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BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

Styro Stone GB Ltd
The Old Post House
91 Heath Road
Weybridge
Surrey KT13 8TS
Tel: 0871 789 76 78
e-mail: info@styrostone.co.uk
website: www.styrostone.com

Agrément Certificate No 06/4339

Designated by Government to issue European Technical Approvals

STYRO STONE PERMANENT INSULATING CONCRETE FORMWORK

Coffrage perdu
Betonschalung ortsfest

Product

- *THIS CERTIFICATE RELATES TO STYRO STONE PERMANENT INSULATING CONCRETE FORMWORK (PIF), COMPRISING EXPANDED POLYSTYRENE PANELS WITH SOLID POLYSTYRENE INTERCONNECTING SPACERS.*
- *The product is for use in loadbearing and non-loadbearing internal, separating or external walls in dwellings and in buildings of similar occupancy.*
- *The product provides permanent formwork for in-situ dense aggregate concrete walls and contributes to the thermal insulation of the finished construction.*

continued

Regulations

1 The Building Regulations 2000 (as amended) (England and Wales)

The Secretary of State has agreed with the British Board of Agrément the requirements of the Building Regulations to which formwork can contribute in achieving compliance. In the opinion of the BBA, Styro Stone Permanent Insulating Concrete Formwork, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting the relevant requirements.

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 7.2, 7.3, 9.1 and 9.2 of this Certificate.
Requirement:	B3(1)(2)(3)	Internal fire spread (structure)
Comment:		Walls can meet this Requirement. See section 16.1 of this Certificate. See also section 16.4 of this Certificate.
Requirement:	C2(a)	Resistance to moisture
Comment:		Walls can adequately limit the risk of moisture ingress from the ground. See sections 7.2, 7.3, 15.1 and 15.2 of this Certificate.

continued

- *It is for use with the internal and external finishes.*
- *Subject to design and supervision by a chartered engineer, the formwork may be used for constructing basement walls.*

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 12.1 and 12.3 of this Certificate.
Requirement:	E1	Protection against sound from other parts of the building and adjoining buildings
Requirement:	E2	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 a building meeting the Target Emission Rate. See sections 10.1, 10.2, 11.1 and 11.2 of this Certificate. Walls can also adequately limit heat loss by unwanted air infiltration and excessive additional heat loss at junctions between walls, with other elements and around openings. See sections 10.3 to 10.5 of this Certificate.
Requirement:	Regulation 7	Materials and workmanship
Comment:		The product is acceptable. See sections 19.1 to 19.3 of this Certificate.

2 The Building (Scotland) Regulations 2004

In the opinion of the BBA, Styro Stone Permanent Insulating Concrete Formwork, if used in accordance with the provisions of this Certificate, will satisfy or contribute to satisfying the various Regulations and related Mandatory Standards as listed below.

Regulation:	**8**	**Fitness and durability of materials and workmanship**
Regulation:	8(1)	Fitness and durability of materials and workmanship
Comment:		The product can contribute to a construction satisfying this Regulation. See sections 19.1 to 19.3 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 7.2, 7.3, 9.1 and 9.2 of this Certificate.
Standard:	2.2	Separation
Standard:	2.3	Structural protection
Comment:		Walls can satisfy the short, medium or long fire-resistance durations required by these Standards, with reference to clauses 2.2.1[(1)], 2.2.5[(1)], 2.3.1[(1)] and 2.3.3[(1)]. Junctions between walls can maintain the required fire-resistance durations, with reference to clauses 2.1.16[(2)], 2.2.10[(1)] and 2.3.5[(1)]. See section 16.1 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 2.1.13[(2)], 2.1.14[(2)], 2.2.7[(1)], 2.2.8[(1)], 2.3.2[(1)] and 2.3.3[(1)]. See section 16.2 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 15.1 and 15.2 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 3.15.3[(1)]. See section 12.2 of this Certificate. Walls can contribute to minimising the risk of interstitial condensation, with reference to clauses 3.15.1[(1)] and 3.15.4[(1)]. See section 12.3 of this Certificate.
Standard:	5.1	Resisting sound transmission to dwellings
Comment:		Separating walls can satisfy this Standard, with reference to clauses 5.1.1[(1)(2)], 5.1.2[(1)] and 5.1.4[(1)(2)]. See sections 13.1 and 13.3 of this Certificate.

Standard:	6.2	Building insulation envelope
Comment:		Walls will meet the requirements of the Elemental Method for limiting heat loss, with reference to clause 6.2.1[1][2]. See sections 10.1, 10.2 and 11.3 of this Certificate. Walls can also adequately limit heat loss by unwanted air infiltration and excessive additional heat loss at junctions between walls, with other elements and around openings, with reference to clauses 6.2.4[1][2] and 6.2.5[1][2]. See sections 10.6 and 10.7 of this Certificate.
		(1) Technical Handbook (Domestic).
		(2) Technical Handbook (Non-Domestic).

