NSAI Agrément

IRISH AGRÉMENT BOARD
CERTIFICATE NO. 19/0416
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Carlow Concrete External Wall Panel & LGS Building System

NSAI Agrément (Irish Agrément Board) is designated by Government to carry out European Technical Assessments.

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 the **Building Regulations 1997 to 2019**.

PRODUCT DESCRIPTION:
This Certificate relates to the Carlow Concrete External wall panel and Light Gauge Steel (LGS) Building System (hereafter referred to as the Carlow Concrete Building System), for the manufacture and erection of structural External wall panel and light gauge steel buildings.

The Carlow Concrete Building System is certified to be used in the construction of residential (dwellings) buildings in purpose groups 1(a), 1(b), 1(c), 1(d) and 2(a) as defined in Technical Guidance Document (TGD) of the Building Regulations 1997 to 2019. The Carlow Concrete Building System is suitable for buildings up to 10m in height where the full structure is designed, manufactured, supplied and erected by Carlow Concrete. The system can accommodate a wide range of custom designs.

Site erection is carried out by approved installers employed by Carlow Concrete or specialist sub-contractors under the supervision of Carlow Concrete.

This Certificate certifies compliance with the requirements of the Building Regulations 1997 to 2019.

USE:
The system is certified for the following applications:

1. To provide the structure of a building up to 10m in height to the top floor, which can accommodate either a composite concrete profile metal deck or a lattice light gauged steel (LGS) cold formed section floor (See Figure 5).

2. The system can also be used as the top storeys (Penthouse) of a building more than 10m in height. The Carlow Concrete Building System element of the building must be founded on a concrete floor or non-combustible podium/transfer slab, which has been designed for this purpose.

DESIGN:
The Carlow Concrete Building System is intended for use where Architect's finalized construction and fire strategy drawings are available and satisfy the Building Regulations 1997 to 2019. The Architect and Engineer Design Team of the Developer (the Client) is responsible for the architectural drawings and overall building design to comply with the Building Regulations.

The Carlow Concrete Building System is designed for use with a wide range of traditional roofing finishes. The system may also be designed to incorporate NSAI Agrément approved alternative roofing systems. However, written approval must be sought from Carlow Concrete Chartered Structural Engineers on the use of such roofing systems.

The buildings are assembled using a panelized system, factory made, and site installed. The Carlow Concrete Chartered Structural Engineers are responsible for the final design of the Carlow Concrete Building System.

MARKETING, DESIGN AND MANUFACTURE:
The product is manufactured, marketed, designed and erected by:

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Part One / Certification 1

1.1 ASSESSMENT
In the opinion of the NSAI Agrément Board, the Carlow Concrete External Wall Panel & LGS Building System if used in accordance with this Certificate can meet the requirements of the Building Regulations 1997 to 2019, as indicated in Section 1.2 of this Agrément Certificate.

1.2 BUILDING REGULATIONS 1997 to 2019

REQUIREMENTS:
Part D – Materials and Workmanship
D3 – The Carlow Concrete Building System, as certified in this Certificate, is comprised of 'proper materials' fit for their intended use (see Part 4 of this Certificate).

D1 – The Carlow Building System, as certified in this Certificate, meets the requirements of the building regulations for workmanship.

Part A – Structure
A1 – Loading
The Carlow Concrete Building System once appropriately detailed, designed and constructed has adequate strength and stability to meet the requirements of this Regulation (see Part 3 of this Certificate).

A2 – Ground Movement
An appropriately designed ground floor or podium slab can safely sustain the combined dead, imposed and wind loads of the system into the foundation structure without causing undue deflection to any part of the building.

Part B – Fire Safety
Part B Vol 2 – Fire Safety
For purpose group 1(a), 1(b) and 1(d), the fire safety requirements are laid out in TGD B 2017 Fire Safety Volume 2, Dwelling Houses of the Building Regulations 1997 to 2019. For purpose groups 1(c) and 2(a) the fire safety requirements are laid out in TGD B 2006 Fire Safety of the Building Regulations 1997 to 2019. For the Volume 2 Dwelling Houses, Part B6 – B11 are required to be adhered to while for purpose groups 1(c) and 2(a), Parts B1 – B5 are required to be adhered to.

B1 & B6 – Means of Escape in Case of Fire
The Carlow Concrete Building System is designed and constructed so that appropriate provisions for the early warning of fire and that adequate means of escape in the case of fire from the dwelling house can be accommodated.

B2 & B7 – Internal Fire Spread (Linings)
The plasterboard side of walls and ceilings is designated Class 0 (National Class) or Class B-s3, d2 (European Class). It may therefore be used on the internal surfaces of buildings of every purpose group without restriction.

B3 & B8 – Internal Fire Spread (Structure)
The Carlow Concrete Building System is designed and constructed so that its stability will be maintained for a reasonable period in the event of

fire in compliance with Section B3 and B8 of TGD B to the Building Regulations 1997 to 2019.

B4 & B9 – External Fire Spread
External masonry walls shall have a Class 0 surface spread of flame rating and when installed and used in the context of this Certificate will provide adequate resistance to the spread of flame over the external walls and roofs and can satisfy the relevant requirements of this Regulation as indicated in Section 4.1.3 of this Certificate.

B5 & B10 Access and facilities for the Fire Service
The provision of access and facilities for the fire service is outside the scope of this certificate.

Part C – Site Preparation and Resistance to Moisture
C3 – Dangerous Substances
Each dwelling ground floor must include a radon sump and provide the facility for radon extraction. Where it is shown that protection from dangerous substances e.g. radon, is required, an approved gas resistant membrane and gas handling system must be provided under the ground floor. The Carlow Concrete Building System permits the incorporation of the appropriate membrane, sump and gas handling system.

C4 – Resistance to Weather and Ground Moisture
The Carlow Concrete Building System has adequate damp-proof courses and membranes to resist the passage of moisture from the ground.

Roof and external walls above site Damp Proof Course (DPC) level will have adequate weather resistance in all exposures to prevent the passage of moisture from the external atmosphere into the building as specified in Section 4 of this Certificate.

Part E – Sound
E1 – Airborne Sound (Walls)
Walls can be appropriately detailed and constructed to meet the airborne sound level performance outlined in Table 1 of TGD E of the Building Regulations 1997 to 2019, provided good workmanship is adhered to onsite. (See Section 4 of this certificate).

E2 & E3 – Airborne and Impact Sound (Floors)
Separating floors can be constructed to meet the airborne and impact sound level performance outlined in Table 1 of TGD Part E of the Building Regulations 1997 to 2019, provided good workmanship is adhered to onsite.

Part F – Ventilation
F1 (a) – Means of Ventilation
The building system can accommodate adequate and effective means of ventilation to limit the moisture content of the air so that it does not contribute to excess condensation and mould growth.

F1 (b) – Limiting the concentration of harmful pollutants in the air within the building
The building system can accommodate adequate and effective means of ventilation to limit the concentration of harmful pollutants in the air within the building.

F2 – Condensation in Roofs
Adequate ventilation is provided in roofs to meet this requirement (see Section 4 of this Certificate).

Part J – Heat Producing Appliances
J1- Air Supply
The system can provide an adequate supply of permanent combustible air by means of air ducts, to obviate draughts, within the room in which the fireplace is located.

J3- Protection of Building
When used in accordance with Section 4 of this Certificate, specified separation distances from wall lining insulation meet the Building Regulation requirements.

Part L – Conservation of Fuel and Energy
L1 – Conservation of Fuel and Energy
The Carlow Concrete Building System can be readily designed to incorporate the required thickness of insulation to meet and surpass the backstop elemental U-values as set out in the TGD to Part L of the Building Regulations 1997 to 2019.

Thermally bridged junctions have been assessed for both their linear thermal transmittance (i.e. Psi-value (ψ-value)) and their temperature factors (f_{Rsi}) in accordance with the procedures outlined in IP 1/06[2], BRE report BR 497[3] and I.S. EN ISO 10211[4]. As a result, best practice has been observed to limit heat loss due to thermal bridging and minimise the risk of mould growth due to surface condensation.

Part M – Access for People with Disabilities
M1 – Access and Use
Buildings can be designed to meet the access, circulation and facilities requirements of this Regulation (see Section 4.6 of this Certificate).

M2 – Sanitary Conveniences
Buildings can be designed to meet the installation requirements for sanitary conveniences for people with disabilities (see Section 4.6 of this Certificate).

2.1 PRODUCT DESCRIPTION

This Certificate relates to Carlow Concrete Building System for the design, manufacture and erection of cold-formed light gauge steel frame buildings with precast external wall panels. Buildings using this system are erected on site using a factory-made panelised system and site installed with all major custom components being manufactured at the Carlow Concrete production facility.

Carlow Concrete produce all cold-formed steel sections using computerised plant and roll forming machinery. Rigid board insulation is fixed on the exterior side of the cold formed steel studs with the insulation serving to encase the cold formed steel sections thus creating a "warmframe" environment for the steel frame. Once the steel frame is assembled it is placed in a mould in the factory. The rigid board insulation, the drainage layer, reinforcing steel and the required DPCs for each panel are placed in accordance with the production drawings. All these layers are fixed using a two-piece thermal wall tie/concrete anchor (See Section 2.1.2). The concrete is then poured into the mould and the panel is finished to the required thickness.

2.1.1 External Walls

The exterior face of the Carlow Concrete Building System typically consists of precast concrete panels of variable width which may be clad with NSAI approved cladding systems, rigid board insulation, drainage layer and LGS frame. The LGS frames are load bearing with the precast concrete panels providing resistance to lateral loads. Insulation is fitted to the exterior side of the LGS studs. The interior of the wall panel is filled with stone mineral wool between the studs to achieve acoustic and fire targets. The wall panels are then clad with the required thickness and grade of plasterboard as per Table 4 and Table 5 to achieve the appropriate fire rating required for the building. The plasterboards are screw fixed to the cold formed steel stud and track members.

The installation of the AVCL layer is typically done offsite during the manufacturing process while internal insulation between the studs and plasterboard is fitted onsite after services have been fitted. The fitting of the insulation between the LGS studs and the fixing of the plasterboard layers required to meet the fire and acoustic performance are not the responsibility of Carlow Concrete.

The requirements for the provision of an Air and Vapour Control Layer (AVCL) on external walls are outlined in Section 4.4 of this certificate.

2.1.2 Wall Ties

The external leaf of the Carlow Concrete Building System is built up of precast concrete cast onto a residual cavity layer and fixed to the LGS frame using a stainless-steel hook and anchor wall tie system. The precast concrete is designed to I.S. 325-1[8] and I.S. EN 1996-1-1[9] Eurocode 6.

The wall tie system is in accordance with I.S. EN 845-1[10]. The tie anchors are fitted at each cold-formed steel stud at 450mm centres ensuring a minimum density of 3 anchors per square meter of wall panel or a frequency that can accommodate the requirements for wall tie spacing as outlined in I.S. EN 1996-1-1[9].

Additional wall ties are provided at 225mm centres around all openings, corners and movement joints, such that there is a tie for each 225mm of perimeter of opening or either side of each movement joint/corner.

2.1.3 Internal Walls

The internal load bearing and non-load bearing wall panels are manufactured from cold-formed LGS. When internal wall panels provide racking resistance to external walls, diagonal wind bracing members can be incorporated into the panel to successfully transfer the horizontal loads safely through the building structure in accordance with structural design requirements. The bracing also serves to keep the frames square during erection. Flat strap steel bracing/K Bracing or OSB sheeting boards are also used to provide in-plane stability or racking resistance. The bracing is designed to I.S. EN 1993–1–3[12].

All internal load bearing panels must be sufficiently supported directly under the panels with rising blockwork or equivalent structural support. Plasterboard specifications on the steel panels should be in accordance with Table 4 and Table 5 of this certificate, which shows the plasterboard fire resistance requirements for wall, floor and ceiling elements. The plasterboard and AVCL linings are fixed to the walls and ceilings by means of self-drill/self-tap screws; all joints are then taped and filled where required for decoration.

2.1.4 Compartment floor

The Compartment floors as described in Table 5 of this Certificate will have a prescribed fire-resistant classification which can be used in the separation of one fire compartment from another.

The construction of C-joist/truss compartment floors must be such that the achievement of the

required fire resistance performance relies primarily on the integrity of the linings of such constructions. The integrity of linings of compartment floors should not be breached to allow for the installation of services (e.g. pipes, wires, flues, including manufacturing flues), except where necessary to allow services pass through these compartment floors. Where services pass through compartment floors, they should be adequately fire stopped in accordance with the respective TGD to Part B of the Building Regulations 1997 to 2019 to which the relevant purpose class relates. A composite metal deck floor provides its own fire resistance which is based on the concrete cover to the steel reinforcement.

Services can be accommodated within a service cavity created external to the un-breached linings of the fire-resistant compartment floor on the underside of the ceiling below.

For additional acoustic performance, resilient bars may be added where specified and are fixed to the underside of the floor trusses/C-joist in order to maintain the fire integrity of the floor in accordance with fire performance details outlined in Table 5.

2.1.5 Roof Structure

The roof trusses can be either a traditional timber cut roof or prefabricated roof truss made from timber or steel. The site fitted roof trusses are attached to timber wall plates, which are bolted on site to the head LGS track of the load bearing Carlow Concrete wall panel. The roof trusses can also be fixed down directly with a thermal break onto the top wall track of the load bearing Carlow Concrete wall panel. Roofs may be clad with concrete or clay interlocking tiles or slates. The imposed load on the roof is project specific and is accounted for in the design of the steel frame structure.

2.1.6 Chimney Construction

The Carlow Concrete Building System can be designed to incorporate both traditional block/brick chimney construction or an NSAI Agrément approved pre-fabricated chimney system in accordance with its NSAI Certificate and the Building Regulations 1997 to 2019.

2.1.7 Internal Linings and Finishes

Linings to walls and ceilings are of plasterboard of Type A or Type F as specified in Table 4 and Table 5, manufactured to I.S. EN 520[11]. They are attached by means of self-drill/self-tap screws into steel members. In areas prone to high levels of humidity, moisture resistant plasterboard should be used. Joints in plasterboard can be taped and filled in accordance with the plasterboard manufacturers' instructions for direct decoration. Alternatively skim coat plaster can be applied. Any wall mounted fitting to the wall other than lightweight items, e.g. framed pictures, must be fixed to proprietary grounds, using appropriately sized fixings. To accommodate larger wall mounted fittings such as kitchen units, timber grounds or proprietary grounds can be provided between LGS studs.

2.2 GENERAL BUILDING STRUCTURE

2.2.1 Foundations

Foundations are outside the scope of this Certificate. Responsibility for the design and construction of suitable foundations should be agreed before construction commences.

The Carlow Concrete Structural Engineer can carry out a site-specific load take down and provide the Client appointed Engineer with accurate line loads for which their selected foundation solution must accommodate.

2.2.2 Ground Floor

The ground floor slab is outside the scope of this Certificate. Responsibility for the design and construction of a suitable ground floor slab should be agreed before construction commences.

The ground floor slab must be constructed to a tolerance of ±5mm in a 10-meter length for both line and level.

2.2.3 Concrete Podium Slab (Transfer Slab)

Where the Carlow Concrete Building System is constructed off a concrete podium slab, a tolerance of ±5mm is required on the podium slab line and level. Procedures for variations in slab are as described in Section 2.2.1. The construction of the podium slab is the responsibility of the Main Contractor and the design is the responsibility of the Client's Engineer, who will require line loads from the Carlow Concrete Structural Engineer.

Elements	Tolerance
Length	±5mm in 10m lengths
Opening position	±2mm
Size of openings	+5mm –0mm
Frame squareness	±2mm

Table 1: Manufacturing Tolerances

2.3 DESIGN AND MANUFACTURE

2.3.1 Design Process

Before a Carlow Concrete Building System can be manufactured, a Chartered Structural Engineer must complete the structural design including the specification of all members. The Client's architectural drawings are received by Carlow Concrete and converted into a 3D structural computer aided design model (CAD). The Carlow Concrete Structural Engineer checks and signs off all drawings to ensure structural compliance before

Component Type	Grade of Steel	Typical Section Dimensions (mm)			
		Depth[2] (h)	Width[2] (b)	Lip (c)	Thickness[1] (t)
Wall Stud/ Floor Truss	S350, S390, S550	100	45	10	0.8 – 1.6
Wall track/Noggin	S350, S390, S550	100	45	10	0.8 – 1.6
Floor Joist	S350, S390, S550	250	45	10	0.8 – 2.5
Floor Track End Bearer	S350, S390, S550	250	45	10	1.2 – 1.6
[1] The range of thickness of cold formed section available = 0.8, 1.0, 1.2, 1.5, 1.6 mm. [2] Range of Depth (h) and Width (b) available to allow for uniform cross section of structural zone.					

Table 2: Typical Sized of Elements in the Steel Frame System

any drawing are transferred to production. Once the drawings have been cleared for production, they are run through CAM software which converts the CAD/CAE and CNC files into an optimised machine ready format for use with the roll-forming equipment.

2.3.2 Roll-Form Production

The roll-formers use computer aided manufacturing (CAM) techniques to process the data, which has been transferred from the design office to the roll former. The steel coil is formed into the required C-Section profiles, with the position of cut-outs, punch-holes etc. being accurately located within a tolerance of ±2mm per 10m length. Individual members are automatically labelled by the roll formers inkjet printing system and grouped into bundles as they come off the roll-forming equipment, corresponding to their subsequent handling in the assembly process. Assembly of the components can commence in the factory directly after it has been roll-formed or the components can be transferred in flat pack form for assembly elsewhere by Carlow Concrete approved Assemblers.

2.3.3 Wall Panel Assembly

The steel frame panels are composed of galvanised mild steel manufactured from galvanised coil as described in Section 2.4.2. All profiles are designed in accordance with I.S. EN 1993-1-3[12] Eurocode 3 (including Irish National Annex). Section properties comply with I.S. EN 10162[13]. The wall panels have vertical, C-channel studs at maximum 600mm centres, which are fixed to top and bottom horizontal channels using rivets/screws. The rivets/screws are precisely located in pre-punched holes in the studs, which match holes in the top and bottom channel. The pre-punched holes in the studs are dimpled which allows the flat-topped rivets/screws to be flush with the metal surface.

Where rivets are used in the assembly of panels in the factory, i.e. stud to track connections, it is important to note that these rivet fasteners have not been considered in the structural performance of the panels. It is structurally acknowledged that the rivets will contribute to the structural performance of the panel with increased stiffness, but this has not been considered in the structural design calculations of the panel. Where structural elements are added to the wall panels such as wind bracing, wall tie brackets and lintel plates, these must only be fixed with approved Tek screws as these are structural connections and must be designed and installed in accordance with the Structural Engineers design drawings.

2.3.4 Floor Assembly

Floors can be assembled onsite with loose joists or assembled in the factory as part of a floor cassette. The use of floor cassettes is project specific, with cassettes often being used for mid-rise multi-storey buildings.

The components of the floors are connected using self-tapping screws. Specified floor decking is screwed to the top of the floor. The floors are either supported on vertical wall panels, hung on Z hangers or supported by C-channels at the end of the joists or trusses. The solution adopted is chosen by Carlow Concrete or the Client's Project Structural Engineer.

2.3.5 Quality Control Production

Quality control carried out during manufacture includes visual inspection of steel coiled raw material, calibration of roll forming equipment daily, cross checking of all in-house production drawings, and checks on production dimensions (length, width, and steel thickness) and on the dimensions and squareness of finished panels. Each panel is labelled with a QC sticker confirming it has passed final inspection. Carlow Concrete operates a full in-house quality control system, which outlines procedures on material specification, quality control in production, purchasing of raw materials, design and assembly.

2.4 STRUCTURAL PRINCIPLES

2.4.1 Steel Frame Structure

The basis of the typical Carlow Concrete structure is a cold-formed light gauge steel frame, which is assembled into units in the factory, each unit fixed to precast concrete panel and installed on site. The design, manufacture, assembly and erection of the system is based on the combined services of CAD (Computer Aided Design), CAE (Computer Aided Engineering) which are converted by CAM (Computer Aided Manufacturing) software into useable data for use with the roll-formers and produces the steel elements.

The panels are fabricated from suitably coated steel coil as described in Section 2.4.2. The frequency and size of the structural elements will depend on the individual panel and truss (roof) design. The individual elements manufactured are then assembled by trained personnel to produce the required LGS Panel with fixings as specified by the Structural Engineer.

The wall panels, where required by design, will have ancillary elements assembled into them such as strap, noggin or 'K' bracing, lintel trusses over openings and insulation on the external walls which are described in this Certificate.

The Carlow Concrete Building System utilises prefabricated steel or timber roof trusses which are either designed and manufactured by Carlow Concrete or from outside sources. The fixings used will be specified by the Structural Engineer.

The grades of steel and dimensions of sections used are selected and specified by a Carlow Concrete Chartered Structural Design Engineer in accordance with design requirements. Table 2 shows typical section sizes utilised for both load bearing walls and non-load bearing walls for the cold formed steel elements of their system.

Section properties are calculated using design core thickness of steel (excluding coatings) in accordance to I.S. EN 1993-1-1[14], I.S. EN 1993-1-3[12] and I.S. EN 1993-1-5[15].

2.4.2 Protective Coatings

The steel frame members are all coated with a protective zinc-rich metal coating. The steel frame members are manufactured from galvanized coil steel to I.S. EN 10346[16], (minimum yield stress 350 N/mm^2) with 275 g/m^2 zinc protection.

In addition to the steel members in the system being protected by zinc rich protective coatings, further protection against corrosion and longer design life is given to the steel by providing the following:

- The bottom channel on all ground floor steel frame panels is additionally protected by a DPC.
- The insulation keeps the steel in a "warmframe" environment, which, in conjunction with the AVCL, prevents the formation of condensation within the wall structure.
- The metal and timber in the roof trusses are kept free from prolonged moisture build up, by means of free air circulation in the roof space, using ventilation methods in accordance with Part F2 of TGD to Part F of the Building Regulations 1997 to 2019.
- Where steel is cut on site or where the coating of the steel becomes damaged, it is protected by the application of a zinc rich paint.
- All fasteners have been assessed and tested for use with the system, to ensure the minimum 60-year design life of the system.

2.4.3 Fasteners and Connection Joints

The unique design of the Carlow Concrete Building System allows for no welding of joints in the system. The system is assembled using fasteners such as rivets or screws. Only self-drilling Tek screws are used for the structural connectivity of the system on site. On-site structural connections such as panel to panel connections, OSB boarding to floor joist, floor joist to panel, composite deck to panel and wind bracing are fastened using approved Tek screws.

All fasteners used in the steel frame system are adequately protected against corrosion i.e. galvanising/zinc coating and made from a suitable metal to ensure the design life of the system is maintained.

Carlow Concrete provide a full specification of all fasteners, where they are to be used and how they are to be installed during the construction of the system. Only system fasteners approved or supplied by Carlow Concrete may be used with the system. It is important to ensure that protective coatings on fasteners are not removed, i.e. to assist the fitting of a connection, as this would severely compromise the corrosion performance of the fastener. Where a building is located within one kilometre of the coastline and has a steel roof, all fasteners at the eaves shall be coated with a zinc rich paint to protect against coastal spray or fasteners used that have the required salt spray test for this application.

2.4.4 Load Bearing Walls Structural Principles

The perimeter walls can be the primary load bearing elements of the structure and are therefore designed to bear on the walls of the panels below, i.e. permanent and variable imposed loads are transferred by load bearing external wall panels and if required load bearing internal wall partitions where necessary.

