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Agrément Certificate
88/2059
Product Sheet 3

JETFLOOR SYSTEMS

JETFLOOR FLOOR SYSTEM

This Agrément Certificate Product Sheet(1) relates to the Jetfloor Floor System comprising precast concrete beams; aerated concrete edge, beam spacer and coursing blocks; and expanded polystyrene (EPS) insulation infill blocks, infill sheets and top sheets. The system is for use in conjunction with structural concrete toppings in suspended concrete ground floors (over a sub floor void) in dwellings.

(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

Structural performance — the system has adequate strength and stiffness to support a suitable structural concrete topping and can sustain and transmit 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 system can contribute to limiting the risk of interstitial and surface condensation; the risk of condensation will depend on the construction and the location (see section 8).

Durability — the system components have adequate durability for the design life of the building (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 Fourth issue: 12 December 2018

Originally certificated on 7 October 2013

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Regulations

In the opinion of the BBA, Jetfloor Floor 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)

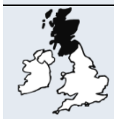
Requirement: A1(1) Loading
Comment: The system can sustain and transmit dead and imposed floor loads to the supporting structure. See sections 6.3 and 6.8 to 6.19 of this Certificate.

Requirement: C2(c) Resistance to moisture
Comment: The risk of condensation will depend on the construction and location. The system can contribute to limiting the risk of surface and interstitial condensation. See sections 8.1, 8.4 and 8.5 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 *Installation* part of this Certificate.

Regulation: 26 CO_2 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; however, compensating fabric and/or services measures may be required. See section 7.3 of this Certificate.



The Building (Scotland) Regulations 2004 (as amended)

Regulation: 8(1)(2) Durability, workmanship and fitness of materials
Comment: The system can contribute to a construction satisfying this Regulation. See section 10 and the *Installation* 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) of this Standard. See sections 6.3 and 6.8 to 6.19 of this Certificate.

Standard: 3.15 Condensation
Comment: The system can contribute to limiting the risk of surface condensation, with reference to clauses 3.15.1(1), 3.15.4(1) and 3.15.5(1) of this Standard. The risk of interstitial condensation will depend on the construction and the location. See sections 8.1 and 8.6 of this Certificate.

Standard: 6.1(b) Carbon dioxide emissions
Comment: The system may require compensating fabric and/or services measures for a dwelling to satisfy this Standard, with reference to clauses 6.1.1(1) and 6.1.6(1). 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(1) and 6.2.3(1). See section 7.3 of this Certificate.
Standard: 7.1(a) Statement of sustainability

Comment: The system can contribute to meeting 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] [Aspects 1[1] and 2[1]], 7.1.7[1] [Aspect 1[1]]. See section 7.3 of this Certificate.

Regulation: 12 **Building standards applicable to conversions**
Comment: Comments in relation to the system under Regulation 9, Standards 1 to 6, also apply to this Regulation, with reference to clause 0.12.1[1] and Schedule 6[1].

(1) Technical Handbook (Domestic).

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

Regulation: 23(a)(i)(iii)(b)(i) **Fitness of materials and workmanship**
Comment: The system is acceptable. See section 10 and the *Installation* part of this Certificate.

Regulation: 29 **Condensation**
Comment: The system can contribute to limiting the risk of interstitial condensation. See section 8.1 of this Certificate.

Regulation: 30 **Stability**
Comment: The system can sustain and transmit dead and imposed floor loads to the supporting structure. See sections 6.3 and 6.8 to 6.19 of this Certificate.

Regulation: 39(a)(i) **Conservation measures**
Regulation: 40(2) **Target carbon dioxide emission rate**
Comment: 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* (3.1 and 3.3), 6 *Structural performance* (6.4) and 14 *Procedure* (14.2, 14.4 and 14.7) of this Certificate.

Additional Information

NHBC Standards 2018

In the opinion of the BBA, the Jetfloor Floor System with concrete toppings reinforced with steel or macro-polymer[1] fibres or steel mesh, 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*.

(1) NHBC do not accept micro-polymer-fibre structural concrete toppings (see also section 6.11 Table 4 of this Certificate).

CE marking

The Certificate holder has taken the responsibility of CE marking the following system components in accordance with the relevant harmonised European Standard:

- EPS infill blocks/sheets and top sheet, in accordance with BS EN 15037-4 : 2010 and BS EN 13163 : 2012
- pre-stressed concrete beams, in accordance with BS EN 15037-1 : 2008
- edge, wide end beam spacer, narrow end beam spacer and coursing blocks, in accordance with BS EN 771-4 : 2011.