3 The Building Regulations (Northern Ireland) 2000

In the opinion of the BBA, Styro Stone Permanent Insulating Concrete Formwork, if used in accordance with the provisions of this Certificate, will satisfy or contribute to satisfying the various Building Regulations as listed below.

Regulation:	B2	Fitness of materials and workmanship
Comment:		The product is acceptable. See sections 19.1 to 19.3 of this Certificate.
Regulation:	C4	Resistance to ground moisture and weather
Comment:		Walls can adequately limit the risk of moisture ingress from the ground. See sections 7.2, 7.3, 14, 15.1 and 15.2 of this Certificate.
Regulation:	C5	Condensation
Comment:		Walls can contribute to minimising the risk of interstitial condensation. See section 12.3 of this Certificate.
Regulation:	D1	Stability
Comment:		Walls will have adequate strength and stiffness to satisfy this Regulation. See sections 7.2, 7.3, 9.1 and 9.2 of this Certificate.
Regulation:	D2	Disproportionate collapse
Comment:		Walls, when suitably reinforced, will have adequate strength and stiffness to satisfy this Regulation. See sections 7.2, 7.3, 9.1 and 9.2 this Certificate.
Regulation:	E4(1)(2)(3)	Internal fire spread — Structure
Comment:		Walls can satisfy this Regulation. See section 16.1 of this Certificate.
Regulation:	F2	Building fabric
Comment:		Walls will meet the requirements of the Elemental Method for limiting heat loss. See sections 10.1 and 10.2 of this Certificate. Walls can also adequately limit heat loss by unwanted air infiltration and excessive additional heat loss around openings. See sections 10.8 to 10.10 and 11.4 of this Certificate.
Regulation:	G2	Separating walls and separating floors
Comment:		Separating walls can satisfy this Regulation. See section 13.1 of this Certificate.

4 Construction (Design and Management) Regulations 1994 (as amended)
Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)

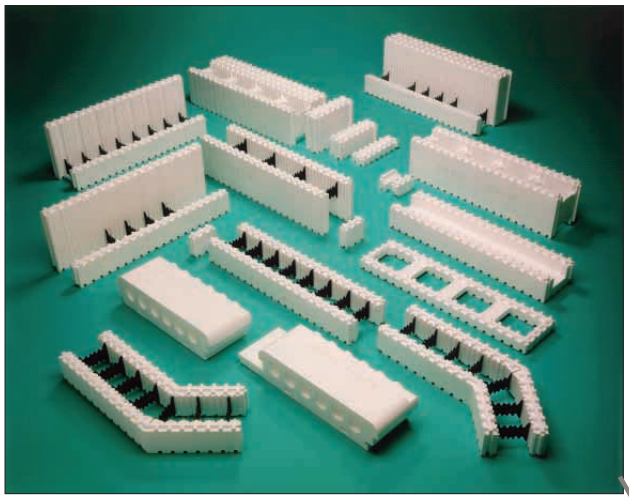
Information in this Certificate may assist the client, planning supervisor, designer and contractors to address their obligations under these Regulations.

See sections:	6 *Site handling and storage* (6.4) and 8 *Practicability of installation* (8.1 to 8.3).

5 Description

5.1 The Styro Stone Permanent Insulating Concrete Formwork (PIF) system comprises elements of two expanded polystyrene panels separated by solid moulded polystyrene spacer ties cast in during production (see Figure 1). The elements interlock and build up horizontally and vertically into a tight, rigid formwork. The wall is formed by placing or pouring concrete into the formwork.

Figure 1 Styro Stone PIF elements[1]



(1) Includes corner and bay angle elements (linear) but not curved structures.

5.2 The modules are 1000 mm long, either 125 mm or 250 mm high and available in two types: Standard PIF and RR, both in white EPS or grey Neopor EPS grade. The two types interlock together. The wall thicknesses achieved are given in Table 1.

Table 1 Wall thickness

Type	Nominal thickness (mm)			
	Polystyrene internal	Concrete	Polystyrene external	Overall
Standard PIF	50	145	50	250
Neopor RR	50	145	150	350

5.3 The formwork components are:

- expanded polystyrene panels — flame retardant Class E, with nominal density of 25 kgm^{-3} and the thermal conductivity may be taken as 0.034 $Wm^{-1}K^{-1}$ for Standard PIF and RR, and 0.031 $Wm^{-1}K^{-1}$ for Neopor Standard PIF and Neopor RR. Upper and lower surfaces are castellated and the vertical mating surfaces are tongue-and-groove to form a tight fit when interlocked together. The rigid formwork does not require supporting falsework, but vertical struts are advisable in order to keep walls plumb during concreting. The inner surfaces have tapered grooves running vertically and are offset on opposite faces to ensure uniform concrete thickness. They also form locks for end stops. The outer surfaces are grooved vertically at 50 mm centres to aid cutting and trimming
- polystyrene spacer — nominally 2.5 mm thick, black or grey, spanning between the two EPS panels and incorporated during manufacture. They are disposed vertically and top edges are serrated giving support to reinforcing bars where required
- end stops — EPS blocks that lock into the internal-tapered grooves running vertically.

