BRE CERTIFICATION Certificate of Assessment					

PRODUCT Modules and Cladding System used within the Vision Modular Structures Building System	CERTIFICATE NUMBER: 141/08 ISSUE DATE: February 2008 SUPPLIED BY VISION MODULAR STRUCTURES RINGPORT BUSINESS PARK RINGASKIDDY COUNTY CORK IRELAND Tel: 00353 21 4848200 Fax: 00353 21 4848230 Web:www.visionmodular.com

SUMMARY

The Modules used within the Vision Modular Structures Building System (VMS Building System) have been assessed to confirm, with limitations, their suitability as part of a prefabricated steel volumetric building system for use in single or multi occupancy residential buildings where the height of the top floor above ground is not more than 30m. This assessment covers the following items which form the module:

Floors	steel reinforced concrete placed in a structural steel frame of the required dimensions of the floor area of the volumetric module.
Structural wall panels	framework of Square (SHS) or Rectangular (RHS) Hollow Section steel studs welded to steel angle top and bottom rails. Stone mineral wool insulation fitted between the studs. Framework clad with magnesium and gypsum based wallboards
Ceilings	vierendeel trusses made from prefabricated steel RHS, which are lined on the underside with plasterboard.
Structural connections	steel brackets – angles and brackets welded and bolted into place.
Cladding and fire cavity barriers.	Brickwork, masonry or stone (grey and cream granite) exterior cladding and fixing system. Cavity barriers incorporating mineral wool.

The modules are manufactured off-site by VMS. The modules are completed with internal fixtures and fittings (both outside the scope of this certificate) relevant to their function and protected from the weather before being delivered to the construction site. The temporary protection is maintained until the exterior cladding is erected.

Characteristics of the modules and the stone cladding system have been reviewed with respect to the current Building Regulations British and European standards and other publications in the United Kingdom and Republic of Ireland in February 2008. The characteristics covered by this certificate are:

- Methodology of generic structural calculations
- Reaction and resistance to fire
- External fire performance
- Thermal transmittance and condensation risk
- Acoustic performance
- Weathertightness and durability
- Site installation
- Factory production

BRE Certification has reviewed the methodology of a set of generic structural calculations for a building incorporating the modules and found that methodology appropriate. Project specific structural calculations produced by a suitably qualified and experienced chartered engineer will be required in all cases.

The assessment is described in the following pages, which form integral parts of this certificate and which should be read in its entirety.

CONDITIONS OF USE

0.1 The modules of the VMS Building System and the cladding systems defined in this certificate are suitable for use in single or multi occupancy residential buildings where the height of the top floor above ground is not more than 30m. The 'height of the top floor' is taken as being the distance from the upper surface of the top storey floor to ground level on the lowest side of the building. Top storeys consisting exclusively of plant rooms are excluded from this measurement.

0.2 The structural adequacy of a building using the VMS Building System shall be confirmed and checked on a project and site-specific basis by suitably qualified and experienced chartered engineers. BRE Certification has reviewed the methodology of structural calculations for a seven storey building located in Co. Dublin, Ireland using the VMS Building System and having its lateral stability provided by core sections of traditional construction. Specific design including foundations, structural cores, overall building stability and roof design has not been assessed as part of the assessment and is therefore not covered by this certificate.

0.3 Based on a two hour structural fire performance test, for a typical storey height of 2.8m, the maximum fire limit state vertical stud load is 46kN for a 60 x 60 x 3mm structural hollow section.

0.4 A masonry external leaf and a VMS supplied stone (granite) cladding system, both with cavity barriers, have been assessed for cladding the walls of buildings incorporating these modules. Other cladding systems having third party approval may be used provided that their interface with the VMS Building System modules has been assessed by BRE C.

0.5 The modules of the VMS Building System are designed to be erected within a short period of time. Any structure shall be made fully weathertight through provision of the external cladding and roof covering as soon as reasonably practicable. However, the modules shall not be left without a weatherproof roof for more than one month after erection, or weatherproof walling for more than 3 months. In all cases, appropriate care shall be taken to ensure the protective weather proof boarding is not damaged.

0.6 The modules of the VMS Building System should only be used above over-site damp proof membrane (DPM) level.

0.7 Pre completion acoustic testing in accordance with Approved Document E *Resistance to the passage of sound* (England and Wales), has been carried out at one site in Ireland and was deemed to meet the performance requirements. However, future monitoring of acoustic compliance shall be carried out as defined in supporting document to the Building Regulations appropriate to where the building is sited.

0.8 The thermal performance (U-values, thermal bridges and condensation risks) of wall and ground floor elements and their typical junctions has been assessed. Where alternative or other details are required, e.g. when the VMS Building System has to incorporate a particular feature or for roofs; these shall be determined and used with relevant information documented in this certificate to demonstrate overall compliance. Compliance shall be demonstrated for each particular dwelling in relation to its CO_2 emissions.

0.9 Prior to transportation to site each module shall be quality checked, and weather protected as specified by VMS to prevent water ingress and potential wind damage during transportation. The VMS procedures for storage, lifting and handling shall be followed.

0.10 Components (outside scope of this certificate) which have not been assessed, but which may be incorporated in the modules, are to individual project specification. These shall conform with appropriate standards and codes of practice and include: claddings (other than as described in sections 1.1.6 and 1.1.7); windows; door sets; staircases; balconies; cavity trays; flashings; roofing materials; DPCs; rain-water goods; services; sanitary ware; fittings; finishes; tiling, painting, sealant and mastic.

0.11 The modules of the VMS Building System shall be installed and maintained strictly in accordance with the VMS Building System *Building Details and Installation Manual*.

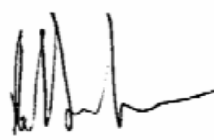
0.12 VMS is responsible for the design, manufacture, supply and the monitoring of the erection and/or dismantling of the system in accordance with their quality procedures. The quality of installation achieved on individual sites is not covered by this certificate and it is therefore essential that only VMS, or specialist subcontractor firms employing operatives approved, trained and monitored by VMS, shall undertake the assembly and installation.

STATEMENT

It is the opinion of BRE Certification that the Modules and Cladding System used within the Vision Modular Structures Building System are satisfactory for use within the stated conditions provided that they are used in accordance with the supplier's instructions and the requirements of this certificate.

CONFIRMATION

For and behalf of BRE Certification



Date : 8 February 2008

1. TECHNICAL SPECIFICATION

1.1 Description of Product

1.1.1 General system

1.1.1.1 The VMS Building System comprises:

1 sub-structure;
2 traditional cores;
3 modules;
4 exterior wall cladding;
5 exterior roof cladding;
6 prescribed fixings and structural connections; and,
7 fire stopping and cavity closers applied on site.

Only items 3, 4, 6 and 7 are the subject of this assessment and are therefore covered by this certificate.

1.1.1.2 The modules are manufactured in a variety of dimensions in order to produce floor layouts and room heights of the required sizes. Typical external module dimensions are shown in Table 1.

Table 1: Typical external dimensions of volumetric modules.

Module types	Module height (m)	Module width (m)	Length (m)
Standard	2.85 – 3.6	3.3 – 4.5	8.7 – 11.1
Link	2.85 – 3.6	3.3 – 4.5	2.5 – 8

1.1.2 Ceiling

1.1.2.1 The module ceilings are constructed from prefabricated steel Vierendeel trusses spaced at maximum 600mm centres spanning between the module walls. The Vierendeel trusses are typically 140mm deep and are fabricated from 50mm x 25mm RHS top and bottom chords and internals protected from corrosion by a minimum layer of 80 microns primer to meet exposure category C2 to BS EN ISO 12944-2 *Paints and varnishes - Corrosion protection of steel structures by protective paint systems*. *Classification of environments*

1.1.2.2 The underside of the trusses is lined with 15mm thick plasterboard. In areas where high levels of moisture are produced, vapour control plasterboard is used.

1.1.3 Floors

1.1.3.1 The module floor comprises materials as listed in Table 2a and arranged as Table 2b.

Table 2a: Typical materials used in the module floor

Material	Description and standards.
Welded perimeter frame (to the required dimensions of the finished floor area).	Parallel Flange Channels (PFC) BS 4-1 *Structural steel sections – Part 1: Specification for hot rolled sections.* Steel grade S275 or S355 to BS EN 10025-2: *Hot rolled products of structural steels – Part 2 Technical delivery conditions for non-alloy structural steels.* Exposed steel work is protected from corrosion by a minimum layer of 80 microns primer to meet exposure category C2 to BS EN ISO 12944-2.
Steel reinforcing.	A142 mesh (typical) near the top; A393 mesh (typical) near the base. Other reinforcement is added as required depending on span/applied loads to prevent hogging and sagging, during temporary lifting, transportation and permanent condition. Concrete cover to the steel reinforcement in accordance with BS 8110-1 *Structural use of concrete Part 1: Code of practice for design and construction* for the required fire resistance.
Concrete.	Self levelling and compacting. 'Compressive strength class' of concrete to be C32/40 (specified in accordance with EN 206-1 Concrete – Part 1: *Specification, performance, production and conformity)*
Floor covering	Soft covering bonded to floor base to meet requirements stated in the appropriate supplementary documents to the Building Regulation (See 1.2.5.2)

Table 2b: Arrangement of materials in module floor/ceilings

Fire Resistance Separating internal floor. See Figs 2 and 6	- 150mm thick steel reinforced concrete slab (base of upper module) 25mm minimum cover provides 90 minutes fire resistance* 35mm minimum cover provides 120 minutes fire resistance* *(in accordance with the requirements of BS 8110-1) - 25mm cavity - 140mm deep steel Vierendeel ceiling truss at 600mm centres - 15 mm thick plasterboard

1.1.3.2 The PFC base frame has cut outs at the module corners to allow for the corner vertical ties (angle) of the wall panels. A number of 130mm long dynamic couplers are welded between the flanges of the PFCs to provide reinforced lifting points. Stiffeners are welded into the PFC at lifting locations with rebar, anchored into the slab to resist any twisting of the channel during lifting.

1.1.3.3 Brackets for balconies (outside the scope of this certificate) and the mounting of the stone cladding system are welded to the PFC frame, if required.

1.1.3.4 Additional corrosion protection treatment shall be provided, where necessary, to perimeter steelwork to ground floors on a site and project specific basis in accordance with the requirements of BS EN ISO 12944-2.

1.1.4. Walls

1.1.4.1 The module walls are prefabricated by an approved VMS assembly plant to a defined specification reviewed by BRE Certification.

1.1.4.2 Table 3a describes the materials used in the walls. Table 3b lists the construction configuration for the walls which have been included in this assessment. All these construction configurations have been assessed for fire resistance, thermal and acoustic performance.

1.1.4.3 The perimeter module walls (around module floors) are load bearing. Separating/party walls with a cavity are produced when the walls of two adjacent modules are put together onsite. Most internal walls of dwellings are also made from the walls of two modules. Internal non load-bearing partitions are fitted within modules around bathrooms and cupboards containing services.

Table 3a: Materials used in the module walls

Materials	Descriptions and standards	Reaction to fire classification
1. Structural framework – non loadbearing walls	50mm x 50mm Square hollow section (non load-bearing partitions) or 50mm light gauge steel C studs at 600 mm centres; or 47mm x 75mm Timber Stud at 600 centres.	Not applicable
2. Structural framework - loadbearing walls	Studs - 60mm to 80mm wide Square Hollow Section (SHS) and/or Rectangular Hollow Section (RHS). Manufactured to - BS EN 10219-1 *Cold formed welded structural hollow sections of non-alloy and fine grain steels. Technical delivery requirements* Sides of studs lined with Fusion Fire Board. Top and bottom rails - Typically 60x60x6mm or 80x80x8mm Rolled Steel Angles (RSA) welded to the box sections studs	Class O, Low Risk
3. Insulation	1. 60mm Rockwool insulation 50kg/m^3 2. 60mm Rockwool insulation 100 kg/m^3 3. 25mm glass mineral wool insulation 16kg/m^3 4. Glasswool 24kg/m^3	Non-combustible
4. Fusion Fire Board	1. 12mm Fusion Fire Board (1000kg/m^3) 2. 15mm Fusion Fire Board 1000kg/m^3 3. 12mm Fusion Fire Board (1300kg/m^3)	Class O, Low Risk
5. Non-combustible board	1. 9mm Fusion Non Combustible Fire Board (1100kg/m^3) 2. 11mm Fusion Non Combustible Fire Board (1100kg/m^3)	(Non-combustible)
6. Plasterboard	1. 12.5mm thick Lafarge Firecheck (Type 5) plasterboard 2. 12.5mm thick Moisture Resistant plasterboard 3. 15mm thick Lafarge Firecheck (Type 5) plasterboard	Class O, Low risk
7. External wall insulation on module.	1. Foil Faced Polyisocyanurate Insulation to BS EN 13165 *Thermal insulation products for buildings. Factory made rigid polyurethane foam (PUR) products - Specification*, held in place with proprietary 60mm x 44mm treated timber battens.	Class 1
8. Cavity barrier	Stone mineral wool	
9. Proprietary stone cladding system	Austenitic stainless steel angles and ties to BS EN 10088: *Stainless steels. Technical delivery conditions for sheet/plate and strip for general purposes*, bridging a 50mm cavity. Stone cladding units to BS 8298 *Design and installation of natural stone cladding and lining*	Non-combustible
10. Masonry wall cladding with ties.	Austenitic stainless steel wall ties and fixing channel bridging a nominal 50mm cavity. To BS EN 845 Part 1: *Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets* Conventional masonry cladding to BS 5628: Part 3: *Code of practice for use of masonry: materials and components, design and workmanship.*	Non-combustible
NOTE: The superscript references in Table 3b refer to this table. The first number refers to the Materials column of this table and the second number (where present) refers to the Descriptions and standards column.		

