Brickwork and Modern Methods of Construction

Structual Guide
Last Updated: April 2023

BRICK DEVELOPMENT ASSOCIATION

The Brick Development Association

The Brick Development Association is the national authority on clay bricks and pavers.

The membership accounts for almost 99% of the bricks produced in the UK; the BDA members are commitment to manufacturing products of outstanding quality and developing one of the nation's most productive and sustainable supply chains.

The BDA Guides and Technical Guides are continually updated to take account of the latest materials, systems and products developed in the clay brick and paver sector.

We are grateful to our various team of experts, contributors, staff as well as our membership whose support, we are eternally grateful for.

Keith Aldis

Chief Executive Officer
Brick Development Association

Scope of Document
The BDA are committed to providing impartial and authoriative information.

We make every effort to ensure the accuracy and quality of information and guidance when it is published. However we can take no responsibility for the subsequent use of this information, nor for any errors or omissions it may contain.

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Denton (15), Ewhurst (20), Hartlebury (22), Kingsbury (26), Sandown (37), Smeed Dean (38), Todhills (43), Waresley (45), Warnham (46)

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Contents

Introduction 5
Definitions of MMC 6
Historic MMC 7

Slip Panel Systems
Individual Slips 8
Panel Systems 9
Rail and Tile 10

Precast Concrete 11
Pre-Fabricated Components 12
Robotics 13
Design & Specification 15
References & Further Reading 17

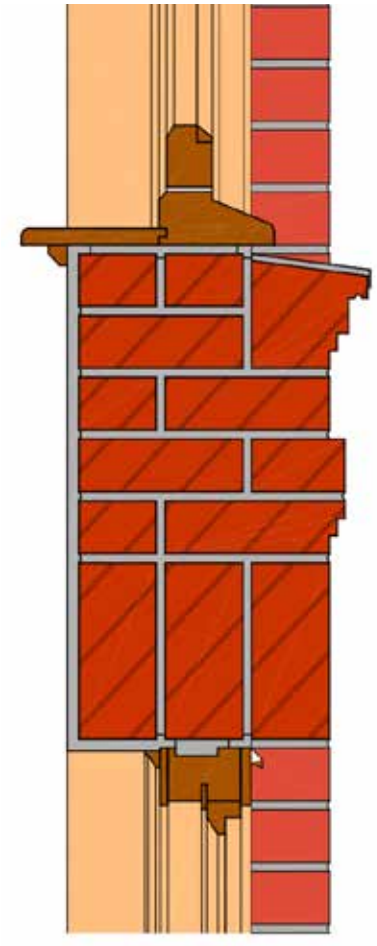
Introduction

In construction, there is a continuous desire to build projects of higher quality, on a shorter timescale and at a reduced cost. The Construction 2025 Strategy was created by the UK government in 2013, it is an ongoing initiative that amongst other targets, aims to reduce construction costs by a third and construction time by 50%. With British and European standards being consistently revised to improve all areas of construction, this will be no easy feat.

One of the key drivers identified to achieve these targets is the development and expansion of Modern Methods of Construction (MMC). Brick manufacturers have been at the forefront of developing MMC systems for several years.

Clay brick has undergone a dramatic transformation during the 20th century. From solid wall construction to the modern cavity wall, with improved levels of insulation and reduced water penetration

The future of clay brick is an exciting one, the ever-improving brick slips systems are at the forefront of what is currently possible to achieve in the sector. The technology associated with this construction method is fast, reliable and repeatable. Due to their modular, lightweight and slender designs, these solutions can be a fast and cost-effective method for erecting large amounts of sections in a short time span.



