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Agrément Certificate
12/4894
Product Sheet 1

ARCELORMITTAL STEEL-FIBRE-REINFORCED CONCRETE

ARCELORMITTAL INSULSLAB STEEL-FIBRE-REINFORCED CONCRETE

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete, a system of fibre-reinforced concrete with expanded polystyrene (EPS) permanent formwork, used in the construction of ground-supported floor slabs, foundations and pile-supported ground beams and slabs in domestic and commercial buildings.

AGRÉMENT 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 — floors incorporating the product can give adequate strength and stiffness when designed in accordance with this Certificate (see section 6).

Moisture resistance — floors incorporating the product and typical details will minimise the risk of condensation (see section 7).

Thermal performance — the U values of floors incorporating the product will depend on the P/A ratio and the pod sizes used (see section 8).

Durability — floors constructed from the product will have a life comparable to that of other structural elements (see section 10).

The BBA has awarded this Agrément Certificate to the company named above for the product described herein. This product has been assessed by the BBA as being fit for its intended use provided it is installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 7 March 2012

Brian Chamberlain
Head of Approvals — Engineering

Greg Cooper
Chief Executive

The BBA is a UKAS accredited certification body — Number 113. The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.

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Regulations

In the opinion of the BBA, ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting 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)

Requirement:	A1	Loading
Comment:		Floors and foundations incorporating the product can be designed to sustain and transmit dead and imposed floor loads to the ground. See sections 6.1 to 6.3 of this Certificate.
Requirement:	C2(a)(c)	Resistance to moisture
Comment:		Floors constructed using the product are of dense concrete and will resist the passage of moisture. Floors will have a minimal risk of surface and interstitial condensation. See sections 7.1 and 7.2 of this Certificate.
Requirement:	L1(a)(i)	Conservation of fuel and power
Comment:		The U value of a ground floor constructed from the product will be dependent on the area of floor and the type of floor finish. See sections 8.1 to 8.4 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The product is of acceptable materials. See section 10 and the *Installation* part of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	8(1)(2)	Fitness and durability of materials and workmanship
Comment:		The product can contribute to a construction satisfying this Regulation. See section 10 and the *Installation* part of this Certificate.
Regulation:	9	Building standards — construction
Standard:	1.1(a)(b)	Structure
Comment:		Floors and foundations incorporating the product can satisfy this Standard, with reference to clauses 1.1.1[1][2], 1.1.2[1][2], 1.1.3[1][2] and 1.1.4[1][2]. See sections 6.1 to 6.3 of this Certificate.
Standard:	3.4	Moisture from the ground
Comment:		Floors constructed using the product are of dense concrete and will resist the passage of moisture, with reference to clauses 3.4.1[1][2], 3.4.2[1][2], 3.4.3[1][2] and 3.4.6[1][2]. See section 7.1 of this Certificate.
Standard:	3.15	Condensation
Comment:		Floors constructed from the product will have minimal risk of interstitial and surface condensation, with reference to clauses 3.15.1[1][2], 3.15.4[1][2] and 3.15.5[1][2]. See section 7.2 of this Certificate.
Standard:	6.2	Building insulation envelope
Comment:		Floors constructed from the product can contribute to satisfying the requirements of this Standard, with reference to clauses 6.2.1[1][2], 6.2.4[1][2], 6.2.5[1][2], 6.2.6[1] and 6.2.13[1]. See sections 8.1 to 8.4 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The product 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.

(1) Technical Handbook (Domestic).
(2) Technical Handbook (Non-Domestic).

The Building Regulations (Northern Ireland) 2000 (as amended)

Regulation:	B2	Fitness of materials and workmanship
Comment:		The product is acceptable. See section 10 and the *Installation* part of this Certificate.
Regulation:	C4	Resistance to ground moisture and weather
Comment:		Floors constructed from the product are of dense concrete and will resist the passage of moisture. See section 7.1 of this Certificate.
Regulation:	C5	Condensation
Comment:		Floors constructed from the product will have a minimal risk of interstitial and surface condensation. See section 7.2 of this Certificate.
Regulation:	D1	Stability
Comment:		Floors and foundations incorporating the product can be designed to sustain and transmit dead and imposed floor loads to the ground. See sections 6.1 to 6.3 of this Certificate.
Regulation:	F2(a)(i)	Building fabric
Comment:		The U value of a ground floor constructed from the product will be dependent on the area of the floor and the type of floor finish. See sections 8.1 to 8.4 of this Certificate.

Construction (Design and Management) Regulations 2007

Construction (Design and Management) Regulations (Northern Ireland) 2007

Information in this Certificate may assist the client, CDM co-ordinator, designer and contractors to address their obligations under these Regulations.

See sections: 3 *Delivery and site handling* (3.2 and 3.3) and 12 *Site preparation* (12.2) of this Certificate.

Additional Information

NHBC Standards 2011

NHBC accepts the use of ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete, when installed and used in accordance with this Certificate, in relation to *NHBC Standards*, Part 2 *Materials*, Chapter 2.1 *Concrete and its reinforcement;* Part 4 *Foundations*, Chapters 4.2 *Building near trees* and 4.5 *Raft, pile, pier and beam foundations;* and Part 5 *Substructure and ground floors*, Chapters 5.1 *Substructure and ground bearing floors* and 5.2 *Suspended ground floors* (supported on void formers).

CE marking

The Certificate holder has taken the responsibility of CE marking the steel fibres in accordance with harmonised standard BS EN 14889-1 : 2001. An asterisk (*) appearing in this Certificate indicates that data shown is given in the manufacturer's Declaration of Performance.

General

ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete is assessed as suitable for use in fully-supported, ground-bearing slab applications, foundations, pile-supported ground beams and in slabs supported on foundation walls or piles, provided the stresses are limited to those given in Table 3. This Certificate does not cover the use of free suspended slabs other than those supported on void formers.

Provision can be made for services without special detailing or cutting of reinforcement as might be required for conventional reinforced concrete.