Table 3b- Arrangement of materials in module walls, Tested Wall Specifications and Construction finishes (See Note to Table 3a for explanation of superscript references)

Wall type	Construction details
Load bearing Separating / External Wall (W1) 60 minutes fire resistance, from inside Room	- 12.5mm Lafarge Firecheck Wallboard (6.1) - 9mm Fusion Non Combustible Fusion Fireboard (5.1) - 60mm thick structural framework 60x60x3mm SHS steel stud (2) without 11mm Fusion Fire board fillets to sides, with 60mm Insulation (3.1) between studs.) - 60mm thick external wall Insulation (7) - 8mm Fusion Non Combustible Fusion Fireboard (5.1) Cladding System with cavity barriers(8) appropriate cavity and mounting system (9or 10)
Load bearing external wall (W2). 90 minutes fire resistance from inside room.	- 12.5mm thick Firecheck wallboard (6.1) - 15mm thick Fusion Fire Board (4.2) - 60mm thick structural framework 60 x 60 x 3mm SHS steel stud(2) with 60mm thick insulation(3.1) between studs. - 12mm thick Fusion Fire Board (4.1) - 60mm thick external wall insulation(7) Cladding system with cavity barriers(8) appropriate cavity and mounting system (9or 10)
Load bearing separating wall (W3) 90 minutes fire resistance, from either side.	- 12.5mm thick Firecheck wallboard(6.1) - 12mm thick Fusion Fire Board (4.1) - 60mm thick structural framework 60 x 60 x 3 mm SHS steel stud(2) with 60mm thick insulation(3.1) between studs - 12mm thick Fusion Fire Board (4.1) - 30 mm thick cavity fully filled with glasswool 24kg/m^3 (3.4) - 12mm thick Fusion Fire Board (4.1) - 60mm thick Structural framework 60 x 60 x 3 mm SHS steel stud(2) with 60mm thick insulation(3.1) between studs - 12mm thick Fusion Fire Board (4.1) - 12.5mm thick Firecheck wallboard (6.1)
Load bearing separating wall (W4) 120 minutes fire resistance, from either side. See Fig 2, 4.	- 12.5mm thick Firecheck wallboard (6.1) - 11mm thick Fusion Non Combustible board (5.2) - 60mm thick structural framework 60x60x3mm SHS steel stud(2) with 60mm thick insulation (3.1) between studs - 9mm thick Fusion Non Combustible board (5.1) - cavity fully filled with glasswool 24kg/m^3 (3.4) (For UK only) - 9mm thick Fusion Non Combustible board (5.1) - 60mm thick structural framework 60x60x3mm SHS steel stud(2) with 60mm thick insulation (3.1) between studs - 11mm thick Fusion Non Combustible board (5.2) - 12.5mm thick Firecheck wallboard (6.1)
Load bearing external wall (W5) 120 minutes fire resistance from inside room. See Fig 1,3,7,8	- 12.5mm thick Firecheck wallboard (6.1) - 11mm thick Fusion Non Combustible board (5.2) - 60mm thick structural framework 60x60x3mm SHS steel stud(2) with 60mm thick insulation (3.1) between studs - 9mm thick Fusion Non Combustible board (5.1) - 60mm thick external wall insulation(7) - 9mm thick Fusion Non Combustible board (5.1) - Cladding system with cavity barriers(8) appropriate cavity and mounting system (9or 10)
Load bearing separating wall (W6) 180 minutes fire resistance, from either side. See Fig 5	- 12.5mm thick Firecheck Wallboard (6.1) - 24mm thick – 2 x 12mm Fusion Fire Board (1300kg/m3) (4.3) - 60mm thick structural framework 60 x 60 x 3 mm SHS steel stud(2), with 60 insulation(3.2) between studs. - 12mm thick Fusion Fire board(4.1) - 30mm thick cavity fully filled with glasswool 24kg/m^3 (3.4) - 12mm thick Fusion Fire board(4.1) - 60mm thick structural framework 60 x 60 x 3 mm SHS steel stud(2), with 60 insulation(3.2) between studs - 24mm thick – 2 x 12mm Fusion Fire board (1300kg/m3) (4.3) - 12.5mm thick Firecheck Wallboard (6.1)
non-load bearing partitions. (within modules) (non-separating module wall) (W7) 30 minutes fire resistance	<u>SHS Stud Wall</u> - 12.5mm thick Firecheck wallboard (either 6.1 or 6.2) either - 50 x 50 x 2 mm SHS at 600 mm centres; or - 50mm Lafarge Cormet C stud at 600 mm centres; or - 47mm x 75mm Timber Stud at 600 centres. - 25mm thick insulation(3.3) between studs. - 12.5mm thick Firecheck wallboard (either 6.1 or 6.2)

1.1.5. Module Assembly

1.1.5.1 The (prefabricated) walls are erected onto the floor channels and bolted in place. The wall panels are connected together at each corner with corner angles, which are 50 x 50 RSA with 12mm thick end plates. The corner angles extend from the top of the wall to the underside of the base channel and form part of the vertical tie system. They are welded to the adjacent box sections.

1.1.5.2 The bearing plates of the ceiling trusses are factory welded onto the top angle of the wall panels. The bearing plates are located in each module to provide direct vertical in-line load transfer from studs above, through the concrete floor and bearing plate to the studs directly below.

1.1.5.3 The module walls which form the external walls of the building are additionally fitted with PIR insulation with an outward facing foil face. The thickness of the insulation will be determined by the thermal performance requirements of the building design in accordance with Section 1.2.6 of this certificate. The insulation is held in place with treated timber battens at 600mm centres which also provide the grounds for fixing the outer weather protective layer of Fusion Fireboard. Once on-site the insulation is clamped to the frame with the additional fixing of stainless steel wall tie channels screwed to the studs.

1.1.6 Proprietary stone cladding system

1.1.6.1 The proprietary stone cladding unit comprises igneous rock (Granite) typically 1000mm wide by 750mm high by 40mm thick. The cladding units have reveals around openings such as doors and windows to reduce the cavity width.

1.1.6.2 The proprietary cladding units are fixed back to the steel framework of the modules by proprietary stainless steel load bearing cladding fixings and proprietary stainless steel lateral restraint fixings (as defined in BS 8298: *Code of practice for design and installation of natural stone cladding and lining*). These are fitted on site by VMS approved contractors to the exterior wall panels, leaving a 50mm (40mm for use in Republic of Ireland) clear drained cavity with weep holes at the horizontally positioned vertical cavity barriers. Further guidance on the use of the stainless steel load bearing cladding brackets and restraint fixings can be obtained from VMS. The Structural Engineer in conjunction with Stone cladding supplier Structural Engineer shall determine the structural requirements of the brackets and tie system.

1.1.6.3 The load-bearing cladding fixings are generally made from 8 mm thick stainless steel plate grade 1.4301 and 1.4307 to BS EN 10088. Grade 1.4401 and 1.4404 stainless steel shall be specified for brackets and fixings in coastal locations. The angles are bent at 90^{o} and are bolted onto brackets which are welded to the module floor frame (Figure 12). The load-bearing cladding fixings fit into slots cut into the back of the stone cladding units. Each load bearing cladding fixing bridges across two stone cladding units and supports the weight of the stone cladding units above it to the next storey as shown in Figure 11.

1.1.6.4 Restraint fixings are slotted into vertical stainless steel channels which are fixed to the structural hollow section studs by screws which shall be fitted with suitable isolating washers under the head. Screws shall be protected with a thickness of zinc and passivation/organic coating suited to the design life and atmospheric environment of the building. The restraint fixings incorporate dowels which are glued into holes drilled into the perimeter of the cladding units (typically 2 in the top and 2 in the bottom) as shown in Figure 11. Further guidance on the use of the stainless steel load bearing cladding brackets and restraint fixings can be obtained from VMS. The VMS Structural Engineer in conjunction with the stone cladding supplier's Structural Engineer shall determine the structural requirements of the brackets and tie system.

1.1.6.5 The joints between the stone cladding units are filled with a proprietary elastic one component sealant.

1.1.6.6 The durability of the stone has been assessed by testing the flexural strength, density, water absorption and a petrographic examination of the stone to BS EN 12407:2000 *Natural stone test methods Petrographic examination* (see Table 12). Flexural strength tests were carried out before and after freeze thaw. The petrographic examination of the stones confirmed that the stone was medium grained granite. The examination also confirmed that the granite contained no minerals or fractures/micro fractures, which would adversely affect the performance life of the stone.

1.1.7 Conventional masonry wall cladding

1.1.7.1 The conventional outer leaf masonry walls shall be fixed back to the steel framework with the proprietary stainless steel wall tie and channel system, pre-fitted by VMS to the exterior wall panels, leaving a 50mm clear drained cavity. Further guidance on the use of the stainless steel wall tie and channel system can be obtained from VMS.

1.1.8 Cavity barriers between modules and between modules and cladding

1.1.8.1 Stone mineral wool is cut to size and compacted between modules and between the module wall and the cladding system at vertical and horizontal module connections.

1.1.8.2 The stone mineral wool shall have a density of 100 kg/m^3.

1.2 PRODUCT PERFORMANCE

1.2.1 General

1.2.1.1 The VMS Building System, when employed as a method for forming the superstructure of a building, is considered suitable for use in single or multi occupancy residential buildings where the height of the top floor above ground is not more than 30m provided that the requirements of this certificate are complied with. Detailed specifications and drawings for the materials and components covered by this certificate have been examined and are retained by BRE Certification.

1.2.1.2 VMS Building Systems retain responsibility for the generation of all architectural and assembly drawings needed for manufacture of the modules and erection of the building modules on site.

1.2.1.3 Building Regulation compliance is the responsibility of the project Architect.

1.2.2 Structural Performance

1.2.2.1 BRE Certification has examined the structural design methodology of modules used within the VMS Building System for a residential building. The features assessed included the following:

- building height of seven storeys
- overall stability provided by 'traditional' reinforced concrete cores
- racking resistance of module walls not considered in calculations
- concrete slabs (module floors) form diaphragm transferring horizontal loads to the cores.

Fig 9 illustrates a typical module to core connection detail.

1.2.2.2 This examination demonstrated the design to be in accordance with the following codes of practice:

BS 5950: Part 1: *Structural use of steelwork in building: Code of practice for design. Rolled and welded sections*
BS 6399: Part 1: *Loading for building: code of practice for dead and imposed loads*
BS 6399: Part 2: *Loading for building: code of practice for wind loads*
BS 6399: Part 3*: Loading for building: code of practice for imposed roof loads*
BS 8110: Part 1: *The structural use of concrete*

1.2.2.3 The substructure, cores, and roof structure are site and project specific and are outside the scope of this certificate. These shall be designed by a suitably qualified and experienced chartered engineer in accordance with all documented procedures (e.g. BS 8004 for foundations) to support and react against loads.

1.2.2.4 Based on a two hour structural fire performance test, for a typical storey height of 2.8m, the maximum fire limit state vertical stud load is 46kN for a 60 x 60 x 3mm structural hollow section.

1.2.2.5 The structural assessment of the building shall be site and project specific and demonstrate that all the requirements of the relevant Building Regulations and this certificate are complied with. The structural engineering of the building shall be undertaken by a suitably qualified and experienced chartered engineer. In accordance with good practice a second competent engineer shall check all designs.

1.2.2.6 VMS Building Systems retain full control of the design of the superstructure, including holding down provisions, loadings imposed on and by the overall construction and roof design.

1.2.3 Fire Performance

1.2.3.1 Fire resistance

1.2.3.1.1 The fire resistance for the floors has been determined by assessment in accordance with BS 8110: Structural use of concrete – Part 1: Code of practice for design and construction and Part 2: Code of practice for special circumstances. The results are shown in Table 4a.

Table 4a – Fire resistance of module floor constructions.

Construction element	Figure Ref.	Fire resistance period (minutes)
Reinforced concrete floor 25mm concrete cover over steel reinforcement	2, 6	90
Reinforced concrete floor 35mm concrete cover over steel reinforcement	2, 6	120

1.2.3.1.2 The fire resistance of wall constructions have been determined by test and assessment. The fire resistance of load bearing and non-load bearing walls has been assessed in accordance with:

- BS EN 1365 Part 1: *Fire resistance tests for loadbearing elements - Walls*
- BS 476 Part 22: *Fire tests on building materials and structures – Methods for determination of the fire resistance of non-loadbearing elements of construction*.

A summary of the results is given in Table 4b below.

Table 4b: Fire resistance of wall details

Construction element (W reference from Table 3b)	Figure Ref.	Fire resistance period (minutes)
Load bearing walls tested to BS EN 1365-1		
Separating wall (W1)	N/A	REI 60
External cavity wall (W2) Brick or stone clad*	N/A	REI 90
Separating wall (W3)	N/A	REI 90
Separating wall (W4)	2, 3, 4	REI 120
External cavity wall (W5) Brick or stone clad*	1, 3, 8	REI 120
Separating wall (W6)	5	REI 180
Non-load bearing walls assessed to BS 476 Part 22		
Internal partitions (W7)	N/A	30 Insulation & Integrity
* The external wall was not tested with the brick or stone cladding in place. Where an external wall is located within 1m of a boundary an assessment will be required for each cladding system.		

1.2.3.1.3 Any dampers, ductwork, and sealing of gaps (all outside the scope of this certificate) formed by services that pass though the compartment walls and floors, shall use suitably tested/assessed systems for the required fire resistance period. Details around penetrations and openings such as door sets and windows shall avoid any excessive heat ingress into the wall cavities.

1.2.3.1.4 Cavity barriers and fire stops shall be correctly located and detailed as specified in the VMS fire stopping details and in accordance with the supporting documents to the Building Regulations. Each external wall cavity shall be closed at separating elements and around each module, including at the head. Cavities between modules shall also be closed off. A dedicated VMS installation team responsible for all fire stopping to the modules shall fit the cavity barriers and fire stops. The VMS site quality manager shall inspect and record all fire stopping at each floor level on the fire stopping check sheets supplied by VMS, which are kept on site for inspection. In addition to this site supervision a third party fire inspection shall be carried out by nominated fire consultants as required by the VMS installation manual.

