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Agrément Certificate
20/5812
Product Sheet 1

INSULATED FOUNDATION SYSTEM

JACKODUR ATLAS FOUNDATION INSULATION SYSTEM

This Agrément Certificate Product Sheet(1) relates to the JACKODUR Atlas Foundation Insulation System, for use in construction of ground-supported raft foundations in conjunction with timber frame, insulated concrete form (ICF) walls and non-load bearing blockwork internal walls. The system comprises extruded polystyrene (XPS) boards and reinforced concrete.

(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 — ground-supported raft foundations incorporating the XPS insulation and reinforced concrete can provide adequate strength and stiffness to resist the applied loading from the superstructure, and distribute to the substrata when designed in accordance with this Certificate (see section 6).

Thermal performance — the XPS components can enable a raft foundation to satisfy the design U values specified in the documents supporting the national Building Regulations (see section 7).

Condensation — the system can contribute to minimising the risk of condensation (see section 8).

Durability — the system will have a service life in excess of 60 years (see section 10).

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

On behalf of the British Board of Agrément

Date of Second issue: 27 July 2021

Hardy Giesler
Chief Exective Officer

Originally certificated on 19 October 2020

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Regulations

In the opinion of the BBA, the JACKODUR Atlas Foundation Insulation 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**	**Loading**
Comment:		The system can be designed to sustain and transmit dead and imposed floor and superstructure loads to the ground. See section 6 of this Certificate.
Requirement:	**A2**	**Ground movement**
Comment:		The system will have adequate strength and stiffness. See section 6 of this Certificate.
Requirement:	**C2(c)**	**Resistance to moisture**
Comment:		The system can contribute to limiting the risk of surface condensation. See sections 8.1 and 8.2 of this Certificate.
Requirement:	**L1(a)(i)**	**Conservation of fuel and power**
Comment:		The system can contribute to satisfying this Requirement. See sections 7.1, 7.2 and 7.4 of this Certificate**.**
Regulation:	**7(1)**	**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. See sections 7.1 and 7.2 of this Certificate.

The Building (Scotland) Regulations 2004 (as amended)

Regulation:	**8(1)**	**Durability, workmanship and fitness of materials**
Comment:		The system can contribute to a construction satisfying this Regulation. See section 10 and the *Installation* part of this Certificate.
Regulation:	**9**	**Building standards applicable to construction**
Standard:	1.1(a)	Structure
Comment:		The system can sustain and transmit dead and imposed floor loads to the ground, with reference to clauses 1.1.1$^{(1)(2)}$ to 1.1.4$^{(1)(2)}$ of this Standard. See section 6 of this Certificate.
Standard:	3.15	Condensation
Comment:		The system can contribute to limiting the risk of surface and interstitial condensation, with reference to clauses 3.15.1$^{(1)(2)}$, 3.15.4$^{(1)(2)}$ and 3.15.5$^{(1)(2)}$ of this Standard. See sections 8.1 and 8.3 of this Certificate.
Standard:	6.1(b)	Carbon dioxide emissions
Comment:		The system can contribute to satisfying this Standard, with reference to clauses 6.1.1$^{(1)(2)}$ and 6.1.6$^{(1)(2)}$. See sections 7.1 and 7.2 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)(2) and 6.2.3(1)(2). See sections 7.1, 7.2 and 7.4 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The system can contribute to satisfying the relevant requirements of Regulation 9, Standards 1 to 6, and therefore will contribute to a construction meeting a bronze level of sustainability as defined in this Standard. In addition, the system can contribute to a construction meeting a higher level of sustainability as defined in this Standard, with reference to clauses 7.1.4(1)(2) [Aspects 1(1) and 2(1)], 7.1.6(1)(2) [Aspects 1(1) and 2(1)] and 7.1.7(1) [Aspect 1(1)]. See section 7.3 of this Certificate.

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

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

Regulation:	**23(a)(i)(iii)(b)**	**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 ground. See section 6 of this Certificate.
Regulation:	**39(a)(i)**	**Conservation measures**
Comment:		The system can contribute to satisfying this Regulation. See sections 7.1 and 7.2 of this Certificate.
Regulation:	**40(2)**	**Target carbon dioxide emission rate**
Comment:		The system can contribute to satisfying this Regulation. See sections 7.1 and 7.2 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: 2 *Manufacture* (2.2), 3 *Delivery and site handling* (3.4 and 3.7) and 14 *Procedure* (14.6) of this Certificate.

Additional Information

CE marking

The Certificate holder has taken the responsibility of CE marking the XPS components in accordance with harmonised European Standard BS EN 13164 : 2012.

Technical Specification

1 Description

1.1 The JACKODUR Atlas Foundation Insulation System comprises factory made XPS in conjunction with concrete strength class C32/40 reinforced with steel mesh or steel bar in the raft foundation. The XPS components consist of JACKODUR Atlas Corner Element, JACKODUR Atlas Side Element, JACKODUR Atlas Formwork and JACKODUR Surface Element (see Figures 1a and 1b for JACKODUR Atlas XPS insulation boards). The JACKODUR Atlas Formwork can be either L shape (see Figures 1a and 1b) or rectangular shape (see Figure 1b). The system can be used with insulated concrete formwork (ICF) and timber frame walls for any height of the building where the applied stress on the XPS at the serviceability limit state (SLS) does not exceed 83 kPa (see section 6).