Technical Specification

1 Description

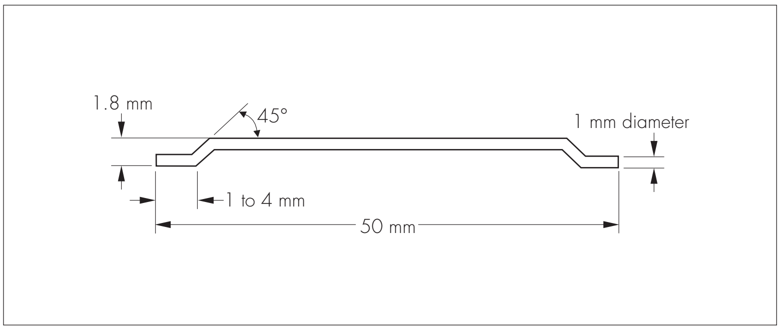
1.1 ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete is a combination of ArcelorMittal Steel-Fibre-Reinforced Concrete and Insulslab expanded polystyrene (EPS) permanent formwork.

Fibres and concrete

1.2 The concrete is to a standard structural grade in accordance with BS 8500-2 : 2006, with the addition of a super-plasticiser (outside the scope of this Certificate) to BS EN 934-2 : 2001, and incorporating HE+1/50 hooked-end steel fibres at a minimum dosage rate of 50 $kg{\cdot}m^{-3}$.

1.3 The Hooked-End Steel Fibre HE+1/50 [designated type 1 (cold-drawn wire) to BS EN 14889-1] is manufactured from cold drawn steel wire with a declared tensile strength of 1500 MPa*, to the dimensions* given in Figure 1.

Figure 1 Typical detail of hooked-end steel fibre



1.4 The fibres are for use in a range of mix specifications. As a minimum, the mix design must comply with the specification defined in Table 1 and Figure 2.

Table 1 Concrete specifications

Material/characteristic	Value
Concrete grade (minimum)	C30/37
Cement content (minimum) (kg·m^{-3})	350[(1)] or 320[(1)] + 80[(2)]
Aggregate grading[(3)]	Maximum 20 mm
Water-reducing agent content[(4)]	According to manufacturer's recommendations
Super-plasticiser content[(4)]	According to manufacturer's recommendations
Slump at discharge (mm)	180 – 220

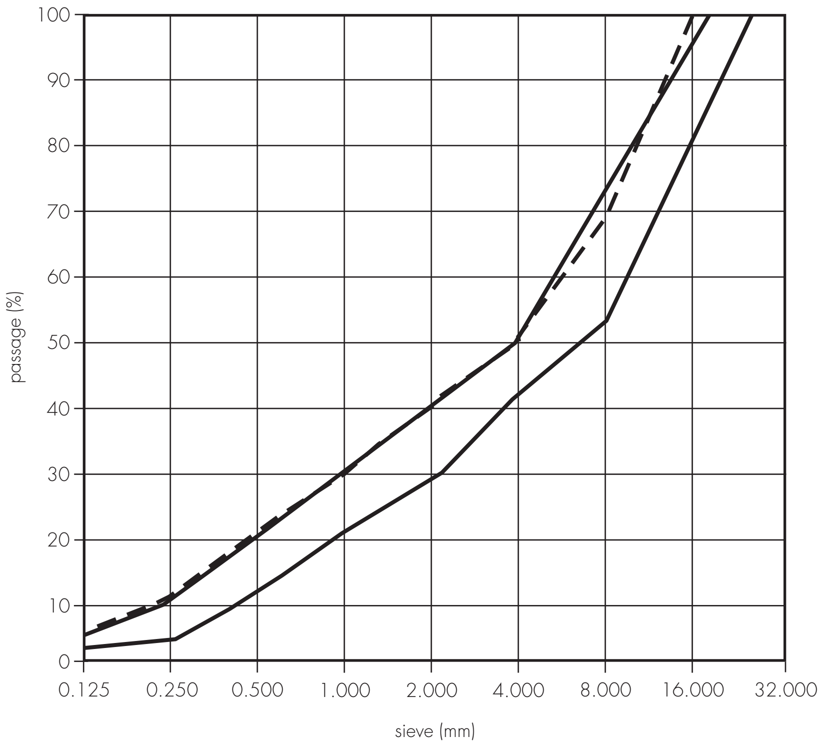
(1) Cement to be designated CEM 1 as defined in BS 8500-1 : 2006.

(2) Cement combinations containing fly ash or ground granulated blast furnace slag (GGBS) to notations CIIA-V and CIIA-S respectively, in accordance with BS EN 8500-2 : 2006.

(3) The aggregate grading should be in accordance with Figure 2. The suitability of a proposed mix design, including an evaluation of the aggregate grading and sieve curve analysis, must be verified by the Certificate holder prior to use.

(4) The water-reducing agent and the super-plasticiser should be sourced from the same manufacturer and used in accordance with that manufacturer's recommendations.

Figure 2 Aggregate grading — sieve analysis



Insulslab pods (permanent formwork)

