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International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XII **Month of publication:** December 2023

DOI: https://doi.org/10.22214/ijraset.2023.57796

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XII Dec 2023- Available at www.ijraset.com

Cost Effective and Trending Housing Techniques

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Abstract: ***Housing is the most required development to build a nation developed. In India most of the population in urban as well as in rural areas still required a better shelters or houses for accommodation with better living environment including with all amenities , social , cultural , healthy , safe , hygienic , spacious , pollution free , climatically comfortable , eco- friendly and affordable houses. The economic weaker section can't afford the housing cost in present conditions. Government of India support needy people by funds, and also provides subsidized affordable houses by developing many policies and projects in this direction. This paper aims towards the study of effective housing demand , current patterns of development and finding the Innovative Contraction techniques , Materials (local and eco friendly) , Planning and designing methods , to make the solution . With the help of techniques of construction, Planning, and use of local and sustainable material , the Cost effective housing can be developed in less time and in budget .***

Keywords: Cost effective housing , Fast and time saving construction , innovative techniques and methods , Nature friendly construction , Climatic comfort - Durability and safety , easy maintenance .

I. INTRODUCTION

Large sections of the society are migrating to urban areas for better job opportunities and quality of life from rural areas. These Cities need to provide a receptive, innovative and productive environment, which can promote faster and sustainable growth ensuring a better quality of living. Cost Effective or Low-cost housing is a critical issue in India, as many people cannot afford to buy or rent a home. There are many challenges faced by middle and lower-income groups in attaining home ownership. The use of low-cost construction techniques and local materials is to provide affordable housing solutions in proper way to improve the living of low-income communities in the society. The Ministry of Housing and Urban Affairs (MOHUA) through its flagship mission Pradhan-Mantri-Awas- Yojana – Urban (PMAY-U) ensures a PUCCA HOUSE to all eligible urban households. PMAY-U aims to achieve Urban Development through Transformation, Innovation and Sustainable Inclusions. Due to rapid increase in urbanization and believing it as an opportunity to reduce poverty.

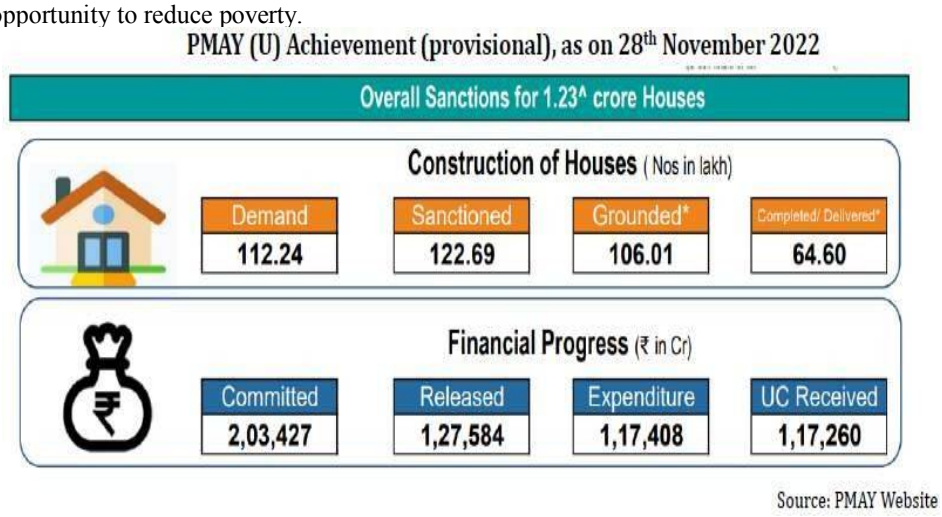


Figure: 1

II. METHODOLOGY

For finding the facts of the topic , the Case study of the Latest Cost effective housing project done with Modern and innovative technique , material and design is done along with some past but very popular project Low cost housing Literature study is done . Analysis of the parameters, purpose, designs, materials , techniques is done and comparative data is prepared .

