NSAI Agrément

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Castle Group Modular Building System

NSAI Agrément (Irish Agrément Board) is designated by Government to issue 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 TGD Part D of the second schedule of the **Building Regulations 1997 to 2024.**

SCOPE

This Certificate relates to the Castle Group Modular Building System (a MMC Category 1 – 3D-Volumetric building system), for the design, manufacture and erection of volumetric buildings. The Castle Group Modular Building System is a factory manufactured structural building system completed (with internal fixtures, fittings and finishes outside of scope of this Certificate). The system is designed for use in buildings with traditional brick and block outer leaf cladding and roof coverings as per Section 2.1.6 and 2.1.14 of this Certificate. Other cladding systems and roof coverings may be suitable but have not been considered as part of this Certificate.

The Castle Group Modular Building System is certified to be used in the following Purpose Groups 1(a), 1(b) and 1(d) as defined in the Technical Guidance Document (TGD) Part B Fire Safety - Volume 2 – Dwelling Houses (2017) of the Irish Building Regulations and not more than 30m to the top floor of the building in Purpose Groups 1(c), 2(a), 2(b), 3, 4 (a), 5(a), 5(b) as defined in TGD Part B Fire Safety – Volume 1 – Buildings other than Dwelling Houses (2024) of the Irish Building Regulations.

The Castle Group Modular Building System (MMC Category 1) is designed and manufactured by Castle Group. Site erection is carried out by Castle Group or specialist sub-contractors / Main Contractor under the supervision of Castle Group.

In the opinion of NSAI, the Castle Group Modular Building System (MMC Category 1 as a 3D-Volumetric system), as described in this Certificate, can comply with the requirements of the Irish Building Regulations 1997 to 2024.

Refer to Section 2 of this Certificate for information on items outside of the scope of this Certification.

Readers are advised to check that this Certificate has not been withdrawn or superseded by a later issue by contacting NSAI Agrément, NSAI, Santry, Dublin 9 or online at http://www.nsai.ie

INTERNAL USE – This information should not be shared outside of Etex unless authorized to do so / except with certain authorized external partners.

DESIGN
The Castle Group Modular 3D-Volumetric Building System (MMC Category 1) is intended for use where Architect's finalised construction and fire strategy drawings are available and satisfy the Building Regulations. The Building Owner / Client and their appointed Architect and Engineering Design Team of the Client are responsible for the architectural drawings and compliance of the building design with the applicable Building Regulations and with this certificate.

The Castle Group Chartered Structural Engineer is responsible for the structural design of the modular building system. Depending on the agreed project scope, Castle Group may be responsible for other engineering aspects of the project.

Coordination between Castle Group and the Client's Engineering Design Team is required to successfully complete the project. The Client is responsible for the coordination of Engineering Design Teams.

RESPONSIBILITIES
Prior to the commencement of the contract, the responsibilities are determined and agreed between Castle Group and the Client including substructure, fire stopping, cavity barriers, roof completion, coordination of design and other elements.

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

Factory:
Castle Group / Castle Modular,
Raheen,
Gort,
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Company Head Office:
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1.1 PRODUCT DESCRIPTION

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

The Castle Group Modular Building System is comprised of 'proper materials' i.e. materials which are fit for their intended use and for the conditions in which they are to be used.

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

Buildings incorporating the Castle Group Modular 3D-Volumetric Modular Building System can be designed to meet the requirements of the following clauses of the Irish Building Regulations 1997 to 2024:

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

Part B – Fire Safety
For Purpose Groups 1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a) and 5(b) the fire safety requirements are laid out in TGDs to Part B of the Building Regulations. Refer to maximum building height stated on cover page of this Certificate. Distance to relevant boundary to be reviewed by a competent Fire Engineer.

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

Note: In a building with a topmost floor >15m high, insulation material used in drained and/or ventilated cavities in the external wall construction shall have a reaction to fire classification of Class A2-s3, d2 or better as in accordance with TGDs Part B of the Building Regulations. Where the topmost floor >15m the reaction to fire classification of the whole external wall build-up shall meet requirements of the TGDs Part B of the Building Regulations. The requirements depend on the specific Purpose Group of the building, building height and distance to relevant boundary.

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

Part E – Sound
E1 – Airborne Sound (Walls)
E2 & E3 – Reverberation and its' definition

Part F – Ventilation
F1 – Means of Ventilation
F2 – Condensation in Roofs

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

2.1 PRODUCT DESCRIPTION

This Certificate relates to the Castle Group Modular Building System for the design, manufacture and erection of the volumetric building system.

The Castle Group Modular Building System is supplied as prefabricated, three-dimensional units. Each module is built with a primary structural steel frame and light gauge steel (LGS) infill panels between the primary steelwork. Components within each module are connected using welded joints, bolts, or self-drilling screws. Module dimensions vary, typically ranging from 6m to 15m in length, 2.5m to 4.5m in width, and up to 4m in height.

All elements of the system are connected together in the Castle Group factory to create volumetric units that are then transported to specific sites for installation. The modules are delivered to site finished internally. This includes windows (outside of the scope of this Certificate); insulation, plasterboard, electrical, plumbing, air condition systems (services are outside of scope of this Certificate) where applicable.

2.1.1 Foundations

The construction of the foundations is outside the scope of this Certificate. The construction of the foundations is the responsibility of the Main Contractor and should be constructed in accordance with the Client's Engineering specification. Structure supporting the Castle Group Modular Building System shall be checked by Client's Engineer for structural load criteria specified by Castle Group Structural Engineer. Tolerances for the system installation on foundations are defined by Castle Group Structural Engineer.

2.1.2 Ground Floor

The ground floor forms part of the three-dimensional unit of the Castle Group Modular Building System. Castle Group provides two options for the ground floor of the lowest module (ground floor module):

- Composite Concrete Metal Deck Ground Floor Module: the ground floor is supported of the main structural steel within the module. The lowest level of the metal deck is located minimum 150mm above external ground level. The structural steel below the metal deck is galvanised. The ground floor is designed as a composite concrete metal deck by Castle Group Structural Engineer. Refer to Figure 4 for detailed explanation of the ground floor build up.
- LGS floor joists on main structural steel: the LGS joists are supported on the structural steel within ground floor depth. LGS and ground floor steelwork is located minimum 150mm above external ground level. The structural steel below the metal deck is galvanised. The ground floor is designed as a steel structure by Castle Group Structural Engineer. Mineral wool insulation is provided between the LGS studs. OSB3 decking is provided on the top of LGS joists.

The ground floor is constructed from the following:

- 150mm void and radon sump,
- 9mm cement board,
- DPM/Radon barrier,
- XPS insulation installed by others on site,
- AVCL wrapped around the module
- Ground floor structure (Composite Concrete Metal Deck or LGS floor joists on main structural steel)
- Floor finishes by Castle Group or others

The XPS insulation is provided at ground floor to meet the requirement of TGDs to Part L of the Building Regulations including the avoidance of thermal bridging. An NSAI or equally approved radon resistant membrane/DPM is installed below XPS insulation in accordance with TGD to Part C of the Building Regulations. The radon/DPM membrane shall be fully sealed over the entire footprint of the building. The DPC/DPM membrane shall be adequately repaired where it is punctured by anchor bolts connecting the modular units to the rising wall/foundations. The hardcore bed below radon/DPM membrane shall be constructed in accordance with TGD to Part C of the Building Regulations.

The ground floor structure is supported on foundations as per Figure 4. Galvanized steel studs with top plate, bottom plate and a Farrat thermal break are provided to connect the ground floor with the foundation structure. Galvanised anchor bolts are provided for the steel studs to foundation connection. All structural steelwork up to 150mm above external ground level is galvanised as per Section 2.3.2.

2.1.3 Load-Bearing Walls

The walls are manufactured from cold or hot rolled structural steel (CR/HR) elements (square hollow section posts – SHS and perimeter flange channels - PFC beams) and LGS infill studs. The primary load-bearing elements are SHS/PFC sections which are located at module corners, and intermittently along the length of the module as

required. These sections are continuous in line with each stacked module throughout the superstructure and are connected by means of a bespoke intermodular connection. The LGS infill studs transfer vertical load of masonry outer leaf and they are utilised to transfer lateral forces onto to primary structure of the modules. The infill panels are formed using 100x50mm LGS C-stud sections at approximately 600mm centres. LGS sections are also provided to trim window and door openings where required. All LGS infill stud sections are provided with deflection heads.The LGS/HR bracing is provided at walls as specified by Castle Group Structural Engineer. All perimeter walls within a module are load-bearing walls. Figure 1 shows a typical assembled modular unit.

Figure 1: Modular unit without finishes

2.1.4 Non-Load-Bearing Walls

The non-load bearing wall panels are made from cold-formed LGS sections. Non-load bearing walls shall be adequately fixed to modules using fixings as per Castle Group Structural Engineer's specification. All non-load bearing LGS studs are provided with deflection heads, All walls shall be designed to resist lateral loads and to provide for required sound and/or fire resistance where required for compliance with Building Regulations.

2.1.5 External Walls

External walls form part of the three-dimensional unit of the Castle Group Modular Building System. The external wall is constructed similarly as a load-bearing wall described in Section 2.1.3.

Insulation is fitted to the external cavity side of the cold formed steel studs. The wall panels are filled with stone mineral wool between the studs for acoustic, thermal and fire performance. The wall panels are then clad with the required thickness and grade of plasterboard as per Table 1 to achieve the appropriate fire rating required for the building.

The requirements for the provision of an Air and Vapour Control Layer (AVCL) on external walls are outlined in Section 3 and drawing details in this Certificate.

The system has been assessed with traditional brick and block outer leaf cladding. Other external façade claddings systems may be suitable but have not been considered as part of this certification.

Typical external wall build up with traditional brick/block outer leaf cladding consists of:

- Plasterboard, in accordance with this Certificate (refer to Table 1)
- Air and vapour control layer (AVCL),
- External wall structure with mineral wool insulation between the studs,
- External insulation layer (mineral wool),
- Stainless steel wall ties and brickwork/blockwork outer leaf

Refer to Figure 3 & Figure 5 for typical external wall details.

2.1.6 External Cladding & Wall ties

Traditional outer leaf cladding utilises a cavity layer with mineral wool insulation and brick/block outer leaf to I.S. EN 1996-1-1[1] and S.R. 325[2]. The external leaf of the Castle Group Modular Building System is constructed on site.

The masonry outer leaf is tied to the Castle Group Modular Building System with a stainless-steel channel cavity wall tie system in accordance with I.S. EN 845-1[13]. The wall tie system comprises two parts, the channel and the tie and the design is intended to be used in masonry to studded applications. The channel incorporates a slot and is factory fitted through the insulation with the required depth of stainless-steel Tek / Tech screw(s) directly into the flange of the studs. The tie channels are fitted to the steel studs at a frequency which will satisfy the requirements for wall tie spacing as outlined in I.S. EN 1996-1-1[1]. Using the channel system allows for variations within block/brick courses. Around openings, channels are positioned within 150mm of the opening, and line up with the steel studs. The slot in the wall tie bracket enables a wall tie to be adjusted vertically for variations in mortar thickness during construction of the masonry outer leaf. Additional wall ties are provided at 225mm centres around openings or either side of each movement joints, such that there is a tie for each 225mm of perimeter of opening on either side of each movement joint/corner. Wall ties are available as standard flat ties and are also available with a twist for installation over window and door openings. Where masonry cladding is being used over 4 storeys' (12m) in height, a Type 1 wall tie in accordance with I.S. EN 845-1[3] must be used. The wall tie and channel are made from minimum Grade 304 austenitic stainless steel.

Castle Group Structural Engineer to provide specification for stainless steel masonry support brackets if required for the project. Weep holes, thermal break and DPC shall be installed at

bracket locations. Refer to Figure 5 for typical detail.

All stainless steel elements protruding through cavity shall be made from minimum Grade 304 austenitic stainless steel.

The cavity in the external wall must be maintained and kept clear of construction debris. Masonry claddings must have adequate weep holes along their bases and over openings to allow moisture to exit the cavity. Stepped DPC/DPM shall be installed at ground floor level. Refer to Figure 4 for typical detail.

Castle Group Structural Engineer to provide specification for movement joints if required for the project. Design and spacing of movement joint shall be in accordance with I.S. EN 1996-2[4].

Precast concrete and aluminium window cills with DPC are installed in accordance with Certificate holder's instructions. The sills shall have stop ends, be designed to prevent water ingress and incorporate drip details to shed water clear of the system.

Proprietary cavity barriers/fire stops are installed in accordance with the Certificate holder's instructions as defined in Section 2.1.13 of this Certificate, at locations defined in the project specific site package and in accordance with manufacturer's instructions.

2.1.7 Separating & Compartment Walls

Full separating/compartment wall build up consists of two adjacent perimeter wall modules. The full compartment wall build up is constructed from the following:

- Plasterboard, in accordance with this Certificate (refer to Table 1)
- Air and vapour control layer (AVCL),
- HR/CR primary steelwork and LGS infill from module 1 with mineral wool insulation between the steelwork (forming part of modular unit 1 by Castle Group)
- Fibre-cement board (refer to Table 1)
- 50mm cavity
- Fibre-cement board (refer to Table 1)
- HR/CR primary steelwork and LGS infill from module 2 with mineral wool insulation between the steelwork (forming part of modular unit 2 by Castle Group)
- Air and vapour control layer (AVCL),
- Plasterboard, in accordance with this Certificate (refer to Table 3)

Refer to Figure 10 for a typical compartment/separating wall detail.

The plasterboard finish is provided for acoustic and fire properties, as per Table 1. The space between LGS studs and HR steelwork is filled with 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 mineral wool insulation must go up to the underside of the roof for acoustic purposes. Where the party wall abuts an external wall, the mineral wool insulation within the cavity of the party wall extends through the inner leaf of the external wall and abuts the external leaf of the system and forms the fire stop in the wall. This detail seals air gaps and minimises flanking sound transmission. Refer to Figure 12 for external wall to compartment/separating wall detail.