Technical Specification

1 Description

1.1 The Jetfloor Floor System comprises precast concrete beams; aerated concrete edge, beam spacer and coursing blocks; and EPS insulation infill blocks, infill sheets and top sheets. Details of each system component are:

Pre-stressed precast concrete beams

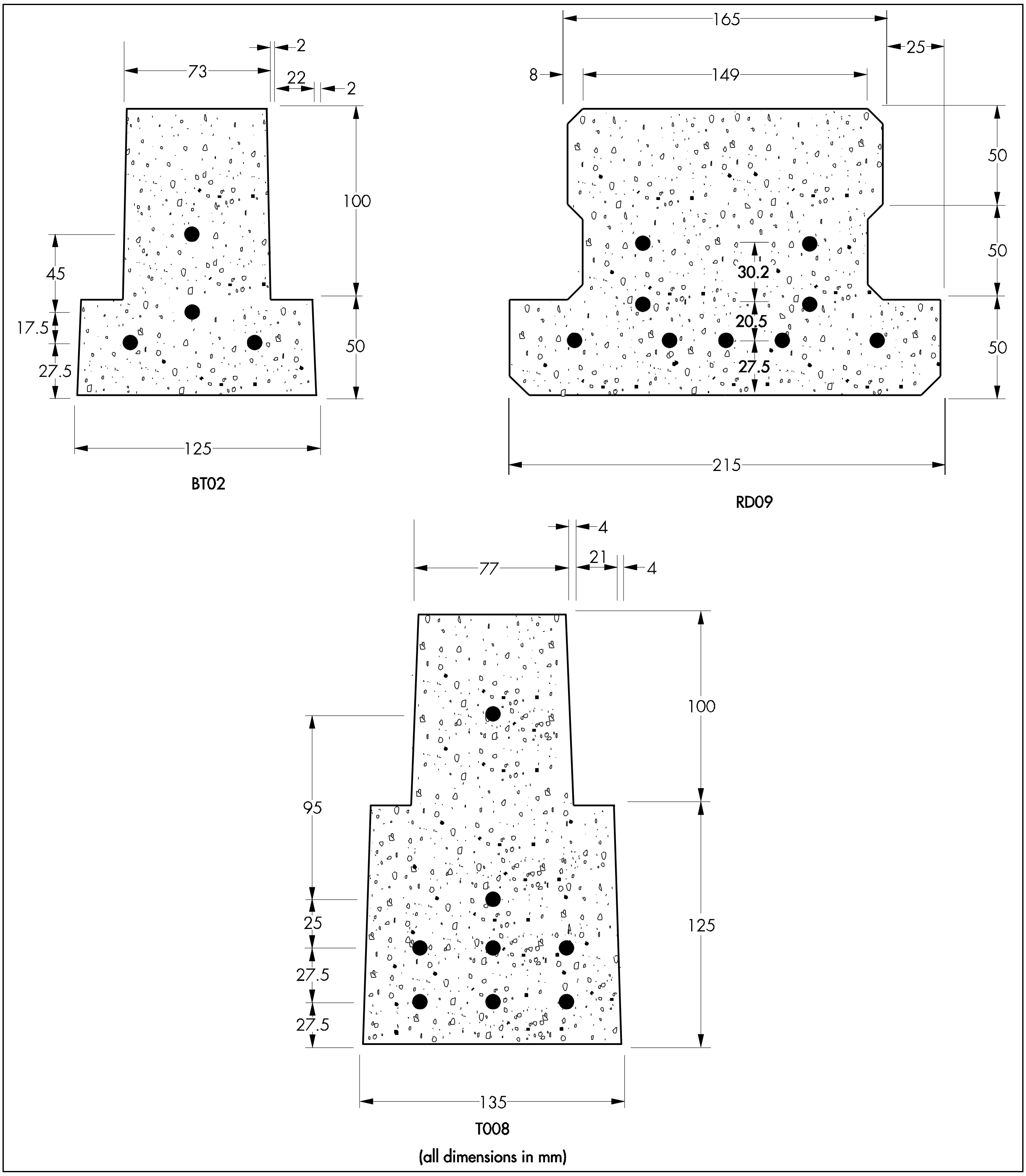
The pre-stressed concrete beams are available in three types (BT02, RD09 and T008), with the dimensions and characteristics given in Table 1 and shown in Figure 1. The beams are designed in accordance with BS EN 206 : 2013, BS 8500-1 : 2015 and BS 8500-2 : 2015.

Table 1 Beam properties

Characteristic (units)	Beam type		
	BT02	**RD09**	**T008**
Height (mm)	150	150	225
Top width (mm)	73	165	77
Bottom width (mm)	125	215	135
Number of 5 mm diameter wires[(1)]	4	9	8
Beam mass ($kg{\cdot}m^{-1}$)	33.24	63.40	58.74
Service bending moment resistance (kN·m)	6.00	12.50	15.90
Ultimate bending moment resistance (kN·m)	8.70	19.50	23.60
Minimum tensile strength of pre-stressing wire ($N{\cdot}mm^{-2}$)		1770	
Minimum characteristic tensile 0.1% proof-stress ($f_{p0,1K}$) of pre-stressing wire ($N{\cdot}mm^{-2}$)		1470	
Minimum concrete compressive strength class at 28 days		C50/60	

(1) Steel wire in accordance with BS 5896 : 2012.

