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Rapid Rebuild Ukraine

Pattern Book of Modular Residential Buildings

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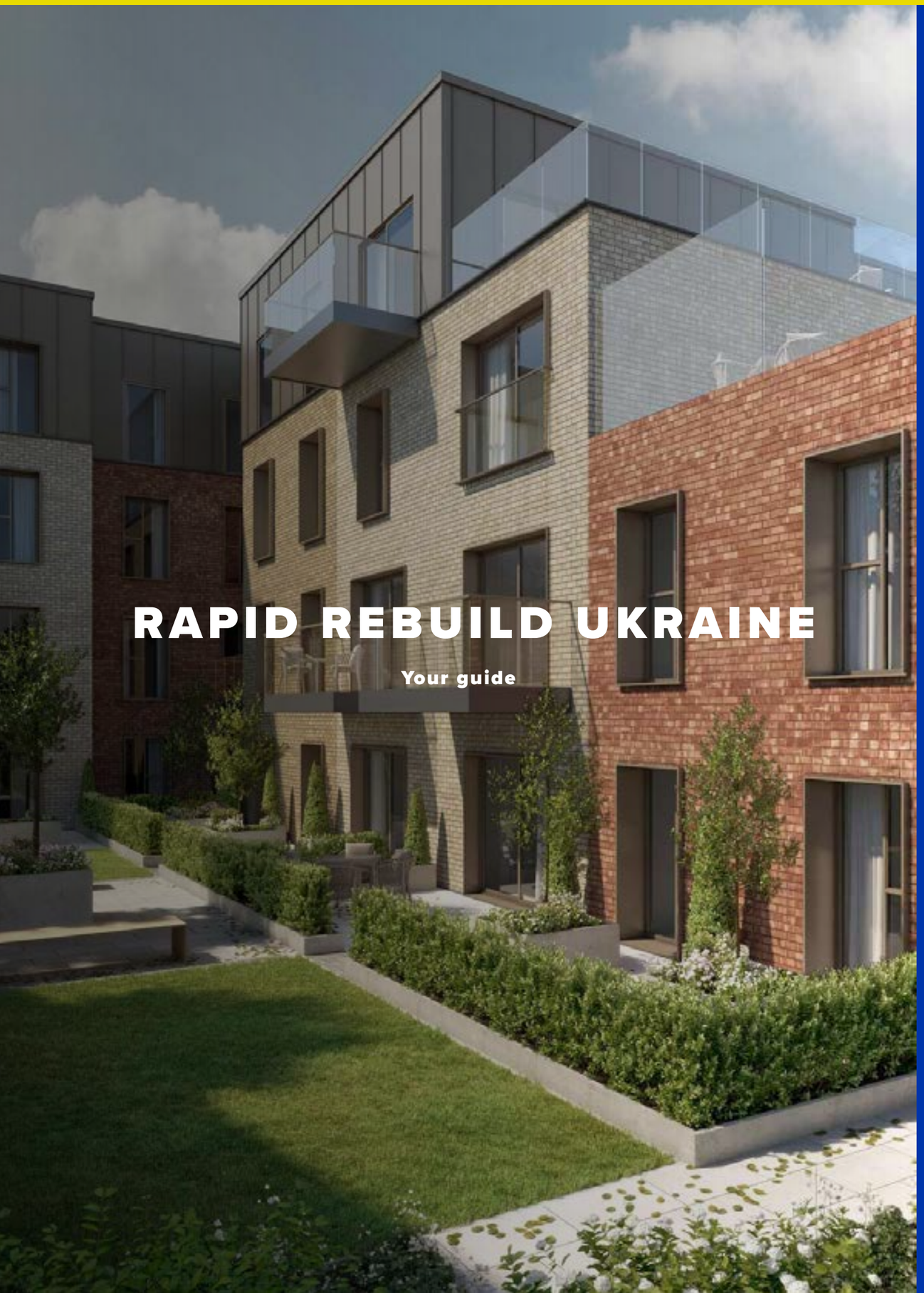

RAPID REBUILD UKRAINE

Your guide

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RAPID REBUILD UKRAINE

Mission Statement

The rapid re-building of Ukraine will require an unprecedented scale of construction of housing and residential buildings using new technologies based on off-site manufacture, and modular construction in particular. This will require construction of large regional factories each capable of producing up to 30,000 modules a year with an Innovation Hub that drives the design, automated manufacture and procurement process. This manufacturing output is required on a scale not seen in Europe, and Ukraine will lead the way in this innovative technology.

The initiative RapidRebuildUkraine is aimed at building capabilities and manufacturing infrastructure in modular construction in Ukraine, including pilot projects and tests to satisfy Ukrainian functionality requirements and to demonstrate the rapid building process and cost-effectiveness.

Our group of specialists and academics in the field of modular construction is able to provide the required expertise to assist Ukraine in this World-leading initiative.

Rapid Reconstruction

'Ukraine Rapid Damage and Needs Assessment' by the World Bank/EU (4th Report February 2025) states that '13% of the total housing stock has been damaged or destroyed affecting more than 2.5 million households. More than 500,000 have lost their homes and will need to be provided with new housing built to high quality'. The World Bank estimates that the housing rebuild programme will be at least $80 billion. This will require re-building on a huge and rapid scale.

Housing Needs

Of the 500,000+ households in Ukraine that will require new housing, 20 to 30% could be accommodated using modular solutions, with each home, either a house or apartment, consisting of 2 to 4 modules. The total production requirement over 5 years would be 60,000 to 80,000 modular units a year and this would require construction and setting up of 2 to 4 advanced regional factories to serve the most affected Oblasts.

A 3 to 5 storey modular building consisting of 30 to 80 modules would take only 6 to 8 weeks to manufacture and construct, provided the factory infrastructure is set up first. An advanced regional factory to produce modules could be 50,000 m2 in floor area and should be within 200 km of the main areas of housing need. It would require a suitable level of automation and Building Information systems (BIM) that would be at the heart of the design, manufacturing, construction and facilities management process. The buildings would have safe refuge areas and would aim to be 'nearly net zero' in terms of their energy strategy.

TEAM

Professor Konstantinos D Tsavdaridis of CityStGeorge's University of London;

R Mark Lawson, Consultant to The Steel Construction Institute;

James Walsh, Founder of Studio Anyo;

Oliver Rogan, Managing Director Metek Building Systems;

Stergios Mitoulis, Assistant Professor, The Bartlett School of Sustainable Construction, University College London;

Kostya Rapina, CEO & Co-Founder of Powerkh;

RAPID REBUILD UKRAINE TARGETS

The target application of modular systems is in housing and medium-rise residential buildings. For urban locations, the modules may be supported on a podium or transfer structure at first floor to create open-plan space at ground floor.

The infrastructure of modular production requires a major investment in mechanised factories that are inter-linked in terms of their design and manufacturing functions. This may start at a small scale of production of say 500 modular units a year in the cities that have suffered the most damage, but it should also extend to regional production of say 3000 units a year. The manufacturing facilities will create new well-paid jobs for local people. The production may extend to components such as windows, services units, kitchens and bathrooms.

In the case of Ukraine, these factories may be built in regional Oblasts, where the demand is greatest. Ideally these factories should be within 200 km of the building location, in order to limit transport costs. The first factory may be built in a western Oblast or in an area such as Mikolaiv, which has a long history of ship building and mechanical engineering, in order that modules can be produced without delay when the conflict is over.

BENEFITS OF OFFSITE MODULAR HOUSING

Why choose Offsite Modular Housing?

- A higher level of quality because of the factory production system used
- A faster build time as the project is being built while the foundations are being constructed
- A reduction in costs through framework agreements
- Off-site, efficient and environmentally friendly construction
- Reduced risk and cost certainty
- A much shorter construction programme
- Early occupation and faster return on capital investment
- A reduction in health and safety risks
- Lightweight construction, which can reduce foundation and podium costs
- Reuse

What is an Offsite Modular Housing?

- Fully constructed factory builds for volumetric/ panelised modular, and prefabricated buildings
- The same Codes and Standards as traditional build
- Rooms are built off-site and sealed on-site, where the modules become integrated walls, floors and roof structures
- The benefit of manufacturing techniques of cost, quality and speed

KEY FEATURES OF MODULAR CONSTURCTION

1. An ‘economy of scale’ in the rapid production of modules reduces their unit costs but it also requires a high degree of standardisation in module sizes, materials used, and in their inter-connectivity. The modular system should satisfy Regulations and local requirements and it should be adaptable to a range of housing and residential building forms without affecting the basic principles of economy in manufacture.
2. The factory production of modules requires mechanised manufacturing facilities in terms of assembly of the modules, the supply of materials and components, and then the final storage and distribution of the completed modules. Regional factories should be set up close to the main areas of demand but may have a single common management and design/ Information Technology ‘hub’.
3. The modules are weather-tight and can be clad in range of materials to suit local architecture styles. Installation of the modules is fast and efficient so that completion on site takes only a few days. The building system should include foundation systems, easily operated lifting equipment, centralised services, façade and roofing systems, and additional modular components such as stair/entrance lobby and balconies. The modules are well insulated and fire safe so they can be occupied before the cladding and roofing system is installed to speed up the delivery of much needed housing.
4. Modules can be demounted and re-used in different locations or in different configurations and so are an important asset of the ‘circular economy’, which is a unique feature of modular systems. The modules are designed so that they can be configured in different ways and they are re-usable with minor modifications.

DESIGN PROCESS GUIDE

Design for Manufacture and Assembly (DfMA) is a pivotal engineering methodology aimed at enhancing the efficiency of both manufacturing and assembly processes. This methodology is chiefly divided into two components:

Design for Manufacturing (DfM): This element focuses on minimising complexity during the design phase, thereby optimising the manufacturing of a product's constituent parts.

Design for Assembly (DFA): This segment emphasises the reduction of assembly time and cost, streamlining the assembly process through effective design principles.

By integrating these two methodologies, DfMA not only augments development quality but also significantly reduces manufacturing costs and mitigates associated risks. Its applicability spans

Application in Construction

In the construction realm, DfMA entails the prefabrication of building components in a controlled manufacturing environment, as opposed to traditional on-site assembly methods. This transition can lead to significant advantages:

Reduced Energy and Carbon Footprint: Streamlined processes lead to lower energy consumption and carbon emissions.

Minimised Waste: Efficient design and fabrication result in less material waste.

Enhanced Safety: Off-site production reduces the number of hazardous activities on-site.

Accelerated Construction Timeline: Prefabricated elements can substantially shorten project durations.

Decreased On-site Labour Requirements: Fewer personnel are needed on site, minimising potential for labour-related delays.

Easier Quality Control: Components manufactured in a factory setting allow for more rigorous quality assessment before site arrival.

Principles of DfMA

The principles guiding DfMA are akin to lean construction methodologies, emphasising waste minimisation and efficiency. Key principles include:

-Minimisation of Components: Reduce module assembly and ordering costs and simplifies operations.
-Ease of Manufacture: Simplify module geometry and avoid unnecessary features.
-Tolerances: Modules are designed to high accuracy within process capabilities.
-Design: Limit the use of complex elements.
-Facilitation of Assembly: Design modules for easy assembly.
-Elimination of Adjustments: Reduce adjustments during assembly.

Advantages of DfMA

Implementing DfMA principles confers numerous advantages, particularly in construction: Increased Speed: Prefabricated elements significantly reduce on-site timelines. Cost Reduction: Fewer parts and labour requirements can lead to substantial cost savings.

Quality Improvement: Reduced complexity translates to lower error rates and enhanced durability.

Shortened Assembly Time: Standard assembly practices expedite construction processes.

Enhanced Reliability: Fewer components correlate with a decreased risk of failure.

The application of Design for Manufacture and Assembly (DfMA) in construction provides a strong foundation for rebuilding Ukraine efficiently, sustainably, and to a high standard. By involving experienced practitioners, DfMA can support the delivery of resilient housing with shorter construction timelines, reduced waste, and improved quality control.

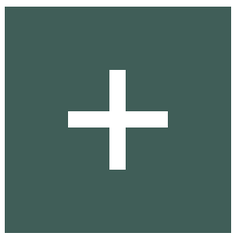
In support of the Rapid Rebuild Ukraine mission, our team is committed to sharing expertise in modular and off-site manufacturing to help meet urgent housing needs and contribute to Ukraine's long-term recovery.

Off-site, efficient, eco-friendly, recyclable construction

Early cost certainty and reduced risk

Early integration of room M&E, which are pre-installed in the factory

A much shorter construction programme



Health and Safety is greatly improved

Lightweight construction can reduce foundation and podium costs

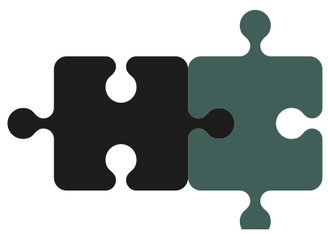
BENEFITS OF MODULAR CONSTRUCTION

Ability to create full scale mock-ups for review

Construction materials are stored in the factory reducing the risk of damage or loss

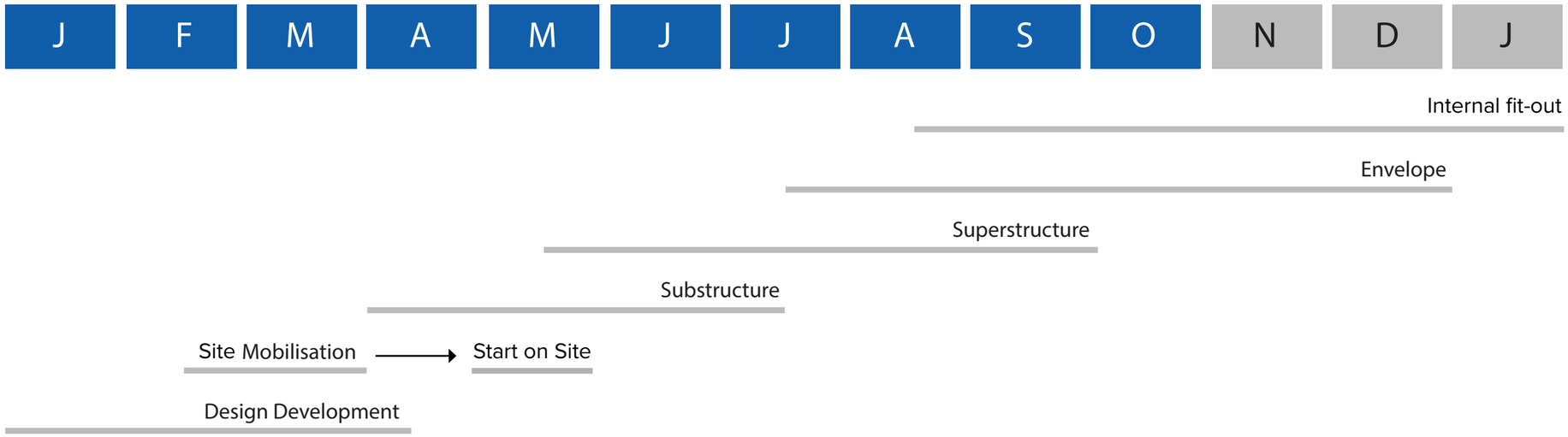
Early occupation and quicker return on investment

Low risk to clients and contractors due to off-site construction ahead of time

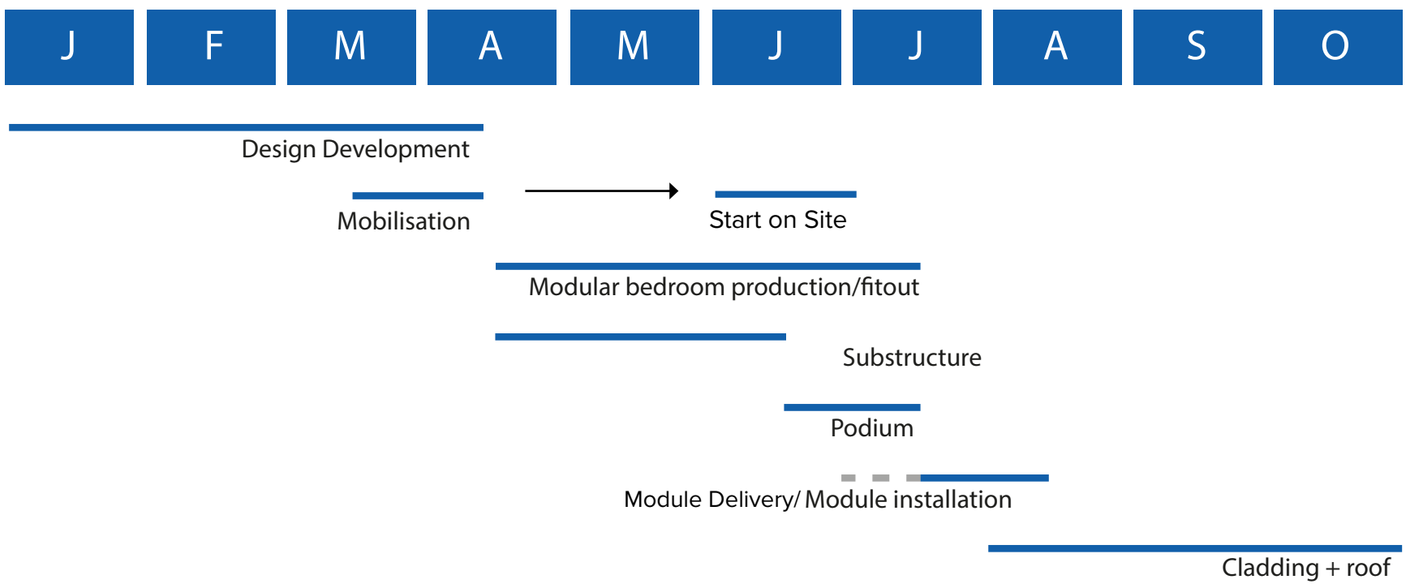


Ability to template all design and specifications for generic building types

Local labour can be used for module fabrication and fit out



traditional
12months



modular
5 months

BENEFIT 01

PROGRAMME

- Modular construction projects are completed up to 50% faster than traditional construction
- Modular manufacture can over-lap with the foundation and preparatory work on site
- Projects can deliver a 35-50% saving due to the speed of construction
- This in turn means a reduced financial cost and an earlier return on investment
- The developer can then benefit from a higher cash flow in the early phase, an early design freeze and off-site material payments
- The reduced construction period reduces disturbance to the locality.