At the junction of the floor and the compartment/separating wall, an additional 1000mm section of mineral wool insulation is provided within a deflection gap between modules to minimize flanking and direct sound transmission and provide cavity fire protection. Refer to Figure 10 for drawing detail.

The head of the party wall must also be fire stopped and cavity closed as specified on Castle Group drawing detail and in accordance with TGDs to Part B of the Building Regulations. This is shown in Figure 6.

Where services are required in a party wall, they can be accommodated by creating a service cavity to the party wall with timber battens or metal top hat sections and plasterboard. All battens used with the Castle Group Modular Building System are treated in accordance with BS 8417[5]. The design must comply with the requirements of Section 3 of TGDs to Part B of the Building Regulations for all Purpose Groups to which this Certificate applies.

2.1.8 Single Frame Compartment Wall

A compartment wall within the Castle Group Modular Building System can be constructed of a single frame wall and must be designed and specified to meet the acoustic, fire and structural requirements of the Building Regulations.

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.

2.1.9 Separating & Compartment Floors

The compartment floors can be constructed using composite concrete metal deck structure. The build-up of the compartment/separating floor is outlined in Table 1 and in Figure 10. The Castle Group Modular Building System compartment floor can be designed to provide up to 90mins fire resistance from the underside. The compartment floor is non-combustible and is suitable for use in buildings of any Purpose Group up to the maximum height allowed in this Certificate.

The composite concrete metal deck structure adopts the use of steel decking as both a permanent shutter for concrete and as a structural element forming composite action between steel and concrete. Castle Group uses a dovetail metal deck, which usually adopts the profile height of 51mm (R51 profile).

Full floor build up consists of upper module floor sitting on lower module ceiling. The full floor build up is constructed from the following:

- Internal floor finish in upper module unit,
- Resilient layer in accordance with TGD to Part E,
- Upper module composite concrete metal deck structure (forming part of upper module unit by Castle Group)
- 20mm deflection gap,
- Lower module ceiling as per Section 2.1.10 (outside of the compartment/separating floor criteria)

Refer to Figure 10 for typical separating and compartment floor detail.

An additional layer of resilient material is added to the top of the composite slab to meet the requirements outlined in Section 4.4 of TGD to Part E of the Building Regulations (see Section 4.4.2.1 of TGD to Part E for definition of resilient material).

The electrical and mechanical services shall not be accommodated within the compartment wall build up. All services shall be provided in the ceiling void (lower module). Where services pass through compartment floors, they should be contained in fire-resistant ducts, and the opening of such ducts should be protected and fire-stopped in accordance with TGDs to Part B of the Building Regulations (Vol. 1 and Vol. 2). Refer to the National Rules for Electrical Installations - I.S. 10101:2020+AC2:2025 [41] requirements for Electrical installation, inspection and testing.

2.1.10 Ceiling Structure

The ceiling structure can be constructed as:

- 350-400mm deep Vierendeel trusses formed with structural sections which are sheathed with 18mm OSB to the top and 15m mm Type F plasterboard to the underside or
- 150mm deep LGS C sections with which are sheathed with 12mm cement board on top and 15mm Type F plasterboard to the underside

The top of OSB/cement board is protected by a waterproofing membrane. The services may be accommodated in the ceiling void as per Section 2.1.16.

2.1.11 Intermediate Floors

The intermediate floor is constructed of LGS floor joists with OSB3 (Oriented Strand Board) and ceiling of the lower module. Fire protection is provided by plasterboard to the underside of the upper module floor in accordance with Table 1.
Typical intermediate floor consists of:

- Internal floor finish in upper module unit,
- Resilient layer in accordance with TGD to Part E,
- 18mm thk. OSB3 boarding,
- Upper module LGS floor joists with mineral wool insulation (forming part of upper module unit by Castle Group)
- 26mm cavity formed by tophat ceiling rails,
- Plasterboard, in accordance with this Certificate (refer to Table 1)
- 20mm Deflection gap,
- Lower module ceiling as per Section 2.1.10 (outside of the intermediate floor criteria)

All service penetration in the module ceiling such as down-lighters, soil vent pipes or ventilation duct heads must be fire stopped by the use of fire collars, fire hoods or fire rated products. Refer to TGDs to Part B of the Building Regulations for requirements for service penetrations.

2.1.12 Compartment Junctions

Compartment junctions shall be designed in accordance with Section 3 TGDs Part B (Vol. 1 and Vol. 2) of the Building Regulations.

Where a compartment wall or compartment floor meets another compartment wall or compartment floor, or an external wall, the junction should maintain the fire resistance of the compartmentation.

Where a compartment wall or floor meets an external wall, the compartmentation should be maintained to the inside surface of the outermost element, including external rendering and cladding systems.

2.1.13 Cavity Barriers and Fire stops

To meet the requirements of TGDs to Part B of the Building Regulations, 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 as follows:

- At the top of an external cavity wall and at the junction of any such wall with a separating wall.
- At the junction between an external cavity wall, and every compartment floor and compartment wall.
- At the junction between an internal cavity wall and every compartment floor, compartment wall, or other wall or door assembly which forms a fire-resisting barrier.
- At the junction between any internal cavity compartment wall or cavity

compartment floor and any other internal cavity compartment wall or cavity compartment floor.
- At top of separating/compartment wall and roof junction.
- In a protected escape route, above or below any fire-resisting construction which is not carried full storey height, or (in the case of a top storey) to the underside of the roof covering.
- Cavity barriers are required around all openings in external walls (with cavity) such as doors, windows, vents, extractor fans, meter cupboards, services, etc.
- At openings and passage of services in fire resisting construction.

For special provision for cavity barriers for Purpose Groups 2(a), 2(b), 3, 4(a), 5(a) and 5(b) refer to TGDs to Part B of the Building Regulations.

The cavity barriers and fire stopping shall be in accordance with Section 3 of TGDs to Part B of the Building Regulations. The fixing of the fire stopping and cavity barriers shall be carried out as per manufacturer's specification.

Castle Group Site Manager must inspect all cavity barriers/fire stops prior to the closing up of the cavities, ceilings etc. and record it in the quality control file for that project.

2.1.14 Roof Structure

The roof trusses can be either a traditional timber cut roof, prefabricated roof truss made from timber or steel or a modular steel roof structure by Castle Group. A modular steel roof structure can be constructed similarly to intermediate floor or compartment floor as described in Sections 2.1.9 and 2.1.11. The choice of roof structure to be constructed must be assessed and signed off by Castle Group Structural Engineer.

The roofing solution chosen for a particular building is both Client and project specific and must be assessed and signed off by a Castle Group Structural Engineer. The System has been assessed only with traditional roofing finishes and NSAI Agrément certified roofing finishes. Other roofing solutions may be suitable but have not been considered as part of this certification. Refer to TGDs to Part B of the Building regulations on roof finish over compartment/separating wall. B_{ROOF}(t4) roof covering shall be provided 1.5m each side of the compartment/separating wall as per TGDs to Part B of the Building Regulations.

2.1.15 Internal Linings and Finishes

Internal finishes are outside of the scope of this Certificate.

Linings to walls and ceilings are of plasterboard as specified in Table 3, manufactured to I.S. EN 520[6]. 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 manufacturer's instructions. Alternatively skim coat plaster can be applied.

Reaction to fire classification of surface linings of walls and ceilings shall meet the fire classification as per TGDs to Part B of the Building Regulations.

2.1.16 Services

Services are outside the scope of this Certificate.

Refer to Section 2.1.9 of this Certificate for information on services penetrations through compartment floors and Section 2.1.7 through compartment walls. No openings are permitted in the separating wall construction.

Refer to TGDs to Part B of the Building Regulations for requirements and methods of protection of openings and fire stopping. If an element is intended to provide fire separation (i.e. it has a requirement for fire resistance in terms of insulation and integrity), then every joint 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.

2.1.17 Intermodular connections

Intermodular connections between the units are shown in Figure 13. The intermodular connection provides lateral and vertical connection between the adjacent modules. The connection utilizes:
- Pins welded in the factory to lower modules for ease of installation,
- Horizontal tie plate with countersunk bolts installed between two lower modules for horizontal tying between two lower modules,
- Vertical tie plate with countersunk bolts installed between four modules (two upper and two lower) for vertical and horizontal tying.

The intermodular connection can be utilised to join a maximum of four modules together (two lower modules and two upper modules). The limitation applies to the connection capability, which allows a maximum of four modules to be joined (two lower modules and two upper modules), primarily due to site accessibility constraints. Buildings utilising more than 4No. modular units can be constructed using Castle Group Modular Building System considering the limitation of intermodular connections mentioned above.

The Castle Group Chartered Structural Engineer is responsible for connections design. The connections are installed on site by Castle Group. Castle Group Site Manager must inspect all connections prior to closing up cavities, etc. and record it in the quality control file for that project.

2.1.18 Ancillary elements

Non-exhaustive list of ancillary elements is provided below. The ancillary elements that are outside the scope of this Certificate, include:

- Foundation/substructure (though interfaces must be considered and addressed as per Section 2.3.3 below)
- Internal finishes (ceiling/wall/floor, not contributing to Building Regulations compliance).
- Mechanical and Electrical installations & services.
- Windows and doors.
- Fittings and furniture.

2.2 DESIGN AND MANUFACTURE

2.2.1 Design Process

The Castle Group Modular Building System must be designed in accordance I.S. EN 1993-1[7]. by Castle Group Chartered Structural Engineer. The structural analysis is carried out by Finite Element Modelling (FEM). All connections including intermodular connections must be checked for project specific loading.

Structural design is to be reviewed and checked by Castle Group Chartered Structural Engineer independent of the original designer.

Each module is analysed at a number of stages throughout the design process at:

- Construction stage in the Fabrication factory
- Transport stage
- Lifting into place stage
- Permanent State

2.2.2 Manufacture Process

The Castle Group Modular Building System is manufactured in accordance with I.S. EN 1090-1[8] to minimum Execution Class EXC2. The manufacture is the responsibility of Castle Group.

The main structural elements of the Castle Group Modular Building System are composed of cold or hot rolled structural steel elements. The structural steel columns used in each module are typically cold or hot rolled SHS sections (minimum 100x100x5mm) which are welded to the horizontal beam and floor PFC section. The header beam is minimum 100x100x10mm section and the floor is typically a 150x90 PFC. The Vierendeel trusses make up of the ceiling module are typically constructed of 50x30x5mm cold rolled RHS sections. Ceiling module may be also constructed using 150mm deep LGS C-section.

All LGS infill panels are manufactured from 100x50 C-sections. Stud gauge ranges from 1.2mm to 1.5mm. All infill studs are provided with deflection heads,

The modules are manufactured off site at the Castle Group manufacturing facility in a quality-controlled factory environment. The module assembly at the factory includes all internal finishes required for acoustic, fire and structural requirements. Some elements including cavity barriers and firestopping, external wall façade, external and internal finishes must be installed on each construction site.

The level of finishes that can be installed in the factory varies and is project dependant. In all modules 1st and 2nd fix, plumbing, electric, carpentry, tiling and painting is carried out in the factory. Internal fixtures and finishes have not been assessed as part of the assessment and are therefore outside the scope of this Certificate.

Several factors may influence the allowable sizes of a module. These factors include transportation, site accessibility, weight and preferred module dimensional limitations. Typical modules sizes vary in size but can range from 6m to 15m in length and 2.5m to 4.5m in width and 4m in height.

2.3 STRUCTURAL PRINCIPLES

2.3.1 Structural Steel Structure

The basis of the typical Castle Group Modular Building System is a cold or hot rolled steel structure with LGS infill. The perimeter/intermediate columns and beams form primary structural elements of the system. The LGS infill panels transfer lateral load and vertical load from masonry outer leaf only to the primary structure.

The vertical loading is transferred through roof structure and floor units to wall elements and then to substructure/foundations. The horizontal loading is transferred through the wall elements down to substructure/foundation through shear elements.

2.3.2 Protective Coatings

The LGS members are all coated with a protective zinc-rich metal coating. The LGS members are manufactured from galvanized coil steel to I.S. EN 10346[12] with 275 g/m^2 zinc protection.

The paint system in accordance with ISO 12944-5[9] is used on the hot or cold rolled primary structure. The paint system for the primary structure is designed to achieve high durability and C2 corrosivity category for all elements except the ground floor structure. For ground floor structure:

- Structural steel elements above 150mm above external ground level, the paint system is designed to achieve C2 corrosivity category and high durability. The paint system is in accordance with ISO 12944-5[9].

- Structural steel elements below 150mm above ground floor are characterised by C5 corrosivity category and are hot dip galvanised to I.S. EN ISO 1461[10] and I.S. EN ISO 14713-2[11]. Minimum coating thickness (nominal dry film thickness)/ weight equals to 710gms/m^2.

In addition to the steel members in the system being protected by a paint system and hot-dip galvanising, further protection against corrosion and longer life is given to the steel by providing the following:

- The ground floor structure is fully wrapped in damp proof membrane (DPM).
- DPC is provided at ground floor to foundation connection. Where the anchors bolts go through DPC, any puncture(s) shall be repaired on site.
- Stepped DPC and weepholes are provided at ground floor level and at masonry support system locations.
- The external insulation keeps the steel in a "warm frame" environment, which in conjunction with an AVCL prevents the formation of condensation within the wall structure.
- Galvanised anchor bolts are used between the foundation and ground floor galvanised steel footing/plate

Where the protective coating on steelwork is damaged during the installation, it shall be adequately repaired to meet the protective coatings requirements stated in this Section.

