IRISH AGRÉMENT BOARD
CERTIFICATE NO. 17/0394
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MHI (Modern Homes Ireland) Modular Steel Frame Building System

Systèmes pour constructions Bausystem

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

NSAI Agrément Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with the **Building Regulations 1997 to 2019**.

PRODUCT DESCRIPTION:

This Certificate relates to the Modern Homes Ireland (MHI) Modular Steel Frame (MSF) Building System, for the manufacture and installation of volumetric buildings. The MHI MSF Building System is a factory manufactured structural building system comprising of pre-assembled modules. After the modules, have been assembled they are completed with internal fixtures, fittings and finishes (outside the scope of this Certificate) relevant to their function. The modules are applied with temporary weatherproofing in the factory prior to delivery to site.

The modules are used in conjunction with suitable weatherproof external wall cladding systems and roof coverings. The external wall claddings and roof coverings are both outside the scope of this Certificate.

Other aspects of the modules not covered by this assessment include; foundations, staircases, windows, window sills, hearths, fireplaces, chimney, door set's and fittings, internal decorative coatings and coverings or the adequacy of the heating and plumbing, drainage, electrical services supplied with the buildings and the ventilation of bathrooms and rooms containing sanitary conveniences.

The MHI MSF Building System is certified in the applications defined below and can be used in purpose groups 1(a), 1(b) and 1(d) as defined in the Technical Guidance Document Part B Fire Safety Dwelling Houses Volume 2 (2017) of the Building Regulations 1997 to 2019 and not more than 30m to the top floor in purpose group 1(c), 2(a), 2(b), 3, 4(a) & 5 as defined Technical Guidance Document B Fire Safety (2006) of the Building Regulations 1997 to 2019. The system can accommodate a wide range of custom designs.

USE:

The system is certified for the following applications:

1. The MHI MSF Building System may provide the structure of a building up to ten storeys in height but not greater than 30m in height to top of final floor level, which can accommodate a cold formed section floor or a concrete floor (metal deck) as required.
2. MHI MSF Building System may be used in the construction of the top floor of a multi-storey building provided the new building height is not greater than 30m in height and the system is constructed off a concrete floor or non-combustible podium/transfer slab.
3. MHI MSF Building System non-loadbearing infill panels can be used in building not more that 30m in height where a fire resistance of 90mins is required (see Section 1 Part B of this Certificate). The infill panels can be incorporated in concrete or steel framed building systems which possess their own independent lateral stability systems

DESIGN:

The MHI MSF building system consists of three main structural elements, floor, wall, and ceiling or roof. The system is a hybrid of light gauge steel (LGS) and hot rolled steel sections (HRS).

The system is intended for use where Architect's finalised construction and fire strategy drawings are available and satisfy the Building Regulations 1997 to 2019. The developer's (Client's) Architect, Engineer and Design team is responsible for the architectural drawings and compliance of the building design with the Building Regulations.

The MHI nominated Chartered Structural Engineer is responsible for the final structural design of the MHI MSF Building System. The MHI MSF Building System is designed for use in permanent buildings with a brick/block external wall finish with a wide range of traditional roofing finishes. The roof structure may be manufactured as a module using the system.

The system may also be designed to incorporate NSAI (National Standards Authority of Ireland) Agrément approved alternative roofing and external wall cladding systems. However, written approval must be sought from MHI on the use of such claddings.

The modules are factory assembled and weather protected, delivered to site and craned into place with site connections completing the construction sequence. Site installation must only be carried out by approved licensed installers employed by MHI or by a specialist sub-contractor under the supervision of MHI.

MARKETING, DESIGN AND MANUFACTURE:

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

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1.1 ASSESSMENT

In the opinion of the NSAI Agrément Board, the MHI MSF building system, if used in accordance with this Certificate, can meet the requirements of the Building Regulations 1997 to 2019, as indicated in Section 1.2 of this Agrément Certificate.

1.2 Building Regulations 1997 to 2019

REQUIREMENTS:

Part D – Materials and Workmanship

D1 – Materials & Workmanship

The MHI MSF Building System, as certified in this Certificate, can meet the requirements for workmanship.

D3 – Proper Materials

MHI MSF Building System, as certified in this Certificate, is comprised of 'proper materials' fit for their intended use (see Part 4 of this Certificate).

Part A - Structure

A1 – Loading

The MHI MSF Building System once appropriately detailed, designed and constructed has adequate strength and stability to meet the requirements of this Regulation (see Part 3 of this Certificate).

A2 – Ground Movement

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

Part B – Fire Safety

For purpose group 1(a), 1(b) and 1(d), the fire safety requirements are outlined in TGD B Fire Safety Volume 2, Dwelling Houses of the Building Regulations 1997 to 2019. For purpose group 1(c), 2(a), 2(b), 3, 4(a) & 5 the fire safety requirements are laid out in TGD B Fire Safety of the Building Regulations 1997 to 2019.

For the Volume 2 Dwelling Houses, Part B6 – B11 are required to be adhered to, while for purpose group 1(c), 2(a), 2(b), 3, 4(a) & 5 Parts B1 – B5 are required to be adhered too.

B1 & B6 – Means of Escape in Case of Fire

The MHI MSF Building System is designed and constructed so that appropriate provisions for the early warning of fire and that adequate means of escape in the case of fire from the dwelling house can be accommodated.

B2 & B7 – Internal Fire Spread (Linings)

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

B3 & B8 – Internal Fire Spread (Structure)

The MHI MSF Building System is designed and constructed so that its stability will be maintained for a reasonable period in the event of fire in compliance with Section B3 and B8 of TGD B to the Building Regulations 1997 to 2019.

B4 & B9 – External Fire Spread

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

Note: In a building more than 18m high, all insulation material used in drained and/or ventilated cavities in the external wall construction should be of limited combustibility A2-s1, d0 rating to EN 13501-1: 2007 + A1: 2009.

B5 & B10 Access and facilities for the Fire Service

The provision of access and facilities for the fire service is outside the scope of this Certificate.

Part C – Site Preparation and Resistance to Moisture

C3 – Dangerous Substances

The ground floor must include sufficient radon sumps and provide the facility for radon extraction. Where it is shown, that protection from dangerous substances e.g. radon, is required, an approved gas resistant membrane and gas handling system must be provided under the ground floor. MHI MSF building system permits the incorporation of the appropriate membrane, sump and gas handling system.

C4 – Resistance to Weather and Ground Moisture

MHI MSF building system has adequate damp-proof courses and membranes to resist the passage of moisture from the ground.

Roof and external walls above site Damp Proof Course (DPC) level will have adequate weather resistance in all exposures to prevent the passage of moisture from the external atmosphere into the building as specified in Section 4.7 of this Certificate.

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Part E – Sound

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

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

Part F – Ventilation

F1 (a) – Means of Ventilation
Adequate ventilation can be incorporated into the MHI MSF building system to meet this requirement. Walls and roofs used in the system can be designed and constructed to prevent any harmful effect from interstitial or inner surface condensation to comply with the requirements of BS 5250:2011+A1:2016*.*

F1 (b) – Limiting the concentration of harmful pollutants in the air within the building
The ventilation rate is required to be designed to meet the level of air pollutants present in the building. This will be based on the project specific design.

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

Part J – Heat Producing Appliances

J1-Air Supply
The system can provide an adequate supply of permanent combustible air by means of air ducts, to obviate draughts, within the room in which the fuel burning appliance is located.

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

Part L – Conservation of Fuel and Energy

L1 – Conservation of Fuel and Energy
All building elements of the MHI MSF building system can be readily designed to incorporate the required thickness of insulation to meet a wide range of elemental u-values. The elemental u-values are calculated using the elemental heat loss method calculations for walls as per the TGD to Part L of the Building Regulations 1997 to 2019 (see Section 4.2 and Tables 7, 8, 9, 10 and 11).

The system can readily be detailed to accommodate a wide variety of plan forms, but users of the system must ensure that Building Regulation requirements (avoidance of cold bridging) that are affected by plan form and internal sub-division of the building are complied with.

Thermally bridged junctions have been assessed for both their linear thermal transmittance (i.e. Psi -value (ψ)) and their temperature factors (f_{Rsi}) in accordance with the procedures outlined in IP 1/06 *"Assessing the effects of thermal bridging at junctions and around openings"* and BRE report BR 479 and I.S. EN ISO 10211:2007. As a result, best practice has been observed to limit heat loss due to thermal bridging and minimising the risk of mould growth due to surface condensation.

Part M – Access for People with Disabilities

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

M2 – Sanitary Conveniences
Buildings can be designed to meet the installation requirements for sanitary conveniences for people with disabilities (see Section 4 of this Certificate).

2.1 PRODUCT DESCRIPTION

This Certificate relates to the design, manufacture and erection of the three-dimensional MHI MSF building system. The building system, when assembled, is made up of three main parts – walls, floors and ceiling/roof. These parts are made from LGS and HRS and assembled into modules in the factory. The modules are transported to site and sequentially assembled to produce the designed building.

MHI uses HRS and LGS, in the construction of their modular building product. Dependent on optimum design of a project, MHI may utilise the LGS as the primary structure. Alternatively, they use SHS (square hollow sections), RHS (rectangular hollow sections) & PFC (parallel flange channels) as their primary structure within each module and then utilise LGS (light gauge steel) as non-load bearing infill panels between the structural hot-rolled members. MHI also use cold-rolled steel decking for their composite concrete floors in the modules. MHI produces all cold-formed steel stud sections using a computer numerical controlled (CNC) plant. MHI source their fabricated hot rolled sections from EN 1090 System 2 approved Certified steel suppliers.

This Certificate contains illustrations to explain the various elements of the MHI MSF Building System such as intermediate floor, compartment floor, separating wall etc. These illustrations are not intended to be construction drawings. MHI in conjunction with the design team on a project will produce a set of project specific details on a project by project basis. All drawings should be in compliance with relevant codes of practice and relevant standards along with current Building Regulations.

2.1.1 Ground Floors

The MHI MSF Building System provide three options for the ground floor of the lowest module (ground floor module). The flooring options are as follows:

1. Floorless Module: As illustrated in Figure 6. The module is installed on a traditional ground floor slab which provides the floor of the lowest module.
2. Composite Concrete Metal Deck Ground Floor Module: The floor is made from steel reinforced concrete, which is cast on a permanent metal deck, supported on a permanent steel PFC frame. The ground floor module is installed on a traditional ground floor slab or on a certified foundation system.
3. LGS Floor Joists: As illustrated in Figure 5. This floor build-up is similar to intermediate floor build up described in Section 2.1.2.

Below the various ground floor options, insulation is provided to meet the requirements of TGD to Part L of the Building regulations 1997 to 2019 including the avoidance of thermal bridging. An NSAI or equally approved (refer to Table 3 of TGD Part 3) radon resistant membrane/DPM is installed in accordance with Clause 8 of IS EN 1996-1-1:2005 Eurocode 6 and BS 8102:2009, to protect the floor and bottom channels of the steel studs from rising damp. Alternatively, a proprietary suspended ground floor may be used, provided it is approved by the MHI Structural Engineer for use with the MHI MSF building system to meet the structural loads criteria (dead load, uplift, etc). The structural design for the ground floor should be in accordance with Part 3 of this Certificate.

The installation of the DPM/radon barriers and radon sumps is not the responsibility of the Certification holder and is therefore outside the scope of this Certificate.

2.1.2 Intermediate Floor

The intermediate floor is constructed of LGS floor joists with OSB 3 (Oriented Strand Board) or Plywood decking. Fire protection is provided by plasterboard to the underside of the module ceiling in accordance with Table 5. 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.
Figure 8 & 9 illustrate typical intermediate floor details.

2.1.3 Compartment Floor

The MHI MSF Building System offers a number of options in terms of compartment floors to meet the different regulations as laid out in both TGD B of the Building Regulations 1997 to 2019.

2.1.3.1 Compartment Floor Option 1

Where the building height is less than 10m in height the joist compartment floor is constructed as follows:

- 200mm or 250mm deep LGS floor joists
- OSB 3 decking fixed to the top of the LGS floor joists
- 90mm LGS ceiling joists
- 100mm mineral wool insulation between the LGS Ceiling joists

Figure 14 illustrates compartment Floor Option 1.

2.1.3.2 Compartment Floor Option 2
In a building of any purpose group where the height of the top storey is 10m or more and to comply with TGD B 2006 of Building Regulations 1997 to 2019, section 3.2.5.2, compartment floors in high buildings, MHI provide a non-combustible joist compartment floor. The floor construction is similar to option 1 but the OSB is replaced with an alternative Class A1 non-combustible board which provides the required structural properties as determined by the structural design of the building.

- 200mm or 250mm deep LGS floor joists
- Class A1 non-combustible decking fixed to the top of the LGS floor joists
- 90mm LGS ceiling joists
- 100mm mineral wool insulation between the LGS Ceiling joists

The fire protection to both compartment floor options 1 and 2 is provided to the underside of the module ceiling and boarding is in accordance with Table 5 of this Certificate. The plasterboard is required to have a minimum reaction to fire classification of A2-s1, d0 in accordance with EN 13501-1: 2007 + A1: 2009.

2.1.3.3 Compartment Floor Option 3
The MHI MSF Building System also has the option to provide a non-combustible steel/concrete composite deck where the structure of the compartment floor consists of metal deck profile and concrete. The following is the structure/configuration of this floor

- Steel/Concrete composite deck spanning between the vertical supports (propping to be used as required by design)
- 90mm LGS ceiling joists
- 100mm mineral wool insulation between the LGS Ceiling joists

Steel reinforcement is installed on top of the metal deck as determined by the design, concrete to the required thickness is then poured. 100mm of mineral wool insulation is provided between the LGS Ceiling joists.

Both floor options 2 & 3 are non-combustible and are suitable for use in buildings of any purpose group up to the maximum height allowed in this Certificate.

2.1.4 Fire Resistance of Steel/Concrete Composite Deck
The fire resistance of the composite deck is provided from the underside of the deck as detailed in Table 5 of this Certificate. 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 additional layer of gypsum plasterboard to the underside of the deck will provide additional fire protection but is not considered in the fire resistance performance.

As illustrated in Figure 19 all electrical and ventilation services are installed to the underside of the deck. The fire stopping of holes in the composite deck floor slab to accommodate pipes passing through a compartment floor (unless the pipe is in a protected shaft) should comply with Section 3.4 of the TGD to Part B 2006 of the Building Regulations 1997 to 2019 for all other purpose groups to which this Certificate relates

2.1.5 Forming Holes in Composite Deck
When holes or openings to accommodate service penetrations are required, these can be incorporated in the composite concrete slab design prior to pouring the concrete. When additional openings are required the size and exact location must be signed off by the MHI nominated Chartered Structural Engineer who designed the steel/concrete composite deck.

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

2.1.7 Services in Compartment Floors
Electrical installations and recessed lights cannot be accommodated within any of the compartment floor build ups. All electrical installations must be accommodated by creating a separate service void under the compartment floor. All installed services must be in accordance with Section 3.5.4.1 of TGD B 2019 Volume 2 for purpose group 1(a), 1(b) & 1(d) and in accordance with Section 3.2.5.7 and 3.4 of TGD B 2006 for all other purpose group to which this certificate applies. Figure 16 and 19 show how services are accommodated in the MHI compartment floor options between modules.

Mechanical Ventilation extraction ducts are allowed to pass vertically through the floor but must be appropriately fire sealed where they enter and exit and comply with the recommendations contained within BS 9999:2019.

2.1.8 Loadbearing Perimeter Walls
The perimeter module walls are the primary load bearing elements of structure and are therefore designed to carry all the required loads. Vertical dead and imposed loads are transferred by load bearing external wall panels. If required, the internal partitions can be designed to transfer the loads if required to lower structural elements. These walls are therefore designed to bear on the walls of the modules below them, or on the foundation in the case of the ground floor modules.

The LGS load bearing wall panels are comprised of vertical studs, fixed to horizontal head and bottom channel sections. Horizontal noggins are fitted at the mid-height of all panels where required to provide additional strength and where particularly high vertical loads occur. Studs can interlock together to form box sections as required under high concentrated loads.

Typically, roof trusses are aligned with the vertical studs, which in turn are aligned above studs in the wall below. Where windows are present or where roof trusses change centres, a cold formed lintel or hot rolled section is provided to allow the load to transfer to the vertical wall studs. The design loads from each level are transferred through the primary load bearing elements into the substructure/foundations. Perimeter steel Z or C sections can be used to support floor joists before permanent fixing and can also be designed to act as a lintel over openings.

HRS structural members may also be incorporated into the design of the wall panels as required to accommodate more complex designs. Any HRS structural members used as part of the MHI MSF building system must be fabricated in accordance with IS EN 1090-1:2009 and in accordance with execution class specified in the project specific design.

The loadbearing wall panels can be made from a combination of HRS and cold-formed LGS, depending on the design requirements of the project. The HRS is also used for lifting of the modules to accommodate more complex structural designs. The loadbearing walls can also be completely made from LGS where design permits and designed for lifting and transportation without the need of additional structural steel.

The wall panels are filled with stone mineral wool between the studs to meet the fire resistance requirements and for additional thermal insulation and acoustic properties. The wall panels are then boarded with the required thickness and grade of plasterboard as per Table 5 of this Certificate accordingly depending on their location within the module and building to meet fire requirements, acoustic requirements and/or weathering requirements.

2.1.9 External Walls
The external walls in the context of this Certificate refer to the permanent external walls of the building. These walls are designed to meet the requirements of Sections B4 and B9 of TGD to Part B of the Building Regulations 1997 to 2019, Part B. Figure 5 illustrates an external wall fitted with rigid insulation which can be used in buildings up to 18m in height.

Figure 7 illustrates an external wall fitted with Class A1 non-combustible insulation which is required to be used in buildings over 18m. In buildings over 18m, the insulation is required to be of limited combustibility A2 – s1, do from the ground floor upwards.

The insulation outside the stud wall encases the LGS/HRS sections thus creating a "warmframe" environment for the steel frame. A breather membrane is installed between the LGS/HRS panel and the rigid board insulation.

This breather membrane provides a secondary water management defense in addition to the cladding and residual cavity between the external cladding and the insulation.

In buildings which relate to purpose group 1(a), 1(b) and 1(d), and are 10m or less in height, the buildings are temporarily weathered with polyethylene sheeting before being delivered to site.

In buildings which relate to purpose group 1(c), 2(a), 2(b), 3, 4(a) & 5, and are 10m or greater in height, Table 5 of this Certificate describes the detail to be used. These details refer to the use of specific weather resistant boards.

Where modules are boarded with weather resistant boarding it serves the purpose of providing additional prolonged weathering resistance to the module during its time outside the factory and the completion of the external leaf of the wall construction on site. In taller buildings the cladding will take longer to complete, and the modules will be exposed for longer periods.

As illustrated in Figure 10, the insulation and weather resistant board are screw fixed to the steel stud in the wall through the wall tie track. Only weather resistant board that has been approved by NSAI with the MHI MSF building system is to be used.

The requirements for the provision of an Air and Vapour Control Layer (AVCL) on the room side of the external walls are outlined in Section 4.4.1 of this Certificate.

The external walls are boarded on the internal face with a combination of OSB 3 and plasterboard in accordance with Table 5 of this Certificate and weather resistant boarding as required to provide the required racking and fire resistance.

Where structural design permits the OSB 3 can be removed from the inner face of the external walls.

The external walls are filled with stone mineral wool between the studs. The density of the stone mineral wool is dependent on the fire, acoustic or thermal properties required in an external individual wall.

