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**Agrement Certificate**

**17/5431**

Product Sheet 2

## S AND B FLOORING SYSTEMS

### S AND B WARMBEAM TOP SHEET SYSTEM

This Agrément Certificate Product Sheet<sup>(1)</sup> relates to the S and B Warmbeam<sup>(2)</sup> Top Sheet System comprising precast, prestressed concrete beams, a range of expanded polystyrene (EPS) infill panels, EPS top sheet, concrete perimeter slip-bricks and concrete closure blocks. The system is for use in conjunction with structural concrete topping in suspended concrete ground floors in single-family dwellings, flats and communal areas in blocks of flats within the load criteria specified in this Certificate.

(1) Hereinafter referred to as 'Certificate'.  
(2) Registered trademark.

#### 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 structural concrete topping and can sustain and transmit the dead and imposed floor loads to the supporting structure (see section 6).

**Thermal performance** — the EPS components 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 components can contribute to limiting the risk of condensation (see section 8).

**Durability** — the system components 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

Paul Valentine  
Technical Excellence Director

Claire Curtis-Thomas  
Chief Executive

*Certificate amended on 16 January 2020 to update sections 6 and 16.*

*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](http://www.bbacerts.co.uk)  
Readers **MUST** check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA directly.*

*Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.*

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## Regulations

In the opinion of the BBA, the S and B Warmbeam Top Sheet 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)

<b>Requirement:</b>	<b>A1(1)</b>	<b>Loading</b>
Comment:		The system can sustain and transmit dead and imposed floor loads to the supporting structure. See sections 6.2, 6.3 and 6.7 to 6.23 of this Certificate.
<b>Requirement:</b>	<b>C2(c)</b>	<b>Resistance to moisture</b>
Comment:		The system can contribute to limiting the risk of condensation. See sections 8.1 and 8.4 of this Certificate.
<b>Requirement:</b>	<b>L1(a)(i)</b>	<b>Conservation of fuel and power</b>
Comment:		The system can contribute to satisfying this Requirement. See section 7.3 of this Certificate.
<b>Regulation:</b>	<b>7</b>	<b>Materials and workmanship</b>
Comment:		The system is acceptable. See section 10 and the <i>Installation</i> part of this Certificate.
<b>Regulation:</b>	<b>26</b>	<b>CO<sub>2</sub> emission rates for new buildings</b>
<b>Regulation:</b>	<b>26A</b>	<b>Fabric energy efficiency rates for new dwellings (applicable to England only)</b>
<b>Regulation:</b>	<b>26A</b>	<b>Primary energy consumption rates for new buildings (applicable to Wales only)</b>
<b>Regulation:</b>	<b>26B</b>	<b>Fabric performance values for new dwellings (applicable to Wales only)</b>
Comment:		The system can contribute to satisfying these Regulations. See section 7.3 of this Certificate.



### The Building (Scotland) Regulations 2004 (as amended)

<b>Regulation:</b>	<b>8(1)</b>	<b>Durability, workmanship and fitness of materials</b>
Comment:		The system can contribute to a construction satisfying this Regulation. See section 10 and the <i>Installation</i> part of this Certificate.
<b>Regulation</b>	<b>9</b>	<b>Building standards in relation to construction</b>
Standard:	1.1(a)	Structure
Comment:		The system can sustain and transmit dead and imposed floor loads to the supporting structure, with reference to clause 1.1.1 <sup>(1)</sup> . See sections 6.2, 6.3 and 6.7 to 6.23 of this Certificate.
Standard:	3.15	Condensation
Comment:		The system can contribute to limiting the risk of interstitial condensation, with reference to clauses 3.15.1 <sup>(1)</sup> , 3.15.4 <sup>(1)</sup> and 3.15.5 <sup>(1)</sup> . See sections 8.1 and 8.5 of this Certificate.
Standard:	6.1(b)	Carbon dioxide emissions
Comment:		The system can contribute to satisfying this Standard, with reference to clauses 6.1.1 <sup>(1)</sup> and 6.1.6 <sup>(1)</sup> . See section 7.3 of this Certificate.
Standard:	6.2	Building insulation envelope
Comment:		The system can contribute to satisfying the requirements of this Standard, with reference to clauses 6.2.1 <sup>(1)</sup> , 6.2.3 <sup>(1)</sup> and 6.2.4 <sup>(1)</sup> . See section 7.3 of this Certificate.

Standard: 7.1(a) Statement of sustainability  
 Comment: 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<sup>(1)</sup>[Aspects 1<sup>(1)</sup> and 2<sup>(1)</sup>], 7.1.6<sup>(1)</sup>[Aspects 1<sup>(1)</sup> and 2<sup>(1)</sup>] and 7.1.7<sup>(1)</sup>[Aspect 1<sup>(1)</sup>]. See section 7.3 of this Certificate.

(1) Technical Handbook (Domestic).



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

<b>Regulation:</b> Comment:	<b>23(a)(i)(iii)(b)</b>	<b>Fitness of materials and workmanship</b> The system is acceptable. See section 10 and the <i>Installation</i> part of this Certificate.
<b>Regulation:</b> Comment:	<b>29</b>	<b>Condensation</b> The system can contribute to limiting the risk of interstitial condensation. See section 8.1 of this Certificate.
<b>Regulation:</b> Comment:	<b>30</b>	<b>Stability</b> The system can sustain and transmit dead and imposed floor loads to the supporting structure. See sections 6.2, 6.3 and 6.7 to 6.23 of this Certificate.
<b>Regulation:</b> <b>Regulation:</b> Comment:	<b>39(a)(i)</b> <b>40(2)</b>	<b>Conservation measures</b> <b>Target carbon dioxide emission rate</b> 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* (3.6), 6 *Strength and stability* (6.4) and 14 *Procedure* (14.1 and 14.6) of this Certificate.

