IRISH AGRÉMENT BOARD
CERTIFICATE NO. 24/0443
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BuildWright Modular Concrete Building System

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

NSAI Agrément Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with TGD Part D of the second schedule of the **Building Regulations 1997 to 2023.**

SCOPE

This Certificate relates to the BuildWright Modular Concrete Building System, for the design, manufacture and erection of High Performance Fibre Reinforced Concrete (HPFRC) modular buildings. The BuildWright Modular Concrete Building System is a factory manufactured structural building system completed with internal fixtures, fittings and finishes (outside of scope of this Certificate).The system is designed for use in buildings with traditional brick and block outer leaf cladding or External Thermal Insulation Composite System (ETICS) as per Section 2.1.5 of this Certificate. Assessed roof coverings are included in Section 2.1.10 of this Certificate. Other cladding systems and roof coverings may be suitable but have not been considered as part of this Certificate.

The BuildWright Modular Concrete Building System is certified to be used in the following purpose groups 1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a) and 5(b) as defined in Technical Guidance Documents (TGDs) Part B of the Building Regulations. The maximum height of the building system depends on the external façade system used:

- For traditional brick and block outer leaf cladding, the system is certified in the stated purpose groups where the height to the upper floor surface of the top floor is not more than 15m from ground level on the lowest side of the building. Maximum building height does not exceed 18m.
- For ETICS, the system is certified in the stated purpose groups where the height to the upper floor surface of the top floor is not more than 5m from ground level on the lowest side of the building. Maximum building height does not exceed two storeys.

The BuildWright Modular Concrete Building System is designed and manufactured by BuildWright. Site erection is carried out by BuildWright or specialist sub-contractors/ Main Contractor under the supervision of BuildWright.

In the opinion of NSAI, the BuildWright Modular Concrete Building System, as described in this Certificate, complies with the requirements of the Building Regulations 1997 to 2023.

Refer to Section 1 of this Certificate for information on items outside of the scope of this Certification.

DESIGN

The BuildWright Modular Concrete 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 Engineering Design Team of the Client are responsible for the architectural drawings and compliance of the building design with the Building Regulations and this certificate.

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

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

RESPONSIBILITIES

Prior to the commencement of the contract, the responsibilities are determined and agreed between BuildWright and the Client including substructure, fire stopping, cavity barriers, roof completion, coordination of design and works, etc.

MARKETING, DESIGN, MANUFACTURE, AND INSTALLATION

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

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1.1 PRODUCT DESCRIPTION

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

The BuildWright Modular Concrete 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 BuildWright Modular Concrete Building System can be designed to meet the requirements of the following clauses of the Irish Building Regulations 1997 to 2023:

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

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

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

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 BuildWright Modular Concrete Building System for the design, manufacture and erection of High Performance Fibre Reinforced Concrete Modular building system.

The BuildWright Modular Concrete Building System is supplied as prefabricated three-dimensional units. The system is manufactured from High Performance Fibre Reinforced Concrete (HPFRC) elements and expanded polystyrene (EPS) insulation to form a three dimensional modular unit. The system can be supplied with varying degrees of finishing (refer to Section 1 of this Certificate for more information on certification scope).

The system is developed in the factory by casting a series of HPFRC panels, four wall panels, a roof panel and floor panel for each module. Typically the walls are comprised of beams/ column elements with a thin skin element between them. The beam /columns location and centres are designed and specified according to the requirements of each project. The wall and floor panels are assembled in the factory into the module and the corners connected through casting HPFRC. The roof panel is then lifted onto the module and secured. Typically, the EPS insulation is affixed during the casting process.

2.1.1 Foundations

The construction of the foundations are outside the scope of this Certificate. The construction of the foundations are the responsibility of the Main Contractor and should be constructed in accordance with the Client's Engineering specification. Structure supporting the BuildWright Modular Concrete Building System shall be checked by Client's Engineer for structural load criteria specified by BuildWright Structural Engineer. Tolerances for the system installation on foundations are defined in BuildWright Installation Manual[1].

2.1.2 Ground Floor

The ground floor forms part of the three dimensional unit of the BuildWright Modular Concrete Building System. The ground floor is constructed from HPFRC elements – 160mm deep rib beams and skin elements connecting the beams together.The ground floor is constructed from the following:

- DPM/Radon barrier installed by others on site,
- EPS insulation installed by others on site,
- HPFRC ground floor (forming part of modular unit by BuildWright),
- Floor finishes by BuildWright or others

Refer to Figure 2 and Figure 3 for typical ground floor details.

The ground floor structure is supported on rising walls/foundations as per Figure 2. The connection between ground floor and rising wall/foundation is provided using anchor bolts as per BuildWright Structural Engineer's specification.

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

2.1.3 Load-Bearing Walls

The walls are manufactured by inserting pins in the EPS and then placing these with the protruding side up on the casting table. The EPS acts as formwork for HPFRC elements of the wall. The EPS depth varies to suit the location of structural beams as required and also to deliver the required thermal performance. The window openings are boxed out accordingly as per the wall panel design and additional reinforcement is placed along with lifters and sockets as specified in the production drawings.

All module perimeter walls are load-bearing walls. In upper level modules, the head beam of the top module transfers the roof load to the wall columns. These wall columns in upper modules transfer the load to the wall columns in the modules underneath which in turn transfer the load to the foundations.

2.1.4 External Walls

External walls forms part of the three dimensional unit of the BuildWright Modular Concrete Building System. The external wall is constructed from HPFRC Columns with a skin infill element. designed for each project specifically. The external wall is constructed from the following:

- Internal finish, installed by BuildWright or others as per Section 2.1.12
- HPFRC wall structure with EPS insulation between the columns (forming part of modular unit by BuildWright)
- External cladding/finish system as per Section 2.1.5

Refer to Figure 4 & Figure 5 for typical external wall details.

If the plasterboard is used as the internal finish, it is installed in the factory environment using full contact compound over the entire area of the wall. The grade and thickness of plasterboard shall be as per BuildWright specification. Table 3 shows fire testing of the external wall to I.S. EN 1365-1[22] without plasterboard. The result in Table 3 confirms that the external wall constructed without plasterboard can meet requirements of the Part B of the Building Regulations for the purpose groups and heights of the buildings as defined in the scope of this Certificate.

2.1.5 External Cladding/Finish

The BuildWright Modular Concrete Building System is certified to be used with:

- traditional brick and block outer leaf cladding, where the height to the upper floor surface of the top floor is not more than 15m from ground level on the lowest side of the building. Maximum building height does not exceed 18m.
- ETICS façade finish, where the height to the upper floor surface of the top floor is not more than 5m from ground level on the lowest side of the building. Maximum building height does not exceed two storeys

The following subsections describe the use of these two different façade finishes. The system has been assessed with traditional brick and block outer leaf cladding and NSAI approved ETICS façade finish. Other external façade claddings systems may be suitable but have not been considered as part of this certification.

2.1.5.1 Traditional Brick/Block Outer Leaf Cladding

Traditional outer leaf cladding utilises cavity layer with EPS insulation and brick/block outer leaf to I.S. EN 1996-1-1[3] and SR 325[37]. The EPS and outer leaf are connected to the HPFRC structure with stainless steel channel cavity wall ties. The wall tie system comprises two parts, the channel and the tie to provide required flexibility of installation of outer leaf on site. Refer to Figure 3 for a typical external wall detail with traditional outer leaf brick/block finish.

The wall ties system is in accordance with I.S. EN 845-1[2]. Minimum 30mm embedment of channel fixings into HPFRC slab elements is required. The wall ties system and their spacing shall be designed by BuildWright Structural Engineer on project specific basis for horizontal and vertical loading. Additional wall ties may be required as per structural design around openings, corners and movement joints. Channels are installed by BuildWright in the factory. Wall ties and masonry leaf are constructed on site.

BuildWright Structural Engineer to provide specification for stainless steel masonry support brackets if required for the project. Weep holes and DPC shall be installed at bracket locations. Refer to Figure 5 for typical detail.

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

Masonry claddings must have adequate weep holes along their bases and over openings to allow moisture to exit the cavity. Stepped DPC/DPM shall be installed at ground floor level. Refer to Figure 3 for typical detail.

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

Precast concrete window sills with DPC are installed in accordance with Certificate holder's instructions.

Proprietary cavity barriers/fire stops are installed in accordance with the Certificate holder's instructions as defined in Section 2.1.11 of this Certificate, at locations defined in the project specific site package and in accordance with manufacture's instructions.

2.1.5.2 ETICS façade finish

NSAI Agrément certified ETICS systems may be used with the BuildWright Modular Concrete Building System. The ETICS system must be approved by the ETICS Certificate holder, NSAI and BuildWright. The approved specification of the ETICS façade finish is shown in Table 1.

The EPS is placed on horizontal bed in factory environment with anchors protruding up. The HPFRC wall structure is cast onto EPS and forms a bond between the EPS and HPRFC elements. After the panels have cured, they are assembled into three dimensional units. External render base coat and reinforcing mesh is installed in the factory. The key coat and the finishing coat are applied on

site. All rendering shall follow best practice guidelines, e.g. I.S. EN 13914-1[5].

Base beads and all full system beads are fixed as specified by BuildWright. EPS boards (minimum grade EPS150) are fixed to the wall below the starter track to provide the necessary resistance to impact and capillary action. The EPS board shall be bonded to the rising wall by adhesive and mechanical fixings as per Certificate holder's instructions.

Purpose-made powder coated aluminium window sills with PVC stop-ends are installed in accordance with the Certificate holder's instructions. They are designed to prevent water ingress and incorporate drip details to shed water clear of the system.

Movement joints shall be provided in accordance with the project specific site package as designed by BuildWright Structural Engineer.

Table 1: ETICS façade finish specification

	Component	Thickness (mm)
Insulation	EPS-EN 13163-T1-L2-W2-S5-P5-DS(70,-)2-BS115-CS(10)70-DS(N)2-DLT(1)5 MW-EN 13162-T4 or T5 -DS(70,90) -CS(10,Y)4010 -TR7.5 or TR10 or TR15 -WS- -WL(P)	120-265
Anchor	Rawlplug T-Fix 8M Min – 4 fixings per square meter Stainless steel insulation anchors for MW firestopping Min – every 400mm ctrs	-
Basecoats	Ceresit CT 85 Ceresit CT 87 Ceresit CT 80	4.0
Glass Fibre Mesh	Ceresit CT325	-
Key coat/ Primer	Ceresit CT16	
Finishing coats	Ceresit CT174 Ceresit CT74 Ceresit CT79 Ceresit CT136	Regulated by particle size

Mineral wool fire stops are installed in accordance with the Certificate holder's instructions as defined in Section 2.1.11 of this Certificate, at locations defined in the project specific site package.

BuildWright typically undertakes the application of the ETICS systems. Where a subcontractor is used, they must be registered on the NSAI ETICS Installer Scheme and be trained by BuildWright for specific installation of ETICS façade elements onto HPFRC elements. Uncertified wet/dry dash finishes and brick slips finishes are not approved for use with the system as compatibility of any supplementary or substituted components must be verified.

2.1.6 Separating & Compartment Walls

The typical wall panel forms part of the three dimensional unit of the BuildWright Modular Concrete Building System. The typical wall structure is constructed from columns of HPFRC connected with a thin skin element of the same material. Full compartment wall build up consist of two adjacent wall modules. The full compartment wall build up is constructed from the following:

- Internal finish, installed by BuildWright or others, as per Section 2.1.12
- HPFRC wall from module 1 with EPS insulation between the columns (forming part of modular unit 1 by BuildWright)
- Minimum 20mm cavity
- HPFRC wall from module 2 with EPS insulation between the columns (forming part of modular unit 2 by BuildWright)
- Internal finish, installed by BuildWright or others, as per Section 2.1.12

Refer to Figure 6 for a typical compartment wall detail.

If the plasterboard is used as the internal finish, it is installed in the factory environment using full contact compound over the entire area of the wall. The grade and thickness of plasterboard shall be as per BuildWright specification. Table 3 shows fire testing of compartment wall to I.S. EN 1365-1[22] without plasterboard. The result in Table 3 indicate that compartment wall constructed without plasterboard can meet requirements of the Part B of the Building Regulations for the purpose groups and heights of the buildings as defined in the scope of this Certificate.

Junction between compartment wall and roof shall be capable of restricting fire spread between the buildings. Fire stopping and detailing shall be as per Section 3 to TGDs to Part B of the Building Regulations. Typical detail is shown in Figure 13.

Junction of compartment wall and external wall shall be fitted with a suitable cavity barrier/fire stop.

No services shall pass through or breach separating walls. Where services are required in a

separating wall, they can be accommodated by creating a service cavity to the separating wall with timber battens or metal top hat sections and plasterboard.

