STEEL-FRAMED MODULAR CONSTRUCTION FOR HIGH-RISE HOTELS: WHAT YOU NEED TO KNOW
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I've spent more than three decades designing and managing the development of high-rise commercial buildings across the U.S., but only recently have I encountered steel-framed modular construction being used to build these types of structures.

Although the use of wood-framed modular construction on low-rise buildings has become increasingly common in North America, the modular industry here is still in its infancy. More sophisticated modular products, like steel-framed modular units for high-rises – and the processes behind utilizing them – are still a rarity and have only recently begun to reach our shores from places like Europe, where they have been implemented successfully for years.

I've learned much about the unique challenges and opportunities of high-rise steel-framed modular construction, including installation methods, benefits/limitations, potential pitfalls and the nuances, as well as misconceptions many owners and developers have about the product and its application. What follows is a snapshot of that insight, including recommendations on how to execute modular construction projects and the potential benefits of this innovative approach.

Dale Stern
Vice President

Overview

First Things First: What Is Modular Construction?

Modular construction is a process in which a majority (or portion) of the building is fabricated off-site under factory controlled conditions. The building is manufactured in pieces called “modules” that each include completed structure, mechanical, electrical, plumbing, furniture, fixtures, & equipment, and exterior and interior finishes.

These modules are then transported to site where they are stacked (typically using cranes), sealed, and connected to mechanical, electrical, and plumbing (by general contractor crews) to form the completed building structure. Modular structures must adhere to the same building codes that conventionally built structures do, in addition to others which I will cover later.

In my experience, there are 2 main types of modules: “Room Pods” and “Structural Modules”. Room Pods are prefabricated building components integrated into traditional, on-site construction projects (ie: bathroom pods), while structural modules must support the weight of the building and are much more complex.

Steel-framed “structural” modules like the one shown on the opposite page are simply modules built with steel framing rather than wood. These types of modules can be safely stacked much higher than their wood-frame counterparts.
For those of you unfamiliar with modular construction, there are numerous advantages to employing this approach in a hotel development project. Below are the three main benefits, which apply to both steel and wood-framed modular units. I will dive deeper into each section further on in this blog.

• **Reduced Construction Time:** Modular units are delivered to the site pre-assembled and pre-finished, then stacked. Construction time can be reduced significantly, compared with conventionally built structures. This is especially important in dense urban areas, where traffic disruption and noise mitigation equate to significant costs.

• **Higher Quality:** By building and finishing modular units in a factory under controlled conditions, final product quality can be enhanced with a more precise fitting of components, and repetitive installation and finishing performed in a dry, climate-controlled environment.

• **Less Cost and Waste:** With reduced waste, reduced construction time, and completion of assembly and installation in a controlled environment, the possibilities for cost savings are compelling. Additionally, these cost savings often result in a “green” advantage for the project.

**The Fine Print**

Modular construction is not suited for every hotel type or hotel brand.

Modules generally works best for select-service hotels that have built their brand standards around smaller guestrooms, as module sizes are typically based on the dimensions of shipping containers and/or the limitations of highway transport. Module widths and room widths also need to be compatible. A module-and-a-half-wide room is not practical for this approach.

**Time + Planning**

Modular construction is frequently touted as a time-saver. Time is money in construction, in terms of equipment rental, manpower, and lost revenue. With this method, contractors can stack multiple modules per day, potentially reducing total construction duration by a significant amount.

The challenge with the various phases of this process—namely design, permitting, fabrication, inspection and coordination—is planning ahead. A lot of developers want to get in the ground quickly, but with modular, there’s a lot of upfront legwork and planning that needs to happen. Time savings is an easy advantage to latch onto with modular, but there’s going to be more planning required. If you don’t start planning earlier, you will likely finish later, even with the shortened construction time.
Cost + Financing

Cost

There’s a common perception that building modular offers cost savings versus a traditional construction approach. However, there are many nuances that the owner and/or cost estimator needs to understand in order to skillfully develop a reliable cost comparison.

The fact that modular units are pre-manufactured can require cash flows to be more front-loaded than conventionally constructed projects. This will depend on the payment structure agreed upon with the fabricator.

The modular structure itself also differs significantly from its traditionally built counterparts, in terms of material (most hotel structures are concrete), erection process, and building components. Even though many components may have the same material costs, they could have very different installation costs, based on the differing location.

Due to these factors and more, a comparative cost analysis should always be performed before embarking on a high-rise steel-framed modular project, to validate the anticipated cost savings and help determine whether the decision to go modular is right for a given project.

Financing

A developer/owner/operator may have very different tolerances for risk or rate of return thresholds than a developer seeking conventional financing with an ultimate goal of selling to investors. A developer/owner/operator – especially one that is familiar with modular construction – may place greater value on the quality potential or construction time-savings than the initial construction cost savings. Given the market’s unfamiliarity with this product type, a hotel developer might require a higher return to take on what they perceive to be greater risk.

