

Modern Methods of Construction: Case Study 2

Background

Despite the current uplift in home building, housing shortages persist around the country and particularly in Dublin. The Engineers Ireland State of Ireland 2019 Report focused on Ireland's housing sector, which was allocated a 'D' grade – highlighting the engineering expert view that the capacity, condition, and connectivity of Irish housing is of grave concern and requires immediate action. The report included a clear reference to the vital contribution that Modern Methods of Construction (MMC), including BIM, can play in expediting the delivery of housing provision in Ireland¹.

While new housing output is rising, the negative is that, according to the Central Bank, Ireland need to build 34,000 new homes per annum out to 2030². These figures are enforced through the realisation that 10,271 people were homeless in January 2020 across Ireland. The number of homeless families has increased by 302% since January 2015³.

The CitA Digital Transformation Series on the 10th March 2020 will provide a focus on using modern methods of construction for residential developments through four keynote speakers from Tempo Housing, Horizon Offsite, BRE and Fewer Harrington & Partners.

TempoHousing

TempoHousing has been building prefabricated homes and hotels, from small to big, for over 15 years. They build with various prefabricated modular systems in many sizes, from steel frame, to ISO shipping containers, or DIY packs.

Their modular home products include concrete 35, SP 20, and SP47. The modular home product concrete 35 is built with lightweight concrete walls, floor, and

ceiling with a surface of about 35m². This model has been developed for permanent housing or hotels and meets the highest standards. Lightweight concrete is a new product that has been developed due to the ideal properties of concrete for improved sound insulation, better fire resistance and the ability to accumulate the indoor temperature. While traditional concrete is too heavy for transporting a complete module by truck, lightweight concrete offers a viable solution. The module home SP20 and 47 is based on steel frames with insulated sandwich panels of 60 x 120mm. The external dimensions are 7.3m in length and 3.2m wide, which allows permit-free transportation by truck. With a variety of sizes (starting with 20 m²), they are very suitable for urgency shelters.

The Timberframe or Cross Laminated Timber (CLT) modular home is similar to the modular homes made of steel frame, as they have almost the same structural properties, and they offer the same long durability. CLT is a wood panel product made from gluing together layers of solid-sawn lumber. The CLT homes offer the advantage of having a significantly lower carbon footprint.

The ISO home products include Professor 30 and Director 60. The ISO Professor 30 home is based on a 40ft ISO shipping container and is ideal for converting to comfortable homes. With a surface of about 30 m², this container home is very suitable for student housing, staff accommodation, hotel rooms, and urgency shelters. The Director 60 module is based on two connected 40ft ISO shipping containers. These two containers, 4.8m (2 x 2.4) wide and 12m long, have connecting sections at the long sides. By connecting the two containers, a surface of about 60m² is created. These modules are also very suitable for (semi)-permanent housing solutions, student housing, staff accommodation, urgency shelter, and hotel rooms.

The FlatPack module home products include the FP 15 and 30. The modules (15m² and 30m²) is delivered as a 'build it yourself' kit. It consists of a steel frame and sandwich panels. The external dimensions are 6m in length and 2.4m wide. The flat-pack homes (kits) can be shipped as a bundle with the volume of a single 20ft container or as seven kits in a standard 40ft container. These flat packs are easy to connect to create larger spaces and are suitable for all types of housing and buildings.

Some recent projects TempoHousing have been involved in include the Urban Village 4000 in Denmark which comprised of 48 Homes with balconies (figure 1), 2 blocks (3 stories each) with lifts, communal house, 115 bicycle park spaces, and 17 parking spaces. Light gauge steel was used on this project because it has the highest strength to weight ratio and is 60% lighter than wood. This makes it easier to transport and much more durable than other building materials. In regard to the homeless crisis, TempoHousing converted 40ft shipping containers to build a homeless shelter in Brighton. The container homes offered an actual apartment for the local homeless population. This shelter was erected in less than eight weeks to help solve the city's acute shortage of affordable accommodation. Concerning social housing, TempoHousing worked on a project titled Skaeve House in Amsterdam where unique architecture was applied to give the prefab homes an image of permanent houses. Some of these houses have been relocated three times in three different locations since they were placed in 2006.



