NSAI Agrément

IRISH AGRÉMENT BOARD
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Greenstone Structures LGS Building System

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

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

SCOPEF

This Certificate relates to the Greenstone Structures LGS Building System, for the manufacture and installation of structural cold-formed Light Gauge Steel (LGS) frame buildings. The Greenstone Structures LGS Building System is certified to be used in the construction of buildings up to 10 storeys (maximum 30m) in height to the top storey in purpose groups 1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5 and 7(b) as defined in TGDs to Part B of the Building Regulations. The system is used for structural walls and floors in the above purpose groups where the height to the upper floor surface of the top floor is not more than 30m from ground level on the lowest side of the building, and where the full structure is designed, manufactured, supplied and erected by Greenstone Structures Limited.

The Greenstone Structures LGS is also approved for use in non-loadbearing infill panels. The infill panels are used within reinforced concrete, steel frames and traditional construction that possess their own independent lateral stability systems.
Site erection is carried out by approved installers employed by Greenstone Structures or specialist sub-contractors under the supervision of Greenstone Structures. The buildings are assembled using a panelised system, factory made, and site installed.

The system is designed for use in buildings with traditional brick and block outer leaf cladding or NSAI certified external wall cladding systems and roof coverings as per Section 2.1.6 and 2.1.8 of this Certificate. Other claddings systems may be suitable but have not been considered as part of this certification.

In the opinion of NSAI, the Greenstone Structures LGS Building System, as described in this Certificate, complies with the requirements of the Building Regulations.

DESIGN

The Greenstone Structures Building System is intended for use where Architect's finalized construction and fire strategy drawings are available and satisfy the Building Regulations. The Architect and Engineer Design Team of the Developer (the Client) is responsible for the architectural drawings and overall building design to comply with the Building Regulations.
The Greenstone Structures Chartered Structural Engineers are responsible for the final design of the Greenstone Structures LGS Building System.

RESPONSIBILITIES

Prior to the commencement of the contract, the responsibilities are determined and agreed between Greenstone Structures and the main contractor, including foundations, fire stopping, cavity barriers, roof completion and other elements.

MANUFACTURE, MARKETING, DESIGN & INSTALLATION

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

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

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

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

Buildings incorporating the Greenstone LGS Building System can be designed to meet the requirements of the following clauses of the Building Regulations:

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

Part B – Fire Safety
For purpose groups 1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a) and 5, 7(b) the fire safety requirements are laid out in TGDs to Part B of the Building Regulations.

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

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

B5 & B10 – Access and Facilities for the Fire Service

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

Part E – Sound
E1 – Airborne Sound (Walls)
E2 & E3 – Airborne and Impact Sound (Floors)

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

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

2.1 PRODUCT DESCRIPTION

This Certificate relates to the Greenstone Structures LGS Building System for the design, manufacture and erection of cold-formed light gauge LGS buildings.

The building system is comprised of a panelised LGS building elements for wall units, and LGS elements or composite concrete metal deck for floor construction.

Greenstone Structures' Chartered Engineer is responsible for design, specification, inspection and sign off of all components of the building system described in this certificate.

This Certificate contains illustrations to explain the various elements of the Greenstone Structures LGS Building System – these illustrations are not intended to be used as construction drawings. Greenstone Structures, in conjunction with the design team on a project, will produce a set of project specific details on a project-by-project basis. All drawings should be compliant with the relevant codes of practice and relevant standards, along with current Building Regulations.

2.1.1 Foundations, Ground Floor & Podium Slab

The construction of the foundations, ground floor and podium slab are outside the scope of this certificate. The Greenstone Structures LGS Building System can be constructed on foundations, ground floor or podium slab.

The construction of the foundations, ground floor and podium slab are the responsibility of the Main Contractor and should be constructed in accordance with the Client's Engineering specification. Structure supporting the Greenstone Structures LGS Building System shall be checked by Client's Engineer for structural load criteria specified by Greenstone Structures' Engineer. Tolerances for the system installation on foundations, ground floor or podium slab are defined in Greenstone Structures' installation manual.

2.1.2 Structural Floors

Greenstone Structures provides 2No. options for floor structures: intermediate floors and compartment floors. Further information on compartment floors is provided in Section 2.4.1 and intermediate floors in Section 2.1.3 of this Certificate.

2.1.3 Intermediate Floors

Intermediate floors can be constructed using LGS lattice trusses. Floor units can be delivered to site as floor cassettes or separate members. The lattice trusses are supported using steel hangers on a wall panel.

Typical intermediate floor consists of:

- Floor build up, installed by others
- OSB boarding, installed by others or applied by Greenstone Structures
- Greenstone Structures LGS lattice trusses with mineral wool insulation
- Plasterboard, installed by others and in accordance with this Certificate (refer to Table 2)

2.1.4 Load Bearing Walls

The load bearing wall panels are encompassed of vertical 89-150mm deep LGS 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 are normally at 600mm centres maximum, but lower centres of 400mm can also be accommodated. Studs are aligned vertically in-line down the height of a building and floor trusses align with the stud centres. Lateral resistance of the wall is provided by combination of bracing and boarding.

2.1.5 Non-Load Bearing Walls & Infill Panels

The non-load bearing wall panels are made from cold-formed LGS sections minimum 65mm deep. When internal wall panels provide racking resistance to external walls, diagonal wind bracing members can be incorporated into the panel to successfully transfer the horizontal loads safely through the building structure in accordance with structural design requirements. The bracing also serves to keep the frames square during erection. Panels are designed to resist lateral loads only.

2.1.6 External Walls

The external walls can be load bearing or non-load bearing (infill panels).

The system was assessed as a hybrid frame where insulation is included both outside of the steel structure and in between the steel components. The wall panels are clad with the required thickness and grade of plasterboard as per Table 2 to achieve the appropriate fire rating required

for the building. The plasterboards are screw fixed to the cold formed steel stud and track members.

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

Typical external wall for buildings below 18m in height with traditional facade brickwork outer leaf consists of:

- Plasterboard, installed by others and in accordance with this Certificate (refer to Table 2)
- Air and vapour control barrier, installed by others
- Greenstone Structures LGS studs with mineral wool insulation between the studs
- External insulation layer – PIR, installed by others or by Greenstone Structure
- Stainless steel wall ties and brickwork outer leaf, installed by others

Typical external wall for buildings above 18m in height with traditional facade brickwork outer leaf consists of:

- Plasterboard, installed by others and in accordance with this Certificate (refer to Table 2)
- Air and vapour control barrier, installed by others
- Greenstone Structures LGS studs with mineral wool insulation between the studs
- External sheathing board (installed by others or Greenstone Structures)
- External insulation layer – mineral wool, installed by others
- Stainless steel wall ties and brickwork outer leaf, installed by others

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

2.1.7 Internal Walls

The internal load bearing and non-load bearing wall panels are made from cold-formed LGS as described in sections 2.1.4 and 2.1.5. When internal wall panels provide racking resistance to external walls, diagonal wind bracing members can be incorporated into the panel to successfully transfer the horizontal loads safely through the building structure in accordance with structural design requirements.

Typical internal load-bearing wall consists of:

- Plasterboard, installed by others and in accordance with this Certificate (refer to Table 2)
- Greenstone Structures LGS studs with/without mineral wool insulation between the studs
- Plasterboard, installed by others and in accordance with this Certificate (refer to Table 2)

All internal load bearing panels must be sufficiently supported directly under the panels with rising blockwork or equivalent. Plasterboard specifications on the steel panels should be in accordance with Table 2 of this certificate, which shows the plasterboard fire resistance requirements for wall, floor and ceiling elements. The plasterboard and AVCL linings are fixed to the walls and ceilings by means of self-drill/self-tap screws; all joints are then taped and filled where required for decoration.

2.1.8 Roof Structure

The roof trusses can be either a traditional timber cut roof, prefabricated roof truss made from timber or steel or a steel prefabricated roof module. The roofing solution chosen for a particular building is both client and project specific and must be assessed and signed off by a Greenstone Structures' chartered structural engineer.

2.1.9 Internal Linings and Finishes

Linings to walls and ceilings are of plasterboard as specified in Table 2, manufactured to I.S. EN 520[4]. They are attached by means of self-drill/self-tap screws into steel members. In areas prone to high levels of humidity, moisture resistant plasterboard should be used. Joints in plasterboard can be taped and filled in accordance with the plasterboard manufacturer's instructions. Alternatively skim coat plaster can be applied.

2.1.10 Services

Services are outside the scope of this Certificate. Electrical installation should be designed and installed in accordance with I.S. 10101[5]. Heating and plumbing services must be designed and installed by competent professional engineers.

Care shall be taken to avoid dissimilar metals coming into contact to avoid risk of galvanic corrosion. Local earth connection to the steel frame shall be avoided. The structural frame should be earthed in accordance with the current regulations I.S. 10101[5].

Electrical installations and recessed lights may not 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 services are installed with reference to Section 3 of TGDs to Part B of the Building Regulations for all purpose groups to which this certificate applies. Penetrations through compartment floors should

be minimised. 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[6].

Services can pass through a compartment wall when they are appropriately protected with reference to Section 3 of TGDs B of Building Regulations for all purpose groups to which this Certificate applies. Services passing through compartment walls should be kept to a minimum and avoided where possible.

2.2 DESIGN AND MANUFACTURE

The Greenstone Structures LGS Building System must be designed in accordance I.S. EN 1993-1[7], and manufactured in accordance with I.S. EN 1090-1[8] to EXC2. The design and manufacture are the responsibility of Greenstone Structures.

The steel frame panels which form the wall element are composed of light gauge steel manufactured from a galvanised coil. Walls panels are assembled from C-profile LGS sections using self-tapping screw connections. Panels assembly is carried out in the factory environment. Steel grade S390 or S450 is used for non-loadbearing and load bearing panels. Table 1 shows typical LGS profiles for Greenstone Structures LGS Building System.

2.3 STRUCTURAL PRINCIPLES

2.3.1 LGS Structure

The basis of the typical Greenstone structure is a cold-formed light gauge steel frame, which is assembled into structural panels in the factory and installed on site. Alternatively the system can be stick built if required.

2.3.2 Protective Coatings

The LGS members are all coated with a protective zinc-rich metal coating. The LGS members are manufactured from galvanized coil steel to I.S. EN 10346[9] and coated with 275 g/m^2 zinc.

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 LGS panels is additionally protected by a DPC.
- The insulation keeps the steel in a "warmframe" environment, which, in conjunction with an AVCL prevents the formation of condensation within the wall structure.
- Studs shall be located minimum 150mm above ground level.
- An increase in the grade of zinc layer is provided where there is an increased risk of corrosion. Where the studs cannot be installed minimum 150mm above the ground level, the protective layer on zinc shall be increase to z600
- All fasteners have been assessed and tested for use with the system, to ensure the minimum 60-year design life of the system.

2.3.3 Fasteners and Connection Joints

The design of the Greenstone Structures LGS Building System allows for no welding of joints in the system. The system is assembled using fasteners such as self-tapping screws. On-site structural connections such as panel to panel connections, OSB boarding to floor joist, floor joist to panel, composite deck to panel and wind bracing are fastened using approved Tek screws and bolted connections.