BENEFIT 02

SUSTAINABILITY

- The factory manufacture of the modules leads to efficient use of materials and improved insulation and air tightness that reduces energy use and improves the quality of the built environment.
- Any surplus materials can be recycled back into the inventory for other projects
- Modular systems are potentially demountable and can be re-used as part of a ‘circular economy'
- Worker travel and material deliveries and disturbance during construction are reduced
- More reliable thermal performance of the building components by manufacture in controlled factory conditions.
- Using local workers to add value to the localised supply chain and give a higher quality product
- Less space is needed around the building site, which results in a smaller construction footprint and reduced site disturbance
- This in turn means less disruption to the local community

BENEFIT 03

COST + VALUE

- Costs are more predictable than traditional construction
- Economy of scale in manufacture leads to significant savings in large or repeated projects
- Modular construction can be an excellent choice for projects where affordability and cost control is a primary issue
- Costs will vary for each project and in some cases the modules may need to be overbuilt to meet transportation and set needs, plus more complex designs might increase fabrication costs
- Large modules may need special transport permits which need to be considered in costing
- The reduction in deliveries will mean less need for crane lifts, which could offset the higher cost of larger cranes for the larger components
- Modular construction is a life-cycle investment and needs to be treated as such when costing
- Regardless of the upfront costs, if carried out properly, it should prove to be a more cost effective way to create value in the long-term
- Whether to use modular construction or not should not be decided purely on cost, but on the long-term benefits

BENEFIT 04

SCHEDULE

- Because much of the construction is off-site, this means there is less likelihood of delays due to poor weather, which allows for a much more accurate schedule
- Off-site construction also means work that would normally have to be sequenced can be done simultaneously
- If site work is arranged so pre-construction and building components are constructed at the same time, the schedule can be shortened by 35-50%
- The more construction that takes place off-site, the greater the saving because of the increased amount of time saved on-site
- Building components should be delivered to site according to when the site infrastructure has been finished, which avoids the cost of storage

BENEFIT 05

QUALITY

- Due to the monitored manufacturing setting, the precise use of fabrication tools like CAD/CAM and the ability to automate processes, a high level of quality control and consistency is always maintained
- This is particularly useful when installing sensitive high-tech components like fire and security systems or sensor based controls
- The increased precision in fabrication for exterior wall components gives a much tighter building envelope with higher levels of thermal and acoustic performance
- Customisation can be achieved within the scope of the design/manufacturing process.
- Semi-automated manufacturing processes can achieve significant ‘economy of scale’ and improved quality and reliability.
- Due to the improved quality assurance, this means less snagging and defects
- The production and storage of components in an enclosed building means less weather exposure, which prevents moisture damage and reduces the potential for mould growth

BENEFIT 06

PRODUCTIVITY + EFFICIENCY

- Labour productivity increases when using an off-site approach, due to a factory crew being less affected by adverse weather - meaning a higher level of efficient quality is achieved
- Off-site construction means consistency of work from the crew and a more controlled work flow - less prone to disruption
- A reduction in construction time because of scheduling means building construction can be simultaneous to foundation construction
- Waste reduction of 50 to 70%, due to tighter material control and the use of CAD/CAM
- Making use of standardised components, to give a mass customised approach with a flexible amount of variation to suit client vision

BENEFIT 07

SAFETY

- As the amount of work on site is greatly reduced and is done by specialist teams, worker safety is improved and workers are not exposed to extreme weather conditions, noise etc
- The factory environment improves working conditions and gives a safe, clean construction culture with improved job security and flexible shift patterns
- Serious injury rates are much lower in manufacturing than traditional on-site construction
- By moving construction work to off-site facilities, it could greatly improve the overall culture of construction work through better job security and flexible shift work availability

THE DESIGN PROCESS

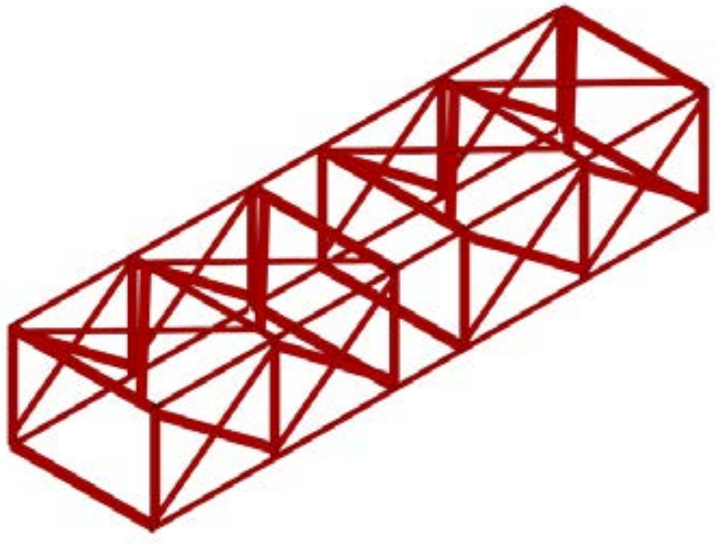
- The manufacturing process requires that design is carried out early and requires a high level of design coordination.
- When the design needs design development, the process of using a prototype is ideal as a full sized room can be manufactured and signed off
- Pre-designed modular systems reduce design time and cost but allow for ‘customisation’.
- Design is carried out by specialist designers and architects as part of the design and manufacturing ‘package’

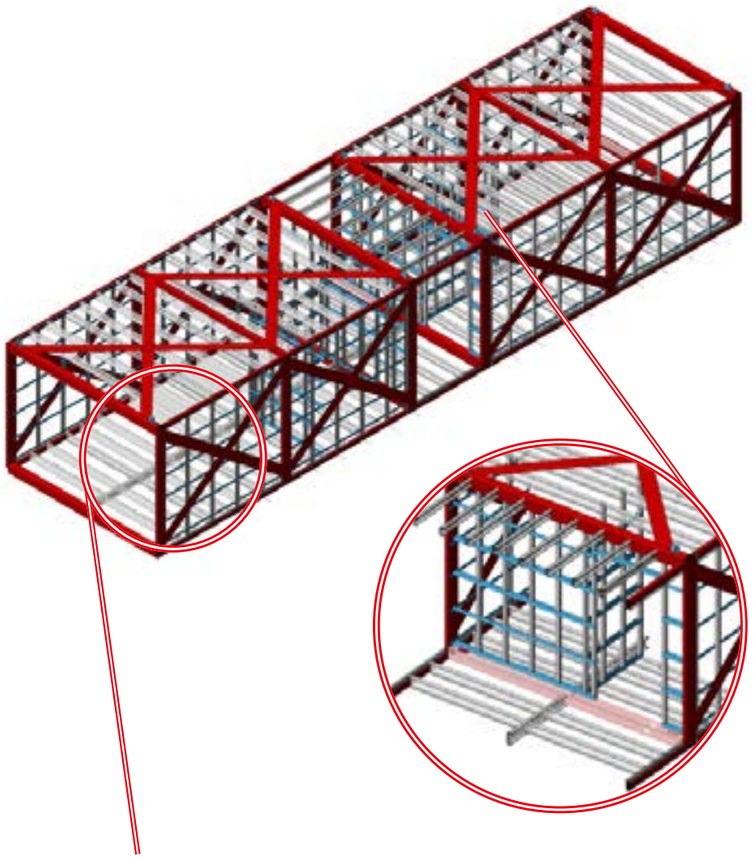
ARCHITECTURAL DESIGN

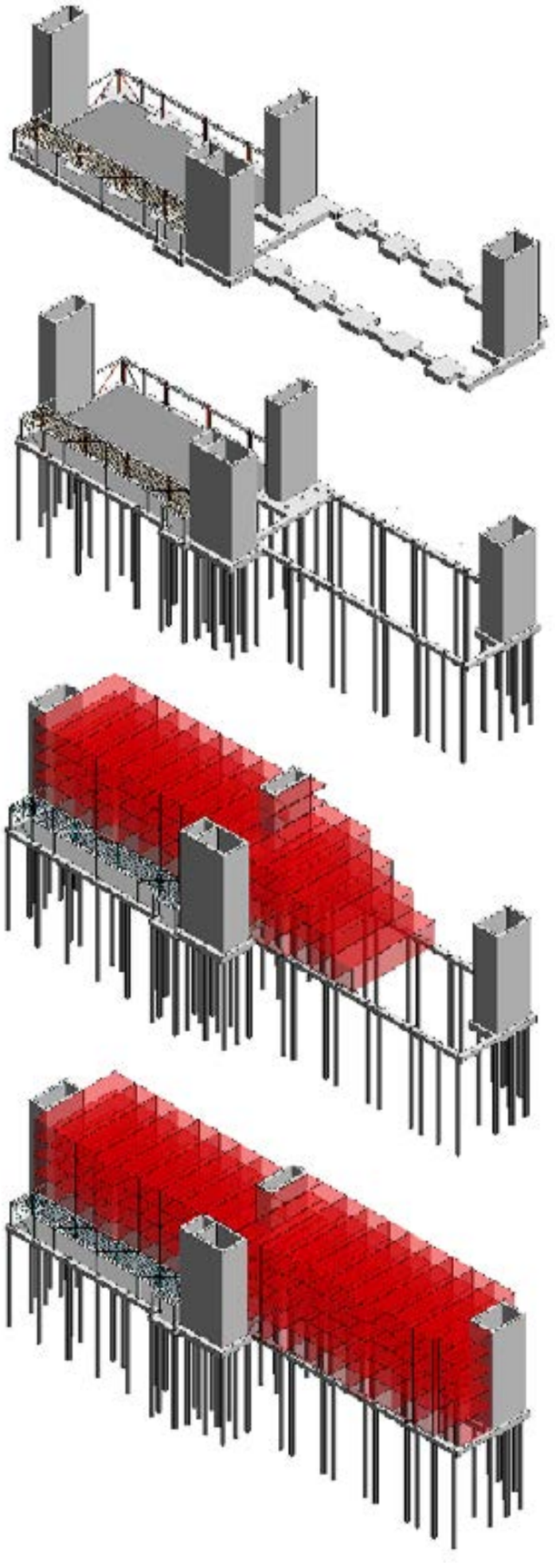
- Modular systems provide opportunities for architectural expression including a variety of cladding systems and features such as patio doors and connected balconies.
- While making use of bearing wall panels, additional columns and beams frame the space between rooms, the window openings and also support the heavy roof mounted structure and plant items
- Modular units are manufactured to a high level of dimensional accuracy.
- The double wall and floor and ceiling construction provide a high level of acoustic insulation and fire separation and enhances the stability and robustness of the building.
- Modules can be designed and manufactured with large openings to create large rooms and patio doors etc
- Customisation can be achieved within the scope of the design/manufacturing process.

STRUCTURAL DESIGN

- When two or more modules are placed next to each other they can be designed with open sides to make larger open spaces
- Designs can also include knock-out-panels in the module bearing walls so smaller rooms can be expanded to suit the changing needs of the space
- Modules will also work alongside traditional construction either below or above the modular components, as loads will be transferred through the bearing walls and isolated columns down to the foundations, which means roof terraces, bars, offices and plant rooms can all be included
- When it comes to tolerances, factory controlled fabrication allows complex interior fit outs to be mass produced, and those buildings with intricate façades can be constructed to a high level of accuracy through the pre-installation of glazing and cladding elements

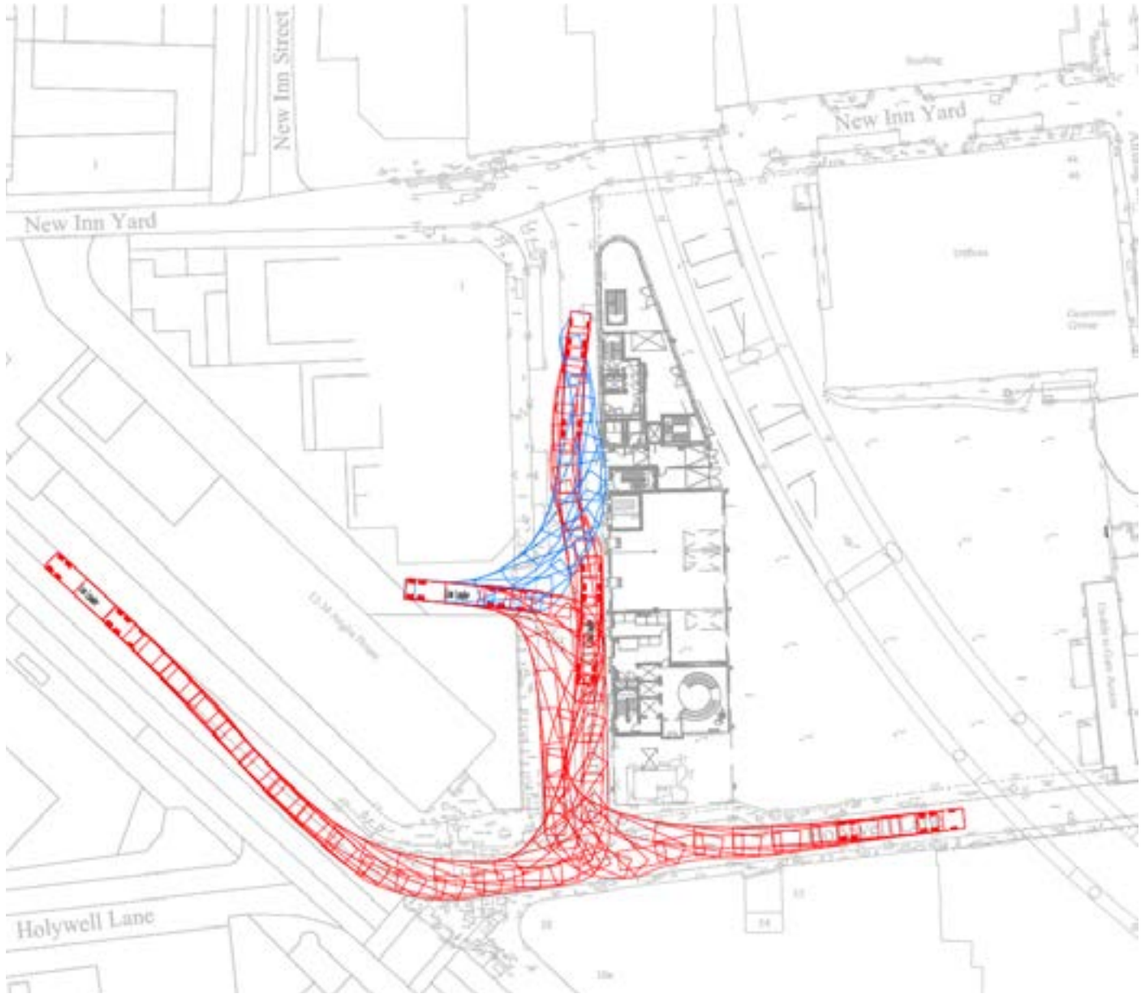






FACTORY SYSTEMS

- Modular manufacturing achieves a high degree of integration of complex equipment and services, including renewable energy systems. This is important in medical facilities and plant rooms etc.
- Semi-automated manufacturing processes improve efficiency and materials ordering and handling with ‘just in time’ delivery to site
- Modular units can be manufactured with customisation in internal fit-out and furniture , if required.
- Modular construction is a realistic and affordable option and a viable alternative to a labour-intensive, time-consuming on-site production and assembly
- Modules are lifted and connected at 4 or more points depending on their size and connectivity on site is efficient.

