

Rapid Pace Construction Using Prefabrication

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Abstract: “Rapid Pace Construction using Prefabrication” refers to the construction technique which is quick paced in comparison with standard construction. The rapid paced construction is made possible with the help of Prefabrication technique. In this all the building components such as roof, column, beam, etc. are manufactured in industries and then assembling these components in site. Day to day increased popularity of this construction technique have provided construction industry a new dimension for cheap, stable and fast construction method. Prefabricated building is a type of building that is build using factory-made components or units that are brought and assembled on-site to complete the building. Prefabrication is the process of assembling building components of a structure in a factory or other manufacturing site, and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. Prefabrication is the process of assembling building members from the more conventional construction practice of transporting the basic materials to the construction site where all assembly is carried out.

Keywords: Rapid Pace Construction, Prefabrication, Manufacturing, Assembling.

1. Introduction

Rapid Pace Construction is the most necessary factor in the construction industry today which widely applicable for all types of buildings according to their usability. Rapid Pace Construction is made possible by the help of Prefabrication.

The use of prefabrication technology has proven to be more viable than ever due to various advances in design and construction technologies, combined with increasing emphasis of the industry to highlight cost, schedule and labour issues. The new technologies such as computer-controlled fabrication equipment, 3D CAD, electronically controlled data and mechanization have provided opportunities for advances in design efficiency and coordination. While these technologies may provide overall project benefits regardless of the construction method, certain arrangements can be directly reduced through the use of these technologies.

2. Need and Concern of Topic

Architects, Engineers, Developers and contractors explains stories that sound too good to be true about prefabricated construction: a student housing project that cut its delivery time by a third or a hospital that installed hundreds of bathrooms in three days with only five laborers, A skyscraper built of 57 floors in China using prefabricated members in just 19 days.

The main concern of this study is to understand the planning, methods, technology and execution involved in rapid pace construction using prefabrication. The important concern for research is to know certain objectives as follows:

- Major elements required in prefabrication.
- Importance of Planning and Time management in Prefabrication Project.
- Construction of modular elements.
- Assembling of modular elements on site.

3. Prefabrication

The concept of prefab construction is growing at a rapid pace. Prefabricated building has become a popular choice among construction these days. Prefabricated construction is sometimes misunderstood as a low-end and mass-produced mode of construction.

There are various reasons for the growing popularity of prefab buildings are:

- Faster build time.
- Sustainability.
- Saves labour time.
- Cost-effective.
- Durability of Structure.

Types of Prefabrication

The types of Prefabrication available are:

3.1 Plant Prefabrication

The prefabrication technology where the manufacturing takes in a factory or a plant. The prefabricated components are manufactured in a permanent industry from where it is transported in the construction site. Prefabrication plant is housed within a shelter, and therefore climatic condition does not influence the construction process. These plants have controlled temperature and thus speed of curing is greatly enhanced.

3.2 Site Prefabrication

This is the method where building components are made on the site; they are manufactured either in the open or in temporary shed. The rate of manufacture is slower as compared to factory-based components. There is always a factor of rain and cold which also affects the curing process. The temporary site is set for manufacturing is only for one project hence the mechanization level is lower.

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4. Rapid Pace Construction

The definition of rapid pace construction is still evolving, rapid pace construction is usually defined as the overlapping of functions and development stages to reduce the amount of time needed to complete a Project.

Most construction projects follow a sequencing: concept, design, design development, construction drawings, and construction execution. Rapid pace construction overlaps these stages to allow construction to begin earlier and proceed at a faster pace. To accomplish fast construction, there is need of proven decision-making processes, well sequenced communication plans and an overall dedication and commitment in place. Briefly stated, rapid pace compresses the project schedule by progressive design and construction phases simultaneously.

In a typical rapid pace project, site preparation works as well as the procurement of major long-term delivery components are taken up in parallel. The objectives & challenges upon the rapid pace construction program are:

- Duration or Time factor for design and construction are fixed for a given size and complexity.
- To reduce project time to save costs.
- To reduce project time to allow the owner to generate economy and reduce costs.
- Identify statutory and regulatory requirements and permitting for projects with multiple work packages.
- Organize Drawings & specifications for multiple work stages.
- Overlapping design and construction periods.

5. Prominent Projects – Case Studies

The prominent projects studied for this research includes following:

5.1 Hotel – T30

The Hotel – T30: A 30 Story Hotel Building was Constructed in 15 Days.

The hotel was built on 31 December 2011. It took 15 Days to assemble on site with the help of 200 workers. It took 45 Days to manufacture in the factory. 170,000 square foot, 30 story hotel that was constructed in 360 hours by Broad Sustainable Group, China. This prefabricated building system is completely wired, plumbed, tiled and drywalled. The prefabricated modules are assembled on top of the columns that come complete with diagonal bracing, and then another column is fixed on top.

The features of the hotel are as follows:

- Earthquake Resistance up to level 9: diagonal bracing structure, light weight, steel construction, passed level 9 earthquake resistance testing.
- Less Material up to 6 times: even though the construction materials are much lighter(250kg/m²)

than the traditional materials (over 1500kg/m²), the floors and walls are solid with sure footedness, airtight and sound-proofing.

- Energy Efficiency up to 5 times: 150mm thermal insulation for walls and roofs, triple glazed plastic windows, external solar shading, heat insulation, fresh air heat recovery, LED lighting, yearly HVAC energy consumption equivalent to just 7 liters oil.
- Purification up to 20 times: after 3 levels of purification, the efficiency for fresh air reaches 95%-99.9%; air exchanged 1-2.5 times per hour, and indoor air is 20 times cleaner than the air outside.
- Construction Waste reduction up to 1%: all components are factory made, construction waste, mainly package materials, result from onsite set-up only and amount to 1% of the total weight of the building.
- This was the first building in human history which amalgamates all environmentally friendly, comfortable and secure elements.

