted in-situ, prior to the installation of the next row of EPS blocks or beam (ie in multiple beam situations – see Figure 5).

Figure 5 Toe extension dovetail pieces to increase the toe length for multiple beam situations



14.5 Half-EPS blocks are used for the last row and where reduced beam centres are specified. End blocks are cut from standard or half-blocks to fit flush to the wall width, with a top width not exceeding 300 mm.

14.6 Any awkward gaps (eg around services) are to be filled with expanding foam and excess foam to be cut off flush with the top of the EPS.

14.7 At the perimeter, closure blocks should follow the prestressed concrete beam manufacturer's drawings. The closure or aircrete blocks are cut to suit, bridging the gap between the wall and the prestressed concrete beam shoulder.

14.8 To provide a damp-proof, airtight radon or gas barrier, the membrane must be laid in accordance with the manufacturer's instruction.

14.9 When used in conjunction with underfloor heating, the minimum design thickness of concrete topping (see Table 2) must be used and the pipework covered by a minimum 40 mm thick concrete. The Certificate holder's instructions should also be sought regarding installation of these systems.

14.10 Once the panels are installed, care must be taken not to walk on them. If a temporary working platform is required, the panels should be covered with a suitably rigid board. To avoid damage to the polystyrene panels, the structural floor screed should be laid as soon as possible after the blocks have been installed.

14.11 Prior to pouring the structural floor screed, it must be ensured that the polystyrene blocks are centrally located between the prestressed concrete beams, with a maximum gap of 5 mm between the polystyrene and the prestressed concrete beam face. These gaps may be due to normal construction or manufacturing tolerances.

14.12 Where gaps occur, concrete is placed along the edges of the polystyrene blocks to prevent displacement during the main concreting operation.

14.13 When using a concrete pump, truck or skip, concrete should not be discharged onto the polystyrene blocks from heights greater than 300 mm and concrete heaps must not be formed over 150 mm high.

14.14 When wheelbarrows are used, planks must be placed to spread the wheel load to the prestressed concrete beams. Spot boards must be used when tipping and shovelling.

14.15 The concrete screed should be placed and compacted. Provision should be made for a suitable concrete finish to be achieved without standing on or overloading the EPS panels. Alternatively, self-levelling and self-compacting concrete screed can be used.

14.16 The following good practice should be taken into account throughout the installation process:

- cube compressive strength and slump tests for concrete topping
- limitation of slump for standard concrete and slump flow for self-compacting concrete
- concrete topping not to be poured below 5°C
- the maximum temperature at which the concrete should be placed is 30°C and decreasing
- concrete should not be poured during rainfall
- all the ingredients including the fibres should be added at the plant mixer.

14.17 To prevent shrinkage cracks:

- joints should be incorporated into the slab and appropriate joints between the opening of two adjacent rooms provided. Inclusion of joints must not compromise structural performance of the concrete topping
- where internal walls are built through the slab, a joint should be formed across the door threshold where the wall separates the two rooms
- an aspect ratio greater than 2:1 should be avoided
- a compressible insulating material around the perimeter of the plot should be provided
- the use of high shrinkage potential aggregate should be avoided
- the w/c ratio should not be increased beyond the limits specified in BS 8500-1 : 2015, BS 8500-2 : 2015 and BS EN 206 : 2013
- a steel mesh or loose reinforcing bars should be provided at each corner of an opening if the size of the opening exceeds 500 x 500 mm
- Consideration should be given to the provision of an appropriate detail (eg crack inducer) on external walls at the position of porches

Technical Investigations

15 Tests

15.1 A series of full-scale tests was carried out to ensure the compatibility of the concrete topping with the maximum deflection of the concrete beams under service and ultimate loads. The tests were designed to create the maximum curvature of the beam using the macro-/micro-polymer-fibre-reinforced and steel-reinforced concrete toppings.

15.2 Prism tests were carried out in accordance with BS EN 14651 : 2005 for concrete toppings reinforced with steel and macro-polymer fibres.

15.3 Tests were conducted on the system and the results assessed to determine:

- resistance to construction loads
- thermal conductivity (λ_D values)
- dimensional accuracy.

16 Investigations

16.1 An evaluation was made of existing data to determine:

- adequacy of concrete topping reinforced with steel mesh in terms of thickness, strength class of concrete and diameter of steel reinforcement in accordance with BS EN 1992-1-1 : 2004 and BS EN 15037-1 : 2008
- practicability of installation
- thermal conductivity ($\lambda_{90/90}$ values)
- dimensional accuracy
- the durability, practicability of installation and detailing techniques of the system.

16.2 Floor deck U values were derived by modelling to BS EN ISO 10211 : 2017 and BS EN 15037-4 : 2010 Annex F and example floor U values calculated to BS EN ISO 13370 : 2017.

16.3 The risk of condensation was assessed to BS 5250 : 2011.

16.4 The manufacturing processes for the EPS blocks was evaluated, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

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17 Conditions

17.1 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 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.

17.2 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.

17.3 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.

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

17.5 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.

17.6 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.