2.3.3 Fasteners and Connection Joints

All primary structural steel elements are welded together in the factory in accordance with I.S. EN 1090-1[8] to achieve minimum Execution Class 2 (EXC 2). Weld records to be maintained in accordance with the I.S. EN 1090-1 certification requirements. Where LGS elements connect to primary structural steel screw fasteners are used. Similarly screw fasteners are used for LGS to LGS connections. On-site connections such as intermodular connections are bolted. Countersunk bolts are used in intermodular connections.

Finishes connection to the steel elements such as boarding to steelwork, where the boarding provides fire protection shall be in accordance with Table 1 (of this certificate).

All fasteners used in the Castle Group Modular Building System are adequately protected against corrosion and made from a suitable metal to ensure the design life of the system is maintained. Castle Group provides 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 Castle Group 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.

Holding down connections are installed to provide adequate loading transfer to foundations. Galvanised anchor bolts are provided and designed by Castle Group Structural Engineer to I.S. EN 1992-4[13]. The installation is to be in accordance with the **HSA: Code of Practice for the Design and Installation of Anchors**[14] and is to be carried out by competent personnel in accordance with Castle Group Installation Manual.

2.3.4 Racking

The composite action of the steel studs, bracing and horizontal diaphragm action of the floor and roof elements combine, as per the design, to provide the required stiffness to meet the stability requirements of the building system.

The horizontal load transfer in the intermediate floor is provided by floor sheeting in conjunction with OSB3 or composite concrete metal deck structure in compartment floors. Load transfer between the modules is provided by intermodular connections. The horizontal load transfer in the wall elements is provided by LGS infill and bracing of the primary structural elements.

Foundations and lateral stability systems such as concrete cores are outside of the scope of this certificate. All structural criteria and load transfer to lateral stability system must be determined by Castle Group Structural Engineer and communicated to Client's Structural Engineer.

2.4 DELIVERY, STORAGE AND SITE HANDLING

2.4.1 Site Preparation

Site conditions should be satisfactory before any installations are carried out, adverse weather conditions such as snow, high winds or lightning could affect the safety of the installation and assembly process. Before modules are delivered to site there should be a full survey carried out of the concrete foundation slab ensuring the slab is level and in line with the dimensions of the agreed substructure plans. The survey should be recorded in the Quality Inspection & Test Plan records, and any discrepancies should be reported to the Castle Group site management team.

Slab perimeter insulation should be inspected to insure it is correctly installed and free from damage. DPC should be installed in accordance with layout drawing ensuring that at the galvanised steel structure to foundation connection there is DPC present.

2.4.2 Delivery & Storage of Modules

The modules leave the factory as weather protected sealed units and are labelled with a

Castle Group logo, a customer logo, a serial number and module number. The serial number is taken from Castle Group's Module Marking System and assigned a serial number based on the façade type, floor level, frame type and sub-frame type of each module. This ensures modules are delivered to site in the correct order and subsequently placed in the correct sequence.

When delivered to site an inspection sheet must be filled out to ensure the modules have arrived to site in accordance with the project specifications and free from damage. The weather protection membrane should be inspected at this stage to ensure there are no tears or damage to the module. All modules should be stored on level ground on timber bearers with the identification label facing the same direction for easy identification.

Modules are transported on trailers to site. Lifting operation is carried out using crane with adequate lifting capacity for transporting modules. Lifting points are located, designed and certified by the Castle Group Structural Engineer, taking into account the unit weight, dimensions and the distance of lift required.

Transport and lifting shall be carried out by competent personnel in accordance with the Castle Group Installation Manual[15]. and site-specific safety statement. Care is needed to avoid any damages to modular units. Typically offloading of module from the trailer will be directly onto substructure location or to the set down storage area.

2.4.3 Safe Handling

For every site a specific risk assessment must be created in order to access the risks involved with the handling and installation of the modular units.

Modules should always be moved using a crane organised by Castle Group or Main Contractor (project specific) using lifting frame as designed by Castle Group.

2.4.4 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 and fixing schedule to site to complete the installation of the Castle Group Modular Building System.

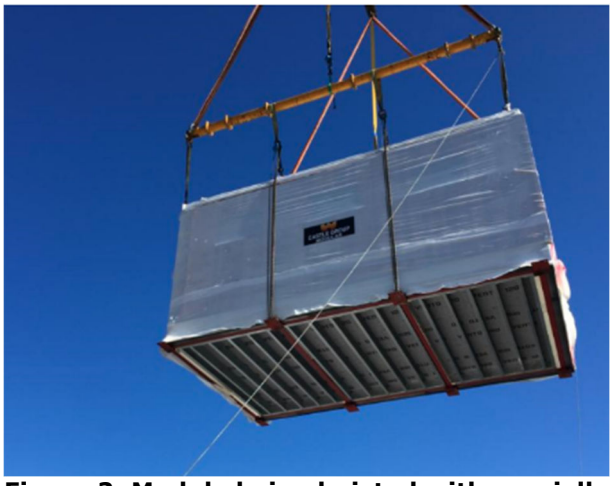


Figure 2: Module being hoisted with specially designed lifting frame

2.5 INSTALLATION

2.5.1 General

Site erection is carried out by Castle Group or approved licensed installers employed by Castle Group or by specialist sub-contractors/ Main Contractor under the supervision of Castle Group. The Castle Group Modular Building System is to be installed in accordance with the procedures in the dedicated Installation Manual[15]. The Castle Group Installation Manual[15] was reviewed during the NSAI assessment, Certificate Holder shall be contacted for information on latest Installation Manual. Castle Group is responsible for site inspections and sign off in accordance with Building Regulations.

Installers are approved once they have undergone classroom and on-site training, and understand the fundamental structural principals of the system, fire stopping requirements, modular connections, tolerances, importance of weathering, storage and handling of the modular units and all other relevant information. Installers must have installed modules under the guidance of a Castle Group qualified installer and shall have a signed record of training.

All off-loading and erection should be in accordance with the Castle Group method statement, erection procedures and the lifting plan. Care must be taken to avoid any damage to the modules during lifting, transportation and installation.

A Castle Group Structural Engineer must assess the adequacy of the design of the proposed superstructure of the building system in accordance with the Castle Group Inspection Plan and the DHLGH *Code of Practice for Inspecting and Certifying Buildings and Works*[16].

This Certificate does not contain a complete set of installation instructions, but an overview of the procedures involved. For a full list of these instructions, refer to the Certificate holder's

Installation Manual[15]. Should a conflict arise between this Certificate and the Certificate holder's manuals, this Certificate shall take precedence.

2.5.2 Site Supervision

All modular system installation works are supervised by Castle Group.

Where subcontractor/Main Contractor is used for installation of the system, level of supervision depends on contractor's industry experience, qualification and experience in Castle Group modular system installation. Castle Group employs a Site Supervisor who works closely with the Main Contractor and ensures project specific roadmap for inspections is met.

The Main Contractor/Client is always responsible for ensuring the substructure is within the Engineer's specified tolerances before modules are installed on site. Ground connection detail shall be inspected to check DPM, DPC, concrete foundation and insulation placement. Substructure must be signed off by Contractor before installation of modular units.

The Castle Group Site Supervisor and Main Contractor/subcontractor are responsible for the quality of work carried out by the erection crew for modular units. The Site Supervisor ensures all work follows the requirements of the design drawings, specification and project specific roadmap for inspections. Castle Group is always responsible for review of inspection records and final sign off of modular units.

Each building has its own quality control file which is kept by the Castle Group Site Supervisor. Quality control file includes records of inspections, photographs and sign off. Defects noted are recorded, photographed and notified in writing to Site Supervisor and Contractor. Where necessary Site Supervisor will inspect and approve the remediation before work can proceed.

The approved module installation contractors are subject to continuous supervision by the Castle Group Site Supervisor. The following checklist is provided to offer guidance to clients who intend to carry out their own additional site supervision. The items listed, are of a general nature which 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 Castle Group before the modules are positioned.
- Substructure's Designer signed off foundations/substructure for the loading as defined by Castle Group Structural Engineer.
- The modules are not erected until any inaccuracies in the substructure have been corrected.
- Radon membrane/DPC/DPM are correctly installed by Main Contractor prior to placing the modules.
- The DPC course is laid between steel and concrete at all ground floor to foundation connections.
- Modules are in line and plumb in accordance with the Castle Group design drawings.
- Ground floor modules are connected to substructure/foundations as per Castle Group specification.
- Horizontal and vertical connections are installed between the modules as per Castle Group specification (intermodular connections). Infill mineral wool is installed at there locations to provide continuity of insulation in the external wall build up
- Deflection gap is filled with mineral wool at all floor junctions with external wall/roof/compartment wall as per Castle Group specification.
- Insulation at the walls is free from damage after the erection.
- Where traditional block/brick outer leaf is installed, the channels are not damaged and correctly spaced and positioned.
- Cavity barriers and fire stops are installed and signed off by Castle Group/Main Contractor as specified and in accordance with the Building Regulations.
- All fixings used are supplied or approved by Castle Group.
- Where roof structure is installed on site, the connection between the roof and modules is in accordance with Castle Group design drawings and specification
- All service penetrations are adequately finished as per Castle Group specification
- The proper application of plasterboard to the steel frame members is critical for both fire and sound performance. Attention shall be given to proper and practical detailing on the part of the designer and a high standard of workmanship. Plasterboard, in addition to all cavity barriers and fire stops on all structural walls and floors and separating walls, must be fully checked on site and signed off in accordance with project specific details by the appropriate personnel. All boarding that provides fire resistance must conform to the specification given in Table 1.

Note: This Certificate contains illustrations to explain the various elements of the Castle Group Modular Building System – these illustrations are not intended to be used as construction drawings. Castle Group in conjunction with the Design Team on a project, will produce a set of project specific details on a project-by-project basis. All drawings should be compliant with the relevant codes of practice and standards, along with Irish Building Regulations.

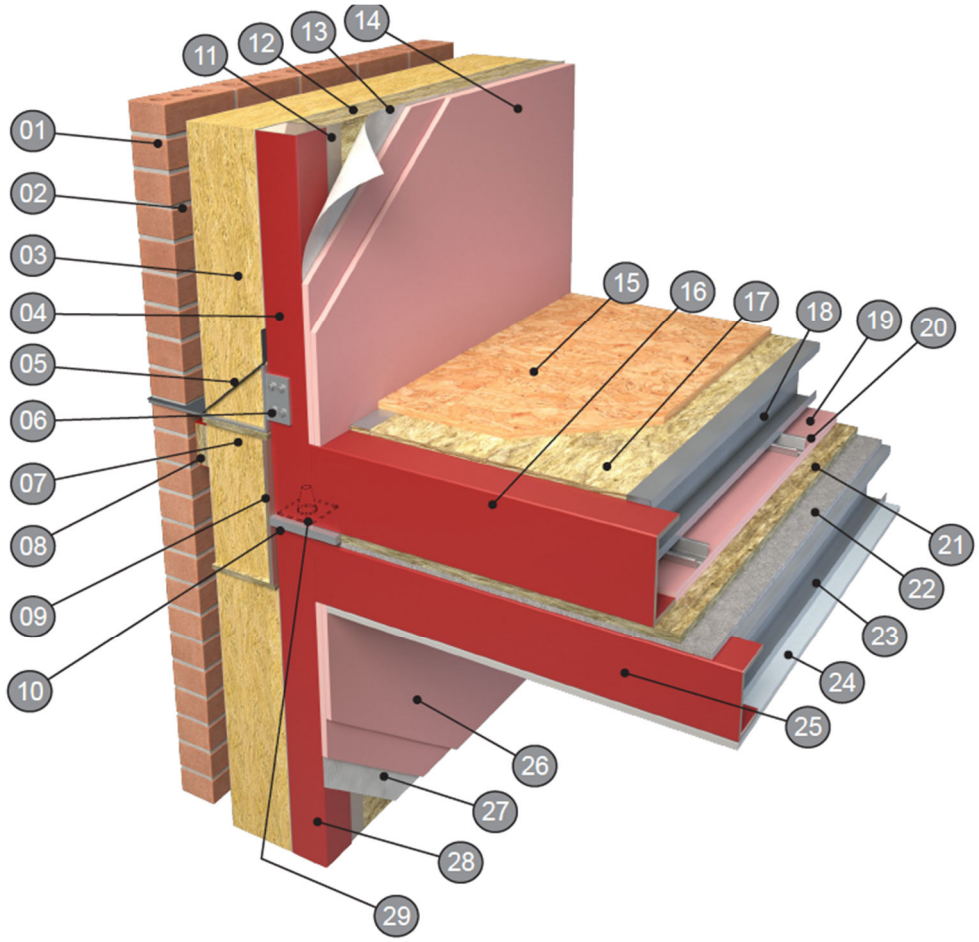


Figure 3: External wall with traditional brick/block outer leaf cladding to intermediate floor detail

1. Brickwork outer leaf
2. 50mm drained cavity
3. Eurobond Rainspan Panel to specification
4. SHS steel column with paint system as in accordance with this Certificate
5. Stepped DPC
6. Masonry support bracket with thermal break as per Castle Group Structural Engineer detail
7. Stone mineral wool infill
8. Tenmat NVFB 60/60 fixed as per manufacturer's instructions
9. Vertical module connection plate with counter sunk bolts (part of the intermodular connection)
10. Horizontal module connection plate with counter sunk bolts (part of the intermodular connection)
11. LGS infill frame
12. Stone mineral wool to specification (min. density 22kg/m^3)
13. Air and Vapour Control Layer (AVCL)
14. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
15. 18mm OSB3 deck fixed to LGS joists. Resilient layer to be provided over OSB3 in accordance with this Certificate
16. 190 PFC steel beam between columns with paint specification as in accordance with this Certificate
17. Mineral wool insulation to specification
18. LGS floor joists
19. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (underside of the PFC, Table 1)
20. 26mm cavity formed by tophat ceiling rails
21. Deflection gap filled with stone mineral wool (min 600mm)
22. 12mm cement board
23. LGS ceiling joists
24. 15mm Wallboard (Class A2)
25. 150 PFC steel beam between columns with paint specification as in accordance with this Certificate
26. Type F plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate
27. AVCL
28. SHS steel column with paint system as in accordance with this Certificate
29. Conical module locator/lifting pin.