Figure 1 Pre-stressed precast concrete beam dimensions



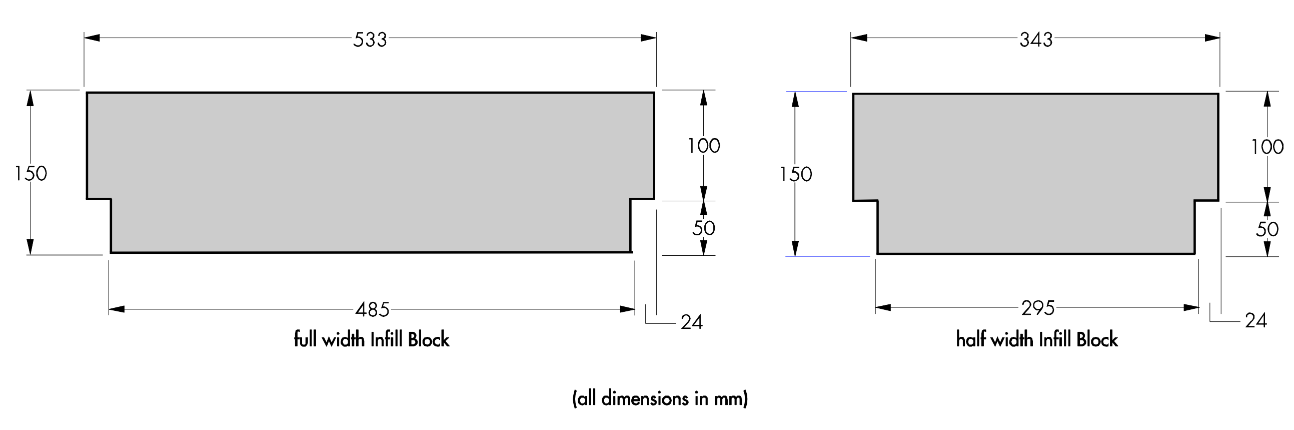
EPS infill blocks, infill sheets and top sheets

Thermal insulation infill blocks, infill sheets and top sheets are available in white and grey grade EPS with the nominal characteristics given in Table 2 and Figure 2.

Table 2 EPS insulation properties

Property	Block/sheet type			
	Wide infill block	**Narrow infill block**	**Infill sheet**	**Top sheet**
Product code	JCW/JPW	JCN/JPN	J100C/J100P	J80C/J80P
Length (mm)	1200	1200	2400	2400
Width (mm)	533	343	1200	1200
Thickness (mm)	150	150	100	80
Declared level of compressive stress of EPS at 10 % deformation	CS (10) 90	CS (10) 90	CS (10) 130	CS (10) 130
Mechanical resistance according to BS EN 15037-4 : 2010	Type R1 and Class R1 a	Type R1 and Class R1 a	Type R1 and Class R1 a	—
Thermal conductivity (W·m^{-1}·K^{-1}) λ_D value white grey	 0.038 0.030	 0.038 0.030	 0.038 0.030	 0.036 0.030
Declared level of compressive creep to BS EN13163: 2012	—	—	—	CC(2/1.5/50)30
Moisture diffusion coefficient (μ)	30-70			

Figure 2 EPS infill blocks



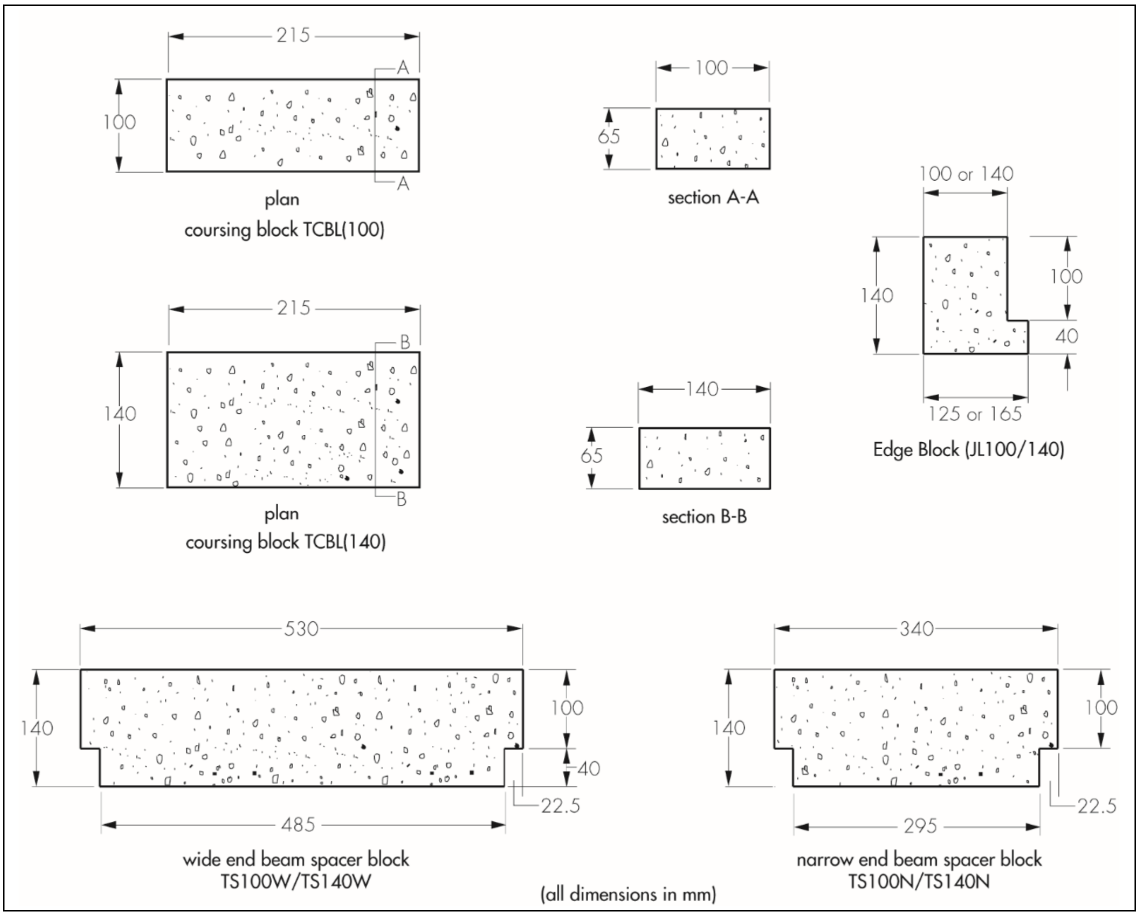
Concrete edge, beam spacer and coursing blocks