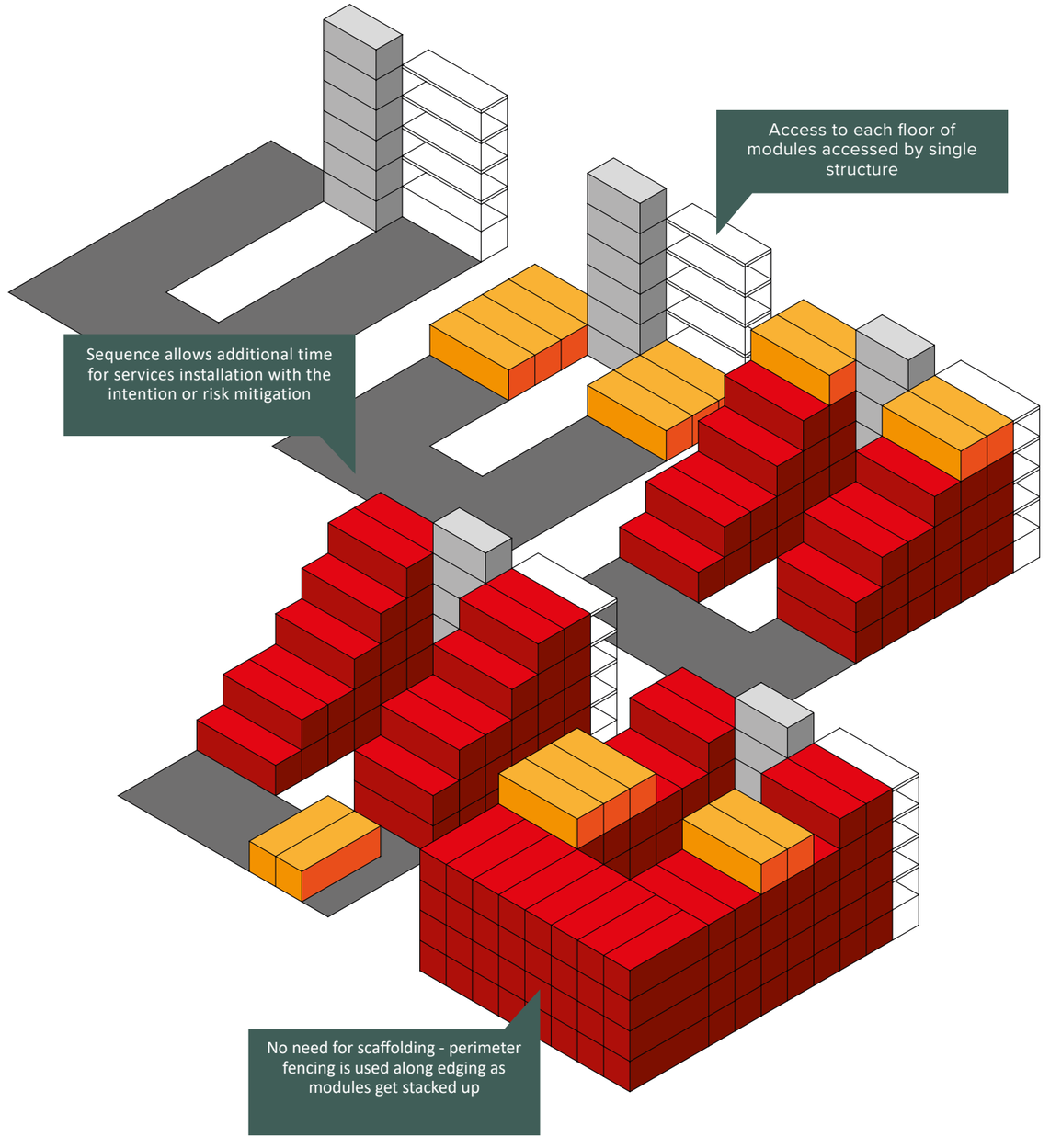


Logistics

• Manufacturers of modular systems can give a full lifting service with a team who are fully certified to design and deliver modular projects

• Our team of architects and design experts will help you come up with the best design solutions, then the team of logistic experts will make sure your delivery runs smoothly

• Also, in addition to supplying RAMs (Risk Assessment and Method Statement) and a lifting and stacking plan, a local contractor will be engaged for crane hire

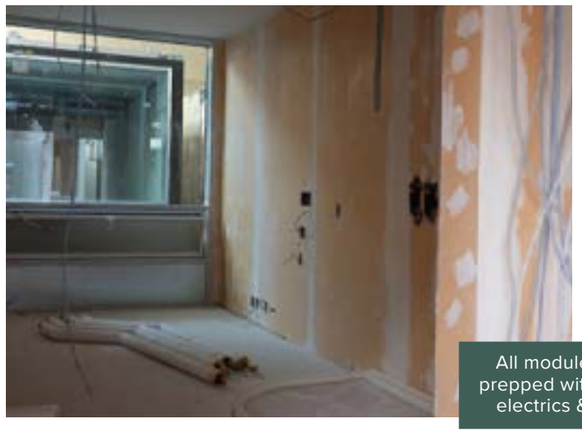


MODULAR CONSTRUCTION SEQUENCES

How To Design Modular

MODULAR CONSTRUCTION SEQUENCES

STORAGE & TRANSPORTATION



All modules are fully prepped with insulation, electrics & A/C units

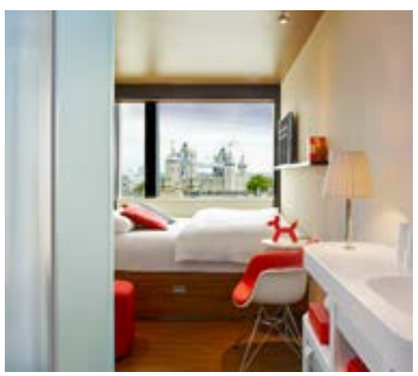
Joints between modules are sealed

Modules are lifted into position by crane

How To Design Modular

STORAGE + TRANSPORTATION / SURVEY + INSTALL SEQUENCE

Modules are transported from factory to transporter lorry by steel frame bracing



Components of the Modules

The 3-D modular units are manufactured off-site and provide the primary structure of the building. They have the following features:

Structure

A robust steel frame forms the structural backbone of the unit. These frames are precisely engineered and often feature demountable connections, allowing for easy assembly, disassembly, or relocation. This flexibility supports stacking for multi-storey buildings and adaptability to different sites.

MEP (Mechanical, Electrical, Plumbing)

Services are pre-integrated into the module during factory fabrication. This includes heating, ventilation, plumbing, and electrical systems, all installed under controlled conditions. Prefabricated MEP reduces on-site work, improves safety, and ensures consistent quality.

Façade

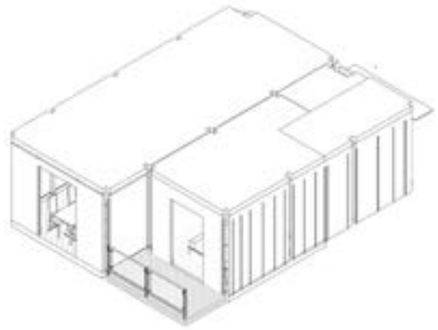
The exterior envelope includes insulation, cladding, windows, and weatherproof layers. Designed for energy efficiency and durability, the façade can be tailored to local aesthetics and climate requirements while meeting high performance standards.

Complete Unit View

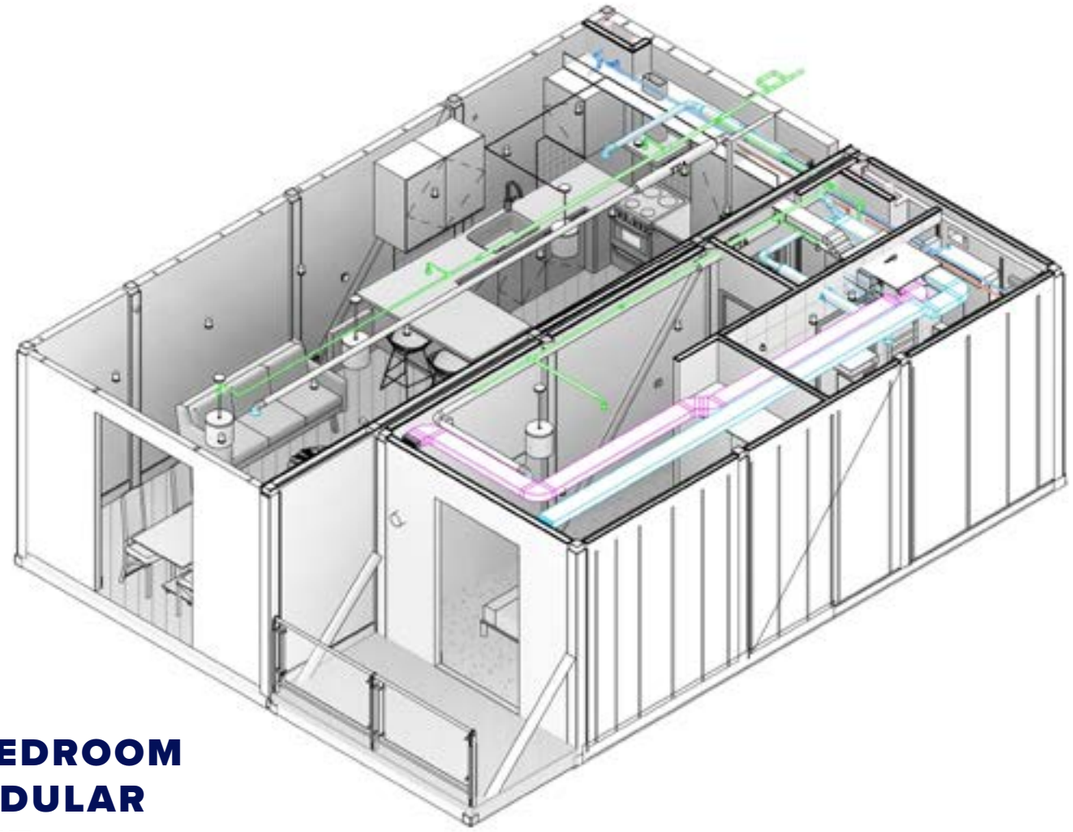
The assembled module integrates all these systems into a finished, move-in-ready apartment. Off-site production ensures speed, reduced waste, and reliable quality—making it ideal for large-scale housing projects and post-disaster reconstruction efforts.

STRUCTURE

MEP



FACADE



1 BEDROOM MODULAR UNIT

Design of the Modules

Layout

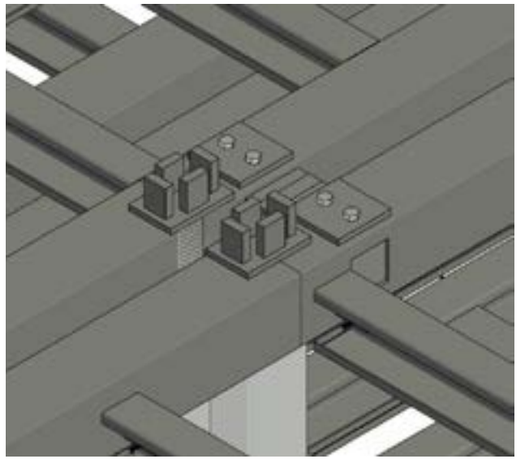
The plan view shows a well-designed living space with an open kitchen/living area, private bedroom, and integrated bathroom. Carefully planned circulation, built-in storage, and pre-installed services make the unit highly functional and comfortable despite its compact footprint.

MEP Integration

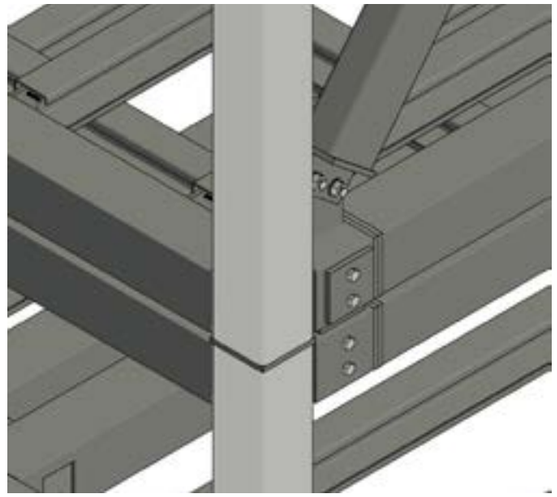
Coloured overlays in the plan highlight factory-installed Mechanical, Electrical, and Plumbing (MEP) systems. This approach ensures precise, consistent quality while dramatically reducing on-site installation time.

Structure Detail and Connection

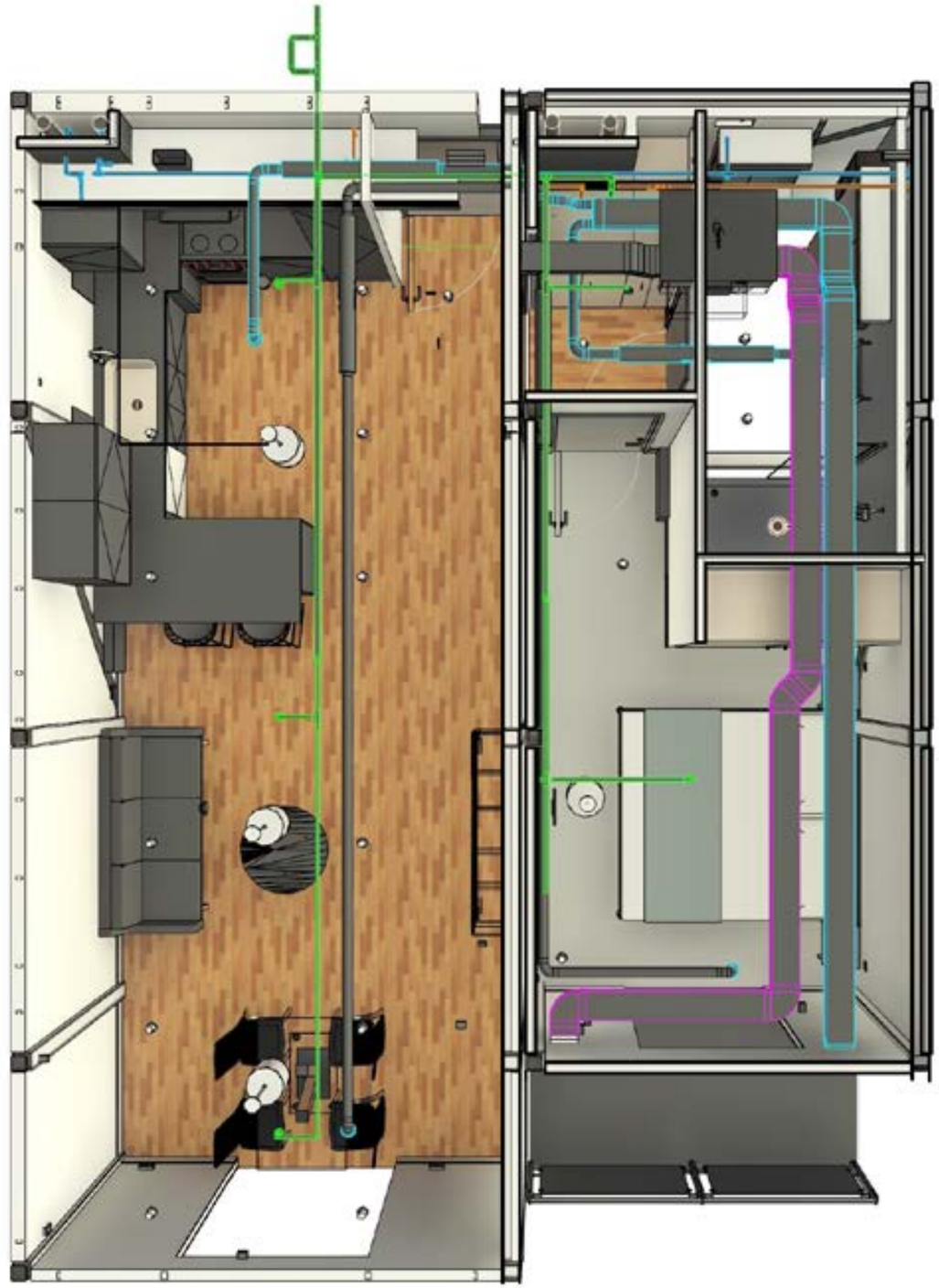
Close-up views of the steel structure connection and detail demonstrate the module's engineered steel frame. These connections are specifically designed to be demountable and reusable, enabling easy assembly, disassembly, relocation, or even reconfiguration over time. This flexibility supports sustainable building practices by allowing structures to be adapted or reused as needs change.