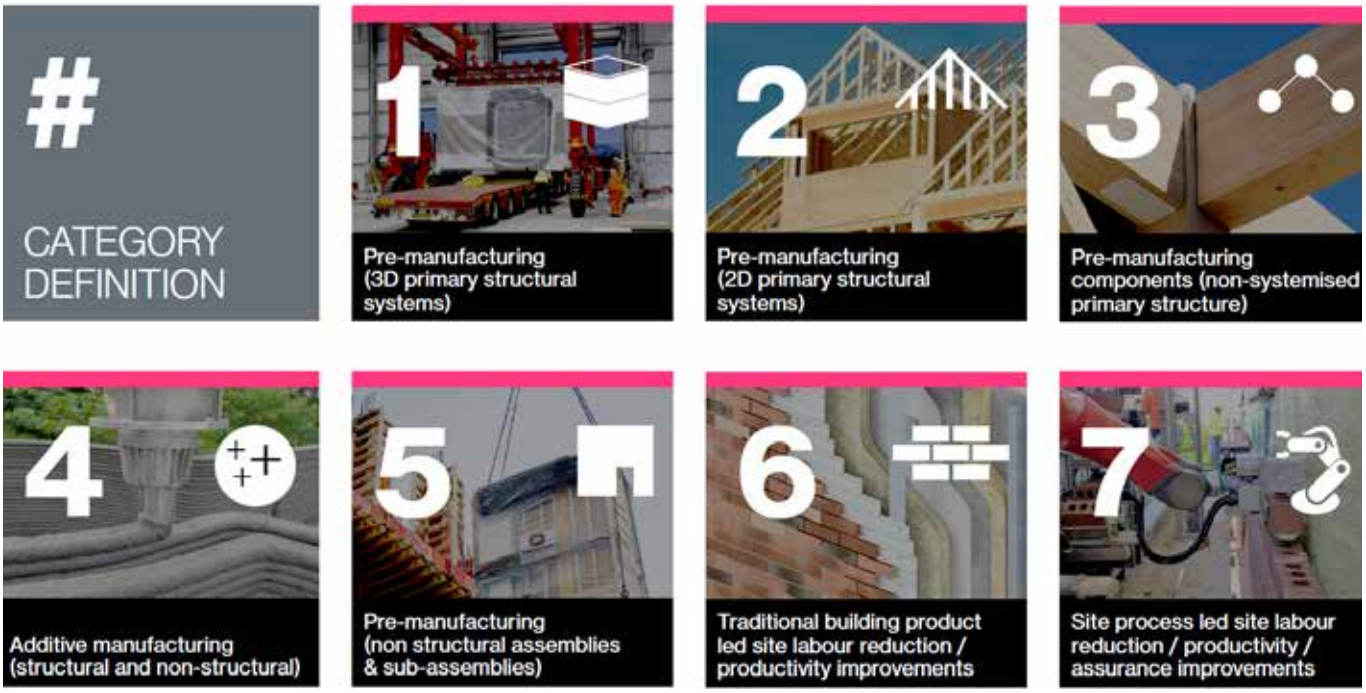
Traditional brick detailing

Modern Methods of Constructins (MMC) Definitions

Modern Methods of Construction Definitions

Historically the term Modern Methods of Construction (MMC) has been used as quite a loose term to describe all different types of construction systems, construction components and construction processes. MMC is not as well understood as the traditional construction trades.

The Government's Joint Industry Working Group on MMC have produced a definition framework to enable MMC within homebuilding to be better understood, with regularised terminology. The definition framework spans all types of pre-manufacturing, site based materials and process innovation.



Modern Methods of Construction, definition framework produced by MHCLG Joint Industry Working Group

Brickwork Modern Methods of Construction - Options

MMC is probably most widely understood as fabricating building components, in factories away from the site, but it can also cover a number of other systems and processes. The term 'pre-manufacturing' includes processes completed away from the final installed position, including in remote factories, near site or on-site 'pop up' factories. Brickwork solutions fall into a number of categories including:

Category 1 - pre-manufactured 3D primary structure with brick slips.

Category 2 - whole wall build up & brick faced pre-cast concrete sandwich panels.

Category 3 - pre-manufactured lintels & arches.

Category 5 - pre-manufactured chimneys, balconies, decorative panels & soffit systems.

Category 6 - site applied brick slip systems, panel systems & precast concrete panels.

Category 7 - brick laying robots

History of Brickwork MMC

General Cleaning Advice

Brick making was introduced to the UK by the Romans and their process for making and laying bricks would be recognisable to a modern day audience. One of the great selling points for brickwork is the long established reputation for durability and robustness.

Throughout the history of the brick there have been examples of the 'traditional' brick unit being developed for specific purposes.