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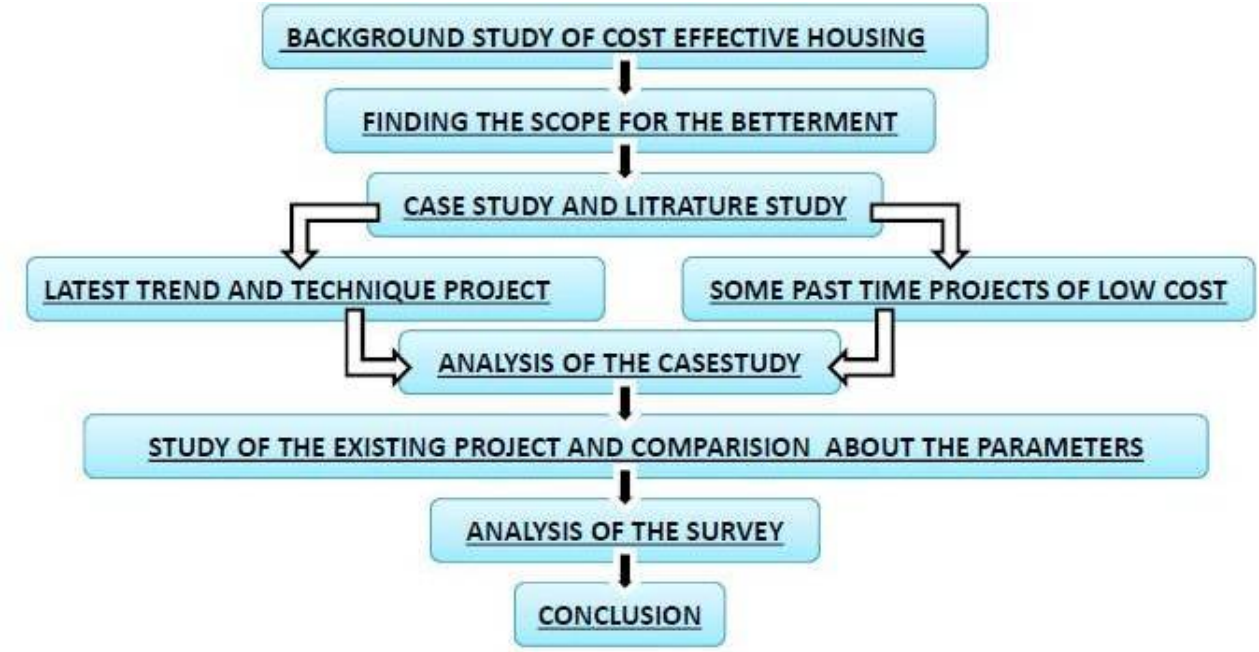


Figure 2 : Flow chart of methodology

III. CASE STUDY

A. Light House Project, Lucknow

The LIGHT HOUSE PROJECT Lucknow is one of the six projects started in all around India, by our Prime Minister , Mr. Narendra Modi's vision ," A fast , low cost and new technology to build houses for the poor and the middle class ." These light house projects will be constructed through modern technology and innovative processes. This will reduce the construction time and prepare the more resilient, affordable and comfortable homes for the poor.

