

Impact and Opportunities in Assessing Prefabrication in Construction

Praveen.B¹, Naveen Kumar S², Aravind K³

^{1,2,3} *Construction Technology & Management,*

School of Civil Engineering, Vellore Institute of Technology, Vellore

Abstract - Construction industry is the major developing industry in India. In current scenario there is a need for the advancement in the construction industry. Most of the construction projects are carried out by conventional method. Conventional method requires large amount of time and workforce. The disadvantage of using conventional methods of construction is that the process takes longer time. High skilled designers were required for the construction process. Then the construction costs, materials and work force are more expensive. By adopting prefabrication method, the total time of construction can be minimized. In many instances, Prefabrication construction method outnumbered the time when compared to the conventional method of construction. The Prefabrication method of construction has numerous benefits like it reduces the construction time, better quality and easy assembly. This study aims to compare the offsite- prefabricated construction and onsite conventional construction of buildings and point out the better option for the future. Questionnaires were prepared and survey is done to find out the general perception regarding the prefabrication construction, the factors that to be given more significant in both conventional construction and precast construction and the various risks and their level of impact on the people at the site. A G+1 commercial building is taken to compare the conventional construction and prefabrication construction. Time and price are the factors taken for the comparison, estimation is done separately for both the methods and the results are obtained.

Index Terms - Automation, Comparison, Conventional Construction, Prefabricated Construction.

I.INTRODUCTION

The scope of automation in construction is wide, comparing all the stages of construction life from initial planning and design, till constructing the facility, its operation and maintenance, to the eventual

deconstruction and recycling of buildings and structures. The recent growth in the field of Automation have helped to evolve new technologies in the field of construction industry. Businesses are looking for ways of automating Monotonous, time-consuming, and dangerous tasks to build up efficiency and improve the safety of workers. The construction industry is no different. In fact, automation is a suitable solution for builders to increase efficiency and to cut down construction costs. Typically, humans dislike banal, repetitive tasks. However, Automating Equipment's perform them without complaint. Tasks that lack variance provides a place for automated systems to glow, but also holds true for Equipment's that converts advanced sensors and integration. If the task requires conditions that are unfit to human comfort or focus in automation. Humans make mistakes when they exhaust. This embodies the sentiment of the "human condition." Mistakes using equipment's causes damage to raw materials, components, assemblies, and end products. For rapid construction with less risk and better quality there should be much more use of machineries as well as equipment in the construction industry. Human efforts and risks are minimized by using machines, Automatic Equipment, etc. at proper places. Automation tends to increase the productivity of the construction project, reduces the time taken and Man power work, and increases the safety, quality of work when compared to unskilled workers. Today precast concrete buildings are the most advanced construction technique available in the entire world. The prefab industry is the keystone for the development of new ideas in construction business of any country, its wide applicability, and the total precast concrete buildings systems are seemly a popular choice for many constructions. The compelling benefits include shortened time of actual site installation compared

with conventional construction methods, much smaller team on the construction site, reduced amount of supervision needed, small amount of technical staff from other trades, small deliveries, and less garbage disposal and clean up. Automation is becoming a reality for more construction projects as it evolves, reflects a principal need for advancing the coherence that can be brought to support in reducing overall costs while simultaneously enhancing design and construction quality.

II. METHODOLOGY

*AUTOMATION IN BUILDING CONSTRUCTION
(Introduction and comparison between off site-prefabricated construction and onsite conventional construction methods)*

PREREQUISITE

Literature Study about Automation processes and Conventional Construction ways in Industry

QUESTIONNAIRE SURVEYING

RESEARCH PROCESS

STAGE 1 – Understanding client requirements and planning

STAGE 2 – Cost comparison between conventional and prefabricated construction methods.

STAGE 3 – Time comparison between conventional and prefabricated construction methods.

