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Cost Effective and Trending Housing Techniques (Design)

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Abstract: ***The Ministry of Housing and Urban Affairs (Mo HUA) through its flagship mission "Pradhan Mantri Awas Yojana" – Urban (PMAY-U) ensures a PUCCA HOUSE to all eligible urban house-holds. 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.***

This paper aims towards the design solution example after 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.

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

I. HOUSING PROJECTION & SHORTAGE (LUCKNOW)

At an average household size of 5.8 persons and assuming 2% as dilapidation rate per decade, the projected housing requirement for Lucknow city for the year 2016 would be 544270, in 2021 it would be 625011 and 717730 in the year 2026. The housing shortage for the city is calculated based on census data, estimations and assumptions pertaining to existing housing stock in the city, dilapidated housing structures, vacant houses, slum households. The housing shortage for the city is estimated for the next 15 years under two circumstances

A) Taking into account the existing slum household stock and assuming they will remain same in future.

B) assuming that all the existing slum households are developed into a decent affordable housing under PMAY-U and other slum development programmes. The Housing requirement and shortage projections for the city is shown in

Table 1: Projection of Housing & Housing shortage in Lucknow city

Year	2016	2021	2026
Projected housing	544270	625011	717730
Housing shortage*	236227	316968	409687
Housing shortage**	-	168851	261570

Note: * - Estimated housing shortage of the city if existing slums in the city are not improved in the city

**- Estimated housing shortage, considering that all the slums in the city are improved under slum developed programmes like RAY.

II. EWS/LIG HOUSING

Working towards slum free Lucknow city, there is need to build up EWS and LIG housing stock. EWS housings are meant for people whose annual income is below Rs 60, 000 while LIG housing are meant for people whose annual income is less than Rs 1,20,000. As mentioned in City Development Plan 2006, estimates that there is need to create at least 7000 housing units per annum. Most BPL/EWS and LIG households in cities live in informal settlements/slums on encroached public lands. There is no data on numbers of poor families without adequate housing in cities. Census of India provides estimates of number of poor in each city and they also project future population growth for cities using an urban growth rate.

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City Master Plans etc. make estimates on housing demand on the basis of Census information. Considering the past census data and development plans of the city it is assumed that 30% of the Lucknow households belongs to either EWS or LIG population.
In Lucknow city Slums, 68% of the slum households are living under below poverty line (BPL), which accounts 21% of the total city households. Assuming the other 9% of the households live in other parts of the city, the EWS/LIG housing projections are calculated for the next 15 – 20 years.
DESIGN CONSIDERATION:
There area many points and aspects which are considered in Designing the project as per
Study are as follows :

1) High rise housing is more effective in cost due to shortage land high cost of urban land.
2) Pre cast construction (in site construction) time , cost and transport can be saved .
3) Less wastage of materials like steel , cement in Pre Cast construction .
4) Saving of water and other natural resources in pre cast construction.
5) Saving of shuttering , curing and man power in pre cast construction
6) More building life and durability
7) Climatic consideration in design for user's comfort .
8) Good building quality and low cost maintenance

