



PREFABRICATED SYSTEMS AS A FUTURE OF MASS HOUSING IN INDIA

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Abstract : The main aim of this paper is to analyze which prefabrication system is in construction of mass housing in India. As we all know prefabrication is better than normal conventional construction system. The PMAY scheme housing for all states the same, the fast and affordable housing technology to cater large population in India. This paper also throws light on which of the prefabrication system is better among the ongoing prefab systems in India. The research methodology of quantitative descriptive evaluation has been used. Finally, the role prefabrication in development of nation has been defined with understanding of what steps to be taken in future approach in housing sector.

IndexTerms - Component,formatting,style,styling,insert.

I. INTRODUCTION

AIM-

To explore the suitability of Prefabrication in mass housing.

OBJECTIVES -

To explore of types of prefabrication system in India. And the advantages and disadvantages of prefab structures and materials used in walling and roofing. Also, to find which of these system is more feasible for construction through case studies. Analysis of case studies will be done with respect to time, cost, energy and carbon footprint.

NEED TO STUDY

- To cater housing demand for large population in India
- To decrease the labour requirement of construction.
- To improve the quality of construction with low cost.
- To increase the productivity of construction and to attain sustainability of the structure.

METHODOLOGY

- Overview of construction materials used in prefabrication
- To study properties of alternate materials used in prefabrication.
- Niche area of study will be embodied energy of alternate building materials.
- Case studies of existing prefabricated buildings in India which used alternate building materials in walling and roofing.
- Selection of alternate building materials based on parameters.

SCOPE –

- We will study the methods and types of prefab systems in housing only.
- Analysis will be done only on case studies.

LIMITATIONS –

- The study does not deal with manufacturing process of building materials and components.
- The study does not deals in assembling and joinery details of structural parts in prefabricated buildings.
- The study is primarily based on secondary research through books and internet.

WHAT IS Prefabricated Construction ?

A prefabricated construction system approach (i.e., one where the materials have been pre-selected and assembled into a holistic system) can help builders make their construction activities and decisions with confidence that the final outcome will meet the NZEB requirements. (Source:- Net Zero Energy Buildings (NZEB), 2018)

The construction industry contributes significantly to global economic growth. However, its rapid development also produces adverse effects on the environment.

According to the International Energy Agency, the most energy consumption and CO₂ emissions come from the building industry.



Besides severe environmental damage, conventional construction methods could also cause economic and social issues, such as long construction periods, low labor productivity, and a high frequency of safety accidents.

II. . LITERATURE STUDY

S. No	Author & Year	Name	Objective	Conclusion
1	Mark B Luther, 2009	Towards Prefabricated Sustainable Housing	In industrialized countries, there is need for an alternative to the current resources and energy intensive housing.	Prefabricated architecture can deliver high order design and diversity within the framework of waste reduction and renewable Systems integration.
2	Mohammad Arif Kamal, February 2021	Exploration of Prefabricated Building System in Housing Construction	To determine the housing factors needed for the successful use of prefabrication in construction Industry.	The use of prefabrication merely offers an alternative route to procuring a building.
3	Sharon T. Abeyl * K. B. Anand, August 2019.	Embodied Energy Comparison of Prefabricated and Conventional Building Construction	The study was to quantify energy consumption in prefabricated and conventional building.	The building EE of conventional (4.02FJ/m ²) was as good as prefabricated (4.25GJ/ ²) construction, adopting brick infill walls.
4	E. C. Mpakati-Gama*, S. C. Wamuziri and B. Sloan, June 2012	Use of alternative building materials in developing countries.	To find ways for promoting sustainability in developing countries.	The ABM's are considered to contribute to the reduction of fuel wood consumption attributed to the construction Industry.
5	Shilpa Narayanamurthy	Prefabrication in developing countries : a case of India	To illustrate the advantages and disadvantages of prefabrication adoption in Indian culture.	Prefabrication technology has not transferred as easily when compared with other technologies because it is a production technology or knowledge based.

Emerging Trends in Housing construction

- 2.1 Precast construction
- 2.2 Tunnel form construction
- 2.3 Large area formwork construction

- 2.4 Lightweight concrete construction
- 2.5 Cold-Formed Steel (CFS) housing system
- 2.6 Prefabricated building system
- 2.7 GFRG building system
- 2.8 EPS Panel system

Why New Technologies for Mass Housing?

- 2.9 There is too much of dependency on cement, aggregates and water in these traditional constructions. In particular, the fine aggregate (sand) and water to-day are quite scarce.
- 2.10 It is also seen that, on account of shortage of skilled labour, these constructions today, in general, are not upto the mark in terms of quality.
- 2.11 In addition, traditional construction cannot be green buildings normally. But green buildings are the order of the day, in view of energy scarcity and, fast depletion of precious natural materials.