5.4 Concrete — usually Grade C30/37 for basement work and C20/25 elsewhere, specified to BS EN 206-1 : 2000. The recommended maximum aggregate size is 10 mm. It should contain a superplasticising and/or set retarding admixture complying with BS EN 934-2 : 2001 to allow placement either by rodding or by free flow. Vibrating equipment must not be used.

5.5 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 render — in accordance with BS 5262 : 1992, typically a basecoat of cement, sand and polymer reinforced, with either a stainless steel lath polypropylene mesh, or an alkaline-resistant glass-fibre mesh
- acrylic render — the Certificate holder is able to advise on acrylic render products for use with the system
- external masonry — may be of brickwork or stonework fixed in accordance with the provisions of BS 5628-3 : 2005 or BS 8298 : 1994 respectively
- internal finish (not covered by this Certificate) — 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
- trestle support as supplied by the Certificate holder.

6 Site handling and storage

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

6.2 The product is supplied shrink-wrapped and wrapping should not be opened until the contents are required.

6.3 Packs should be stored on their sides to protect the castellations from damage.

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

Design Data

7 General

7.1 Styro Stone Permanent Insulating Concrete Formwork (PIF) is satisfactory for use in loadbearing and non-loadbearing internal, separating or external walls as permanent formwork for in-situ dense aggregate concrete. It acts as lost shuttering and provides a significant contribution to the thermal insulation of new walls.

7.2 Buildings subject to the national Building Regulations should be constructed in accordance with the relevant recommendations of BS 8110-1 : 1997, BS 8110-2 : 1985, BS 8102 : 1990 and CP 102 : 1973.

7.3 Other buildings not subject to any of the Regulations defined in section 7.2 should also be built in accordance with BS 8110-1 : 1997, BS 8110-2 : 1985 and CP 102 : 1973.

7.4 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 may be checked by removal of a section of EPS panel, observation, and then replacement. Voids are readily detected during the concrete placement, by hitting the EPS panel (eg with the palm of the hand or a wooden mallet) and listening for a 'hollow' sound. Suitable supervision during placing and compacting of the concrete must be provided.

7.5 Storey-height concrete walls are normally constructed in one or more lifts. Particular care is necessary to maintain alignment during concrete filling, and checking between lifts.

8 Practicability of installation

8.1 Installation of the formwork by trained operatives, including the forming of door and window openings, is practicable. The panels can be cut using conventional woodworking tools, thus carpentry skills are appropriate.

8.2 Concrete can be placed by hand, by skip with adapted neck or by pump. The requirements given in sections 21.10 to 21.13 of this Certificate must be observed during placing and compacting of the concrete.

8.3 Fixings, suitably durable and mechanically adequate, must be supported by the concrete and not by the polystyrene. Appropriate fasteners may be post-drilled or cast into the concrete. In specifying wall fixings carrying vertical loads, consideration should be given to the line of action of the load with respect to the face of the concrete wall and the effect on the strength of the fixing.

8.4 Consideration should be given at the design stage to the positioning of wall fixings, service pipes and joists, relative to the position of connecting assemblies. They can be incorporated by following the manufacturer's recommendations. Care must be taken not to damage the elements and cold bridging effects must be considered.

8.5 Facing brickwork or stonework should be fixed to the concrete with stainless steel ties[1]. Fixings should be applied to the depth recommended by the manufacturer. See section 5.5.

(1) Available from the Certificate holder and can be customised to suit the application.

8.6 Weatherboarding and hung tiles should be fixed to treated battens secured to the in-situ concrete as described in section 8.5 and in accordance with the *Styro Stone Technical Manual*. See section 5.5.

9 Strength and stability

9.1 Walls constructed using the product may be treated as conventional concrete walls and should be designed and constructed in accordance with the recommendations of BS 8110-1 : 1997 and BS 8110-2 : 1985. 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.

9.2 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 BS 8110-2 : 1985, Section 4, whichever is the greater (see section 21.6 of this Certificate).

9.3 To achieve structurally-stable walls sufficiently plane for finishings, it will be necessary to brace the units during construction, check the plumb and alignment of the walls after each lift and make adjustments to the bracing as necessary. Attention to the accurate levelling of the foundation and initial setting out of the bracing (see sections 21.1 and 21.24) should prevent the need for significant adjustments to be made.

9.4 When used in situations where walls are exposed but have some protection, eg walls of private dwellings and walls of communal dwellings above ground-floor level, the render finish has adequate resistance to impact and abrasion. Guidance may be obtained from the Certificate holder and BRE Current Paper CP 6 : 81 *Assessment of external walls — Hard body impact resistance*.

9.5 The render finish, incorporating the fixing methods and movement joints specified in this Certificate, will withstand the thermal stresses and wind pressures normally experienced in the United Kingdom. In special circumstances (ie in conditions

of severe exposure, as defined in Clause 18 of BS 5262 : 1991) consideration should be given, at the corners of buildings and other special risk positions, to increasing the number of fixings. Typical pull-out strength for a stainless steel fixing in sound substrate is taken as 1000 N and the standard fixing rate is defined as one per square metre.