1.2 For nominal characteristic properties and dimensions of the JACKODUR Atlas XPS insulation boards, see Table 1.

Table 1 Nominal characteristic properties and dimensions of JACKODUR Atlas XPS insulation boards

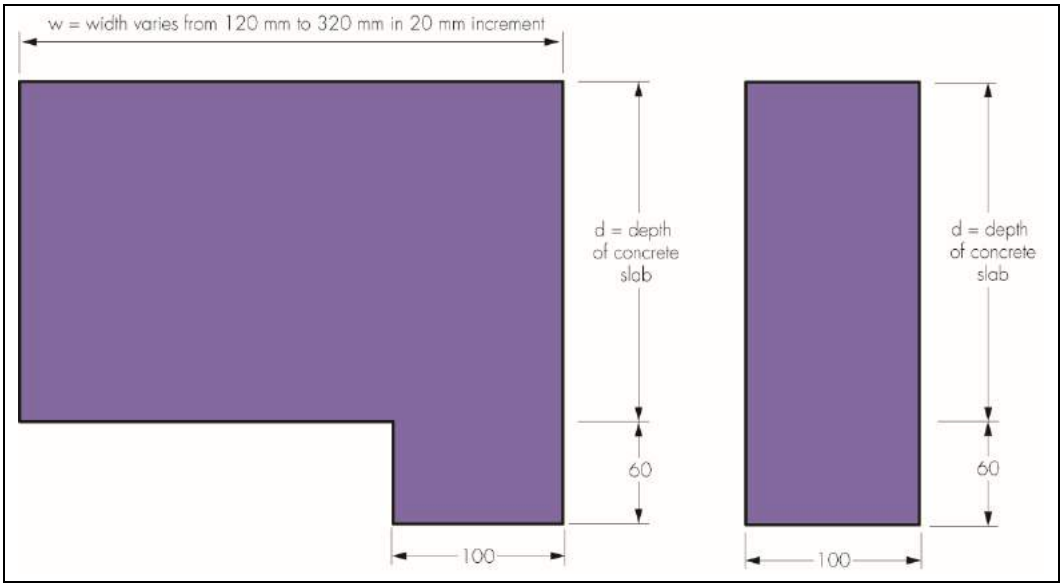
Description	Appearance	Dimensions (mm)	Thickness (mm)	Compressive stress at 10% deformation (kPa)	Design thermal conductivity (λ_u) u value ($W \cdot m^{-1} \cdot K^{-1}$)
JACKODUR Atlas Corner Element (see Figure 1)	Ship-lapped edge smooth, extrusion-compressed surface	1230 x 580	100 to 320[(1)]	300	0.037 (for thicknesses 100 to 180 mm) 0.038 (for thicknesses 200 to 320 mm)
JACKODUR Atlas Side Element (see Figure 1)	Ship-lapped edge smooth, extrusion-compressed surface	1230 x 580			
JACKODUR Atlas Formwork (see Figure 1)	Tongue and groove, smooth, without skin	1220 x (height equal to thickness of concrete slab)			
JACKODUR Atlas Surface Element (see Figure 1)	Ship-lapped edge smooth, extrusion-compressed surface	1250 x 600			

(1) In 20 mm increments

Figure 1a JACKODUR Atlas Corner Element, JACKODUR Atlas Side Element, JACKODUR Atlas Formwork (L shape) and JACKODUR Atlas Surface Element[(1)]

(1) The components are purple coloured

Figure 1b JACKODUR Atlas Formwork L and rectangular shapes (including their dimensions)



1.3 JACKODUR perimeter adhesive, a solvent-free single-component polyurethane adhesive, is used to seal off penetrations and open joints in the insulation layer. The adhesive has a working temperature range of -5 to +35°C.

1.4 The specifications of structural components used in conjunction with the system, but not manufactured by JACKON Insulation GmbH, are defined in Table 2.

Table 2 Specifications of components used in conjunction with the JACKODUR Atlas Foundation Insulation System but not manufactured by JACKON Insulation GmbH

Description		Characteristic
Concrete	Compressive strength class for raft foundation	C32/40
	Cement and combination types	Appropriate cement and combination type must be selected from BS 8500-1 : 2015, Table A.4, for XC3 exposure class
	Maximum aggregate size	Maximum aggregate size must be 20 mm, and aggregate must comply with BS EN 12620 : 2002
	Concrete depth	Typical depth (1) 200(1) or 250(1) mm
	Consistency class	S3
	Admixture/super-plasticiser	Per manufacturer's instructions and BS EN 934-2 : 2009
Reinforcement for raft foundation		Minimum one layer of A393 mesh at top and bottom of the raft foundation to BS 4483 : 2005 for raft foundations with a characteristic yield strength (f_{yk}) of 500 N·mm^{-2}. The nominal cover to steel reinforcement must be 40 mm
Reinforcement for U bar at the edge of the raft foundation		H8 (link) for U bar for edge of the raft foundation, and H12 for longitudinal bar Characteristic yield strength (f_{yk}) of 500 N·mm^{-2} The nominal cover to steel reinforcement for external edge and internal concrete beams must be 40 mm The scheduling, dimensioning, bending and cutting of the steel reinforcement must be in accordance with BS 8666 : 2020. Steel reinforcement must comply with BS 4449 : 2005
Hardcore sub-base material		Minimum 150 mm well graded (non-frost susceptible) and with good drainage material, minimum MOT type 1, must be used. The material must be in accordance with the *Manual of Contract Documents for Highway Works* (MCHW), Volume 1 *Specification for Highway Works, Series 800* (February 2006), and must be compacted in layers of 150 mm

(1) For other concrete depth, a suitably experienced and qualified engineer must check the adequacy of the concrete and the XPS against the limits and requirements mentioned in section 6.7 of this Certificate.

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

- where required, gas/radon and/or VOC resistant barrier(1) with third-party approval
- vapour control layer (vcl)(1) with third-party approval
- damp-proof membranes (dpm)(1), if required, with third-party approval
- damp proof course (dpc) with third-party approval
- grit sand 2 to 5 mm or 4 to 8 mm, used as a levelling filler on the top of hardcore and below the dpm or gas barrier membrane (if required) to minimise the risk of puncturing them
- flexible or rigid drainpipes
- granular and selected fill material for bedding and backfilling of flexible or rigid drainpipes – must be in accordance with Approved Document H
- ICF
- timber frame
- screed with underfloor heating
- drainage channel
- bottle gully and gully
- JACKODUR KF Gefiniert insulation blocks.

(1) Must be compatible with XPS.

2 Manufacture

2.1 XPS is manufactured through an extrusion process, by melting beads of polystyrene in an extruder and then injecting a blowing agent into the molten material. This creates a closed cell structure with no voids in the material and a uniform skin surface that repels water.

2.2 Where required, the XPS components are joined together by means of either adhesive or a welding process to form multilayer plates, and then milled to shape.

2.3 Concrete must be produced in ready-mix concrete batching plants approved by the Certificate holder and in accordance with the Certificate holder's recommendations. 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 (QSRMC) or BSI Kitemark or equivalent quality scheme. The concrete must be placed by personnel with appropriate skill and experience.

