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BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

Agrément Certificate
07/4482
Product Sheet 1

ICF TECH HIGH PERFORMANCE WALL SYSTEM

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to the ICF Tech High Performance Wall System, for use in the formation of loadbearing and non-loadbearing internal or external and separating walls in dwellings and in buildings of similar occupancy.

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 aspects — the system components have adequate strength to resist the loads associated with installation loading (see section 5).

Thermal insulation — the system contributes to the overall thermal performance of the wall construction (see section 6).

Condensation — walls, openings and junctions with other elements will adequately limit the risk of surface condensation (see section 7).

Behaviour in relation to fire — the concrete walls formed from the system provide fire resistance when designed in accordance with BS 8110-2 : 1985 (see section 8).

Sound insulation — separating and internal walls with a minimum concrete core density and detailing stated in this Certificate will provide sufficient sound resistance (see section 13).

Durability — The system components are durable (see section 15).

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 Second issue: 29 January 2009
Originally certificated on 8 May 2008

Brian Chamberlain
Head of Approvals — Engineering

Greg Cooper
Chief Executive

Certificate amended on 11 September 2013 to include change of address and contact details.

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

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

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Regulations

In the opinion of the BBA, the ICF Tech High Performance Wall System, 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 Building Regulations 2000 (as amended) (England and Wales)

Requirement:	A1	Loading
Requirement:	A2	Ground movement
Requirement:	A3	Disproportionate collapse
Comment:		Walls will have adequate strength and stiffness to satisfy these Requirements. See sections 5.1 to 5.3, 5.9 and 5.10 of this Certificate.
Requirement:	B3(1)(2)(3)	Internal fire spread (structure)
Comment:		Walls can meet this Requirement. See sections 8.1 to 8.6 of this Certificate.
Requirement:	C2(a)	Resistance to moisture
Comment:		Walls can adequately limit the risk of moisture ingress from the ground. See sections 10.1 and 10.2 of this Certificate.
Requirement:	C2(b)	Resistance to moisture
Comment:		Walls can adequately limit the risk of moisture penetration from precipitation and wind-driven spray. See sections 9, 10.1 and 10.2 of this Certificate.
Requirement:	C2(c)	Resistance to moisture
Comment:		Walls can adequately limit the risk of surface condensation and contribute to minimising the risk of interstitial condensation. See sections 7.1 and 7.2 of this Certificate.
Requirement:	E1	Protection against sound from other parts of the building and adjoining buildings
Requirement:	E2(a)	Protection against sound within a dwelling-house etc
Comment:		Walls can adequately meet these Requirements. See sections 13.1 to 13.3 of this Certificate.
Requirement:	L1(a)(i)	Conservation of fuel and power
Comment:		Walls can contribute to limiting heat loss within a dwelling. See sections 6.4, 6.6, 6.7, 12.1 and 12.2 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The system is acceptable. See sections 15.1 and 15.2 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 system can contribute to a construction meeting this Regulation. See sections 14, 15.1 and 15.2 and the *Installation* part of this Certificate.
Regulation:	9	Building standards — construction
Standard:	1.1(a)(b)	Structure
Standard:	1.2	Disproportionate collapse
Comment:		Walls will have adequate strength and stiffness to satisfy these Standards, with reference to clause 1.1.1[1][2] and, when suitably reinforced, clause 1.2.1[1][2]. See sections 5.2, 5.3, 5.9 and 5.10 of this Certificate.
Standard:	2.1	Compartmentation
Comment:		Walls can satisfy the short, medium or long fire-resistance durations required by this Standard, with reference to clauses 2.1.2[2], 2.1.3[2], 2.1.5[2], 2.1.9[2], 2.1.10[2], 2.1.11[2], 2.1.12[2], 2.1.13[2] and 2.1.14[2]. Openings in walls can maintain the fire-resistance durations, with reference to clause 2.1.16[2]. See section 8.1 of this Certificate. Junctions between walls can maintain the required fire-resistance durations, with reference to clause 2.1.16[2]. See section 8.1 of this Certificate. The expanded polystyrene component of the wall would be classified as combustible, however, the completed wall can satisfy the required durations of fire resistance, with reference to clause 2.1.3[2]. See sections 8.1 to 8.4 and 8.6 of this Certificate.
Standard:	2.2	Separation
Comment:		Walls can satisfy the short, medium or long fire-resistance durations required by this Standard, with reference to clauses 2.2.1[1], 2.2.2[1][2]. 2.2.3[1][2], 2.2.5[1][2] and 2.2.8[1]. Junctions between walls can maintain the required fire-resistance durations, with reference to clauses 2.2.7[2] and 2.2.10[1]. See section 8.1 of this Certificate. The expanded polystyrene component of the wall would be classified as combustible, however, the completed wall can satisfy the required durations of fire resistance, with reference to clauses 2.2.4[2], and 2.2.7[1]. See sections 8.1 to 8.4 and 8.6 of this Certificate.
Standard:	2.3	Structural protection
Comment:		Walls can satisfy the short, medium or long fire-resistance durations required by this Standard, with reference to clauses 2.3.1[1][2] and 2.3.3[1][2]. Junctions between walls can maintain the required fire-resistance durations, with reference to clauses 2.3.2[1] and 2.3.5[1][2]. See section 8.1 of this Certificate.
Standard:	2.4	Cavities
Comment:		To limit the risk of fire spread by way of EPS formwork, detailing should address the need for sealing cavities in fire-resistant materials at junctions and edges of openings. Fire barriers should completely seal the cavity and be chased into the outer EPS formwork, with reference to clauses 2.4.1[1][2] to 2.4.7[1][2], 2.4.8[2] and 2.4.9[2]. See section 8.6 of this Certificate.
Standard:	2.5	Internal linings
Comment:		Walls can satisfy the reaction to fire required by this Standard, with reference to clause 2.5.1[1][2], provided the system is used in conjunction with suitable materials. See section 8.3 of this Certificate.

