



A Guide to Volumetric Construction

**Stelling
Properties**



Introduction to Volumetric Construction

“Innovation is the ability to see change as an opportunity, not a threat”

Steve Jobs

The phrases Modern Methods of Construction and Modular Construction are becoming common place within the construction industry, thanks to Government support, greater industry awareness and understanding of the productivity benefits. However, What does this mean in practice? What are the common problems? What are the misconceptions? And how does a project work? This document is intended to answer some of those questions and provide some practical guidance.

There are a number of different types of Modular Construction, these are defined in the MMC Definition Framework. At Stelling Properties we specialise in Volumetric Construction, as a result this guidance will focus mainly on the use of volumetric construction, although elements will apply equally to other methods of modular construction. Modern methods of construction is a process which focuses on off-site construction techniques, such as mass production and factory assembly, as alternatives to traditional building.

In this brief document we aim to explain some of the benefits of Volumetric Construction and how the process works, whilst also highlighting considerations through the supply chain, from land acquisition through construction to service and management.

Volumetric Construction

Let's define exactly what is meant by Volumetric Construction. Volumetric Construction is the process of assembling fully enclosed, six-sided building modules in an offsite factory setting and then joining them together to construct one large building.

Benefits

1 Certainty of delivery

Offsite manufacture is carried out within a controlled factory environment using best practice lean manufacturing principles, as a result it is not subject to the same impact from bad weather as traditional construction during winter months or inclement weather. As the modules are delivered to site fully fitted and installed using a crane, the only disruption to the construction pattern comes from high winds. This allows for greater delivery certainty and ensures projects are completed on time.

2 Certainty of project costs

The controlled working environment allows for speedier comple-

tion of projects, with certainty over delivery, projects can be completed up to 40% quicker than with traditional construction, this in turn leads to a reduction in projects costs.

Modular construction allows for multiple phases of the building to be worked on simultaneously, for example the factory could start work on the ground floor modules at the same time as the foundations are being laid.

As importantly for project cost certainty, there are no weather delays allowing the projects to stay on schedule. This can translate into a significant reduction in the construction time and project cost.

3 Improved and Consistent Quality

Offsite construction allows for the use of standardised processes and tighter controls, which deliver improved and consistent levels of quality in the finished product. This helps eliminate the need and cost for re-work and snagging and provides a better product for the customer and an improved experience.

4 Reduced environmental impact

Modular Construction can deliver a reduction in both the embedded and operational carbon, within a project.

Due to the better quality of the finished product because of the controlled processes of manufacture, there is better air tightness, reducing the air leakage means there is less energy used in heating the building.

The reduced project times, offsite construction reduces the traffic flows around sites leading to significant reduction in pollution from traffic.

By the early engagement of the design team, as much as a 90% reduction in wasted material can be achieved.

Due to the improved build quality from standardisation

and the implementation of factory based processes, there is potential for the asset to deliver significant operational cost savings.

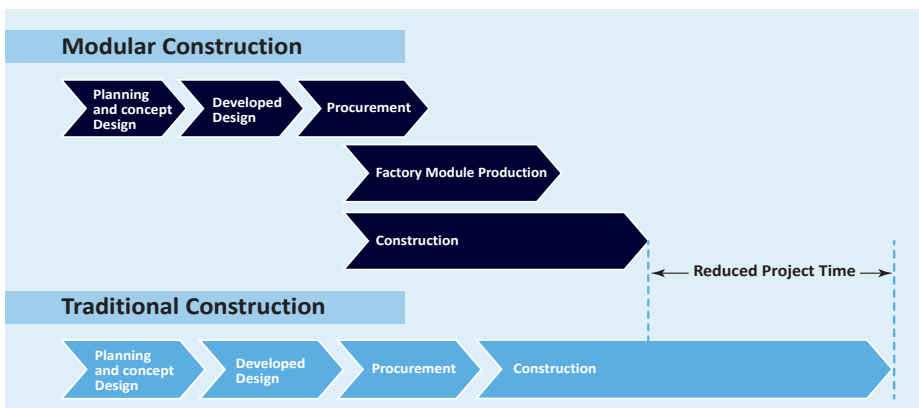
5 Reduced disruption of local communities

By reducing project time, on-site labour requirements and the range of elements of construction that need to be completed on site compared to traditional on-site methods, it leads to projects that are completed faster with less noise, less local air pollution and less traffic disruption.

6 Improved Health & Safety

Off-site construction has the potential to significantly reduce the risk of accidents. The reasons for this include a controlled, clean, and warm environment, and the use of production line techniques and standards and the permanent nature of staff contracts.