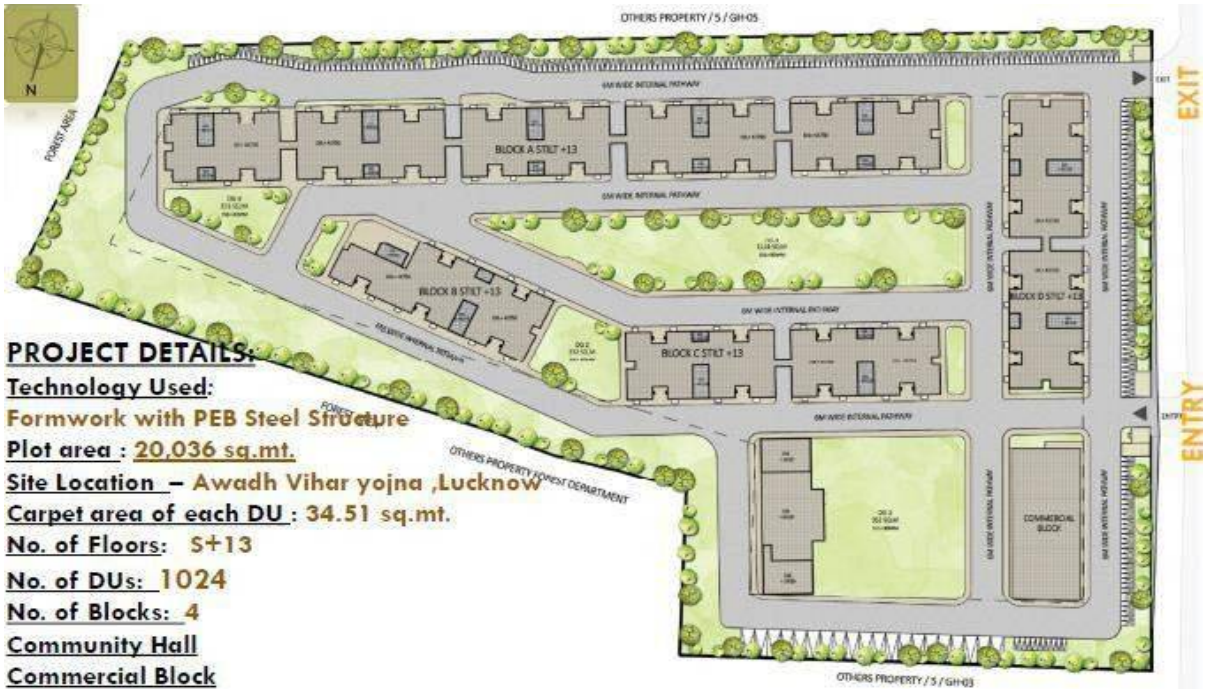


Figure: 3 SITE PLAN

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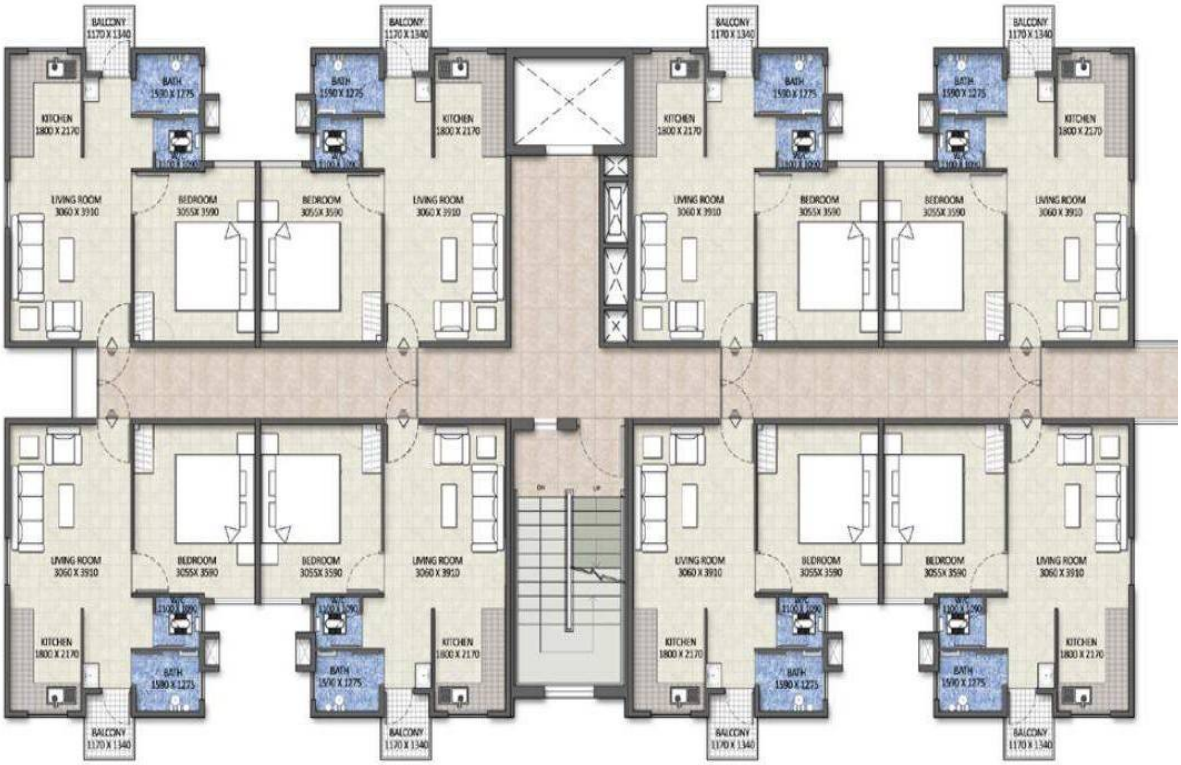