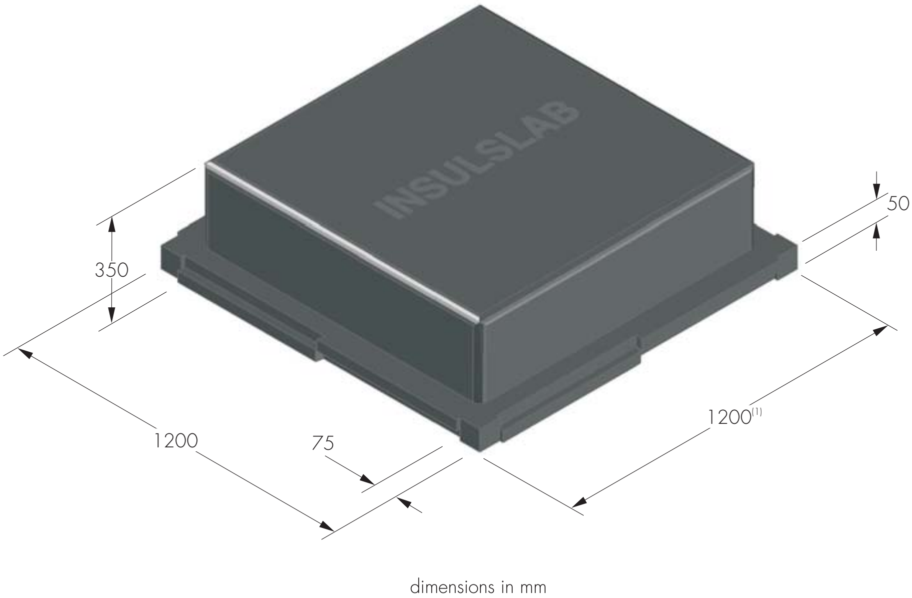
1.5 The EPS pods are manufactured with the minimum properties given in Table 2, and incorporate EPS150 in the bottom 50 mm zone and EPS70 in the remainder. The dimensions of the standard pods are given in Figure 3. Quarter, half and three-quarter size pods are also available to cater for most layouts with minimal cutting. The pods are designed to interlock to maintain the correct rib width and minimise the risk of movement during the installation process. To cater for full-depth beams, some pods are supplied with the lower lip removed on one edge. For corner pods, an extra lip may have to be removed on site.

1.6 In addition to the pods, 100 mm and 50 mm thick slabs of EPS150 and EPS70 are used as under-beam and edge insulation respectively.

Table 2 Properties of EPS for the system

Property	Value	
	EPS150	EPS70
Compressive strength (10% compression) (kPa)	150	70
Compressive strength (1% nominal strain) (kPa)	70	20
Bending strength (kPa)	200	115
Water vapour diffusion resistance factor (μ)	0.010 – 0.024	0.018 – 0.036
Water vapour resistivity ($mg \cdot Pa^{-1} \cdot h^{-1} \cdot m^{-1}$)	238	145
Thermal conductivity at 10°C ($W \cdot m^{-1} \cdot K^{-1}$)	0.035	0.038
Thermal resistivity ($m \cdot K \cdot W^{-1}$)	28.57	26.32

Figure 3 Insulslab pod



(1) Full pod external dimension. Pods have internal dimensions of: full pod 1050 mm, ¾ pod 775 mm, ½ pod 525 mm and ¼ pod 300 mm.

1.7 Other components used with the product, but outside the scope of this Certificate, include:

- damp-proof membrane — polyethylene sheet, 1200 g (300 micrometre) minimum
- radon barrier — where radon or other harmful gases are present a full barrier should be installed with additional care taken to ensure the provision of taped and sealed membrane joints and effective sealing of services passing through the floor. Steps should be taken to ensure compliance with the relevant national Building Regulations in areas where harmful gases are present. Guidance is given in:

  General — BRE Report 211 (BR 211 : 2007) *Radon : Guidance on protective measures for new dwellings*

  Scotland — BRE Report (BR 376 : 1999) *Radon : Guidance on protective measures for new dwellings in Scotland*

  Northern Ireland — BRE Report (BR 413) *Radon : Guidance on protective measures for new dwellings in Northern Ireland*
- void formers — when the product is used for pile-supported slabs in locations subject to clay heave, the slabs must be supported on BBA-certificated void formers selected and installed in accordance with the related BBA Certificate(1).

(1) Such as BBA Certificate 11/4862 *Cellcore HX* or similar third-party certificated void former.

2 Manufacture

2.1 The steel-fibre-reinforced concrete is prepared by adding 50 $kg \cdot m^{-3}$ of steel fibres to the concrete, either in a stationary mixer in the batching plant or directly into a truck mixer on the job site. The EPS components are manufactured using conventional EPS manufacturing procedures.

2.2 To ensure product quality is consistently maintained to the required specification, the BBA has

- agreed with the Certificate holder/manufacturer the quality control procedures and product testing to be undertaken in relation to the steel fibres, Insulslab pods and EPS panels
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of non-conformities
- checked that measuring equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis as part of a surveillance process to ensure that standards are maintained and that the product or system remains as Certificated.

3 Delivery and site handling

3.1 The steel fibres, in 25 kg lots, are supplied in cardboard boxes on pallets of 36 or 48 boxes wrapped in polythene sheeting and weighing 900 kg or 1200 kg respectively. The specified number of boxes of fibres is incorporated into the concrete by the concrete manufacturer at the batching plant or directly into the ready-mix truck[1] to achieve the dosage rate of 50 $kg{\cdot}m^{-3}$.

(1) Further information is given in the Certificate holder's *Best Practice User Manual*.

3.2 The boxes of fibres must be stored away from moisture.

3.3 Concrete intended to have the fibres incorporated must be produced in ready-mix concrete batching plants in accordance with the recommendations of the Certificate holder and be approved by the Certificate holder. The quality assurance procedures at these plants must be accredited by a third-party certifying body such as the Quality Assurance Scheme for Ready Mixed Concrete or BSI. The procedures must describe the steps taken to ensure compliance with specified quality and dosing for each component of the concrete and in particular the fibre.

3.4 Insulslab pods, EPS70 panels and EPS150 panels are supplied shrink-wrapped, should be stored away from the risk of damage and should remain packaged until required for installation.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete.

Design Considerations

4 General

4.1 ArcelorMittal Insulslab Steel-Fibre-Reinforced Concrete is for use in:

- slabs/rafts on compacted granular material (see section 4.3)
- slabs/rafts on materials with variable plasticity (see section 4.4)
- slabs/rafts in zones subject to clay heave (see section 4.5)
- slabs on piles used with void formers in zones subject to clay heave (see sections 1.6 and 4.6)
- slabs on piles in soils without clay content (see section 4.6).

4.2 Construction joints should be provided in the locations specified in clause 6.11.

4.3 The fill material below the concrete must have a minimum bearing capacity of 20 $kN{\cdot}m^{-2}$ and soil stiffness of 30 $MPa{\cdot}m^{-1}$ (K value), approximately equivalent to a clay or sandy clay [defined as Type III in the Building Regulations 2010 (England and Wales), Approved Document A, Table 10].