1.2.3.1.5 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.

1.2.3.1.6 Services, i.e. sockets and switches, are permitted within the structural walls (including compartment and separating walls) of the VMS Building System as each wall is backed by a non-combustible board and each service is surrounded by non-combustible mineral wool. Additionally, each stud member is lined with non-combustible board giving full protection to the wall. Figure 13 illustrates this. All services are installed in a factory controlled environment and are checked before transport to site. No services are allowed to pass through separating walls. All fire and

acoustic testing on the VMS Building System walls has been carried out with services installed in the walls.

1.2.3.2 Reaction to Fire

1.2.3.2.1 The wall and ceiling lining plasterboards identified in Tables 2 and 3 have been demonstrated by fire testing to the following standards to achieve a 'Class 0' as defined in supporting documents to the Building Regulations for England and Wales and Northern Ireland and a 'low risk' as defined in the Technical Handbook (Scotland) Section 2:

- BS 476 Part 6 *Fire tests on building materials and structures. Method of test for fire propagation for products.'* and
- BS 476 Part 7 '*Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.*

1.2.3.2.2 The external wall insulation is Class 1.

1.2.3.3 Reaction to Fire – Cladding

1.2.3.3.1 The fire performance of the stone, brackets, fasteners, ties, and cavity barriers was assessed by testing the VMS Building System (having a floor to floor height of 2.8m) to BS 8414 Part 2: *Fire performance of external cladding systems – Part 2: Test method for non-loadbearing external cladding systems fixed to and supported by a structural steel frame*. The wall build up (see Figure 1) met the fire performance requirements based on Annex B of BR 135*: Fire performance of external thermal insulation for walls of multi-storey buildings.*

1.2.4 Environment.

1.2.4.1 Weathertightness of the building relies upon a conventional masonry external leaf or proprietary stone cladding system, a drained cavity and a water and vapour resistant layer on the outside of the modules.

1.2.4.2 Assuming conventional materials to the appropriate standards and adequate workmanship are used, the systems defined in 1.2.4.1 can adequately resist the passage of moisture into the building from precipitation provided that correct detailing and finishes at the openings and joints (stone cladding) are incorporated. This performance can be maintained subject to regular inspection and repair of damaged or defective materials.

1.2.4.3 Ground floor elements and junctions can be detailed to adequately resist the passage of moisture from the ground assuming conventional materials and adequate workmanship is used. The VMS Building System should only be used above over-site damp proof membrane (DPM) level.

1.2.5 Acoustic Performance

1.2.5.1 'Pre completion' acoustic testing, UKAS accredited, (as defined in Approved Document E: Resistance to the passage of sound (England and Wales)) was carried out between rooms of different occupancy within one building to assess airborne and impact sound insulation of the walls and floors. The testing and assessment was carried out in accordance with:

- BS EN ISO 140, *Acoustics - Measurement of sound insulation in buildings and of building elements - Part 7: Field measurements of impact sound insulation of floors.*
- BS EN ISO 140, *Acoustics - Measurement of sound insulation in buildings and of building elements - Part 4: Field measurements of airborne sound insulation between rooms.*
- BS EN ISO 717, *Acoustics - Rating of sound insulation in buildings and of building elements – Part 1: airborne sound insulation*
- BS EN ISO 717, *Acoustics - Rating of sound insulation in buildings and of building elements – Part 2: impact sound insulation*

1.2.5.2 The results obtained were assessed against guidance values stated in the following documents:

- Approved Document E: Resistance to the passage of sound (England and Wales)
- Technical Handbook Domestic, Section 5, Noise (Scotland)
- Technical Booklet G: Sound (Northern Ireland)
- Technical Guidance Document E: Sound (Ireland)

1.2.5.3 Four separating walls (construction type W3 in Table 3b) were tested for airborne sound insulation. The guidance values and single number quantity derived from the test results are shown in Table 5

Table 5: Values for assessing separating walls for airborne sound insulation

Country		Units	Guidance requirement min. (dB)	Test results		
				Mean (dB)	Min (dB)	SD (dB)
E & W	Dwelling houses and flats	$D_{nT,w}+C_{tr}$	45	48.25	46	2.6
	Rooms for residential purposes		43			
S, NI, I	Residential buildings	$D_{nT,w}$	53 (mean) 49 (min)	63	61	1.7

1.2.5.4 Four concrete separating floors were tested for airborne sound insulation. The guidance values and single number quantities derived from the test results are shown in Table 6. The mass per unit area of the floors, coverings and ceilings meets the specifications for a Type 1 separating floor as defined in Approved Document E (2003 Edition): *concrete base with ceiling and soft floor covering*.

Table 6: Values for assessing separating floors for airborne sound insulation

Country		Units	Guidance requirement Min. (dB)	Test results		
				Mean (dB)	Min (dB)	SD (dB)
E & W	Dwelling houses and flats Rooms for residential purposes	$D_{nT,w}+C_{tr}$	45	53	52	1.1
S, NI, I	Residential buildings	$D_{nT,w}$ (dB)	52 (mean) 48 (min)	58.75	58	1.0

1.2.5.5 Four concrete separating floors were tested for impact sound insulation. The guidance values and single number quantities derived from the test results are shown in Table 7. The mass per unit area of the floors, coverings and ceilings meets the specifications for a Type 1 separating floor as defined in Approved Document E (2003 Edition): *concrete base with ceiling and soft floor covering*. Testing was conducted with one 5mm layer of a soft floor covering (Damtec), which meets the thickness requirements for soft floor coverings in 3.28 of Approved Document E (2003 Edition). This covering is not intended to be the final floor finish but is intended to act as a resilient layer beneath a number of different finishes such as vinyl, carpet, laminate flooring, tiles. Soft floor coverings for Type 1 floors defined in 3.28 of Approved Document E (2003 Edition) are intended to be final floor finishes.

Table 7: Values for assessing separating floors for impact sound insulation.

Country		Units	Guidance requirement Max (dB)	Test results		
				Mean (dB)	Max (dB)	SD (dB)
E & W	Dwelling houses and flats Rooms for residential purposes	$L'_{nT,w}$ (dB)	62	47.75	49	1.9
S, NI, I	Residential buildings	$L'_{nT,w}$ (dB)	61 (mean) 65 (max)	47.75	49	1.9

1.2.5.6 3.28 of Approved Document E (2003 Edition) defines soft floor coverings in terms of their reduction in impact sound pressure level (ΔL_w) when this is measured in accordance with BS EN ISO 140-8:1998. Any floor covering having ΔL_w of not less than 17 dB is considered to be a soft floor covering suitable for use on Type 1 separating floors. The soft floor coverings tested and their measured values of ΔL_w are shown in Table 8.

Table 8: measured values of ΔL_w for soft floor coverings

Soft floor covering	ΔL_w (dB)
9 mm laminate flooring on 3 mm Damtec	18
Carpet on carpet underlay	43
9 mm laminate flooring on 5 mm Damtec	18
10 mm ceramic tiles on 5 mm Damtec	17

1.2.5.7 The measured values of ΔL_w for the floor coverings in Table 8 demonstrate that they are suitable for use on Type 1 separating floors as defined in Approved Document E (2003 Edition).

1.2.5.8 In England and Wales, the airborne and impact sound insulation of the separating floors described in tables 2b and 3b will be confirmed on each development by pre-completion testing using the procedures for sound insulation testing described in Annex B of Approved Document E (2003 Edition).

1.2.5.9 The non-load bearing partitions (within modules) forming internal walls within one occupancy as defined in Table 3b and the non-separating module walls within one occupancy described in Figure 6 are assessed as equivalent to 'internal wall type B' described in Section 5 of Approved Document E (2003 Edition), England and Wales, with regard to airborne sound insulation.

1.2.5.10 Results obtained from testing walls and floors on a single project have been used in the preparation of this certificate for sound insulation performance standards for UK and Ireland. On the basis of just four tests it is not possible to give statistical confidence that compliance will be achieved. Therefore future testing to show compliance shall be carried out as defined in the supporting documents as shown in Section 1.2.5.2 e.g. New buildings in England and Wales using this system shall require pre-completion testing as defined in Approved Document E.

1.2.6 Thermal Performance

1.2.6.1 The modules of the VMS Building System are designed as hybrid warm frame.

1.2.6.2 Some building elements, namely the roof, ground floor, windows and doors are site and project specific. The U-value of these elements will have to be calculated before overall compliance with the relevant building regulations can be determined.

1.2.6.3 BRE Certification has assessed the thermal performance of the typical details as listed in this certificate. The assessment involved the calculation of the U-value of the building elements and checking the junction details between elements and around openings for compliance with:

- Approved Document L1 of the Building Regulations (England and Wales),
- The Building (Scotland) Regulations 2004 Section 6,
- Technical Booklet F of the Building Regulations (Northern Ireland), and,
- Technical Guidance Document L: Conservation of fuel and energy Dwellings (Ireland).

1.2.6.4 A summary of the calculated U-values is given in Table 9. The U-value calculations have been made according to the calculation method of BS EN ISO 6946 *Building Components and building elements – thermal resistance and thermal transmittance – calculation method*.

1.2.6.5 Compliance is demonstrated for any particular dwelling with regard to its emissions of CO_2 where the Dwelling Emission Rate (DER) is shown to be no greater than the Target Emission Rate (TER) as calculated using SAP 2005 or SBEM. Demonstrating compliance for a particular example dwelling is not covered in this certificate. In addition, compliance with AD L1 requires calculated U-values that are all lower than the limiting U-value requirements given in that document.

1.2.6.6 Table 9: U-value of system elements.

Fig Ref.	Building element	Calculated U-value (W/m²K)
External wall		
Fig 8	Brick cladding	0.22
Fig 1	Stone cladding	0.25
	Cedar cladding (Penthouse wall)	0.24
Module and podium ground floor to underground car park		
	42mm thick insulation minimum	0.25
	85mm thick insulation minimum	0.19
Slab-on-ground floor		
	38mm thick Neopor	0.25
Fig 7	132mm thick Neopor	0.14

1.2.6.7 Table 10 lists the temperature factors and Ψ-values following the thermal bridging assessment of the various junctions

1.2.6.8 All of the details in Table 10 pass the temperature factor criteria. The additional heat loss (last column in Table 10) shall be taken into account when determining overall compliance with the thermal building regulations as described in IP 1/06.

1.2.6.9 For the full thermal benefit of this building method to be attained, the detailing techniques specified in this certificate shall be undertaken. Notably, peripheral seals around windows and around service(s) lines shall be correctly installed to obviate localised air leakage and increased heat loss through floors. Air leakage testing has been carried out and the results confirmed air leakage to be less than the minimum requirement of $10m^3.h^{-1}.m^{-2}$ of Approved Document L1a. New buildings in England and Wales using this system shall require pre-completion testing as defined in Approved Document L1a.

1.2.6.10 An assessment of interstitial condensation was carried out on the external wall construction. The assessment predicts no condensation within the wall constructions as both wall constructions (stone clad and brick clad – see Figures 1, 7 and 8) pass the risk criteria in BS EN ISO 13788 *Hygrothermal performance of building materials and building elements – internal surface temperature to avoid critical surface humidity and interstitial condensation – Calculation risks.*

1.2.6.11 Table 10: Temperature factors and Ψ-values of junctions

Figure reference	Junction description	Temperature factor (Min = 0.75)		Ψ-value (W/m·K)	Maximum Ψ-value (W/m·K)	Extra heat loss (W/m·K)
Window openings						
FSVM-C-001	Cill – Stone Cladding	0.91		0.08	0.04	0.04
FSVM-D-001	Cill - Brick Cladding	0.78		0.07	0.04	0.03
FSVM-D-002	reveal - Brick Cladding	0.83		0.07	0.05	0.02
FSVM-C-003	Head Detail–Stone Cladding	0.93		0.07	0.30 (0.21)[2]	-0.23 (-0.14)
FSVM-D-003	Head Detail – Brick Cladding	0.94		0.03	0.30 (0.21)[2]	-0.27 (-0.18)
Parapet details						
FSVM-H-001	Stone Cladding	0.87		0.30	0.06	0.24
FSVM-H-002	Brick Cladding	0.88		0.23	0.06	0.17
Slab-on-ground ground floor to external wall						
FSVM-B-001	Brick Cladding	0.82	0.73	0.49	0.16	0.33
FSVM-A-003 / FSVM -B-001	External Door Threshold	0.84	-	0.49	0.16	0.33
Intermediate floor to external wall						
FSVM-C-004	Stone Cladding	0.84		0.36	0.14	0.22
FSVM-D-005	Brick Cladding	0.88		0.26	0.14	0.12
Separating wall to external wall						
FSVM-C-006	Stone Cladding	0.90		0.17	0.06	0.11
External wall corner						
FSVM-C-007	Stone Cladding	0.82		0.14	0.09	0.05

1 Where only one detail is given for one type of cladding (brick or stone); this detail is considered the worst case of the two. The temperature factor for the junction with the other type of cladding is considered to be no worse than that given and the Ψ-value is considered to be no greater than that of the given detail

2 The non-bracketed value is from Table 3 of IP 1/06 and the bracketed value is from Table 3 of IP 17/01.

1.2.6.12 Reference shall be made to BS 5250 *Code of practice for control of condensation in buildings*, and BRE Report BR 262 (2002 Edition) *Thermal insulation - avoiding risks* to verify the adequacy of the weather and moisture protection to be provided by the external cladding and roof for each project.

1.2.7 Durability

1.2.7.1 Provided that the system is installed and maintained in accordance with the Certificate holder's instructions, and the requirements of this certificate, the modules of the VMS Building System with stone or brick cladding are considered capable of a minimum design life of 60 years.

