

Modular Construction and its Adaptation in India

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Abstract—The primary objective of this paper is to provide a review of the potential for modular construction and its need in multi-story commercial buildings in India. The goal is to provide a framework of an implication of a modular building as well as a comprehensive analysis of the benefits and costs of conventional as well as modular construction for a multi-story commercial building to determine the more cost-effective method of the two. The methodology consists of a quantitative analysis that compares the cost of the two construction methods. Both analyses are conducted by estimating a hypothetical multi-story commercial building in India. The data and information provided is the review of the available relevant literature on this research topic.

Index Terms—Modular construction, on-site construction, cost-effective, sustainability.

I. INTRODUCTION

Modular construction is one of the most rising and high Technology innovations of architectural and construction industry. It is defined as construction that is moderately built in a manufacturing plant, installed on a foundation, after which the roof and exterior finishes are completed, followed by interior finishes. It has been categorized into off-site, pre-assembly, paralyzed systems and modular buildings. It is rapidly evolving as a productive/ powerful alternative to the conventional on-site buildings. It aims at providing quality output and satisfactory results through quantitative analysis and discerning of the approximate estimates are significant problems in the industry. It provides a variant range of social, environmental, economic advantages, thus contributing to sustainability. This paper will address the prospective influence of the high rise modular construction to attenuate time and financial costs, thereby leading to a higher adoption rate in India.

II. WHAT IS MODULAR CONSTRUCTION?

Modular construction is a type of construction in which a building is constructed using three-dimensional units or modules, which are then assembled and produced in a manufacturing plant. Modular construction also includes the assembly and logistics aspect of it, which is done in proper coordination through planning, integration, and communication.

Modular construction is also referred to as, modular building system, modular system or volumetric construction.

Modular construction is most reliable when used for

modular construction has to adhere to the same building code requirements as conventional construction methods and the same building materials and standards are adapted to fabricate each module. All modules have to meet the building, safety, and occupancy code requirements. In many cases, modular buildings exceed local building specification. It would be a more successful integration of the manufacturing industry through a good collaboration with the construction industry.

Through modular construction, the overall project construction timeline can be decreased by 30 to 50 % since site preparation and module fabrication processes occur simultaneously.

III. MODULAR CONSTRUCTION IN INDIA

Modular building systems in India are slowly getting a hand on with many builders and construction companies now adopting the methodology in India. As far as the world is concerned, this system has already been accepted and has gained a lot of popularity.

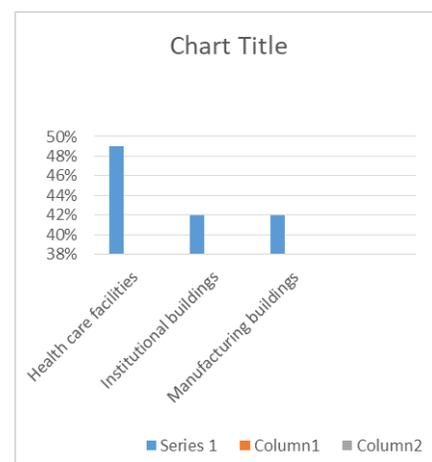


Fig. 1. Current usage

Currently, prefabricated modular buildings comprise of merely 1% of India's total \$100 billion real estate market. However, given the extended fall in the residential real estate, with inventories at an all-time high, developers believe that its popularity will rise. The reason behind this is the much faster completion of projects due to prefabrication which further decreases the overall costs. According to the experts, if it takes

a year to complete a housing project using conventional methods, it takes only 5 to 6 months using modular construction, with the scale being the same.

In India, the government currently aims to provide housing for all by 2022, which requires constructing 30 million low-cost houses along with building 98 smart cities. Both these proposals are expected to provide a boost to the modular system.

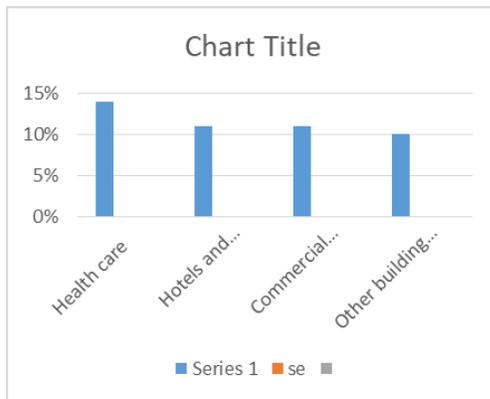


Fig. 2. Future scope

Moreover, the government’s decision in late 2014 to relax previous conditions relating to 100% FDI in real estate has enabled quicker adoption of modular technologies.