2.1.10 Internal Walls

Internal walls within the modules vary in design, depending on the project specific design of the overall building and on the service requirements which each wall is required to meet. Therefore, different types of internal walls exist within the modules, including, load-bearing walls, non-load bearing walls and non-load bearing walls designed for lateral wind load resistance.

Non-load bearing internal walls are those which serve no structural function during the service life of the building. The non-load bearing partitions are generally fitted within modules to divide the internal area of a particular module. These walls may or may not be required to serve a structural purpose during the transportation, lifting and installation of the modules. These walls also, may or may not be required to serve a weathertightness purpose during the transportation and installation of the modules.

Non-load bearing walls comprise LGS studs with plasterboard (Type A or Type F) where walls are used for only partition purposes within the module. These non-loadbearing walls will have fire ratings in accordance with plasterboard manufacturers test data. Where an internal wall is loadbearing it may be fully constructed of LGS or it may be comprised of HRS primary studs, with LGS non-load bearing studs as infill panels and plasterboard for finishing.

All loadbearing walls must have plasterboard fire protection and stone mineral wool insulation in accordance with all tested loadbearing walls listed in Table 5 of this Certificate. The MHI MSF Building System loadbearing walls have been tested with services in the walls. Services on loadbearing walls should not be back to back. Internal walls that are required for lateral wind bracing are a bespoke design to cater for the wind load.

Other design considerations for internal walls is that internal walls during the service life of a building, may be external walls during the construction phase of the modules. Examples of these would be separating walls between dwelling houses or apartments (See Figures 10 and 13).

2.1.11 External Cladding & Wall Ties

The external leaf of the MHI MSF building system is constructed on site, generally of traditional brick/block masonry to IS 325-1:2013+A1:2014 and IS EN 1996-1-1:2005 or with other claddings approved by the NSAI Agrément.

The masonry outer leaf is tied to the MHI MSF building system with a stainless-steel channel cavity wall tie system in accordance with IS EN 845-1:2013+A1:2008. 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, with a design cavity width of 50mm in accordance with IS 325:1:2013. The cavity width is defined as the distance between the outer surface of the insulation and the inner surface of the outer masonry leaf.

The cavity in the external wall must be maintained and kept clear of construction debris to 150 mm below DPC level. Masonry claddings must have adequate weep holes along their bases and over openings to allow moisture to exit the cavity.

The channel incorporates a slot and is factory fitted through the insulation with the required depth of stainless-steel tech screw 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 *IS EN 1996-1-1:2005+A1:2012 Eurocode 6.*

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.

The wall ties have been assessed and meet the performance requirements given in IS EN 845:2013 for a Type 6 wall tie and designed in accordance with IS EN 1996-1-1:2005+A1:2012. Where masonry cladding is being used over 4 storeys' (12m) in height, a Type 1 wall tie in accordance with IS EN 845:2013 must be used. The design of the ties and their centres is the responsibility of the project Principle Structural Engineer and outside of MHI design responsibility. The wall tie and channel are made from minimum Grade 304 austenitic stainless steel.

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2.1.12 Module Ceiling

The ceilings are constructed from LGS panels spaced at maximum 400-600mm centres, ceiling joists are typically 70mm, 90mm or 140mm deep and are designed to support the load of installers during installation.

Table 5 of this Certificate provides plasterboard specifications to meet the fire resistance requirements of the design, the plasterboard is fixed to the underside of the LGS ceiling joists with OSB 3 fixed to the top of the LGS ceiling joists. A heat shrunk weatherproof polythene roof cover or alternative permanent roof covering is placed on the OSB 3 layer to make the roof of each module watertight during storage, transportation and erection. Where a polythene roof cover is used, it is removed during the installation process. Where alternative permanent roof covering is used, this is not removed, it remains in place.

The ceiling of each module provides the support structure for workers during the erection process. This is the most onerous loading the ceiling will experience, as the in-service condition only requires the ceiling cassette panels support lightweight services and the ceiling finishes. In intermediate floor construction, a service zone is provided between the ceiling panel and the upper floor joist to accommodate services as shown in Figure 8 and Figure 9. Services in this location are located above the ceiling fire resistant plasterboard protection and all penetrations to the ceiling in intermediate floor must be appropriately fire stopped to maintain 30 REI fire rating.

Intermediate floors in single occupancy dwellings where large services such as soil pipes and ventilation ducting are required to travel horizontally, these are accommodated in the depth of the floor joists above the cassette ceiling panel as illustrated in Figures 8 and 9. These services must also be fire stopped from the underside of the ceiling to maintain 30min fire resistance.

2.1.13 Roof Structure

The roof structure can be either conventional prefabricated roof truss made from timber or steel or a modular steel roof structure by MHI assembled in components as shown in Figure 1. The choice of roof structure to be constructed must be assessed and signed off by a nominated MHI Chartered Structural Engineer.

Timber roof trusses are attached to timber wall plates, which are bolted on site to the top wall track of the load bearing MHI wall panel. MHI cold formed roof trusses can be fixed down directly onto the top wall track of the load bearing MHI wall panel. The structure from the wall plate to the foundations is explained in Section 2.2.1. Figure 17 illustrates a typical eaves detail for MHI MSF building system.

2.1.14 Internal Linings and Finishes

Linings to walls and ceilings are of plasterboard manufactured to IS EN 520:2004+A1:2009. They are attached by means of self-drill/self-tap screws into steel members. In accordance with good building practice all wall linings in moisture prone areas such as bathroom, kitchen and utility are lined with foil-backed or moisture resistant plasterboard.

Joints in plasterboard wall linings are taped and filled in accordance with the plasterboard manufacturers' instructions for direct decoration. Joints in ceilings are similarly treated.

Any wall mounted fitting to the wall, other than lightweight items, such as framed pictures, must be fixed into vertical studs behind plasterboard using appropriately sized proprietary fixings. The fixings should be appropriate for fixing up to 2mm LGS and 8mm HRS. The studs can readily be located in completed construction using a magnet.

2.1.15 Services

The level of finishes in place in modules when they arrive on site is project specific. Generally, the module arrives to site with many services in place. Plumbing and wiring are completed in the module with site connections required between adjacent modules. Kitchens and bathrooms are complete with all wall mounted fixed furniture in place. When a floorless ground floor module is supplied by MHI the ground floor toilets are fitted on site, while first and subsequent floor toilets are fitted in the factory. Vertical connections to soil stacks and horizontal connections of other services are completed on site. Thus, all service locations must be determined at an early stage in a project's life to fully plan the modules. Wall mounted fittings must also be selected at a much earlier stage than in traditional construction as these may be fitted before the modules arrive on site.

Building services (electrical, plumbing etc.) are outside the scope of this Certificate but shall comply with relevant standards and legislation. Their design and installation shall avoid risk of corrosion damage to the modules. Local earth connection to the steel frame shall be avoided. The structural frame should be earthed in accordance with the current regulations, ET 101 2008. Earthing is the responsibility of the Main Contractor (See Section 4.8).

2.2 GENERAL BUILDING STRUCTURE
2.2.1 Foundations
Foundations are outside the scope of this Certificate. Based on finalised layouts, the nominated MHI Structural Engineer can carry out load take down calculations and provide the Client appointed Structural Engineer with accurate line loads which they can accommodate into their foundation design.

The MHI MSF building system may be used with a variety of foundation types, depending on the ground conditions encountered on site. A site investigation should be carried out by an appropriately qualified and experienced Engineer to determine the maximum bearing pressure the soil can carry. Once this is determined, a suitable foundation type can be selected.

The foundations and ground floor slab should be constructed in accordance with the clients engineering specifications. Due to the low tolerance of the modular steel frame manufacture, the foundation and ground floor slab must be constructed accurately, i.e. correct dimensions, square and level so that the steel frame system can be assembled and erected properly within the specified tolerances.

MHI must inspect all slabs prior to installation of the building modules and complete a comprehensive concrete substrate/rising wall level and flatness survey. All concrete substrate/rising walls must be within the specific tolerance accuracy specified by MHI which is:

- Viewed on plan (line) +/-2mm per 10m run
- Viewed in elevation (level) +/- 5mm over the total area of the slab
- Maximum deviation in line and level over the full slab are +/- 5mm

Where the slab is outside the acceptable tolerance levels, the Main Contractor will be responsible for the remedial works (concrete grinding etc.) to bring the slab within the allowable tolerances.

Where minor variations in slab level occur, such variations are catered for using non-corrosive structural steel packers located directly below the studs as required. However, the use of such packers should be kept to a minimum and their use needs to be reviewed and agreed with the MHI Structural Engineer. The remaining gaps below the steel frame panel sole plate are filled using structural grade non-shrink grout.

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

Table 1: Manufacturing Tolerances

2.2.2 Concrete Podium Slab (Transfer Slab)
Where the MHI MSF building system is constructed off a concrete podium slab, a tolerance of ±5mm over the total area of the slab is required on the podium slab line and level. Procedures for variations in slab are described in Section 2.2.1. The design of the podium slab is the responsibility of the Client's Engineer, who will require line loads from the MHI Structural Engineer. MHI Structural Certification applies from transfer slab level upwards.

2.3 DESIGN AND MANUFACTURE
2.3.1 Design Process
The nominated Chartered Structural Engineer must complete the structural design including the specification of all members before an MHI MSF building can be manufactured.

The Clients architectural drawings are received by MHI and converted into a 3D structural computer aided design model (CAM/CAD). This system automatically calculates all framing requirements for wall, floors, and roof trusses and allows for all openings such as doors and windows.

Each individual frame member is allocated a unique identification number and has its length calculated, along with the position of any cut-outs, punch holes or bracket positions.

The MHI nominated structural engineer checks and signs off all drawings to ensure structural compliance before any drawing is transferred to production.

2.3.2 Roll-Form Production
The roll-formers use computer aided manufacturing (CAM) techniques to process the data, which has been transferred from the design office to the roll former. The steel coil is then formed into the required shapes, with the position of cut-outs, punch-holes etc. accurately located within a tolerance of ±2mm per 10m length (Table 1). Individual members are grouped into bundles for assembly as they come off the roll-forming equipment, corresponding to their subsequent handling in the assembly process. Assembly of the components can commence in the factory directly after it has been roll-formed.

2.3.3 Wall Panel Assembly
The steel frame wall panels which form the modules walls are composed of galvanised mild steel manufactured from a galvanised coil. All profiles are designed in accordance with IS EN 1993-1-3-2006 Eurocode 3 (including Irish National Annex). Section properties comply with IS EN 10162:2003.

The wall panels have vertical, C-channel studs at maximum 600mm centres, which are fixed to top and bottom horizontal channels using self-tapping galvanised steel screws. The screws are precisely located in pre-punched holes in the studs, which match holes in the top and bottom channel. The pre-punched holes in the studs are dimpled which allows the flat-topped self-tapping galvanised steel screws to be flush with the metal surface. These dimples also mate with the dimples in the horizontal channel, which increase the shear strength of the joint.

2.3.4 Module Assembly
The modules are manufactured off site at the MHI manufacturing facility in a quality-controlled factory environment, which allows a higher level of finish to be achieved than would normally be expected on site. The modules vary in shape from simple rectangular elements to complex irregular shapes.

The modules are manufactured from a series of panelised elements including floor (with the exclusion of the ground floor, floorless module), ceiling and a variety of walls depending on the complexity of the module. MHI uses HRS and LGS, in the construction of their modular building product.

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. Table 2 shows the preferred module dimensional limitations. Larger sizes can be accommodated.

2.3.5 Quality Control Production
Quality control carried out during manufacture includes visual inspection of steel coiled raw material, calibration of roll forming equipment daily, cross checking of all in-house production drawings and checks on production dimensions (length, width, and steel thickness) and on the dimensions and squareness of finished panels. Each module is labelled confirming it has passed final inspection.

In addition to this MHI operate a full in-house quality control system, which outlines procedures on material specification, quality control in production, purchasing of raw materials, design and assembly.

2.4 STRUCTURAL PRINCIPLES
2.4.1 Steel Frame Structure
The basis of the structure is cold-formed LGS panelised frames with integrated HRS where required by design, which are assembled into module units in the factory. The design, manufacture, assembly and erection of the system is based on the combined services of BIM (Building Information Modelling) and CNC software, which feeds the required code into the proprietary roll-formers and produces the documentation required to manufacture and install accurately.

The LGS profiles are fabricated from a suitably coated steel coil, as described in Section 2.4.2 which is formed into the required shapes by proprietary roll-forming equipment. The frequency and size of vertical studs will depend on the design of an individual panel. The individual elements manufactured are then assembled by trained personnel on the floor to produce the required module fixed in accordance with the requirements specified by the structural engineer.

Typically, timber prefabricated roof trusses are used in the MHI MSF building system where required. Timber roof trusses are designed and supplied by others. Roofs may also be supplied as an LGS truss system or module roof designed and manufactured by MHI. These would be produced using typical sections produced by MHI and the fixings specified by the Structural Engineer.

The grades of steel and dimensions of sections used are selected and specified by the MHI Chartered Structural Engineer in accordance with the design requirements. Table 3 shows typical section sizes utilised for both load bearing walls and trusses for the LGS elements of the system.

Section properties are calculated using design code thickness of steel (excluding coatings) in accordance to IS EN 1993-1-1 NA: 2005, IS EN 1993-1-3 NA: 2006 and IS EN 1993-1-5 NA: 2010.

2.4.2 Protective Coatings

The steel frame members which comprise the module are all coated with a protective zinc-rich metal coating. The steel frame members are manufactured from galvanized coil steel to IS EN 10346:2015, (min. yield stress 350 N/mm^2) with 275 g/m^2 zinc protection for external structure and Z100, G280 for internal non-structural elements.

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

- The bottom channel on all ground floor steel frame panels is additionally protected by a 100mm wide DPC from the floor slab.
- The insulation on the outside of the external walls keeps the steel in a "warmframe" environment, which, in conjunction with the external breathable membrane and internal AVCL prevents the formation of condensation within the wall structure.
- The metal and timber in the roof trusses are kept free from prolonged moisture build up, by means of free air circulation in the roof space, using ventilation methods in accordance with Part F2 of TGD to Part F of the Building Regulations 1997 to 2019.
- Where steel is cut on site or where the coating of the steel becomes damaged, it is protected by the application of a zinc rich paint.
- All fasteners have been assessed and tested for use with the system, to ensure the minimum 50-year design life of the system per the Eurocodes.

HRS structural members are to be corrosion protected in accordance with EN 1090-1:2009 Part 2.

	Module Dimensions
Width	4.3m outer dimensions
Length	14m outer dimensions
Height	3.20m floor to floor

Table 2: Typical Module Dimensions

Table 3: Typical Sizes of Elements in the Steel Frame System

Component Type	Grade of Steel	Typical Section Dimensions			
		Depth (h)	Width (b)	Lip (c)	Thickness[1] (t)
Wall Stud	S350, S390, S450, S550	70 90 140[3]	35 42 50	10.8 – 12.5 9.8 – 12.7 10.8 – 13.7	0.8 – 2.0 0.8 – 2.0 0.8 – 2.0
Wall Track/Noggin[2]	S350, S390, S450, S550	72 – 73.8 92 – 93.8 142 – 143.8	43.2 – 43.7 49.2 – 49.7 58.2 – 58.7	0 0 0	0.8 – 2.0 0.8 – 2.0 0.8 – 2.0
Floor Joist	S350, S390, S450, S550	200 250 300	50 50 50	11.7 – 13.8 11.7 – 17.9 13.8 – 17.9	1.5 – 2.0 1.5 – 3.0 2.0 – 3.0
Floor Track[2] End Bearer	S350, S390, S450, S550	203.8 – 205 253.8 – 257.5 305 – 307.5	56.7 – 57.1 56.8 – 58.0 57.1 – 58.0	0 0 0	1.5 – 2.0 1.5 – 3.0 2.0 – 3.0

1. The range of thickness of cold formed section available = 0.8, 1.0, 1.2, 1.5, 2.0, 2.5, 3.0mm.
2. Range of Depth (h) and Width (b) available to allow for uniform cross section of structural zone.
3. These profiles are standard; other special profiles are available on request.

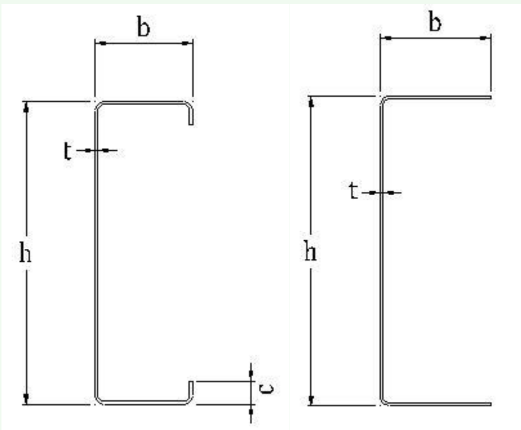

Figure 2: Channel with Lip and Channel without Lip

2.4.3 Fasteners and Connection Joints

The distinctive design of the MHI MSF building system allows for no welding of joints within the LGS elements of the system. The system is assembled using fasteners such as self-fastening screws or bolts. All fasteners used in the steel frame system are adequately protected against corrosion i.e. galvanising/zinc coating and made from a suitable metal to ensure the design life of the system is maintained.

MHI provide a full specification of all fasteners, where they are to be used and how they are to be installed during the construction of the system. Only fasteners approved or supplied by MHI may be used with the system.

It is important to ensure that protective coatings on fasteners are not removed, e.g. to assist the fitting of a connection, as this would severely compromise the corrosion performance of the fastener. Where a building is located within one Kilometre of the coastline and has a steel roof, all fasteners at the eaves shall additionally be coated with a zinc rich paint to protect against coastal salt spray or fasteners used that have the required salt spray test for this location.

2.4.4 Racking

Resistance to horizontal loading (racking) is provided by the horizontal diaphragm action of the approved floor sheeting and roof in conjunction with OSB 3 or metal diagonal cross-bracing straps or K bracing members on specific external or internal walls. All cross bracing is pre-assembled in the factory and has the dual function of ensuring squareness of factory produced panels in addition to providing lateral stability for the overall structure.

The composite action of the steel studs and OSB 3 combine as per the design to provide the required stiffness to meet the global stability requirements of the modular units. Where structural steel is incorporated into module design, then the OSB 3 in the walls can be omitted. The fixings used must meet the specific requirements of the designer.

2.4.5 Holding Down

To provide resistance to uplift, the bottom channel of the external panels is fixed to the ground floor slab, podium slab with anchor bolts or rising blockwork with chemical anchors. The type of anchor used to hold down the external panels of the system will be dependent on what substrate the anchor is being fixed to. These post fixed anchors are designed by MHI Chartered Structural Engineer and in accordance with the *Code of Practice for the Design and Installation of Anchors in accordance with Section 60 of the Safety, Health and Welfare at Work Act 2005.* The positions of the anchors are Project specific and are determined by MHI's Chartered Structural Engineer and are factory positioned in the bottom channel member.

Figure 6Figure 6 shows the preferred option of fixing a floorless ground floor steel frame bottom channel to a reinforced concrete slab with a proprietary anchor. In addition to the internal leaf of the external wall being fixed to the foundation all internal panels on the ground floor are fixed to the concrete slab with proprietary approved anchors.

2.5 COMPARTMENTATION

2.5.1 Separating Wall (Party Wall)

Separating walls (party walls) are constructed using two independent LGS framed leaves (studs at 600mm centres max.), two layers of 15mm gypsum plasterboard internal lining on each side, fixed with the joints staggered, boarding specification in accordance with Table 5 of this Certificate. The studs are full filled with stone mineral wool batts of minimum density 22kg/m^3.These wool batts are continuous from ground floor to the upper floor ceiling level and help to provide the required acoustic performance. Where the attic space is habitable, the mineral wool fibre must go up to the underside of the roof for acoustic purposes.

