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BBA APPROVAL INSPECTION TESTING CERTIFICATION
TECHNICAL APPROVALS FOR CONSTRUCTION

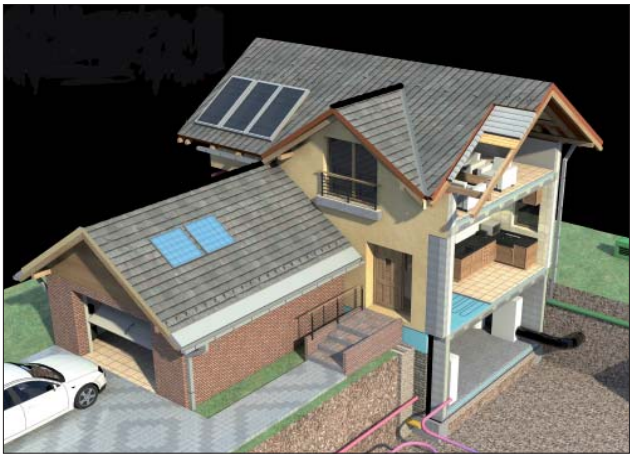
Agrément Certificate
09/4707
Product Sheet 1

CREO WALL SYSTEMS

CREO ICF WALL SYSTEM

PRODUCT SCOPE AND SUMMARY OF CERTIFICATE

This Certificate relates to the Creo ICF Wall System, for use in the formation of loadbearing and non-loadbearing internal, external and separating walls in domestic and commercial buildings.



AGRÉMENT CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Structural 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 and interstitial condensation (see section 7).

Behaviour in relation to fire — walls will provide adequate fire performance, provided the system is used in conjunction with suitable materials (see section 8).

Sound insulation — separating and internal walls with the 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. The 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: 1 December 2011
Originally certificated on 21 December 2009

Brian Chamberlain
Head of Approvals — Engineering

Greg Cooper
Chief Executive

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

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

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Regulations

In the opinion of the BBA, the Creo ICF 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 2010 (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 5.2, 5.8 and 5.9 of this Certificate.
Requirement:	B2(1)	Internal fire spread (lining)
Comment:		Walls can satisfy the reaction to fire characteristics, provided the system is used in conjunction with suitable materials. See section 8.4 of this Certificate.
Requirement:	B3(1)(2)(3)(4)	Internal fire spread (structure)
Comment:		Walls can meet this Requirement. See sections 8.1, 8.6 and 8.8 of this Certificate.
Requirement:	B4(1)	External fire spread
Comment:		Walls can satisfy the reaction-to-fire characteristics, provided the system is used in conjunction with suitable materials. See sections 8.2 and 8.5 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 to 10.3 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 section 9 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 to 7.3 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 6.1, 6.5, 6.6, 6.9, 12.1 and 12.2 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The system is acceptable. See section 15 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 and 15 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, 5.8 and 5.9 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 2.1.1[2], 2.1.4[2], 2.1.8[2], 2.1.9[2], 2.1.10[2], 2.1.11[2] and 2.1.13[2]. Openings in walls can maintain the fire-resistance durations, with reference to clause 2.1.14[2]. See sections 8.1 and 8.8 of this Certificate. Junctions between walls can maintain the required fire resistance durations, with reference to clause 2.1.16[2]. See sections 8.1 and 8.8 of this Certificate. The expanded polystyrene component of the wall, on its own, would be classified as combustible but the completed wall can satisfy the required durations of fire resistance, with reference to clause 2.1.12[2]. See section 8.1 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], 2.2.2[1][2], 2.2.3[1][2], 2.2.4[1], 2.2.5[1][2], 2.2.6[1] and 2.2.8[1]. Openings in walls can maintain the fire-resistance durations, with reference to clauses 2.2.6[2] and 2.2.9[1]. See sections 8.1 and 8.8 of this Certificate. Junctions between walls can maintain the required fire-resistance durations, with reference to clauses 2.2.7[2] and 2.2.10[1]. See sections 8.1 and 8.8 of this Certificate. The expanded polystyrene component of the wall, on its own, would be classified as combustible but 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 section 8.1 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 clause 2.3.5[1][2]. See sections 8.1 and 8.8 of this Certificate. The expanded polystyrene component of the wall, on its own, would be classified as combustible but the completed wall can satisfy the required durations of fire resistance, with reference to clauses 2.3.2[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 to seal 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], 2.4.5[1], 2.4.6[1], 2.4.7[1][2], 2.4.8[2] and 2.4.9[2]. See sections 8.7 and 8.8 of this Certificate.
Standard:	2.5	Internal linings
Comment:		Walls can satisfy the reaction-to-fire characteristics 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 8.4 of this Certificate.
Standard:	2.6	Spread to neighbouring buildings
Comment:		Walls can satisfy the relevant requirements of this Standard within the limitations set out in this Certificate, with reference to clauses 2.6.1[1][2], 2.6.2[1][2], 2.6.5[1] and 2.6.6[2]. See sections 8.1, 8.3 and 8.5 of this Certificate.
Standard:	2.7	Spread on external walls.
Comment:		Walls can satisfy the reaction-to-fire characteristics 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 8.5 of this Certificate.
Standard:	3.4	Moisture from the ground
Comment:		Walls can satisfy this Standard, with reference to clause 3.4.5[1][2]. See sections 10.1 to 10.3 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], 3.15.4 and 3.15.5[1]. See sections 7.1 to 7.3 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 and 13.2 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], 6.2.1[1][2], 6.2.3[1], 6.2.4[1][2] and 6.2.5[2]. See sections 6.1, 6.7, 6.8, 6.9, 12.1 and 12.3 of this Certificate.
Standard:	7.1(a)(b)	Statement of sustainability
Comment:		The system can contribute to meeting the relevant requirements of Regulation 9, Standards 1 to 6, and, therefore, will contribute to a construction meeting a bronze level of sustainability as defined in this Standard.