FINDINGS AND DISCUSSIONS

CONCLUSION

A. Process involved in Conventional Construction Method:

The Conventional method of construction has been the accepted standard method for a long time. Conventional buildings are constructed involving strenuous effort, with architectural planning, design, foundation, and building over a span of time on-site. Once the site development is done, marking, excavation and foundations are laid. This is followed by the construction of columns, walls, lintel over door, window gaps and roof. Depending on the height of the

building, stairs, or elevators may be established and plastering is done. As the building rises, ducts, pipes, and electric circuits and wiring are positioned. Finishing operations include installation of windows, doors, electrical, plumbing fixtures, tiling and painting works were done. The process involved in conventional building as in Fig.1 techniques are time consuming and had to be revamped. Hence it paved a way for prefabrication in construction to reduce time, cost and clutter free way of construction.

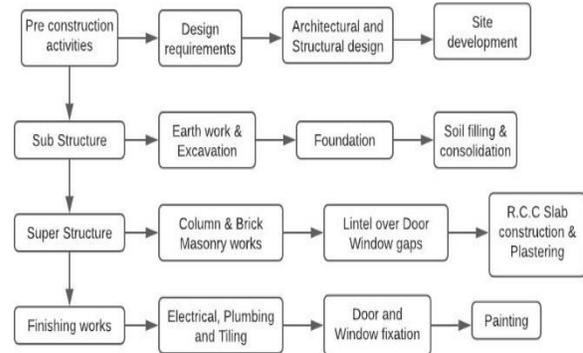


Fig:1 – Process involved on conventional Construction Method

B. Process involved in Prefabricated Construction Method:

Prefabrication technology aims at creating an advance method of construction. By adopting prefabrication method, the total time of construction can be minimized. In many instances, Prefabrication construction method takes outnumbered the time when compared to the conventional method of construction. Prefabricated construction is the practice of compiling a wide range of components of a structure at a manufacturing site. In the prefabrication method a building is constructed in parts that are prefabricated off site in well-equipped manufacturing facilities under controlled environment.

The demand for raw materials is remarkably reduced. It minimizes expended energy and decreases overall time of construction. The use of BIM act as the element for design, development, production and execution of the project. BIM helps in analyzing and distributing the exact data required for the project. Before construction of the project, it is digitally assembled and visualized in three-dimensional (3D). So, this has a significant impact on off-site construction. It ameliorates the prefabrication yield,

constructability, and quality, time of construction, economy, and safety of work environment.

The process involved in Prefabrication building as in Fig.2 are simple comparing with the conventional construction method. It minimizes the total construction time. The components required for the construction are designed with electrical, plumbing and HVAC details. The manufactured sub-assemblies are transported to the location of the construction jobsite. The components are erected and installed. The joints were provided between the core structure and the components to withstand all types of stresses. After the installation of the components grouting and finishing operations which include installation of windows, doors, electrical, plumbing fixtures, tiling and painting works.

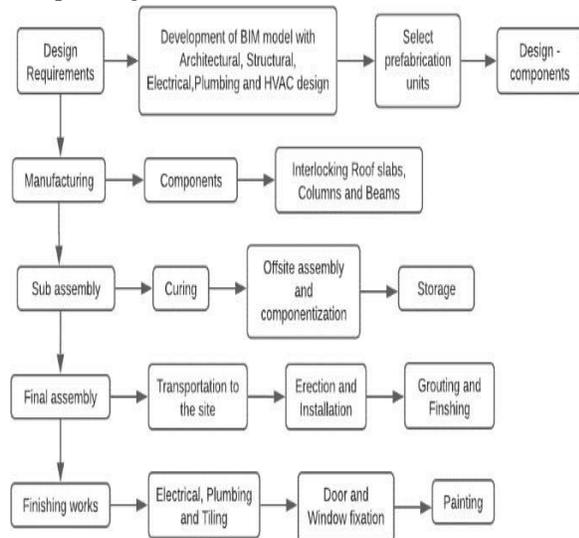


Fig: 2 – Process involved on Prefabricated Construction Method

C. Principles involved in Prefabricated Construction Method:

Prefabricated structures are always manufactured in accordance to the specific design codes. The Prefabrication construction requires experienced manpower and heavy machineries than conventional method of construction for maintain accuracy. The biggest problem in adoption of prefabrication technologies in construction industry is involving skilled manpower at site and the issues due to the lack of onsite automation.