## Additional Information

### NHBC Standards 2018

In the opinion of the BBA, the S and B Warmbeam Top Sheet System with macro-polymer fibres, steel fibres or steel mesh structural concrete topping, if installed, used and maintained in accordance with this Certificate, can satisfy or contribute to satisfying the relevant requirements in relation to *NHBC Standards*, Chapter 5.2 *Suspended ground floors*.

### CE marking

The Certificate holder has taken the responsibility of CE marking the EPS products in accordance with harmonised European Standard BS EN 15037-4 : 2010 and BS EN 13163 : 2012. The steel and polymer fibres used in the concrete topping should be CE marked in accordance with BS EN 14889-1 : 2006 and BS EN 14889-2 : 2006 respectively.

# Technical Specification

## 1 Description

1.1 The S and B Warmbeam Top Sheet System consists of precast prestressed concrete beams, a range of expanded polystyrene (EPS) infill panels (see section 1.2), an EPS top sheet (grey or white), concrete closure blocks and structural concrete toppings, for use in suspended ground floors.

1.2 The infill panels (full, half, start, end and make-up) and top sheet have the nominal characteristic properties given in Table 1 and Figure 1.

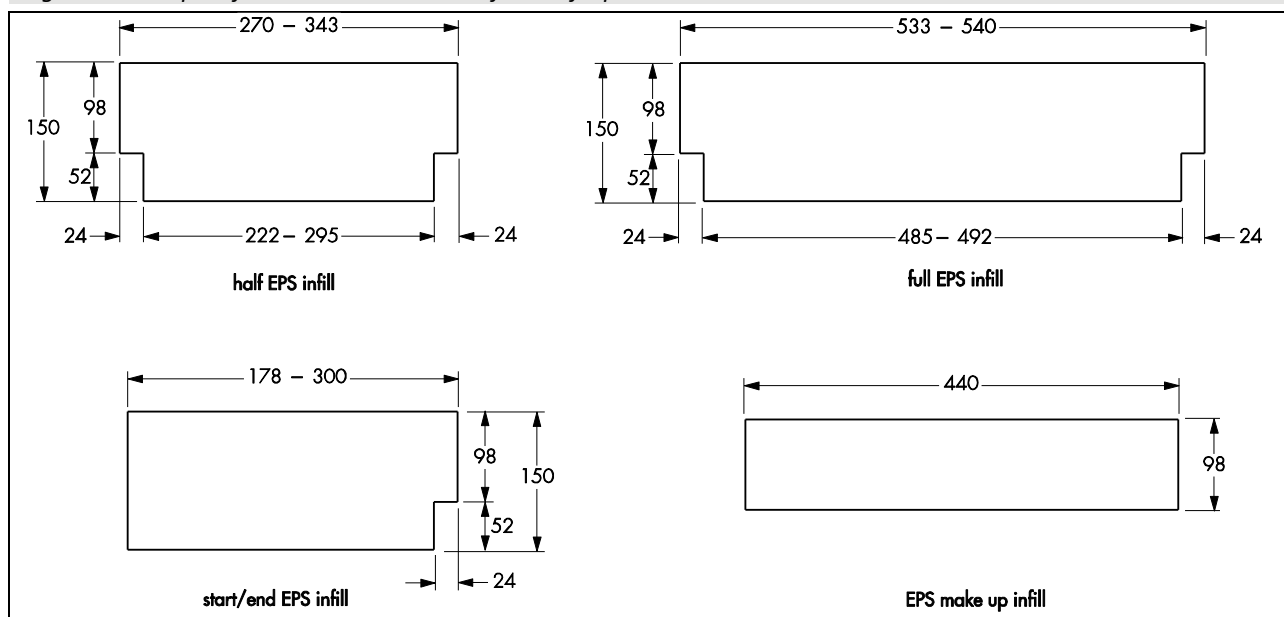
*Table 1 Characteristic properties of the EPS top sheet and infill panels*

Description	Thickness mm	Top width max/min mm	Bottom width max/min mm	Length mm	Compressive strength at 10% deformation kPa	Mechanical resistance according to BS EN 15037-4 : 2010	Declared level of compressive creep to BS EN 13163 : 2012	Declared Thermal conductivity W·m <sup>-1</sup> ·K <sup>-1</sup>	Colour	Moisture diffusion coefficient (μ) <sup>(2)</sup>
Full panel	150 to 225	533 to 540	485 to 492	1200	70	Type R1 and Class R1 a	-	0.038	White	20 to 40
Half panel		270 to 343	222 to 295					0.031	Grey	
Combined start/end panel		178 to 300	154 to 276					0.036	White	
Make-up panel	98	Up to 440	-		100			0.030	Grey	30 to 70
Top sheet	50 <sup>(1)</sup> to 300	1200	2400	120	-	CC(2/1.5/50)30	0.036	White		
				150			0.031	Grey		
				200			0.035	White		
						CC(2/1.5/50)60	0.031	Grey		
							0.034	White	40 to 100	

(1) For other thicknesses of the top sheets between 50 mm (see Table 2 for further details) and 300 mm, the Certificate holder should be contacted. For configuration of the maximum thickness of the top sheet and the minimum width of the top flange of the concrete beams, see Table 2 of this Certificate.

(2) It is recommended that the least favourable value is used in calculations of risk of interstitial condensation; see section 8.1 of this Certificate.