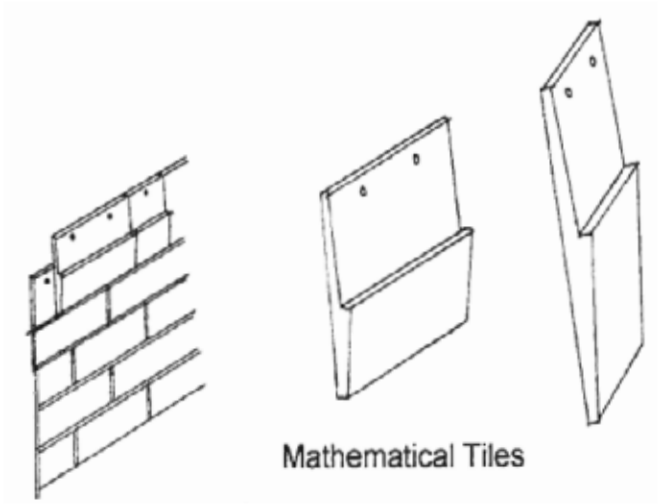
Mathematical Tiles

The 18th and 19th century saw the use of mathematical tiles around Kent and East Sussex. These are essentially an overlapping brick slip system which would have been fixed to a timber frame and grouted to resemble brickwork.

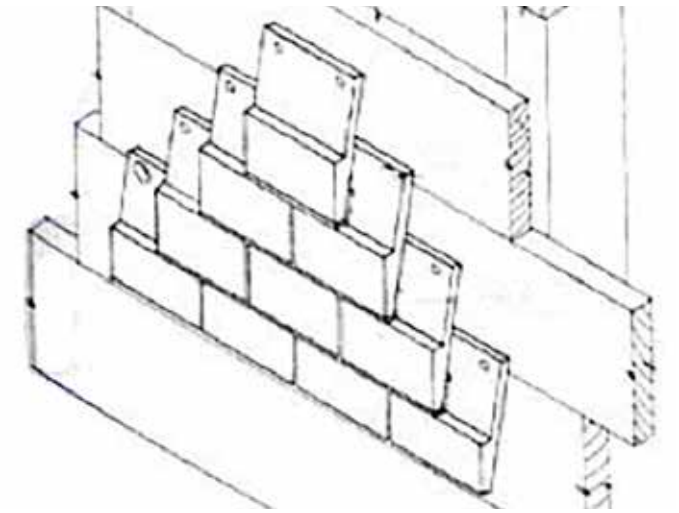
These systems can be seen as a precursor to modern day slip systems and share much of the same design reasoning.

Timber framed property clad in mathematical tiles

Glazed finish on mathematical tiles



Stretcher and header units



Overlapping fixings onto timber frame

Brick Slips - Individual Slips

Individual Slip Systems

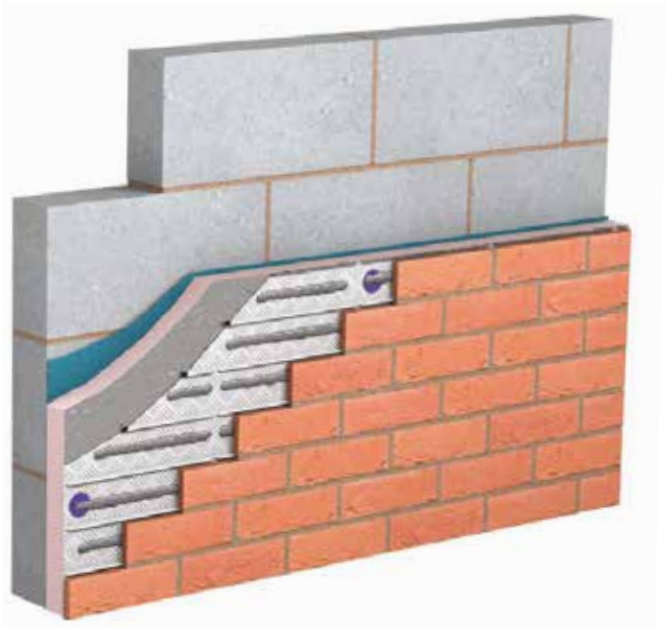
Individual brick slip systems can cover a wide range of different uses, depending on the required performance.

In the most simple scenario, brick slips can be used internally as a decorative finish. In this scenario the wall build up and adhesive will be similar to the application of tiles. To ensure that the slips replicate the effect of traditional brickwork it is important to follow the normal setting out, for bonding and coursing.

Slips are placed individually, which has the benefit of being able to accommodate construction tolerances but requires some skilled application.

