



Analytical Study of Prefabricated Construction Technique Practicability in Solapur City

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ABSTRACT - In Western countries the precast system has been widely used in constructing bridges, office buildings and residential buildings. In India, cast-in-place is the traditional construction system that has been mostly used and precast system is used merely for floor slabs in India. Only a few parties in the Indian construction market have adopted fully precast concrete systems. However, many factors have an impact on the adoption of precast concrete system. The study take account of an analysis of the significant factors in the adoption of precast concrete elements and system, such as labor cost, equipment and machinery cost, quality work and time required for execution. The study concludes the adaptability of Prefabricated Construction Technique for multistoried building in Solapur City.

KEYWORDS - Prefabricated Construction Technique, Cast in Situ, Conventional construction Technique, Labour Cost, Solapur

I. INTRODUCTION

Precast concrete elements are one of the most remarkable developments in the construction of concrete structures. In recent decades, precast concrete elements have been widely used for architectural and structural buildings. The construction method is mainly divided into two stages: manufacture of mass-produced components in a permanent construction facility, and assembly of components on the construction site. Numerous researchers have studied the adoption model within their individual fields of study. This study attempts to model the various factors that influence this industry's effectiveness in adopting precast concrete elements. ^[1]

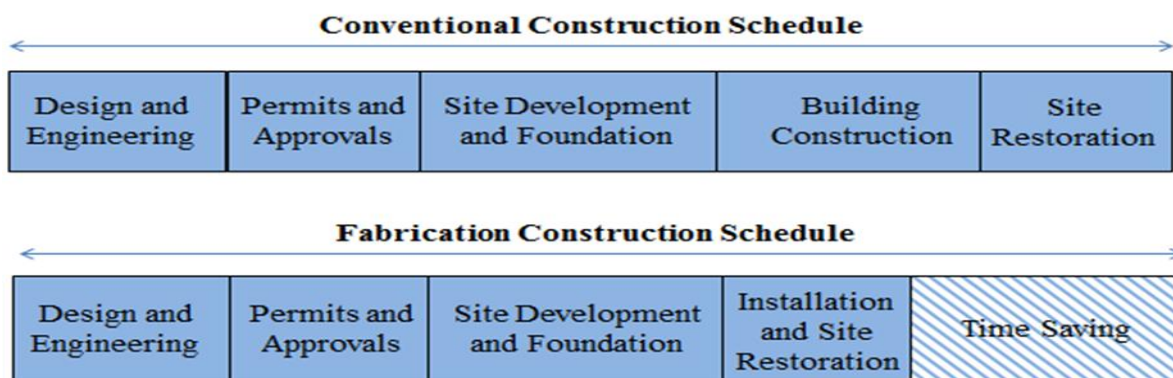


Fig 1: Comparison of conventional and fabrication construction schedule

II. OBJECTIVE OF STUDY

The ultimate objective of this study is, to systematically perform comparative and analytical study of cost, quality and time for precast construction over conventional construction.

III. LITERATURE REVIEW

This literature review is used in support development of the research hypotheses and the methodologies used to test those hypotheses. An extensive literature review provides background information on current knowledge related to the research topic.

N. Dineshkumar and P. Kathirvel

The main objective of the research paper is to study the present situation of the precast construction industry in India. Author has Proposals for improvement of the industry and study on cost effectiveness of precast concrete construction for single and multi-story residential buildings. The prefab construction for individual double story residential building cost is 13% more than the conventional construction. Prefab construction is easy to work and reduces the project duration of similar magnitude of project, reduced by 63 days when compared to the conventional. It's the main advantages for prefab construction and also it helps when there is labor shortage. As per the survey carried out by author, the prefab constructions have more advantages and procurement in industrialized, heavy infrastructures. But in individual houses there are lot of constraints and lack of knowledge its get struggling to implement in India. At this stage conventional construction is economical and comfortable when compared to the prefabrication construction. ^[2]

Vaishali Turai and Ashish Waghmare

Author has analysed the precast practice followed in India with case study. The paper based on cost comparison of precast concrete vs. cast-in-place concrete. Cost of any construction is directly varied with time of construction. Precast is manufactured in factory (i.e. in controlled environment) with required quality, can easily mix, cure with good quantity. Precast concrete is manufactured in factory and transport to site. The precast construction less manpower is required; labours are required only to joint precast members. That means indirectly saving cost on labours. ^[3]