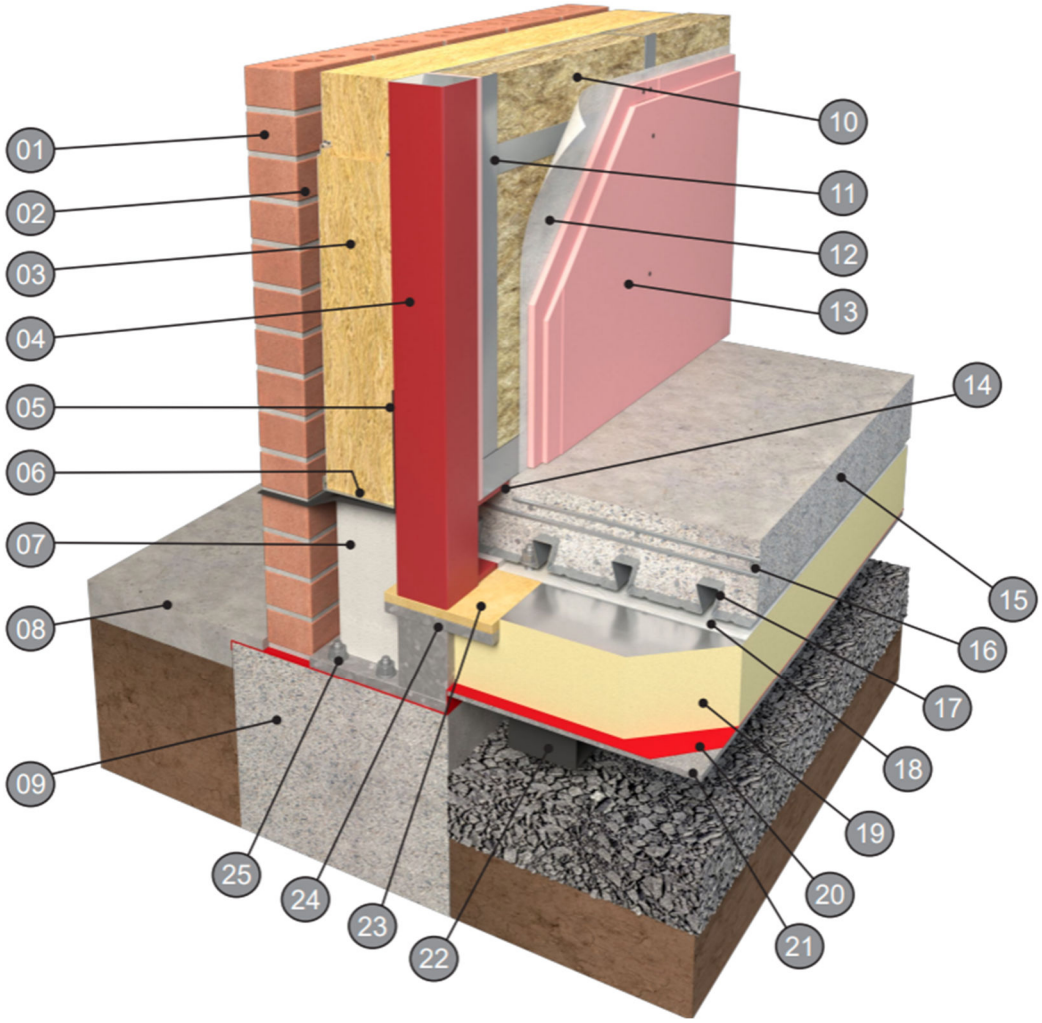


Figure 4: External wall with traditional brick/block outer leaf cladding to substructure detail

1. Brickwork outer leaf
2. 50mm drained cavity
3. Eurobond Rainspan Panel to specification
4. SHS steel column with paint system as in accordance with this Certificate
5. Stepped DPC
6. Kingspan panel starter track as per Castle Group specification. Weepholes in the masonry outer leaf.
7. XPS insulation cut to size as indicated
8. Finished external ground level
9. Reinforced concrete rising wall/foundation, minimum 450mm thick
10. Stone mineral wool to specification (min. density 22kg/m^3)
11. LGS infill frame
12. Air and Vapour Control Layer (AVCL)
13. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
14. 150 PFC steel beam between columns with paint specification as in accordance with this Certificate
15. Composite concrete metal deck to specification
16. Reinforcement as per Castle Group Structural Engineer specification
17. Dovetail metal deck to specification
18. AVCL
19. Underfloor insulation secured with 9mm cement board
20. Damp proof membrane/radon membrane to specification
21. 9mm cement board
22. Underfloor ventilator to specification
23. Farrat plate (or equal and approved) thermal break
24. Galvanised plate
    Galvanised plate with dpc under and anchor bolts to Castle Group Structural Engineer specification.

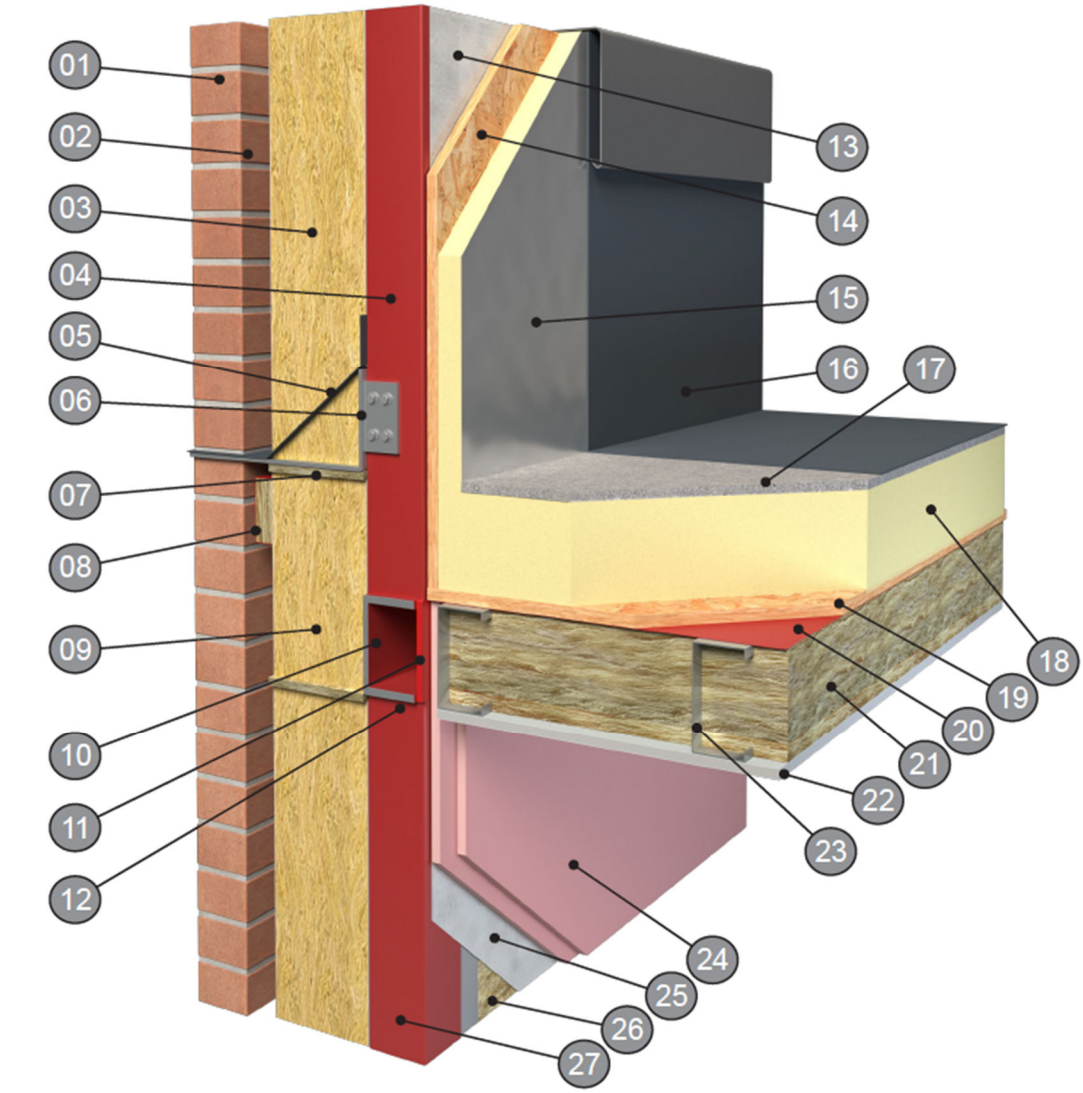


Figure 5: External wall with traditional brick/block outer leaf cladding to roof detail

1. Brickwork outer leaf
2. 50mm drained cavity
3. Eurobond Rainspan Panel to specification
4. SHS steel column with paint system as in accordance with this Certificate
5. Stepped DPC
6. Masonry support bracket with thermal break as per Castle Group Structural Engineer detail
7. Stone mineral wool infill
8. Tenmat NVFB 60/60 fixed as per manufacturer's instructions
9. Mineral wool infill to provide continuity of the insulation
10. 150 PFC steel beam between columns with paint specification as in accordance with this Certificate
11. Steel plate welded to PFC as per Castle Group Structural Engineer specification
12. 15mm Gyproc Fineline board
13. Air and Vapour Control Layer (AVCL)
14. 18mm WPB board to specification
15. 50mm PIR insulation to specification
16. NSAI Agrément certified roof membrane system
17. 12mm cement board
18. 150mm PIR insulation to specification
19. OSB3 to specification
20. Weatherproofing membrane/AVCL, lapped 150mm minimum and taped with airtightness membrane
21. Mineral wool to specification
22. 15mm Wallboard (Class A2)
23. LGS roof joists
24. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
25. AVCL
26. Stone mineral wool to specification (min. density 22kg/m^3)
27. SHS steel column with paint system as in accordance with this Certificate.

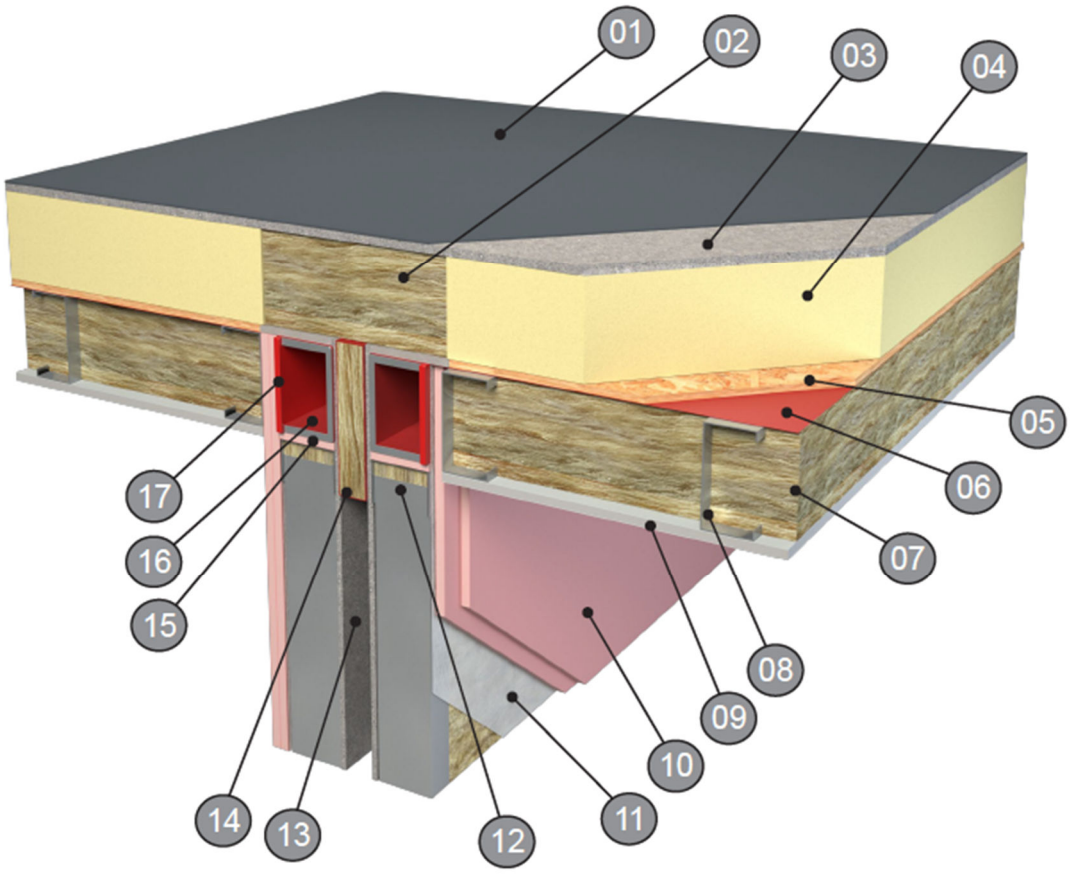


Figure 6: Compartment wall to roof detail

1. NSAI Agrément certified roof membrane system, fire reaction classof roofing over compartment wall to comply with TGDs to Part B of the Building Regulations
2. Mineral wool insulation over compartment wall
3. 12mm cement board
4. 150mm PIR insulation to specification
5. OSB3 to specification
6. Weatherproofing membrane/AVCL, lapped 150mm minimum and taped with airtightness membrane
7. Mineral wool to specification
8. LGS roof joists
9. 15mm Wallboard (Class A2)
10. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
11. Air and Vapour Control Layer (AVCL)
12. LGS studs with deflection head
13. 9mm Cembrit Windstopper Extreme board
14. Tenmat NVFB 60/60 fixed as per manufacturer's instructions
15. 15mm Gyproc Fireline board
16. 150 PFC steel beam between columns with paint specification as in accordance with this Certificate
17. Steel plate welded to PFC as per Castle Group Structural Engineer specification.