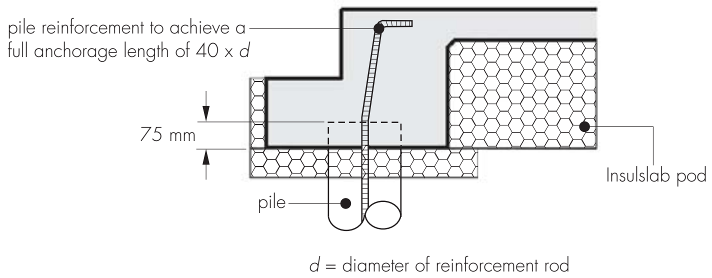
4.4 A site investigation must be carried out to establish the loadbearing capacity of the soil and whether there is a risk of clay heave or other hazards.

4.5 When building near trees in zones liable to be affected by clay heave, the installation may be designed and constructed using the procedure described in NHBC Standard 4.2 provided the proposal complies with the acceptance criteria stated in detail in NHBC Standard 4.2, clause D.7(e), which has a requirement for the:

- depth of foundation derived in accordance with NHBC procedures to be less than 2.5 m
- system to be founded on granular fill placed and compacted in layers
- fill to be at least 50% of the derived foundation depth
- granular material to extend by a distance equal to its natural angle of repose plus 500 mm beyond the face of the raft
- raft to be generally rectangular with an aspect ratio less than 2:1.

4.6 Piles must extend 75 mm into the concrete ground beam and at least one 12 mm diameter ribbed reinforcing bar secured a full tension lap into the pile (40 times diameter) and extending a full tension lap beyond the top of the pile (40 times diameter) (see Figure 4).

Figure 4 Detail at pile cap



5 Practicability of installation

5.1 This product should only be installed by installers who have been trained and approved by the Certificate holder.

5.2 The corners of pods are vulnerable and can be broken during installation. Minor damage will not affect the performance of the system but, if extensive, the damaged pods should not be used.

6 Structural performance

6.1 Concrete incorporating the fibres at a dosage rate of 50 kg·m^{-3} can be considered to have enhanced properties such that, unlike plain concrete, the failure mode is ductile in nature rather than brittle. This is confirmed by testing.

6.2 The structural performance of the fibre-reinforced concrete defined in Table 1 has been established by the 'design assisted by testing' approach.

6.3 Concrete used to the specification defined in this Certificate will have the strength and resistances given in Table 3.

Table 3 Basic characteristics of steel-fibre-reinforced concrete

Characteristic (unit)	Value
Compression strength (grade)	C30/37
Design flexural strength ULS (N·mm^{-2})	4.3[1]
Design shear stress ULS (N·mm^{-2})	0.50[1]

(1) This value incorporates a material factor of 1.5.

6.4 The strength values are for use by the Certificate holder or their approved design engineers, in accordance with procedures agreed with the BBA.

6.5 Safe load tables have been derived in accordance with agreed procedures to establish the data given in Tables 4, 5, 6A and 6B.

6.6 The procedure for establishing the suitability of the waffle slab zones in a ground-supported raft foundation to withstand the loading for particular projects should be carried out thus:

- the average unfactored service load pressure (P_{SLT}) on the ground over the whole foundation area including below the edge beams and internal ribs is determined and the average over the complete area is calculated
- the average ultimate pressure (P_{ULT}) on the ground over the whole foundation area including below the edge beams and internal ribs is determined and the average over the complete area is calculated
- the values for P_{ULT} and P_{SLT} are compared with those given in Table 4, to verify that the slab can sustain the ultimate load and that the ground is adequate to resist the service load for the applicable span between centrelines of beams
- the maximum differential settlement across the foundation should be the lesser of the maximum overall dimension of the slab divided by 400 or 25 mm.

Table 4 Ground pressure resistance allowed for ground-supported ribbed slabs

Condition[1][2][5][6][7][8]	Loading condition	Maximum pressure onto ground[3][4][9] ($kN \cdot m^{-2}$)						
		Slab size *w* x *l* (m)						
		3 x 3	3 x 5.6	4 x 4	4 x 5.6	5 x 5	5 x 5.6	5.6 x 5.6
Four edges discontinuous	Ultimate UDL ($kN \cdot m^{-2}$)	70	70	70	46	47	40	38
Four edges discontinuous	Service SLS ($kN \cdot m^{-2}$)	50	50	50	33	33	28	27

(1) These values relate to a ribbed slab with ribs at 1200 mm centres each 150 mm wide by 300 mm deep below a 100 mm deep slab (see section 8.1).
(2) Deflection limited by ensuring the span/depth ratio < 14 and < span/500.
(3) Ultimate load limited by stress in the concrete (material factor of 1.5).
(4) Slabs are designed as two-way spanning for values of L_y/L_x between 1.0 and 2.0 using bending moment coefficients from BS 8110-1 : 1997, Table 3.14.
(5) Total line loads of up to 17 $kN \cdot m^{-1}$ ultimate (12 $kN \cdot m^{-1}$ service) can be accommodated where imposed loads are less than 1.5 $kN \cdot m^{-2}$ (total line load per m is the sum of all the line loads in any 3 m x 3 m segment within the slab zone, divided by three).
(6) Concentrated design loads up to 10 kN can be resisted at any location on the slab. Maximum slab imposed load 6 kN m^{-2} (based on 3 m sinkhole).
(7) For slab panels outside the scope of this table, calculations can be provided by an engineer approved by the Certificate holder.
(8) For calculation of subgrade settlement by a geotechnical engineer, the waffle slab can be considered as a flat slab with a thickness of 300 mm.
(9) The service loads onto the ground should not exceed the bearing capacity of the soil (see section 4.4).

