Scottish Building Standards Futures Board

Technical Strategy

Modern Methods of Construction (MMC): Guidance for Building Standards Verification

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Contents

1. Introduction

1.1. Purpose of the document

The purpose of this document is to provide guidance to Local Authority verifiers and Certifiers as defined under the Building (Scotland) Act 2003 when assessing building warrant applications and certifying works which use Modern Methods of Construction (MMC) and when assessing the compliance of MMC buildings during construction with the building warrant approved drawings and regulations.

The building standards system is pre-emptive, ensuring as far as possible that the proposed works will comply with the regulations prior to work commencing on-site. Verifiers check that building plans comply with building regulations when an application is made for a building warrant. The system also requires the verifiers to undertake reasonable inquiry to verify that the building work complies with the approved plans, details and with the building regulations. However, verifiers do not inspect all materials and work on every building site as the responsibility for compliance with the building regulations sits with the relevant person (usually the owner or developer). The reasonable inquiry verifier role is to make inspections or other checks during the construction phase on a risk-based basis, to take account of building type and complexity and will, generally have due regard to developer type as well.

Certification of Design or Construction is an option available to building warrant applicants where approved suitably qualified and experienced building professionals and tradesmen can certify certain specified areas of works forming part of a building warrant as complying with the building regulations. Verifiers do not verify such certified areas of design and construction.

Certifiers of construction, where used, will require to certify MMC construction works on site that have been completed in a factory and will need to satisfy themselves as to these factory based works also being compliant and the risks and assurances as highlighted in the guidance is applicable. The current certifier of design schemes under the Building (Scotland) Act 2003 cover structure and energy and the current certifier of construction schemes electrical work, plumbing/drainage and heating installations

It should be noted that for MMC projects - as with all building warrant projects - the proposed design can only be approved if the verifier is satisfied that compliance with the regulations is demonstrated - including Regulation 8 - Durability, workmanship and fitness of materials.

1.2. What is MMC?

Modern Methods of Construction (MMC) encompass a wide range of offsite manufacturing and onsite assembly techniques. Use of MMC can vary from a kitchen or bathroom pod assembled offsite in a factory and transported to site – through to fully factory-built volumetric modules.

Other terms as well as MMC are often used interchangeably – including Modular Construction, Offsite Construction and Offsite Manufacture (OSM).

MMC are typically divided into different categories, as fully defined in the MMC Definition Framework[1], which relates to all types of pre-manufacturing[2], site-based materials and process innovation. The most commonly used are:

- 3D structural systems (MMC Category 1 - volumetric), which typically take the form of volumetric modular "boxes" which fully manufactured away from site and assembled on site. This is often called *3D modular construction.*

- 2D structural systems (MMC Category 2 – panellised), in which the two-dimensional frame of the building is manufactured away from site and assembled on site. This includes timber and steel frame solutions for instance. This is often called *2D frame construction.*

- 3D sub-assemblies (MMC Category 5), in which sub-sections of the building (but not the whole building) are manufactured away from sites. These typically include bathroom and kitchen pods for example. These are often called *3D pods.*

- Models that combine different categories of MMC, the most common of which is the combination of 2D frames and 3D pods. This is typically known as *hybrid MMC.*

This guidance relates to:

- Category 1: Volumetric
- Category 2: Panelised

[1] The MMC Definition Framework was published in 2019 and was an output of a specialist sub-group of the Ministry for Housing, Communities and Local Government (MHCLG)* MMC cross-industry working group, led by Mark Farmer. *Now the department for Levelling Up, Housing and Communities (DLUHC)

[2] Explained in the MMC Definition Framework as 'processes executed away from final workface, including in remote factories, near site, or on-site "pop-up" factories. The pass test is the application of a manufactured led fabrication or consolidation in controlled conditions prior to final assembly/install.'

1.2.1. Volumetric construction

Volumetric construction[3] is:

'The production of three-dimensional units in controlled factory conditions prior to final installation. Volumetric units can be brought to final site in a variety of forms ranging from a basic structure only to one with all internal and external finishes and services installed, all ready for installation.' and provide the greatest challenge to verify against approved plans and details on site by the usual visual verification inspection methods.

1.2.2. Panelised construction

Panelised construction[4] is:

'A systemised approach using flat panels used for basic floor, wall and roof structures of varying materials which are produced in a factory environment and assembled at the final workface to produce a final three-dimensional structure'.

Panelised construction describes a two-dimensional unit, typically manufactured offsite, which may or may not have a structural function. Panelised systems can have various levels of enhancement in the factory.

