IRISH AGRÉMENT BOARD
CERTIFICATE NO. 23/0433
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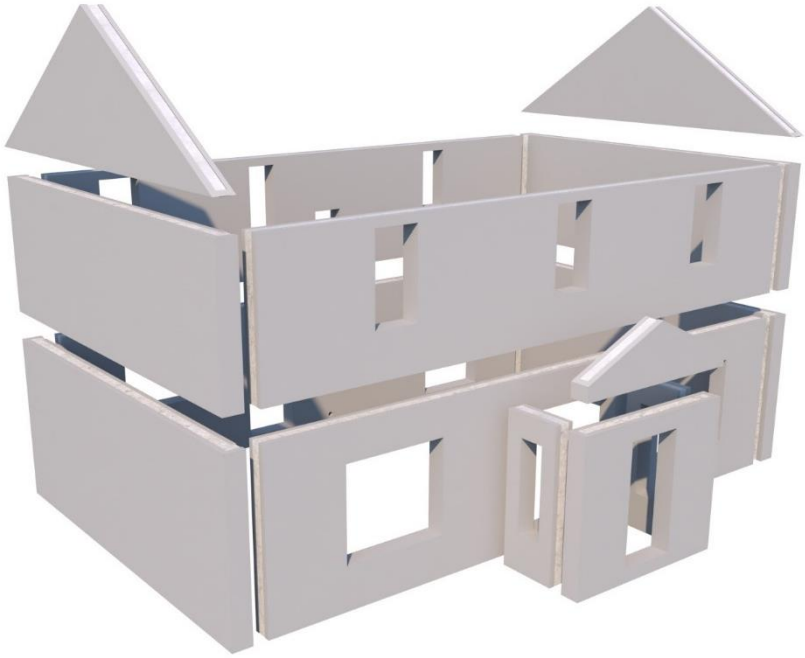
FLI Homes
MMC Rapid Build Sustainable Solutions

NSAI Agrément (Irish Agrément Board) is designated by Government to issue European Technical Approvals.

NSAI Agrément Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with TGD Part D of the second schedule of the **Building Regulations 1997 and subsequent revisions.**



SCOPE

This Certificate relates to the FLI Homes MMC Rapid Build Sustainable Solutions building system for the manufacture and installation of prefabricated ICF (Insulated Concrete Formwork) wall system. The system comprises of panelised IFC wall elements that are factory fitted. The expanded polystyrene (EPS) is fitted as permanent formwork and concrete core installed in a factory environment.

The FLI Homes MMC Rapid Build Sustainable Solutions building system is certified to be used in the construction of buildings up to three storeys (maximum 10m) in height to the top storey or maximum 15m to the ridge in main purpose groups 1(a), 1(b), as defined in TGD to Part B Volume 2 of the Building Regulations.

The product comprises of prefabricated wall panel without external and internal finishes. External finishes shall meet the requirements of Section 3 and 4 of this Certificate.

The system has been assessed for use as load bearing and non-load bearing walls in the buildings purpose groups as stated above. Fire and sound rated walls may be constructed using the system.

DESIGN

The FLI Homes MMC Rapid Build Sustainable Solutions building system is designed, manufactured and supplied by FLI Precast Solutions. The installation of the system is carried out by FLI Precast Solutions or trained and approved subcontractors which are supervised by FLI Precast Solutions. The building system is inspected and certified by FLI Precast Solutions.
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The FLI Precast Solutions nominated Chartered Structural Engineer is responsible for the final structural design of the FLI Homes MMC Rapid Build Sustainable Solutions building system.

In the opinion of NSAI, the FLI Homes MMC Rapid Build Sustainable Solutions building system, as described in this Certificate, complies with the requirements of the Building Regulations.

RESPONSIBILITIES

Prior to the commencement of the contract, the responsibilities are determined and agreed between FLI Precast Solutions and the main contractor, including foundations, fire stopping, wall finishes, roof completion and other elements.

MANUFACTURE, MARKETING & DESIGN

The product is manufactured, marketed, designed and erected by:

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1.1 BUILDING REGULATIONS

Part D – Materials and Workmanship
D1 – Materials and Workmanship
D3 – Proper Materials

The FLI Homes MMC Rapid Build Sustainable Solutions building system is comprised of 'proper materials' i.e. materials which are fit for their intended use and for the conditions in which they are to be used.

Note: Nothing in this Certificate is intended to prevent the use of materials of equivalent or superior quality, strength, fire resistance, effectiveness, durability and safety over those described in this Certificate.

Buildings incorporating the FLI Homes MMC Rapid Build Sustainable Solutions building system can be designed to meet the requirements of the following clauses of the Building Regulations:

Part A - Structure
A1 – Loading
A2 – Ground Movement
A3 – Disproportionate Collapse

Part B – Fire Safety
For purpose groups 1(a), 1(b) the fire safety requirements are laid out in TGD to Part B Volume 2 of the Building Regulations.

B1 & B6 – Means of Escape in Case of Fire
B2 & B7 – Internal Fire Spread (Linings)
B3 & B8 – Internal Fire Spread (Structure)
B4 & B9 – External Fire Spread

Part C – Site Preparation and Resistance to Moisture
C3 – Dangerous Substances
C4 – Resistance to Weather and Ground Moisture

Part E – Sound
E1 – Airborne Sound (Walls)

Part F – Ventilation
F1 – Means of Ventilation

Part J – Heat Producing Appliances
J3 – Protection of Building

Part L – Conservation of Fuel and Energy
Sections L1, L5, L6

2.1 PRODUCT DESCRIPTION

This Certificate contains illustrations to explain the various elements of the FLI Homes MMC Rapid Build Sustainable Solutions building system – these illustrations are not intended to be used as construction drawings. FLI Precast Solutions, in conjunction with the design team on a project, will produce a set of project specific details on a project-by-project basis. All drawings should be compliant with the relevant codes of practice and relevant standards, along with current Building Regulations.

2.1.1 Materials

The FLI Homes MMC Rapid Build Sustainable Solutions building system is supplied as a panelised prefabricated wall system. The wall system compromise of an Agrément certified ICF (Insulated Concrete Formwork) system and reinforced concrete core installed in the factory environment.

The ICF blocks comprise of two EPS panels which are connected by polypropylene webs. The inner ICF panel is 75mm thick while the outer ICF panel is supplied in thicknesses of 125/150mm. The webs are located at 200mm centres and maintain a core thickness between the EPS panels of either 150mm or 200mm. The EPS panels are manufactured from fire retardant grade EPS in accordance with I.S. EN 13163[1]. The lowest density ranges between 20-24kg/m^3. The EPS characteristics are shown in Table 2.

The reinforced concrete core is installed in the factory by FLI Precast Solutions. The steel reinforcement used in FLI Homes MMC Rapid Build Sustainable Solutions building system is minimum 10mm diameter round or deformed bars, high tensile to BS 4449[3], BS 4482[4], BS 4483[5], I.S. EN 10020[6], IS EN 10080[29] and I.S. EN 1992-1-1[7], and have a maximum yield strength of 500N/mm^2.

The concrete specification used for panels manufacture is as per Table 1. The concrete specification conforms to I.S. EN 206[2].

Reinforced concrete core is designed and specified by FLI Precast Solutions Chartered Structural Engineer on project by project case basis. The concrete core may be constructed as 150mm or 200mm thick panel between EPS blocks.

Material Characteristics	Concrete	Standard
Minimum Concrete Strength	C40/50	I.S. EN 206
Aggregate Size	Maximum 14mm	I.S. EN 206
Aggregate Type	limestone	I.S. EN 206

Table 1. Concrete Specification

Material Characteristics	EPS 150	Test Standard
Thermal Conductivity	0.031W/mK	EN 12667
Reaction to Fire	Class E	EN 15715
Compressive Strength σ10	CS (10) 150	EN 826
Bending Strength	BS 200	EN 12089
Long Term Water Absorption by Total Immersion	WL(T)i 4.0%	EN 12087
Dimensional Stability	DS(N)5	EN 1603
Length	L2	EN 822
Width	W2	EN 822
Thickness	T1	EN 823
Flatness	P(5)	EN 825
Squareness	S (5)	EN 824

Table 2. ICF EPS Characteristics

2.1.2 Prefabricated Wall Panels

The walls are supplied by FLI Precast Solutions as prefabricated panels. Maximum panel size is 13m long and 3m high. Maximum weight per wall unit is 14.5 tons.

The wall panels are supplied with vertical and horizontal connections. Connection points are cast in the panels in the factory environment. Horizontal connections between the panels are provided using precast couplers. Vertical connections are achieved with dowel bars. All panels are supplied with lifting sockets for the installation purpose. Connections between the panels are shown on Figure 2 and Figure 3.

Window and door openings are formed in the factory environment by FLI Precast Solutions. Window and door openings are formed by the insertion of ICF EPS approved "vertical closer" and horizontal "header closer".

The FLI Homes MMC Rapid Build Sustainable Solutions wall panel is shown on Figure 1.

Figure 1. Prefabricated External Wall Panel

2.1.3 External Walls

The different elements of the external wall are as follows, from external surface to internal:

- An NSAI Agrément approved render system for EPS applied per render manufacturer's approval, instructions and conditions described in that certificate (installed by others)
- 125mm/150mm Agrément certified ICF EPS board (part of the MMC Rapid Build Sustainable Solutions wall system).
- 150mm or 200mm reinforced concrete core width and polypropylene webs (part of the MMC Rapid Build Sustainable Solutions wall system).
- 75mm Agrément certified ICF EPS board (part of the MMC Rapid Build Sustainable Solutions wall system).
- 12.5mm plasterboard slabs screw fixed to the embedded polypropylene web flanges (installed by others).
- 4mm gypsum skin coat plaster, applied over the taped plasterboard joints or on the overall wall (installed by others)

2.1.4 Compartment Walls

Compartment walls can be constructed as either prefabricated ICF wall, precast concrete wall or block wall. Typical prefabricated ICF compartment wall consists of the following:

- 4mm gypsum skin coat plaster, applied over the taped plasterboard joints or on the overall wall (installed by others).
- 12.5mm plasterboard slabs screw fixed to Agrément certified ICF EPS board (through polypropylene web flanges, installed by others).
- 75mm EPS board (part of the MMC Rapid Build Sustainable Solutions wall system).
- 190mm reinforced concrete core width (part of the MMC Rapid Build Sustainable Solutions wall system).
- 75mm EPS board (part of the MMC Rapid Build Sustainable Solutions wall system).
- 12.5mm plasterboard slabs screw fixed to Agrément certified ICF EPS board (through polypropylene web flanges, installed by others).
- 4mm gypsum skin coat plaster, applied over the taped plasterboard joints or on the overall wall (installed by others).

Compartment walls constructed using prefabricated ICF wall panels meet acoustic and fire safety requirements of Building Regulations.

When the wall is constructed as traditional blockwork or precast concrete panel, the wall thickness and finishes shall meet the requirements of TGD to Part B and Part E of the Building Regulations.

2.1.5 Internal Walls

Load bearing internal walls may be constructed using 150mm precast concrete wall panels, prefabricated ICF wall panels (by FLI Precast Solutions); or timber or metal stud wall panel (by others). When using ICF wall panels, the wall shall be slabbed and plastered as per section 2.1.4.

2.1.6 Rising walls

Rising walls can be constructed as precast concrete and prefabricated ICF wall panels (by FLI Precast Solutions); or as traditional blockwork or raft foundations (by others). Typical rising wall detail including connection to foundation is shown on Figure 4.