Refer to Section 3.2.2 of this Certificate for requirements of fire classification of materials forming part of the compartment wall.

2.1.7 Non-Load Bearing Walls

The non-load bearing wall panels are made from traditional timber/steel studwork, slabbed and lined with plasterboard.

Non-load bearing walls shall be adequately fixed to modules using fixings as per BuildWright Structural Engineer specification. All walls shall be designed to resist lateral loads and to provide for required sound and/or fire resistance where required for compliance with Building Regulations.

2.1.8 Floors including Separating & Compartment Floors

The typical floor panel forms part of the three dimensional unit of the BuildWright Modular Concrete Building System. The typical floor is constructed from ribs beams and a thin skin element. Rib beams are spaced at maximum 2m centres. Full floor build up consist of upper module floor sitting on lower module ceiling. The full floor build up is constructed from the following:

- Internal floor finish in upper modular unit, installed by BuildWright or others
- Upper module HPFRC floor structure (forming part of upper modular unit by BuildWright)
- Lower module HPFRC ceiling structure (forming part of lower modular unit by BuildWright)
- Plasterboard, installed by BuildWright in accordance with this Certificate (refer to Table 3)
- Ceiling system fixed to concrete rib beams, installed by BuildWright or others

Refer to Figure 4 and Figure 5 for typical separating and compartment floor details.

The compartment floor is of a fire classification A2-s3, d2. The compartment floor as constructed in accordance with this Certificate meets requirements of TGDs to Part B of the Building Regulations for as certified purpose groups up to the maximum height allowed in this Certificate.The compartment floor is boarded in the factory with the appropriate level of boarding required to provide acoustic and fire performance, as outlined in Table 3.

Electrical installations and recessed lights may not be accommodated within any of the compartment floor build ups. All electrical installations are 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 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[8].

2.1.9 Intermediate Floors

Intermediate floors are constructed similarly as separating and compartment floors with plasterboard at lower module as per Section 2.1.8.

2.1.10 Roof Structure

The roof trusses can be either a traditional timber cut roof, prefabricated roof truss made from timber or steel, a steel prefabricated roof module or HPFRC structure similar to modular floor construction as described in Section 2.1.8. The roofing solution chosen for a particular building is both Client and project specific and must be assessed and signed off by a nominated BuildWright Structural Engineer. The System has been assessed only with traditional roofing finishes and NSAI Agrément certified roofing finishes. Other roofing solutions may be suitable but have not been considered as part of this certification.

2.1.11 Cavity Barriers and Fire stops

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

- At top of an external cavity wall including any gable wall
- At top of separating/compartment wall and roof junction
- Vertical cavity barrier/fire stop at a separating/compartment wall junction with the external wall.
- Horizontal cavity barrier/fire stop at the perimeter of all compartment floors.
- Cavity barriers are required around all openings in external walls (with cavity) such as doors, windows, vents, extractor fans, meter cupboards, services, etc.
- At openings and passage of services in fire resisting construction

The cavity barrier/fire stop should be appropriate for the external cladding that is intended to. For ETICS façade finish all fire stopping shall be provided using mineral wool strips fixed with stainless steel fixings at minimum 400mm centres. For traditional brick/block outer leaf cladding proprietary mineral wool fire cavity closers are used. Installation of proprietary cavity closers shall be carried out as per manufacturer's specification.

The cavity barriers and fire stopping shall be in accordance with Section 3 of TGDs to Part B of the Building Regulations. BuildWright site install manager will inspect all cavity barriers/fire stops prior to the closing up of the cavities, ceilings etc. and will record it in the quality control file for that project. The fire stopping and cavity barriers must be installed as in accordance with TGDs to Part B of the Building Regulations prior to BuildWright issuing the sign off certificate for the project.

2.1.12 Internal Linings and Finishes

Internal finishes are outside of the scope of this Certificate.

Linings to walls and ceilings may be of plasterboard. If plasterboard is used as the internal finish, it is installed in the factory environment using full contact compound over the entire area of the wall. Plasterboard shall be manufactured to I.S. EN 520[6]. In areas prone to high levels of humidity, moisture resistant plasterboard should be used. Joints in plasterboard can be taped and filled in accordance with the plasterboard manufacturer's instructions. Alternatively skim coat plaster can be applied.

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

2.1.13 Services

Services are outside the scope of this Certificate. Electrical installation should be designed and installed in accordance with I.S. 10101[7]. Heating and plumbing services must be designed and installed by competent professional engineers.

Refer to Section 2.1.8 of this Certificate for information on services penetrations through compartment floors.

No pipework should pass through any separating wall. See Section 2.1.6 of this Certificate.

Where services are to penetrate the wall, a duct or sleeve through EPS insulation is inserted prior to placing concrete in the factory. Electrical cables should be ducted (to avoid plasticizer migration). The cables must be placed in a conduit and must be sized to minimize heat build-up in accordance with I.S. 10101[7]. All electrical sockets and switches are be installed in PVC or metal boxing.

2.1.14 Ancillary elements

Non-exhaustive list of ancillary elements is provided below. All ancillary elements are outside the scope of this Certificate.

- Foundation/substructure
- Internal finishes (ceiling/wall/floor, not contributing to Building Regulations compliance)
- Mechanical and electrical installations & services
- Windows and doors
- Fittings and furniture

2.2 DESIGN AND MANUFACTURE

2.2.1 Design Process

The BuildWright Modular Concrete Building System must be designed in accordance I.S. EN 1992-1-1[9]. by BuildWright Structural Engineer. The structural analysis is carried out by Finite Element Modelling (FEM). Structural design is reviewed and checked by BuildWright Chartered Structural Engineer independent of the original designer.

2.2.2 Manufacture Process

The BuildWright Modular Concrete Building System is manufactured in accordance with I.S. EN 13369[10].The design and manufacture are the responsibility of BuildWright. HPFRC concrete is to be manufactured to I.S. EN 206[11].

The main structural elements of the BuildWright Modular Concrete Building System are composed of High Performance Fibre Reinforced Concrete (HPFRC) elements cast in the factory. EPS forms permanent formwork for the HPFRC elements and is installed in the factory. Level of finishes that can be installed in the factory varies and is project dependant. In all modules 1st and 2nd fix, plumbing, electric, carpentry, tiling and painting is carried out in the factory. Internal fixtures and finishes have not been assessed as part of the assessment and are therefore outside the scope of this Certificate.

HPFRC panels are cast on horizontal EPS beds with anchors/pins protruding up. After concrete curing, as finished panels are assembled into modular units in the factory. Connections between the panels are provided by cast in reinforcement or proprietary cast in connectors. Several factors may influence the allowable sizes of a module. These factors include transportation, structural design requirements, site accessibility, weight and preferred module dimensional limitations.

Table 2 shows typical HPFRC specification.

Table 2: HPFRC Properties

Property	Value
Characteristic Tensile Strength	5.5 MPa
Characteristic Compression Strength	105 MPa
Exposure Class	XC1

2.3 STRUCTURAL PRINCIPLES

2.3.1 HPFRC Structure

The basis of the typical BuildWright Modular Concrete Building System is a HPFRC structure, which is cast, cured and assembled into modular units in the factory.

The structure is manufactured from HPFRC as described in Section 2.2. The frequency and size of the structural elements (rib beams, columns) depends on the individual panel/module design. BuildWright Structural Engineer determines rib beams/ columns spacing on a project by project basis. Each module is analysed at a number of stages throughout the design process at:

- Construction stage in the plant (each single panel as well as the whole module)
- Transport stage
- Lifting into place stage
- Permanent State

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

HPFRC rib beams and columns form primary structural elements of the BuildWright Modular Concrete Building System. The thin skin element between columns and beams in floors, roofs and walls are considered to be secondary structural elements of the system.

2.3.2 Connection Joints

All HPFRC panel to panel connections are carried out by BuildWright in the factory. The panels connections are provided by cast in reinforcement or proprietary cast in connectors.

Connections in between the modules are installed on site. Connections on site include the following:

- Holding down bolts to foundations/substructure
- Vertical connections between the modules
- Horizontal connections between the modules

Requirement for vertical and horizontal connections depends on consequence class in accordance with I.S. EN 1991-1-7[13]. The consequence class determination considers building type/occupancy and building height.

Holding down connections are installed (where necessary) to provide adequate loading transfer to foundations . The type of fixing used to hold down the modules of the system will be dependent on what substrate the anchor is being fixed to. Typically cast in reinforcement or chemical anchors are used. Anchors design and installation shall be in accordance with HSA: Code of Practice for the Design and Installation of Anchors [38].

Vertical connections between the modules are installed (where necessary) using threaded bars and non-shrink grout. Horizontal connections are provided (where necessary) through proprietary cast in connectors between the modules.

All connections shall be designed by BuildWright Structural Engineer to I.S. EN 1992-4[12] and installed by competent personnel in accordance with BuildWright Installation Manual[1]. The positions of the fixings are project specific and are determined by the BuildWright Structural Engineer.

2.4 DELIVERY, STORAGE AND SITE HANDLING

2.4.1 Delivery & Storage of Modules

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

Transport and lifting shall be carried out by competent personnel in accordance with the BuildWright Installation Manual[1]. and site-specific safety statement. Care is needed to avoid any damages to modular units. Typically offloading of module from the trailer will be directly onto substructure location. When modules are offloaded from trailers for storage, then they should be covered with tarpaulins and secured.

2.4.2 Safe Handling

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

Modules should always be moved using a crane organised by BuildWright or Main Contractor (project specific) using the pre-attached lifting eyes on each module.

2.4.3 Typical Material List Supplied to Site

With each customised delivery to site, a comprehensive bill of materials is supplied. This bill of materials gives a detailed list of all components delivered and fixing schedule to site to complete the installation of the BuildWright Modular Concrete Building System.

Figure 1: Positioning a module on substructure

2.5 INSTALLATION

2.5.1 General

Site erection is carried out by BuildWright or specialist sub-contractors/ Main Contractor under the supervision of BuildWright. The BuildWright Modular Concrete Building System is to be installed in accordance with the procedures in the dedicated Installation Manual[1]. BuildWright Installation Manual[1] was reviewed during the NSAI assessment, Certificate Holder shall be contacted for information on latest Installation Manual. BuildWright is responsible for site inspections and sign off in accordance with Building Regulations.

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

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

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

This Certificate does not contain a complete set of installation instructions, but an overview of the procedures involved. For a full list of these instructions, refer to the Certificate holder's Installation Manual[1]. Should a conflict arise between this Certificate and the Certificate holder's manuals, this Certificate shall take precedence.

2.5.2 Site Supervision

All modular system installation works are supervised by BuildWright.

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

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

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

Each building has its own quality control file which is kept by the BuildWright Site Supervisor. Quality control file includes records of inspections, photographs and sign off of the following elements:

- Ground floor,
- Structural connections,
- Fire stopping and cavity barriers,
- Weathertightness elements (render, finishes, etc.)
- Final sign off

Defects noted are recorded, photographed and notified in writing to Site Supervisor and Contractor. Where necessary Site Supervisor will inspect and approve the remediation before work can proceed.

The approved module installation contractors are subject to continuous supervision by the BuildWright Site Supervisor. The following checklist is provided to offer guidance to clients who intend to carry out their own additional site supervision. The items listed, are of a general nature which are in addition to all other building requirements.

- All components delivered to site comply with the bill of materials.
- Components are not damaged and are properly pre-marked for erection.