III. SITE ANALYSIS

A. Site location
AWADH VIHAR YOJNA , LUCKNOW

B. Site Area :
31286.825 SQ.M.

C. Site Neighbourhood

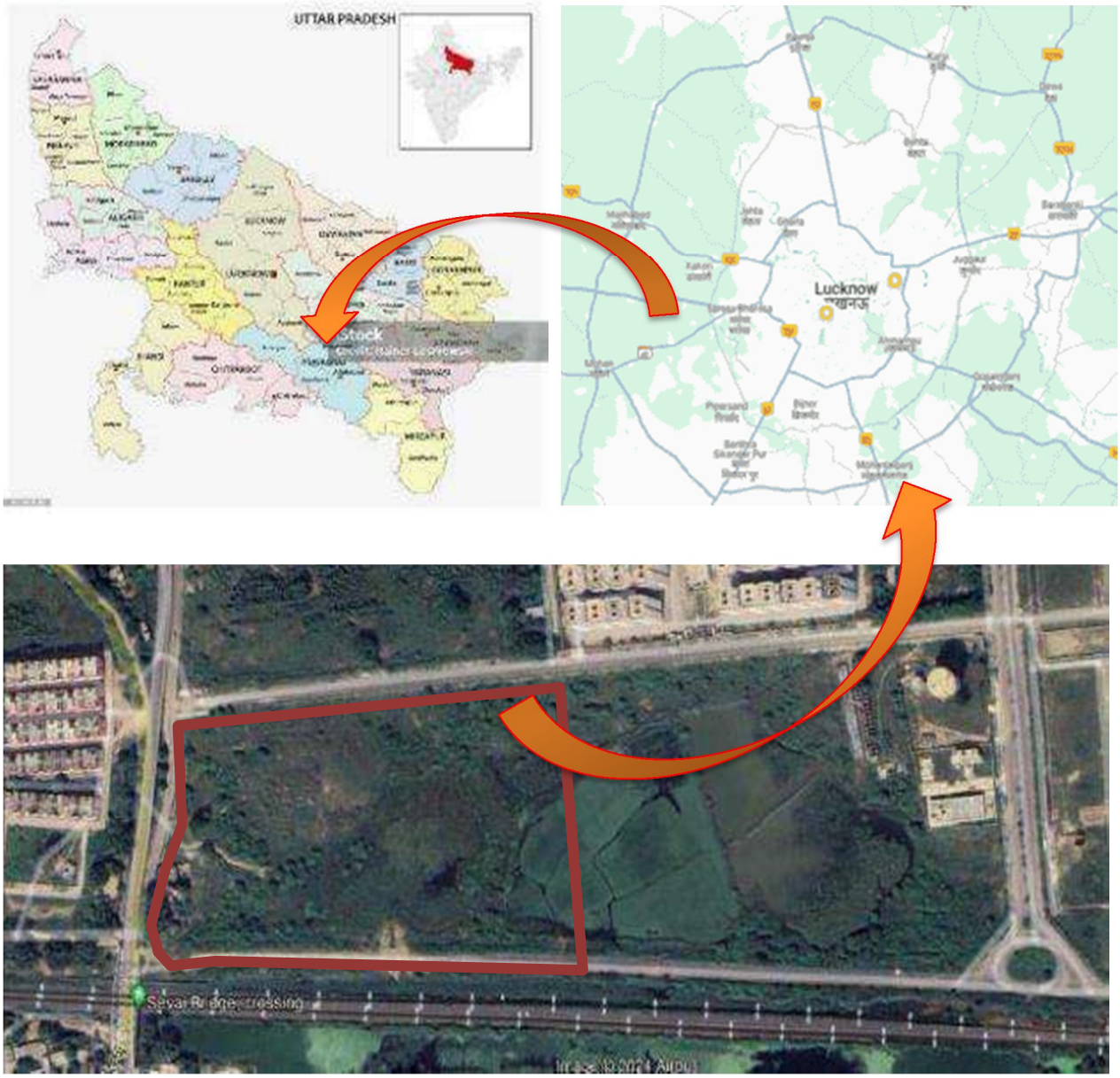
- PMAY (G+4 HOUSES)
- SBI HOUSING
- MIG AND LIG ROW HOUSING SITE
- PROPOSED CHILD CARE / PHC.

D. Road And Connectivity
Site location is connected with Amar shahid path Awadh-vihar entrance gate by 1.5 k.M. and 13.4 k.M. From Charbagh Railway station.

E. Topography And Amenities
Site topography is mostly Leveled and average level is .5 to 1 m.
Storm water drains , metaled roads , Sewer line , Street light are available at all around the site.

SITE PHOTOGRAPHS

F. Site Map And Liocation



G. Climate Analysis

Lucknow has an extreme tropical climate with very cold and dry winters from December to Mid February and dry, hot summers from April to Mid June. The rainy season is from mid-June to mid-September, when it gets an average rainfall of 1000 mm mostly from the south-west monsoon winds. During extreme winter the maximum temperature is around 25 degrees Celsius and the minimum is 3 to 4 degrees Celsius range. Fog is quite common from late December to late January. Summers can be quite hot with temperatures rising to the 40 to 45 degree Celsius range.

The average wind speed in Site location (Lucknow) is 2.6 m/s with the maximum wind speed of around 10 m/s.

1) The average ambient temperature remains 25.3°C, varies from 6.2°C to 41.9°C.
2) The average relative humidity remains around 68.6%, varies from 17.5% to 99.7%.
3) The station pressure varies from 995 hPa to 976 hPa, averaged around 1011 hPa.
4) Windrose of Lucknow shows that predominantly wind blow from the WNW - about 24.75% of all wind directions.

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	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	14.9 °C (58.9) °F	18.6 °C (65.4) °F	24.3 °C (75.7) °F	30.3 °C (86.6) °F	32.8 °C (91.1) °F	32.3 °C (90.2) °F	29 °C (84.1) °F	28.4 °C (83.1) °F	27.7 °C (81.8) °F	25.5 °C (77.9) °F	21.2 °C (70.1) °F	16.4 °C (61.6) °F
Min. Temperature °C (°F)	9.1 °C (48.3) °F	12.2 °C (54) °F	16.9 °C (62.4) °F	22.6 °C (72.6) °F	26.1 °C (78.9) °F	27.5 °C (81.5) °F	26.2 °C (79.2) °F	26.8 °C (78.4) °F	24.5 °C (76.2) °F	20 °C (68) °F	14.9 °C (58.8) °F	10.3 °C (50.6) °F
Max. Temperature °C (°F)	21.3 °C (70.3) °F	25.2 °C (77.4) °F	31.5 °C (88.8) °F	37.7 °C (99.9) °F	39.2 °C (102.6) °F	37.1 °C (98.9) °F	32.3 °C (90.2) °F	31.7 °C (89) °F	31.4 °C (88.5) °F	31.1 °C (88) °F	27.7 °C (81.9) °F	23.1 °C (73.5) °F
Precipitation / Rainfall mm (in)	19 (0)	25 (0)	14 (0)	9 (0)	17 (0)	129 (5)	310 (12)	265 (10)	165 (6)	34 (1)	2 (0)	10 (0)
Humidity(%)	67%	60%	44%	30%	30%	54%	79%	82%	80%	66%	58%	64%
Rainy days (d)	2	2	2	2	3	8	18	18	15	2	0	1
avg. Sun hours (hours)	8.4	9.6	10.6	11.5	11.9	10.7	8.4	8.0	8.4	9.6	9.6	9.0

