Chapter

11.3

Volumetric systems

This chapter gives guidance on meeting the Technical Requirements for volumetric systems used to form homes where the height of the top floor above ground does not exceed 18m.

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Introduction

This chapter provides guidance for volumetric systems used to form homes where the height of the top floor above ground does not exceed 18m.

The guidance in this chapter does not apply to volumetric roof systems or pre-manufactured structural components made of mass engineered timber.

This chapter should be used in conjunction with Chapter 11.1 MMC systems: general requirements. This chapter seeks to focus on areas of guidance that are unique to the system type and method of construction employed, giving references to complimentary existing guidance provided elsewhere in the Standards where relevant.

There is a strong link to all chapters in Part 6 of the Standards, particularly Chapters 6.2 and 6.10.

The term 'Modern Methods of Construction (MMC)' is very broad and covers a wide range of differing offsite manufactured systems and onsite construction techniques.

MMC types have been categorised and defined in the MHCLG Joint Working Group 'MMC Definition Framework', see Chapter 11.1 MMC systems: general requirements. The scope of the guidance in this chapter will cover volumetric systems that generally fall under Category 1 under the 'MMC Definition Framework' and as defined below:

Volumetric

Three-dimensional structural volumetric units fabricated offsite in a factory environment used to form all or part of the basic structure of a building. Volumetric units may incorporate varying degrees of offsite fabrication and finish, including internal and external linings, external claddings, windows and doors, internal finishes, concealed insulation, membranes, internal services, internal fixtures and fittings and fire-stopping.

Volumetric units can be used in varying configurations to form the entire structure of the home or be supported by surrounding construction. Units can be manufactured in varying structural forms and be formed from timber, concrete, steel or light gauge steel or a combination of those materials.

Definitions for this chapter

Cavity	A space enclosed by elements of a building which may either be the space between the cladding system and the backing wall or the space between building elements such as volumetric units. The external wall cavity should be adequately drained, and ventilated where required.
Cavity barrier	A construction within a cavity, other than a smoke curtain, to perform either of the following functions: ● close a cavity to stop smoke or flame entering ● restrict the movement of smoke or flame within a cavity.
Factory installed	An element of the construction that is placed, positioned, fitted or secured in, on or as part of the unit as part of the factory construction process.
Fire-stopping	A seal provided to close an imperfection of fit or design tolerance between elements or components, to restrict the spread of fire and smoke.
Installation Manual	Detailed installation guidance and information for the system compiled by the system manufacturer. The Installation Manual describes general instructions for storage and transport of the system, and procedures for on-site assembly and installation.
Interface	Interface either between similar or dissimilar envelope systems (eg at panel joints) or between envelope systems and other elements of the building (eg walls, roof, doors, and windows).
Junction	The point where components, including panels are joined with each other or with other elements of the building (eg supporting structure, roofs and foundations).
Manufacturer	The company which is responsible for the design and assembly of the volumetric system.
Non-standard components	Components that are assembled as part of the system but vary for individual projects. These may be windows, doors or services that may be built into the system.
Primary structural components	Elements of the structure designed to carry and transfer primary loads of the building, including self-weight, dead loads, and live loads.
Secondary structural components	Elements of the structure which do not play a wider role in the structure, but carry loads directly imposed on them (and transfer them to the primary structure) such as self-weight, wind loads, cladding and openings.
Standard components	Components that are assembled as part of the system and are common to all projects.
System	For the purposes of this chapter, this term refers to acceptable forms of volumetric systems.
System Manual	Detailed technical information on the system compiled by the system manufacturer. The System Manual describes the system, the declared performance of the system and evidence to support the declared performance.
Unit	A prefabricated building unit, manufactured offsite as a structural or non-structural assembly in three-dimensional or flat panel format used as part of a system to form the superstructure of a building.
Volumetric	Three-dimensional structural units which are commonly stacked to form a building. Volumetric units may incorporate varying degrees of off-site fabrication and finish, including internal and external linings, external claddings, windows and doors, internal finishes, concealed insulation, membranes, internal services, internal fixtures and fittings and fire-stopping.

11.3.1 Compliance

Also see: Chapters 2.1 and 11.1

Volumetric systems shall comply with the Technical Requirements.

Volumetric systems that comply with the guidance in this chapter and associated chapters will generally be acceptable. This chapter should be used in conjunction with guidance in Chapter 11.1 MMC Systems: general requirements.

As many components of volumetric systems cannot be inspected on site, they should be treated as a building system as defined in Chapter 2.1, Requirement R3 and subject to assessment by an independent technical approvals authority or assessed under the NHBC Accepts service; **www.nhbc.co.uk/accepts**.

11.3.2 Provision of information

Also see: Chapter 11.1

Designs and specifications shall be produced in a clearly understandable format, include all relevant information, and be distributed to all appropriate personnel.

Design, specification, and installation information should be issued to site supervisors, relevant specialist subcontractors and suppliers, and be made available on site to enable work to be carried out in accordance with the design. This should include:

- a System Manual (see Clause 11.1.3)
- clear, coordinated and fully detailed drawings providing sufficient information for construction and installation of the system
- a system Installation Manual (see Clause 11.1.9).

Refer to Chapter 11.1 MMC Systems: general requirements for further guidance.