STRUCTURE CONNECTION



STRUCTURE DETAIL



1 BEDROOM MODULAR LAYOUT

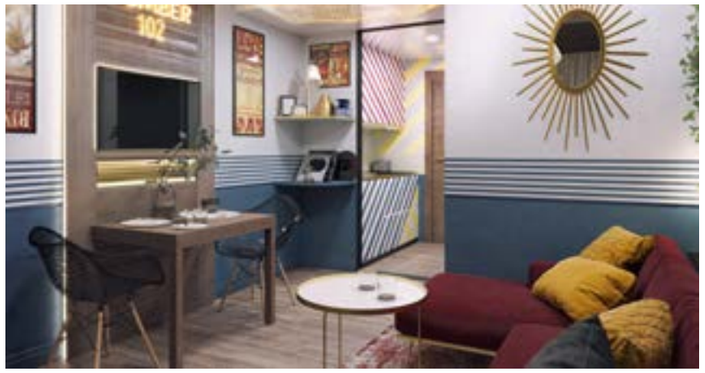
INTERIOR DESIGN

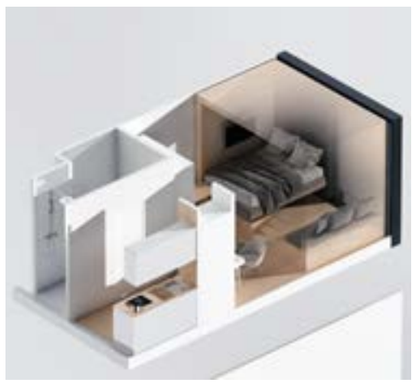







UNIT DESIGN

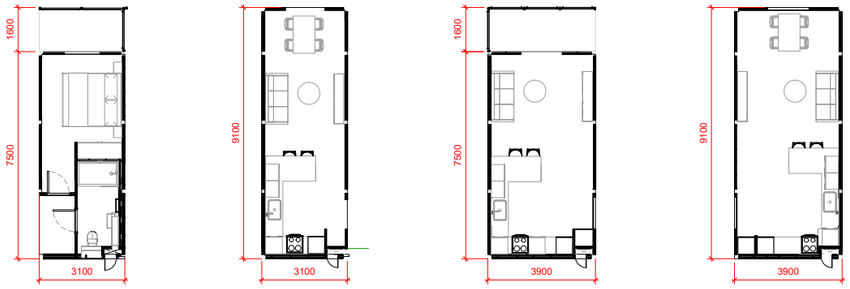




Details of the Modules

The proposed modular system has the following features:

- The modules for the main living space are 3.9m wide and 7.2m to 10.8m long (external dimensions). The bedroom modules are 3.1 or 3.3m wide.
- The modules are 3m or 3.2m external height and 2.5m or 2.7 m internal height.
- The combined width of the walls of adjacent modules is 300mm (allowing for a nominal 50mm gap between the modules): The target external wall width including cladding and insulation is 300 to 350mm (additional cladding zone is 175 to 225mm).
- The module sizes means that they can generally be transported on urban and inter-urban roads without an escort and can be lifted into place by a mobile crane.
- The modules are light weight (less than 200 kg/ m2 floor area) so that an internally finished module weighs approximately 5 Tonnes. The modules can be lifted by a 20 to 35 Tonne capacity mobile crane, depending on the building form and height.
- The modules are designed to be stable under wind and modest seismic loads for 3 and 6 storey buildings and to support the vertical loads from the modules above.
- The double layer construction of the walls and floor/ceiling has excellent acoustic insulation and fire resistance (up to 120 minutes).
- External sheathing boards provide weather protection and stability during transport and lifting.
- Prefabricated balconies may be attached to the ends of the modules. The modules are also designed with a potential for two 2m wide openings in their sides to create wider spaces by combining modules.

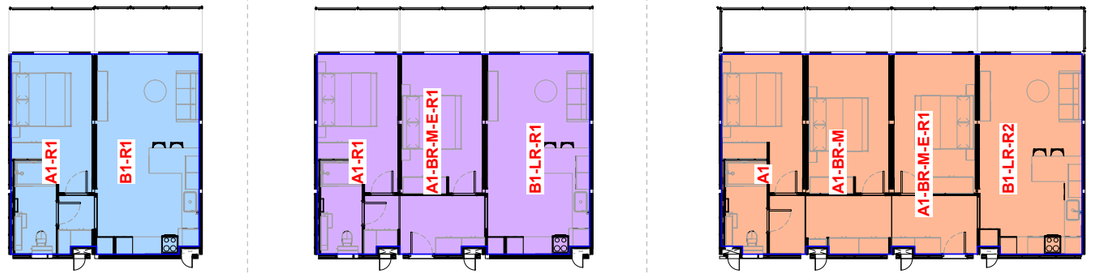
MODULE TYPE



MODULE A1 | MODULE A2 | MODULE B1 | MODULE B2

APARTMENT TYPE

BALCONY



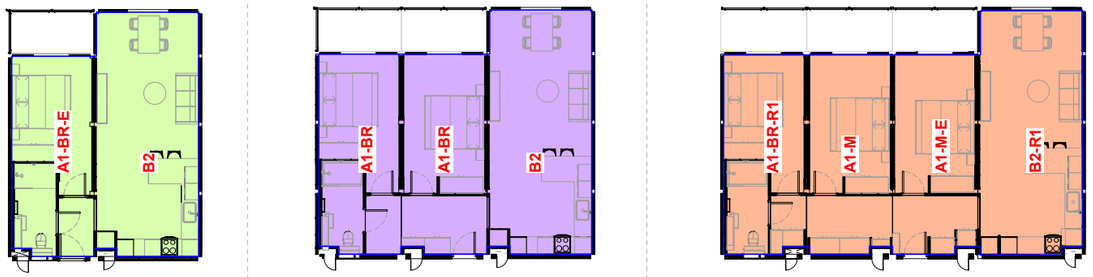
GIA: 48 sqm — STUDIO

GIA: 70 sqm — 2 BEDROOM

GIA: 93 sqm — 3 BEDROOM

APARTMENT TYPE

INSET BALCONY



GEA: 54 sqm — 1 BEDROOM

GEA: 76 sqm — 2 BEDROOM

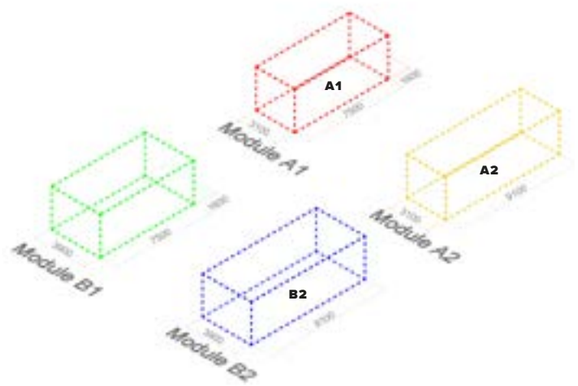
GEA: 98 sqm — 3 BEDROOM

Modules

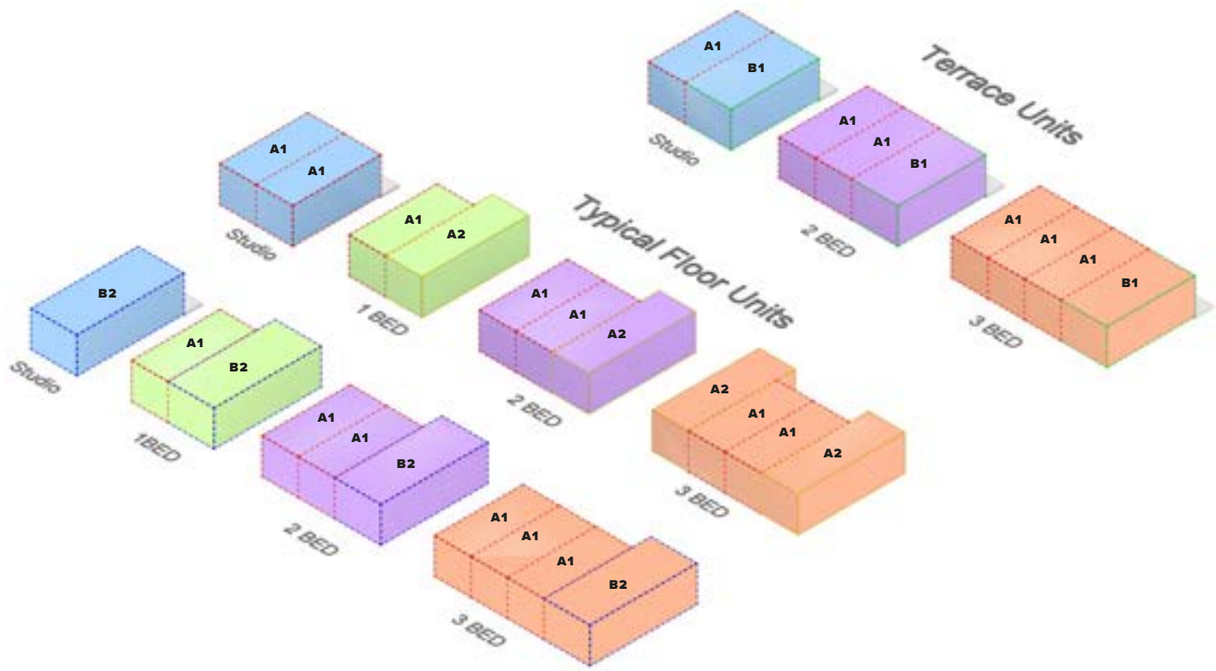
- All modules have a 300mm x 450mm services riser one end of the module.
- The modules may have different internal layouts with the bathroom and kitchen being located next to the service riser.
- Modules for housing can incorporate stairs and openings in the floor and ceiling.
- The same module sizes may also be designed as stair and lobby modules with the option of a single lift (for buildings of 4+ storeys).
- A variety of cladding systems may be used. The modules are durable until the cladding is installed ‘off the critical path’.
- The modules and their cladding may be supported on prefabricated ground beams and pile caps supported by single driven piles.

All modular systems can be assembled and demounted, or modules re-used, as part of a ‘circular economy’. The modules can also be designed to be resistant to blast fragmentation. Damaged modules can be replaced.

MODULE TYPES



APARTMENT TYPES



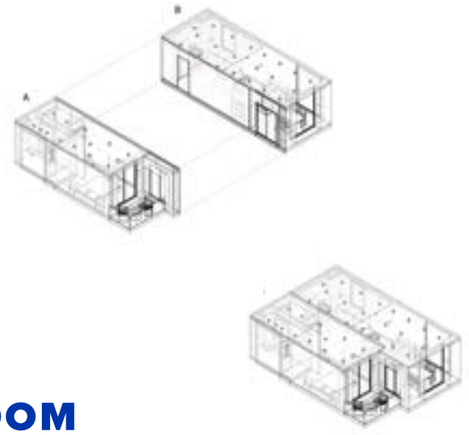
Unit Types

The nature of modular construction through typical unit configurations is flexible and scalable. Modular construction uses prefabricated volumetric units that can be combined in various ways to create different apartment types while maintaining efficiency in design and production.

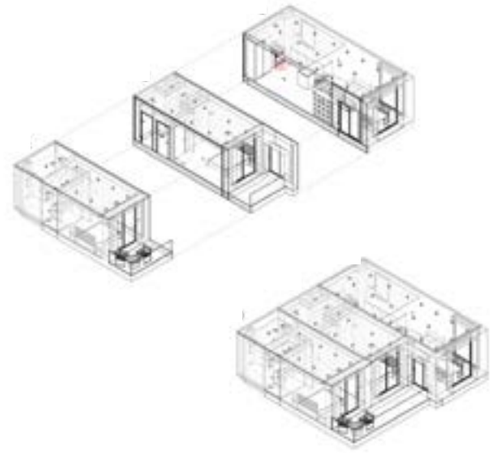
One Bedroom Units:
Compact, efficient layouts ideal for singles or couples. The image shows variations in one-bedroom modules, each designed to maximize space with integrated living, kitchen, and bedroom zones. These units can be deployed singly or stacked in multi-unit buildings.

Two Bedroom Units:
These layouts offer greater flexibility for small families or shared living. The modular system allows two-bedroom units to be configured with different orientations and footprints, enabling design adaptability while standardizing construction elements for cost efficiency.

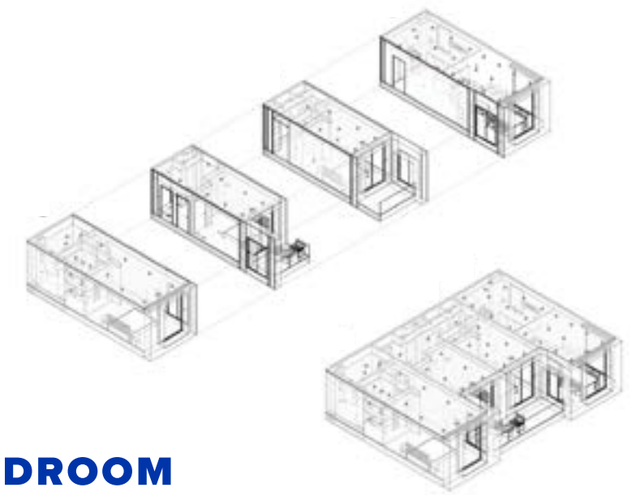
Three Bedroom Units:
Larger modules designed for family living. These configurations provide expanded living areas and additional bedrooms while maintaining the modular approach's benefits—speed of construction, quality control in manufacturing, and reduced site disruption.