Figure 1 Example of standard dimensions of EPS infill panels



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

- concrete topping reinforced with steel mesh to the specifications given in Table 3, depending on the proposed floor usage. The steel-mesh-reinforced 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 UK National Annexes, with a maximum aggregate size of 20 mm
  - concrete topping<sup>(1)</sup> reinforced with macro polymer or steel fibres to the specifications given in Table 3, with a maximum aggregate size of 10 to 20 mm
- (1) The specification of concrete toppings must be in accordance with BS EN 206 : 2013, BS 8500-1 : 2015 and BS 8500-2 : 2015
- insulation strips (width 25 mm) — for perimeter of structural concrete toppings.

1.4 Ancillary items outside the scope of this Certificate include:

- prestressed concrete beams — of the type and size shown in Figure 3, and CE marked and designed in accordance with BS EN 15037-1 : 2008, BS EN 1992-1-1 : 2004 and its UK National Annex, BS EN 206 : 2013, BS 8500-1 : 2015 and BS 8500-2 : 2015. See sections 6.16 to 6.23 of this Certificate
- concrete closure blocks and concrete perimeter slip-bricks — with a compressive strength equal to, or greater than, that of the blocks used to form the inner leaf of the wall. For dimensions of concrete closure blocks, see Figure 2
- where required, gas barrier membranes<sup>(1)</sup> with third-party approval
- vapour control layer (VCL)<sup>(1)</sup>
- damp-proof membranes (dpm)<sup>(1)</sup> with third-party approval

(1) must be compatible with EPS.

Figure 2 Closure blocks and slip-bricks details

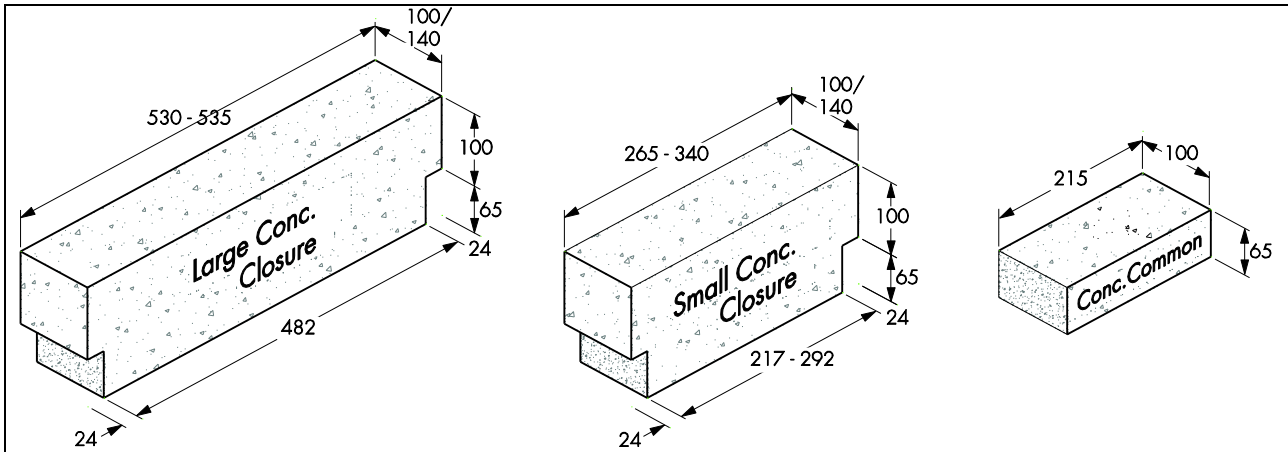
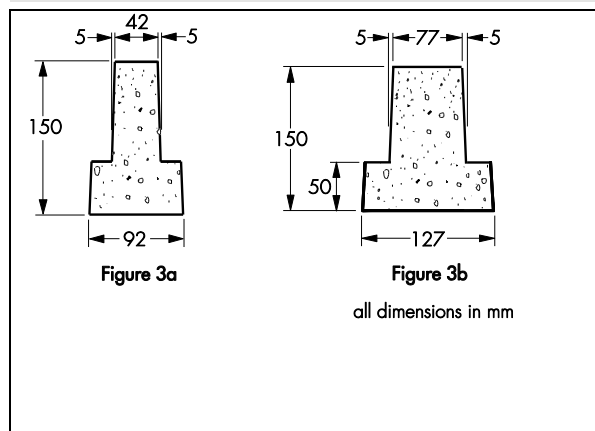


Figure 3 Precast concrete beams used for structural testing and thermal calculations



## 2 Manufacture

2.1 The top sheet and infill panels are manufactured from expanded polystyrene beads using conventional moulding techniques.

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 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.

2.3 The management system of S and B EPS Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2008 by the BBA (Certificate 03/Q001).

## 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 suitably 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 advice of the Certificate holder should be sought when the storage of unprotected beams on site exceeds three months.

3.4 The top sheet and infill panels are wrapped in polyethene, but are otherwise unprotected. Therefore, reasonable care must be taken during transit and storage to avoid damage.

3.5 The top sheet and infill panels should be stacked on a flat base, clear of the ground, protected against prolonged direct sunlight and secured to avoid wind damage. Care must be taken to avoid contact with organic solvents.

3.6 The top sheet and infill panels 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 S and B Warmbeam Top Sheet System.

### Design Considerations

#### 4 Use

4.1 The S and B Warmbeam Top Sheet System is suitable for use as part of a suspended ground floor (over a sub-floor void) in buildings where the loads do not exceed those specified in Table 4 of this Certificate.