Figure 1: Modular Home Urban Village 4000 Denmark
Horizon Offsite

Horizon Offsite provide structural light gauge steel building systems for commercial, education residential and industrial developments. The Light gauge steel products and systems are used as part of the structural element in the construction of walls, floors, ceilings, and roofs, creating a full accredited structural system. Light gauge steel products and systems are at the cutting edge of modern methods of manufacturing and construction due to the increasing demand for more offsite construction globally.

The Horizon Offsite design team works closely with the client's design team to structurally design and produce frame drawings for the steel frame building, including specification of all members before manufacture. The framing software used is called Vertex, which converts the client's architectural drawings into a 3D structural computer-aided design model. The Vertex system automatically calculates all framing requirements for walls and floors and allows for all openings such as windows and doors in conjunction with the Horizon Structural Engineer. Each individual frame component is allocated a unique number and has all dimensions calculated for cut-outs, punch outs, and brackets.

Horizon Offsite has a rigorous checking procedure before any codes are sent to their production facility, making sure all members are in compliance. The roll formers use computer-aided manufacturing techniques to access the data that has been transferred from the Horizon Offsite design office. The steel coils are then formed into the required components, positioning cut-outs, punch holes, etc. from the transferred data. The process is accurate to +/- 2mm. Assembly of the components commences in the facility directly after it has been roll formed.

The external light gauge steel wall panels used in this system are insulated in the factory using closed-cell insulation; the thickness of the insulation can be changed to increase or decrease the U Values as necessary. Cavity closer and specific grounds can be

fitted to the external light gauge steel wall panel depending on the external finish to the building. This process creates a fully factory insulated external wall panel with all the benefits of being constructed within a controlled environment.

The Horizon Offsite infill panel system can be used to fit between columns and beam in both hot rolled steel buildings and concrete buildings; it can be designed to sit inside the structure or designed as an out fill panel. The infill panel system can be designed to come to site insulated or non-insulated. The offsite floor is constructed by using single lattice floor joists or C Section joists, factory manufactured floor panel cassettes, or composite concrete floor deck.

Some recent projects include Lawlor's Hotel in Naas, where Horizon will be adding 48 bedrooms and a conference room. The light gauge steel systems were chosen for speed and convenience to eliminate challenges associated with impacting a live building. All floors, full structural walls and all hot-rolled steel were prefabricated offsite and transported from their manufacturing plant to site ready for installation, cutting downtime needed on-site by 50 %.



Figure 2: Lawlor Hotel

Fewer Harrington + Partners

Fewer Harrington & Partners (FHP) is one of Ireland's leading Architectural practices. They are committed to the core values of excellence, integrity, innovation, creativity, enjoyment and diversity. FHP has extensive knowledge and worldwide experience in a variety of sectors such as Healthcare, Education, Master planning, Mixed use, Residential, Pharmaceutical, Bio Medical, Retail, Residential & Industrial.

Increasing the green agenda has become a strategic imperative. The implications of climate change are now manifesting and there is a requirement to future-proof buildings. As an example, this includes lowering carbon emissions to offset potential carbon taxes. The value added for clients is that green certified buildings are more economical and realize greater value in the longer term. FHP is committed to designing energy efficient and environmentally responsible developments. They are qualified to assess sustainable build under BREEAM & LEED International standards.

Some recent projects included Maritana Gate in Waterford which is one of the prime mixed use developments in the South East of Ireland. This development consists of 72 high-end residential apartments and 7,000 sqm of "A class" office spaces overlooking people's park. The office spaces have been designed to cater for offices from 35 sqm to over 1,000sqm, with each building providing for own door entrances off high quality spacious lobbies to maximize each occupant's corporate identity. The building used a steel frame, multi deck system and prefabricated reconstituted stone panels for speed of construction. Modular kitchen and bathroom pods were used for all residential apartments and the offices accommodation incorporated raised access floors and suspended ceiling systems. Due to these new methods of construction the building was designed, constructed and handover in less than 14 months from start to finish.