The load bearing wall panels are comprised of vertical studs, fixed to horizontal head and bottom

channel sections. Horizontal noggins are fitted to panels where required to provide additional strength. Under high concentrated loads, studs can take multiple forms including, but not limited to, back to back formations and box formations, amongst others. The formation for a project is decided by Carlow Concrete chartered Structural Engineer's particular design.

Where windows are present a cold formed lintel or hot rolled section is provided to allow the load to transfer to the vertical wall studs. The design loads from each level are transferred through the primary load bearing elements into the substructures / foundations. Perimeter steel Z or C sections can be used to support floor joists/trusses and can also be designed to act as a lintel over openings.

HRS (Hot Rolled Steel) structural members may also be incorporated into the design of the wall panels as required to accommodate more complex structural designs. Any HRS structural members used as part of the Carlow Concrete External Wall Panel & LGS Building System must be fabricated in accordance with I.S. EN 1090-1[17] and in accordance with execution class specified in the project specific design.

2.4.5 Racking

Resistance to horizontal loading (racking) is provided by the horizontal diaphragm action of the approved floor sheeting and roof in conjunction with the metal diagonal cross-bracing or K bracing members on specific external inner leaf and internal walls. All flat strap, cross bracing or K bracing is pre-assembled in the factory and has the dual function of ensuring squareness of factory produced panels in addition to providing lateral stability for the overall structure.

2.4.6 Holding Down

To provide resistance to uplift, the bottom channel of the external panels is fixed to the ground floor slab, podium slab or rising wall with approved fixings. The type of fixing used to hold down the panels of the system will be dependent on what substrate the fixing is being fixed to. These fixings are designed by Carlow Concrete chartered Structural Engineer and are installed in accordance with the *Code of Practice for the Design and Installation of Anchors in accordance with section 60 of the Safety, Health and Welfare at Work Act 2005*[18]. The positions of the fixings are project specific and are determined by Carlow Concrete's Chartered Structural Engineer. The plasterboard is site applied allowing access for the fixings to be installed through the sole plate on site.

2.5 COMPARTMENTATION

2.5.1 Separating Wall (Party Wall)

Separating walls (party walls) are constructed using a minimum of two independent cold formed steel framed leaves with a recommended minimum cavity of 50mm between both frames. The individual frames are boarded (on site or in the factory) with the appropriate level of boarding required to provide the acoustic and fire properties, as outlined in Table 4. The LGS studs are filled with the appropriate stone mineral wool insulation from ground floor to the underside of the roof structure to provide the required fire and acoustic properties.

Where the attic space is habitable the rock wool insulation must extend up to the underside of the roof for acoustic and fire purposes. Where the party wall abuts an external wall, the stone mineral wool insulation within the cavity of the party wall extends through the inner leaf of the external wall and abuts the precast concrete external face of the system and forms the fire stop in the wall. This detail seals air gaps and minimises flanking sound transmission (see figure 12).

The head of the party wall must also be fire stopped and cavity closed as specified by the Carlow Concrete construction details. Where services are required on a party wall, they can be accommodated by either surface mounting on the party wall or by creating a service cavity to the party wall with timber battens or metal top hat sections and plasterboard. All Battens used with the Carlow Concrete Building System are treated in accordance with BS 8417[19]. Design must comply with the requirements of Section 3.5 of TGD B 2019 Volume 2 of Building Regulations 1997 to 2019 for purpose class 1(a), 1(b) & 1(d).

2.5.2 Single Frame Compartment Walls

A compartment wall within the Carlow Concrete Building System can be constructed of a single steel frame wall. This wall can be used in situations where a building is sub-divided into different compartments, but this compartment wall **must not** be used where a wall is common to two or more buildings (separating wall) or where a compartment wall is used to separate dwellings from each other within a building. The single frame compartment wall must be designed and specified to meet the acoustic, fire and structural requirements required by the wall within the building to meet the requirements of TGD to Part B 2017 Volume 2 of the Building Regulations 1997 to 2019 for purpose groups 1(a), 1(b) and 1(d), and of TGD to Part B 2006 of the Building Regulations 1997 to 2019 for all other purpose groups to which this Certificate applies.

No services are allowed to run vertically or horizontally within the compartment wall. Where services are required in a compartment wall, they can be accommodated by battening out the wall with timber battens or with resilient bar similar to accommodating services in a party wall. Services however can pass through a compartment wall, but they must be appropriately protected in accordance with Section 3.5.4.1 of TGD B 2019 Volume 2 of

Building Regulations 1997 to 2019 for purpose class 1(a), 1(b) & 1(d) and in accordance with Section 3.2.5.7 and 3.4 of TGD B 2006 of Building Regulations 1997 to 2019 for all other purpose classes to which this certificate applies. Services passing through compartment walls should be kept to a minimum and avoided where possible

2.5.3 Compartment Floors

The Carlow Concrete Building System compartment floor can be designed to provide 60mins fire resistance from the underside. There are two forms of compartment floors used with the Carlow Concrete Building System:

a) Steel Lattice Truss or C-joists protected with Plasterboard.
b) Steel Concrete Composite Deck

2.5.3.1 Compartment Floor Steel Lattice Truss or C-Joists Protected with Plasterboard

The structure of a compartment floor used with the Carlow Concrete Building System consists of cold formed steel lattice trusses or C -Joists.

The construction of compartment floors must be such that the achievement of the required fire resistance performance relies primarily on the integrity of the linings of such constructions. The integrity of linings of compartment floors should not be breached to allow for the installation of services (e.g. pipes, wires, flues, including manufactured flues), except where necessary to allow services pass through these compartment floors. Where services pass through compartment floors, they should be installed in accordance with Section 3.2.5.7 and Section 3.4 of TGD to Part B 2006 of the Building Regulations 1997 to 2019, and Section 3.5.4.4 and Section 3.7 of TGD to Part B 2017 Vol 2 of the Building Regulations 1997 to 2019.

Services may be surfaced mounted or accommodated in service ducts or within service cavities created externally to the un-breached linings of the fire-resistant compartment floor.

The compartment floor construction can comply with Part E of the Building Regulations 1997 to 2019 through the appropriate use of gypsum boarding and stone mineral wool insulation between the steel lattice trusses or steel C-joists, while maintaining the fire performance of the compartment floor. Further improvements to acoustic reductions can be achieved by using resilient bars between the ceiling and the plasterboard where appropriate and without compromising the fire performance of the floor.

Where a steel lattice truss type floor is supplied as a non-compartment floor, services can be catered for through the lattice diagonals, but these services must be fire sealed.

2.5.3.2 Compartment Floor Steel Concrete Composite Deck

The floor is constructed of a composite profiled metal deck which is fixed to the head track of the supporting load bearing walls. Steel reinforcement is installed on top of the deck and the required concrete thickness is then poured as required by the design (See Figure 7).

The fire resistance of the composite deck is provided from the underside of the deck. The composite deck can provide up to 60 minutes' load bearing fire resistance from a combination of the bars within the trough of the decking and adequate concrete cover to the reinforcement steel bars in question.

The additional layers of plasterboard will provide additional fire protection but is not considered in the fire resistance performance. The composite deck compartment floor is suitable for use in all-purpose groups to which this Certificate relates.
All electrical and ventilation services are installed to the underside of the deck. The fire stopping of holes in the composite deck floor slab to accommodate pipes passing through a compartment floor (unless the pipe is in a protected shaft) should comply with Section 3.4 of the TGD to Part B 2006 of the Building Regulations 1997 to 2019 for all other purpose groups to which this certificate relates.

2.5.4 Forming Holes in Profiled Decks

When holes or opes to accommodate service penetrations are required, these can be incorporated in the composite concrete slab design prior to pouring the structural concrete. When additional opes are required, the size and exact location must be signed off by the Chartered Structural Engineer who designed the concrete slab.

2.5.5 Exposure of Metal Decks

Steel concrete composite decks are intended for internal use within the building envelope. Where design requires the metal deck to be exposed to the external environment, such as in a balcony situation, the metal deck needs to be thermally insulated to provide the required U-value and to limit thermal bridging. In addition, it should be suitably weather protected in accordance with the project specific design.

2.5.6 Cavity Barriers and Fire Stops

To meet the requirements of TGD to Part B Volume 2 of the Building Regulations 1997 to 2019 and TGD to Part B 2006 of the Building Regulations 1997 to 2019, the correct specification and placement of cavity barriers and fire stops shall be detailed and shown on a schedule for the project. Typically, cavity barriers and fire stops should be provided in the construction of steel frame walls as follows:

- Separating walls shall have a vertical cavity barrier sealing the cavity at the wall ends, running from DPC level to the underside of the fire stopping at the top of the wall.
- At a separating wall junction with the external wall, the vertical cavity barrier runs out to the inner face of the external precast panel and held in place with timber battens to form the cavity barrier.
- Horizontal cavity barriers shall be placed at the perimeter of all compartment floors (See Figure 7).
- A cavity barrier shall cover the full floor depth as well as the upper wall panel rail and lower wall panel head plate.
- Eaves boxes shall be provided at the junctions of separating wall with external walls to reduce the risk of fire passing across these junctions.
- Cavity barriers are required around all openings in external walls such as doors, windows, vents, extractor fans, meter cupboards, etc.
- The integrity of compartment/separating walls within roof voids that are continuous with the compartment walls between flats or continuous with a separating wall between dwellings is essential to prevent fire spread. These walls must be fire stopped at the wall/roof junction to afford a minimum 60 minutes fire resistance. The method of fire stopping should be in accordance with guidance given in Diagram 10 of TGD to Part B Volume 2 of the Building Regulations 1997 to 2019 for purpose groups 1(a), 1(b) and 1(d) and Diagram 13 of TGD to Part B 2006 of the Building Regulations 1997 to 2019 for all other purpose groups for which this Certificate applies.

The Carlow Concrete Building System can incorporate both horizontal and vertical cavity barriers and fire stops to comply with the fire strategy drawings supplied by the Clients fire consultant. Carlow Concrete are responsible for ensuring all fire stopping/cavity closers are installed in accordance with the approved construction drawings. The main contractor's site manager shall inspect and record all cavity closers/fire stopping at each floor level on the fire stopping record supplied by Carlow Concrete, which are kept on site for inspection. The site manager will inspect all cavity barriers and fire stops prior to the closing up of the cavities and ceilings.

2.5.7 Fire Stopping Service Penetrations

If an element, intended to provide fire separation (i.e. it has a requirement for fire resistance in terms of insulation and integrity), is to be effective, then every joint or imperfection of fit, or opening to allow services to pass through the element should be adequately protected by sealing of fire-stopping so that the fire resistance of the element is not impaired.

Section 3.4 of TGD to Part B 2006 of the Building Regulations, and Section 3.7 of TGD to Part B Volume 2 of the Building Regulations provide guidance on the methods of protection of openings and fire stopping.

If it essential that both the designer and the specialist contractor are fully conversant with the fire protection requirements for pipe, cable and service penetrations. It is the responsibility of the main contractor to complete the fire stopping of the service penetrations. The fire stopping is then inspected by the Carlow Concrete site manager and recorded in the Carlow Concrete quality control file for that site – the fire stopping must be installed correctly before Carlow Concrete will issue the certificate for the building.

2.6 DELIVERY, STORAGE AND SITE HANDLING

2.6.1 Delivery of Panels

The Carlow Concrete Building System panels are lifted and moved by steel lifting loops, which when required are screwed into threaded inserts which have been incorporated into the precast panels during the manufacturing process. Where lifting points are required, they are located, designed and certified by the Structural Engineer, taking into account the unit weight and dimensions and the distance of lift required. They will conform to the requirements of the Safety, Health and Welfare at Work Act 2005[20] and the Safety, Health and Welfare at Work (Construction) Regulations 2013[21].

The panels are loaded and transported vertically on stillages to site. All off-loading and erection should be in accordance with the Carlow Concrete Method Statement and erection procedures. Erection tools should be of suitable quality to avoid surface contamination. The internal LGS panels can be flat packed horizontally and transported to site. Smaller internal panels may be manually manoeuvred into position.

All lifting shall be carried out by competent personnel in accordance with the Carlow Concrete Erection Manual and site-specific safety statement. Care is needed to avoid scratching the surface of any zinc coated steel frame members. Frames must be stored on a dry, clean, level base with a suitable packing to prevent damage and must not be dropped or allowed to rest on projecting objects.

The use of protective gloves when handling the LGS panels is necessary, as steel members formed from cut or sheared sheet can have sharp edges and care should be taken when handled, to avoid injury. The zinc coated steel frames members must be kept out of contact with dry cement and lime.

Flooring and other ancillary items such as insulation and cavity barriers must also be kept dry and stored on a firm level base.

2.6.2 Traceability

The Carlow Concrete CAM software assists the tailor made custom designed roll formers in arranging production groups and complex punching operations. The software also directs dynamic inkjet printing for parts identification and positioning ensuring all pieces are identified for accurate and fast assembly.

Each assembly drawing contains the unique identification number for each steel member. This allows for ease of assembly by the assemblers.
When each wall panel is complete and within the required dimensional tolerances, it is labelled with a "Quality Passed" sticker when it has been checked according to the building drawing and stacked according to the off-loading plan for the building.

2.6.3 Typical Material List Supplied to Site

With each customised delivery to site, a comprehensive bill of materials is supplied. This bill of materials gives a detailed list of all components delivered to site to complete the installation of the steel frame building. All panels are individually numbered using the pre-marking system during production to correspond with the erection drawings supplied with the bill of materials. This pre-marking system gives the advantages of both speed and accuracy during assembly and erection on site.

2.7 INSTALLATION

2.7.1 General

Installation is carried out in accordance with the requirements of this Certificate and all relevant codes of building practice, regulatory Health & Safety requirements and the manufacturer's instructions contained in the Carlow Concrete Installation Manual, a copy of which must be available on each site. Site erection must only be carried out by a Carlow Concrete approved installer or a specialist sub-contractor under the supervision of Carlow Concrete and in accordance with the Carlow Concrete Installation Manual.

All off-loading and erection should be in accordance with the Carlow Concrete Method Statement and erection procedures. All structural connections to the foundation must be installed in accordance with the structural design details, independently checked by qualified members of the installation team and formally recorded on the Carlow Concrete site quality control records.

2.7.2 Site Supervision

The approved installation contractors are subject to supervision by the Carlow Concrete site manager. Typically, the Carlow Concrete site manager will agree a schedule of inspections with the erection contractor. The supervisor of the erection crew is responsible for the quality and productivity of work carried out by the erection crew. The erection supervisor reports directly to the Carlow Concrete site manager to ensure all work follows the requirements of the design drawings and the requirements of Carlow Concrete Structural certification for the building.

Carlow Concrete employ a full-time site manager who works very closely with the erection supervisor and the main contractor. Panels are installed on an suitable concrete base. All fixings and brackets between panels are visually inspected and recorded on the assembly quality control sheet for structural connections.

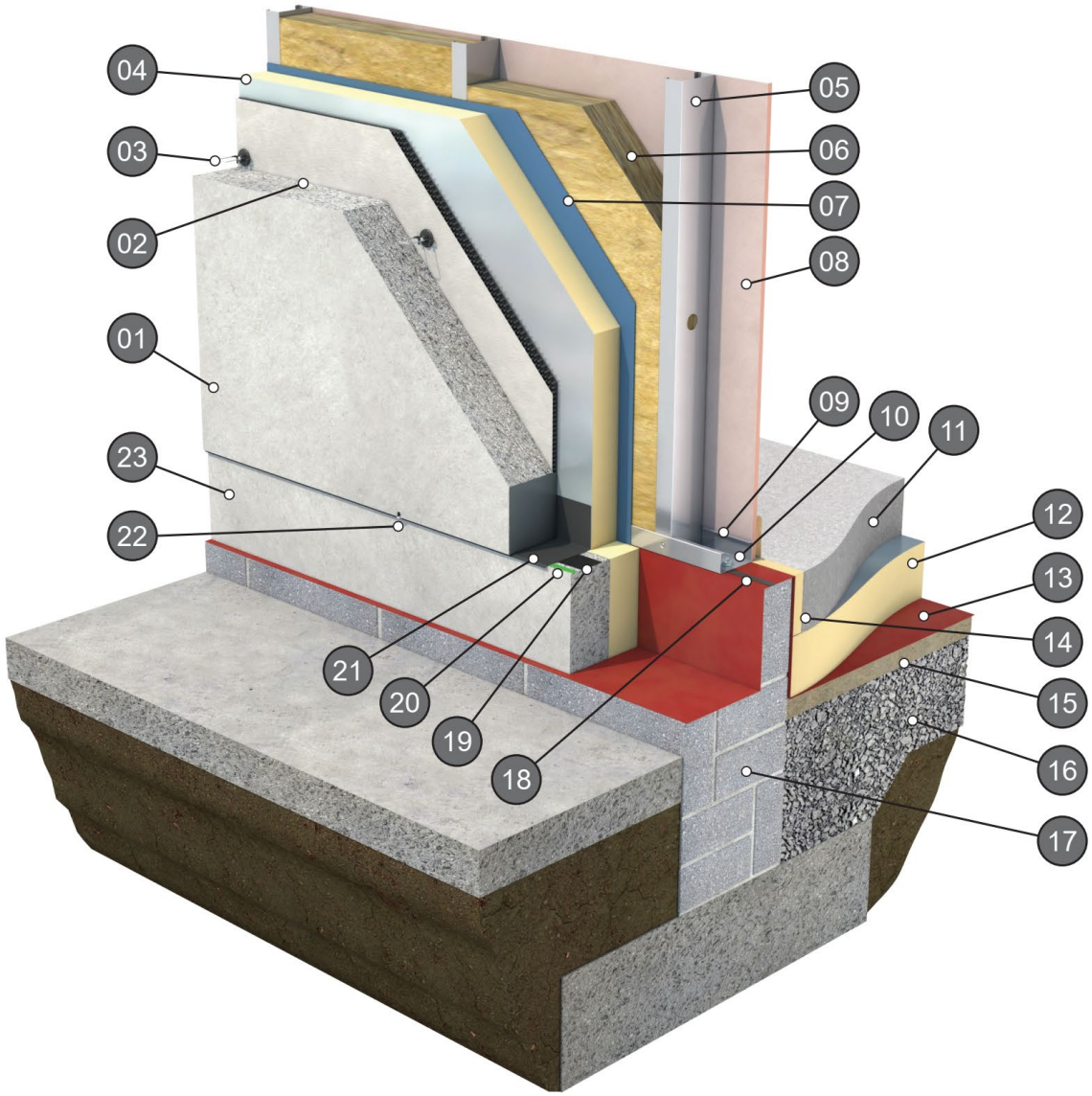
Each building has its own quality control file which is kept on site by the Carlow Concrete site manager. The site manager also inspects fire stopping and cavity closing of all panels, records of the fire stopping are recorded by Carlow Concrete. Any defects noted are recorded, photographed where possible and notified in writing to the erection supervisor. The site manager will inspect and approve the remediation before work can proceed.

The approved Carlow Concrete Building System erection contractors are subject to continuous supervision by the Carlow Concrete site manager. The following checklist is provided to offer guidance to clients who intend to carry out their own additional site supervision. This non-exhaustive list of items are of a general nature and are in addition to all other building requirements.

- All components delivered to site comply with the Bill of Materials.
- Components are not damaged and are properly pre-marked for erection.
- The substructure is set out accurately and level within the tolerance specified by Carlow Concrete before the wall panels are positioned.
- The wall panel should not be erected unless any inaccuracies in the floor slab have been corrected.
- The ground floor layout is properly marked out.
- Site applied DPC and DPM are correctly installed in accordance with BS 8102[46].
- DPC course is laid under all ground floor panels, as a good practice measure between steel and concrete slab, both internal and external walls.
- Panels are in line and plumb and in accordance with the Carlow Concrete panel layout.
- Rooms are checked for squareness.
- All insulated wall panels are free from damage after erection.
- All horizontal and vertical joints are correctly detailed.

- All bottom tracks are free of construction debris.
- Joints in floor decking occur on the centre line of the joists and all T&G joints run perpendicular to the floor C-joists. Decking sheet joints must be staggered.
- If floor decking is exposed to weather for prolonged periods, then it will need to be protected with a weatherproof cover.
- Floor decking is screwed at the correct centres.
- All bracing is properly tensioned.
- Check requirements of web stiffeners when floor joists are continuous over internal load bearing support walls against Engineers drawings.
- Cavity barriers and fire stops are installed as specified and in accordance with the Building Regulations 1997 to 2019.
- Roof trusses are installed plumb and per layout.
- Roof bracing installed where required.
- Where galvanised steel section is cut or where any damage occurs to the steel frame a coat of zinc rich paint or galvanised spray is applied to exposed surfaces.
- All fasteners supplied are approved by Carlow Concrete.
- No modification i.e. cutting of the steelwork is allowed without prior written permission by a Carlow Concrete Chartered Structural Engineer.
- Always maintain the recommended minimum 50mm between the two leaves of the party wall.

Note: This Certificate contains illustrations to explain the various elements of the Carlow Concrete Building System such as intermediate floors, external walls, separating wall etc. These illustrations are not intended to be construction drawings. Carlow Concrete 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 in compliance with relevant codes of practice and relevant standards along with current Building Regulations.



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. Thermal anchor.

04. PIR Insulation.

05. LGS metal stud.

06. Stone mineral wool insulation.

07. Selected AVCL.

08. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

09. Bottom track.

10. Anchor bolt.

11. Concrete Floor.

12. Floor Insulation.

13. Selected DPM or Radon Membrane.

14. PIR Perimeter strip.

15. Sand blinding.

16. Hardcore.

17. Foundation detail to specification.

18. Butyl Sealant Tape.

19. Compressible Butyl Strip.

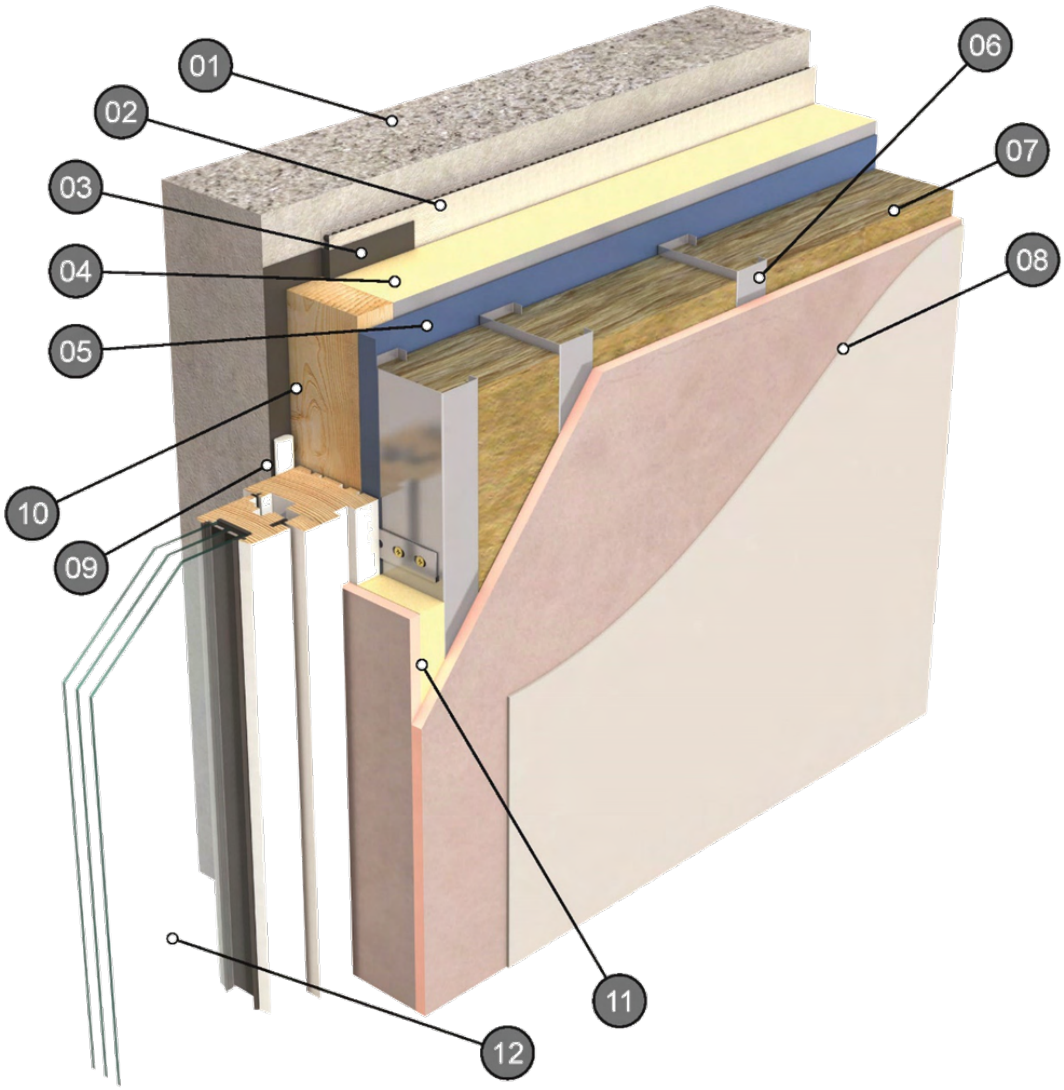
20. Slected Mastic sealant.