(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 section 15 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 to 10.3 of this Certificate.
Regulation:	C5	Condensation
Comment:		Walls can contribute to minimising the risk of interstitial condensation. See sections 7.2 and 7.3 of this Certificate.
Regulation:	D1	Stability
Comment:		Walls will have adequate strength and stiffness to satisfy this Regulation. See sections 5.2, 5.8 and 5.9 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, 5.8 and 5.9 of this Certificate.
Regulation:	E3(a)(b)	Internal fire spread – Linings
Comment:		Walls can satisfy the reaction-to-fire characteristics, provided the system is used in conjunction with suitable materials. See section 8.4 of this Certificate.
Regulation:	E4(1)(2)(3)(4)	Internal fire spread – Structure
Comment:		Walls can satisfy this Regulation. See sections 8.1, 8.7 and 8.8 of this Certificate.

Regulation:	E5(a)	External fire spread
Comment:		Walls can satisfy the reaction-to-fire characteristics, provided the system is used in conjunction with suitable materials. See sections 8.2 and 8.5 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 6.1, 6.5, 6.6, 6.9, and 12.1 and 12.2 of this Certificate.
Regulation:	G2	Separating walls and separating floors
Comment:		Separating walls can satisfy this Regulation. See sections 13.1 and 13.2 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: 2 *Delivery and site handling* (2.4), 4 *Practicability of installation* (4.1 and 4.2) and 16 *General* (16.1 and 16.5).

Non-regulatory Information

NHBC Standards 2011

NHBC accepts the use of the Creo ICF 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*.

General

The Creo ICF Wall System is for use in loadbearing and non-loadbearing internal, external and separating walls in domestic and commercial buildings with up to a five-storey superstructure and for single-storey basements.

The system provides permanent formwork for in-situ dense aggregate concrete walls and contributes to the thermal insulation of the finished construction. The maximum concrete pour height for the system is 500 mm.

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 Creo ICF Wall System comprises the following components. The components are made from expanded polystyrene (EPS) (see Figures 1 and 2). The wall is formed by placing or pouring concrete into the formwork:

- standard wall elements
- end elements
- corner elements
- ring beam elements
- lintel elements
- insulation spacers
- end piece.