Standard:	2.7	Spread on external walls
Comment:		Walls can satisfy the reaction to fire required by this Standard, with reference to clause 2.7.1[1][2], provided the system is used in conjunction with suitable materials. See section 8.4 of this Certificate.
Standard:	3.4	Moisture from the ground
Comment:		Walls can satisfy this Standard, with reference to clauses 3.4.1[2] and 3.4.5[1]. See sections 10.1 and 10.2 of this Certificate.
Standard:	3.10	Precipitation
Comment:		Walls can adequately limit the risk of moisture penetration from precipitation, with reference to clause 3.10.2[1][2]. See section 9 of this Certificate.
Standard:	3.15	Condensation
Comment:		Walls can adequately minimise the risk of surface condensation, with reference to clauses 3.15.1[1] and 3.15.4[1]. See section 11.1 of this Certificate. Walls can contribute to minimising the risk of interstitial condensation, with reference to clauses 3.15.1[1] and 3.15.5[1]. See sections 7.1 and 7.2 of this Certificate.
Standard:	5.1	Resisting sound transmission to dwellings using appropriate constructions
Comment:		Separating walls satisfy this Standard, with reference to clauses 5.1.1[1], 5.1.2[1] and 5.1.6[1]. See sections 13.1 to 13.3 of this Certificate.
Standard:	6.1(b)	Carbon dioxide emissions
Standard:	6.2	Building insulation envelope
Comment:		The system will enable, or contribute to enabling, a wall to meet these Standards, with reference to clauses 6.1.1[1][2], 6.1.4[1], 6.1.5[1], 6.2.1[1][2], 6.2.3[1], 6.2.4[1][2] and 6.2.5[2]. See sections 6.5 to 6.7 of this Certificate.
		(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 system is acceptable. See sections 15.1 and 15.2 and the *Installation* part of this Certificate.
Regulation:	B3(2)	Suitability of certain materials
Comment:		The system is acceptable. See section 14 of this Certificate.
Regulation:	C4	Resistance to ground moisture and weather
Comment:		Walls can adequately limit the risk of moisture ingress from the ground and weather. See sections 9, 10.1 and 10.2 of this Certificate.
Regulation:	C5	Condensation
Comment:		Walls can contribute to minimising the risk of interstitial condensation. See section 7.2 of this Certificate.
Regulation:	D1	Stability
Comment:		Walls will have adequate strength and stiffness to satisfy this Regulation. See sections 5.2, 5.3, 5.9 and 5.10 of this Certificate.
Regulation:	D2	Disproportionate collapse
Comment:		Walls, when suitably reinforced, will have adequate strength and stiffness to satisfy this Regulation. See sections 5.2, 5.3, 5.9 and 5.10 of this Certificate.
Regulation:	E4	Internal fire spread — Structure
Comment:		Walls can satisfy this Regulation. See sections 8.1 to 8.4 and 8.6 of this Certificate.
Regulation:	F2(a)(i)	Conservation measures
Regulation:	F3	Target carbon dioxide Emissions Rate
Comment:		The system will enable or contribute to enabling, a wall to satisfy these Regulations. See sections 6.4, 6.6 and 6.7 of this Certificate.
Regulation:	G2	Separating walls and separating floors
Comment:		Separating walls can satisfy this Regulation. See sections 8.1 to 8.4 and 8.6 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: 4 *Practicability of installation* (4.1 and 4.2) and 16 *General* (16.1 to 16.5).

Non-regulatory Information

NHBC Standards 2008

NHBC accepts the use of the ICF Tech High Performance Wall System when installed and used in accordance with this Certificate, in relation to *NHBC Standards*, Chapters 2.1 *Concrete and its reinforcement* and 5.1 *Substructure and ground bearing floors*.

Zurich Building Guarantee Technical Manual 2007

In the opinion of the BBA, the ICF Tech High Performance Wall System, when installed and used in accordance with this Certificate, satisfies the requirements of the *Zurich Building Guarantee Technical Manual*, Section 3 *Substructure*, Sub-section *Basements* (pages 101 to 107) and Section 4 *Superstructure*, Sub-section *External walls — thermal insulation* (pages 162 to 171 for thermal aspects).

General

The ICF Tech High Performance Wall System is for use in loadbearing and non-loadbearing internal or external and separating walls in dwellings and in buildings of similar occupancy.

The system provides permanent formwork for in-situ dense aggregate concrete walls and contributes to the thermal insulation of the finished construction.

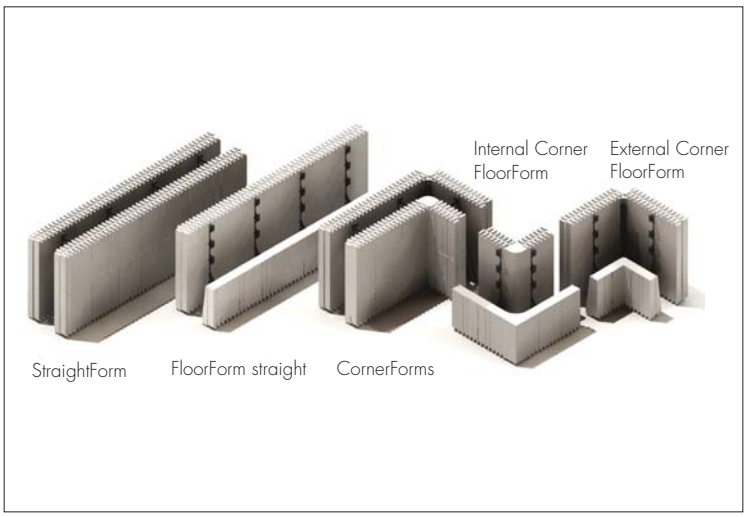
Subject to design and supervision by a Chartered Engineer, the system may be used for constructing basement walls.

Technical Specification

1 Description

1.1 The ICF Tech High Performance Wall System comprises two expanded polystyrene panels (EPS) separated by polypropylene webs at 300 mm centres. The EPS is formed around the web during the moulding process. Top edges of the spacers are moulded to support and lock-in horizontal reinforcing bars where required. Vertical reinforcement is secured to horizontal reinforcement at the required centres. Each EPS element interlocks and builds, horizontally and vertically, into a tight, rigid formwork (see Figure 1). The wall is formed by placing or pouring concrete into the formwork.

Figure 1 Components



1.2 The EPS elements are flame-retardant, interlock at top and bottom (flush fit to sides) and are available in a single grade of density 30 kgm^{-3} with a shear strength(1) from 190 kPa to 240 kPa and flexural strength(2) from 410 kPa to 470 kPa. Two types are available: HouseForm with a 100 mm wide concrete core and 75 mm thick EPS skins and WallForm 150 mm wide and 75 mm thick respectively. The overall height of the elements is 460 mm (450 mm when joined together).

(1) Measured in accordance with DIN 53427 : 1986.

(2) Measured in accordance with DIN EN 12089 : 1997.