11.3.3 Structural design

Also see: Chapters 3.1, 3.3, 6.2, 6.5 and 6.10

Volumetric systems shall be designed to support and transfer loads to foundations and supporting construction safely and without undue movement and shall have adequate resistance to loads imposed during manufacture, transportation, and installation. Issues to be taken into account include:

1) **overall stability**
2) **unit connections**
3) **temporary loads**
4) **durability.**

The structural design of the building should ensure adequate resistance to loadings in accordance with either the relevant Eurocode parts and their corresponding National Annexes relevant to the materials used to form the structural frame of the volumetric unit.

Where necessary, supplementary industry guidance should be followed where permitted by the relevant Eurocode and corresponding National Annex.

The design data may be supplemented with appropriate values derived from structural tests, acceptable to NHBC, where permitted by the relevant Eurocode and corresponding National Annex.

11.3.3.1 Overall stability

The building comprising volumetric units should be capable of supporting the specified loadings with adequate safety against structural collapse, inadmissible deformations, vibration, and disproportionate collapse.

Each unit should be framed in order to support itself fully and safely, by either:

- being designed as a rigid frame, or
- additional bracing or sheathing.

Overall stability of the building should be provided by either:

- the fully braced volumetric units, or
- connection to an independent bracing system such as a building core, shear walls and/or stability frame/s.

Design of a completed building should account for the effect of discontinuities in any system providing overall stability, eg the interruption of diaphragms or shear walls between modules.

Where differential movement between the volumetric units and any supporting structure such as a building core is expected, this should be considered as part of the design.

11.3.3.2 Unit connections

Connections between volumetric units should be designed by a Structural Engineer in accordance with Technical Requirement R5.

The design of connections between units or between units and surrounding construction, typically in-situ, should be compatible and have sufficient strength to transfer the necessary design loads and stiffness to enable the connected units to behave as a complete structure.

Connections should be designed and installed to achieve the required structural performance, and:

- accommodate movement where required
- allow for tolerance and adjustment
- be designed to avoid the risk of damaging or compromising the functional performance of factory installed elements such as breather membranes, AVCLs and lining boards.

The design, System Manual, and Installation Manual should include details of:

- specification and limits for shimming or adjustment of connections
- design and specification of fixings
- sequencing of installation.

Volumetric units should be mechanically fastened to supporting slab or foundations and not rely wholly on frictional resistance to resist sliding.

11.3.3.3 Temporary loads

Structural design of the units should consider the loads imposed during manufacture, storage, lifting and transportation and provide sufficient stiffness or protection against inadmissible deformation or deflection. See also Clause 11.1.8.

Where required, the design should specify temporary bracing and/or additional support arrangements for large openings or weak points in the structure and clearly identify the conditions under which such works can be removed.

11.3.3.4 Durability

The durability of materials and components should be specified in accordance with Technical Requirement R3. Structural elements and components that cannot easily be repaired or replaced should be suitably durable for the environment to which they will be exposed.

Metal fasteners, connectors and other structural steel parts in the element should either be:

- inherently corrosion resistant, or
- protected against corrosion to provide the required design life for the expected exposure condition.

Reinforced concrete should be in accordance with Chapter 3.1 Concrete and its reinforcement.

Timber should have adequate natural durability or be preservative treated in accordance with Chapter 3.3 Timber preservation (natural solid timber).

Steelwork should have protective coating in accordance with Chapter 6.5 Steelwork.

Light steel frame should have corrosion protection in accordance with Chapter 6.10 Light steel framed walls and floors.

11.3.4 Structural design checking and certification

Contact us: **operationssupport@nhbc.co.uk**

Design of the superstructure shall be adequately checked by an appropriate NHBC registered volumetric frame certifier.

Homes with a volumetric frame superstructure require certification confirming that the design has been checked by an NHBC registered volumetric frame certifier.

The certifier should:

- be listed on NHBC's list of volumetric frame certifiers
- be a suitably qualified civil or structural engineer with relevant experience in volumetric construction
- not be the designer of the volumetric frame or be employed by the same practice
- check supporting details and calculations
- complete and sign a certificate confirming assessment of structural adequacy for each specific project
- provide the registered builder with the completed and signed certificate.

The registered builder should ensure that the completed certificate is available on site for inspection by NHBC.

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- if you require contact details of volumetric frame certifiers, or
- to apply to become a volumetric frame certifier.

11.3.5 Behaviour in relation to fire

Volumetric systems shall have adequate fire resistance and resist the spread of fire and smoke in accordance with Building Regulations. Issues to be taken into account include:

1) **cavity barriers and fire-stopping**
2) **services**
3) **fire resistance of the unit**
4) **movement.**

Guidance within supporting documents to the Building Regulations should be fully considered in the design and construction of volumetric systems.

The design and System Manual should clearly define:

- the overall fire protection strategy of the system
- which elements of fire protection are either factory or site installed.

11.3.5.1 Cavity barriers and fire-stopping

The provision and installation of cavity barriers and fire-stopping should:

- be specified to accommodate design, manufacturing and installation tolerances
- be in accordance with the Building Regulations and the design
- be designed to accommodate ventilation or drainage paths
- be used in accordance with manufacturers recommendations
- account for movement in the frame.

Detailing and specification of cavity barriers and fire-stopping should be in accordance with the manufacturer's recommendations and supported with representative test evidence.