The edge, beam spacer and coursing blocks are manufactured from autoclaved aerated concrete. Dimensions and characteristics are given in Table 3 and Figure 3.

Table 3 Autoclaved aerated concrete block properties

Property	Block type			
	Edge block	**Wide end beam spacer block**	**Narrow end beam spacer block**	**Coursing block**
Product code	JL100/140	TS100W/ TS140W	TS100 N/ TS140 N	TCBL
Length (mm)	440	530	340	215
Width (mm)	100/140	100/140	100/140	100/140
Height (mm)	140	140	140	65
Mean compressive strength (N·mm^{-2}) — Category II masonry units according to BS EN 771-4 : 2011 (N·mm^{-2})	7.3			
Thermal conductivity (W·m^{-1}·K^{-1}) $\lambda_{90/90}$ value	0.18			

Figure 3 Beam spacer, edge and coursing blocks details



1.2 The Certificate holder's specifications for ancillary items used in conjunction with concrete beams and the EPS blocks include:

- concrete topping specifications(1):
  - reinforced with steel mesh to the specifications given in Table 4, depending on the proposed floor usage. The concrete topping reinforced with steel mesh 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(1) reinforced with steel or macro-polymer fibres to the specifications given in Table 4, with a maximum aggregate size of 10 to 20 mm
  - concrete topping(1) reinforced with micro-polymer fibres to the specifications given in Table 4, with a maximum aggregate size of 20 mm
- insulation strips (width 25 or 30 mm) — for perimeter of structural concrete toppings.

(1) The concrete used in the concrete toppings must comply with BS EN 206 : 2013, BS 8500-1 : 2015 and BS 8500-2 : 2015.

1.3 Ancillary items for use with the system, but outside the scope of this Certificate, include:

- where required, gas barrier membranes(1) with third-party approval
- vapour control layer (VCL)(1)
- damp-proof membranes (dpm)(1) with third-party approval
- pipe clips
- spacer and spreader plate for steel reinforcement

(1) Must be compatible with EPS.

2 Manufacture

2.1 The beams are cast in moulds or extruded around pre-stressing wires which are released when the concrete has achieved adequate strength.

2.2 The EPS infill blocks, infill sheets and top sheets are manufactured using conventional moulding techniques from EPS beads.

2.3 The edge, beam spacer and coursing blocks are manufactured using conventional techniques from cement, lime, pulverised-fuel ash, coarse sand and aluminium powder.

2.4 As part of the assessment and on-going 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

2.5 The management system of Forterra Building Products Ltd has been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by the CPC (Certificate No CP00213).

3 Delivery and site handling

3.1 The concrete beams are delivered to site stacked and supported on timber bearers, and stored clear of the ground. Beams must always be handled and moved the 'right way up' (narrow section on top), and supported close to the ends when lifting by fork lift trucks or crane. The ground on which they are placed should be firm and level, and the beams stacked horizontally and separated with timber bearers placed in line with each other near the beam ends (within 300 mm). The advice of the Certificate holder should be sought when the storage of unprotected beams on site exceeds three months.

3.2 Pallets of edge, beam spacer and coursing blocks are shrink-wrapped and should be stored on a flat level base.

3.3 The EPS infill blocks, infill sheets and top sheets are wrapped in polythene, but are otherwise unprotected. Therefore, reasonable care must be taken during transit and storage to avoid damage. They should be stacked on a flat base, clear of the ground and protected against prolonged direct sunlight and secured to avoid wind damage. Care must be taken to avoid contact with solvents and with materials containing volatile organic components and flame or ignition sources.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on Jetfloor Floor System.

Design Considerations

4 General

4.1 The JetFloor Floor System is satisfactory for use as part of a suspended ground floor (over a sub floor void) in a dwelling of single occupancy.