21. DPC.

22. Weep vent.

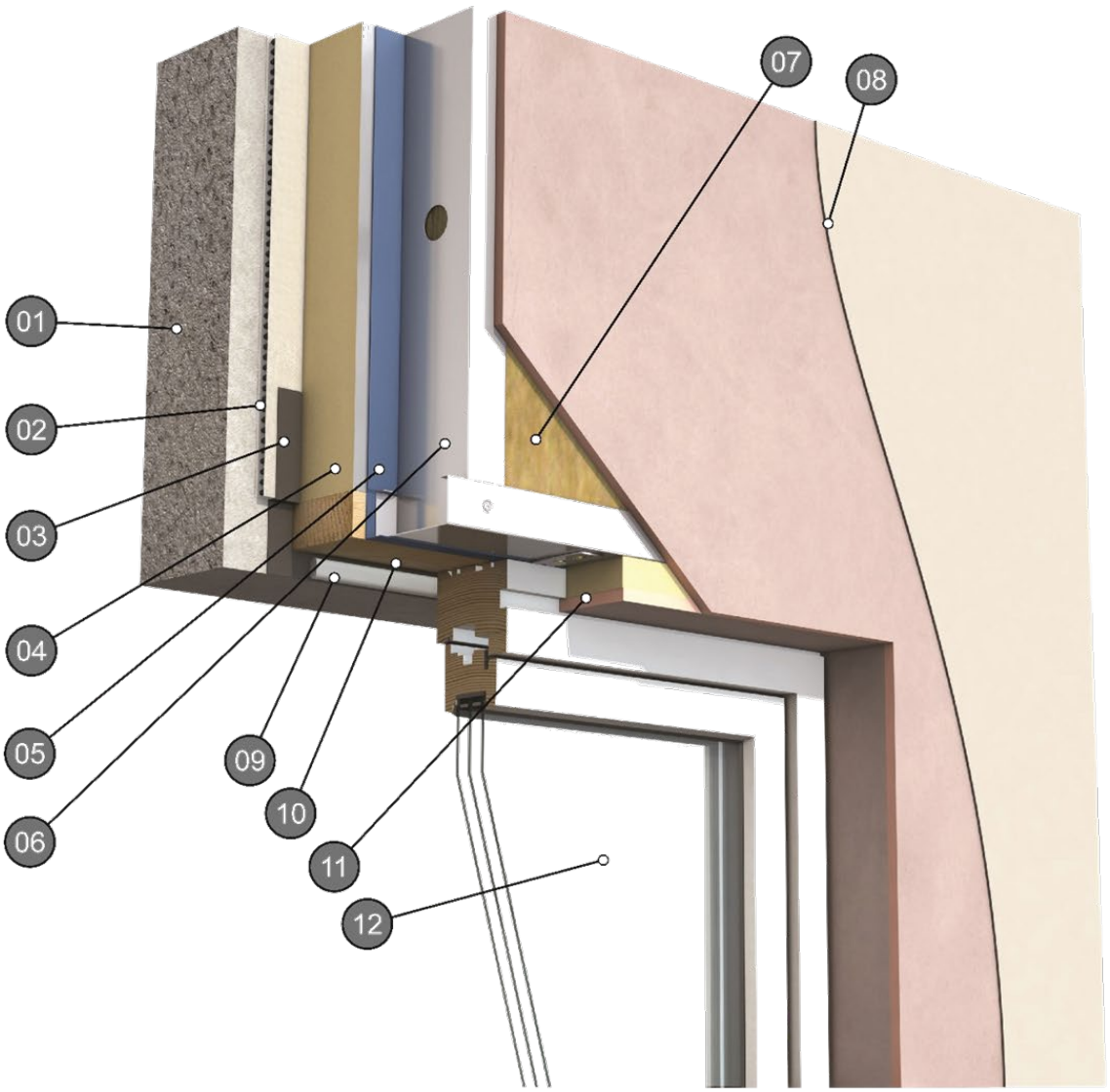
23. Cast in-situ concrete beam or masonry course.

Figure 1 - Ground Floor Exterior Wall Detail



1. Precast concrete wall or other NSAI approved cladding system.
2. Residual cavity.
3. DPC
4. PIR Insulation.
5. Selected AVCL taped to window frame.
6. LGS metal stud.
7. Stone mineral wool insulation.
08. 1 no layer of 12.5mm Type F Plasterboard to provide REI 30 External Wall in accordance with table 4 fire performance requirements.
09. Selected Sealant.
10. Treated timber batten.
11. Insulation backed plasterboard.
12. Selected window.

Figure 2 - Window Reveal Detail



1. Precast concrete wall or other NSAI approved cladding system.

2. Residual cavity.

3. DPC

4. PIR Insulation.

5. Selected AVCL taped to window frame.

6. LGS metal stud.

7. Stone mineral wool insulation.

08. 1 no layer of 12.5mm Type F Plasterboard to provide REI 30 External Wall in accordance with table 4 fire performance requirements.

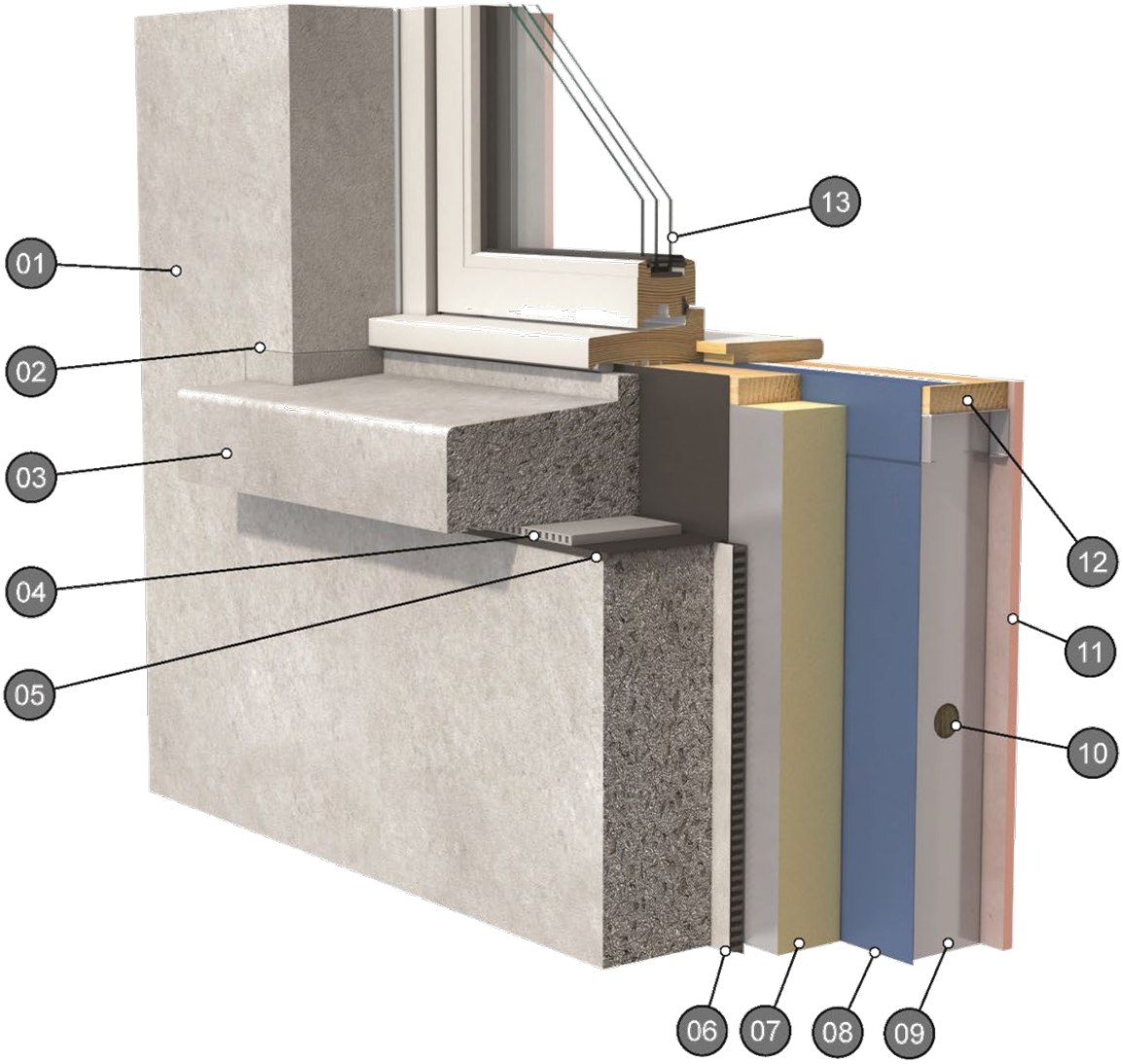
09. Selected Sealant.

10. Treated timber batten.

11. Insulation backed plasterboard.

12. Selected window.

Figure 3 - Window Head Detail



1. Precast concrete wall or other NSAI approved cladding system.

2. Movement joint.

3. Stooled sill.

4. Weep vent.

5. DPC tray.

6. Residual cavity.

7. PIR Insulation.

08. Selected AVCLtaped to window frame.

09. LGS metal stud.

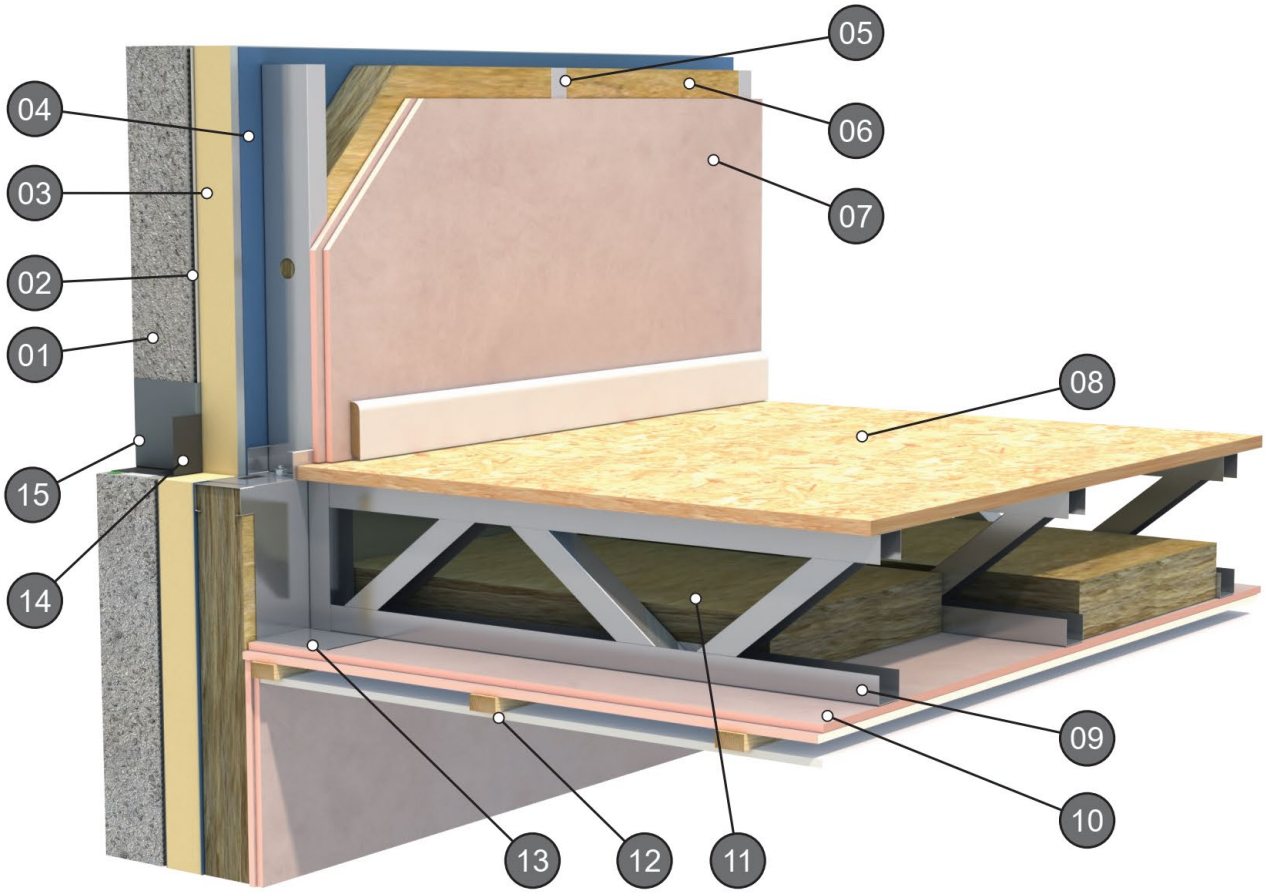
10. Stone mineral wool insulation.

11. 1 no layer of 12.5mm Type F Plasterboard to provide REI 30 External Wall in accordance with table 4 fire performance requirements.

12. Treated timber batten.

13. Selected window.

Figure 4 - Window Sill Detail



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. PIR Insulation.

04. Selected AVCL.

05. LGS metal stud.

06. Stone mineral wool insulation.

07. 2 layes 15mm Type F Plasterboard to provide REI 60 External wall in accordance with table 4 fire performance requirements.

08. OSB3 or equivalent floor decking.

09. LGS Lattice Joist.

10. 2 layers 15mm Type F Plasterboard to provide REI 60 in accordance with Table 4 fire performance requirements.

11. Stone mineral wool insulation.

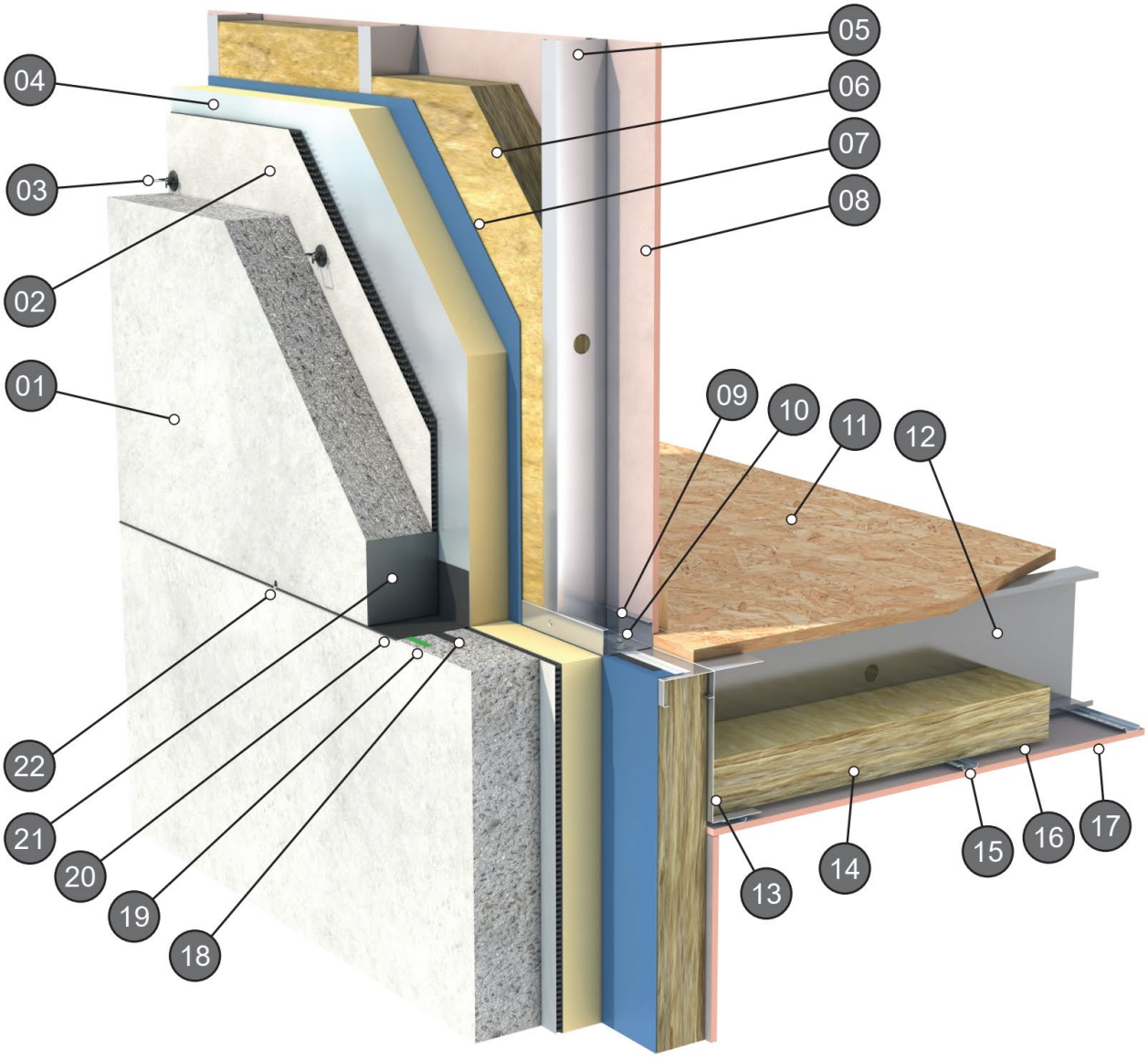
12. 12.5 Type A platerboard fixed to battens.

13. Z Hanger.

14. Pre-formed Corner.

15. DPC.

Figure 5 - Lattice Floor to Exterior Wall Detail



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. Thermal anchor.

04. PIR Insulation.

05. LGS metal stud.

06. Stone mineral wool insulation.

07. Selected AVCL.

08. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

09. Bottom track.

10. Screw fixing

11. OSB3 or equivalent floor decking.

12. LGS Floor Joist.

13. C-Channel.

14. Stone mineral wool insulation.

15. Resilient bar.

16. Service cavity.

17. 12.5mm Type F Plasterboard to provide R 30 REI 15 in accordance with table 4 fire performance requirements.

18. Compressible Butyl Strip.

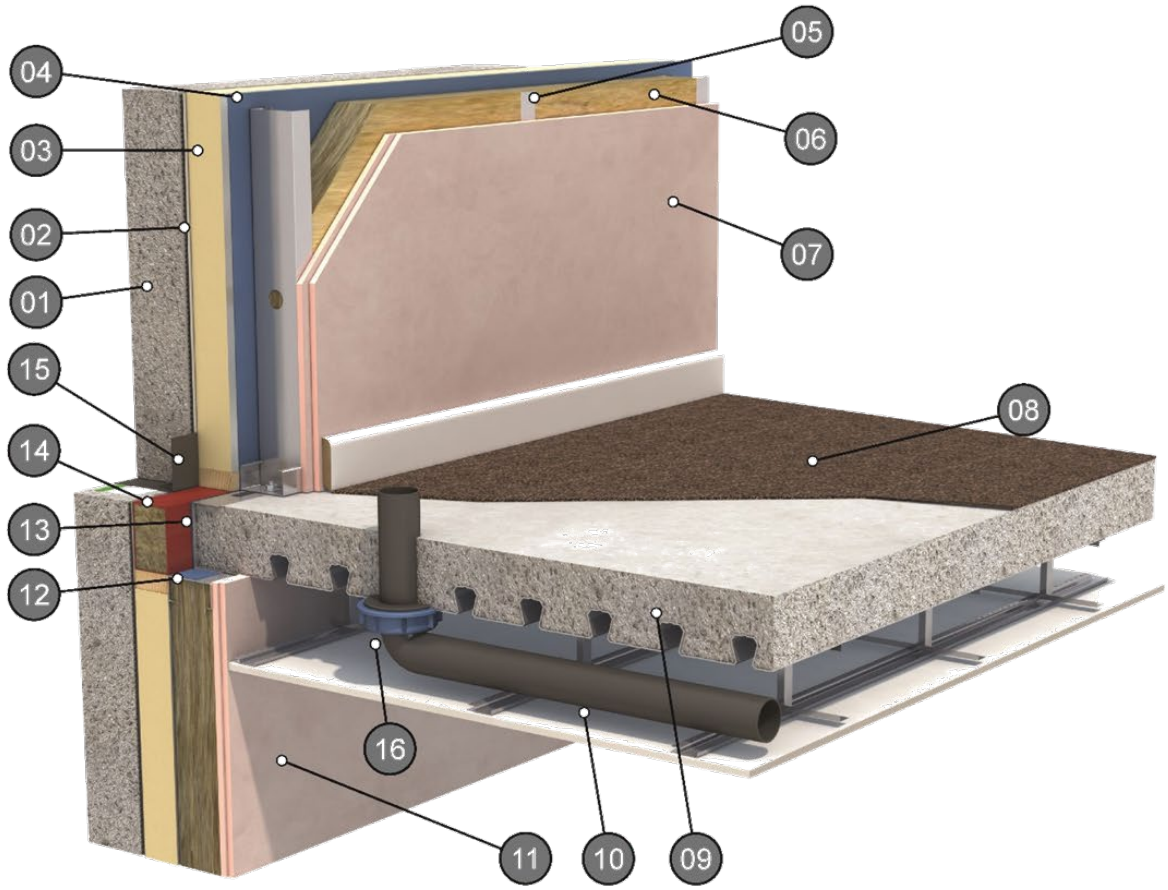
19. Slected Mastic sealant.

20. DPC.

21. Pre-formed Corner.

22. Weep vent.

Figure 6 - Intermediate Floor to Exterior Wall Detail



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. PIR Insulation.

04. Selected AVCL.

05. LGS metal stud.

06. Stone mineral wool insulation.

07. 2No. layers 12.5mm Type F Plasterboard to provide REI 60 External wall in accordance with table 4 fire performance requirements.

08. Appropriate resilient soft covering.

09. Concrete poured into metal deck.

10. Suspended ceiling to specification.

11. 2No. layers 12.5mm Type F Plasterboard to provide REI 60 in accordance with Table 4 fire performance requirements.