6.7 The suitability of the edge beams and internal beams in a ground-supported raft foundation will depend on the beam dimensions and the loads applied. The procedure used to confirm that the members have adequate load capacity is:

- the service loads and ultimate loads on the edge and internal beams, including the weight of the concrete slab between the beams, are determined
- the values are compared with those given in Table 5 which are based on the slab and edge beam being dimensioned in accordance with Figure 5.

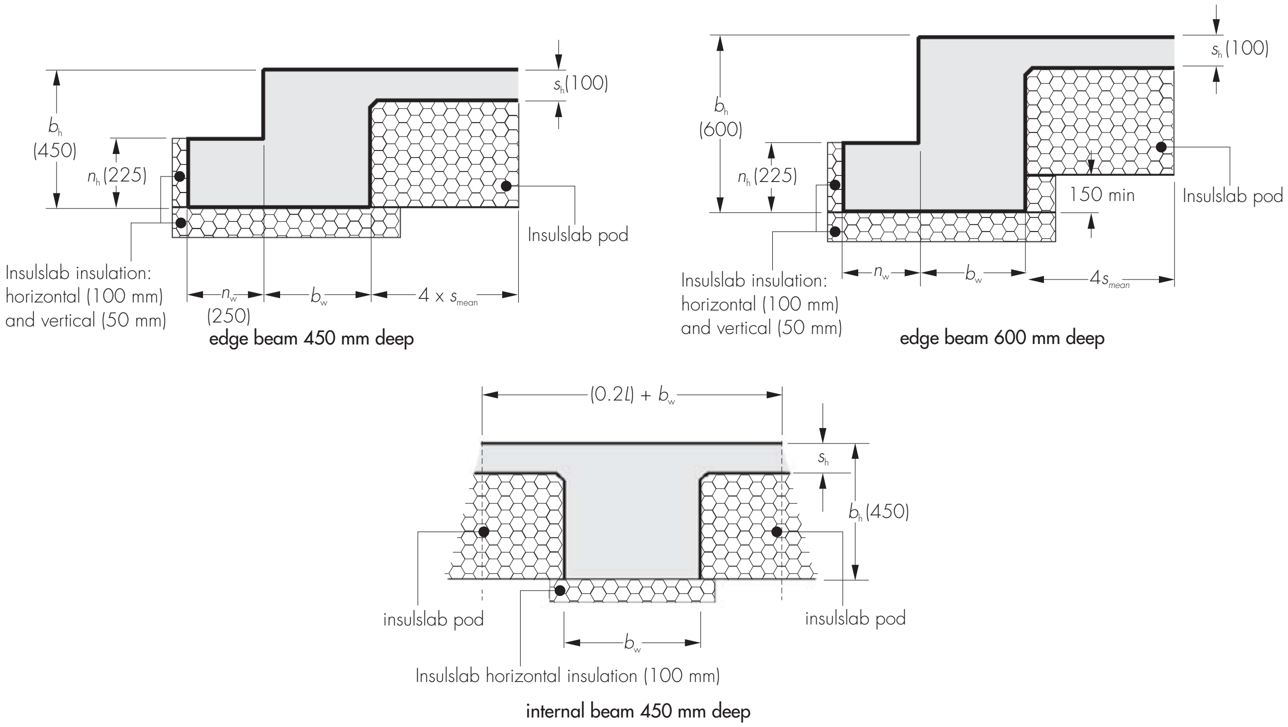
Table 5 Capacity of edge and internal beams[1] (see Figure 4)

Size (b_w x b_h)	Edge beam		Internal Beam		
	Ultimate load	Service load limited by compression in the EPS[2]	Ultimate load ($kN \cdot m^{-1}$)		Service load limited by compression in the EPS[2]
(mm)	($kN \cdot m^{-1}$)	($kN \cdot m^{-1}$)	full + ¾ pods	½ + ¼ pods	($kN \cdot m^{-1}$)
300 x 450	68	60	44	42	33
350 x 450	75	66	51	49	38
450 x 450	88	77	64	62	49
450 x 600	115	77	115	106	49
600 x 600	142	93	132	122	66

(1) Conditions applying to the values in this table are:
- the self-weight of the beam and slab are included in the values given in the table
- edge beam nib dimensions: n_w = 250 mm and n_h = 225 mm
- the slab adjacent to the edge beam is assumed to have an average thickness (s_{mean}) of 137.5 mm, and a 550 mm width of the slab contributes to the resistance of the edge beam
- the slab adjacent to the internal beam is assumed to have an average thickness (s_{mean}) of 137.5 mm, and a width of slab 0.2 x effective span (*L*) contributes to the resistance of the internal beam. Where half- and quarter-pods are located adjacent to internal beams, the contribution of the slab is limited to half of the pod width from each side
- the worst case for design is taken as:
  - for internal beams, the formation of a 3 m diameter sinkhole below
  - for external beams, the formation of a 3 m diameter sinkhole below or a 1500 mm cantilever
- the values are based on the design stresses given in Table 3
- the values have been verified for unfactored service load and deflection and ultimate loads (based on load factors of 1.5 imposed and 1.35 dead)
- for beam sizes outside the scope of this table, calculations can be provided by an engineer approved by the Certificate holder.

(2) The loads will restrict the long-term compression in the EPS to less than 4 mm. The beam may be widened to reduce the pressure on the EPS and increase the capacity of the system.

Figure 5 Beam details



Note: The various dimensions of b_h and b_w are given in Table 5. s_h = depth of slab adjacent to beam.

Design method for pile-supported Insulslab slabs

6.8 This method covers situations where the concrete is used over piles to form edge beams, internal beams and a two-way spanning waffle slab, and is appropriate for situations where:

- slab and beams have dimensions in accordance with Figure 5, Table 6A and 6B
- minimum size of the piles is 180 mm diameter
- maximum loading as indicated in Table 6A and 6B
- maximum distance between piles is 5.6 m
- maximum ultimate load per pile is 300 kN (for 180 mm diameter piles)
- the floor area is fully supported (see section 4.1)
- voidformers used with the system should be selected to ensure that the maximum uplift pressure is less than 14 kN·m^{-2} in the slab zone. Where voidformers are incorporated in the system, the maximum span of slab (ie centre to centre pile distance) should not exceed 5 m when the slab is continuous over at least one of its sides. If the slab is not continuous over at least one support, the designer should determine the reduction in the span in accordance with the structural properties of the steel-fibre-reinforced concrete (SFRC).