The precast units are grouped floaty, not exceeding 30kg in weight and meant to be put up by using workforce. Moderate weight up to 500kg are to be

handled with simple mechanical equipment. Heavy, upward of 500kg, the structure requires the use of heavy handling plant or machineries.

The off-site fabrication process takes place in the factory or in warehouse. The materials required for construction arrive on site in preassembled condition. So as a result prefabricated buildings produce nominal waste when compared to structures built by using traditional method. The individual units are casted, cured and then transported to site and assembled using various equipment's. Accuracy and good finish quality is achieved in prefabrication construction method than conventional method, because the units are casted in factories. Prefabrication process won't get affected by any of the weather conditions.

Raising of foundation and plinth is done by the conventional method of construction and then the construction of superstructure is done by using prefabrication technology. The prefabrication technology cannot be used for the construction of substructure.

Proper monitoring is required in prefabrication construction before starting of the work and while erecting, transporting. So, another major issue is that there is possibility of prefabricated units to get damaged while transported from the factory to the site or while erection. For erection and the arrangement of the unit's heavy equipment's were required.

Compared with conventionally built structures, Prefabrication limits the risk of errors and involving site manpower are reduced to 50%. Also it provides safe working environment for the workers.

IV. QUESTIONNAIRE SURVEYING

A. Response from Users:

A general questionnaire is prepared to know about the user's perception regarding the prefabrication construction. Questions regarding time, perfection, cost and various other details concerning the consumer market were considered while designing the questionnaire.

The general public with a minimal exposure towards construction activities were educated about the drawbacks of conventional construction techniques, advantages and disadvantages of prefabrication construction techniques with necessary case studies and references. Then the responses have been recorded as in Fig.4.1

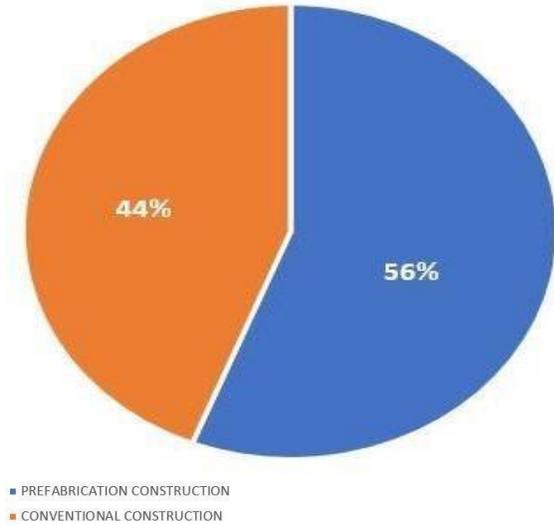


Fig: 4.1 – User Response

B. Response from Engineers, Project Managers, Architects:

Another questionnaire is prepared for all the stakeholders such as design engineers, project managers, structural engineers & architects with the objective of finding out the factors and also to give more prominence in conventional construction and precast construction.

Various factors that are considered in the study includes planning, design time, construction time, workmanship, availability of workforce and equipment, project completion at estimated cost, safety requirement, risk factors, quality control assurance, environmental and social challenges etc., The questionnaire was filled with response criteria as indicated in pie chart in Fig. 4.2 and such criteria were chosen by every individual which they felt to be an appropriate reason for choosing prefabricated construction method.

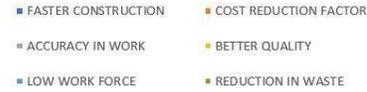


Fig: 4.2 Response from Engineers, Project Managers, Architects

The reason for choosing prefabrication construction by the engineers because of the faster construction, quality of the construction is maintained, reduced site disruption, Easy for erection and installing, requirement of work force is less. So they prefer prefabrication over conventional construction methods.