1.2.8 Services

1.2.8.1 Building services (electrical, plumbing etc) are outside the scope of this certificate, but shall comply with the relevant standards and legislation. Their design and installation shall avoid risk of corrosion damage to the modules. In particular, local earth connections to the steel frame shall be avoided. The structural frame should be earthed at one point only and all subsequent earthing of services should be to this point only.

2. BUILDING REGULATIONS

2.1 Appropriately detailed constructions incorporating the modules of the VMS Building System when used in accordance with this certificate and the Certificate holder's installation instructions can contribute towards satisfying the following relevant Regulations Requirements and Standards. References (Ref) in 2.2 refer to national supporting documents.

- Building Regulations (England and Wales) 2000 (as amended) (E & W)
  Approved Documents (AD)
- The Building (Scotland) Regulations 2004 (S)
  Technical Handbook Domestic (THD) or Non Domestic (THND)
- The Building Regulations (Northern Ireland) 2000 (NI)
  Technical Booklets (TB)
- Building Regulations 1997-2006 (Ireland) (I)
  . Technical Guidance Documents (TGD)

2.2 Justification for compliance with defined Building Regulations.

2.2.1 Structure

2.2.1.1 Loading/stability

Country	Req.	Opinion
E & W	A1	Structural design methodology has been assessed in this certificate, and buildings designed and constructed in accordance with Section 1.2.2 can comply with these requirements.
S	1.1	
N I	D1	
I	A1	

2.2.1.2 Disproportionate collapse

Country	Req.	Ref.	Opinion
E & W	A3	AD-A Table 11 – Class 2B	Design for disproportionate collapse has been assessed in this certificate, and buildings designed and constructed in accordance with Section 1.2.2 can comply with these requirements.
S	1.2		
N I	D2		
I	A3		

2.2.2 Fire

2.2.2.1 Internal fire spread (Linings)

Country	Req.	Ref.	Opinion
E & W	B2(1)	AD-B Table 10	Walls and ceiling as designed in accordance with Tables 2b and 3b can comply with these requirements.
S	2.5	THD & THND 2.5.1	
N I	E3	TB E, 2.10 to 2.13 and Table 2.1	
I	B2, B1	TGD 2.1 and 2.2	

2.2.2.2 Stability in a fire

Country	Req.	Ref.	Opinion
E & W	B3 (1)	AD-B Table A1 and A2	Structural elements designed and constructed in accordance with Tables 2b and 3b can comply with these requirements. Fire resistance assessment of structural elements (see Section 1.2.3) shows that walls can be designed to maintain their stability for up to 3 hours.
S	2.3	THD - Table 2.B , THND - Tables to 2.1.2	
N I	E4 (1)	TB E, Table 3.1 and 3.2;	
I	B3 (1)	TGD B, Table A1 & A2	

2.2.2.3 Internal fire spread (structure) - {separation}

Country	Req.	Ref.	Opinion
E & W	B3(2) & (3)	AD-B Sec. 9	Structural elements designed and constructed in accordance with Tables 2b and 3b can comply with these requirements. Fire resistance assessment of structural elements (see Section 1.2.3) shows that elements can maintain their stability for up to 3 hours depending on specification. Penetrations can be suitably fire stopped (outside scope of this certificate) to the performance of the surrounding element.
S	2.2	THD, 2.2.1 to 2.2.7 & 2.A.2 THND, 2.2.1 to 2.2.4	
N I	E4 (2)	TB E, 3.15 to 3.22 inclusive	
I	B3 (2)#	TGD B, Sec 3.2	

2.2.2.4 Internal fire spread (structure) {cavities}

Country	Req.	Ref.	Opinion
E & W	B3 (4)	AD-B Sec. 9 and 10	Suitable fire stops can be installed in cavities etc. in order to control the spread of fire (see Section 1.2.3).
S	2.4	THD, 2.4.1, 2.4.2, 2.4.4, 2.4.5, 2.4.7, THND 2.4.1, 2.4.2	
N I	E4 (4)	TB E, 3.35 to 3.47 inclusive	
I	B3 (3)	TGD B, Sec 3.3	

2.2.2.5 External fire spread {Spread to adjoining buildings}

Country	Req.	Ref.	Opinion
E & W	B4(1)	AD-B Sec 13 and 14 Table A1 and A3	Appropriately detailed external walls with the defined external cladding can be designed to comply with these requirements (see Section 1.2.3). Test to BS 8414 – 2 has demonstrated that the stone cladding can meet the fire performance requirements
S	2.6, 2.7	THD, 2.6.0 to 2.6.6 & 2.7.1, Table 2B	
N I	E5(a)	TB E, Sec. 4 Table 3.1 and 3.2	
I	B4#	TGD B, Table A1 and A2	

Separating and compartment walls between two dwellings contain plasterboards which are materials of limited combustibility and therefore consideration is required for compliance with 2.A.2, 2.A.4, of Doc 2.2. and 3.2.5 of Doc 4.2. External Walls contain plasterboards, insulation and timber which are combustible materials and therefore consideration is required for compliance with 2.A,6 and 2.A.7 of Doc. 2.2

2.2.3 Environment

2.2.3.1 Moisture from the ground, Precipitation, and Condensation.

Country	Req,	Opinion
E & W	C2	A ground floor/foundation and external wall (See Section 1.2.4) can be designed to resist the passage of moisture from the ground into the building. Weathertight external claddings applied to the wall can resist the passage of moisture from the atmosphere into the building. External walls with brick and stone claddings can be designed and constructed to prevent any harmful effect from interstitial or inner surface condensation.
S	3.4,3.10, 3.15	
N I	C4 , C5	
I	C4	

2.2.4 Noise

2.2.4.1 Airborne Sound (Separating Walls)

Country	Req.	Ref.	Opinion
E & W	E1 (a)	AD E, Sec 0 & 1	Separating walls (see Table 3b) can be designed and constructed to achieve the required resistance to the passage of sound as shown in Section 1.2.5. It is a requirement that the necessary pre-completion testing as defined in the supporting documents is carried out as described.
S	5.1	THD, 5.1 & 5.1.12,	
N I	G2 (1)	TB G, Sec 2, Table 2.	
I	E1	TGD E, Sec 4, Table 1.	

2.2.4.2 Airborne Sound (Non- Separating Walls)

Country	Req	Opinion
E & W	E1 (b)	Non separating walls (see Table 3b) can be designed to comply with the constructions described in 5.18 of Approved Document E (Building Regulations – England and Wales).
S, NI, I	N/a	

2.2.4.3 Airborne and Impact Sound (Separating Floors)

Country	Req.	Ref.	Opinion
E & W	E2 & E3	AD E, Sec 0 & 1	Separating Floors (see Table 2b) can be designed and constructed to achieve the mass per unit area of the floors, coverings and ceilings as detailed for a Type 1 separating floor as defined in Approved Document E (see Section 1.2.5). It is a requirement that the necessary pre-completion testing as defined in the supporting documents is carried out as described.
S	5.1	THD, 5.1 & 5.1.12,	
N I	G2 (2)	TB G, Sec 2, Table 2.	
I	E2 & E3	TGD E, Sec 4, Table 1.	

2.2.5 Energy

2.2.5.1 Conservation of fuel and power

Country	Req.	Ref.	Opinion
E & W	L1	AD L1	Compliance is based on emissions of CO_2 where the Dwelling Emission Rate (DER) is shown to be no greater than the Target Emission Rate (TER) as calculated using SAP 2005 or SBEM on a specific building. (See Section 1.2.6) Representative U-values for walls and floors have been calculated (see Section 1.2.6) As all Ψ-values are higher than their respective maximum (default) Ψ-values, the additional heat loss has to be taken into account as per IP 1/06 and IP 17/01 when determining overall compliance with the thermal bridging regulations.
S	6.2	THD, 6.2	
N I	F2	TB F, Sec 1	
I	L1	TGD, Sec 1	

2.2.6 Materials and workmanship

2.2.6.1 Materials and workmanship

Country	Req.	Opinion
E & W	Regulation 7	The System is manufactured to controlled procedures using suitably durable materials for their application and can be installed so as to perform satisfactorily. The materials used are considered to be adequately safe and acceptable for the intended application and to be adequately resistant to deterioration and wear under normal service conditions, provided that they are installed and maintained in accordance with the requirements of this certificate.
S	Regulation 8(1)	
N I	B2, B3, B5	
I	D1	

2.3 CDM Regulations

Construction (Design and Management) Regulations 2007
Construction (Design and Management) Regulations (Northern Ireland) 1995 (as amended)
Safety, Health and Welfare Regulations 2006 (Ireland)
The Certificate should form part of the information used by client, planning supervisor, designer and contractors to discharge their responsibilities under these Regulations

3. INSTALLATION/PRACTICAL APPLICATION

3.1 Delivery Storage and Handling

3.1.1 Each module is labelled with a unique numbering system e.g. 545-E0-22. This number is taken from the "Project numbering register" and records the following information:

545	Project Number – e.g. 545
E	reference to the Block/building
0	represents the floor which the module is placed, e.g. 0 for ground floor, 1 for first floor etc.
22	Individual Module Number (Not apartment number)

3.1.2 The modules leave the factory protected from short term exposure to weather. The modules are lifted on to vehicles for transport and positioned on site, by crane. All lifting of the modules use the designated lifting points and equipment and shall be carried out by competent personnel in accordance with the VMS Erection Manual and site specific safety method statement.

3.2 Installation

Installation procedures shall include the following matters:

3.2.1 Installation shall only be carried out by operatives formally trained and approved by VMS, following the VMS Erection Manual (as reviewed by BRE Certification) and the requirements of this certificate which must both be available on each site. Each module shall be located and fixed to its intended location in line with the erection sequence shown on the drawings.

3.2.2 The VMS Installation Manager on each site is responsible for ensuring each installation is carried out correctly and for producing and retaining quality control records.

3.2.3 VMS produce procedures for their approved installers to work to. These installers carry out the following on site:

- position the modules onto the substructure and around the cores;
- structurally connect the modules to the substructure and cores;
- connect the services between modules;
- fit cavity closing around modules and between the modules and the cladding; and,
- fit proprietary stone exterior cladding.

3.2.4 The performance of the VMS Building System depends on correct installation. It shall be installed strictly in accordance with the Certificate holder's installation instructions, the requirements of this certificate and the design laid down by the Structural Engineer. The quality of installation actually achieved on specific sites is not covered by this certificate. Therefore it is recommended that the quality of installation and workmanship is subject to appropriate checks by a competent person for each installation.

3.2.5 Any building shall be erected on pre-prepared foundations, complying with the appropriate clauses of BS 8004 and BS 8103: Part 1, to suit site conditions. Special precautions (e.g. compliance with BRE Special Digest 1) shall be made where aggressive ground conditions are encountered. A competent, qualified and experienced Civil or Structural Engineer shall design these.

3.2.6 The substructure shall be set out accurately and level to +/- 1mm or no more than 1mm in 3m along any load bearing ground floor slab edge, as measured from a suitable datum position, prior to the erection of the building system. Steelwork shall be packed underneath with flat, adequately galvanised (BS EN 10326), steel packing shims where appropriate, to achieve this level. These operations shall be under the supervision of authorised VMS personnel. Where the tolerances are in excess of 20mm, the foundation levels shall be corrected prior to the installation.

3.2.7 To achieve adequate damp proofing, any foundation shall incorporate a continuous DPM of a performance equivalent to that of a 1200 gauge polyethylene sheet, and any sleeper walls or footings, as appropriate, shall incorporate a DPC.

3.2.8 As shown in figure 7, the DPC shall have lapped and sealed joints, and shall be placed immediately below each base channel. The DPM shall have lapped or sealed joints and be brought out to the slab periphery, so as to be under the superstructure and any subsequent internal lining, to provide suitable moisture protection. This shall be all in accordance with VMS general

specifications and method as inspected by BRE Certification, and shall comply with the appropriate clauses of:

- BS 8000:Part 4,
- BS 8102 *Code of practice for protection of structures against water from the ground*,
- BS 8215 Code of practice for design and installation of damp-proof courses in masonry construction,
- CP 102 *Code of practice for protection of buildings against water from the ground* and
- BRE Report BR 262 "*Thermal insulation - avoiding risks".*

3.2.9 Core/s shall be constructed on site in order to support the modules from lateral forces. VMS shall supply information on the erection of the cores.

3.2.10 All structural connections between each module, and between modules to the foundation or the core, shall be installed in accordance with the structural design details, independently checked by qualified members of the installation team and formally recorded on the VMS Structural site quality control records. Additional inspections are undertaken by the design Structural Engineer to ensure that work is carried out generally in compliance with their drawings and specifications.

3.2.11 All cavity barriers and fire stops shall be correctly located and installed as specified in the VMS Fire Stopping Details and as described in Section 1.2.3.1.4.

3.2.12 The external cladding (masonry or proprietary stone) should be erected as soon as possible in accordance with the VMS Site Details and this certificate.

3.2.13 Any external wall cavities shall be of sufficient width and be maintained clear of debris, notably to below DPC level. Claddings shall have adequate weep holes along their base.

3.2.14 The external wall cavity around openings shall be suitably sealed in accordance with the VMS site specific details. A cavity tray and cavity barrier shall also be installed. The fitting shall be independently checked and inspected by qualified members of the installation team and formally recorded on site quality control records.

3.2.15 Any external window or door in an elevation, formed using this building system, once clad, should be inset by a minimum of 40mm, or there should be a minimum 40mm external projection above to assist the throwing of water off the elevation, especially in geographic areas classified as being of "severe" or higher exposure rating. Any sill should project by a minimum of 50mm to the outside of the building line. Window sills (and sub-sills) and external thresholds shall either be impervious, full-width and suitably jointed to provide a complete barrier to the downward flow of water into the wall, or a horizontal, continuous cavity tray or DPC, preferably flexible, shall be provided under the opening provision. Care shall be taken, when installing the horizontal cavity tray or DPC below an external window board, to ensure that provision for any condensation that may occur on the window is conducted away to the cavity, and not to the steelwork.