6.9 The ultimate loads on the edge and internal beams, including the self-weight of the ground floor and beams are determined. The acceptable loads that can be resisted by the edge beams and internal beams are indicated in Table 6A.

Table 6A Ultimate load capacity of edge and internal beams of pile-supported slabs[1][2] (see Figure 5)

Beam section[3] (b_w x b_h) (mm)	Location	Load capacity (kN·m^{-1})				
		Span between piles (m)				
		2	3	4	5	5.6[4]
300 x 450	Edge	111	68	38	24	19
	Internal (full + ¾ pods)	83	44	25	16	13
	Internal (½ + ¼ pods)	80	42	24	15	12
350 x 450	Edge	121	75	42	27	21
	Internal (full + ¾ pods)	93	51	29	19	15
	Internal (½ + ¼ pods)	89	49	27	17	14
450 x 450	Edge	140	88	49	31	25
	Internal (full + ¾ pods)	111	64	37	23	19
	Internal (½ + ¼ pods)	108	62	35	22	17
450 x 600	Edge	173	115	86	57	45
	Internal (full + ¾ pods)	145	106	67	43	35
	Internal (½ + ¼ pods)	142	95	63	40	32
600 x 600	Edge	213	142	106	69	55
	Internal (full + ¾ pods)	185	132	88	56	45
	Internal (½ + ¼ pods)	181	122	83	53	42

(1) These figures are based on the following assumptions:
- edge beam values assume nib dimensions of: n_w = 250 mm and n_h = 225 mm (see Figure 4)
- shear capacity based on beam depth less 75 mm (see Figure 4)
- beams are designed as simply supported between piles.

(2) The figures cover resistance to ultimate loads (ultimate loads assumed to be 1.35 dead plus 1.5 x imposed). Deflection limited by ensuring the span/depth ratio < 14 and < span/500.

(3) For beam sizes outside the scope of this table, calculations can be provided by an engineer approved by the Certificate holder.

(4) Not applicable for installations incorporating voidformers (see section 6.8, last bullet point).

Table 6B Ultimate load resistance for pile-supported ribbed slabs

Condition[1][2][5][6][7]	Uniformly distributed load (kN·m^{-2})						
	Span between centreline of beams[3][4][8] (m)						
	3.0 x 3.0	4.0 x 4.0	5.0 x 5.0	5.6 x 5.6	3.0 x 5.6	4.0 x 5.6	5.0 x 5.6
Four edges discontinuous	42	24	15	12	22	15	12
Three edges discontinuous (one long edge continuous)	54	30	19	15	32	22	17
Two adjacent edges discontinuous	65	36	23	18	35	24	19
	Maximum ultimate line load (kN·m^{-1})[5]						
All conditions	23	14	8	5	12	7	6

(1) These values relate to a ribbed slab with ribs at 1200 mm centres each 150 mm wide by 300 mm deep below a 100 mm slab (see section 8.1).

(2) Deflection limited by ensuring the span/depth ratio <14 and <span/500.

(3) Ultimate load limited by stress in the concrete (material factor of 1.5).

(4) Slabs are designed as two-way spanning for values of L_y/L_x between 1.0 and 2.0 using the bending moment coefficients from BS 8110-1 : 1997, Table 3.14. Self-weight of concrete is included in the design.

(5) These values apply when the imposed load is 1.5 kN·m^{-2}.

(6) Concentrated design loads up to 10 kN can be resisted at any location on the slabs with spans up to 4 m, and 7 kN on spans greater than 4 m.

(7) For slab panels outside the scope of this table, calculations can be provided by an engineer approved by the Certificate holder.

(8) Not applicable for installations incorporating voidformers (see section 6.8, last bullet point).

6.10 Slabs and rafts[1] greater than 200 m^2 with re-entrant corners larger than 1 m by 1 m, and a length to width ($L/_w$) ratio smaller than 1.5, will not require additional reinforcement at the re-entrant corners. Slabs outside these criteria will need to incorporate wiremesh (A252) reinforcement 1 m by 0.8 m at the re-entrant corners, placed at 45°, and the Certificate holder's advice should be sought.

(1) Slabs and rafts covered by this Certificate.

6.11 Movement joints and, where necessary, day joints, should be checked and installed as required by the structural engineer. In general, joints are required when:
- slab area is greater than 900 m^2, or
- length to width ratio >1.5, or
- length of the slab exceeds 30 m.

6.12 Service penetrations less than 150 mm square can be accommodated within the beams, ribs or pods. Back-to-back service penetrations at party wall locations through a beam strip are acceptable providing nominal 110 mm diameter pipework is used. Penetrations should be wrapped by isolation joint material to allow for smaller movements and concrete shrinkage. Larger service holes may require additional reinforcement and should be verified by a suitably experienced chartered engineer.

7 Moisture resistance

7.1 The completed floor will provide adequate resistance to moisture from the ground where the specified damp-proof membrane is correctly installed and detailed in accordance with conventional good working practice.

Condensation

7.2 For buildings in internal humidity class 4[1] and in buildings or areas of a building with special internal design conditions, a hygrothermal assessment of the proposed floor construction should be undertaken using the guidance given in BS 5250 : 2002, to establish whether special provisions are required.

(1) In accordance with BS 5250 : 2002, humidity class 4 covers dwellings with high occupancy, such as sports halls, kitchens, canteens, buildings heated with unflued gas heaters.