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

- the EPS blocks, EPS infill/top sheets, 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
- the floor is not loaded by construction materials until the structural concrete topping has reached its design strength and construction loads do not exceed the design load of the floor
- 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 at least 150 mm deep must be provided for the system 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 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 micro-macro-polymer or steel fibres must be in accordance with Table 4.

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

4.8 For micro- or macro-polymer or 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.

4.11 Care must be taken to ensure that overlay sheets are closely butt jointed, and that joints do not occur over beams and are no less than 150 mm apart.

5 Practicability of installation

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

6 Structural performance

6.1 A suitably experienced/qualified engineer must ensure that the concrete beams, edge block, beam spacer block, coursing blocks and concrete structural topping are suitable for the intended use.

EPS infill blocks, infill sheets and top sheets

6.2 The EPS infill blocks and infill sheets make no contribution to the long-term structural performance of the floor, once the structural concrete topping has been placed over the EPS top sheets and obtained its full design strength.

6.3 The EPS top sheets contribute to the short- and long-term structural performance of the floor, by transferring the vertical imposed and dead loads to the concrete beams.

6.4 Subject to compliance with the design and installation requirements of this Certificate, the EPS infill blocks and infill sheets have adequate strength to carry the normal temporary loads expected during the construction phase of the floor system. Blocks/sheets may be cut to accommodate varying beam lengths, but must be a minimum of 300 mm long.

6.5 The EPS infill blocks are designed to have a normal bearing of not less than 21 mm, with a 5 mm allowance for misalignment and manufacturing tolerances in the straightness of the beam. A minimum bearing width of 16 mm must therefore be ensured. Infill sheets should be cut to ensure the same minimum bearing width.

6.6 The infill sheets should not be used at widths greater than 343 mm.

6.7 The edge blocks (see Figures 3 and 4 and section 12) must be used along perimeters parallel to the concrete beams.

EPS top sheets

6.8 EPS top sheets have adequate resistance to short- and long-term compressive creep. The strain against stress performance of the EPS top sheets under the applied loads at Serviceability Limit State (SLS) condition remains well below the permitted elastic performance limit of 1.5%. The long-term thickness reduction of the EPS top sheets remains within the acceptable limit of 2% after 50 years, when subjected to a permanent compressive stress of 0.3 σ_{10} (σ_{10} is the compressive stress of the EPS at 10 % deformation).

6.9 Spacers for supporting mesh reinforcement should be located on spreader plates (dimension not less than 50 by 50 mm and minimum four spacers per m^2) over the EPS top sheets. This will reduce the risk of accidental penetration of the EPS during the construction phase and resulting misalignment of the reinforcement within the structural concrete topping depth.

Structural concrete topping

6.10 The concrete forming the topping must be in accordance with BS 8500-1 : 2015, BS 8500-2 : 2015 and BS EN 206 : 2013. Concrete should be manufactured in plants covered by the Quality Scheme for Ready Mixed Concrete (QSRMC), BSI Kitemark or equivalent scheme quality and laid by personnel with appropriate skill and experience.

6.11 The method of verification and suitability of each concrete topping reinforced with various reinforcements corresponding to the characteristic loads defined in Table 5, in conjunction with the EPS infill blocks and top sheets (as specified in Table 2 and Figure 2 of this Certificate), is defined in Table 4.

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

	Reinforcement of concrete topping	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	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}	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}	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 200,000 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 µm 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 µm diameter, tensile strength 312 N·mm^{-2}	Alternative acceptable micro fibre

(1) The overall depth of concrete topping above the services is 70 mm.
(2) All of the fibres in this Table can be used within a C28/35 standard concrete (see note 3, below) with maximum 20 mm aggregate (see note 5, below) or within a C28/35 self-compacting concrete (see note 4, below) 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: 2002.
(6) The steel and polymer fibres for concrete topping must comply with BS EN 14889-1: 2006 and BS EN 14889-2 : 2006 respectively.
(7) For fresh concrete, macro-polymer fibres content should be measured in accordance with BS EN 14488-7: 2006
(8) The dosage rates of steel and polymer fibres defined in this table 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.
(9) For fresh and hardened concrete, steel fibres content should be measured in accordance with BS EN 14721: 2005.
(10) Micro-polymer fibre structural concrete toppings are not accepted on NHBC sites.

Table 5 Characteristic imposed load for concrete topping reinforced with steel or polymer fibres or steel mesh for single-family dwellings. Imposed concentrated load of 2 kN must be applied to an area not less than 100 x 100 mm

Characteristic imposed loads	Value
Characteristic imposed concentrated load (kN)	2.0[(1)(2)]
Characteristic imposed UDL ($kN \cdot m^{-2}$)	1.5[(1)]
Allowance imposed load for lightweight partitions (moveable) ($kN \cdot m^{-2}$)	0.5[(3)]
Maximum line load from partitions perpendicular or parallel to beams ($kN \cdot m^{-1}$)	1.0[(3)]
Maximum weight of finishes ($kN \cdot m^{-2}$)	0.5

(1) Concentrated load of 2 kN must not be combined with the uniformly distributed load (UDL) of 1.5 $kN \cdot m^{-2}$ or other variable actions. For imposed UDL and concentrated loads, refer to BS EN 1991-1-1 : 2002 and its UK National Annex.
(2) Either the imposed load for lightweight partitions (moveable) or line load partition must be considered.
(3) Non-load bearing partition walls heavier than 1 $kN \cdot m^{-1}$, any orientation to the concrete beams, must be either supported by a foundation or supported directly by the concrete beams designed to sustain the specific loading.