In precast concrete construction wastage of materials is negligible as compared with cast-in-place concrete. There is no need of curing on site after erection of members because members are cured in factory for desired days. There for the time (in days) is saving in construction which will reduces the cost of construction. Precast construction reduced the cost of construction required for maintenance of work. The cost on shuttering and de-shuttering is eliminated by using precast will result into saving total cost of construction. The cost of rework due to improper work, faulty construction method, unskilled labour, material quality, onsite environmental problem can be eliminated by using precast members. ^[3]

B. Raghavendra K. Holla, Siddhant Anant et. Al

This paper reviews and summarizes the role of time, cost, quality and productivity of the precast system in order to compare with the conventional. The productivity of the construction is high and wastes are minimum. Being a county with a large number of unskilled labours, it gets difficult to work with heavy machinery without experience and the cost of transportation of structural elements from the factory to various sites is variable.

At present India has only 2% of skilled labour. To implement precast in larger scale in India this percentage should be increased which can help in meeting the huge housing demand using precast. Author expressed its view on site. ^[4]

Akash Lanke and Dr. D. Venkateswarlu

In this research paper author has taken one building as a case & design the same building as a precast building & Traditional Cast in-situ building. Author has made a cost analysis as well as feasibility check on basis of costing & duration. Author analysis resembles the cost of precast building is significantly reduces & duration of construction is also much lesser than traditional method. From all this study it has been conclude that the precast concrete system is economical than conventional cast in place method but still there are some conditions which we have to take care of while using precast, those are quantity of construction, distance of site from manufacturing unit, type of building etc. ^[5]

Krish R. Villaitramani and Dhruv P. Hirani

In this paper author has studied the feasibility of Prefabricated Construction for Mass Housing in Mumbai. Prefabrication of houses, an innovation that has potential to address environmental and sustainability concerns at a rapid pace, mechanizes the construction process, enabling mass manufacture of affordable houses. This paper discusses the case of Mumbai, the city of maximum slum population density in the world, where prefabrication can be a promising solution to housing scarcity. ^[6]

Author has review in this paper to plan, analyse and design residential building using prefabricated techniques in Mumbai, bearing in mind, the cost of total construction and planning of the building are done in such a way that the maximum area utilization is achieved for minimum space and cost. Prefabrication has the capability to make a difference within the Indian construction industry in economic, social and environmental terms. It is essential that the potential benefits of this innovation are yielded so that required development can take place. ^[6]

I.

IV. METHODOLOGY

The primarily data will be collected on site from concern competent persons. All data analysis and reporting will be done on the bases of data obtained from site and investigation.