H. Sun-Path Analysis

Shadow analysis is a crucial aspect of architectural and urban design, involving the study of how shadows cast by buildings, structures, or natural elements change over time. This analysis provides valuable insights into various aspects of design, urban planning, and environmental considerations.

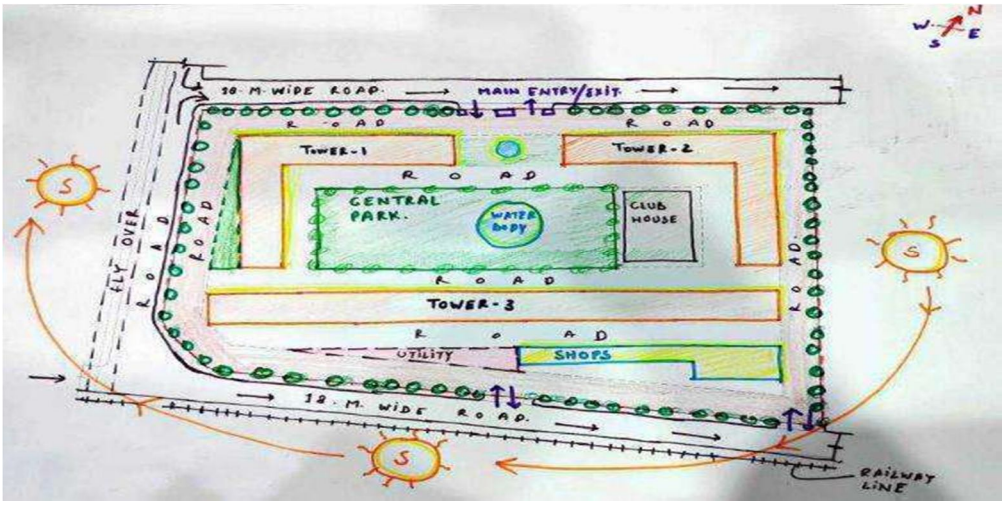
Here are some key aspects and significance of shadow analysis:

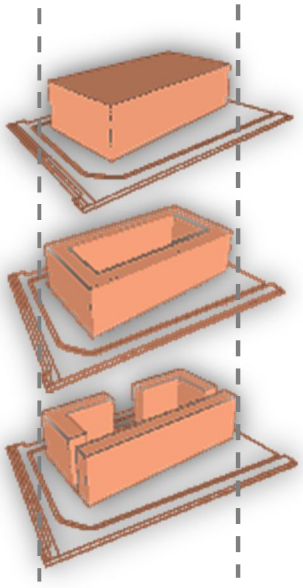
1) Daylight and Sunlight Studies:
2) Energy Efficiency:
3) Urban Planning:
4) Building Orientation:
5) Seasonal Variations:

SITE SUNPATH DIAGRAM

IV. DESIGN CONCEPT

A. Zoning And Concept Site Plan





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B. Planning Consideration And Proces

CONSTRUCTION TECHNIQUES:

1) *Modular Construction Design:* Modular construction is a process in which a building is constructed off-site, under controlled plant conditions, using the same materials and designing to the same codes and standards as conventionally built facilities – but in about half the time. When these modules are put together on site, it reflects the identical design intent and sophisticated specifications. Advantages of this technique are, it is a sustainable practice (green practice), faster and smarter ways of constructing a house.

ADVANTAGES: Modular construction has the following advantages:

- Weather delays can be eliminated.
- Materials are less wasted.
- Can be reused and has greater flexibility.
- It is the safest method of construction.

2) *Passive Design Techniques:*

- Passive design techniques use the naturally available sources of energy like sun and wind for the purposes of heating, cooling, lighting and ventilation.
- This will reduce the energy bills in a building and also the heating load on a building.
- A building can be made comfortable for the people to live in, by naturally reducing the fluctuations in temperature and also it improves the indoor air quality.
- There is no need to incorporate much heavy external loads on a building to keep it cool.
- Hence it reduces the cost of HVAC systems or cost of air conditioners in a normal building.
- Passive design can be achieved only if a building is oriented properly so that it allows good ventilation and sunlight into the rooms.