All fasteners used in the LGS 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. Greenstone Structures provides a full specification of all fasteners, where they are to be used and how they are to be installed during the construction of the system. Only system fasteners approved or supplied by Greenstone Structures may be used with the system. It is important to ensure that protective coatings on fasteners are not removed, i.e. to assist the fitting of a connection, as this would severely compromise the corrosion performance of the fastener. Greenstone Structures specify corrosion protection of fasteners with consideration to the environment in which they are to be used, with additional coatings applied on site where required.

2.3.4 Racking

Resistance to horizontal loading (racking) is provided by the horizontal diaphragm action of the approved floor sheeting and roof in conjunction with the metal diagonal X-bracing or K-bracing in the wall panels transferring lateral loads to the foundations, stability cores or other lateral stability system. All X-bracing or K-bracing is preassembled 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.

Foundations and lateral stability systems such as concrete cores are outside of the scope of this certificate. All structural criteria and load transfer to lateral stability system will be determined by the Greenstone Structures' chartered engineer and communicated to the Client's structural engineer.

2.3.5 Holding Down Fixings

The bottom channel of the external panels is fixed to the ground floor slab, podium slab or rising wall with approved holding down fixings. The type of

fixing used to hold down the panels of the system will be dependent on what substrate it is being fixed to. The fixings are designed by the Greenstone Structures to I.S. EN 1992-4[11] and are installed in accordance with the HSA *Code of Practice for the Design and Installation of Anchors*[10]. The positions of the fixings are project specific and are determined by the Greenstone Structures. The bottom channel member is predrilled during assembly to accommodate anchor fixings on site. 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.

2.4 COMPARTMENTATION

2.4.1 Compartment Floors

The compartment floors can be constructed using steel concrete composite deck structure. The build is outlined in Table 2. The Greenstone Structures LGS Building System compartment floor can be designed to provide up to 90mins fire resistance from the underside. The compartment floor is non-combustible and is suitable for use in buildings of any purpose group up to the maximum height allowed in this Certificate.

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

Typical steel concrete composite deck consists of:

- Floor finishes, installed by others
- Resilient layer (cork matting or similar), installed by others
- Greenstone Structures steel concrete composite floor system
- Mineral wool (if required) by others
- Plasterboard supported on proprietary metal frame, installed by others and in accordance with this Certificate (refer to Table 2)

An additional layer of resilient material is added to the top of the composite slab to meet the requirements outlined in Section 4.4 of TGD to Part E of the Building Regulations (see Section 4.4.2.1 of TGD to Part E for definition of resilient material). The underside of the deck is fitted with the ceiling type required by the specific project.

Steel metal deck may be supported directly on the top track or via the use of Z-hangers. Z-hangers are fixed to the top track of the panel.

2.4.2 Compartment Wall

Separating walls are constructed using a minimum of two independent cold formed steel framed leaves with a recommended minimum cavity of 40mm between both frames. The individual frames are boarded (on site or in the factory) with the appropriate level of boarding required to provide the acoustic and fire properties, as illustrated in Table 2.

Where the attic space is habitable the mineral wool insulation must go up to the underside of the roof for acoustic purposes. Where the party wall abuts an external wall, the mineral wool insulation within the cavity of the party wall extends through the inner leaf of the external wall and abuts the external leaf of the system and forms the fire stop in the wall. This detail seals air gaps and minimises flanking sound transmission.

The head of the party wall must also be fire stopped and cavity closed as specified by the Greenstone Structures' construction details. Where services are required in a party wall, they can be accommodated by creating a service cavity to the party wall with timber battens or metal top hat sections and plasterboard. All battens used with the Greenstone Structures LGS Building System are treated in accordance with BS 8417[12]. Design must comply with the requirements of Section 3 of TGDs to Part B of the Building Regulations for all purpose classes to which this certificate applies.

A compartment wall within the Greenstone Structures LGS Building System can be also constructed of a single frame wall and can be designed and specified to meet the acoustic, fire and structural requirements of the Building Regulations. This compartment wall must not be used where a wall is common to two or more buildings (separating wall) or where a compartment wall is used to separate dwellings from each other within a building.

2.4.3 Cavity Barriers and Fire Stops

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

- Separating/compartment 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/compartment wall junction with the external wall, the vertical cavity barrier runs out to the inner face of the external cladding to form the cavity barrier.
- Horizontal cavity barriers shall be placed at the perimeter of all compartment floors. The cavity barrier should be appropriate for the external

cladding that is intended to cavity close in the event of a fire and smoke entering the cavity.
- A cavity barrier shall cover the full floor depth as well as the upper wall panel rail and lower wall panel head plate.
- Cavity barriers are required around all openings in external walls such as doors, windows, vents, extractor fans, meter cupboards, etc.

The method of fire stopping should be in accordance with guidance given in Section 3.6 of TGD to Part B Volume 2 of the Building Regulations for purpose groups 1(a), 1(b) and 1(d), and Diagram 13 and section 3.3 of TGD to Part B 2006 of the Building Regulations for all other purpose groups for which this Certificate applies.

The Greenstone Structures site installation manager will inspect all cavity barriers and fire stops prior to the closing up of the cavities and ceilings and will record it in the quality control file for that site. The fire stopping must be installed correctly before Greenstone Structures will issue the certificate for the building.

2.5 DELIVERY, STORAGE AND SITE HANDLING

2.5.1 Delivery of Panels

Frame panels are transported vertically or horizontally to site. Where lifting points are required, they are located, designed and certified by the Greenstone Structural Engineer, taking into account the unit weight and dimensions and the distance of lift required. They will conform to the requirements of the Safety, Health and Welfare at Work Act 2005 and the Safety, Health and Welfare at Work (Construction) Regulations 2013.

2.5.2 Storage of Panels

To minimise any risk of damage or deterioration of the Greenstone Structures' products on site the following precautions shall be followed:

- Panels which are stored on site should be kept off the wet ground, using steel studs or timber skids.
- While in storage, packs of panels should be covered from the rain, using a plastic tarpaulin or similar waterproof membrane.
- Where panels do get wet, the bottom track of the panel should be inspected for moisture entrapment. If water exists, a hole between studs should be drilled in the corner of the track.
- Greenstone Structures' products should not be stored near lime, dry cement, plaster, mortar or salt.
- Where Greenstone Structures has supplied boarding to site, be it orientated strand board, cement board, insulation boards, these products should be protected from exposure to rain/ moisture.

2.5.3 Safe Handling

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

Panels should always be moved using a crane supplied by the steel frame installer or contractor (project specific) using the pre-attached lifting eyes on each panel or via slings. The only exception to this is small panels below a safe weight limit as specified in the risk assessment. The ends of all steel sections are sharp, gloves must always be worn when moving steel products.

2.5.4 Traceability

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

Each assembly drawing contains the unique identification number for each steel member. This allows for ease of assembly by the assemblers.
When each wall panel is complete and within the required dimensional tolerances, it is quality control checked according to the building drawing and stacked according to the off-loading plan for the building.

2.5.5 Typical Material List Supplied to Site

With each customised delivery to site, a comprehensive bill of materials is supplied. This bill of materials gives a detailed list of all components delivered to site to complete the installation of the Greenstone Structures LGS Building System.

All panels are individually numbered using the pre-marking system during production to correspond with the erection drawings supplied with the bill of materials. This pre-marking system facilitates speed and accuracy during assembly and erection on site.

2.6 INSTALLATION

2.6.1 General

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

sign off in accordance with the Building Regulations.

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

2.6.2 Tolerances

Prior to installation of the wall panels, the tolerances are checked at the base of the wall frame by the main contractor and Greenstone Structures. The required tolerances can be found in the Greenstone Structures' installation manual.

2.6.3 Panels Lifting

All lifting shall be carried out by competent personnel in accordance with the Greenstone Structures' installation manual and site-specific safety statement. The placement of a panel should be carried out using a crane or teleporter.

The panel is positioned in place aligning with its location on the provided plan drawings. Prior to temporary fixing of the panel, the frame should be checked for horizontal and vertical level, shimming the panel where necessary. Once the level is within tolerance the panel should be temporarily fixed in place. The temporary fixing of the panel typically requires a connection along the bottom track and props to the topside at specified centres. The fixing specification may differ depending on the project.

2.6.4 Panels Fixing

Permanent anchorage of the panel may commence as soon as the connecting subassembly surrounding the panel are set (hot rolled steel/floor etc.). Anchorage of the panel should follow the specification stated within the detailed drawings provided. Any grouting of shimming shall be carried out prior to panels fixings (refer to Greenstone Structures' installation manual).

2.6.5 Floors Fixing

LGS lattice trusses

The floor cassettes arrive onsite pre-assembled in maximum widths of 4.0m and are slung into position using the crane. The cassette typically sits on an external wall and on the party wall or an internal supporting wall. A strip of fireboard shall be placed at the top of the supporting wall prior to placing of the joists hangers and installing floor cassettes. A layer of EPDM is to be placed at the point where the Z-hanger sit on the supporting wall. Where the floor spans parallel to the external wall, the floor cassette shall be fixed to the external wall as per Greenstone Structures' specification.

Steel concrete composite floor deck

Compartment floors can be constructed using steel concrete composite floor deck. Steel sheets shall be slid into place on the joists hangers or atop the LGS steel frame. Sheets shall be fixed as shown on project's drawings.

Temporary propping may be required for sheets typically in excess of 3.5m in length. All propping locations are indicated on Greenstone Structures' drawings. Propping shall remain in place during construction for a specified time by Greenstone Structures.

Reinforcement shall be installed as per Greenstone Structures' drawings and specification. Once reinforcement is installed the concrete pour may commence.

2.6.6 Plasterboard Installation

The proper application of plasterboard to the steel frame members is critical for both fire and sound performance. Attention shall be given to proper and practical detailing on the part of the designer and a high standard of workmanship on behalf of Greenstone Structures. Plasterboard, in addition to all cavity barriers and fire stops on all walls and floors must be fully checked on site and signed off in accordance with project specific details by the appropriate personnel. All boarding that provides fire resistance must conform to the specification given in Table 2.

2.6.7 Infill Panels Installation

Infill panels installation shall be in accordance with Greenstone Structures' installation manual.

Infill panels shall be installed on supporting structure with minimum bearing width and fixings as stated on Greenstone Structures' drawings.
Typical fixings include:

- Base track to supporting structure
- Vertical connection to vertical elements (columns etc.)
- Deflection head to structure over
- Deflection head to infill panel
- Two panels connection

Fixings manufacturer specifications should be followed as to minimum embedment depth and edge distances. When fixing a ground floor slab a DPC layer should be positioned underneath the base track.

Deflection head shall be installed at the top of the infill panel to take account of deflection of the structure overhead. Deflection criteria shall be identified by Client's structural engineer.