2.1.7 Ground Floors and Foundations

The construction of the foundations and ground floor slab are the responsibility of the Main Contractor and should be constructed in accordance with the Client's Engineering specification and TGD to Part A of the Building Regulations. Ground floor and foundations shall be checked by Client's Engineer for structural load criteria specified by FLI Precast Solution Engineer. Ground floor and foundations are not part of FLI Homes MMC Rapid Build Sustainable Solutions building system. Tolerances for the system installation on foundations, rising wall or raft are defined in FLI Precast Solutions installation manual.

Dowel bars are used to provide connection between foundation/rising wall and prefabricated ICF wall panel. Figure 2 shows typical dowel connection between ICF wall panels.

Where a suspended slab is specified, it shall be seated on a bed of mortar bearing directly onto the ICF concrete core. The bearing surface shall be 100mm minimum.

2.1.8 Intermediate and Compartment Floors

The FLI Homes MMC Rapid Build Sustainable Solutions building system enables the use of different flooring systems including timber joists, engineered timber joists or precast concrete slabs. Compartment floors shall have appropriate fire resistance. Floor structure is outside the scope of this certificate. Floors design must comply with TGD to Part A of the Building Regulations. Possible floor solutions are listed below.

Precast Concrete Slabs

Where precast concrete slabs are specified for upper floors, the slab ends are laid on a bed of mortar and directly onto the ICF concrete core. The bearing surface shall be 100mm minimum.

Reinforcing tying steel is provided between lower wall unit and floor screed. The dowel bar is provided between lower and upper wall panels for vertical connection. The floor reinforcing steel design is specified by a Client's structural engineer. Typical precast concrete slab to external wall detail is shown on Figure 5.

Timber Joist Floor

Upper floor may be constructed using traditional or engineered timber joists. The joists shall be fixed to concrete pocket cast in wall panel at upper floor level. The timber ledger and joists hanger shall be fixed with anchor bolts to the concrete pocket. The connection shall be specified by a Client's structural engineer. Typical timber joists floor to external wall detail is shown on Figure 6 and Figure 7.

2.1.9 Roof

The roof structure is outside of the scope of this Certificate. The FLI Homes MMC Rapid Build Sustainable Solutions building system enables the use of different roofing system including conventional timer or trussed roof with slating and tiling to SR 82[8].

2.1.10 Chimney

Chimneys are not part of the FLI Homes MMC Rapid Build Sustainable Solutions building system and are not covered by this Certificate. The requirements of Clause 2.15 of TGD to Part J of the Building Regulations require that combustible material such as polystyrene insulation have at least the following separation distance:

a) 200mm from a flue, or
b) 40mm from the outer surface of a brick or blockwork chimney or fireplace recess.

2.1.11 External Finishes

The external faces of the prefabricated ICF wall panels are lightly grooved vertically and horizontally to receive the applied finishes. A light rasping is required to ensure good adhesion. All external finishes are outside of the scope of this Certificate.

NSAI Agrément certified EPS external render, with a minimum B-s1, d0 fire classification, can be applied directly to the EPS in the FLI Homes MMC Rapid Build Sustainable Solutions wall panel. Render to meet requirements of Section 3 & 4 of this certificate, including EPS characteristics as per Table 2.

Before any external finish is applied all fire barriers must be fitted opposite all compartment walls and compartment floors (see Section 3.2).

2.1.12 Internal Linings and Finishes

Linings to walls and ceilings are of gypsum plasterboard Type F, manufactured to I.S. EN 520[30]. Plasterboard slabs shall be screwed to the webs of the polypropylene connectors and have a Class 0 rating to meet the TGD to Part B of the Building Regulations requirements for all internal areas.

2.1.13 Ancillary Items

- Anchor bolts;
- PVC pipe sleeves for penetrations;
- Radon membrane/barrier;
- Low-Expanding foam adhesive;
- Waterproofing membrane;
- Fire stops.

These items are outside the scope of this Certificate.

2.1.14 Services

Services are outside the scope of this Certificate. Electrical installation should be designed and installed in accordance with I.S. 10101**Error! Reference source not found.**. Heating and plumbing services must be designed and installed by competent professional engineers.

Services openings in the precast ICF wall panels can be cast in the factory. Electrical cables shall be prevented from coming into contact with expanded polystyrene by enclosure in conduits or trunking in accordance with I.S. 10101[15]. Electrical sockets and switches shall be installed in PVC or metal boxing.

Service penetrations in compartment walls shall be fire stopped. Service penetrations in the compartment walls shall be appropriately protected in accordance with the Building Regulations.

2.2 DESIGN AND MANUFACTURE

The FLI Homes MMC Rapid Build Sustainable Solutions building systems ICF EPS blocks are manufactured in accordance with I.S. EN 13163[1]. The ICF EPS blocks have a valid Agrément certificate for purpose groups to which this Certificate applies.

Precast wall elements are manufactured in accordance with I.S. EN 14992[31]. Concrete

specification conforms with I.S. EN 206[2]. Reinforced concrete core is designed in accordance with I.S. EN 1992-1[7]. The design and manufacture are the responsibility of FLI Precast Solutions.

2.3 DELIVERY, STORAGE AND MARKING

2.3.1 Delivery of Panels

The FLI Homes MMC Rapid Build Sustainable Solutions wall panels are delivered to site in vertical/upright position.

2.3.2 Storage

The FLI Homes MMC Rapid Build Sustainable Solutions wall panels shall be stored in an upright position and covered to provide protection from the elements. If precast ICF wall elements are exposed to the elements for an extended period, they should be covered by tarpaulins or other such covers to protect them from water and UV light. The FLI Homes MMC Rapid Build Sustainable Solutions wall elements shall be protected from prolonged exposure to direct sunlight and must not be exposed to plastic materials containing plasticizers or to volatile aggressive solvents. The polystyrene must not come into contact with aggressive chemicals or deleterious agents, e.g., diesel oil, petrol, various cleaning solvents, hydrocarbons, membranes containing coal tar pitches or building products containing solvents. Reasonable care must be taken to prevent damage to forms before, during and after installation.

2.3.3 Safe Handling

For every site a specific risk assessment must be created in order to access the risks involved with the handling and installation of the precast ICF wall panels and any ancillary products.

Wall panels should always be moved using a crane supplied by the precast concrete installer or contractor (project specific) using the lifting inserts cast into the units for that purpose.

2.3.4 Traceability

When the panel is completed and passed quality control in the factory, the label is attached to it stating typically:

- Project name and number
- Reference number of the panel in the project
- Quality check
- Total weight

2.4 INSTALLATION

2.4.1 General

All off-loading and erection shall be in accordance with the FLI Precast Solutions method statement and erection procedures. Site installation must only be carried out by approved and trained installers employed by FLI Precast Solutions or by a specialist sub-contractor under the supervision of FLI Precast Solutions and in accordance with the FLI Precast Solutions installation manual. In any scenario, the FLI Precast Solutions is responsible for site inspections and sign off in accordance with Building Regulations.

This Certificate does not contain a complete set of installation instructions, but an overview of the procedures involved. For a full list of these instructions, refer to the Certificate holder's manuals. Should a conflict arise between this Certificate and the Certificate holder's manuals, this Certificate shall take precedence.

2.4.2 Tolerances

Prior to installation of the wall panels, the tolerances are checked on foundations/rising walls by the main contractor and FLI Precast Solutions. The required tolerances can be found in the FLI Precast Solutions installation manual.

2.4.3 Damp Proof Course (DPC)

Dpc, dpm and radon membranes shall be installed by the main contractor prior to panels assembly. DPC shall be certified to EN 13967. Plastic dpc shall be applied across the rising wall along the full width of the prefabricated ICF wall thickness. Where plastic dpc is punctured by starter bars, liquid dpc repair product shall be applied at punctures location or similar product as specified and approved by Client's architect.

2.4.4 Panels Assembly

The assembly of panels should follow the sequencing of panels labelled and shown on the panel labels and detailed drawings.

2.4.5 Panels Lifting

All lifting shall be carried out by competent personnel in accordance with the FLI Precast Solutions Installation Manual and site-specific safety statement. Installers are approved once they have undergone on-site training, and understand the fundamental structural principals of the system, fire stopping requirements, tolerances, importance of weathering, storage and handling of the prefabricated ICF wall panels and all other relevant information.

The placement of a panel should be carried out using a crane. Wall units are generally lifted in the upright condition. Panels shall only be lifted using the lifting inserts cast into the units. Lifting details for each unit will be provided to the crane operator and installers by FLI Precast Solutions.

2.4.6 Panels Fixing and Bracing

Anchorage of the panels to the foundations/rising walls are provided through starter bars cast into foundations. The starter bar's location shall be identified on foundations drawings and prefabricated ICF wall drawings. Starter bar's locations shall be checked on site prior to installation of wall units. Alternatively starter bars

can be drilled into foundation/rising walls (as per Client's structural engineer specification).

Bedding of M6 mortar shall be provided to the bearing surface of the wall unit as per FLI Precast Solutions project drawings. The wall shall be lifted into position and its level and line checked. Bracing as per FLI Precast Solutions drawings and specification shall be installed prior to removing the unit from the crane. Non-shrink grout to be applied to all connections and fixings as per FLI Precast Solutions specification.

Installation and propping of the wall units shall be in accordance with method statement provided by FLI Precast Solutions. Propping of wall units is project specific. Assembly of next panel can commence only if the first panel is installed and braced. The adjacent units shall be connected horizontally as per FLI Precast Solutions project drawings using the cast-in fixings and bolts to ensure a robust and stable joint.

Typical erection sequence is shown below:

- First unit must be bedded in mortar, lined, levelled and temporary bracing fixed in place before the lifting crane moves off
- Second unit is bedded in mortar, lined, levelled, braced and bolted to previous unit before crane moves to next unit.
- Next unit is placed as per second step.
- Continue until a closed cell is completed.
- Bracing can be removed when a closed cell is complete.
- Complete one level before moving to the next level.
- Concrete floor or roof slabs and screeds must be installed before erecting ICF units above the floors.
- Timber floors and roofs should be installed immediately after the supporting structure is completed.

2.4.7 Floors Fixing

Upper floors fixing shall be in accordance with Section 2.1.8 and Client's structural engineer specification.

Upper Floors will be installed at different stages, depending on floor type. Precast concrete floors will be installed when the support walls are installed, braced and grout in joints have cured. Timber floors will typically be installed as soon as the whole of the concrete structure is in position.

Galvanised straps shall be installed for timber floors as per FLI Precast Carlow drawings and in accordance with Client's structural engineer specification.

2.4.8 Roof Fixing

Roofs may be installed as soon as the support walls are complete. FLI Precast Solutions method statement shall be followed by the main contractor. Timber roofs shall be anchored to wall plate and concrete core of the prefabricated ICF wall panel as per Client's structural engineer specification.