Moisture protection should be provided to horizontal and vertical cavity barriers.

Where cavity barriers or fire-stopping cannot be easily replaced they should be specified in accordance with the design life of the building.

Buildings incorporating volumetric units may have significant concealed cavities between units. The building design should consider appropriate subdivision of cavities at horizontal and vertical junctions of volumetric units and between volumetric units and surrounding construction. Fire-stopping should be provided where necessary at junctions, to complete lines of compartmentation.

Factory installed cavity barriers or fire-stopping may be damaged or dislodged during the transportation or installation of volumetric units on site. Manufacturers and installers should allow for suitable access to inspect and verify concealed cavity barriers and fire-stopping post-installation.

When providing cavity barriers and fire-stopping:

- fire-stopping should be specified and sized to accommodate dimensional and installation tolerances of the unit
- gaps between compartments should be sealed
- presence of temporary weather protection membranes should not affect the performance, and should be removed unless tested or approved by the design.

At compartment walls fire-stopping should be provided to seal any gaps between the underside of units and the tops of foundations or substructure walls.

11.3.5.2 Services

Only the services shown in the design should be installed in volumetric system floors and walls, and:

- service outlets should not impair the fire resistance of floors and walls
- service mains should not pass through separating wall cavities.

11.3.5.3 Fire resistance of the unit

All building elements should have adequate fire resistance in accordance with Building Regulations, supported with representative test evidence and supporting engineering assessments to appropriate standards.

The design should specify:

- whether primary structural members require individual encasement or are protected by fire-resistant linings to the wall, floor, or ceiling frame
- details of junctions of secondary attachments to the primary structural frame and how fire resistance is maintained
- details of service openings, voids, and penetrations
- details demonstrating that columns and beams, where provided, are protected on all sides for the full height or width, including connections to other structural members, and how protection is maintained where the members extend through a ceiling or floor voids.

Where units join together and continuous linings are required or where access points are left open to facilitate connections, internal fire-resisting linings should be:

- installed with minimum laps in accordance with manufacturer's recommendations, or
- in accordance with the design and supported with representative test evidence to appropriate standards.

11.3.5.4 Movement

Fire-stopping should be specified and designed to accommodate anticipated movement in the building structure.

Where units are connected to surrounding construction, differential vertical movement should be considered in the design and specification of suitable fire-stopping and cavity barriers.

Non-loadbearing infill walls within volumetric units should accommodate anticipated deflection within the primary frame in accordance with the design. Should these walls be fire resisting, detailing at the head should be such that performance in this regard is not compromised.

11.3.6 Acoustic performance

Also see: Chapters 6.3 and 6.4

Volumetric system walls and floors shall have adequate resistance to the passage of sound.

Separating walls and floors

Separating walls and floors should be in accordance with Building Regulations and the design. Care should be taken to avoid gaps:

- between mineral wool quilt or batts
- between internal lining board layers
- between cavity barriers
- around openings for services.

Walls and floors in volumetric units will commonly be of complex construction and independent test evidence of acoustic performance or assessment by a suitably qualified expert should be provided prior to construction and detailed in the System Manual. Values derived from partition manufacturers data may not be appropriate to determine the sound performance of the wall construction where additional structural elements are included in the wall, or the panel serves as an infill.

Bedrooms and rooms containing a WC

The construction of internal walls should comply with Building Regulations, including the recommended sound reduction between bedrooms and rooms that include a WC and:

- living rooms
- dining rooms
- studies
- bedrooms, except where the WC is an ensuite serving that bedroom.

Proprietary partitions

Proprietary partitions should be independently assessed or tested for ‘sound transmission’ performance in compliance with Technical Requirement R3.

Sound insulation of SVPs and soil pipes in floor voids

All soil pipes running horizontally through a floor void above or below a habitable room should be wrapped in at least 25mm of mineral wool (10kg/m³ min) and be adequately supported to avoid contact with the floor decking or ceiling.

Sound insulation should be provided to soil pipes passing through homes by an encased boxing, using lining materials (minimum 15kg/m²) and wrapping the pipe with a minimum 25mm of unfaced mineral fibre (10kg/m³ minimum). The insulation should be continued through the thickness of each sound-insulating floor).

11.3.7 Differential movement

Also see: Chapters 6.2 and 6.10

Buildings formed using volumetric systems shall account for differential movement between the frame and other building elements or supporting structures.

Where volumetric units connect to surrounding construction and differential vertical movement is expected, consideration should be given to:

- the design of joint details and accommodation of differing floor levels at thresholds, staircases and lift shaft enclosures
- service entries and risers
- design and provision of suitable weather resistant and durable joints
- interface of self-supporting cladding and cladding attached to the unit
- design of connection brackets, anchors, and ties to accommodate movement.

Timber frame volumetric

Where the primary structure of volumetric units is timber, it will shrink as the timber dries out, reducing the overall height. In some cases the expected shrinkage can be greater than that of traditional platform framed timber buildings due to the form of construction. The extent of the differential movement increases with the number of storeys, and the design should allow for differential movement between the volumetric units and other parts of the construction, including:

- door and window openings
- eaves and verges
- balconies (including Juliet balconies)
- service entries, risers and fixed vertical external services
- openings for drive throughs
- staircases and lift shaft enclosures (where they are not timber framed)
- the interface of the timber volumetric unit with any other construction at each floor level where cladding is fixed to the unit.