3) *Precast Techniques*

ADVANTAGES WITH PRECAST STRUCTURAL ELEMENTS:

- If many numbers of houses (mass housing) are constructed with precast elements, then cost reduction can be observed.
- Installation of precast elements is an easy process. While conventional construction takes lot of time for the construction. It requires less movement of materials in the construction site. There is no need to maintain inventory of cement, sand and coarser materials in the site, except for smaller works.
- Also, a conventional construction requires lot of equipment's and also lot of labours. But in a precast method of construction, it requires only few skilled personnel to install the various concrete elements.
- Acoustic performance of the precast elements is high as they contain hollow spaces and allows for sound dispersion.
- Flexible designs can be obtained. Even designs with long spans are also possible with the help of precast technology.
- Most of the precast elements are recyclable. Used elements can be crushed in a crusher and can be used again for various purposes like road filling, basement filling, or road bases, etc.
- Even doors and window frames can also be replaced by precast frames which will reduce the cost of material and also cost of maintenance.

V. DESIGN TECHNIQUES ADOPTED IN PROJECT

A. Prefabricated Or Pre-Cast Structure System

India is the world's fastest developing country. We are currently on the verge of large-scale urbanisation hence facing a huge demand for building houses. The construction industry contributes to about 10% of Gross Domestic Production (GDP) of the Nation. Housing is the primary need of everyhuman being. With the rapidly growing population, and to fulfil the housing demand, a more reliable, faster, sustainable method of construction is deemed necessary by the construction industry. The concept of "built it fast" in the most economical way has not changed since the beginning; however, new technologies have been developed to suit the modern world construction.

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B. Advantages Of Pre-Cast Structure System

There are many advantages use of precast concrete components.Of course, these require proper design, use of the correct materials and manufacturing processes with skilled and knowledgeable personnel. Properly designed and specified precast concrete go a long way toward reducing and eliminating many common utility construction problems, while the economics of precast translate into faster, more cost-effective projects. Benefits available include:

- Fast construction
- Cost and time saving
- Required less man power
- Great finishing and durability
- Less maintenance
- Climate friendly
- Less wastages of materials
- Less uses of transportation and other natural resources

C. Precast Components & Connections

Structural precast elements can largely be classified into two categories based on their production methodology, namely tilts and hollow core. For a typical residential unit construction, the major elements are columns, beams, canopy, wall panels, cladding, balcony, staircase, slabs etc. Out of these columns, beams, canopy, wall panels, cladding and balcony, stair case, landings are tilts and slabs are hollow core of varying thickness. The common area of a building has many other precast elements such as lift core, boundary walls, curb stones, etc. Figure 1 shows the typical precast elements and their assembly for a residential unit.

PRECAST COMPONENTS:

1) PRECAST SLABS:

Main types of slabs used in precast frames are: hollow core slab and solid slab. The details of hollow core slabs are shown in the Figure 2 The hollow core slabs are prestressed, precast concrete slabs, with hollow portions in the zones of zero stresses. They reduce the overall concrete dead load, concrete requirement and provides for better insulation.

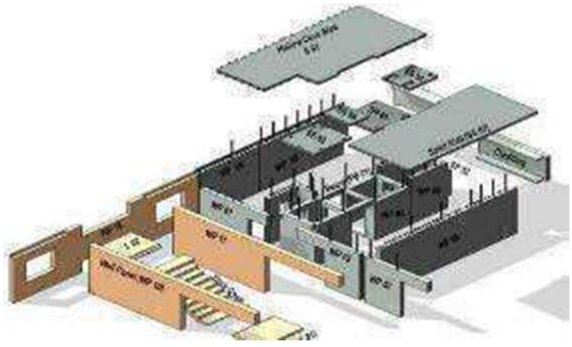

Figure 1: Precast Concrete Structural Elements for a Typical Residential Unit

Figure 2: Precast half Slab

It is possible to achieve larger unsupported spans. Their general thickness used are 150, 200, and 265 mm. These slabs are casted 140m long at a time, with a fixed width of 1.2m. After steam curing the slabs are cut into smaller pieces as per site requirement. They are then delivered to site and installed in position using tower cranes. After installation as per drawings, a thin reinforcement screening of 50-75mm is laid on the top, to seal the joints. Another common type of slab used are solid slab. These slabs are casted on a tilting bad with lateral and longitudinal reinforcement. These slabs are generally used for long span in the common areas and toilets where it is required to facilitate for various MEP services. They are helpful to reduce weight thus easy for site crane handling.It also eliminates the shuttering cost, and helps to attain a superior slab soffit.

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2) PRECAST COLUMNS:

Columns (Shear walls) in precast construction can either be done in CIS or precast. They are most suited in commercial, industrial bay buildings where thicker sections are needed.Precast columns are provided with corbel for simple beam column connections. Precast also allows for casting of triple height columns, thus faster erection.

Figure3:Typical Precast Column Details

3) PRECAST BEAMS:

There are two main categories of beams used in a precast structure. Internal beams are used where floor loading is approximately symmetrical, and external beams are used where floor loading is predominantly non-symmetrical. The use of precast beams with proper designed connections ensure higher structural stability.