3.2.16 The roof structure is outside the scope of the certificate, however it is to be designed to BS 5268: Parts 2 and 3. VMS shall structurally design their building modules to support the design of the roof.

4. TECHNICAL INVESTIGATIONS

4.1 A site inspection during construction has been carried out and the procedures and practicality of installation assessed. Assessment, tests and investigations have been undertaken to determine the properties of VMS Building System as follows:-

- a review of loadbearing capacity
- fire performance
- thermal insulation performance
- condensation risk
- weathering and ground moisture protection
- acoustic performance
- durability

Modules (Table 11)

	Justification	**Results**	**Clause reference**
1. Structural	Assessment	Maximum storey height 3.6m	1.2.1.1
	Assessment	Design by suitably-qualified engineer	1.2.2
2. Fire			1.2.3
Fire performance	EN 1365-1 BS 476-6 & 7 BS 8414-2	REI 60, REI 90, REI 120, REI 180 Class 0 Pass	Table 3b & 4b Table 3b & 4b 1.2.3.2.1 1.2.3.3.1
3. Environment			1.2.4
Hygrothermal Assessment	BSEN ISO 13788 BS EN 6946	Zero interstitial condensation	1.2.6.10
Precipitation	BS 12155 & 12154	Pass	1.2.4.2
4. Acoustic			1.2.5
Acoustic performance Field sound insulation tests	BS EN ISO 140 BS EN ISO 717	Pass (tests on sample building)	Tables 5, 6, 7
5. Thermal			1.2.6
Element U values	BS EN ISO 6946	Calculated values	Table 9
Numerical modelling of junction details.	IP 1/06, IP 17/06	Calculated values	Table 10
Pre-completion airtightness testing	AD L1a	Less than $10m^2h^{-1}m^{-2}$ Pass	1.2.6.9

Stone Cladding (Table 12)

	Justification	**Results**	**Clause reference**
1. Structural	BS EN 13161	Grey Cream New: 12.24 MPa 13.76MPa Aged: 11.71 MPa 12.36MPa	1.1.6.6
2. Fire			
	BS 8414 part 2	Pass	1.2.3.3.1
3. Environment			
Hygrothermal Assessment	BS EN ISO 13788, BS EN 6946	Assessed as satisfactory	1.2.6.10
4. Safety in use			
Weathertightness	BS 12155 & 12154	Exposure grade R7	1.2.4.2
Air permeability	Post completion test	Passed Doc L1a being less than $10.m^3.h^{-1}.m^{-2}$	1.2.6.9
Petrographic examination	BS EN 12407.	Granite	1.1.6.6

4.2 Quality Control

4.2.1 Traceable quality records are maintained by the manufacturer. In the opinion of BRE Certification the materials and procedures of the manufacturer are suitable for the product. The manufacturer carries out checks at regular intervals to ensure that the quality of VMS Building System is maintained within the defined product specification. BRE Certification undertakes regular monitoring of the factory production audits on the manufacture of the product against an agreed Quality Plan for the product.

4.2.2 The quality control procedures for the product include visual checks on materials as received, factory component inspections, the checking of all in-house drawings and on-site stage monitoring. The latter shall be undertaken by VMS staff, or by the approved and monitored specialist subcontractor, during the erection to ensure conformity with the manufacturer's specifications.

4.3 The following Standards and other publications have been referred to for this assessment:-

CP 102:1973	Code of practice for protection of buildings
BS EN 135:2006	Classification of fire performance based on draft for consultation of Annex B BR135:2006
BS EN ISO 140-3: 1995	Acoustics. Measurements of sound insulation in buildings and of building elements. Part 3 Laboratory measurements of airborne sound insulation of building elements.
BS EN ISO 140-4: 1998	Acoustics. Measurements of sound insulation in buildings and of building elements. Field measurements of airborne sound insulation between rooms.
BS EN ISO 140-6: 1998	Acoustics. Measurement of sound insulation in buildings and of building elements. Laboratory measurements of impact sound insulation of floors
BS EN ISO 140-7: 1998	Acoustics. Measurement of sound insulation in buildings and of building elements. Field measurements of impact sound insulation of floors
BS EN ISO 140-8: 1998	Acoustics. Measurement of sound insulation in buildings and of building elements. Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor
BS EN 206-1:2000	Concrete part 1: Specification, performance, production and conformity
BS 476-6:1989	Fire tests on building materials and structures. Method of test for fire propagation for products
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.
BS 476-22:1987	Fire tests on building materials and structures – Methods for determination of the fire resistance of non load-bearing elements of construction.
BS EN ISO 717-1: 1997	Acoustics. Rating of sound insulation in buildings and of building elements. Part 1. Airborne sound insulation.
BS EN ISO 717-2: 1997	Acoustics. Rating of sound insulation in buildings and of building elements. Part 2. Impact sound insulation.
BS EN 845-1:1987	Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets.
BS EN 970:1997	Non destructive examination of fusion welds, visual examination
BS 1243:1978	Specification for metal ties for cavity wall construction.
BS EN 1364-1:1999	Fire resistance tests for non load-bearing elements. Walls
BS EN 1365-1:1999	Fire resistance tests for load-bearing elements. Walls
BS EN 1365-2:2000	Fire resistance tests for load-bearing elements. Part 2. Floors and roofs.
BS 5234-2:1992	Partitions (including matching linings). Specification for performance requirements for strength and robustness including methods of test.
BS 5250:2002	Code of practice for control of condensation in buildings.
BS 5628-3:1985	Code of practice for use of masonry: materials and components, design and workmanship.
BS 5950-7:1992	Structural use of steelwork in building: specification for materials and workmanship: cold formed sections.
BS 5950-1:2000	Structural use of steelwork in building: Code of practice for design. Rolled and welded sections
BS 6399-1:1996	Loading for buildings: code of practice for dead and imposed loads.

BS 6399-2:1997	Loading for buildings: code of practice for wind loads.
BS 6399-3:1988	Loading for buildings: code of practice for imposed roof loads.
BS EN ISO 6946: 1997	Building components and building elements. Thermal resistance and thermal transmittance. Calculation method
BS 7543:2003	Guide to the durability of buildings and building elements, products, and components.
BS 8000-4:1989	Workmanship on building sites: code of practice for waterproofing.
BS 8000-5:1990	Workmanship on building sites: code of practice for carpentry, joinery and general fixings.
BS 8004:1986	Code of practice for foundations.
BS 8102:1990	Code of practice for protection of structures against water from the ground.
BS 8103-1:1995	Structural design of low-rise buildings: code of practice for stability, site investigation, foundations and ground floor slabs for housing.
BS 8110-1:1997	Structural use of concrete. Code of practice for design and construction
BS 8110-2:1985	Structural use of concrete. Code of practice for special circumstances
BS 8215:1991	Code of practice for design and installation of damp-proof courses in masonry construction.
BS 8233:1999	Code of practice for sound insulation and noise reduction for buildings.
BS 8298:1994	Code of practice for design and installation of natural stone cladding and lining
BS 8414-2:2005	Fire performance of external cladding systems. Test method for non load-bearing external cladding systems fixed to and supported by a structural steel frame.
BS EN ISO 9001: 2003	Quality Management Systems
BS EN 10025-2: 2004	Hot rolled products of structural steels – Part 2 Technical delivery conditions for non-alloy structural steels.
BS EN 10088-2: 1995	Stainless steels. Technical delivery conditions for sheet/plate and strip for general purposes
BS EN 10219-1: 2006	Cold formed welded structural hollow sections of non-alloy and fine grain steels. Technical delivery requirements
BS EN 10259:1997	Cold rolled stainless and heat resisting steel, wide strip and plate/sheet. Tolerances on dimensions and shape.
BS EN 10326:2004	Continuously hot-dip coated strip and sheet of structural steels. Technical delivery conditions
BS EN 12407:2000	Natural stone test methods Petrographic examination
BS EN ISO 12944-2: 1998	Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments
BS EN 13161:2001	Natural stone test methods. Determination of flexural strength under constant moment
BS EN 13165:2001	Thermal insulation products for buildings. Factory made rigid polyurethane foam (PUR) products – Specification
BS EN 13501-1: 2002	Fire classification of construction products and building elements. Classification using test data from reaction to fire tests.
BS EN 13501-2: 2003	Fire classification of construction products and building elements. Part 2 Classification using data from fire resistance tests, excluding ventilation services.
BS EN ISO 13788: 2002	Hygrothermal performance of building components and building elements. Internal surface temperature to avoid critical surface humidity and interstitial condensation. Calculation methods
CIBSE TM23	Testing buildings for air leakage
BS EN 13829:2000	Thermal performance of buildings - determination of air permeability of buildings - fan pressurization method
BS EN ISO 14713: 1999	Protection against corrosion of iron and steel in structures – Zinc and aluminium coatings – Guidelines.
BRE Report BR 262 (2002 Edition)	Thermal insulation - avoiding risks
IP 1/06	Assessing the effects of thermal bridging at junctions and around openings
IP 17/01	Assessing the effects of thermal bridging at junctions around openings

SAP 2005 (2005 Edition)	The government's Standard Assessment Procedure for Energy Rating of Dwellings
SBEM	Simplified Building Energy method
Regulations	Building Regulations England & Wales 2000 Building Regulations Ireland 1997-2006 Building Regulations Northern Ireland 2000 Building Regulations Scotland 2004 Construction, Design and Management Regulations 2007

5 CONDITIONS OF CERTIFICATE USE

5.1 Validity

This certificate will be valid for a period of 3 years from the date of issue of this certificate. It will remain valid so far as:

a) The materials and methods of manufacture are unchanged or BRE Certification has assessed any changes and found them to be satisfactory.

b) The design and specification are unaltered from those examined by BRE Certification.

c) Vision Modular Structures continues to have the product regularly checked by BRE Certification through factory production control inspections.

5.2 Health & Safety

This certificate and the recommendations herein do not purport in anyway to restate the requirements of the Health & Safety at Work Act 1974 or any statutory or common law duty of care which exists now or in the future; nor is compliance with these recommendations to be assumed as satisfying the requirements of the said Act or any existing or future statutory or common law duty of care.

5.3 Reference to Other Documentation

Where reference is made in this certificate to any Act of Parliament, Regulation, Code of Practice, British or other Standard or other publication, it shall be construed as reference to such publication, in the form in which it is in force at the date of issue of certificate.

5.4 Patents

BRE Certification makes no representational warranty that any patent or similar industrial property right is valid or that the manufacture, use, sale, lease or any other dealing or disposition of the product in whole or in part is not an infringement of any patent or industrial property right not owned by Vision Modular Structures.

Confirmation that a certificate is current may be obtained from the BRE Certification website (www.RedBookLive.com)

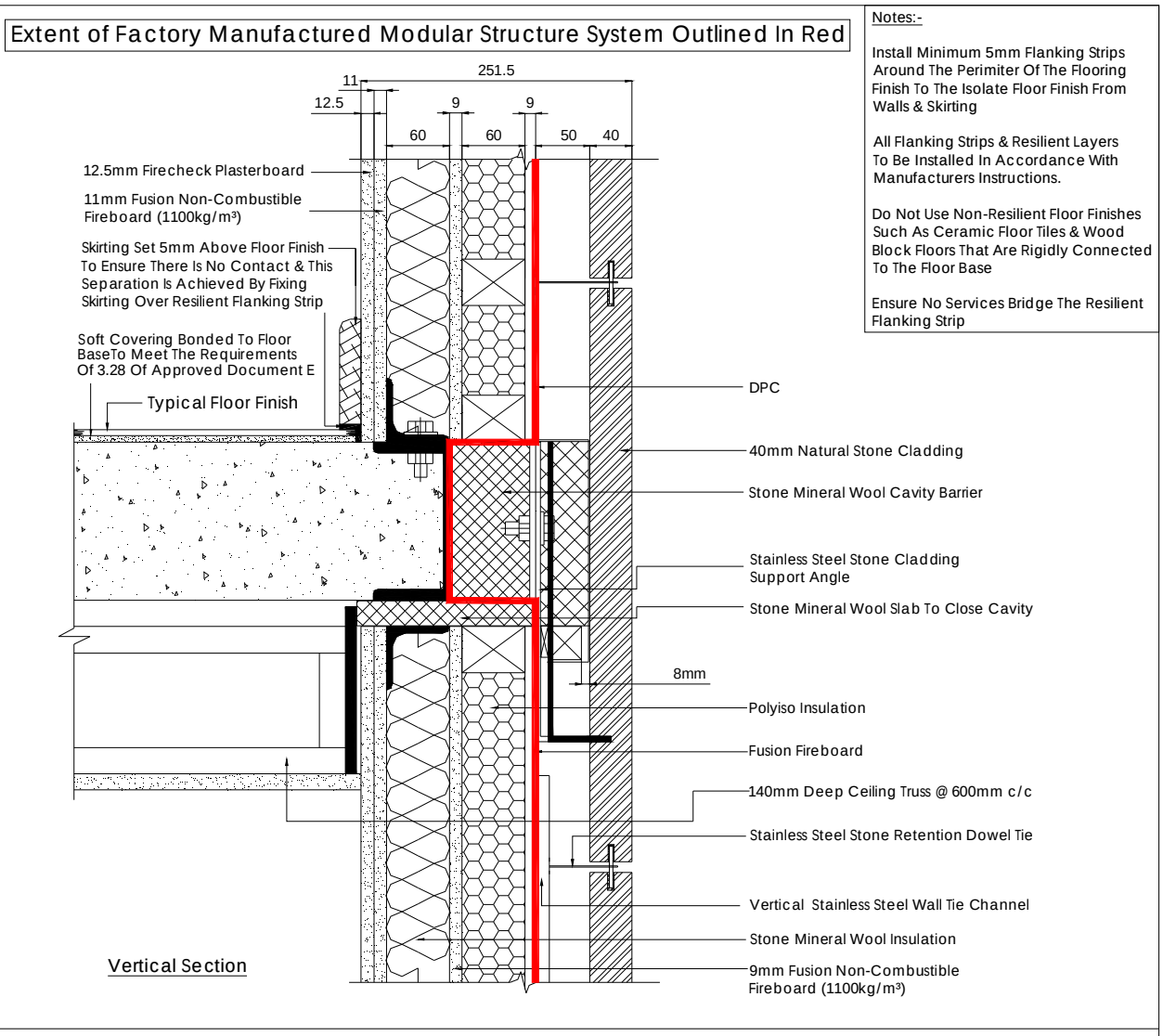


Figure 1, External wall with stone cladding (120 minutes fire resistance), (vertical section)