C. Response from Workers:

Another questionnaire is prepared to know challenges faced by the workers in site conditions. The survey is based on the workers’ health condition, job safety, working hours, risk of accidents and retirement life. The survey was done from various people under conventional construction method. The questionnaire was filled with response criteria as indicated in pie chart as Fig. 4.3

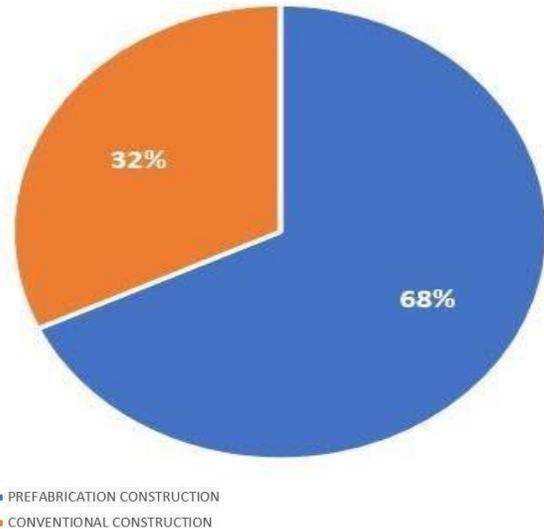
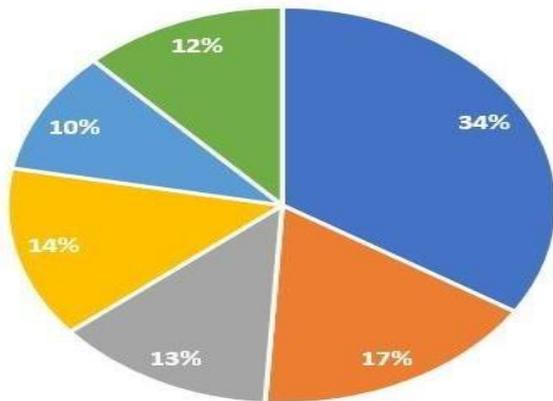


Fig: 4.3 Response from Workers

The reason for choosing prefabrication construction by the workers is because of job security, safety, work timings, quality of life, and work culture over conventional construction methods.

V. RESEARCH PROCESS

A. Planning according to client requirements

The brief is to construct a G+1 commercial building in a crowded urban area for rental purposes. The plan is finalized Fig 5.1, Fig 5.2 and no other alterations or

changes in the project is needed. Based on the brief provided an estimate Table 1, Table 2 and time schedule Table 4, Table 5, Gantt chart Fig 5.3, Fig 5.4 is created as in to analyze the effectiveness of the suitable construction technique.