For timber frame volumetric structures the shrinkage and associated gap sizes to accommodate differential settlement should be subject to specialist calculation.

Where claddings are factory installed and supported by the volumetric unit, consideration should be given to interfaces with self-supporting cladding.

Refer to Clause 6.2.8 for guidance on how to accommodate differential movement in traditional platform timber frame construction.

Light steel frame volumetric

The design for differential movement in light steel frame volumetric structures should be in accordance with the System Manual. Also see Clauses 6.10.20 and 6.10.21.

11.3.8 Protection from moisture

Also see: Chapters 5.1, 6.1, 6.2, 6.10 and 11.1

Volumetric systems shall be adequately protected from the effects of moisture. Details of volumetric systems at low level shall fully consider the durability of materials, protection of the building from moisture ingress and condensation as a result of thermal bridging. Issues to be taken into account include:

1) **cavities in external walls**
2) **protection at low level**
3) **DPCs, DPMs and cavity trays**
4) **junctions between adjoining units.**

Guidance on temporary weather protection can be found in Clause 11.1.5. Guidance on moisture management strategies for structural timber buildings can be found in Structural Timber Association publication ‘Moisture management strategy’.

11.3.8.1 Cavities in external walls

A clear cavity in accordance with Table 1 should be provided between the cladding and insulation.

Table 1: Minimum cavity widths

Cladding	Cavity width
Masonry	50mm
Render on board background	25mm
Vertical tile hanging(1) where a breather membrane is provided and fixed to sheathing	Dependant on batten support layout and spacing(1)
Other cladding(1)	See Chapter 6.9 Curtain walling and cladding

Note
1. See Chapter 6.9 Curtain walling and cladding.

Cavities should be:

- drained (for light steel frame backing walls)
- extend at least 150mm below DPC
- drained and vented (for timber frame backing walls)
- be kept clean, free from obstructions and capable of draining freely.

Timber frame backing walls

Cavities to volumetric units with a timber frame backing wall should be in accordance with Clause 6.2.10.

Light steel frame backing walls

Cavities to volumetric units with a light steel frame backing wall should be in accordance with Clause 6.10.16.

11.3.8.2 Protection at low level

Timber frame walls

The lowest timber should be a minimum of 150mm above finished ground level. This may be reduced to 75mm in situations where the site is not subject to a high-water table or where the cavity will not have standing water.

DPCs should be installed below the sole plates of ground floor walls and internal partitions.

Where external ground levels are raised locally to accommodate accessible entrances, consideration should be given to the following:

- appropriate drainage installed along the perimeter or ground falling away from the building
- adjacent surface finishes which do not promote splashing
- additional cavity ventilation either side of raised ground levels
- use of a 'kerb' to raise level of timber frame elements.

Light steel frame walls and floors

The base rail of LSF should be kept a minimum of 150mm above the external ground level (or waterproofing layer of a flat roof, balcony, or terrace) and cavity fill.

DPCs should be installed underneath the full width of the lowest section of framing, eg all ground floor walls and internal partitions, to protect the steel from corrosion due to moisture.

Locally raised ground levels (up to the internal floor finish) to less than 15% of the external perimeter (of an individual building, eg row of terraced homes, apartment blocks and detached garages, measured on plan) to accommodate level thresholds can be accepted. The cavity should be kept clear and allow drainage. Wall insulation should overlap the base rail by a minimum of 150mm.

Where the base rail or lowest steel is less than 150mm above ground level:

- light steel frame should be in accordance with Clause 6.10.16b
- hot rolled steel components should have a factory-applied protective coating system in accordance with Clause 6.5.3.

11.3.8.3 DPCs, DPMs and cavity trays

Damp proofing should:

- be installed correctly to provide a physical barrier to the passage of water, and to ensure water is directed to the outside
- use only appropriate tapes and sealant (but not solely rely on sealant) in accordance with the design and manufacturer's recommendations
- use DPCs/DPMs where necessary, including junctions between systems and any other component or systems.

DPCs

The following materials are acceptable for use as DPCs:

Bitumen-based materials	BS 6398, BS EN 14967
Polyethylene (except as cavity trays in walls, below copings and in parapets)	BS 6515, BS EN 14909
Proprietary materials	Technical Requirement R3
Thermoplastics and Elastomers	BS EN 14909

DPMs

Where DPMs are required, they should be linked with any DPCs in the supporting structure, in order to provide continuous protection from moisture from the ground or through the supporting structure.

DPMs should be properly lapped in accordance with Chapter 5.1 Substructure and ground-bearing floors.

Suitable materials for DPMs include:

- 1,200-gauge (0.3mm) polythene sheet
- minimum 1,000-gauge (0.25) polythene sheet where assessed in accordance with Technical Requirement R3
- bitumen sheet to BS 6398
- proprietary materials assessed in accordance with Technical Requirement R3.

Cavity trays
Cavity trays should be provided at all interruptions to the cavity (eg window and door openings and air bricks) and abutments unless otherwise protected (eg by overhanging eaves) or alternative means of protection are provided (eg profiled metal flashings) such as part of a proprietary cladding system.