Figure 4 : Unit Cluster Plan

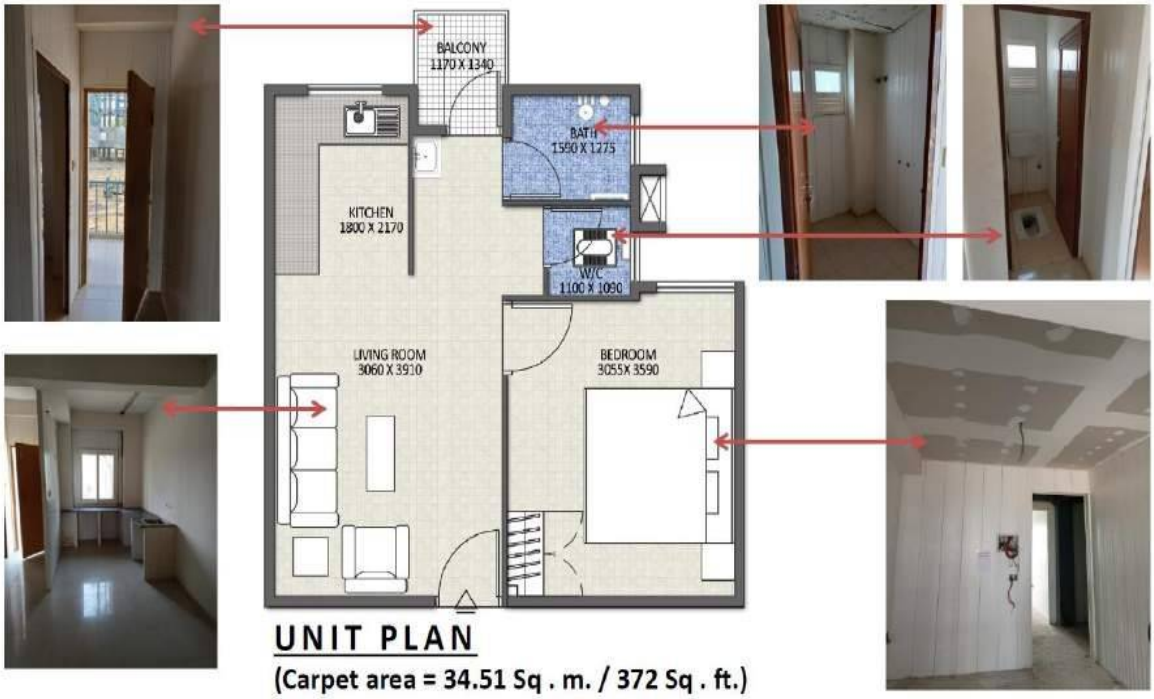


Figure 5:Flat Unit Plan

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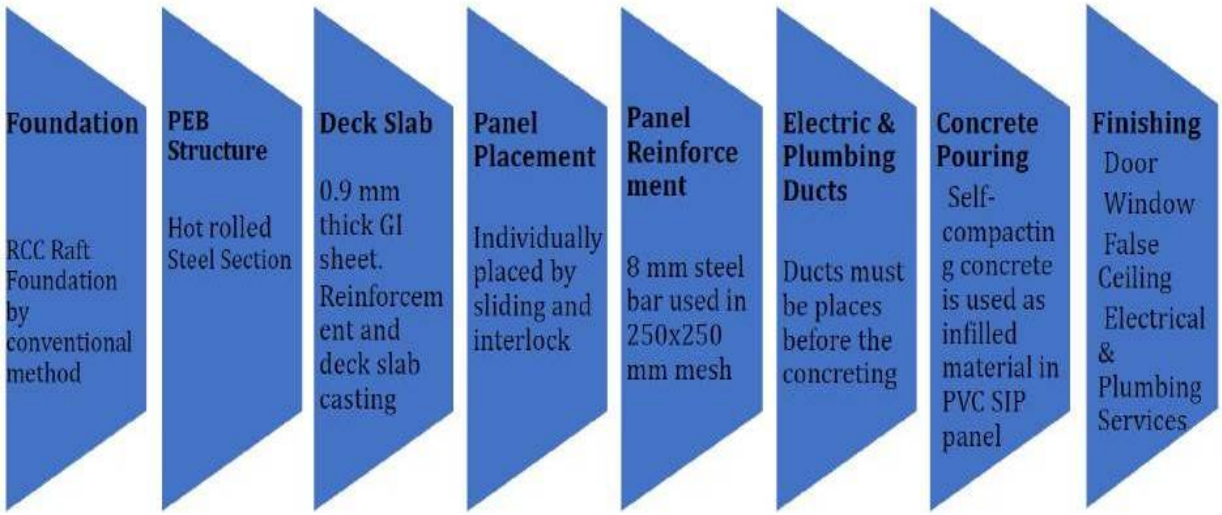


Figure 6: Building Elements L.H.P. Lucknow

1) Foundation

Conventional as per geo-technical investigations, bearing capacity, soil strata, water table, etc. Raft foundation with RCC column up to plinth height. RCC plinth beam and grade slab at plinth level. All building blocks have Raft foundation with 500 mm thick M-25 Concrete. An additional thickness of 400 mm has been constructed around stair case and lift well. Anchor bolts have been cast with concrete at plinth level over which factory made built up columns with base plate will be erected. The reinforcement laying & shuttering work is in progress for shear wall construction of lift & staircase portion.


Figure 7: Foundation & Columns in L.H.P.

2) Deck Slab

After erection of steel beams and column (PEB Structure), Steel deck sheet of thickness 0.9 mm are placed with required bearing on the beams .Concrete screed of 75 mm is poured on the deck sheet in M25 with reinforcement as per structural design.