Individual slip systems are also available for locations with increased performance requirements, including externally, where they are often used as an over-cladding. These systems will often include a backing board or track, which will improve adhesion and aid setting out.

Systems incorporating insulation can be used for new build applications, or for over-cladding existing buildings to improve thermal performance. The insulation is often supplied as part of a panel, pre-bonded to a track sheet to provide a grid for fixing the individual slips. Alternatively the slips may be bonded directly to the insulation.



Individual slips with track and insulation system

Mesh backing board to improve adhesion

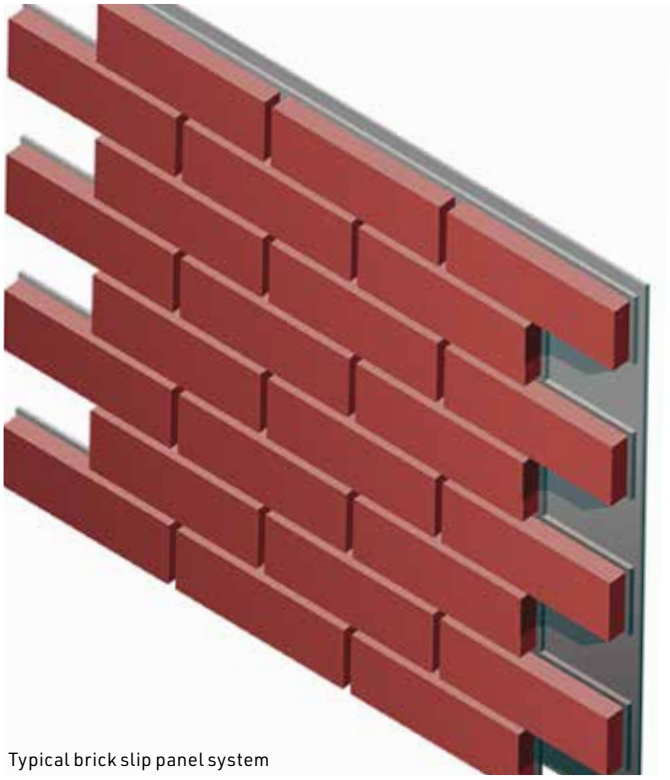
Brick slips used internally

Brick Slips - Panel Systems

Panel Systems

Panel systems are brick slips bonded to a rigid backer board or panel. Panel based systems are normally pre-manufactured and supplied with the brick slip already attached (sometimes pre-pointed). The main benefits are that brick bonding is completed under controlled factory conditions and speed of install is increased on site.

The specification of boards/backers used can vary significantly in terms of weather tightness, moisture absorption and fire performance, the panel shapes can be standard or bespoke and of varying aspect ratio and size; their design influences the handleability and installation on site. How panels are joined and aligned is also critical to the eventual finish, therefore construction tolerances must be coordinated.