Figure 1 Standard wall elements

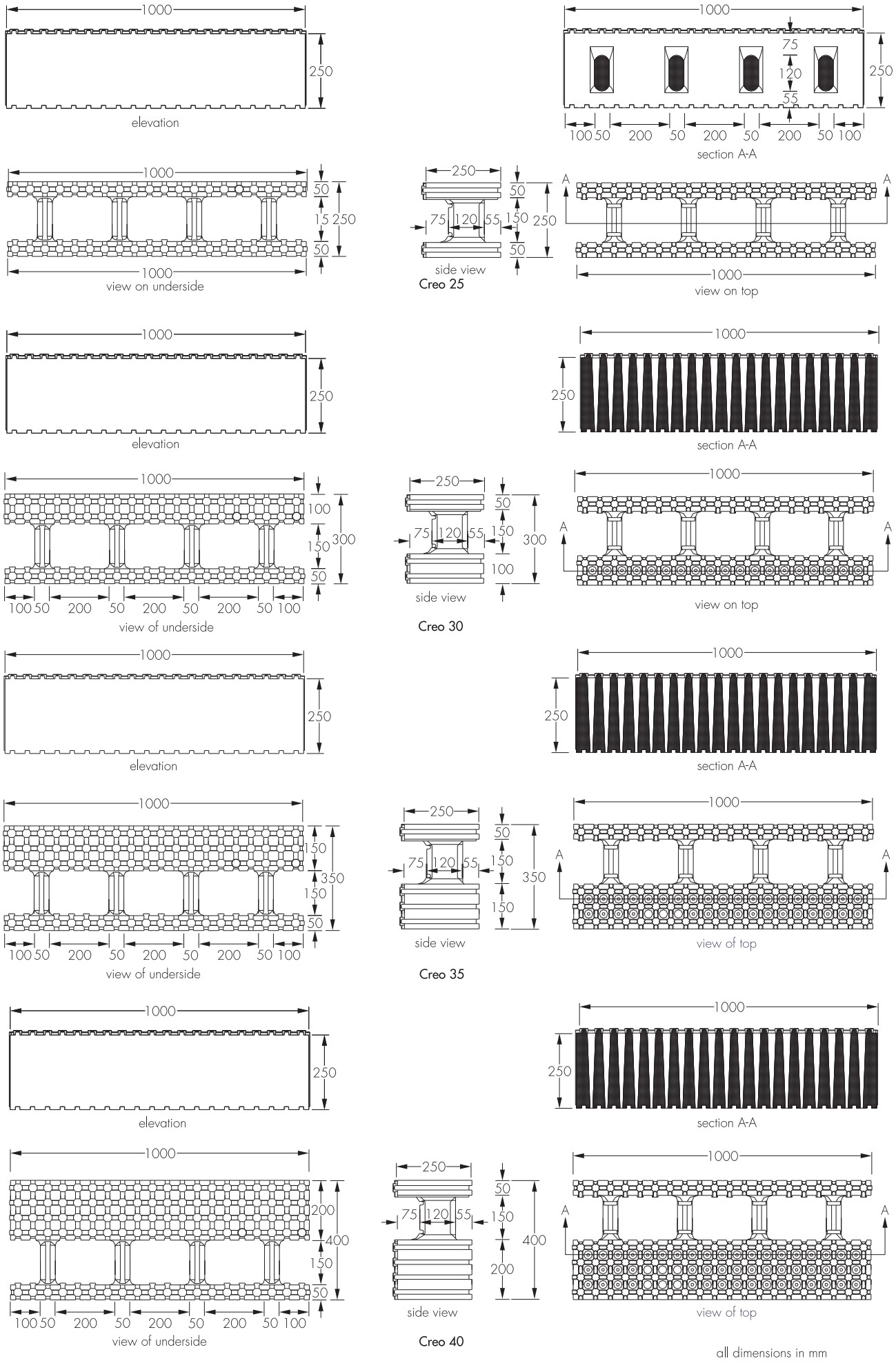
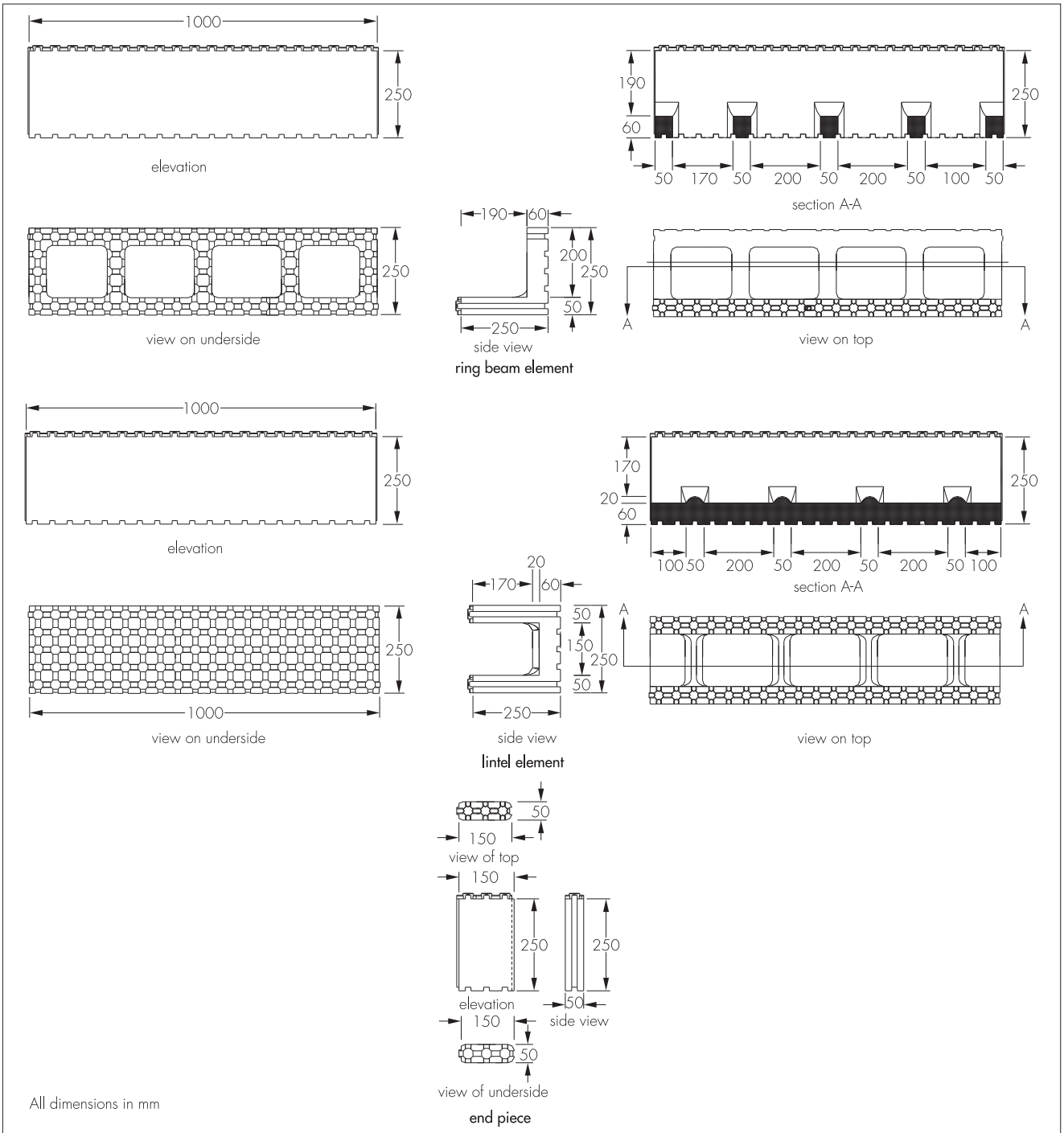


Figure 2 Other elements



1.2 The standard wall elements consist of an inner and outer skin of EPS with an integral EPS web connecting both skins. Blocks are joined together horizontally using a castellated horizontal joint, with the perpendicular joints being butted together. The inner skin is 50 mm thick and the outer skin 50 mm, 100 mm, 150 mm or 200 mm thick creating a total wall thickness of 250 mm, 300 mm, 350 mm or 400 mm with a 150 mm concrete core. The webs are 50 mm thick by 99 mm deep and slotted at the top to accommodate horizontal reinforcement as required by the designer. The 100 mm, 150 mm and 200 mm thick outer skins incorporate vertical conical air channels in one, two or three rows respectively. The elements are a standard 250 mm high and 1000 mm long, however, the length can vary depending on function. The voids formed by the skins and webs are 150 mm wide by 200 mm long and once filled with concrete create a structural pattern of interlinking columns that acts as the structural element of the system.

1.3 The end elements close wall sections at the side of openings. They are available in right-hand and left-hand versions with a height of 250 mm, a width of 250 mm and a length of 500 mm. Thickness of the inner and outer skin is 50 mm.

1.4 Corners are formed using the corner elements. They are available in right-hand and left-hand versions with a height of 250 mm and leg lengths of 100 mm and 250 mm measured inside. Thickness of the inner and outer skins is 50 mm creating a total width of 250 mm.

1.5 The ring beam elements are used at the junction of wall and floor structures. They are 250 mm wide by 1000 mm long by 250 mm high.