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

- agreed with the manufacturer the quality control procedures and product testing to be undertaken
- assessed and agreed the quality control operated over batches of incoming materials
- monitored the production process and verified that it is in accordance with the documented process
- evaluated the process for management of nonconformities
- checked that equipment has been properly tested and calibrated
- undertaken to carry out the above measures on a regular basis through a surveillance process, to verify that the specifications and quality control operated by the manufacturer are being maintained.

2.5 The management systems of JACKON Insulation GmbH have been assessed and registered as meeting the requirements of BS EN ISO 9001 : 2015 by DAKKS (067674 QM15 UM15).

3 Delivery and site handling

3.1 The JACKODUR Atlas components are shrink-wrapped in polythene and delivered to site on pallets. Each pack shows the manufacturer's name, grade, type marking and the BBA logo incorporating the number of this Certificate.

3.2 The components must be protected from prolonged exposure to sunlight and should be stored under cover (vital in high winds) or protected with light-coloured opaque polythene sheets.

3.3 Normal precautions for handling XPS materials should be taken to avoid damaging the components during offloading, storage, handling and installation.

3.4 Care must be taken to avoid exposing XPS to solvents or materials containing organic components. In addition, they must not be exposed to open flame or other ignition sources.

3.5 The components must be stored flat, off the ground, on a clean, level surface.

3.6 Damaged components must not be used.

3.7 All trained operatives involved with placing, compacting and finishing the concrete should wear appropriate personal protective equipment (goggles, impermeable gloves, long-sleeved jackets, full length trousers, boots etc) to avoid direct eye and skin contact with fresh concrete.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the JACKODUR Atlas Foundation Insulation System.

Design Considerations

4 Use

4.1 The JACKODUR Atlas Foundation Insulation System is satisfactory for use as a ground-supported raft foundation on compacted granular MOT type 1 material, as defined in section 1.4 of this Certificate.

4.2 Prior to commencement of the detailed design, a ground investigation must be conducted to assess both the geotechnical and geo-environmental status of the site and its environs. Ground investigations should follow the guidance of BS 5930 : 2015, BS 10175 : 2011, and BS EN 1997-2 : 2007 and its UK National Annex.

4.3 An appropriately qualified engineer should perform a site-specific assessment/design taking into account all the risks and factors impacting on design solutions, including:

- frost-susceptible soils and cold weather construction
- building conditions, shape, size and construction to evaluate the wind, snow, imposed, self-weight and total loads applied to the XPS by the superstructure
- the modulus of subgrade reaction of the ground
- the modulus of subgrade reaction of the XPS insulation grade 300 as defined in Table 3 of this Certificate
- the sub soil settlement and the maximum relative rotation in accordance with BS EN 1997-1 : 2004 and its UK National Annex
- loadbearing capacity of the soil
- the effect of the ground water table on bearing capacity of soil
- the suitability of the underlying soil strata to support the loading imposed from the foundation
- risks presented by the geo-environmental status of the site, which might involve further consultation with other specialists to determine suitable additional protective measures and/or suitability of the foundation system with respect to ground gasses, contaminants and aggressive chemicals or soils that may be present
- risks associated with land prone to flooding
- risks associated with building near trees
- risk of floatation of the XPS due to hydrostatic pressure, before the concrete is poured
- risks associated with construction of a raft foundation below the water table level – it must be ensured that the raft foundation can resist against the uplift force due to hydrostatic pressure during construction works before the weight of superstructure is in place
- details of the construction above foundation level
- site plan giving details of levels
- underground services including drains, and the relationship with adjacent services and drains
- details and specifications of any additional groundworks, earthworks or remedial measures to mitigate other risks identified from the ground investigation to suit the adoption of the JACKODUR Atlas Foundation Insulation System
- construction sequencing, to ensure that the floor is not loaded by construction materials until the reinforced concrete has fully cured and the magnitude of loads does not exceed the design resistance of the foundation system
- where the floor is to support a separating wall, the wall and floor junction must adequately limit impact and airborne flanking sound transmission. Advice can be found in the documents supporting the relevant national

Building regulations. Also, the suitability of the system under the load applied from the party wall for the limits mentioned in section 6.7 must be checked.

4.4 Foundations in shrinkable soils must be capable of accommodating the effects of trees, shrubs and hedgerows on shrinkable soils without excessive movement. Items to be taken into account include:

- distance between trees and foundation
- method of assessment of foundation depths
- foundation depths related to the zone of influence of new tree planting
- foundation depths related to new shrub planting.

4.5 Shrinkable soils are classified as those which contain more than 35% fine particles (silt and clay), with a Plasticity Index of 10% or greater (shrinkable soils are susceptible to clay heave and shrinkage under a change in moisture content).

4.6 When building near trees in zones liable to be affected by clay heave, the installation may be designed and constructed using the procedure described below:

- raft to be generally rectangular with an aspect ratio less than 2:1. For aspect ratios greater than 2:1, an appropriate mitigation against concrete shrinkage by a suitably experienced and qualified engineer should be taken into account
- system to be founded on granular fill placed and compacted in layers
- fill to be at least 50% of the derived foundation depth, and no more than 1.25 m deep (measured from ground level determined)
- granular material to extend by a distance equal to its natural angle of repose plus 500 mm, beyond the face of the raft.

4.7 The system can be used with timber-framed buildings or ICF walls where the design considerations and limitations defined in sections 4 and 6 of this Certificate are taken into account.

4.8 Services and drainage entries must be positioned and installed accurately; errors will be difficult to rectify after the concrete has been cast. Services should be sleeved, and future access must be provided for without affecting structural stability. Drainpipes require flexible connections or other means of accommodating differential settlement.

4.9 On sloping sites, the minimum length of the overlap and the maximum step height of the stepped foundation, must be in accordance with the requirements of BS 8103-1 : 2011, Section 6.5.3.

5 Practicability of installation

The system should only be installed by contractors who have been trained and approved by the Certificate holder.

6 Structural performance

6.1 Foundations incorporating the system should be designed by a suitably experienced and qualified engineer to the relevant sections of BS EN 1991-1-1 : 2002, BS EN 1992-1-1 : 2004 and BS EN 1997-1 : 2004, and their UK National Annexes, and TR34 4th edition March 2016.