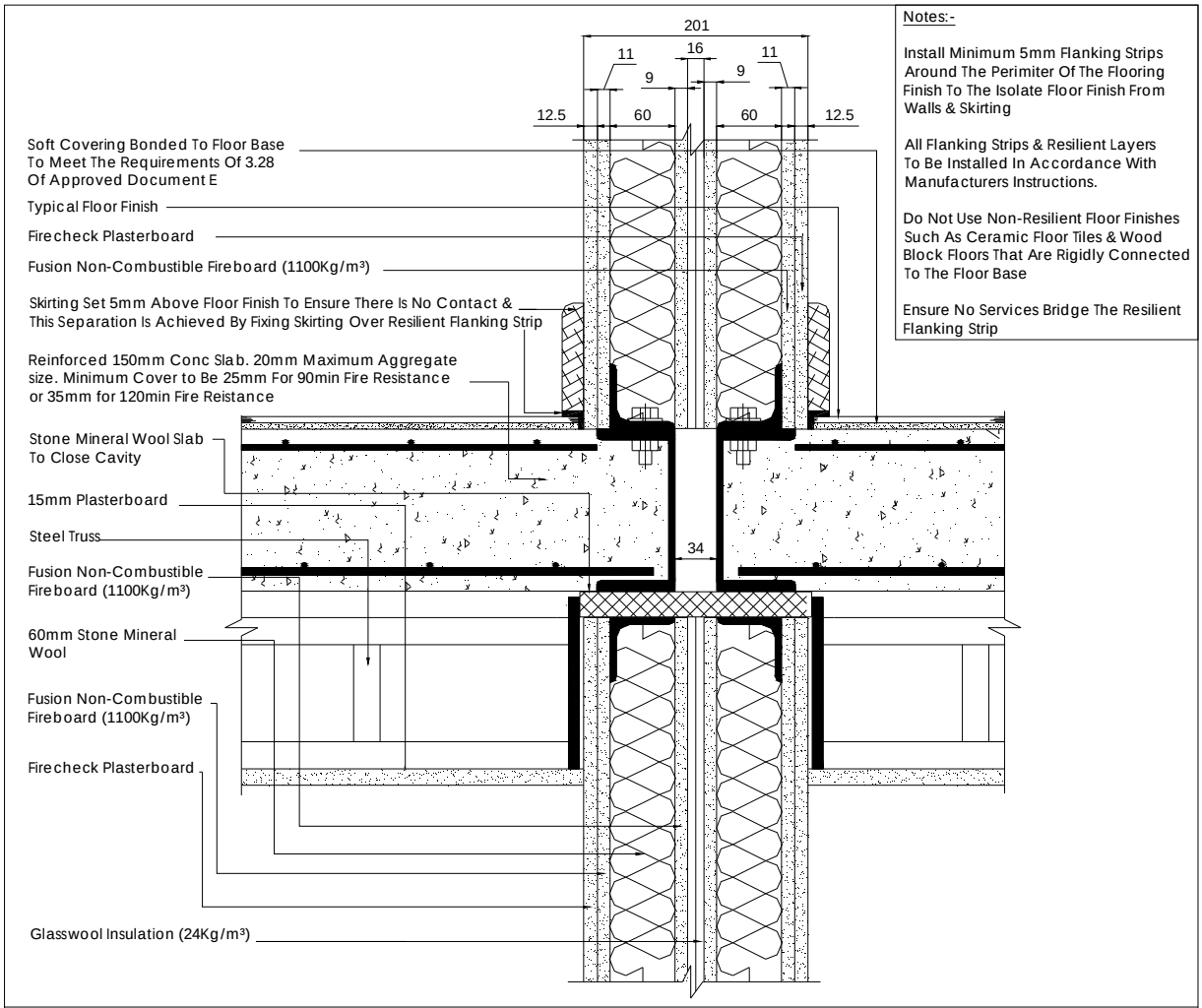


Figure 2, Loadbearing Separating Walls (120 minutes fire resistance from either side), (separating), (vertical section)

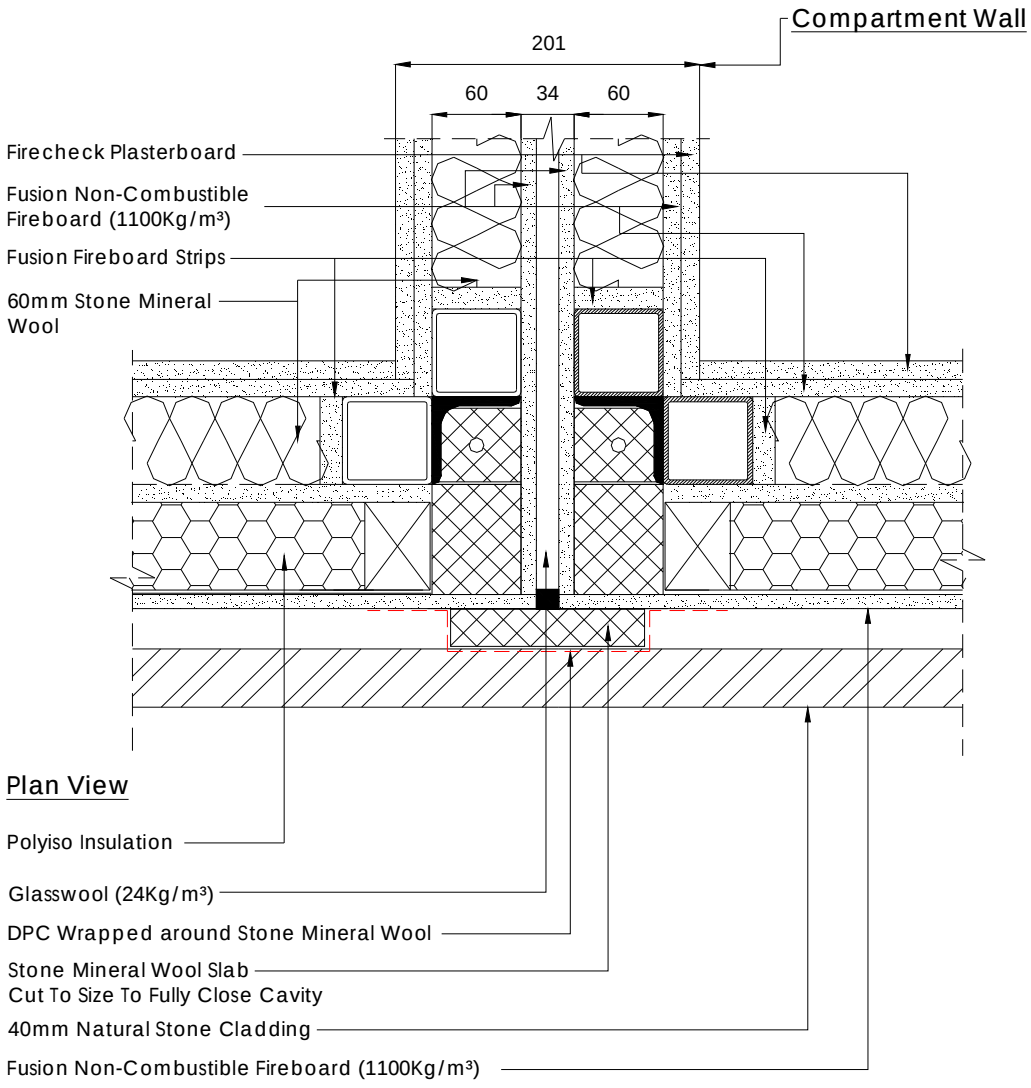
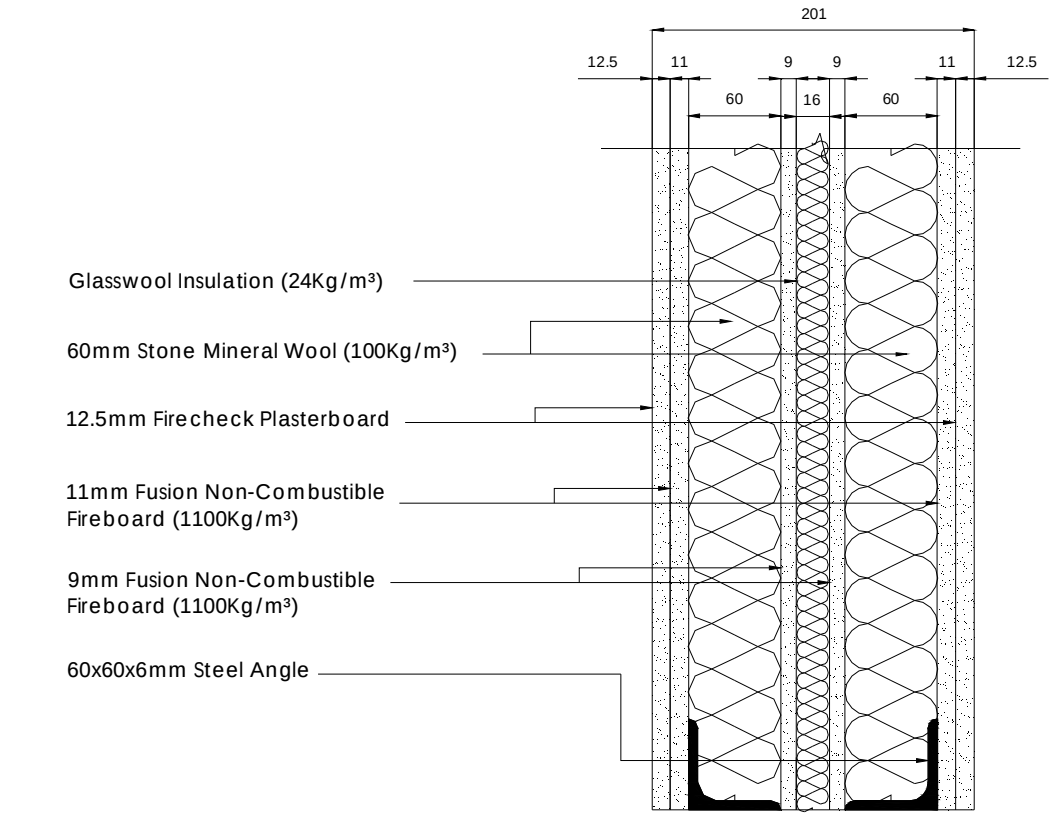
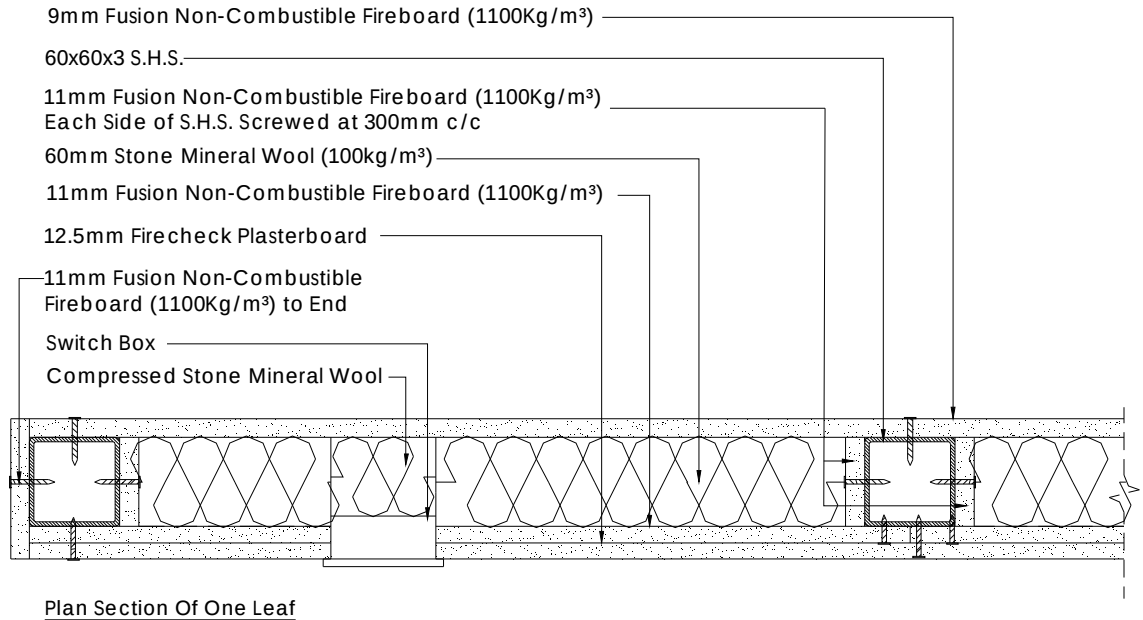


Figure 3, Vertical Fire Stopping in external cavity between apartments and cladding, (plan section)



Loadbearing Compartment Wall (120 Minutes Fire Resistance)
Vertical Section (46kN Stud Load)



Plan Section Of One Leaf

Figure 4, Loadbearing compartment wall (120 minutes fire resistance) (separating), vertical & plan section