1.6 The lintel elements are used above openings. They are 250 mm wide by 1000 mm long by 250 mm high.

1.7 The end piece and corner and ring beam elements have a standard width of 250 mm. Where the width of the standard wall element is wider than 250 mm, the insulation spacers will increase the width of these elements to balance the difference. The insulation spacers are 250 mm high by 50 mm thick and their length can vary. The number of the spacers depends on the width difference to be balanced.

1.8 End pieces can be inserted into the standard wall elements to close the gap at openings and at the end of free standing wall. They can also be used to curtail the length of standard wall elements and, as an alternative, for creating corners and wall ends from standard wall elements. Each piece is 150 mm long by 250 mm high by 50 mm thick.

1.9 The density of the EPS used is 30 $kg \cdot m^{-3}$ with a minimum compressive strength of 150 kPa at 10% deformation.

1.10 The elements are dry laid in brick-bond formation and interlocked to form a tight joint. Where a storey-height formwork is built, it must be supported during the concrete filling operation.

1.11 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 : 2009 to allow placement by free flow only. In relation to consistence of the concrete, the recommended slump is 170 mm when tested to BS EN 12350-1 : 2009. Specific concrete mixes are dependent on individual requirements and are outside the scope of this Certificate.

1.12 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 + A2 : 2009
- 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 compatible with the system, subject to testing or assessment
- brick or stone slips — the Certificate holder's advice should be sought
- internal finish — typically plasterboard or a dry-lined finish with or without a plaster skim coat conforming to BS 8212 : 1995 and BS EN 520 : 2004
- brickwork/stonework ties — to BS EN 845-1 : 2003 + A1 : 2008 fixed directly into the concrete core
- bracing and alignment support system — as supplied or specified by the Certificate holder
- basement waterproofing membrane — see section 10.2.

Quality controls

1.13 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 shrinkwrapped — 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 Creo ICF Wall System.

Design Considerations

3 Use

3.1 The Creo ICF Wall System is for use in loadbearing and non-loadbearing internal, external and separating walls in domestic and commercial buildings with up to a five-storey superstructure and for single-storey basements.

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 The system should only be installed by operatives who have been trained and approved by the Certificate holder. The elements can be cut using conventional wood saws or hot wire tools.

4.2 Concrete is generally placed by pump using concrete from a batching plant. Small volumes can also be placed by hand, skip with adapted neck or pump, if necessary. The requirements given in sections 17.12 to 17.14 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. 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 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 as this could result in the loss of integrity or overall stability of the temporary construction. Cold bridging effects must also be considered where services pass through the wall construction.

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 8110-1 : 1997, BS 8110-2 : 1985 or 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 skin, 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 skins (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.

5.5 The formwork is normally filled with concrete in layers of two courses of the formwork.

5.6 Storey-height formwork can also be constructed and concrete pouring is performed in 500 mm deep steps 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 the filling process to ensure stability and maintain alignment.

5.7 When used for basement or retaining wall construction, an external waterproofing membrane must be employed ensuring correct detailing and jointing methods to manufacturer's instructions and in accordance with the *Creo ICF Wall System Installation Manual*.

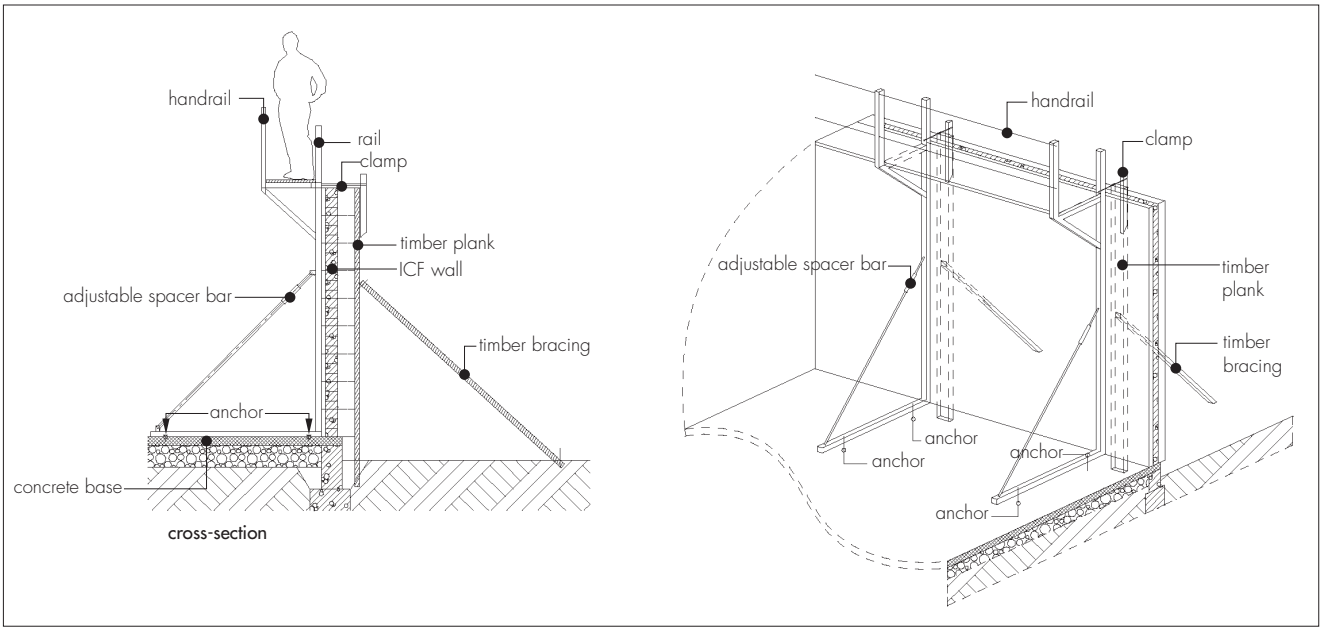
Strength and stability

5.8 Running 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. During structural design, the effective width of the concrete core needs to be reduced by 50 mm to account for the EPS webs. Reinforcement always needs to be placed above openings, around corners, at parapet and basement walls or, where required, to resist larger loads including point loads of beam supports. Particular attention should be paid to the the type of concrete mix used 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.