10 Thermal transmittance

10.1 For the purposes of the U value calculations, the nominal thermal conductivity EPS can be taken as 0.034 $Wm^{-1}K^{-1}$ for Standard PIF and RR, and 0.031 $Wm^{-1}K^{-1}$ for Neopor Standard PIF and Neopor RR.

10.2 The thermal transmittance (U value) of external walls can be taken as shown in Table 2, without any contribution from internal and external finishes. Calculations for specific constructions and finishes should be carried out in accordance with the Combined method in BS EN ISO 6946 : 1997 and BRE 443 : 2006 *Conventions for U-value calculations* document.

Table 2 U values[1]

Type	$Wm^{-2}K^{-1}$
Standard PIF	0.29
Neopor Standard PIF	0.26
Standard RR	0.16
Neopor RR	0.14

(1) See Table 1.

10.3 External walls, typically, can improve on the Elemental U value requirement of the Building Regulations (ie 0.35 $Wm^{-2}K^{-1}$) by 17% to 60% and, therefore, will contribute to enabling a building to meet the Target Emission Rate 'average' improvements of 20% (dwellings) and between 23% and 28% (buildings other than dwellings) specified in Approved Documents L1A and L2A respectively.

10.4 Junctions between external walls and between external walls and separating walls will maintain insulation continuity and the default psi values from BRE Information Paper IP 1/06 *Assessing the effects of thermal bridging at junctions and around openings in the external elements of buildings*, Table 3 and SAP 2005 *The Government's Standard Assessment Procedure for Energy Rating of Dwellings*, Table K1, may be used in Target Emission Rate calculations to SAP 2005 or the Simplified Building Energy Model (SBEM)[1]. See Figures 2 and 3.

(1) Published by the Department for Communities and Local Government on its website: www.communities.gov.uk

Figure 2 Typical opening details

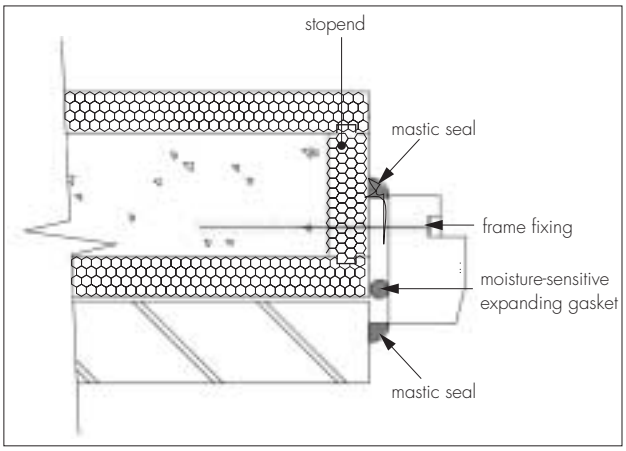
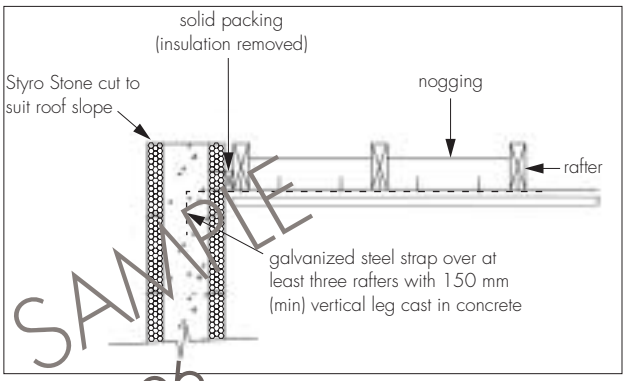


Figure 3 Typical wall/roof junction detail



10.5 Junctions with other elements and openings in external walls, should be designed in accordance with the relevant guidance given in *Limiting thermal bridging and air leakage : Robust construction details for dwellings and similar buildings*[1] or IP 1/06.

(1) Published by The Stationery Office (TSO), 2002.

10.6 External walls can satisfy the Elemental Target U value of 0.30 $Wm^{-2}K^{-1}$ specified in Mandatory Standard 6.2, clause 6.2.1[1][2].

(1) Technical Handbook (Domestic).

(2) Technical Handbook (Non-Domestic).

10.7 Junctions with other elements and openings in external walls, should be designed to limit heat loss. Guidance given in BRE report (BR 262 : 2006) *Thermal insulation : avoiding risks* or IP 1/06 : 2006 is acceptable.

10.8 External walls can satisfy the Elemental Target U value of 0.45 $Wm^{-2}K^{-1}$ specified in the Building Regulations Technical Handbook F, Tables 1.2 and 1.4.

10.9 Openings in external walls, should be designed to limit heat loss. Guidance given in BRE Information Paper IP 12/94 *Assessing condensation risk and heat loss at thermal bridges around openings* may be used (see Figures 2 and 3).

10.10 The walls will adequately limit heat loss by air infiltration, however, care must be taken in the design and detailing of junctions with other elements.