Structural design for reinforcement is as per IS 456-2000. Generally, nominal reinforcement is provided in concrete screed of deck slab to take care of shrinkage & cracking.

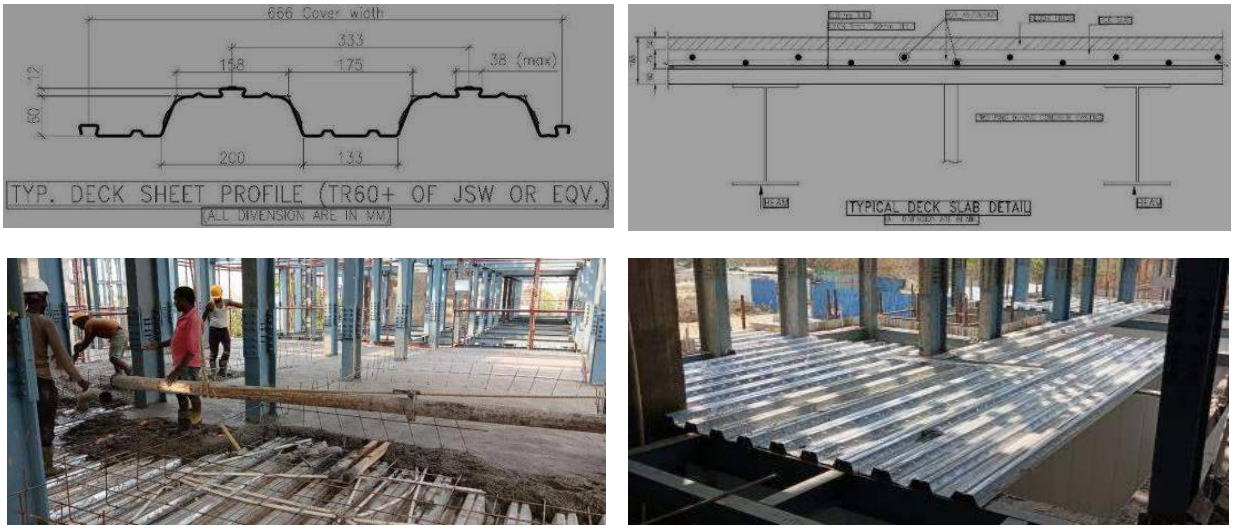


Figure 8: Deck slab details and casting

3) Wall Erection

Factory made PVC walls are used for walls and partitions .Outer wall is 126 mm. thick and inner wall is 66 mm. thick. Concrete core is filled with M-30 grade of concrete along with mild reinforcement between panels for support. Panels are stored with a defined pattern at store yards and used with as per size requirements with floor support .M.S. channels and panel joining brackets.



Figure 9: Wall Erection



Figure 10: Other finishes

4) Limitations

Stay in Place PVC Form walls need pre planned installation of MEP services for concealed networks. Doors and windows position shall not be changed after pouring of concrete .Erection of panels shall be under the supervision of trained staff. High- intensity UV rays harm the outer envelope, so it is not advisable in the tropical region. Skilled worker needed for PEB Erection and SIP Installation.

5) Advantages

Gives very aesthetic finished surface in different color options without plastering. No curing is required. About 50% less use of water. Faster as compared to convention al buildings. About 40% Less usage of manpower as compared to conventional construction. As all panels are prefabricated in the factory. Light in weight as compared to other conventional materials. SIP does not corrode , chip , or stain & is resistant to UV , bacteria , fungi , etc. The polymer content used in the manufacturing of form work is up to 55% recycled content and is further recyclable , making it an eco-friendly material. The PVC system provides insulation from the surroundings and gives better thermal comfort to occupants. Overall, this system is energy efficient as less water and operation energy requirements are less as compared to conventional buildings.

B. Bharat City Phase-II , Ghaziabad

This first project is located in Ghaziabad at the outskirts of Delhi where the real estate prices are at an affordable level. The project is being developed on 60 acres of land by real estate developer BCC Infrastructure Pvt. Ltd and the first phase of the project which was launched in 2011 comprised of almost 1800 apartments of 1BHK, 2BHK, 3BHK and 4BHK. Phase one was constructed using conventional cast in place reinforced concrete structures with apartment towers of ground plus fourteen floors. Although achieving an affordable costing the real estate developer was not satisfied with the speed and quality of construction. A technical feasibility study was prepared for phase two of the project to investigate the possibilities of constructing the remaining 39 apartment towers with precast technology.

Based on the performed investigation and research it was concluded that a large precast panel system would be the most suitable with respect to structural safety, economics, aesthetics and constructability.