5.9 The nominal concrete cover to reinforcement should be in accordance with BS 8110-1 : 1997, section 3.3.5, or as required for fire resistance in accordance with BS 8110-2 : 1985, section 4, whichever is the greater. Alternatively, the recommendations given in BS EN 1992-1-2 : 2004 may be adopted.

5.10 To achieve adequate structural stability for a storey-height 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 can provide a propping system (see Figure 3) 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.

Figure 3 Propping/support system



5.11 Attention is drawn to the need for accurate levelling of the foundation and, where necessary, 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.

6 Thermal insulation

6.1 The thermal performance of each building incorporating the walls must be evaluated in accordance with the relevant national Building Regulations, and is the responsibility of the overall designer of the building.

6.2 Calculated thermal transmittance (U value) for the external walls with a typical external thin-render finish and an internal 12.5 mm thick plasterboard lining are given in Table 1. Air channels in the outer EPS skin have been considered in the calculation. Alternative external and internal finishes can improve the U values of walls.

Table 1 U values for a typical wall structure

Wall thickness[1] (mm)	U value ($W \cdot m^{-2} \cdot K^{-1}$)
250	0.29
300	0.21
350	0.16
400	0.13

(1) Without external and internal finishes.

6.3 Calculations of the 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 nominal thermal conductivity of 0.032 $W \cdot m^{-1} \cdot K^{-1}$ for the EPS insulation. The U value of a specific wall construction will depend on the external and internal finish and the number and type of fixings used.

6.4 Wall constructions that require internal or external finishes to be fixed to the 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 and BRE report (BR 443 : 2006) to determine U values.

6.5 Walls are better than the U value specified for a wall in a 'notional' building detailed 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).

6.6 Walls are better than the area-weighted limit U values as specified in Approved Documents L1A and L2A and Technical Booklets F1 and F2 respectively (see Table 2). Therefore, the system can contribute to enabling a building to meet the Target CO_2 Emission Rate (TER).

6.7 Walls, depending on the thickness and external and internal finishes, can be better than the U value specified for a wall in a 'notional' building detailed in the Mandatory Standard 6.1, clauses 6.1.2[1] and 6.1.3[2].

6.8 Walls satisfy the area-weighted limit U values specified in Mandatory Standard 6.2, clause 6.2.1[1][2], and, depending on the wall thickness and external and internal finishes, can also satisfy the U values of the simplified approach given in Mandatory Standard 6.1, clause 6.1.2[1] (see Table 2). Therefore, the system can contribute to enabling a building to meet the Target CO_2 Emission Rate (TER).

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

Table 2 Requirements of the national Building Regulations

Area/use	U value ($W \cdot m^{-2} \cdot K^{-1}$)	
	Area weighted limit	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) Details for replacement elements in existing buildings are given in Technical Booklets F1, Table 3.2 (domestic), and F2, Table 3.3 (non-domestic).
(5) Technical Booklet F2.

6.9 The system can maintain, or contribute to maintaining, continuity of thermal insulation at junctions between the wall and other building elements. The default psi value quoted in BRE Information Paper IP 1/06 *Assessing the effects of thermal bridging at junctions and around openings*, Table 3, therefore, may be used in SAP or SBEM calculations. Guidance in this respect can be found in:

England and Wales and Northern Ireland — Accredited Construction Details (version 1.0)

Scotland — Accredited Construction Details (Scotland).

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 6, will also be acceptable.

Interstitial condensation

7.2 Calculations show that the risk of interstitial condensation of the external walls with a typical external thin-render finish and an internal 12.5 mm thick plasterboard lining will be minimal. Any vapour build-up will be low and will dissipate during the summer months. Therefore, a vapour check is not required.

7.3 Calculations of the interstitial condensation risk of a specific wall construction should be carried out in accordance with BS 5250 : 2002. A nominal vapour diffusion factor (μ) of 60 (a vapour resistivity of 300 $MN \cdot s \cdot g^{-1} \cdot m^{-1}$) may be taken for the EPS skins.

8 Behaviour in relation to fire

8.1 Fire resistance classification, based on tests to EN 1365-1 : 1999 with a test load of 120 $kN \cdot m^{-1}$ and following assessment of concrete walls constructed from the system with different finishes are summarised in Table 3. The expanded polystyrene elements are combustible and have a reaction-to-fire classification of E to BS EN 13501-1 : 2007. During design, the relevant requirements of the national Building Regulations should be observed.

Table 3 Resistance-to-fire classification

Wall type	External finish	Internal finish layers (towards inside)	Resistance-to-fire classification (from inside)[1]
External wall	Thin render	15 mm Fireline plasterboard	REI 30
External wall	Thin render	15 mm normal plasterboard 15 mm Fireline plasterboard	REI 60
External wall	Thin render	50 mm mineral wool insulation (minimum density 30 kg·m^{-3}) 20 mm air gap 15 mm Fireline plasterboard[2]	REI 60
External wall	Thin render	50 mm mineral wool insulation (minimum density 30 kg·m^{-3}) 20 mm air gap 15 mm Fireline plasterboard[2] 15 mm normal plasterboard[2] 15 mm Fireline plasterboard[2]	REI 90
External wall	Thin render	15 mm Fireline plasterboard[2] 15 mm normal plasterboard[2] 15 mm Fireline plasterboard[2]	REI 90
External wall	Thin render	60 mm mineral wool insulation (minimum density 100 kg·m^{-3}) 20 mm air gap 3 x 15 mm Fireline plasterboard[2]	REI 120
External wall	Thin render	3 x 15 mm Fireline plasterboard	REI 120
Internal wall	N/A	15 mm Fireline plasterboard on both sides	REI 30
Internal wall	N/A	2 x 15 mm Fireline plasterboard on both sides	REI 60

(1) REI 30, REI 60 and REI 120 are short, medium and long fire-resistance durations respectively in Scotland.