Clause 6.1.17 contains further guidance on the installation of cavity trays in masonry cladding.

The following materials are acceptable for use as cavity trays:

- plastic and rubber to BS EN 14909 and hold satisfactory assessment by an appropriate independent technical approval's authority accepted by NHBC
- proprietary materials as part of a cladding system holding satisfactory assessment by an appropriate independent technical approvals authority accepted by NHBC.

11.3.8.4 Junctions between adjoining units

At junctions of volumetric units or between volumetric units and surrounding construction, particularly where they incorporate factory installed external claddings, consideration should be given to:

- providing suitable access to install breather membranes and achieve minimum laps
- providing suitable access to adequately link DPCs and DPMs in the substructure
- use of appropriate tapes and sealant (but not solely rely on sealant) in accordance with the design and the manufacturer's recommendations
- design of suitable cladding joints in accordance with the manufacturer's recommendations
- interaction of cavity barriers and cladding joints
- use of damp proofing materials which are compatible with adjoining components.

Connections between volumetric units and between volumetric units and surrounding construction should be designed to avoid the risk of fixing through and thus puncturing or damaging AVCLs or breather membranes.

11.3.9 Insulation

Also see: Chapters 6.2 and 6.10

Insulation shall be suitable for the intended use, correctly installed, and be of a suitable material and thickness to comply with Building Regulations and reduce the risk of surface and interstitial condensation.

Insulation should be:

- in accordance with the design
- installed correctly to minimise the risk of thermal bridging, surface, and interstitial condensation
- installed in accordance with the manufacturer's recommendations.

The System Manual and design should include control measures to mitigate risk of slump of non-rigid insulation during transport and site installation.

Where insulation is to be installed to the external/cavity face of the frame, workmanship and tolerances of external walls, particularly at panel joints, should be maintained to minimise:

- reducing the width of clear cavities
- gaps between insulation boards
- ledges between insulation boards forming moisture traps.

Timber frame backing walls
Insulation to volumetric units with a timber frame backing wall should be in accordance with Clause 6.2.15.

Light steel frame backing walls
Insulation to volumetric units with a light steel frame backing wall should be in accordance with Clause 6.10.17.

11.3.10 Junctions and interfaces

Also see: Chapters 6.2 and 6.10

Junctions and interfaces shall be suitably detailed, built to appropriate tolerances and provide satisfactory performance.

The use of volumetric units, particularly where finished linings or claddings are installed will introduce junctions and interfaces between adjoining units that are not common in traditional construction.

The junctions of volumetric units should be designed with appropriate tolerances to avoid excessive deviation:

- to external faces of adjacent units, which may impact cavity widths, installation of insulation and cladding as well as performance of cavity barriers or fire-stopping
- to internal faces of adjacent units, which may impact continuity of acoustic or fire-resisting linings or installation and fit of surrounding construction (eg staircases).

Spatial tolerances are critical for the performance of joints, details, and interfaces. The design should:

- include dimensions and the permissible deviation clearly indicated in the System Manual and on relevant drawings
- allow for adjustability to accommodate the tolerances for manufactured units and range of deviation in site construction in the form of levelling bolts, bracket systems and detailing allowing horizontal and vertical adjustment.

The manufacturer and designer should consider:

- guidance on jointing methods for structures, claddings, openings, and services passing through building elements given in BS 6093
- undertaking of mock-ups or trials to ensure satisfactory fit and tolerances can be achieved.

Foundations

Foundations should be installed to tolerances in accordance with the System Manual. The foundation tolerances should consider:

- level of foundation
- straightness of foundations
- dimensional tolerance
- level between foundation and substructure brickwork
- squareness of foundations.

Floors

Interfaces of floors at unit junctions should be designed to achieve necessary tolerances to allow installation of floor coverings. Interfaces of floor decking may either be designed as a butt joint or by using a transition piece to accommodate minor tolerances between decking finishes.

Floor interfaces should:

- have a nominal 3mm gap at decking joints
- filled with an appropriate gap filler or covered with a cover strip
- be kept clear of debris
- not exceed 2mm level difference between floor decking at any position.

11.3.11 Cladding

Also see: Chapters 6.1, 6.2, 6.9, 6.10 and 9.1

External claddings shall be suitable for their intended purpose, have suitable junctions and interfaces to resist the penetration of water and wind, be suitably durable and have an acceptable finished appearance. Issues to be taken into account include:

1) **junctions and interfaces between cladding types and adjoining units**
2) **movement**
3) **continuity of insulation, breather membranes and AVCLs**
4) **tolerances**
5) **finished appearance.**

Masonry external cladding should be in accordance with Chapter 6.1 External masonry walls.

Lightweight external claddings, whether factory or site installed, should be:

- in accordance with Chapter 6.9 Curtain walling and cladding
- compatible with the framing system
- supported by systems assessed in accordance with Technical Requirement R3 which ensure that cladding design loads are effectively and safely transferred to the building structure.

Further guidance on render onto board backgrounds can be found in Clause 6.11.8.

The design and construction of cladding to external walls should consider:

- durability
- cavity drainage
- differential movement
- restraint
- performance in relation to fire.

Timber frame backing walls
Further guidance on the use of masonry and lightweight claddings with timber frame walls can be found in Chapter 6.2 External timber framed walls.