6.2 The JACKODUR Atlas Corner, Side, Formwork and Surface Element contribute to the short- and long-term structural performance of the foundation by transferring the vertical design imposed and dead loads to the ground.

6.3 Tests for short- and long-term creep of the XPS grade 300, in accordance with BS EN 826 : 2013 and BS EN 1606 : 2013, indicate that the short- and long-term strain of the XPS will not exceed 2% if the pressure applied on the XPS 300 remains below 83 kPa.

6.4 The maximum short- and long-term modulus of subgrade reaction of the XPS 300 at SLS condition based on tests and calculations for different thicknesses of the XPS, are given in Table 3.

Table 3 Maximum short- and long-term modulus of subgrade reaction of the XPS 300 at SLS condition

Thickness (mm)	Short-term modulus of subgrade reaction ($N \cdot mm^{-2} \cdot mm^{-1}$)	Long-term modulus of subgrade reaction ($N \cdot mm^{-2} \cdot mm^{-1}$)
100	0.185	0.042
120	0.154	0.035
140	0.132	0.030
160	0.116	0.026
180	0.103	0.023
200	0.093	0.021
220	0.084	0.019
240	0.077	0.017
260	0.071	0.016
280	0.066	0.015
300	0.062	0.014
320	0.058	0.013

6.5 The maximum short- and long-term modulus of elasticity of the XPS 300 at SLS condition based on tests and calculations, is 21963 kPa and 4833 kPa respectively.

6.6 The imposed loads (UDL and concentrated loads) must be in accordance with BS EN 1991-1-1 : 2002 and its UK National Annex. The characteristic loads for the imposed loads, finishes and line (partition) loads for single-family dwellings are shown in Table 4 of this Certificate.

Table 4 Characteristic imposed, partition loads and finishes for raft foundation reinforced with steel reinforcement as specified in Table 2 of this Certificate

Description	Characteristic value of loads for single-family dwellings
Imposed UDL ($kN \cdot m^{-2}$)	1.5 (1)(3)
Imposed concentrated load (kN)	2.0 (1)(3)
Line load partition wall ($kN \cdot m^{-1}$)	1.0 (2)(3)
Allowance for moveable partition ($kN \cdot m^{-2}$)	0.5 (2)(3)
Finishes ($kN \cdot m^{-2}$)	0.5

(1) Concentrated loads of 2 kN must not be combined with the 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. Imposed concentrated loads of 2 kN must be applied to an area not less than 50 x 50 mm.

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

(3) The characteristic loads could be increased provided that a suitably experienced and qualified engineer checks the limits and the requirements noted in section 6.7 of this Certificate.

6.7 A suitably experienced and qualified engineer should perform a site-specific assessment as defined in section 4 of this Certificate and then carry out a structural analysis of the system using a design methodology based on the appropriate parts of the Eurocodes and TR34 4th Edition March 2016, taking into account the following:

- the variable actions (imposed, snow and wind load in accordance with BS EN 1991-1-1 : 2002, BS EN 1991-1-3 : 2003 and BS EN 1991-1-4 : 2005, and their UK National Annexes)
- the permanent actions in accordance with BS EN 1991-1-1 : 2002 and BS EN 1997-1 : 2004, and their UK National Annexes
- action during execution and accidental action in accordance with BS EN 1991-1-6 : 2005 and BS EN 1991-1-7 : 2006, and their UK National Annexes
- the maximum pressure applied on the XPS 300 at SLS(1) condition beneath the raft foundation (see Figure 2) must not exceed 83 kPa
- the total short- and long-term thickness reduction of the XPS at SLS(1) condition beneath the raft foundation must not exceed 2%
- the design stress on the XPS at ULS(2) beneath the raft foundation must not exceed 300/1.3 = 230 kPa where 1.3 is the partial material factor for the XPS grade 300
- the maximum pressure on the ground at SLS(3) condition must not exceed the allowable ground-bearing pressure
- the maximum sub soil settlement and the maximum relative rotation soil settlement must be in accordance with BS EN 1997-1 : 2004
- the maximum characteristic values of the imposed loads, line loads and finishes must be as defined in Table 4 of this Certificate
- the reinforcement required for the raft foundation including the area of reinforcement must be designed in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex, and TR34, 4th Edition March 2016
- for Finite Element Analysis (FEA), the modulus of subgrade reaction of the ground from the site soil investigation report must be used; and for the modulus of subgrade reaction of the XPS, the values defined in Table 3 of this Certificate must be used (see Figure 2 for example of raft foundation reinforced with steel mesh A393 obtained from FEA and in accordance with BS EN 1992-1-1 : 2004)
- particular attention must be paid in the design of structural raft foundation where there is an opening in the wall
- movement joints and, where necessary, day (construction) joints, must be provided. The joints must be designed as if they act as a hinge which transfers vertical shear but no moment. The shear capacity of dowel bars or plates must be designed in accordance with TR34.
- the failure mode due to sliding lightweight structures due to lateral loads

(1) For calculations of loads at SLS for XPS deformation, the quasi-permanent combination equation 6.16a must be used (refer to BS EN 1990 : 2002 and its UK National Annex).
(2) For calculations of loads at ULS, the equation 6.10, or the less favourable equations 6.10a and 6.10b, must be used (refer to BS EN 1990 : 2002 and its UK National Annex).
(3) For calculations of loads at SLS for ground bearing pressure, the characteristic combination equation 6.14a must be used (refer to BS EN 1990 : 2002 and its UK National Annex).