Pre-stressed concrete beams

6.12 The EPS top sheet, wide/narrow width infill blocks and infill sheets are for use with self-bearing, pre-stressed concrete beams from normal weight concrete.

6.13 The maximum effective spans of single beams simply supported, including the self weight of beam and 70 mm concrete topping, for the imposed UDL of 1.5 $kN \cdot m^{-2}$ plus 0.5 $kN \cdot m^{-2}$ imposed load for moveable partitions, in acccordance with BS EN 1992-1-1 : 2004 (Eurocode 2), are summarised in Table 6 of this Certificate.

Table 6 Maximum self-weight of floors and maximum effective span of Beams BT02, RD09 and T008

Property	Single beam BT02		Single beam RD09		Single beam T008	
	Wide infill blocks	Narrow infill blocks	Wide infill blocks	Narrow infill blocks	Wide infill blocks	Narrow infill blocks
	Beam centres (mm)					
	610	420	698	508	618	428
Maximum self-weight of beam, infill blocks and concrete topping ($kN \cdot m^{-2}$)	2.24[(1)]	2.47[(1)]	2.61[(1)]	2.93[(1)]	2.67[(1)]	3.08[(1)]
Maximum effective span[(2)] (m)	4.00	4.50	5.40	5.90	6.60	7.30

(1) These values do not allow for concentrated imposed load, the floor finish or partitions parallel and perpendicular to the concrete beams.
(2) The effective span of single span simply supported beam should be calculated as:
Effective span = Clear span +min {1/2h; 1/2t} where h is the depth of concrete slab and t is the bearing width of supporting beam (refer to clause 5.3.2.2 of BS EN 1992-1-1 : 2004).

6.14 The serviceability deflection limit must be in accordance with BS EN 1992-1-1 : 2004, clause 7.4 and is summarised in Table 7 of this Certificate.

Table 7 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 Ecm/(1+Ψ), 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% if the aggregate for the concrete beams is limestone.

6.15 A suitably experienced/qualified engineer must ensure that the natural frequency (*f*) of the concrete beam due to footfall(1) is greater than 4 Hertz (Hz) as defined below for each floor 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 (*f*) 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) 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.

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

6.17 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 (6.14a and 6.10 or the less favourable equations 6.10a and 6.10b). The lowest effective span obtained from these equations will be considered to be the maximum effective span of the concrete beam.

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

6.19 The concrete beam is self-bearing and no account is made for possible composite action between the concrete beams and the EPS blocks or the 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 under-floor ventilation and the ground thermal conductivity. Each floor U value should therefore be calculated to BS EN ISO 13370 : 2017 and BRE Report BR 443 : 2006.

7.2 A floor deck U value (from inside to the underfloor void) will depend significantly on the type and number of precast concrete beams and the EPS infill block, top sheet and infill sheet type. The thermal resistance of each beam and EPS configuration should be numerically modelled to BS EN ISO 10211 : 2017. 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 The system can therefore enable a floor to meet, or improve on, most of the design floor U values of 0.13 to 0.25 $W{\cdot}m^{-2}{\cdot}K^{-1}$ specified in the documents supporting the national Building Regulations. In England and Wales, compensating fabric and/or services measurements may be required to meet the dwelling Target Emission Rates (refer to Table 8 for example floor U values).

Table 8 Example floor U values(1)(2) for single beam configurations(3) ($W \cdot m^{-2} \cdot K^{-1}$)

Beam type	p/a ratio	Grey top sheet 80 mm	White top sheet 80 mm
	(m/m²)	Grey infill block	White infill block
BT02	0.4	0.14	0.17
	0.6	0.15	0.18
	0.7	0.15	0.18
	0.9	0.16	0.18
T008	0.4	0.15	0.17
	0.6	0.16	0.18
	0.7	0.16	0.18
	0.9	0.16	0.19
RD09	0.4	0.16	0.18
	0.6	0.17	0.19
	0.7	0.17	0.19
	0.9	0.17	0.20

(1) These calculations are in accordance with sections 7.1 and 7.2 and assume:
- a 300 mm thick perimeter wall with a U value of 0.35 $W \cdot m^{-2} \cdot K^{-1}$
- the beam dimensions shown in Figure 1 and beam straightness is $\leq$5 mm
- the beam λ is 2.0 $W \cdot m^{-1} \cdot K^{-1}$ and 70 mm concrete topping λ is 1.15 $W \cdot m^{-1} \cdot K^{-1}$
- 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 BR 443 : 2006.

(2) Infill panel is EPS 90 high performance (grey).
(3) Configuration used – 100% single beams at full centres.

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. Detailed guidance can be found in the documents supporting the national Building Regulations.