Light steel frame backing walls
Further guidance on the use of masonry and lightweight claddings with light steel frame walls can be found in Chapter 6.10 Light steel framed walls and floors.

11.3.11.1 Junctions and interfaces

Junctions and interfaces, including those between factory installed lightweight cladding systems to adjoining units, and those between lightweight cladding systems and other elements of the building, should be carefully designed and detailed to be weather resistant, and prevent moisture reaching parts of the wall it could adversely affect.

The design should take account of:

- differing profile characteristics
- movement
- design of suitable interfaces between differing cladding types
- tolerances and deviation
- the erection sequence.

For lightweight cladding finishes applied to an insulation backing, the use of small infill pieces at unit junctions or differing types of backing insulation (eg to form cavity barriers or fire-stopping at compartment lines) should be detailed in accordance with the manufacturer's recommendations and within the scope of certification by an independent technical approvals authority acceptable to NHBC.

11.3.11.2 Movement

Movement joints to masonry cladding should be in accordance with Clause 6.1.3. Refer to Clause 6.2.8 for further guidance on accommodating movement in masonry cladding to timber frame structures, and Clause 6.10.20 for masonry cladding to light steel frame structures.

Lightweight claddings
Where lightweight or self-supporting cladding is used movement joints should be provided where required by the design.

Movement joints should be:

- formed in accordance with the cladding system manufacturers' recommendations
- positioned to accommodate calculated movement
- continued through the depth of the cladding.

Accommodation of differential movement should be made at floor zones between lightweight cladding.

11.3.11.3 Continuity of insulation, breather membranes and AVCLs

Junctions and interfaces of adjoining units or units with surrounding construction should be carefully designed and detailed to ensure continuity of insulation, breather membranes and AVCLs.

The design should:

- ensure adequate laps of membranes or provision for suitable method of sealing in accordance with manufacturer's recommendations
- make allowance for secure fixing of insulation, including at panel junctions, to the support frame or wall.

11.3.11.4 Tolerances

Where factory installed lightweight claddings extend to the edges of units, the cladding interfaces should meet the following tolerances unless specified otherwise by the design:

- be adequately straight in elevation, with a maximum ± 6mm deviation from nominal design width in any unit edge width or height up to 3m (see Figure 1)
- a maximum of 5mm from plumb or level in the overall interface joint between units (see Figure 2)
- a maximum deviation of 6mm in plan or section between faces of adjoining units (see Figure 3)
- a maximum deviation of 6mm in elevation between in-line edges across a transverse or cruciform interface joint (see Figure 4).

Figure 1: Straightness of interface joint widths

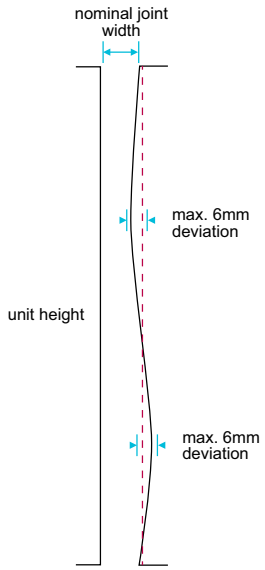


Figure 2: Taper of interface joints

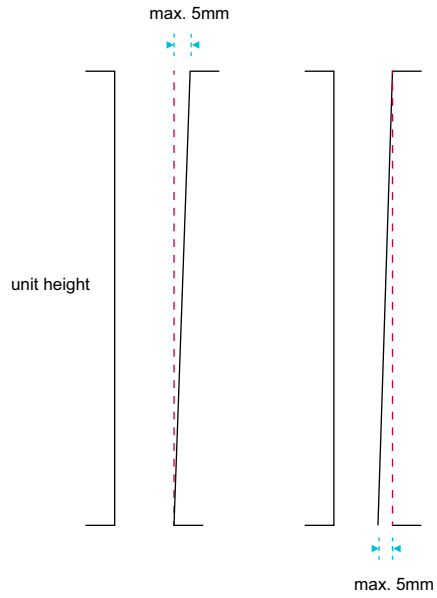


Figure 3: Offset of cladding faces

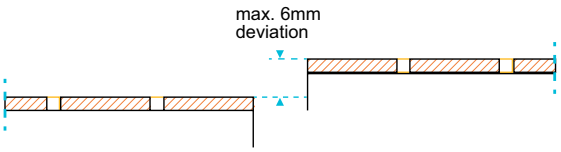
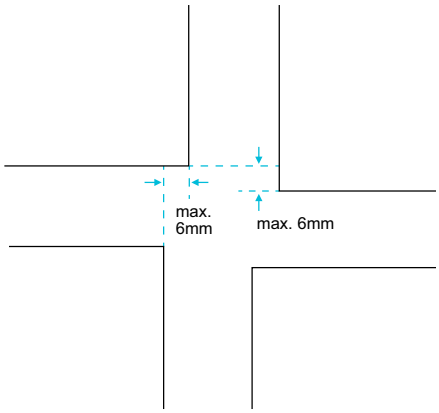


Figure 4: Accuracy of cruciform interface joints



11.3.11.5 Finished appearance

Tolerances and finishes for factory installed external claddings should be in accordance with Chapter 9.1 A consistent approach to finishes.