Additional notes

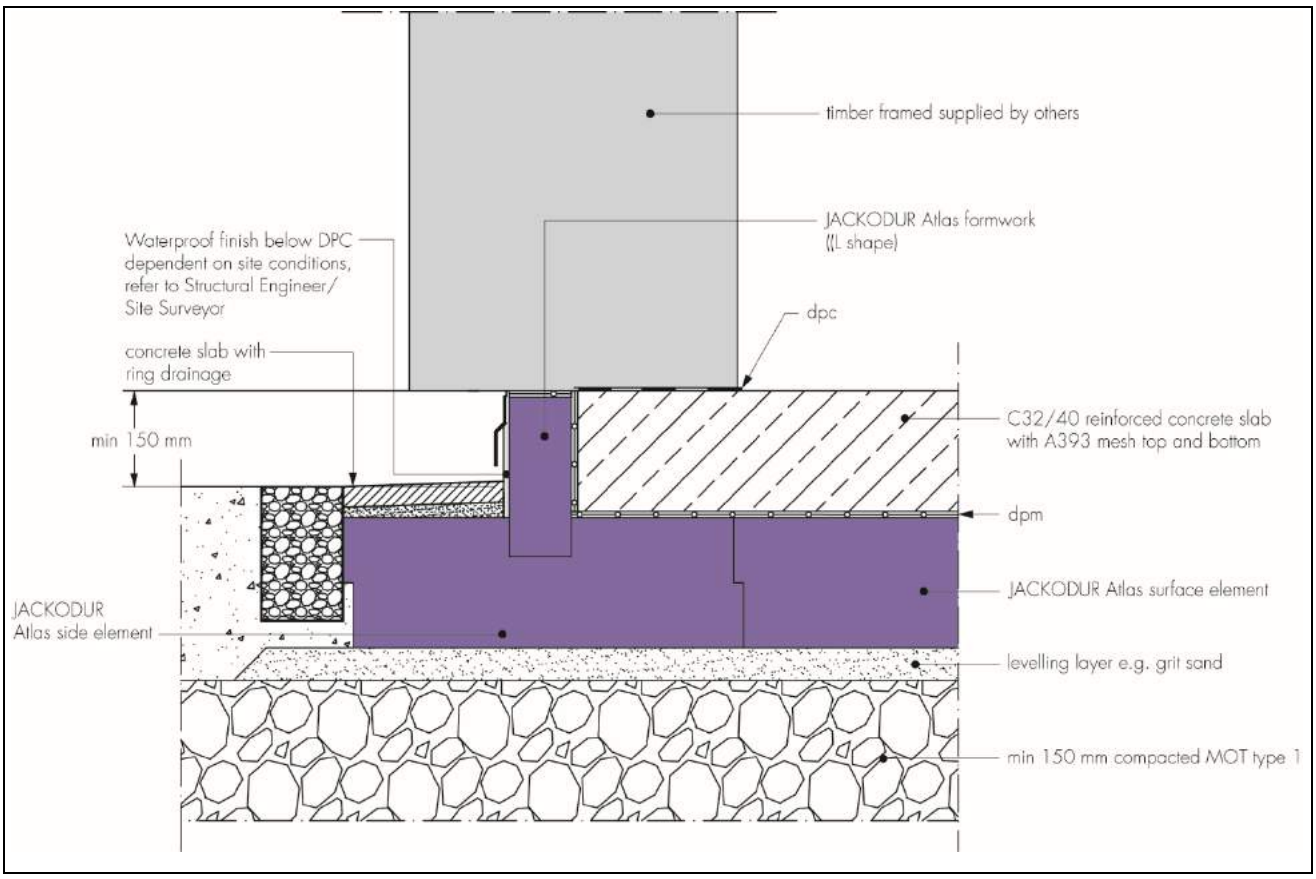
For quasi-permanent load combination, refer to equation 6.16a of BS EN 1990 : 2002.

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

6.8 The specification of the concrete and reinforcement must be as detailed in section 1.2.

6.9 The concrete must be in accordance with BS 8500-1 : 2015, BS 8500-2 : 2015 and BS EN 206 : 2013, manufactured in plants covered by the QSRMC or BSI scheme and laid by personnel with the appropriate skills and experience.

Figure 2 Example of raft foundation reinforced with steel mesh A393, with timber-framed wall and JACKODUR Atlas Formwork (rectangular shape)



7 Thermal performance

7.1 The overall floor U value will depend on the thickness of the insulation selected, the ratio of the exposed (and semi-exposed) floor perimeter length to floor area (p/a) and the ground conductivity. Each floor U value should be calculated to BS EN ISO 6946 : 2017, BS EN ISO 13370 : 2017 and BRE Report BR 443 : 2019, using the design thermal conductivities (λ_u) specified in Table 1 of this Certificate.

7.2 Example floor U values given in Table 5 indicate that the system can enable a floor to satisfy, or improve upon, the design floor U values in the documents supporting the national Building Regulations.

Table 5 Example floor U values (1)

Maximum P/A ratio ($m \cdot m^2$)	Target U value ($W \cdot m^{-2} \cdot K^{-1}$)					
	0.13	0.15	0.18	0.20	0.22	0.25
	Minimum insulation thickness (mm)					
0.20	160	120	100	100	100	100
0.40	220	180	140	120	100	100
0.60	240	200	160	140	120	100
0.80	240	200	160	140	120	100
1.00	240	200	160	140	140	120

(1) These calculations are in accordance with sections 7.1 and 7.2 and assume:
- 200 mm reinforced concrete slab with conductivity $\lambda = 2.5\ W \cdot m^{-1} \cdot K^{-1}$
- a 300 mm thick perimeter wall
- ground conductivity of $1.5\ W \cdot m^{-1} \cdot K^{-1}$

Junction ψ values

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

7.4 The junction Psi-values given in Table 6 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 : 2016, 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 6 Ground floor junction Psi Ψ values

Junction type	Ψ-value ($Wm^{-1}·K^{-1}$)
External wall	0.32(1)
Party wall	0.16(1)

(1) Conservative defaults from SAP 2012.

8 Condensation

Interstitial condensation

8.1 A dpm must always be installed above the insulation as shown in Figure 2. In accordance with the guidance in BS 5250 : 2011, Section F.4, the dpm will act as an effective vcl in this position and limit the risk of interstitial condensation.

Surface condensation

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

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

9 Maintenance

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

10 Durability

10.1 The XPS components, if protected in service from organic solvents and substances liable to cause deterioration, will be effective as insulation for a service life in excess of 60 years.

10.2 The concrete reinforced with steel mesh will have adequate durability for exposure class XC1 for internal concrete foundations and class XC3 for the external edge concrete beam, provided that the nominal cover to the steel, the specification of the concrete and the steel reinforcement are as specified in this Certificate.

11 Reuse and recyclability

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

12 General

12.1 Before site preparation, certain investigations must be made, and information supplied by the developer to all parties, including (also see section 4.3):

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

12.2 The Certificate holder will supply:

- design documents incorporating:
  - specification for the concrete raft foundation including details of construction joints, if required, and specification of the XPS
  - details of steel mesh reinforcement
- list of all XPS components required
- copy of all 'approved for construction' drawings including details.