Open panels are most commonly used in Scotland – these are a skeletal structure, typically non-insulated with internal finishing and external cladding installed on site. Timber frame open panel kit construction is the most common form of construction for housing in Scotland and the open panel nature readily allows for verification inspections during the construction/assembly phase on site.

Closed panels are more complex in that there is a greater degree of factory-based fabrication, which may include lining materials, insulation, and potentially also services, windows, doors, internal wall finishes and external cladding.

Panels may be made using timber frame, StructuralInsulated Panels (SIPs) or mass timber systems such as Cross Laminated Timber (CLT). On building sites these are often referred to as 'timber kit' regardless of whether they are open or closed.

[3] All definitions and explanations are taken from the MMC Definition Framework
[4] All definitions and explanations are taken from the MMC Definition Framework

1.3. Structure of this guidance document

This document provides general points for consideration. It is then divided into a further 5 sections, aligning to the typical construction process and where the verifier role fits in, i.e.

- Building warrant assessment
- Factory assembly
- Transportation to site[5]
- On-site assembly
- Completion

For each of these stages, the guidance sets out potential risks pertinent to MMC for context, what should be considered as a consequence, and types of evidence or information a verifier could expect to see, what reasonable inquiry should include specific to MMC. References made to standards, accreditation and other types of evidence should be carefully considered alongside guidance in the Technical Handbooks.

[5] Whilst this is not the responsibility of the verifier, there is potential for damage to modules during transit which, if not adequately resolved, would have consequences for the safety, resilience and durability of the building once completed – so it is relevant to include here

2. General points

While this document provides high-level guidance, it should be noted that in the event of further queries relating to the verification of innovative or unusual constructions, opinion can be sought from LABSS.

It should be noted, when assessing applications that propose the use of MMC:

- Existing quality assurance standards[6], accreditation and relevant legislation are applicable to offsite construction in the same way as onsite construction[7], for example:

    - ISO
    - CE marking (under the Construction Products Regulation[8] or other EU Directives and Regulations)
    - British Standards
    - Codes of Practice
    - European Standards
    - Product certification schemes (certification body accredited by UKAS)

- Where possible, product standards which specifically assess/test/accredit MMC products or systems should be specified – **however** it should be taken into account that at the time of writing, there are a limited number of relevant standards.
- There are a number of accreditation schemes for MMC, however there is no universal certification scheme.

- There are two accreditations for the use of MMC which are most widely used in industry– Build Offsite Property Assurance Scheme (BOPAS) and NHBC Accepts. Both provide assurance that delivery has been undertaken to a set of defined processes, which have been assessed to meet their standards. In January 2021, the BRE launched its own accreditation scheme for MMC – BPS 7014. However, it should be noted that these accreditations have been designed to meet their own, self-set standards and they do not set out to align with the standards set in the Building (Scotland) Regulations 2004. Therefore, these accreditations alone are not sufficient to demonstrate compliance with the Scottish building regulations and standards.

- There are some processes which have been written specifically for the use of MMC – for example, RIBA/BSRIA Plans of Work and the BSRIA Design

[6] See Technical Handbook Appendix B for a full list. See also the Glossary of Terms at the end of this document.
[7] Building & Engineering Services Association (2015) An Offsite Guide for the Building and Engineering Services Sector
[8] Recognition of the CE mark will end and be replaced by UK marking using a UK-recognised approved body from 1st January 2023

Framework for Building Services[9]. While it is not essential that these processes have been used, applicants may wish to include evidence of adherence to these MMC specific processes as additional assurance.

Evidence of BOPAS, NHBC Accepts, or BPS 7014 accreditation should provide assurance that products and processes specific to MMC have been risk-assessed and subject to comprehensive inspection. The verifier will still need to be satisfied that there is sufficient evidence to demonstrate that the applicable building standards have been met in full.

- **The Scottish Type Approval Scheme**

The Scottish Type Approval Scheme (STAS) offers national approvals of standard building types, mainly aligning with the volumetric model of MMC where a design and specification will be replicated regardless of geographical location. STAS can also address a national approval of systems including innovative designs or building elements, prepared by designers and developers aligning both with volumetric and panelised MMC.

STAS is applicable for both domestic and non-domestic projects and is used to support building warrant applications in Scotland. STAS produces savings in time in the building warrant approval process, supports national consistency of assessment and may be particularly well suited to less familiar MMC products – allowing the main verification assessment process to take place before any building warrant is submitted.

STAS national approvals can also include conditions and wider information that may support and inform both the verification of design and the approach to reasonable inquiry onsite.

All Scottish Local Authority verifiers accept **STAS** approvals.