1.3 The formwork components are detailed in Table 1.

Table 1 Components

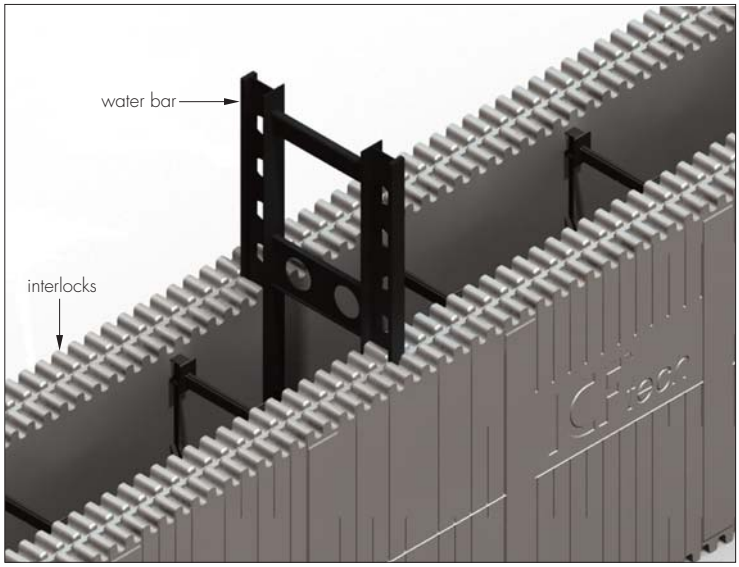
Part number	Description	Core size (mm	Colour/material
SF100	StraightForm 100	100	White/EPS
FF100	FloorForm 100	100	White/EPS
SF150	StraightForm 150	150	White/EPS
FF150	FloorForm 150	150	White/EPS
CF100	CornerForm 100	100	White/EPS
CF150	CornerForm 150	150	White/EPS
FFIC100	Internal Corner FloorForm	100	White/EPS
FFEC100	External Corner FloorForm	100	White/EPS
FFIC150	Internal Corner Floo Form	150	White/EPS
FFEC150	External Corner FloorForm	150	White/EPS
DIRP	Double Interlock Raising Piece	–	White/EPS
SIRP	Single Interlock Raising Piece	–	White/EPS
DIRPIC	Double Interlock Raising Piece Internal Corner	–	White/EPS
DIRPEC	Double Interlock Raising Piece External Corner	–	White/EPS
SIRPIC	Single Interlock Raising Piece Internal Corner	–	White/EPS
SIRPEC	Single Interlock Raising Piece External Corner	–	White/EPS

1.4 Polypropylene web spacers — nominally 3.5 mm thick, black in colour, embedded 60 mm into the inner surface of each element and spanning between them. A 40 mm wide recessed fastening flange forming the outer part of each web runs from top to bottom of the EPS skin. The flange can be used for fixings for internal finishes (eg plasterboard directly fixed or via battens). Wall ties for brickwork and heavier loads require fixings to be embedded into the concrete core. The location of the web flanges are indicated on internal and external surfaces of the formwork by wider bands at 300 mm centres.

1.5 The EPS element skins have a nominal density of 30 kgm^{-3} and a nominal thickness of 75 mm.

1.6 Upper and lower surfaces interlock and the vertical mating surfaces are smooth to form a flush fit when joined together (see Figure 2). The interlocking design of the horizontal joints allows the elements to be reversible and resists concrete slurry seepage through the horizontal joints. In vertical joints, a proprietary water bar is inserted during assembly of the wall to resist slurry seepage.

Figure 2 Method of jointing (perpendicular)



1.7 Elements are dry laid in brick-bond formation. The surfaces are grooved vertically at 25 mm centres. The formwork requires support during concrete filling.

1.8 Concrete, typically strength class C35 for basement work and C25 elsewhere, is specified to BS EN 206-1 : 2000. The recommended aggregate size is 10 mm. It should contain an admixture complying with BS EN 934-2 : 2001 or BS EN 480-1 : 2006 to allow placement by free flow only. Specific concrete mixes are dependent on individual requirements and are outside the scope of this Certificate. The Certificate holder does not recommend the use of vibrating equipment or rodding.

1.9 Components and finishes specified for use with the system by the Certificate holder and covered by this Certificate are:

- moulded PVC form closer
- moulded PVC polypropylene rebar cradle
- extruded PVC FormLock channel
- extruded PVC water bar.

1.10 Components and finishes specified for use with the system by the Certificate holder but not assessed or covered by this Certificate are:

- steel reinforcement — where required, should comply with BS 4449 : 2005
- external masonry — may be of brickwork or stonework fixed in accordance with the provisions of BS 5628-3 : 2005 or BS 8298 : 1994 respectively
- external render — in accordance with BS EN 13914-1 : 2005 and suitable for use with the system
- acrylic render — suitable acrylic render products for use with the system
- brick or stone slips — the Certificate holder's advice should be sought
- internal finish — typically 12.5 mm thick plasterboard or a dry-lined finish with or without a plaster skim coat conforming to BS 8212 : 1995
- brickwork/stonework ties to BS EN 845-1 : 2003
- bracing and alignment support system as supplied by the Certificate holder
- basement waterproofing membrane (see section 10.2).

Quality controls

1.11 System components are brought in to agreed specifications or in accordance with British or European Standards and/or current Agrément Certificates.

1.12 Quality checks are made during the moulding process and on the finished components.

2 Delivery and site handling

2.1 Good site practice should be observed to prevent damage to the components.

2.2 The system components are supplied shrunkwrapped — the wrapping should not be opened until the contents are required.

2.3 EPS components should be stored on their sides to protect toothed edges from damage.

2.4 Care must be taken when handling the EPS components to avoid damage and contact with solvents or materials containing volatile organic components such as newly treated timber. The elements must not be exposed to open flame or other ignition sources.

Assessment and Technical Investigations

The following is a summary of the assessment and technical investigations carried out on the ICF Tech High Performance Wall System.

Design Considerations

3 Use

3.1 The ICF Tech High Performance Wall System is for use in loadbearing and non-loadbearing internal or external and separating walls in commercial or domestic construction.

3.2 The system provides permanent formwork for in-situ dense aggregate concrete walls and contributes to the thermal insulation of the finished construction.

3.3 It is for use with the internal and external finishes specified in this Certificate.

3.4 Subject to design and supervision by a Chartered Civil or Structural Engineer, the formwork may be used for constructing basement walls.

4 Practicability of installation

4.1 Installation of the formwork should be carried out by trained operatives, including the forming of door and window openings using the PVC form closers. The panels can be cut using conventional wood saws or hot wire tools.

4.2 Concrete is generally placed by pump using concrete from batching plant. Small volumes can also be placed by hand, skip with adapted neck or pump, if necessary. The requirements given in sections 16.5 to 16.7 must be observed during placing and compacting of the concrete.

4.3 Suitably durable and mechanically adequate fixings must be used for all structural elements or support brackets and must be post-drilled or cast into the concrete core. The EPS forming each of the system components must not be used as a structural medium although fixing/spacer flanges as described in section 1.4 can be used. In specifying wall fixings carrying vertical loads, consideration should be given to the effect of bending between the face of the concrete core and outer edge of the EPS.