Brick slip cladding

Factory installed brick slip claddings should be set out to co-ordinate with adjacent units and surrounding construction to avoid:

- cutting of brick slips, particularly in the storey heights, at corners, around openings, and at panel edges except when it is essential
- irregular or broken bonds of brick finishes, particularly at openings
- small cuts of brick finishes
- broken bond and out of line joints at junctions of panel and junctions with surrounding construction (eg substructure brickwork).

Care should be taken to ensure the finish specification of mortar used for site installed brickwork is the same as used for factory installed brick slip claddings to avoid variation in the texture, finish, and colour.

Weatherboard cladding

Factory installed weatherboard cladding should be set out to co-ordinate with adjacent units and surrounding construction to avoid:

- cutting and notching cladding boards around window and door openings
- misaligned cladding boards at panel junctions.

11.3.12 Doors, windows, and glazing

Also see: Chapter 6.7

Doors, windows, and glazing shall comply with the Technical Requirements and be designed and specified to ensure adequate in-service performance.

Doors, windows, and glazing should be designed, specified, and installed in accordance with Chapter 6.7 Doors, windows and glazing.

The specification of fixings for doors and windows should be adequate to resist the effects of vibration and loads imposed during storage, transport and installation.

Adequate protection against damage should be provided to factory installed doors and windows, particularly where protruding from the face of the unit.

11.3.13 Staircases

Also see: Chapter 6.6

Staircases shall comply with the Technical Requirements and be designed to ensure adequate safety and performance.

Staircases should be designed, specified, and installed in accordance with Chapter 6.6 Staircases.

Wall linings should be continuous behind the string of staircases.

Fixing connections should be coordinated to ensure fire protection continuity and structural adequacy.

Where staircases are factory installed into volumetric units, consideration should be given to construction tolerances and the potential for differential vertical movement when designing connections to upper units. Landings should be framed to provide full support and solid fixings for the tops of flights, nosings, newels, apron linings, etc.

Suitable access should be provided to facilitate final installation of staircases and connection to upper units on site, including any necessary fixings or supports required.

The top nosing of staircases should be:

- level with the floor decking
- fixed firmly.

11.3.14 Air and vapour control layers

Air and vapour control layers shall be designed and installed correctly to restrict the passage of water from within the home to the structural frame.

Where they are provided, AVCLs should be:

- 500g polyethylene sheet, vapour control plasterboard, or material assessed in accordance with Technical Requirement R3
- in accordance with the design
- overlapping the base rail
- fixed on the warm side of the wall insulation and frame
- placed to cover the external wall, including base rails, head rails, studs, lintels, and window reveals
- taped or sealed in accordance with the manufacturer's recommendations and punctures made good
- sealed around service penetrations.

Air and vapour control layers should be:

- stapled at 250mm centres to the top and bottom of the frame, at laps and around openings to closed panel timber frame
- fixed with double-sided tape or adhesive as a temporary fixing before the wall board is fixed to closed panel light steel frame backing walls.

Joints in air and vapour control membranes should:

- have 100mm minimum laps
- be located on studs or noggings.

Where vapour control plasterboard is used:

- joints between sheets should be positioned on studs or noggings
- joints should be filled, taped, and finished
- care should be taken not to displace the vapour control material when cutting vapour control plasterboard.

The junctions of volumetric units, particularly where the junction includes back-to-back internal walls, should be carefully designed to ensure the continuity of air and vapour control layers.

Where internal linings are factory installed to volumetric units, provision should be made to allow adequate access to achieve correct lapping and sealing of air and vapour control layers at unit junctions when installed in the final position on site.

Light steel frame backing walls

A high resistance air and vapour control layer should be provided, unless a condensation risk analysis shows that it is not necessary, and the air and vapour control function is being provided by another solution complaint with NHBC Technical Requirements. Modelling where appropriate should be undertaken in accordance with BS EN ISO 13788 or BS EN 15026. The following boundary conditions should be used for the purposes of calculation to BS EN ISO 13788:

- at 21ºC internally
- at -2ºC externally
- >60% internal RH.

Multiple layers of AVCL-type material through the thickness of the element should be avoided, except where condensation risk analysis shows it to be acceptable.

11.3.15 Breather membranes

Breather membranes shall be correctly installed to protect the sheathing and frame from external moisture, and capable of allowing vapour to pass into the cavity.

Breather membranes should be:

- vapour resistant to less than 0.6MNs/g (0.12 Sd) when tested in accordance with BS EN ISO 12572 using the set of conditions C and using five test specimens
- at least Class W2 to BS EN 13859-2 with no water leakage during testing. In areas of very severe exposure (see Clause 6.1.6 for classification of exposure zones) or where liquid water penetration of the cladding is anticipated, for example open-jointed cladding, Class W1 should be used. When open-jointed claddings are used or the membrane likely to be left exposed during construction for a duration longer than normally to be expected (also see the membrane manufacturers recommendations on exposure times), performance should be based on artificial aged behaviour in accordance with BS EN 13859-2. Where a vented and ventilated cavity with full rainscreen and no gaps, for example masonry or rendered board claddings, are used, performance should be based on artificial aged behaviour in accordance with BS EN 13111
- self-extinguishing
- fixed so that vertical joints are staggered where possible, and at regular intervals, to prevent damage by wind
- installed so that each joint is protected, and moisture drains outwards
- lapped so that upper layers are over lower layers to ensure rain runs away from the sheathing
- lapped to a minimum of 100mm at horizontal joints and a minimum of 150mm at vertical joints
- fixed at a maximum spacing of 600mm horizontally and 300mm vertically
- fixed at a maximum spacing of 150mm around openings
- marked with stud positions for wall tie fixing
- applied using austenitic stainless-steel fixings
- repaired or replaced before proceeding with the cladding, if damaged
- durable and adequately strong when wet, to resist site damage
- capable of resisting water penetration.