Typical brick slip panel system

Panel system on 3D primary structure

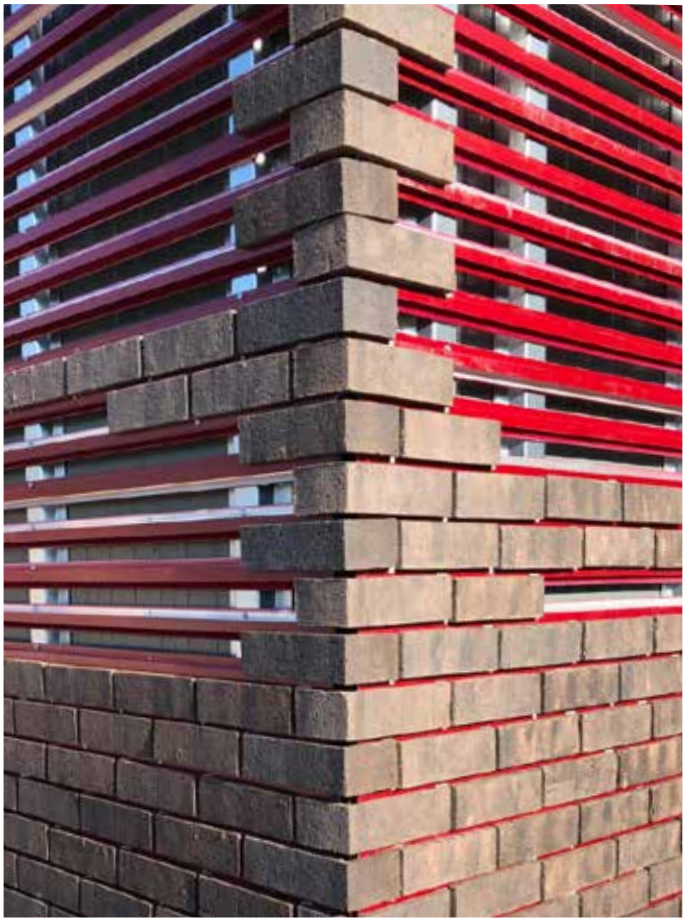
Panel system corner profile

Brick Slips - Rail and Tile Systems

Panel Systems

This is a group of systems where metal rails are fixed back to a supporting frame on site, and brick components are clipped or slotted into the rail. This can produce a mechanically retained slip, with no reliance on adhesive, which makes them non-combustible and therefore suitable for use on high-rise projects. The potential for performance variation is in the material the rail is made from, including any coatings applied, the design of the rail and the brick.

The decreased weight of construction and reduced wall thickness, when compared to other forms of construction means that the benefits are enhanced as the number of storeys increases. These systems are typically used for high rise construction and specific details, such as balconies or dormers.



Rail system to achieve mechanical fixing

Window revel detail

Curved profile

Precast Concrete

Precast Concrete

These panels are generally not considered to be a rainscreen system. Whole wall build-ups, including cavity and insulation are possible, which can dramatically speed up construction and benefit sites that suffer from challenging logistics. Although they create their own issues of increased design coordination and less flexibility for changes.

Precast systems can also be used to create details that would not be possible with hand laid construction, which has opened up a new language for brick architecture.

Single skin prefabricated brickwork

Precast panels to create details unachievable in hand set construction

Panels can be fixed to a variety of frame types

Prefabricated Components

Structural Components

The most widely used structural components are lintels and arches. Sometimes these will be a single material but more usually they will be a composite of steel or concrete and brick slips. A more recent development is prefabricated brickwork wall panels. These are factory formed brick and mortar walls that can be craned and transported as a unit and then positioned on site, eliminating the need for bricklayers on site.

The use of structural components can reduce the complexity of construction required on site and the amount of formwork and falsework required for construction.

Structural arch with bonded slips

Non-Structural Components

Non-structural components tend to be used to reduce the complexity of construction required on site, but don't form part of the primary building structure.

The use of these components essentially shifts the construction time required on site to an off-site manufacturing location. Early engagement with a manufacturer is essential to ensure that construction time and quality improvements are realised.

Some of the most well known examples are pre-manufactured chimneys, which can be lightweight and allow quicker installation. The labour time for complex decorative panels can also be shifted off site if it is beneficial for the construction sequence.
Some non-structural components, such as soffit systems, enable new types of design solutions.

Brickwork soffit system

Pre-manufactured chimney

Robotic Construction

Current Solutions

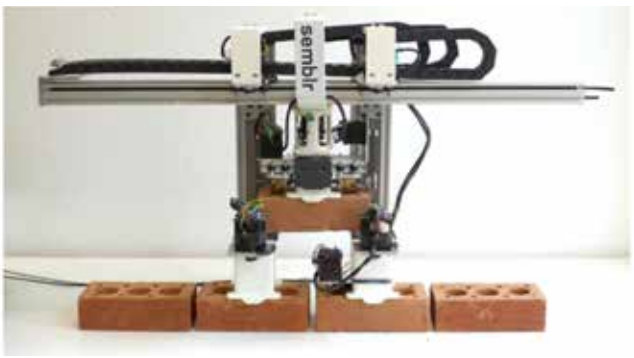
Bricklaying robots have been developed which can replicate some of the more repetitive elements of bricklaying. The Hadrian X bricklaying robot has a record braking capacity to lay a thousand bricks in a single hour. With the advancements in robotics and mechanical engineering this form of construction os set to grow exponentially.

Panels can be fixed to a variety of frame types

Alternative Approaches in Development

The currently available solutions have limitations to their widespread use due to the high capital costs and required enabling works. An alternative 'relative robotics' approach uses a smaller scale robot, which can move over the brickwork and build as 'swarms'. Both approaches require digital modelling of the project which can enable other benefits, such as reducing waste and optimising deliveries.