- The substructure is set out accurately and level within the tolerance specified by BuildWright before the modules are positioned.
- Substructure's Designer signed off foundations/substructure for the loading as defined by BuildWright Structural Engineer.
- The modules are not erected until any inaccuracies in the substructure have been corrected.
- Radon membrane/DPM, thermal block layer and thermal insulation is correctly installed by Main Contractor prior to placing the modules.
- Modules are in line and plumb in accordance with the BuildWright design drawings.
- Ground floor modules are connected to substructure/foundations as per BuildWright specification (see Section 2.3.2).
- Horizontal and vertical connections are installed between the modules as per BuildWright specification (see Section 2.3.2).
- Insulation at the walls is free from damage after the erection.
- Where traditional block/brick outer leaf is installed, the channels are not damaged and correctly spaced and positioned.
- Where ETICS façade finish is installed, the infill façade between the modules is installed as per BuildWright's Installation Manual. Render is fully completed on site as per BuildWright specification (see Table 1)
- Cavity barriers and fire stops are installed and signed off by BuildWright/Main Contractor as specified and in accordance with the Building Regulations (see Section 2.1.11)
- All fixings used are supplied or approved by BuildWright.
- Where roof structure is installed on site, the connection between the roof and modules is in accordance with BuildWright design drawings and specification
- All service penetrations are adequately finished as per BuildWright specification (see Section 2.1.13)

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

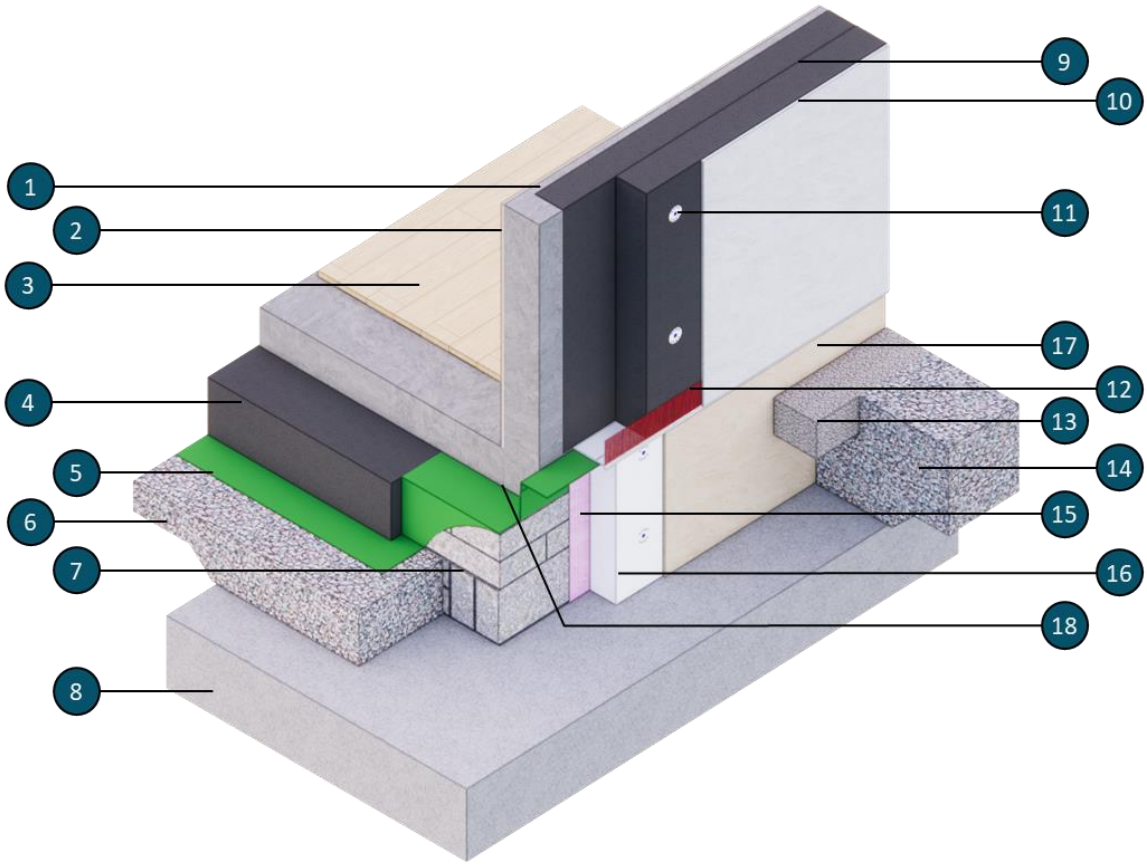


Figure 2: External wall with ETICS façade finish to substructure detail

1. HPFRC structure
2. Internal wall finish as per this Certificate
3. Internal floor finish
4. EPS insulation (site installed, by others)
5. DPM & radon barrier (site installed, by others)
6. Compacted hardcore (in accordance with Part C of the Building Regulations, by others)
7. Masonry support pier as per thermal modelling detail including min. 7.5N thermal block layer (by others)
8. Strip foundations (by others)
9. EPS wall insulation
10. ETICS façade finish (in accordance with this Certificate)
11. Thermally broken insulation fixing (in accordance with this Certificate)
12. Starter track
13. Natural gravel drain (by others)
14. Compacted hardcore (in accordance with Part C of the Building Regulations, by others)
15. Adhesive (in accordance with this Certificate)
16. Plinth EPS insulation (in accordance with this Certificate, minimum EPS150)
17. Plinth ETICS render (in accordance with this Certificate)
18. Vertical connection detail to foundations (where necessary, see Section 2.3.2 & Figure 15)

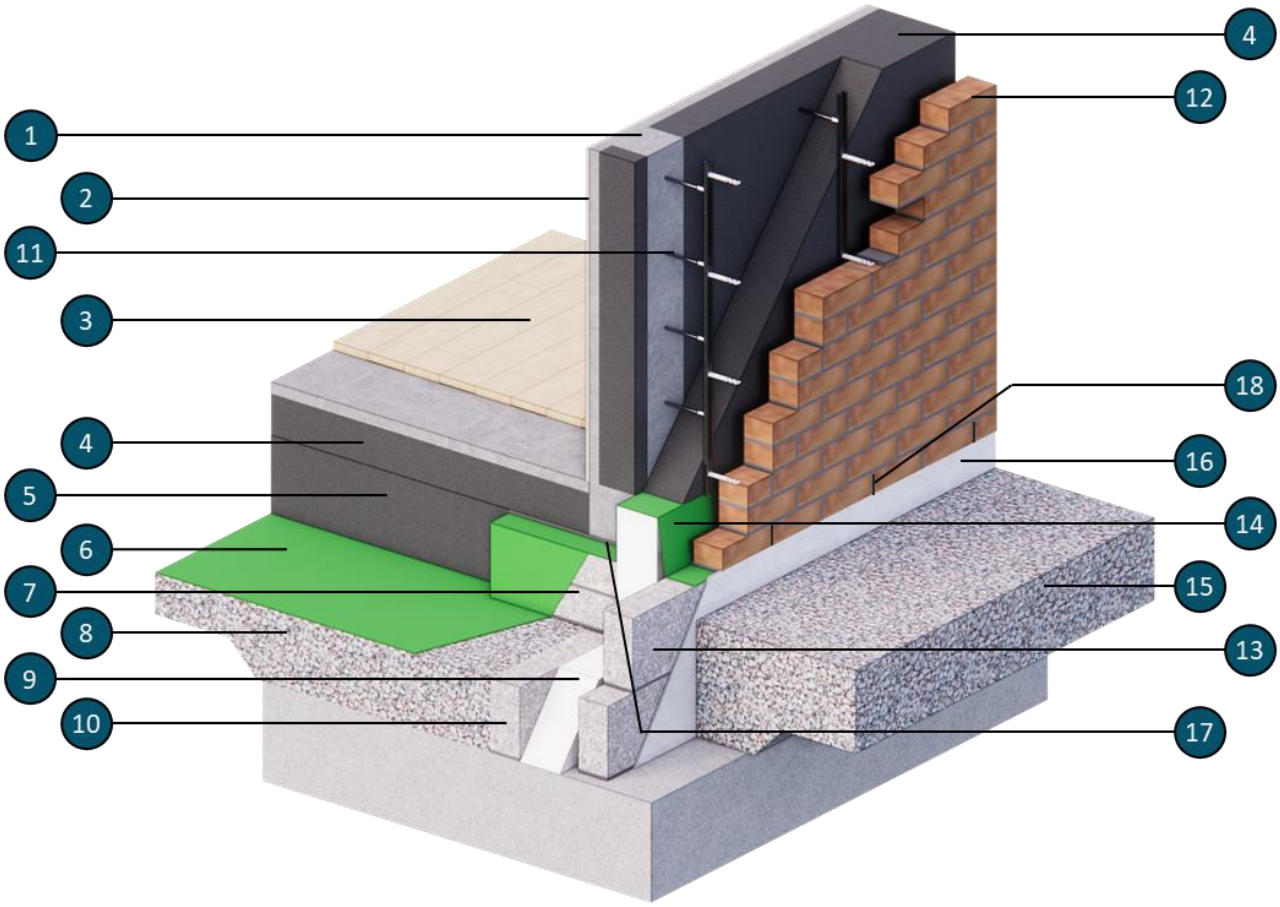


Figure 3: External wall with traditional brick/block outer leaf cladding to substructure detail

1. HPFRC structure
2. Internal wall finish as per this Certificate
3. Internal floor finish
4. EPS insulation
5. EPS insulation (site installed, by others)
6. DPM & radon barrier (site installed, by others)
7. Masonry support pier as per thermal modelling detail including min. 7.5N thermal block layer (by others)
8. Compacted hardcore (in accordance with Part C of the Building Regulations, by others)
9. EPS insulation (in accordance with this Certificate, minimum EPS150)
10. Perimeter Blockwork (by others)
11. Proprietary channel wall tie system (in accordance with this Certificate)
12. Masonry outer leaf (site installed)
13. Footing blockwork (by others)
14. Stepped DPC/DPM (site installed, by others)
15. Compacted hardcore (in accordance with Part C of the Building Regulations, by others)
16. Plinth Render (by others)
17. Vertical connection detail to foundations (where necessary, see Section 2.3.2 & Figure 15)
18. Weepholes

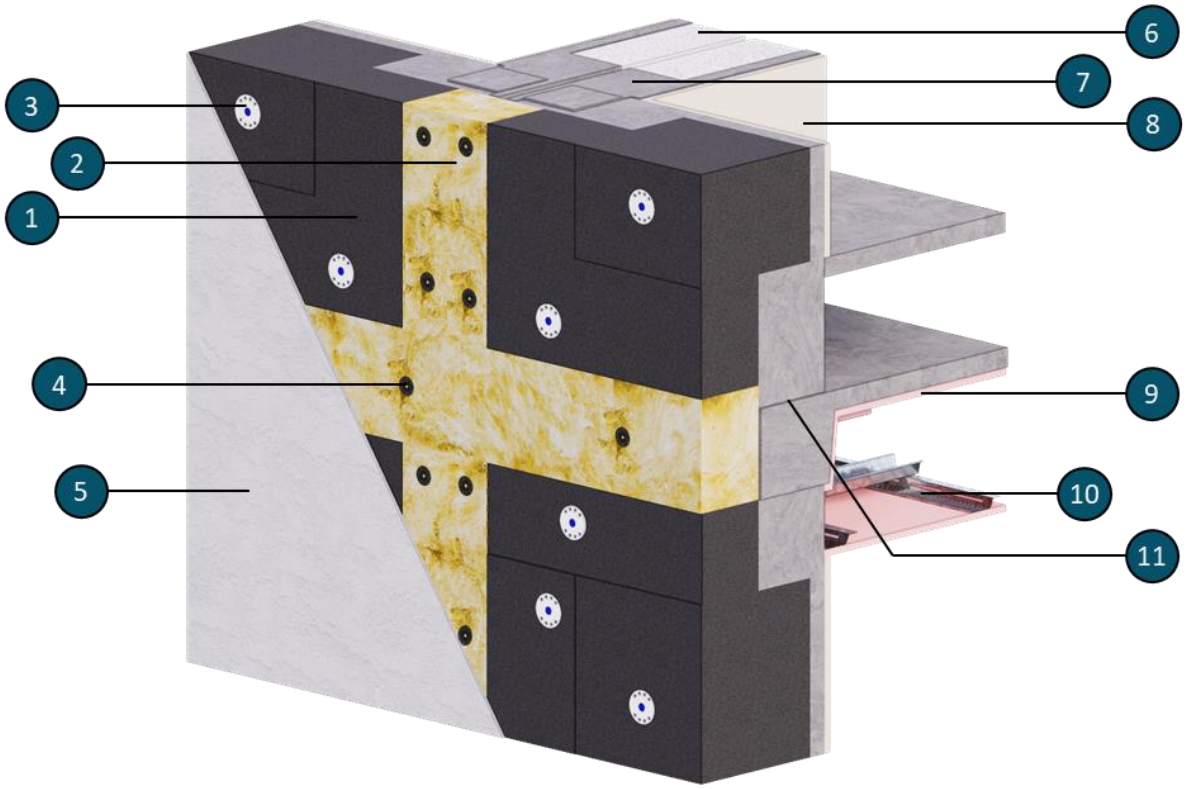


Figure 4: External wall with ETICS façade finish junction with compartment floor and compartment wall

1. EPS Insulation
2. Mineral wool (MW) fire stop (horizontal & vertical, in accordance with this Certificate)
3. Thermally broken insulation fixing (in accordance with this Certificate)
4. Stainless steel fixing with MW cap (in accordance with this Certificate)
5. ETICS façade finish (in accordance with this Certificate)
6. EPS Insulation
7. HPFRC structure
8. Internal wall finish as per this Certificate
9. Plasterboard to provide adequate protection to HPFRC module (in accordance with this Certificate)
10. MF ceiling system fixed to HPFRC rib beams
11. Vertical connection detail between modules (where necessary, see Section 2.3.2 & Figure 14)