12. Isolation strip between deck and LGS wall.

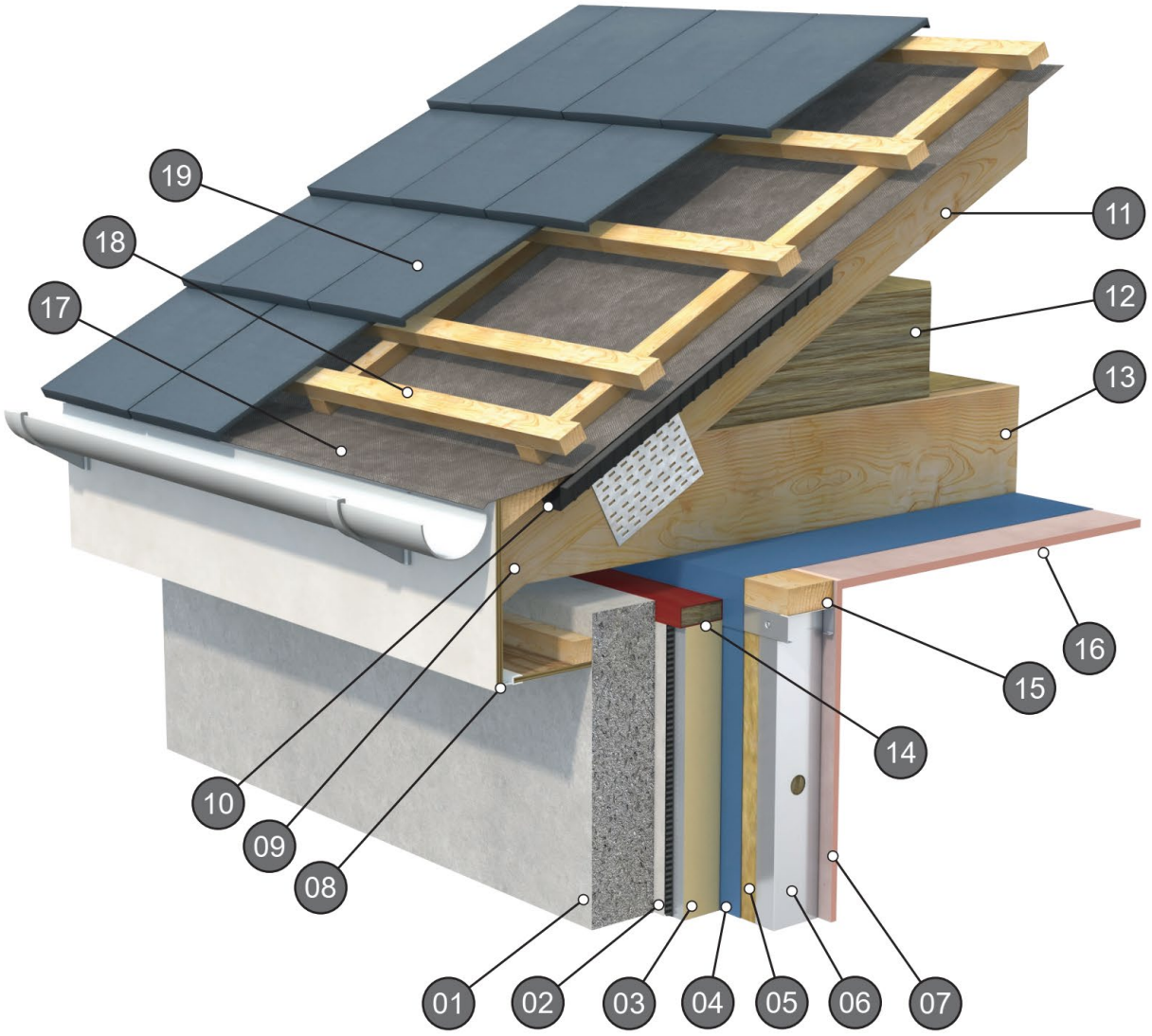
13. Composite Deck edge trim.

14. Cavity Barrier to specification fixed to timber battens.

15. DPC lapped over cavity closer.

16. Vertical services through compartment floor to have proprietary fire collar in accordance with TGD part B.

Figure 7 - Compartment Floor Steel Concrete Composite Deck



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. PIR Insulation.

04. Selected AVCL.

05. Stone mineral wool insulation.

06. LGS metal stud.

07. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

08. Fascia & Soffit with proprietry soffit vent.

09. Rafter.

10. Proprietry rafter ventilator.

11. Pre-fabricated roof truss

12. Stone mineral wool insulation.

13. Cieling joist.

14. Cavity Closer.

15. Treated Wall Plate.

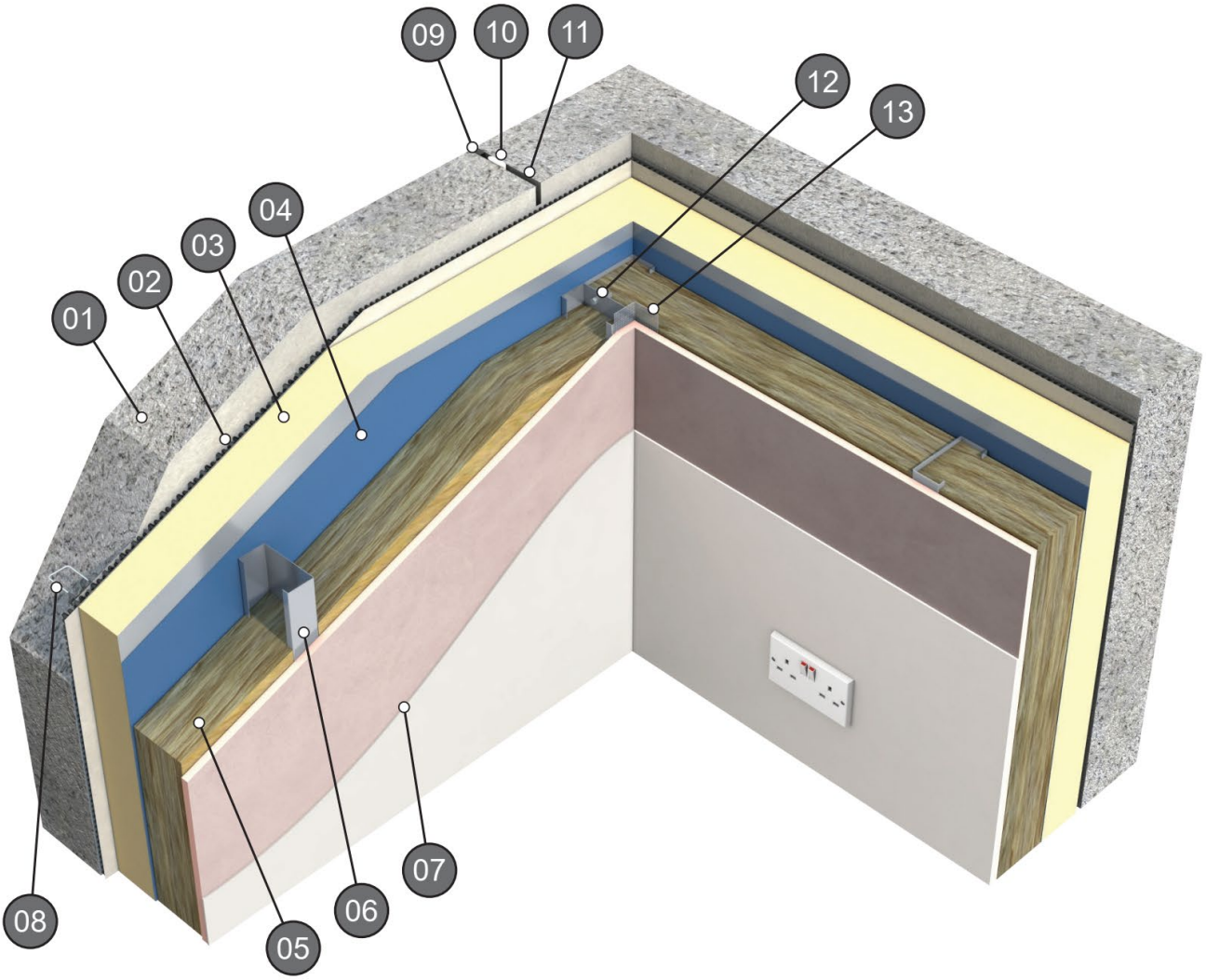
16. 12.5mm Type F Plasterboard with skim finish.

17. Selected roofing felt.

18. Batten.

19. Roof tile or slate.

Figure 8 - Typical Eaves Detail



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. PIR Insulation.

04. Selected AVCL.

05. Stone mineral wool insulation.

06. LGS metal stud.

07. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

08. Thermal anchor.

09. Mastic sealant.

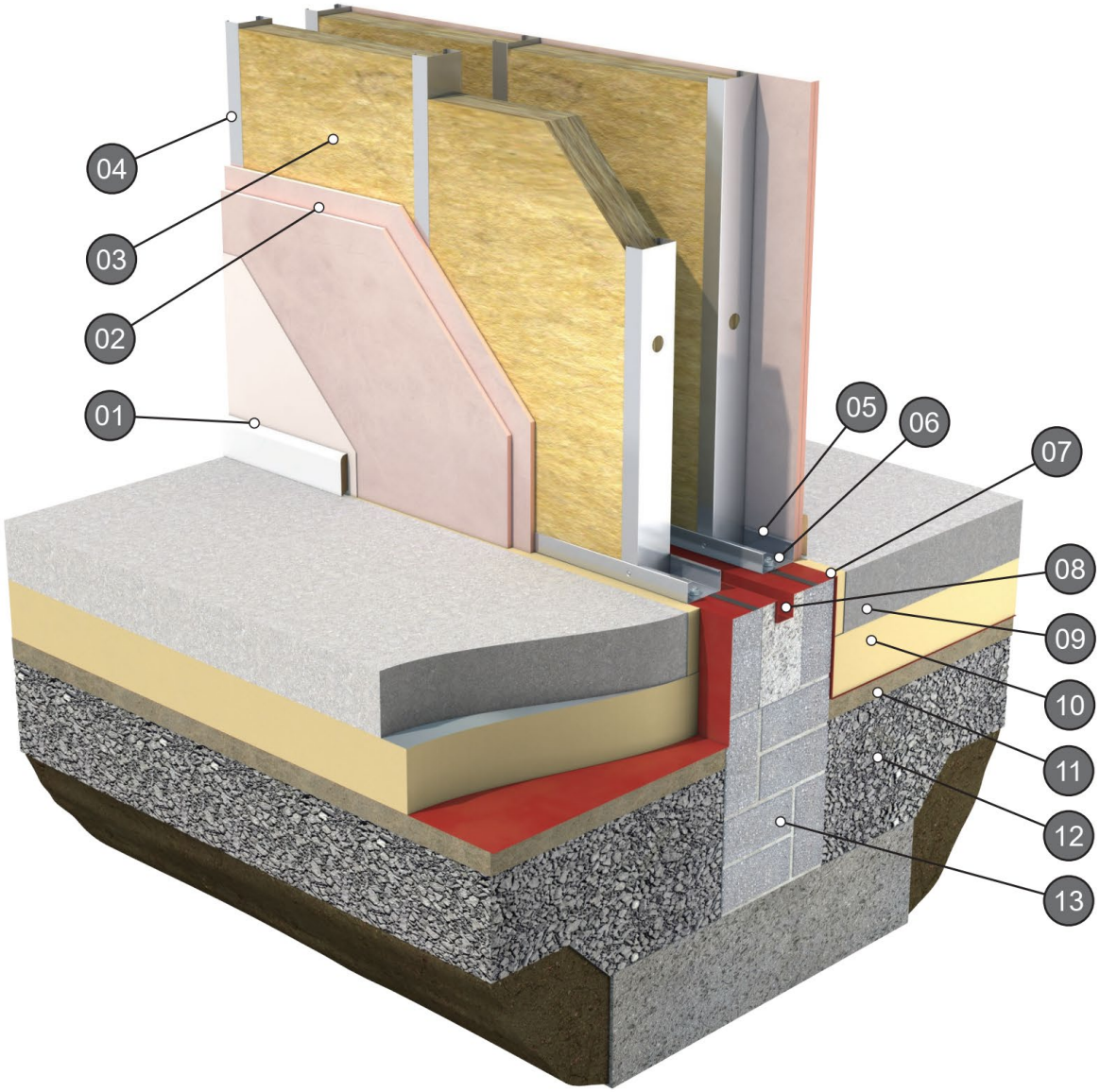
10. Backing rod.

11. Vertical joint.

12. Screw fixing.

13. Perimeter angle or corner stud.

Figure 9 - External Corner Detail



01. Skim plaster finish & skirting board.

02. 2 No. layers of 15mm Type F Plasterboard to provide REI 60 Separating wall in accordance with table 4 fire performance requirements.

03. Stone mineral wool insulation.

04. LGS metal stud.

05. Bottom track.

06. Anchor bolt.

07. Selected DPM or Radon membrane.

08. Cast-In drainage slot.

09. Concrete floor.

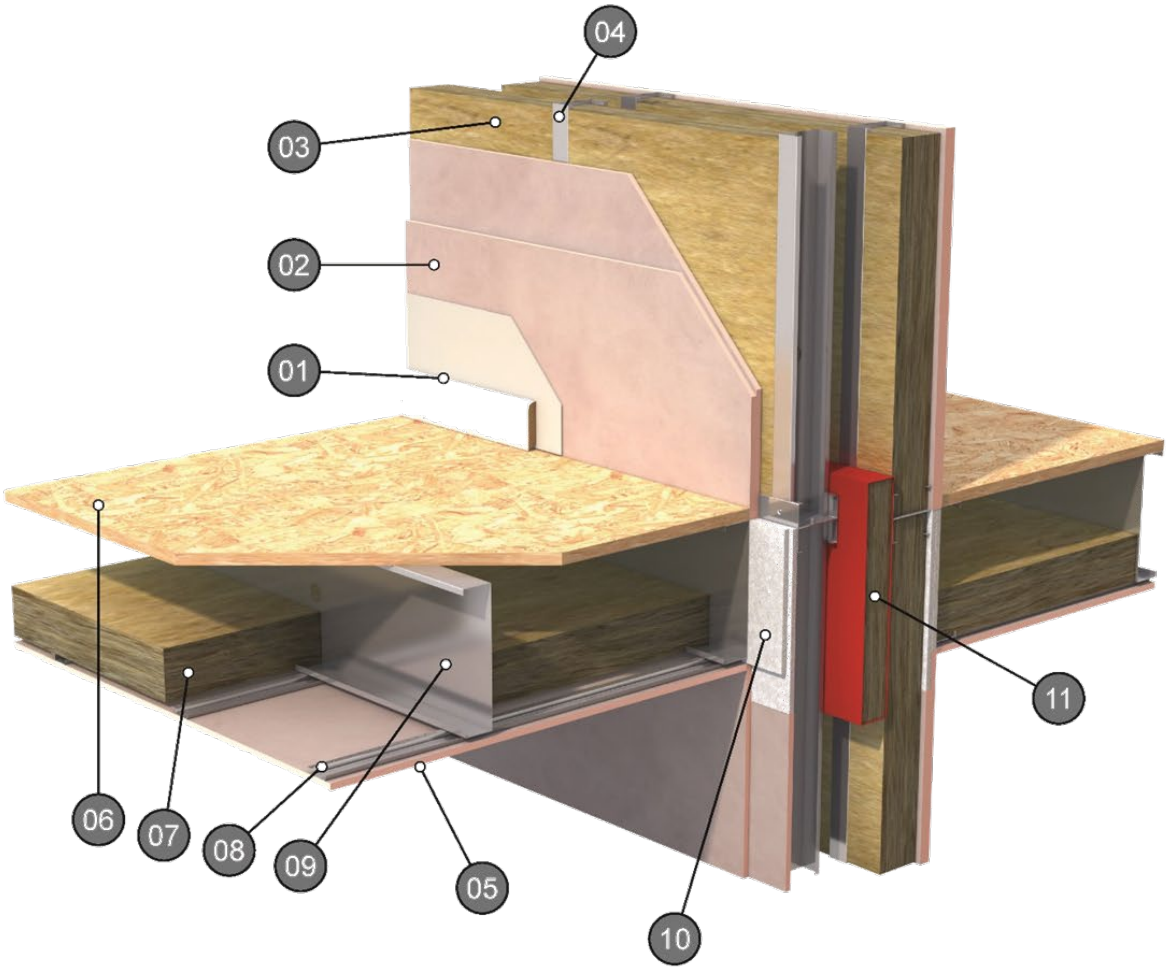
10. Floor Insulation.

11. Sand Blinding.

12. Hardcore.

13. Foundation detail to specification.

Figure 10 - Separating Wall to Foundation Detail



01. Selected finish & skirting board.

02. 2 No. layers of 15mm Type F Plasterboard to provide REI 60 Separating wall in accordance with table 4 fire performance requirements.

03. Stone mineral wool insulation.

04. LGS metal stud.

05. 12.5mm Type F plasterboard to provide R 30 REI 15 in accordance with table 4 fire performance requirements.

06. OSB3 or equivalent floor decking.

07. Stone mineral wool insulation.

08. Resilient bar.

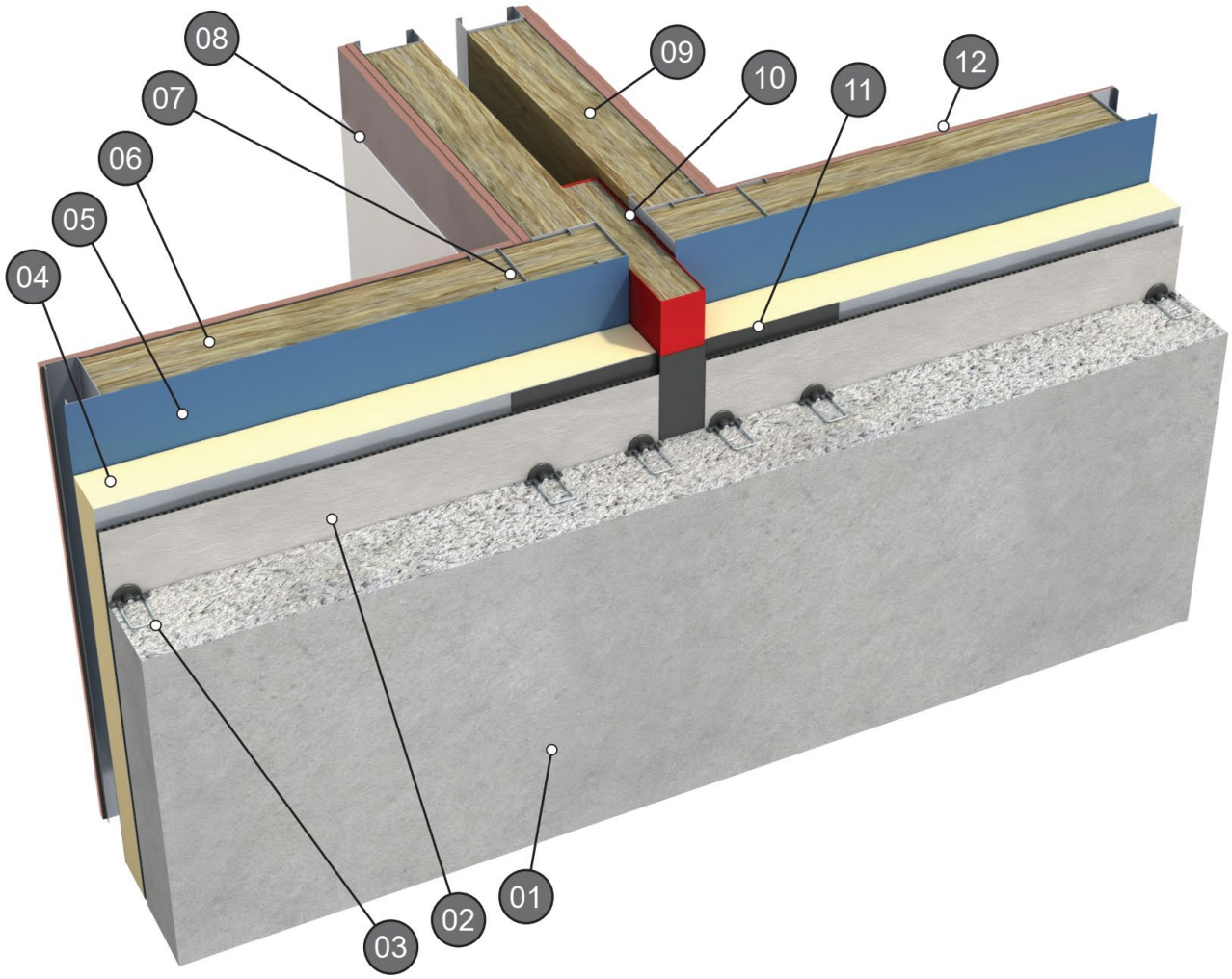
09. LGS floor joist

10. 2 No. layers of selected 15mm weatherboard infill with appropriate fire resistance.

11. Proprietary fire stop as required.

Note:all services penetrations in intermediate floor must be fully fire stopped to maintain R 30 REI 15 fire protection.

Figure 11 - Separating Wall to Intermediate Floor Detail



01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. Thermal anchor.

04. PIR Insulation.

05. Selected AVCL.

06. Stone mineral wool insulation.

07. LGS metal stud.

08. 2 no layers of 15mm Type F Plasterboard to provide REI 60 Separating wall in accordance with table 4 fire performance requirements.

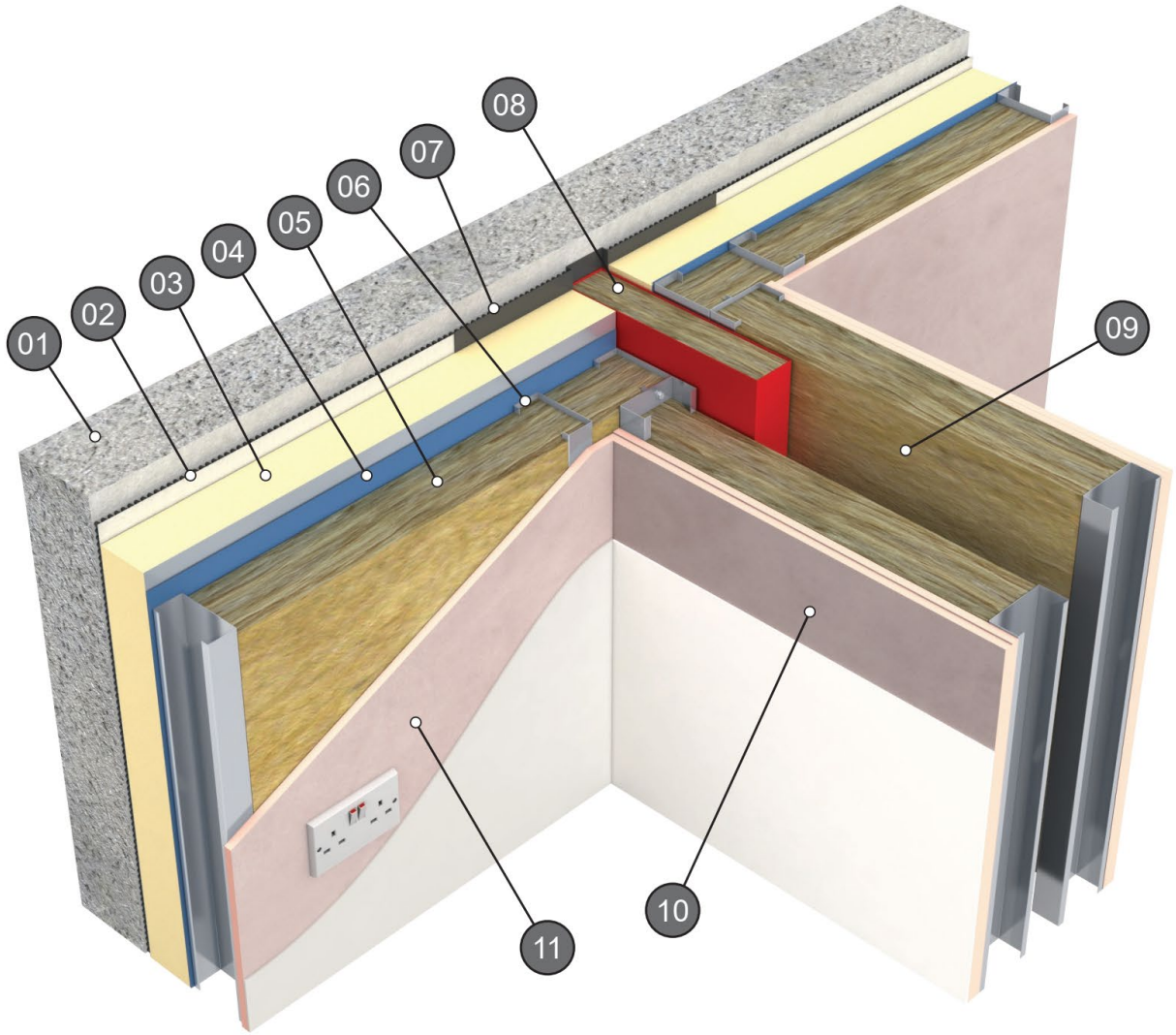
09. Stone mineral wool insulation.