Figure4: Typical Precast Beams

4) PRECAST WALL PANELS:

Precast wall panels and claddings are smart substitute for conventional infill blockwork or brick walls. These walls offer superior finish surface, eliminates the plaster and touch ups,facilitate for desired & accurate openings of doors, windows, ventilators etc. These wall panels also improve the overall lateral stability of the structure.

Figure5: Precast wall panels

5) PRECAST STAIR-CASE:

Precast staircase eliminates the complicated-on site shuttering & reinforcement, and provides high quality finish. They can either be a single precast unit containing all flights and landings or separate precast flights & landings.

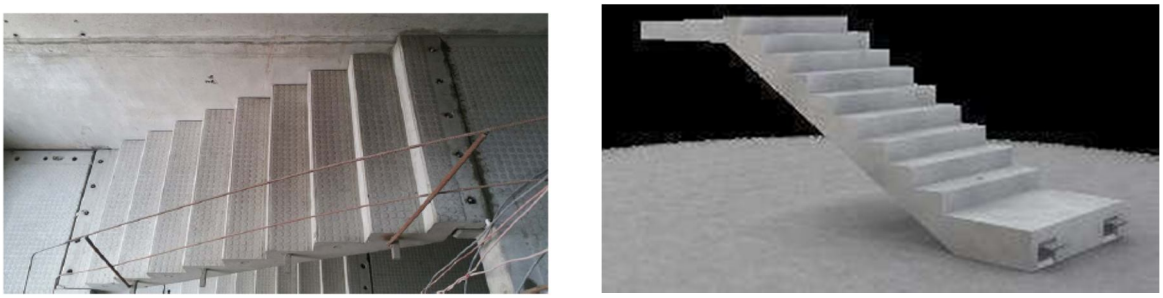

Figure 6: Precast stair case

D. SOME OTHER MATERIALS:

FACTORY MADE PVC WALL PANELS:

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.

Figure7: PVC Wall panels

VI. CONVENTIONAL V/S PRECAST CONSTRUCTION TECHNIQUES

A. Conventional Construction System

1) Load Bearing Structure

In this system, walls are constructed using bricks/stone/block masonry and floor/roof slabs are of RCC/stone/composite or truss. It is cast in-situ system and called load bearing ed to foundation and then to ground through walls.

2) RCC Framed Structure

In this cast in-situ system, the skeleton of a structure is of RCC column and beam with RCC slab. The infill walls can be of bricks/blocks/stone/panels. The load of the structure is transferred through beam and column to the foundation.

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3) Steel Framed Structure

Here RCC beam and columns are replaced by hot rolled steel sections.

CONVENTIONAL CONSTRCTION SYSTEMS

There is too much of dependency on cement, aggregates and water in these traditional constructions. In particular, the fine aggregate (sand) and water today are quite scarce.

• It is also seen that, on account of shortage of skilled labour, these constructions today, in general, are not up to the mark in terms of quality.

• 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.

(This system is Slow track construction)

BUSSINESS AS USUAL APPROACH:

BUILDINGS CONSUME	BUILDINGS ACTIVITIES CONTRIBUTE
* 40% OF ENERGY	* 50% OF AIR POLLUTION
* 25% OF WATER	* 42% OF GHG EMISSION
* 40% OF RESOURCE	* 50% OF WATER POLLUTION
* 35% OF MANPOWER	* 48% OF SOLID WASTES

SUSTAINABLE BUILDINGS

- 30%-50% REDUCTION IN ENERGY USE
- 40% REDUCTION IN WATER USE
- 35% REDUCTION IN GHG EMISSION
- 75% REDUCTION IN WASTE

PRECAST CONSTRUCTION AS SUSTAINABLE SOLUTION:

Precast uses little water during production and hardly any at the construction site. Quick erection minimizes noise and pollution impact on the neighbourhood. At the same time, the site remains clean and in order because precast elements are ready to install and storage need is negligible. Precast concrete encourages environmental sustainability by creating durable and energy-efficient structures. It promotes downcycling and product reuse, which contribute to economic sustainability. It also promotes social sustainability by promoting safer working conditions.

COMAPRISION OF CONVENTIONAL AND PRECAST CONSTRUCTION SYSTEM

Conventional Construction Systems	Alternate Construction Systems
Slow	Fast
Maximum Use of Natural Resources	Optimum use of Resources
Waste Generation	Minimum Waste
Air/Land/Water Pollution	Minimum Pollution
Labour Intensive	Industrialized System
Prescriptive Design	Cost-effective Design
Unhealthy Indoor Quality	Better health & Productivity
Regular Maintenance	Low Life Cycle Cost
Energy Intensive	Energy Efficient
Cast-in-situ Poor Quality	Factory Made Quality Products
High GHG Emissions	Low GHG Emissions
Unsustainable	Sustainable