Single skin prefabricated brickwork



Precast panels to create details unachievable in hand set construction

Design and Specification

Modern Methods of Construction - Suitability

Once the decision has been made to proceed with a brickwork design solution, the evaluation to determine whether a hand laid or MMC option is appropriate can begin. It is important that the evaluation is holistic and project specific including; cost, speed of construction and quality.

It is impossible to have a 'one size fits all' approach to projects and the most efficient solution may be a combination of hand laid and MMC.

Tar stain on a textured brick

Installation and Project Logistics

One of the key principles of brickwork MMC is to increase the construction speed on site, by reducing complexity or transferring the process to an offsite location.

This is a potential benefit for projects with a time-critical construction programme, such as schools. Holistic evaluation is required, however, as interdependent factors such as delivery, storage, distribution, crane availability and the possibility to work on multiple construction activities concurrently will also impact the critical path and overall project performance.

Hand laid construction utilises the well-established supply chain of bricklayers, and whilst most MMC solutions can reduce the required installer skill, other MMC solutions require alternative specialist skill sets.

The availability of appropriately skilled labour should be carefully considered.

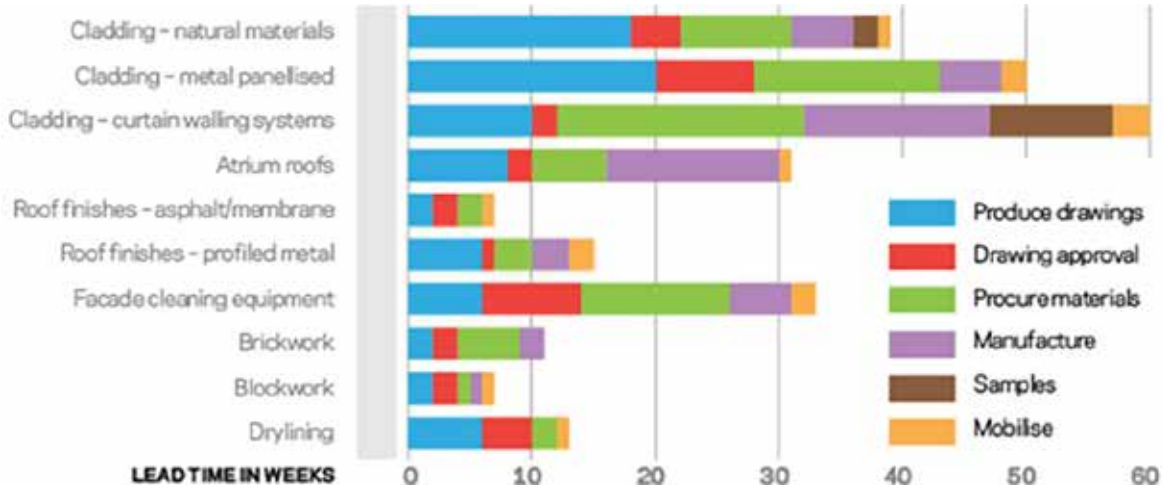
Lead in Times

Traditional hand laid construction typically has short lead-in times and ready availability compared to other facade systems.

The installation time for MMC systems will often be quicker than hand laid construction however. The different lead-in time will vary the point at which capital outlay is required.

Finally, the lead time will also impact when the design needs to be frozen.

For MMC solutions to be beneficial, the holistic time and cost benefits need to be greater than those achieved by hand laid construction.



Design and Specification

Project Scale

Larger and more repetitive projects will typically maximise the benefits of using MMC. This is because the accumulated benefit of each element can be such that they outweigh the extra coordination required to move the fabrication/construction off-site.

Complexity of Detailing

The complexity and the repetition of the brickwork detailing can influence whether MMC will be beneficial. Individual slip and panel systems will achieve the greatest time savings when the detailing is simple and repetitive.

Conversely, if the detailing is complex and repetitive then precast or pre-manufactured components may result in a time saving over hand laid construction.

Weight of Construction

In particular areas, such as gable ends and balconies, reducing the weight of the construction can allow the primary structure to be reduced because less weight needs to be supported.

For these areas, individual slip systems and panel systems can reduce the weight whilst blending in with hand laid panels of brickwork.

Design and Specification

Thermal Performance

For refurbishment and over-cladding of existing structures MMC slip systems can offer an effective solution.