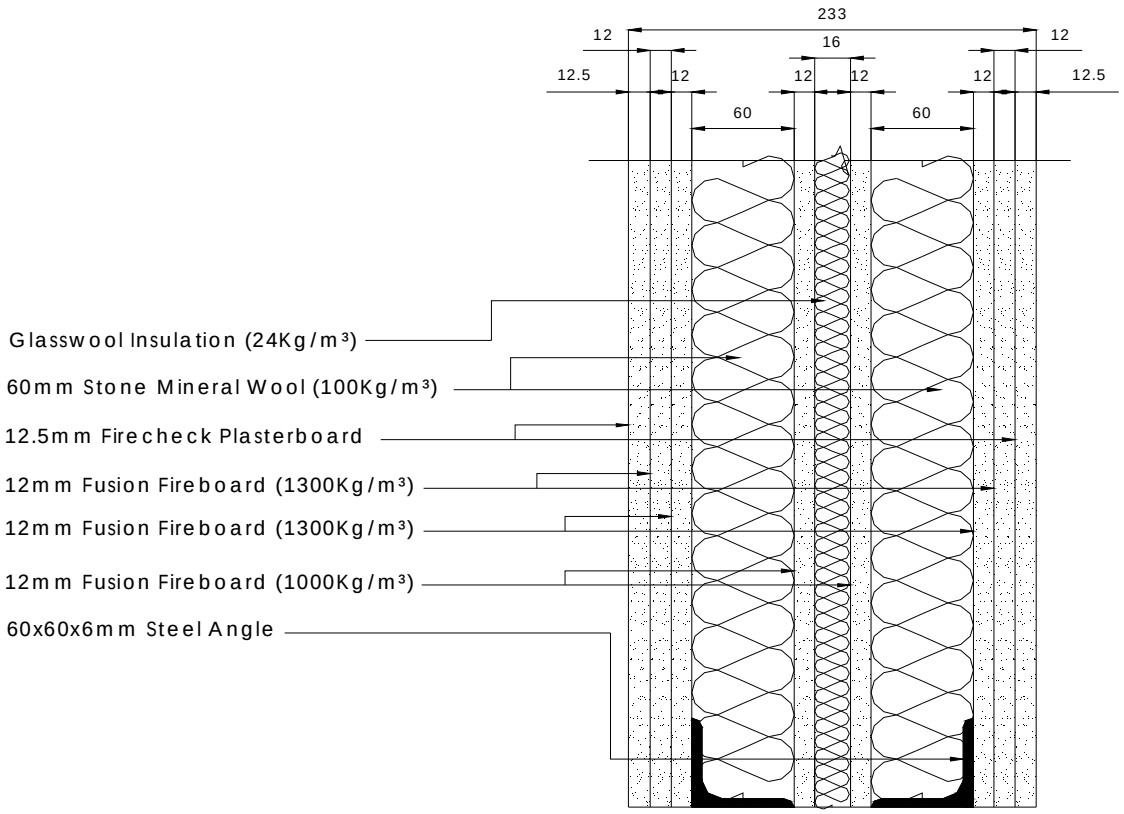


Figure 5, Loadbearing Compartment Wall (180 minutes fire resistance), (separating), (vertical section), (31kN stud load)

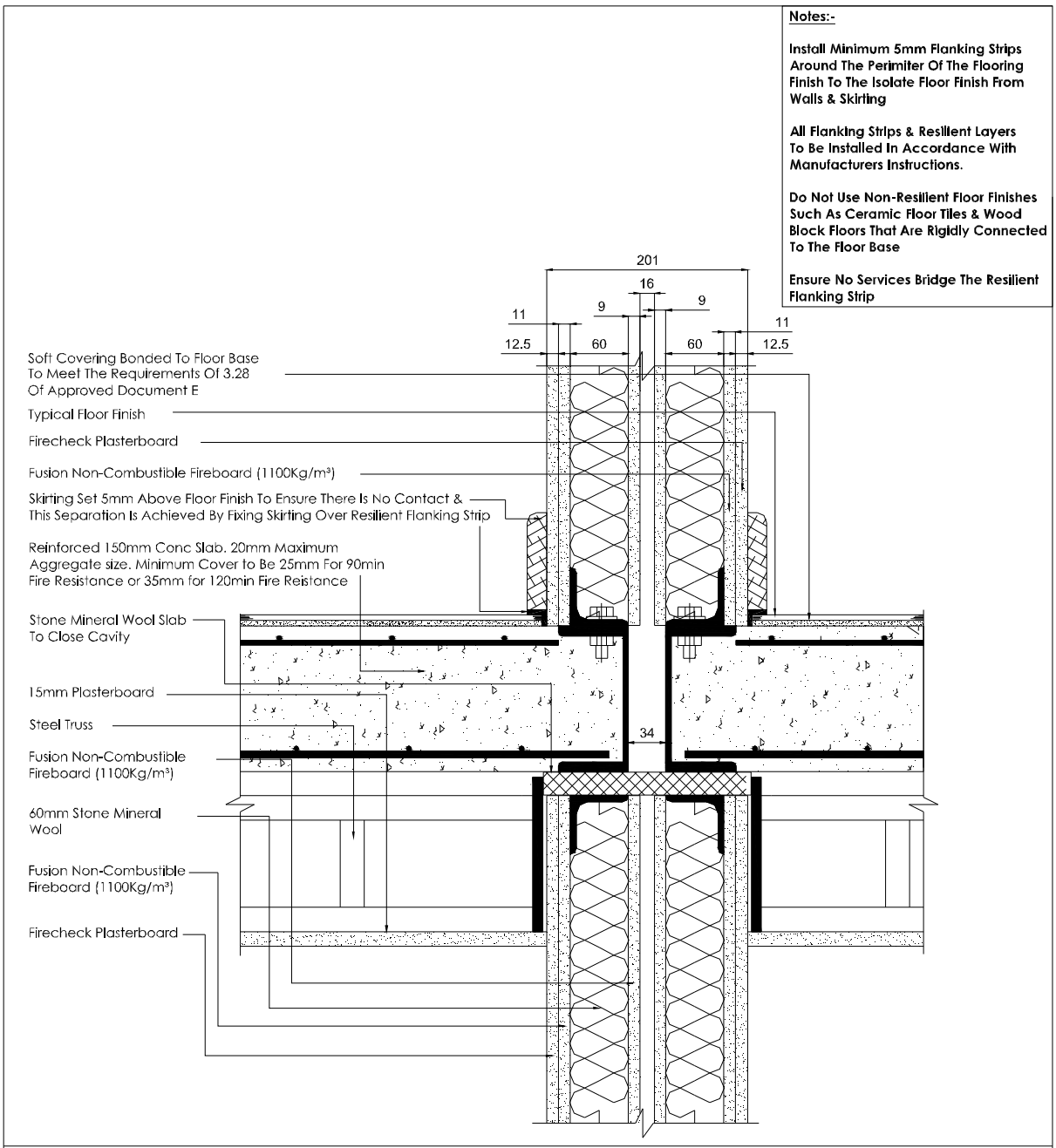


Figure 6, Module walls shown together within single occupancy (non-separating) (120 minutes fire resistance), vertical section

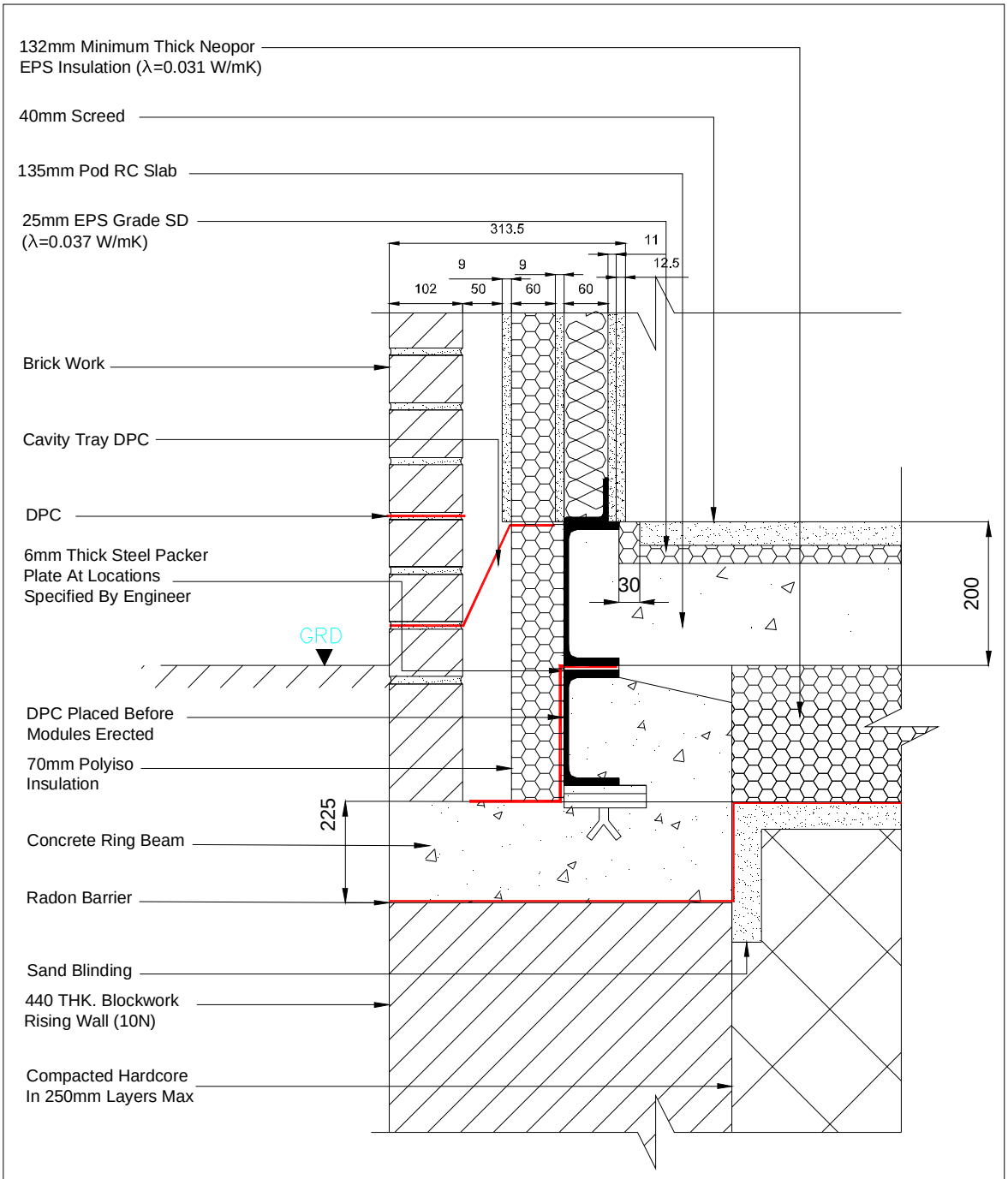


Figure 7, Vertical Section at External Wall to Ground Floor where Ground Floor is on Grade

Foundation details are informative (outside scope of certificate)

Extent of Factory Manufactured Modular Structure System Outlined In Red

Notes:-

Install Minimum 5mm Flanking Strips Around The Perimiter Of The Flooring Finish To The Isolate Floor Finish From Walls & Skirting

All Flanking Strips & Resilient Layers To Be Installed In Accordance With Manufacturers Instructions.

Do Not Use Non-Resilient Floor Finishes Such As Ceramic Floor Tiles & Wood Block Floors That Are Rigidly Connected To The Floor Base

Ensure No Services Bridge The Resilient Flanking Strip

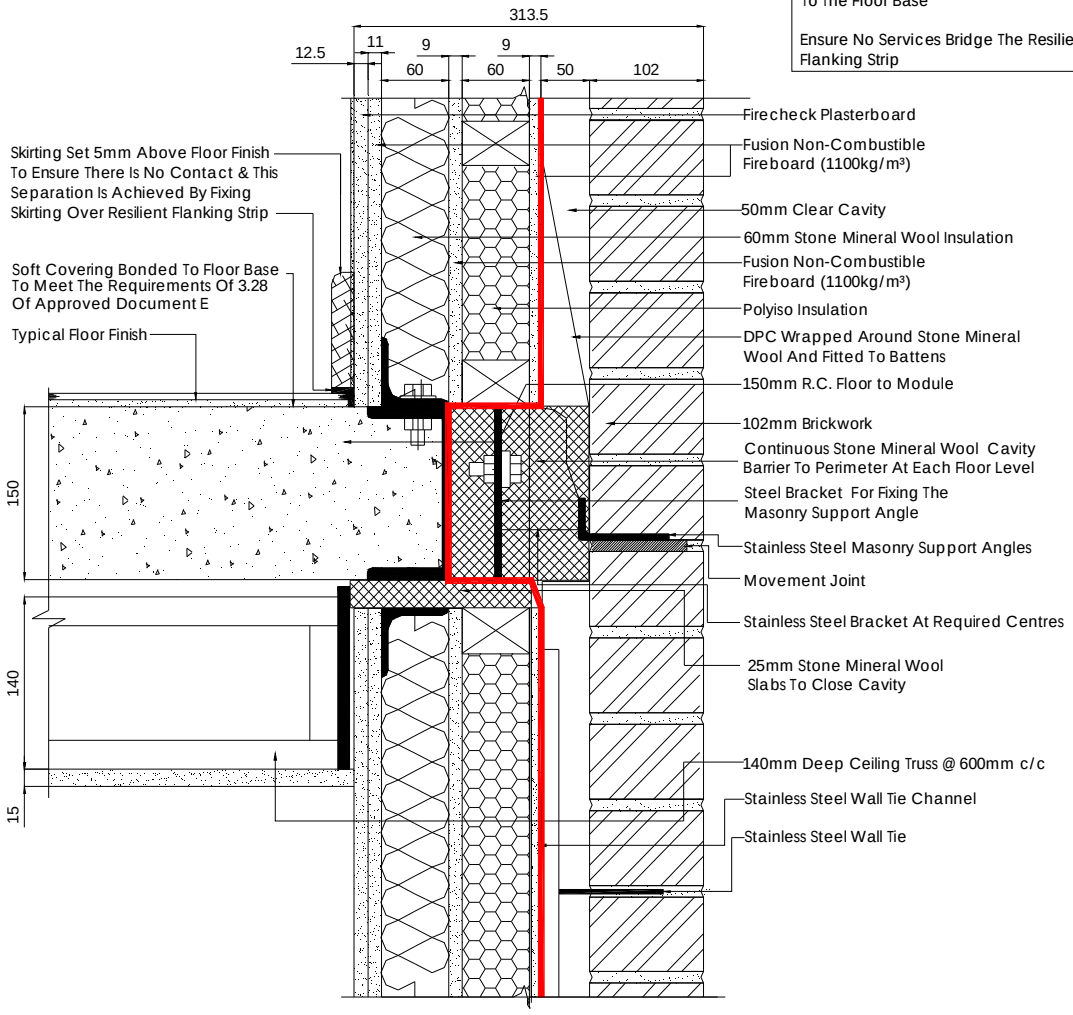


Figure 8, Floor to External wall junction with masonry cladding (vertical section)

