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Precast Construction as a Sustainable Alternative for Affordable Housing Under PMAY-G

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Abstract*— Housing schemes are plentiful in India, and their demand is very high, especially in rural areas where the housing need is greatest. That's why Pradhan Mantri Awas Yojana Gramin (PMAY-G), under the Housing for All (HFA) initiative, is implemented in rural areas of India. In rural regions, classification of beneficiaries is based on Social Economic Criteria (SEC) data, which targeting the homeless, destitute, manual scavengers, and auto-excluded groups. The SEC group depend on financial support provided through government housing schemes. Most beneficiaries face this problem during the initial stages of the PMAY-G application. The estimate is analyzed before sanction, and the installment amount is released in this scheme in steps. It is observed that the previous construction amount sanctioned under PMAY-G is insufficient due to increased material, transportation costs, etc., in the post-Corona period. Therefore, reducing these conflicts in the application process, sanctioned amount and installments under the PMAY-G scheme is required an alternative. In this study, the complete precast house unit installation is proposed as an alternative solution for rural areas. A material and cost comparison is also conducted between precast and traditional construction methods. A viable solution is suggested for beneficiaries to construct a housing project with proper planning under the scheme. It may improve the users from the SEC group, which is also highly beneficial for running the housing schemes.

***Index Terms*— Housing, Pradhan Mantri Awas Yojana Gramin, Precast construction, Beneficiary**

I. INTRODUCTION

India's economy is the fourth largest economy in the world, and has experienced rapid economic growth over the last decade, positioning itself one of the fastest growing economies. With a population of over 1.4 billion people, has one of the largest and fastest growing population in the world [8]. Despite this, poverty remains major issue. A small section of the population has benefited from the growth, while a large majority still struggle basic needs of humankind has been very well captured in the tittle of an iconic Bollywood movie "Roti, Kapda aur Maakan"[1]. For centuries this need has remained the prime focus, and most of the efforts of mankind have evolved around this three pillars. House is one of essential needs of every human being in today's society to live standard life. In India, the importance of securing a roof over head occupies the central position, and host of the economic efforts revolve around it. And this uncertainty of basic needs of humankind specially of the housing is majorly in the rural areas of India. Over a 900 million of people are in the rural areas of India, roughly two-third of total population [9]. Growth of rural population in India remains significant, creating massive housing demand[2]. The rapid population growth creates shortage of houses and proper houses in the both urban and especially in rural areas. A high percentage (around 82%) of housing poverty, affecting the poorest, is concentrated in rural areas [3].

Fulfilling the housing demand of the poorest people in the India under the initiative of "Housing for All" is the main problem to address, to achieve the goal of "Viksit Bharat" (Developed India) by 2047 includes ensuring robust infrastructure and enhancing quality of life with better homes for every Indian citizen [10]. By this the government of India introduced the Pradhan Mantri Awas Yojana (PMAY) in 2015 with an aim of providing affordable housing. PMAY aims to provide a pucca house with basic amenities to all houseless households and households living in kutcha house by 2022[3]. There are two components of PMAY. One is Pradhan Mantri Awas Yojana-Urban (PMAY-U) for the urban poor, and the other which is our priority for the paper is Pradhan Mantri Awas Yojana-Gramin (PMAYG) for rural poor. PMAY-G was introduced in 2016 after realizing the urgent demand for suitable rural homes [3].The main purpose of this scheme is to provide affordable housing to the poor and needy rural people. Government aim is to provide affordable house to beneficiaries through PMAY-G by the traditional construction method such as Load Bearing Structure (LBS) and Reinforced Concrete Structure (RCC) [9].

A. Aim:

The aim of the study is to use the precast housing technique under the PMAY-G scheme which is provided the Pucca House shelters to the houseless beneficiaries in the rural area.

B. Objective:

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To achieve the aim of "Housing for All" the target number of houses to be constructed by the year 2029. The overall target was 2.95 crore houses construction under PMAY-G. In the first phase, 1.00 crore houses were taken up for construction in 3 years, i.e. 2016-2019 financial year (FY). The remaining houses was to be completed by 2024. But the 1.69 houses were constructed in the FY of 2024 and additionally 2 crore houses approved for construction till the 2029 FY[4]. PMAY-G envisaged that the beneficiaries themselves will be constructed the quality houses using locally available construction materials, using appropriate house design typologies and through trained rural mason [8].