Broad Parameters for Evaluation of Technologies



- 2.12 Suitability to Indian climatic and hazard conditions
- 2.13 Structural stability including fire safety
- 2.14 Material specification and its durability
- 2.15 Thermal and acoustic behaviour
- 2.16 Green concept
- 2.17 Joints and connections specially for prefabricated system
- 2.18 Cost effectiveness of the emerging technologies vis-à-vis conventional construction system (RCC and masonry construction)
- 2.19 Speed of construction and quality
- 2.20 Fixing of plumbing & electric services
- 2.21
- 2.22 Scale of minimum number of houses
- 2.23 Users' feedback and certification, wherever possible.
- 2.24 Compatibility and adherence of the system to established standards

III. CASE STUDY SELECTION CRITERIA

- 3.1 Prefabricated building Structure.
- 3.2 Light House Project or Demonstrating Housing Project
- 3.3 Projects of Housing.
- 3.4 Innovative Building Materials being used in walls/slabs/Roofs.

PARAMETERS FOR CASE STUDY

- 3.5 Light House Project (LHP) & Demonstrating Housing Project (DHP)
- 3.6 Type of frame structure used
- 3.7 Innovative materials used for walls/Slabs/Flooring
- 3.8 Size of modules
- 3.9 Manufacturing of units
- 3.10 Energy effectiveness

Structure	Projects	Selected Projects
	Tiruppur lore ya, Guv hkhula	
Structure)		
Stay in place formwork system	Lucknow, Biharshariff,	Lucknow,

IV. DETAILED CASE STUDY ANALYSIS



Demonstration Housing Project (DHP) at Bhubaneswar, Odisha.

Demonstration Housing Project at Panchkula, Haryana.



Light House Project

Light House Project , Indore, Madhya Pradesh.



Light House Project at Agartala, Tirupura



Demonstration housing project at Nellore, Andhra Pradesh

CASE STUDY 1 : DEMONSTRATING HOUSING PROJECT AT BHUBNESHWAR ,ODISHA**PROJECT PROFILE**

No. of houses : 32(G+3)

Carpet area of each unit : 23.97 sqm.

Built up area of each unit including common area : 34.10 sqm.

Total built up area under the project is 11,782 sq.ft.

Technology: PREFABRICATED SANDWICH PANEL SYSTEM -

Reinforced Expanded Polystyrene sheet core with sprayed concrete

Each Unit consists of One living room, one bedroom, cooking space, Bath and WC. Includes Earthquake Resistant Features.

**CASE STUDY 2 : DEMONSTRATING HOUSING PROJECT AT NELLORE, ANDHRA PRAESH****PROJECT PROFILE**

No. of houses : 36 (G+1)

Carpet area of each unit

Type A – 16 DUs : 31.06 sq.mts.

Type B – 16 DUs : 29.39 sq.mts.

Type C – 4 DUs : 56.74 sq.mts.

Built up area of each unit

Type A – 16 DUs : 45.51sq.mts.

Type B – 16 DUs : 42.24 sq.mts.

Type C – 4 DUs : 77.86 sq.mts.

Type A & B Unit consist of : Living room, Bedroom, Kitchen, Bath, WC and Balcony

Type C Unit consist of : Living room, 3 Bedroom, Kitchen, 2 WC & Bath and Balcony & Terrace

includes Earthquake Resistant Features.



CASE STUDY 3 : LIGHT HOUSE PROJECTS - LUCKNOW, UTTAR PRADESH**PROJECT PROFILE**

Location of Project - Avadh Vihar, Lucknow, U.P.

No. of DUs -1,040 (S+13)

Plot area - 20,036 sq.mt.

Carpet area of each DU - 34.51 sq.mt.

Total built up area - 48,702 sq.mt.

Technology being used - Stay In Place Formwork System
with pre-engineered steel structural system

**CASE STUDY 4 : LIGHT HOUSE PROJECTS - INDORE, MADHYA PRADESH****PROJECT PROFILE**

Plot Area for LHP : 1412.36 Sq.mts.

Total Covered Area : 2015.95 Sq.mts.

No. of Units/Rooms : 1024(S+8)

Carpet Area of a unit : 29.92 Sq.mts.

Each unit consist of a living area, bedroom, toilet,
kitchen, circulation area, balcony, threshold area.

**CASE STUDY 5 : LIGHT HOUSE PROJECTS - AGARTALA, TIRUPURA****PROJECT PROFILE**

No. of Houses - 1,000

No. of Floors - G+6

Plot Area - 24,000 sqmtrs

Per House Carpet Area - 30.00

Project Cost - 162.50 Cr

Per House cost (with infrastructure) - 16.25lacs

**CASE STUDY 6 : DEMONSTRATING HOUSING PROJECT AT NELLORE, ANDHRA PRAESH**

PROJECT PROFILE

No. of houses : 36 (G+1)
 Carpet area of each unit
 Type A – 16 DUs : 31.06 sq.mts.
 Type B – 16 DUs : 29.39 sq.mts.
 Type C – 4 DUs : 56.74 sq.mts.
 Built up area of each unit
 Type A – 16 DUs : 45.51sq.mts.
 Type B – 16 DUs : 42.24 sq.mts.
 Type C – 4 DUs : 77.86 sq.mts.
 Type A & B Unit consist of : Living room, Bedroom, Kitchen, Bath, WC and Balcony
 Type C Unit consist of : Living room, 3 Bedroom, Kitchen, 2 WC & Bath and Balcony & Terrace
 includes Earthquake Resistant Features.