(2) Plasterboard installed on a steel frame.

8.2 Buildings subject to Building Regulations in England and Wales or Northern Ireland have not been assessed for use within one metre of a boundary. Due regard must be taken of all 'unprotected areas'.

8.3 Buildings subject to the Building Standards in Scotland must be sited in accordance with Mandatory Standard 2.6 for compliance with these Regulations. 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.

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

8.5 The risk of fire spread over the external wall surface will depend on the external finishes that are used. During design, the relevant requirements of the national Building Regulations should be observed.

8.6 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.

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

8.8 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 1.12). The external skin or finishes are not covered by this Certificate.

10 Damp-proofing and waterproofing

10.1 Walls at or near ground level and below ground should be constructed in accordance with BS 8102 : 1990.

10.2 A damp-proof course always needs to be used below the first course of the EPS formwork.

10.3 When used below ground or formation level, eg basement or retaining wall, 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 J

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 are subject to pre-completion testing for airtightness in accordance with the requirements of Approved Documents L1A and L2A (Regulation 20B), Technical Booklet F1 (sections 2.46 to 2.54), and Technical Booklet F2 (sections 2.57 to 2.61) respectively.

12.3 Completed buildings in Scotland are only subject to pre-completion airtightness testing if the target air permeability of the proposed building is less than 10 $m^3 \cdot h^{-1} \cdot m^{-2}$, or if the figure is between 10 $m^3 \cdot h^{-1} \cdot m^{-2}$ and 15 $m^3 \cdot h^{-1} \cdot m^{-2}$ and the designer does not wish to use the 15 $m^3 \cdot h^{-1} \cdot m^{-2}$ default figure in the proposed dwelling, in accordance with the Mandatory Standard 6.2, clauses 6.2.5[1][2] and 6.2.6[1][2].

(1) Technical Handbook (Domestic).

(2) Technical Handbook (Non-Domestic).

13 Sound insulation

13.1 Separating walls with a concrete core density of 2200 $kg \cdot m^{-3}$ and thickness of 150 mm, will achieve a mass per unit area for the core of 304 $kg \cdot m^{-2}$. When used with suitable framing, lining and flanking details, walls can meet the requirements of a Type 3 wall.

13.2 Walls flanking separating walls in new dwellings and rooms for residential purposes should have a minimum mass per unit area, excluding finishes, of 120 $kg \cdot m^{-2}$. Where framed walls connect to the concrete core of a separating wall, the frame should be fixed to the core through a continuous pad of mineral wool.

13.3 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.

13.4 A field test carried out to EN ISO 140-4 : 1998 has resulted in an airborne sound insulation value of R'_W (C; C_{tr}) = 47 (–2; –6) dB, where the wall with a total thickness of 250 mm was lined with 12.5 mm thick plasterboard bonded on both sides. In the same building, a 250 mm thick wall has achieved an airborne sound insulation value of R'_W (C; C_{tr}) = 52 (–2; –6) dB, where the wall was lined with 12.5 mm thick plasterboard bonded on one side and fixed on a frame on the other.

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 is possible.

15 Durability

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.

Installation

16 General

16.1 The preparation and installation of the Creo ICF Wall System must be in accordance with the *Creo ICF Wall System Installation Manual* and this Certificate. The Certificate holder can also give guidance on the use of a suitable propping system. 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 +10 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. Starter or dowel bars, where required, must be to the engineer's design.

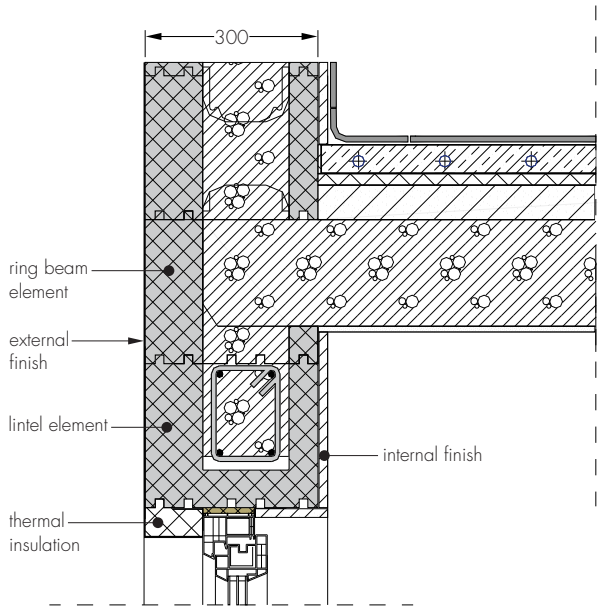
16.4 When stepped foundations are required, they should be provided in 250 mm steps, subject to foundation depth, so as to avoid cutting forms.

16.5 It is essential that, where necessary, 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 a suitable propping system (not covered by this Certificate). The system includes a vertical support channel, a horizontal rail anchored to the concrete slab and a diagonal adjustable brace.

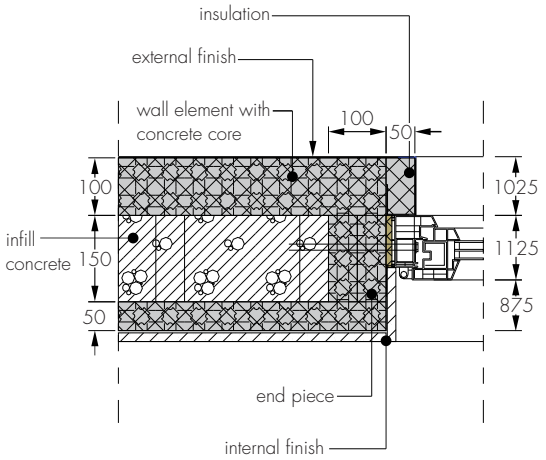
16.6 Typically, the bracing and alignment systems are placed on one side of the formwork (usually the inside face) during construction. Consideration should be given to additional bracing where stability could be compromised.