II. METHODOLOGY

Analytical and qualitative methodology was adopted in this study. Field visit and interaction with beneficiaries through questioner methods was adopted to collect the data. This study comprises analysis of the schemes, precast housing materials and cost of the project. Detailed study on the PMAY-G, Traditional Construction method with its cost analysis of the materials, Precast construction, cost analysis of the material etc. which is needed for the research in detailed for the proper result and findings.

Following points were considered during the analysis:

- Concept of the PMAY-G scheme.
- Analysis of the Traditional Construction Method
- Detailed study on the Precast Construction Technique.
- Compare the traditional construction method and precast construction technique to identify the suitability of scheme for the beneficiaries.
- Analysis the Results of construction method after comparison.

A. Pradhan Mantri Awas Yojana- Gramin (PMAY-G):

In the year 2016, Indira Awas Yojana(IAY) restructured into the Pradhan Mantri awas yojana- Gramin because of some gaps found in the audit report of the CAG, such as many beneficiaries who were not eligible for benefit, lack of transparency in selection of beneficiaries, no proper assessment of housing shortage, lack of convergence, etc. it was crucial need to reform in the scheme and the aim was government to provide housing to all by 2022. IAY was made an independent program with effect from 1st January, 1966 aimed at addressing housing needs of the Below Poverty Line (BPL) households [5].

B. Impact of the COVID-19 on the construction sector:

Inflation in India is rising rapidly, placing significant strain on the construction industry. The cost of essential materials such as timber, steel, and other critical inputs has increased sharply, while supply chain disruptions and material shortages continue to limit availability. Although these issues initially stemmed from COVID-19–related disruptions, ongoing geopolitical tensions and increased government-led infrastructure development have further intensified demand and pricing pressures.

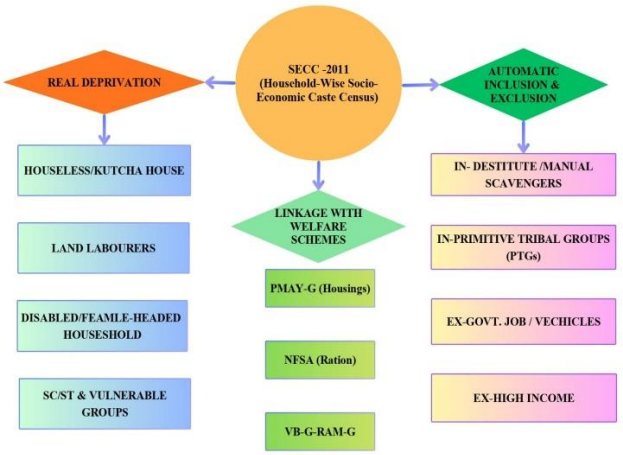

Fig1. Socio economic cast census

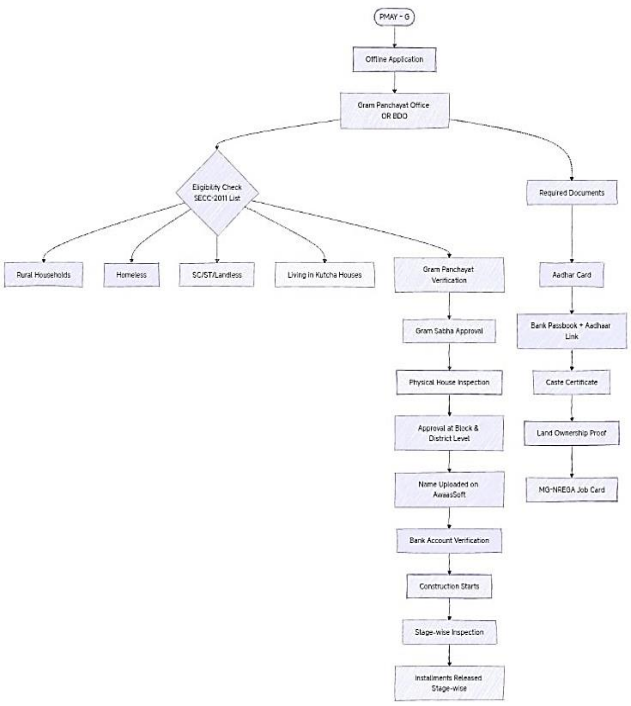

Fig 2 PMAY-G Scheme

At the same time, the construction workforce is shrinking as skilled workers retire, face mobility restrictions, or transition to other sectors offering higher wages. Rising fuel prices have added to costs by increasing transportation expenses and operating costs for heavy machinery. Since labor accounts for more than half of total construction costs, wage inflation has a major impact on project profitability. Contractors, operating on thin margins, struggle to accurately price bids amid cost uncertainty, delays, and fixed-price contracts. As a result, financial stress is growing, with some

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firms facing liquidity challenges, reduced competitiveness, and difficulty securing project funding [6].