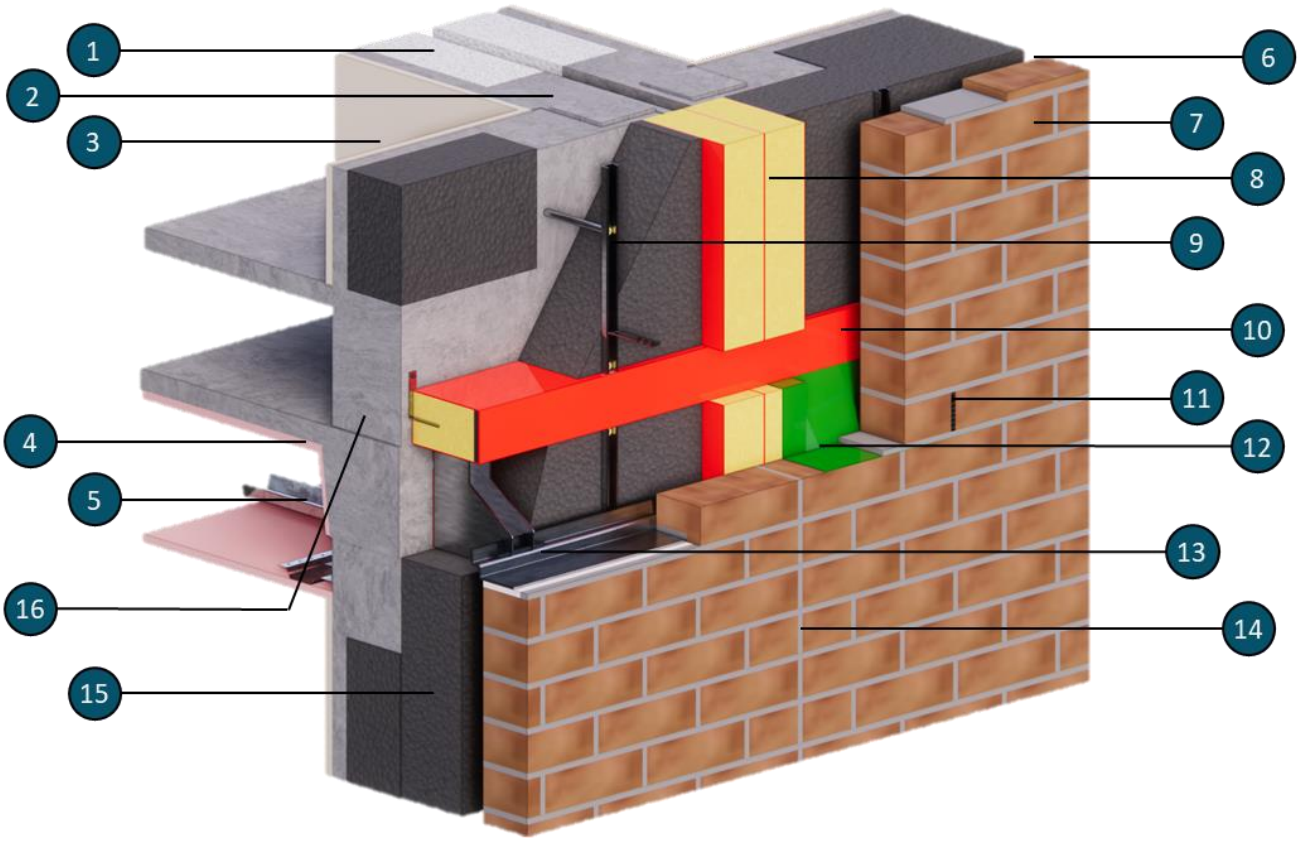


Figure 5: External wall with traditional brick/block outer leaf cladding junction with compartment floor and compartment wall

1. EPS insulation
2. HPFRC structure
3. Internal wall finish as per this Certificate
4. Plasterboard to provide adequate protection to HPFRC module (in accordance with this Certificate)
5. MF ceiling system fixed to HPFRC rib beams
6. Cavity
7. Masonry outer leaf (site installed)
8. Vertical fire stop/ cavity barrier (in accordance with this Certificate)
9. Proprietary channel wall tie system (in accordance with this Certificate)
10. Horizontal open state cavity barrier (in accordance with this Certificate)
11. Weep holes
12. DPC
13. Proprietary masonry support system
14. Movement joint in masonry leaf
15. EPS insulation
16. Vertical connection detail between modules (where necessary, see Section 2.3.2 & Figure 14)

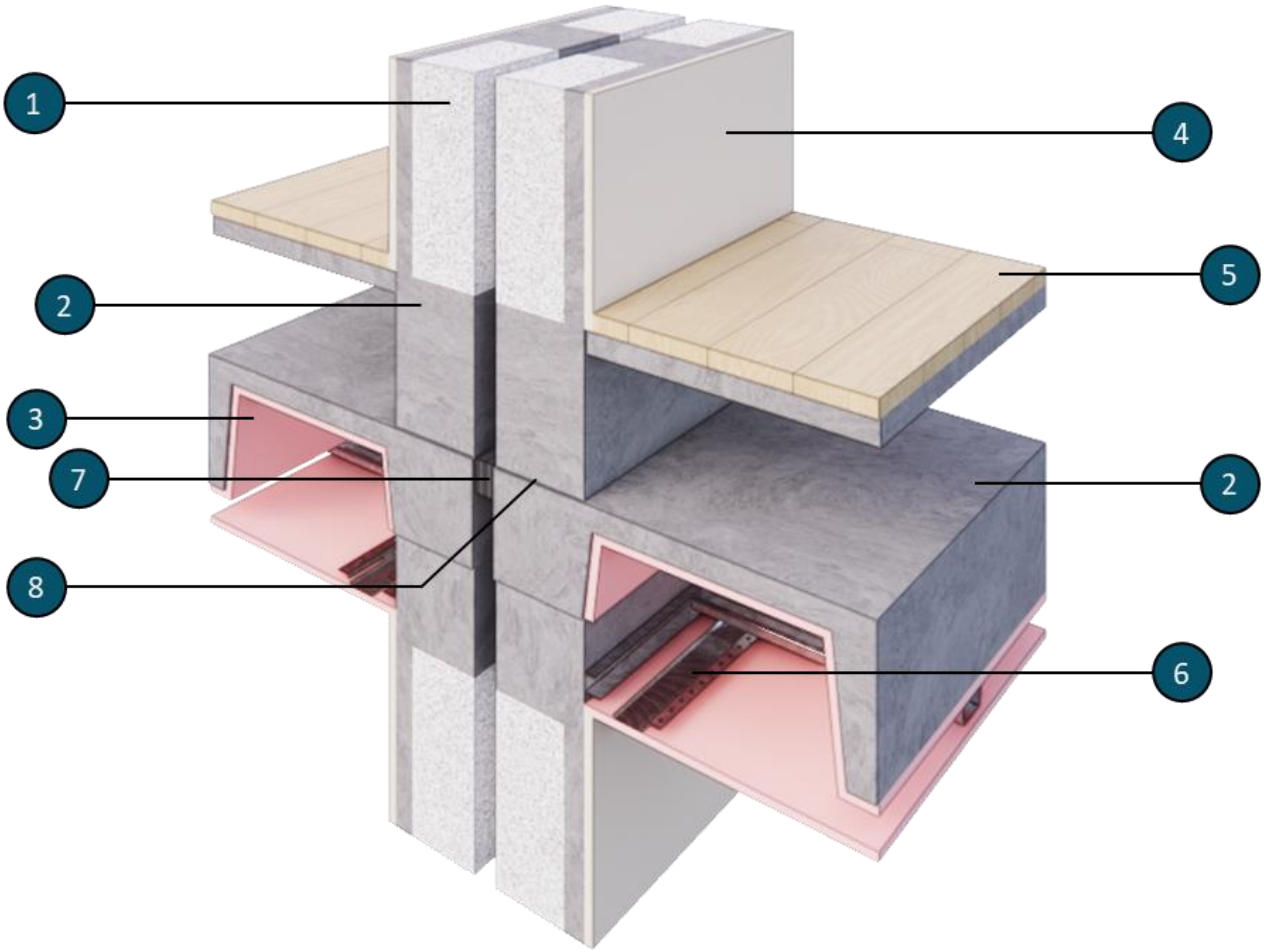


Figure 6: Compartment wall to compartment floor junction

1. EPS insulation
2. HPFRC structure
3. Plasterboard to provide adequate protection to HPFRC module (in accordance with this Certificate)
4. Internal wall finish as per this Certificate
5. Internal floor finish
6. MF ceiling system fixed to HPFRC rib beams
7. Fire stopping (intumescent linear gap seal)
8. Vertical connection detail between modules (where necessary, see Section 2.3.2 & Figure 14)

Note: Horizontal connection between modules was omitted for clearnace of drawing detail. BuildWright will provide horizontal connection detail where necessary for project.

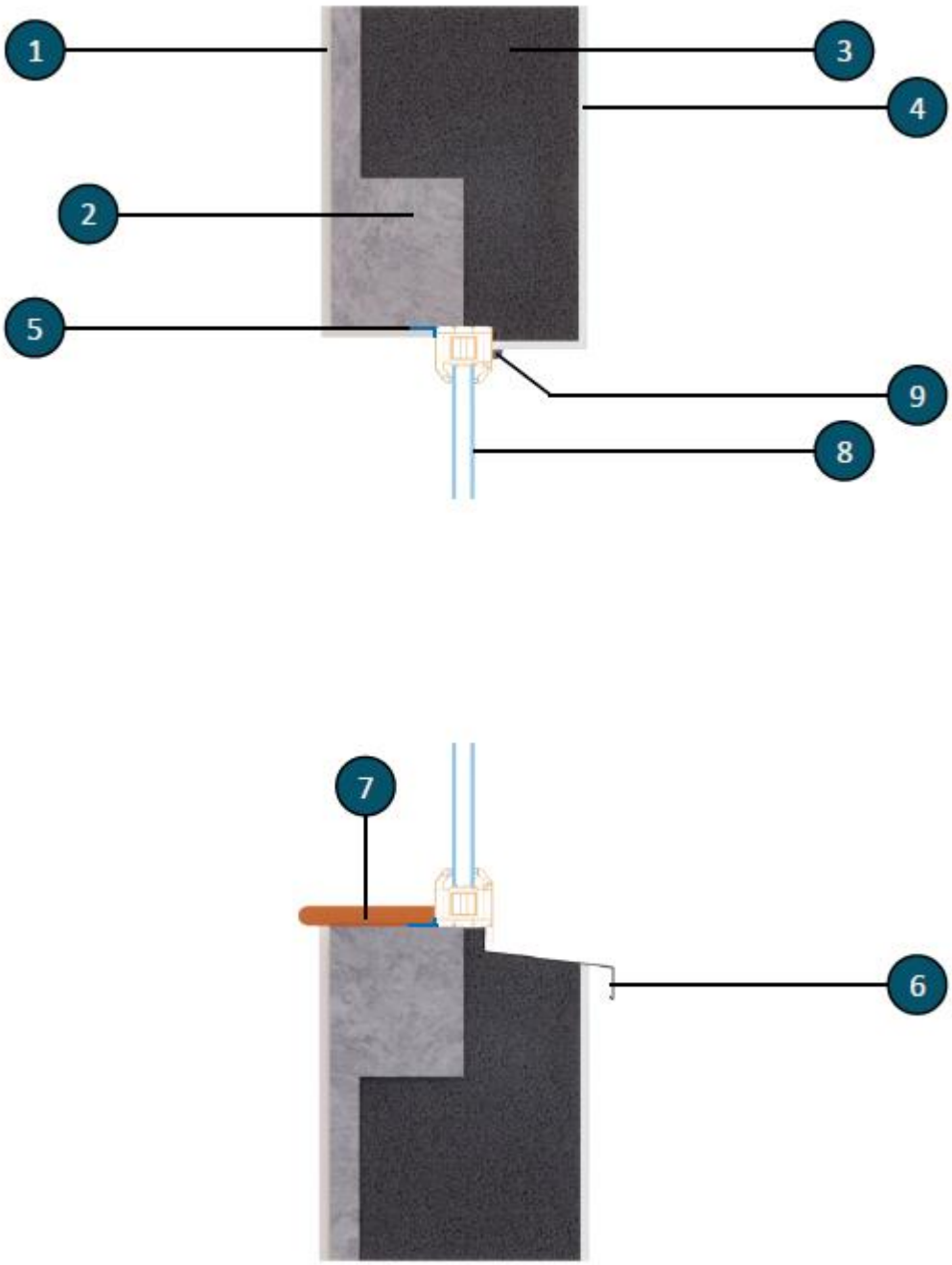


Figure 7: Window head and sill detail – ETICS façade finish

1. Internal wall finish as per this Certificate
2. HPFRC structure
3. EPS insulation
4. ETICS façade finish (in accordance with this Certificate)
5. Airtight tape
6. Powder coated aluminium sill
7. Window board
8. Window unit
9. Mastic Sealant