V. INFERENCES

Parameters	Bhubneshwar, Odissa	Panchkula Haryana	Lucknow, Uttar Pradesh	Indore, Madhya Pradesh	Agartala, Tirupura	Nellore, Andhra Pradesh	Inferences
Total built up area	1,094 sq.mt	2,015.95 Sq.mt	48,702 sq.mt.	1,520 sq mt	24,000 sq mtrs	7486 sq mt	Used in mass housing, not feasible in single dwelling
No of Dwelling Units	32 (G+3)	40(G+3)	1040(G+13)	1024(S+13)	1000(G+6)	36 (G+1)	Height of G+13 can be achieved in steel frame and stay in place PVC
Carpet area of each DU	23.97 Sq.mt.	2015.95 Sq.mt.	34.51 sq.mt.	29.29 sq mt.	30.00 sq mtrs	31.06 sq.mts.	
Structure Frame	RCC/Steel framed	Light Gauge Steel Framework System	Pre-engineered steel structural frame	RCC or steel framed structure.	pre-engineered steel structural system for buildings above G+3	RCC Column footing with M-25 concrete	Steel frame structures are more suitable for using these innovative materials.
Material used for walls	Expanded Polystyrene Core Panel System with Sprayed Concrete Structural Plaster for wall/slab/roof	Cement Fiber board (Aerocon) on both side of walls and infill of rock wool.	Stay In Place PVC Formwork System for walls	EPS (Beads) Cement Panels	Light Gauge Steel Frame (LGSF)	Glass Fibre Reinforced Gypsum Panel (GFRG)	These materials could be easily used in walling , roofing, cladding .

Material used for Slabs/Flooring	Ceramic tile flooring in rooms Ceramic tile flooring in WC & Bath Kota stone in passage	MS deck sheeting resting on web joist for slab and concrete screed with false ceiling of gypsum board	Cast in-situ deck slab	EPS (Beads) Cement Panels	Cement concrete panels with lightweight concrete as infill	GFRG Panel Slab for floor & roof	
Sizes of modules	3000mmX610mm-60mm/75mm/90mm.	1200mmX2400mm/3000mm	4300mmX64mm/126mm	(1500mm-3000mm)x610mm	Fully integrated computerized system with Centrally Numerical Control (CNC)	1200 mm X 300 mmX12.4mm	Prefabricated in different sizes and thickness
Embodied Energy	6.75MJ/kg	5.5MJ/kg	115.00 MJ/Kg	3.23MJ/kg		5.44MJ/KG	EPS panels have least embodied
Embodied Carbon	0.38 kg CO ₂ /kg	0.12CO ₂ /kg	11.270kg CO ₂	0.27kg CO ₂ /kg		0.38 kg CO ₂ /kg	
Cost per unit (Lacks)	9.80	11.50	12.58	12.50	16.25	9.06	Cost of using GFRG panels is least
Time per unit	55 days	45 days	40 days	40 days	40 days	45 days	LHP projects are more time saving

V1. CONCLUSION

The six categories of prefabricated system technologies discussed in this paper offer improvement in speed, quality and resource management in building mass housing compared to conventional in-situ construction. However, their adoption for residential projects has remained low.

Among these each one has some benefit over the other and has a scope of improvement when used in future for mass housing in India

6.1 With respect to time-

All the light house projects consume less time , as only 11 days are required to construct the sub structure and 29 days are required to construct super structure.

6.2 With respect to cost –

Expanded Polystyrene Core Panel System with Sprayed Concrete Structural Plaster is more economic (followed by GFRG panel system) than the others as the raw material (cement concrete) is readily available and easy to transport.

6.3 With respect to energy –

EPS cement panels have less embodied energy (followed by GFRG panels) compared to other walling and roofing materials used in LHP's and DHP's .

6.4 With respect to sustainability –

For the GFRG demo building, the embodied energy works out to be only 5.24 GJ/m² , which is better from some other prefab systems .

Even GFRG has almost 50% lesser embodied energy when compared to conventional building system.

It also consumes less time of 45 days as compared to other prefab systems and conventional construction methods.

This makes GFRG a competent alternative to conventional building materials and systems. Moreover, GFRG buildings offer better interior thermal comfort even during the hottest days. This minimizes the energy requirement for air conditioning of the building and thereby results in saving of electricity. This reveals that the use of GFRG panels in building construction improves the sustainability of the building sector.

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Instead, try "R.B.G. thanks". Put applicable sponsor acknowledgments here; DO NOT place them on the first page of your paper or as a footnote.

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