Figures 7, 10 and Figure 12 illustrate how the junction of the party wall and external wall is cavity closed. This detail seals air gaps and minimises flanking sound transmission.

OSB is removed from compartment walls in a building of purpose group 2(a) Residential (Institutional) and in a building of any purpose group, where the height of the top storey is 10m or more. A compartment wall which is required to have a fire resistance of one hour or more shall be constructed of materials of limited combustibility.

At the junction of the floor and the party wall, an additional 400mm section of mineral wool insulation is provided within cold formed section zone on each side of the separating wall to minimize flanking and direct sound transmission and provide additional fire protection.

The head of the party wall must also be fire-stopped, and the cavity closed as specified by the MHI construction details. Where services are required in a party wall, they can be accommodated by additional dry lining to the party wall with battens and plasterboard. All battens used in the MHI MSF building system are treated in accordance with BS 8417:2011+A1:2014.

Design must comply with the requirements of section 3.5 of TGD B 2019 Volume 2 of Building Regulations 1997 to 2019 for purpose group 1(a), 1(b), & 1(d) and in accordance with Section 3.2.5 of TGD B 2006 of Building Regulations 1997 to 2019 for all other purpose groups to which this certificate applies.

Figure 8 illustrates how the intermediate floor void junction is appropriately fire stopped. Figure 16 illustrates how the void under a non-loadbearing compartment/protected corridor wall over a separating floor void junction is appropriately fire stopped. Both these details along with all other critical fire stopping details must be inspected and signed off on every building by the MHI Design Manager, SHEQ (Safety, Health, Environment Manager and Quality) site manager or an appointed MHI representative.

2.5.2 Single Frame Compartment Walls

A compartment wall within the MHI MSF building system can be constructed of a single frame wall. The wall can be used in situations where a building is sub-divided into different compartments, but this compartment wall **must not** be used where a wall is common to two or more buildings (separating wall) or where a compartment wall is used to separate dwellings from each other within a building. The single frame compartment wall must be designed and specified to meet the acoustic, fire and structural the requirements of the Building Regulations 1997 to 2019.

No services are allowed to run vertically within the compartment wall and where services are required in a compartment wall, they can be accommodated by battening out the wall with timber battens or with resilient bar, similar to accommodating services in a party wall. Services however can pass through a compartment wall, but they must be appropriately protected in accordance with section 3.5.4.1 of TGD B 2019 Volume 2 of the Building Regulations 1997 to 2019 for Purpose Class 1(a), 1(b) & 1(d) and in accordance with Section 3.2.5.7 and 3.4 of TGD B 2006 of Building Regulations 1997 to 2019 for all Purpose Classes to which this Certificate applies. Services passing horizontally through compartment walls should be kept to a minimum and avoided where possible.

2.5.3 Cavity Barriers and Fire Stops

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

- Separating walls shall have a vertical cavity barrier sealing the cavity at the wall ends, running from DPC level to the underside of the fire stopping at the top of the wall.
- At a separating wall junction with the external wall, vertical cavity barriers shall be placed in the external wall on either side of the separating wall junction.
- Horizontal cavity barriers shall be placed at the perimeter of all compartment floors. The cavity barrier should be appropriate for the external cladding that it is intended to close in the event of a fire or to prevent smoke entering the cavity.
- A cavity barrier shall cover the full length of the separating/compartment wall and shall tightly abut the rear of the vertical fire stops at the ends of the separating/compartment wall and the non-combustible board at the top of the separating/compartment wall.
- A cavity barrier shall cover the full ceiling depth as well as the upper wall panel rail and lower wall panel head.
- Eaves boxes shall be provided at the junctions of separating wall and compartment walls with external walls to reduce the risk of fire passing across these junctions.
- At the top of any external cavity wall including any gable wall, as can be seen in Table 3.2 of TGD B 2006 of Building Regulations 1997 to 2019
- Above the enclosures to a protected stairway.
- Cavity barriers are required around all openings in external walls (doors, windows, vents, extractor fans, meter cupboards etc.) in framed construction.

Figures, 10, 12, 13, 15, and 16 show typical details on the proper installation of cavity barriers and fire stops in the MHI MSF building system.

2.5.4 Fire Stopping Service Penetrations

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.

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

It is essential that both the designer and the specialist contractor are fully conversant with the fire protection requirements for pipe, cable and service penetrations. The fire stopping is inspected by the Modern Homes Ireland (MHI) site manager and recorded in the Modern Homes quality control file for that site – the fire stopping must be installed correctly before MHI will issue the Certificate for the building.

2.6 DELIVERY, STORAGE AND SITE HANDLING

2.6.1 Delivery of Modules

The modules leave the factory as weather proofed sealed units. Figure 4 illustrates a module covered with a white waterproof membrane to ensure weather proofing after completion in factory until installation on site is complete. Figure 3 also illustrates how the modules are lifted and transferred from the factory floor to a trailer for transportation to site.

The modules are delivered to site by truck. A crane with a specifically design lifting frame lifts the modules into place directly from the delivery trailer. All lifting from the trailer shall be carried out by competent personnel in accordance with the MHI Installation Manual and site-specific safety statement. Care is needed to avoid scratching the surface of any exposed steel frame members or contamination from carbon steel during pick-up and placing. Modules are lifted from the trailer in a sequential manner.

The use of protective gloves when handling the volumetric units is required, as steel members formed from cut or sheared sheet can have sharp edges and care should be taken when handling to avoid injury. The exposed steel frame members must be kept out of contact with dry cement and lime.

2.6.2 Traceability
Each module is labelled with a unique numbering system. This number is taken from the "Project Numbering Register" and records the project number, reference to the building, floor, where the module is to be placed, and individual module number. This ensures modules are delivered to site in the correct order and subsequently placed in the correct sequence.

2.6.3 Typical Material List Supplied to Site
With each customised delivery of an MHI MSF unit to site, a comprehensive bill of materials is supplied. This bill of materials gives a detailed list of all components delivered to site to complete the installation of the volumetric units.

Figure 3: Module being lifted into place using a lifting frame

2.6.4 Responsibilities
Prior to the commencement of the contract, the responsibilities are determined and agreed between Modern Homes Ireland (MHI) and the main contractor.

MHI provides the Main Contractor with project specific building details on the construction of their modular steel frame system. Construction of the foundations, ground floor slab or podium slab must be within the tolerances specified by Modern Homes as detailed in Cl. 2.2.1 of this certificate.

The Main Contractor is generally responsible for the construction of all wall claddings, roof claddings and the installation of fire stopping and cavity barriers where it is impractical for MHI to install prior to these claddings being applied.

When the modules are completely erected, brick/block laying trades or cladding can commence. The provision of the site-specific fall arrest system to wall plate level is to be agreed between MHI and the Main Contractor before commencement of the project on site.

INSTALLATION
2.6.5 General
Installation is carried out in accordance with the requirements of this Certificate and all relevant codes of building practice, regulatory Health & Safety requirements and the manufacturer's instructions contained in the MHI Installation Manual, a copy of which must be available on each site.

Figure 4: Specifically, designed travel bed used to transport MHI MSF Unit

Site installation must only be carried out by approved licensed installers employed by MHI or by a specialist sub-contractor under the supervision of MHI and in accordance with the MHI Installation Manual.

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

All off-loading and erection should be in accordance with the MHI method statement and erection procedures. Care must be taken to avoid any damage to the steel frame components during lifting and connection brackets during transportation and installation.

An MHI Structural Engineer or MHI nominated Consulting Engineer must assess the adequacy of the design of the proposed superstructure of the building system.

All structural connections to the foundation must be installed in accordance with the structural design details. They then need to be independently checked by qualified members of the installation team and formally recorded on the MHI site quality control records.

2.6.6 Site Supervision
The approved installers are subject to continuous supervision by the MHI site manager. Typically, the MHI Site Manager will agree a schedule of inspections with the Erection Contractor. The supervisor of the erection crew is responsible for the quality and productivity of work carried out by the erection crew.

The erection supervisor ensures that works are carried out in line with Health & Safety requirements as per the site-specific Method Statement & Risk Assessment.

The erection supervisor reports directly to the MHI Site Manager to ensure all work follows the requirements of the design drawings and the requirements of the MHI Structural certification for the building.

MHI employ a full-time site Safety, Health, Environment and Quality (SHEQ) Site Manager who works very closely with the erection supervisor, and the main contractor. The SHEQ site manager is responsible for ensuring all concrete slabs are within the engineer's specified tolerances before modules are installed on site. No modules are installed until the MHI SHEQ Site Manager approves the concrete slab to which the modules are being fixed. All fixings and brackets between modules are visually inspected, periodically photographed and recorded on the module assembly quality control sheet for structural connections. Each building has its own quality control sheet for structural connections, which is kept on site by the MHI SHEQ Site Manager. The MHI SHEQ site manager also inspects fire stopping and cavity closing of all modules and service shafts and then records this information on the fire stopping check sheets which are recorded for each floor of each building. Any defects noted are recorded, photographed where possible and notified in writing to the erection supervisor. The MHI SHEQ Site Manager will inspect and approve the remediation before work can proceed.

The approved module installation contractors are subject to continuous supervision by the MHI SHEQ site manager. 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 MHI before the modules are positioned.
- The modules are not erected until any inaccuracies in the floor slab have been corrected.
- The ground floor layout is properly marked out.
- DPC and DPM are correctly installed in accordance with BS 8102:2009.
- DPC course is laid under all ground floor modules, as a good practice measure between steel and concrete, both internally and externally.
- Modules are in line and plumb and in accordance with the MHI module layout.
- All ground floor, first floor and roof modules are correctly anchored into position in accordance with the erection drawings (penetrating the DPC but not penetrating the DPM
- All insulated external wall panels of modules are free from damage after erection.
- All horizontal and vertical joints are correctly detailed.
- Wall ties are correctly spaced and positioned.
- Horizontal DPCs are correctly turned up against the bottom channel upstands.
- Before any infill plasterboard is attached to the OSB 3 lined wall panels all joins in the airtight barrier are taped and jointed and all service penetrations are fully sealed.
- Where two modules join, the procedure is executed on site with infill plasterboard sections, taped and jointed and all service penetrations fully sealed.
- Cavity barriers and fire stops are installed and signed off by MHI as specified and in accordance with the Building Regulations 1997 to 2019.
- Roof trusses are installed plumb and per layout.
- Roof bracing is installed where required.
- Steel frame at all floor levels is correctly electrically earthed at one point and all earth returns are connected back to that point.
- Where galvanised steel section is cut or where any damage occurs to the steel frame a coat of zinc rich paint is applied to exposed surfaces.
- All fasteners used are supplied or approved by MHI.
- No modifications i.e. cutting of the steelwork, without prior written permission by a MHI Chartered Structural Engineer.
- Minimum 40mm cavity between the two leaves of the party wall has been maintained.

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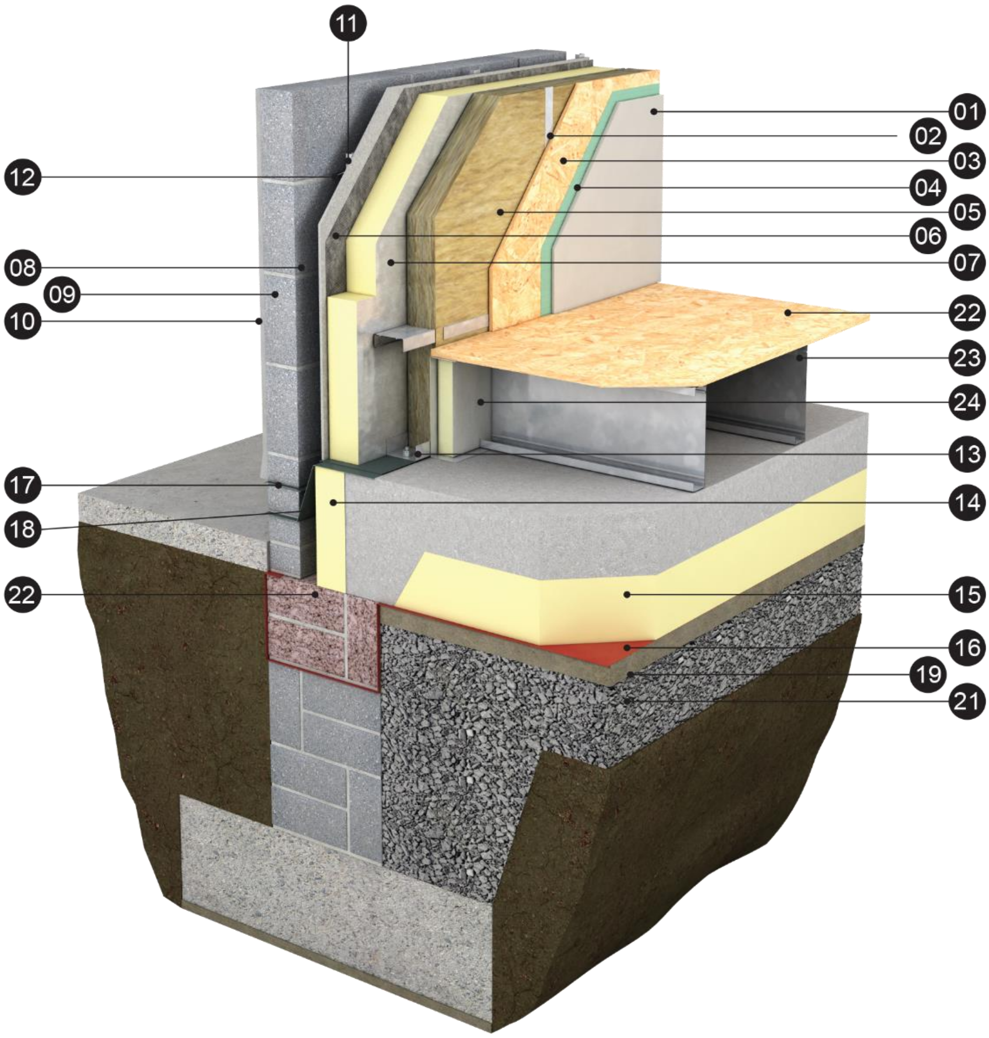

01.	Plasterboard specification in accordance with Table 5.	**14.**	Strip of rigid PIR insulation or similar approved.
02.	MHI galvanised steel stud.	**15.**	PIR rigid board floor insulation or similar approved.
03.	11mm OSB3 board.	**16.**	Radon Barrier.
04.	Vapour control layer.	**17.**	Damp proof course to be at least 150mm above ground level.
05.	Stone wool insulation placed between studs.	**18.**	Stepped damp proof course bonded to radon barrier.
06.	Breather Membrane.	**19.**	Sand binding to engineers design & specification.
07.	PIR rigid board insulation or similar approved.	**20.**	Compacted hardcore to engineers design & specification.
08.	50mm residual cavity.	**21.**	2 rows of concrete thermal block (Min. 7.5N).
09.	100mm concrete block outer leaf.	**22.**	Selected floor finish on plywood/OSB
10.	25mm sand/cement external render.	**23.**	Galvanised steel C-Joist 250mm.
11.	Stainless steel (or galvanized powder coated) wall restrain system for outer leaf.	**24.**	60min. Fire bat.
12.	Stainless Steel wall tie.		
13.	Galvanized anchor bolt placed at centres specified by engineer or approved alternative fixing.		

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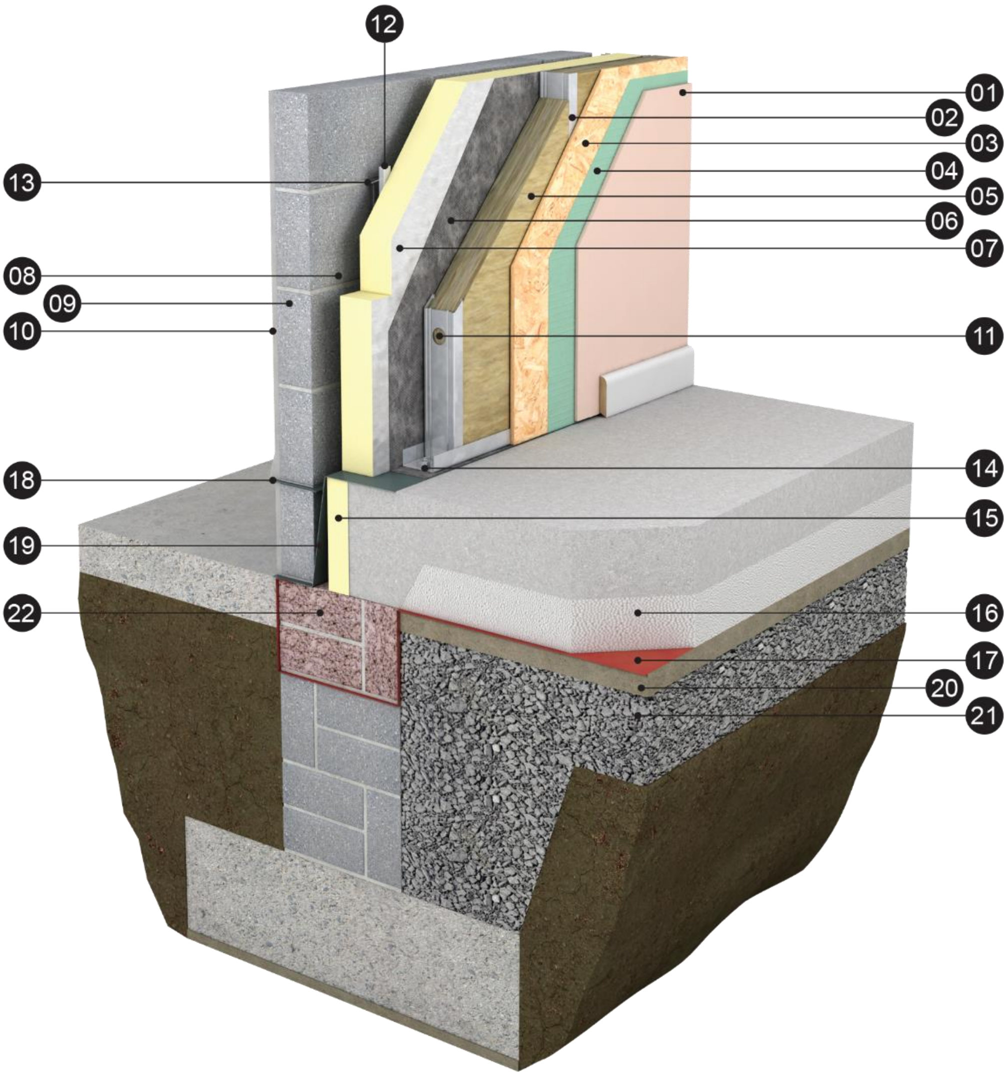
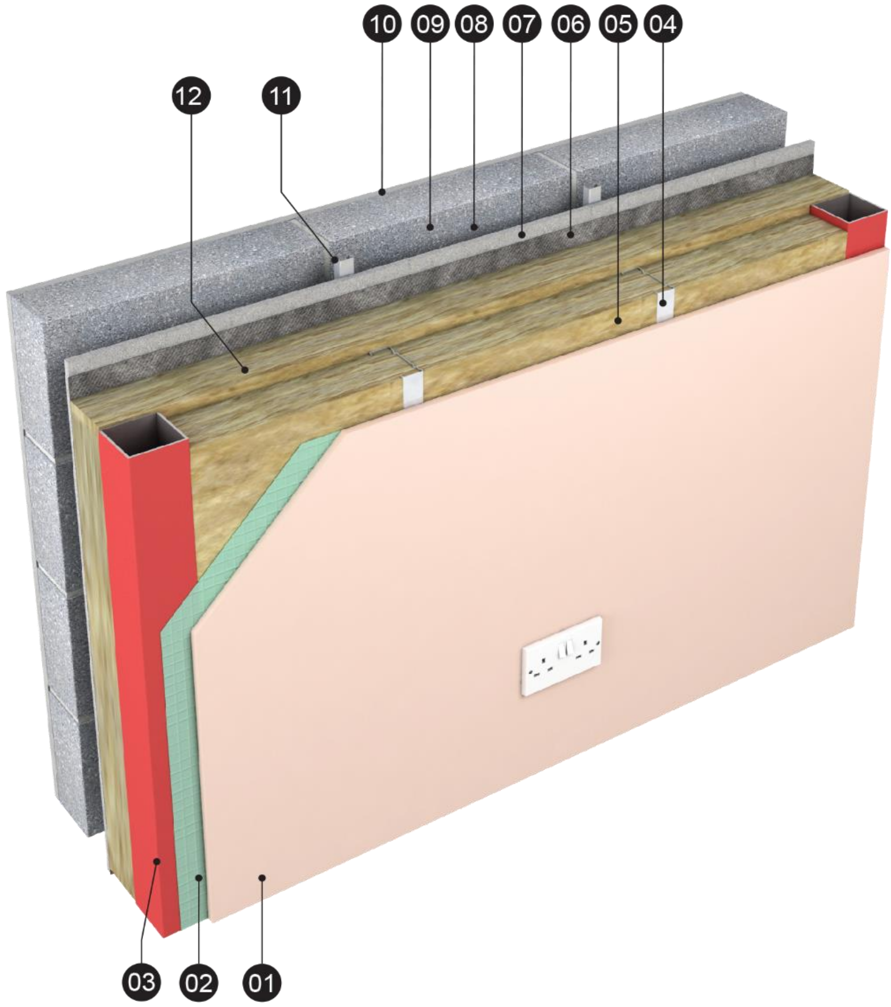