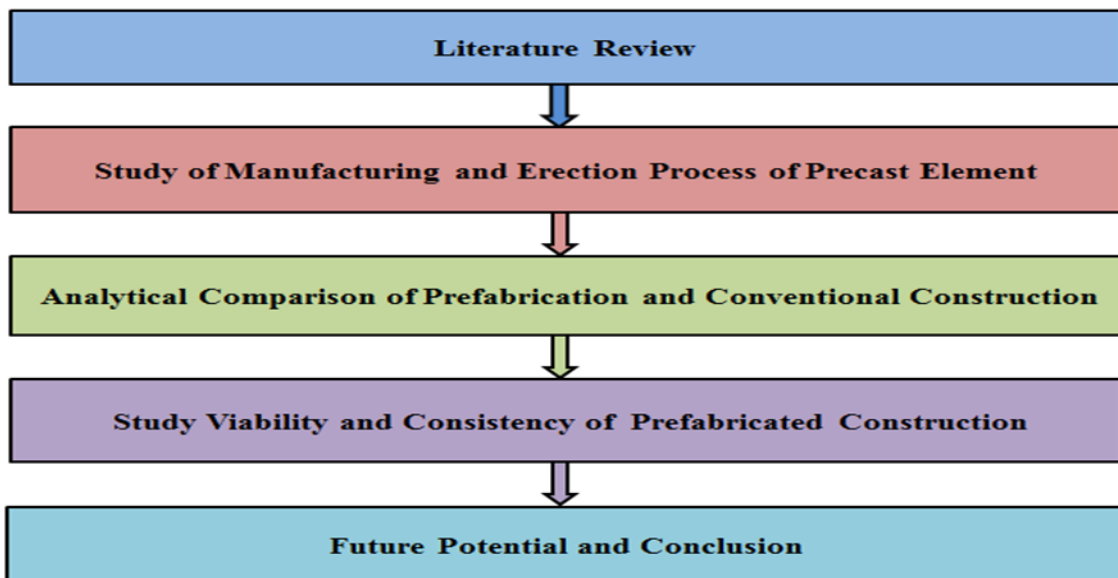


Fig 2: Overall Methodology Process

V. DATA COLLECTION AND ANALYSIS

1) COMPARATIVE STUDY OF CONVENTIONAL CONSTRUCTION AND PRECAST CONSTRUCTION IN COST PANORAMA

The analysis based on cost comparison of precast concrete vs. cast-in-place (i.e. traditional) concrete. In what way the total cost of construction by precast concrete system is varying the cost by use of cast-in-place concrete. In this analysis footing and column is considered for analysis. For cost analysis labor cost, machinery and equipment cost and water charges are considered into analysis. The site for conventional construction study AG Tech Park and for precast construction study Schmersal Ind Pvt Ltd is taken into analysis.

Table 1: Man power required for Cast-In-Situ Project

Srl. No.	Resources	Numbers
1.	Supervisor	1
2.	Steel Fixer Foreman	1
3.	Concreting In-Charge	1
4.	Welder	0
5.	Carpenter & Carpenter Labor	20
6.	Mason & Mason Labor	15
7.	Steel fixer	15
8.	Electrician	1
9.	Labor (mazdoor)	12
10.	QC Inspector	1
Total Manpower		67

Table 2: Work done for Construction of footing and Column for Cast In Situ

CONSTRUCTION OF FOTTING & COLUMN					
Work done up to 4.5m height (Avg. column ht.4.5m)					
Particular	No. of Groups	Manpower per group	Avg. Daily Salary	Duration (Days)	Amount Rs.
Welders	0	0	0	0	0
Carpenters & Labor	5	4	500	25	250000
Steel fixers	3	5	500	25	187500
Mason & Labor	3	5	500	25	187500
Laborers (mazdoor)	1	12	300	25	90000
Supervisor	1	1	500	25	12500
Steel Fixer Foreman	1	1	500	25	12500
Concreting In-Charge	1	1	500	25	12500
Electrician	1	1	500	25	12500
QC Inspector	1	1	550	25	13750
Total Amount (Direct Labor Cost) Rs.					7,78,750
Work Done	Quanti	Unit			

	ty	
Total shuttering work	917	sq. m
Total concreting work	341	cum
Work done only up to 4.5 m height (column up to 1 st floor)		

Table 3: Man power required for Precast Project

Srl. No.	Resources	Numbers
1.	Supervisor	1
2.	Steel Fixer Foreman	1
3.	Concreting In-Charge	1
4.	Welder	16
5.	Carpenter & Carpenter Labor	8
6.	Mason & Mason Labor	6
7.	Steel fixer	8
8.	Electrician	1
9.	Labor (mazdoor)	10
10.	QC Inspector	1
Total Manpower		53

Elements to cast simultaneously;

1. Footing (Weight = 18 ton to 30 ton) - Molds will be fabricated here in the factory (existing plant) and to be delivered to site.
2. Columns (Weight = 25 ton to 36ton)
 - All columns will be cast at site.
 - Location of casting beds was located under the tower crane during our site visit (30 -40) m from actual location of column).

Table 4: Work done for Construction of footing and Column for Precast Project

CONSTRUCTION OF FOTTING & COLUMN					
Work done up to 20 m height (Avg. column ht.20 m)					
Particular	No. of Groups	Manpower per group	Avg. Daily Salary	Duration (Days)	Amount Rs.
Welders	4	4	550	55	484,000.00
Carpenters & Labor	4	2	550	55	242,000.00
Steel fixers	1	8	550	55	242,000.00
Mason & Labor	1	6	550	55	181,500.00
Laborers (mazdoor)	1	10	300	55	165,000.00
Supervisor	1	1	550	55	30,250.00
Steel Fixer Foreman	1	1	550	55	30,250.00

Concreting In-Charge	1	1	550	55	30,250.00
Electrician	1	1	550	55	30,250.00
QC Inspector	1	1	600	55	33,000.00
Total Amount (Direct Labor Cost) Rs.					14,68,500.00

Work Done	Quantity	Unit
Total shuttering work	2205	sq. m
Total concreting work	778	cum
Work done only up to 20 m height (column up to Roof truss bottom)		

MAN POWER (Labor Cost)

- Cast in situ per sq. m (shuttering) = Rs.850.
 - Precast per sq. m (shuttering) = Rs.666
- Man Power (Labor cost) for shuttering work 183 Rs/sq. m additional in conventional method.