4.4 Consideration should be given at the design stage to the incorporation of wall fixings, support brackets, service entry points, ducting, pipework and other building elements, to minimise post construction cutting out or chasing of the concrete core. Other detailing can also be incorporated in the construction of the formwork subject to the Certificate holder's recommendations. In carrying out any cutting or modifications to the system care must be taken not to damage or weaken the formwork elements that could result in the loss of integrity or overall stability of the temporary construction. Cold bridging effects must also be considered where any services pass through the wall construction.

4.5 Minor repairs to the system can be carried out prior to concrete pouring using expanding foam to reduce leakage of wet concrete and maintain the thermal integrity of the EPS.

5 Structural aspects

General

5.1 The system is satisfactory for use in loadbearing and non-loadbearing walls as permanent formwork for in-situ dense aggregate concrete.

5.2 Structures subject to the national Building Regulations incorporating the system should be designed to the relevant sections of BS 8007 :1987, BS 8102 : 1990, BS 8110-1 : 1997, BS EN 1992-1-1 : 2004 and BS EN 1992-1-2 : 2004.

5.3 Other buildings not subject to any of the Regulations defined in section 5.2 should also be built in accordance with BS 8110-1 : 1997 and BS 8110-2 : 1985, BS EN 1992-1-1 : 2004 and BS EN 1992-1-2 : 2004.

5.4 The concrete is not easily examined after casting, hence, as specified in BS 8110-1 : 1997, Section 2, care must be taken to ensure full compaction. Compaction is best checked by removal of a section of EPS panel, observation and then replacement. Particular attention should be given to basement walls and areas adjacent to formed openings. Voids may be detected during the concrete placement, by hitting the EPS panels (eg with the palm of

the hand or a wooden mallet) and listening for a 'hollow' sound, otherwise concrete cores can be taken once concrete has reached initial design strength. Suitable supervision must be provided during placing and compacting of the concrete. The use of self-compacting concrete (SCC) is recommended by the Certificate holder but care must be taken to control the water content to ensure segregation of the mix does not occur.

5.5 Storey-height concrete walls are normally constructed in one continuous pour, progressing around the perimeter of the building in pour heights of from 1 m to 1.2 m using free-flowing, pumpable concrete mixes. Particular care is necessary to maintain alignment during concrete filling, and checking between pours. Propping systems used in conjunction with the system must be checked prior to and during concreting filling to ensure stability and alignment is maintained.

5.6 Small diameter poker vibrators may be used, with care, for the compaction of wet concrete, other than SCC.

5.7 When used for basement or retaining wall construction, an external waterproofing membrane should generally be employed ensuring correct detailing and jointing methods to manufacturer's instructions (see Figure 3) and in accordance with the *ICF Tech High Performance Wall System Installation Manual*.

5.8 Timber weatherboarding and hung tiles should be fixed to treated battens screwed into the concrete core and in accordance with the *ICF Tech High Performance Wall System Installation Manual*.

Figure 3 Typical basement detail with external waterproofing membrane

Strength and stability

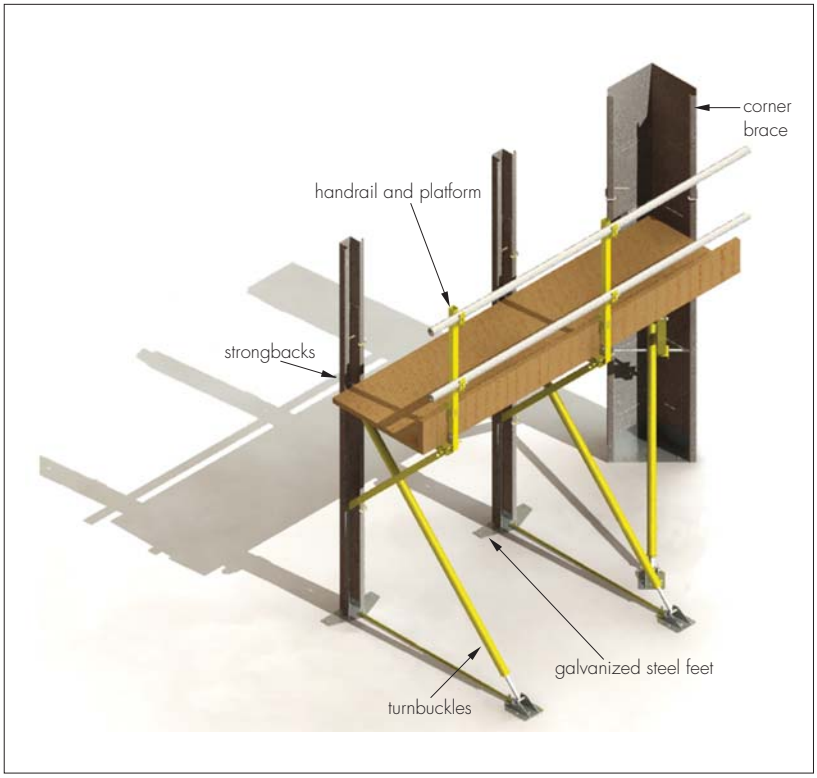
5.9 Walls constructed using the system may be treated as conventional plain or reinforced concrete walls and should be designed in accordance with BS 8110-1 : 1997, BS 8110-2 : 1985 or BS EN 1992-1-1 : 2004 and BS EN 1992-1-2 : 2004. Particular attention should be made to the use of the type of concrete mix to ensure segregation does not occur and the wet concrete is allowed to flow freely around formed openings and through congested areas of reinforcement, particularly when the system is used in basement construction. The Certificate holder is able to provide suitable design mixes on request.

5.10 The nominal concrete cover to reinforcement should be that appropriate to 'mild' exposure in accordance with BS 8110-1 : 1997, Tables 3.2 and 3.4, or as required for fire resistance in accordance with section 8.1, whichever is the greater. Alternatively, the recommendations given in BS EN 1992-1-2 : 2004 may be adopted.

5.11 To achieve structurally stable formwork during the construction process, the system must be braced sufficiently to resist the loads imparted on the system by the wet concrete and other construction loads. The Certificate holder supplies a propping system (see Figure 4) designed to give lateral support during the pouring of the concrete and post pouring stage. The system also provides a platform access for operatives and includes screw props for adjustment purposes both prior to and immediately following pouring operations.

5.12 Attention is drawn to the need for accurate levelling of the foundation and initial setting out of the propping (see sections 16.2, 16.4 and 16.5) which should prevent the need for significant adjustments to be made.