10. Selected firestop at perimeter wall juction.

11. DPC

12. 1 no layers of 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance wit table 4 fire performance requirements.

Figure 12 - Separating Wall to Exterior Wall Junction (Exterior View)



NSAI approved cladding system.

01. Precast concrete wall or other NSAI approved cladding system.

02. Residual cavity.

03. PIR Insulation.

04. Selected AVCL as required.

05. Stone mineral wool insulation.

06. LGS metal stud.

07. DPC.

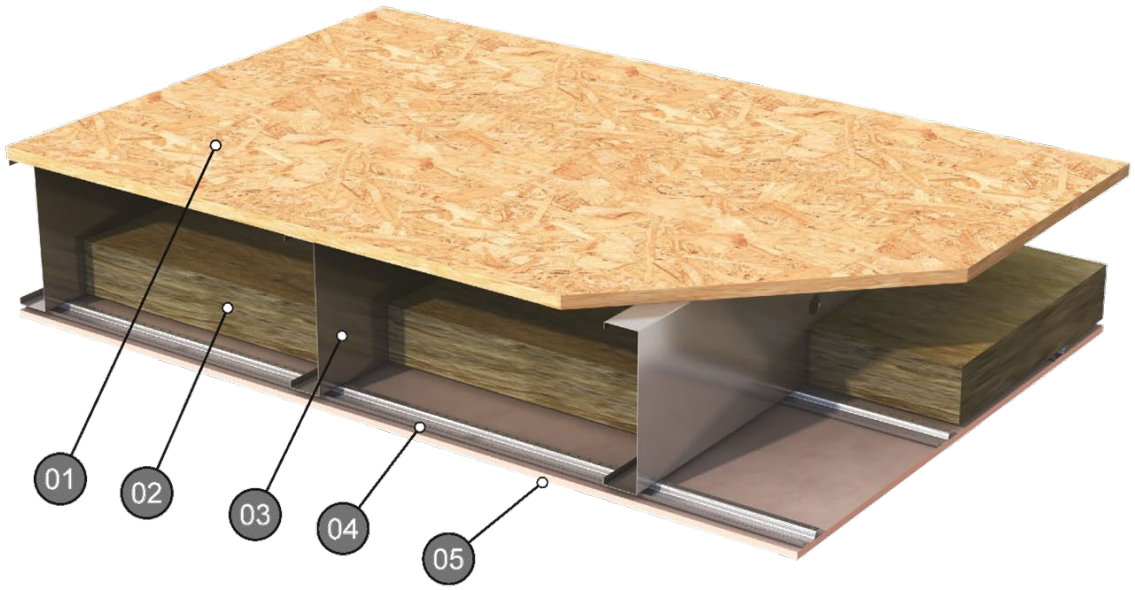
08. Selected firestop at perimeter wall juction.

09. Stone mineral wool insulation.

10. 2 no. layers of 15mm Type F Plasterboard to provide REI 60 Separating wall in accordance with table 4 fire performance requirements.

11. 1 No layer of 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance

Figure 13 - Separating Wall to Exterior Wall Detail (Interior View)



01. 22mm OSB3 decking boards.

02. Stone mineral wool insulation.

03. LGS C-Section floor joists.

04. Resilient Bars.

05. 12.5mm Type F plasterboard to provide R 30 REI 15 in accordance with table 4 fire performance requirements.

Note: All services penetrations in intermediate floor must be fully fire stopped to maintain R 30 REI 15 fire protection.

Figure 14 - 30min Intermediate Floor Detail

3.1 STRENGTH AND STABILITY

3.1.1 Certificate of Structural Compliance

The Carlow Concrete External Wall Panel & LGS Building System is intended for use where the Client's Design Team/Architect's drawings are available and satisfy the Building Regulations 1997 to 2019. The Architectural and Engineering design team of the client are responsible for the architectural drawings and overall building design to comply with the Building Regulations. Carlow Concrete using an experienced Chartered Structural Engineer, are responsible for the structural design of the Carlow Concrete External Wall Panel & LGS Building System.

Building Control (Amendment) Regulations (S.I. 9) of 2014 (BCAR) came into action from 1st March 2014. The Carlow Concrete Building System certification will typically be supplied as a sub-contractor role under BCAR projects which will require Carlow Concrete to furnish the relevant ancillary certification per project. The appointed person within Carlow Concrete will liaise with the Assigned Certifier (AC)/Employers Representative (ER) and the Design Certifier where applicable, furnishing the relevant Commencement Notice data, within the timeframe requested, along with an inspection notification framework summary and completion ancillary certificate as and when required.

It is imperative that all design team members are clear in relation to what elements of the project Carlow Concrete are responsible for and what the ancillary certificate relates to.

Buildings constructed using the Carlow Concrete External Wall Panel & LGS Building System shall be certified by a competent, Chartered Engineer as being in accordance with Part A of the Building Regulations 1997 to 2019.

3.1.2 Superstructure Design

The system can be designed to comply with the requirements of Part A of the Building Regulations 1997 to 2019 regarding the Design to Avoid Disproportionate Collapse.

The structural assessment of the Carlow Concrete Building System shall be site and project specific and a Structural Design Engineer suitably experienced in this type of structure shall undertake the structural engineering of every building element designed by Carlow Concrete. In accordance with I.S. EN 1990[22], a DSL2 (Design Supervision Level) should be employed to check the design in line with good practice.

This structural design certificate should cover the adequacy of all the cold formed elements with precast concrete panels or cladding system and hot rolled elements within the structure in question which Carlow Concrete supply. It should also address the dimensions and thickness of each element and member making up the superstructure. The structural certificate of compliance must also confirm that there is sufficient uplift resistance and that there is adequate racking and load bearing capacity to either side of any opening to ensure the stability of the walls. Dwellings designed and constructed in accordance with this Certificate will have adequate strength and stability as per the building codes and standards.

3.1.3 Substructure Design

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

3.1.4 Design Loads

The design of a typical building has been examined by the NSAI Agrément and demonstrates compliance with the following Codes of Practice. In general, the wall panels, floor trusses and roof truss are designed in accordance with:

- I.S. EN 1993-1-1[14] and timber roof trusses to I.S. EN 1995-1-1[27] Eurocode 5.
- I.S. EN 1991-1-1[24] Eurocode 1.
- I.S. EN 1991-1-4[25] Eurocode 1.
- I.S. EN 1991-1-3[26] Eurocode 1.

Design wind and snow loads should be based on Diagrams 1 and 14 of TGD to Part A of the Building Regulations 1997 to 2019.

Non-load bearing partitions and walls are designed in conformance with the criteria set out in BS 5234-1[28] and I.S. EN 10143[29]. Typical design loads, in the absence of client specified, project specific loads, are:

- Imposed load on floor of 1.5kN/m^2 plus an allowance of 0.5kN/m^2 for internal partitions.
- Roof imposed loads of 0.60kN/m^2 with an allowance of 0.25kN/m^2 distributed load over a loft space with access, along with a concentrated load (point load) of 0.9kN i.e. water tank.
- Wind loads based on I.S. EN 1991-1-4[25].
- Snow loads to be assessed based on I.S. EN 1991-1-3[26].

Greater loads can be accommodated by request.

3.1.5 Steel Concrete Composite Deck Design

Carlow Concrete Structural Engineer is responsible for the structural design of all profiled steel composite concrete decks. The Carlow Concrete chartered structural Engineer is also responsible for design of the propping of this deck and the design of the procedure to remove the propping. A safe system of work for the propping of the slab must be agreed between the Clients Engineer and Carlow Concrete's Structural Engineer and needs to be strictly adhered to on site.

The profiled steel deck and all accessories such as slab edge trim, restraint strap and closures etc. are installed by Carlow Concrete trained erectors. All propping and reinforcement are to be done to Carlow Concrete propping and deck reinforcement plans. The execution of the propping and reinforcement plan is the responsibility of the main contractor or Carlow Concrete installers if included in their scope of works.

The Carlow Concrete Structural Engineer and Carlow Concrete Site Manager inspect the installation of all decks prior to pouring of concrete to ensure the supporting structure, including temporary props, all reinforcement, screw fixings, shutters and straps are installed correctly. The metal deck is designed to bear on to the top of the head track and must have a minimum end bearing suitable to the profile being used before it is fixed. Steel reinforcement bars and mesh should be placed into position using plastic spacers, wheels and tying as required.

The concrete mix must be specified in accordance with project specific design to I.S. EN 1992-1-2[32] and should be supplied and manufactured in accordance with I.S. EN 206[31]. The concrete must be supplied and laid in accordance with I.S. EN 1992-1-2[32] Eurocode 2. The concrete should be dispensed across the decking to avoid 'heaping' and the surface levelled in accordance with the decking manufacturer's recommendations.

The results of concrete cube compressive test must be supplied to the Carlow Concrete Structural Engineer to ensure that the actual concrete strength attained, achieve the strengths required. Concrete run-off and spillage should be minimised and build-up of debris in base tracks should be avoided. In cold weather the concrete should be protected from the effects of frost and rain until adequately cured. Props are not to be removed until concrete has reached required strength, curing period and approval is given by Carlow Concrete Structural Engineer to remove props.

3.1.6 Structural Testing

Where it is required, structural testing has been used to verify the relevant aspects of the structure where the design falls outside the scope of I.S. EN 1993-1-1[14].

3.1.7 Wind Load

Buildings designed in accordance with the Carlow Concrete Building System Design Manual will have adequate resistance to wind load in areas as outlined in Figure 1 (a) Map of wind speeds (v) in m/s of TGD to Part A of the Building Regulations 1997 to 2019). For very exposed sites on hills above the general level of the surrounding terrain, the system can be specifically designed to meet the requirements as defined in I.S. EN 1991-1-4[25]. The system can be designed to be used in all locations in Ireland.

3.2 STRUCTURAL FIRE SAFETY

Any dampers, ductwork, and sealing of gaps formed by services that pass through the compartment walls and floors will involve suitable tested systems which have included appropriate fire resistance testing for the required time duration. Details around penetrations and openings such as doors and windows shall avoid any excessive heat ingress into the wall cavities.

All materials such as cavity barriers and fire stops, used in the construction comply with I.S. EN 13501-1[33]. They shall be detailed as described in Section 2.5.6 (of this Certificate) and as specified in the Carlow Concrete fire stopping details in line with the supporting documents to the Building Regulations 1997 to 2019.

Any compartment or separating wall providing fire compartmentation shall be carried up through any roof space and brought up to the underside of the roof cladding to provide adequate fire stopping. Services are permitted within all internal and external loadbearing and non-loadbearing walls of the Carlow Concrete External Wall Panel & LGS Building System provided the wall is not a separating wall.

All fire testing on the Carlow Concrete walls has been carried out with services penetrations in the wall to accurately test the system.

3.2.1 Structural Fire Safety Purpose Groups (Vol 2)

The buildings in purpose class 1(a), 1(b) & 1(d) are covered under TGD B Fire Safety Dwelling Houses Volume 2 of the Building Regulations 1997 to 2019. Under this revision buildings designed in accordance with the Eurocodes require the structural fire resistance performance specified, to be achieved in accordance with European test methods. The European tests required to be used are I.S. EN 1364-1[34], I.S. EN 1365-1[35], I.S. EN 1365-2[36].

The load-bearing and non-loadbearing elements of the above purpose classes have a fire resistance performance in accordance with the required European test method. Table 4 and Table 5 outlines

a combination of 30-minute and 60-minute fire resistance tests.

3.2.2 Structural Fire Safety Purpose Group 2006

The fire resistance performances of elements of non-loadbearing and loadbearing structure are given in Table 4 and Table 5 as a combination of I.S. EN 1364-1[34] and I.S. EN 1365:2-2014. Table 4 and Table 5 contains fire resistance tests to 30 and 60 minutes.

3.3 IMPACT RESISTANCE

The interaction of components is such that, if subjected to exceptional impacts causing local failure, the overall stability of the structure will not be dangerously impaired.

Part Four / Technical Investigations 4

4.1 BEHAVIOUR IN RELATION TO FIRE

4.1.1 Fire Resistance

Fire tests and assessment of test results show that buildings constructed using the Carlow Concrete Building System can meet the Building Regulation requirements in relation to fire resistance as shown in Table 4 and Table 5. The tests have demonstrated the ability of the system to withstand severe fire exposure for the period required for compliance with the Building Regulations in terms of fire performance. Tests have been conducted by Carlow Concrete to meet fire test requirements I.S. EN 1364-1[34], I.S. EN 1365-1[35] and I.S. EN 1365-2[36]. The fire resistance required is dependent upon the purpose class of the building being designed and constructed.

The Carlow Concrete Building System must be designed with the required boarding specification to meet the minimum requirements of Table A1 of TGD B 2017 Volume II of the Building Regulations 1997 to 2019 for purpose class 1(a), 1(b) & 1(d) and to meet the minimum criteria of any other building specific structural fire performance requirements. Table 4 and Table 5 of this Certificate provides tables of fire resistance performances which provide a variety of boarding specifications and their associated fire resistance performance that will have its stability maintained for the minimum required period in the event of fire.

There shall be two leaves in a steel frame separating wall with a recommended minimum of 50mm clear cavity distance between the two leaves maintained throughout the cavity. Services shall not be placed in the cavity or penetrate the wall linings of separating walls. Where services are required, an additional cavity shall be provided so that the integrity of the fire lining is maintained.

Services shall not be placed in the cavity of a compartment wall. Where services are required to penetrate a compartment wall, all such penetrations shall be kept to a minimum and shall be fire stopped. Where services (e.g. light switches and sockets) are placed on a compartment wall, a service cavity shall be provided so that the integrity of the fire lining is maintained. Where a compartment wall has two separate leaves, a recommended minimum of 50mm clear distance shall be maintained throughout the wall cavity.

Accommodation of Services in Compartment Walls/Floors and Separating Walls must be in accordance with Section 3.5.4.1 of TGD B 2017 Volume 2 of Building Regulations 1997 to 2019 for purpose class 1(a), 1(b) & 1(d). Services may be surface mounted or accommodated in service ducts or within service cavities created external to the linings of the fire-resistant compartment walls or floor.

The system can be designed to accommodate sub-divided fire resisting construction in accordance with a Fire Safety Certificate where it is necessary to inhibit the spread of fire within the building.

The building details of the system incorporate suitable cavity barriers and fire stops, in accordance with I.S. EN 13501-1[33], to satisfy the requirements of section 3.3 to Part B of the TGD 2006 to the Building Regulations 1997 to 2019.

An apartment, a house in a terrace and a semi-detached house are treated as separate buildings and therefore must be separated by a separating wall (party wall), as shown in Part B of the TGD to the Building Regulations 1997 to 2019. Where a window is required to provide an alternative means of escape in a dwelling house or apartment, it must provide an unobstructed opening of at least 0.33m^2 with a minimum width and height of 450mm. The opening section should be capable of remaining in an open position, which provides the minimum clear area. The window should be positioned as required by BS 9991[37] and in accordance with Part B1 of TGD to Part B of the Building Regulations 1997 to 2019. Any restrictor fitted on the window, must be easy to operate.

The fire resisting elements of the construction that are specified in Table 4 and Table 5 of this

Certificate provide for 30-minutes and 60-minutes fire resistance, for a range of specifications.

4.1.2 Plasterboard Installation

The proper application of plasterboard to the steel frame members is critical for both fire and sound performance. Attention shall to be given to proper and practical detailing on the part of the designer and a high standard of workmanship on behalf of the contractor. Plasterboard in addition to all cavity barriers and fire stops on all structural and separating walls must be fully checked on site and signed off by main contractor in accordance with project specific construction details. All plasterboard that provides fire resistance to load bearing and non-load bearing elements of the structure must conform to the requirements of Type F to I.S. EN 520[11] and must be installed in accordance with the specification given in Table 4 and Table 5. If alternative boarding is proposed, then an independent fire test report from an Accredited Laboratory needs to be provided and assessed by a competent Fire Engineer. Typically, all Carlow Concrete System panels are delivered to site un-boarded.

4.1.3 Surface Spread of Flame

The precast concrete panel has a designated Class 0 surface spread of flame as shown in Table 3. For a more comprehensive list of material and product fire performance ratings, reference should be made to Table A6 of TGD to Part B 2006 of the Building Regulations 1997 to 2019.

Material	Fire Rating (National Class)	Fire Rating (European Class)
Precast Concrete Panel	Class 0	A1
Internal Plasterboard before decoration	Class 0	Class A2-s3, d2
Slates/Tiles	AA	Class B Roof(t4)

Table 3: Surface Spread of Flame Characteristics

4.1.4 Protection of Building

Combustible material e.g. insulation, should be separated from the flue of a masonry chimney by at least 200mm, or at least 40mm from the outer surface of the chimney. Details are given in Section 2 and diagrams 2 – 6 of TGD to Part J of the Building Regulations 1997 to 2019. The separation from a heating appliance to combustible wall insulation material should be as per Clause 2.5.6 and Diagram 6 of TGD to Part J of the Building Regulations 1997 to 2019. For chimneys, covered by I.S. EN 1859[38], separation between this product and the external surface of the chimney is determined in accordance with Clause 2.5.7 to 2.5.8 and in accordance with diagram 7 of Part J of the Building Regulations 1997 to 2019.

Combustible material in proximity to a constructional hearth must be protected by 250mm of solid concrete or as detailed in Diagram 8 of TGD to Part J of the Building Regulations 1997 to 2019.

4.1.5 Roof Designation

All tiles or slates used in the roof in conjunction with the Carlow Concrete Building System are designated AA in accordance with TGD to Part B of the Building Regulations 1997 to 2019 (see Table A5 of TGD Part B 2006 and Table A4 of TGD to Part B Volume 2 for notional designations of roof coverings). Other NSAI Agrément approved roof coverings may also be used with the system under the guidance of a Carlow Concrete Chartered Engineer.

4.1.6 Cavity Barriers

Cavity barriers are covered in clause 2.5.6 of this certificate.

4.2 THERMAL INSULATION

The panels are designed as hybrid warm frame system where the LGS sections are located on the warm frame side of the insulation. Some building elements, namely the roof, ground floor, windows and doors may be site and project specific. Therefore, the U-value of these elements must be calculated before overall compliance with Part L of the Building Regulations 1997 to 2019 can be determined. The Carlow Concrete Building System can be provided for a wide range of required elemental U-values.

TGD Part L of the Building Regulations 1997 to 2019 directs users to BRE Digest 465[6] published by BRE of light steel-framed constructions. A more precise result is obtained by using a numerical method which conforms to I.S. EN ISO 10211[4].

Table 6 of this certificate gives a range of external wall elemental U-values for the Carlow Concrete Building System. Table 7 gives a sample U-value calculation for an external wall taking account of the approached outlined in BRE Digest 465[6].

Both Table 6 and Table 7 allow for a light gauge steel (LSG) section 1.2mm thick @ 600 centres. Table 8 provides an overview of the effects on the elemental U-value of increasing the gauge of the LSG and changing the spacing (c/c) of same.

U-values for roofs should be calculated to I.S. EN ISO 6946[5]. U-value for ground floor slab should be calculated to I.S. EN ISO 13370[7].

4.2.1 Limiting Thermal Bridging

The linear thermal transmittance ψ-value (Psi-value) 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.

Table 9 of this certificate gives ψ-value for a range of Carlow Concrete Building System junctions and their corresponding flanking elemental U-values. When flanking elemental U-values deviate by an aggregated 20% from the target U-values given in Table 9, the ψ-values no longer remain valid and guidance must be sought from the Certificate holder. A full listing of ψ-value calculations, along with the building details on which calculations are based, are contained within the Certificate holder's Technical manual.

Bridged junctions were thermally modelled in accordance with BRE IP 1/06[2] and BRE Report BR 497[3] by NSAI Certified Thermal Modellers.

The Dwelling Energy Assessment Procedure (DEAP) used to produce the Building Energy Rating (BER) for a dwelling takes account of the total effects of thermal bridging through the input of the Y-value, which is a multiplier applied to the total exposed area of the building.

Where limited provisions are made to eliminate any risk of surface condensation or mould growth, the default Y-value of 0.15 must be entered into DEAP. When all building junctions are demonstrated to be equivalent to or better than the corresponding Acceptable Construction Details (ACD), then the Y-value can be taken as 0.08.

Alternatively, the transmission heat loss coefficient due to thermal bridging (H_{TB}) can be calculated out by summing up the ψ-values for each junction and multiplying by the linear length of each junction. The Y-value is calculated by dividing H_{TB} by the exposed surface area.

ψ-values for other junctions outside the scope of this Certificate should be assessed by an NSAI registered Thermal Modeller or equivalent competent person in accordance with the BRE IP1/06[2] and the conventions outlined in BRE Report BR 497[3].

4.2.2 Internal Surface condensation

As part of the assessment carried out to determine the ψ-values, internal surface temperatures factors (f_{Rsi}) are also checked. When internal surface temperatures are greater than 15°C, best practice will have been adopted to safeguard against the risk of surface condensation occuring under normal occupancy and humidity class levels.

Table 9 of this certificate gives internal surface temperature factors (f_{Rsi}) for a range of building junctions and their corresponding flanking elemental U-value.

The Carlow Concrete Building System has been assessed and when detailed in accordance with this certificate, these thermally bridged junctions comply with the requirements of Section D.2 of appendix D of TGD to Part L of the Building Regulations 1997 to 2019.

4.3 VENTILATION

4.3.1 Un-designed Air Infiltration

Air permeability can be measured by means of a pressure test and this is now a mandatory requirement under TGD to Part L of the Building Regulations 1997 to 2019 to show compliance with the backstop air permeability index at a pressure differential of 50Pa across the building envelope.

When inputting values into DEAP, the measured air permeability index at a pressure differential of 50Pa across the building envelope is divided by 20 to determine an air permeability value which is more representative of the actual pressure differential across the building envelope under normal conditions.

The procedure for testing is specified in I.S. EN ISO 9972[39] with additional guidance given in the NSAI's "Certified Air Tightness Tester Scheme Master Document" and clause 1.5.4 of TGD to Part L of the Building Regulations 1997 to 2019. As outlined in Clause 1.5.4.1 of TGD to Part L, two sets of measurements should be made when testing a dwelling namely a pressurisation and depressurisation test.