In addition there is a reduced need for working at height, therefore eliminating one of the greatest causes of accident in the construction industry.



Process

Although it will vary between Modular Manufacturers some will offer a full turnkey experience others will provide support from Land Acquisition, through manufacture, construction to service and management. This allows you the opportunity to have a different entry point into the relationship with a manufacturer dependent on your requirements.

In this publication, we have breakdown the process into 5 stages, and will look at some considerations for each stage of the process

Considerations in Land Acquisition

This will in most cases be the starting point of the journey, however no two projects will be the same. It could be that you already have land which might or might not have planning permission and you want somebody to lead the development; if the land doesn't have planning permission it might be that you need to work with a manufacturer's design and planning team to progress the project.

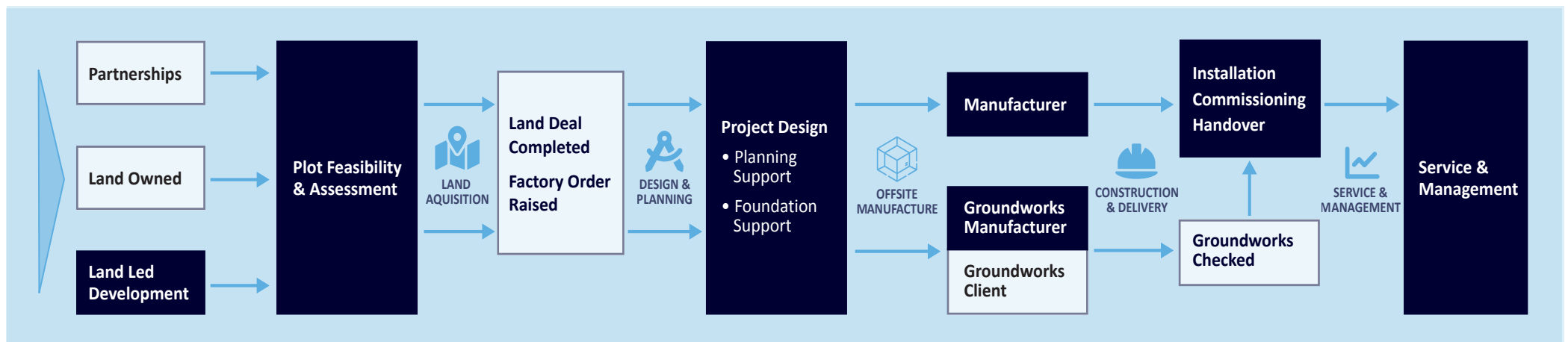
If you don't currently have the land but have a need to provide housing it could be that you work the manufacturer's land team to identify opportunities to purchase land based on your requirements.

The acquisition of the land will involve several stages:

1. Land identification
2. Assess the feasibility of development
3. Submit offer terms
4. Negotiation
5. Completion of purchase

When looking at land for development what are the key considerations?

- How good is the location?
- How accessible is the site?
- Does the plot already have planning permission? Will the local planning authority be likely to grant permission to develop the site for what we want?
- How "Buildable" is the site? (E.g. is it within a flood zone)?
- Will it be easy to get utilities to the site?
- Would there be any planning requirements, such as a particular design code?
- Would there be any abnormal costs, such as land remediation?
- Is the location right for the type of dwellings you want to build?
- Can you buy the site at a price which fits with your budget for delivering the accommodation?
- Are there important considerations regarding the scheme that need the expertise of design team.





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Considerations in Design and Planning

Structural loadings and grids

As a part of the feasibility of development study, you will have had outline plans produced identifying how many units will be included in the development, once you have purchased the land a detailed set of plans will need to be produced.

When using volumetric construction, the need for the early engagement of the design team cannot be over emphasized, due to the method of manufacture and construction there are important considerations regarding the scheme that need the expertise of design team.



feasibility plan

The key considerations for planning are:

- Which configuration of dwellings provides the best optimisation of the site for all the stakeholders.

- Submit a pre-app as early as possible to flush out any potential issues.

The key considerations for design/manufacturing/construction

- Ensuring the design delivers standardisation to maximise manufacturing performance and minimise waste.



off-site manufacturing

- Performance specification.
- Interfaces between foundations, central cores, existing buildings.
- Structural loadings and grids.
- Fire compliance.
- Standardisation of production.
- Installation prioritisation.
- Thermal performance of the modules and air permeability.
- Façade.
- Services and connections.
- Ventilation.
- Overheating.

Considerations in Manufacturing

Unlike traditional construction, over 80% of a Volumetric construction project is built in a factory environment, allowing for greater control over the process and consistency of construction.