Figure 4 Propping/support system



6 Thermal insulation

6.1 Calculations of the thermal transmittance (U value) of a specific wall construction should be carried out in accordance with BS EN ISO 6946 : 2007 and BRE report (BR 443 : 2006) *Conventions for U-value calculations*, using the estimated thermal conductivity lambda ($\lambda_{90/90}$ *value*) of 0.037 $Wm^{-1}K^{-1}$ for the EPS insulation. The U value of a typical wall construction will depend on the finish and the number and type of fixings used.

6.2 As an example, using the Certificate holder's preferred construction comprising (external to internal) an 8 mm thick render, the ICF Tech system (100 mm or 150 mm thick concrete sandwich), with a 13 mm thick plasterboard bonded directly to the ICF (using adhesive 'dot and dab') achieved a U value of 0.22 $Wm^{-2}K^{-1}$. Other wall constructions that require internal or external finishes to be fixed into either the spacers or concrete core will increase the thermal transmittance, as will chasing into the EPS for services. Therefore, for other constructions, specific thermal calculations will need to be carried out in accordance with BS EN ISO 6946 : 2007 to determine U values.

6.3 Under the national Building Regulations, the system performs thus:

England and Wales and Northern Ireland

6.4 Walls are better than the U value specified for a wall in a 'notional' building in SAP 2005 *The Government's Standard Assessment Procedure for Energy Rating of Dwellings*, Appendix R, Table R1, or the Simplified Building Energy Model (SBEM). Therefore, the system can contribute to enabling a building to meet the Target CO_2 Emission Rate (TER) as specified in Approved Documents L1A and L2A and Technical Booklets F1 and F2 respectively.

Scotland

6.5 Walls containing the system can satisfy the Limit U values specified in the Technical Handbooks, clause 6.2.1. Therefore, the system can contribute to enabling a building to meet its TER or it can meet the U values of the simplified approach given in the Domestic Handbook, clause 6.1.2 (see Table 2).

6.6 The system can maintain, or contribute to maintaining, continuity of thermal insulation at junctions between the wall and other building elements. Guidance in this respect, and on limiting heat loss by air infiltration, can be found in:

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

Scotland — Accredited Construction Details (Scotland)

Northern Ireland — Accredited Construction Details (version 1.0).

Table 2 Requirements of the national Building Regulations

Area/use	U value ($Wm^{-2}K^{-1}$)	
	Limit area weighted	Simplified approach limit
England and Wales/Domestic[1]	0.35	N/A
England and Wales/Non-Domestic[2]	0.35	N/A
Scotland/Domestic	0.30	0.25 (options 1–5) or 0.20 (option 6)
Scotland/Non-Domestic	0.30	N/A
Northern Ireland/Domestic[3]	0.35[4]	N/A
Northern Ireland/Non-Domestic[5]	0.35[4]	N/A

(1) Approved Document L1A.
(2) Approved Document L2A.
(3) Technical Booklet F1.
(4) For replacement elements in existing buildings, refer to Technical Booklets F1, Table 3.2 (domestic), and F2, Table 3.3 (non-domestic).
(5) Technical Booklet F2.

6.7 The system can maintain, or contribute to maintaining, continuity of thermal insulation at junctions between wall and other building elements. The guidance given in BRE report (BR 262 : 2002) *Thermal insulation: avoiding risks* is acceptable.

7 Condensation

Surface condensation

7.1 External walls will adequately limit the risk of surface condensation. Openings in walls and junctions with other elements, designed in accordance with the relevant guidance given in section 10, will also be acceptable.

Interstitial condensation

7.2 Subject to the construction used and amount of vapour being produced, the risk of interstitial condensation will be minimal. Any vapour build-up will be low and will dissipate during the summer months. Therefore, a vapour check is not required. For the purposes of calculating condensation risk in accordance with BS 5250 : 2002, a nominal vapour diffusion factor (μ) of 60 (a vapour resistivity of 300 $MNsg^{-1}m^{-1}$) may be taken for the EPS panels.

8 Behaviour in relation to fire

8.1 Concrete walls constructed from the system have been assessed in accordance with BS 8110-2 : 1985, Table 4.6. Fire resistance values for concrete core wall thicknesses formed using the system elements are given in Table 3. This assessment does not take account of any additional protection provided by the internal and external finishes. The use of the formwork with the specified finishes will not reduce the fire resistance of the concrete wall.

Table 3 ICF Tech High Performance Wall System walls with vertical reinforcement[1]

Reinforcement and concrete specification		Minimum dimensions (mm) of concrete in the ICF Tech formwork excluding any combustible finish for a fire resistance (loadbearing capacity, integrity and insulation) of:		
		0.5 h	1 h	1.5 h
Walls with less than 0.4% reinforcement made from dense aggregate	Concrete thickness (mm)	–	150	–
Walls with 0.4% to 1% reinforcement made from dense aggregate with cover to reinforcement of 25 mm	Concrete thickness (mm)	100	150	150

(1) It should be noted that where reinforcement is less than 0.4%, the 250 mm wall with 100 mm thick concrete cannot be assumed to provide the minimum level of fire resistance required by regulations (30 minutes). Whilst the plasterboard lining will provide some protection, no data has been supplied to permit assessment of this specific case.

8.2 The expanded polystyrene component of the system would be classified as combustible. For buildings in Scotland, completed walls with appropriate finishes can satisfy the required durations of fire resistance and, therefore, may be used in separating walls. Where external walls are one metre or less from a relevant boundary, the construction should comply with the relevant exceptions on the use of combustible materials permitted by the guidance supporting the Building Regulations in Scotland.

8.3 The risk of fire spread over the internal wall surface will depend on the finishes that are used. The relevant requirements of the national Building Regulations should be observed. A typical plasterboard lining will provide a Class 0 surface ('low risk' in Scotland).

8.4 The risk of fire spread over the external wall surface for the render systems described has not been assessed. Therefore, the relevant requirements of the Building Regulations should be observed.

8.5 To limit the risk of fire spread between floors in buildings subject to the Building Regulations in England and Wales, fire barriers should be installed at each floor level above the first floor, ie starting with the second storey. Fire barriers should completely seal the cavity and be chased into the outer EPS formwork.

8.6 In buildings other than those described in section 8.5, it is recommended that designers consider the guidance given in that section.

8.7 Care should be taken to ensure that all detailing at junctions adequately maintains the required periods of fire resistance, that any cavities formed in the completed walls are appropriately fire stopped and detailing around any openings provides sufficient protection to the EPS.

9 Weathertightness

Resistance to rain ingress is provided by the external finishes described in this Certificate (see section 1.10). The external skin or finishes are not covered by this Certificate.

10 Damp-proofing and waterproofing

10.1 The system's EPS elements will not transmit moisture by capillary action. The concrete wall formed with the system should be constructed using the specified concrete recommended by the Certificate holder (see sections 1.8 and 5.2).