2.6.8 Installation of NSAI Agrément certified external wall insulation façade

Where NSAI Agrément certified external façade will be installed on Greenstone Structures LGS Building System, it shall be installed in accordance with cladding manufacturer's installation manual. The build-up of external wall shall match as certified an NSAI Agrément external façade system. Refer to external façade system NSAI Agrément certificate for further information.

All claddings fixed to the LGS frame shall be agreed with the Greenstone Structures' structural engineer to ensure that LGS system structure is designed to support cladding loads.

Greenstone Structure offers the external cladding system installed in the factory environment or traditionally installed on site. External cladding systems are outside of the scope of this Certificate. The system has been assessed with claddings as per section 2.1.6.

2.6.9 Site Supervision

The approved installation contractors are subject to supervision by the Greenstone Structures' site manager. Typically, the Greenstone Structure' site manager will agree a schedule of inspections with the erection contractor. The supervisor of the erection crew is responsible for the quality and productivity of work carried out by the erection crew.

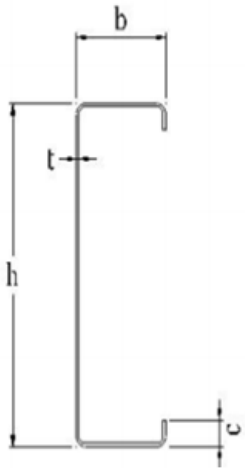
The erection supervisor reports directly to the Greenstone Structures' site manager to ensure all work follows the requirements of the design drawings and the requirements of Greenstone Structures' certification for the building.

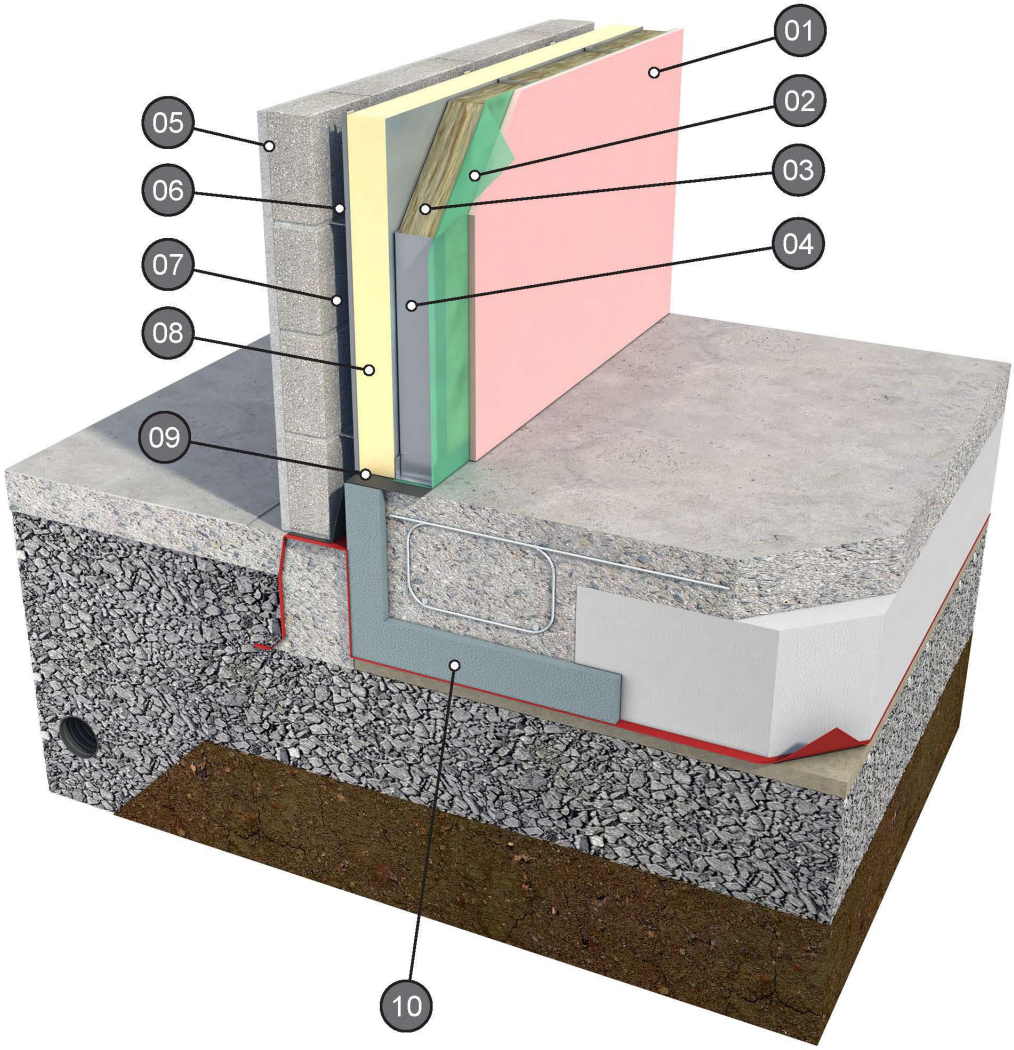
Each building has its own quality control file which is kept on site by the Greenstone Structures' site manager. All fixings and brackets between panels are visually inspected, periodically photographed and recorded in the quality control file. The site manager also inspects and records all fire stopping performed on site. Any defects noted are recorded, photographed where possible and notified in writing to the erection supervisor. The site manager will inspect and approve the remediation before work can proceed.

2.6.10 Main Contractor Responsibilities

The Main Contractor is generally responsible for the construction of all facade claddings, roof claddings and the installation of fire stopping and cavity barriers where it is impractical for Greenstone Structures to install prior to these claddings being applied. All other fire stopping, and cavity barriers are the responsibility of Greenstone Structures.

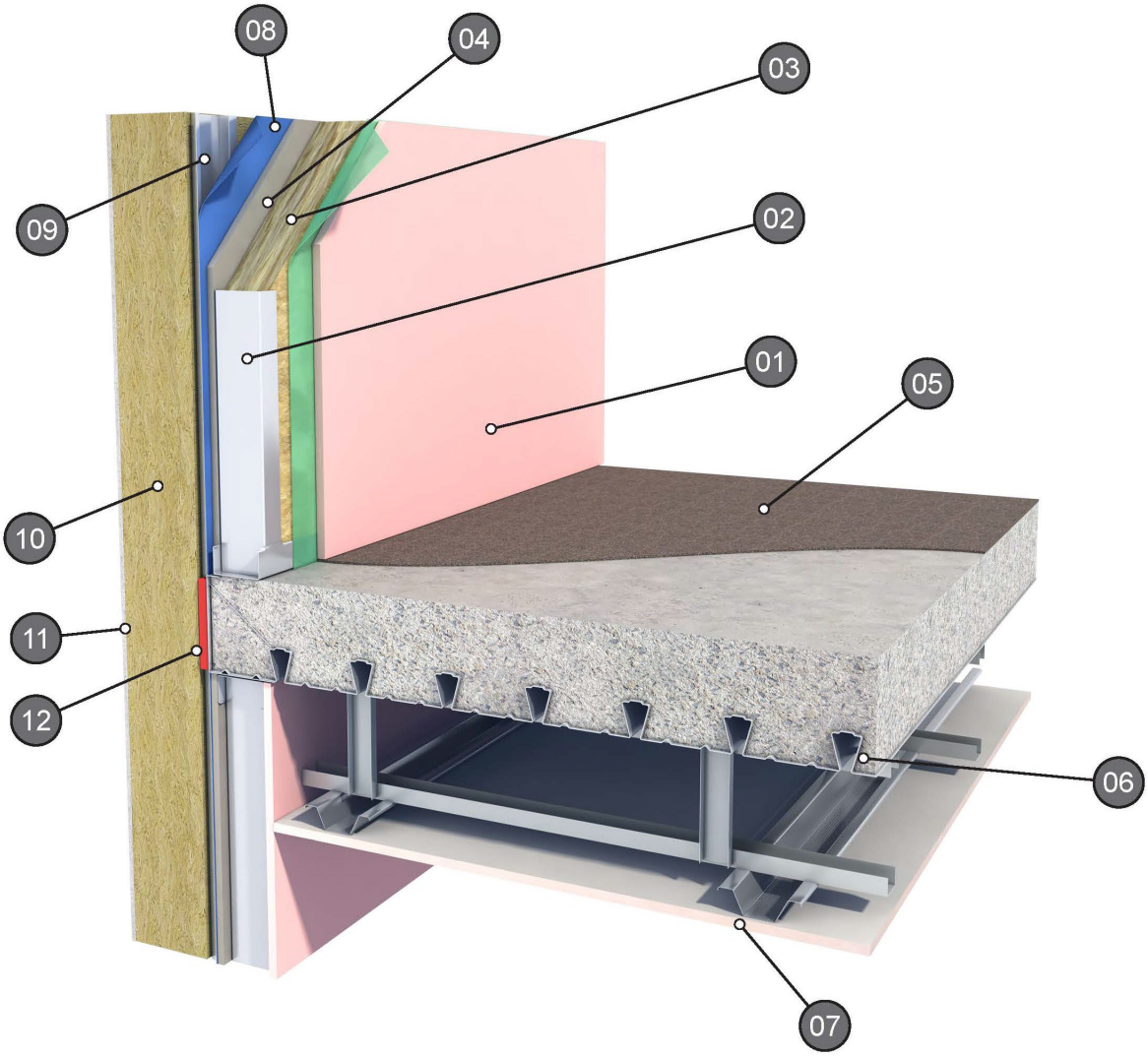
Table 1: LGS Profiles and properties					
Greenstone Structures– LGS Frame Profile					
Component Type	**Grade of steel**	**Typical Section Details (mm)**			
		Depth (h)	**Width (b)**	**Lip (c)**	**Thickness (t)**
Wall Stud	S390, S450, S550	89	45	10	0.9 - 1.6
Wall Stud /Roof Truss	S390, S450, S550	100	51	15	1.0 - 2.0
Wall Stud/Roof Truss /Floor Joist	S390, S450, S550	150	51	15	1.0 - 2.0
Floor Joist	S390, S450, S550	200	51	15	1.0 - 2.0
Floor Joist	S390, S450, S550	250	51	15	1.0 - 2.0