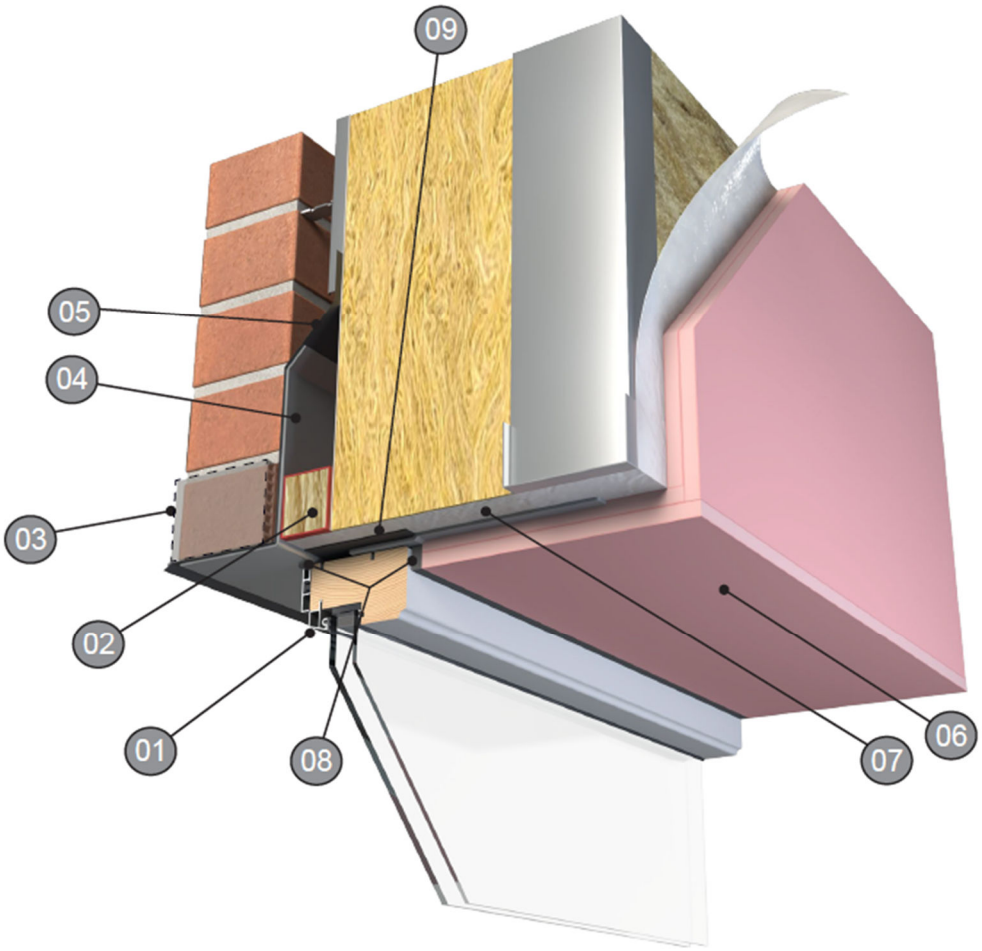


Figure 7: Window head detail

1. Window to specification
2. Fire stop cavity closer to specification
3. Weepholes at 450mm centres
4. Single leaf lintel to Structural Engineer's specification
5. Stepped DPC fixed to Eurobonf Rainspan Panel and dressed over lintel
6. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
7. Air and Vapour Control Layer (AVCL) taped to window frame to manufacturer's specification
8. Sealant to front and back of frame
9. EPDM to specification, fitted by window installer.

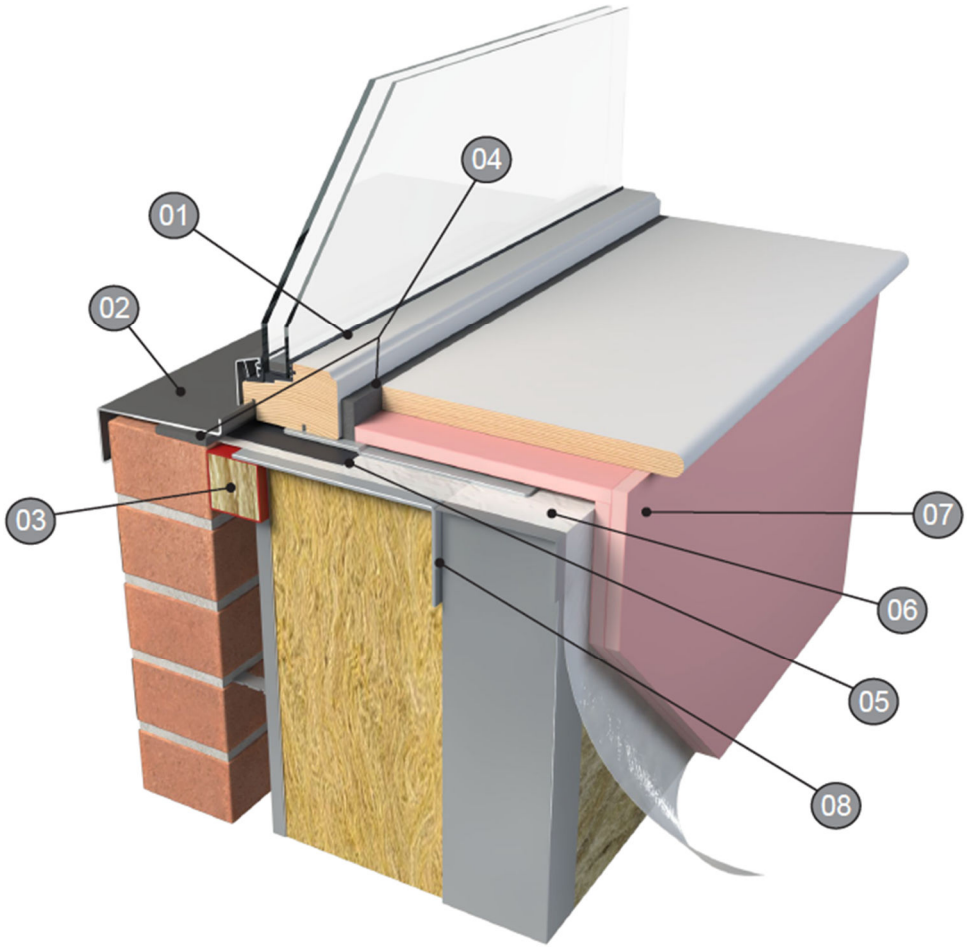


Figure 8: Window sill detail

1. Window to specification
2. Aluminium cill with stop ends by window manufacturer
3. Fire stop cavity closer to specification
4. Sealant to front and back of frame
5. EPDM to specification, fitted by window installer
6. Air and Vapour Control Layer (AVCL) taped to window frame to manufacturer's specification
7. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
8. Stainless steel L-angle support angle fixed to LGS. Isolation patch between stainless steel and LGS members.

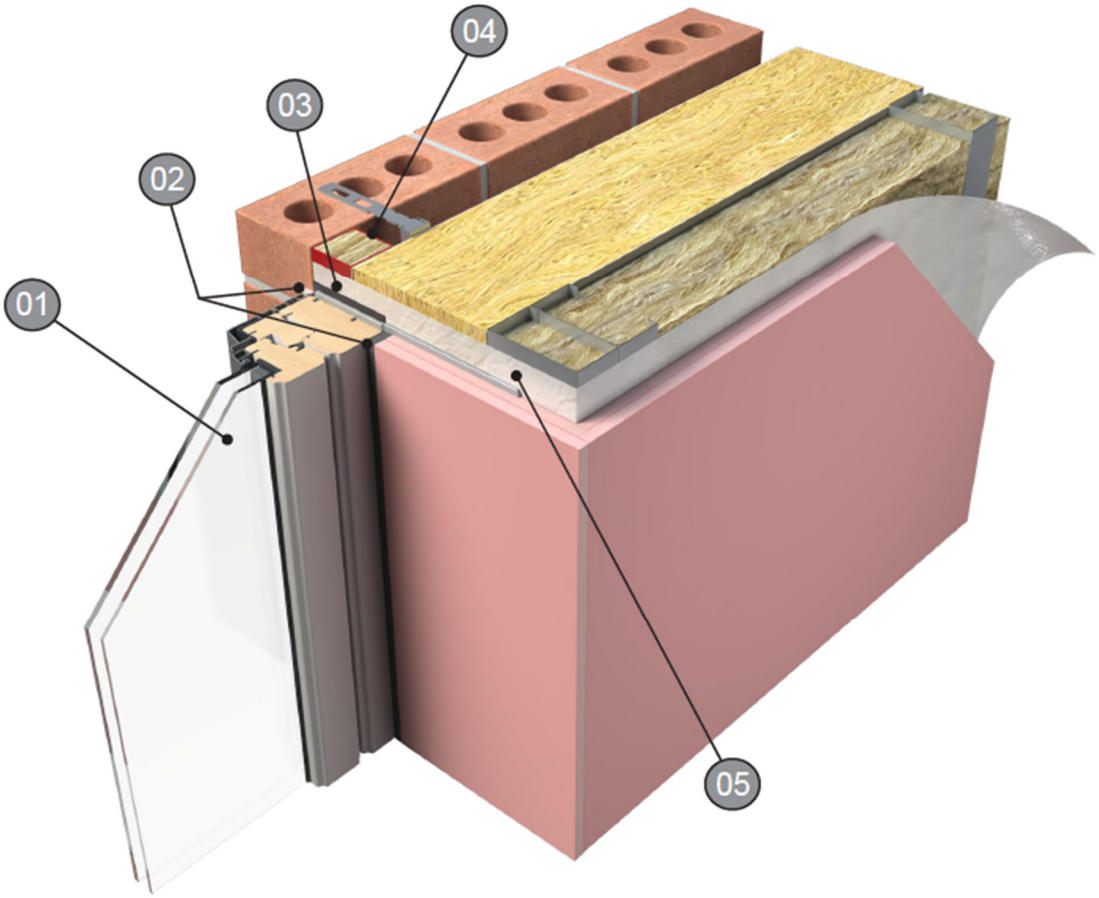


Figure 9: Window jamb detail

1. Window to specification
2. Sealant to front and back of frame
3. EPDM to specification, fitted by window installer
4. Fire stop cavity closer to specification
5. Air and Vapour Control Layer (AVCL) taped to window frame to manufacturer's specification.

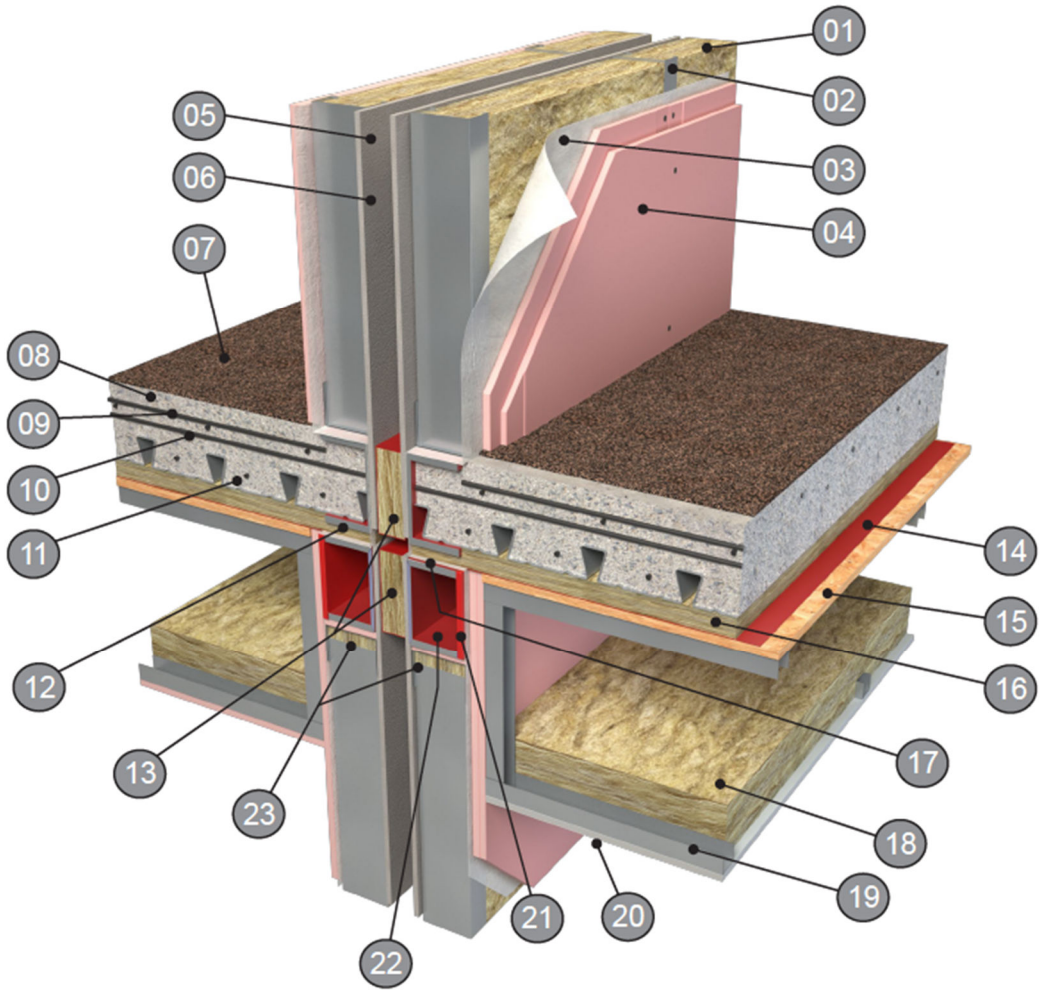


Figure 10: Compartment floor to compartment/separating wall detail

1. Stone mineral wool to specification (min. density 22kg/m^3)
2. LGS infill frame
3. Air and Vapour Control Layer (AVCL)
4. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
5. 9mm Cembrit Windstopper Extreme board
6. 50mm cavity
7. Resilient layer to specification
8. Composite concrete metal deck to specification
9. Reinforcement as per Castle Group Structural Engineer specification
10. Reinforcement bars to provide horizontal tying as per Castle Group Structural Engineer specification
11. Reinforcement bars as per Castle Group Structural Engineer specification
12. PFC steel beam between columns with paint specification as in accordance with this Certificate
13. Tenmat NVFB 60/60 fixed as per manufacturer's instructions
14. Weatherproofing membrane to specification
15. 18mm OSB3 to specification
16. Deflection gap filled with a strip of stone mineral wool (min 1000mm each side), installed on site
17. 20mm deflection gap
18. Mineral wool to specification
19. Vierendell truss forming a ceiling
20. 15mm Wallbord (Class A2)
21. Steel plate welded to PFC as per Castle Group Structural Engineer specification
22. PFC steel beam between columns with paint specification as in accordance with this Certificate
23. LGS studs with deflection head.