01.	Plasterboard specification in accordance with Table 5.	**14.**	Galvanized anchor bolt placed at centres specified by engineer or approved alternative fixing.
02.	MHI galvanised steel stud.	**15.**	Strip of rigid PIR insulation or similar approved.
03.	11mm OSB3 board.	**16.**	PIR rigid board floor insulation or similar approved.
04.	Vapour control layer.	**17.**	Radon Barrier.
05.	Stone wool insulation placed between studs.	**18.**	Damp proof course to be at least 150mm above ground level.
06.	Breather Membrane.	**19.**	Stepped damp proof course bonded to radon barrier.
07.	PIR rigid board insulation or similar approved.	**20.**	Sand binding to engineers design & specification.
08.	50mm residual cavity.	**21.**	Compacted hardcore to engineers design & specification.
09.	100mm concrete block outer leaf.	**22.**	2 rows of concrete thermal block (Min. 7.5N).
10.	25mm sand/cement external render.		
11.	Service holes.		
12.	Stainless steel (or galvanized powder coated) wall restrain system for outer leaf.		
13.	Stainless Steel wall tie.		

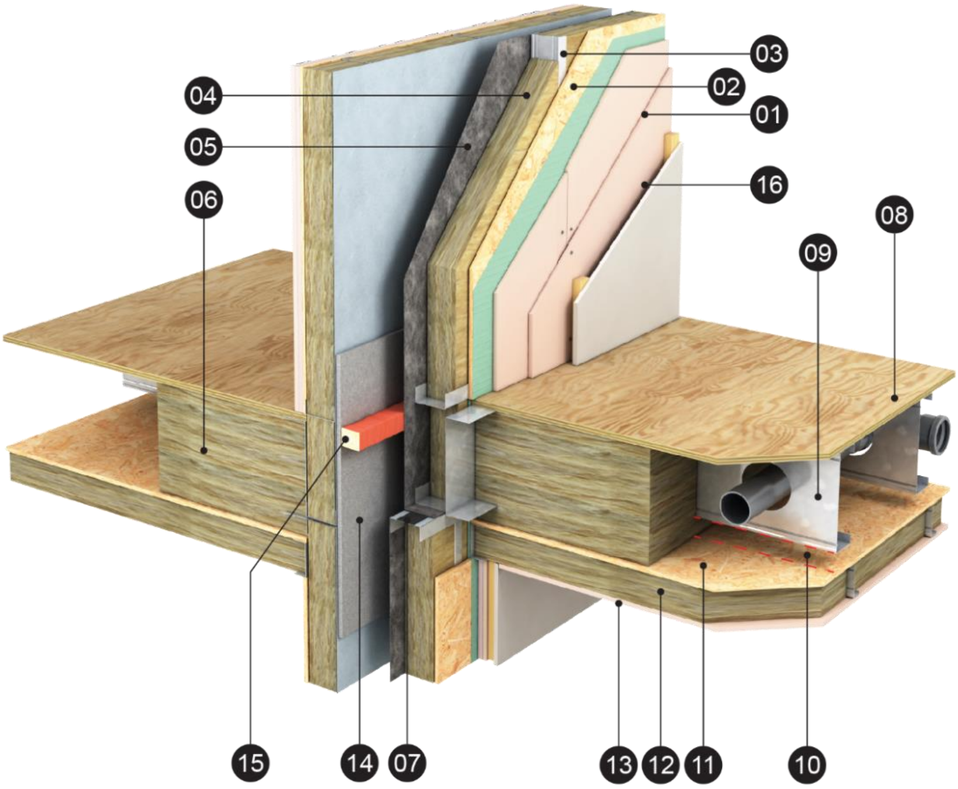
Figure 6: External Wall with steel floor



01.	Plasterboard specification in accordance with Table 5.	**09.**	100mm concrete block (or brick) outer leaf.
02.	Vapour control layer.	**10.**	25mm sand/cement external render.
03.	SHS Corner Post	**11.**	Stainless steel or galvanised powder coated external leaf restrain system and Stainless Steel wall-tie.
04.	MHI galvanised steel stud.	**12.**	Stone wool insulation to meet required U-Value.
05.	Stone wool insulation placed between steel stud.		
06.	Breather Membrane with airtightness tape at joints.		
07.	Class A1 weather resistant board.		
08.	50mm residual cavity.		

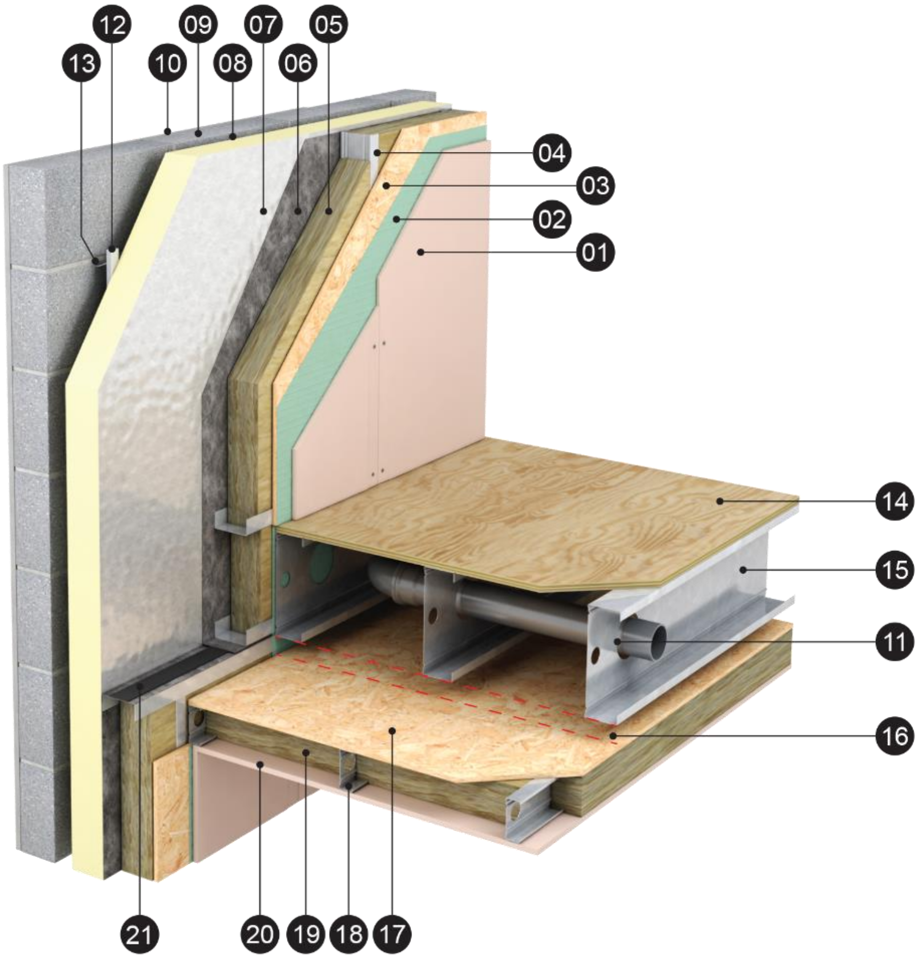
Figure 7: Non-combustible wall

NSAI Agrément



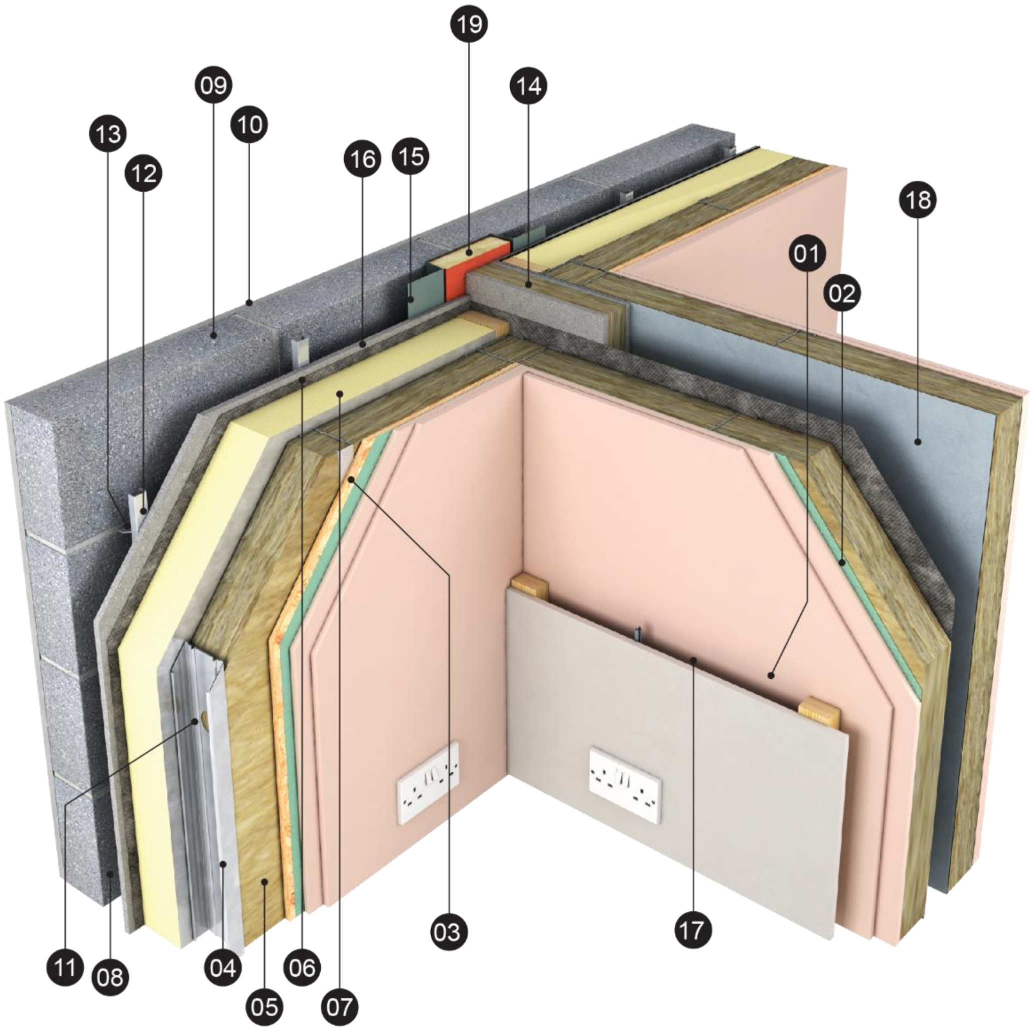
01.	Plasterboard specification in accordance with Table 5.	**09.**	Galvanised steel C joist - 250mm to party wall floor void.
02.	11mm OSB3 board.	**10.**	Void for services.
03.	MHI galvanised steel stud.	**11.**	11mm OSB3 board to top of ceiling.
04.	Stone wool insulation placed between stud.	**12.**	Stone wool insulation betweeen ceiling joists / channel.
05.	Breather Membrane.	**13.**	Plasterboard specification in accordance with Table 5.
06.	Full fill floor void with 400mm width of stone wool insulation. No services allowed in floor void that is within 400mm of separating wall.	**14.**	Clas A1 weather board or similar approved site fixed (cavity side).
07.	Breather Membrane taped and jointed at junction with airtight tape.	**15.**	Compression fixed cavity closer fixed to board.
08.	Selcted floor finish on 18m plywood/OSB.	**16.**	Services void.

Figure 8: Fire Stopping and Cavity Closer Detail on Intermediate Floor Between Two Modules at Separating Wall



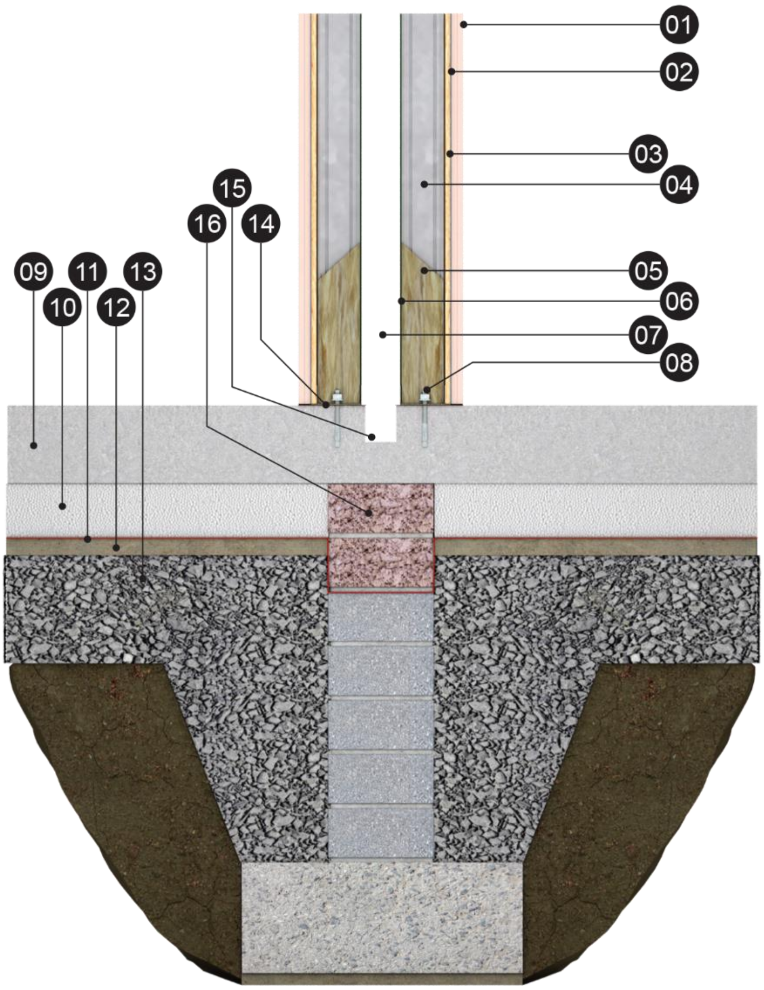
01.	Plasterboard specification in accordance with Table 5.	**12.**	Stainless steel (or galvanized powder coated) wall restrain system for outer leaf.
02.	Vapour control layer.	**13.**	Stainless Steel wall tie.
03.	11mm OSB3 board.	**14.**	Selcted floor finish on plywood / OSB.
04.	MHI galvanised steel stud.	**15.**	MHI galvanised steel C joist - 250mm
05.	Stone wool insulation placed between stud.	**16.**	Void for services.
06.	Breather Membrane.	**17.**	11mm OSB3 board to top off ceiling.
07.	PIR rigid board insulation or similar approved.	**18.**	MHI galvanised steel joists/frame - 90mm.
08.	50mm residual cavity.	**19.**	Stone wool insulation placed between ceiling stud.
09.	100mm concrete block outer leaf.	**20.**	Plasterboard to meet fire requirements.
10.	25mm sand/cement external render.	**21.**	Breather Membrane taped and jointed at junction with airtight tape.
11.	Service hole.		

Figure 9: Intermediate Floor Junction Detail with External Wall Illustrating Cassette Ceiling providing 30 mins Fire Resistance to Intermediate Floor



01.	Plasterboard specification in accordance with Table 5.	**10.**	25mm sand/cement external render.
02.	Vapour control layer.	**11.**	Services holes.
03.	11mm OSB3 board.	**12.**	Stainless steel or galvanised powder coated external leaf restrain system.
04.	MHI galvanised steel stud.	**13.**	Stainless Steel wall-tie.
05.	Stone wool insulation placed between steel stud.	**14.**	300mm x 75mm wired stone wool cavity barrier.
06.	Breather Membrane with airtightness tape at joints.	**15.**	Wrapped DPC to cavity closer.
07.	PIR rigid board insulation or similar approved.	**16.**	Class A1 weather board fixed to metal frame.
08.	50mm residual cavity.	**17.**	Services void.
09.	100mm concrete block (or brick) outer leaf.	**18.**	Breather membrane.
		19.	Cavity Closer to specification.

Figure 10: : Separating wall (Party Wall) Junction with External Wall. Illustrating Wall Boarding and Accommodation of Services in External Wall and Separating Wall



01.	Plasterboard specification in accordance with table 5.	**09.**	Concrete floor slab.
02.	Vapour control layer.	**10.**	Floor insulation.
03.	11mm OSB Board.	**11.**	Radon barrier
04.	MHI galvanised steel stud.	**12.**	Sand binding.
05.	Stone wool insulation.	**13.**	300mm min. well compacted hardcore in layers not exceeding 300mm to engineers details & specifications.
06.	Breather Membrane with airtightness tape at joints.	**14.**	Damp proof course.
07.	Recommended 40mm minimum void.	**15.**	Drainage channel.
08.	Galvanized anchor bolt to engineers specification.	**16.**	225mm thermal concrete 7.5N block.