16.7 Typical construction details are shown in Figure 4.

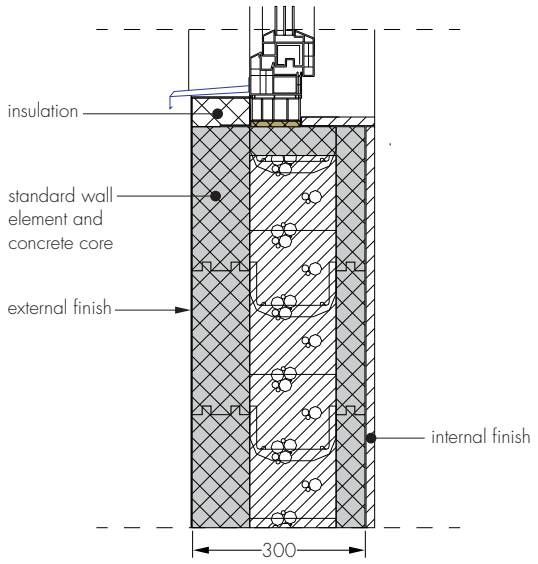
Figure 4 Typical construction details



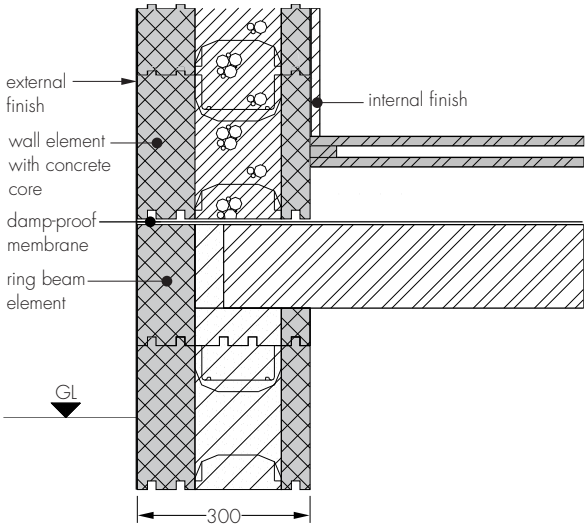
Detail at head of window and wall/floor junction



window detail (plan)



Detail at base of window



ground floor detail

all dimensions in mm

17 Procedure

Laying

17.1 If the damp-proof course under the first course of the EPS formwork cannot be made even enough, an additional concrete levelling course should be applied.

17.2 Construction commences by forming the corners and working inwards towards the mid-point of each wall line. The longer end of the corner element should be used to start the first course maintaining a running bond. It is important to run the elements through door and deep window openings to preserve dimensional accuracy. In the second course, the shorter end should be used to ensure staggered joints, and this process is followed to complete the formwork. Alternatively, standard wall elements can be used to create the corners using end pieces but parts of the joining standard wall elements need to be cut out to provide continuity of the concrete core.

17.3 Following completion of the first course, concrete is poured up to half the depth of the form, and the subsequent two courses are laid in a running bond.

17.4 At openings, end elements are used to close the sides of wall sections. In the subsequent course an end piece is inserted into the standard wall element.

17.5 T-junctions are formed from standard wall elements. Parts of the connecting wall elements need to be cut out to provide a continuous concrete core.

17.6 Above openings U-shaped lintel elements are used. The lintel element should overhang the opening by 250 mm at either side and the bottom of the lintel element cut out where it rests on the standard wall elements to ensure a continuous concrete core is cast over the opening. Lintel elements spanning an opening more than 500 mm wide must be supported when the concrete is poured.

17.7 At wall and floor junctions, L-shaped ring beam elements are used. At corners, the ring beam elements need to be cut at an angle of 45°. The ring beam elements need to be supported from outside when the concrete is poured.

Reinforcement

17.8 The quantities of reinforcement placed within the system are dependent on design and detail requirements (see section 5). Horizontal reinforcement can be placed adjacent to core edges using the preformed slots at the top of the EPS webs. Vertical reinforcement can 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. Generally, high tensile reinforcement is used.

Restraint and propping

17.9 Where required, the bracing and alignment system is erected by fixing the vertical channels to the horizontal rails and the diagonal adjustable braces. The horizontal rails are anchored to the concrete slab. The supporting system should be fixed at 1.0 m horizontal centres but subject to verification by calculation depending on the wall configuration. A working platform can be erected on the bracing and alignment system.

17.10 Once the bracing and propping is erected, adjustments are made for plumb and level by use of the diagonal brace.

Windows and doors

17.11 Window and door openings are formed during construction of the formwork with wall end elements, end pieces and lintel elements. Door and window frames are mechanically fixed through the EPS skins into the concrete core.

Concrete placement

17.12 Prior to concrete pouring, a check should be carried out on the system to ensure conformity to design and layout, correct alignment and plumb, and, where required, bracings and props are secured. Reinforcement should be checked for correct cover and rigidity. Horizontal joints should also be protected for concrete overspill.

17.13 After the first course has been half filled with concrete and it has hardened, the subsequent two courses of the formwork are laid and concrete placed up to half height of the third course and allowed to harden. The next two courses are placed and concrete poured up to the half height of the top course. This process is repeated until full height is reached. Alternatively, using a suitable bracing system, a storey-height formwork can be built, the first two courses filled with concrete and allowed to harden before pouring the next two courses. The process is repeated until full height is reached.

17.14 Concrete placement should be directed away from corners allowing concrete to free-flow into corners and below window openings. The concrete must be poured onto the EPS webs to prevent uplift of the elements. Only manual compaction should be used — mechanical vibration must not be used.