4.2 A suitably experienced/qualified engineer should perform a site-specific assessment/design to ensure that:

- the top sheet, infill panels, make-up infill panels, concrete beam and structural concrete toppings are designed in accordance with recommendations in this Certificate and the relevant parts of BS EN 15037-1 : 2008 and BS EN 15037-4 : 2010
- the prestressed concrete beams are designed in accordance with BS EN 1991-1-1 : 2002 and BS EN 1992-1-1 : 2004 and their National Annexes, and have adequate resistance to transfer the applied loads to the supporting structure
- the floor is not loaded by construction materials until the concrete toppings have reached their 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
- where required, lateral restraint is provided at ground floor level in accordance with the requirements of the national Building Regulations, BS 8103-1 : 2011 and *NHBC Standards 2018*

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 (refer to *NHBC Standards 2018*) may be required 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 topping must be designed and installed strictly in accordance with this Certificate and the Certificate holder's instructions (see section 6.11). The dosage rate for macro-polymer and steel fibres must be in accordance with Table 3 of this Certificate.

4.7 The tolerance for the batching process and criteria for acceptability of the macro-polymer and steel 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 in contact with the EPS should be enclosed in a suitable conduit. The Certificate holder should be consulted for further advice.

4.10 The S and B Warmbeam Top Sheet System can be used in floors with suitable under-floor 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

### General

6.1 A suitably experienced/qualified engineer must ensure that the concrete beams and structural concrete toppings are suitable for the intended application (see section 4.2 of this Certificate).

### EPS components



6.2 The top sheet, in conjunction with the infill panels, provides a permanent formwork for the structural concrete toppings. The top sheets also contribute to the short- and long-term structural performance of the floor by transferring the vertical imposed and dead loads to the concrete beams.

6.3 Subject to compliance with the design and installation requirements of this Certificate, the EPS components 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.

6.4 Infill panels may be cut to accommodate varying beam lengths but must be at least 300 mm long, and should be positioned at the floor edges. The widths of the start/end panels are 178 and 300 mm respectively.

6.5 The infill panels are designed to have a normal bearing of 18 mm, with a 3 mm allowance for misalignment and manufacturing tolerances in the straightness of the concrete beam, with a minimum bearing width of 15 mm.

6.6 The make-up panels (see section 14.8) should not be used at widths greater than 440 mm.



6.7 The top sheets have adequate resistance to short- and long-term creep compression. The strain against stress performance of the top sheets under the applied loads at serviceability limit state (SLS) condition remains within the permitted elastic performance limit of 1.0 to 1.5%. The long-term thickness reduction of the top sheets remains within the acceptable limit of 2% after 50 years, when subjected to a permanent compressive stress of  $0.3 \sigma_{10}$  ( $\sigma_{10}$  is the compressive stress of the EPS at 10 % deformation).



6.8 The top sheets must be used in conjunction with a concrete beam that has a top flange width equal to or greater than 42 mm. Alternative concrete beams with top flange width greater than specified in Table 2 of this Certificate can be considered as acceptable.

Table 2 Correlation between the EPS Top sheet properties, width of top flange of concrete beam and loads<sup>(1)</sup>

EPS top sheet thickness (mm)	Declared level of compressive stress at 10% strain of EPS top sheet (kPa)	Minimum width of top flange of concrete beam (mm)	Maximum imposed <sup>(2)(3)</sup> concentrated load kN	Maximum imposed <sup>(2)</sup> UDL kN.m <sup>-2</sup>	Maximum line load partition in any orientation kN.m <sup>-1</sup>
65-95	120	42	2.0	1.5	1.0
96-119			4.0	3.0	1.0
120-300			4.0	3.0	3.0
50-74	150		2.0	1.5	1.0
75-89			4.0	3.0	1.0
90-300			4.0	3.0	3.0
50-74	200		4.0	3.0	1.0
75-300			4.0	3.0	3.0

(1) Self-weight of 75 mm concrete slab and weight of 0.5 kN.m<sup>-2</sup> finishes have been taken into account. For further details, see Table 4 of this Certificate

(2) Imposed concentrated loads must not be combined with imposed uniformly distributed loads (UDL) or other variable actions.

(3) Imposed concentrated load must be applied on a 100 x 100 mm plate.

6.9 Spacers for supporting the mesh reinforcement should be located on spreader plates (with minimum dimensions of 50 by 50 mm and a minimum number of four spacers per m<sup>2</sup>) over the EPS top sheets. 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.

### Structural concrete toppings

6.10 The concrete topping thickness and reinforcement specification must be as shown in Table 3 for loadings defined in Table 4 of this Certificate. The concrete topping above the start/end panels must be designed as a cantilevered slab.

6.11 The structural concrete toppings should be in accordance with BS 8500-1 : 2015, BS 8500-2 : 2015 and BS EN 206 : 2013, manufactured in plants covered by the QSRMC scheme (Quality Scheme for Ready Mixed Concrete) and laid by personnel with the appropriate skills and experience.

6.12 The specifications of the structural concrete toppings (as shown in Table 3), in conjunction with the top sheets and infill panels specified in Table 1 and Figure 1 and the concrete beams defined in section 1.4, are suitable for use in buildings with the characteristic loads defined in Table 4. This has been confirmed by:

- calculation to BS EN 1992-1-1 : 2004 and its UK National Annex for the steel mesh reinforcement, thickness and strength class of concrete topping (see concrete reference no. 1 of Table 3), in conjunction with the specification of concrete beams defined in section 1.4 of this Certificate.
- structural calculation in accordance with 'equation 6' of TR34 (fourth edition, March 2016) of the ultimate bending moment capacity of a 75 mm concrete topping reinforced with macro-polymer or steel fibres for reference concretes no. 2 to 5 of Table 3 of this Certificate, for characteristic loads from single-family dwellings (see Table 4 of this Certificate).