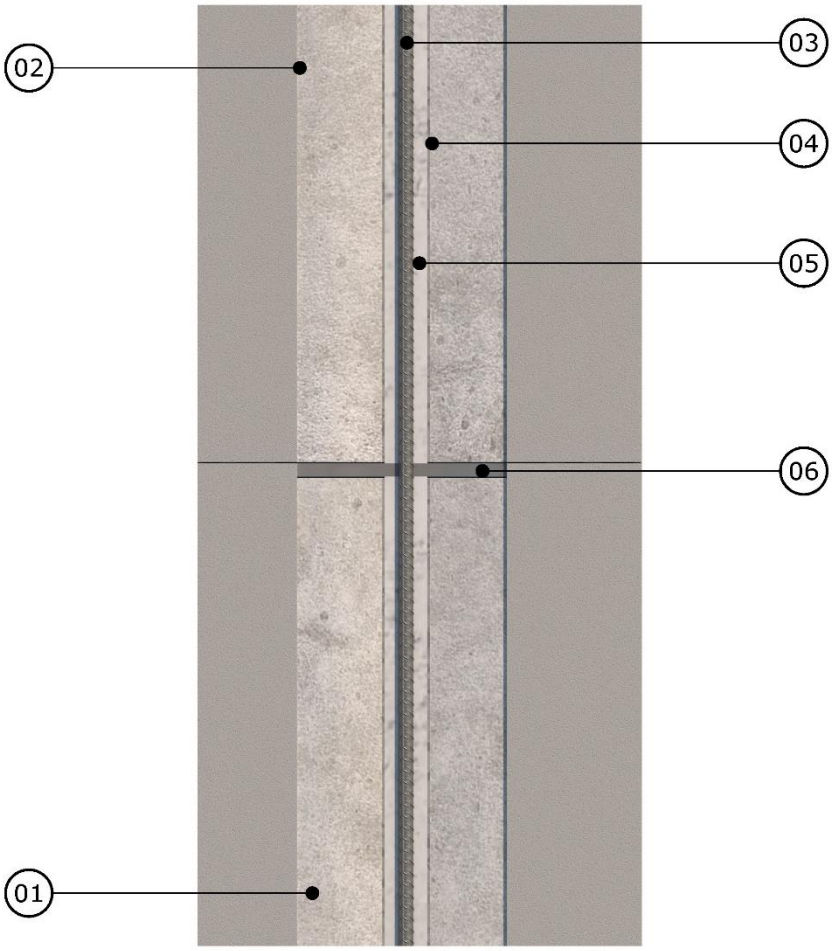
Galvanised straps shall be installed for timber roofs at gable wall as per FLI Precast Solutions drawings and in accordance with Client's structural engineer specification.

2.4.9 Post Installation Tasks

When a render finish is to be applied to the external wall panels, a pre-rendering checklist report shall be completed before rendering commences, which shall include checking that all fire barriers are correctly installed. Where the panels are damaged for example mechanically or by weather conditions, the manufacturer shall be contacted to confirm if the surface of EPS is adequate for applying finishes.

The external render system shall be applied by trained installers of render onto EPS systems. Renders installers shall be registered by NSAI as ETICS installation company. A light rasping of EPS surface is required to ensure good adhesion of render to the wall panel.

Plasterboards shall be screw fixed to the webs of the polypropylene connectors. Fixings shall be in accordance with Client's architectural specification.



SECTION

01. ICF lower wall panel.

02. ICF upper wall panel.

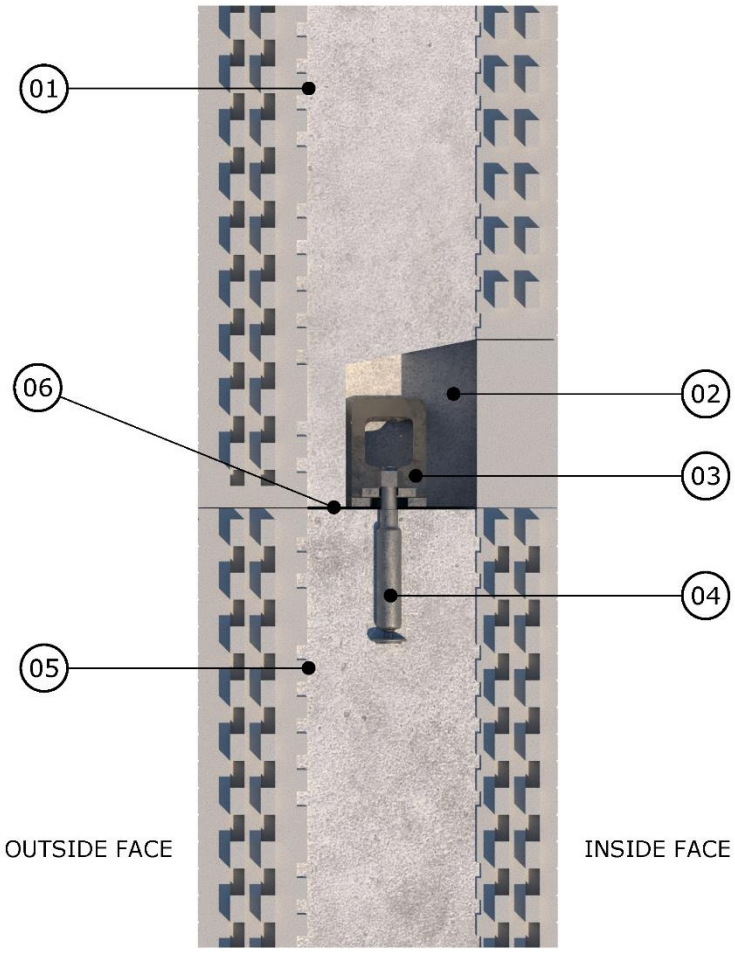
03. H16 dowel bar

04. 50mm Ø PCT spiral void tube

05. Grout as per specification

06. Mortar bed

Figure 2. Typical Horizontal Connection Detail



PLAN

01. ICF wall panel A.

02. Hand access void filled with grout as per specification when connector is tightened.

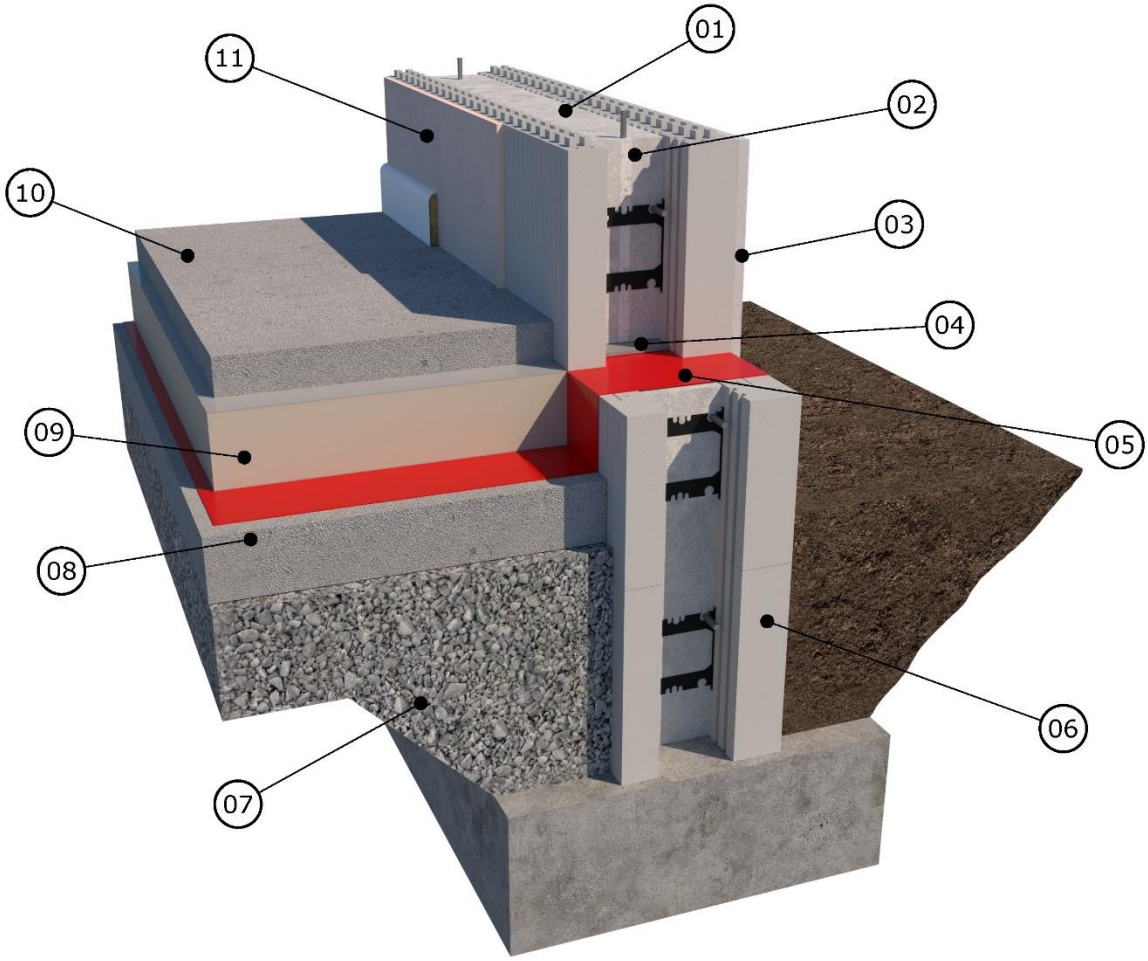
03. Halfen HEK precast coupler or similar approved.

04. Halfen DEMU T-Fixx or similar approved.

05. ICF wall panel B.

06. Joint filled with grout as per specification.

Figure 3. Typical Vertical Connection Detail



01. ICF upper wall panel.

02. Starter bars grouted into cast-in PCT spiral void tubes.

03. IAB approved render for ICF wall system.

04. Mortar bed.

05. Radon/DPM lapped and taped where appropriate.

06. ICF rising wall panel.

07. Hardcore.

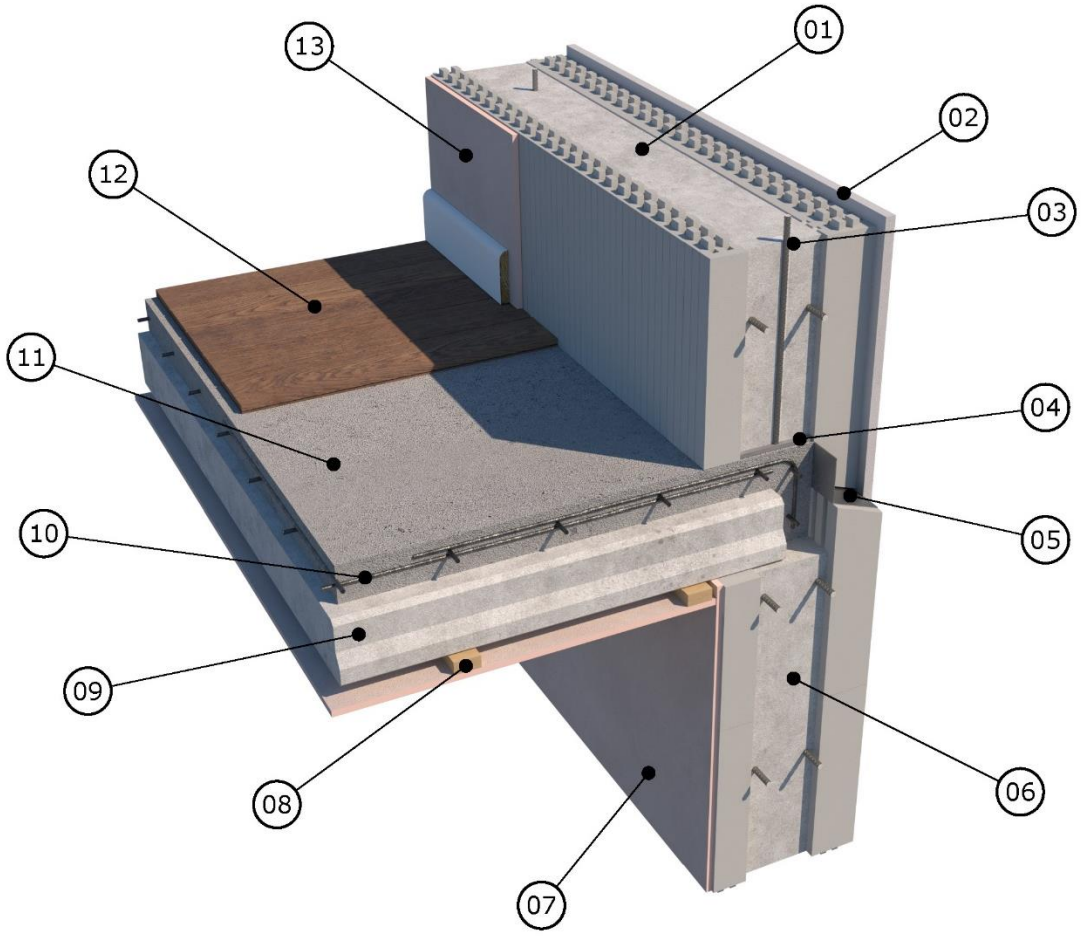
08. Subfloor.