TGD to Part L of the Building Regulations 1997 to 2019 requires an air permeability pressure tests to be carried out on all dwellings by an independent third party such as a National Standards Authority of Ireland (NSAI) certified tester or an Irish National Accreditation Board (INAB) accredited tester or equivalent.

The Carlow Concrete Building System can be designed to provide the required project specific airtightness requirement and can be achieved in practice due to its offsite production process; hybrid construction build up and the quality of product produced in a factory-controlled environment. The Carlow Concrete Building System will therefore significantly contribute to the reduction of the un-designed air permeability from a building. The system incorporates an AVCL on all external walls and ceiling lines which is designed to maximize airtightness performance. To avoid excessive heat losses due to un-designed air infiltration and to maintain continuity on the building component relied upon to perform the air sealing function of the building, it is necessary to install peripheral seals around windows, doors, services, floors, roof and all building junctions which penetrate the envelope of the building.

Type	Element:	Test Standard	Results	Purpose Class
External Load Bearing Walls				
1	LGS C-Studs (89x45x1.2mm) with 1No. layer of 12.5mm Type F plasterboard fixed to the fire side face and 75mm PIR Insulation fixed to the non-fire side with 100mm stone mineral wool insulation between the studs. 2 No. Double Sockets were also fitted on the Fire Side.	IS EN 1365-1[35]	30 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a)
2	LGS C-Studs (89x45x1.2mm) with 2No. layers of 12.5mm Type F plasterboard fixed to the fire side face and 70mm PIR Insulation fixed to the non-fire side with 100mm stone mineral wool insulation between the studs. 2 No. Double Sockets were also fitted on the Fire Side.	IS EN 1365-1[35]	60 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a)
Internal Load Bearing Walls				
3	LGS C-Studs (89x45x1.2mm) with 1No. layer of 12.5mm Type F plasterboard fixed to the fire side face and 1No. layer of 12.5mm Type F plasterboard fixed to the non-fire side with 100mm stone mineral wool insulation between the studs. 2 No. Double Sockets were also fitted on the fire side.	IS EN 1365-1[35]	30 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a)
4	LGS C-Studs (89x45x1.2mm) with 2No. layers of 12.5mm Type F plasterboard fixed to the fire side face and 2No. layers of 12.5mm Type F plasterboard fixed to the non-fire side with 100mm stone mineral wool insulation between the studs. 2 No. Double Sockets were also fitted on the fire side.	IS EN 1365-1[35]	60 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a)
Separating Walls				
5	**Twin Frame Wall** 2No. layers of 12.5mm Type F plasterboard fixed to LGS C-Studs (89x45x1.2mm) with 100mm stone mineral wool insulation between the studs, 50mm cavity, LGS C-Studs (89x45x1.2mm) with 100mm stone mineral wool insulation between the studs with 2No. layers of 15mm Type F plasterboard fixed to the LGS C-studs.	IS EN 1365-1[35]	60 mins from either side	1(a), 1(b), 1(c), 1(d), 2(a)
6	**Twin Frame Wall** 1No. layer of 12.5mm Type A plasterboard, fixed to timber battens to form service cavity, fixed to 2No. layers of 15mm Type F plasterboard fixed to the LGS C-Studs (89x45x1.2mm) with 100mm stone mineral wool insulation between the studs, 50mm cavity, LGS C-Studs (89x45x1.2mm) with 100mm stone mineral wool insulation between the studs with 2No. layers of 15mm Type F plasterboard fixed to the LGS C-studs, with timber battens to form service cavity, with 1No. layer of 12.5mm Type A plasterboard.	IS EN 1365-1[35]	60 mins from either side	1(a), 1(b), 1(c), 1(d), 2(a)

Table 4: Fire Protection Requirements for Loadbearing Wall, Floor and Ceiling Elements

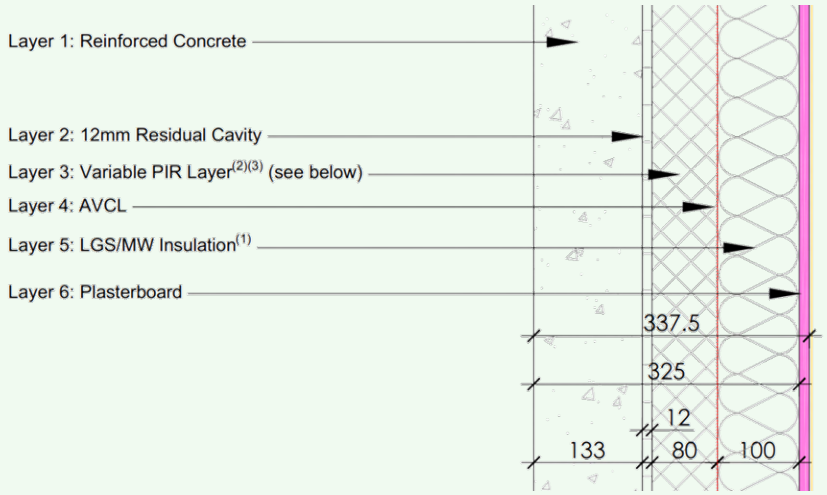
Type	Element:	Test Standard	Results	Purpose Class
Non-Load Bearing Walls				
7*	**Internal Non-Load Bearing Partition Wall** LGS C-Studs (89x45x1.2mm) with 1No. layer 12.5mm Type F plasterboard fixed to each face of the LGS C-studs with 100mm stone mineral wool insulation between the studs.	IS EN 1365-1[35]	30 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a)
8*	**Internal Non-Load Bearing Partition Wall** LGS C-Studs (89x45x1.2mm) with 2No. layers of 12.5mm Type F plasterboard fixed each face of the LGS C-studs with 100mm stone mineral wool insulation between the studs.	IS EN 1365-1[35]	60 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a)
Compartment floors: Loaded Floors Truss				
9	**Floor supporting an Imposed Load of 1.5kN/m²** 1No. layer of 12.5mm Type F plasterboard, onto resilient bar @400mm centres, onto 250mm LGS C-Section Joists at 600mm centres, with 100mm stone mineral wool between the trusses, with 22mm OSB3 floor deck.	IS EN 1365-2[36]	30 mins from below ceiling level	1(a), 1(b), 1(c), 1(d), 2(a)
10	**Floor supporting an Imposed Load of 1.5kN/m²** 1No. layer of 12.5mm standard plasterboard, onto 50mm x 25mm timber battens to form service cavity, onto 2no. layers of 15mm Type F plasterboard, onto 250mm LGS Floor trusses at 400mm centres, with 100mm stone mineral wool between the trusses, with 22mm OSB3 floor deck.	IS EN 1365-2[36]	60 mins from below ceiling level	1(a), 1(b), 1(c), 1(d), 2(a)
Compartment floors: Loaded Floors Composite Metal Deck				
11	**Loaded Floor Supporting imposed load of 2.0kN/m²** 140mm normal weight concrete with 0.9mm Tata Comflor 51. Concrete reinforced with A393 Mesh with a minimum 30mm cover below the upper surface - 4500mm span.	Eurocode Design	30 mins from below deck	1(a), 1(b), 1(c), 1(d), 2(a)
12	**Loaded Floor Supporting imposed load of 2.0kN/m²** 160mm normal weight concrete with 1.2mm Tata Comflor 60. Concrete reinforced with A393 Mesh with a minimum 30mm cover below the upper surface - 3420mm span.	Eurocode Design	60 mins from below deck	1(a), 1(b), 1(c), 1(d), 2(a)

Notes:

- Type F plasterboard refers to the particular type of plasterboard tested in the respective fire tests and the details are available directly from Carlow Concrete.
- Stone mineral wool refers to the particular type and density of stone mineral wool used in a particular fire test and the details are available directly from Carlow Concrete.
- All wall tests were completed without the joints being taped and jointed.
- In situations where there is no fire requirement for non-loadbearing walls, alternative non-loadbearing wall boarding specifications can be used once they have been agreed and signed off on by Carlow Concrete.
- *Non-load bearing wall fire resistance data is provided from the load bearing data and can be utilised under the Field of Direct Application whereby the load can be decreased on the specimen.

Table 5: Fire Protection Requirements for Loadbearing Wall, Floor and Ceiling Elements (Cont.)

External walls U-value for variable PIR (0.022 W/m.K) thickness



Wall thickness	PIR variable thickness:	Calculated U-value (W/m²K)
340mm	80mm	0.18
350mm	90mm	0.17
360mm	100mm	0.16
370mm	110mm	0.15
380mm	120mm	0.14
395mm	135mm	0.13

Calculation comply with BRE Digest 465[6] *U-values for light steel-frame construction*
(1) Corrections have been made for 1.2mm LGS studs @ 600mm c/c bridging layer 4.
(2) Correction for mechanical fasteners have been applied to layer 3 equating to 4 No. 6mm Ø Stainless steel fixing to connect brick tie channel to LGS section.

Table 6: Typical External Wall U-Values

Sample U-value Calculation for 80mm PIR

Layer	Description	% Bridged	Thickness [mm]	Thermal conductivity **λ** [W/m K]	Thermal resistance **R** [W/m²K]	
	R_{se}				0.04	
1	Precast Concrete Wall		133	2.3	0.058	
2	Unventilated Residual Cavity		12		0.16	
3	PIR Insulation		**80**	0.022	3.636	
4	AVCL					
5	Steel Stud	0.002	100	50	0.002	
	Mineral Wool	0.998	100	0.04	2.5	
6	Type F Plasterboard		12.5	0.25	0.05	
	R_{si}				0.13	
				Ru Total =	6.566	
				RL Total =	4.789	
	From BRE Digest 465[6]			P = 0.681, $R_T = pR_{max} + (1-p)R_{min}$ =	5.999	
				Correction term, ΔU =	0.0149	
				Corrected U-Value (2DP) =	**0.182**	W/m²K

Table 7: Sample U-value calculation for 80mm PIR

Effect on 0.161W/m²K 100mm PIR for variations in LGS thickness and centres						
Centres of studs	**LGS Thickness (Gauge)**					
	0.8mm	1.0mm	1.2mm	1.5mm	2.0mm	2.5mm
300mm	0.17	0.171	0.173	0.174	0.176	0.177
400mm	0.163	0.165	0.166	0.167	0.169	0.17
600mm	0.157	0.158	0.159	**0.161**	0.162	0.163

Table 8: Effect on U-value for variations in LGS thickness and centres

Target linear thermal transmittance (ψ) for different types of junctions.			
Detail Ref:	**Junction Description**	**Temperature Factor f_{Rsi} (Min = 0.75)**	**Carlow Concrete Ψ-value [2] (W/m.K)**
SD-001	Ground Floor - Insulation below slab	0.76	0.201
SD-003	Intermediate Floor	0.95	0.013
SD-004B	Intermediate Floor – Lattice Joist	0.875	0.083
SD-023	Intermediate Floor – Composite Floor	0.943	0.137
SD-015	External Wall Party Wall [1]	0.92	0.041
SD-010	Separating Wall Head [1]	0.894	0.06
SD-005	Eaves Detail	0.838	0.076
SD-006	Gable end detail	0.81	0.085
SD-012	Window Head Detail	0.89	0.041
SD-011	Window Jambs	0.88	0.053
SD-013	Window Sill Detail	0.897	0.058
SD-009	Party Wall through Ground Floor [1]	N/A	0.21
SD-007	External Corner Plan	0.84	0.052

[1] Value of ψ is applied to each dwelling.
[2] The published Ψ-values in this table relate to the following flanking element U-values; Walls, U_W = 0.18 W/m²k, roof insulation at ceiling, U_R = 0.10 W/m²k and a modelling floor U-value, U'_F = 0.126 W/m²k, which is based on 125mm insulation (λ=0.022 W/m.K) and a P/A ratio = 0.25

Table 9: Typical ψ-Value W/mK

Please note: All U-value and Ψ-value calculations illustrated in the above Table 6 to Table 9 should be taken as examples of performance that can be achieved. It is strongly recommended that U-value calculations are produced on a project specific basis by a competent person as U-value calculations may increase or decrease depending on a wide range of parameters such as number of fixings per square metre, size of fixing, thickness of PIR etc, therefore U-values or Ψ-value should be recalculated if the build-ups differ from those described in Table 6 to Table 9.

4.3.2 Designed Ventilation

TGD to Part F of the Building Regulations 1997 to 2019 prescribes ventilation requirements to meet the needs of occupants within the building. This can be achieved by limiting moisture content of the air within the building so that it does not contribute to condensation and mould growth and to limit the concentration of harmful pollutants in the air within the dwelling.

In addition to ventilation requirements within the dwelling living space, TGD to Part F makes provisions for ventilation requirements in roofs and roof voids above the insulation line. These provisions will allow for the removal of moisture laden air or condensation which may enter the roof structure from the dwelling either through diffusion or exfiltration.

Where the air permeability is greater than 3 $m^3/(h.m^2)$ and lower than 5 $m^3/(h.m^2)$, natural ventilation can be considered as one acceptable ventilation solution for a dwelling. When the air permeability is lower than 3 $m^3/(h.m^2)$ natural ventilation is no longer acceptable and some form of mechanical ventilation system must be considered.

All ventilation systems will need to be installed, balanced and commissioned by competent installers and validated by a competent person to ensure that they achieve the design flow rates. The validation should be carried out by a person certified by an independent third party to carry out this work, e.g. National Standards Authority of Ireland (NSAI) certified or equivalent.

When continuous mechanical ventilation systems are being considered, low air permeability values will be required for the energy efficient operation of the mechanical systems.

For all ventilation systems, provision for a 10mm gap under internal doors to facilitate transfer of air and cross ventilation between rooms must be provided.

4.4 INTERSTITIAL CONDENSATION

4.4.1 Condensation in Walls

Calculations to BS 5250[1] have been carried out for wall build ups as covered by this certificate and predict no interstitial condensation within the external wall and pass the risk criteria in I.S. EN ISO 13788[40].

The AVCL is applied in between the PIR and the external side of the LGS framework which protects against interstitial condensation. The AVCL is applied during the manufacturing process at the factory. In situations where an AVCL is omitted, a condensation risk calculation must be provided by the Clients Design Team to assess the build-up proposed, considering the location of the building, the buildings occupancy and purpose class.

4.4.2 Condensation in Roof

Although roof trusses are outside the scope of this certificate, it is recommended that in both cold (insulation at ceiling level) and warm (insulation along the slope) roofs, an AVCL is provided on the warm side of the insulation to limit the migration of moisture laden air from the dwelling, entering the roof structure through diffusion.

Roof ventilation should be carried out in accordance with TGD Part F of the Building Regulations 1997 to 2019 and the recommendations of BS 5250[1]. It is important to ensure that the ventilation is not obstructed by roof insulation at eaves level. When roof insulation is packed into the eaves space, proprietary eaves tray may be provided to maintain ventilation at the eaves.

In the case of cold flat roofs, a cross-ventilated void, not less than 50mm deep, between the slab or deck and insulation should be provided in conjunction with the AVCL being provided on the warm side of the insulation. Ventilation openings should be provided to every roof void along two opposite sides of the roof and should be equivalent in area to a continuous opening of not less than 25mm at each side. It should also be noted that the dimensions of the cross-ventilated void and the ventilation depends on the size of the roof.

In the case of warm flat roofs, the risk of surface condensation is dependent on the nature of the supporting structure. With all flat roofs, there is a risk of interstitial condensation forming between the thermal insulation and the waterproof covering. To avoid this risk, an AVCL should be provided immediately above the supporting structure.

In the case of inverted flat roofs, it is essential that the thermal insulation used resists water absorption and is sufficiently load bearing to support the protective finish of ballast, paving or soil.

4.5 SOUND

4.5.1 Separating Walls (Party Wall)

The acoustic performance of the party wall specified in Section 2.5.1 has been assessed by both on site testing and *SCI Publication P 372 Acoustic Detailing for Steel Construction*[41] as well as through adopting best practice at salient junctions minimise the effects of airborne, impact and flanking sound. In respect of party walls (separating wall) an examination was also carried out of the key junctions in the external walls to ensure compliance with the requirements of Part E of the Building Regulations 1997 to 2019.

The specification for the separating wall achieves airborne sound insulation through the following:

- Structural isolation is achieved by leaving a recommended minimum 50mm cavity between the two steel frames.
- Stone mineral wool of minimum 22kg/m^3 density is placed between the studs in each frame. These wool batts are continuous from ground floor to the underside of the fire stopping under the roofing slates and provide the required acoustic properties.
- Mass is achieved using dense wall linings. Each steel frame is boarded with two layers of plasterboard to provide the minimum total mass per unit area of 22Kg/m² per face. All joints between the outer layer of plasterboard are staggered, taped and filled (where required for decoration) in accordance with manufacturers specifications.
- Reduction of flanking sound is achieved by sealing between the end of the separating wall frames and the outer cladding leaf.
- At the junction of the compartment floor and the party wall, an additional 500mm section of stone mineral wool insulation is provided within the cavity between the two steel frames to minimise flanking and direct sound transmission.

The separating wall (party wall) in the Carlow Concrete External Wall Panel & LGS Building System has been assessed and when constructed in accordance with this Certificate can meet the requirements of TGD to Part E of the Building Regulations 1997 to 2019.

4.5.2 Compartment Floor

The acoustic performance of the compartment floor specified in Section 2.5.3 has been assessed by both on site testing and comparison with Robust Standard Details for Separating Floor-Metal Joist E-FS-3 and SCI Publication P 372 Acoustic Detailing for Steel Construction[41]. Best practice has been adopted at salient junctions to minimise the effects of airborne, impact and flanking sound. In respect of compartment floor (separating floor) an examination was also carried out of the key junctions with the external walls to ensure compliance with the requirements of Part E of the Building Regulations 1997 to 2019.

4.5.3 Compartment Floor Steel Concrete Composite Deck

The composite deck can meet either the requirement of a Type 1 floor concrete base with a soft covering or a Type 2 floor concrete base with a floating floor as described in section 4 of TGD to Part E of the Building Regulations 1997 to 2019.

In both floor types the resistance to airborne sound depends mainly on the mass of the concrete base, plasterboard ceilings and good flanking detailing. In Type 1 the soft covering reduces the impact sound at source. The mass per unit area of the floor, coverings and ceilings meet the specification for a Type 1 separating floor. The impact sound reduction is achieved with the use of suitably approved 5mm layer of soft floor covering. This covering is not intended to be the final finished floor but is intended to act as resilient layer beneath different floor finishes such as vinyl, carpet, timber flooring, tiles etc.

In the Type 2 floor with a concrete base and a floating layer, the floating layer reduces the transmission of impact sound to the base and to the surrounding construction.

4.5.4 Lightweight Floating Floors on Compartment Floors

A lightweight floating floor consists of a floating layer and resilient layer. A floating floor uses a resilient layer to isolate the walking surface from the base and this isolation contributes to both airborne and impact sound insulation. The joist and steel concrete composite deck compartment floor systems have been assessed with both an approved batten system and an acoustic flooring grade stone mineral wool product.

4.5.5 On Site Testing

The Carlow Concrete Building System separating wall and floor details have been assessed and when constructed in accordance with this Certificate, can meet the minimum sound level performance outlined in TGD to Part E of the Building Regulations 1997 to 2019. All sound insulation testing was carried out in accordance with I.S. EN ISO 16283-1[42] and I.S. EN ISO 16283-2[43].

4.6 ACCESS FOR PEOPLE WITH DISABILITIES

4.6.1 Access and Use

Building designs can accommodate minimum dimensions for doors/corridors/rooms and circulation spaces to provide access for people with disabilities as indicated in Section 3 of TGD to Part M of the Building Regulations 1997 to 2019.

4.6.2 Sanitary Conveniences

Buildings can be designed to meet the installation requirements for all necessary and special sanitary conveniences for people with disabilities.

4.7 WEATHERTIGHTNESS AND DAMP PROOFING

Suitable precautions must be undertaken when preparing the site for the installation of the system so that water cannot flow or pond under the substructure. Unless a peripheral drainage system is to be used, the finished ground level adjacent to the building must be maintained at a minimum of 150mm below the DPC, which must not be bridged.

Thresholds shall be detailed to allow level access (as required), while protecting the steel frame from weather and ground moisture. Weep holes and cavity vents should be avoided in immediate threshold areas and should be placed on either side of the threshold.

In accordance with good practice a drainage channel is provided on the ground floor where there is a separating wall. The drainage channels reduce the risk of accidental flooding in one dwelling causing water damage to the neighbouring dwelling.

4.7.1 Floor Damp Proofing

The system has adequate DPCs and DPMs to resist the passage of moisture from the ground.

4.7.2 Roof Cladding

Roof coverings will provide adequate weather resistance in all situations covered by Section 3 of this Certificate, when completed in accordance with this Certificate and the manufacturer's instructions.

4.7.3 External Cladding

The external wall panel incorporates a 12mm proprietary drainage system. Wind-driven rain, which may reach the proprietary drainage system under adverse conditions, will be effectively prevented from penetrating the inner leaf.

The design of the external panels keeps the galvanised steel frame members in a "warm frame" environment, which prolongs the life of the steel. Good building practice such as stepped DPC and weep-holes are essential to ensure that moisture within the proprietary drainage system is deflected to the outside of the building.

4.7.4 Windows and Doors

The detailing at window and door openings has been assessed and is considered adequate to ensure that water penetration will not occur at these locations assuming conventional window frame profiles and sealing arrangements are used.

Window and door openings complete with sills, their DPC trays and weep vents together with vertical and horizontal DPC's at window jamb and head are incorporated into the panels during the manufacturing process at the factory. Proprietary weep holes are provided over window heads as specified by the Carlow Concrete design office.

The windows and doors are made to order by the window manufacturer using the dimensions provided by Carlow Concrete design office and supplied and fitted on site. Once fitted, windows are made weathertight externally using a sealant between the frame and the concrete panel while internally the continuity of the AVCL is maintained using proprietary sealed tape to connect AVCL to the window frame.

The weathertightness of the window installation was subject to full scale testing to establish the air leakage, water penetration and wind resistance as described in clause 4.11 of this certificate.

4.7.5 Rainwater Goods

Buildings constructed using the Carlow Concrete External Wall Panel & LGS Building System can readily accommodate adequate rainwater gutters and down pipes.

4.8 ELECTRICAL AND PLUMBING SERVICES

Electrical and plumbing services are outside the scope of this Certificate. However, in designing and installing these services it is essential that the following procedures are followed, and precautions are taken to minimise the risk of long-term damage to the steel frame or the services.

- At the design stage, it is useful if the positions and sizes of services can be established in advance, as special holes may be cut in the factory to help with the rapid and economic installation of services. A considerable amount of services is generally required in bathroom, hot press and utility areas.
- In general, the steel frame at each floor level must be connected directly onto the main earthing terminal in the main fuse box and all earth connections in the circuit wired back to this point. This measure is necessary to control the flow of electric current to earth without the risk of corrosion of critical structural components. However, the earthing system must be installed in accordance with the National Rules of the Electro Technical Council of Ireland E.T. 101 (current version).
- All service holes in the steel frame members must be fitted with rubber or plastic grommets to avoid damage to services. To ease the installation of services, particularly electrical cables, these purpose-made rubber or polyethylene grommets form the inner face of the openings. The service holes may alternatively be formed by swaging which is fully rounded to offer a non-sharpened surface to the services. Where plastic coated electrical wiring is in contact with insulation, then the cables must be enclosed in a suitable conduit, e.g. PVC as outlined in the National Rules of the Electro Technical Council of Ireland E.T. 101 (current version).
- Under no circumstances should electrical cables be placed within compartment floors, compartment walls and/or separating walls. Walls must be battened out to provide a false service zone in which to distribute electrical services on these fire rated build-ups.
- The enclosure of cold-water pipe work within the external wall should be avoided as

condensation on the pipe work could lead to wetting of the steel frame with a consequent risk of corrosion. If enclosure is unavoidable, the cold-water pipework must be insulated with tubular plastic insulation, which must be accurately cut at junctions and at changes of direction and held firmly in place with adhesive tape. Where hot water pipework is enclosed in the inner leaf of the wall, contact between copper pipes and the galvanised frame must be avoided using rubber or plastic grommets.
- Additional slots, notches or holes should not be cut through any steel member without the approval of the Chartered Structural Engineer responsible for the overall design of the structure.