Historic buildings have little or no insulation, so the use of a slip system incorporating external insulation can be a way of improving the facade performance, whilst retaining the attractive appearance of brickwork.

Compliance and Lifespan

There are a number of different manufacturers producing MMC systems. It is important to ensure that the specified system is appropriate to the risk class of the project.

Third party assessment, such as BBA certification or BSI kite mark can be a useful indication. A positive factor for hand laid brickwork is the long life expectancy and minimal maintenance. Some MMC solutions will not match this long-term performance so care should be taken during specification to ensure that design life of the system is appropriate.

Brick Retention

Generally this is not a risk for certified MMC systems. However for individual components and composite systems, it should be confirmed that they are suitable for use in the designed location.

Good installation controls are required to ensure that systems are installed as tested. Poor workmanship or installation in unfavourable weather conditions can affect the performance and appearance.

Fire and Combustibility

Brickwork MMC systems will need to comply with the ban on combustible materials above the regulated height threshold and not contribute to the spread of flame below this height.

All systems and components must be evaluated by a suitability competent person who understands the wider fire life safety design and construction strategy.

References and Further Reading

Characterising the Performance of Thin Brick Facade Systems to enable more Informed Design Choices for Specifiers. Richard Willetts, 2018/19. MSc Architectural Engineering: Façade Engineering. The University of Bath, Department of Architecture and Civil Engineering.

EN 771-1, Specification for masonry units Part 1: Clay masonry units

BS EN 845-1, Specification for ancillary components for masonry – Part 1: Ties, tension straps, hangers and brackets

BS EN 845-2, Specification for ancillary components for masonry – Part 2: Lintels

BS EN 845-3, Specification for ancillary components for masonry – Part 3: Bed joint reinforcement of steel meshwork

BS EN 998-2, Specification for mortar for masonry – Part 2: Masonry mortar

BS EN 1990, Eurocode – Basis of structural design

BS EN 1996-1-1, Eurocode 6 – Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures

BS EN 1996-1-2, Eurocode 6. Design of masonry structures. General rules. Structural fire design

BS EN 1996-2, Eurocode 6 – Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry

BS EN 1996-3, Eurocode 6. Design of masonry structures. Simplified calculation methods for unreinforced masonry structures

PD 6697, Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2

BS 8000-3, Workmanship on building sites – Part 3: Code of practice for masonry

http://brick.org.uk/about/our-members

Brick Development Products & Services

Brick Awards
The Brick Awards celebrate the best examples of clay brick in our built environment. Each year the awards attract over 350 entries from leading architects, housebuilders, developers and contractors; accross 17 hotly contested categories. It is FREE and simple to enter on our web site: www.brick.org.uk

Technical Publications
The BDA provides a range of technical publications and guides; which are freely available to Architects, Developers, Builders and General public on our web site: www.brick.org.uk

The Fourth Eddition of 'Guide to Successful Brickwork' is available at all good book shops.

Brick Works Events
The BDA regularly runs courses and seminars for all those professionals involved with the design and construction of brick buildings. Please contact George Spreckley our Events & PR Manager on email: georgespreckley@brick.org.uk

Brick Bulletin
This widely acclaimed e-magazine features the latest developments in brick design and is recognised world wide as the foremost journal of contemporary brickwork. It is available free through the 'Brick Bulletin' tab our website: www.brick.org.uk.

Brickmakers Quality Charter
Clay brick makes a significant contribution to the UK's safe, healthy and sustainable built environment. The Brickmakers Quality Charter scheme promotes the responsible sourcing of clay brick, through credentialling and the flexibility businesses seek from an established and audited supply chain.

Training and Education
The BDA offers lectures and other educational services for Architects, Engineers, Developers as well as support for students and public interested in creating successful brickwork. We also provide technical input to events for practicing architects, engineers and organisations involved in continuing professional development.

Research and Testing
The BDA identifies specific areas where independent research and testing programmes are required to further the confident use of clay brick and to ensure quality.

Statistical and Marketing Information
The Brick Development Association is an independent body committed to providing authoriative information about the use of clay brick in construction.

We collate statistical information on brick production, UK deliveries, and related supply for imported products together with volume information including testing, research and development.

We provide free technical support on the use of clay brick, and encourage best practice in the use of brick in the built enviornment.

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