09. Insulation.

10. In-situ floor screed (floor level to be min. 150mm above ground level)

11. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

Figure 4. External Wall to Foundation Detail



01. ICF upper wall panel.

02. IAB approved render for ICF wall system.

03. Starter bars grouted into cast-in PCT spiral void tubes.

04. Mortar bed.

05. Fire break - Galvanised metal strip.

06. ICF lower wall panel.

07. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

08. Timber battens.

09. Precast concrete floor to structural engineers specification.

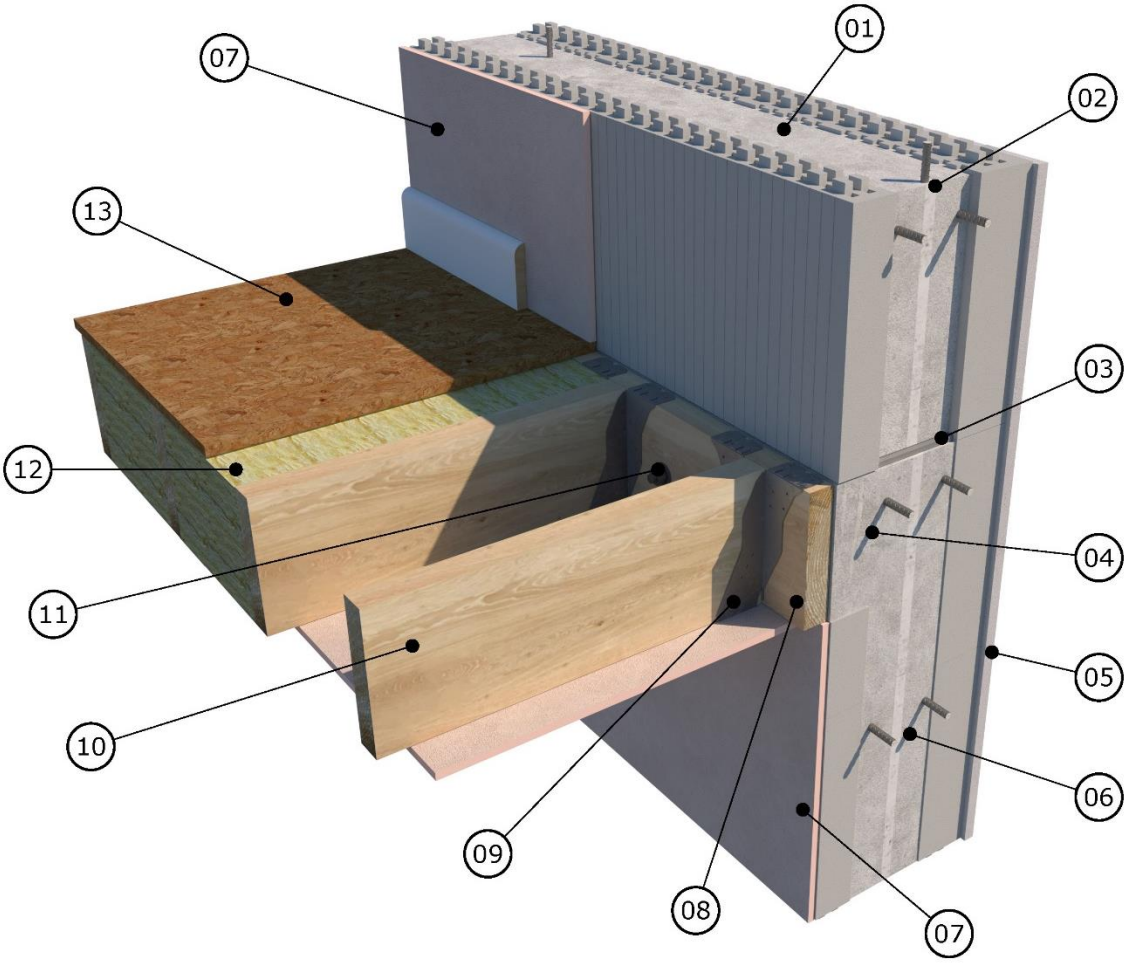
10. Steel mesh reinforcement including tying steel.

11. In-situ floor screed.

12. Flooring material.

13. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

Figure 5. External Wall to Compartment Precast Concrete Floor Detail



01. ICF upper wall panel.

02. Starter bars grouted into cast-in PCT spiral void tubes.

03. Mortar bed.

04. Precast concrete corbel for joists (forming part of the ICF lower wall panel).

05. IAB approved render for ICF wall system.

06. ICF lower wall panel.

07. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

08. Timber ledger fixed to precast concrete support element.

09. Timber joist hanger.

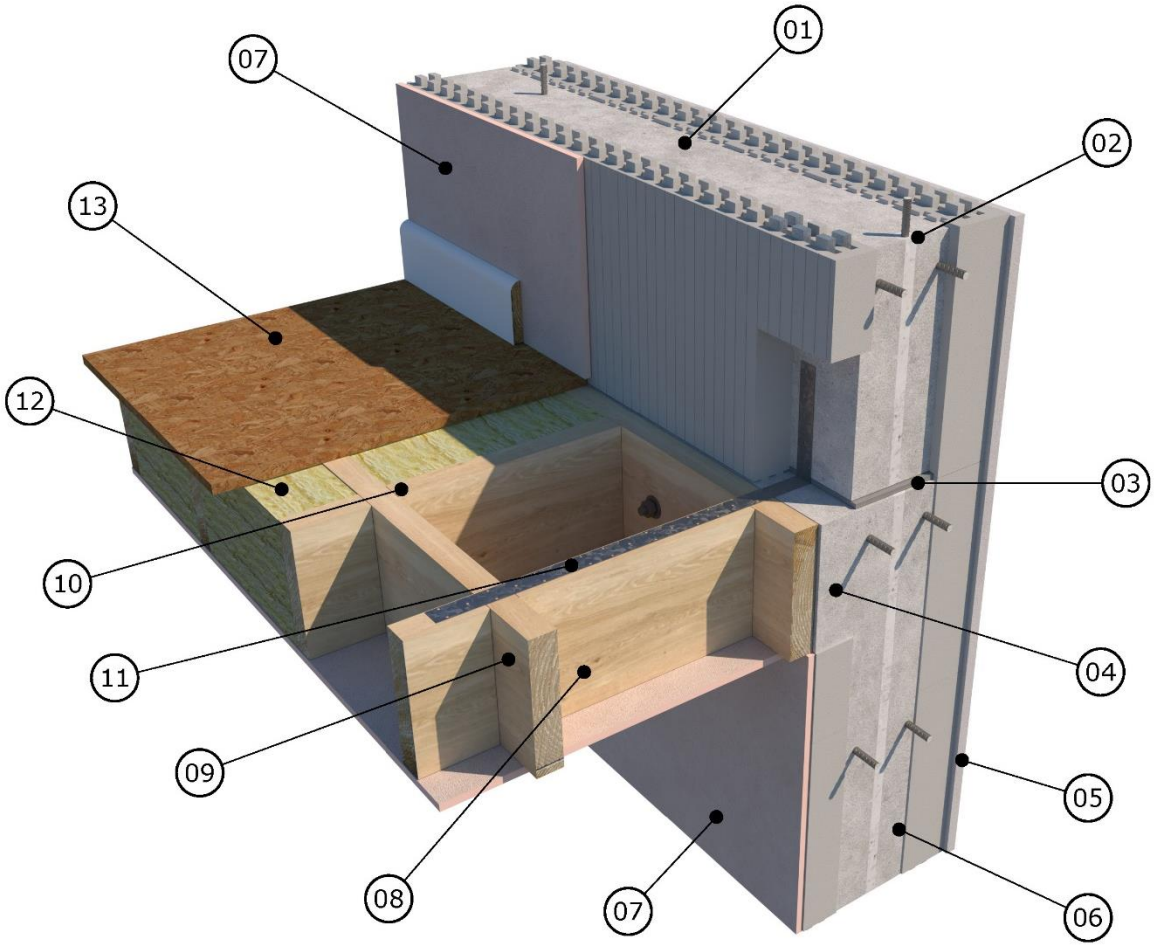
10. Timber joist to structural engineers specification.

11. Anchor bolt into precast concrete support element by others.

12. Insulation.

13. Min. 18mm thick OSB 3 Board or similar approved.

Figure 6. External Wall to Intermediate Timber Floor Detail (Joists supported on the wall)



01. ICF upper wall panel.

02. Starter bars grouted into cast-in PCT spiral void tubes.

03. Mortar bed.

04. Precast concrete corbel for joists (forming part of the ICF lower wall panel).

05. IAB approved render for ICF wall system.

06. ICF lower wall panel.

07. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

08. Timber bridging joist.

09. Timber joist to structural engineers specification.

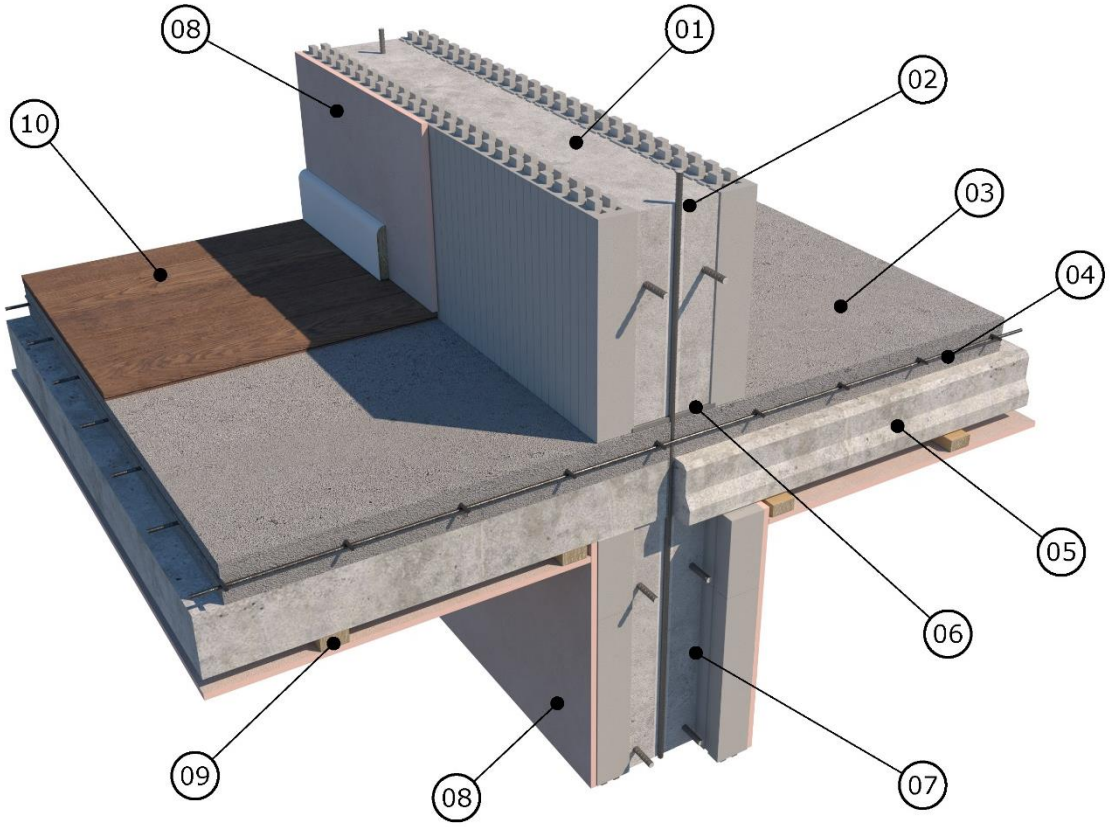
10. Anchor bolt into precast concrete support element by others.