Figure 11: Site plan Bharat city phase-II

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Figure 12: 1BHK and 2 BHK Layout plan

6) Building System

In this project the foundations and basement structure are made entirely as conventional cast in-situ reinforced concrete structure. The basement areas below the towers are utilized for car parking while the driveways are situated in the extended basement areas. The apartment towers which come on top of the basement are made in load bearing precast concrete with the use of large precast elements like slabs and walls. The precast walls are considered to be shear walls and are part of the lateral load resisting system and are adequately connected to the floor diaphragm to achieve an earthquake resistant structure. Due to manufacturing and transportation limitations the precast wall panels are made as one story high elements and will be jointed at floor level (picture 13). The horizontal and vertical connections between the precast walls are established at the building site only.


Figure 13: Precast concrete wall erection


Figure 14: Precast structure on top of basement

Adequate buttressing of the external wall panels has been achieved by connecting the internal wall panels to the external wall panels by grouted shear key joints and reinforced wire loop connections. All load bearing elements at the corners of the building have been stiffened by jointing structural elements perpendicular to it (picture 14). The load bearing precast walls are placed on top of each other and are properly connected to each other at floor level and adequately connected to the floor slab with protruding reinforcements. The precast shear wall system is designed to emulate the behavior of cast in-situ concrete construction in terms of stiffness, strength, ductility and energy dissipation. Because of the provisions for car parking the layout of the basement structure is somewhat different from the superstructure and wherever possible the precast load bearing shear walls of the superstructure are supported by cast in-situ RCC walls at basement level and only at a few locations the precast walls are supported on short span transfer beams.

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The vertical dead loads and live loads are carried by the floors and transferred towards the load bearing structural elements. The floor slab system of the superstructure is made of precast concrete planks on which a reinforced cast in-situ concrete topping will be poured. This system is commonly known as the precast half slab system (picture 15). The precast planks are made as room sized slabs and are supported on the interior and exterior load bearing walls or beams. Due to continuation of the top reinforcement over the interior supports the slab system has structural behavior of continuous floor span system. The bottom reinforcement of the slabs will be anchored at interior supports by placing extra bottom reinforcement directly on top of the precast slabs. At exterior supports the extra bottom reinforcement shall be provided in the form protruding bars from the walls which will be bend down directly on top of the precast slab.



Figure 15: Precast half slab with lattice girder



Figure 16: Precast cantilever balconies

All the balconies are cantilevered precast solid slabs and are connected by protruding reinforcement to the cast in situ RCC topping of the floor (picture 16). Bathroom slabs are also made a precast solid slabs to achieve a waterproof slab and are connected to the half slab system by protruding reinforcement at the slab edges.

The lateral load path of the precast superstructure is formed by a large number of precast concrete shear walls which are placed in x-direction and y-direction. The precast shear walls are solid reinforced concrete panels and due to their large in plane stiffness most of the lateral forces are resisted by these structural elements. Load transfer at horizontal joints is achieved by fully filling the 20mm gap between the precast panels with non-shrink high strength grout. Furthermore reinforcement starter bars are passing through the horizontal joints which will ensure a proper connection between one precast wall panel to the next precast wall panel. The starter bars are placed in the center of the precast walls and are connecting inside oversized steel corrugated dowel tubes which are later fully filled with non- shrink grout (picture 17). The starter bars are anchored inside both the precast walls and are lapping indirectly with the reinforcement meshes of the precast wall panels. At the horizontal joints the shear forces between the precast concrete wall panels are transferred by the friction of the joint interfaces and by the dowel action of the starter bars.



Figure 17: Erection of load bearing Precast wall panel

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Figure 18: half slab top reinforcement lapped with protruding wall and balcony reinforcement .

The precast buildings have been designed with proper structural integrity to avoid situations where damage to small areas of the structure or failure of single elements may lead to collapse of major parts of the structure. This has been achieved by providing effectively continuous peripheral tie reinforcement near the edge of the building perimeter. Furthermore internal tie reinforcement has been provided at each floor and roof level in two directions at right angles. The peripheral and internal tie reinforcement has been placed as extra reinforcement inside the RCC cast in-situ topping. Also all the external load-bearing members such as precast walls have been anchored or tied horizontally into the structure at each floor and roof level by providing uniform reinforcement protruding from top of precast walls and bend down inside the RCC cast in-situ topping (picture 18). Each precast wall carrying vertical load has been tied continuously from the foundation to the roof level. At all horizontal precast joint locations the starter bars haven been placed staggered by using a combination of normal length grout tubes and longer grout tubes in combination with continuous dowel reinforcement running from bottom to top inside the precast wall panels.

The staircases are made of precast solid slab landings at floor level and mid landing level. The flights are made as precast stair elements which are resting on the precast landings and connected by dowel connections (picture 19).