C. Analysis of the Traditional Construction Method:

Traditional Construction Method is the method of the construction of the houses where the most used techniques are Load Bearing Structure (LBS) and Reinforced Concrete Structure (RCC). This method widely used for rural housing in India including PMAY-G. Traditional construction method involves building structures on-site using conventional techniques and material.

D. Key steps involved in the traditional construction method in PMAY-G.

1. Site Preparation:

Site preparation is the initial step in traditional construction, setting the stage for a successful project. It involved:

1. Clearing: Remove vegetation, debris, and obstacles.
2. Grubbing: Remove roots and organic matter.
3. Grading: Level the ground to the required elevation.
4. Excavation: Dig trenches for foundations, utilities, and drainage.
5. Soil Testing: Check soil bearing capacity and stability.
6. Compaction: Compact the soil to prevent settling.

2. Foundation Work:

Foundation work is crucial for structural stability and durability. It involved,

1. Excavation: Dig trenches for footings and foundations.
2. Footings: Lay concrete footings for support.
3. Foundation Walls: Build walls using Brick or stone masonry, Concrete blocks, Reinforced concrete (RCC).
4. Placing Reinforcement: Add steel bars (rebar) for strength.
5. Concrete Pouring: Fill foundation with concrete.
6. Curing: Allow concrete to set and cure.

3. Wall Construction:

Wall construction involves building vertical structures using various materials and techniques. It involved,

1. Brickwork: Lay bricks with mortar (cement-sand mix), ensure proper bonding and alignment, use plump and level checks.
2. Blockwork: Use concrete blocks or AAC blocks, similar to brickwork with mortar joints.
3. RCC Walls: Build formwork and place reinforcement, pour concrete and cure.
4. Masonry: Use stones or bricks with mortar, ensure interlocking and stability.

4. Roofing:

It involved,

1. Roof Structure: Beams, rafters, and purlins.
2. Roofing Material: Tiles, sheets (GI, asbestos, etc.), or concrete slab.
3. Waterproofing: Apply waterproofing layers (membranes, coatings).
4. Drainage: Ensure proper slope and gutter systems.

5. Finishing Work:

It involved,

1. Plumbing and Electrical: Install fixtures and fittings.
2. Flooring: Lay tiles, stones, or other materials.
3. Doors and Windows: Install frames and fittings.
4. Painting and Finishing: Apply paint, varnish, or other finishes.
5. Fixtures and Fittings: Install hardware (handles, locks, etc.).

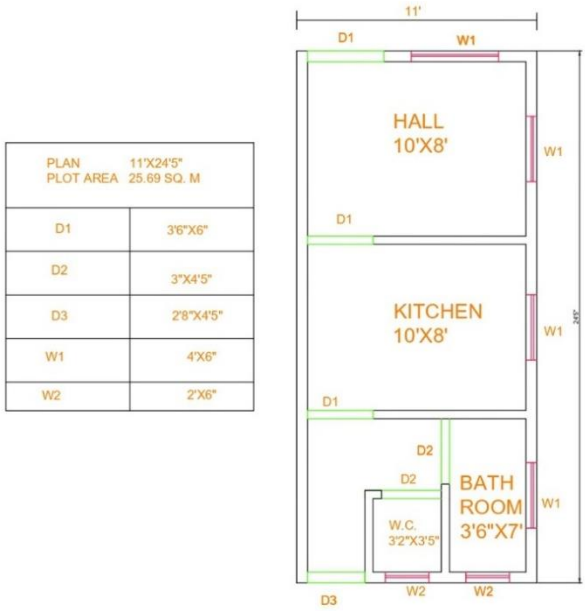

Fig 4 Plan of House

Table 1: Estimation for the LBS and RCC Adopted in PMAY-G

Material	Quantity	Rate	Cost in Rs
Cement	150 Bags (6000kg)	350/Bag	52,500
Steel	850 Kg	50/Kg	42,500
Sand	15 Brass	5,000/Brass	75,000
Aggregate	4.5 Brass	3000/Brass	14,000
RCC labor cost	48 Days	1500 /Day	60,000
Brick work	48 Days	1450/Day	47,000
	Total Cost	**A**	2,91000