Backfilling

17.15 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 (after 28 days is recommended by the Certificate holder). The top of basement walls must be supported by temporary supports or by using the floor construction where the floor/wall joint allows full transfer of loads through diaphragm action.

Partitions

17.16 Any type of partition wall can be jointed to the system. Partitions need to be attached to the concrete core after removing the EPS skin, and using suitable fixing methods.

Electrical and plumbing installation

17.17 Electrical and plumbing services may be located within the concrete core subject to structural design consideration, or 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

17.18 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

17.19 A range of roof and floor systems can be accommodated with the system. Further details can be obtained from the Certificate holder.

Internal finishes

17.20 A range of internal finishes can be applied to the system. Common dry lining systems, such as gypsum plasterboard, can be screw-fixed on a separate frame or bonded to EPS using compatible adhesive.

External finishes

17.21 External cladding systems can be installed on battens or rails fixed to the concrete core or suitable renders can be applied directly to the EPS surface in conjunction with metal or plastic lathing, but these are outside the scope of this Certificate. The EPS surface is grooved vertically to assist bonding of external render systems. Further details of suitable systems can be obtained from the Certificate holder.

Waterproofing

17.22 The ICF system relies on an externally applied compatible waterproofing membrane (applied to the surface of the EPS), together with effective detailing, to provide a barrier to the ingress of groundwater to basement walls. The waterproofing method is not covered by the Certificate but full details can be obtained from the Certificate holder.

17.23 A damp-proof course must always be installed below the first course of the EPS formwork.

Heavy wall loads

17.24 Heavy wall loads (such as wall units) should be supported by the concrete core. Typical methods include the use of timber blocks screwed or bolted into the concrete core or cast-in anchor bolts and metal plates.

Technical Investigations

18 Investigations

18.1 A site visit was carried out to see a completed building and its performance in use.

18.2 An assessment was made on technical data relating to:

- mechanical resistance of the EPS elements against concrete pressure
- structural design
- fire performance
- acoustic performance.

18.3 Calculations in accordance with BS EN ISO 6946 : 2007 and BS 5250 : 2002 were carried out relating to hygrothermal performance.

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

Bibliography

BS 4449 : 2005 *Steel for the reinforcement of concrete — Weldable reinforcing steel — Bar, coil and decoiled product — Specification*

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

BS 5628-3 : 2005 *Code of practice for the use of masonry — Materials and components, design and workmanship*

BS 8102 : 1990 *Code of practice for protection of structures against water from the ground*

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

BS 8110-2 : 1985 *Structural use of concrete — Code of practice for special circumstances*

BS 8212 : 1995 *Code of practice for dry lining and partitioning using gypsum plasterboard*

BS 8298 : 1994 *Code of practice for design and installation of natural stone cladding and lining*

BS EN 206-1 : 2000 *Concrete — Specification, performance, production and conformity*

BS EN 520 : 2004 *Gypsum plasterboards — Definitions, requirements and test methods*

BS EN 845-1 : 2003 *Specification for ancillary components for masonry — Ties, tension straps, hangers and brackets*

BS EN 934-2 : 2009 *Admixtures for concrete, mortar and grout — Concrete admixtures — Definitions and requirements, conformity, marking and labelling*

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

BS EN 1992-1-2 : 2004 *Eurocode 2 : Design of concrete structures. General rules and rules for buildings. General rules. Structural fire design*

BS EN 12350-1 : 2009 *Testing fresh concrete — Sampling*

BS EN 13914-1 : 2005 *Design, preparation and application of external rendering and internal plastering — External rendering*

BS EN 13501-1 : 2007 *Fire classification of construction products and building elements. Classification using test data from reaction to fire tests*

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

EN 1365-1 : 1999 *Fire resistance tests for load-bearing elements— Walls*

EN ISO 140-4 : 1998 *Acoustics — Measurement of sound insulation in buildings and of building elements — Field measurements of airborne sound insulation between rooms*

Conditions of Certification

19 Conditions

19.1 This Certificate:

- relates only to the product/system that is named and described on the front page
- is issued only to the company, firm, organisation or person named on the front page — no other company, firm, organisation or person may hold or claim that this Certificate has been issued to them
- is valid only within the UK
- has to be read, considered and used as a whole document — it may be misleading and will be incomplete to be selective
- is copyright of the BBA
- is subject to English Law.

19.2 Publications, documents, specifications, legislation, regulations, standards and the like referenced in this Certificate are those that were current and/or deemed relevant by the BBA at the date of issue or reissue of this Certificate.

19.3 This Certificate will remain valid for an unlimited period provided that the product/system and its manufacture and/or fabrication, including all related and relevant parts and processes thereof:

- are maintained at or above the levels which have been assessed and found to be satisfactory by the BBA
- continue to be checked as and when deemed appropriate by the BBA under arrangements that it will determine
- are reviewed by the BBA as and when it considers appropriate.

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

19.5 In issuing this Certificate, the BBA is not responsible and is excluded from any liability to any company, firm, organisation or person, for any matters arising directly or indirectly from:

- the presence or absence of any patent, intellectual property or similar rights subsisting in the product/system or any other product/system
- the right of the Certificate holder to manufacture, supply, install, maintain or market the product/system
- individual installations of the product/system, including their nature, design, methods, performance, workmanship and maintenance
- any works and constructions in which the product/system is installed, including their nature, design, methods, performance, workmanship and maintenance
- any loss or damage, including personal injury, howsoever caused by the product/system, including its manufacture, supply, installation, use, maintenance and removal.

19.6 Any information relating to the manufacture, supply, installation, use, maintenance and removal of this product/system which is contained or referred to in this Certificate is the minimum required to be met when the product/system is manufactured, supplied, installed, used, maintained and removed. It does not purport in any way to restate the requirements of the Health and Safety at Work etc. Act 1974, or of any other statutory, common law or other duty which may exist at the date of issue or reissue of this Certificate; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any statutory, common law or other duty of care.

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