10.2 When used below ground or formation level, eg basement or retaining wall (see Figure 3), waterproofing materials compatible with EPS must be used on the external surface. A suitable collector drain and backfilling medium should be provided to eliminate the build up of hydrostatic head behind the wall. The Certificate holder is able to advise on suitable waterproofing materials.

11 Proximity of flues and appliances

When installing the product in close proximity to certain flue pipes and/or heat-producing appliances, the following provisions to the national Building Regulations are acceptable:

England and Wales — Approved Document J3

Scotland — Mandatory Standards 3.18, clause 3.18.5[1][2], and 3.19, clause 3.19.4[1][2]

(1) Technical Handbook (Domestic).

(2) Technical Handbook (Non-Domestic).

Northern Ireland — Technical Booklet L.

12 Airtightness

12.1 Buildings can achieve adequate resistance to unwanted air infiltration provided there is effective sealing around junctions.

12.2 In England, Wales and Northern Ireland, completed buildings, respectively, are subject to pre-completion testing for airtightness in accordance with the requirements of Approved Documents L1A and L2B, Section 20B, and Technical Booklet F1, sections 2.46 to 2.54, and Technical Booklet F2, sections 2.54 to 2.61.

12.3 Completed dwellings in Scotland are only subject to pre-completion airtightness testing if the target air permeability of the proposed building is less than 10 $m^3h^{-1}m^{-2}$, or if the figure is between 10 $m^3h^{-1}m^{-2}$ and 15 $m^3h^{-1}m^{-2}$ and the designer does not wish to use the 15 $m^3h^{-1}m^{-2}$ default figure in the proposed dwelling, in accordance with the Technical Handbook (Domestic), clause 6.2.5.

13 Sound insulation

13.1 Separating walls with a concrete core density greater than 2000 kgm^{-3} and thickness of 150 mm, will achieve a minimum mass per unit area for the core of 300 kgm^{-2}. When used in conjunction with suitable framing, lining and flanking details, the wall can meet the requirements of a wall Type 3.

13.2 Separating walls in dwellings and rooms for residential purposes in England and Wales are subject to pre-completion testing in accordance with Approved Document E, Section 1.

13.3 Internal walls and walls flanking separating walls in new dwellings and rooms for residential purposes should have a minimum mass per unit area, excluding finishes, of 120 kgm^{-2}.

14 Maintenance and repair

Although maintenance is not envisaged for the system, regular checks should be carried out on the finishes to ensure damage is detected and repaired as soon as possible.

15 Durability

15.1 Concrete walls constructed with the system will have a service life of not less than 60 years provided they are designed in accordance with section 5.2. The EPS formwork will have a similar service life provided it is protected from damage by the external and internal finishes of the wall construction and these are adequately maintained during the life of the building.

15.2 The polypropylene form tie/spacers, PVC FormLock channels and form closers are of conventional building materials and will have a durability compatible with the EPS, if protected from damage by the external and internal finishes.

Installation

16 General

16.1 The preparation, installation and support of the ICF System and application of any specified finishes must be in accordance with *ICF Tech High Performance Wall System Installation Manual*. Particular attention must be given to the requirements given in sections 16.2 to 16.5 of this Certificate.

16.2 The system requires that the foundation be level, smooth finished and within a tolerance of 25 mm. Any out-of-tolerances must be made good prior to placement of formwork.

16.3 All reinforcement should be accurately positioned to ensure that the minimum required concrete cover is provided (see Figures 5, 8 and 9). Starter or dowel bars (see Figure 6), where required, must be to the engineer's design. Polypropylene form ties/spacers should not be cut or modified when locating reinforcement.

16.4 When stepped foundations are required, they should be provided in 450 mm steps, subject to foundation depth, so as to avoid cutting forms.

16.5 It is essential that effective bracing and propping of walls takes place during construction to ensure stability, level, straightness and plumb of walls. The Certificate holder is able to provide and recommends the use of the ICF Tech Performance Wall Propping System (not covered by this Certificate). The system includes a vertical, aluminium support channel, diagonal turnbuckle brace, platform bracket and guard rail post assembly. Bracing and alignment systems should be fixed at 1.2 m horizontal centres but subject to verification by calculation depending on the wall configuration. A bracing and alignment system is available for supporting corners.

16.6 Typically the bracing and alignment systems are placed on one side of the formwork (usually the inside face) during construction. Consideration should be given for additional bracing where stability could be compromised.

16.7 Window and door openings are formed during construction of the formwork with extruded PVC cavity closers (see Figure 7) located around and to seal openings during concrete pouring. To ensure that the framing remains square, reusable steel corner strengtheners are slotted into preformed channels and internal bracing provided. The frame closers remain and are used for subsequent fixing of finishes or for through fixing of door and window frames.

Figure 5 Typical reinforcement layout around openings

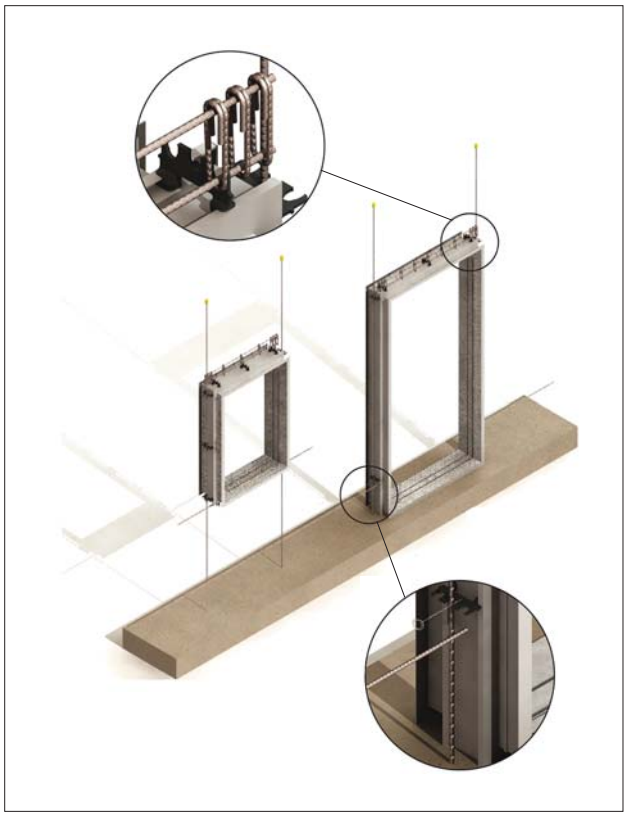
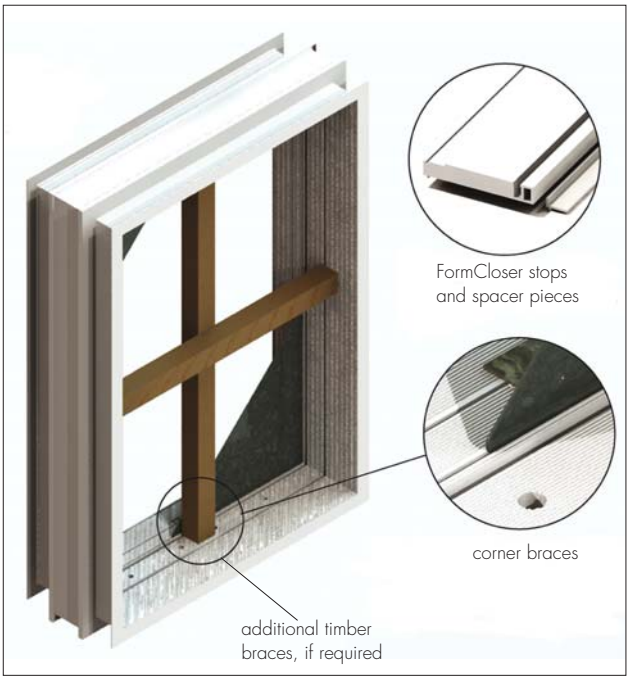