- **Fire Service Consultation**

The Scottish Fire and Rescue Service (SFRS) have an interest in certain types of MMC developments involving closed panel or volumetric construction beyond the current building warrant statutory consultations primarily in the interests of fire fighter safety in the event of a Fire (see Section 3.3)

[9] Building & Engineering Services Association (2015) An Offsite Guide for the Building and Engineering Services Sector

3. Building warrant assessment

3.1. Potential risks at the outset

Potential risks relating to the use of MMC to consider upon receipt of the building warrant application are:

Does the proposed MMC product achieve and evidence compliance with all the necessary building regulations and standards.

- MMC projects rely on Design for Manufacture and Assembly (DfMA), and therefore there is a risk that the design will not be fit for purpose if there is not sufficient consideration given to material/product size and weight for transportation prior to assembly. While this is a logistics rather than a regulatory issue, it is flagged here as damage during transportation could mean the design approved in the building warrant is compromised, potentially leading to non-compliance.

- There is a risk that the design will not be built as specified to meet the building warrant approved design if a design freeze is not imposed before manufacture commences in the factory. Such changes may not be readily identified on site particularly in the case of closed panel and volumetric units.

- Expert input may be needed at the design phase in relation to structural fire engineering. The insurance industry, firefighting, and fire safety bodies have flagged concerns about fire risks within MMC. While there is no strong evidence to suggest fires are more likely to occur in an MMC building (compared with a traditionally constructed building), if a fire occurs it could result in more severe consequences in an MMC building because of the typically greater occurrence of voids and cavities through which smoke and fire could travel rapidly if not adequately controlled. These risks should therefore be considered in the design, via detailed specification and testing that clearly demonstrates compliance with the building regulations, and also be considered within the development of the CCNP.

- The product specification and component use is required at building warrant, i.e., how it will be used and installed reflecting geographical location factors. For example, certain products/components require additional treatment if used in a particular region such as coastal or may require a particular type of installation depending on matters such as the building height and exposure.

- For high rise, the more compartments that are stacked on top of each other, the greater the potential risk is for cumulative error if the design and/or subsequent installation is not fit for purpose.

- Individual components and products are subject to testing, but innovative materials may not have been tested comprehensively to consider how a full system or module performs (in the event of fire; structural resilience; energy efficiency etc.). There is no mandatory requirement for performance testing of individual panels or full modules. Standard fire testing and approaches typically assess individual details and do not test connections i.e. how one module is connected to the floor. Volumetric systems are not tested in their entirety in a way that takes the height of the building into account.

3.2. Building warrant assessment: considerations for verifiers

Considerations:

- Is there sufficient and appropriate independent product testing beyond trade literature or manufacturers declarations which demonstrates compliance in accordance with Section 0.8 - Durability, workmanship and fitness of materials (Regulation 8).

- Additional testing of innovative materials and their use in combination may be needed to provide assurance of compliance with building regulations before approval can be considered, particularly in the areas of durability and fire safety.

- Is there evidence of the MMC system/product accreditation e.g., BOPAS, NHBC Accepts, BPS 7014.

- Is there evidence that products/components/systems specified meet the requirements of British or equivalent European standards at the time the application was made?

- Is there evidence of that products or systems are covered by an independent UKAS accredited[10] third-party approval body and there is evidence of the testing body accreditation.

- Are the products/components CE marked as required by the Construction Products Directive until 1st January 2023, or UKCA marked after that date.

- Is there evidence that product testing and certification has taken place in the context of its intended use i.e., tests are suitable for MMC rather than for traditional forms of construction.

- In the absence of appropriate testing, is there evidence of bespoke testing and certification (for example, BBA Certification).

- For timber frame panels, do panel systems have quality assured systems in place which are registered with the STA or BM TRADA?

[10] Or European equivalent accredited organisation

- For any Section 2 Fire or other 'alternative to guidance' solution, has this been developed by a suitably qualified professional with experience in the use of MMC.

- For innovative systems, whether fire testing has been undertaken against BRE loss prevention standard 1501[11]. This standard is intended to provide a fire test, performance and classification system for innovative building systems used in building construction. Fire test results from LPS 1501 may be used as evidence contributing towards compliance with the mandatory building standards.

3.3 Consultations with the Fire Authority (SFRS)

- In addition to the statutory building warrant consultations with the fire authority required under Section 11 of the Building (Procedure) (Scotland) Regulations 2004, the SFRS may have an interest in certain other MMC building warrant application beyond the types requiring statutory consultation.