12.3 Where a gas membrane is required (outside the scope of this Certificate), it must be laid and sealed in, and take into account the ventilation requirements.

12.4 Drainage and service ducting are installed in accordance with the building design.

12.5 In areas where the soil may be affected by shrinkage or tree or shrub growth, additional hardcore layers may need to be placed.

12.6 Details of typical assemblies for external ICF and internal block work wall are shown in Figures 3 and 4.

Figure 3 Example of Insulated Concrete Form (ICF) with JACKODUR Atlas Formwork (L shape)

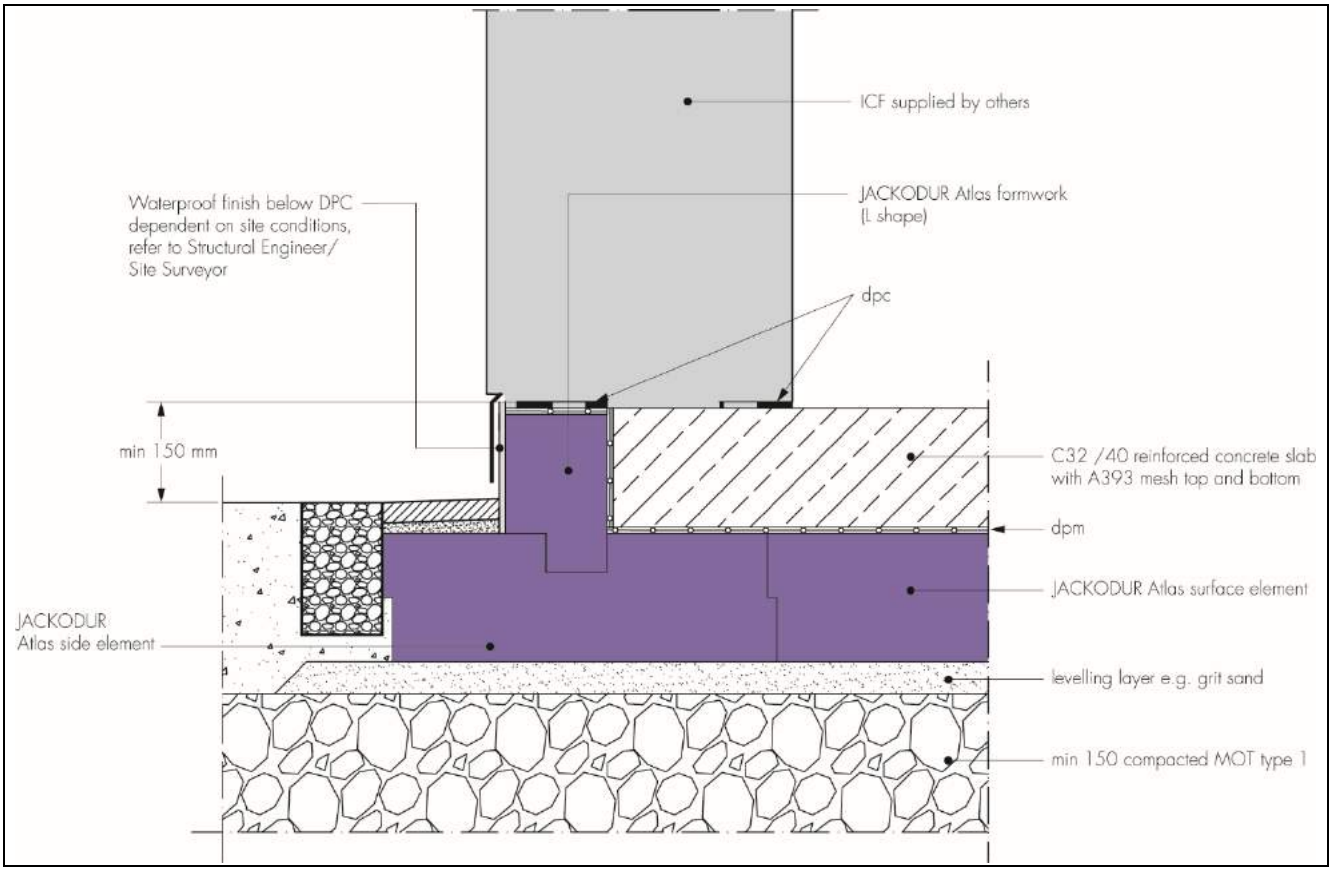
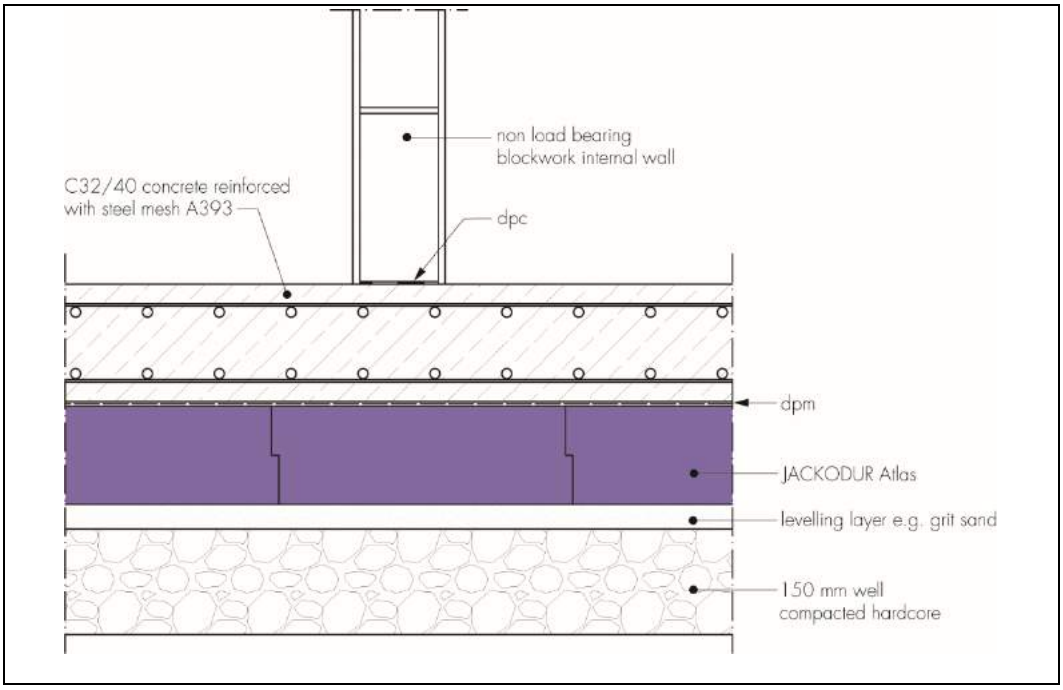


Figure 4 Example of Internal block work wall



13 Site preparation

13.1 The area should be excavated to a depth of 600 mm below the projected top level of the slab, ensuring all topsoil, degradable material and soft spots are removed; additional fill may be required to compensate.