Likewise, because lenders and underwriters are unfamiliar with the product, they should be engaged early, to both explain the nuances of the product type and determine any special requirements they will have for participating in the project. As noted earlier, cash flow disbursements will be front-loaded in comparison with a conventionally built project. For a hotel developer proposing a modular project, there may be an extra layer of related upfront logistics for putting together a proforma. This includes who’s going to lend it, who’s going to buy it, and who’s going to operate it once it’s complete.

Although it depends on the payment structure agreed upon with the fabricator, cash-flows for modular construction are typically more front-loaded than conventional projects.

Image credit: Pinsdaddy
Labor Unions

In most cases, modules work for guestrooms, but not for common areas like lobbies, gyms, restaurants and bars, so the first one or two floors are built conventionally, and then the guestroom modules start stacking on the second or third floor. Contractors still build the entire structure when using modular construction; it’s just that after the lower floors are complete, they will build the rest of the hotel using modules instead of steel or concrete.

This brings me to another important localization issue: the labor market where the hotel will be built and the acceptance by, and strength of, local construction unions. While off-site construction may offer an innovative means to enhance construction productivity, resistance may be encountered from local labor unions.

Module Dimensions

Although modular units offer the benefits of factory-built uniformity, there’s also a significant localization process for every project. Localizing may entail design based on site constraints, labor and market issues that need to be addressed to get the project built, or other factors such as seismic concerns.

If you build a modular hotel on a greenfield site next to the airport, you can simply buy your modules, stack them up, and build your hotel. All that changes when you build on an urban site, and/or you’re building between two other buildings.

Imagine your site is 119 feet wide but your module units are 10 feet wide. You can only fit 11 of these units on each floor, but your proforma dictates 12 guestrooms. Now to fit the required number of units per floor, each module must be downsized to 9.9 feet wide. Likewise, there are also height restrictions to consider. This is one of the key challenges, because the idea of modular is mass production: to diminish cost and error in the factory in relation to the more things you can make the same. But the reality is, modules on urban sites end up being very customized for each location, because you just can’t afford to waste cubic footage or buildable area.

Seismic Concerns

Yet another item to consider among the localization factors are the seismic concerns: in higher seismic zones, such as the West Coast of the U.S., there’s a very different design to the modules compared to modules for non-seismic zones.

Structural engineers determine which parts of the building they want to resist seismic loads, and which parts they don’t want to resist seismic loads, because they want to transfer those loads elsewhere. The modules may actually need to be less stiff, because the structural engineer has designed the seismic loads to be transferred in different ways.

Therein lies another challenge, because the modules need to be transported to the site, then lifted into place by a crane. Generally, a stiffer module is better able to withstand the stresses of transport and installation; too flimsy of a module could result in twisting of the structure and cracks in the finished guestrooms. Besides needing a prototype room module to confirm quality and finishes (discussed later), prototypes may also be needed to test the suitability of the design for transport and installation.

Localization

Modular units often require significant localization of dimensions based on unique site constraints.

Image credit: Pinsdaddy
A Creative Structural Engineering Team

Many of the completed modular projects in the U.S. are wood-frame units stacked three to four stories high. When you're building three- and four-story modular hotels, it makes sense to design them all the same. But once you start stacking modules up 20 floors, the module on the bottom has to bear a lot more weight than the one on top.

This becomes a point of efficiency: You don’t want to build every module to be as strong as the one on the bottom, when the top one can be a lot lighter and contain a lot less steel. This is because you build steel by the pound, and on a high-rise building, steel is one of your highest costs. That drives the need to engineer steel thicknesses and related components for differing loads depending on where the module is located in the stack.

In this scenario, you’re no longer producing hundreds of identical modules; now you’re starting to customize them based on their location in the building, so each module has a limited number of places it can go. Typically, each module has a number and goes in a designated spot. If that module is damaged, it will need to be repaired on site, because the contractor can’t substitute a different module in its place. It’s possible that a module designated for the first floor is interchangeable with another one designated for the first floor, but not one that’s designated for the fifth floor.

For projects in seismic regions in particular, different methods should be considered in connecting the modules and in transferring seismic forces between them. Each method may have different impacts on the amount of steel needed, and thus, on the efficiency of the design.

Selecting a Fabricator: Can They Build It?

In building something like a branded hotel room, you don’t just Google someone who says on their website, “I do modules,” and then sign them up. Vetting potential fabricators is a long process, including having them build a prototype first, to prove they can deliver the aesthetic and quality you and your brand (if applicable) require.

This can be challenging, especially since most manufacturers in the U.S. today specialize in building wood-frame school classrooms or construction trailers; they may not yet be readily able to convert to high-rise steel-framed modules.