ONE BEDROOM



TWO BEDROOM

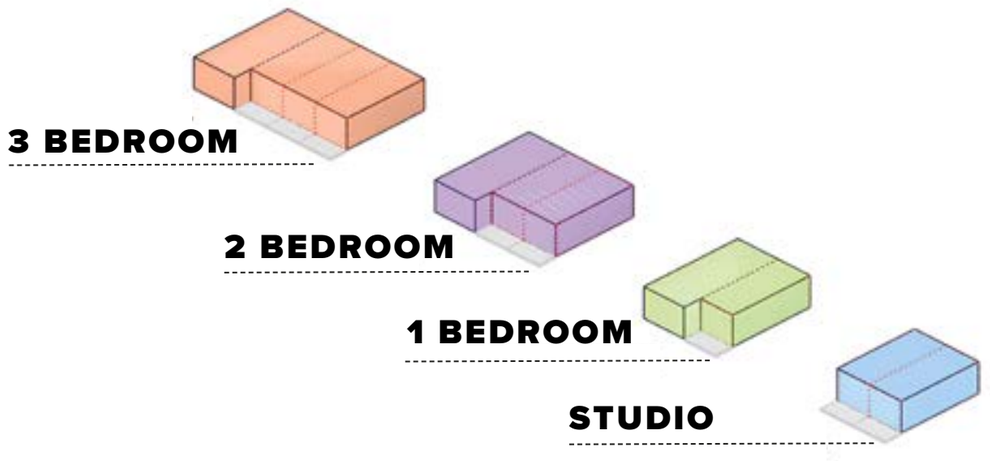


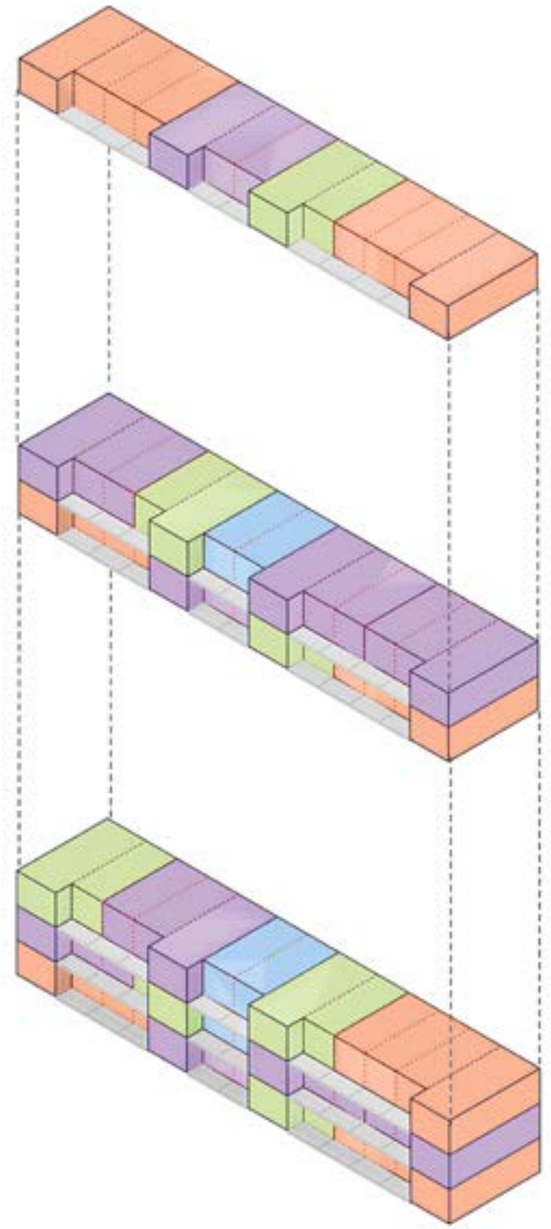
THREE BEDROOM

Potential Combinations

Proposed Modular Building Typologies

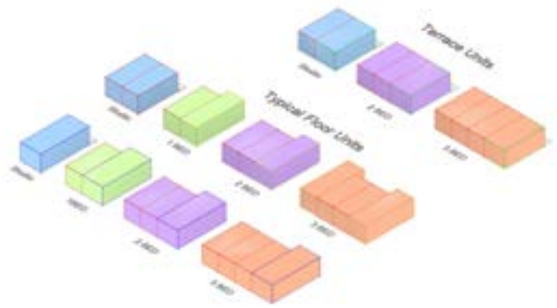
- It is proposed that the following building typologies should be considered to meet the largest demand for rapid re-building of Ukraine:
- Two-storey individual housing and terraced housing consisting of 4 modules per house.
- 2 and 3 storey maisonettes (houses at one level) with separate external access and consisting of 2 or 3 modules per level (4 to 9 modules in total).
- 3 to 4 storey residential buildings with 8 to 12 modules per level, including modular stairs and lobby (25 to 48 modules per building).
- 5 to 8 storey residential buildings based on a corridor layout with 20 to 30 modules per level (100 to 200 modular units per building), and requiring a concrete lift and stair core for fire safety and stability.
- 2 to 4 storeys of modules placed on a podium structure to create a workshop or office, or shops or public space at ground floor with separate access to the residential levels, The first-floor podium could be built in concrete using recycled concrete rubble as aggregate, or as a steel frame.
- The modules should be adaptable to a range of configurations-. A 2:1 ratio of length to width of the modules means that they can be re-orientated and connected easily.