2) COST ANALYSIS OF MACHINERY AND EQUIPMENT FOR CONVENTIONAL PROJECT AND PRECAST PROJECT

A) CONVENTIONAL PROJECT: The working duration for construction of footing for column in our case study is 25 days, but while execution or setting up the concrete mixture machine and requisite accessories require 28 days for setup. The boom placer has been hired on hourly basis and used for the casting last two grid of column from the approach road.

Machinery & Equipment Cost per Cum of Concrete = (Total Amount (Rs.)) / (Total concrete work (cum))

$$= 60000/341 = \text{Rs. } 175.95 \text{ per cum}$$

- Machinery & Equipment Cost per Cum of Concrete Rs. 176 /-

B) PRECAST PROJECT: Machinery & Equipment Cost per Cum of Concrete = (Total Amount (Rs.)) / (Total concrete work (cum))

$$= 8,84,850/778 = \text{Rs. } 1137 \text{ per cum}$$

- Machinery & Equipment Cost per Cum of Concrete Rs. 1137 /-

❖ The comparative cost analysis of machinery and equipment is not pertinent due to the difference in height parameter, in case of conventional construction case study the average height of column is 4.5 m where in case of precast construction case study the average height of column is 20 m but the analysis per cum of concrete is done to get an inkling of huge cost variances. The machinery & equipment cost is high in precast construction.

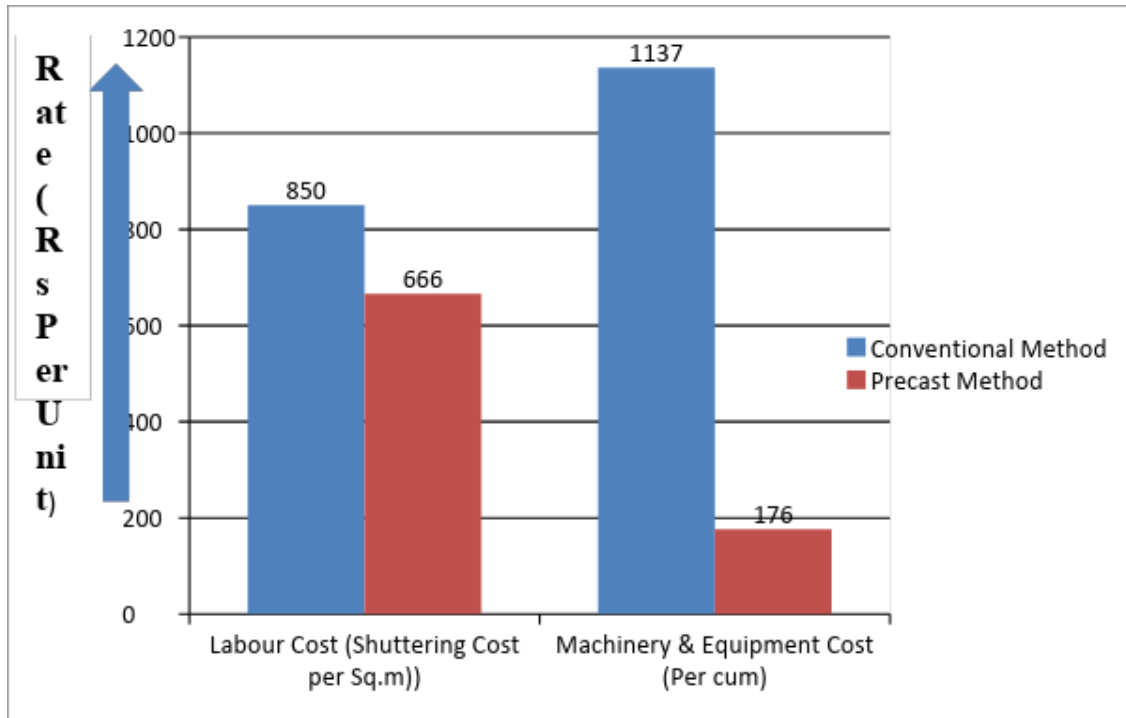
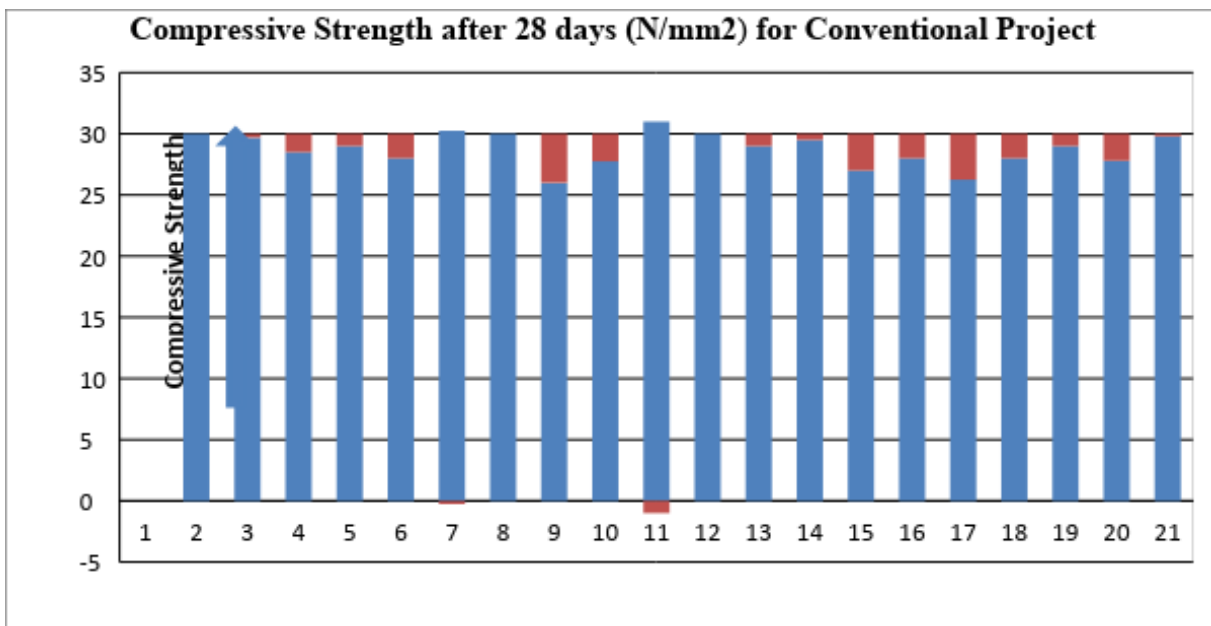