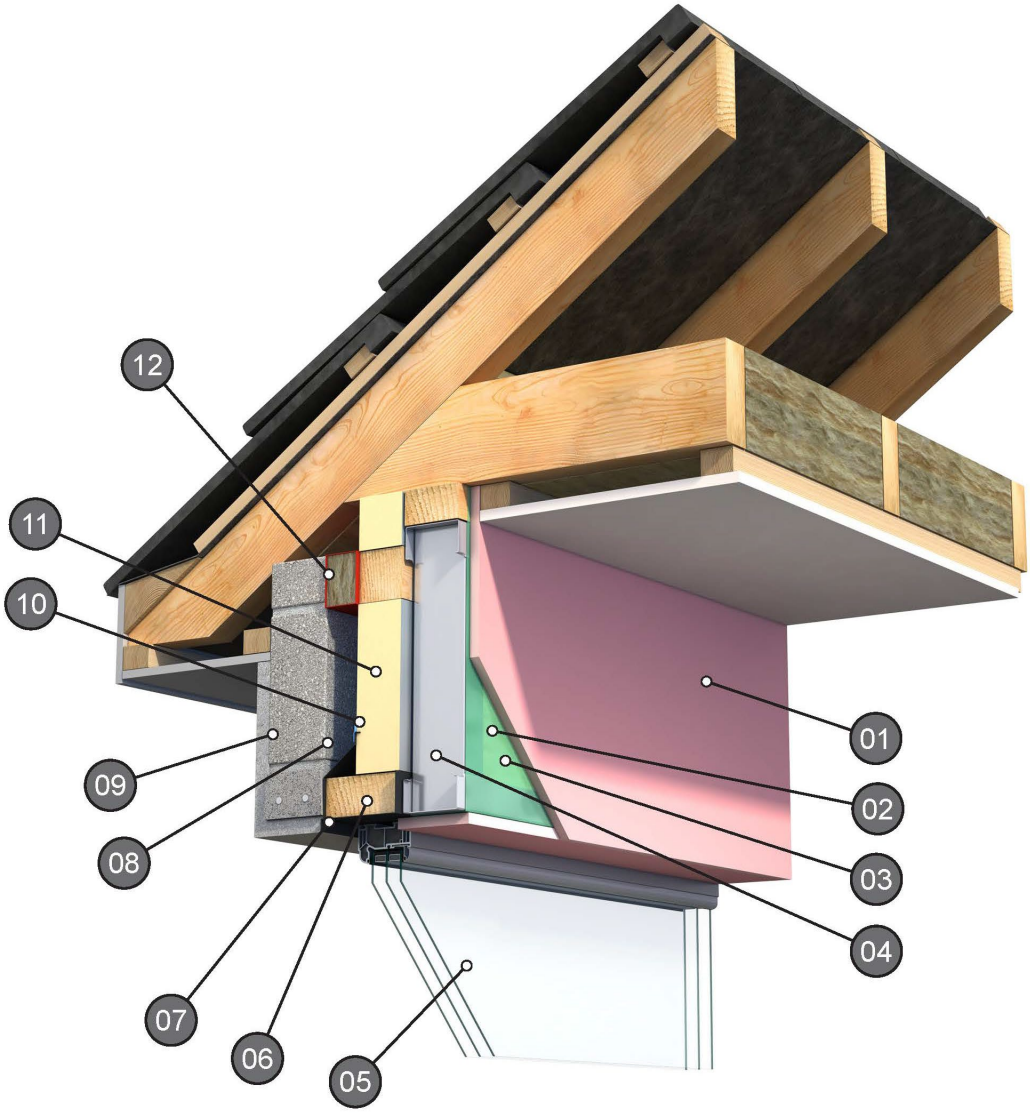
01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. Air & Vapor Control Barrier.
03. 100mm Stone Wool Insulation (22 kg/m3) placed between studs.
04. 89mm Galvanised Steel Stud.
05. Brick (or Block) outer layer.
06. Wall Tie & Channel fixed through Insulation to frame.
07. Cavity.
08. PIR Insulation to design specifications.
09. DPC.
10. Insulated foundation system by others.

Figure 1 External Wall with PIR or Phenolic Insulation and Masonry Outer Leaf to Insulated Foundation Detail



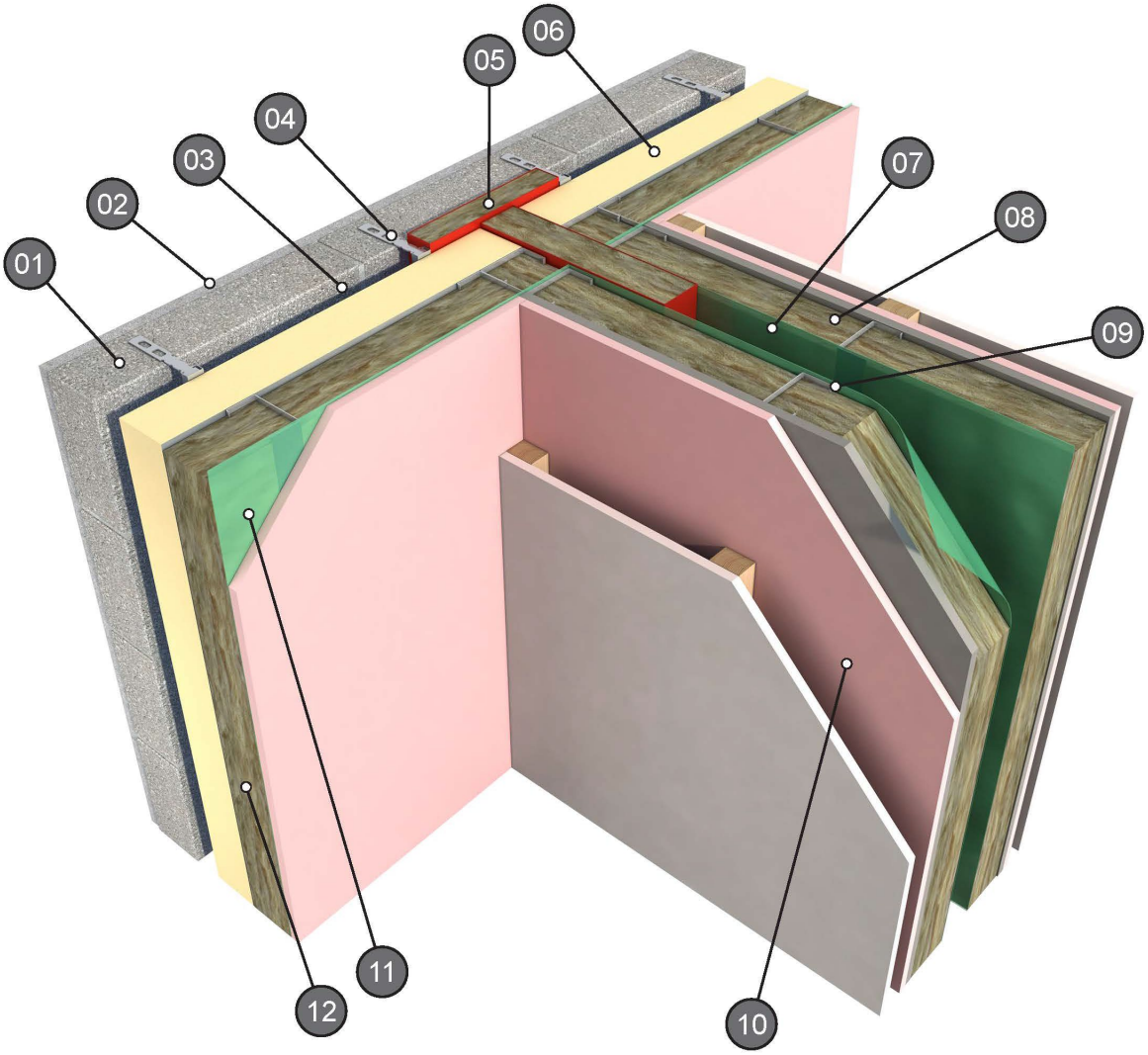
01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. 89mm Galvanised Steel Stud.
03. Stone Wool Insulation placed between stud.
04. Exterior board as per NSAI Agrément Certified External Wall Insulation System specification.
05. 4-6mm Cork Matting resilient layer installed by others.
06. 51mm Dovetail Metal Deck Profile.
07. Plasterboard on Suspended Cieling by others.
08. Breather Membrane as per NSAI Agrément Certified External Wall Insulation System specification.
09. Vertical Rails as per NSAI Agrément Certified External Wall Insulation System specification.
10. External Mineral Wool Insulation as per NSAI Agrément Certified External Wall Insulation System specification.
11. External Render as per NSAI Agrément Certified External Wall Insulation System specification.
12. Openstate caviy barrier as per NSAI Agrement certified External Wall insulation system specification.

Figure 2 External Wall with Agrément Certified External Wall Insulation Façade System and Compartment Floor Junction



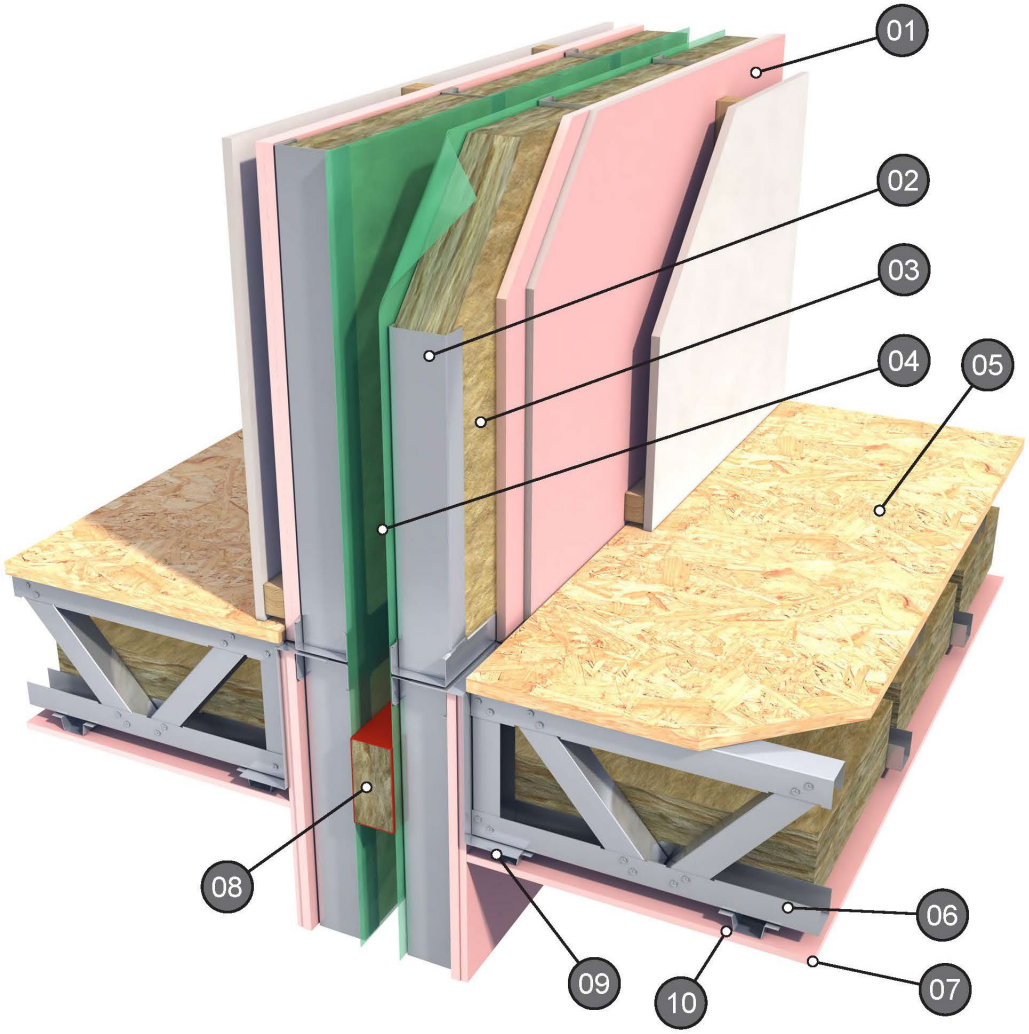
01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. Air & Vapor Control Barrier.
03. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.
04. 89mm Galvanised Steel Stud.
05. Window to client specification.
06. Cavity Closer.
07. DPC..
08. 50mm Cavity.
09. Brick (or Block) outer layer.
10. Stepped DPC detail, recessed to PIR & sealed with PUR foam/Breather tape.
11. PIR Insulation to design specifications.
12. Cavity Barrier (60 min) Rockwool PWCB & TCB.