Table 2: Precast Concrete Estimation

Material	Quantity	Rate	Cost in RS
Cement	177 Bags	350/Bag	62,000
Steel	890 Kg	50/Kg	44,500

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Sand	16 Brass	5,000/Brass	80,000
Aggregate	5.3 Brass	3000/Brass	16,000
Precast labor cost	48 Days	650 Rs./Day	31200
	Total Cost	**B**	2,33,700
	Cost Difference	**A-B =**	57,300

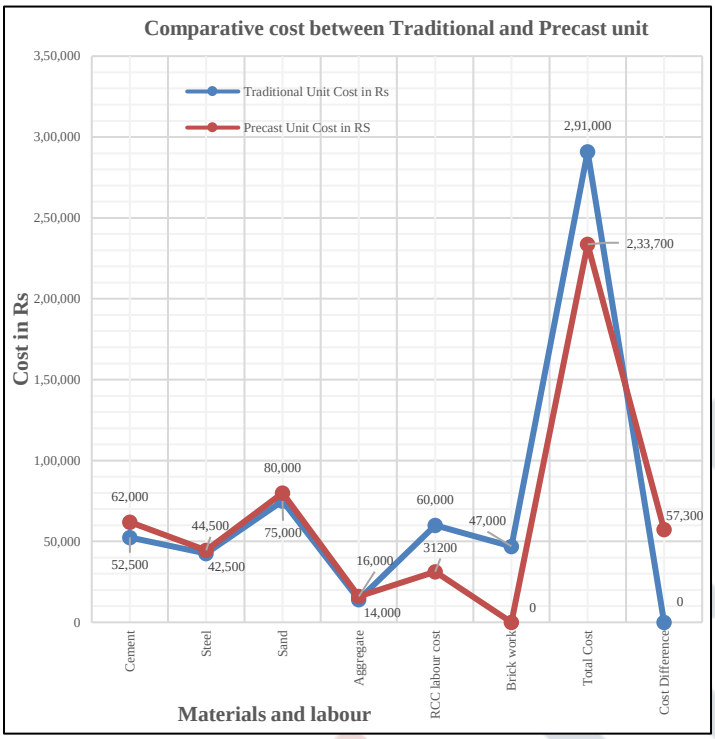

Fig3 Comparative between Traditional and Precast unit

E. Precast Concrete Technology

1. Study of Precast Concrete Technology, Background and Current Scenario

Precast concrete construction has become an integral part of modern and contemporary architecture due to its efficiency, speed, and cost-effectiveness. The use of precast methods allows for better resource utilization while significantly reducing construction time and overall project costs. The origins of precast concrete can be traced back to the Romans, who developed an early concrete-like material by mixing limestone, sand, and water and casting it into wooden molds. This molding technique ensured dimensional accuracy and enhanced structural durability. In the early 20th century, further advancements were made by British engineers, leading to the development of modern precast concrete systems. Today, precast concrete is widely used in building superstructures and consists of various structural elements and connection systems. Based on production methods, precast elements are classified into tilt-up components—such as columns, beams, wall panels, balconies, staircases, and cladding—and hollow-core slabs. Precast slabs may be solid or hollow, with hollow sections reducing dead load and improving insulation. Precast columns and beams are connected using corbels, while structural connections are designed to ensure load transfer, continuity, durability, economy, and monolithic behavior of the structure[7].