The technology involved in the construction of hotel are as follows:

- Use of Identical Panels - The floors and ceilings of the skyscraper are built in sections, each measuring 15.6 by 3.9 meters, with a depth of 45 centimeters.
- Pipes and ducts are threaded through each floor module in the factory. The choice of flooring finish is also pre-installed on top.
- Instant Assembly - Each module is lifted by crane directly to the top of the building. Workers use the materials on the sections to quickly connect the pipes and wires.
- Snap in Columns - The unique column design, with diagonal bracing at each end and tabs that bolt into the floors above and below.
- Standardized Truck Load - Each load carries two modules to the site, with the necessary columns, bolts, tools, and other peripherals to connect them stacked on top of each.
- Custom made slab modules of 15.6m X 3.9m for Easy Transportation.
- Efficient Bracing Slab with earthquake resistant and also prewired with all the plumbing and mechanical systems installed
- The diagonal braces make frame light and strong.
- Slab is floor section are casted with four tubed threaded sockets at the end. This lets them fix fitting in all the walls and fixtures that travel with that particular floor, and provides an engineered set of lifting points for the crane.

5.2 Apartment – Mini Sky City

Apartment – Mini Sky City: A 57 Story Apartment Building Constructed in 19 Days.

The building was constructed by Broad Sustainable Group, China. It was built on 30 April 2015. It took 19 Days to assemble on site with help of 1200 workers. It took 4.5

Months to manufacture in factory. Mini Sky City covers - 186,000 sq. m. Mini Sky City consists of 19 atriums, 800 residential apartments and working office spaces for 4,000 people. Broad Sustainable Building, constructed the rectangular, glass and steel building in the Hunan provincial capital of Changsha, assembling three floors a day using a modular method.

The features of the apartment are as follows:

- The tower is 80% more energy efficient than other similar structures in China.
- The walls are made with 20-cm-thick thermal insulation, and three- and four-pane windows.
- The HVAC system includes fresh-air heat exchange.
- The building can withstand a 9-magnitude earthquake, according to independent testing by the China Academy of Building Research.
- BSB's construction process uses as little concrete as possible; this project eliminated an estimated 15,000 truck deliveries of concrete.
- The first 10 floors of the 200-meter-tall tower are offices, and the rest are apartments in 20 sizes that range from 90 to 600 sqm.
- The building contains a kindergarten, education center, organic farm, and restaurant. A 3.6-km "sky street," which accommodates bicyclists inside the building.
- The tower's 19 atriums include tennis courts, theaters and cinemas, and a botanic garden.

The technology involved in the construction of apartment are as follows:

- It took team BSB around 5 months to prepare and complete the building's foundation, and another 30 days to prepare site and bring in cranes, which are necessary to a construction whose target is to assemble 3 floors per day.
- The firm constructed the first 20 floors in seven working days. The site had three shifts, each with 400 labors and 10 superintendents. Supplier contracts enforced delivery times to prevent bottlenecks and delays.
- Use of Identical Panels - The floors and ceilings of the building are constructed in various identical sections, each measuring 15.6 x 3.9 meters, with a thickness of 45 centimeters.
- Pipes and ducts are threaded through each floor module in the factory. The choice of flooring finish is also pre-installed on top.
- Instant Assembly - Each member is lifted by crane to the top of the building. Workers use the materials on the members to quickly connect the pipes and wires.
- Standardized Truck Load - Each load carries two modules to the site, with the necessary columns, bolts, tools, and other peripherals to connect them stacked on top of each.
- Snap in Columns - The unique column design, Tetris-style assembled with bolts, use of no welding.

The cost breakdown of apartment are as follows:

The total cost of J57, a 57-story building in Changsha, was USD 960/m², which is broken down by phases of construction, as follows:

- USD 336/m² for structure,
- USD 192/m² for installation,
- USD 144/m² for MEP,
- USD 144/m² for interior decoration,
- USD 96/m for facade,
- USD 28/m² for design review and
- USD 20/m² for transportation.

6. Conclusion

The use of prefab can help to achieve results for the society's immediate needs because the fast-changing environment, business, economics, industrialization, residential needs, settlements and many other factors of transportation like bridges, towers, railways calls for fast settlement and requirement for buildings, offices and industries, hence prefabrication is the solution for fast and time saving construction.

The technologies involved in achieving Rapid Pace Construction are as follows:

The three types of panel technology:

- **Current System** – The panel is constructed in steel and the concrete cast on the uppermost level
- **New System** – The panels are assembled in stainless steel medium.
- **Honeycomb** – It offers strength, anti-corrosion and soundproofing benefits.

The Design Process:

- **Design Software** - SAP2000, Midas and YJK
- **Floor Panel Clear Spans** - Honeycomb panels allow buildings to enjoy a 12m x 12m column grid. The whole building is stainless steel structure (or carbon steel as required by the client), and the second design of facade is more convenient than that of reinforced concrete buildings, even balconies can be added or removed as required.

Logistics and Transportation:

- **Container example:** All components (including assembled main boards) are placed in a container for long distance transport. Each truck container can handle 120 square meters of structural parts or 90 square meters of components like exterior façade or 70 square meters with interior wall doors
- **Truck loading example:** 3 columns (12m X 0.8M X 0.4M) at the bottom and 3 main board (12M X 4 M), 8 cross beams and 1 staircase on top.

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Author Profile



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