**Table 3 Specification of structural concrete toppings** <sup>(1)(2)</sup>

Ref no.	Reinforcement
1	One layer of A142 mesh to BS 4483 : 2005 with a characteristic yield strength ( $f_{yk}$ ) of 500 N·mm <sup>-2</sup> . Reinforcement should be placed at mid height of the concrete slab
2	Novomesh B&BA <sup>(7)(8)</sup> (steel), dosage rate 17.5 kg·m <sup>-3</sup> , steel flat end, steel fibres, fibre length 50 mm, diameter 1.0 mm, tensile strength 1150 N·mm <sup>-2</sup>
3	Novomesh B&BA <sup>(6)(7)</sup> (macro polymer and micro polyolefin), dosage rate 3.84 kg·m <sup>-3</sup> , shape of macro fibre: continuously deformed, 60 mm long, 0.56 mm diameter, tensile strength 600 N·mm <sup>-2</sup> , modulus of elasticity 7000 N·mm <sup>-2</sup>
4	Adfil SF86 <sup>(7)(8)</sup> (steel fibre), dosage rate 13.33 kg·m <sup>-3</sup> , 60 mm long, diameter 0.75 mm, tensile strength 1225 N·mm <sup>-2</sup> , modulus of elasticity 200000 N·mm <sup>-2</sup>
5	Durus Easy Finish <sup>(6)(7)</sup> (macro-polymer fibre), dosage rate 3.00 kg·m <sup>-3</sup> , 40 mm long, 0.7 mm equivalent diameter, tensile strength 470 N·mm <sup>-2</sup> , modulus of elasticity 6000 N·mm <sup>-2</sup>

- (1) The overall depth of concrete topping above the services is 75 mm
- (2) The fibres listed in the Table can be used within a C28/35 standard concrete (see note 3, below) with maximum 20 mm aggregate (see note 4, below) or C28/35 self-compacting (see note 5, below) concrete with maximum 10 mm aggregate (see note 4, 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) The aggregate for concrete must comply with BS EN 12620: 2013.
- (5) 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%.
- (6) For fresh concrete, the macro-polymer fibres content should be measured in accordance with BS EN 14488-7: 2007
- (7) The dosage rates of steel and polymer fibres defined in the Table include 15% additional fibres and are designed to give the minimum required residual flexural tensile strength of concrete topping with steel or macro-polymer fibres. See section 6.13 of this Certificate.
- (8) For fresh and hardened concrete, the steel fibres content should be measured in accordance with BS EN 14721: 2005.

6.13 The maximum length of the cantilevered slab from the top face of the concrete beam should not exceed 280 mm ( $300^{(1)} - 25^{(2)} + 5^{(3)}$ ) (see Figures 1 and 3 of this Certificate).

6.14 The maximum distance of the concentrated load applied on the cantilever from the top face of the concrete beam must not exceed 188 mm ( $300^{(1)} - 25^{(2)} + 5^{(3)} - 42^{(4)} - 50^{(5)} = 188$ ).

- (1) Length of end panel
- (2) Width of EPS insulation strip
- (3) Upper taper of the concrete beam
- (4) Thickness of plasterboard, skirting board and skim
- (5) Half of width of a 100 mm square plate (imposed concentrated load for residential buildings is assumed to be applied over a square plate not less than 100 mm by 100 mm)

6.15 The permitted characteristic loadings for structural concrete topping reinforced with macro-polymer fibres, steel fibres or steel mesh are shown in Table 4. (Also see Table 2 for correlation between the top sheet thicknesses and compressive stresses in conjunction with concrete beams.)

**Table 4 Maximum characteristic imposed partition loads and weight of finishes for structural concrete topping reinforced with macro-polymer or steel fibres or steel mesh A142. Imposed concentrated load must be applied over a square plate of area not less than 100 mm by 100 mm**

Description	Maximum characteristic loads for single-family dwellings — reinforced with macro-polymer fibres, steel fibres or steel mesh A142	Maximum characteristic loads for communal areas in blocks of flats or other suitable buildings — reinforced with steel mesh A142
Imposed UDL (kN·m <sup>-2</sup> )	1.5 <sup>(1)</sup>	3.0 <sup>(1)</sup>
Imposed concentrated load (kN)	2.0 <sup>(1)(2)</sup>	4.0 <sup>(1)(2)</sup>
Line load partition, parallel and perpendicular to the beam (kN·m <sup>-1</sup> )	1.0	1.0-3.0 <sup>(3)</sup>
Allowance for moveable partition (kN·m <sup>-2</sup> )	1.0	1.0
Finishes (kN·m <sup>-2</sup> )	0.5	

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

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

(3) For further details, see Table 2 of this Certificate

### Prestressed concrete beam

6.16 The EPS top sheets, start, end, half, full and make-up infill panels are for use with self-bearing prestressed concrete beams, normal weight concrete, which provides the final strength of the floor system independently of any other constituent part of the floor system.

6.17 The prestressed concrete beams are outside the scope of this Certificate and must be specified and designed by a suitably experienced/qualified engineer. The following information is offered for guidance only.

6.18 A suitably experienced/qualified engineer must design the concrete beam required for the floor in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex and ensure that the natural frequency (f) of the concrete beam due to footfall<sup>(1)</sup> is greater than 4 Hertz (Hz) as defined below for each floor under the specified loading conditions:

- 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)
- The natural frequency (f) in Hz of a simply supported concrete beam under UDL loading is determined from equation  $f = 18/\Delta^{0.5}$ , where  $\Delta$  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 from the beam-and-block floor systems.