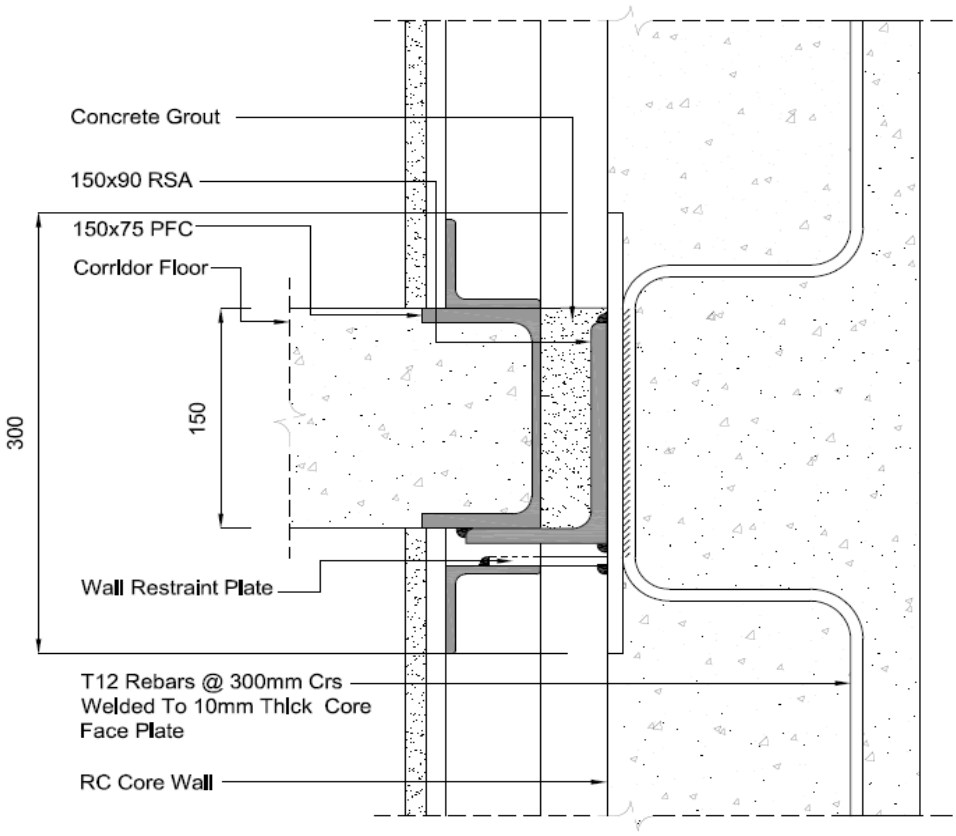


Figure 9, Typical module floor to stair or lift core wall connection detail.

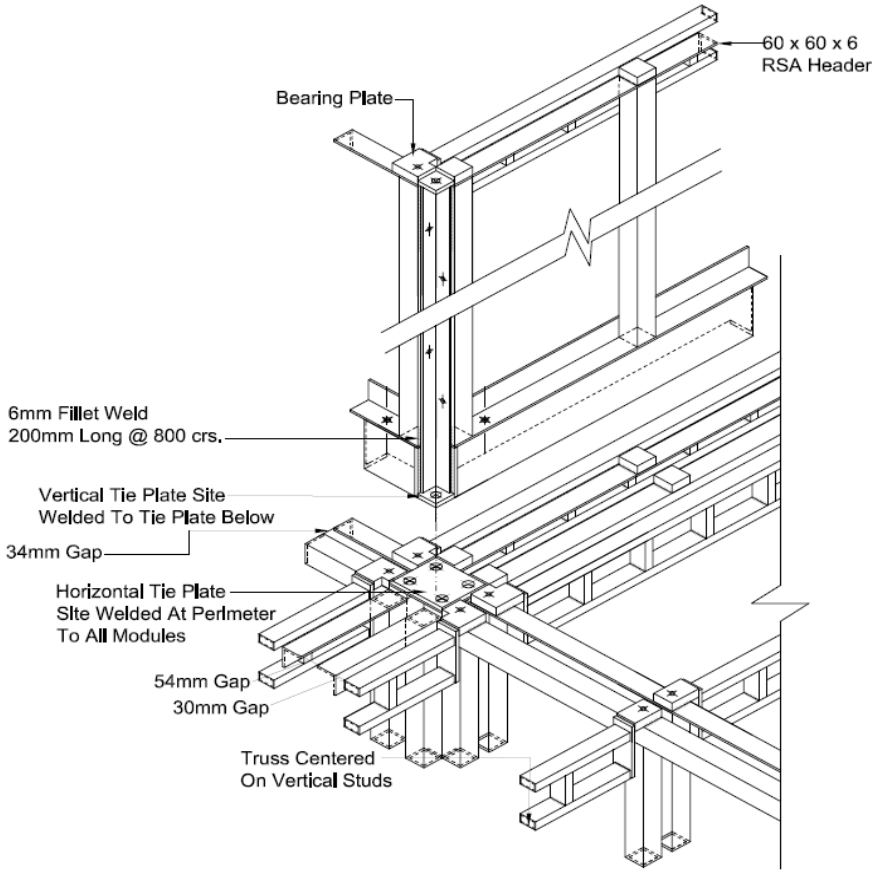


Figure 10, Typical corner detail showing structural components of module (expanded isometric)

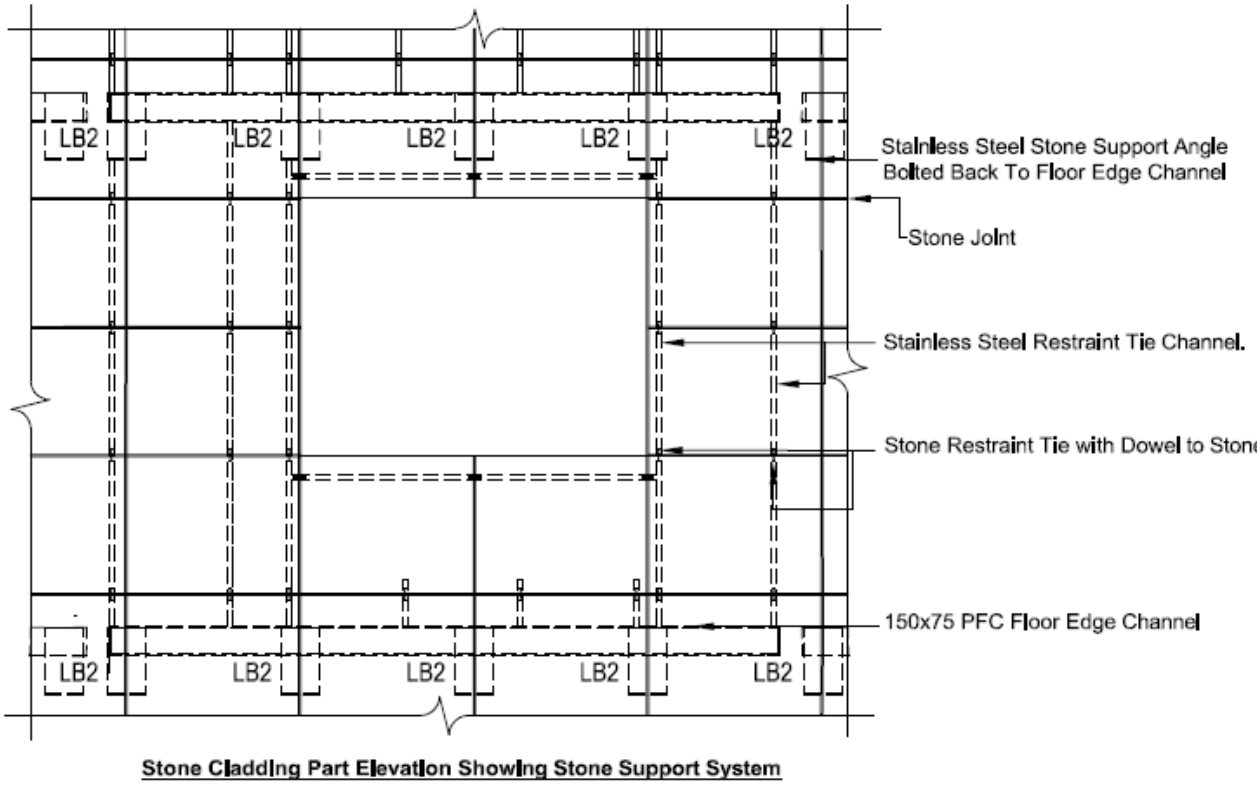


Figure 11, Stone Cladding Part Elevation Showing Stone Support System

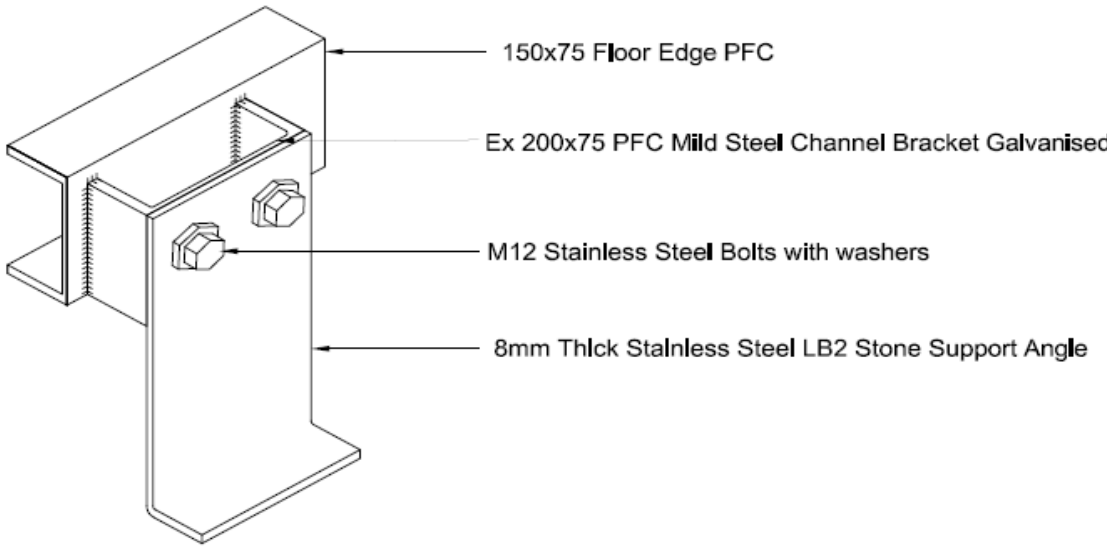


Figure 12 Isometric Of Load-bearing Cladding Support Bracket Connection Detail To Module

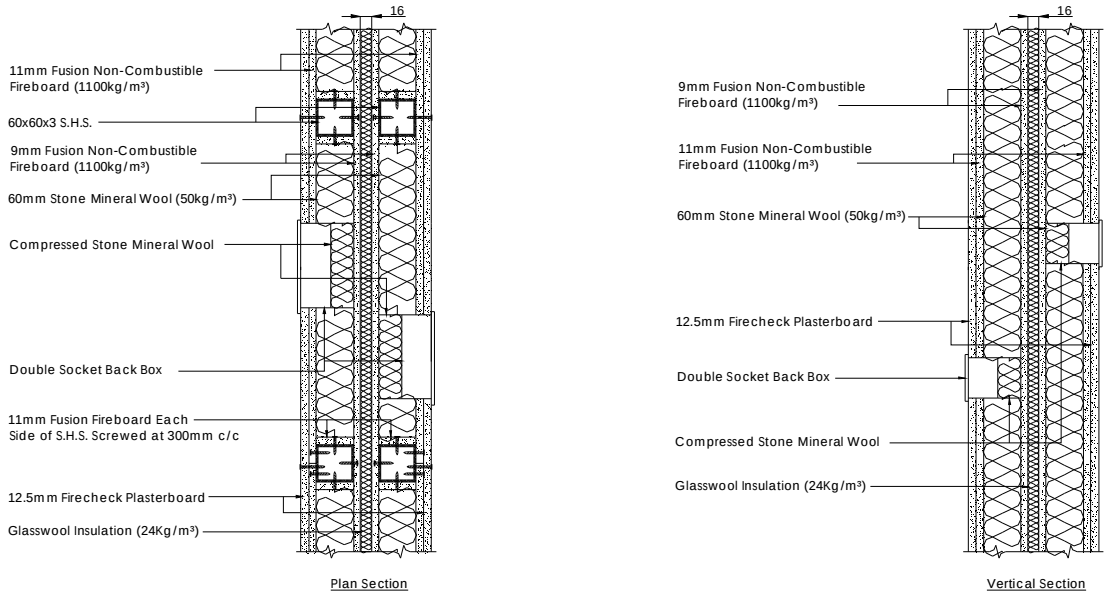


Figure 13, Services in separating compartment walls