13.2 On relatively level sites, the setting out should be undertaken using normal procedures, ensuring that the lines of external and internal beams are accurately placed in accordance with the Certificate holder's construction drawings. On steeply sloping sites, special provisions may need to be made; the advice of the Certificate holder should be sought.

14 Procedure

14.1 To avoid any risk of frost heave, the granular hardcore (150 mm) is placed and compacted as per the requirements of the *MCHW*, Volume 1, Series 800, and in order to satisfy the level tolerance of ± 10 mm over 5 m. Any provision for service pipes, services and drains is made at this stage.

14.2 If the hardcore is frost susceptible or if the maximum local depth of frost penetration is not reached, frost insulation according to BS EN ISO 13793 : 2001 is installed.

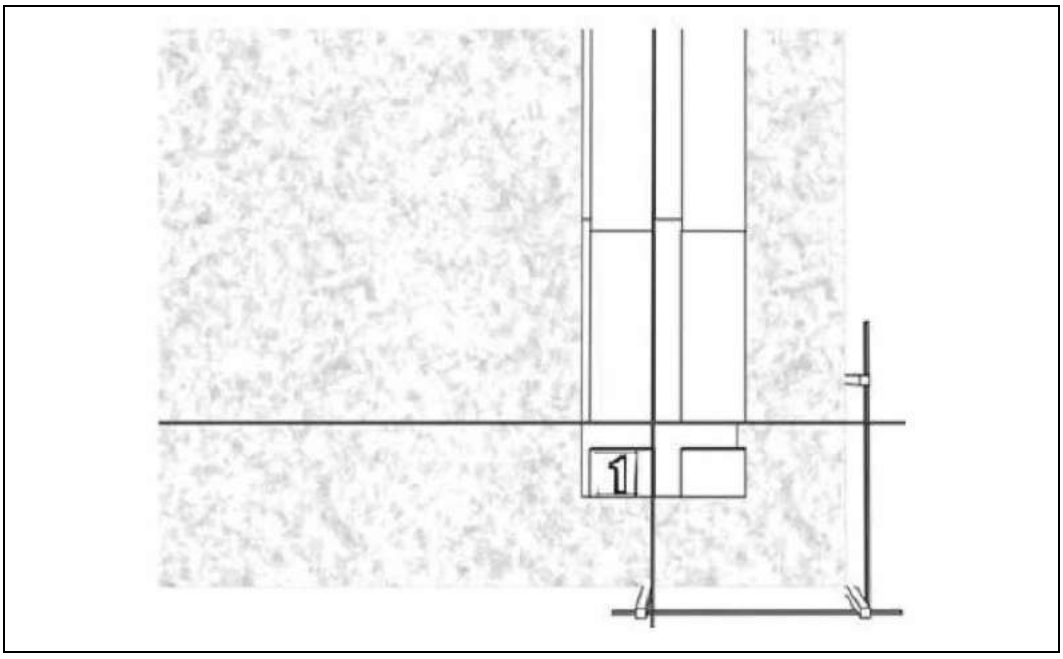
14.3 A levelling layer under the insulation of grit sand (2/5 mm, 4/8 mm) is placed. The thickness of levelling layer is 50 mm and it must be laid approximately 400 mm wider than the outer edge of the raft foundation. The tolerance for the levelling layer is ± 10 mm on 5 m length. It is recommended that batter boards for setting out should be erected at a distance of about 800 mm from the outer edge of the floor slab (see Figure 5).

Installation of side and corner elements

14.4 The installation plan provided by the Certificate holder shows at which corner to begin the installation. All elements must be installed as shown in the installation plan.

14.5 The side elements are installed in the direction of the first installation row and thereafter the installation is continued in the direction of the second installation row, and so on until the edge is completed.

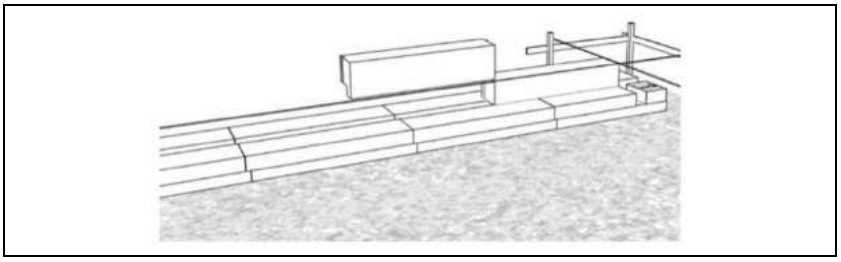
Figure 5 Installation of JACKODUR Atlas Side Element using batter boards



Installation of formworks elements

14.6 The formwork elements are inserted progressively into the groove of the side elements with joints offset, until the next corner element is reached. The formwork elements must be cut with a handsaw or a hot wire cut to the required length (see Figure 6).

Figure 6 Installation of JACKODUR Atlas Corner and Side Elements boards



Installation of surface elements

14.7 The surface elements are installed according to the installation plan in the direction of 'third area installation' (see Figure 7) until the floor is completed. See Figure 8 for interlocking the JACKODUR Atlas Side, Formwork and Standard Elements to each other.