Ground floor Area – 180 sq.m
 First floor Area - 180 sq.m
 Total area - 360 sq.m

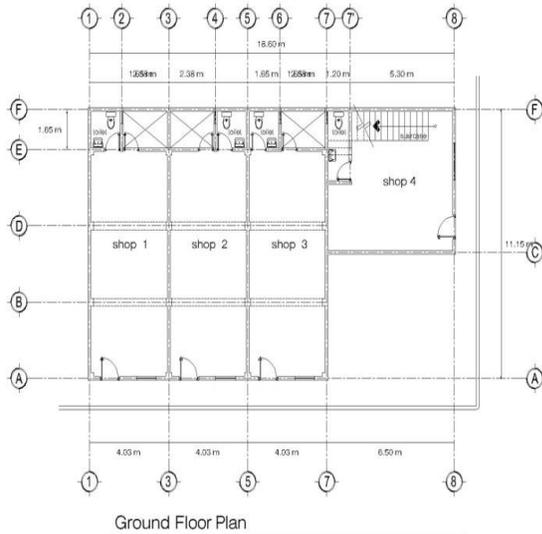


Fig: 5.1 Ground Floor Plan

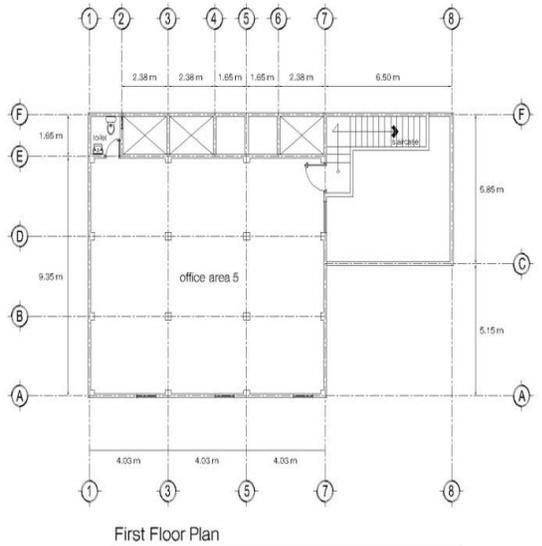


Fig: 5.2 First Floor Plan

B. Cost comparison between conventional and prefabricated construction methods:

S.NO	DESCRIPTION OF WORK	QUANTITY	UNIT	RATE	AMOUNT
1	Earthwork	97.14	CUM	250	24285
2	PCC for foundation	10	CUM	3500	35000
3	Brickwork	628	CUM	1600	86464
4	RCC concrete	332	CUM	8000	2656000
5	Soil Filling	210	CUM	200	42000
6	PCC - 1:4:8 for floor	14	CUM	3200	44800
7	Plastering	1403	CUM	300	420900
8	Floor finishing with tile	355	SQ.M	300	1060500
9	Aluminium doors and windows	46.8	SQ.M	2000	140580
10	Painting (exterior and interior)	L.S	LTR	2200	137720
11	Fixing of MS staircase handrails	L.S	KGS	1250	20000
12	Electrical works	L.S			200000
13	Water supply & Sanitation	L.S			150000
14	Septic tank and soak pit	6000	LTR	10	60000
15	Underground sump	6000	LTR	10	60000
16	Provision for overhead water tank	7500	LTR	10	75000
17	Rain water pipes				12000
TOTAL					6003431

Table: 1 Estimate for Conventional construction method

S.N O	DESCRIPTION OF WORK	QUANTITY	UNIT	RATE	AMOUNT
1	Earthwork	97.14	CUM	250	24285
2	RCC for foundation	10	CUM	3500	28384
3	Modular RCC Column, beams, slabs	360	SQ.M	70000	2520000
4	Transportation to site	L.S			140250
5	Installation on site	L.S			805650
6	Grouting of joints	L.S			78950
7	Soil Filling	210	CUM	2000	28000
8	PCC - 1:4:8 for floor	14	CUM	3200	44800
9	Floor finishing with tile	355	SQ.M	1500	1060500
10	Aluminium doors and windows	46.8	SQ.M	220	140580
11	Painting (exterior and interior)		LTR	220	137720
12	Fixing of MS safety grill and handrails		KGS	1250	20000
13	Water supply & Sanitation		L.S		150000
14	Septic tank and soak pit	6000	LTR	8	48000
15	Underground sump	6000	LTR	8	48000
16	Provision for overhead water tank	7500	LTR	8	60000
TOTAL					5335119