Fig. 3: Cost Analysis of Conventional Project and Precast Project

3) COMPARATIVE STUDY OF CONVENTIONAL CONSTRUCTION AND PRECAST CONSTRUCTION IN QUALITY PANORAMA

The analysis based on quality comparison of precast concrete vs. cast-in-place (i.e. traditional) concrete has been carried out by the study of compressive strength after 28 days. In this analysis casting of slab is considered for examination. The site for conventional construction study West One Project, Hinjewadi and for precast construction study Infosys Building, Hinjewadi is taken into analysis.



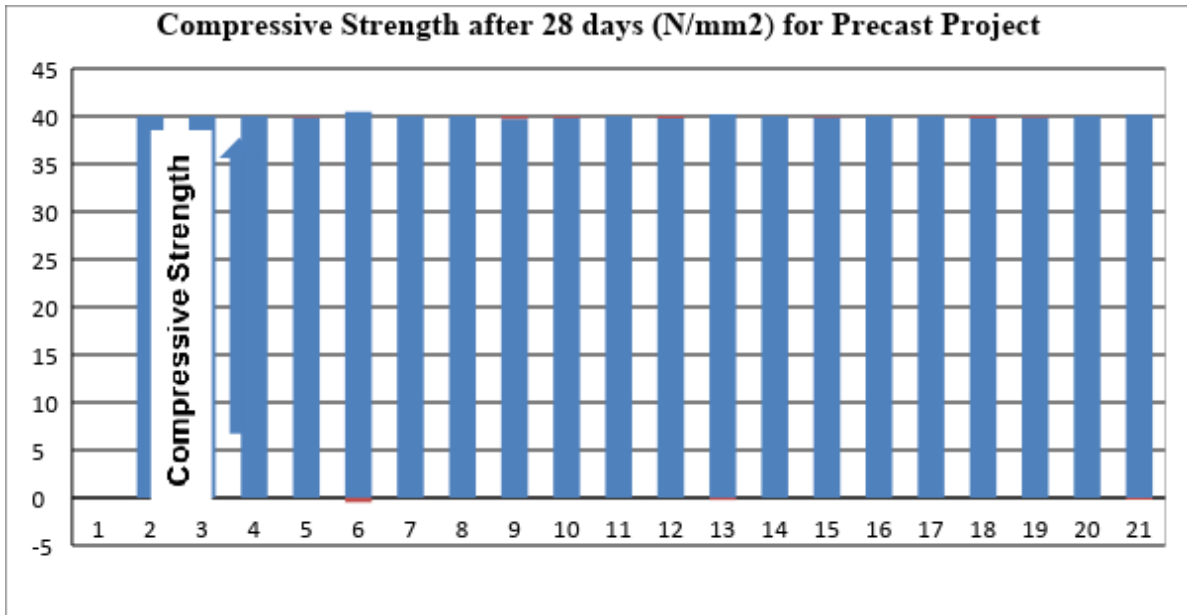


Fig. 4: Graphical Presentation of Quality Analysis of Conventional Project and Precast Project

- **CONVENTIONAL PROJECT:** Some Standard deviation of sample of cubes results is 3 to 4 Mpa, this shows poor control at site on concrete operation (according to revised IS 456 2000).
- **PRECAST PROJECT:** Standard deviation is very negligible around 0.1 to 0.15 that means we get higher control on design mix and get quality result in case of precast concrete.

4) COMPARATIVE STUDY OF TIME REQUIRED FOR PROJECT BY CONVENTIONAL CONSTRUCTION AND PRECAST CONSTRUCTION

A comparative study has been trying for the analysis of time required by both the methods on similar scale of project located in Hinjewadi. Below are the tabular comparison, activity wise number of days required for four numbers of footing and column. The lead time required for precast element to reach site after releasing the order is minimum of 20 days. In this analysis, the days considered for precast construction approach is after reaching to the site that is the time considered for assembling time in site.

Table 5: Time Required For Project by Conventional Construction And Precast Construction For Footing And Column

Srl. No.	Operation / Activity	Number of Days Required For	
		Precast	Cast in Situ
1.	Setting Out	Same	Same
2.	Excavation	Same	Same
3.	P.C.C	01	01
4.	R.C.C (footing and column)	01	
i	Rebar cutting, bending, shifting, placing and tying (footing)		02
ii	Shuttering (footing), Rebar work (column)		01
iii	Concreting		01

iv	Shuttering (Column)		01
V	De shuttering of footing and Column		01
Total Duration (Days)		02	06

The primary benefit of precast construction is the speed of construction (i.e. reduction in time of construction). Precast elements can be cast in controlled environment conditions at a pre casting yard in advance of when they will be required, stocked, and transported to the construction site carefully as required. The structure can then simply be assembled precast elements that's why it consume very less amount of duration as compare to conventional method as illustrated in above table.