Figure 19: Precast staircase with landings



Figure 20: Completed precast building structures

ITEM	SPECIFICATIONS
Load bearing precast walls	160mm thick solid precast walls 200mm thick solid precast walls
Partition walls	100mm thick solid precast walls
Shaft walls	160mm thick L-shaped precast walls
Slabs	50mm thick precast half slab with lattice girders
Bathroom slabs	Solid precast slabs with protruding reinforcement
Balconies	Precast solid balcony slabs with protruding reinforcement
Staircase	Precast stair flights Precast solid slab landings
Beams	Precast beams 200x600mm

Figure 21: Overview of precast components for the superstructure

7) Precast Plant – Fabrication, Storage And Transportation

The precast plant is located within the boundaries of the project site which makes it easy and fast to transport and erect the precast elements. The precast plant has been designed in such a way that it can be dismantled in future and be relocated to another construction site. The plant has been divided in two parallel bays in which different activities take place. The first bay is utilized for the precast wall panel production and has two battery moulds of twenty cells each and several tilting tables. The battery mould system is used for manufacturing of precast walls in vertical position and the tilting tables are utilized for manufacturing complicated wall panels in horizontal position and tilting them later (pictures 22 and 23).



Figure 22: Battery mould for vertical precast wall panels


Figure 23: Tilting tables for horizontal production of precast wall panels

Bay two of the plant is used for manufacturing precast slabs, balconies, solid slabs, beams and L-shaped walls. This bay has two 40m long steel casting beds for the slab production and several customized moulds for the production of the other precast elements (picture 24). Precast balconies are made in special customized moulds with form liners which will create a texture finish at the top surface of the balcony slabs. Both bays each have three overhead gantry cranes with 10 ton lifting capacity for activities like lifting rebar cages, lifting concrete casting buckets, and de moulding the precast elements. The gantry cranes have an extended rail system which leads in the stockyard to lift and store the precast elements. Precast walls are stacked vertically in steel storage racks while precast slabs are stored horizontally stacked on top of each other (picture 25). The precast half slabs with lattice girders are lifted by special lifting frames.


Figure 24: Steel casting beds for Precast slab


Figure 25: Stockyard for precast elements

The concrete batching plant is located just outside the precast plant and a trolley system transports the concrete casting buckets to the precast plant. Raw materials are stored in storage bays next to the batching plant. Rebar cages are prepared in an adjacent area to bay one and two and gantry cranes from both bays can access this area. The precast plant is equipped with an advanced laboratory for strict quality control. Precast walls are transported in vertical position on trailers with A-frames. All other precast elements are transported in horizontal position on flat trailers (pictures26 and 27).


Figure 26: Transport of precast wall panels


Figure 27: Transport of precast slabs

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IV. ANALYSIS

PARAMETER	L.H.P. LUCKNOW	BHARAT CITY–II , GHAZIABAD
1. UNIT SIZE	EWS 34.51 SQ.M.	58.99 SQ.M.
2. COST	4.76 LAKH (CHARGABLE)	27 LAKH
3.PLANNING TYPE	MULTI STORY APARTMENT(S+13)	MULTI STORY APARTMENT(B+13)
4.SCOPE FOR EXTENSION	NO	NO
5. LOCATION	IN THE URBAN CITY	IN THE URBAN CITY
6.OTHER SPACES	COMMERCIAL , COMMUNITY CENTRE	PARK ,COMMERCIAL , CLUB , POOL , COMMUNITY CENTRE
7. OWNERSHIP TYPE	SUBSIDIZED	SUBSIDIZED
8. BUILDING MATERIALS	PVC PANEL, ISMB, GI SHEET, RCC.	PRE CAST COLUMNS , WALL , STAIRS , BALCOBY,SLAB,BEAMS
9.STRUCTURE	PEB	PRE FABRICATED
10.TECHNIQUE	PREFABRICATION & MODULAR CONSTRUCTION	PREFABRICATION & MODULAR CONSTRUCTION
11.CLIMATIC CONSIDERATION IN DESIGN	YES	YES
12.SERVICES AND AMINITIES	ALL REQUIRED	ALL REQUIRED
13.ECO FRIENDLY	YES	YES

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V. FINDINGS

There area many points and aspects which are considered in study and some findings are as follows :

1) High rise housing is more effective in cost due to shortage land high cost of urban land.
2) Modular and precast Construction type is more cost effective than traditional .
3) In pre cast construction (In site construction) Time , transport can be saved .
4) In PCC wastage of materials like Steel , Cement can be saved.
5) In PCC water and other natural resources can be saved .
6) Less requirement of Shuttering , curing and man power is also in PCC.
7) Building Life and durability is more in PCC .
8) Climatic consideration in design for user's comfort is also considered in PCC.
9) Good building quality and low cost maintenance is in PCC.