Table:2 Estimate for Prefabricated construction method

C. Time comparison between conventional and prefabricated construction methods:

ACTIVITY	START DATE	END DATE	DURATION
Site Clearing	02/11/2020	04/11/2020	2 Days
Earthwork	05/11/2020	07/11/2020	2 Days
Foundation	09/11/2020	25/11/2020	15 Days
Soil Filling	26/11/2020	28/11/2020	2 Days
Consolidation	30/11/2020	02/12/2020	3 Days
Column Casting	03/12/2020	24/12/2020	18 Days
Brick Work	25/12/2020	16/01/2021	20 Days
Lintel Beam	17/01/2021	22/01/2021	7 Days
Beam and Slab	23/01/2021	17/03/2021	45 Days
Plastering	18/03/2021	14/04/2021	24 Days
Electrical	15/04/2021	17/04/2021	3 Days
Plumbing	19/04/2021	28/04/2021	8 Days
Tiling	29/04/2021	07/05/2021	10 Days
Painting	08/05/2021	31/05/2021	20 Days
Install Door Windows	01/06/2021	17/06/2021	15 Days
Miscellaneous	18/06/2020	12/07/2020	20 Days
TOTAL DURATION			214 days

Table: 3 Time comparison for Conventional construction method

ACTIVITY	START DATE	END DATE	DURATION
Foundation	02/11/2020	03/12/2020	24 Days
Erection, Installation	04/12/2020	23/12/2020	14 Days
Grouting	24/12/2020	28/12/2020	3 Days
Electrical Work	29/12/2020	30/12/2020	2 Days
Plumbing Work	31/12/2020	01/01/2021	2 Days
Tile laying	02/01/2021	15/01/2021	10 Days
Painting and Aluminum Cladding	16/01/2021	22/01/2021	5 Days
Install Doors, Windows	23/01/2021	29/01/2021	5 Days
Final Finishing Miscellaneous	30/01/2021	09/02/2021	7 Days
		TOTAL DURATION	72 days

Table: 4 Time comparison for Prefabricated construction method

VI. FINDINGS AND DISCUSSIONS

Construction is a risky and complicated industry to work with, so companies want to apply secure process and techniques. With prefabrication, there is reduced risk for the trouble like dirt, moisture, and other environmental hazards because workers create subgroups in factory-controlled environments.

On working sites, the workers and feasible occupants allowing to weather-related health risks, so a factory-monitored climate ensures more safety compared to construction site with adequate working hours.

In Prefabrication, workers smoothly disassemble and relocate subunits to different sites. General contractors and Clients are tilted more towards the prefabricated methods of construction because it offers flexibility, feasible cost, systematic in time consumption without constraining creativity.

According to the Engineers and Designers, Prefabrication takes less construction time because of the precise planning, elimination of on-site weather conditions, Shorter construction times helps companies to work on many projects at once, allowing growth of business instead of focusing on a single project at a time.

As per the survey the construction industry with conventional method has reinvented prefabrication and modularization due to the innovations for the future construction technology. BIM (Building Information Modeling) technology is a useful tool that is making the construction industry more environmentally sustainable and economical by its Inventory method or technology.

BIM combined technology and construction helps contractors and companies to visualize the scope of the project.

The incorporation of technology and construction could visualize the expense and material differences, which can reduce the material costs and unused labor hours.

VII. CONCLUSION

- The construction industry in India had been described as worker intensive, dangerous and polluting. Most of the buildings are still constructed with Conventional methods involving concrete cast at site, timber Formworks and wet trades with high workforce requirement. Improved quality was achieved as the precast elements were manufactured in a factory atmosphere with stringent quality control.

- Prefabrication is a latest construction process that is gaining popularity. In the construction industry, there are creative ideas and approaches that could increase productivity and save money. All in all, prefabrication enables time and cost savings, quality control, and a more eco-friendly construction process which will act as the milestone to the future construction Industry. Precast construction requires a restructuring of the entire conventional construction which acted as a core for prefabricated construction process to enable relationship between the design phase and fabrication phase in to improve and speed up construction activities.

- Prefabricated construction proves to be an extremely practical option, and as manufacturing technology continues to improve, expect to see its benefits and advantages rise in the future. In Industrial revolution almost every sector like Automotive, IT had shown rapid growth whereas comparatively in construction industry shown low development in automation in this era, prefabrication technology with major advantages is an essential technological upgradation in construction sector to defeat the present challenges world-wide and it has the capability to make a revolution in the construction industry in terms of financial, social, ecological sustainability in India as well.

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