Figure 6 Starter bar

Figure 7 Frame closer to openings



Once the concrete has hardened, corner stiffeners and internal bracing are removed. Stop ends are generally sealed using 100 mm or 150 mm by 50 mm timber inserts screw-fixed through the EPS formwork or plywood plates held in position using adjustable props.

17 Procedure

Laying

17.1 The inner and outer lines of PVC FormLock channels are fixed using masonry nails (or other suitable fixings) and lined level. Any gaps beneath the tracking are filled with low expansion polyurethane foam.

17.2 Construction commences by forming the corners and working inwards towards the mid-point of each wall line. On subsequent courses, a running bond should be maintained with vertical joints staggered in stretcher bond fashion. It is important to ensure that fixing strips align vertically. Forms are cut to size to accommodate window and door

openings as laying proceeds. The long end of the corner form should be used first maintaining a running bond. With the first course it is also important to run the forms through door and deep window openings (these can be marked for subsequent forming as laying proceeds).

17.3 Plastic water bar strips are inserted in the mating grooves along the vertical edges, as construction proceeds, to provide a mechanical fixing and seal each joint to prevent seepage of concrete slurry.

17.4 Following completion of the first course, subsequent courses[1] are laid in a running bond, this being achieved by reversing the corner forms to create a 300 mm stagger.

(1) Depending on design considerations once formwork reaches ground or basement floor level and formwork checked for plumb and level, concrete can be poured to form a stable base for subsequent wall construction.

17.5 Wall formwork, for separating or internal walls, is jointed into external formwork by removal of a vertical slice (see Figure 8). Internal wall formwork must be located between external wall spacers to avoid cutting the spacer. Reinforcing tape (supplied by the Certificate holder) is used to strengthen the formed joint.

Reinforcement

17.6 The quantities of reinforcement placed within the system are dependent on design and detail requirements (see section 5). Horizontal reinforcement (see Figure 9) can be placed in the centre or adjacent to core edges using the spacer preformed slots. Vertical reinforcement can then be placed against the horizontal reinforcement and secured using standard reinforcement wire tying methods. Bar lapping lengths in accordance with BS 8110-1 : 1997 should be adopted. The system requires that, in plain walls, horizontal reinforcement be provided in top and bottom courses of every storey. Generally, 10 mm diameter, high tensile reinforcement is used.

Figure 8 Separating wall detail

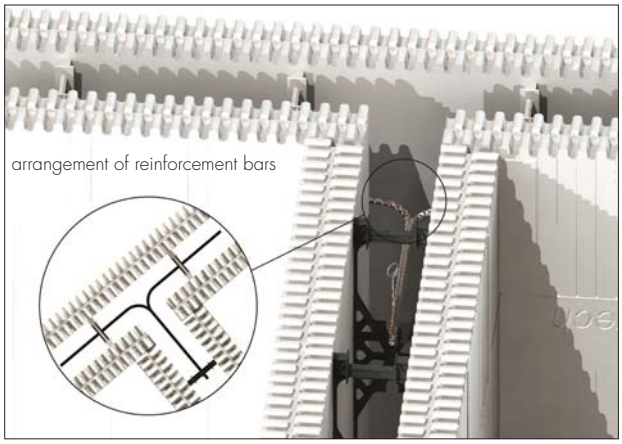
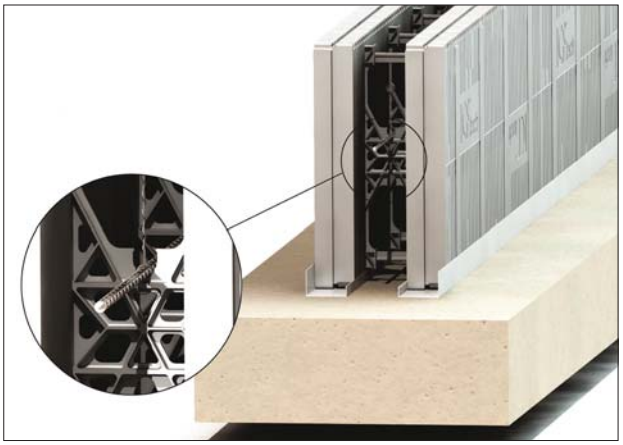


Figure 9 Reinforcement detail



Restraint and propping

17.7 Restraint is provided by securing the bottom course to the foundation using the PVC FormLock channels shot-fired or screwed into the foundation or ground floor depending on the method of construction. The patent bracing and alignment system is erected by securing the vertical bracing channel (Strong-back) to the ground floor slab or firm ground. The turnbuckle assembly is connected to the channel to provide a rigid adjustable support. When over three storeys high, a working platform can be erected on the bracing and alignment system.

17.8 Once the bracing and propping is erected, adjustments are made for plumb and level by use of the turnbuckle.

Windows and doors

17.9 Window and door openings are formed as work proceeds with any adjustments to opening size made using a handsaw or hot wire tool. Once completed and dimensions checked, PVC form closers are pressed onto the opening edges and corner stiffeners and internal bracing fitted. To avoid the potential formation of voids, small holes are drilled into the sill section of the form closer to allow for the escape of air and monitoring of concrete flow.

Concrete placement

17.10 Prior to concrete pouring, a check should be carried out on the system to include conformance to design and layout, correct alignment and plumb, bracings and props secured. Reinforcement should be checked for correct cover distance and rigidity. Horizontal joints should also be protected for concrete overspill by use of the PVC FormLocks, inverted over the top of the formwork, or by use of plastic sheeting strips taped to the EPS.