Note: Intermodular connection between modules is shown in Figure 13.

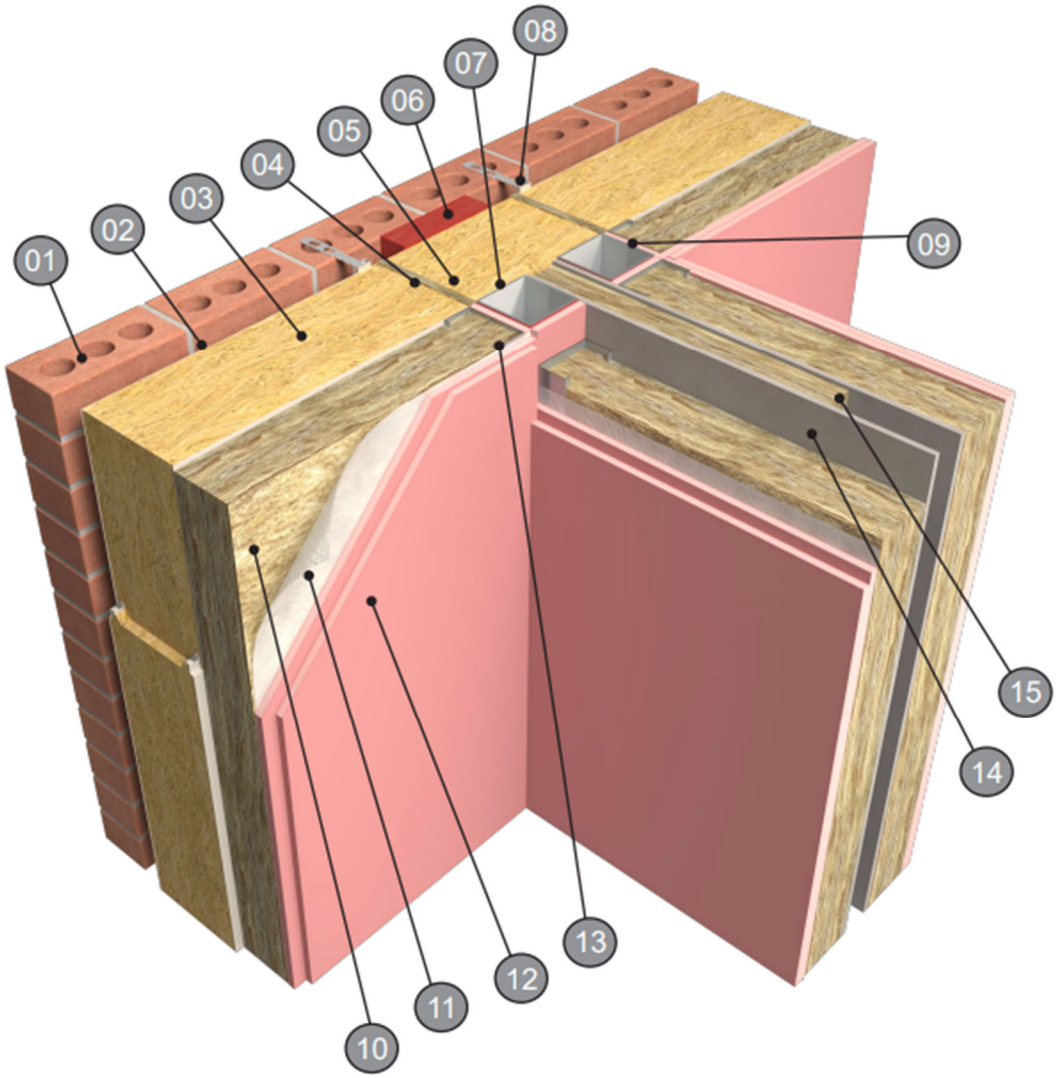


Figure 11: Compartment/separating wall to external wall detail

1. Brickwork outer leaf
2. 50mm drained cavity
3. Eurobond Rainspan Panel to specification
4. Mineral wool packer
5. Mineral wool infill, site applied
6. Tenmat NVFB 60/60 fixed as per manufacturer's instructions
7. SHS steel column with paint system as in accordance with this Certificate
8. Wall ties to specification
9. 15mm Gyproc Fireline plasterboard to protect SHS
10. Stone mineral wool to specification (min. density 22kg/m^3)
11. Air and Vapour Control Layer (AVCL)
12. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
13. LGS infill frame
14. 9mm Cembrit Windstopper Extreme board
15. 50mm cavity with full fill mineral wool to specification (min. 600mm).

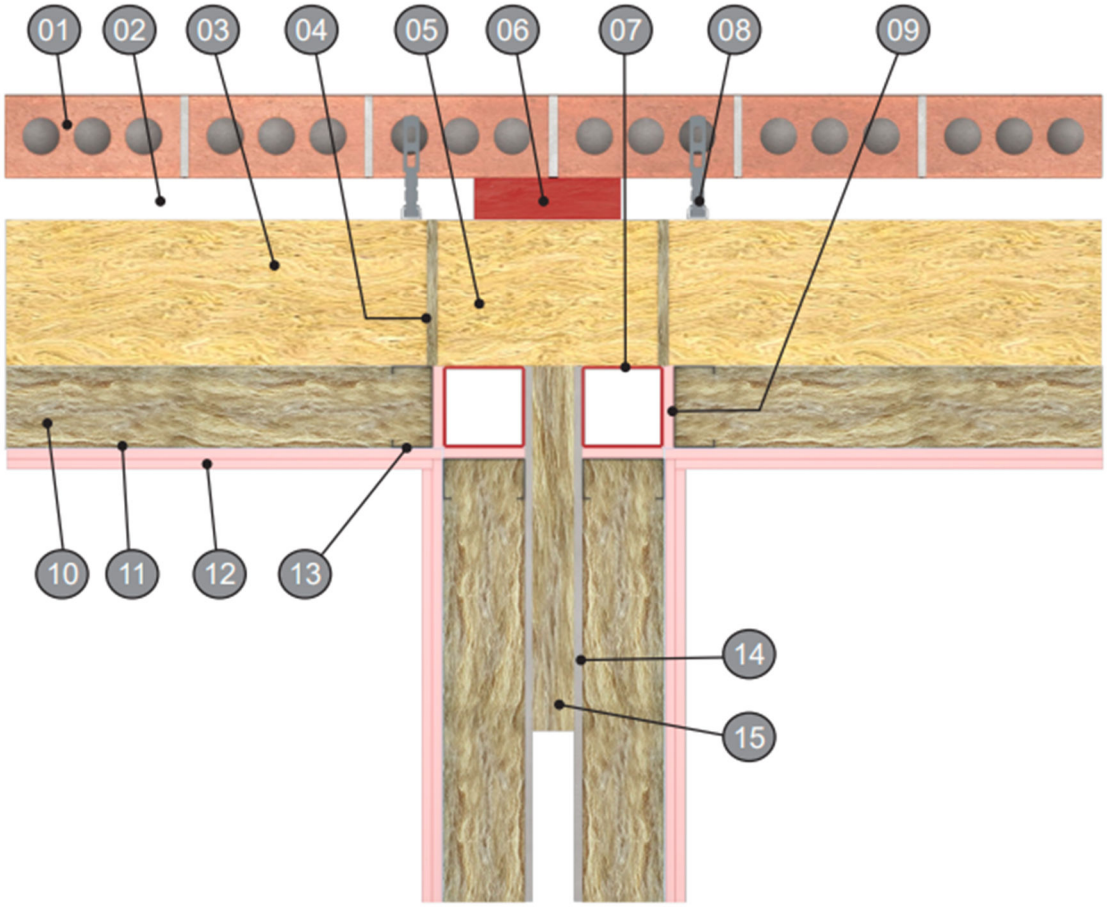


Figure 12: Compartment/separating wall to external wall detail – plan view

1. Brickwork outer leaf
2. 50mm drained cavity
3. Eurobond Rainspan Panel to specification
4. Mineral wool packer
5. Mineral wool infill, site applied
6. Tenmat NVFB 60/60 fixed as per manufacturer's instructions
7. SHS steel column with paint system as in accordance with this Certificate
8. Wall ties to specification
9. 15mm Gyproc Fireline plasterboard to protect SHS
10. Stone mineral wool to specification (min. density 22kg/m^3)
11. Air and Vapour Control Layer (AVCL)
12. Plasterboard lining to provide adequate protection to steel frame in accordance with this Certificate (Table 1)
13. LGS infill frame
14. 9mm Cembrit Windstopper Extreme board
15. 50mm cavity with full fill mineral wool to specification (min. 600mm).

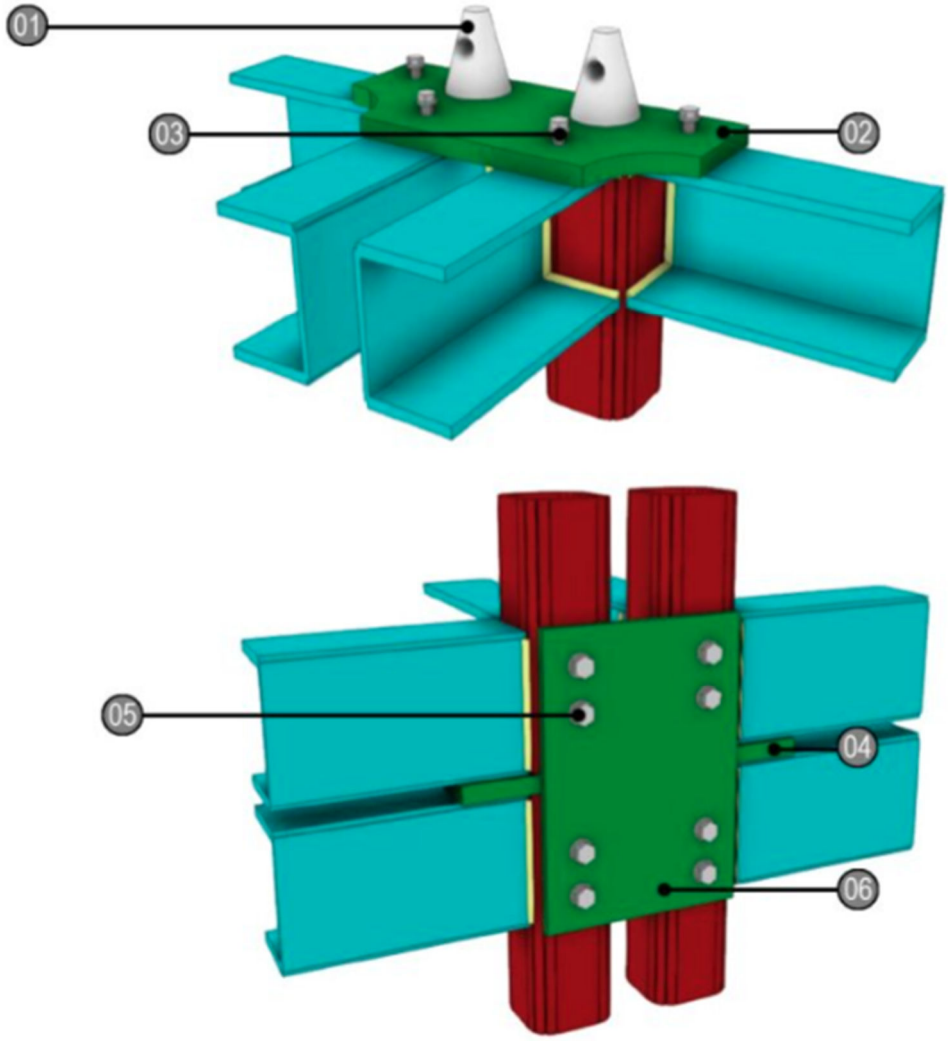


Figure 13: Intermodular connection

1. Conical module locator/lifting pin
2. Hortizontal module connection plate
3. Counter sunk bolts to Castle Group Structural Engineer specification
4. Hortizontal module connection plate
5. Counter sunk bolts to Castle Group Structural Engineer specification
6. Vertical module connection plate.

Note: Maximum of four modules can be connected together with the intermodular connection (two upper modules and two lower modules).