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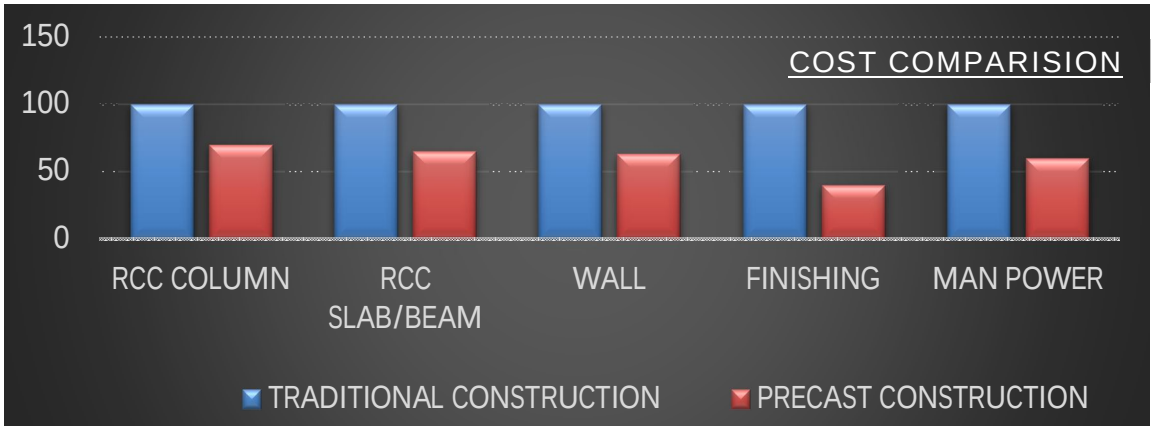