Figure 11: Fixing of Ground Floor Modules to Ground Floor Slab at separating Wall with cavity Maintained and Drainage Channel in Ground Floor Slab

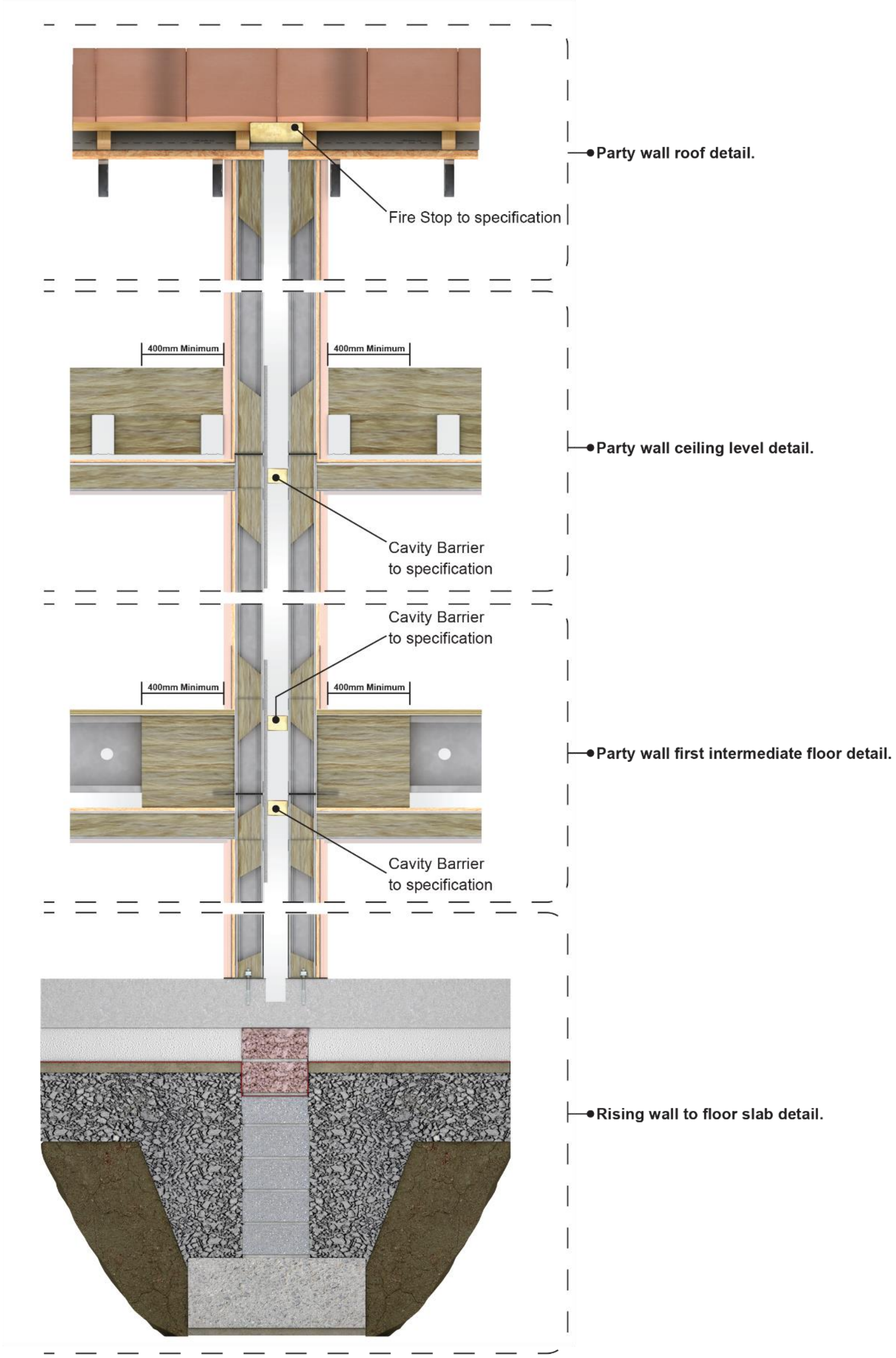
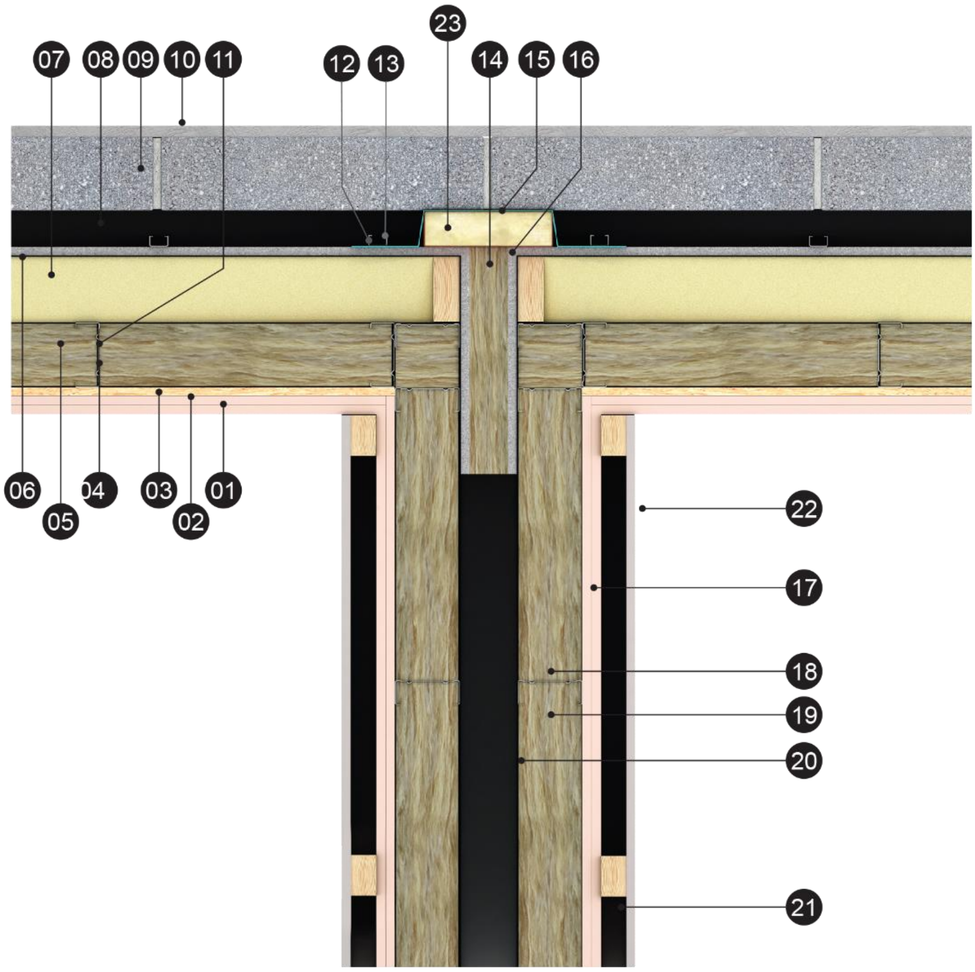


Figure 12: Section Through Separating Wall in Module Construction Illustrating Cavity Barriers and Fire Stops



01.	Plasterboard specification in accordance with Table 5.	**13.**	Stainless Steel wall-tie.
02.	Vapour control layer.	**14.**	300mm x 50mm stone wool cavity barrier.
03.	11mm OSB3 board.	**15.**	Wrapped DPC to cavity closer.
04.	MHI galvanised steel stud.	**16.**	Class A1 weather board fixed to metal frame with 30min fire resistance or similar approved.
05.	Stone wool insulation placed between steel stud.	**17.**	Plasterboard specification in accordance with Table 5.
06.	Breather Membrane with airtightness tape at joints.	**18.**	MHI galvanised steel stud.
07.	PIR rigid board insulation or similar approved.	**19.**	Stone wool insulation placed between steel stud.
08.	50mm residual cavity.	**20.**	Breather Membrane.
09.	100mm concrete block (or brick) outer leaf.	**21.**	Services void.
10.	25mm sand/cement external render.	**22.**	12.5mm standard plasterboard.
11.	Services holes.	**23.**	Cavity Closer to specification.
12.	Stainless steel or galvanised powder coated external leaf restrain system.		

Figure 13: Separating Wall Illustrating Cavity Barriers and Flanking Airborne Sound Installation Detail

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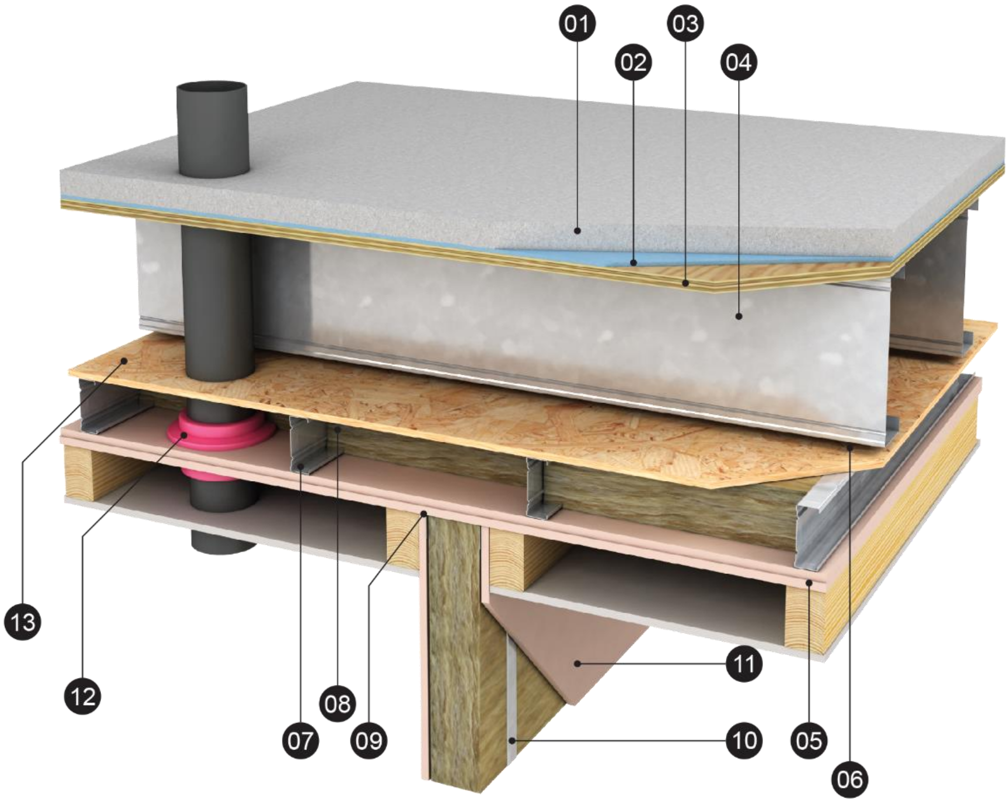
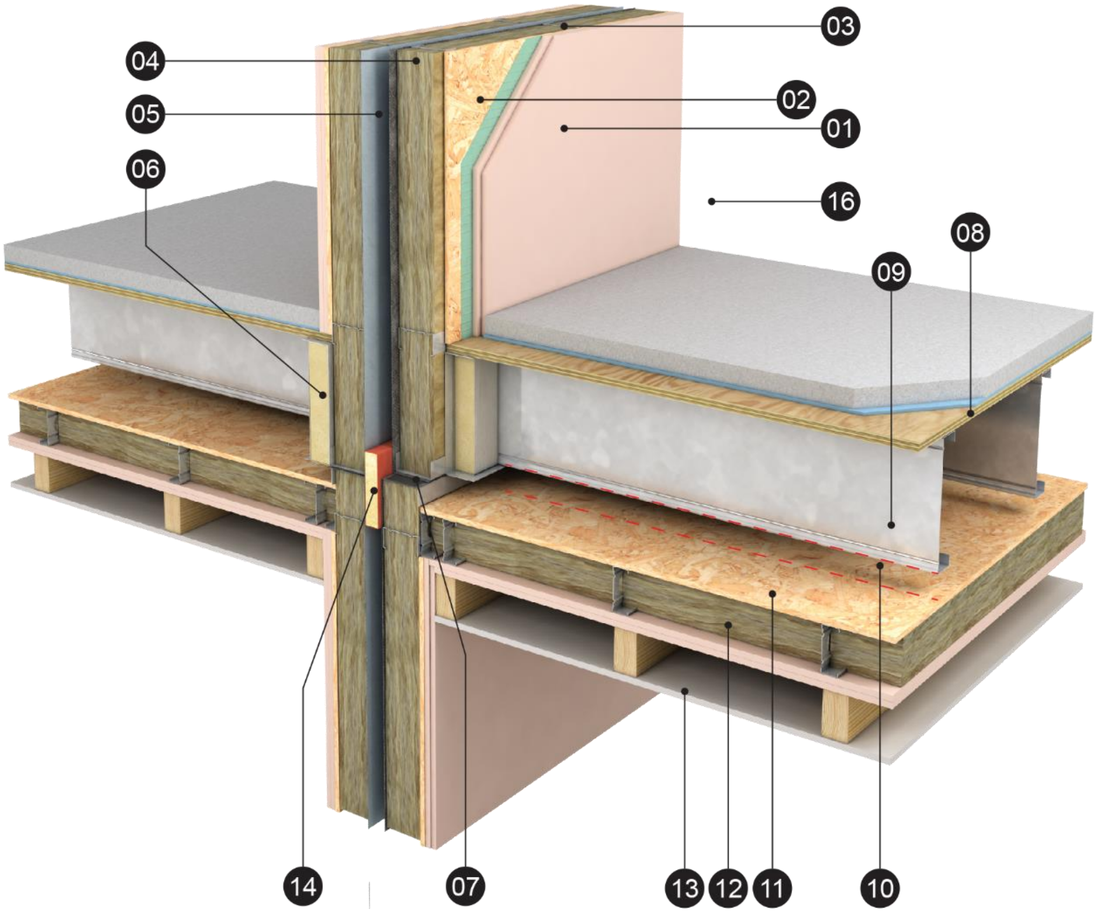


01.	38mm Acoustic Screedboard.	**08.**	90mm rockwool quilt / fibreglass insulation.
02.	Resilient material in accordance with section 4.4.2.1 of TGD Part E of the building regulations 1997-2017.	**09.**	Mastic acoustic sealant.
		10.	MHI metal stud.
03.	18mm plywood/OSB	**11.**	Plasterboard specification in accordance with Table 5.
04.	250mm MHI metal C joist.		
05.	Plasterboard specification in accordance with Table 5.	**12.**	Vertical services through compartment floor to have proprietary fire collar in accordance with TGD Part B .
06.	Void.		
07.	90mm MHI metal C channel.	**13.**	11mm of OSB3 board to top of ceiling.

Figure 14: Joist Compartment Floor Illustrating How Services are Accommodated within Ceiling



01.	Plasterboard specification in accordance with Table 5.	**08.**	Selcted floor finish on 18mm plywood/OSB
02.	11mm OSB3 board.	**09.**	Galvanised steel C joist - 250mm to party wall floor void.
03.	MHI galvanised steel stud.	**10.**	Void for services.
04.	Stone wool insulation placed between stud.	**11.**	11mm OSB3 board to top of ceiling.
05.	Breather Membrane to be lapped and sealed at junction between modules.	**12.**	Stone wool insulation betweeen ceiling joists / channel.
06.	Fire batt factory fitted to provide 60 REI.	**13.**	Plasterboard specification in accordance with Table 5.
07.	Breather Membrane taped and jointed at junction with airtight tape.	**14.**	Compression fixed standard cavity closer fixed to board.

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Figure 15: Fire Stopping Detail under a Protected Corridor Wall to a concealed Space within a Joist Compartment Floor

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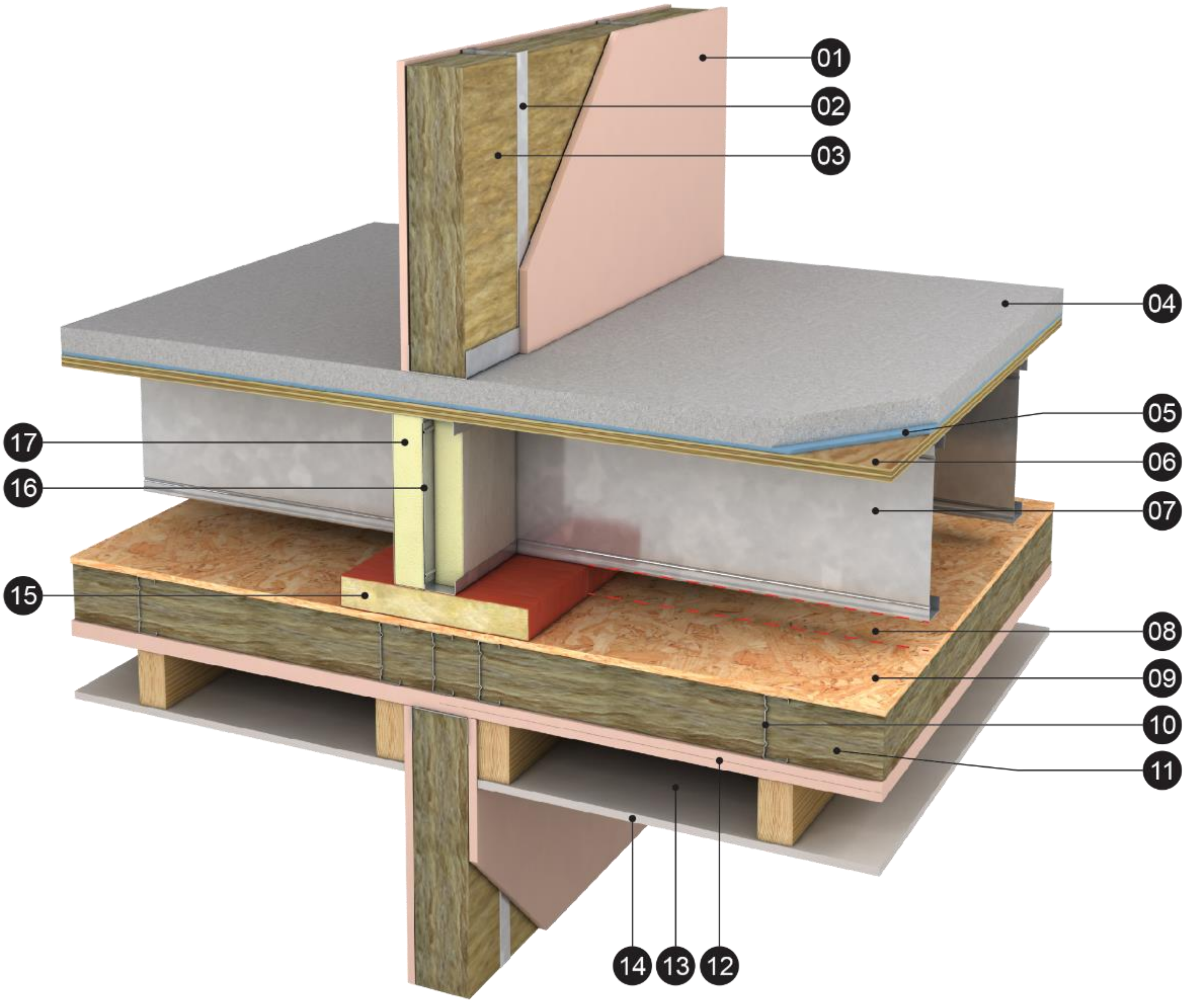

01. Plasterboard specification in accordance with Table 5.
02. MHI galvanised steel stud.
03. Stone wool insulation placed between stud.
04. 38mm Screedboard
05. 6mm soft covering.
07. Galvanised steel C joist - 250mm
08. Void.
09. 11mm OSB board to top of ceiling
10. MHI galvanised steel stud.
11. Stone wool insulation betweeen ceiling joists / channel.
12. Plasterboard specification in accordance with Table 5.
13. Void for services.
14. Plasterboard specification in accordance with Table 5.
15. Firestop. Site fitted.
16. Galvanised steel C joist - 250mm
17. 60min. fire bat. Factory Fitted.