7.5 The junction ψ-values given in Table 9 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 : 2007, 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 9 Junction Ψ values

Junction	Ψ ($Wm^{-1}K^{-1}$)
External wall	
• Worked example	0.070(1)
• Other	0.32(2)
Party wall	0.16(2)

(1) Value correct for junction shown in Figure 4a for single BT02 beams parallel and perpendicular to the wall.
(2) Conservative defaults from SAP 2012.

8 Condensation risk

Interstitial condensation

8.1 There is a risk of interstitial condensation forming on the concrete beam which may be persistent. 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, Annexes D.3 and F, accounting for the slab construction, dwelling humidity class, dwelling type, dwelling location and use of any VCL and/or gas membrane.

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 $mm^2 \cdot m^{-1}$ run of external wall or 500 $mm^2 \cdot m^{-2}$ 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 interstitial condensation at junctions with external walls, specifiers should ensure that wall insulation extends to at least 150 mm below the top of the EPS top sheets.

Surface condensation

8.4 Floors will adequately limit the risk of surface condensation when the thermal transmittance (U value) does not exceed 0.7 $W \cdot m^{-2} \cdot K^{-1}$ at any point and the junctions with walls are designed in accordance with section 7.4 of this Certificate.

8.5 The example construction described in section 7.5 was used to model a 3D corner which achieved a temperature factor of 0.85, which equals or improves upon most of the critical temperature factors, fCRsi, detailed in tables 1 and 2 of BRE Information Paper IP1/06.

8.6 Floors will adequately limit the risk of surface condensation when the thermal transmittance (U value) does not exceed 1.2 $W \cdot m^{-2} \cdot K^{-1}$ 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 and section 7.4 of this Certificate.

8.7 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 designed to be installed within the floor structure, therefore they do not require maintenance.

10 Durability

10.1 Provided the EPS products are protected in service from organic solvents and substances liable to cause deterioration, they will be effective as insulation for the design life of the building in which they are installed (taken as 60 years).

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 must comply with the requirements of BS EN 13369 : 2018 to have adequate durability for this exposure condition, for a design life of not less than 60 years.

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

10.4 The structural concrete topping reinforced with steel mesh will have adequate durability for exposure class XC1, for a design life of not less than 60 years.