3.1 STRENGTH AND STABILITY

3.1.1 General

The Castle Group Modular Building System is intended for use where Architect's finalised construction and fire strategy drawings are available and satisfy the current Building Regulations. The Building Owner / Client and their appointed Architect and Engineering Design Team of the Client are responsible for the architectural drawings and compliance of the building design with the applicable Building Regulations and with this certificate.

The Castle Group Chartered Structural Engineer is responsible for the structural design of modular building system. Depending on the agreed project scope Castle Group may be responsible for other engineering aspects of the project.

3.1.2 Certificate of Structural Compliance

Castle Group is responsible for the design, manufacture, supply, installation (if applicable) and certification of the modular system. Buildings constructed using the Castle Group Modular Building System must be certified by a competent, Chartered Structural Engineer.

3.1.3 Superstructure Design

The design must be in accordance with I.S. EN 1993-1-1[7] and Part A of the Building Regulations.

The structural assessment of the Castle Group Modular Building System shall be site specific and project specific. Castle Group Chartered Structural Design Engineer suitably qualified in steel modular design shall undertake the structural engineering of the system. Design supervision level shall be in accordance with I.S. EN 1990[17] (minimum DSL2 to be employed).

The design shall cover all structural elements of the system (e.g. primary main steel elements, LGS infill, connections design, stability) and consider all different loadings scenarios during the manufacture, transport, lifting and permanent state.

The design load shall be in accordance with:

- I.S. EN 1990[17]
- I.S. EN 1991-1-1[18]
- I.S. EN 1991-1-4[19]
- I.S. EN 1991-1-3[20]

Snow and wind loads must be based on guidance given in TGD to Part A of the Building Regulations.

3.1.4 Substructure Design

The design of the building's substructure is outside the scope of this Certificate. Refer to Section 2 of this Certificate.

3.1.5 Structural Testing

Where it is required, structural testing can be used to verify the relevant aspects of the structure where the design falls outside the scope of I.S. EN 1993-1-1[7]. No structural testing has been carried out as part of NSAI Agrément certification assessment.

3.1.6 Disproportionate Collapse

The Castle Group Structural Engineer is responsible for disproportionate collapse design and risk of exceptional loads occurring.

3.2 FIRE

3.2.1 General

Buildings using the Castle Group Modular Building System must be designed to comply with the relevant requirements of TGDs to Part B of the Building Regulations.

The building details of the system incorporate suitable cavity barriers and fire stops to satisfy the requirements of Section 3 of TGDs to Part B of the Building Regulations. Additional guidance is contained in BS 9991[21] & BS 9999[22].

The Castle Group Modular Building System must be designed with the required boarding specification as per Table 1 to meet the minimum requirements of Table A1 and Table A2 to TGDs to Part B of the Building Regulations for all Purpose Groups to which this certificate applies, and any other building specific structural fire performance requirements.

All roof coverings in conjunction with the system shall be designated AA/B_{ROOF} (t4) per TGDs to Part B of the Building Regulations. Other NSAI Agrément approved roof coverings may also be used with the system under the guidance of the Castle Group Chartered Engineer.

3.2.2 Fire Resistance of Compartment Walls

Table 1 lists the fire resistance tests for loadbearing wall elements in accordance with I.S. EN 1365-1[23]. All fire testing has been carried out with service penetrations in the walls. The compartment wall can provide up to 90 minutes load bearing fire resistance.

Refer to TGDs to Part B for reaction to fire classification requirements depending on the

Purpose Group, building height and required fire resistance.

Any compartment 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. Refer also to Section 2.1.7 and Figure 6.

Refer to Section 2.1.7 for more information on compartment walls including any service provisions.

3.2.3 Fire Resistance of Compartment Floors

Table 1 lists the fire resistance tests for loadbearing floor elements in accordance with I.S. EN 1994-1-2[28]. The composite deck can provide up to 90 minutes load bearing fire resistance from a combination of the reinforcement steel bars within the trough of the decking and adequate concrete cover to the reinforcement steel bars.

The composite concrete metal deck compartment floor is constructed of materials having a reaction to fire classification A2-s3, d2 or better. The composite concrete metal deck can be used as a compartment floor for all Purpose Groups and up to maximum height of the building as covered in this Certificate.

Refer to Section 2.1.9 for more information on compartment floors including any service provisions.

3.2.4 External fire spread

Table 1 lists the fire resistance tests for external wall in accordance with I.S. EN 1365-1[23]. All fire testing has been carried out with service penetrations in the walls. External wall can provide up to 120 minutes load bearing fire resistance from inside.

Distance to relevant boundary, Purpose Group and height of the topmost storey should be reviewed with reaction to fire classification of external walls as per TGDs to Part B of the Building Regulations.

3.2.5 Internal Fire Spread (Linings)

Reaction to fire classification of surface linings of walls and ceilings should meet the classification as per TGDs to Part B of the Building Regulations.

3.2.6 Compartment Junctions

Where a compartment wall or compartment floor meets another compartment wall or compartment floor, or an external wall, the junction should maintain the fire resistance of the compartmentation. Refer to TGDs to Part B of the Building Regulations.

3.3 AIRTIGHTNESS

Airtightness testing is a mandatory requirement of TGDs to Part L of the Building Regulations. Testing must be carried out as specified in I.S. EN ISO 9972[24] with additional guidance given in the NSAI's "Certified Air Tightness Tester Scheme Master Document" and TGDs to Part L of the Building Regulations.
The airtight tape and AVCL is required to achieve compliance with the Building Regulations.

3.4 VENTILATION

The Castle Group Modular Building System can accommodate ventilation solutions, designed by a M&E engineer competent in the design of multiple occupancy buildings, that meet the requirements of TGD to Part F of the Building Regulations. These should be verified using an NSAI registered ventilation validator.

3.5 WEATHERTIGHTNESS AND DAMP PROOFING

The system has adequate DPCs and DPMs to resist the passage of moisture. Good building practice such as weep holes are essential to ensure that moisture within a cavity is deflected to the outside of the building. Roof coverings will provide adequate weather resistance when completed in accordance with this Certificate and the manufacturer's instructions.

Buildings constructed using the Castle Group Modular Building System can readily accommodate adequate rainwater gutters and down pipes.

3.5.1 External Cladding

Where the external facade is constructed of a masonry/brick outer leaf it must incorporate a minimum 40mm clear drained, ventilated cavity, to minimise the risk of water reaching the cavity face of the inner leaf. Weep holes as per this Certification shall be adopted.

In the case of aluminium window cills, they shall be provided with stop ends. In the case of concrete sills, they shall either be stooled or be 75mm wider than the window opening and be provided with the wraparound DPC.

3.6 WINDOWS AND DOORS

Windows and doors are outside the scope of this Certificate. However, Figures 7, 8 & 9 give indicative details of how they can be installed to limit heat loss and moisture penetration.

Other considerations for the design of windows and doors include:

- Escape in the event of fire,
- Safety and security,
- Thermal performance.

Note: NSAI's Window Energy Performance (WEP) Scheme gives full details of the energy performance aspects of window systems.

3.7 THERMAL PERFORMANCE

The system/panels were assessed as a hybrid warm frame system where the insulation is included both outside of the steel structure and in between the steel components. The Castle Group Modular Building System can be provided for a wide range of required elemental U-values.

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 can be determined.

3.7.1 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.

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 should be taken. 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 (HTB) 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 HTB by the exposed surface area.

ψ-values for other junctions outside the scope of this certificate should be assessed in accordance with Appendix D of TGD to Part L of the Building Regulations.

U-values and Ψ-values are to be calculated by an NSAI approved Thermal Modeller as per Section 4.3.1.

3.7.2 Internal Surface Condensation

As part of the assessment carried out to determine the 'Ψ' values, internal surface temperatures (fRsi) are also checked. When internal surface temperatures (fRsi) are greater than 0.75, best practice will have been adopted to safeguard against the risk of surface condensation occurring under normal occupancy and humidity class levels.

3.8 INTERSTITIAL CONDENSATION

3.8.1 Condensation in Walls

An Air and Vapour Control Layer (AVCL) is provided behind the plasterboard for protection against interstitial condensation.

3.8.2 Condensation in Roofs

Roof ventilation should be provided in accordance with TGD Part F of the Building Regulations and the recommendations of BS 5250[25].

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.

3.9 SOUND

As per TGD to Part E to the Building Regulation, all building, post completion must be subjected to acoustic testing. Acoustic testing shall be carried out in accordance with TGD to Part E of the Building Regulations.

Correct detailing of the system is necessary to meet the requirements of the TGD to Part E of the Building Regulations.

Refer to Section 4.5 for technical investigations on acoustic performance.

3.10 MAINTENANCE

Maintenance will be required at a level comparable with that for buildings of traditional construction.

Regular inspections should be made over the life of the system. The system shall be inspected and maintained in accordance with the Certificate holder's instructions, as detailed in the Repair and

Maintenance Method Statement, which is incorporated into the Building Owner's Manual.

Below is a **non-exhaustive list** of maintenance inspections and works which should be undertaken regularly:

- Visually inspect the render and architectural details for signs of damage or water ingress (at least annually).
- Necessary repairs should be carried out immediately and must be in accordance with the Certificate holder's instructions to prevent deterioration or damage, and to protect the integrity of the system.
- Sealants shall be subject to regular inspection (at least annually).
- Sealants should be replaced as required and fully replaced every 18 to 20 years to maintain performance.
- Synthetic finishes may be subject to aesthetic deterioration due to exposure to UV light. They should be re-painted at least every 18 to 20 years, or as necessary, to maintain appearance.
- Repainting should be carried out in accordance with the relevant recommendations of BS 6150[26].
- Timber boarding, fascia, 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.
- Care should be taken to ensure that the synthetic finish used is compatible with the original system and that the water vapour transmission or fire characteristics are not adversely affected.
- The contractor/tenant shall not cut, drill, modify, or otherwise damage the finished plasterboard surfaces. Any penetration, alteration, or damage caused to the finished plasterboard is not permitted.

Taking account of the above variable criteria, it is not possible to accurately determine a cyclic period for planned maintenance. However, regular cleaning and inspections will assist in maintaining a fully functioning, aesthetically pleasing façade.

It shall be the responsibility of the building owner to monitor the condition of the building and commission maintenance and repairs as required. It is envisaged these will be carried out by the building owner in accordance with BS 8210[27].

4.1 STRENGTH AND STABILITY

The assessment of the structure was carried out to I.S. EN 1993-1-1[7] and Part A of the Building Regulations.

The design of a typical building has been examined by the NSAI and demonstrates compliance with the TGD to Part A of the Building Regulations.

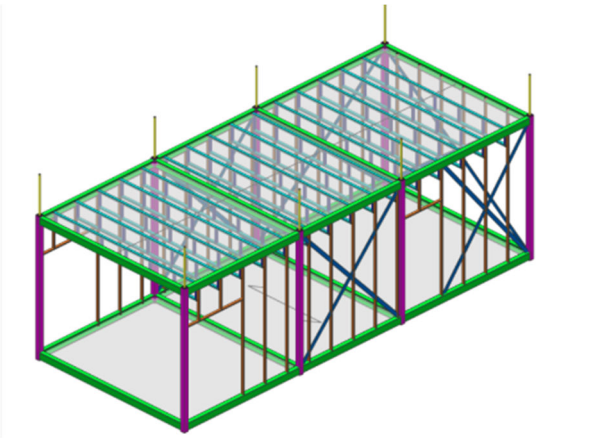


Figure 14: Structural design model of the module

4.2 BEHAVIOUR IN FIRE

4.2.1 Fire Resistance

Assessment of test results to I.S. EN 1365-1[23] and I.S. EN 1994-1-2[28]shows that buildings constructed using the Castle Group Modular Building System can meet the Building Regulation requirements in relation to fire resistance as shown in Table 1.

4.3 THERMAL PROPERTIES

Assessment of U-value calculations shows that the Castle Group Modular Building System meets and can exceed the maximum back-stop elemental U-value requirements of TGDs to Part L of the Building Regulations.

Table 2 of this Certificate give the various elemental wall U-values in W/m^{2}K with a traditional brick/block outer leaf cladding.

4.3.1 Limiting Thermal Bridging

Table 4 of this Certificate give ψ-values for a range of the Castle Group Modular Building System junctions. 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 data sheets for ψ-values.

U-values and Ψ-values are to be calculated by an NSAI approved thermal modeller – a register of these can be found at https://www.nsai.ie/certification/agrement-certification/thermal-modellers-scheme/.

4.3.2 Internal Surface Condensation

Table 4 of this Certificate give internal surface temperature factors (fRsi) for a range of building junctions.

The junctions of the Castle Group Modular Building System have been assessed to comply with the requirements of TGDs to Part L of the Building Regulations.

4.4 INTERSTITIAL CONDENSATION

4.4.1 Condensation in Walls

Calculations to I.S. EN ISO 13788[29] have been carried out for all wall build ups as covered by this Certificate. They predict no interstitial condensation within the external wall and pass the risk criteria in I.S. EN ISO 13788[29].

4.5 SOUND

4.5.1 Separating Walls

The acoustic performance of the separating wall specified in Section 2.1.7 has been assessed by both on-site testing and comparison with Robust Standard Details for Separating Wall - Steel Frame E-WS-1 and SCI Publication P372 Acoustic Detailing for Steel Construction and through adopting best practice at salient junctions to minimise the effects of airborne, impact and flanking sound.

The separating wall in the Castle Group Modular 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.

4.5.2 Separating Floors

The acoustic performance of the separating floor specified in Section 2.1.9 has been assessed using TGD to Part E of the Building Regulations. The composite concrete metal deck can meet either the requirements 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 TGD to Part E of the Building Regulations.

In both floor types, the resistance to airborne sound depends mainly on the mass of the concrete base, plasterboard ceiling and good flanking detailing. Minimum mass area of concrete shall be as per Section 4 of the TGD to Part E of the Building Regulations.