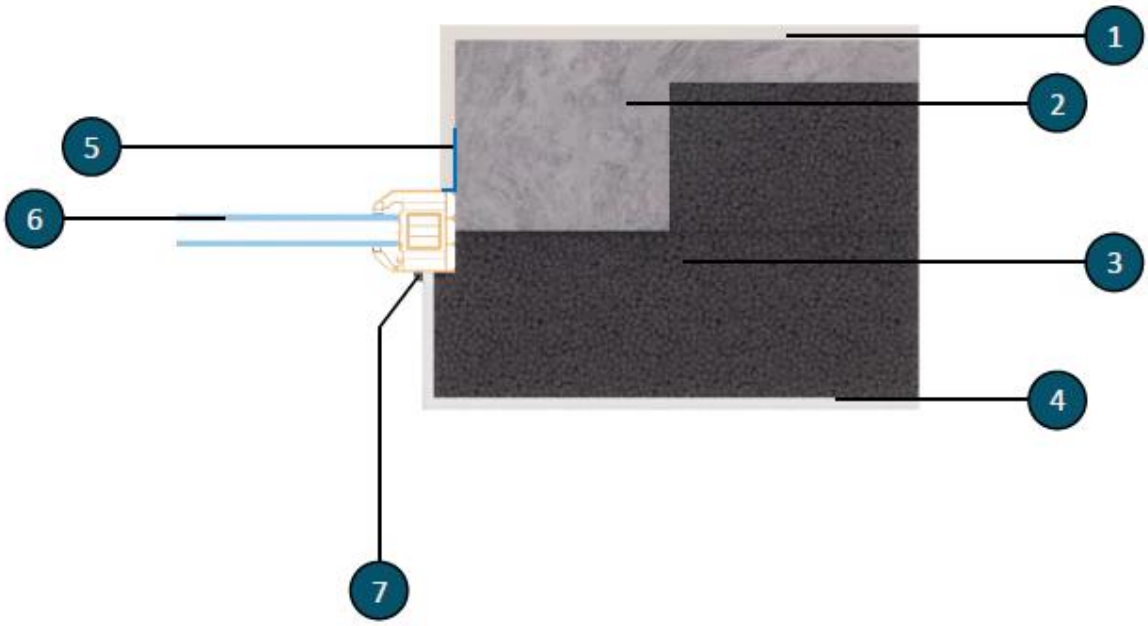


Figure 8: Window jamb – ETICS façade finish

1. Internal wall finish as per this Certificate
2. HPFRC structure
3. EPS insulation
4. ETICS façade finish (in accordance with this Certificate)
5. Airtight tape
6. Window unit
7. Mastic Sealant

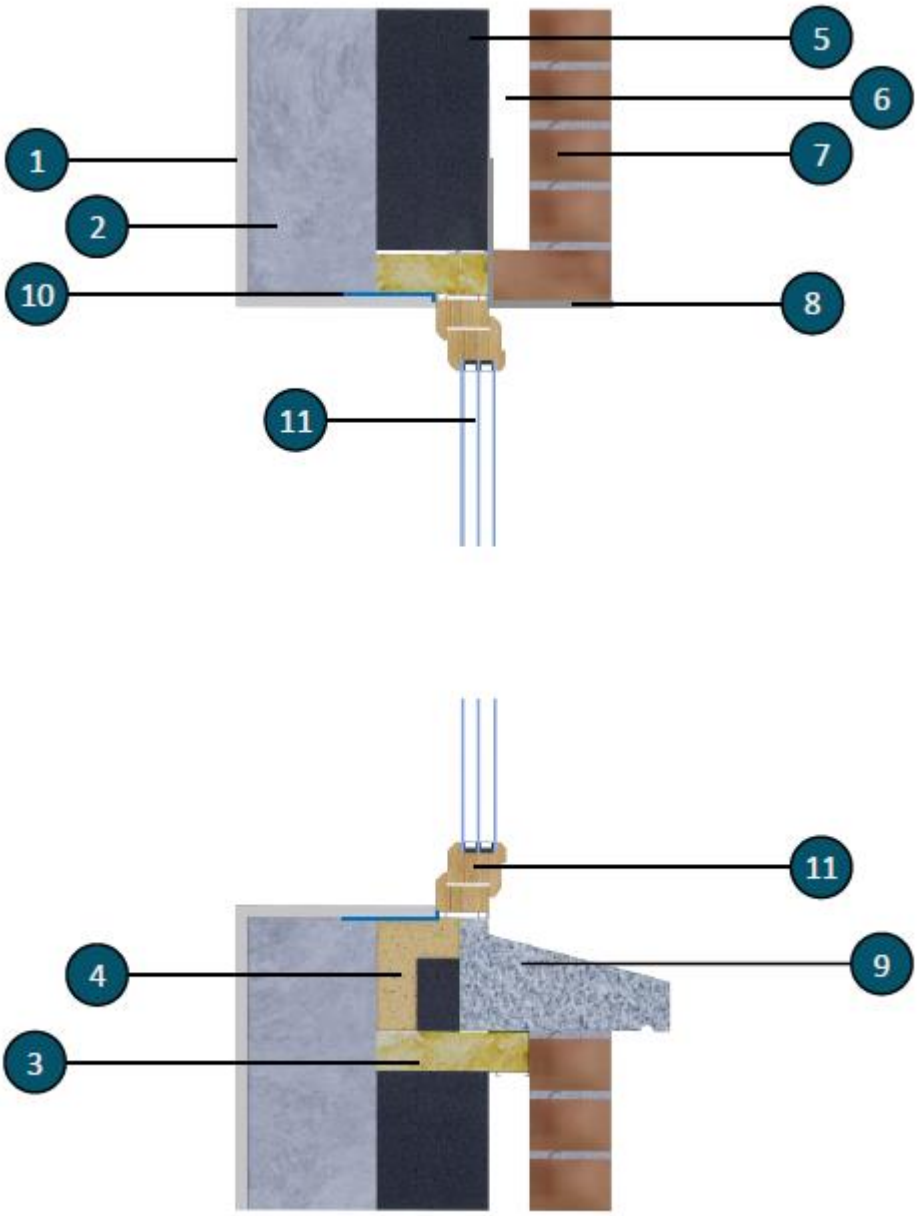


Figure 9: Window head and sill detail – traditional brick/block outer leaf cladding

1. Internal wall finish as per this Certificate
2. HPFRC structure
3. Proprietary cavity barrier (in accordance with this Certificate)
4. Structural insulator
5. EPS insulation
6. Cavity
7. Masonry outer leaf (site installed)
8. Proprietary single leef steel lintel (site installed)
9. Precast concrete sill
10. Airtight tape
11. Window unit

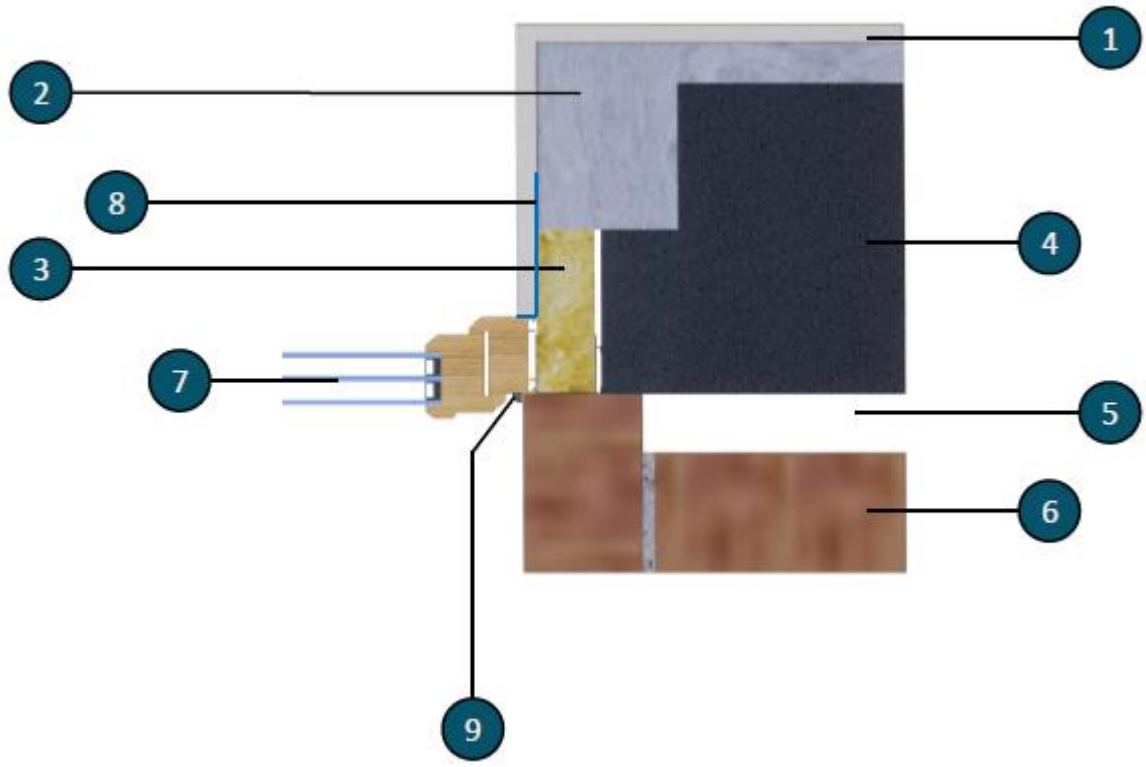


Figure 10: Window jamb – traditional brick/block outer leaf cladding

1. Internal wall finish as per this Certificate
2. HPFRC structure
3. Proprietary cavity barrier (in accordance with this Certificate)
4. EPS insulation
5. Cavity
6. Masonry outer leaf (site installed)
7. Window unit
8. Airtight tape
9. Mastic Sealant

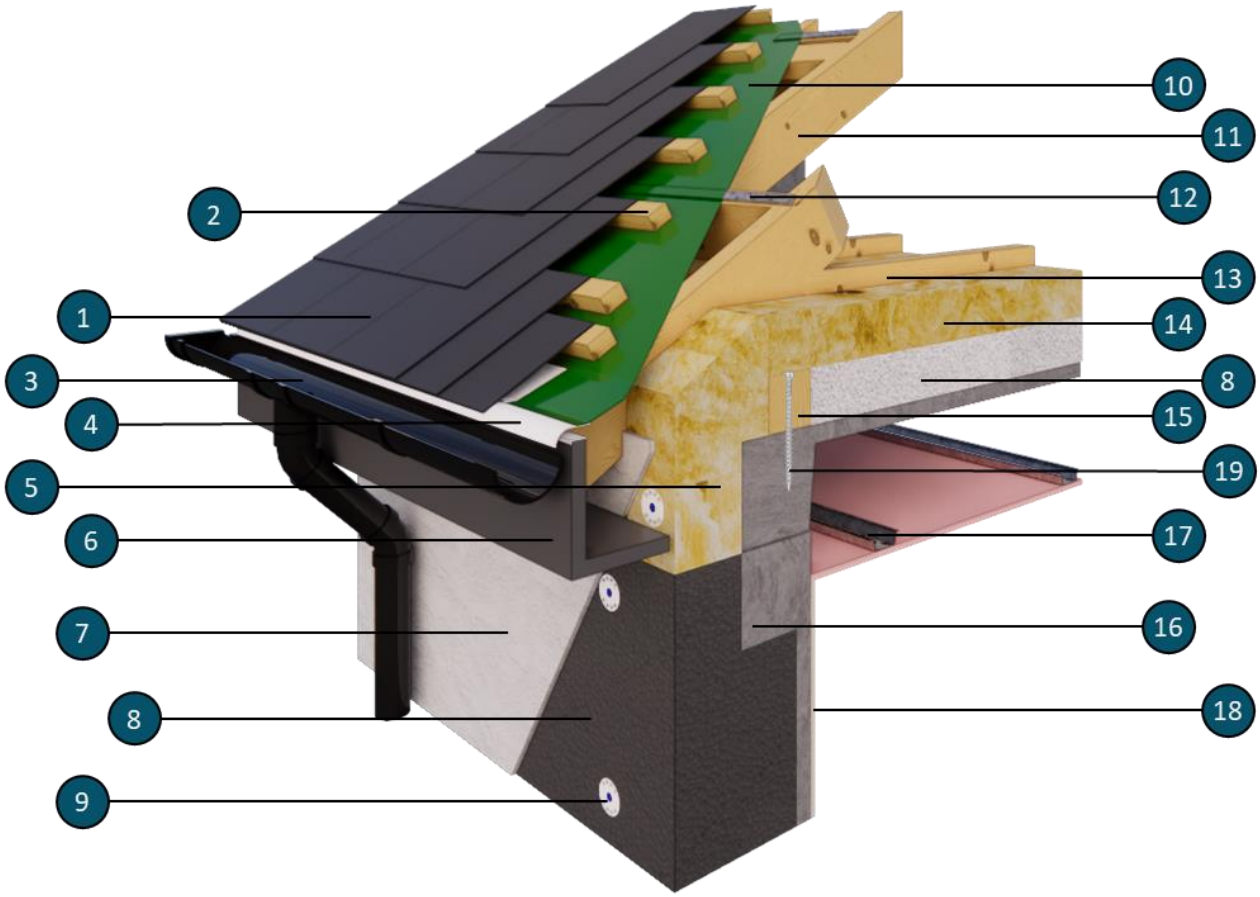


Figure 11: External wall with ETICS façade finish to roof junction (non-habitable attic space)