Figure 3 Eaves Detail



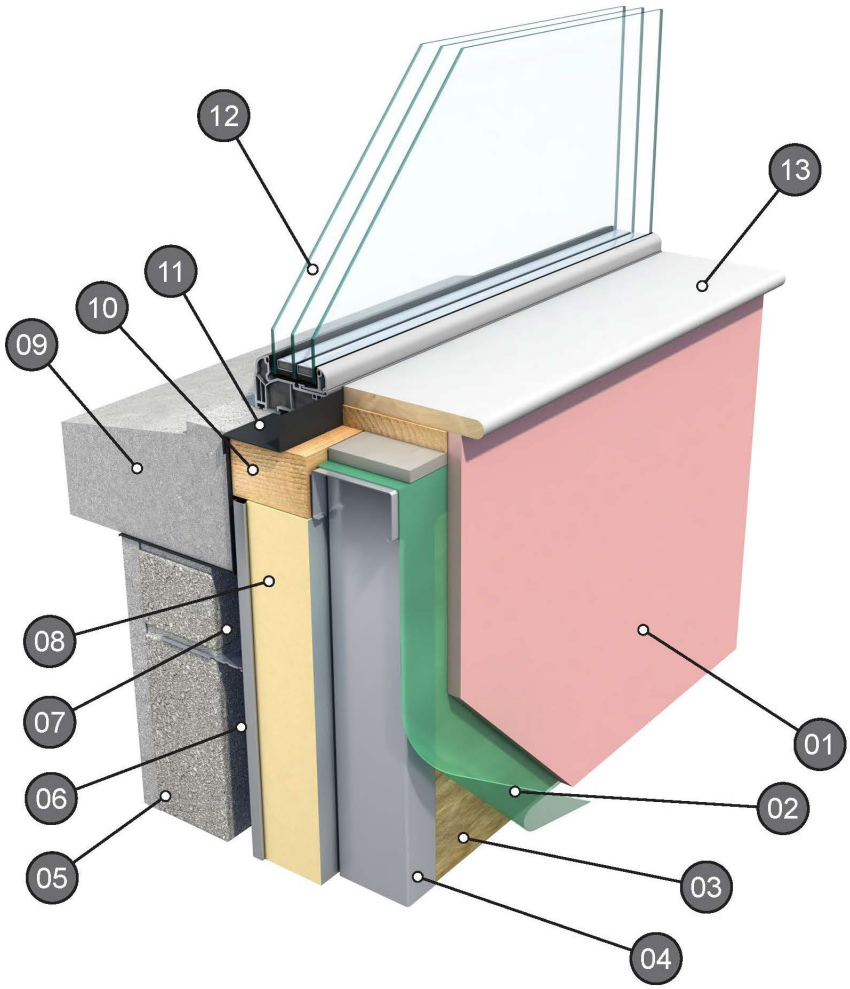
01. Brick (or Block) outer layer.
02. External Render.
03. 50mm Cavity.
04. Wall Tie & Channel fixed through Insulation to frame.
05. Cavity Barrier (60min) Rockwool PWCB & TCB.
06. PIR Insulation to design specifications.
07. Air & Vapor Control Barrier.
08. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.
09. 89mm Galvanised Steel Stud.
10. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
11. Air & Vapor Control Barrier.
12. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.

Figure 4 External Wall with PIR or Phenolic Insulation and Masonry Outer Leaf and Compartment Floor Junction



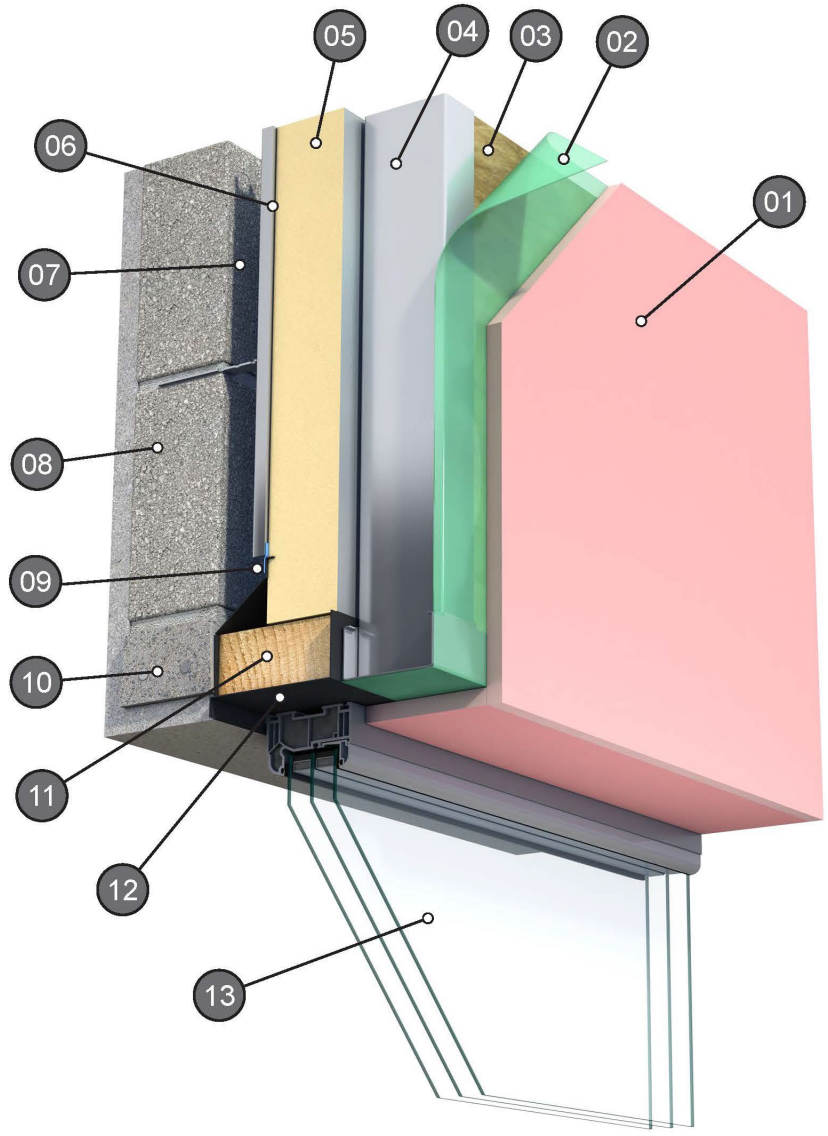
01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. 89mm Galvanised Steel Stud.
03. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.
04. Air & Vapor Control Barrier.
05. 18mm OSB Board.
06. Lattice Truss
07. 12.5mm Type F Fireline Plasterboard.
08. Cavity Barrier (60min) Rockwool PWCB & TCB.
09. Z-Hangers to support Lattice Truss.
10. Resilient bar.

Figure 5 Compartment Wall to Intermediate Floor Detail



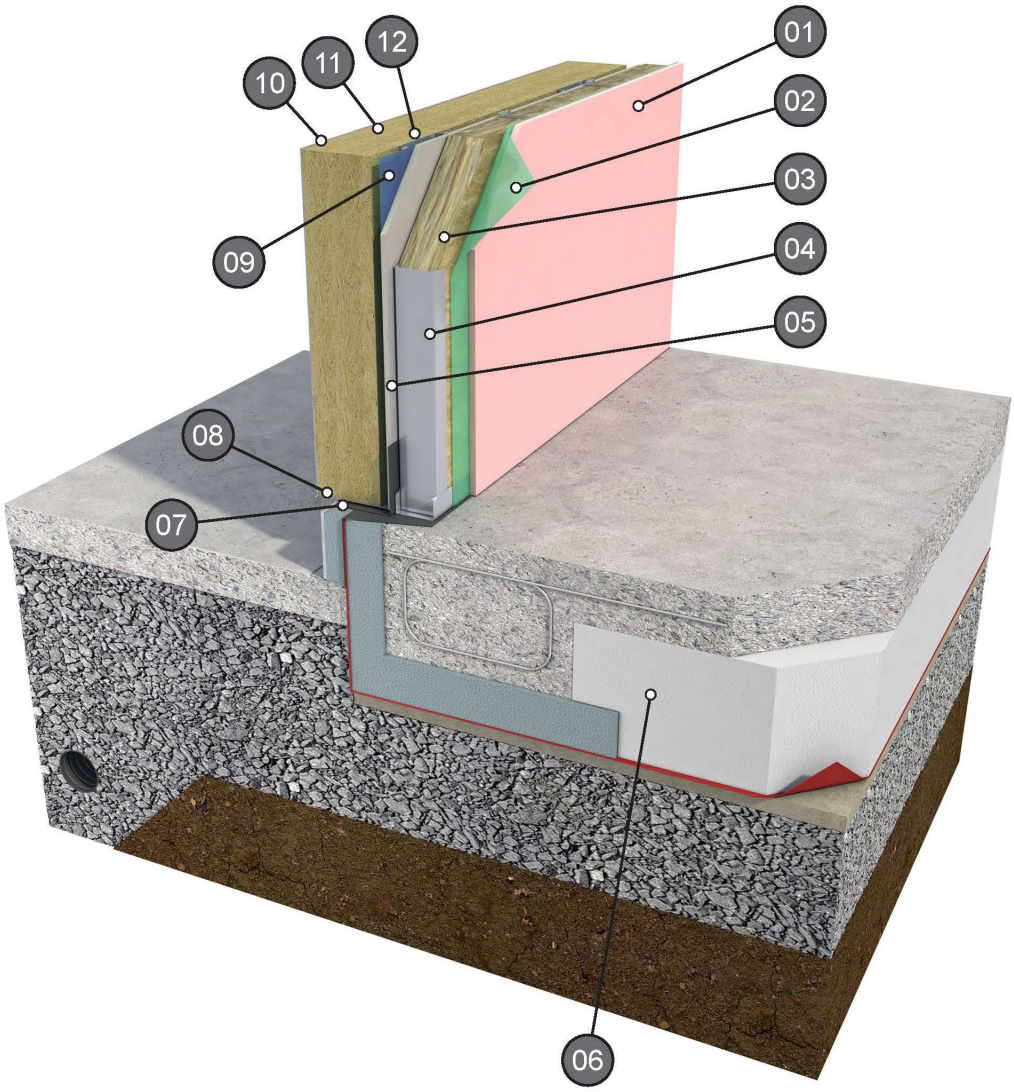
01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. Air & Vapor Control Barrier.
03. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.
04. 89mm Galvanised Steel Stud.
05. Brick (or Block) outer layer.
06. Wall Tie & Channel fixed through Insulation to frame.
07. 50mm Cavity.
08. PIR Insulation to design specifications.
09. Concrete Cill.
10. Cavity Closer.
11. DPC.
12. Window to client specifictaion.
13. Window Board to specification.