This provides the opportunity to introduce standard operating procedures and the ability to look outside of the traditional construction industry to identify the best practices and learnings from other manufacturing industries to constantly identify areas of improvement in terms of product quality, product development and increasing productivity.

Some of the key considerations at the manufacturing stage are:

- Standardisations of processes, materials, and skills.
- “Just in time” manufacturing, ensuring the materials are at the right workstation at the right time to ensure that production line runs efficiently.
- Resilient supply chain.

- Materials provided in sub-assemblies, cut to size and in the correct order for installation.
- Work and labour requirement are balanced at each workstation to ensure the work on each workstation is completed in the same timeframe to allow the balanced production line to work effectively.

Considerations in Construction

Investing time and effort in design and setting out volumetric modules will work to tolerances that are not normally achieved in the construction industry, at Stelling Properties the modules are built to a +/- 2mm tolerance, as a result attention needs to be given to the interfaces with the modules and any structure that is a part of the project, for example foundations, circulation cores, connections to existing buildings or large communal areas.

Investing time and effort in setting out to ensure that the interface surfaces meet the same exacting standards is key to preventing construction issues later in the project as the volumetric modules are installed.

The key considerations in the construction stage of a volumetric construction project are:

- The precision required at the interfaces between the modules and the elements constructed onsite.
- The logistics of transporting, unloading, and installing the modules on site, to maximise the efficiency of construction the modules should be lifted straight from the transport lorry to the final location.
- Get early engagement with the groundworks and utilities teams.
- Crane lifting capacity, site location and jibbing configuration.
- Provision of services and utilities.
- Public and site safety with modules being lifted.
- Weatherproofing.



Legal Considerations:

A different approach to construction, will also mean that there is a need to look at legal and contractual matters differently, the key areas to address are, legal ownership

and when ownership title of the modules is officially completed, the associated risk of damage in storage or transit.

Another consideration is quality control and provision of access for progress monitoring during the manufacturing stage.

When signing a contract using modular construction the below are key considerations:

- Provision of access allowing the purchaser to inspect quality and progress during the manufacturing process.
- The cash flow profile for modular construction is different.
- Warranty protection.
- Retention of title provision to ensure title passes on payment not on delivery.
- Marking and separation of goods, once payment has been made and the title for those goods has been transferred.
- Damage during storage or transport.
- Delivery schedule.
- Payment security such as an off-site material bond to cover the value of the materials purchased.

3 Core Principles to Delivery Successful Modular Construction Projects

1. Early Engagement with the Design Team
2. Bring Factory Precision to Site
3. Improved Collaboration and Communication

F.A.Q's

Q *Do you need to make any additional fire safety considerations when using Volumetric Construction?*

As owners and operators of buildings across several sectors we are obsessed with our clients, the buildings residents. There is nothing more important to us than their safety. Therefore, we take an engineered approach to fire safety, appointing an external fire consultant to review, approve and insure all of the details within our buildings. To support this approach, we have conducted our own fire testing. This allows us to interrogate temperature readings to understand how our build ups perform as well as ensuring our buildings exceed the regulatory requirements.

Q *How does your design prevent acoustic and thermal transfer between different properties?*

Our buildings are constructed from Modules that bear only on their corners. This approach limits the contact between adjoining modules,

giving best in class thermal and acoustic performance.

We have invested in the detailed design of our products ensuring all interfaces are optimised, for example, even with a complete separate party floor and ceiling build up, we can achieve a per storey height of 2775mm with a clear internal height of 2400mm. Our approach is to ensure our clients receive the flexibility they require; therefore, we can configure our products to meet your exact requirements.

Q *Can I specify a different fixtures and fittings for the modules?*

Yes, that is possible, we believe that the materials and finish used should be dictated by our clients' specifications, not imposed by us. Our internal design team will work with you to put together material and colour pallets to ensure that your exact brief is met.

F.A.Q's cont.

Q *Will the onsite tolerances impact the installation of the modules, and does it impact any warranties?*

Ensuring the interfaces with other structures involved in the project meet the same tolerance as the factory produced modules is key to the success of the project. We have invested heavily in developing interfaces that have the same level of design definition as our factory products and require minimal site activity. We have engaged with our supply chain and an external fire consultant to ensure all of our details are approved and warranted before they go into production.

Q *Will it be difficult to secure a mortgage for modular constructed property?*

Homes built using modular construction are becoming an increasing part of the UK housing stock, this has led to the major mortgage lenders offering mortgages specifically for homes built using modular construction. Stelling Properties is accredited by BOPAS, this gives our customers and mortgage lenders the confidence that our homes have the robustness and durability for two mortgage terms equivalent to 60yrs as required by the mortgage lenders. The material in our homes is designed to last significantly longer, as a result there is no limit to the actual lifespan of our buildings.