6.19 The serviceability deflection limit must be in accordance with BS EN 1992-1-1 : 2004, clause 7.4 and is summarised in Table 6 of this Certificate.

**Table 5 Deflection limitation of prestressed concrete beams**

Description	Limit for deflection
Camber at transfer (upward deflection) of pre-stressed force under the self-weight of the concrete beam	Span/250
Deflection at application of finishes – downward from the level of the bearings	Span/250
Deflection for long-term quasi permanent loading ( $M_{QP}$ ) <sup>(1)</sup> after losses in pre-stress force and creep measured from below the level of the bearings. $E_{c,eff}$ <sup>(2)(3)</sup> 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/250

(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  $\Psi$  is the long-term creep coefficient of the concrete beam and assumed to be equal to 2.

(3) For limestone and sandstone aggregates, the value of  $E_{cm}$  should be reduced by 10% and 30% respectively.

6.20 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 6.14a). The lowest effective span obtained from these equations will be considered to be the maximum effective span of the concrete beam.

6.21 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.

6.22 The minimum bearing width to support the concrete beam is 90 mm in accordance with BS EN 8103-1 : 2011.

6.23 The concrete beam is self-bearing and there should be no account made for possible composite action between the beams and the EPS top sheets or the structural concrete topping.

## 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, therefore, should be calculated to BS EN ISO 13370 : 2017, BRE Report 443 : 2006 and the declared thermal conductivity shown in Table 1 of this Certificate.

7.2 A floor deck U value (from inside to the underfloor void) will depend significantly on the types and number of precast concrete beams and EPS infill panels. The thermal resistance of each concrete beam and EPS 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 system can enable a floor to meet, or improve upon, the design floor U values of between  $0.13 \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$  and  $0.25 \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$  specified in documents supporting the national Building Regulations.

Table 6 Example floor U values<sup>(1)</sup> for single beam configurations<sup>(2)</sup> ( $\text{W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$ )

Beam option	P/A ratio $\text{m}/\text{m}^2$	50 mm EPS White 120 top sheet with 150 mm EPS White 70 infill panel	300 mm EPS Grey 120 or 150 top sheet with 150 mm EPS Grey 70 infill panel
150 x 92 mm Refer to Figure 3a	0.4	0.18	0.070
	0.6	0.20	0.072
	0.7	0.20	0.072
	0.9	0.21	0.073
150 x 127 mm Refer to Figure 3b	0.4	0.19	0.071
	0.6	0.21	0.073
	0.7	0.21	0.074
	0.9	0.22	0.074

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

- the concrete beam  $\lambda$  is  $2.0 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$  and 75 mm concrete topping  $\lambda$  is  $1.15 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$
- a 300 mm thick perimeter wall with a U value of  $0.35 \text{ W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$
- underfloor ventilation area is  $0.0015 \text{ m}^2\cdot\text{m}^{-1}$
- ground conductivity is  $1.5 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$
- all other parameters are default values from BRE Report BR 443 : 2006.

(2) Configuration used – All single beams at full centres.

### Junction $\psi$ -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 The junction  $\psi$ -values given in Table 7 may be used in Standard Assessment Procedure (SAP) calculations or values can be modelled in accordance with the requirements and guidance in BRE Report BR 497, BRE Information Paper IP 1/06 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  $\psi$  values

Junction	Ref <sup>(1)</sup>	$\psi$ ( $W \cdot m^{-1} \cdot K^{-1}$ )
External wall with ground floor (normal)	E5	0.32 <sup>(2)</sup>
Party wall with ground floor	P1	0.16 <sup>(2)</sup>

(1) From SAP 2012 Table K1.

(2) Conservative defaults from SAP 2012.

## 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, Annexes D and F. Where there is no VCL or gas membrane below the concrete topping, the risk for each case should be assessed, both through the beam and through the insulation in accordance with BS EN ISO 13788 : 2012 and BS 5250 : 2011, Annex D.3, accounting for the slab construction, dwelling humidity class, dwelling type and dwelling location.

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  $1500 \text{ mm}^2 \cdot \text{m}^{-1}$  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 diameter.

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

### 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 floor is designed and constructed to BS 5250 : 2011. Additional guidance can be found in BRE Report BR 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.

## 9 Maintenance

The system components are installed within the floor structure and, therefore, do not require maintenance.

## 10 Durability



10.1 The EPS products are protected in service from organic solvents and substances 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 the concrete topping reinforced with macro-polymer fibres 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 Reuse and recyclability**

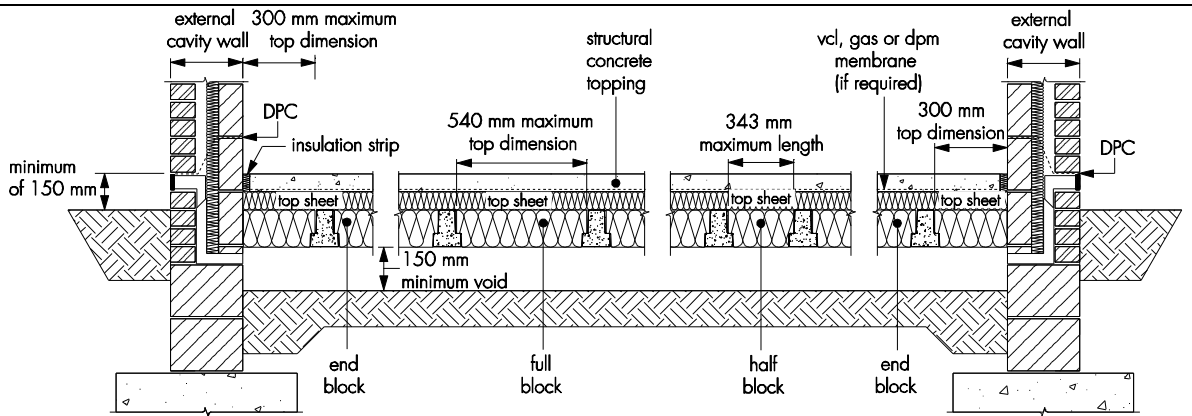
EPS material can be recycled if free from debris and contamination. The concrete and reinforcement steel can also be recycled.