Figure 6 Window Sill Detail



01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. Air & Vapor Control Barrier.
03. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.
04. 89mm Galvanised Steel Stud.
05. PIR Insulation to design specifications.
06. Wall Tie & Channel fixed through Insulation to frame.
07. 50mm Cavity.
08. Brick (or Block) outer layer.
09. Stepped DPC detail, recessed to PIR & sealed with PUR foam/Breather tape.
10. Window Lintel - precast or steel as required.
11. Cavity Closer.
12. DPC.
13. Window to client specification.

Figure 7 Window Head Detail



01. Type F plasterboard to provide adequate protection to steel frame in accordance with this certificate (refer to Table 2).
02. Air & Vapor Control Barrier.
03. 100mm Stone Wool Insulation (22 kg/m3) placed between stud.
04. 89mm Galvanised Steel Stud.
05. Exterior board as per NSAI Agrement Certified external wall insulation system specification
06. Insulated foundation system by others.
07. Vertical DPC 100mm above FFL to 150mm below FFL.
08. Starter track.
09. Breather membrane as per NSAI Agrement Certified external wall insulation system specification.
10. External render as per NSAI Agrement Certified external wall insulation system specification.
11. External mineral wool insulation as per NSAI Agrement Certified external wall insulation system specification.
12. Vertical rails per NSAI Agrement Certified external wall insulation system specification.

Figure 8 External Wall with Agrément Certified External Wall Insulation Facade System to raft Foundation Detail

3.1 STRENGTH AND STABILITY

3.1.1 General

The architectural and engineering design team are responsible for ensuring that architectural drawings and overall building design comply with the Building Regulations. Greenstone Structures, using an experienced chartered structural engineer, are responsible for the structural design of the Greenstone Structures LGS Building System.

3.1.2 Certificate of Structural Compliance

Greenstone Structures are responsible for the design, manufacture, supply, installation, and certification of the system.

3.1.3 Superstructure Design

The design must be in accordance with I.S. EN 1990[13], IS EN 1993-1[7] and Part A to Building Regulations.

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

3.1.4 Infill Panels Design

Non-load bearing partitions and walls are designed in conformance with the criteria set out in I.S. EN 1993-1[7], BS 5234-1[14] and I.S. EN 10143[15].

3.1.5 Substructure Design

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

3.1.6 Design Loads

During the design process, loads are determined by Greenstone Structures depending on the intended use of the building and client's requirements, using I.S. EN 1991-1 suite and designed with reference to:

- Dead and imposed load to I.S. EN 1991-1-1[16]
- Snow load to I.S. EN 1991-1-3[18]
- Wind loads based on I.S. EN 1991-1-4[17]

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

3.1.7 Structural Testing

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

3.2 FIRE

3.2.1 General

Buildings using the Greenstone Structures LGS Building System must be designed to comply with the relevant requirements of TGDs to Part B of the Building Regulations.

The building details of the system incorporate suitable cavity barriers and fire stops to satisfy the requirements of Section 3 to TGDs to Part B of the Building Regulations. Additional guidance is contained in BS 9991[19] & BS 9999[6].

The Greenstone Structures LGS Building System must be designed with the required boarding specification to meet the minimum requirements of Table A1 and Table A2 to TGDs to Part B of the Building Regulations for all purpose groups to which this certificate applies, and any other building specific structural fire performance requirements.

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

3.2.2 Fire Resistance of Compartment Walls

Table 2 lists the fire resistance tests for non-loadbearing and loadbearing elements, in accordance with I.S. EN 1364-1[22], I.S. EN 1365-1[20] and I.S. EN 1365-2[21]. All fire testing has been carried out with service penetrations in the walls.

Any compartment wall providing fire compartmentation shall be carried up through any roof space and brought up to the underside of the roof cladding to provide adequate fire stopping.

3.2.3 Fire Resistance of Compartment Floor (Steel/Concrete Composite Deck)

The fire resistance of the composite deck is provided from the underside of the deck as detailed in Table 2 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.

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 to TGDs to Part B of the Building Regulations for all purpose groups to which this certificate relates.

3.3 AIRTIGHTNESS

Airtightness testing is a mandatory requirement of TGDs to Part L of the Building Regulations. Testing must be carried out as specified in I.S. EN ISO 9972[23] with additional guidance given in the NSAI's "Certified Air Tightness Tester Scheme Master Document" and TGDs to Part L of the Building Regulations.

The air tight tape must be installed as per Greenstone Structures Installation Manual between external wall and party wall panels and the foundations, external to external wall junctions, external wall to party wall junctions and at roof junction. Location of AVCL is shown on Figures 1 to 8 of this Certificate.

3.4 WEATHERTIGHTNESS AND DAMP PROOFING

The system has adequate DPCs and DPMs to resist the passage of moisture. Roof coverings will provide adequate weather resistance when completed in accordance with this Certificate and the manufacturer's instructions.

Buildings constructed using the Greenstone Structures LGS Building System can readily accommodate adequate rainwater gutters and down pipes.

3.4.1 External Cladding

Where the external facade is constructed of a masonry/brick outer leaf it must incorporate a minimum 40mm clear cavity, to minimise the risk of water reaching the cavity face of the inner leaf. The external leaf of the Greenstone Structures LGS Building System can be constructed of traditional brick/block to I.S. 325-1[24] and I.S. EN 1996-1-1[2], or NSAI Agrément approved external cladding system.

Non-traditional facades, certified by NSAI Agrément, can be used within the parameters set out in the scope of their certificate.

3.5 WINDOWS AND DOORS

Windows and doors are outside the scope of this Certificate. However, Figures 6 and 7 give indicative details of how they can be installed to limit heat loss and moisture penetration.

Other considerations for the design of windows and doors include:

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

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

3.6 THERMAL PERFORMANCE

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

Some building elements, namely the roof, ground floor, windows and doors may be site and project specific. Therefore, the U-value of these elements must be calculated before overall compliance with Part L of the Building Regulations can be determined.

TGDs to Part L of the Building Regulations 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 I.S. EN ISO 10211[25].

3.6.1 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 as well as used Acceptable Construction Details to meet the requirements of Building Regulations.

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

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

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

ψ-values for other junctions outside the scope of this certificate should be assessed in accordance with the BRE IP 1/06[26] and BRE Report BR 497[27]

in accordance with Appendix D of TGD to Part L of the Building Regulations.

3.6.2 Internal Surface Condensation

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

3.7 INTERSTITIAL CONDENSATION

3.7.1 Condensation in Walls

Air and vapour control layer is provided behind the plasterboard for protection against interstitial condensation.

3.7.2 Condensation in Roofs

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 the roof structure through diffusion. The AVCL can double as the airtight barrier.

Roof ventilation should be provided in accordance with TGD Part F of the Building Regulations and the recommendations of BS 5250[28].

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

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

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

3.8 SOUND

3.8.1 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 Part E of the Building Regulations.
In both floor types the resistance to airborne sound depends mainly on the mass of the concrete base, plasterboard ceiling and good flanking detailing.

In a Type 1 floor the soft covering reduces the impact sound at source. The impact sound reduction is achieved with the use of a suitable approved layer of soft floor covering. The covering is not intended to be the final finished floor but is intended to act as a resilient layer beneath different floor finishes such as vinyl, carpet, timber flooring, tiles etc.

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

As per TGD Part E to Building Regulation, all building, post completion must be subjected to acoustic testing. In all cases, where applicable, the values achieved for buildings incorporating the Greenstone Structures separating floors design must meet TGD to Part E requirements.

3.9 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[29]. 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.

It shall be the responsibility of the building owner to monitor the condition of the building and commission maintenance and repairs as required. It is envisaged these will be carried out by the building owner in accordance with BS 8210[30].

4.1 BEHAVIOUR IN FIRE

4.1.1 Fire Resistance

Assessment of test results shows that buildings constructed using the Greenstone Structures LGS Building System can meet the Building Regulation requirements in relation to fire resistance as shown in Table 2.

4.2 THERMAL PROPERTIES

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

Tables 3 – 5 of this certificate gives the various elemental wall U-values in W/m^{2}K with a traditional 100mm masonry cladding and Tables 7 – 8 give the various elemental wall U-values in W/m^{2}K for the Agrément certified external wall insulation façade system when used with the Greenstone Structures LGS Building System.

4.2.1 Limiting Thermal Bridging

Tables 6 and 9 of this certificate gives ψ-values for a range of the building system junctions. A full listing of ψ-value calculations, along with the building details on which calculations are based, are contained within the certificate holder's technical data sheets for ψ-values.

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

4.2.2 Internal Surface Condensation

Tables 6 and 9 of this Certificate gives internal surface temperature factors (fRsi) for a range of building junctions.

The junctions of the Greenstone Structures LGS Building System have been assessed to comply with the requirements of TGDs to Part L of the Building Regulations.

4.3 INTERSTITIAL CONDENSATION

4.3.1 Condensation in Walls

Calculations to BS 5250[28] have been carried out for all external wall build ups as covered by this certificate. They predict no interstitial condensation within the external wall and pass the risk criteria in I.S. EN ISO 13788[31].

4.4 SOUND

4.4.1 Separating Walls

The acoustic performance of the separating wall has been assessed by both on-site testing and comparison with Robust Standard Details for Separating Wall - Steel Frame E-WS-1 and SCI P372[32] and through adopting best practice at salient junctions to minimise the effects of airborne, impact and flanking sound.

The separating wall in the Greenstone Structures LGS Building System has been assessed and when constructed in accordance with this certificate can meet the requirements of TGD to Part E of the Building Regulations.

4.4.2 Separating/Compartment Floors

Separating floor build up was assessed using SCI P322[33], TGD to Part E to the Building Regulations and acoustic calculations.

The mass per unit area of the Greenstone Structures dovetail composite floor structure, finishes and ceilings meet the specification for a Type 1 separating floor when complying with the guidelines in Section 4 of TGD to Part E of the Building Regulations.

4.4.3 Acoustic Testing

Successful on-site acoustic tests were carried out on the Greenstone Structures LGS Building System. The testing included sound insulation tests on separating walls in accordance with I.S. EN ISO 16283-1[34]. Table 10 shows acoustic test results for separating wall.

4.5 DURABILITY

The LGS 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 insulation is durable material 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.

4.6 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE THE FOLLOWING

- Structural strength and stability (racking resistance, load bearing capacity),
- Behaviour in relation to fire,
- System specific load bearing fire testing to I.S. EN 1365-1[20],
- On-site acoustic performance,
- Thermal insulation performance calculations,
- Desktop study on 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,
- 3D thermal modelling of junction details in accordance with BRE IP 1/06[26].