11 Air leakage

11.1 External walls can provide adequate resistance to heat loss by air infiltration. Care should be taken to ensure that junctions with other elements and openings in external walls, comply with the relevant guidance for airtightness given in the relevant documents referred to in section 10.5.

11.2 Completed buildings are subject to pre-completion testing for airtightness in accordance with the requirements of the Building Regulations, Approved Documents L1A and L2A, Section 20B.

11.3 Junctions with other elements and openings in external walls, should be designed to limit air infiltration (see section 10.7).

11.4 Junctions with other elements should be designed to limit air infiltration as described in the Building Regulations, Technical Booklet F, section 1.35.

12 Surface condensation

12.1 Walls, openings and junctions with other elements shown in Figures 2 and 3 will adequately limit the risk of surface condensation when, the thermal transmittance (U value) does not exceed 0.7 $Wm^{-2}K^{-1}$ at any point. Any such junctions with other elements should be designed in accordance with TSO publication *Limiting thermal bridging and air leakage : Robust construction details for dwellings and similar buildings* TSO 2002 or BRE document IP 1/01, *Assessing the effects of thermal bridging at junctions and around openings*.

12.2 Walls will adequately limit the risk of surface condensation when the thermal transmittance (U value) does not exceed 1.2 $Wm^{-2}K^{-1}$ at any point. Guidance may be obtained from Section 8 of BS 5250 : 2002 and BRE report (BR 262 : 2002).

12.3 A suitably-positioned vapour control layer should be used unless a condensation risk assessment in accordance with BS 5250 : 2002 shows it not to be necessary for the purposes of calculations, a nominal vapour diffusion factor μ of 60 (a vapour resistivity of 300 $MNsg^{-1}$), may be taken for the EPS component of the system.

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 for 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 Section 1 of Approved Document E.

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

14 Weathertightness

Resistance to rain ingress is provided by the external weather cladding system. Typical options are described in section 5.5 and care should be taken to ensure that design and construction comply with the relevant good practice described in the applicable Codes and the Certificate holder's instructions.

15 Damp-proofing and waterproofing

15.1 The product will not transmit moisture by capillary action. The concrete wall formed with the product should be constructed using the specified concrete in accordance with Type B structures — structures without membrane in BS 8102 : 1990 (see also sections 5.4 and 7.2 of this Certificate).

15.2 When used below ground level, eg basement or retaining wall, proper waterproofing materials, compatible with EPS must be used on the external surface. Where groundwater is present then 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.

16 Behaviour in relation to fire

16.1 Concrete walls with 0.4% to 1% reinforcement and a minimum cover to the reinforcement of 25 mm are assessed as having a fire resistance of 1.5 hours (long duration in Scotland) in accordance with Table 4.6 of BS 8110-2 : 1985, provided they have at least a concrete thickness of 140 mm. Concrete walls containing less than 0.4% reinforcement are assessed as having a fire resistance in excess of one hour, provided they have at least a concrete thickness of 150 mm. 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.

16.2 The expanded polystyrene component of the system would not be classified as non-combustible. For buildings in Scotland, completed walls with appropriate finishes can satisfy the required durations of fire resistance and may therefore 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.

16.3 The risk of fire spread over the internal and external wall surfaces will depend on the finishes that are used. The relevant requirements of the national Building Regulations should be observed.

16.4 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.

16.5 In buildings other than those described in section 16.4, it is recommended that designers consider the guidance given in that section.

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

17 Proximity of flues and appliances

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

England and Wales

Approved Document J3

Scotland

Mandatory Standard 3.19, clauses 3.19.4[1][2] to 3.19.7[1][2]

(1) Technical Handbook (Domestic).

(2) Technical Handbook (Non-Domestic).

Northern Ireland

Technical Booklet L.

18 Maintenance and repair

18.1 Regular checks should be carried out on render finishes to ensure that any damage is detected and repaired as soon as possible.

18.2 Minor repairs to the system can be carried out prior to concrete pouring using expanding foam, supplied by the Certificate holder, to reduce leakage of wet concrete and maintain the thermal integrity of the EPS.

19 Durability

19.1 Concrete walls constructed with the product will have a service life of 60 years provided they are designed in accordance with section 9 and proper maintenance is carried out in accordance with section 18.

19.2 The EPS formwork will have a similar service life provided that it is protected from damage by the external and internal finishes of the wall construction and these are adequately maintained.

19.3 The solid polystyrene spacers, polypropylene mesh, steel fixing pins, movement joint beads and profile trims are conventional building materials and will have a durability compatible with the expanded polystyrene.

Installation

20 General

The preparation, installation and support of the panels and application of the specified finishes must be in accordance with the *Styro Stone Technical Manual*. Particular attention must be given to the requirements given in sections 8.1 to 8.6 of this Certificate.

21 Procedure

21.1 The foundation should be flat and level to within ±10 mm. Normally, four courses are laid around the perimeter, aligned and the trestle support, or similar, bolted into position. These are precisely levelled and adjustments made to the panels with slate shims or dry mortar where necessary. The base panels should be supported to maintain panel stability before concrete to a maximum depth of three blocks height or one metre (whichever is the least) is poured into the PIF to anchor the formwork base.