Figure 7 Installation of JACKODUR Surface Area Elements

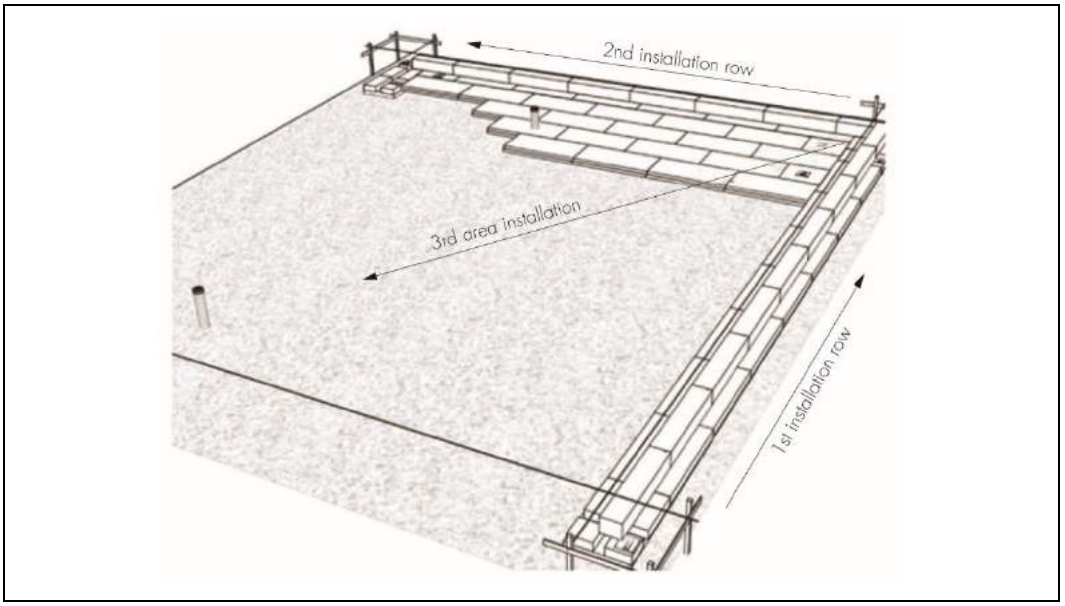
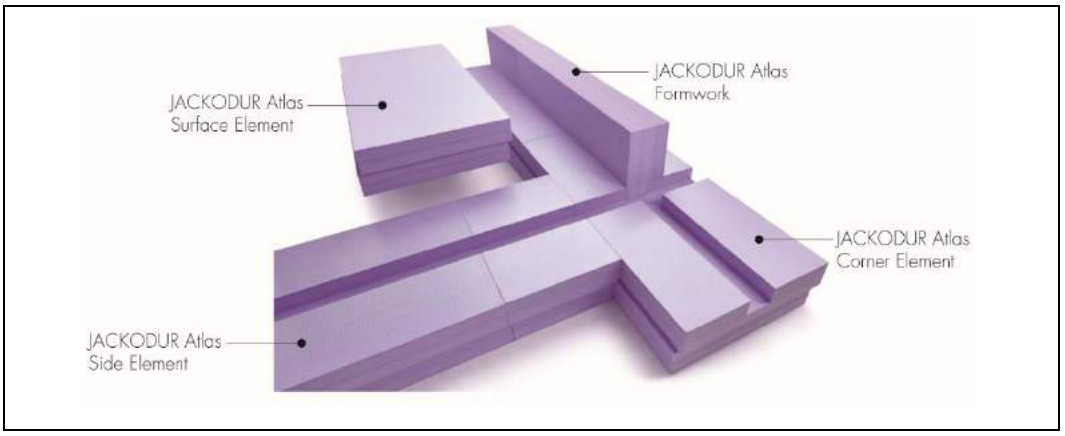


Figure 8 Interlocking JACKODUR Atlas Side, Formwork, Corner and Surface Elements



Penetrations

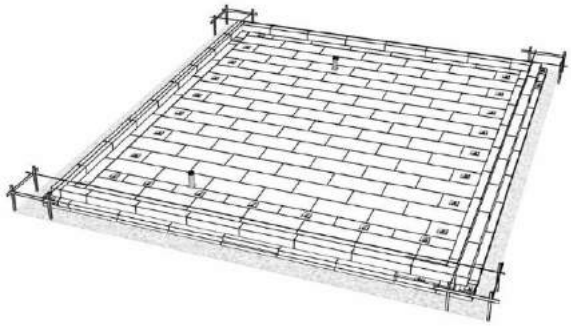
14.8 The required penetrations (drainage line, conduits, ventilation ducts, etc) must be notched to size on site with a handsaw or portable jigsaw. JACKODUR perimeter adhesive is used to seal off penetrations and open joints in the insulation layer (see Figure 9).

Figure 9 Installation of penetrations

After installation of XPS boards

14.9 A separation layer (eg PE film with a minimal thickness of 0.15 mm over the thermal insulation boards) is laid with overlapping, and all joints are taped (see Figure 10).

Figure 10 Laying a separation layer over the insulation boards



Placing steel reinforcement

14.10 Steel reinforcement (as specified) must be laid, and spacers should be positioned over spreader plates. These should be installed so as to position the steel at the correct level.

Placing concrete

14.11 Concrete should always be supplied by a ready-mix plant approved by the Certificate holder.

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

- cube compressive strength and slump tests for concrete carried out
- limitation of consistency class for standard concrete
- concrete not to be poured below 5°C
- maximum temperature at which the concrete should be placed is 30°C and decreasing
- concrete not to be poured during rainfall
- all raw materials added at the plant mixer.

14.13 To prevent shrinkage cracks:

- an aspect ratio greater than 1.5:1 should be avoided
- the use of high-shrinkage-potential aggregate should be avoided
- the water/cement (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.

15 Tests

Tests were conducted to assess:

- dimensional accuracy
- thermal conductivity (λ_D values)
- the compressive strength of the XPS in accordance with BS EN 826 : 2013
- the compressive creep of the XPS in accordance with BS EN 1606 : 2013.

16 Investigations

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

- the adequacy of concrete raft foundation reinforced with steel mesh reinforcement in accordance with BS EN 1992-1-1 : 2004 and its UK National Annex, and TR34 4th Edition March 2016
- the adequacy of the compressive stress of 83 kPa to ensure the short- and long-term thickness reduction of the XPS boards remain within the acceptable limit of 2% after 60 years
- 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 example floor U values calculated to BS EN ISO 13370 : 2017.

16.3 The risk of condensation was determined in accordance with BS 5250 : 2011.

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

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17 Conditions

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- 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
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- 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.

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