- For example for buildings of closed panel, volumetric or innovative MMC construction, the SFRS invites consultation in line with Regulation 10 of the Building (Procedure) (Scotland) Regulations 2004 for MMC as above in the following circumstances and with the verifier stating if the consultation being for comment or being simply notification for awareness:

    - Domestic building or residential building with any storey at a height of more than 7.5 metres above the ground
    - Educational establishments (schools, colleges and universities), community/sport centres
    - Hospitals
    - Residential care buildings and
    - any other MMC buildings the verifier may think appropriate

All SFRS Consultations or Notifications should be via sfrs.fireengineering@firescotland.gov.uk

[11] https://www.redbooklive.com/download/pdf/LPS1501.pdf

4. Factory assembly

4.1. General

- The verification of building warrant construction works carried out in a factory potentially significantly remote from the construction site can be problematic and particularly in the case of closed panel and volumetric construction. During the onsite construction/assembly phase of a project, these methods by their closed panel nature reduce the opportunity for verifiers to readily inspect internalised construction hidden from view. Verifiers have visited factories for this purpose when practical/ considered necessary to do so.

- This section identifies potential risks and other assurance methods that may be considered.

- As indicated in Section 2, STAS is beneficial in achieving a national decision on compliance accepted by all 32 authorities appointed as verifiers. This outcome may be particularly beneficial if applied to the factory assembled process of MMC where the assessments can be carried out once at the geographical location of the assembly plant, through the STAS process rather than by 32 authorities.

4.2. Potential risks: manufacture and quality assurance in the factory

- There is a risk of product substitution[12] i.e., deviation from the drawings and details provided in the building warrant application.

- Defects in manufacturing may occur in the absence of a clearly defined and robust quality assurance process and other relevant controls.

- Bespoke systems may not have quality assurance procedures in place, making it more difficult to assess quality.

4.3 Factory assembly: considerations for verifiers and certifiers of construction

Considerations:

- Is there is evidence of quality-controlled systems for factory production (MMC accreditation such as BOPAS, NHBC Accepts would provide assurance that this has been assessed) which may provide evidence of compliance with design specification

- In the absence of MMC accreditation, is there is evidence of the factory's quality assurance and inspection processes and controls subject to review/audit – for example ISO 9001.

[12] This is an increasing risk at the time of writing (Q1 2022) in light of significant materials and products shortages in the supply chain

- Particularly in terms of closed panel and volumetric systems - do the quality-controlling systems in place provide sufficient evidence and assurance of building warrant compliant construction in areas that will not be available for inspection on site? A physical or virtual factory/process inspection or photography/videos may provide further assurances – see Section 4.1 General above.

5. Transportation to site

5.1. Potential risks when modules are in transit

- There is a risk of damage to the module during transportation, particularly if the design did not consider logistics, access to site, loading and the potential need for storage of the module once at site. Damage could affect fire stopping details which poses a major risk if not identified at the point of on-site assembly.

- There is a risk that water could enter the module either in transit (though this is unlikely if correct processes exist for packing of goods in the factory) or once the module arrives on site.

5.2. Transportation: considerations for verifiers

- Transportation is not in the scope of the verifier's work; however, the verifier may consider whether there is a need to seek assurance from the relevant person of suitable processes in place which check modules for damage or water entry, and actions which are taken to repair any issues.

6. On-site assembly

6.1. Potential risks during assembly

- There is a risk of incorrect alignment when modules are being assembled, which could compromise performance of fire barriers and overarching structural integrity of the building.

- Fire separation and compartmentation must be carefully undertaken to ensure fire performance is maintained at these junctions in line with the approved building warrant.

- Incorrect assembly sequencing creates a similar risk.

- The risk of product/component substitution is a risk on site as well as in the factory, which would result in deviation from the original design.

- Follow on trades could potentially damage placement of fire stopping details. Once modules are connected, it is not possible to undertake an inspection.

- Once modules are connected it is not possible to inspect correct installation e.g., of fire stopping details. If the verifier decides that a site inspection is necessary, this would need to take place prior to module connections. The verifier may also consider utilising alternative evidence e.g. photography or videography.

6.2. On-site assembly: considerations for verifiers and certifiers

The relevant person is responsible for building in accordance with the approved plans and building regulations by ensuring adequate professional supervision to confirm that the work (onsite and offsite construction) is compliant. This will enable the relevant person or duly authorised agent then to competently certify, sign and submit the completion certificate submission to the verifier. Verifiers make risk based inspections/checks during the construction stage of a building warrant project in line with national Verification during Construction (VDC) Guidance. Checks undertaken by the verifier will be influenced where a Certifier of Construction is being used.