4.7 OTHER INVESTIGATIONS

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

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

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

Table 2: Fire Protection Requirements for Loadbearing Wall, Floor and Ceiling Elements				
Type	**Element:**	**Test Standard**	**Results**	**Purpose Class**
External Load Bearing Walls - Inside to Outside				
1	• Test conducted on 2920mm x 3000mm x 183mm (w x h x th) panel with total vertical load of 42kN • 6 No. LGS C-Studs (89x45x1.2mm) – no noggins • 90mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Single layer of SINIAT GTEC Fireboard Type F 12.5 mm thick using 32mm long drywall screws at 300mm centres. • Non-fire side: 80mm thick PIR Quinntherm panel fixed to the vertical studs by stainless steel wall tie 1.2mm thick channel and spaced at 600mm ctrs, and screws 110mm long • On the exposed side only, every junction and screw heads of the last layer were treated by a joint filler (GTEC Joint Filler) bonded to a joint tape (GTEC Joint Tape) • (2 No. Double Sockets were fitted on the fire side)	I.S. EN 1365-1[20]	30 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
2	• Test conducted on 3000mm x 3000mm x 208mm (w x h x th) panel with total vertical load of 78kN • 6 No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Two layers of SINIAT GTEC Fireline Type F 12.5 mm thick using 25mm and 40mm long drywall screws at 300mm centres. • Non-fire side: 80mm thick PIR Mannok Therm Wall/MW PIR Insulation panel fixed to the vertical studs with wall tracks Ancon 25/14 restraint system (at 600mm centres) and 130mm long screws at 450mm centres • (2 No. Double Sockets were fitted on the fire side)	I.S. EN 1365-1[20]	60 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
3	• Fire Assessment on 3000mm x 3000mm (w x h) panel with total vertical load of 42kN • 6No. LGS C-Studs (89x45x1.2mm) • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Single layer of SINIAT GTEC Fireboard Type F 12.5 mm thick using 25mm long drywall screws at 300mm centres. • Non-fire side: Single layer of 12mm A2 Versapanel fibre cement board using 38mm long drywall screws at 600mm centres, 20mm Hadley spacer rail, 120mm Rockwool Rainscreen Duo Slab Insulation, basecoat render with glass fibre mesh (8mm thick) – as per Agrément certified external wall insulation façade system specification • (2 No. Double Sockets were fitted on the fire side)	I.S. EN 1365-1[20]	30 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)

4	• Fire Assessment on 2975mm x 3000mm (w x h) panel with total vertical load of 78kN • 6No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Two layers of SINIAT GTEC Fireboard Type F 12.5 mm thick using 25mm long drywall screws at 300mm centres. • Non-fire side: Single layer of 12mm A2 Versapanel fibre cement board using 38mm long drywall screws at 600mm centres, 20mm Hadley spacer rail, 120mm Rockwool Rainscreen Duo Slab Insulation, basecoat render with glass fibre mesh (8mm thick) – as per Agrément certified external wall insulation façade system specification • (2 No. Double Sockets were fitted on the fire side)	I.S. EN 1365-1[20]	60 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
5	• Test conducted on 3000mm x 3000mm x 288 mm (w x h x th) panel with total vertical load of 78kN • 6 No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Three layers of SINIAT GTEC Fireboard Type F 12.5 mm thick using 35mm and 45mm long drywall screws at 300mm centres. • Non-fire side: Single layer of 12mm A2 Versapanel fibre cement board using 38mm long drywall screws at 600mm centres, 20mm Hadley spacer rail, 120mm Rockwool Rainscreen Duo Slab Insulation, basecoat render with glass fibre mesh (8mm thick) – as per Agrément certified external wall insulation façade system specification • (2 No. Double Sockets were fitted on the fire side)	I.S. EN 1365-1[20]	120 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
External Load Bearing Walls – Outside to Inside				
6	• Test conducted on 3000mm x 3000mm x 252mm (w x h x th) panel with total vertical load of 78kN • 6No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Single layer of 12mm A2 Versapanel fibre cement board using 38mm long drywall screws at 600mm centres, 20mm Hadley spacer rail, 120mm Rockwool Rainscreen Duo Slab Insulation, basecoat render with glass fibre mesh (8mm thick) – as per Agrément certified external wall insulation façade system specification • Non-fire side: Single layer of SINIAT GTEC Fireboard Type F 12.5 mm thick using 25mm long drywall screws at 300mm centres. • (2 No. Double Sockets were fitted on the fire side)	I.S. EN 1365-1[20]	90 mins from outside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)

Internal Load Bearing Walls				
7	• Fire Assessment on 3000 mm x 3000 mm (w x h) test panel with total vertical load of 42kN • 6 No. LGS C-studs (89x45x1.2mm) • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Single layer of SINIAT GTEC Fireboard Type F 12.5 mm thick using 32mm long drywall screws at 300mm centres. • Non-fire side: Single layer of SINIAT GTEC Fireboard Type F 12.5 mm thick using 32mm long drywall screws at 300mm centres. • (2 No. Double Sockets fitted on the fire side)	I.S. EN 1365-1[20]	30 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
8	• Fire Assessment on 3000 mm x 3000 mm (w x h) test panel with total vertical load of 78kN • 6 No. LGS C-studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Two layers of SINIAT GTEC Fireboard Type F 12.5 mm thick using 32mm and 42mm long drywall screws at 300mm centres. • Non-fire side: Two layers of SINIAT GTEC Fireboard Type F 12.5 mm thick using 32mm and 42mm long drywall screws at 300mm centres. • (2 No. Double Sockets fitted on the fire side)	I.S. EN 1365-1[20]	60 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
9	• Fire Assessment on 3000 mm x 3000 mm (w x h) test panel with total vertical load of 78kN • 6 No. LGS C-studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m^3 density) fitted between studs • Fire side: Three layers of SINIAT GTEC Fireboard Type F 12.5 mm thick using 35mm and 45mm long drywall screws at 300mm centres. • Non-fire side: Three layers of SINIAT GTEC Fireboard Type F 12.5 mm thick using 35mm and 45mm long drywall screws at 300mm centres. • (2 No. Double Sockets fitted on the fire side)	I.S. EN 1365-1[20]	90 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
Compartment Walls				
10	**Twin frame separating Wall** • Test conducted on 3000mm x 3000mm x 253mm (w x h x th) panel with total vertical load of 156kN • 6 No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 1No. layers of 12.5mm Siniat Weather Defence Board fixed with 40mm screws to LGS at 300centres. • 1No. layers of 15mm Siniat Gtec Fireboard fixed with 25mm screws to LGS at 300centres. • 100mm stone mineral wool (22kg/m3 density) fitted between studs • 20mm Cavity • 6 No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m3 density) fitted between studs	I.S. EN 1365-1[20]	60 mins from either side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)

	• 1No. layers of 15mm Siniat Gtec Fireboard fixed with 25mm screws to LGS at 300centres. • 1No. layers of 12.5mm Siniat Weather Defence Board fixed with 40mm screws to LGS at 300centres.On the exposed side only, every junction and screw heads of the last layer were treated by a joint filler (GTEC Joint Filler) bonded to a joint tape (GTEC Joint Tape) • (2 No. Double Sockets fitted on the fire side)			
11	**Twin frame separating Wall** • Fire Assessment on 3000mm x 3000mm panel with total vertical load of 78kN • 6 No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 3No. layers of 12.5mm SINIAT GTEC Fireboard Type F 12.5 mm thick fixed with 35 and 45mm screws to LGS at 300centres. • 100mm stone mineral wool (22kg/m3 density) fitted between studs • 20mm Cavity • 6 No. LGS C-Studs (89x45x1.2mm) with noggins at mid height • 100mm stone mineral wool (22kg/m3 density) fitted between studs • 3No. layers of 12.5mm SINIAT GTEC Fireboard Type F 12.5 mm thick fixed with 35 and 45mm screws to LGS at 300centres. • (2 No. Double Sockets fitted on the fire side)	I.S. EN 1365-1[20]	90 mins from either side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
Non-Load Bearing Walls				
12*	**Internal Non-Load Bearing Partition Wall** Panel dimensions and build up as per No.7	I.S. EN 1364-1[22]	30 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
13*	**Internal Non-Load Bearing Partition Wall** Panel dimensions and build up as per No.8	I.S. EN 1364-1[22]	60 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
14*	**Internal Non-Load Bearing Partition Wall** Panel dimensions and build up as per No.9	I.S. EN 1364-1[22]	90 mins from exposed side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5, 7(b)
Intermediate floor: LGS Lattice Truss				
15	**Floor supporting a Uniformly Distributed Load of 1.5kN/m2** • Test conducted on 4308mm long x 3000mm wide x 300.5mm thick floor • Exposed side: 1No. layer of 12.5mm Gyproc Fireline Board fixed on fire side face using 25mm screws at 400mm max centres • 16mm Resilient bar • 6 No. LGS lattice trusses 250mm deep at 600mm nominal centres • 100mm Rockwool Rollbatt (22kg/m^3 density) between the joists • 1No. layer of 22mm OSB fixed to LGS joists 45mm screws at 300mm centres	I.S. EN 1365-2[21]	30 mins from below ceiling level	**

	• (9No. Downlighters)			
Compartment floors: Composite Metal Deck				
16	**Loaded Floor supporting Imposed Load of 2.0kN/m²** 160mm normal weight concrete with 1.2mm dovetail metal deck. Concrete reinforced with 2xA252 Mesh and rebar in each trough (minimum 30mm cover to the top of the reinforcing mesh). 4500mm span. (additional build up required to meet acoustic requirements as per Figure 2)	Eurocode Design	60 mins from below deck	**

Notes:

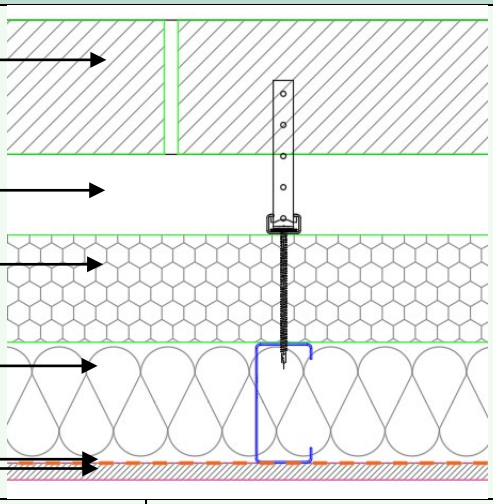
- The above build-ups are summaries of those tested to the referenced standards – they should not be taken as an exhaustive list. For full details of test reports and assessments, the Certificate holder should be contacted.
- For alternative approaches to fire safety requirements, refer to TGDs to Part B of the Building Regulations.
- In situations where there is no fire requirement for non-loadbearing walls, alternative non-loadbearing wall boarding specifications can be used once they have been agreed and signed off on by Greenstone Structures where the boarding supplier has provided supporting fire test data.

* Non-load bearing wall fire resistance data is provided from the load bearing data and can be utilised under the Field of Direct Application whereby the load can be decreased on the specimen.