VI. CONCLUSION AND RECOMMENDATION

On the basis of investigation the concluding performance of the precast element building is considered excellent element for the rapid changing construction industry.

1. Precast element manufacturing procedure is providing a high quality final product with wonderful productivity, minimum number of labours & it is found that labour construction cost efficiency around 20-25% was generally obtained by replacing conventional structural systems with precast concrete element..
2. Standard deviation is very negligible around 0.1 to 0.15 that means we get higher control on design mix and get quality result in case of precast concrete. It has also been proved that the construction speed was able to be increased significantly in-line with the achievement of better quality works and more eco-friendly construction projects. The use precast/pre-stressed concrete as structural components will definitely enhance in the future.
3. The proposed system uses all precast structural members, which allows for greater quality and erection speed over conventional methods. This gives the system incredible flexibility in its construction and greatly reduces floor-to-floor construction durations.

The construction boom in and around Solapur is developing at a fast rate of growth. It provides wide opportunity in Solapur for a new entrant in prefab sector. At present precast concrete buildings are the advanced construction techniques available over India and worldwide. Being its wide applicability, the total precast concrete buildings systems are becoming a popular choice for many construction. Precast concrete available in many shape, sizes, including structural elements and unreinforced pieces. The prefab industry is the backbone for the development of new ideas in construction business; factory buildings, residential buildings and the industrial township are needed practically by all the sectors, either to support the manufacturing or services of any industry.

Despite of having multiple applications and advantages still precast construction is trying to grip its root in Solapur. It has been observed that the city has a source of small component like precast compound wall manufacturer but, lacks fully dedicated precast production facility for all structural component of construction.

While sighting the current construction growth and forecasting, the future requirement and the city is among the 20 cities selected as part of the first batch of the Smart City initiative. It is high time for Solapur city to opt for smart construction technology in greater measure to fulfil the dream of Smart Cities Mission by Solapur Municipal Corporation.

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