1. Roof finish (in accordance with this Certificate, site installed)
2. Roofing battens (site installed)
3. Gutter (site installed)
4. Continuous vent over fascia (site installed)
5. Mineral wool
6. Fascia & soffit
7. ETICS façade finish (in accordance with this Certificate)
8. EPS Insulation
9. Thermally broken insulation fixing (in accordance with this Certificate)
10. Breather membrane (site installed)
11. Timber rafters/Timber truss (site installed)
12. Restraint strap (site installed)
13. Timber joist/Timber truss (site installed)
14. Mineral wool attic insulation
15. Timber wall plate
16. HPFRC structure
17. MF ceiling system fixed to HPFRC rib beams
18. Internal wall finish as per this Certificate
19. Fixing between timber plate and roof structure

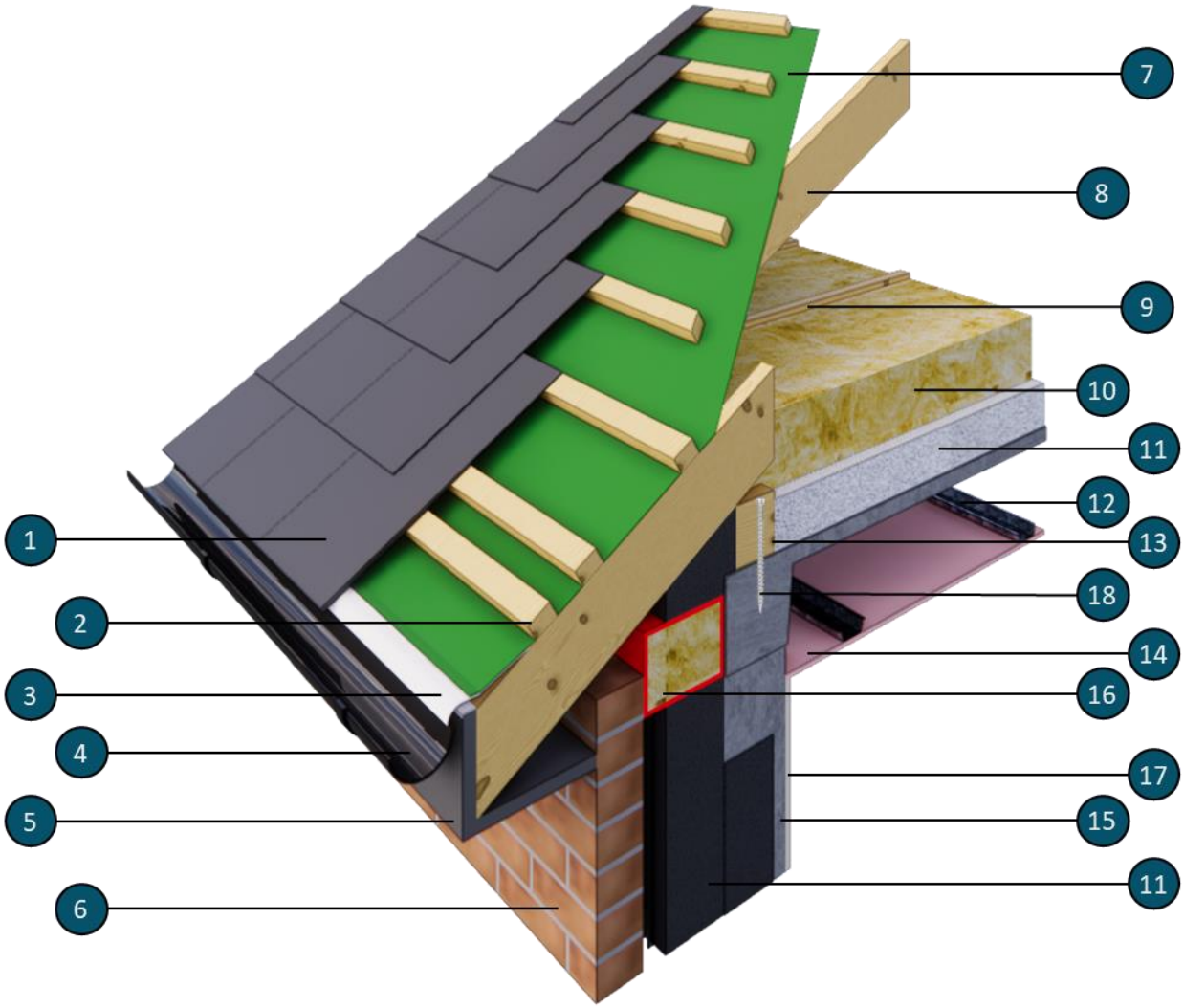


Figure 12: External wall with traditional brick/block outer leaf cladding to roof junction (non-habitable attic space)

1. Roof finish (in accordance with this Certificate, site installed)
2. Roofing battens (site installed)
3. Continuous vent over fascia (site installed)
4. Gutter (site installed)
5. Fascia & soffit
6. Masonry outer leaf (site installed)
7. Breather Membrane
8. Timber rafters/Timber truss (site installed)
9. Timber joist/Timber truss (site installed)
10. Mineral wool
11. EPS insulation
12. MF ceiling system fixed to HPFRC rib beams
13. Timber wall plate
14. Plasterboard to provide adequate protection to HPFRC module (in accordance with this Certificate)
15. HPFRC structure
16. Proprietary cavity barrier (in accordance with this Certificate)
17. Internal wall finish as per this Certificate
18. Fixing between timber plate and roof structure
19. Vertical connection detail between modules (where necessary, see Section 2.3.2)

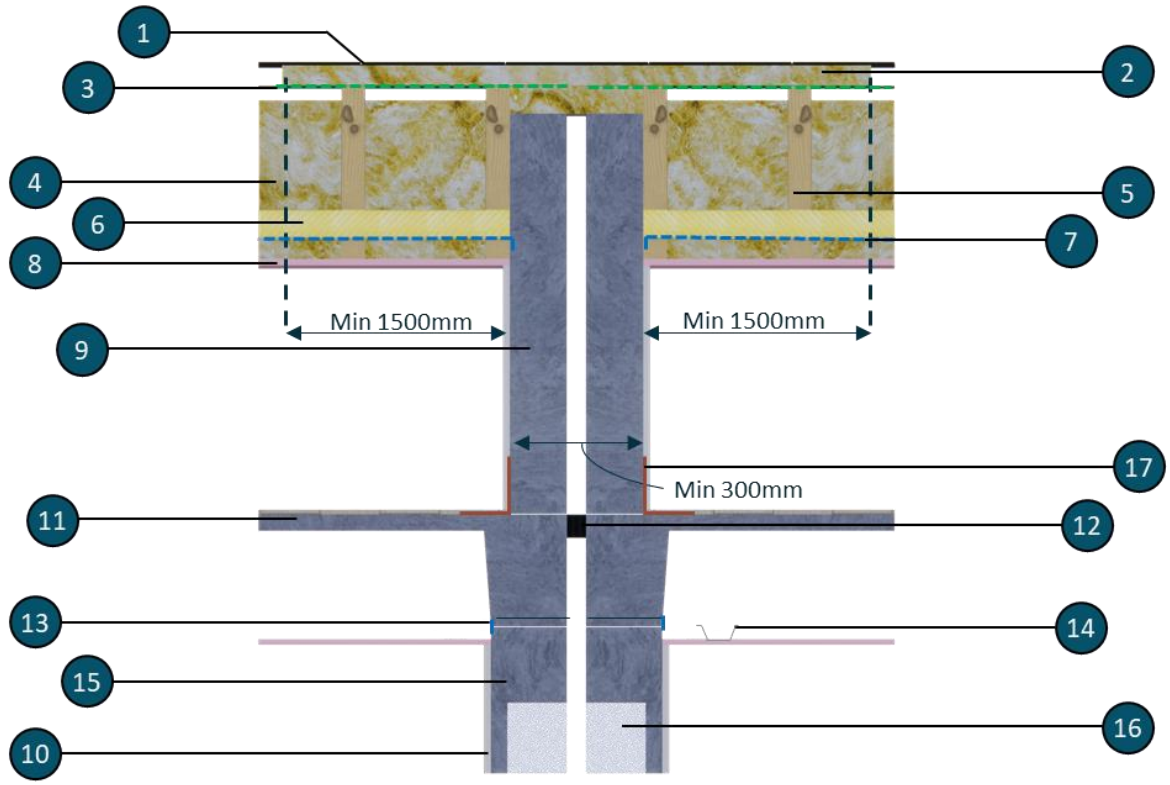


Figure 13: Compartment wall to roof junction (non-habitable attic space)

1. Roof finish (in accordance with this Certificate, site installed, refer to TGDs Part B of the Building Regulations)
2. Fire stoping at roof level
3. Breather Membrane
4. Mineral Wool
5. Timber rafters/Timber truss (site installed)
6. Insulation
7. Airtight membrane
8. Internal roof finish as per this Certificate
9. Precast concrete spandrel panel
10. Internal wall finish as per this Certificate
11. HPFRC structure
12. Fire stopping (intumescent linear gap seal)
13. Airtight tape
14. MF ceiling system fixed to HPFRC rib beams
15. HPFRC structure
16. EPS Insulation
17. Connection between precast spandrel panel and HPFRC structure

Note: Horizontal connection between modules was omitted for clearnace of drawing detail. BuildWright will provide horizontal connection detail where necessary for project.

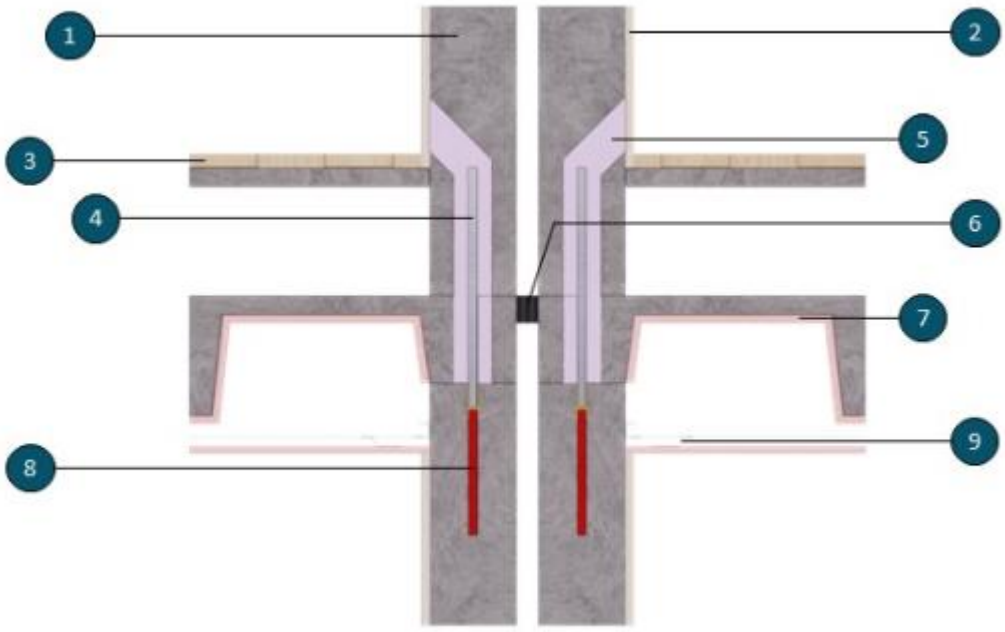


Figure 14: Vertical Connection Detail

1. HPFRC structure
2. Internal wall finish as per this Certificate
3. Internal floor finish
4. Threaded Bar
5. Non-shrink grout
6. Fire stopping (intumescent linear gap seal)
7. Plasterboard to provide adequate protection to HPFRC module (in accordance with this Certificate)
8. Fixing socket with tail
9. MF ceiling system fixed to HPFRC rib beams

Note: Horizontal connection between modules was omitted for clearnace of drawing detail. BuildWright will provide horizontal connection detail where necessary for project.