## **Installation**

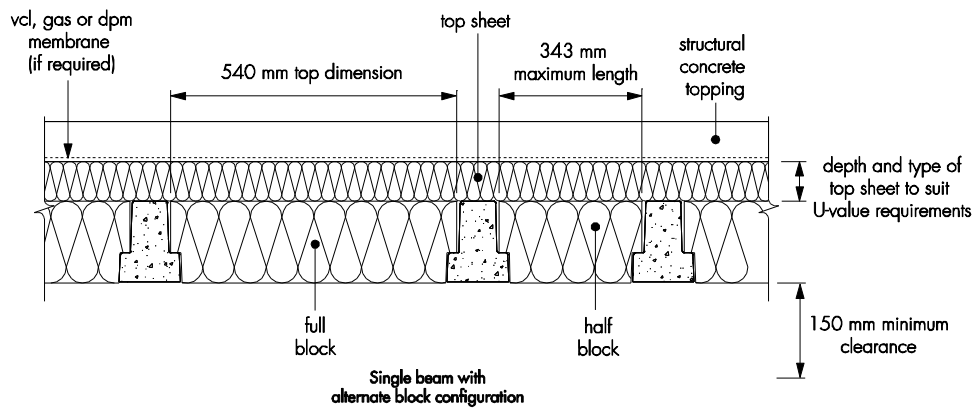
## **12 General**

Details of typical precast concrete beams and EPS component assemblies using the S and B Warmbeam Top Sheet System are shown in Figure 4.

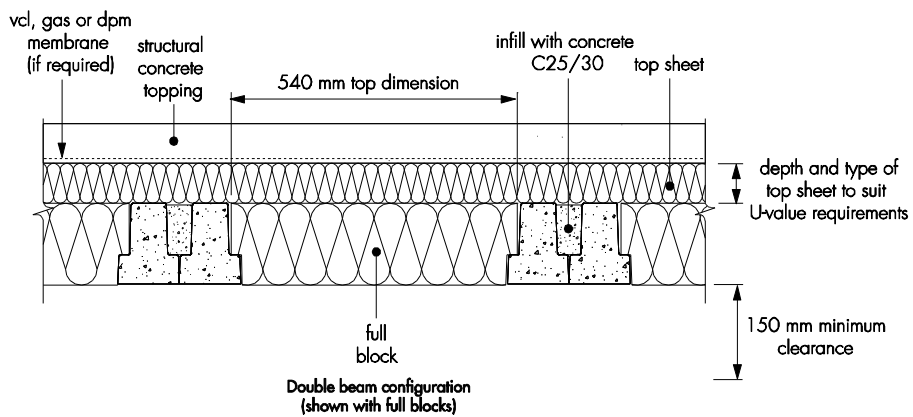
Figure 4 Example beam and EPS block assemblies



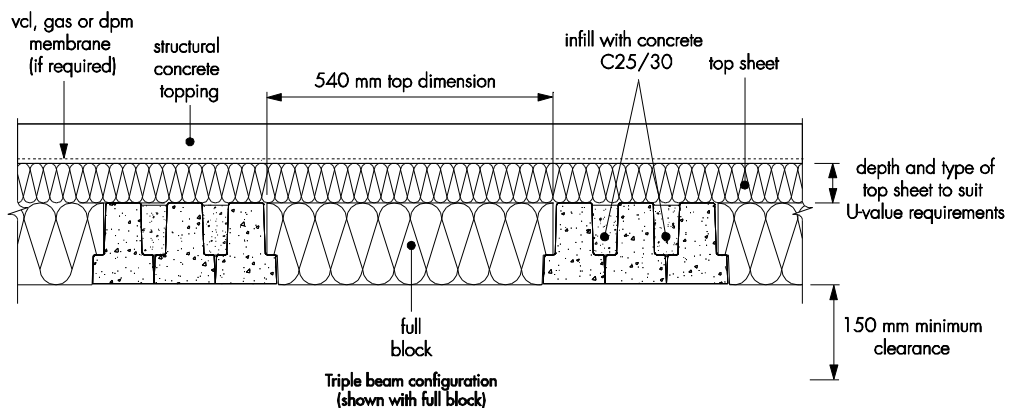
Typical section through insulated flooring system



Single beam with alternate block configuration



Double beam configuration (shown with full blocks)



Triple beam configuration (shown with full block)

## 13 Site preparation

13.1 The ground beneath the floor should be free of topsoil and vegetation. Oversite concrete or other surface seal is not required, but material added to bring the solum to an even surface must be hard and dry.

13.2 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 clay heave. With good natural drainage or where site drains are provided to prevent water collecting and standing, the ground level beneath the floor does not need to be raised to the external ground level.

13.3 Damp-proofing and ventilation arrangements must be in accordance with normal good practice, for example, by the 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 bearings in accordance with BS 8102 : 2009.