11. Galvanised steel straps 30x5mm in cross section fixed to ICF upper wall panel, carried over at least 2 no. joists and secured with 4 no. fixings, at least 1 of which should be in the second joist at 2m max centres. Bridging to be provided between joists directly below straps together with packing between joist and wall.

12. Insulation.

13. Min. 18mm thick OSB 3 Board or similar approved.

Figure 7. External Wall to Intermediate Timber Floor Detail (Joists parallel to the wall)



01. ICF upper wall panel.

02. Starter bars grouted into cast-in PCT spiral void tubes.

03. In-situ floor screed.

04. Steel mesh reinforcement.

05. Precast concrete floor to structural engineers specification.

06. Mortar bed.

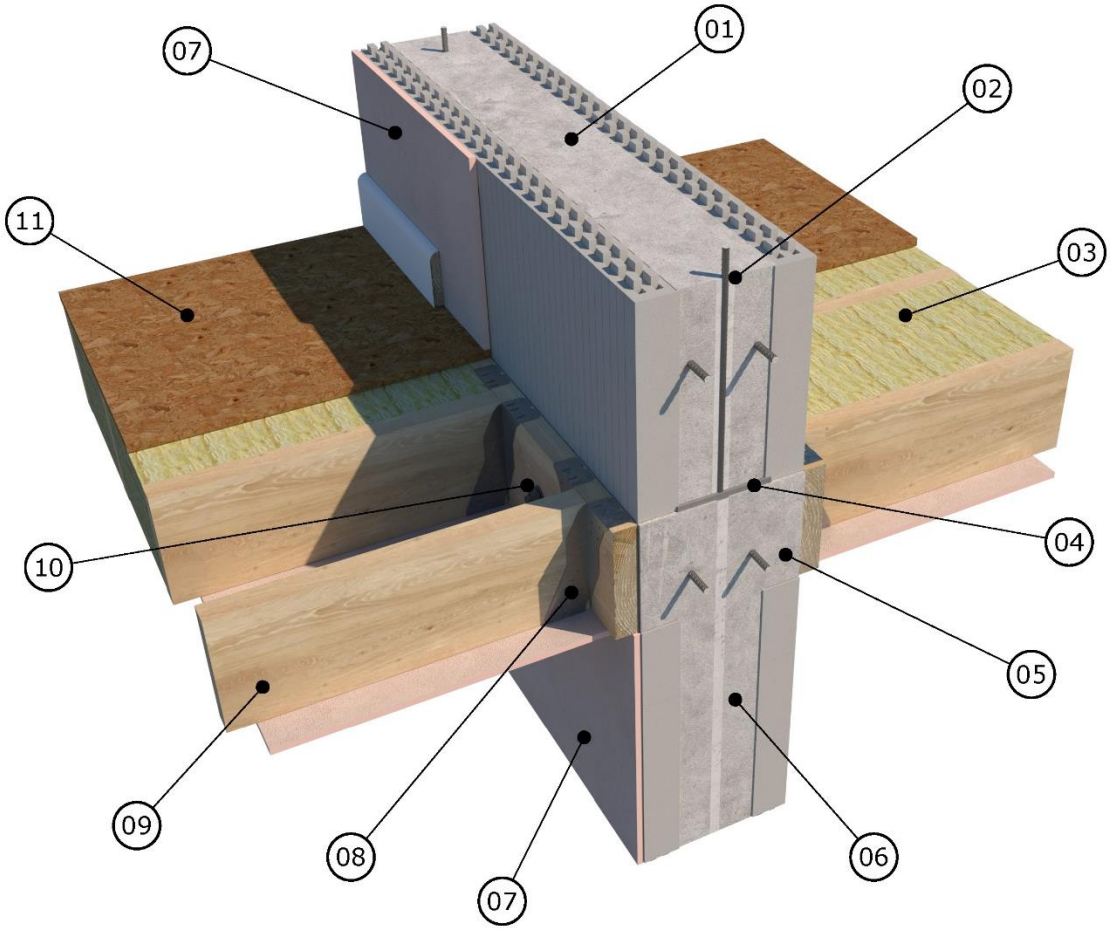
07. ICF lower wall panel.

08. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

09. Timber battens.

10. Flooring material.

Figure 8. Compartment Wall to Compartment Precast Concrete Floor Detail



01. ICF upper wall panel.

02. Starter bars grouted into cast-in PCT spiral void tubes.

03. Insulation.

04. Mortar bed.

05. Precast concrete corbel for joists (forming part of the ICF lower wall panel).

06. ICF lower wall panel.

07. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

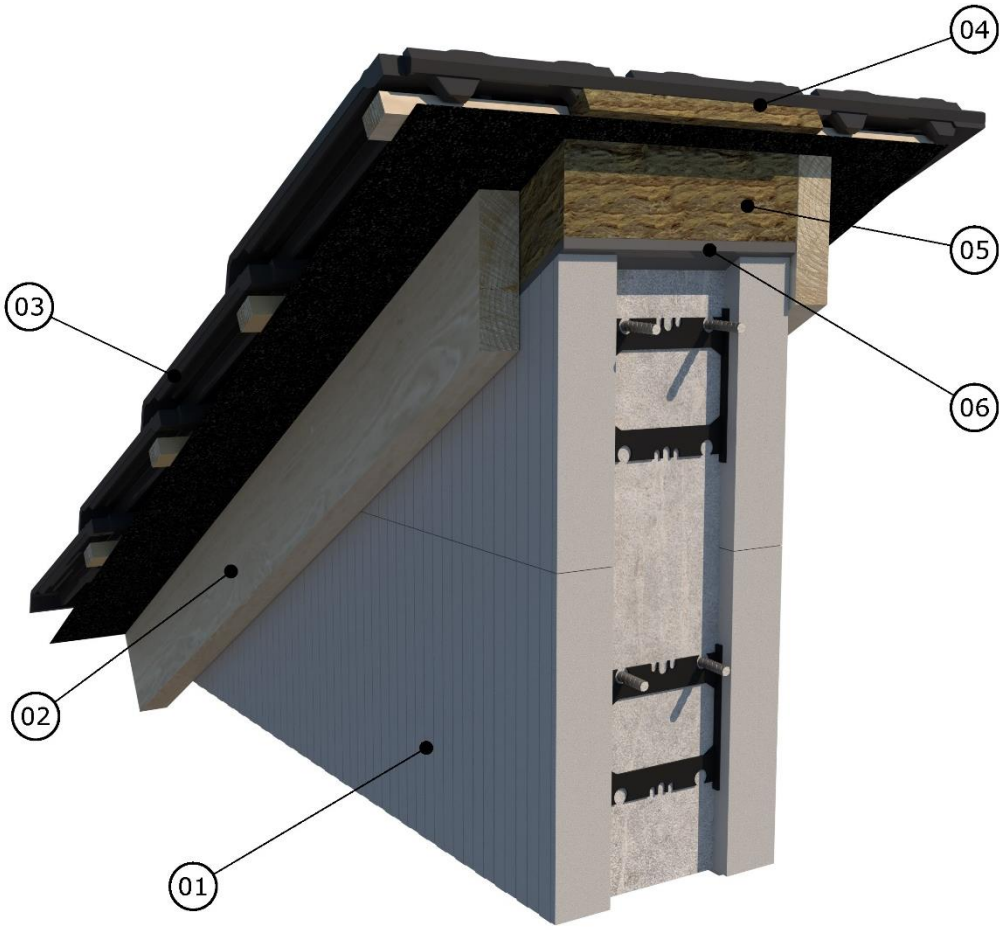
08. Timber joist hanger.

09. Timber joist to structural engineers specification.

10. Anchor bolt into precast concrete support element by others.

11. Min. 18mm thick OSB 3 Board or similar approved.

Figure 9. Compartment Wall to Intermediate Timber Floor Detail (Joists supported on the wall)



01. ICF wall panel.

02. Timber trusses to structural engineers specification.

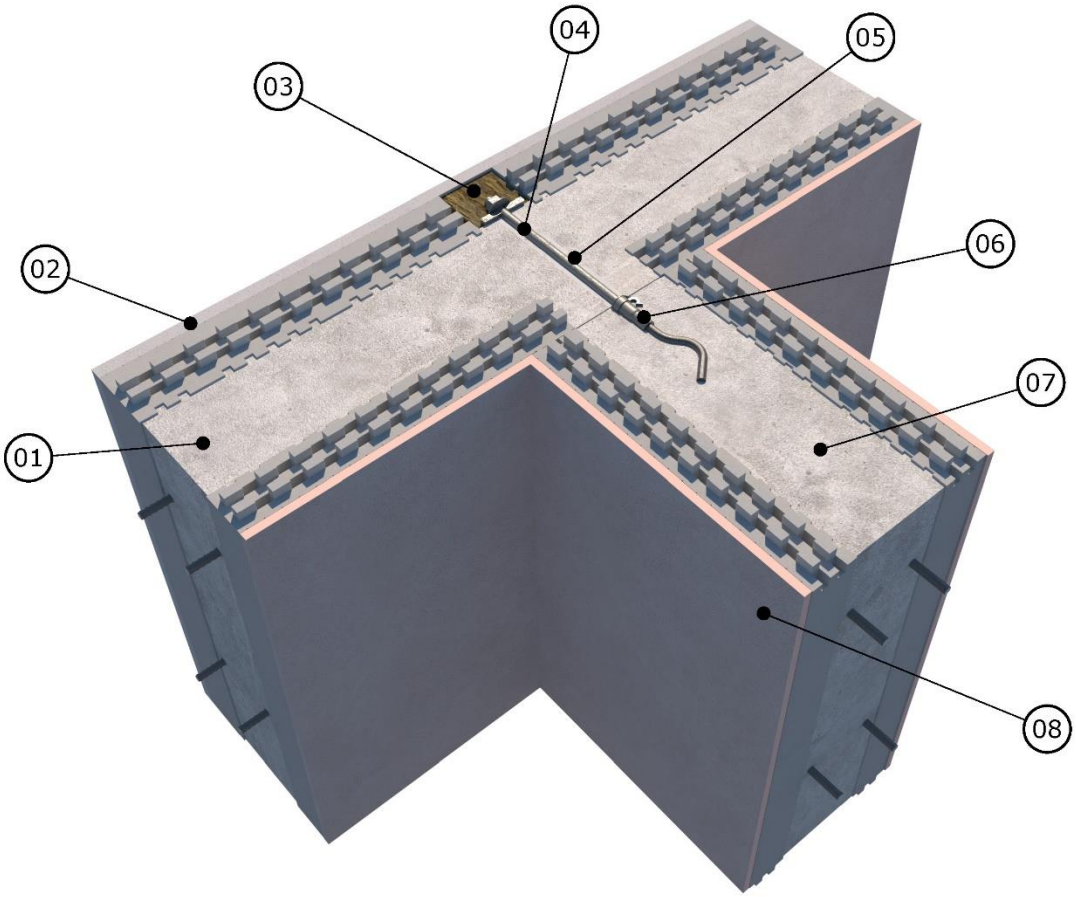
03. Roof finish by others.