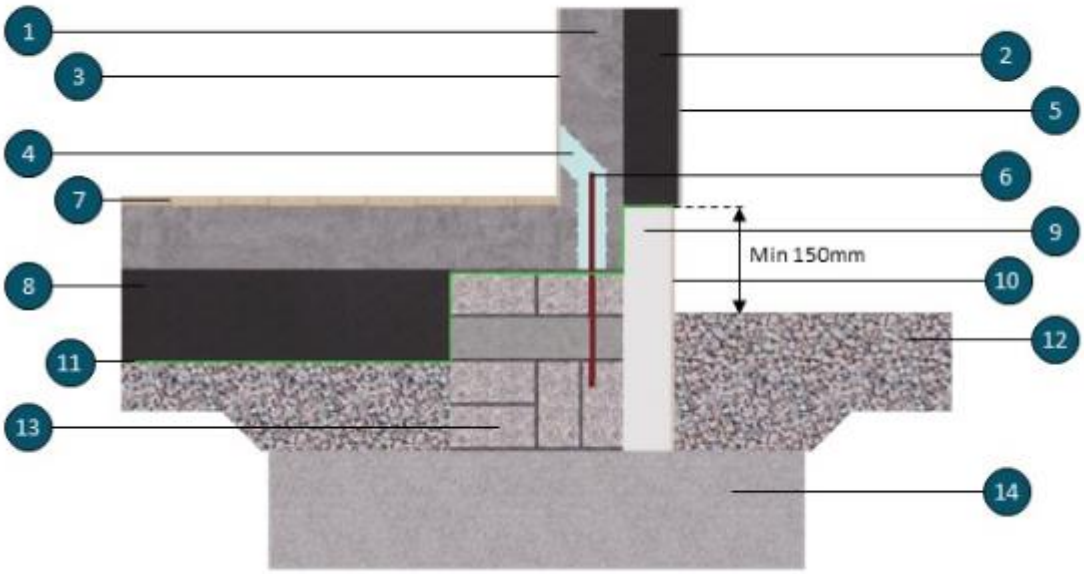


Figure 15: Ground Floor Connection Detail

1. HPFRC structure
2. EPS insulation
3. Internal wall finish as per this Certificate
4. Non-shrink grout
5. ETICS façade finish (in accordance with this Certificate)
6. Resin fixed threaded bar
7. Internal floor finish
8. EPS insulation
9. Plinth EPS insulation (in accordance with this Certificate, minimum EPS150)
10. Plinth ETICS render (in accordance with this Certificate)
11. DPM & radon barrier (site installed, by others)
12. Compacted hardcore (in accordance with Part C of the Building Regulations, by others)
13. Masonry support pier as per thermal modelling detail including min. 7.5N thermal block layer (by others)
14. Strip foundations (by others)

3.1 STRENGTH AND STABILITY

3.1.1 General

The BuildWright Modular Concrete 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 Engineering Design Team of the Client is responsible for the architectural drawings and compliance of the building design with the Building Regulations.

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

3.1.2 Certificate of Structural Compliance

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

3.1.3 Superstructure Design

The design must be in accordance with I.S. EN 1992-1-1[9] and Part A of the Building Regulations. Due to lack of Irish national rules for design, specification and testing of HPFRC, French standards NFP 18 710[15], NFP 18 470[16] and NPF 18 451[17] have been used.

The structural assessment of the BuildWright Modular Concrete Building System shall be site specific and project specific. BuildWright Structural Design Engineer suitably qualified in HPFRC design shall undertake the structural engineering of the system. Design supervision level shall be in accordance with I.S. EN 1990[14] (minimum DSL2 to be employed).

The design load shall be in accordance with:

- I.S. EN 1990[14]
- I.S. EN 1991-1-1[18]
- I.S. EN 1991-1-4[19]
- I.S. EN 1991-1-3[20]

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

3.1.4 Substructure Design

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

3.1.5 Structural Testing

Structural testing was used to verify the relevant aspects of the structure where the design falls outside the scope of I.S. EN 1992-1-1[9] and I.S. EN 206[11]. Structural testing carried out during the assessment included third point bending test and ultimate load test of HPFRC panel.

3.1.6 Disproportionate Collapse

The BuildWright Structural Engineer is responsible for disproportionate collapse design and risk of exceptional loads occurring. See also Section 2.3.2.

3.2 FIRE

3.2.1 General

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

The building details of the system incorporate suitable cavity barriers and fire stops to satisfy the requirements of Section 3 of TGDs to Part B of the Building Regulations. Additional guidance is contained in BS 9991[21] & BS 9999[8].

The BuildWright Modular Concrete Building System must be designed with the required boarding specification as per Table 3 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 BuildWright nominated Chartered Engineer.

3.2.2 Fire Resistance of Compartment Walls

Table 3 lists the fire resistance tests for loadbearing wall elements in accordance with I.S. EN 1365-1[22]. All fire testing has been carried out with service penetrations in the walls, but no plasterboard boarding. The compartment wall can provide up to 90 minutes load bearing fire resistance.

Refer to TGDs to Part B for reaction to fire classification requirements depending on the purpose group, building height and required fire resistance. Compartment walls using EPS insulation will not be adequate for buildings of any

purpose group with a topmost floor level greater than 11m and a fire resistance requirement of 60 minutes or more.

Any compartment wall providing fire compartmentation shall be carried up through any roof space and brought up to the underside of the roof cladding to provide adequate fire stopping. Refer also to Section 2.1.6 and Figure 13.

Refer to Section 2.1.6 for more information on compartment walls including any service provisions.

3.2.3 Fire Resistance of Compartment Floors

Table 3 lists the fire resistance tests for loadbearing floor elements in accordance with I.S. EN 1365-2[23]. The compartment floor can provide up to 90minutes load bearing fire resistance. Plasterboard lining as per Table 3 is required for construction of compartment floor to satisfy the requirements of TGDs to Part B of the Building Regulations. All compartment floors are constructed of materials having a reaction to fire classification A2-s3, d2 or better.

Refer to Section 2.1.8 for more information on compartment floors including any service provisions.

3.2.4 External fire spread

Table 3 lists the fire resistance tests for external wall in accordance with I.S. EN 1365-1[22]. All fire testing has been carried out with service penetrations in the walls, but no plasterboard boarding.

The external render approved for use onto EPS must have a spread of flame rating of B-s1, d0 to I.S. EN 13501-1[25] (refer to Table 1).

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

3.2.5 Internal Fire Spread (Linings)

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

3.2.6 Compartment Junctions

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

3.3 AIRTIGHTNESS

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

3.4 VENTILATION

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

3.5 WEATHERTIGHTNESS AND DAMP PROOFING

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

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

3.5.1 External Cladding

The external leaf of the BuildWright Modular Concrete Building System can be constructed of traditional brick/block outer leaf or NSAI Agrément approved ETICS façade as per Section 2.1.5 of this Certificate. Refer to Section 2.1.5 for as certified height limitations for each façade system.

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

Where the external facade is constructed of a ETICS façade finish the walls are protected by an approved render and correct detailing of the system.

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

3.6 WINDOWS AND DOORS

Windows and doors are outside the scope of this Certificate. However, Figures 7, 8, 9 & 10 give indicative details of how they can be installed to limit heat loss and moisture penetration.

Other considerations for the design of windows and doors include:

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

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

3.7 THERMAL PERFORMANCE

The panels were assessed as a warm frame system where the insulation is included both outside of the HPFRC structure and in between the HPFRC elements. The BuildWright Modular Concrete Building System can be provided for a wide range of required elemental U-values.

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

3.7.1 Limiting Thermal Bridging

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

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

3.7.2 Internal Surface Condensation

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

3.8 INTERSTITIAL CONDENSATION

3.8.1 Condensation in Walls

Condensation risk analysis shall be carried out by BuildWright to assess the build up proposed, considering the location of the building, the building occupancy and purpose class. Refer also to Section 4.4 on technical investigation of interstitial condensation.

3.8.2 Condensation in Roofs

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

3.9 SOUND

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

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

Refer to Section 4.5 for technical investigations on acoustic performance.

3.10 MAINTENANCE

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

Regular inspections should be made over the life of the system. The system shall be inspected and maintained in accordance with the Certificate holder's instructions, as detailed in the Repair and Maintenance Method Statement, which is incorporated into the Building Owner's Manual. Below is a non-exhaustive list of maintenance inspections and works which should be undertaken regularly:

- Visually inspect the render and architectural details for signs of damage or water ingress (at least annually).
- Necessary repairs should be carried out immediately and must be in accordance with the Certificate holder's instructions to prevent deterioration or damage, and to protect the integrity of the system.
- Sealants shall be subject to regular inspection (at least annually).
- Sealants should be replaced as required and fully replaced every 18 to 20 years to maintain performance.
- Synthetic finishes may be subject to aesthetic deterioration due to exposure to UV light. They should be re-painted at least every 18 to 20 years, or as necessary, to maintain appearance.
- Repainting should be carried out in accordance with the relevant recommendations of BS 6150[26].
- Timber boarding, fascia, soffits etc. where used, should be treated with an appropriate paint system or translucent stain and should be maintained by periodic re-coating using a paint or stain suitable for external applications, applied in accordance with the manufacturer's instructions.
- Care should be taken to ensure that the synthetic finish used is compatible with the original system and that the water vapour transmission or fire characteristics are not adversely affected.

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

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

4.1 STRENGTH AND STABILITY

The assessment of the structure was carried out to I.S. EN 1992-1-1[9] and Part A of the Building Regulations. Due to lack of Irish national rules for design, specification and testing of HPFRC, French standards NFP 18 710[15], NFP 18 470[16] and NPF 18 451[17] have been used.

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

4.2 BEHAVIOUR IN FIRE

4.2.1 Fire Resistance

Assessment of test results to I.S. EN 1365-1[22] and I.S. EN 1365-2[23] shows that buildings constructed using the BuildWright Modular Concrete Building System can meet the Building Regulation requirements in relation to fire resistance as shown in Table 3.

4.3 THERMAL PROPERTIES

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

Table 4 and Table 6 of this Certificate give the various elemental wall U-values in W/m^{2}K with a traditional brick/block outer leaf cladding and ETICS façade finish.

4.3.1 Limiting Thermal Bridging

Table 5 and Table 7 of this Certificate give ψ-values for a range of the BuildWright Modular Concrete Building System junctions. A full listing of ψ-value calculations, along with the building details on which calculations are based, are contained within the certificate holder's technical data sheets for ψ-values.

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

4.3.2 Internal Surface Condensation

Table 5 and Table 7 of this Certificate give internal surface temperature factors (fRsi) for a range of building junctions.

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

4.4 INTERSTITIAL CONDENSATION

4.4.1 Condensation in Walls

Calculations to I.S. EN ISO 13788[29][28] have been carried out for all wall build ups as covered by this Certificate. They predict no interstitial condensation within the external wall and pass the risk criteria in I.S. EN ISO 13788[29].

4.5 SOUND

4.5.1 Separating Walls

The acoustic performance of the separating wall specified in Section 2.1.6 has been assessed by on-site testing of the building constructed using the BuildWright Modular Concrete Building System and third-party acoustic assessment calculations. The testing included sound airborne insulation tests on separating walls in accordance with I.S. EN ISO 16283-1[30]. Results from on-site testing are shown in Table 8.

The separating wall in the BuildWright Modular Concrete Building System has been assessed and when constructed in accordance with this Certificate can meet the requirements of TGD to Part E of the Building Regulations.

4.5.2 Separating Floors

The acoustic performance of the separating floor specified in Section 2.1.8 has been assessed by on-site testing of the building constructed using the BuildWright Modular Concrete Building System and third-party acoustic assessment calculations. The testing included impact sound insulation to I.S. EN ISO 16283- 2[31]. Results from on-site testing are shown in Table 8.

The separating floor in the BuildWright Modular Concrete Building System has been assessed and when constructed in accordance with this Certificate can meet the requirements of TGD to Part E of the Building Regulations.

4.6 WEATHERTIGHTNESS

Centre of Window and Cladding Technology (CWCT) Hose test in accordance with CWCT TN41[36] was carried out on panel with ETICS façade finish. No leakage was observed during the testing.

4.7 DURABILITY

The HPFRC structure of the system has been assessed in accordance with I.S. EN 1992-1-1[9] and NFP 18-470[16]. The durability was assessed against basic threshold tests and exposure conditions for which the basic threshold tests are applicable in accordance with NFP 18-470[16]. For exposure class XC1 the tests confirmed 100 years design working life for HPFRC structure in accordance with NFP 18-470[16].