Figure 16: Fire Stopping Detail to a Joist Compartment Floor where Two Modules Meet

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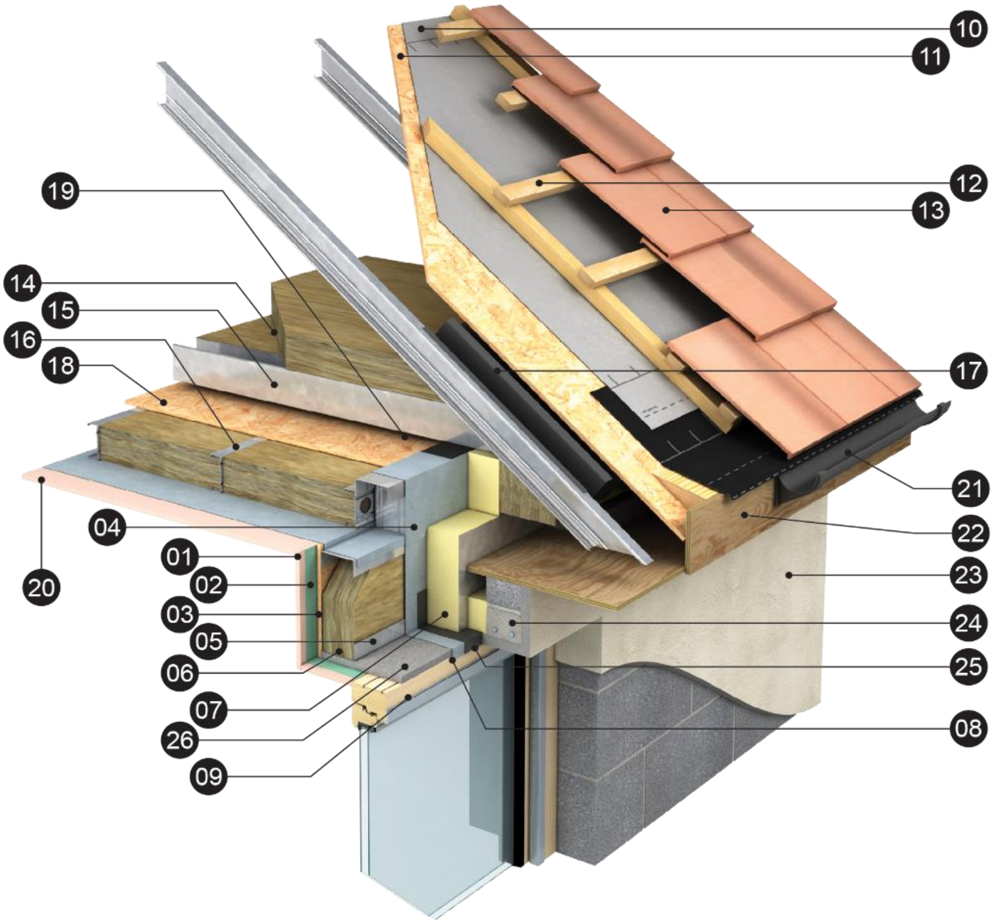
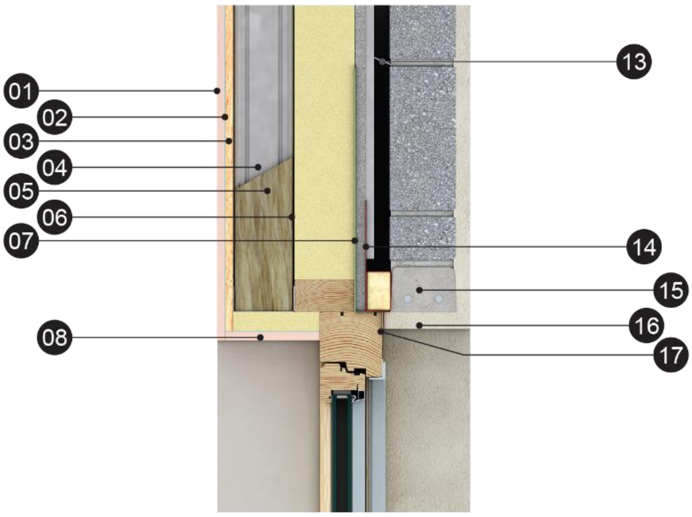
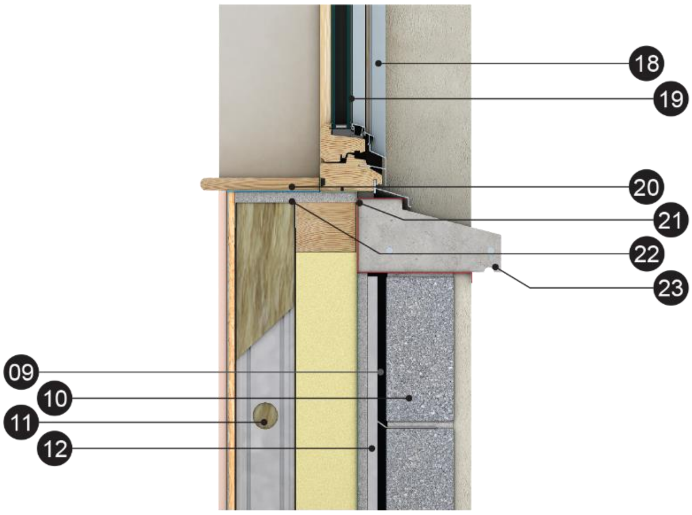


01. Plasterboard specification in accordance with Table 5.
02. Vapour control layer.
03. 11mm OSB3 board.
04. Breather Membrane.
05. MHI galvanised steel stud wall.
06. Stone wool insulation placed betweeen studs.
07. PIR rigid board insulation or similar approved.
08. Breather Membrane taped to window frame.
09. Selected window fixed with galvanised steel fitting straps to MHI steel frame to manufactures details.
10. Sarking felt/Breather membrane lapped at all joints.
11. 11mm OSB3 to rafters.
12. 44x38mm treated timber battens on 50x25mm treated timber counter battens.
13. Selected tile/slate as per specification.
14. 100mm stone wool in the ceiling and 200mm over ceiling.
15. MHI galvanised steel roof trusses.
16. MHI 90mm galvanised steel joist.
17. Eaves ventilator to be installed over insulation as required to vent roof space or similar approved.
18. Breather Membrane on11mm OSB3 board.
19. 23mm deflection void area.
20. Plasterboard specification in accordance with Table 5.
21. UPVC gutter and downpipes.
22. UPVC fascia board to be fixed to 22mm thick WBP plywood board.
23. 25mm sand/cement external render.
24. Precast concrete lintel to engineers specifications.
25. Stepped damp proof course bonded to radon barrier.
26. Class A1 weather board to provide 30 mins. fire cavity barrier to window and door openings or similar approved.

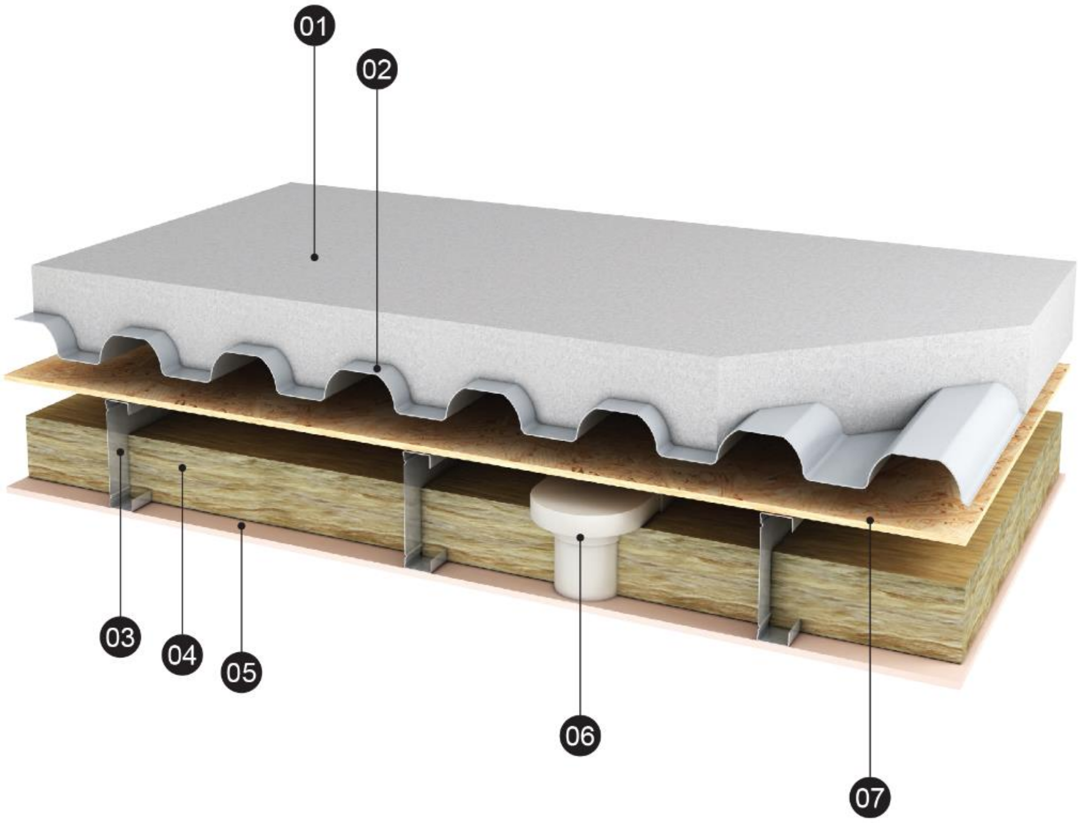
Figure 17: Roof Eaves Detail





01.	Plasterboard specification in accordance with Table 5.	**14.**	Cavity tray stepped DPC.
02.	Vapour control layer.	**15.**	Precast concrete lintel to engineers detail and design.
03.	11mm OSB3 board.	**16.**	25mm sand cement rendering or similar approved finish.
04.	MHI galvanised steel stud.	**17.**	Breather Membrane taped to window frame.
05.	Stone wool insulation placed between steel stud.	**18.**	Selected window fixed with galvanised steel fitting straps to MHI steel frame to manufactures details.
06.	Breather Membrane with airtightness tape at junctions / windows / doors.	**19.**	NB. Position of window relative to block work courses may vary depending on window cill height.
07.	PIR rigid board insulation or similar approved.	**20.**	Window board to specification.
08.	Type F Insulated Plasterboard.	**21.**	Breather Membrane brought into reveal & taped/sealed to window frame.
09.	50mm residual cavity.	**22.**	Class A1 weather resistant board to provide 30min fire cavity barrier to windows and door openings.
10.	100mm concrete block (or brick) outer leaf.	**23.**	Precast concrete cill unit wrapped in DPC.
11.	Services holes.		
12.	Stainless steel or galvanised powder coated external leaf restrain system.		
13.	Stainless wall-tie.		

Figure 18: Window Cill and Head Detail



01.	Concrete to specification.
02.	Composite metal deck.
03.	150-200mm Ceiling joists to create service void in module ceiling.
04.	Stone mineral wool insulation placed between ceiling joists.
05.	Plasterboard specification in accordance with Table 5.
06.	Ventilation ducting.
07.	11mm OSB3 board to top of ceiling.

Figure 19: Composite Concrete/Metal Deck Floor

3.1 STRENGTH AND STABILITY

3.1.1 Certificate and Structural Compliance

The MHI MSF building system is intended for use where Architect's drawings are available and satisfy the Building Regulations 1997 to 2019. The Architectural and Engineering design team are responsible for ensuring that architectural drawings and overall building design comply with the Building Regulations. MHI, using an experienced Chartered Structural Engineer, are responsible for the structural design of the MHI MSF Building System.

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

It is imperative that all design team members are clear in relation to the elements of the project for which MHI are responsible and what the Ancillary Certificates relates to.

Buildings constructed using the MHI MSF building system shall be certified by a competent, Chartered Structural Engineer as being in accordance with Part A of the Building Regulations 1997 to 2019.

3.1.2 Superstructure Design

The Metal Frame Construction Building System can be designed to comply with the requirements of Part A of the Building Regulations 1997 to 2019 regarding the design to avoid disproportionate collapse.

The structural assessment of the MHI MSF building system shall be site specific and project specific. A Structural Design Engineer suitably qualified in this type of structure shall undertake the structural engineering of every building element designed by MHI. In accordance with IS EN 1990:2002. A DSL2 (Design Supervision Level) should be employed to check the design in line with good practice.

This structural design certificate should cover the adequacy of all the cold formed and hot rolled elements within the structure in question. It should also address the dimensions and thickness of each element and member making up the steel module superstructure and assess the suitability of the interface between the superstructure and the external cladding.

Traditional brick, block or NSAI Agrément approved cladding systems can be used with MHI MSF building system.

The structural certificate of compliance must also confirm that there is sufficient uplift resistance and that there is adequate racking and load bearing capacity to either side of any opening to ensure the stability of the modules.

3.1.3 Substructure Design

The design of the building's substructure is outside the scope of this certificate. The Design Engineer needs to be a suitably qualified Chartered Engineer and the design will need to be in accordance with the relevant codes and standards.

3.1.4 Design Loads

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

- IS EN 1993-1-1 NA:2007 and timber roof trusses to IS EN 1995-1-1:2004 Eurocode 5
- IS EN 1991-1-1:2002 Eurocode 1
- IS EN 1991-1-4:2005 Eurocode 1
- IS EN 1991-1-3:2003 Eurocode 1.

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

3.1.5 Structural Testing

Where it is required, structural testing may be used to verify the relevant aspects of the structure where the design falls outside the scope of IS EN 1993-1-1 NA 2007 *Eurocode 3.*

3.2 FIRE

3.2.1 Structural Fire Safety – General

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

All materials such as cavity barriers and fire stops, used in the construction comply with IS EN 13501-1:2007. They shall be detailed as described in Section 2.5.3 (of this Certificate) and as specified in the MHI fire stopping details in line with the supporting documents to the Building Regulations 1997 to 2019.

Any compartment or separating wall providing fire compartmentation shall be carried up through any roof space and brought up to the underside of the roof cladding to provide adequate fire stopping. No services can pass through a separating wall.

Services are permitted within all internal and external loadbearing and non-loadbearing walls of the MHI MSF building system provided the wall is not a compartment wall and services are not provided within 200mm of each other back to back. All services are installed in a factory-controlled environment and are fully quality checked before transport to site.

All fire testing listed in Table 5 on the MHI walls has been carried out with services penetrations in the wall to accurately test the system. Figure 10 and 14 illustrate how services are installed in separating walls and floors.

3.2.2 Structural Fire Safety Purpose Groups (Volume 2)

The buildings in purpose group 1(a), 1(b) & 1(d) are now covered under TGD B Fire Safety Dwelling Houses Volume 2 of the Building Regulations 1997 to 2019. Under this revision buildings designed in accordance with the Eurocodes require the structural fire resistance performance specified, to be achieved in accordance with European test methods. The European tests required to be used are IS EN 1364-1:2015, IS EN 1365-1:2012 and IS EN 1365-2:2014.

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

3.2.3 Structural Fire Safety Purpose Group 2006

In purpose group 1(c), 2(a), 2(b), 3, 4(a) and 5 to which this Certificate relates is covered under TGD B 2006 Fire Safety of the Building Regulations 1997 to 2019. The fire resistance performance of elements of non-loadbearing and loadbearing structure are given in Table 5 of this Certificate as a combination of EN 1364-1:2015, IS EN 1365-1:2012 and IS EN 1365-2:2014. Table 5 of this Certificate contains fire resistance tests to 30, 60 and 90 minutes.

3.3 DISPROPORTIONATE COLLAPSE

Structural design must consider disproportionate collapse and risk of exceptional loads occurring.

4.1 BEHAVIOUR IN RELATION TO FIRE

4.1.1 Fire Resistance

Fire tests show that buildings constructed using the MHI MSF Building System can meet the Building Regulation requirements in relation to fire resistance as shown in Table 5**.** The tests have demonstrated the ability of the MHI MSF building system to withstand severe fire exposure for the period required for compliance with the Building Regulations in terms of fire performance. Tests have been conducted to meet fire test requirements of IS EN 1364-1:2015, IS EN 1365-1:2012 and IS EN 1365-2:2000. The test required is dependent upon the purpose group of the building being designed and constructed.

The MHI MSF building system must be designed with the required boarding specification to meet the minimum requirements of Table A1 of TGD B 2019 Volume II of the Building Regulations 1997 to 2019 for purpose group 1(a), 1(b) & 1(d), to meet the minimum requirements of Table A1 and Table A2 of TGD B 2006 of the Building Regulations 1997 to 2019 for all other purpose groups to which this certificate applies, and any other building specific structural fire performance requirements. Table 5 of this Certificate provides a table of tested fire results which provide a variety of boarding specifications and their associated fire resistance performance that will have its stability maintained for the minimum required period in the event of fire.

There shall be two leaves in a steel frame separating wall with a minimum of 40mm clear cavity distance between the two leaves maintained throughout the cavity. Services shall not be placed in the cavity or penetrate the wall linings of separating walls. Where services are required, an additional service cavity shall be provided so that the integrity of the fire lining is maintained.

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

Accommodation of services in compartment walls/floors and separating walls must be in accordance with Section 3.5.4.1 of TGD B 2019 Volume 2 of Building Regulations 1997 to 2019 for purpose group 1(a), 1(b) & 1(d) and in accordance with Section 3.2.5.7 and 3.4 of TGD B 2006 of the Building Regulations 1997 to 2019 for all other purpose group to which this certificate applies.

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

The building details of the system incorporate suitable cavity barriers and fire stops, in accordance with IS EN 13501-1:2007, to satisfy the requirements of Section 3.6 of TGD B 2019 Volume 2 of the Building Regulations 1997 to 2019 for purpose group 1(a), 1(b) and 1(d) and Section 3.3 of TGD B 2006 of the Building Regulations 1997 to 2019 for all other purpose groups to which this Certificate applies. This can be seen in Figure 12, 13, 15, and 16.

An apartment, a house in a terrace and a semi-detached house are treated, as separate buildings and therefore, must be separated by a separating wall (party wall) as shown in Part B of the TGD to the Building Regulations 1997 to 2019, and as illustrated in Figure 11, 12, and 13.

Where a window is required to provide an alternative means of escape in a house, flat or maisonette, it must provide an unobstructed opening of at least $0.33m^2$ with a minimum width and height of 450mm. The opening section should be capable of remaining in the position which provides this minimum clear area. The window should be positioned as required by BS 9991:2015 and BS 9999:2017, and in accordance with Part B1 of TGD B 2006 and Part B6 of TDG B Volume 2 2019 of the Building Regulations 1997 to 2019. Any restrictor fitted, must be easy to operate.

The fire resisting elements of the construction that are specified in Table 5 of this Certificate provide 30, 60 and 90-minutes fire resistance from either side, for a range of specifications.

4.1.2 Plasterboard Installation

The proper application of plasterboard to the steel frame members (LGS or HRS) is critical for both fire and sound performance. Attention shall to be given to proper and practical detailing on the part of the designer and a high standard of workmanship on behalf of MHI. 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, as detailed in Cl. 2.6.4 of this certificate. All plasterboard that provides fire resistance must conform to the requirements of Type F to IS EN 520:2005 and must be installed in accordance with the specification given in Table 5.

If alternative boarding is proposed, then an independent fire test report from an Accredited Laboratory needs to be provided and assessed by a competent Fire Engineer.

4.1.3 Surface Spread of Flame

An external cladding of brick/block has a designated Class 0 National Rating surface spread of flame as shown in Table 4. For a more comprehensive list of material and product fire performance ratings, reference should be made to Table A5 of TGD to Part B Volume 2 2019 and Table A6 of TGD B 2006 of the Building Regulations 1997 to 2019. The Classes are defined in accordance with BS 476-7:1997.