04. Mineral wool insulation firestopping to be installed between roofing battens to underside of roof covering in accordance with TGD B volume 2 diagram 10 (by others)

05. 100mm mineral wool insulation firestop packed between calcium silicate board and roofing underlay (by others)

06. 12.5mm non-combustable, fire rated, calcium silicate board installed on top of party wall (by others)

Figure 10. Compartment Wall to Roof Detail



01. ICF wall panel.

02. IAB approved render for ICF wall system.

03. 100mm - 200mm vertical fire stop (e.g. mineral wool) mechanical fixed at 300mm c/c with stainless steel fixings.

04. Stainless steel washer, bolt and nut.

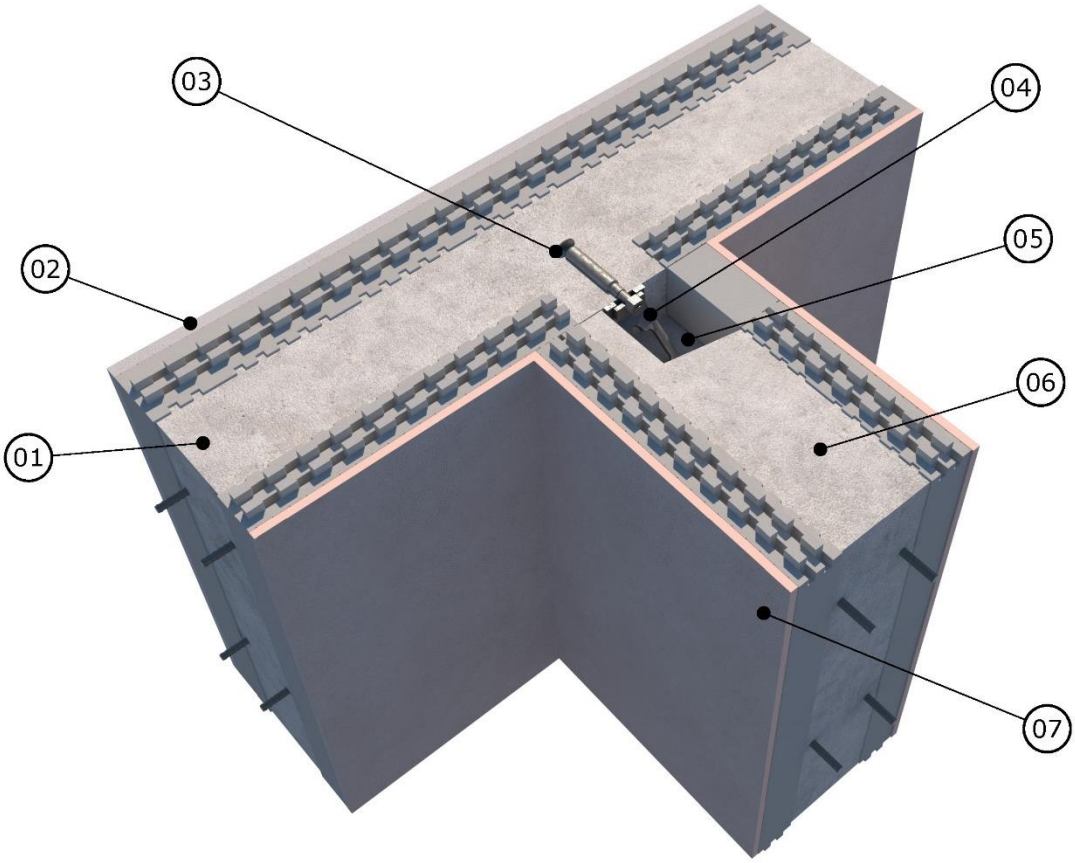
05. Void filled with grout after connector is tightened.

06. Pfeifer waved anchor DB at 800mm c/c cast in compartment ICF wall panel or similar approved.

07. Compartment ICF wall panel

08. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

Figure 11. Compartment Wall to External Wall Detail (Option 1)



01. ICF wall panel.

02. IAB approved render for ICF wall system.

03. Halfen DEMU T-Fixx or similar approved.

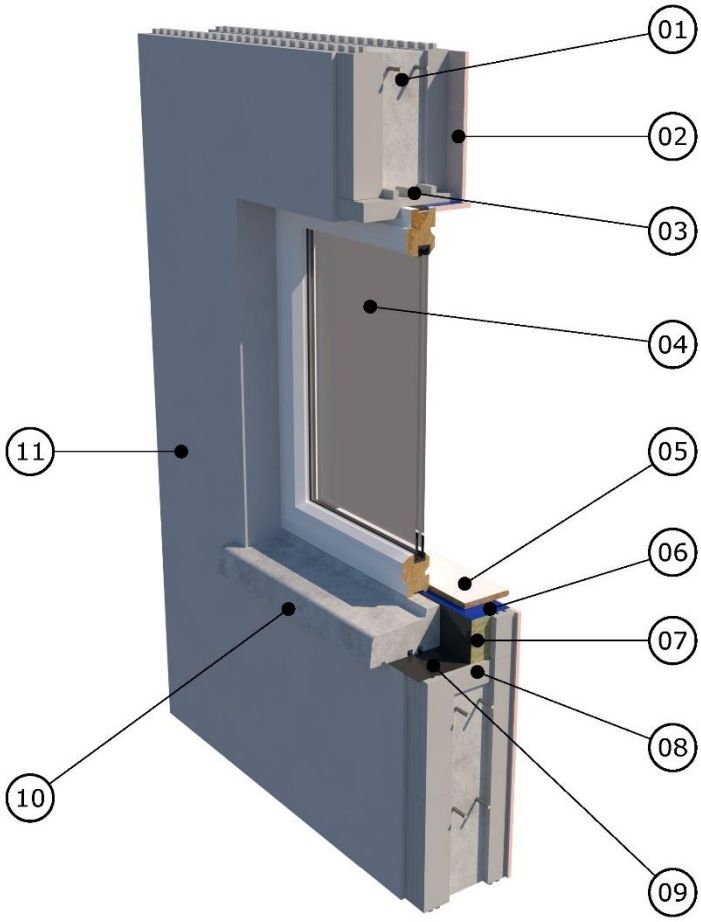
04. Halfen HEK precast coupler or similar approved.

05. Hand access void filled with grout as per specification when connector is tightened.

06. Compartment ICF wall panel

07. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

Figure 12. Compartment Wall to External Wall Detail (Option 2)



01. ICF wall panel.

02. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

03. EPS stop end by approved supplier.

04. Window by others.

05. Window board by others.

06. Air tightness tape by approved supplier.

07. Insulation to back of window cill.

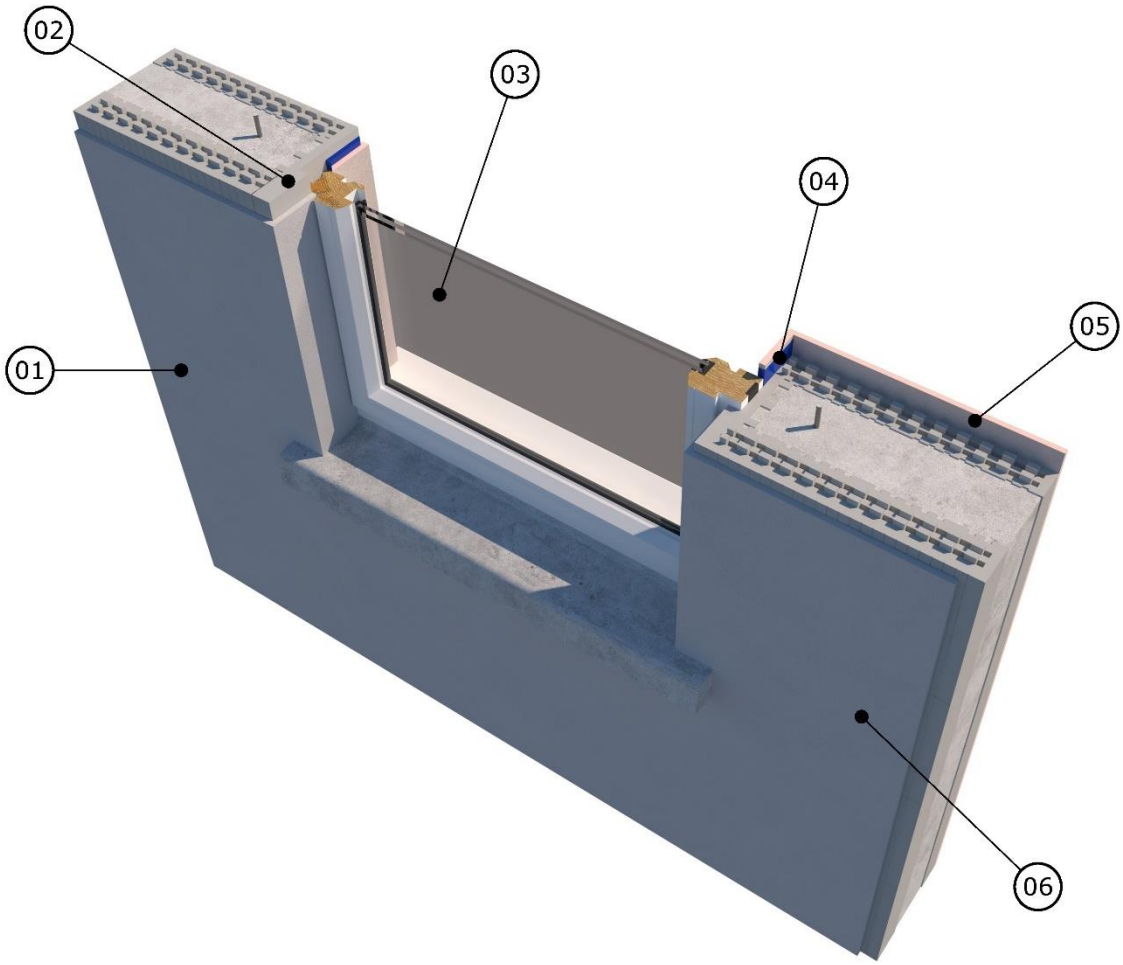
08. EPS stop end by approved supplier.