Railway Square was designed to bring life to a previously derelict and contaminated city centre site in Waterford. It now consists of 3 main blocks with underground car parking and landscaped plazas including children's play areas. Using similar techniques as Maritana Gate, the building was designed, constructed and handed over in less than 14 months from start to finish.



Figure 3: Railway Square

Other projects included the Castle Gardens Housing in Waterford which was a very high specification development of 48 luxury holiday villas, constructed on a private island where quality and finish were paramount. The houses range from 3 to 4 bedroom units. The form of construction used was a light gaged steel structure which enabled the 48 houses to be delivered in 24 weeks from start to handover.

FHP are now working with Ilke Homes, one of leading UK modular housing companies to establish their Irish operation to deliver homes to the Irish market. Ilke Homes aims to help address the Ireland chronic shortfall in housing, to consistently create high-quality, energy-efficient modular homes at scale for the people that need them most. Using precision engineering and inspiring designs, they provide homes that can be clad in a wide range of traditional and contemporary external finishes and rooflines to suit the local vernacular or to transform and regenerate a site. All Ilke homes have a 2.5m floor to ceiling height with large windows as standard which provide excellent daylight. Ilke Homes cost 20% less to heat than other new homes and less than half the cost to run than the average UK home. Acoustic tests

have also shown Ilke homes to be significantly quieter than traditional new builds. They are all fully mortgageable with all the standard warranties available including NHBC Buildmark and BLP Secure.

BRE

BRE delivers a range of services to help one benefit from innovation. These include providing state-of-the-art advice on innovative systems, product design, and development, including evaluating prototypes, market research, feasibility studies, risk assessments, and training. BRE provides expert advice regarding the best practices in innovative construction to ensure conformity to building regulations and other relevant standards, including fire performance, durability, structural stability and robustness, acoustics performance, security, and thermal performance.

To assure the growth in offsite construction, BRE Global is developing the new standard, BPS 7014, forming the basis for a certification scheme for offsite construction systems and components. BPS 7014 will complement existing sector standards and initiatives, such as those being explored with Build offsite.

BRE is working to ensure that key requirements are met when it comes to modular building, such as acoustics. Acoustic properties for modular constructions can be built in at the factory and tested to meet Approved Document E. With their new sound transmission laboratory and anechoic chamber BRE is well-equipped to help manufacturers reach industry standards for acoustic rating. The durability of modular homes has also been an issue in the past, but advances in technology are addressing these issues. BRE, amongst other things, can assess the structural design of modular units and the racking resistance of walls. Their vast structural laboratory enables them to test full-scale 3-D structures. The ability to do so offers confidence that those certified to BPS 7014 will be able to withstand the rigours of what is expected.

The materials used in offsite construction must have the fire resistance and protection that is legally required. BRE's team of experts can undertake numerous types of tests on a variety of materials to ensure that the construction conforms to standards and will safeguard the occupants and property. Other areas where BRE assist regarding modular include certifying systems to verify intruder resistance, enhancing sustainability, and ensuring positive health and wellbeing by exploring optimum heating and lighting options.

BRE has a series of Innovation Parks that use a wide range of innovative construction methods and promote sustainable development. They feature full-scale demonstration buildings that have been developed by industry partners. These buildings display innovative design, materials, and technologies that combine to address the development challenges facing regions across the world.

Conclusion

The MMC discussed in this paper can offer both a potential solution to the ongoing housing crisis through the application of innovative modular products and materials, while in parallel producing a fast and ready-made housing solution for the homeless. If targets are to be achieved in the *Rebuilding Ireland Action Plan for Housing and Homelessness*⁴ and the dramatic increase in the delivery of homes nationwide is to be realised, then the MMC discussed in this case study will need to be adequately explored.

Acknowledgments

Deborah Smyth (TempoHousing), Ger Fahey (Horizon Offsite), Ian Fewer (Fewer Harrington + Partners) and John Whyte (BRE)

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