**Design to be dictated by project specific loading requirements on a case by case basis to meet the requirements of Part B of the Building Regulations

Table 3: External walls U-value for variable PIR thickness

Wall build-up:
Layer 6: Brick/masonry cladding
Layer 5: 50mm low E cavity
Layer 4: Variable PIR layer (2)(3) (see below)
Layer 3: LGS/MW insulation (1)
Layer 2: AVCL
Layer 1: 12.5mm Plasterboard



Wall thickness	PIR variable thickness:	Calculated U-value (W/m²K)
334mm	80mm	0.181
344mm	90mm	0.169
354mm	100mm	0.158
364mm	110mm	0.149
374mm	120mm	0.14
389mm	135mm	0.13
404mm	150mm	0.12
424mm	170mm	0.11

Calculation complies with BRE Digest 465 *U-values for light steel-frame construction*
(1) Corrections have been made for 1.2mm LGS studs @ 600mm c/c bridging layer 3.
(2) A level 0 correction for air voids has been applied to layer 4
(3) Correction for mechanical fasteners have been applied to layer 4 equating to 6 No. 5.5mm 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. It is strongly recommended that U-value calculations are produced on a project specific basis by a competent person as U-value calculations may increase or decrease depending on a wide range of parameters such as number of fixings per square meter, size of fixing, emissivity of PIR surface facing into cavity etc.

Table 4: Sample U-value Calculation for 80mm PIR						
Layer	**Description**	**% Bridged**	Thickness [mm]	Thermal conductivity **λ** [W/m K]	Thermal resistance **R** [W/m²K]	
	Rsi				0.13	
1	Plasterboard		12.5	0.25	0.05	
2	AVCL					
3	Steel Stud	0.002	89	50	0.0018	
	Mineral Wool	0.998	89	0.044	2.023	
4	Variable PIR Insulation		**80**	0.022	3.636	
5	Cavity Low-e (0.9, 0.2)		50		0.44	
6	Brickwork Outer Leaf		102.5	0.77	0.133	
	Rse				0.04	
				Ru Total =	6.446	
				RL Total =	5.048	
	From BRE Digest 465			P = 0.711, $R_T = pR_{max} + (1-p)R_{min}$ =	6.04198	
				Correction term, ΔU =	0.015	
				Corrected U-Value (2DP) =	**0.181**	W/m²K
Correction as described in Table 3 apply						

Table 5: Effect on 0.181 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	0.191	0.193	0.194	0.196	0.198	0.199
400mm	0.185	0.186	0.188	0.189	0.191	0.192
600mm	0.179	0.18	0.181	0.182	0.184	0.185

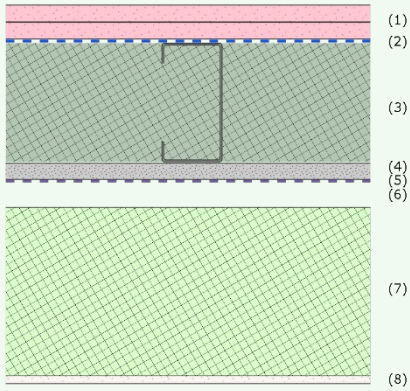
Table 6: Target linear thermal transmittance (ψ) for masonry outer leaf wall build up					
ACD Ref:	**Junction Description**	**Temperature Factor f_{Rsi} (Min = 0.75)**	**Greenstone Ψ-value (W/m.K)**		**TGD L Default Ψ-value (shown for indicative purposes only)**
5.01	Ground Floor - Insulation above slab(2)	0.796	0.136	>	0.038
5.02	Ground Floor - Insulation below slab(2)	0.88	0.178	>	0.106
5.03	Intermediate Floor	0.95	0.017	<	0.055
5.04	Separating Wall (plan)(1)	0.90	0.035	<	0.057
5.05	Separating Wall top (section)(1)	0.87	0.083	<	0.095
5.07/5.08	Eaves Detail - Unventilated/Ventilated Attic(2)	0.85	0.096	>	0.026
5.15	Gable end detail(2)	0.79	0.083	>	0.034
5.19	Ope - Lintel	0.88	0.016	=	0.016
5.20	Ope – Jambs(2)	0.77	0.034	>	0.019
5.21	Ope - Sill(2)	0.89	0.045	>	0.021
5.22.1	Steel Frame Separating Wall through ground floor (base)(1)	0.93	0.077	<	0.263
5.23.1	Corner Detail(2)	0.84	0.053	>	0.029
5.23.2	Inverted Corner Detail	0.96	-0.05	<	-0.043

(1) Value of ψ is applied to each dwelling.
(2) Some ψ-values do not meet the default ψ-values; however, all junctions pass f_{Rsi} assessments.
(3) Flanking element U-values for walls, roof and floor thermal models above were based on,

U_W = 0.17 W/m²K,U_F = 0.128 W/m²K (ACD Ref: 5.01);U_F = 0.101 W/m²K (ACD Ref: 5.02);U_R = 0.105 W/m²K
Modelled junction ψ-values are based on typical Greenstone details above can be used in y-value calculations, if relevant detail is applicable

Table 7: External walls U-value for variable Agrément certified external wall insulation system

Wall build-up:
Layer 8: 8mm render
Layer 7: Insulation – mineral wool (see below)
Layer 6: 20mm cavity
Layer 5: Breather membrane
Layer 4: Carrier board
Layer 3: LGS/MW insulation (89mm)
Layer 2: Polythene, VCL and Air leakage barrier
Layer 1: 12.5mm Plasterboard



Wall thickness	Mineral wool variable thickness:	Calculated U-value (W/m²K)
292mm	150mm	0.175
302mm	160mm	0.167
317mm	175mm	0.158
332mm	190mm	0.149
352mm	210mm	0.139
377mm	235mm	0.129

Calculation complies with BRE Digest 465 *U-values for light steel-frame construction.*
(1) Corrections have been made for 1.2mm LGS studs @ 600mm c/c bridging layer 3.
(2) A level 0 correction for air voids has been applied to layer 7 (IS EN ISO 6946 Table D.1)

Note: All U-value calculations illustrated in the above U-value tables should be taken as examples of performance that can be achieved. It is strongly recommended that U-value calculations are produced on a project specific basis by a competent person as U-value calculations may increase or decrease depending on a wide range of parameters such as number of fixings per square meter, size of fixing, emissivity of PIR surface facing into cavity etc.

Table 8: Sample U-value Calculation for 150mineral wool (Agrément certified external wall insulation system)

Layer	Description	% Bridged	Thickness [mm]	Thermal conductivity **λ** [W/m K]	Thermal resistance **R** [W/m²K]
	Rsi				0.13
1	Plasterboard		12.5	0.25	0.05
2	Mineral Wool Insulation/ LGS	0.002	89	0.044	2.023
3	Versapanel		12	0.26	0.046
4	Breather membrane		-	-	-
5	Cavity (unventilated)	0.0033	20	R 0.180	0.18
6	Mineral Wool Insulation		**150**	0.036	4.167
6	Render		8	0.94	0.009
	Rse				0.04

	Ru Total =	6.638	
	RL Total =	5.132	
From BRE Digest 465	P = 0.711, $R_T = pR_{max} + (1 - p)R_{min}$ =	6.191	
	Correction term, ΔU =	0.0128	
	Corrected U-Value (2DP) =	**0.175**	W/m²K

Correction as described in Table 7 apply

Table 9: Target linear thermal transmittance (ψ) for Agrément certified external wall insulation system					
ACD Ref:	**Junction Description**	**Temperature Factor f_{Rsi} (Min = 0.75)**	**Greenstone Ψ-value (W/m.K)**		**TGD L Default Ψ-value (shown for indicative purposes only)**
5.01	Ground Floor - Insulation above slab(2)	0.759	0.378	>	0.038
5.03	Intermediate Floor	0.92	0.011	<	0.055
5.04	Separating Wall (plan)(1)	0.91	0.038	<	0.057
5.07/5.08	Eaves Detail - Unventilated/Ventilated Attic(2)	0.87	0.055	>	0.026
5.15	Gable end detail(2)	0.79	0.079	>	0.034
5.19	Ope - Lintel	0.92	0.015	=	0.016
5.20	Ope – Jambs	0.93	0.016	<	0.019
5.21	Ope - Sill	0.92	0.006	<	0.021
5.23.1	Corner Detail(2)	0.82	0.066	>	0.029
5.23.2	Inverted Corner Detail	0.96	-0.057	<	-0.043

(1) Value of ψ is applied to each dwelling.
(2) Some ψ-values do not meet the default ψ-values; however, all junctions pass f_{Rsi} assessments.
(3) Flanking element U-values for walls, roof and floor thermal models above were based on,
U_W = 0.168 W/m^{2}K,U_F = 0.101 W/m^{2}K, U_R = 0.105 W/m^{2}K
Modelled junction ψ-values are based on typical Greenstone details above can be used in y-value calculations, if relevant detail is applicable

Table 10: Acoustic results *				
Separating construction	**Airborne sound insulation DnT,w dB**		**Impact sound insulation L'nT,w dB**	
	Performance Target	**Result**	**Performance Target**	**Result**
Walls (compartment wall as per Table 2, item 9)	≥53dB DnT,w	60-65	N/A	N/A

* The results above were obtained from on-site project specific testing, Results may vary based on project specific conditions but must always meet or exceed TGD Part E performance requirements.

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

(a) the specification of the product is unchanged.

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

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

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

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

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

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

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

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

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

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

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

5.5 Any recommendations contained in this Certificate relating to the safe use of the certified product/process are preconditions to the validity of the Certificate. However, the NSAI does not certify that the manufacture or installation of the certified product or process in accordance with the descriptions and specifications set out in this Certificate will satisfy the requirements of the Safety, Health and Welfare at Work Act 2005, or of any other current or future common law duty of care owed by the manufacturer or by the Certificate holder.

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

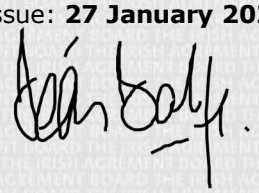
5.7 Where reference is made in this Certificate to any Act of the Oireachtas, Regulation made thereunder, Statutory Instrument, Code of Practice, National Standards, manufacturer's instructions, or similar publication, it shall be construed as reference to such publication in the form in which it is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

NSAI Agrément

This Certificate No. **23/0435** is accordingly granted by the NSAI to **Greenstone Structures Ltd** on behalf of NSAI Agrément.

Date of Issue: **27 January 2023**

Signed



Seán Balfe
Director of NSAI Agrément

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

NSAI Agrément

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[29] BS 6150:2006+A1:2014 *Painting of buildings - Code of Practice*.

[30] BS 8210:2020*: Facilities maintenance management. Code of practice*

[31] I.S. 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.*

[32] SCI P372:2008 *Acoustic Detailing For Steel Construction*

[33] SCI P322:2003 *Acoustic Performance of Composite Floors*

[34] I.S. EN ISO 16283-1: 2014: Acoustics - Field measurement of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation

[35] I.S. EN ISO 16283-2: 2020: *Acoustics - Field measurement of sound insulation in buildings and of building elements - Part 2: Impact sound insulation*