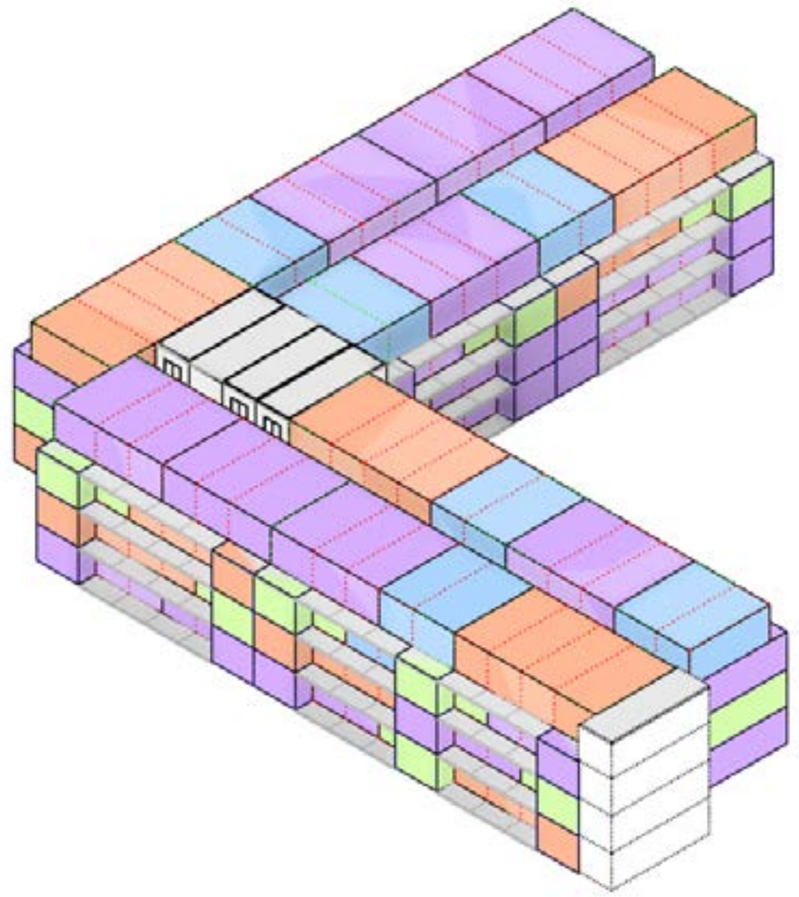


VARIED PLAN CONFIGUURATION

Potential Combinations

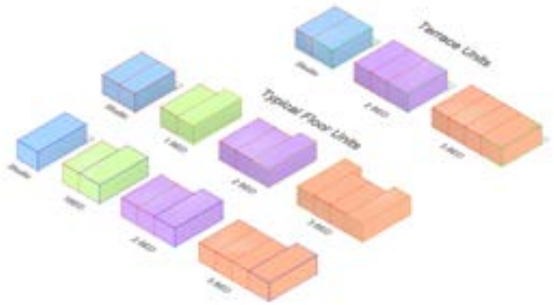


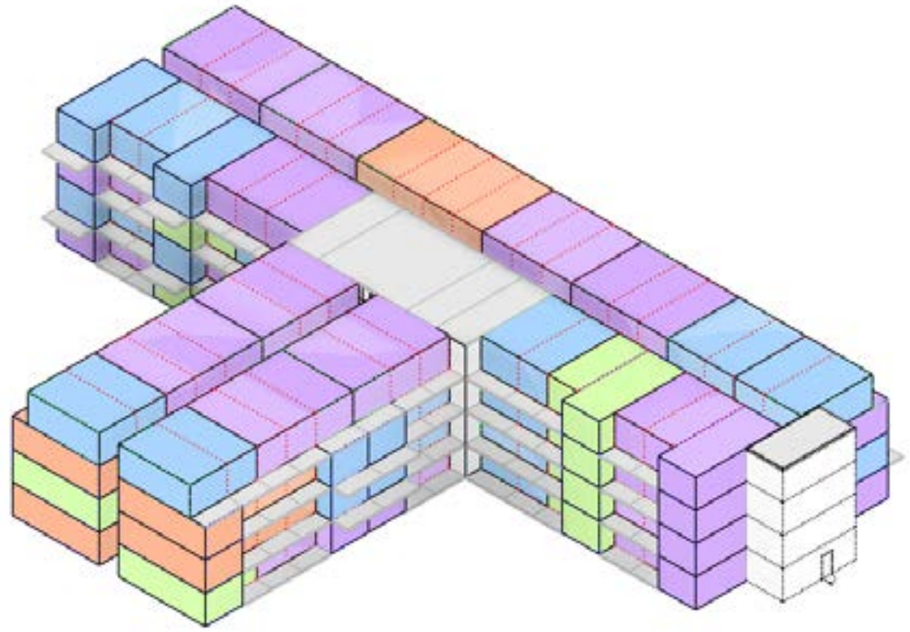
APARTMENT TYPES



TYPE L

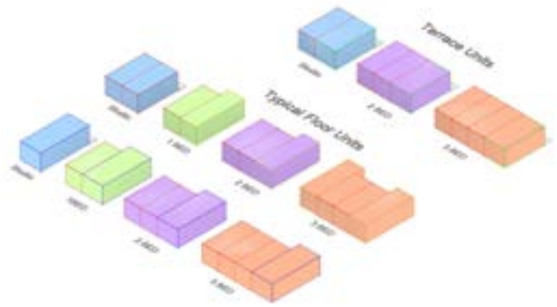
Potential Combinations



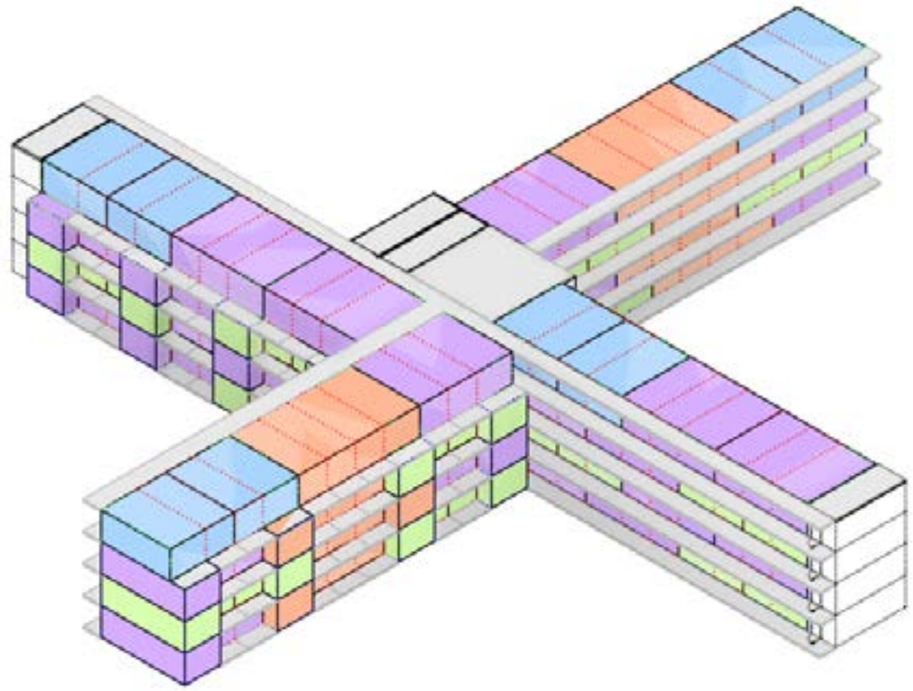


TYPE T

Potential Combinations

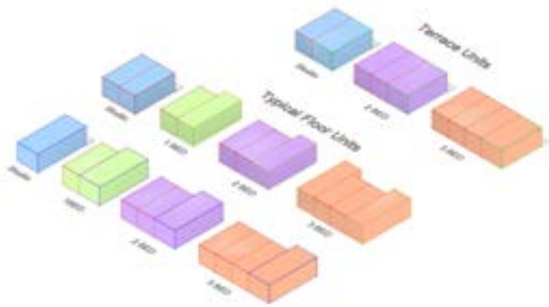


APARTMENT TYPES

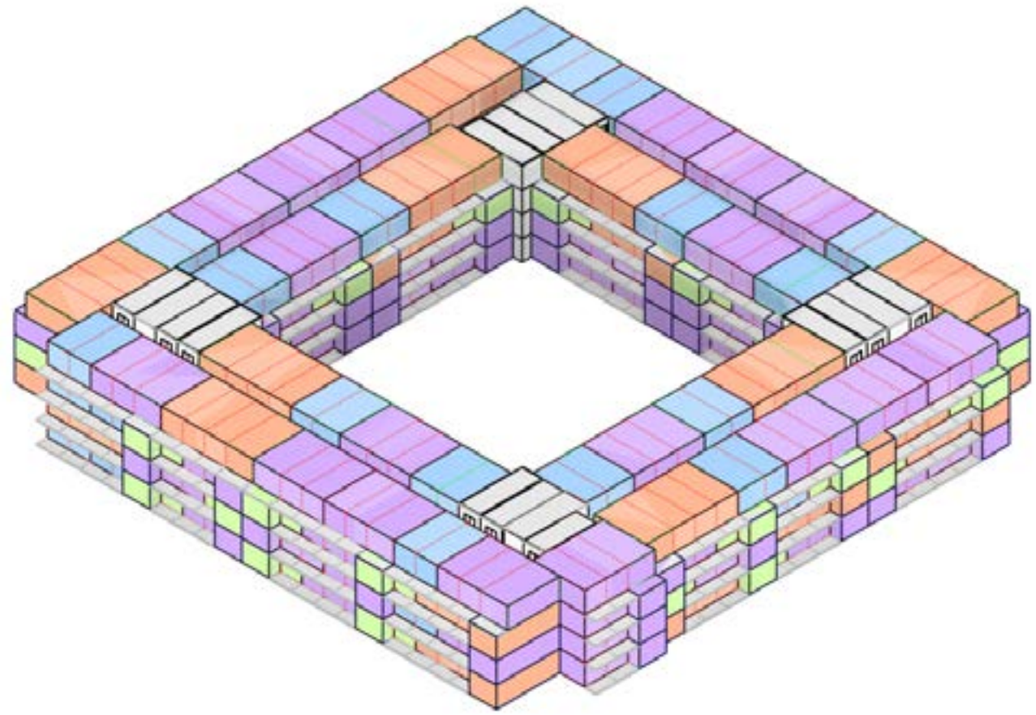


TYPE X

Potential Combinations

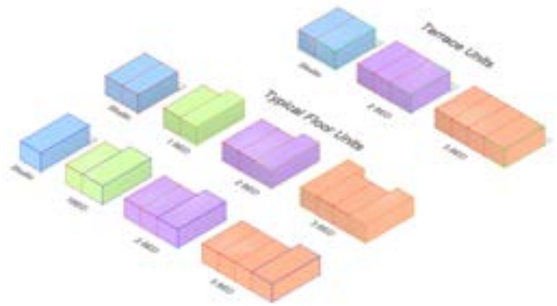


APARTMENT TYPES



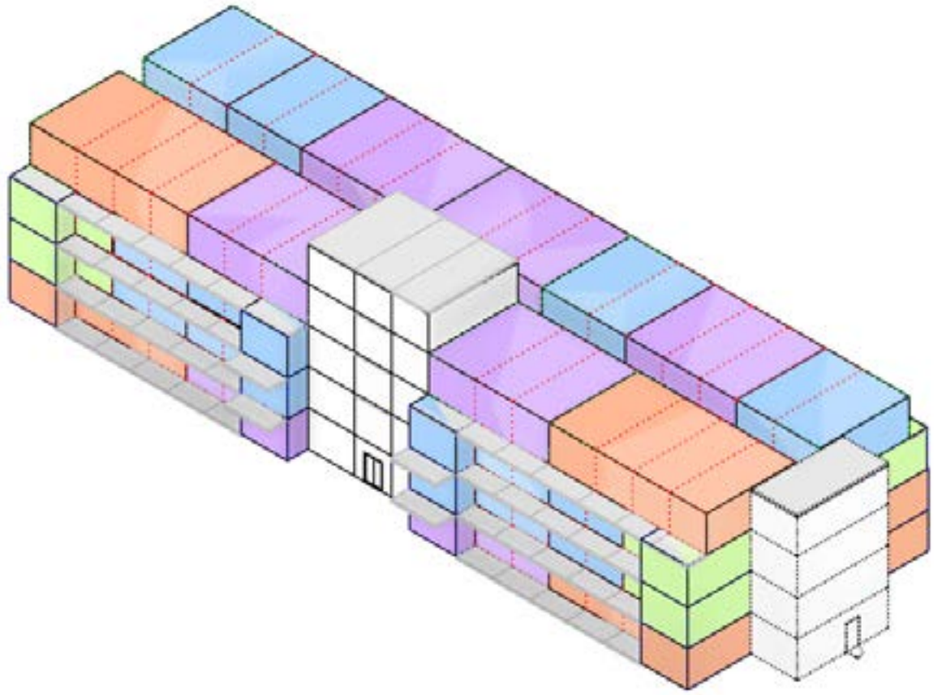
TYPE O

Potential Combinations

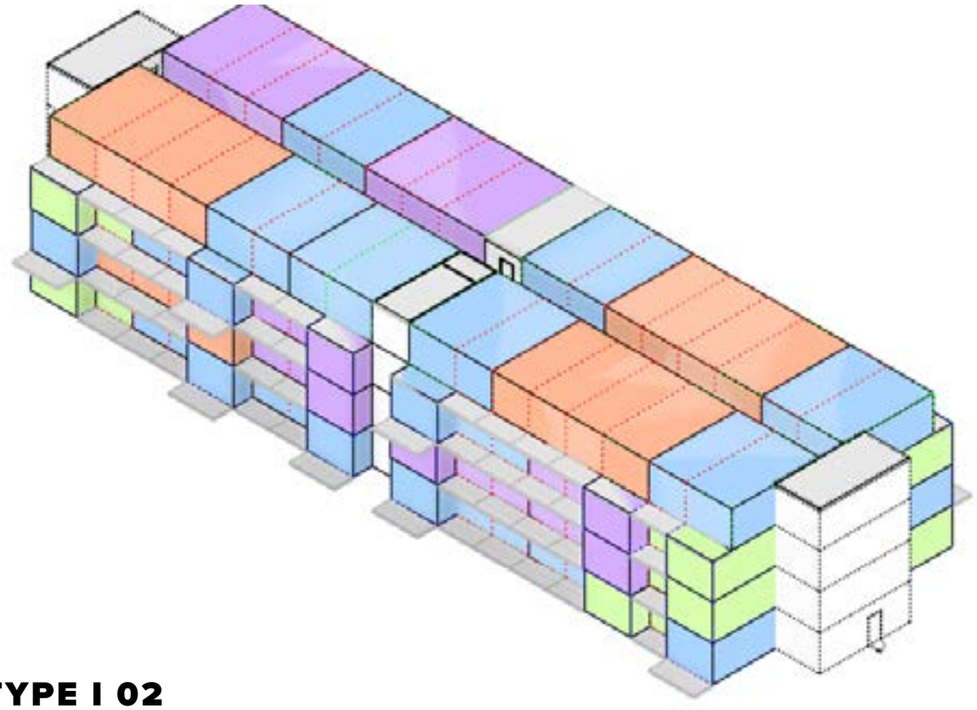


APARTMENT TYPES

SYSTEM DESIGN
BUILDING TYPES



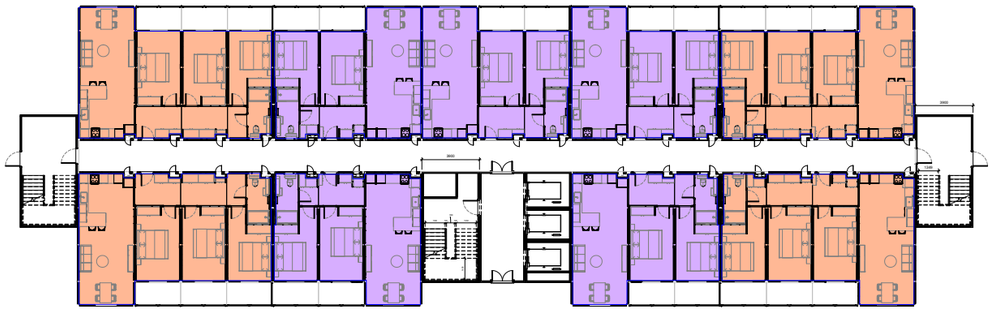
TYPE I 01



TYPE I 02

Potential Combinations

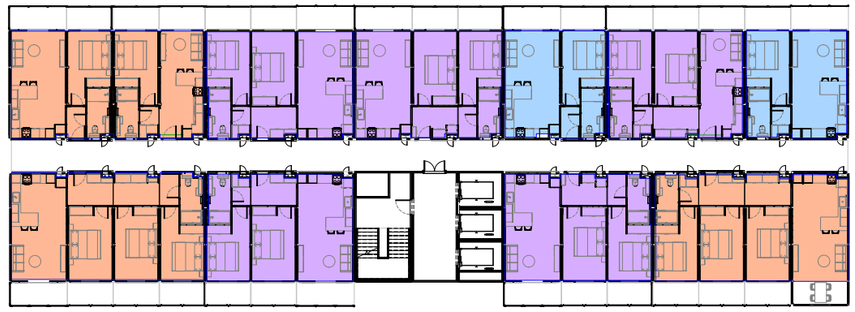
SYSTEM DESIGN
LAYOUT VARIATION



1 Level 00
1 : 100

Mixed use potential
A1 and B2 cages can be adapted to student residential or hotel or apart hotel rooms

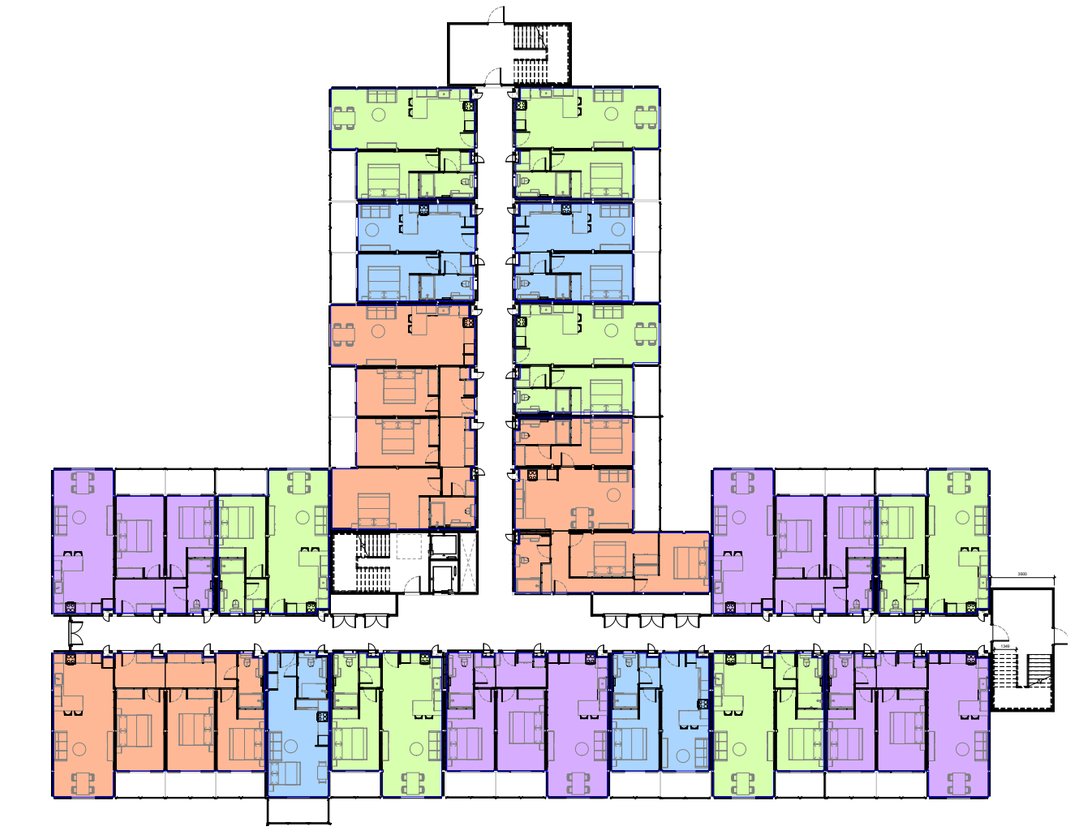
1 Level 02
1 : 100



2 Level 03
1 : 100

Potential Combinations

SYSTEM DESIGN
LAYOUT VARIATION



1 **Level 00**
1 : 100

Consequence Classes in Ukrainian Construction Standards

All construction projects in Ukraine are classified at the design stage according to one of three consequence classes:

- CC1 – Buildings with insignificant consequences
- CC2 – Buildings with medium consequences
- CC3 – Buildings with significant consequences

This classification is based on the potential risk to human life, social impact, and the economic value of the building,and it determines the level of regulatory oversight, design complexity, and safety requirements.

Criteria for consequence class CC1:
- Danger to people permanently present - up to 50 people
- Danger to people temporarily present - up to 100 people
- Danger to people in the adjacent territory - up to 100 people
- Material damage - up to 425,000 Euro

CC1 includes:
- Single-family private houses
- Residential buildings up to 3-4 floors
- Small public buildings
- Small retail enterprises
- Coffee shops, cafes, and restaurants

Criteria for consequence class CC2:
- Danger to people permanently present - 51-400 people
- Danger to people temporarily present - 101-1,000 people
- Danger to people in the adjacent territory - 101-50,000 people
- Material damage - up to 8,500, 000 Euro

CC2 includes:
- Residential buildings over 3-4 floors
- Residential and public buildings no higher than 73.5 m
- Hotels, dormitories, offices
- Retail and public catering establishments
- Sports halls
- Polyclinics

Criteria for consequence class CC3:

- Danger to people permanently present - over 400 people
- Danger to people temporarily present - over 1,000 people
- Danger to people in the adjacent area - over 50,000 people
- Material damage - over 8,500 000 Euro

CC3 includes:
- Residential buildings with a conditional height from 73.5 m to 100 m
- Non-industrial buildings with a conditional height over 100 m
- Shopping and entertainment and multifunctional centers
- Universities, institutes, schools
- Hospitals
- Large industrial facilities
- Infrastructure facilities
- Civil defense shelters

Design Loads for Buildings in Ukraine

1. Dead Loads:
- Self-weight of structural elements (walls, floors, roofs, finishes)
- Permanent equipment and non-removable fixtures

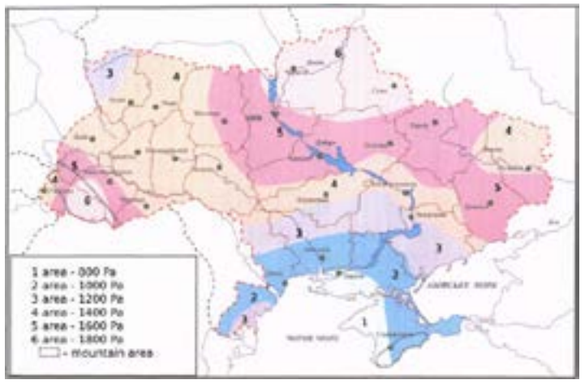
2. Live Loads (According to DBN B.2.1-10-2009):
- Residential buildings: 1.5–2.0 kN/m²
- Offices and schools: 2.0–3.0 kN/m²
- Corridors, stairs, public areas: up to 4.0 kN/m²

3. Snow Load:
- Ranges from 0.8 to 1.8 kN/m²

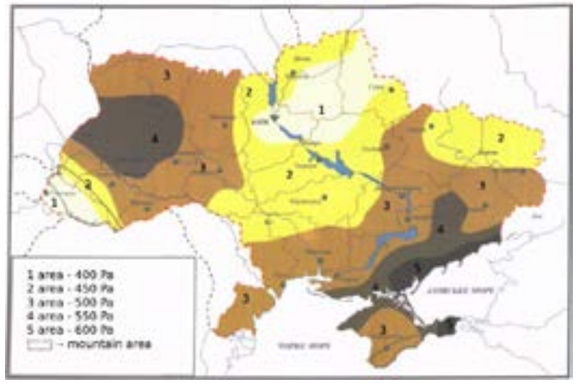
4. Wind Load:
- Ranges from 0.4 to 0.6 kN/m²

5. Seismic Loads:
- Considered in seismically active regions (e.g., Zakarpattia, Crimea, Odesa)

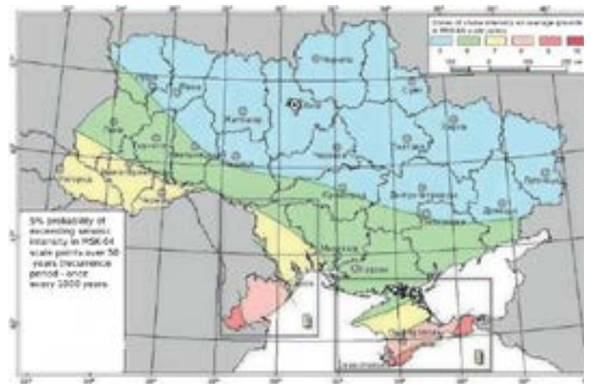
Snow Load



Wind Load



Seismic Loads (CC1 and CC2)

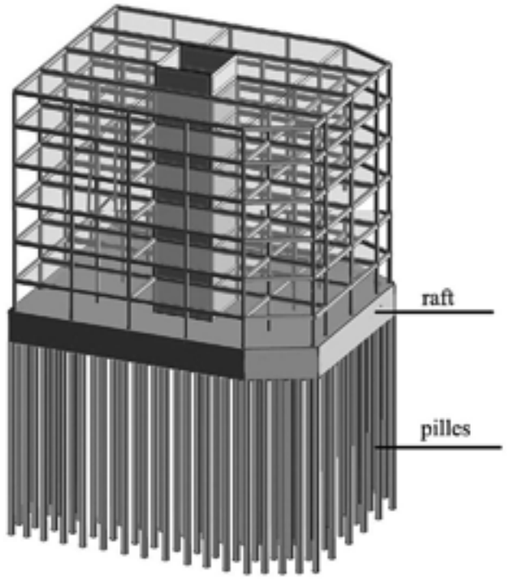


Ground conditions in Ukraine

Key Factors
- Soil Conditions(clay, loess, sand etc)
- Groundwater Table (high water levels demand drainage or waterproofing)
- Frost Depth (foundations must go below 0.8–1.4 m)
- Seismic Risk

Common Foundation Solutions
- Strip Foundation (for low-rise buildings on stable ground)
- Raft Slab (for weak or variable soils)
- Raft on Piles (for poor ground conditions, flood-prone or seismic areas)

Foundation Solutions 5 - 6 Storey Modular Residential Buildings
- Underground shelters are mandatory and are often combined with parking
- This makes a Raft Slab foundation the most rational solution
- In difficult soil conditions - Raft on Piles Key Factors



Structure and Materials Description

1. Construction site: Lviv, Lviv Oblast, Ukraine.
2. Purpose of the building: Residential building.
3. Consequence class: CC2 – in accordance DBN V.1.2-14:2018 "General Principles for Ensuring Reliability and Structural Safety of Buildings and Structures"
4. Material used: Steel grade S245.
5. Load determination and load combination:
- Design loads and load combinations have been defined in accordance with DBN V.1.2-2:2006 “Loads and Actions. Design Standards”:
6. The strength and deformability of the steel structures have been calculated in accordance with DBN V.2.6-198:2014 "Steel Structures. Design Standards"
7. Limit state deformation criteria have been adopted in accordance with Table 4 of DSTU B V.1.2-3:2006 “Deflections and Displacements. Design Requirements”.

Loading

Self-weight of structures

The self-weight of the load-bearing structures is automatically assigned by the software based on the previously selected cross-sections of the elements.