VI. CONCLUSION

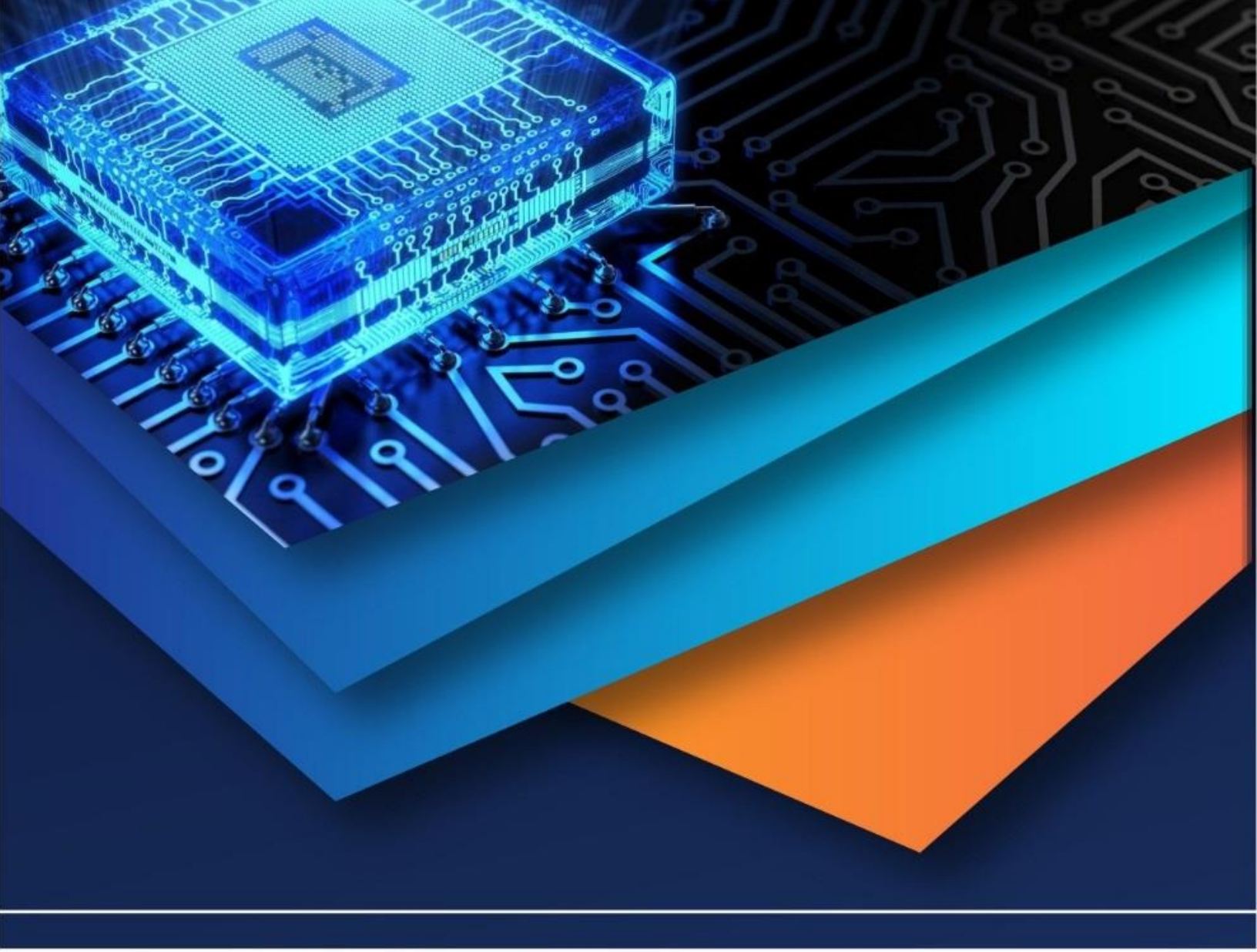
After the study and analysis there are some points which came as a conclusion for the research in low cost housing techniques , that :

1) It is not mandatory that the cost effective housing is bounded with the use of traditional materials , designs , and techniques but new methods can also be effective to make the housing Cost effective for EWS and LIG categories .
2) Use of pre fabricated building elements can make housing cost effective , Time saving , easy to construct , climatically comfortable and user friendly .
3) Pre-casting and storage yard with-in the site campus can save time and travel cost along with the quality control , site testing aspect .
4) The innovative and Modular type construction and designing of such project make the project having less waste generator , Nature friendly .
5) Being pre designed and tested structural elements it more Durable and safe for the project .
6) By use of some innovative materials like PVC wall panels and windows , less requirement of maintenance is in the project.

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