13.5 The concrete beams must be laid in the positions shown on the floor plan. Each concrete beam is tightly placed against the beam spacing blocks. Further installation details are given in section 14.

## 14 Procedure

14.1 Normal precautions for handling EPS materials should be taken to avoid damaging the EPS products during offloading, storage, handling and installation. Any damaged products must be replaced before pouring the concrete.

14.2 A dpc should be laid on top of the bearing and end walls.

14.3 The precast concrete beams are positioned at approximate locations and centres shown on the S & B EPS Ltd approved drawing.

14.4 The start panels are positioned against the inside face of the wall. The adjacent beam is then moved into position to support the profiled edge of the panel. The flat face of the panel provides a tight friction fit against the wall.

14.5 The remaining concrete beams are the installed in line with the S & B EPS Ltd approved layout drawing using the relevant closure blocks or a suitable gauge to ensure the correct centres. The closure blocks are bedded in mortar.

14.6 Panels may be cut with a handsaw where required. Offcuts greater than 300 mm may be used elsewhere in the floor.

14.7 Infill panels are then used to complete the floor zone at the normal beam spacing.

14.8 Gaps in non-standard beam spacing may be filled using the make-up panel to a maximum of 440 mm; these can be cut on site to the required dimension.

14.9 Finally, the end infill panels are installed to complete the infill installation.

14.10 The EPS top Sheet insulation is laid over the floor and cut with a handsaw to accommodate service penetrations and part sheet widths where necessary. Small offcuts can be used to seal around service penetrations.

14.11 If required a gas barrier can be installed, as per the manufacturer's instructions.

14.12 If specified, underfloor heating pipes can be installed. These can be secured to the top sheet insulation material using standard pipe clips. Care must be taken not to puncture any membranes if installed.

14.13 Perimeter edge strips may be installed if required to prevent cold bridging.



14.14 The specified concrete topping must be poured carefully and not dropped from a height greater than 500 mm; concrete heaps must not be formed over 300 mm high.

14.15 Should any other cutting be required, the advice of the Certificate holder should be sought.

14.16 Although they can withstand light foot traffic, care should still be taken not to walk unnecessarily over the installed EPS panels. If a temporary working platform is required, the panels should be covered with a suitably rigid board. To avoid damage to the panels, the structural concrete topping should be laid as soon as possible after the panels have been installed.

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

14.18 Throughout the installation process, due consideration must be given to the relevant health and safety regulations

14.19 To prevent concrete ingress where a VCL, gas membrane or dpm is not placed above the top sheets, the procedures described below should be followed:

- the joints between the top sheets, or around service openings, should be taped, with minimum width 75 mm, and/or
- any gaps between insulation top sheets or around service openings, visible prior to installing the concrete, must be filled with either expanding foam or strips of insulation.

14.20 The following good practice should be followed 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.

To prevent shrinkage cracks:

- joints should be incorporated into the slab and appropriate joints between the opening of two adjacent rooms to be provided. Inclusion of joints must not compromise structural performance of the concrete topping
- where the 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 to be provided
- avoid the use of high shrinkage potential aggregate
- 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
- steel mesh or loose bars should be placed across re-entrant corners and any openings greater than 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 Tests were carried out to ensure that the short-term strain of the EPS top sheets under the applied loads remained below the permitted elastic performance limit of 1% to 1.5%.

15.2 Prism tests were carried out in accordance with BS EN 14651: 2005 for 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 ( $\lambda_D$  values)
- dimensional accuracy.

15.4 The practicability of installation and detailing techniques was assessed.

## 16 Investigations

16.1 Evaluation and calculations were made of existing data to assess:

- 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
- adequacy of ultimate bending moment capacities of concrete topping reinforced with steel or polymer macro fibres in accordance with TR34 (fourth edition) against ultimate applied loads on the floor
- adequacy of long-term thickness reduction of the EPS Top Sheet against acceptable limit of 2% after 50 years, when subjected to a permanent compressive stress of  $0.3 \sigma_{10}$  ( $\sigma_{10}$  is the compressive stress of the EPS at 10 % deformation) were examined
- the durability, practicability of installation and detailing techniques of the system were assessed.

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 determined in accordance with BS 5250 : 2011.

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

## Bibliography

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BRE Report (BR 497 : 2007) *Conventions for calculating linear thermal transmittance and temperature factors*

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BS 5250 : 2011 + A1 : 2016 *Code of practice for control of condensation in buildings*

BS 8102 : 2009 *Code of practice for protection of below ground structures against water from the ground*

BS 8103-1 : 2011 *Structural design of low-rise buildings ground structures against water from investigation, foundations, precast concrete floors and ground floor slabs for housing*

BS 8500-1 : 2015 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier*

BS 8500-2 : 2015 *Concrete — Complementary British Standard to BS EN 206-1 — Specification for constituent materials and concrete*

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BS EN 14488-7 : 2007 *Testing sprayed concrete — Fibre content of fibre reinforced concrete*

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BS EN 14889-2 : 2006 *Fibres for concrete — Polymer fibres — Definitions, specifications and conformity*

BS EN 15037-1 : 2008 *Precast concrete products — Beam-and-block floor systems — Beams*  
BS EN 15037-4 : 2010 *Precast concrete products — Beam-and-block floor systems — Expanded polystyrene blocks*

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BS EN ISO 13788 : 2012 *Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation — Calculation methods (ISO13788 : 2012)*

TR34,4<sup>th</sup> Edition March 2016 *Concrete Industrial Floors — A guide to design and construction*

TSO 2002 : *Limiting thermal bridging and air leakage : Robust construction details for dwellings and similar buildings*

### 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 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.

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.