Dead Load

Typical self-weights of the modules:

Floor of module	1.3 kN/m2
Ceiling of module	0.7 kN/m2
Side walls	0.5 kN/m2
Façade walls	0.6 kN/m2

Foundation in Ukraine

Key Factors
- Soil Conditions(clay, loess, sand etc)
- Groundwater Table (high water levels demand drainage or waterproofing)
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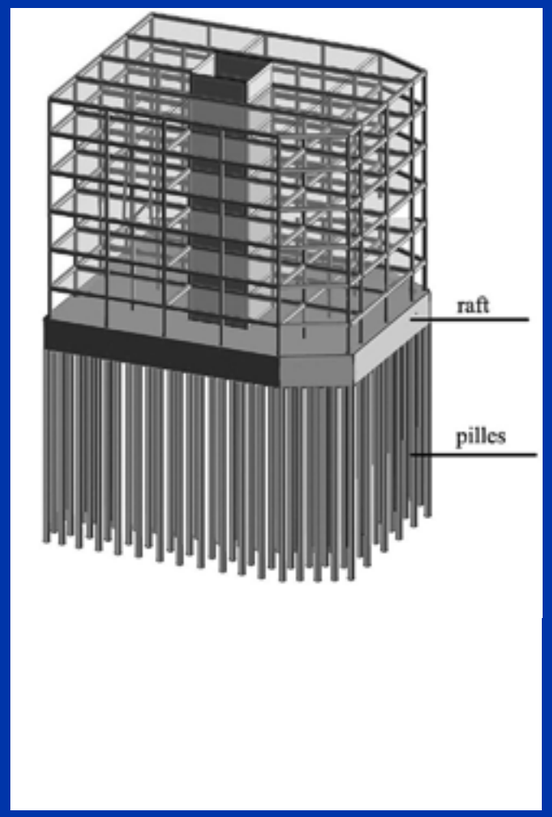
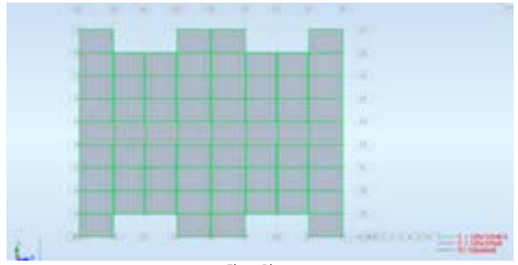
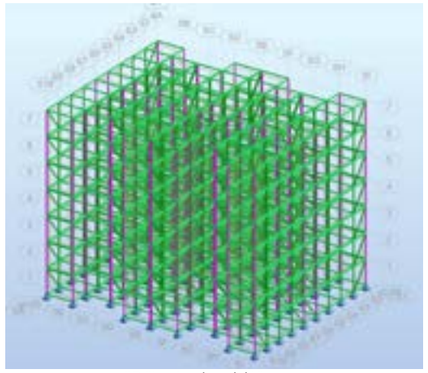


Structural Calculations

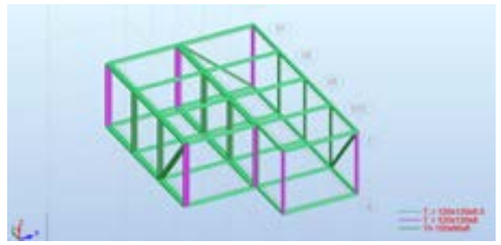
Each module is connected to adjoining modules by means of bolted connections, creating a three-dimensional structural system that ensures stability and rigidity in both principal directions



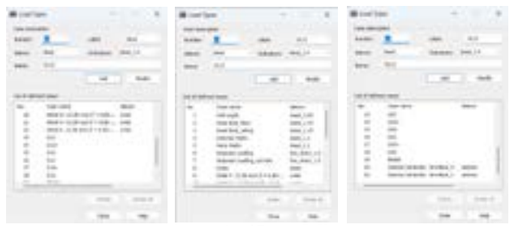
Floor Plan



3D Structural model View



3D Module View



Load Types

Mobile Shelters

Mobile shelters provide rapid, adaptable protection where
permanent structures are unavailable.

Used when:
- No stationary shelter within 500m
- Underground shelter is technically unfeasible
- Temporary gatherings (markets, stops, events)

Key Features:
- Made of precast concrete, metal, or reinforced plastic
- Basic protection: debris shielding, ventilation, entry/exit
- Must meet SESU safety standards and be approved by local
authorities

These shelters are a flexible solution for civilian safety in high-risk
or crowded areas

Stationary Shelters

- Must accommodate 100% of building residents
- Minimum 0.6 m² per person
- Parking areas can serve as shelters
- Area distribution:
- ~ 50% for parking
- ~ 50% for auxiliary shelter functions
- Wall thickness: minimum 350 mm
- Concrete grade: minimum C20/25

Compliance to local codes

1. According to the regulations, the minimum ceiling height is 2.5 m for all regions of Ukraine except for the southern regions: Odesa, Kherson, Zaporizhzhia, and Mykolaiv. For these areas, the required minimum ceiling height is 2.7 m.

2. For the bathrooms the minimum required area is 4.9 m².

3. The minimum hallway width requirement is 1.6 m, as stated in clause 5.22 of DBN V.2.2-15:2019.

4. Windows/glazing connecting living rooms to balconies/loggias needs to be “fire-resistant” solid wall sections.

5. At least 1.2 m wide from the edge of the opening to the end of the balcony/loggia;
At least 1.6 m wide between openings.

6. The width of stair flights must be no less than 1.35 m.

7. Stairwell width — the minimum requirement in Ukraine for this dimension is 120 mm.

Ukrainian fire protection regulations allow the use of multiple passive fire protection methods, as long as the combined system achieves the required REI rating.

Therefore, for example, to meet the 120-minute requirement for columns, it may be necessary to combine plasterboard cladding with intumescent paint.

The paint could provide the additional 60 minutes needed.

According to current Ukrainian standards, it is permissible to design an apartment or apartment block without a vestibule or entrance hallway.

The key requirement is that the widths of the corridors and adjoining rooms meet the minimum dimensions specified by the building codes.

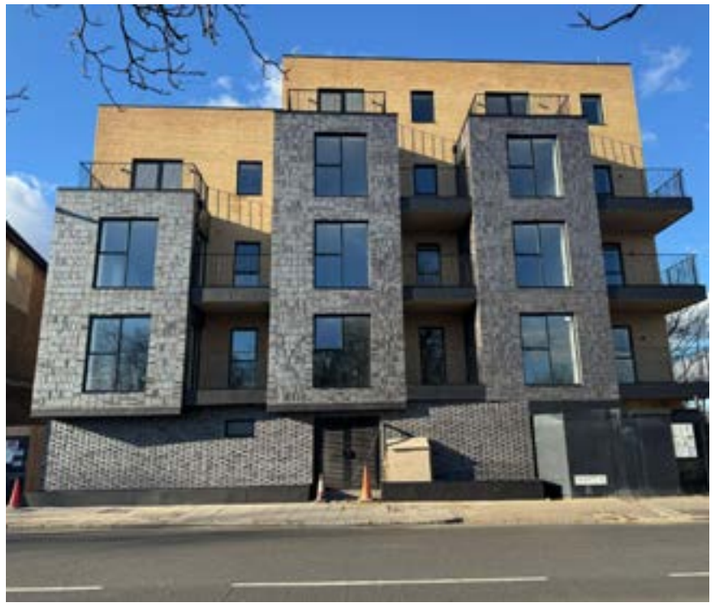
DESIGN CODES

Fire Resistance for Residential Buildings

Element	**England** (Approved Document B) **Height up to 18m**	**Ukraine** (DBN B.1.1-7:2016) **3–10 storeys**
Structural Columns	R 60	R 120
Floor Slabs	REI 60	REI 45
Structural Walls	REI 60	REI 120
Stairwell Core Walls	REI 60	REI 120
External Walls	RE 30	E 30 / E15
Stairs	R 60	R 60

FACADE STUDY

Vertical and horizontal orientations of brickwork with variable window positions



Brick or ceramic tiles

ARHITECTURAL DESIGN

Figure 13: Ground supported brickwork in housing

Alternative façade systems

The modules are delivered as weather-tight and insulated units. They may be finished on site with different cladding and roofing systems which are illustrated in the following figures.

- Vertical and horizontal orientations of brickwork with variable window positions -see Figure 11
- Brick or ceramic tiles attached to a rigid board or horizontal rails -see Figure 12.
- Ground supported brickwork in housing -see Figure 13.
- HPL panels in various colours- see Figure 14.
- Mix brick with powder-coated aluminium panels –see Figure 15.
- Vertically orientated timber planks –see Figure 16.
- Projecting balconies and concrete panels –see Figure 17.
- Rainscreen panels – see Figure 18.
- Metal Panels- see Figure 19.
- Possible use of GRC and Portland stone -see Figure 20.
- Anodized aluminum and curtain wall -see Figure 21 .

It aims to break down the structure into a series of blocks that respond to various aspects on site. The elevation was specifically designed to be fully created in the factory.

FACADE STUDY

HPL panels in various colours

Mix brick with powder-coated aluminium panels

ARHITECTURAL DESIGN

Vertically orientated timber planks

Projecting balconies and concrete panels

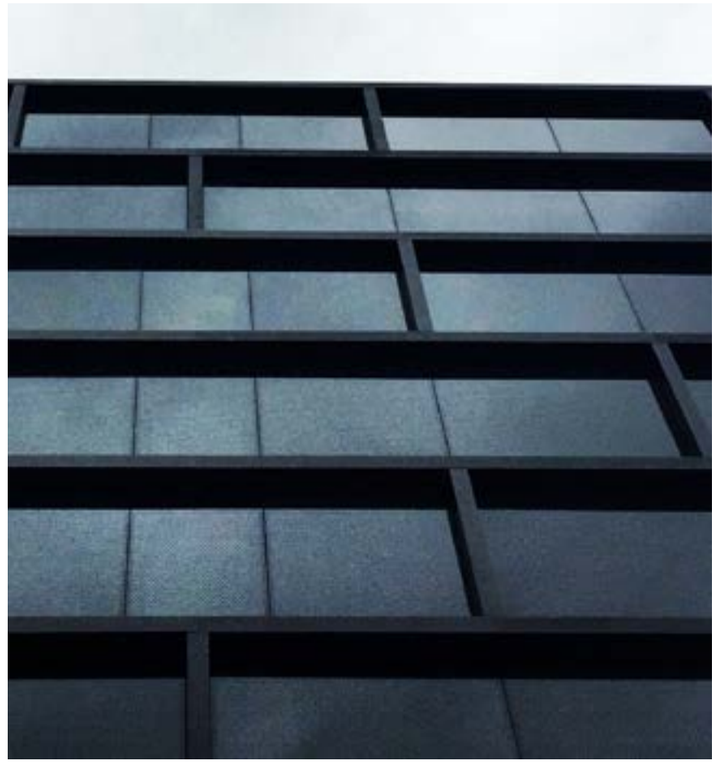
FACADE STUDY

Rainscreen panels

Metal Panels

ARHITECTURAL DESIGN

Possible use of GRC and Portland Stone



Anodized aluminum and curtain wall

SELECTED PROJECTS

Modular Housing and Residential Buildings

Project information provided by Studio Anyo

PROJECT 001

Project 001

EXCELSIOR SPECTRUM HOUSE

Location: Hendon, London

47 Apartments

Project information provided by Studio Anyo

EXCELSIOR SPECTRUM HOUSE

Excelsior Spectrum House

The Excelsior Developments project in Hendon was for 42 MMC units of ESS Modular and consisted of a range of one, two and three bedroom luxury apartments with gardens, balconies and underground parking.

All 42 units were open sale apartments ranging from £450-£1 million in value and were very high specification homes. Constructed up to 80% completion in Ireland then transported to site and put up in three weeks, the project was quickly finished.

Ultimately, we helped the modular supplier to deliver a project which consisted of the contract being split into two - the basement and a separate MMC main contract.

It took existing planning permission and redesigned it to MMC principles, allowing a vertical extension.

PROJECT 002

Project 002

BERKELEY HOMES

B11

Location: Royal Arsenal, London

42 Apartments

Project information provided by Studio Anyo

B11 ROYAL ARSENAL

B11 Royal Arsenal

On this project we worked with modular supplier Forta Pro to give local support and compliance and developed a scheme that was compliant with modular system design and UK regulations.

As part of this we redesigned the layouts to comply with building control and maintained the planning permission and compliance with Berkeley Homes Standard. Alongside this, we inspected the factory, assisted with the site installation and developed the modular suppliers system to comply with UK standards.

As a scheme designed with modular in mind, but with many principles not being fully understood, this meant the detailed design was complex.

However, the external elevation was maintained by the principle architect and we coordinated the model between the master plan architect and the modular supplier.

PROJECT 003

Project 003

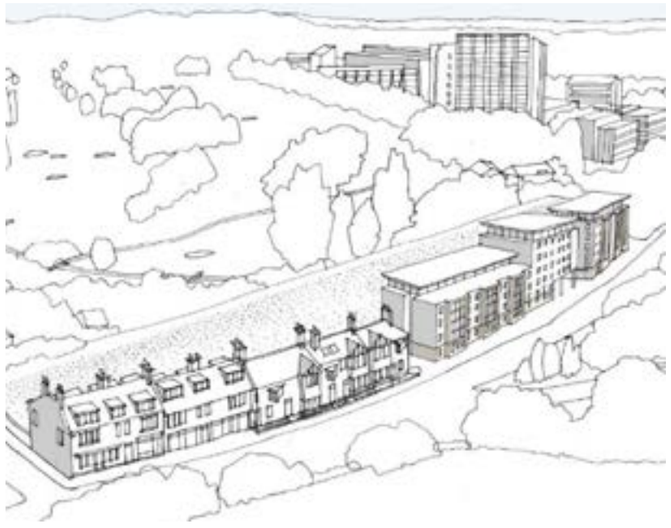
AIMROK DMD

Location: Edinburgh

Various properties

Project information provided by Studio Anyo

AIMROCK MMC STRATEGY



Aimrok MMC Strategy

In partnership with polish manufacturer, DMD, we created a MMC strategy and interior design concept so Aimrok could create a framework agreement to deliver a series of student residential sites.

Through creating and designing a set of brand standards for MMC delivery and using DMD system design, we helped deliver a fantastic project.

A key objective of this was to create a suite of units that meet the target ambience, but could revert back to existing planning permissions.

Finally, the design was tested on a few sites to make sure the approach was compatible with the site roll out.

PROJECT 004

Project 004

IRES ROCKBROOK

Location: Dublin

492 Apartments

Project information provided by Studio Anyo

ROCKBROOK DUBLIN

Rockbrook Dublin

This project was for a 492 mid-range apartment complex for the private rental sector. As the site was partly developed, the scheme was designed to accommodate the existing structural lines and include provision for three, fourteen-storey blocks using two single-aspect basic modules - bedroom and kitchen/ living space.

It also included ground floor retail and crèche spaces, and aligned with existing urban grain, positioned to maximise solar gain and light penetration.
As a modular residential project we chose a central core design and created an oriel dual aspect lounge window to allow panoramic views of the landscape.

PROJECT 005

Project 005

EXCELSIOR GOLDERS GREEN

Location: Hendon, London

111 Apartments

Project information provided by Studio Anyo

EXCELSIOR GOLDERS GREEN

Excelsior Golders Green

Having been granted planning permission for an MMC scheme for 111 units in Golder Green, we aimed to build on the success and framework agreement created for spectrum, so designed a scheme with the same modules.

After creating the framework agreement with suppliers, we agreed rates to allow us to get the planning phase started with a secure cost structure.

The scheme was designed as a modularisation of existing permission, changing the mix and increasing the amount of units.

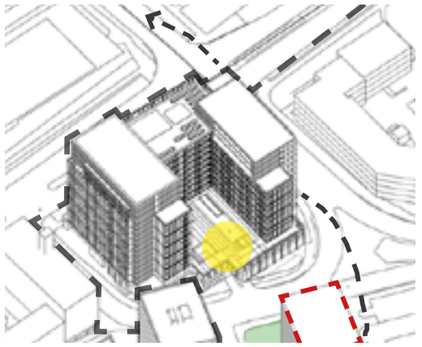
It aims to break down the structure into a series of blocks that respond to various aspects on site. The elevation was specifically designed to be fully created in the factory.

Project 006

GREAT OAKS

Location: Basildon

245 Apartments



Project information provided by Studio Anyo

Great Oaks

Working alongside GS8 Developments, we submitted planning to Basildon Council for a 245 unit MMC modular scheme at Great Oaks as part of the Basildon Master-plan.

The building addresses four different street conditions and the proposal focused on enhancing the ground floor level as well as adding new green spaces for local residents.

Designed around a large central courtyard with a south facing open aspect, the ground floor level also provides commercial and community spaces and there's 45 car parking spaces included too.

Above ground level a slab is formed to support the courtyard and MODE modular apartment units, which are stacked so that servicing is simple and accessible.

The four cores are designed as modular components with lift cores giving stability and structure, and the choice of a modular system gives a much shorter construction time alongside aligning with client aspirations of zero construction waste and the apartments fully finished when delivered to site.