Only tapes and sealants in accordance with the design and the manufacturer's recommendations should be used for sealing of membrane joints.

Light steel frame backing walls

Breathable membranes should be used to protect sheathing boards and insulation. Breather membranes may be omitted where water resistant insulation boards with taped joints are used. Tape should be of a type recommended by the insulation manufacturer, breathable to allow water vapour to move freely and resist water penetration. Suitable taping should be applied at the lintel interfaces and other penetrations to direct water outside.

11.3.16 Sheathing boards

Also see: Chapters 6.2 and 6.10

Sheathing boards shall be durable and suitable for their intended purpose.

Where they are required, sheathing boards should be:

- of a suitable strength and quality
- compatible with the frame
- attached using suitably specified and durable fixings.

Sheathing boards contribute to many functions critical to the performance of the system and building and cannot be easily replaced, so should comply with Technical Requirement R3.

Timber frame backing walls

Sheathing boards to volumetric units with a timber frame backing wall should be in accordance with Clause 6.2.7.

Light steel frame backing walls

Sheathing boards should be appropriate for the exposure of the building and suitable for use in humid conditions.

Sheathing boards to volumetric units with a light steel frame backing wall should be in accordance with Clause 6.10.20.

11.3.17 Wall ties

Wall ties and fixings shall adequately connect the cladding to the frame.

Wall ties and their fixings should be:

- compliant with BS EN 845-1
- fixed to studs and not the sheathing
- in accordance with and of the type specified in the design
- of austenitic stainless steel or assessed in accordance with Technical Requirement R3
- kept clean and free from mortar droppings
- inclined away from the sheathing so that the slope is maintained following differential movement
- capable of accommodating differential movement
- installed at a minimum density of 3.7 ties/m^2 for masonry cladding, eg spaced at a maximum of 600mm horizontally and 450mm vertically
- spaced at jambs of openings and at movement joints at a maximum of 300mm vertically and within 225mm of the masonry reveal or movement joint; additional studs may be needed
- spaced within 225mm of the top of the wall, including at gables.

11.3.18 Services

Also see: Chapters 6.2, 6.10 and 8.1 to 8.6

Internal services shall comply with the Technical Requirements and be in accordance with statutory requirements. Issues to be taken into account include:

1) **installation**
2) **recording of factory testing and commissioning**
3) **access for site connections, inspections, and commissioning.**

All service installations should be designed and installed in accordance with Part 8 Services.

The design and System Manual should clearly define:

- how design, manufacturing and installation tolerances are accommodated
- which services are factory installed and which are site installed
- designer responsibilities for factory installed and site installed elements and overall coordination.

Service mains and service outlets should be:

- designed to ensure the fire resistance of walls and floors is not impaired
- designed to ensure that the required sound insulation of walls and floors is maintained
- installed in accordance with the design
- on the warm side of the insulation
- designed to accommodate differential movement where required.

Careful positioning of service pop-ups and entry points is required to align with service entry points and factory installed services to volumetric units. A pre-installation survey should be undertaken prior to installation of units.

11.3.18.1 Installation

Prefabricated wiring systems should be tested and installed in accordance with BS 8488. The manufacturer should provide details of whether any or all of the connectors within the prefabricated wiring system should be accessible for inspection, testing and maintenance.

Timber frame walls and floors
Services installed in volumetric units with timber frame walls and floors should be in accordance with Chapter 6.2 External timber frame walls and Chapter 6.4 Timber and concrete upper floors.

Light steel frame walls and floors
Services installed in volumetric units with light steel frame walls and floors should be in accordance with Clause 6.10.22.

11.3.18.2 Factory testing and commissioning

The method of testing and commissioning of factory installed services should be detailed in the System Manual.

Pressure testing of factory installed water supply, gas supply, heating and waste pipework should be undertaken where practicable. Exposed ends of all pipework should be sealed to prevent contamination and protected to prevent damage.

Appropriate performance and safety testing should be undertaken to factory installed prefabricated wiring systems in accordance with BS 8488.

Written records should be provided for testing undertaken to factory installed services and included in system verification documentation.

11.3.18.3 Access

Where access is required to connect service mains through walls or floors, a suitable method should be detailed in the System Manual for making good the access point in accordance with the design to maintain the fire, sound, air, thermal, and moisture resistance of the structure.

Consideration should be given to:

- providing adequately located and sized access points to install, test and commission service connections on site
- provision of suitable information in the handover file where access points are to be permanently sealed (such as behind a tiled wall), to allow future users access in the event of a fault or for routine maintenance.

Consideration should be given to providing access for inspection or maintenance or a leak detection system where concealed riser voids contain water supply pipework.

11.3.19 Further information

- *Structural Timber Association — Moisture management strategy*

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