In a Type 1 floor the soft covering reduces the impact sound at source. The impact sound reduction is achieved with the use of a suitable approved layer of soft floor covering. The covering is not intended to be the final finished floor but is intended to act as a 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.

The separating floor in the Castle Group Modular 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.

4.6 DURABILITY

The steel frame structure and LGS infill has been assessed as capable of achieving a minimum design life of 60 years. All steelwork is provided with corrosion protection as per Section 2.3.2 of this Certificate. In addition to this, the steel is kept in a "warm frame" environment, which should prolong the life of the steel. Where there is a risk of water ingress, DPC/DPM/weepholes are provided to ensure the steel is not in contact with water.

The insulation materials are durable 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 constructed from conventional durable materials.

In any case any damage to the surface finish shall be repaired immediately and regular maintenance shall be undertaken as outlined in Section 3.10 of this Certificate.

Strictly no penetrations, openings, or alterations to plasterboard finish is permitted. The plasterboard must remain intact and damage free. Correct installation and maintenance of plasterboard finish ensure the fire protection and acoustic performance is provided.

4.7 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE THE FOLLOWING

- Sample structural design for a typical building,
- Design and assessment of fixings and connections,
- Behaviour in relation to fire,
- System specific load bearing fire testing to I.S. EN 1365-1[23] and I.S. EN 1365-2[34]
- Durability assessment,
- Typical drawing details,
- U-value and thermal modelling for typical junctions,
- Risk of condensation both surface and interstitial,
- Acoustic performance, resistance to airborne and impact sound transmission,
- Material specifications,
- Compatibility with other materials,
- System and installation manuals,
- Quality control in the factory and during construction,
- Sample airtightness reports, and
- Watertightness of external cladding finishes.

4.8 OTHER INVESTIGATIONS

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

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

(iii) Site visits were conducted to assess the practicability of installation and the history of performance in use of the product.

Table 1: Fire Data for Loadbearing Wall, Floor and Ceiling Elements				
Type	**Element:**	**Test Standard**	**Results**	**Purpose Group**
External Load Bearing Wall – Inside to Outside				
1	• Test conducted on 3000mm x 3000mm x 257mm (w x h x thk) panel with total vertical load of 150kN • 4No. Square Hollow Section (SHS) vertical members (100x100x5), 1No. top RHS horizontal member (150x100x10), and 1No. bottom SHS horizontal member (100x100x10), which surrounded two Light Gauge Steel (LGS) sub-frames (LGS studs 100x50x1.2mm). Internal layer of plasterboard fitted to SHS • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Exposed side: 2No. layers 15mm Gyproc Fireline fixed using 25mm and 55mm long drywall screws at 300mm centres. • Unexposed side: Eurobond Rainspan 125 • 2 No. Double Sockets were fitted on the fire side.	I.S. EN 1365-1[23]	120mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)
External Load Bearing Wall– Outside to Inside				
2	• Test conducted on 3000mm x 3000mm x 257mm (w x h x thk) panel with total vertical load of 150kN • 4No. Square Hollow Section (SHS) vertical members (100x100x5), 1No. top RHS horizontal member (150x100x10), and 1No. bottom SHS horizontal member (100x100x10), which surrounded two Light Gauge Steel (LGS) sub-frames (LGS studs 100x50x1.2mm). Internal layer of plasterboard fitted to SHS • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Exposed side: Eurobond Rainspan 125 2No. layers 15mm Gyproc Fireline fixed using 25mm and 55mm long drywall screws at 300mm centres. • Unexposed side: 2No. layers 15mm Gyproc Fireline fixed using 25mm and 55mm long drywall screws at 300mm centres.	I.S. EN 1365-1[23]	120 mins from outside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)
Compartment/Separating Wall				
3	**Twin frame separating wall** • Test conducted on 3000mm high x 3000mm wide x 165mm thick panel (half of twin wall) with total vertical load of 150kN • 4No. Square Hollow Section (SHS) vertical members (100x100x5), 1No. top RHS horizontal member (150x100x10), and 1No. bottom SHS horizontal member (100x100x10), which surrounded two Light Gauge Steel (LGS) sub-frames (LGS studs 100x50x1.2mm). Internal layer of plasterboard fitted to SHS • 100mm stone mineral wool (22kg/m^3 density) fitted between studs.	I.S. EN 1365-1[23]	120 mins from fire side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)

	• Exposed side: 2No. layers 15mm Gyproc Fireline fixed using 25mm and 55mm long drywall screws at 300mm centres. • Unexposed side: 2 layers of 9mm Cembrit Windstopper Extreme with 17mm cavity in between created by resilient bar • 2 No. Double Sockets were fitted on the fire side (the build up represents half of compartment/separating wall build up) *This fire testing was provided as a basis for assessment listed in the item 4. The compartment/separating wall build up is as per item 4 and Section 2.1.7.*			
4	**Twin frame separating wall** • Assessment conducted on 3000mm high x 3000mm wide panel (half of twin wall) with total vertical load of 150kN The build up as described in (3) is modified by the removal of the outer most of the unexposed face 9mm Cembrit board and the associated 17mm resilient bar. The inner most Cembrit board is to remain. The remaining construction will result in a symmetrical build-up (50mm cavity between each frame) allowing fire exposure from either side. *Note the wall build up of the compartment wall is as per Section 2.1.7 and it is constructed as a twin frame structure.*	I.S. EN 1365-1[23]	90 min from either side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)
Internal Load/ Non-Load Bearing Walls *				
5	**Single frame internal wall** • Assessment conducted on 3000mm high x 3000mm wide panel (half of twin wall) with total vertical load of 150kN The build up as described in (3) is modified by the removal of the two unexposed 9mm Cembrit boards and associated resilient bar. There elements will be replaced by 2 layers of 15mm Gyproc Fireline plasterboards fixed using 25mm and 55mm long drywall screws at 300mm centres. This modification to the construction will result in a symmetrical build up thus allowing exposure from either face.	I.S. EN 1365-1[23]	90 min from either side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)
Intermediate Floor ***				
6	**Floor supporting a Uniformly Distributed Load of 0.55kN/m²** • Test conducted on 4280mm long x 2980mm wide x 219mm thick floor with a uniformly distributed load of 0.55kN/m² • Exposed side: 2No. layers of 12.5mm Gyproc Fireline plasterboard fixed on fire side face using 25mm (at 230/150 centres) and 41mm screws (at 230/150mm centres); and top hats (MF5) installed at 400mm centres perpendicular to the joists fixed with R-WFS-4213 4.2x13mm 2No. screws at each top hat-joists intersection • 6 No. LGS floor C-Joists 150mm deep (50x1.2mm) at 600mm nominal centres	I.S. EN 1365-2[34]	60 min from underside of the floor structure ***	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)

	• 100mm Isover Spacesaver mineral wool between the joists • 1No. layer of 18mm OSB3 fixed to LGS joists 4.8 x 44mm screws at 400mm centres.			
Compartment/Separating Floor **				
7	Loaded Floor supporting Imposed Load of 2.0kN/m^2 140mm normal weight concrete with 1.2mm Tata Comflor 51. Concrete reinforced with 2 layers of A252 Mesh (30mm cover), 1No. 10mm bar per trough (50mm cover) – 3900mm span.	Eurocode design	90 mins from below ceiling level	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)

Notes:

- The above build-ups are summaries of those tested to the referenced standards – they should not be taken as an exhaustive list. For full details of test reports, the Certificate holder should be contacted.
- For alternative approaches to fire safety requirements, refer to 0.2 of TGD to Part B of the Building Regulations.
- 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 Castle Group.
- Joints are staggered on successive layers of plasterboard.
- All wall tests were completed without the joints being taped and jointed.

* 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.

** Design to be dictated by project specific loading and span requirements on a case-by-case basis in accordance with I.S. EN 1994-1-2[28]

*** Design to be dictated by project specific loading and span requirements on a case-by-case basis in accordance with P424[39]

External walls U-value for variable insulation thickness – traditional brick/block outer leaf

Wall build-up:

Layer 7: Brick Outer Leaf

Layer 6: Unventilated Cavity

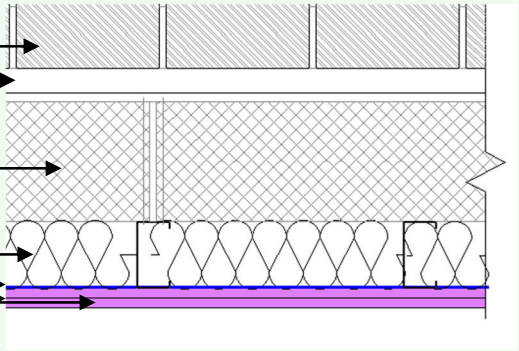
Layer 5: Eurobond Rainspan Panel (Variable)

Layer 4: 100mm Rockwool Rollbatt Insulation/SHS

Layer 3: AVCL

Layer 2: 15mm Gyproc Fireline Board

Layer 1: 15mm Gyproc Fireline Board



Wall thickness	Insulation variable thickness:	Calculated U-value (W/m^{2}K)
443mm	160mm	0.18
458mm	175mm	0.17
473mm	190mm	0.16
493mm	210mm	0.15
513mm	230mm	0.14
533mm	250mm	0.13

Calculation complies with BRE Digest 465 *U-values for light steel-frame construction*

(1) Correction for mechanical fasteners have been applied to layer 4 equating to 4.2 No. 6.3mm Ø stainless steel fixings to fix Eurobond Rainspan Panel to studs. This may be subject to change on project specific basis.

Table 2: Typical External Wall U-Values – traditional brick/block outer leaf

Sample U-value Calculation for 160mm Mineral Wool					
Layer	**Description**	**% Bridged**	Thickness [mm]	Thermal conductivity **λ** [W/m K]	Thermal resistance **R** [W/m²K]
	Rsi				0.13
1	Plasterboard		15	0.21	0.071
2	Plasterboard		15	0.21	0.071
3	Rothoblass Vaporlies 120		-	-	-
4	LGS stud	0.003	100	50	0.002
	Rockwool Rollbatt	0.997	100	0.044	2.273
5	Eurobond Rainspan Panel (Variable)		**160**	0.044	3.636
6	Unventilated Cavity		50	R 0.180	0.18
7	Brick Outer Leaf		103	0.77	0.134
	Rse				0.04
				Ru Total =	6.525
				RL Total =	4.779
	From BRE Digest 465		P = 0.566, $R_T = pR_{max} + (1-p)R_{min}$ =		5.767
				Correction term, ΔU =	0.007
				Corrected U-Value (2DP) =	**0.18** W/m²K

Table 3: Sample U Value Calculation for 160mm Mineral Wool – Brick Outer Leaf

Target linear thermal transmittance (ψ) for different types of junctions			
ACD Ref:	**Junction Description**	**Temperature Factor f_{Rsi} (Min = 0.75)**	**Castle Group Ψ-value (W/mK)**
5.18	Parapet (external wall to composite concrete metal deck roof)	0.84	0.411
-	Compartment/separating wall to external wall	0.81	0.245 (1)
-	Compartment/separating wall to roof (composite concrete metal deck roof)	0.97	0.035 (1)
5.02	Ground floor to external wall (composite concrete metal deck ground floor)	0.88/0.79	0.105
5.02	Ground floor to external wall (LGS ground floor)	0.88/0.79	0.097
5.22.1	Ground Floor to compartment/separating wall (composite concrete metal deck ground floor)	0.93	0.087 (1)
5.22.1	Ground Floor to compartment/separating wall (LGS ground floor)	0.89	0.093 (1)
5.23.1	External wall - corner	0.84	0.118
5.23.2	External wall – inverted corner	0.91	-0.027
5.04	Compartment/separating wall to external wall - plan	0.89	0.041 (1)
5.19	Window head	0.79	0.035
5.21	Window cill	0.92	0.040
5.20	Window jamb	0.89	0.040
-	Door threshold	0.77	0.228

(1) Value of ψ is applied to each dwelling.
(3) Flanking element U-values for walls, roof and floor thermal models above were based on:
U_W = 0.182 W/m²k/0.15 W/m²k (external wall), U_R = 0.132 W/m²k (flat roof on composite concrete metal deck structure), U_{GF} = 0.166 W/m²k/ 0.108 W/m²k (ground floor – composite concrete metal deck structure/ LGS structure)
Modelled junction ψ-values are based on typical Castle Group details above can be used in y-value calculations, if relevant detail is applicable.

Table 4: Typical ψ-Value W/mK

Please note: All U-value calculations illustrated in the U-value tables in this Certificate 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 meter, size of fixing, etc. therefore U-values should be recalculated if the build-ups differ from those described in Tables 2, and 3.

Acoustic tests results*				
Separating Construction	**Airbourne sound insulation DnT,w [dB]**		**Impact sound insulation L'nT,w [dB]**	
	Performance Target	**Result**	**Performance Target**	**Result**
Separating Wall	≥53	53-63	N/A	N/A
*The results above were obtained from on-site project specific testing. Results may vary based on project specific conditions but must always meet TGD to Part E Building Regulations requirements.				

Table 5: Acoustic test results

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

(a) the specification of the product is unchanged.

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

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

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

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

(f) the registration and/or surveillance fees due to IAB / NSAI 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 and The Safety, Health and Welfare at Work (Construction) Regulations, 2013 [43], 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. **26/0449** is accordingly granted by the NSAI to **S.B. Castle Modular** on behalf of NSAI Agrément.

Date of Issue: **27th February 2026**

Signed

Martin Searson
Head of MMC

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. 1 Note: Minor correction made to Section 2.3.2 to confirm the correct unit of measure (mm) and to clarify the Building System is MMC Category 1 – 3D Volumetric building system.

NSAI Agrément

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