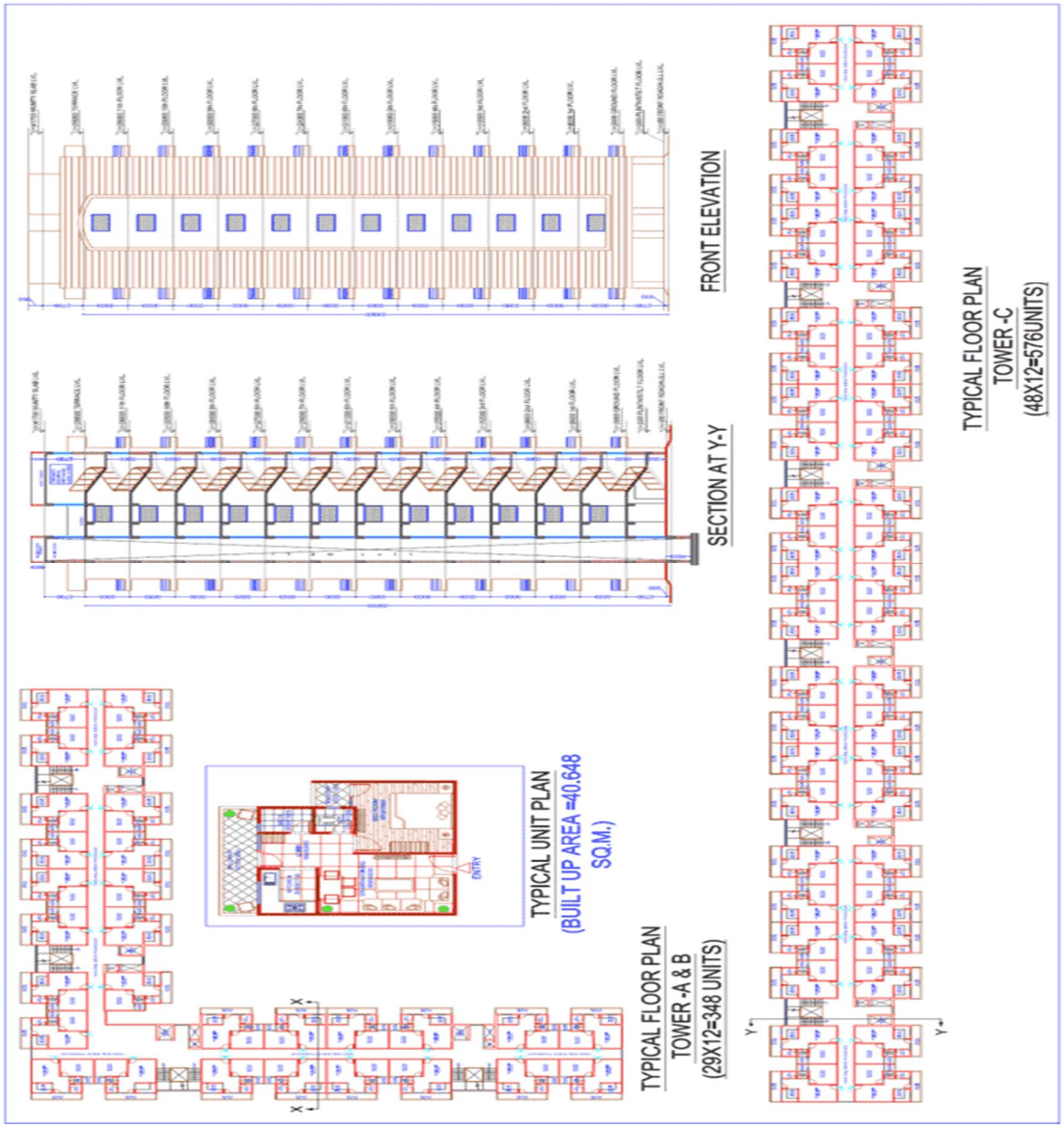
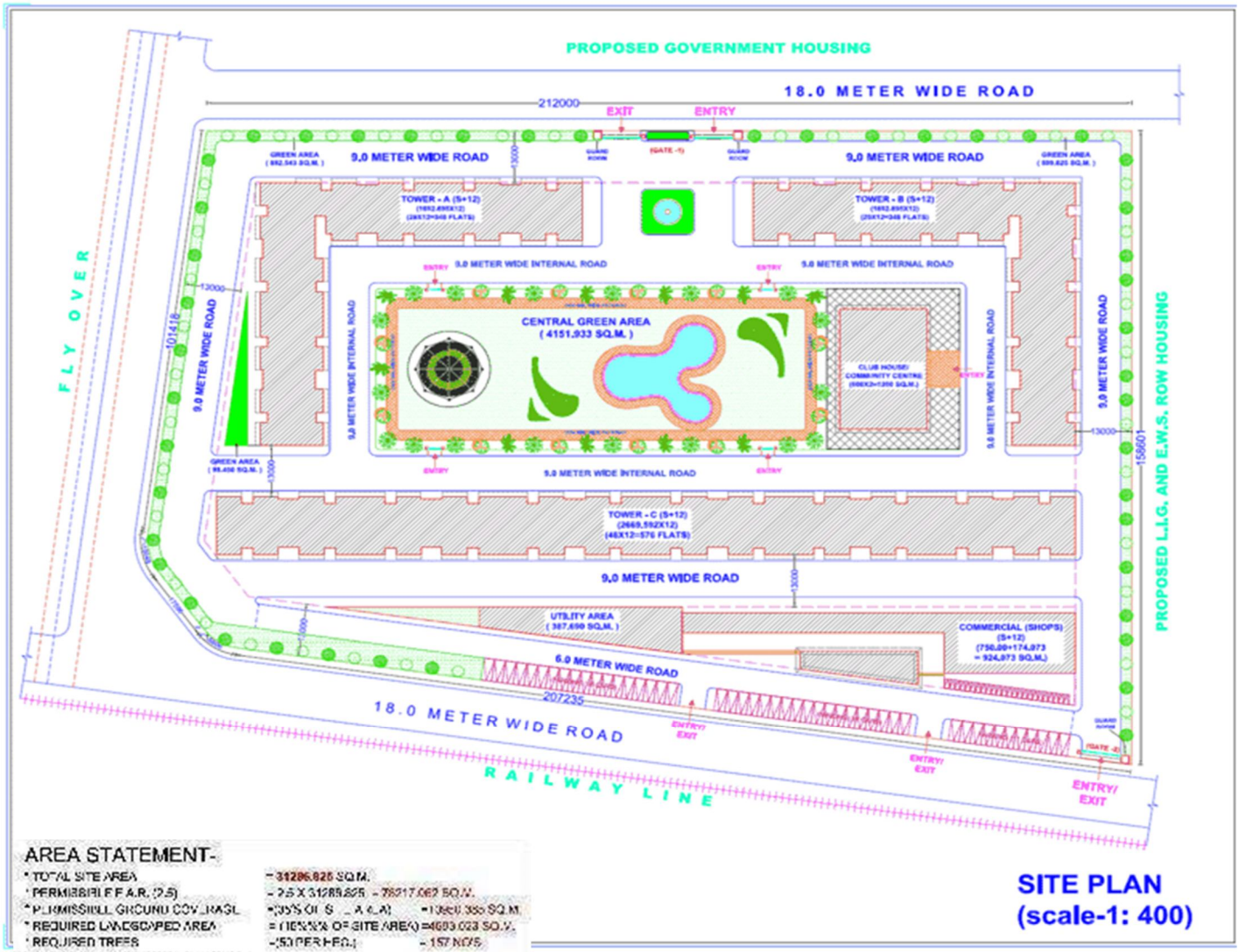
PROCESS COMPARISION