8 Thermal performance

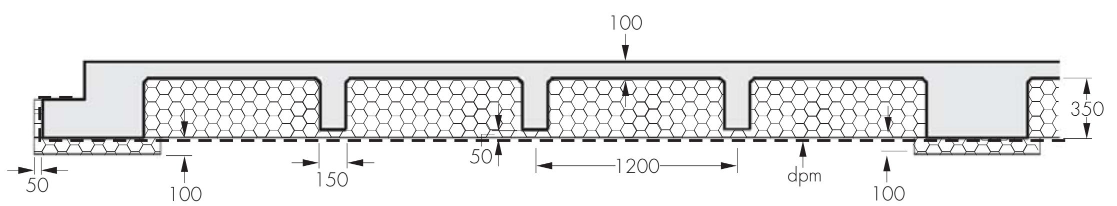
8.1 From example calculations, it can be shown that the maximum perimeter/area (P/A) ratio, for a typical range of pod layouts, will achieve the design floor U values (see Table 7) given in documents supporting the national Building Regulations. In general, the majority of floors have a P/A ratio in the range between 0.4 and 0.9. Where a proposed floor does not meet the required U value, compensating fabric and/or services measures should be considered. A typical floor is shown in Figure 6.

Table 7 Example maximum floor P/A ratios meeting typical design mean U values

U value of floor[1] ($W \cdot m^{-2} \cdot K^{-1}$)	Maximum P/A ratio[2]	
	Low bridging[3]	High bridging[4]
0.15	0.24	0.23
0.18	0.44	0.38
0.20	0.73	0.58
0.22	1.00	1.00
0.25	1.00	1.00

(1) The specified horizontal edge insulation has minimal effect and has not been included.
(2) These ratios may vary by 0.01 or 0.02 but still achieve the quoted U value when rounded to two significant figures.
(3) Nominal low bridging — slab resistance (R_f) of 3.770 $m^2 \cdot K \cdot W^{-1}$ for an 18.6% repeating beam percentage.
(4) Nominal high bridging — slab resistance (R_f) of 3.545 $m^2 \cdot K \cdot W^{-1}$ for a 21.5% repeating beam percentage.

Figure 6 Typical floor



8.2 For other constructions, the slab bridging percentage should include repeating bridges (concrete beams) within the EPS plan area. Non-repeating bridges, eg beams at perimeters with external and internal walls, should not be included (but should be included when calculating junction Ψ values — see section 8.3). The slab resistance and overall floor U value should be calculated in accordance with BRE report (BR 443 : 2006) *Conventions for U-value calculations*, BS EN ISO 6946 : 2007, BS EN ISO 10211 : 2007 and BS EN ISO 13370 : 2007 using the relevant properties given in section 1 of this Certificate.

Table 8 Insulslab pods

Insulslab pod type	Thermal resistance[1] ($m^2 \cdot K \cdot W^{-1}$)		Concrete bridging[2] (%)
	EPS 70	EPS 150	
Full	2.99	3.21	23.4
Three-quarter	2.82	3.03	26.7
Half	2.58	2.78	31.9
Quarter	2.27	2.44	41.7

(1) EPS 70: λ_D = 0.038 $W \cdot m^{-1} \cdot K^{-1}$. EPS 150: λ_D = 0.035 $W \cdot m^{-1} \cdot K^{-1}$. Concrete: λ = 2.5 $W \cdot m^{-1} \cdot K^{-1}$.
(2) Pro rata by area for pod mixes. For the example in Table 7, bridging = 0.5 x 0.234 + 0.25 x 0.319 + 0.25 x 0.417 = 30.1%.

8.3 The example linear thermal transmittance (Ψ value) given in Table 9 for a typical floor/wall junction, should adequately limit excessive heat loss (but small compensatory measures may be required to reduce carbon emissions). Calculations of Ψ values and temperature factors for junctions should be carried out in accordance with BRE report (BR 497) *Conventions for calculating linear thermal transmittance and temperature factors* and the guidance given in BRE Information Paper IP1/06 *Assessing the effects of thermal bridging at junctions and around openings*.

Table 9 External wall junction Ψ value and minimum temperature factors

Junction	Ψ value ($W{\cdot}m^{-1}{\cdot}K^{-1}$)	Temperature factor (f_{Rsi})
Ground floor — masonry wall	0.19	0.83

8.4 Detailed guidance and/or requirements for calculation competency, robustness of design/construction and on limiting heat loss by air infiltration can be found in:

England and Wales — Approved Documents to Part L and, for new thermal elements to existing buildings, Accredited Construction Details (version 1.0) (for new-build, see also SAP 2009, Appendix K, and the *iSBEM User Manual*)

Scotland — Technical Handbook (Domestic), Technical Handbook (Non-domestic) and Accredited Construction Details (Scotland)

Northern Ireland — Technical Booklets F1 and F2 and Accredited Construction Details (version 1.0).

9 Maintenance

As the product is inaccessible once installed and has suitable durability (see section 10), maintenance is not required.

10 Durability

10.1 The durability of concrete reinforced with fibres will be at least equivalent to that of plain concrete of the same grade. There may be some discoloration on exposed surfaces but this will not penetrate into the concrete provided it is designed and used in accordance with this Certificate. The concrete (as specified in section 1.3) will have adequate durability for the stipulated use.

10.2 Insulslab pods and the EPS strips are rot-proof, dimensionally stable and, when installed in accordance with this Certificate, will remain effective as an insulating material for the life of the building in which they are incorporated.

Installation

11 General

11.1 Before site preparation, certain investigations must be made and information supplied by the developer to all parties, including:

- report on the geo-technical survey of the ground conditions
- drawing of the foundation layout
- details of the construction above slab/foundation level
- plan of site giving details of levels
- details of neighbouring trees/shrubs likely to affect ground conditions.

11.2 The Certificate holder will supply:

- design documents incorporating:
  - — specification for the concrete slab including details of construction joints, if required, and specification of the Insulslab pods
  - — type of fibre and dosage rate
- list of all Insulslab elements required
- copy of all 'approved for construction' drawings including details of concrete mix design, type and position of additional reinforcement and details peculiar to the site involved.