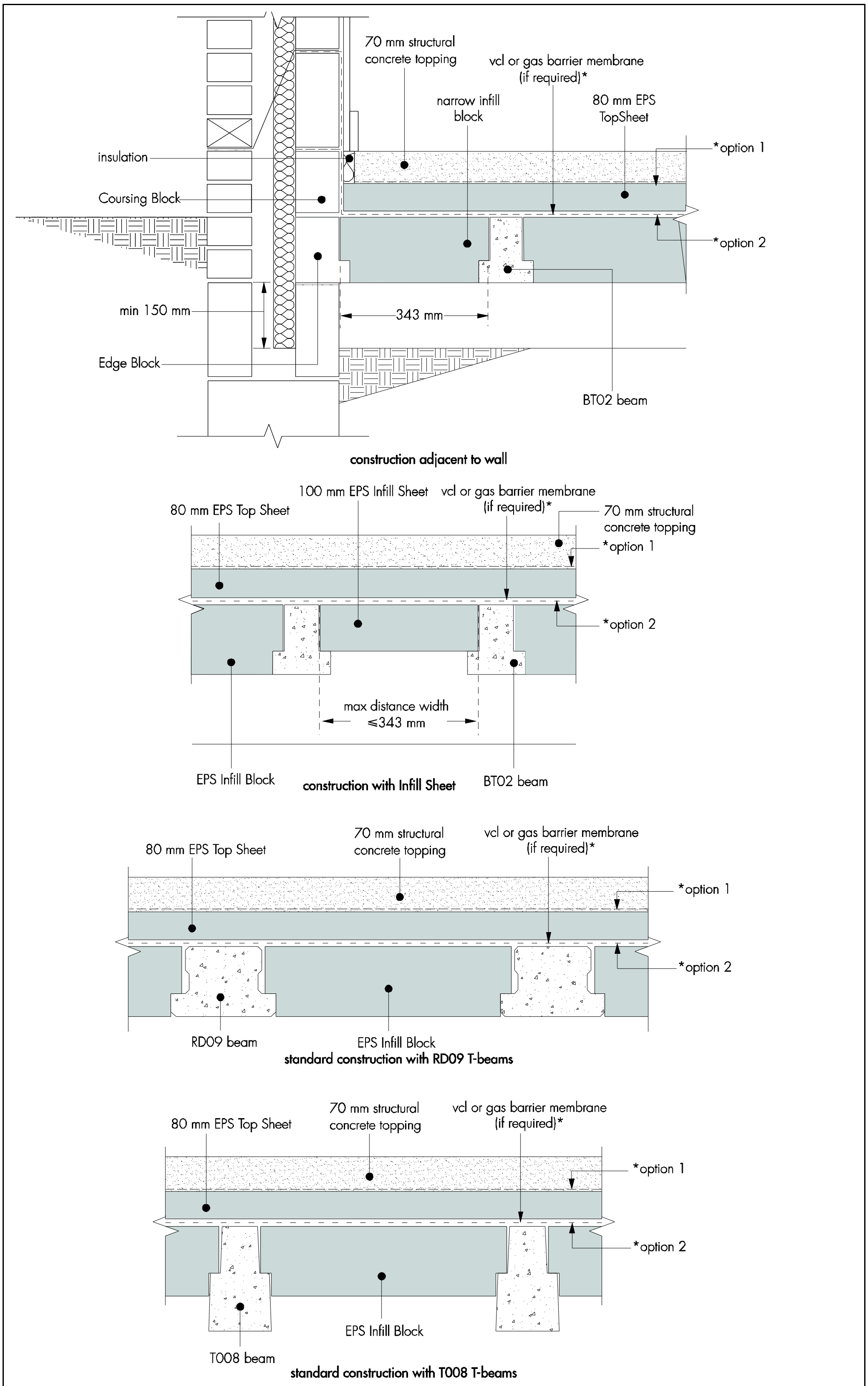
11 Re-use and recyclability

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

12 General

Details of typical precast concrete beams and EPS block assemblies are shown in Figure 4.

Figure 4 Example beam and EPS assemblies



13 Site preparation

13.1 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.

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

13.3 Damp-proofing and ventilation arrangements must be in accordance with normal good practice; for example, provision of damp-proof sleeves to ventilators and adequate drainage.

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

14 Procedure

14.1 The precast concrete beams are positioned at the approximate locations and centres shown on the approved drawing.

14.2 The perimeter edge blocks are placed at either end of the plot. If required, the blocks can be cut with a proprietary handsaw. Prior to installing the EPS infill blocks, site operatives must not walk on top of the edge blocks. The edge blocks must be bedded onto a bed of mortar and fully cured prior to casting the concrete topping.

14.3 The beams are accurately positioned using the narrow and wide aerated concrete beam spacer blocks. All beams must be placed tightly against the beam spacer blocks. The edge and beam spacer blocks can then be bedded in mortar.

14.4 The EPS infill blocks can then be installed and, where necessary, blocks cut with a handsaw to suit service holes. Damaged blocks must be discarded. A ‘make up piece’ of 100 mm infill sheet should be cut and laid if, and as, specified on the approved drawing and not more than 343 mm wide.

14.5 Coursing blocks are bedded around the perimeter and allowed to cure. This provides containment for the structural concrete topping.

14.6 A gas barrier membrane can be installed where required and the continuity of the gas barrier membrane must extend over the footprint of the building, and the gas membrane must be sealed to a gas-resistant dpc. The gas membrane can be installed above (option 1) or below (option 2) the EPS top sheet (as shown in Figure 4).

14.7 The EPS top sheet insulation is laid over the floor and cut with a handsaw to accommodate service holes and part sheet widths, where necessary. Small off-cuts can be used to seal up around service penetrations.

14.8 If a steel mesh is specified, spacers should be positioned over spreader plates (minimum four per m^2 and minimum size 50 by 50 mm). They should be installed to position the steel mesh at the correct level.

14.9 If specified, underfloor heating pipes can be installed. These can be secured to the top insulation sheet material using standard pipe clips without puncturing the gas barrier membrane.

14.10 Perimeter edge insulation strips (25 or 30 mm in width) are installed against the perimeter wall.

14.11 The specified structural concrete toppings (see section 6.11) should be poured carefully and not poured from a height greater than 500 mm, ensuring that heaping is kept to a height of no greater than 300 mm.

14.12 The surface of the concrete topping is finished as required.

14.13 To prevent concrete ingress where a VCL, gas membrane or dpm is not placed above the top sheets, the procedure is as follows:

- the joints between the EPS top sheets should be taped, with a minimum width of 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.

14.14 Good practice should be taken into account throughout the installation process including:

- 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.

14.15 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
- use of a 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
- 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 Full scale tests and calculations were carried out on floor assemblies to assess the adequacy of the system against partition line load, moveable partitions and imposed concentrated load or UDL in conjunction with concrete topping reinforced with micro- and macro-polymer fibres.

15.2 Tests were carried out to ensure that the short-term strain of the EPS top sheets under the applied loads remain well below the permitted elastic performance limit of 1.5%.

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

15.4 Tests were carried out to assess the resistance of the infill blocks to construction loads.

15.5 Tests were carried out to verify the failure load of aerated concrete edge blocks.

16 Investigations

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

- the bending moment capacities of concrete beams BT02, RD09 and T008
- load span tables for concrete beams BT02, RD09 and T008
- 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 concrete topping reinforced with steel or macro-polymer fibres in terms of ultimate bending moment resistance, thickness, required fibre dosage and strength class in accordance with TR34 (fourth edition) and BS EN 1991-1-1 : 2002
- adequacy of long term thickness reduction of the EPS top sheets against acceptable limit of 2% after 50 years, when subjected to a permanent compressive stress of 0.3 σ_{10} (σ_{10} is the compressive stress of the EPS at 10 % deformation)
- 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 Visits to sites in progress were conducted to assess the practicability of installation.

16.5 The manufacturing processes for the beams, EPS infill and top sheet insulation and aerated concrete beam spacer and edge blocks was examined, including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

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