IV. MODULAR CONSTRUCTION PROCESS

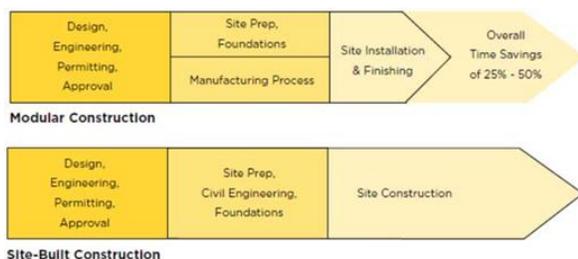
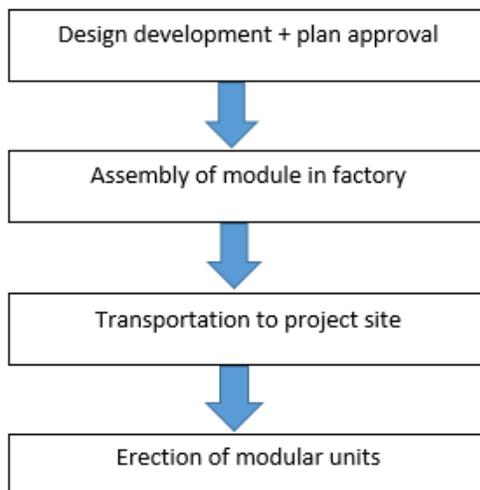


Fig. 3. Modular construction process

V. ADVANTAGES AND CHALLENGES OF MODULAR CONSTRUCTION

1. *High-Quality Identical Modular / Room Size/ Volumetric Units:* Repetitive or identical units ensure for bulk production and lesser complexities in design resulting in less wastage and on-site modifications. Also, quality control is thoroughly checked under excellent supervision.
2. *Sustainability:* Construction is done in a controlled environment which reduces waste and improves the quality management throughout the process and promotes sustainability.
3. *Faster Project Schedule:* Since most of the production is done away from the construction site and on-site construction occurs simultaneously, it results in approximately half the time of conventional construction method.
4. *Appealing:* Since the building is produced with the same materials, same building standards and architectural specifications as conventional construction, it is sometimes impossible to distinguish from the conventional building.
5. *Flexibility and Reusability:* The buildings are movable and flexible where it can be dismantled, refurbish and move to another location for new use.
6. *Better Coordination and Cooperation:* An improved balance between quality and cost results in the reduction in manufacturing and installation costs.
7. *On-Site Safety Conditions:* Safety in modular construction is higher than conventional construction since around 85% of the work is done off the construction site.
8. *Workmanship and Productivity:* It requires less skilled workmanship on site as the work is less complicated and reduced time intervals between trades.



Fig. 4. Modular construction schedule

VI. CHALLENGES

1. *Project Planning:* It requires intensive pre-project planning and engineering. Also, along with the complexity of modules’ design, further considerations and planning are needed when incorporating different components within a module, and when modules are lifted, transported to the final project site, placed on the foundation, and joined to form the building.
2. *High Initial Cost and Site Constraints:* A massive amount of initial capital is required to set up appropriate machinery to run a modular manufacturing plant. In the areas, where

the labor is cheap, new methods of construction may be complicated. Also, the lack of availability of knowledgeable and experienced experts, such as designers and engineers who have enough experience for modular systems is a limitation. Finding off-site construction consultants, suppliers, and contractors is another significant difficulty.

3. *Reduced Adaptability to Design Changes:* Once the design has been approved, other interdependent activities are also undertaken simultaneously, therefore, the design must not change.
4. *Transportation Constraints:* It can be Hard to transport the modules far away. Time delays can occur due to late transmit permits for oversized components.

VII. METHODOLOGY

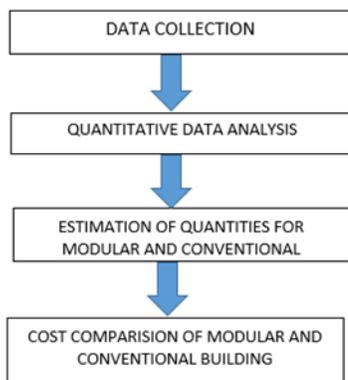


Fig. 5. Flow chart

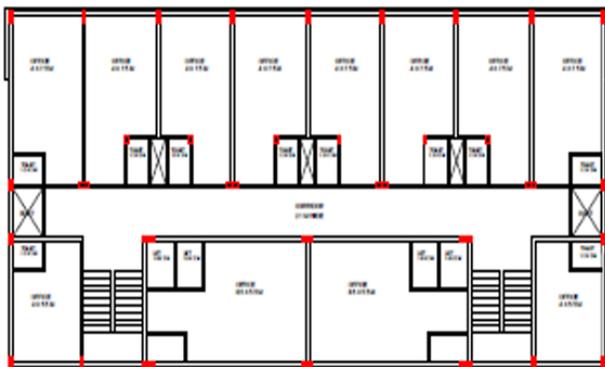


Fig. 6. Methodology

This paper performs a quantitative analysis of the two construction methods i.e. conventional and Modular construction.

To perform the quantitative analysis the cost per square foot of a hypothetical multi-story building was calculated for

conventional as well as a prefabricated modular construction method. For both the buildings, the

Actual manufacturing, and construction costs incurred in building the buildings were broken down and analyzed to calculate the total cost of the finished home per square

Foot which is a comparable unit of measure and ultimately which alternative is more cost-effective is decided.

VIII. CONCLUSION

- An analysis method has been proposed to evaluate modular construction methods quantitatively based on cost per square foot of construction, and on a qualitative way by listing benefits of each construction method and thinking about the tradeoffs between them. Through this method, it is possible to evaluate the cost-effectiveness of the two construction methods for multi-story commercial projects in a way that could serve as a valuable tool for decision making.
- The cost for the building in the conventional method is calculated to be Rs. 1100-1150 per sq. ft. whereas the cost for the building in th modular method is calculated to be Rs. 800-850 per sq. ft.
- The research addressed the question concluding that modular construction method is marginally more cost effective than conventional construction saving up to 30% of total cost for this particular case studies and under the given circumstances.

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