09. DPC dressed under and up behind window cill by others.

10. Concrete cill (min. 50mm projection at each side).

11. IAB approved render for ICF wall system.

Figure 13. Typical Window Detail (Head and Cill)



01. ICF wall panel.

02. EPS stop end by approved supplier.

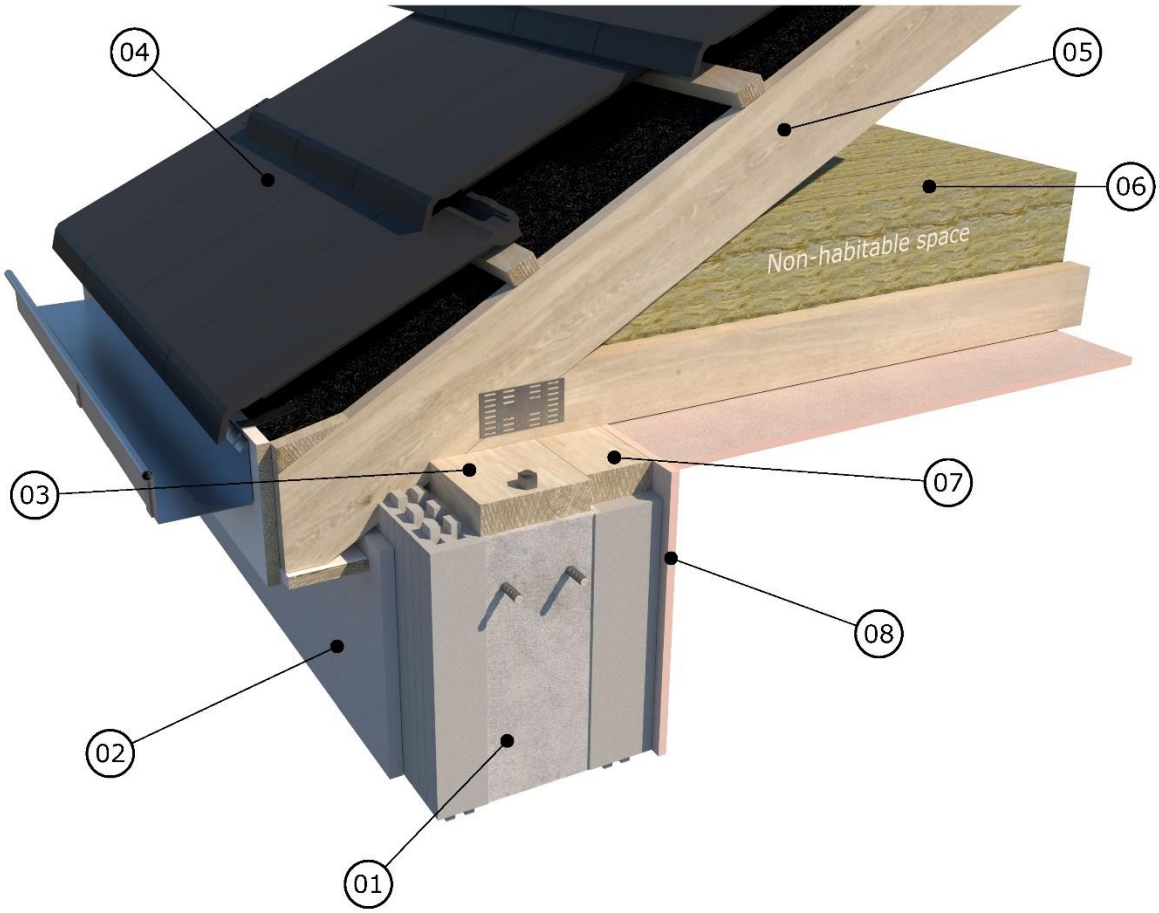
03. Window by others.

04. Air tightness tape by approved supplier.

05. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

06. IAB approved render for ICF wall system.

Figure 14. Typical Window Detail (Reveal)



01. ICF wall panel.

02. IAB approved render for ICF wall system.

03. Timber wall plate with anchor bolts to structural engineers specification.

04. Roof finish by others.

05. Timber trusses to structural engineers specification.

06. Insulation.

07. Insulation or timber packer piece.

08. 1 no. layer of 12.5mm Type F Plasterboard to be screw fixed to ICF wall panel.

Figure 15. Eaves Detail

3.1 STRENGTH AND STABILITY

3.1.1 General

The architectural and engineering design team are responsible for ensuring that architectural drawings and overall building design comply with the Building Regulations. FLI Precast Solutions, using an experienced chartered structural engineer, are responsible for the structural design of the FLI Homes MMC Rapid Build Sustainable Solutions building system.

3.1.2 Certificate of Structural Compliance

FLI Precast Solutions are responsible for the design, manufacture, supply, installation, and certification of the system.

3.1.3 Superstructure Design

The design must be in accordance with I.S. EN 1990[16], IS EN 1992-1[7] and Part A of the Building Regulations.

The design of a typical building has been examined by the NSAI Agrément and demonstrates compliance with as above standards and codes of practice.

3.1.4 Substructure Design

The design of the building's substructure is outside the scope of this certificate.

3.1.5 Design Loads

During the design process, loads are determined by FLI Precast Solutions depending on the intended use of the building and Client's requirements, using I.S. EN 1990[16] and I.S. EN 1991-1 suite and designed with reference to:

- Dead and imposed load to I.S. EN 1991-1-1[17]
- Snow load to I.S. EN 1991-1-3[18]
- Wind loads based on I.S. EN 1991-1-4[19]

Design wind and snow loads should be based on Diagrams 1 and 14 of TGD to Part A of the Building Regulations.

The following self-weights apply to the prefabricated ICF wall thicknesses:

- 150mm concrete core wall: 3.8kN/m^2
- 200mm concrete core wall: 5.1kN/m^2

3.1.6 Retained Earth

Differences in the final level of ground or floor slabs between one side of a wall and the other should not exceed four times the core thickness. Water ingress shall also be addressed in that case by the Client's architect.

3.1.7 Lateral Stability

Lateral stability of any building is dependent on the connections between adjacent walls and between floors and walls. Connections between ICF wall units and between ICF wall units and floors or roofs should be in accordance with FLI Precast Solutions standard details and should be designed by FLI Precast Solutions or a suitably experienced Structural Engineer. All connections should be checked after installation. Overall stability of the building is the responsibility of the Client's structural engineer.

Adequate stability at the construction stage shall be provided by temporary bracing and following method statement as specified by FLI Precast Solutions.

3.1.8 Impact Resistance

The FLI Homes MMC Rapid Build Sustainable Solutions building system provides a robust system that has a high resistance to hard and soft body impacts likely to be associated with normal use situations.

If a render finish is applied to the prefabricated ICF walls the chosen render system must be classed as Category I at a minimum.

3.2 FIRE

3.2.1 General

Buildings using the FLI Homes MMC Rapid Build Sustainable Solutions building system must be designed to comply with the relevant requirements of TGDs to Part B of the Building Regulations.

The concrete structural elements of the FLI Homes MMC Rapid Build Sustainable Solutions building system have a Class 0 rating and are non-combustible as per TGDs to Part B of the Building Regulations. ICF EPS blocks are manufactured in accordance with I.S. EN 13163[1] from flame-retardant EPS. The EPS has a Class E reaction to fire when measured in accordance with I.S. EN 15715 and classified in accordance with I.S. EN 13501-1.

The internal and external finishes of FLI Homes MMC Rapid Build Sustainable Solutions building system shall be designed to have a Class 0 'spread of flame' rating. Prefabricated ICF compartment wall with a 200mm concrete core has over 60 minutes fire performance.

Escape stairways constructed using the FLI Homes MMC Rapid Build Sustainable Solutions building system must be lined with appropriate linings in compliance with the Building Regulations.

The NSAI approved external render system must obtain a B-s1, d0 per I.S. EN 13501-1. In the case of the internal wall, as the design is for use of 12.5mm gypsum plasterboard slabs screwed to the webs of the polypropylene connectors, the internal walls have a Class 0 rating and are acceptable for all areas according to the general provisions of Clause 2.1 of Section B2 of TGD to Part B of the Building Regulations, and Clause 2.4 of Section B7 of TGD Volume 2 to Part B of the Building Regulations.

3.2.2 Fire Stopping

Fire stopping shall be provided at all compartment floors and compartment walls as per drawings included in this certificate. The location of fire breaks should be specified by the Client's architect or fire consultant on a project specific basis.

When cavities are present in ICF wall build up the cavity barriers as per Clause 3.6.2 TGD to Part B should be provided. No cavities will be present when plasterboard is screw fixed to ICF wall and there are no service voids.

External Wall/ Floor Junction

In case where a timber joist floor is used as an intermediate floor, a fire stopping will need to be provided where cavities are present. Where the service void is created in the wall build-up, fire stopping shall be provided at the top of the void at floor level. Fire stopping is achieved by a timber batten (min. 38mm thick) or galvanised metal strip (minimum 1mm thick), combined or not with the use of insulation in the floor void which has a classification of A2 or better for buildings under 10m in height. A section of the inner ICF Therm form is removed allowing the timber batten to be directly fixed back to the concrete core.

External Wall/ Roof Junction (Eaves)

Where the service void is created in the wall build-up, fire stopping shall be provided at the top of the void. Fire stopping is achieved by a combination of timber battens (min 38mm thick), and / or the use of insulation in the roof void which has a classification of A2 or better for buildings under 10m in height. A section of the inner ICF Therm form is removed allowing the timber batten to be directly fixed back to the concrete core.

In general, for dwelling houses (purposes groups 1(a) and 1(b), according to TGD to Part B Volume 2 of the Building Regulations), the fire stopping is required vertically at the junction of external walls with a compartment wall. The insulation around the window and door openings is fire stopped by the external render. The location of fire breaks should be agreed with the Client's architect.

Fire break materials should be continuous and unbroken. A galvanised metal strip with a minimum 1mm thickness (weight 2.68kg/m^2) can be used as both an external and internal fire break. The metal strip is inserted to the full depth of the ICF Therm form, as described in Section 3.3.4 of TGD to Part B of the Building Regulations, and Section 3.6.3 of TGD to Part B Volume 2 of the Building Regulations. Galvanjsed metal strip may be installed in the factory environment by FLI Precast Solutions when as specified on the project. Where walls are externally rendered additional strip of reinforcing mesh is applied over the fire break to strengthen the area. Glass wool is not suitable for use as a firestop.

As an alternative to the external fire break, a non-combustible mineral wool could be used as a fire break, typically installed in 100-200mm wide strips with minimum density of 120kg/m^3. The outer ICF EPS is locally removed by the Contractor, and the mineral wool strip is adhesively bonded to the exposed concrete core substrate and mechanically fixed with stainless steel fixings at 300mm centres.

3.2.3 Toxicity

The system is non-toxic in normal conditions. In fire conditions, the polystyrene will begin to soften, to contract, and finally melt above 200^{o}C. The polystyrene used in the FLI Homes MMC Rapid Build Sustainable Solutions building system is flame retarded.

3.3 WEATHERTIGHTNESS

Externally the walls are protected by an approved render. A DPC/radon barrier is installed at ground level to prevent rising damp. A DPC is also used around window cills, and a double seal -window bead gasket and silicone- is used at window reveals. In the case of concrete sills, they shall project 50mm at each side of the window opening. Concrete sills shall be wrapped in DPC.

3.4 ELECTRICAL AND PLUMBING SERVICES

The positioning and future access to all plumbing and electrical services should be carefully considered during the design phase of the construction. Refer to Section 2.1.14 of the Certificate.

Electrical installation should meet the requirements of I.S. 10101[15]. The FLI Homes MMC Rapid Build Sustainable Solutions building system shall not be placed in direct contact with electrical cables or hot water pipes (max temp 80°C). Conduits for cables and sockets shall be provided in accordance with I.S. 10101[15].

3.5 LIMITING THERMAL BRIDGING

The linear thermal transmittance 'ψ' (Psi) describes the heat loss associated with junctions and around openings. The certificate holder has carried out ψ-value calculations for a range of thermally bridged junctions.