VII. DRAWINGS




PROPOSED GOVERNMENT HOUSING
18.0 METER WIDE ROAD
212000
EXIT
ENTRY
9.0 METER WIDE ROAD
9.0 METER WIDE ROAD
TOWER - A (S+12)
TOWER - B (S+12)
9.0 METER WIDE INTERNAL ROAD
9.0 METER WIDE INTERNAL ROAD
CENTRAL GREEN AREA
(4151.933 SQ.M.)
CLUB HOUSE/ COMMUNITY CENTRE
9.0 METER WIDE ROAD
9.0 METER WIDE INTERNAL ROAD
9.0 METER WIDE INTERNAL ROAD
9.0 METER WIDE ROAD
FLY OVER
TOWER - C (S+12)
(2669.592X12)
(48X12=576 FLATS)
9.0 METER WIDE ROAD
UTILITY AREA
(367.690 SQ.M.)
COMMERCIAL (SHOPS)
(S+12)
6.0 METER WIDE ROAD
207235
18.0 METER WIDE ROAD
RAILWAY LINE
ENTRY/ EXIT
ENTRY/ EXIT
ENTRY/ EXIT
PROPOSED L.I.G. AND E.W.S. ROW HOUSING
AREA STATEMENT-
* TOTAL SITE AREA = 31286.825 SQ.M.
* PERMISSIBLE F.A.R. (2.5) = 2.5 X 31286.825 = 78217.062 SQ.M.
* REQUIRED LANDSCAPED AREA = (15%)% OF SITE AREA) =4693.023 SQ.M.
* REQUIRED TREES (-)50 PER HECT. = 157 NOS.
* PERMISSIBLE GROUND COVERAGE
FOR FACILITIES NOT INCLUDED IN F.A.R. (5% OF SITE AREA OR = 400 SQ.M.
SITE PLAN
(scale-1: 400)

SITE VIEW

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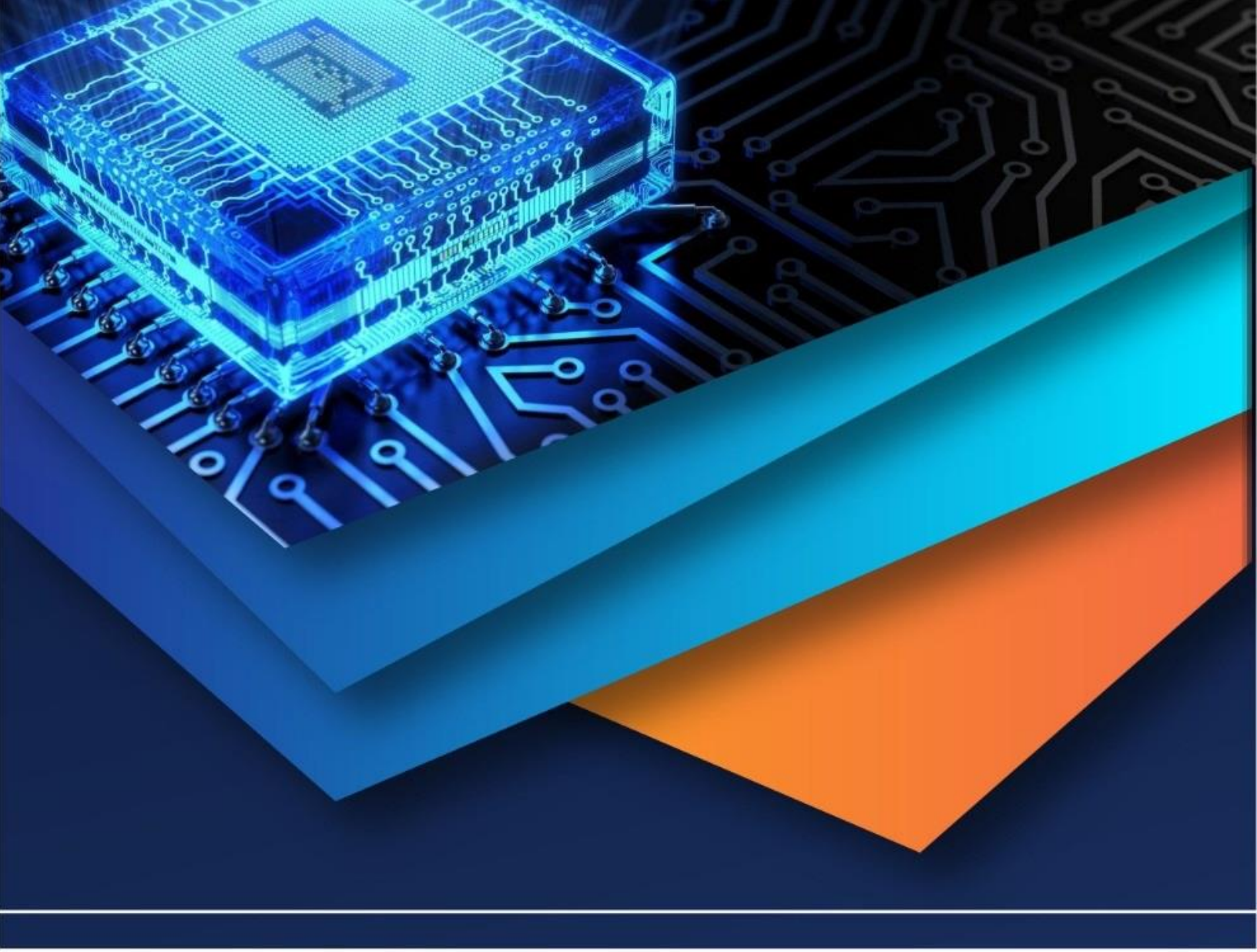

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