The external façade system design working life depends on external finish used:

- The traditional brick/block outer leaf cladding should remain effective for at least 60 years subject to normal use, regular inspection and maintenance; providing that it is designed, installed and maintained in accordance with this Certificate.
- The ETICS façade finish should remain effective for at least 30 years subject to normal use, regular inspection and maintenance; providing that it is designed, installed and maintained in accordance with this Certificate.

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

4.8 TESTS AND ASSESSMENTS WERE CARRIED OUT TO DETERMINE THE FOLLOWING

- Sample structural design for a typical building,
- Third point bending test for HPFRC,
- Ultimate load test of the HPFRC panel,
- HPFRC material characteristics,
- Testing and assessment of fixings and connections,
- Durability testing and durability assessment,
- Masonry outer leaf cladding exemplar design and design methodology,
- Design methodology for HPFRC structure,
- Typical drawing details,
- U-value and thermal modelling for typical junctions,
- Risk of condensation both surface and interstitial,
- Behaviour in relation to fire,
- System specific load bearing fire testing,
- On-site testing acoustic performance,
- Material specifications,
- System and installation manuals,
- Quality control in the factory and during construction,
- Sample airtightness reports,
- Watertightness of external cladding finishes.

4.9 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 3: Fire Data for Loadbearing Wall, Floor and Ceiling Elements				
Type	**Element:**	**Test Standard**	**Results**	**Purpose Group**
External Load Bearing Wall – Inside to Outside				
1	• Test conducted on 3000mm x 3000mm x 260mm (w x h x thk) panel with total vertical load of 150kN • Exposed side: 2No. 160 x160mm HPFRC rib beams and 2No. 160x160mm HPFRC columns at perimeter of the panel, 35mm thk. HPFRC panel between columns and rib beams • 225mm insulation thk. EPS 70 insulation (15kg/m^3 density) fitted between the exposed and unexposed layers. Where the HPFRC section has a thickness different than 35mm – the insulation thickness was reduced to achieve a levelled finish on the unexposed side, R-TFIX insulation fixings • Unexposed side: primer and finishing coat as per fire testing report • 2 No. Double Sockets were fitted on the fire side	I.S. EN 1365-1[22]	60 mins from inside	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)*
External Load Bearing Wall (ETICS façade finish) – Outside to Inside				
2	• Test conducted on 3000mm x 3000mm x 310mm (w x h x thk) panel with total vertical load of 150kN • Unexposed side: 2No. 160 x160mm HPFRC rib beams and 2No. 160x160mm HPFRC columns at perimeter of the panel, 35mm thk. HPFRC panel between columns and rib beams • 275mm insulation thk. EPS 70 insulation (15kg/m^3 density) fitted between the exposed and unexposed layers. Where the HPFRC section has a thickness different than 35mm – the insulation thickness was reduced to achieve a levelled finish on the unexposed side, R-TFIX insulation fixings • Exposed side: basecoat, fibre mesh and render as per fire testing report	I.S. EN 1365-1[22]	30 mins from outside	1(a), 1(b), 1(c), 1(d), 2(b), 3, 4(a)*, ***
Compartment Wall				
3	**Modular separating walls as per Section 1.1.6** • Test conducted on 3000mm x 3000mm x 340mm (w x h x thk) panel with total vertical load of 150kN • 2No. 160 x160mm HPFRC rib beams and 2No. 160x160mm HPFRC columns at perimeter of the panel, 35mm thk. HPFRC panel between columns and rib beams • 125mm insulation thk. EPS 70 insulation (15kg/m^3 density) fitted between the exposed and unexposed layers. Where the HPFRC section has a thickness different than 35mm – the insulation thickness was reduced to achieve a levelled finish on the unexposed side, R-TFIX insulation fixings • 20mm Cavity • 2No. 160 x160mm HPFRC rib beams and 2No. 160x160mm HPFRC columns at perimeter of the panel, 35mm thk. HPFRC panel between columns and rib beams	I.S. EN 1365-1[22]	90 mins from either side	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)

	• 125mm insulation thk. EPS 70 insulation (15kg/m^3 density) fitted between the exposed and unexposed layers. Where the HPFRC section has a thickness different than 35mm – the insulation thickness was reduced to achieve a levelled finish on the unexposed side, R-TFIX insulation fixings • 2 No. Double Sockets were fitted on each side			
Compartment Floor				
4	**Floor supporting a Uniformly Distributed Load of 2.25kN/m^2** • Test conducted on 4450mm long x 2960mm wide x 480mm thick floor • Exposed side: 1No. layer of 15mm Gyproc Fireline Board fixed on fire side face using mushroom head fixings and hammer in metal insulation fixings at 360/440mm max centres (refer to fire report) • 35mm thk. HPFRC panel with 2No. 220x160mm HPFRC rib beams spaced at 2.0m ctrs. HPFRC edge beam supports along the width of the floor (lower module) • 15mm gap between rib beams • Unexposed side: 35mm thk. HPFRC panel with 2No. 220x160mm HPFRC rib beams spaced at 2.0m ctrs. HPFRC edge beam supports along the width of the floor (upper module)	I.S. EN 1365-2[23]	90 mins from below ceiling level	1(a), 1(b), 1(c), 1(d), 2(a), 2(b), 3, 4(a), 5(a), 5(b)**

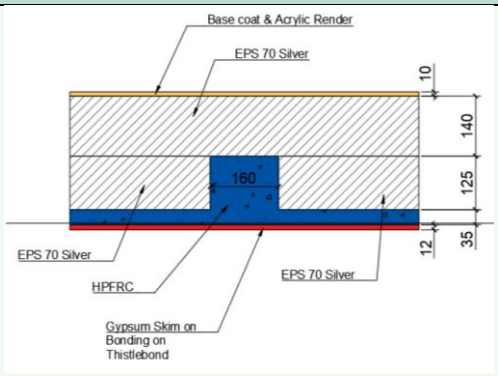
Notes:

- The above build-ups are summaries of those tested to the referenced standards – they should not be taken as an exhaustive list. For full details of test reports, the Certificate holder should be contacted.
- For alternative approaches to fire safety requirements, refer to 0.2 of TGD to Part B of the Building Regulations.

* Refer to cover page of this Certificate for limitation on certified building heights dependent on external cladding finish

**Design to be dictated by project specific loading requirements on a case by case basis

***Purpose groups 2(a), 5(a) & 5(b) (not sprinklered for purpose groups 5) are not included as fire resistance for ETICS façade finish does not meet requirements of TGD to Part B where relevant boundary is less than 1m. Competent Fire Engineer to review fire test data on a project by project basis.

External walls U-value for variable EPS thickness – ETICS façade finish	
Wall build-up: Render EPS 70 (thickness varies) HPFRC with EPS70 insulation 12.5mm Plasterboard	

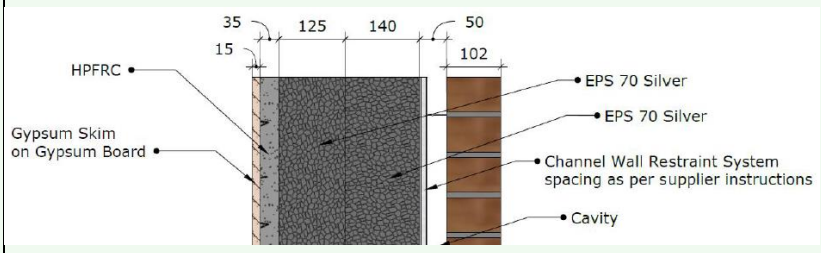
Wall thickness	EPS variable thickness:	Calculated U-value (W/m²K)
303mm	120mm	0.17
323mm	140mm	0.16
343mm	160mm	0.14
363mm	180mm	0.13
383mm	200mm	0.12
403mm	220mm	0.12

Table 4: Typical External Wall U-Values – ETICS façade finish

Target linear thermal transmittance (ψ) for different types of junctions – ETICS façade finish			
ACD Ref:	**Junction Description**	**Temperature Factor f_{Rsi} (Min = 0.75)**	**BuildWright Ψ-value (W/mK)**
2.02	Ground Floor - Insulation below slab	0.786	0.248
2.04	Concrete Intermediate Floor within a dwelling	0.95	0.067
2.05	Separating Wall - plan	0.94	0.150
2.09	Ventilated roof space – cold roof	0.90	0.135
2.12.2	Eaves Ventilated Rafter Void – warm roof	0.954	0.067
2.20	Ope - Lintel	0.949	0.021
2.21	Ope - Jamb	0.95	0.023
2.22	Sill	0.94	0.049
2.23.1	Corner	0.90	0.116
G.05.1	Separating Wall though ground floor(1)	0.864	0.239
-	Door Threshold	0.81	0.151

(1) Value of ψ is applied to each dwelling.
(3) Flanking element U-values for walls, roof and floor thermal models above were based on:
U_W = 0.143 W/m²k (external wall), U_R = 0.152/0.138 W/m²k (cold roof/warm roof), U_{GF} = 0.082 W/m²k (ground floor)
Modelled junction ψ-values are based on typical BuildWright details above can be used in y-value calculations, if relevant detail is applicable

Table 5: Typical ψ-Value W/mK – ETICS façade finish

External walls U-value for variable EPS thickness – traditional brick/block outer leaf	
Wall build-up: 102mm brick 50mm Cavity EPS 70 (thickness varies) HPFRC with EPS70 insulation 15mm Plasterboard	

Wall thickness	EPS variable thickness:	Calculated U-value (W/m²K)
447mm	120mm	0.18
467mm	140mm	0.16
487mm	160mm	0.15
507mm	180mm	0.14
527mm	200mm	0.13
547mm	220mm	0.12

Table 6: Typical External Wall U-Values – traditional brick/block outer leaf

Target linear thermal transmittance (ψ) for different types of junctions – traditional brick/block outer leaf			
ACD Ref:	**Junction Description**	**Temperature Factor f_{Rsi} (Min = 0.75)**	**BuildWright Ψ-value (W/mK)**
1.02	Ground Floor - Insulation below slab	0.80	0.249
1.04	Concrete Intermediate Floor within a dwelling	0.94	0.133
1.04a	Concrete Separating Floor within a dwelling(1)	0.94	0.103
1.06	Separating Wall - plan	0.95	0.107
1.09	Ventilated roof space – cold roof	0.91	0.112
-	Eaves Ventilated Rafter Void – warm roof	0.94	0.080
1.11.2	Eaves - Dormer	0.92	0.067
1.15	Gable – Ventilated Attic	0.81	0.202
1.16/1.17	Gable – Insulation between and under rafters	0.86	0.239
1.27.1	Corner	0.90	0.109
1.27.2	Inverted Corner	0.97	-0.052
-	Ope - Lintel	0.89	0.027
-	Ope - Jamb	0.89	0.026
-	Sill	0.83	0.084
-	Door Threshold	0.79	0.162

(1) Value of ψ is applied to each dwelling.
(3) Flanking element U-values for walls, roof and floor thermal models above were based on:
U_W = 0.158 W/m²k (external wall), U_R = 0.159/0.164 W/m²k (cold roof/warm roof), U_{GF} = 0.082 W/m²k (ground floor)
Modelled junction ψ-values are based on typical BuildWright details above can be used in y-value calculations, if relevant detail is applicable

Table 7: Typical ψ-Value W/mK – traditional brick/block outer leaf

Please note: All U-value calculations illustrated in the U-value tables in this Certificate should be taken as examples of performance that can be achieved. It is strongly recommended that U-value calculations are produced on a project specific basis by a competent person as U-value calculations may increase or decrease depending on a wide range of parameters such as number of fixings per square meter, size of fixing, etc. therefore U-values should be recalculated if the build-ups differ from those described in Tables 4, 5, 6 and 7.

Acoustic tests results*				
Separating Construction	**Airbourne sound insulation DnT,w [dB]**		**Impact sound insulation L'nT,w [dB]**	
	Performance Target	**Result**	**Performance Target**	**Result**
Separating Wall	≥53	54	N/A	N/A
Separating Floor	≥53	55	≤58	47
*The results above were obtained from on-site project specific testing. Results may vary based on project specific conditions but must always meet TGD to Part E Building Regulations requirements				

Table 8: Acoustic test results

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

(a) the specification of the product is unchanged.

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

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

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

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

(f) the registration and/or surveillance fees due to IAB 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. **24/0443** is accordingly granted by the NSAI to **Wright Concrete Innovations Ltd** on behalf of NSAI Agrément.

Date of Issue: 21ST August 2024

Signed

Kevin D. Mullaney
Director of Certification, NSAI

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

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