'ψ' (Psi) values of Table 4 can be used to calculate 'y' factor for DEAP building energy rating (BER) calculation on project by project case basis.

ψ-values for other junctions outside the scope of this certificate should be assessed by an NSAI approved thermal modeller in accordance with TGDs to Part L of the Building Regulations.

3.6 DURABILITY AND MAINTENANCE

The structural core of the system should have a service life of not less than 60 years provided it is designed in accordance with Part A of Irish Building Regulations. The EPS blocks will have a similar service life provided it is protected from damage by the external and internal finishes of the wall construction.

The concrete in the wall panels is maintenance free. If a coloured render finish is used, the coloured rendering may discolour with time. A re-coating of the top coat may be necessary every 18 to 20 years to improve the appearance. The external sealants around window and door frames should be inspected periodically and replaced when necessary.

The render manufacturer is responsible for the design of the render to meet the durability requirements and exposure conditions. Render service life shall match the durability of the FLI Homes MMC Rapid Build Sustainable Solutions building system. Render shall meet exposure conditions as per S.R. 325[32].

4.1 BEHAVIOUR IN FIRE

4.1.1 Fire Resistance

Assessment of fire resistance of the FLI Homes MMC Rapid Build Sustainable Solutions building system has been assessed based on I.S. EN 1992-1-2[22]. The prefabricated ICF compartment wall has over 60 minutes fire resistance performance. Minimum cover to reinforcement is 25mm to comply with I.S. EN 1992-1-2[22].

The concrete in the walls has a Class 0 rating and is non-combustible as per TGD to Part B of the Building Regulations. The EPS used in the wall is Class E rating and flame retardant.

Internal and external finishes shall meet the requirements of Section 3.2.1 of this Certificate.

4.1.2 Fire Stopping

Fire barriers materials and its placement have been reviewed during the assessment. Fire barriers meet the requirements of Section 3.2.2 of this Certificate.

4.2 THERMAL PERFORMANCE

The thermal conductivity, λ value of the EPS is 0.031W/mK, with allowance made for the cold bridging effect of the polypropylene connector. The calculated U-value for the FLI Homes MMC Rapid Build Sustainable Solutions 360mm and 385mm wall can meet or exceed the required U-value of 0.18/m^2K. Where the calculated U-value does not meet the relevant requirement of the Building Regulations, additional energy improvement measures such as internal drylining board may be used to meet the backstop elemental U-values outlined in TGD to Part L of the Building Regulations.

A sample U-value calculation results of the FLI Homes MMC Rapid Build Sustainable Solutions 360mm wall are given in Table 3 of this Certificate. Calculations of the U-value for specific constructions should be carried out in accordance with I.S. EN ISO 6946.

4.3 CONDENSATION

The FLI Homes MMC Rapid Build Sustainable Solutions building system was subjected to an interstitial condensation risk analysis, assessing internal surface temperatures (fRsi). The assessment concluded that the risk of condensation is minimal and that no vapour barrier is required.

4.4 CWCT TESTING

The CWCT (Centre for Window & Cladding Technology) testing has been carried out on external wall panel of the FLI Homes MMC Rapid Build Sustainable Solutions building system. The CWCT testing determine level of serviceability of a façade when subject to climatic elements and object impact. The CWCT testing included the verification of:

- Air-permeability
- Weathertightness
- Wind resistance
- Water penetration (dynamic testing)
- Water penetration – hose testing
- Impact resistance testing

The summary of the testing is included in Table 5 of this Certificate. Full report can be obtained from the Certificate holder.

4.5 SOUND

The separating wall acoustics requirements are met by the ICF wall with concrete core thickness of 190mm which is equivalent to the density of 475kg/m^2. This satisfies the requirement of 415kg/m^2 of Diagram 4 of TGD to Part E of the Building Regulation.

The separating wall in the FLI Homes MMC Rapid Build Sustainable Solutions building system has been assessed and when constructed in accordance with this certificate can meet the requirements of TGD Part E of the Building Regulations.

4.6 PRACTICABILITY

The practicability of construction and adequacy of site supervision arrangements were assessed and considered adequate. FLI Precast Solutions System Design Manual and Installation Manual guidelines are provided by FLI Precast Solutions for each project, and these were reviewed and found to be satisfactory.

4.7 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE THE FOLLOWING

- Structural strength and stability
- Behaviour in fire
- Resistance to airborne sound transmission
- Thermal transmittance values
- Risk of condensation
- Site erection controls
- CWCT testing (weathertightness, air-permeability, wind resistance, water penetration, impact resistance)
- Site erection controls

4.8 OTHER INVESTIGATIONS

(i) Existing data on product properties in relation to fire and the effect on mechanical strength/stability and durability were assessed.

(ii) The manufacturing process was examined including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.

(iii) Mock up unit inspection was conducted to assess the practicability of installation

(iv) No failures of the product in use have been reported to NSAI Agrément.

U-value calculation for 360mm thk. external wall panel					
Layer	**Description**	**% Bridged**	Thickness [mm]	Thermal conductivity **λ** [W/m K]	Thermal resistance **R** [W/m²K]
	Rse				0.040
1	Render (typical values)		7	1.00	0.007
2	Castleform Grey EPS		**125**	0.031	4.032
3a	Grey EPS	50	6	0.031	0.194
3b	Concrete	50	6	2.30	0.003
4	Reinforced Concrete		150	2.30	0.065
5a	Grey EPS	50	6	0.031	0.194
5b	Concrete	50	6	2.30	0.003
6	Castleform Grey EPS		75	0.031	2.419
7	Plasterboard TGD Part L		12.5	0.250	0.050
	Rsi				0.130
				Ru Total =	6.937
				RL Total =	6.754
				R Average =	6.846
				Correction term, ΔU =	0.000
				Corrected U-Value (2DP) =	**0.15** W/m²K

Table 3. U-value calculation for the 360mm external wall panel

Target linear thermal transmittance (ψ) for different types of junctions.		
Junction Description	**Temperature Factor f_{Rsi} (Min = 0.75)**	**Ψ-value (W/mK)**
Strip Foundation Detail with Ground Bearing Slab	0.91	0.065
Eaves	0.84	0.085
Window Jamb	0.92	0.015
Window Head	0.92	0.015
Window Cill	0.90	0.030
Corner Normal	0.92	0.061
Corner Inverted	0.97	0.076
Timber Intermediate Floor within a Dwelling	0.84	0.134
Door Threshold	0.76	0.052
Precast Concrete Separating Wall (plan)	0.91	0.118*
Psi value is for the whole junction. Half the value should be applied to each dwelling on either side of the junction (*). Flanking element U-values for walls, ground floor and ceiling, roof thermal models above were based on U_W = 0.15W/m²k, U_R = 0.15 W/m²k, U_{FG} = 0.16 W/m²k, U_C = 0.16 W/m²k. Modelled junction ψ-values above can be used in y-value calculations.		

Table 4. Typical ψ-Value W/mK

CWCT testing results		
Material Characteristics	**Result**	**Classification/ Standard**
Air leakage - Infiltration (@600MPa)	1.48m^3/hr Air leakage did not increase by more than 0.3 $m^3/hr.m^2$	A4 in accordance with CWCT Standard and I.S. EN 12152
Air leakage - Exfiltration (@600MPa)	0.97m^3/hr Air leakage did not increase by more than 0.3 $m^3/hr.m^2$	A4 in accordance with CWCT Standard and I.S. EN 12152
Water Penetration – Static (@600MPa)	Pass (No leakage visible)	CWCT Standard
Water Penetration – Dynamic Aero Engine (@600MPa)	Pass (No leakage visible)	CWCT Standard
Water Penetration – Hose	Pass (No leakage visible)	CWCT Standard
Wind Resistance – Serviceability(@2400MPa)	Pass (No evidence of permanent deformation or damage to the sample)	CWCT Standard
Wind Resistance - Safety	Pass (Residual deformation within the limits, no deformation or damage to the panel)	CWCT Standard
Impact Testing – Soft Body	Pass	CWCT Standard
Impact Testing – Hard Body	Pass	CWCT Standard

Table 5. CWCT testing results

5.1 National Standards Authority of Ireland ("NSAI") following consultation with NSAI Agrément has assessed the performance and method of installation of the product/process and the quality of the materials used in its manufacture and certifies the product/process to be fit for the use for which it is certified provided that it is manufactured, installed, used and maintained in accordance with the descriptions and specifications set out in this Certificate and in accordance with the manufacturer's instructions and usual trade practice. This Certificate shall remain valid for five years from date of latest revision so long as:

(a) the specification of the product is unchanged.

(b) the Building Regulations and any other regulation or standard applicable to the product/process, its use or installation remains unchanged.

(c) the product continues to be assessed for the quality of its manufacture and marking by NSAI.

(d) no new information becomes available which in the opinion of the NSAI, would preclude the granting of the Certificate.

(e) the product or process continues to be manufactured, installed, used and maintained in accordance with the description, specifications and safety recommendations set out in this certificate.

(f) the registration and/or surveillance fees due to NSAI Agrément are paid.

5.2 The NSAI Agrément mark and certification number may only be used on or in relation to product/processes in respect of which a valid Certificate exists. If the Certificate becomes invalid the Certificate holder must not use the NSAI Agrément mark and certification number and must remove them from the products already marked.

5.3 In granting Certification, the NSAI makes no representation as to;

(a) the absence or presence of patent rights subsisting in the product/process; or

(b) the legal right of the Certificate holder to market, install or maintain the product/process; or

(c) whether individual products have been manufactured or installed by the Certificate holder in accordance with the descriptions and specifications set out in this Certificate.

5.4 This Certificate does not comprise installation instructions and does not replace the manufacturer's directions or any professional or trade advice relating to use and installation which may be appropriate.

5.5 Any recommendations contained in this Certificate relating to the safe use of the certified product/process are preconditions to the validity of the Certificate. However the NSAI does not certify that the manufacture or installation of the certified product or process in accordance with the descriptions and specifications set out in this Certificate will satisfy the requirements of the Safety, Health and Welfare at Work Act, or of any other current or future common law duty of care owed by the manufacturer or by the Certificate holder.

5.6 The NSAI is not responsible to any person or body for loss or damage including personal injury arising as a direct or indirect result of the use of this product or process.

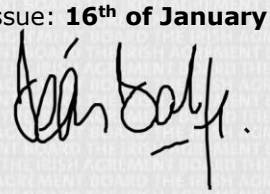
5.7 Where reference is made in this Certificate to any Act of the Oireachtas, Regulation made thereunder, Statutory Instrument, Code of Practice, National Standards, manufacturer's instructions, or similar publication, it shall be construed as reference to such publication in the form in which it is in force at the date of this Certification.

NSAI Agrément

This Certificate No. **23/0433** is accordingly granted by the NSAI to **FLI Precast Solutions Ltd** on behalf of NSAI Agrément.

Date of Issue: **16th of January 2023**

Signed



Seán Balfe
Director of NSAI Agrément

Readers may check that the status of this Certificate has not changed by contacting NSAI Agrément, NSAI, 1 Swift Square, Northwood, Santry, Dublin 9, Ireland. Telephone: (01) 807 3800. Fax: (01) 807 3842. www.nsai.ie

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[25] BRE IP 1/06 *Assessing the effects of thermal bridging at junctions and around openings.*

[26] BRE BR 497 *Conventions for calculating linear thermal transmittance and temperature factors.*

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[32] S.R. 325 *Recommendations for the design of masonry structures in Ireland to Eurocode 6*