21.2 The elements are dry laid in courses with the castellations uppermost, in broken bond to ensure the vertical joints are staggered by quarter of a panel length. This creates a rigid assembly and a void where reinforcement can be fixed and concrete placed or poured. Typical construction details are shown in Figures 4 to 6. Vertical supporting struts can be secured by screwing into the spacers, auger fixing into the EPS, or by timber fillets inside the formwork, preferably spanning a joint.

Figure 4 Typical corbel detail

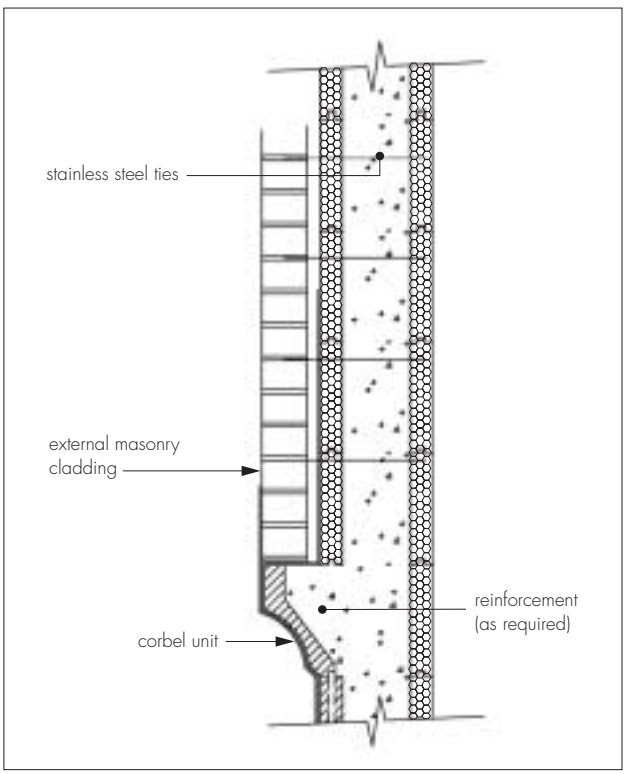


Figure 5 Typical ground-floor detail

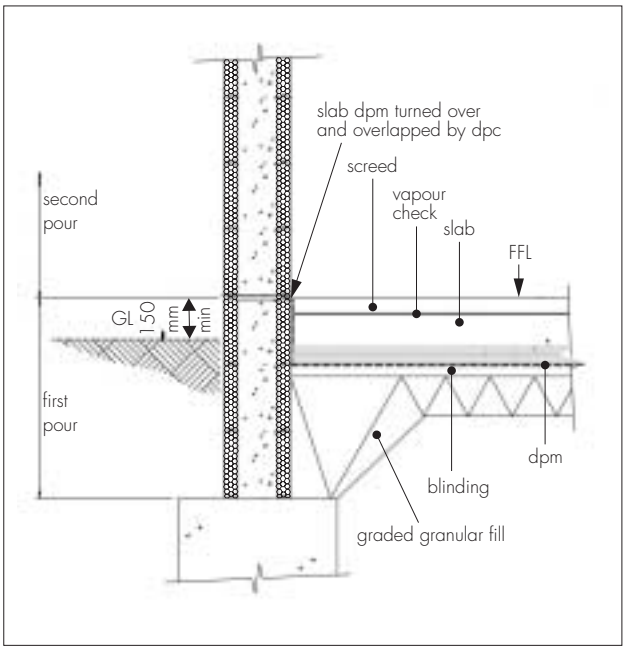
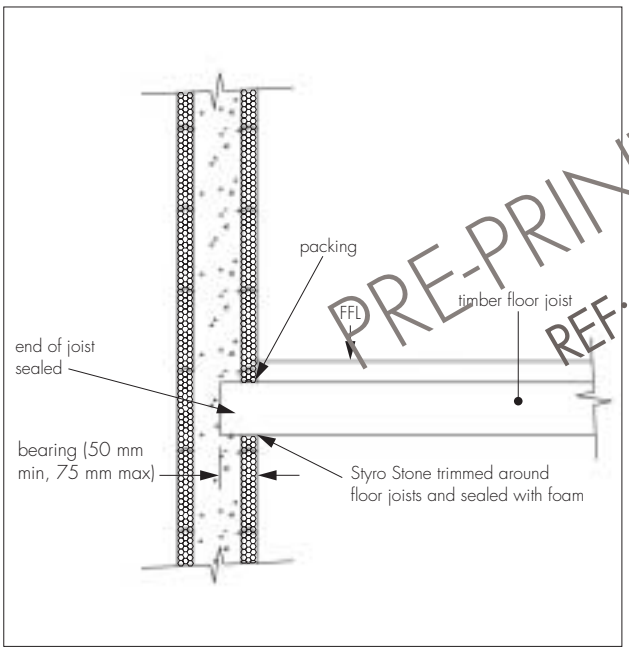


Figure 6 Typical first-floor detail



Openings

21.3 Where an opening is required, eg for a door or window, this is formed by fitting reveal closures to both sides and soffit closures at the top of the opening. The panels may overun the closures and be cut away after the concrete has set. The *Styro Stone Technical Manual* illustrates alternative fixing and weatherproofing details at doors and windows with various cladding systems. Details of design at typical window and door openings are shown in Figure 2. Adhesive tape across horizontal joints on the two to three courses above doorways or windows is recommended, to avoid the product floating as the concrete is placed.