Table 4 Surface Spread of Flame Characteristics

Material	National Rating	Euroclass
Brickwork/Blockwork	Class 0	A1
Weather Resistant Boarding	Class 0	A1
Timber Boarding	Class 3	D-s3, d2
Internal Plasterboard before decoration	Class 0	A2-s1, d0
Slates/Tiles	AA	Broof(t4)

4.1.4 Protection of Building

Combustible material, e.g. insulation, should be separated from the flue of a masonry chimney by at least 200mm, or at least 40mm from the outer surface of the chimney. Details are given in Section 2 and Diagrams 5 to 7 of TGD to Part J of the Building Regulations 1997 to 2019. The separation from a heating appliance to combustible wall insulation material should be as per Clause 2.5.6 and Diagram 6 of TGD to Part J of the Building Regulations 1997 to 2019For chimneys, covered by IS EN 1859:2009, separation between this product and the external surface of the chimney is determined in accordance with Clause 2.5.7 to 2.5.8 and in accordance with Diagram 7 of Part J of the Building Regulations 1997 to 2019.

Combustible material in proximity to a constructional hearth must be protected by 250mmm of solid concrete or as detailed in Diagram 8 of TGD to Part J of the Building Regulations 1997 to 2019. Heat producing appliances will generally be installed on site with appropriate opening designed in the module at ground floor level, through ceiling level to the attic.

4.1.5 Roof Designation

All tiles or slates used in the roof in conjunction with the system shall be designated AA in accordance with TGD to Part B of the Building Regulations 1997 to 2019 (reference Table A4 of TGD B Volume 2 2019 and reference Table A5 of TGD B 2006 depending upon which purpose group applies). Other NSAI Agrément approved roof coverings may also be used with the system under the guidance of the MHI nominated Chartered Engineer.

4.1.6 Cavity Barriers

The MHI MSF can incorporate both horizontal and vertical cavity barriers and fire stops to comply with the fire strategy drawings supplied by the Clients Fire Consultant. The Main Contractor is responsible for ensuring all fire stopping/cavity closers are installed in accordance with Modern Homes Ireland drawings. The MHI offsite site manager will inspect all cavity barriers and fire stops prior to the closing up of the cavities and ceilings and this is recorded in the quality control file for that site – the fire stopping must be installed correctly before MHI will issue the certificate for the building.

Table 5: Fire Protection Requirements for Wall, Floor and Ceiling Elements

	Element:	Test Standard	Results	Purpose Class
Internal Load Bearing Walls				
1	90mm C stud, 42mm flange x 1.2mm thick protected with one layer of 12.5mm Firecheck plasterboard (now referred to as GTEC Fireboard) either side. Stud filled with a minimum 50mm of stone mineral wool.	EN 1365-1999	30 minutes	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
2	LGS C-Studs (89x45x1.2mm) at 400mm centres with 2No. layer 12.5mm Type F Plasterboard fixed to the fire side and 2No. layer of 12.5mm Type F Plasterboard on the non-fire side, with 100mm Stone Mineral Wool Insulation between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	60 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
External Load Bearing Walls				
3	LGS C-Studs (89x45x1.2mm) at 400mm centres with 1No. layer 12.5mm Type F Plasterboard fixed to the fire side and 70mm PIR Insulation fixed to the non-fire side, with 100mm Stone Mineral Wool Insulation (45kg/m³) between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	30 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
4	LGS C-Studs (89x45x1.2mm) at 400mm centres with 2No. layer 12.5mm Type F Plasterboard fixed to the fire side and 70mm PIR Insulation fixed to the non-fire side, with 100mm Stone Mineral Wool Insulation (45kg/m³) between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	60 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
5	LGS C-Studs (89x45x1.2mm) at 600mm centres with 3No. layer 12.5mm Type F Plasterboard fixed to the fire side and 140mm Rockwool DuoSlab Insulation fixed to the non-fire side, with 100mm Stone Mineral Wool Insulation between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
6	LGS C-Studs (89x45x1.2mm) at 600mm centres with 3No. layer 12.5mm Type F Plasterboard fixed to the fire side and 140mm Rockwool DuoSlab Insulation fixed over 1No. layer of 12.5mm Siniat Weather Defence Board to the non-fire side, with 100mm Stone Mineral Wool Insulation between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
7	LGS C-Studs (89x45x1.2mm) at 600mm centres with 3No. layer 12.5mm Type F Plasterboard fixed to the fire side and 1No. layer of 12.5mm Siniat Weather Defence Board fixed over 140mm Rockwool DuoSlab Insulation to the non-fire side, with 100mm Stone Mineral Wool Insulation between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5

8	LGS C-Studs (89x45x1.2mm) at 600mm centres with 3No. layer 12.5mm Type F Plasterboard fixed to the fire side and 140mm Rockwool DuoSlab Insulation fixed over 1No. layer of 12.5mm Glasroc X Board to the non-fire side, with 100mm Stone Mineral Wool Insulation between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
9	LGS C-Studs (89x45x1.2mm) at 600mm centres with 3No. layer 12.5mm Type F Plasterboard fixed to the fire side and 1No. layer of 12.5mm Glasroc X Board fixed over 140mm Rockwool DuoSlab Insulation to the non-fire side, with 100mm Stone Mineral Wool Insulation between studs. 2No. Double Sockets were also fitted on the Fire Side.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
	Separating Wall			
10	**Twin Frame Wall** 1No. 12.5mm Type A Standard Plasterboard, 37mm x 48mm Timber battens, 3No. layers of 12.5mm Type F plasterboard fixed to LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs, 1No. layer of 12.5mm Siniat Weather Defence board, 40mm cavity, 1No. layer of 12.5mm Siniat Weather Defence board, LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs with 3No. layers of 12.5mm Type F plasterboard, 37mm x 48mm Timber battens, 1No. layer 12.5mm Standard Plasterboard fixed to the LGS C-studs. Timber battens create service cavity for sockets.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
11	**Twin Frame Wall** 1No. 12.5mm Type A Standard Plasterboard, 37mm x 48mm Timber battens, 3No. layers of 12.5mm Type F plasterboard fixed to LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs, 1No. layer of 12.5mm Glasroc X Board, 40mm cavity, 1No. layer of 12.5mm Glasroc X Board, LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs with 3No. layers of 12.5mm Type F plasterboard fixed to the LGS C-studs, 37mm x 48mm Timber battens, 1No. layer 12.5mm Standard Plasterboard fixed to the LGS C-studs. Timber battens create service cavity for sockets.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5

12	**Twin Frame Wall** 3No. layers of 12.5mm Type F plasterboard fixed to LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs, 1No. layer of 12.5mm Siniat Weather Defence–board, 40mm cavity, 1No. layer of 12.5mm Siniat Weather Defence board, LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs with 3No. layers of 12.5mm Type F plasterboard. No sockets.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
13	**Twin Frame Wall** 3No. layers of 12.5mm Type F plasterboard fixed to LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs, 1No. layer of 12.5mm Glasroc X Board, 40mm cavity, 1No. layer of 12.5mm Glasroc X Board, LGS C-Studs (89x45x1.2mm) at 400mm Centres with 100mm Stone Mineral Wool Insulation between the studs with 3No. layers of 12.5mm Type F plasterboard. No sockets.	EN 1365-1:2012	90 mins	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
Loaded Intermediate Floor Joist				
14	1No. layer of 12.5mm Type F plasterboard, onto 90mm LGS C-joists, with 100mm Stone Mineral wool between the ceiling joists, 11mm OSB3 was fixed to the top of the ceiling joists. A 15mm Deflection cavity space was provided between LGS ceiling joists and LGS floor joist. 200mm Floor C-Joists at 400mm centres were over the deflection cavity, with 18mm OSB3 fixed to the top of the LGS floor joists.	EN 1365-2:2014	30 mins from below ceiling level	1(a), 1(b), 1(c), 1(d), 2(b), 3, 4(a) and 5
Loaded Compartment Floor Joist				
15*	1No. 12.5mm Type A Standard Plasterboard, 37x48mm Timber Battens, 2No. 15mm Type F Fire Plasterboard, 90mm Deep LGS Ceiling Joists @400mm C/C, 100mm Stone Mineral Wool Insulation Between Ceiling Joists, 11mm OSB3 Board, 15mm Deflection Cavity Space, 250mm Deep LGS Floor Joists @400mm C/C, 37x47mm Bridging Members, 18mm OSB3 Floor Deck.	EN 1365-2:2014	90 mins from below ceiling level	1(a), 1(b), 1(c), 1(d), 2(b), 3, 4(a) and 5
Compartment Floor: Loaded Floors Composite Metal Deck				
16	**Loaded Floor Supporting Imposed Load of 2.0kN/m²** 160mm normal weight concrete with 1.2mm SMD TR60. Concrete reinforced with A393 Mesh with a minimum 30mm cover to top of mesh. 4500mm span propped at centre of span. 12mm Trough bar.	Eurocode Design	60 mins from below deck	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5
17	**Loaded Floor Supporting Imposed Load of 2.0kN/m²** 160mm normal weight concrete with 1.2mm SMD TR60. Concrete reinforced with A393 Mesh with a minimum 30mm cover to top of mesh. 4500mm span propped at centre of span. 16mm Trough bar.	Eurocode Design	90 mins from below deck	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5

Notes (from Table 5) :

- Type F plasterboard refers to the particular type of plasterboard tested in the respective fire tests and the details are available directly from MHI.
- 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 MHI.
- All wall tests were completed without the joints being taped and jointed.
- The loads tested on the structural walls in this table vary dependent on stud capacity. The Structural Engineer designing the MHI Modular Steel Frame building structure needs to ensure that testing loads are in accordance with the calculated Fire Limit State load for the building. Additional boarding may be required where appropriate project specific loading has not been tested.
- For alternative approached to fire safety requirements, refer to 0.2 of TGD B 2006 of the Building Regulations 1997 to 2019.
- Non-loadbearing wall fire resistance data is provided from the Load Bearing Test Data and can be utilised under the field of direct application whereby the load can be decreased on the specimen.
- *Note that Purpose Class 2(a) is removed from the construction in compliance with 3.2.5.1 of TGD B 2006 of the Building Regulations 1997-2019.

4.2 THERMAL INSULATION

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

TGD Part L of the Building Regulations 1997 to 2019 directs users to Digest 465 "U-values for light steel construction" published by BRE. A more precise result is obtained by using a numerical method which conforms to IS EN ISO 10211:2007.

Figure 10 gives the various elemental wall U-values in W/m^{2}K with a traditional 100mm masonry cladding with a 50mm unventilated cavity. In addition, sample U-values for ground floor slab for a range of perimeter to area (P/A) ratios are provided in Table 7 and 10. With the appropriate amount of insulation outside the steel frame, the system meets and can exceed the maximum back-stop elemental U-value requirements of Table 1 of TGD to Part L of the Building Regulations 1997 to 2019.

4.2.1 Limiting Thermal Bridging

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

Table 6 of this certificate gives ψ-value for a range of MHI building system junctions and their corresponding flanking elemental U-value. When flanking elemental U-values deviate by an aggregated 20% from the target U-values given in Table 6, the ψ-values no longer remain valid and guidance must be sought from the Certificate holder.

A full listing of ψ-value calculations, along with the building details on which calculations are based, are contained within the certificate holder's technical data sheets for ψ-values.

Bridged junctions where thermally modelled are in accordance with BRE IP 1/06 "*Assessing the effects of thermal bridging at junctions and around openings*" and BRE Report BR 497 "*Conventions for calculating linear thermal transmittance and temperature factors*" by NSAI Certified Thermal Modellers.

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

Where limited provisions are made to eliminate any risk of surface condensation or mould growth, the default "y" value of 0.15 should be taken. When <u>all</u> building junctions are demonstrated to be equivalent to or better than the corresponding Acceptable Construction Details (ACD), then the "y" value can be taken as 0.08.

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

ψ-values for other junctions outside the scope of this certificate should be assessed in accordance with the BRE IP 1/06 and BRE Report BR 497 in accordance with Appendix D of TGD to Part L of the Building Regulations 1997 to 2019.

4.2.2 Internal Surface Condensation

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

Table 6 of this certificate gives internal surface temperature factors (*f*Rsi) for a range of building junctions and their corresponding flanking elemental U-value.

The MHI MSF building system has been assessed and when detailed in accordance with this certificate, these thermally bridged junctions comply with the requirements of Section D.2 of Appendix D of TGD to Part L of the Building Regulations 1997 to 2019.

4.3 VENTILATION

4.3.1 Un-designed Air Infiltration

Air permeability can be measured by means of a pressure test and this is now a mandatory requirement under both TGD to Part L Conservation of Fuel and Energy – Buildings other than Dwellings and Conservation of Fuel and Energy - Dwellings of the Building Regulations 1997 to 2019. The backstop air permeability index is 5 $m^3/(hr.m^2)$ for Buildings other than Dwellings and 7 $m^3/(hr.m^2)$ for Dwellings at a pressure of 50Pa across the building envelope.

When inputting values into both DEAP and NEAP, the measured air permeability index at a pressure differential of 50Pa across the building envelope is divided by 20 to determine an air permeability value which is more representative of the actual pressure differential across the building envelope under normal conditions. The procedure for testing is specified in IS EN ISO 9972:2015.

Under Part L Conservation of Fuel and Energy – Dwellings, on each development, need an air pressure test to be carried out on at least one unit of each dwelling type. The basic or minimum number of air pressure tests for each dwelling type is described in Table 4 of TGD to Part L of the Building Regulations 1997 to 2019.

When using this method to demonstrate compliance for a multi-unit development, then the backstop air permeability index of 7 $m^3/(hr.m^2)$ must be entered in DEAP for all untested units.

When air permeability values better than the backstop values are targeted, a test must be performed on each unit. When air permeability values better than 5 $m^3/(hr.m^2)$ are achieved, the guidance given in Section 4.3.2 of this Certificate should be considered.

Under Part L Conservation of Fuel and Energy – Buildings other than Dwellings an air pressure test should be carried out on all buildings as outlined in Section 1.5.4.3 to Section 1.5.4.5 of Part L, to show attainment of backstop value of 5 $m^3/(hr.m^2)$.

The MHI MSF building system can be designed to provide the required project specific airtightness requirement and can be achieved in practice due to its offsite production process, hybrid construction build up and quality of product produced in a factory-controlled environment. The MHI MSF building system can therefore significantly contribute to the reduction of air permeability from a building. To enhance the airtightness performance an AVCL is installed on all external walls and ceiling lines but this must be done at design stage to maximize performance as part of the airtightness strategy and reduce penetrations of the airtightness line for the building. To avoid excessive heat losses due to un-designed air-infiltration, peripheral seals have been installed around windows, doors, services, floors, roof and all building junctions which penetrate the envelope of the building relied upon to perform the air sealing function of the building.

4.3.2 Designed Ventilation

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

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

When air permeability values better than 5 $m^3/(hr.m^2)$ are achieved, the basic provisions for background ventilators shall be increased as described in Clause 1.2.2.1 of TGD to Part F of the Building Regulations 1997 to 2019.

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

4.4 INTERSTITIAL CONDENSATION

4.4.1 Condensation in Walls

Calculations to BS 5250:2011+A1:2016 have been carried out for all possible wall build ups as covered by this certificate and predict no interstitial condensation within the external wall and pass the risk criteria in IS EN ISO 13788:2012.

An Air and Vapour Control Layer (AVCL) is provided on all external walls between the plasterboard and the steel studs or between the plasterboard and OSB when OSB is used to provide an additional layer of protection against interstitial condensation.

4.4.2 Condensation in Roof

In both cold (insulation at ceiling level) and warm (insulation along the slope) roofs, it is recommended that an AVCL is provided on the warm side of the insulation to limit the migration of moisture laden air from the dwelling entering into the roof structure through diffusion. The AVCL can double as an airtight membrane.

Roof ventilation should be provided in accordance with TGD Part F of the Building Regulations 1997 to 2019 and the recommendations of BS 5250:2011+A1:2016. It is important to ensure that the ventilation is not obstructed by roof insulation at eaves level. When roof insulation is packed into the eaves space, proprietary eaves tray may be provided to maintain ventilation at the eaves.

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

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

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

4.5 SOUND

4.5.1 Separating Walls (Party Wall)

The acoustic performance of the separating wall specified in Section 2.5.1 has been assessed by both on site testing and comparison with Robust Standard Details for Separating Wall - Modular Build Steel Frame E-WS-1 and *SCI Publication P 372 Acoustic Detailing for Steel Construction* (separating wall twin light steel frames) and through adopting best practice at salient junctions to minimise the effects of airborne, impact and flanking sound. In respect of a separating wall an examination was also carried out of the key junctions in the external walls to ensure compliance with the requirements of Part E of the Building Regulations 1997 to 2019.

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

- Structural isolation is achieved by leaving a minimum 40mm cavity between the two steel frames.
- Mass is achieved using dense wall linings. Each steel frame is boarded with one layer of 11mm OSB3 and with two layers of 15mm Fire grade plasterboard in accordance with Table 5 which provided the minimum 60- or 90-minutes' fire resistance required. All Joints in the plasterboard layer are staggered and room side joints in plasterboard are taped and filled.
- Reduction of flanking sound is achieved by sealing between the end of the separating wall frames and the outer masonry leaf as shown in Figure 10 and Figure 13.
- At the junction of the floor and the party wall, an additional 400mm section of stone mineral wool fiber insulation is provided within the floor void fully filling the floor void with non-combustible material. This is done both sides of the twin frame party wall. This mineral wool layer will also help to minimise flanking and direct sound transmission. This can be seen in **Error! Reference source not found.** and Figure 12.
- In addition to this a single layer of minimum 12mm fire rated board (Class A1 and minimum 30min fire rating) is installed to one side of the cavity to provide additional fire protection.

The separating wall in the MHI MSF building system has been assessed and when constructed in accordance with this certificate can meet the requirements of TGD to Part E of the Building Regulations 1997 to 2019.

4.5.2 Compartment Floor (Joist)

The acoustic performance of the compartment floor, specified in Section 2.1.3.1 and 2.1.3.2 has been assessed by comparison with Robust Standard Details for Separating Floor-Metal Joist E-FS-3 and *SCI Publication P 372 Acoustic Detailing for Steel Construction* (Separating floor, Light Steel Joists with boards). Best practice has been adopted at salient junctions to minimise the effects of airborne, impact and flanking sound. In respect of compartment floor (separating floor) an examination was also carried out of the key junctions with the external walls to ensure compliance with the requirements of Part E of the Building Regulations 1997 to 2019.

4.5.3 Compartment Floor Steel Concrete Composite Deck

The composite deck can meet either the 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 Section 4 of TGD to Part E of the Building Regulations 1997 to 2019.

In both floor types the resistance to airborne sound depends mainly on the mass of the concrete base, plasterboard ceiling and good flanking detailing. In a Type 1 floor the soft covering reduces the impact sound at source. The mass per unit area of the floor, coverings and ceilings meet the specification for a Type 1 separating floor.

The impact sound reduction is achieved with the use of a suitable approved 5mm 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.

4.5.4 On Site Testing

Sound insulation testing is now a mandatory requirement to comply with the TGD to Part E of the Building Regulations 1997 to 2019.

Successful on site, airborne insulation tests were also carried out on the MHI MSF Building System. The testing involved airborne sound insulation tests on separating walls between four pairs of rooms in accordance with IS EN ISO 16283-1:2014 and impact sound insulation to IS EN ISO 16283-2:2015 *Acoustics – Measurement of Sound Insulation in Buildings and of Building Elements Part 2: Impact Sound Insulation.*

MHI MSF building system wall and floor details have been assessed and when constructed in accordance with this certificate, can meet the minimum sound level performance outlined in TGD to Part E of the Building Regulations 1997 to 2019.

