



(Photo: Kier & Integrated Team – via submission in 2020 Offsite Awards.)

# Off-site construction

Over the past few years the Government has made the use of off-site construction techniques as one of its core objectives for the construction industry. Jenny Burrige of *The Concrete Centre* looks at some of these options and the benefits that can be realised by choosing concrete as the off-site construction option.

**M**any people assume that off-site construction involves the use of lightweight volumetric construction such as timber-framed or light-gauge steel options. However, the use of precast concrete elements is a well-established construction method and provides solutions with a great variety of use, location, shape and finish.

Precast concrete can be incorporated into any building type, below or above ground or water, enclosed or outside. In fact, precast concrete is virtually unlimited in its potential application, for both single- and multi-storey construction, and can be considered as an option for any construction project.

Usually used as elements rather than volumetric designs, precast concrete is very versatile and provides a quick, robust construction type.

The modern methods of construction (MMC) framework produced by MHCLG in 2019<sup>(1)</sup> gives seven categories of MMC. Concrete has solutions in all these categories (see Table 1).

## Precast systems and products

Following is a description of some of the systems and products available in the UK, most of which are also made in the UK. Some of these systems are purely precast concrete; others are products to be used in a hybrid concrete option, where precast and in-situ concrete are used together. This is still considered to be an off-site construction.

## Crosswall

Crosswall is a modern and effective method of construction that employs factory-produced, precision engineered, concrete components. It uses precast floors and load-bearing walls, and is ideal for buildings of a cellular nature, eg, hotels, student accommodation, housing and apartments. This method of construction has been developed to facilitate swift construction and is adaptable to suit different building

Figure 1 (above): HMP Five Wells, Wellingborough. The design team optimised the DfMA component library by reducing the number of precast concrete components by almost 50%, providing a programme saving of 18.5 crane weeks per houseblock. The team also made extensive use of digital technology, including BIM, drone flights and robotics, as well as close collaboration to increase productivity.

Table 1 – MMC categories and concrete examples

Category	Category description and concrete example
1	Pre-manufacturing of 3D (volumetric) primary structural systems such as a volumetric stair or lift cores.
2	Pre-manufacturing of 2D (panelised) primary structural systems such as concrete crosswall construction.
3	Pre-manufacturing components of primary structure not part of a systemised design such as concrete floor and wall panels, stairs, columns and beams.
4	Additive manufacturing – structural or non-structural elements created remotely or on-site based on digital design and manufacturing techniques, such as 3D-printed concrete.
5	Pre-manufacturing of non-structural assemblies and sub-assemblies such as bathroom pods.
6	Traditional building product-led site labour reduction and productivity improvements such as large format blockwork and prefabricated reinforcement.
7	Site process-led labour reduction and productivity improvements, including: insulated formwork system; systemised in-situ concrete systems such as tunnel form; standardised formwork and temporary works; robotic site processes for bending reinforcement bar or laying block paving; use of BIM for digitally enabled workflow planning; site-working planning tools like GPS; site-worker augmentation such as AR/VR; and digital site verification tools for striking in-situ concrete.



Figure 2: National Ballet, London. The hybrid concrete structure, combines a cast-in-situ frame with long-span prestressed precast T-beams exposed inside, which together with polished concrete floors provide thermal mass and a comfortable but robust, contemporary environment.

(Photo: Banagher Precast Concrete – via submission in 2020 Offsite Awards.)

## English National Ballet

types. Load-bearing walls across the building provide the means of primary vertical support and lateral stability, with longitudinal stability achieved by external wall panels or diaphragm action taken back to the lift cores or staircases.

Crosswall construction provides an efficient frame without structural downstands, resulting in a structural floor zone typically of 200–250mm, helping to maintain a high degree of sound insulation between adjacent dwellings and rooms.

### Hollowcore floors

Hollowcore slabs derive their name from the voids or cores that run through the units. The cores significantly reduce the self-weight of the slabs, maximising structural efficiency and can also function as service ducts. The cores reduce the volume of material used. Units are generally available in standard 1200mm widths and in depths from 110 to 400mm. Non-standard lengths, splays and notches can readily be accommodated.

Hollowcore slabs have excellent span capabilities, achieving a capacity of 2.5kN/m<sup>2</sup> over a 16m span. The long-span capability is ideal for offices, retail or car park developments. Units are installed with or without a structural screed, depending on requirements. Slabs arrive on-site with a smooth prefinished soffit. In car parks and other open structures, prefinished soffits offer a maintenance free-solution.

### Lattice girder slabs

Lattice girder slabs are a hybrid concrete construction option. The units are usually 2400mm wide and comprise a thin precast concrete 'biscuit' into which a lattice girder made of steel reinforcement is cast. Once in position, reinforcement is fixed to the top of the lattice girder and an in-situ concrete topping is poured that acts compositely with the precast concrete.