12 Site preparation

12.1 On relatively level sites, the setting out should be undertaken using normal procedures ensuring that the lines of edge and intermediate beams are accurately placed in accordance with the Certificate holder's 'Construction issue' drawing. On steeply sloping sites, special provisions may need to be made — the advice of the Certificate holder should be sought.

12.2 The area should be excavated to a depth of 600 mm below the projected top level of the slab and 675 mm below edge beams and internal beams (eg at party walls), ensuring all topsoil, degradable material and soft spots are removed — additional fill may be required to compensate.

12.3 In areas where the soil may be affected by shrinkage or tree or shrub growth, additional hardcore beds may need to be placed in accordance with *NHBC Standards*, Part 4, Chapters 4.2 and 4.5.

12.4 Services and drainage entries must be positioned and installed accurately; errors will be difficult to rectify after the slab has been cast.

12.5 Granular hardcore is placed and compacted with plate or roller compaction equipment to meet a level 550 mm below the top of the projected slab level to a tolerance on level of +10 mm/–20 mm (average –5 mm).

12.6 Where piled construction is used, the piles, ground preparation and void formers should be installed and ground levelled before *Procedure* applied.

13 Procedure

13.1 The horizontal edge insulation (EPS150) and that under internal beams and party walls is laid and the edge shutter set up. The space between the edge and intermediate insulation is filled with granular hardcore and compacted.

13.2 A damp-proof membrane (1200 g minimum) or, where required, a gas barrier is laid over the whole area allowing 300 mm to 500 mm to project beyond the edge of the shutter.

13.3 Starting at one corner, Insulslab pods are placed in the prescribed layout; all full pods are laid before cut pods are used to complete the pod assembly. Where beams occur, spacers are used to maintain the beam width and prevent pods moving. Spacers can be of timber bracing or EPS diaphragms depending on the width of the beam. Where full-depth beams are required, pods with the appropriate lip (or lips at corners) removed are used.

13.4 Service penetrations are made within the beams, ribs or pods. Holes larger than 150 mm square must be approved by a chartered structural engineer and those over 600 mm square will require additional reinforcement as specified by the engineer. The installed service connections should be sealed with a flexible material to allow for subsequent construction and thermal movements.

13.5 Where specified in the 'approved for construction' drawings, additional reinforcement is installed.

13.6 Concrete to the required specification and dosage rate (see section 1) is poured in two stages: up to wall footing level (top of edge shutter) and then up to slab level.

13.7 Concrete is poured in a continuous operation. The free-flowing nature of the mix should obviate the need for vibration techniques. If a pod lifts during the pouring operation, the flow should be blocked, the pod lifted and misplaced concrete returned to the rib area before replacing the pod and continuing with the placement up to the top of the edge shuttering.

13.8 Z-shaped shear reinforcement rods are placed into the wet concrete at 250 mm centres in accordance with the structural engineer's instructions and the concrete allowed to set.

13.9 When set, the edge shutter is stripped and re-erected on the footing for the second stage pour[(1)].

(1) Bars and blocks set into the first-stage concrete are used to support the shutter; these are removed after completion.

13.10 Alternatively, if a brickwork outer leaf is specified, the footing is painted with BBA-certificated sealant selected and installed in accordance with the related BBA Certificate, and the leaf built up to finished slab level. Prior to the concrete pour, a leaf of insulation is placed against the inside face of the brickwork (removed after concrete set to form cavity).

13.11 Concrete to the required specification and dosage rate is placed to fill ribs and beams between pods and create the slab over the pods[(1)]. Care must be taken to level the concrete and float finish the surface to prevent steel fibres from projecting. Power-trowelling may be used.

(1) Spacers and diaphragms are removed when concrete reaches the top of the pods during the pour.

13.12 The horizontal and vertical faces of the footing are painted with BBA-certificated sealant selected and installed in accordance with the related BBA Certificate, and the dpm is lapped against the vertical face of the footing before the vertical insulation is placed against face and held in place with backfilled material.

Technical Investigations

14 Investigations

14.1 An assessment was made of the durability of the dosed concrete.

14.2 An examination was made of data relating to the structural performance of the steel-fibre-reinforced concrete, including:

- reports of full-scale tests
- flexural strength
- tensile strength
- resistance to punching shear.

14.3 Calculations based on procedures defined in BS EN 1992-1-1 : 2004, sections 2.5 and 2.6, were verified and permissible load/span data confirmed for each proposed type of application.

14.4 An examination was made of the *ArcelorMittal UK Housing Best Practice Guide*.

15 Other investigations

15.1 Site visits were made to assess the practicability of installation.

15.2 An examination was made of the production control procedures.

15.3 A review was undertaken of the data on CE marking in accordance with BS EN 14651 : 2005.

Bibliography

BS 5250 : 2002 *Code of practice for control of condensation in buildings*

BS 8110-1 : 1997 *Structural use of concrete — Code of practice for design and construction*

BS 8500-1 : 2006 *Concrete — Complementary British Standard to BS EN 206-1 — Method of specifying and guidance for the specifier*

BS 8500-2 : 2006 *Concrete — Complementary British Standard to BS EN 206-1 — Specification for constituent materials and concrete*

BS EN 934-2 : 2001 *Admixtures for concrete, mortar and grout — Concrete admixtures — Definitions and requirements, conformity, marking and labelling*

BS EN 1992-1-1 : 2004 *Eurocode 2 : Design of concrete structures — General rules and rules for buildings*

BS EN 14651 : 2005 *Test method for metallic fibre concrete — Measuring the flexural tensile strength (limit of proportionality [LOP], residual)*

BS EN 14889-1 : 2001 *Fibres for concrete — Steel fibres — Definitions, specifications and conformity*

BS EN ISO 6946 : 2007 *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

BS EN ISO 10211 : 2007 *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations*

BS EN ISO 13370 : 2007 *Thermal performance of buildings — Heat transfer via the ground — Calculation methods*

16 Conditions

16.1 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.

16.2 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.

16.3 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.

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

16.5 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
- individual 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.

16.6 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.

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