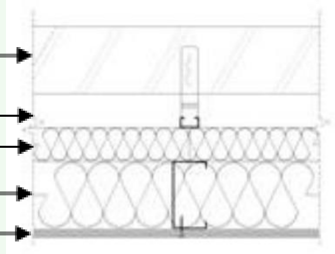
ACD Ref: ACD Detail	Junction Description	U_{Floor}	U_{wall}	U_{Roof}	Temperature Factors f_{Rsi} (Min=0.75)	Default Psi Values based on ACDs (W/m.K) for Hybrid Steel Frame walls with internal insulation[3]	Ψ-Values (W/m.K)
5.02.1	Suspended Slab - Insulation below slab	0.187	0.167	n\a	0.753	0.106	0.297
5.02.2	Suspended Slab - Insulation below slab with Thermal liteblock	0.187	0.167	n\a	0.803	0.106	0.223
5.03	First Floor- External Wall (Intermediate Floor)	n\a	0.167	n\a	0.943	0.055	0.005
5.04	-Party Wall Junction - Plan	n\a	0.167	n\a	0.900	0.057[1]	0.0415 [1]
5.05	Party Wall-Ceiling Section, insulated at ceiling level	n\a	0.163	0.098	0.816	0.095[1]	0.13 [1]
5.07/5.08	Eaves Detail, insulated at ceiling level	n\a	0.163	0.124	0.883	0.026	0.071
5.14/15	Gable end detail, insulated at ceiling level	n\a	0.163	0.124	0.827	0.034	0.139
5.19	Ope - Lintel - Mineral wool Cavity Closer	n\a	0.163	n\a	0.957	0.016	-0.002
5.20	Ope - Jambs - Mineral Wool Cavity Closer	n\a	0.163	n\a	0.964	0.019	0.004
5.21	Ope - Sill – concrete forward sill	n\a	0.146	n\a	0.982	0.021	0.0008
5.22.1	Separating Party wall base through ground floor - Discontinued Raft Slab	uf0.27	n\a	n\a	n\a	0.263 [1]	0.189 [1]
5.23.1	External wall - External corner	n\a	0.146	n\a	0.851	0.029	0.048
5.02	Ground Floor junction with SHS within wall panel (f_{Rsi} check). Rising wall encased in insulation.	0.147	0.166	n\a	0.75	0.106	N/A
5.02	Suspended Ground Floor with steel joists	0.099	0.166	n\a	0.76	0.106	0.224
5.18	Flat Roof – Parapet	n\a	0.166	0.092	0.812	0.054	0.118

(1) Value of Ψ is applied to both dwellings
(2) Some Ψ-values do not meet the default Ψ-values; however, all junctions pass f_{Rsi} assessments.
(3) Default Psi values are relevant to hybrid steel frame walls that would have internal insulation, whereas the proposed system by Modern Homes Ireland is a hybrid steel warm frame with external insulation.
Note: Thermal Models are based on typical MHI details. Separating walls should be modelled on a project specific basis.

Table 6: Typical Ψ -Values W/m.k

External walls U-value for variable PIR thickness

Wall Build-up:
Layer 1: Brick / masonry cladding
Layer 2: 50mm Low E cavity
Layer 3: Variable PIR insulation [2][3] See below
Layer 4: LGS / MW insulation [1]
Layer 5 15mm Plasterboard on AVCL



Wall thickness	PIR variable thickness	Calculated U-value (W/m²k)
327.5mm	60mm	**0.20**
337.5mm	70mm	**0.19**
347.5mm	80mm	**0.18**
357.5mm	90mm	**0.17**
367.5mm	100mm	**0.16**
377.5mm	110mm	**0.15**
387.5mm	120mm	**0.14**
397.5mm	130mm	**0.13**

Calculation comply with BRE Digest 465 *U-values for light steel-frame construction*
[1] Corrections have been made for 1.5mm LGS studs @ 600mm c/c bridging layer 4.
[2] A level 1 correction for air voids has been applied to layer 3 (IS EN ISO 6946 Section D.2.2 Table D.1)
[3] Correction for mechanical fasteners have been applied to layer 3 equating to 6 No. 5.4mm Ø Stainless steel fixing to connect brick tie channel to LGS section.

Note: All U-value calculations illustrated in the above U-value tables should be taken as examples of performance that can be achieved. U-value calculations shall be 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, type of insulation etc. This table relates to Thermal Performance only.

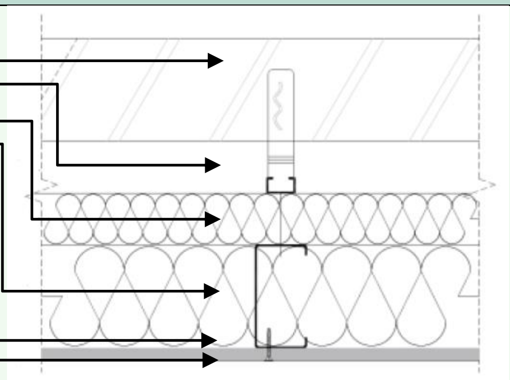
Table 7: U-Values of System Elements PIR Insulation

Effect on 0.18 W/m²K (80mm PIR) U-value for variations in LGS thickness and centres						
Centres of studs	**LGS Thickness (Gauge)**					
	0.8mm	1.0mm	1.2mm	1.5mm	2.0mm	2.5mm
300mm	0.19	0.19	0.19	0.20	0.20	0.20
400mm	0.18	0.18	0.18	0.19	0.19	0.19
600mm	0.17	0.18	0.18	**0.18**	0.18	0.18

Table 8: Effect on U-Value for Variations in LGS thickness and centres

Sample U-value Calculation for 80mm PIR					
Layer	Description	% Bridged	Thickness [mm]	Thermal conductivity λ [W/m K]	Thermal resistance R [W/m²K]
	Rse				0.040
1	Brickwork		102.5	0.77	0.133
2	Cavity Low-e (0.9, 0.06)		50	0.078	0.644
3	PIR Insulation		**80**	0.023	3.478
4	Mineral Wool	0.9975	89	0.040	2.225
	Steel Stud	0.0025	89	50	0.0018
5	Firecheck Plasterboard		15	0.25	0.060
	Rsi				0.130
				Ru Total =	6.702
				RL Total =	5.025
	From BRE Digest 465			P = 0.681, $R_T = pR_{max} + (1 - p)R_{min}$ =	6.172
				Correction term, ΔU =	0.01596
				Corrected U-Value (2DP) =	**0.18** W/m²K
Correction as described in Table 7 apply.					

Table 9: sample U-Value Calculation for 80mm PIR

External walls U-value for variable RW (0.035 W/m.K) thickness		
Wall build-up: Layer 1: Brick/masonry cladding Layer 2: 50mm Cavity Layer 3: Variable RW layer (2)(3) (see below) Layer 4: LGS/MW insulation (1) Layer 5: AVCL Layer 6: 15mm Plasterboard		
Wall thickness	**RW variable thickness:**	**Calculated U-value (W/m^2K)**
358mm	100mm	0.21
368mm	110mm	0.20
378mm	120mm	0.19
388mm	130mm	0.18
398mm	140mm	0.17
418mm	160mm	0.16
428mm	170mm	0.15
448mm	190mm	0.14
468mm	210mm	0.13

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

(1) Corrections have been made for 1.5mm LGS studs @ 600mm c/c bridging layer 4.

(2) A level 1 correction for air voids has been applied to layer 3 (IS EN ISO 6946 Section D.2.2 Table D.1)

(3) Correction for mechanical fasteners have been applied to layer 3 equating to 6 No. 5.4mm Ø Stainless steel fixing to connect brick tie channel to LGS section.

Note: All U-value calculations illustrated in the above U-value tables should be taken as examples of performance that can be achieved. U-value calculations shall be 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, type of insulation etc. This table relates to Thermal Performance only.

Table 10: U-Values of System Elements Stone Mineral Wool Insulation

Ground Floor Slab U-value for varying P/A ratio											
P/A Ratio	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60
U-value	0.086	0.097	0.105	0.11	0.114	0.116	0.119	0.12	0.122	0.123	0.124

Table 11: Typical Ground Floor U-Values

4.6 ACCESS FOR PEOPLE WITH DISABILITIES

4.6.1 Access and Use

Building designs can accommodate minimum dimensions for doors/corridors/rooms and circulation spaces to provide access for people with disabilities as indicated in Diagrams 5 – 12 of TGD to Part M of the Building Regulations 1997 to 2019.

4.6.2 Sanitary Conveniences

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

4.7 WEATHERTIGHTNESS AND DAMP PROOFING

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

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

In accordance with good practice Figure 11 illustrates the requirement for a drainage channel on the ground floor of all modules where there is a separating wall. This drainage channels reduces the risk of accidental flooding in one dwelling causing water damage to the neighbouring dwelling.

4.7.1 Floor Damp Proofing

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

4.7.2 Roof Cladding

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

4.7.3 External Cladding

The external wall with masonry/brick outer leaf incorporates a 50mm clear cavity, when correctly constructed with well filled perpends and mortar-free cavity ties, will minimise the risk of water reaching the cavity face of the inner leaf. For other NSAI Agrément approved wall cladding systems in exposed areas, a water barrier is fixed behind the 25mm (clean) cavity between the inner leaf and external cladding, and this minimises the risk of water reaching the inner lead.

Joints, in the insulating lining to the inner leaf, are weatherproofed and any penetrations are sealed. Wind driven rain, which may cross the cavity under adverse conditions, will be effectively prevented from penetrating the inner leaf.

The construction of the external panels also keeps the galvanised steel frame members in "warmframe" environment, which prolongs the life of the steel. Stepped DPC must be provided over window and door heads to deflect moisture that enter the cavity from entering the dwelling/building. Good building practice such as stepped DPC and weep-holes are essential to ensure that moisture within a cavity is deflected to the outside of the building.

4.7.4 Windows and Doors

The detailing at window and door openings has been assessed and is considered adequate to ensure that water penetration will not occur at these locations assuming conventional window frame profiles and sealing arrangements are used. Figure 18 illustrates a typical building detail that can be used with the system. The windows and doors are supplied and fitted in the factory by MHI and are generally designed and installed to close the cavity.
Windowsills and external thresholds must either be impervious, run the full width of the cavity and be suitably jointed to a horizontal, continuous cavity tray or DPC which is preferably flexible, or a cavity tray must be provided under the opening provision. Good attention to detail must be given to ensuring that, when installing the horizontal cavity tray or DPC below an external window board, provision for any condensation that may occur on the window is deflected into the cavity and away from the steelwork. The windows and doors are made to order by the window manufacturer using the dimensions provided by the MHI design office.

4.7.5 Rainwater Goods

Buildings constructed using the MHI MSF building system can readily accommodate adequate rainwater gutters and down pipes.

4.8 ELECTRICAL AND PLUMBING SERVICES

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

- At the design stage, it is useful if the positions and sizes of services can be established in advance, as special holes may be fabricated in the factory to help with the rapid and economic installation of services. A considerable amount of services is generally required in bathroom, hot press and utility areas.

- The steel frame at each floor level must be connected directly onto the main earthing terminal in the main fuse box and all earth connections in the circuit wired back to this point. This measure is necessary to control the flow of electric current to earth without the risk of corrosion of critical structural components. However, the earthing system must be installed in accordance with the National Rules of the Electro Technical Council of Ireland ET 101 (current version).
- All unswaged service holes in the steel members in the modules must be fitted with rubber or plastic grommets to avoid damage to services. To ease the installation of services, particularly electrical cables, these purpose-made rubber or polyethylene grommets form the inner face of the openings. The service holes may alternatively be formed by swaging which is fully rounded to offer a non-sharpened surface to the services. Where plastic coated electrical wiring is in contact with insulation, then the cables must be enclosed in a suitable conduit, e.g. PVC as outlined in Electro Technical Council of Ireland ET 101 (current version).
- Under no circumstances should electrical cables be placed within compartment floors, walls and/or party walls. Walls must be battened out to provide a false service zone in which to distribute electrical services on these fire rated build-ups.
- The enclosure of cold-water pipework within the external wall should be avoided as condensation on the pipe work could lead to wetting of the steel frame with a consequent risk of corrosion. If enclosure is unavoidable, the cold-water pipework must be insulated with tubular plastic insulation, which must be accurately cut at junctions and at changes of direction and held firmly in place with adhesive tape. Where hot water pipework is enclosed in the inner leaf of the wall, contact between copper pipes and the galvanised frame must be avoided using rubber or plastic grommets.
- Additional slots, notches or holes should not be cut through any steel member without the approval of the Chartered Structural Engineer responsible for the overall design of the structure.

4.9 DURABILITY

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

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

Buildings constructed using the MHI MSF building system will, when constructed in accordance with MHI Erection Manual and the requirements of this Certificate along with all relevant codes of practice will have design life of at least 60 years in accordance with BS 7543:2015.

4.10 MAINTENANCE

Maintenance will be required at a level comparable with that for buildings of traditional construction. The elimination of wet trades in the construction of the inner leaf of external walls reduces drying time and can reduce the incidence of superficial cracking early in the life of the building.

As the plasterboard is screwed into the steel structure, there is much less likelihood of nail popping in plasterwork, which results in less maintenance of plasterwork, than that of a traditionally constructed building.

Repainting should be carried out in accordance with the relevant recommendations of BS 6150:2006+A1:2014. 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.

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

4.11 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE THE FOLLOWING

The following is a summary of the tests and assessments which have been carried out on the MHI MSF building system:

- Structural strength and stability (racking resistance, load bearing capacity).
- Behaviour in relation to fire.
- System specific loadbearing fire testing to EN 1365-1 and EN 1365-2.
- Acoustic performance, resistance to airborne and impact sound transmission.
- Thermal insulation performance calculations.
- Corrosion of fasteners in normal conditions with a view to a minimum 60-year design life.
- Compatibility with other materials.
- Risk of condensation both surface and interstitial.
- Pre-completion airtightness testing.
- 3D thermal modelling of junction details in accordance with BRE IPI/06

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4.11.1 Other Investigations

Existing data was examined to assess:

- Adequacy of the MHI MSF Building System Erection Manual.
- Weather tightness of building constructed using the system.
- Durability of the system.
- Requirements for maintenance.

4.11.2 Production Audits

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

4.11.3 Site Erection Visits

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

Part Five / Conditions of Certification 5

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

a) the specification of the product is unchanged.

b) the Building Regulations 1997 to 2019 and any other regulation or standard applicable to the product/process, its use or installation remains unchanged.

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

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

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

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

5.1 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.

5.2 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

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

5.4 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, or of any other current or future common law duty of care owed by the manufacturer or by the Certificate holder.

5.5 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.

5.6 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. **17/0394** is accordingly granted by the NSAI to **MHI (Modern Homes Ireland) Ltd.** on behalf of NSAI Agrément.

Date of Issue: **September 2019**

Signed

Seán Balfe
Director of NSAI Agrément

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

Revisions: 6th September 2019 – To extend scope of use of the system

Bibliography:

IS EN 13501-1: 2007+A1:2009 Fire Classification of Construction Products and Building Elements Part 1: Classification Using Data from Reaction to Fire Tests.

BS 5250:2011+A1:2016 Code of practice for the control of condensation in buildings.

IP 1/06 Assessing the effects of thermal bridging at junctions and around openings.

BRE report BR 479 Conventions for calculating linear thermal transmittance and temperature factors.

IS EN ISO 10211:2007 Thermal Bridges in Building Construction - Heat Flows and Surface Temperatures – Detailed Calculations.

IS EN 1090-1:2009 Execution of Steel Structures and Aluminium Structures Part 1: Requirements for Conformity Assessment of Structural Components.

IS EN 1996-1-1:2005 + A1:2012 Eurocode 6 Design of Masonry Structures

BS 8102:2009 Code of practice for protection of below ground structures against water from the ground.

BS 9999:2017 Fire Safety in the Design, Management and Use of Buildings - Code of practice.

IS 325-1:2013 + A1:2014 Code of practice for use of masonry – Structural use of un-reinforced masonry.

IS EN 845-1:2013+A1:2008 Specification for ancillary components for masonry Part 1: Ties, Tension Straps, Hangers and Brackets.

IS EN 520:2004+A1:2009 - Gypsum plasterboard – Definitions and test methods.

IS EN 1993-1-3:2006 Eurocode 3 - Design of Steel Structures - Part 1-3: General Rules – Supplementary Rules for Cold-Formed Members and Sheeting.

IS EN 10162:2003 Cold Rolled Steel Sections - Technical Delivery Conditions - Dimensional and

Cross- sectional Tolerances.

IS EN 1993-1-5:2006 Eurocode 3 – Design of Steel structures - Part 1-5: Plated Structural elements.

IS EN 10346:2015, Continuously Hot-dip Coated Strip and Sheet of Structural Steels - Technical Delivery Conditions.

EN 1090-1:2009 Part 1+A1 2011

EN 1090-1:2018 Part 2

BS 8417:2011+A1:2014 Preservation of wood - Code of practice.

IS EN 1990:2002 Eurocode – Basis of Structural Design.

IS EN 1997-1:2005 Eurocode 7 Geotechnical Design – Part 1: General Rules.

IS EN 1993-1-1:2005/NA:2007+A1:2015 Irish National Annex to Eurocode 3: Design of steel structures - Part 1-1: General rules and rules for buildings

IS EN 1995-1-1:2004 Eurocode 5: Design of Timber Structures Part 1-1. General - Common rules and rules for Buildings.

IS EN 1991-1-1:2002 Eurocode 1: Actions on Structures Part 1-1: General actions - Densities, self-weight, imposed loads for buildings.

IS EN 1991-1-4:2005+NA:2013 Eurocode 1: Actions on structures - Part 1 -4: General actions - Wind actions

IS EN 1991-1-3:2003&AC:2009&A1:2015 Eurocode1- Actions on structures -Part1-3: General actions -Snow loads

BS 5234-1:1992 Partitions (including matching linings). Code of practice for design and installation.

IS EN 10143:2006, Continuously Hot-dip Coated Steel Sheet and Strip - Tolerances on Dimensions and Shape.

IS EN 1991-1-3:2007 Eurocode 1 – Actions on Structures

IS EN 1364-1:2015 Fire resistance tests for non-loadbearing elements, Part 1 – Wall.

IS EN 1365-1:2012 Fire resistance tests for loadbearing elements, Part 1 – Walls.

IS EN 1365-2:2014 – Fire resistance tests for loadbearing elements, Part 2 – Floors and roofs.

IS EN 1365-2:2000 Fire resistance tests for loadbearing elements, Part 2 – Floors and Roofs

BS 9991:2015 Fire Safety in The Design, Management and Use of Residential Buildings – Code of Practice.

IS EN 520:2005 GYPSUM Plasterboards - Definitions, Requirements and Test Methods

BS 476-7:1997 Fire tests on building materials and structures – Method of test to determine the classification of the surface spread of flame of products.

IS EN 1859:2009 Chimneys – Metal chimneys – Test methods.

IS EN ISO 9972:2015 - Thermal Performance of Buildings – Determination of Air Permeability of Buildings – Fan Pressurization Method.

IS EN ISO 13788:2012 Hygrothermal performance of building components and building elements and building elements – Internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation Methods.

IS EN ISO 6946:2017 Building components and building elements - Thermal resistance and thermal transmittance- Calculation methods

IS EN ISO 16283-1:2014 Acoustics - Field Measurement of Sound Insulation in Buildings and of Building Elements Part 1: Airborne Sound Insulation.

IS EN ISO 16283-2:2015 Acoustics -Field measurement of sound insulation in buildings and of building elements -Part2: Impact sound insulation.

ET 101:2008 National Rules for Electrical Installations, 4th Edition

BS 7543:2015 Guide to durability of buildings and building elements, products and components.

BS 6150:2006+A1:2014 Painting of buildings - Code of Practice