21.4 Lintel formwork should be temporarily supported over openings during concreting and left in place until the concrete is sufficiently strong. This can be achieved by building up vertical struts within the opening using expanded polystyrene offcuts or by using steel or timber props.

21.5 Both concrete and timber floor types can be used. Any depth of floor can be accommodated by cutting the inner panels at floor level. When a wall is to be raised past a suspended floor, concrete should only be poured to the top level of the floor to minimise the outward pressure of wet concrete. Placing of the concrete can continue after the initial concrete has achieved sufficient strength. A typical wall/roof junction is illustrated in Figure 3.

Concrete floors

21.6 Three types of concrete floor construction can be accommodated by the product, ie in-situ concrete; composite precast with in-situ screed; and precast concrete units. Each type has different requirements with regard to wall/floor location and propping arrangements. Details are given in the *Styro Stone Technical Manual.*

Timber floors

21.7 The panels for the inner face of the walls can be cut to fit around the joists. Any gaps greater than 3 mm should be sealed with expandable foam.

21.8 Where the wall is to continue above joist level, the joist ends are temporarily supported to stay level and concrete poured up to and above the joists. However, when the pour or placement of concrete is not continuous, it is essential that the distance from the top of the previous pour to the bottom of the joists is greater than 100 mm. Where the joists are wider than 100 mm, a small inspection hole is made in the inner face of the panels below each joist to check the concrete completely fills the spaces.

21.9 Where the wall is to stop at joist level, concrete is poured and levelled at the top of the panels. When it has hardened the joists can be placed directly on the concrete or a levelling mortar bed.

Stability ties

21.10 As with any loadbearing wall and floor assembly, ties may be necessary at the junctions of walls and floors to provide stability. These may be either galvanized straps as used in traditional masonry walls or internal and peripheral tie reinforcement at slab level complying with Clause 3.12 of BS 8110-1 : 1997.

Incorporation of services and fittings

21.11 Horizontal ducts can be run through the product before the concrete is poured. Holes of the appropriate size are cut in the panels to take the PVC-U pipes. Gaps over 3 mm between the pipe and panel should be filled with expandable foam.

21.12 Pipes and conduits up to 50 mm diameter can be installed in the inner panel by cutting the panel and spacer with a fine-tooth saw.

21.13 Plasticised PVC cables should be run in a rigid PVC-U or metal conduit to avoid contact with the polystyrene panels and potential plasticiser migration. Electrical cables surrounded by insulation will need to be derated in accordance with current regulations.

21.14 Lightweight fittings, eg mirrors, can be fixed through the plasterboard lining. Heavy items such as door frames, cupboards and sanitary ware require timber supports to be fixed to the concrete core.

Installation of reinforcement bars

21.15 The advice of a chartered engineer will be required on the position and size of any reinforcement bars. In most applications, reinforcement is not necessary.

21.16 Horizontal bars are fitted to the upper or lower surface of the spacers as formwork construction proceeds. At corners, the horizontal steel is overlapped to provide continuity and support for any vertical reinforcement.

21.17 Vertical bars are secured to the horizontal bars using soft iron tie-wire or springwire clips.

21.18 Concrete cover to the reinforcement will be at least 25 mm (see section 16.1).

Concrete and filling

21.19 For basement construction a concrete of Grade C30/37 should be used. Basements should be constructed in accordance with the relevant sections of BS 8007 : 1987, BS 8102 : 1990, BS 8110-1 : 1997, BS EN 1992-1-2 : 2004 and the guidance given in the Approved Document *Basement for Dwellings*[1]

(1) Published by British Cement Association Document No 48.062.

21.20 Ready-mixed concrete must be obtained from a plant approved by the Quality Scheme for Ready Mixed Concrete.

Concreting procedures

21.21 The concrete can be placed by pumping, by skip or by hand using a bucket and should be placed as soon as possible after mixing. A pour of concrete can be comprised of several loads or batches provided that a period of less than three hours elapses between the completion of the placement of one load or batch and the commencement of the next. This minimises the number of construction joints.

21.22 The distance of free fall of the concrete must be kept to a minimum to avoid segregation of the aggregates within the formwork. Planks or similar can be laid along the panel tops during concreting to protect the top edges and keep them free from concrete.