The overall floor depth is generally in the range of 150–300mm. The floor slab can be designed to act continuously across several spans. Void formers can be introduced in the form of polystyrene blocks or spheres made from recycled plastics. Different systems are available from various manufacturers. The void formers reduce the quantity of concrete used and the self-weight of the slab.

### Twinwall

Twinwall is another hybrid option. It consists of two precast concrete panels held apart by a lattice girder, manufactured from steel reinforcement. The precast concrete panels both form a permanent formwork for the in-situ concrete and contribute to the final structural element. The surface finish of the panels is good quality and may only require a skim coat of plaster, or paint finish. The advantage of using an in-situ concrete infill is that the elements can be readily tied together to form a robust structure.

### 3D volumetric structure

This concrete structure can be supplied in a volumetric form, either as two planes (floor and wall) or more commonly as a four-sided box, with or without the floor or roof, depending on the intended use. It is particularly beneficial for stair and lift cores or prison accommodation but with potential for further applications. The modules will generally be delivered to site on low loaders, with the ground-floor units being erected onto a prepared ground-floor slab. The subsequent units are then successively erected onto the roofs of the units below. Units can be fitted out at the factory with windows, vents, bathroom and other fittings, plus plumbing and electrical fixtures and fittings.

### Sustainability

The UK precast sector is represented by the trade body British Precast. As part of membership of British Precast, all manufacturers commit to a sustainability charter, which includes the collection and annual publication of performance data.

Concrete is the local construction material, with production facilities throughout the UK. Although precast concrete can travel further distances than ready-mixed concrete, there is still a regional network of producers throughout the UK. Data collected by British Precast show that an average lorry carried 23.3 tonnes of precast product per delivery to site. The average delivery distance in 2019 was 129.6km.

Some 97.8% of precast concrete produced in the UK (by British Precast members) is covered by an ISO 14001<sup>(2)</sup> environmental management systems. Quality and environmental management systems include not only commitments to address environmental aspects and impacts but also a willingness to embrace new technologies and innovation as part of continuous improvement.

The concrete industry adopted independent certification to the responsible sourcing Standard BES 6001<sup>(3)</sup> from its launch in 2008. Constituent materials

## PRECAST CONCRETE

such as cement and aggregates are now 100% responsibly sourced to BES 6001 (see [www.sustainableconcrete.org.uk](http://www.sustainableconcrete.org.uk)). The latest published data from British Precast shows that 82.1% of all concrete produced by their members is certified to responsible sourcing standard BES 6001. This Standard gives confidence of the ethical sourcing and traceability of concrete products, another advantage of a UK supply chain.

The precast concrete sector and the UK concrete industry, has targets to reduce the carbon emissions of production, or embedded carbon, from its products. The manufacturing carbon emissions of the UK precast concrete sector has dropped by 31.6% since 2012 and 43.6 since 2008. GGBS, fly ash and powdered limestone can reduce the carbon footprint of concrete. In the precast concrete sector, over 18.6% of cement has been replaced with alternative cementitious materials.

The precast sector has also published a number of generic Environmental Product Declarations (EPDs) and 63.6% of British Precast members have their products covered by valid third-party-certified EPDs. These EPDs support the use of building information modelling (BIM) and manufacturers can also provide further information to support BIM.

### Well established

The Government push for off-site construction does not only apply to lightweight forms of construction. The precast industry is well established with a strong supply chain, which can produce strong, efficient and robust buildings. Precast concrete buildings have been used for many years and many of the problems with details, such as fire stopping, vibration and connections, that the lightweight off-site options are currently resolving were solved in the precast industry many years ago. Precast concrete is a safe, robust and efficient way of constructing buildings for the long term. ■

#### References:

1. MINISTRY OF HOUSING, COMMUNITIES & LOCAL GOVERNMENT. *Modern Methods of Construction: introducing the MMC definition framework*. MHCLG, March 2019, available at: <https://bit.ly/3t0t6Bq>, accessed March 2021.
2. BRITISH STANDARDS INSTITUTION, BS EN ISO 14001. *Environmental management systems. Requirements with guidance for use*. BSI, London, 2015.
3. BUILDING RESEARCH ESTABLISHMENT, BES 6001. *The Framework Standard for Responsible Sourcing*. BRE, available at: <https://bit.ly/3sY2DnL>, accessed March 2021.

#### Further information:

Off-site Concrete Construction – <https://bit.ly/3egWajJ>.  
Sustainability Matters – <https://bit.ly/3REGATb>.



Figure 3: Kingston Town House. The new Town House at London's Kingston University is a mixed-use building that has in recent years become increasingly popular with academic institutions. Its six storeys house lecture theatres, study rooms, dance studios, an auditorium, a library and a café. (Photo: PCE Concrete – via submission in 2020 Offsite Awards.)

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