4.9 DURABILITY

The steel frame structure and the precast concrete external wall has been assessed as capable of achieving a minimum design life of 60 years. The steel structure is constructed from steel members having a minimum 275g/m^2 Zinc galvanised coating which will provide adequate protection to the steel members. In addition to this, the steel is kept in a "warmframe" environment, which should prolong the life of the steel. The DPC and the galvanising will provide adequate protection to ensure that the bottom channel has a life equal to that of the other frame members.

The insulations are durable materials and will remain effective as an insulant for the life of the building. The roof, internal wall and ceiling linings and the outer leaf of the external wall are all constructed from conventional durable materials.

Buildings constructed using the Carlow Concrete LGS Building System will, when constructed in accordance with Carlow Concrete Erection Manual and the requirements of this Certificate along with all relevant codes of practice will have a minimum design life of at least 60 years in accordance with BS 7543[44].

4.10 MAINTENANCE

Maintenance will be required at a level comparable with that for buildings of traditional construction.
As the plasterboard is screwed into the steel structure, there is no nail popping in plasterwork, which results in less maintenance of plasterwork, than that of a traditionally constructed building.

Repainting should be carried out in accordance with the relevant recommendations of BS 6150[45].
Timber boarding, fascia's, soffits etc. where used, should be treated with an appropriate paint system or translucent stain and should be maintained by periodic re-coating using a paint or stain suitable for external applications, applied in accordance with the manufacturer's instructions.

The joints in windows and doors may require resealing at approximately 10-year intervals.

4.11 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE THE FOLLOWING

The following is a summary of the tests and assessments which have been carried out on the Carlow Concrete External Wall Panel & LGS Building System:

- Structural strength and stability (racking resistance, load bearing capacity).
- Full scale testing as recommended by the Centre for Window and Cladding Technology (CWCT) for Precast Concrete/Steel Frame Hybrid Panelised Construction System to establish the air leakage, water penetration and wind resistance was carried out by an INAB accredited testing facility
- Behaviour in relation to fire.
- System specific loadbearing fire testing to I.S. EN 1365-1[35] and I.S. EN 1365-2[36].
- Acoustic performance, resistance to airborne and impact sound transmission.
- Thermal insulation performance calculations.
- Corrosion of fasteners in normal conditions with a view to a minimum 60-year design life.
- Compatibility with other materials.
- Risk of condensation both surface and interstitial.
- Pre-completion airtightness testing.
- 3D thermal modelling of junction details in accordance with BRE IP 1/06[2] and BRE Report BR 497[3].

4.11.1 Other Investigations

Existing data was examined to assess:
- Adequacy of weather tightness of building constructed using the system.
- Durability of the system.
- Requirements for maintenance.

4.11.2 Production Audits

Production audits were carried out at the Carlow Concrete factory to examine the process of structural design, steel frame fabrication, assembly and to assess the adequacy of the methods adopted for quality control.

4.11.3 Site Erection Visits

Buildings under construction were visited to assess the practicability of construction (erection) and the adequacy of Carlow Concrete site supervision arrangements.

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 issue or revision date so long as:

(a) the specification of the product is unchanged.

(b) the Building Regulations 1997 to 2019 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 2005[20], 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.

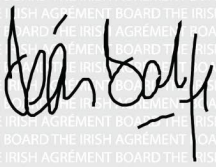
5.7 Where reference is made in this Certificate to any Act of the Oireachtas, Regulation made thereunder, Statutory Instrument, Code of Practice, National Standards, manufacturer's instructions, or similar publication, it shall be construed as reference to such publication in the form in which it is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

NSAI Agrément

This Certificate No. **19/0416** is accordingly granted by the NSAI to Burran Precast Concrete T/A **Carlow Concrete Ltd.** on behalf of NSAI Agrément.

Date of Issue: **February 2020**

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

Rev. A 16 Jan. 2023 Masonry outer leaf added.

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Certificate 19/0416 Detail Sheet 1: Carlow Concrete Building System

PRODUCT DESCRIPTION (Detail Sheet 1)
This detail sheet relates to an alternative external wall configuration to NSAI Agrément Certificate 19/0416 namely the Carlow Concrete External Wall Panel & LGS Building System.

This certificate Detail Sheet certifies an alternative external wall configuration for the same purpose groups listed in Agrément Certificate 19/0416, in the opinion of the NSAI, complies with the requirements of the Building Regulations. This alternative external wall and LGS Building System is suitable for buildings up to 18m in height where the full structure is designed, manufactured, supplied, and erected by Carlow Concrete.

USE
This matter is dealt with in Agrément Certificate 19/0416.

MARKETING, DESIGN AND MANUFACTURE:
The product is manufactured, marketed, designed and erected by:

Burren Precast Concrete T/A Carlow Concrete Ltd,
Milltown,
Garryhill,
Co. Carlow,
R21 KP44,
Ireland.
www.carlowconcrete.com
Tel. +353 (59) 9727620

Detail Sheet 1 / Part One / Certification 1

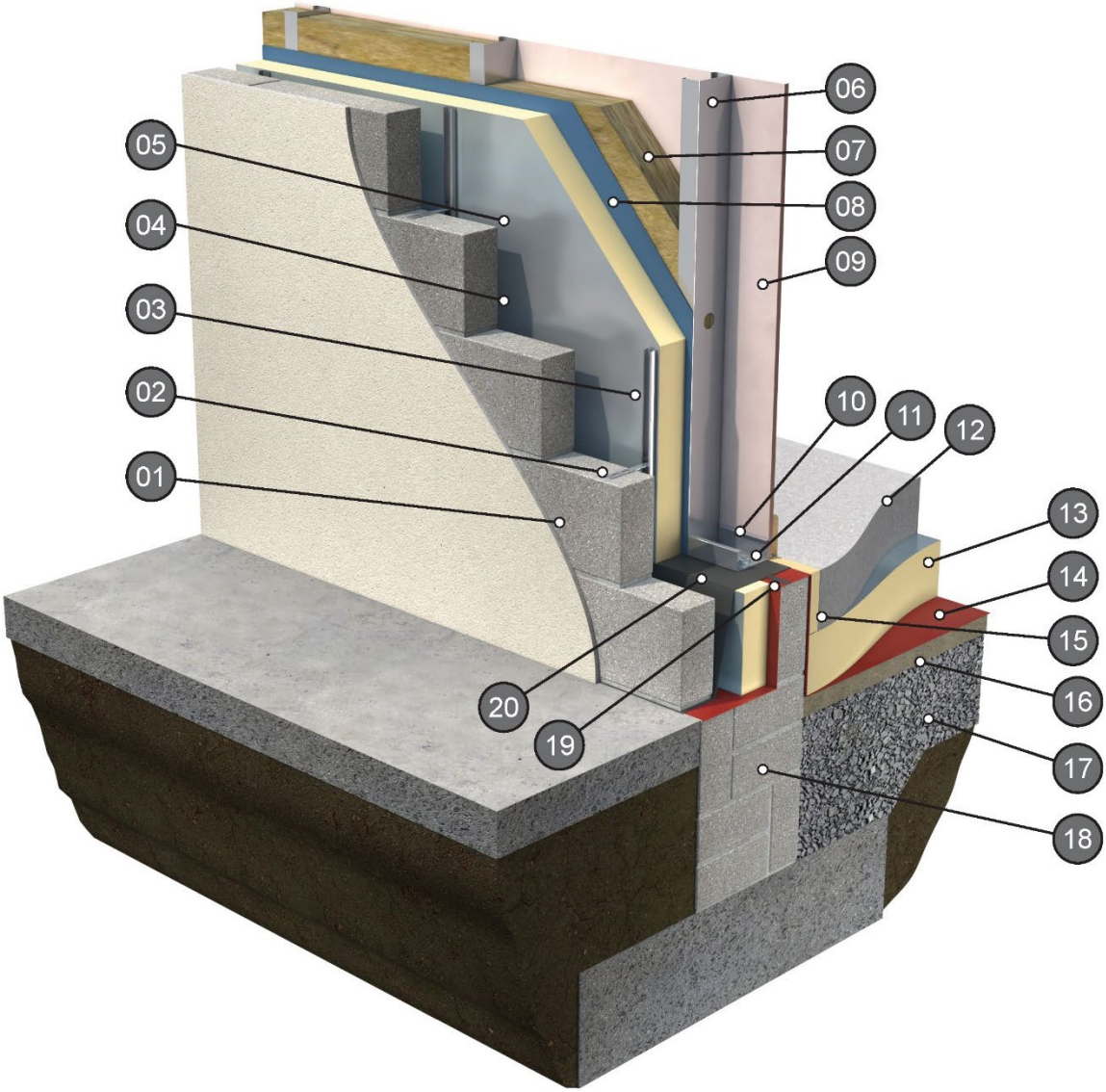
D1.1 BUILDING REGULATION
This matter is dealt with in Agrément Certificate 19/0416.

Detail Sheet / Part Two / Technical Specification and 2

D2.1 PRODUCT DESCRIPTION
This detail sheet relates to the addition of a variation on the external wall as described in Clause 2.1.1 of Agrément Certificate 19/0416.

D2.1.1 Alternative External Wall
This alternative external wall consists of replacing the precast concrete outer panel and drainage channel with a traditional masonry or brick outer leaf with a minimum residual cavity of 40mm or NSAI approved cladding systems.

A selected wall tie system which consists of vertical channels fixed through the external layer of PIR insulation into the LGS is factory installed. As the external masonry or brick outer leaf are installed on site, proprietary wall ties are clipped into the pre-installed vertical channels and the mortar bed joints to provide the required lateral connection between the LGS inner leaf and the masonry outer leaf. The frequency and spacing of wall ties will be as specified by the project specific Chartered Structural Engineer.



01. Masonry outer leaf with exterior render system.

02. Stainless Steel wall tie.

03. Stainless Steel wall tie channel.

04. Cavity.

05. PIR Insulation.

06. LGS metal stud.

07. Stone mineral wool insulation.

08. Selected AVCL.

09. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

10. Bottom track.

11. Anchor bolt.

12. Concrete Floor.

13. Floor Insulation.

14. Selected DPM or Radon Membrane.

15. PIR Perimeter strip.

16. Sand blinding.

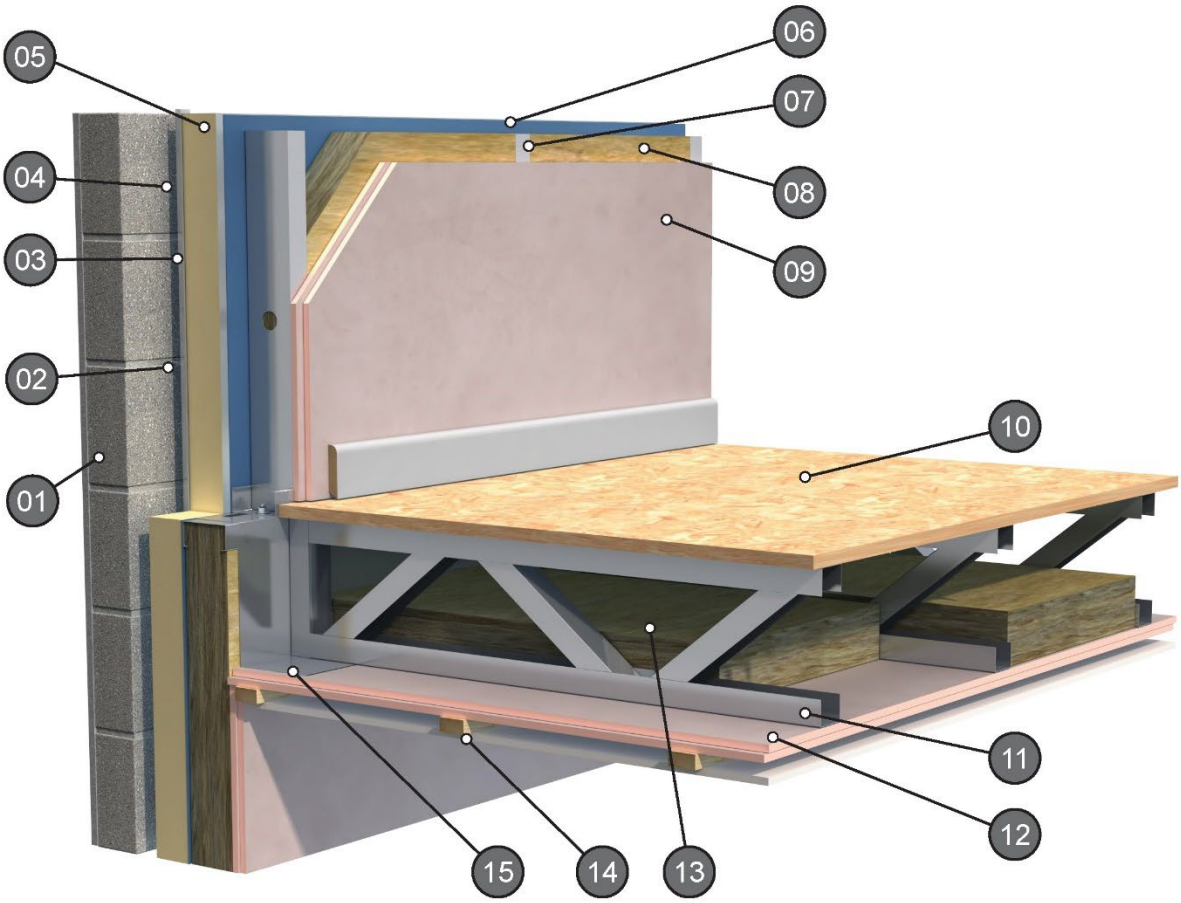
17. Hardcore.

18. Foundation detail to specification.

19. Butyl Sealant Tape.

20. DPC.

Figure 15 - Ground floor external wall junction



01. Masonry outer leaf with exterior render system.

02. Stainless Steel wall tie.

03. Stainless Steel wall tie channel.

04. Cavity.

05. PIR Insulation.

06. Selected AVCL.

07. LGS metal stud.

08. Stone mineral wool insulation.

09. 2 layes 15mm Type F Plasterboard to provide REI 60 External wall in accordance with table 4 fire performance requirements.

10. OSB3 or equivalent floor decking.

11. LGS Lattice Joist.

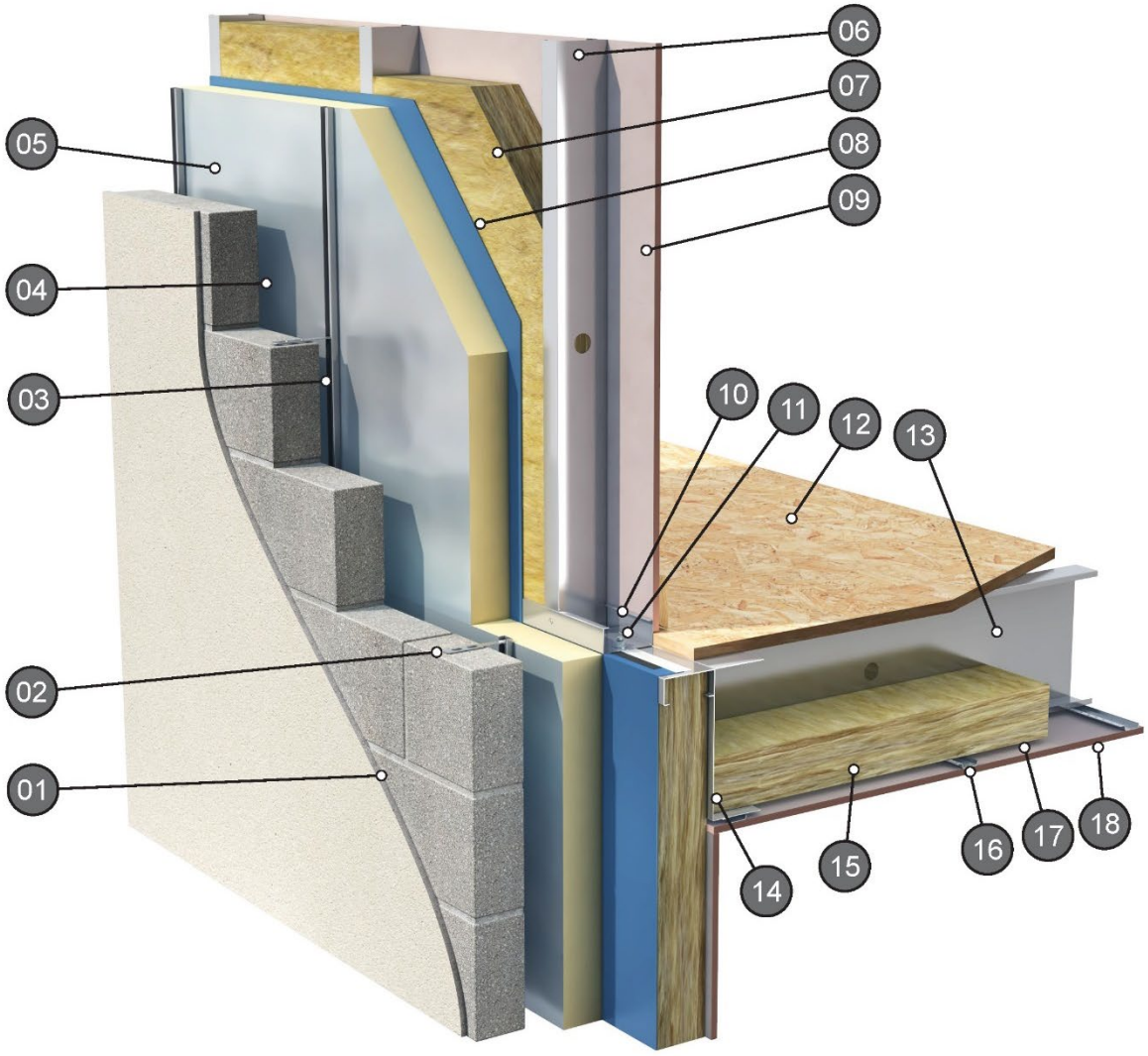
12. 2 layers 15mm Type F Plasterboard to provide REI 60 in accordance with Table 4 fire performance requirements.

13. Stone mineral wool insulation.

14. 12.5 Type A platerboard fixed to battens.

15. Z Hanger.

Figure 16 - Lattice floor to exterior wall detail



01. Masonry outer leaf with exterior render system.

02. Stainless Steel wall tie.

03. Stainless Steel wall tie channel.

04. Cavity.

05. PIR Insulation.

06. LGS metal stud.

07. Stone mineral wool insulation.

08. Selected AVCL.

09. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

10. Bottom track.

11. Screw fixing

12. OSB3 or equivalent floor decking.

13. LGS Floor Joist.

14. C-Channel.

15. Stone mineral wool insulation.

16. Resilient bar.

17. Service cavity.

18. 12.5mm Type F Plasterboard to provide R 30 REI 15 in accordance with table 4 fire performance requirements.

19. Compressible Butyl Strip.

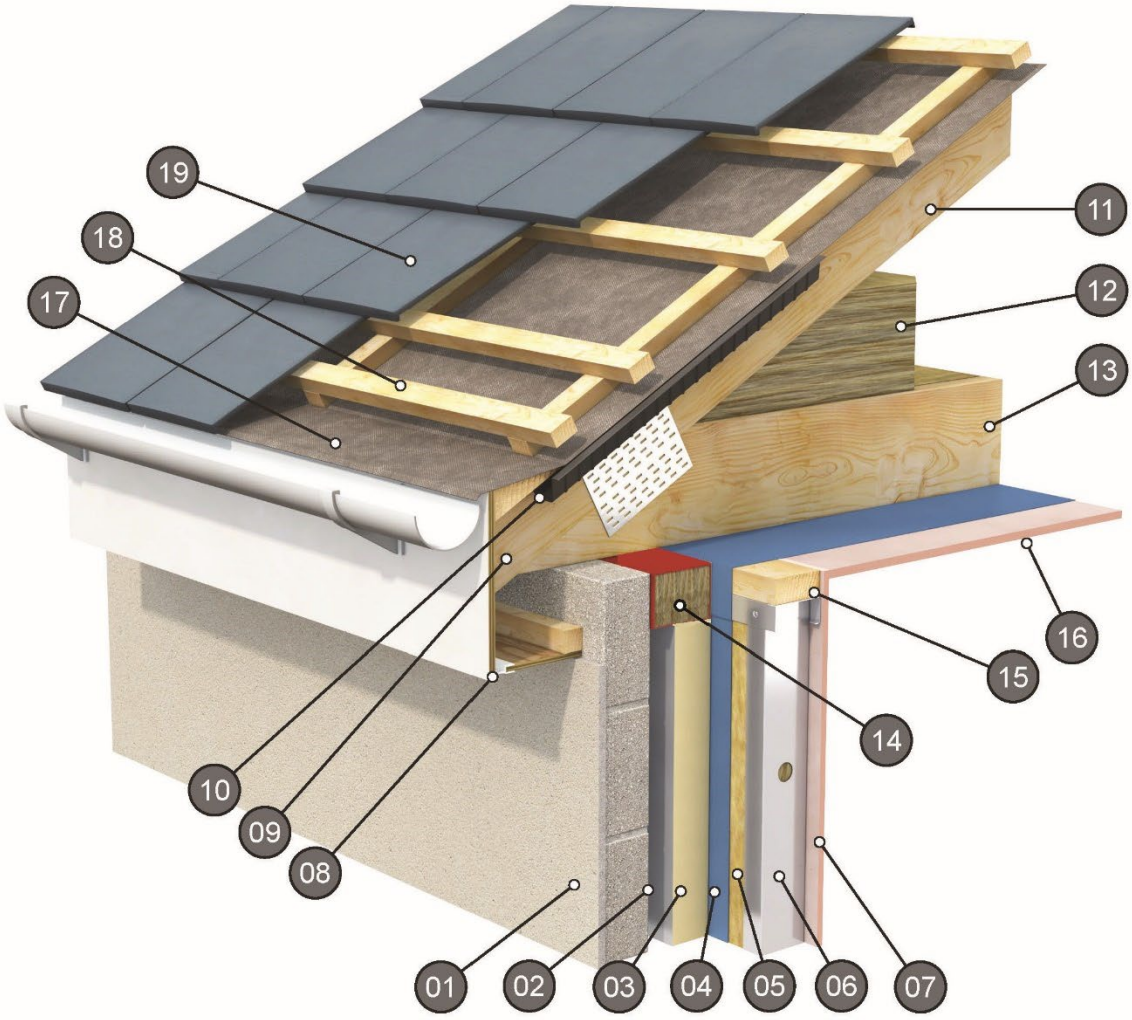
20. Selected Mastic sealant.