2. Current Scenario

i. Maharashtra Housing Project

Project: Maharashtra Police Mega City, Pune
Contractor: BE Billimoria & Company
Precast Contractor: Ingenious Quality Buildings Pvt Ltd
Project Details
4.5 M sq.ft.
G+14 buildings, 60 towers
1BHK, 2BHK, 3BHK, 3.5/4.5 BHK Apartments

ii. Structural system:

The structural system consists of load-bearing walls designed to resist both gravity loads and lateral forces due to wind and earthquakes. These load-bearing walls, located primarily along the building perimeter, also function as the external façade and will be finished with painted surfaces. The system incorporates prestressed solid slabs spanning approximately 6 meters. The slabs are designed to support superimposed dead loads from floor finishes and internal partition walls, resulting in a uniform load of 3 kN/m², along with a live load of 2 KN/m². The use of prestressed solid slabs provides greater flexibility in architectural planning, accelerates construction time, and reduces overall steel consumption, making the system both efficient and economical.

iii. Following precast elements are used in the project:

Load bearing walls, Solid prestressed slab, Staircase Buildings are designed for 50 years as per design requirement for RCC structure in IS codes. Precast products life can easily be assumed to be more than 50 years, as the production is done in a controlled environment resulting in good quality.

Equipment:

Mechanical tilting tables, three 120-meter slab beds with a slip former, battery molds (original and cold shutter)

Services:

Complete project design and engineering, Plant installation, Production and installation supervision, Annual maintenance agreement

iv. PMAY-U Mohanpur Vertical 1 (AHP) Project, Deoghar, Jharkhand

Location: Ward No 25, Mohanpur, Deoghar, Jharkhand
Builder: Deoghar Municipal Corporation.
Units: 522+ apartments (1 BHK, 2 BHK, 3 BHK).
Status: Under construction, possession expected in Q2

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Amenities: Landscaped gardens, children's play areas, dedicated parking, rainwater harvesting, energy-efficient lighting, and fire safety measures.

Sustainability Features: Rainwater harvesting, energy-efficient lighting, and comprehensive fire safety measures.

Eligibility: EWS, LIG, and MIG categories.

v. 350 acres in the Kumbhari area of South Solapur

Total Capacity: The project aims to provide 30,000 houses for Economically Weaker Sections (EWS), including handloom workers, bidi workers, and vendors.

Total Project Area: Spans approximately 350 acres in the Kumbhari area of South Solapur.

Individual Unit Area: Each tenement has a carpet area of 27.94 square meters (approx. 300 sq. ft.).

Configuration: Includes a living room, bedroom, kitchen, individual bathroom, WC, and a balcony.

Construction: Uses precast technology and conventional methods for rapid development

Ownership: Preference is given to women, with 90% of allocated homes registered in their names.

Ray Nagar Project (Phase I): In January 2024, Prime Minister Narendra Modi dedicated 15,024 completed houses to beneficiaries, primarily for unorganized sector workers like bidi and textile workers

The largest concentrated project is the Ray Nagar Housing Society in the Kumbhari area, which was inaugurated in 2024 to provide 15,000 houses. Other specific locations with multiple building permits and occupation certificates include:

Kumbhari (South Solapur): This is a major hub for AHP-PPP projects.

III. FINDINGS

The findings indicate that the use of precast concrete technology is highly suitable for the Pradhan Mantri Awas Yojana–Gramin (PMAY-G) scheme, as it supports faster, more economical, and sustainable housing delivery. Precast concrete construction enables components to be manufactured off-site under controlled conditions, which significantly reduces construction time and ensures consistent quality. This method lowers overall costs by minimizing material waste, optimizing resource use, and reducing dependence on on-site labor. Precast structures are durable, weather-resistant, and require less maintenance, making them well suited for long-term rural housing needs. In addition, improved worker safety and reduced environmental impact enhance the sustainability of this technique, while design flexibility allows customization to suit local requirements.

Adopting a Public–Private Partnership (PPP) model further strengthens the implementation of precast construction for PMAY-G. Under this approach, the government provides land, regulatory clearances, and financial support, while private partners are responsible for design, construction, financing, operation, and maintenance. Precast technology within PPP frameworks enables faster project delivery, better quality control, and innovation through private sector expertise. Risk sharing between public and private stakeholders improves project viability and efficiency. Common PPP models such as Build-Operate-Transfer (BOT) and Design-Build-Finance-Operate (DBFO) ensure sustainable, scalable, and timely housing development.

IV. CONCLUSION

In conclusion, the **Pradhan Mantri Awas Yojana**, launched in **2015**, has taken significant steps towards providing affordable housing to all, aligning with its vision of **"Housing for All."** This initiative has enabled beneficiaries from various **Socio-Economic categories** to have access to affordable house, reflecting the government's commitment to inclusive growth and development. This scheme aims to provide housing to every citizen, necessitating faster progress and improvements. Precast Construction is a sustainable alternative to traditional methods, can accelerate the process.

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