17.11 Concrete placement should be directed away from corners directing the line pump nozzle first around the external walls of the building in 1 m to 1.2 m pour heights allowing concrete to free-flow into corners and below window openings. The first pour should be allowed to stiffen before placing the second pour of concrete.

Backfilling

17.12 Backfilling around bottom layers of formwork to the ground floor or basement walls should not take place until the concrete has reached sufficient design strength (the Certificate holder recommends a minimum period of 28 days[1]). The top of basement walls must be supported by temporary supports or by utilising the floor construction on the basis that the floor/wall joint allows full transfer of loads through diaphragm action.

(1) This can be adjusted by altering the concrete specifications in accordance with the Chartered Civil or Structural Engineer's recommendations.

Electrical and plumbing installation

17.13 Electrical and plumbing services can be fixed within the formwork by cutting chases into the EPS using a router or hot-wire knife. All electrical services should be ducted. Any services introduced should conform to Building Regulation and Health and Safety requirements. Further details on fixing methods can be obtained from the Certificate holder.

Wall penetrations

17.14 Openings, sleeves or ducts for service penetrations can be positioned and sealed effectively against concrete leakage within the formwork prior to concrete pouring. Service entry points to basement walls should be avoided.

Intermediate floors and roof

17.15 A range of installation and floor systems can be accommodated with the system. Typical examples are shown in Figures 10 and 11.

Figure 10 Typical floor/wall connections — ground floor

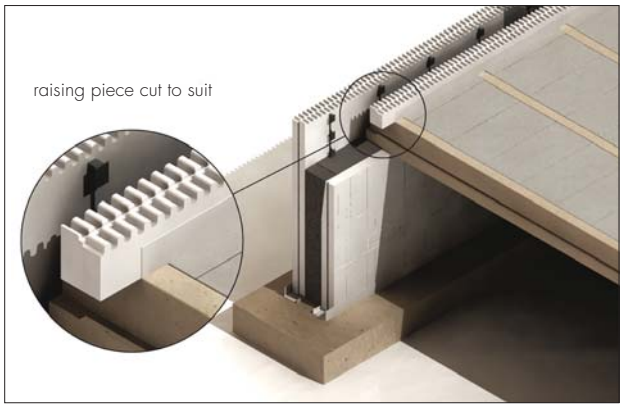
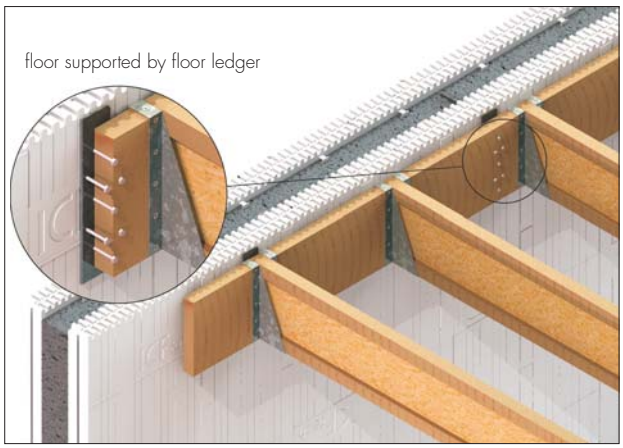


Figure 11 Typical intermediate floor details



Internal finishes

17.16 A range of internal finishes can be applied or fixed directly to the system. Common dry lining systems, such as gypsum plasterboard, can be screw-fixed into the form tie/spacer flanges or bonded to EPS using compatible adhesive.

External finishes

17.17 External cladding systems are outside the scope of this Certificate. Further details of suitable systems can be obtained from the Certificate holder.

Waterproofing

17.18 The ICF system relies either on an externally applied compatible waterproofing membrane (applied to the surface of the EPS) or the use of a waterproofing additive to the concrete core, together with effective detailing, to provide a barrier to the ingress of groundwater to basement walls. Neither waterproofing methods are covered by the Certificate but full details can be obtained from the Certificate holder. A typical basement detail is shown in Figure 3.

Heavy wall loads

17.19 Heavy wall loads (such as wall units) should be supported by the concrete core and not the form spacer flanges. Typical methods include the use of timber blocks screwed or bolted into the concrete core or cast-in anchor bolts and metal plates.

Floor/wall joint

17.20 The system incorporates form elements to create an integral concrete construction where either a reinforced concrete or precast floor is used (see Figure 10).

Technical Investigations

18 Tests

Tests on the ICF Tech High Performance Wall System were carried out in broad accordance with the requirements of ETAG 009 using two specially constructed test structures. Observations were made on resistance to filling pressure (on the EPS and spacer elements) and efficiency of filling using pumped concrete.

19 Investigations

19.1 Two site visits were carried out to witness the installation process including construction of formwork, placement of reinforcement, pouring of concrete and performance of form tie/spacers.

19.2 An assessment was made on technical data relating to airtightness, fire and thermal performance.

19.3 The manufacturing process was examined, including the methods adopted for quality control, and details were obtained of both quality and composition of materials.

Bibliography

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BS EN 1992-1-1 : 2004 *Eurocode 2 : Design of concrete structures. General rules and rules for buildings*
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ETAG 009 : 2002 *Guideline for European Technical Approval of non-loadbearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete*

DIN EN 12089 : 1997 *Thermal insulating products for building applications — Determination of bending behaviour*

DIN 53427 : 1986 *Determination of shear strength of rigid cellular materials sandwiched between metal plates*

20 Conditions

20.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is granted only to the company, firm or person named on the front page — no other company, firm or person may hold or claim any entitlement to this Certificate
- 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.

20.2 References in this Certificate to any Act of Parliament, Statutory Instrument, Directive or Regulation of the European Union, British, European or International Standard, Code of Practice, manufacturers' instructions or similar publication, are references to such publication in the form in which it was current at the date of this Certificate.

20.3 This Certificate will remain valid for an unlimited period provided that the product/system and the manufacture and/or fabrication including all related and relevant 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.

20.4 In granting this Certificate, the BBA is not responsible for:

- 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 the nature, design, methods and workmanship of or related to the installation
- the actual works in which the product/system is installed, used and maintained, including the nature, design, methods and workmanship of such works.

20.5 Any information relating to the manufacture, supply, installation, use and maintenance 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 and maintained. It does not purport in any way to restate the requirements of the Health & Safety at Work etc Act 1974, or of any other statutory, common law or other duty which may exist at the date 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. In granting this Certificate, the BBA does not accept responsibility to any person or body for any loss or damage, including personal injury, arising as a direct or indirect result of the manufacture, supply, installation, use and maintenance of this product/system.

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