21. DPC.

22. Pre-formed Corner.

23. Weep vent.

Figure 17 - Lattice floor to exterior wall detail



01. Masonry outer leaf with exterior render system.

02. Cavity.

03. PIR Insulation.

04. Selected AVCL.

05. Stone mineral wool insulation.

06. LGS metal stud.

07. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

08. Fascia & Soffit with proprietry soffit vent.

09. Rafter.

10. Proprietry rafter ventilator.

11. Pre-fabricated roof truss

12. Stone mineral wool insulation.

13. Cieling joist.

14. Cavity Closer.

15. Treated Wall Plate.

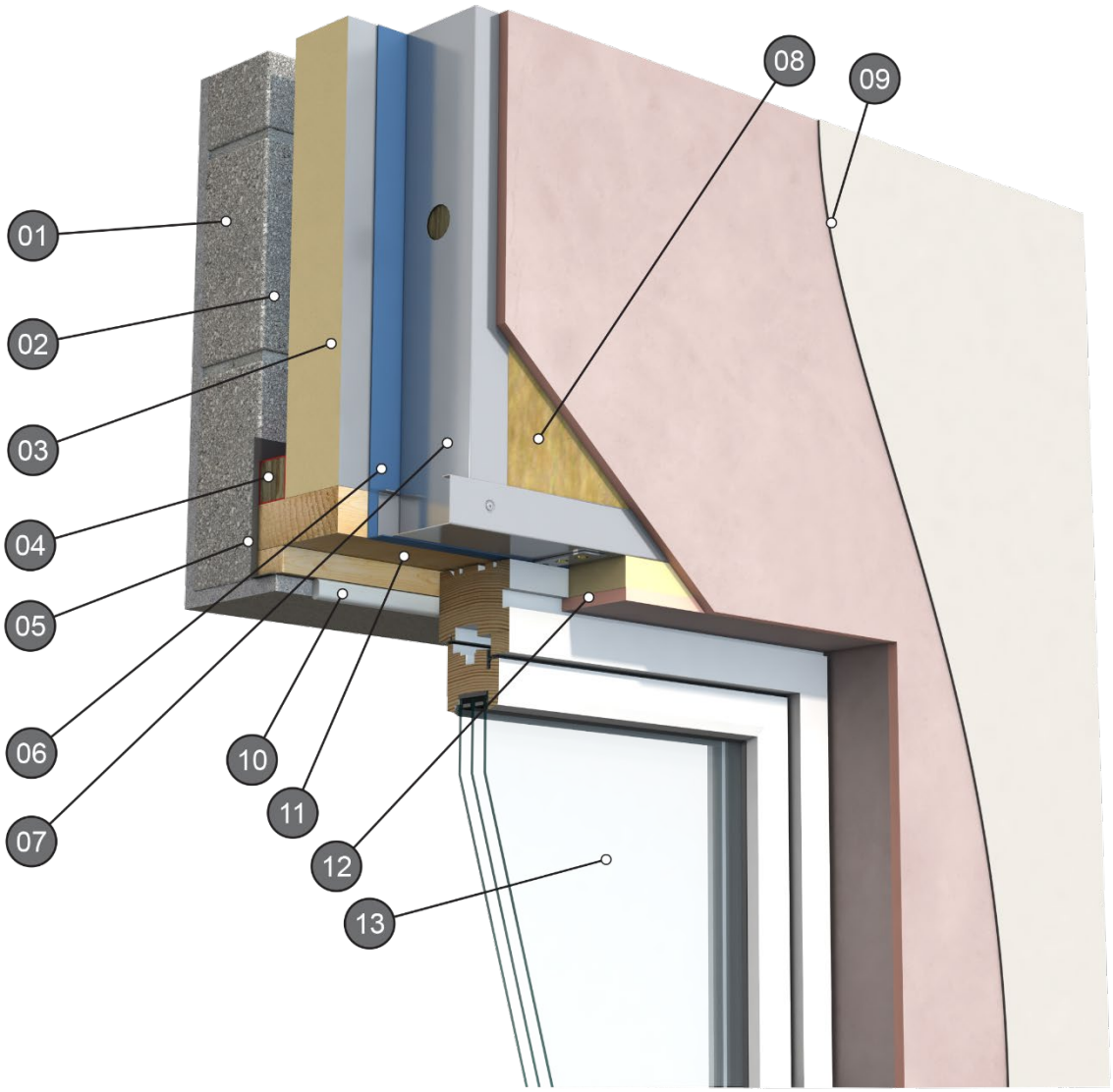
16. 12.5mm Type F Plasterboard with skim finish.

17. Selected roofing felt.

18. Batten.

19. Roof tile or slate.

Figure 18 - Typical Eaves detail - Insulated at ceiling



01. Masonry outer leaf with exterior render system.

02. Cavity.

03. PIR Insulation.

04. Cavity Closer to specification.

05. DPC.

06. Selected AVCL returned along the LGS head rail and taped to the window frame.

07. LGS metal stud.

08. Stone mineral wool insulation.

09. 1 no layer of 12.5mm Type F Plasterboard to provide REI 30 External Wall in accordance with table 4 fire performance requirements.

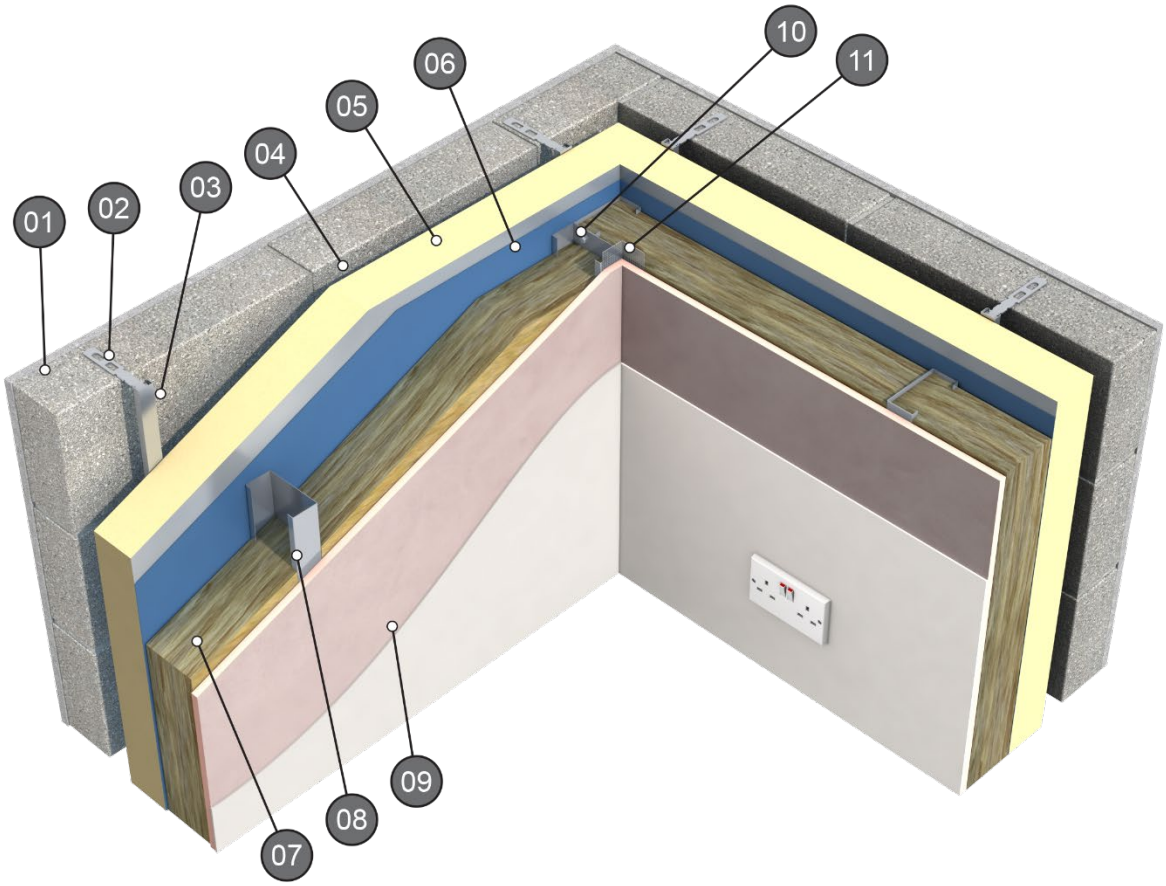
10. Selected Sealant.

11. Treated timber batten.

12. Insulation backed plasterboard.

13. Selected window.

Figure 19 - Window head Detail



01. Masonry outer leaf with exterior render system.

02. Stainless Steel wall tie.

03. Stainless Steel wall tie channel.

04. Cavity.

05. PIR Insulation..

06. Selected AVCL.

07. Stone mineral wool insulation.

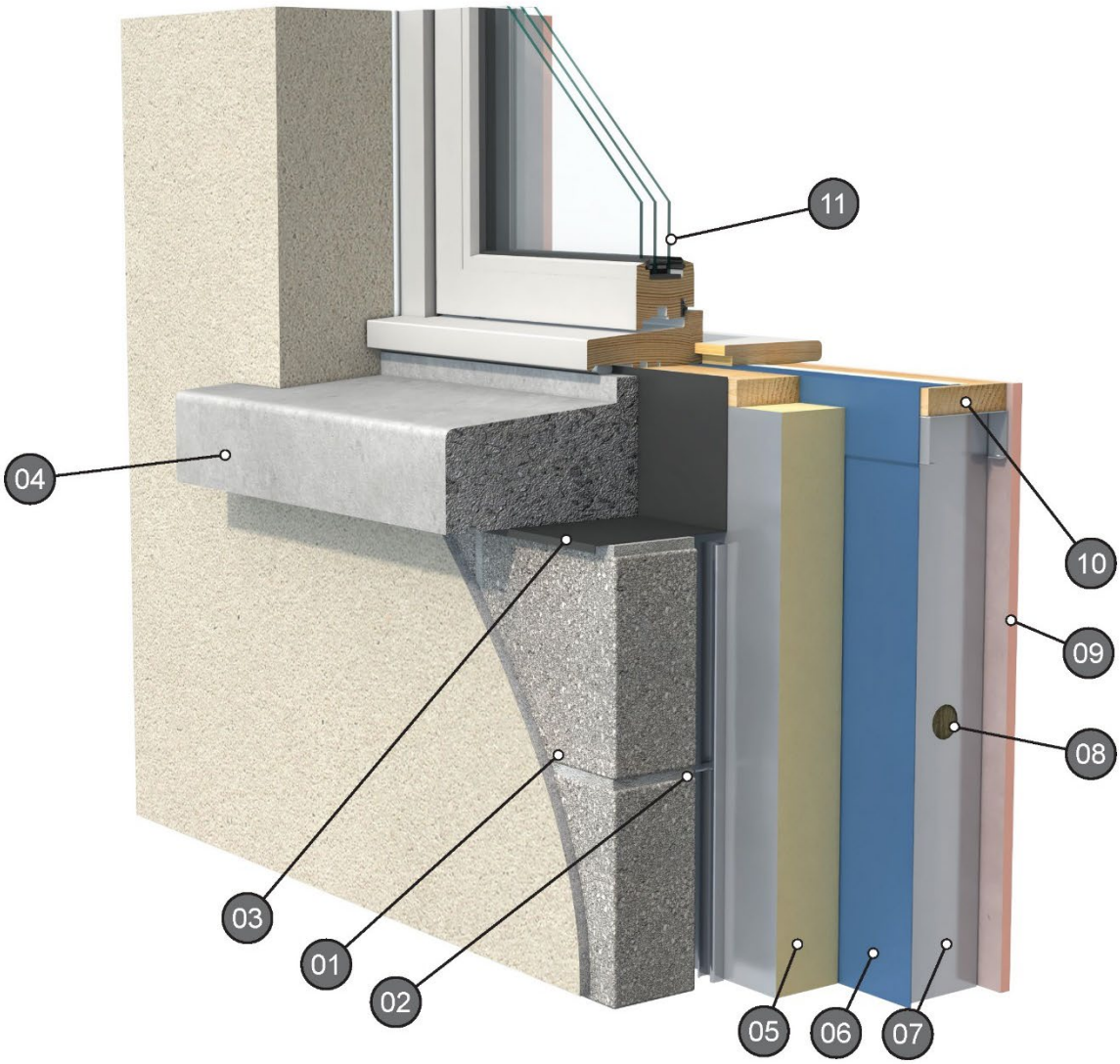
08. LGS metal stud.

09. 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance requirements.

10. Screw fixing.

11. Perimeter angle or corner stud.

Figure 20 - External Corner Detail



01. Masonry outer leaf with exterior render system.

02. Stainless Steel wall tie channel & wall tie.

03. DPC.

04. Selected sill.

05. PIR Insulation.

06. Selected AVCL.

07. LGS metal stud.

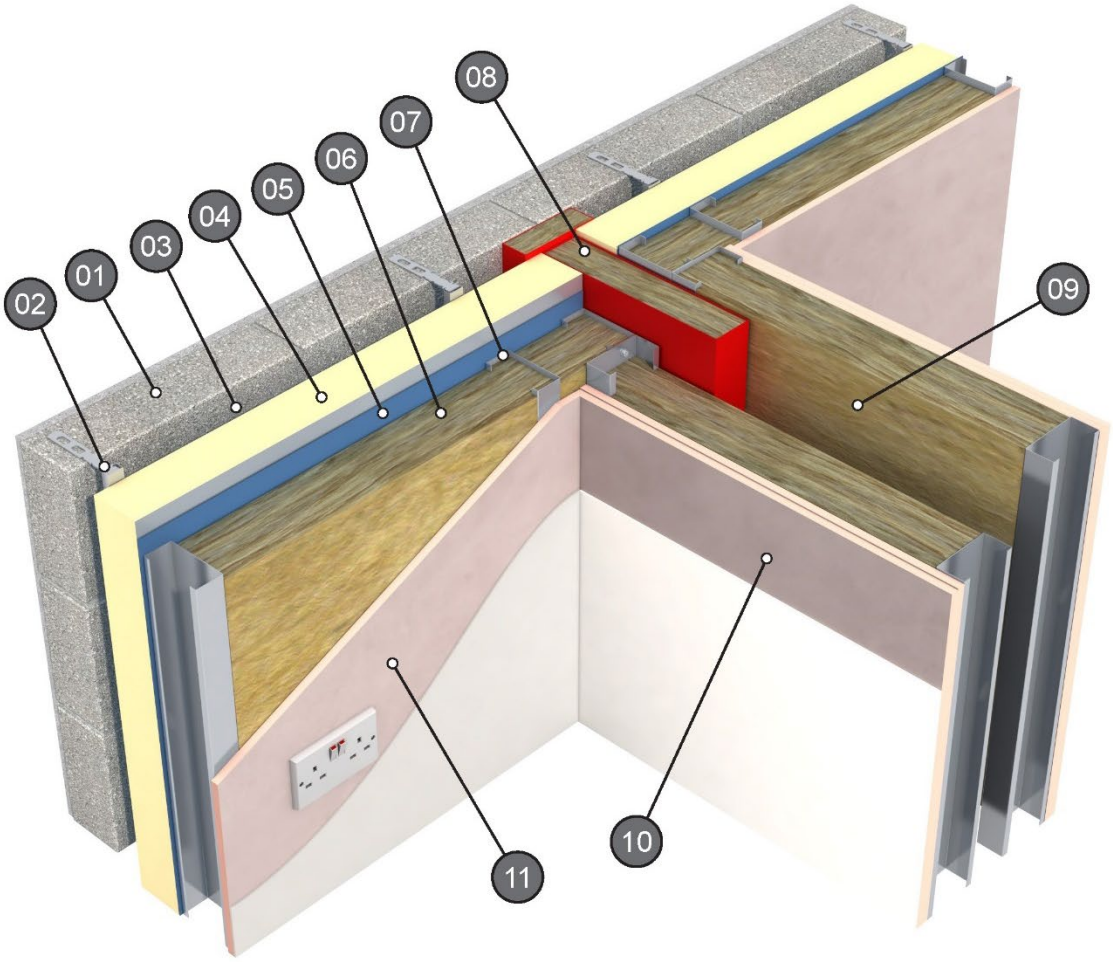
08. Stone mineral wool insulation.

09. 1 no layer of 12.5mm Type F Plasterboard to provide REI 30 External Wall in accordance with table 4 fire performance requirements.

10. Treated timber batten.

11. Selected window.

Figure 21 - Window Sill detail



01. Masonry outer leaf with exterior render system.

02. Stainless Steel wall tie channel & wall tie.

03. Cavity.

04. PIR Insulation.

05. Selected AVCL as required.

06. Stone mineral wool insulation.

07. LGS metal stud.

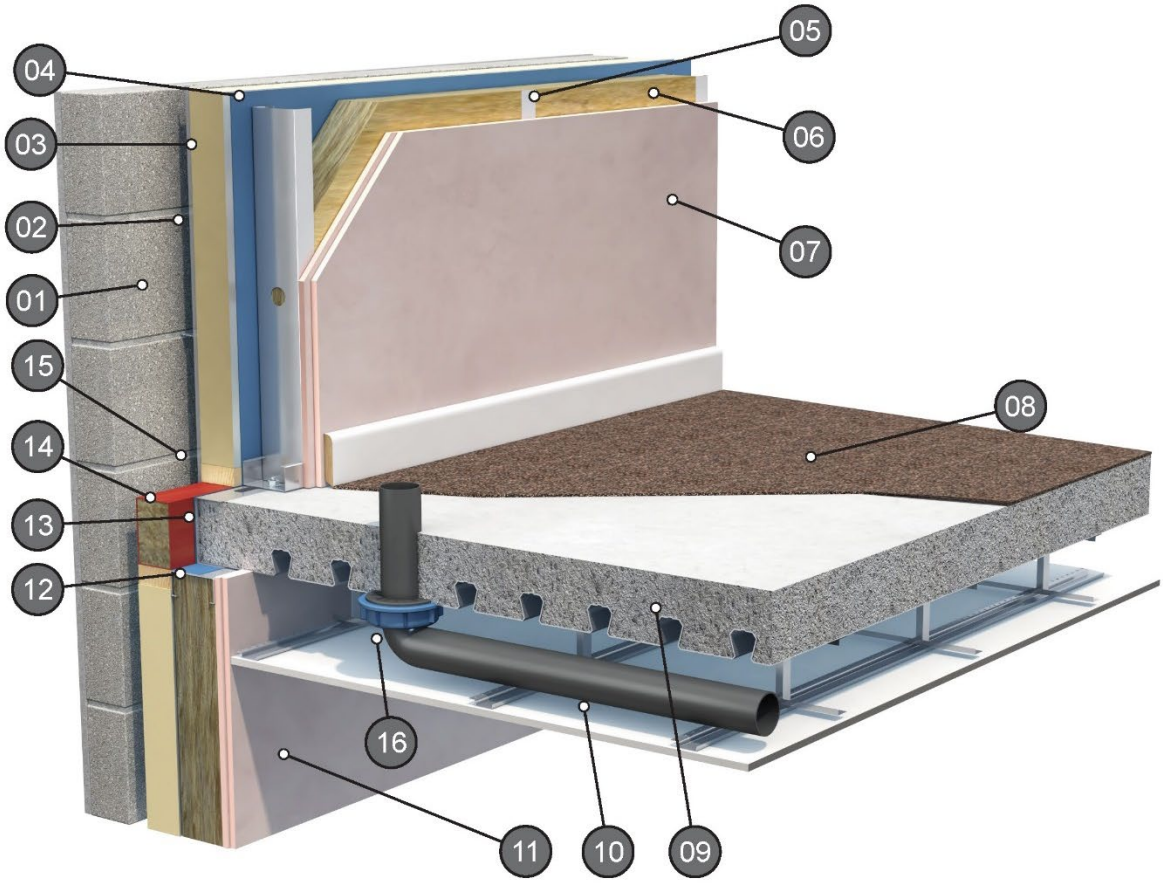
08. Selected firestop at perimeter wall juction.

09. Stone mineral wool insulation.

10. 2 no. layers of 15mm Type F Plasterboard to provide REI 60 Separating wall in accordance with table 4 fire performance requirements.

11. 1 No layer of 12.5mm Type F Plasterboard to provide REI 30 External wall in accordance with table 4 fire performance

Figure 22 - Separating wall to exterior wall detail (Interior view)



01. Precast concrete wall or other NSAI approved cladding system.

02. Cavity.

03. PIR Insulation.

04. Selected AVCL.

05. LGS metal stud.

06. Stone mineral wool insulation.

07. 2No. layers 12.5mm Type F Plasterboard to provide REI 60 External wall in accordance with table 4 fire performance requirements.

08. Appropriate resilient soft covering.

09. Concrete poured into metal deck.

10. Suspended ceiling to specification.

11. 2No. layers 12.5mm Type F Plasterboard to provide REI 60 in accordance with Table 4 fire performance requirements.

12. Isolation strip between deck and LGS wall.

13. Composite Deck edge trim.

14. Cavity Barrier to specification fixed to timber battens.

15. DPC lapped over cavity closer.

16. Vertical services through compartment floor to have proprietary fire collar in accordance with TGD part B.

Figure 23 – Compartment floor steel composite deck

Detail Sheet / Part Three / Design Data 3

D3.1 STRENGTH AND STABILITY
This matter is dealt with in Agrément Certificate 19/0416.

D3.2 STRUCTURAL FIRE SAFETY
This matter is dealt with in Agrément Certificate 19/0416.

Detail Sheet / Part Four / Technical Investigations 4

D2.2 BEHAVIOUR IN FIRE TO FIRE
This matter is dealt with in Agrément Certificate 19/0416.

D2.3 THERMAL INSULATION
The alternative external wall can incorporate sufficient stone mineral wool insulation between the LGS studs combined with the required thickness of PIR insulation to meet the backstop elemental U-value required in TGD to Part L of the Building Regulations. When superior wall elemental U-values are required, the thickness of PIR insulation can be increased up to a maximum of 220mm.

D2.3.1 Limiting Thermal Bridging
The Certificate holder has carried out ψ-value calculations for a range of thermally bridged building junctions common to the additional external build-up in accordance with IP 1/06[2], BRE report BR 497[3] and I.S. EN ISO 10211[4].

Internal surface temperatures have been checked and surpass the minimum surface temperature factor reequipment outlined in Appendix D.2 of TGD to Part L namely that $f_{Rsi} > 0.75$.

D2.3.2 Condensation in Walls
An interstitial condensation risk analysis to I.S. EN ISO 13788[7] has been carried out on the additional external wall and no condensation is predicted at any interface in any month.

Sample U-value Calculation for 75mm PIR						
Layer	**Description**	**% Bridged**	Thickness [mm]	Thermal conductivity **λ** [W/m.K]	Thermal resistance **R** [W/m²K]	
	R_{se}				0.04	
1	Sand Cement render		12	1.0	0.012	
2	Concrete Block 1800Kg/m³		100	1.21	0.083	
3	Unventilated Cavity		40	0.219	0.183	
4	PIR Insulation		**75**	0.022	3.409	
5	AVCL				-	
6	Steel Stud	0.002	100	50	0.002	
	Mineral Wool	0.998	100	0.04	2.5	
7	Type F Plasterboard		12.5	0.25	0.05	
	R_{si}				0.13	
				Ru Total =	6.399	
				RL Total =	4.621	
	From BRE Digest 465[6]			P = 0.658, $R_T = pR_{max} + (1 - p)R_{min}$ =	5.791	
	nf = 4No./m², Af = 28.3mm², λ_{fixing} = 17 W/m.K			Correction term, ΔU =	0.00711	
				Corrected U-Value =	**0.1798**	W/m²K
				Corrected U-Value (2DP) =	**0.18**	W/m²K

Table 10: Sample U-value calculation for 75mm PIR