Partly because of the extensive fabricator vetting process one needs to undertake, don’t decide to go modular until you’re ready to build a hotel. If you think you want to build a modular hotel in two years, start now. That way, you’ll have time to vet vendors, get prototypes built and confirm that the cost equation works for your development, so that when you’re ready to come out of the ground, you have a plan in place. If you try to start modular planning when it’s time to build, it likely won’t happen, because of the time required to successfully launch a modular project. There’s a significant upfront investment just to vet and select a manufacturer to work with.

Selecting a Fabricator: Overseas or Domestic?

While we all want to buy American, the reality is that the potential for cost savings with modular construction is enhanced if the modules are fabricated in an overseas factory. However, this is not without its risks. You need to confirm the ability of the fabricator to build to your specifications and to deliver the quality you require on the timing that meets your schedule.

The goal is to schedule the modules to arrive just in time, so you don’t want your modules sitting in port for six months when you’ve paid for them, or learn your modular fabricator doesn’t have a slot open for you when you want your modules fabricated. There’s a lot of vetting and prototyping needed to ensure that once you’re ready to come out of the ground, you’ll have modules you’re confident in and can stack to be ready for guests when you’re finished.

When using an overseas fabricator, there are many other technical factors to consider. For example, electrical and plumbing items used in the modules need to have a UL certification, which isn’t used in many other parts of the world. So for certain things, modular fabricators may need to ship UL rated components from the U.S. back to their factory location for installation in the modules.

Surprisingly, because most shipping containers leave the U.S. empty, it is relatively inexpensive to ship components from the U.S. to foreign shores, even heavy items such as fire-rated drywall.
Roles and Responsibilities

The permitting process takes on a higher level of complexity for high-rise, steel-framed modular projects, because approvals are required from two different agencies.

An important distinction for hotel owners and developers to note is that the modules themselves are regulated by a completely separate agency than the local building department, which traditionally handles inspections and permitting. With the modules, the process is similar to getting a UL sticker on a product; there’s a different set of regulations and different inspections that are performed on the modules. This is because once the units are brought to the site, they’re fully enclosed, so a building inspector can’t simply look inside the walls to see how the modules have been put together.

So essentially, there are two different approval processes: the local jurisdiction building department; and then typically, the applicable state agency that regulates factory-made, pre-assembled structures. There’s a completely different set of inspections that are required for the modules, and a different set of submittals and documents. When complete, the approving agency gives your module a seal of approval that certified the unit for installation.

Sometimes, there is an overlap in the demarcation between what is reviewed by the local building department and what is typically, the applicable state agency that regulates factory-made, pre-assembled structures. There’s a completely different set of inspections that are required for the modules, and a different set of submittals and documents. When complete, the approving agency gives your module a seal of approval that certified the unit for installation.

Working With Inspectors

With a typical building permit, once you get permission to start building, the building inspector comes by every other week, or you call him/her for specific inspections before covering up sections. But with modules, because they’re assembled in a factory and things are happening every day, the modular regulatory authority typically requires that there be an inspector in the factory for the full duration of the time the modules are being manufactured, wherever in the world that factory may be.

Some states, like California and New York, will allow the inspections to be performed by third-party inspectors who are certified by the state to perform inspections for them. But in states where this option doesn’t exist, the state inspectors must travel to the factory to perform the inspections. Due to limited resources, it may be more challenging to ensure that state inspectors are available when you need them, which can limit uptime during the manufacturing process.

Permitting Conclusion

What Modular Means For The Hospitality And Construction Industry

There is an expectation that over time, industries will self-invent processes that lead to productivity gains, which in turn lead to reduced cost. At the moment however, interest in high-rise, steel-framed modular construction is primarily being driven by owners and developers, who are seeking to reap the benefits of the enhanced productivity/lowered cost and higher quality made possible by the approach.

Despite this growing interest, high-rise steel-framed modular construction remains a very select proposition, only suitable for specific building types, and only compatible with certain brands and price points. It also requires significant upfront investment, work, and careful planning, but when executed properly, it could be exactly the kind of innovation that hotel owners and developers have been eagerly awaiting.

Contact me for more information or questions about modular construction.

Dale Stern
Vice President
E: dstern@mgac.com
O: 425.759.1397
About MGAC

Established in 1996 in Washington, DC, MGAC is a project and cost management firm dedicated to our clients and their organizational success. Over the past five years alone, MGAC has collectively managed more than $5.5 billion of hospitality, residential, retail, cultural, educational, government, and mission critical building projects.

Our expertise includes full-time project management services for planning studies, renovations, and new construction. We assist clients efficiently and cost effectively manage all due diligence, entitlement, planning, design, and construction efforts.