Q *Will the building shrink or move once all the units have been installed?*

No there will be no shrinkage of the buildings as the primary structural material used in our homes is Hot Rolled Steel. We do not innovate with the materials used within the building, just how they are put together. This approach produces primary columns that support the modules. As the building is assembled, the load in these columns increases, but the load in each module remains the same, this minimises any settling effects. Transport lifting and staking trials have proved that our system does not suffer from deflection or decorative cracks from transport, lifting or assembly.

Q *Is modular construction quicker than traditional construction?*

Yes, a major benefit of our system is the reduction in time required on site. We regularly achieve a hook time, the moment the module is lifted from the back the lorry to being landed in the stack and disconnected from the crane, of 4 minutes. This enables 12 modules to be installed a day, with plenty of buffer time. A 100-module development can be assembled within 2 weeks. We are able to adjust our factories output depending on the pipeline, this capability with our storage facility allows modules to be production to be tailored to your project, maximising efficiency.

Q *Is modular construction more expensive than traditional construction?*

It should not be when considering the full project cost and, in most cases, it is less expensive as we are obsessed with efficiency. Both in terms of material usage and how to build our modules and developments. This obsession combined with a passion for manufacturing innovation puts us at the cutting edge of the modular industry. From exploring robotic welding within our frames to automating the lifting of our finished modules, we are investing in ways that will allow us to reduce cost. We also work with our supply chain, putting supply chain agreements in place, giving you cost certainty months in advance. As an end-to-end developer, we will always do things where they are most efficient.

Q *What warranties and standards does your product adhere with?*

Our homes are BOPAS accredited, the leading industry standard for modular construction. The level of design detail required to manufacture a product is greater than required for traditional construction. This detail allows us to work with warranty providers and insurers to take view and approve details both manufacturing starts. Our current projects have secured Buildzone residential warranty.

Q *Can traditional construction and modern methods of construction be used on the same project?*

Yes, both traditional construction and modern methods of construction can be used in conjunction on the same project. As an end-to-end developer we understand that there will always be site activities, with some elements benefiting from traditional construction methods. Our experience has taught us early engagement makes sure that the interfaces can be designed beforehand. We have a set of details and interfaces, which are always expanding, that have been developed and proven on our internal pipeline that we are able to deploy into any future projects.

Q *Does modular construction offer the opportunity to improve the quality of the finished building?*

Yes, due to the standardisation of the product, modular construction does provide the opportunity to deliver better quality. One of the biggest differences between modular and traditional construction is the level of control modular offers. This is true both for people and processes, but also for the environment. All our employees work to assembly drawings with standard operating procedures.

F.A.Q's cont.

These procedures have hold points in them where quality inspectors come and verify their work before documenting the inspection. These inspection reports along with photographic evidence form a 'birth certificate' that accompanies every module we produce. We are also able to control the working environment. The modules are built in dry, heated factories with industrial dust extraction that protects our employees' health. Our employees undertake a full training programme, and each module is inspected using a 200 point checklist before it is given a pass certificate.

Q *How are Stelling Properties working towards building the Net Zero carbon homes of the future?*

Stelling Properties are committed to delivering Net Zero homes, to support this we are on a mission to build a business that does not emit any carbon. Whilst there are some actions we have already taken; some aspect of our supply chain will emit carbon for years to come before sustainable alternative are available. We are working to reduce the number of materials of this kind we use whilst offsetting the carbon from those materials today, for example a recent structural innovation reduced steel content of a current development by 20%. We have partnered with Cardiff University to study the embodied and operational carbon produced by our developments, allowing us to make

informed decisions on how to tackle this most effectively in the future. We have also partnered with Ecologi to offset all the carbon emissions from our employees professional and personal lives.

Q *How do you manage to ensure that you achieve the required tolerances through the supply chain?*

The key to simplifying developments and delivering high quality buildings is control of tolerance. We employ an approach common with Toyota's manufacturing model of partnering with our supply chain to ensure the correct quality is achieved. Instead of setting requirements and waiting to see if they are met, we are proactive, investing in our suppliers, providing designs and funding for tooling that makes it easy from them to deliver to the required tolerance.

Q *How does the procurement process differ from traditional construction?*

We have found that collaborative, open working with early engagement of the design team is the best way to drive value for all parties and the biggest difference to the procurement process. The key to delivering a high-quality modular development efficiently is making the developments as standard as possible. By engaging with us early your development will benefit, as we work together to maximise value for all parties.



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