SPECTRUM HOUSE

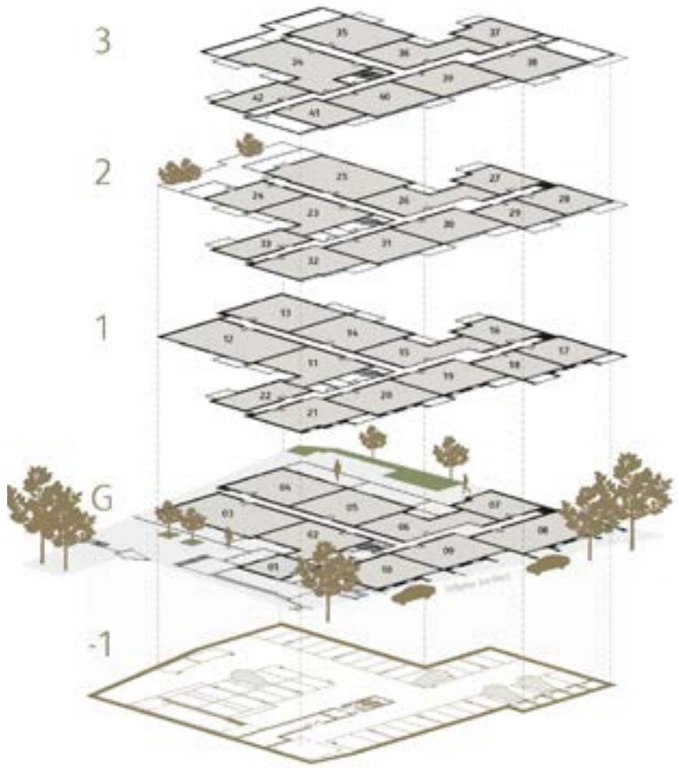
Project 007

EXCELSIOR

SPECTRUM HOUSE

Location: Hendon, London

47 Apartments



This Case Study of a 4 storey residential building in Hendon, north London is presented in detail to illustrate how modular buildings can be designed to meet the challenges of building in an urban location and are visually attractive and spatially efficient in their building form.

The plan forms on all levels show how a wide variety of apartment sizes and layouts are achieved in modular form and all apartments have a private balcony or garden. The modules are placed on a concrete transfer slab above a basement parking level.

CASE STUDY

Excelsior Spectrum House

This 4-storey residential building consists of 42 apartments that are fully constructed using modules together with an underground car park. The building consists of a total of 13 single bedroom apartments, 24 two-bedroom apartments, and 5 three-bedroom apartments, all in a variety of layouts. Two modules form a 50 to 55m2 single bedroom apartment, three modules form a 80m2 2- bedroom apartment and 4 modules form a 120m2 3-bedroom apartment. The building consists of 118 modules.

The ground floor is constructed in reinforced concrete on which the modules sit and the flat slab is designed to support the loads of the lightweight modules. The first-floor plan shown consists of one 3-bedroom, six 2-bedroom and five single bedroom apartments. All apartments have a garden or a private balcony, built as part of the modules.

SPECTRUM HOUSE

Project 007

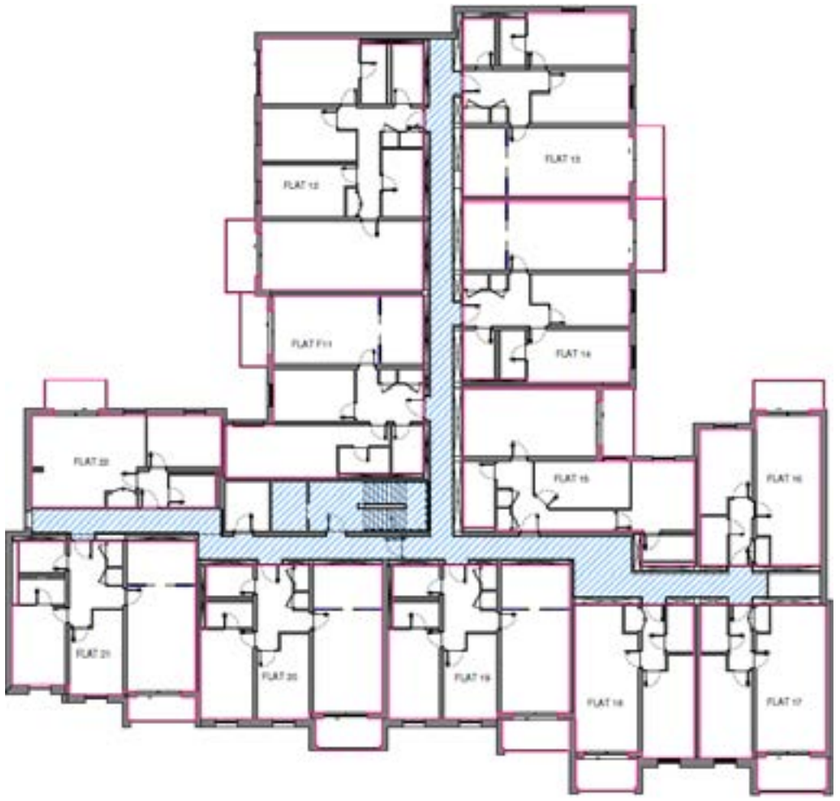
EXCELSIOR

SPECTRUM HOUSE

Location: Hendon, London

47 Apartments

CASE STUDY



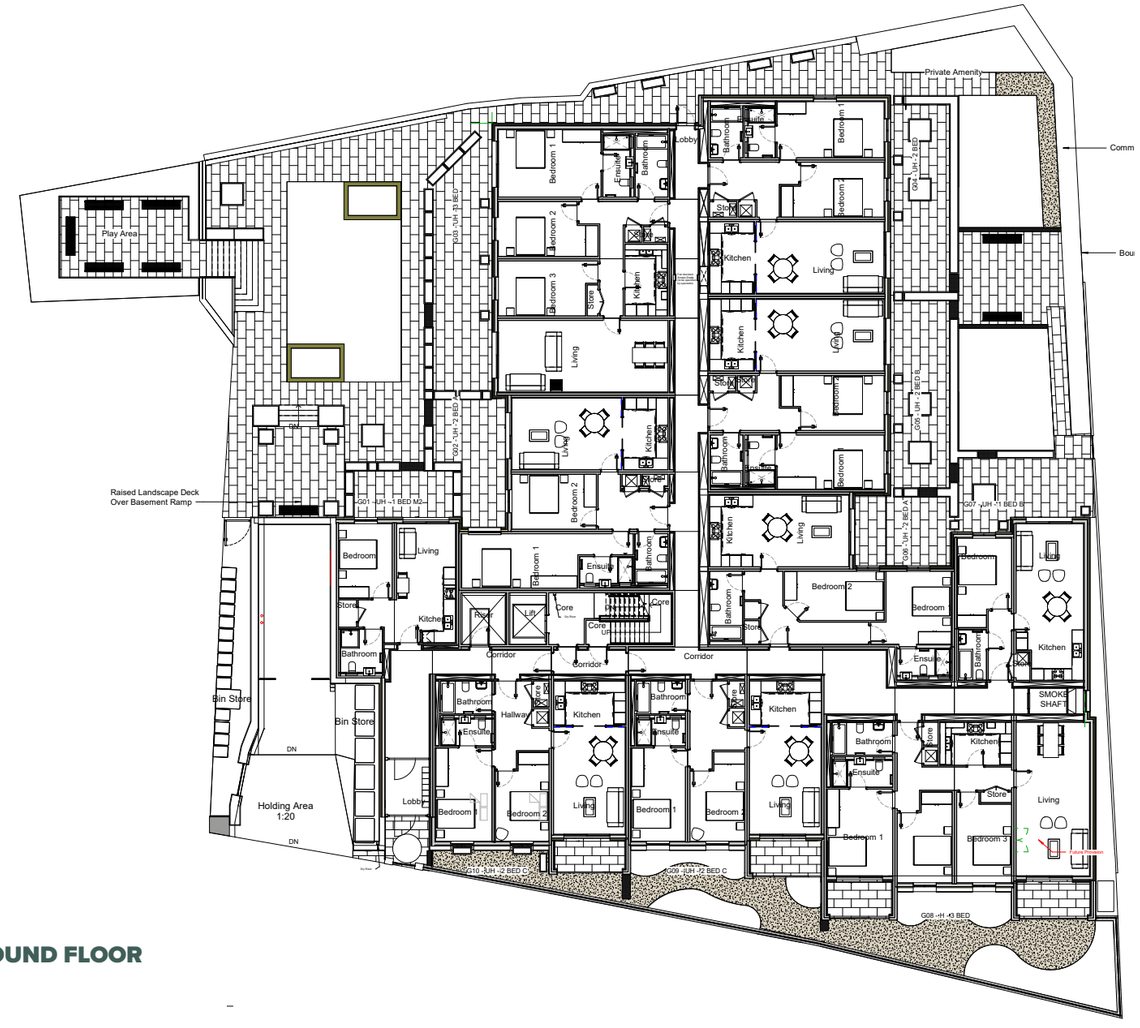
Excelsior Spectrum House

Examples of four apartment configurations and their floor areas are shown above.

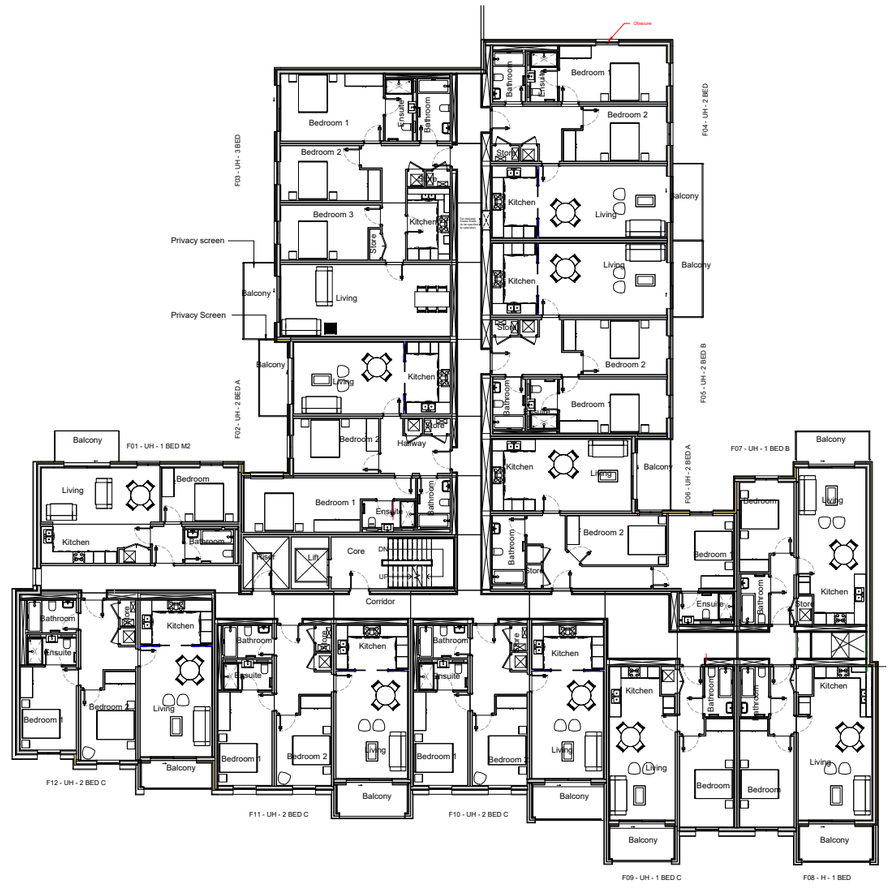
The largest modules are 4.2m wide x 9 to 11m deep (external dimensions) and the bedroom modules are typically 2.8m wide. Openings of up to 4m width are provided in the partially open-sided modules to create larger spaces within the discipline of the modular approach.

The cladding is a brick slip system at the lower levels and light weight metallic cladding for the top floor. The modules have thick mineral wool insulation and a brick-slip cladding system was bonded to a backing board, which achieved a low U value whilst keeping to 350mm external wall thickness. PV panels are attached to the flat roof.

SPECTRUM HOUSE



GROUND FLOOR



FIRST FLOOR

Project 614

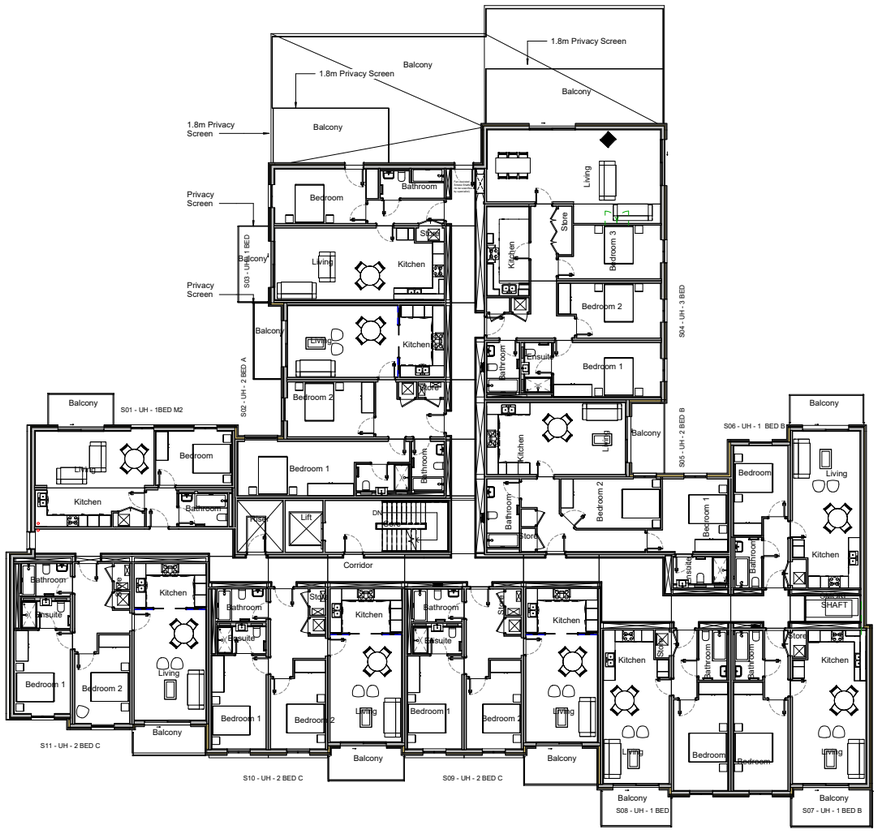
EXCELSIOR

SPECTRUM HOUSE

Location: Hendon, London

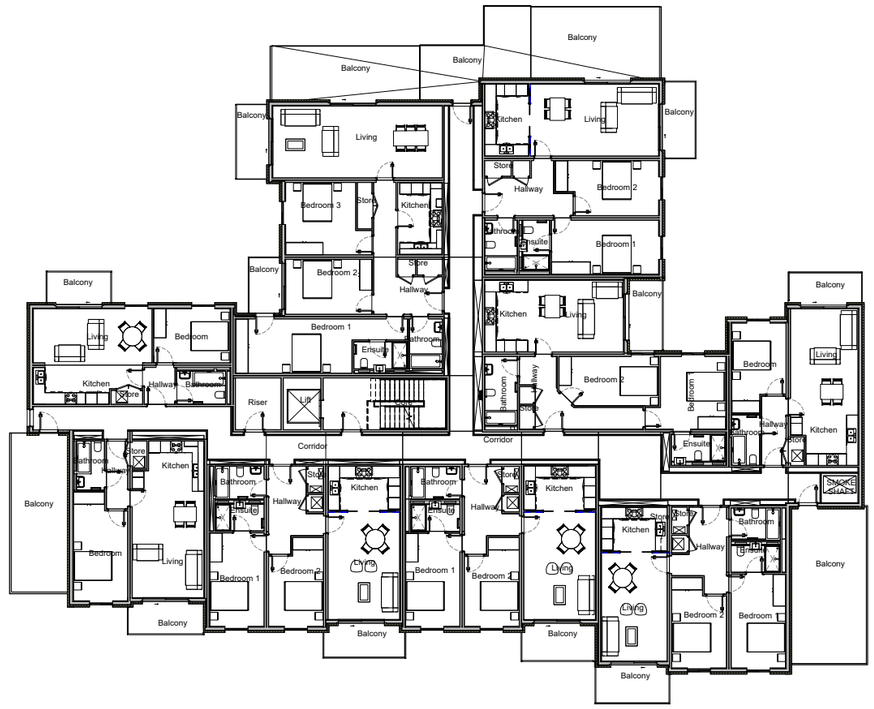
CASE STUDY

SPECTRUM HOUSE



SECOND FLOOR

CASE STUDY



THIRD FLOOR