Considerations:

- What site inspection or other checks are needed in line with Verification during Construction Guidance, and if so, consider carefully the timing of any early or intermediate stage inspection in this context.

- Is there is evidence that the original specification as designed, is being assembled on site. This may include photographic evidence to confirm the use of the specified materials and components.

- Is there is photographic evidence (showing the date) available of fire stopping details, wiring, and plumbing once installed, before modules were connected – to provide assurance they were correctly installed.

In the event that damage is detected during an inspection, the relevant person (owner or developer) should confirm the remedial action that will or has been taken to remedy any damage.

- In the event of any damage or other adaption/variation including component substitution, there is a need to validate that the design remains compliant (by checking with the Certifier of Design (or manufacturer).

- Any design changes should be validated by submitting an amendment of building warrant application evidencing compliance.

7. Completion

7.1. Completion: considerations for verifiers and certifiers

Considerations:

- Have all site inspections identified in the CCNP been carried out. Has alternative evidence as detailed, and as agreed by the verifier, been provided to demonstrate compliance for each of the identified stages. This may for example be demonstrated via a statement, photographs or video evidence from an inspection undertaken by a qualified professional before and after modules are connected e.g., Chartered Structural Engineer, Structural Fire Engineer, Design Engineer.

- Have all enabling works beyond the MMC product, such as foundations, barriers, drainage, electrics (not an exhaustive list) been evidenced to demonstrate compliance with the building warrant and inspections detailed in the CCNP.

- If the CCNP has not been achieved, for example due to lack of notification, disruptive inspections or other methods should be provided to give the same assurance as the fully fulfilled CCNP.

- Where SFRS has been consulted in accordance with Section 11 of the Building (Procedure) (Scotland) Regulations 2004 and there is a requirement for the verifier to send information to the fire authority under Sections 48 and 49 of the Building (Procedure) (Scotland) Regulations 2004, the verifier should also consider providing similar information to SFRS for MMC consultations made in line with this guidance under Section 10 of the Building (Procedure) (Scotland) Regulations 2004 (but not in the case of MMC notifications sent only for SFRS awareness).

- Is there evidence that connections between units have been undertaken correctly and used the specified materials, components and products as stated in the building warrant application? This may be provided via records of installation processes including photographs, or statements from qualified professionals.

8. Future Compliance Plan Approach

8.1. A strengthened approach to compliance

The Compliance and Enforcement Expert Review Panel was set up to support the Ministerial Working Group on Building and Fire Safety following the fire at Grenfell Tower and failings in the construction of Edinburgh School Buildings. The Panel's report highlighted a need to strengthen the Scottish Building Standards system and the Building Standards Futures Board was established in 2019 to oversee this work. The Compliance Plan (CP) is one of the seven work streams being taken forward by the Futures Board.

The CP work stream aims to provide greater assurance that the risk of non-compliance with the building regulations has been minimised. This will be achieved by considering compliance from the inception of a project through to its completion by requiring better evidence and documentation to be provided by the Relevant Person and the people they appoint to undertake the work.

Following support for the proposal during the public consultation which ran from November 2021 to February 2022, the proposals include the creation of a CP for all High Risk Building (HRB) projects by the Relevant Person and their appointed 'Compliance Plan Manager' (a new oversight role acting on behalf of the Relevant Person).

The CP will identify the risks on a project and set out the evidence needed, inspections to be undertaken and the CP Manager will oversee the CP to ensure it is fully discharged. It is expected that the CP Manager on HRB projects will be a suitably qualified and experienced construction professional.

A Compliance Plan Handbook (CPH) will also be developed providing guidance on this new strengthened approach to delivering building regulation compliant buildings in accordance with the approved building warrant plans and details. It is intended this MMC guidance document will be referenced within the CPH to inform and support the verification of buildings using MMC.

9. Glossary of terms

BBA	British Board of Agrément
BOPAS	Build Offsite Property Assurance Scheme
CE Mark	Conformité Européenne (European Conformity)
DfMA	Design for Manufacture and Assembly
ISO	International Organization for Standardisation
NHBC	National House Building Council
PMV	Pre-Manufactured Value
SIPS	Structural Insulated Panels
STAS	Scottish Type Approval Scheme
UKCA	UK Conformity Assessment
BRE	Building Research Establishment
BSRIA	Building Services Research and Information Association
CCNP	Construction Compliance and Notification Plan
CLT	Cross-Laminated Timber
MMC	Modern Methods of Construction
OSM	Offsite Manufacture
RIBA	Royal Institute of British Architects
STA	Structural Timber Association
UKAS	United Kingdom Accreditation Service

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