21.23 The following sequence of operations should be adopted:

(1) the concrete is placed into the lower part of the formwork using the window openings, where appropriate, and pouring continued until the concrete level is up to the bottom of the sill height. Light rodding at the sides of the openings ensures that the concrete flows the maximum distance away from the opening

(2) all wall sections are filled to a level of 1.5 m before proceeding to plain areas between windows. When the formwork has been built to one-storey height and there are no window openings it is recommended that it is supported at the bottom where the pour commences, and that the starting position is close to a corner. The concrete drops into the formwork and forms a heap to a maximum depth of approximately 1.5 m which flows sideways into the unfilled areas. The pouring position follows the flow of concrete until the remaining areas are filled to this depth.

(3) lintels above openings should be supported during the filling process, using offcuts or surplus stones. Concrete at either side of the openings should be allowed a few minutes to stiffen before continuing the pour at these points

(4) areas between windows are filled by pouring close to the lintel ends until the concrete reaches lintel level. The pour should then follow the flow of concrete until the whole section between lintels is full to lintel height. Voids below sills should be filled before the concrete has reached its initial set

(5) the lintel course and areas between lintels should be filled as a 'continuous beam' from a single pour

(6) the PIF panels are continually checked for alignment during the pour/placement, adjusting if necessary before an initial set has occurred. If an interruption in the pour takes place or the time to complete the pour exceeds three hours, further checks on alignment and plumb should be made before proceeding

(7) precautions must be taken between lifts to prevent the accumulation of water or debris within the formwork and to ensure the formation of sound construction joints. Two methods may be used, as described in (8) and (9)

(8) where a construction joint can be prepared two to four hours after completion of placing the concrete it may be done by spraying with a high-pressure jet of water. This should break up the surface layer and expose the fine aggregate and sand. All loose material is washed away and removed from the formwork by using an industrial wet vacuum cleaner or small sludge pump

(9) when the concrete has set, and it is not possible to use the above method, the surface layer will require to be broken up using mechanical devices to chip it away. All loose material must be removed using an industrial

vacuum cleaner to leave the surface of the concrete clean and free from loose material

(10) before a further pour of concrete commences, the formwork is checked to ensure it has remained clear of debris. When pouring recommences, a shallow layer (not more than 250 mm) of concrete should be placed and well compacted at the horizontal joint before continuing

(11) vertical contraction joints can be introduced where necessary in long, straight walls, by using crack inducers

(12) after placing the concrete it should be protected from heavy rain for the first two hours.

Interior and external finishes

21.24 A range of external and 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 glued to EPS using compatible adhesive. External cladding systems can be fixed similarly via battens, rails or into form tie/spacer flanges or with renders applied directly to the EPS surface in conjunction with metal or plastic lathing. Finishes are outside the scope of this Certificate. Further details can be obtained from the Certificate holder.

Technical Investigations

The following is a summary of the technical investigations carried out on Styro Stone Permanent Insulating Concrete Formwork.

22 Tests

22.1 Tests were undertaken to measure dimensions of the formwork.

22.2 The characteristics of the solid polystyrene spacers were assessed.

23 Investigations

23.1 A completed site was visited and the efficiency of concrete compaction was observed.

23.2 A site in progress and after completion was observed.

23.3 An assessment was made of data relating to fire performance.

23.4 Condensation and thermal assessments were made to the requirements of BS 5250 : 2002 and Approved Documents C2 and L1A of England and Wales. Calculations for specific constructions and finishes should be carried out in accordance with the Combined Method in BS EN ISO 6946 : 1997 and BRE 443 : 2006.

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 5262 : 1991 *Code of practice for external renderings*

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

BS 8007 : 1987 *Code of practice for design of concrete structures for retaining aqueous liquids*

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 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 480-2 : 1997 *Admixtures for concrete, mortar and grout — Test methods — Determination of setting time*

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

BS EN 934-2 : 2001 *Admixtures for concrete, mortar and grout — Concrete admixtures — Definitions, requirements, conformity, marking and labelling*
BS EN 934-3 : 2003 *Admixtures for concrete, mortar and grout — Admixtures for masonry mortar — Definitions, requirements, conformity, marking and labelling*

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 ISO 6946 : 1997 *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

CP 102 : 1973 *Code of practice for protection of buildings against water from the ground*

Conditions of Certification

24 Conditions

24.1 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.

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

24.3 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.

24.4 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 or 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.

24.5 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 or in the future; nor is conformity with such information to be taken as satisfying the requirements of the 1974 Act or of any present or future 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.

BBA BRITISH BOARD OF AGRÉMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

In the opinion of the British Board of Agrément, Styro Stone Permanent Insulating Concrete Formwork is fit for its intended use provided it is installed, used and maintained as set out in this Certificate. Certificate No 06/4339 is accordingly awarded to Styro Stone GB Ltd.

On behalf of the British Board of Agrément

Date of issue: 27th July 2006

Chief Executive

British Board of Agrément
P O Box No 195, Bucknalls Lane
Garston, Watford, Herts WD25 9BA
Fax: 01923 665301

e-mail: mail@bba.star.co.uk
website: www.bbacerts.co.uk

For technical or additional information, contact the Certificate holder (see front page).
For information about the Agrément Certificate, including validity and scope, tel: Hotline 01923 665400, or check the BBA website.