Optimizing Blend of Conventional and Prefabricated Components in Building Construction

Mr. Lakhi M. Chavan[1], Prof. D.B.Desai[2]

[1]Master of Engineering (Student), Dept. of Civil Engineering, JJMCOE, Jaysingpur, Maharashtra, India.
[2] Asso. Professor & Dean Faculty Developments, Dept. of Civil Engineering, JJMCOE, Jaysingpur, Maharashtra, India

---

Abstract - The development and application of onsite and precast building is very different in the various countries. Traditionally, cast-in-place construction has been primary method for buildings. Prefabricated systems are a growing technology to aid in rapid building construction to minimize delays. Prefabrication also improves the quality of product because elements are manufactured under controlled conditions in the plant and high-performance materials may be used during casting. Prefabrication also improves safety in the work zone by reducing the amount of activity that is required over traffic or at high elevations to construct the high-rise buildings. Prefabricated Building construction can be used for new projects as well as building rehabilitation. Prefabricated building construction will result in rapid construction and minimized delays during the course of project. Fast track construction systems use prefabrication components to rapidly erect a construction.

***Key Words*: Conventional, Prefabricated, Optimization, Siporex, Screeding.**

1.INTRODUCTION

Now a days there is great boom in infrastructural development that to in a manner of fast-track construction. Today the need is to save time and to optimize the utilization of resources. This method requires large amounts of time and labor at project site. Buildings form an important component of infrastructure, and require huge investment. Overall, building construction is a labor-intensive, lengthy process primarily due to curing times for concrete and formwork construction. Using prefabrication in a project allows to reduced time duration. This means that the impact of the site on the local environment is for a shorter period of time. Using this prefabricated building components in building construction projects can reduced the curing times from the critical path of the project and eliminating the need for temporary formwork.

Thus the purpose of this project is to determine prefabrication and onsite trends and effects on the construction workforce. Therefore, using of these techniques to reduce project duration, & costs. Study of comparison between onsite construction and prefabricated construction and show the graphical representation.

1.1 Aim

The aim of this project is to determine the prefabricated building techniques over a conventional method. Prefabrication techniques have many merits, like availability of materials, labour, and technical skills. Advantages of prefabrication are multiple as the components are readymade and self-supporting, shuttering and scaffolding is eliminated, with a saving in shuttering cost. In traditional construction, the repetitive use of shuttering is limited, as it gets damaged due to frequent cutting, nailing, etc. On the other hand, the mould for the precast components can be used for a large number of repetitions, thereby reducing the cost of the mould per unit. In the prefabricated housing system, there is saving of time, as the elements can be cast beforehand during the course of the foundation being laid.

1.2 Objectives

1.2.1. To study the Conventional &prefabricated building construction.
1.2.2. To Analyze the time and cost required for various building components.
1.2.3 To compare the conventional and prefabricated building construction with respect to time and cost.
1.2.4 To optimize blend of conventional and prefabrication techniques in construction.
Above objectives will be achieved by taking a case study.

1.3 Comparisons Between Conventional and Prefabricated construction method.

Table No -1. Comparison between conventional construction and prefabricated construction.

No	Conventional construction	Prefabricated construction
1	One work cannot start until the previous work is completed.	Work occur simultaneously, and the erection process is fast.
2	Process can be easily delayed by adverse weather or scheduling conflicts.	No impact on the scheduling of the prefabrication manufacturing.
3	Most of onsite construction procedures depend on manual method.	Prefabrication construction procedures depend on automation.

4	Most of workers on site are temporary and technical skills are more variable.	Workers in a prefabrication plant are more proficiently experienced at specific task.
5	Formwork installations are necessary.	Construction formwork are not necessary.
6	All finish work need to be finished on site.	Less finish work is required.

2. CASE STUDY

Name of Company: B.G. Shirke Construction Technology Private Limited

Name Of Project: Maharashtra state police housing and welfare corp.ltd.

Total plot area: 25863.00SQ.M.

Total built-up area (Permissible): 19396.95SQ.M

No. of flats: 132

Total project cost: 18.3Coror

Site location: F.P.NO.:394, Karad.

Address: karve road, Tal-karad, dist- Satara.

2.1 Column-

There are 7 types of column are used in this project and total 17 no of moulds are available on site

2.2 Beam

There are 29 types of beams are used in this project and total 33 no of moulds are available on site.

2.3 Stair Case

Precast staircases are delivered to site ready for installation and can speed up construction schedules to provide safe and immediate routes between floors under construction. Once hoisted into place, the precast stair flight is suitably protected and ready for use.

2.4 Lintel and Chajja

Use of precast lintels and chajja speeds up the construction of walls besides eliminating shuttering and centering.

2.5 Siporex Slab

Siporex is produced by a highly advanced factory process under the control of chemists and engineers, Siporex products are made either as steel reinforced (panels) or as unreinforced blocks. Panel size is 3.5 meters wide and 600mm deep and thickness 150mm, block size 600mm x 200mm x 100mm. The basic raw materials are sand and cement. The dowel bars for beam, column and reinforcement steel for floor screed is laid on complete floor. The screed of 40 mm thickness is laid on the top of panels with a nominal reinforcement of 8 mm dia @ 230 mm c/c having concrete M25 grade.

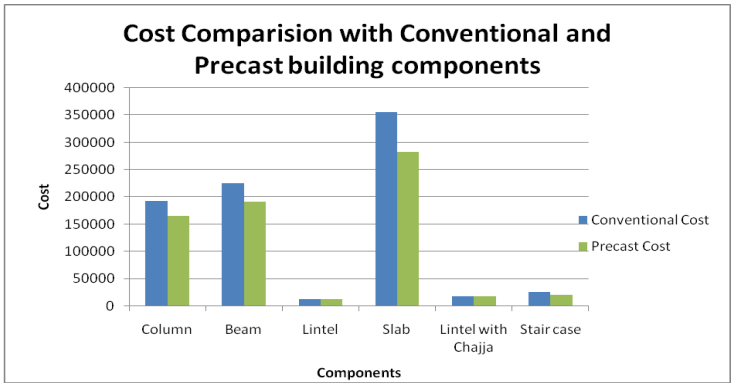
3.RESULTS AND DISCUSSIONS

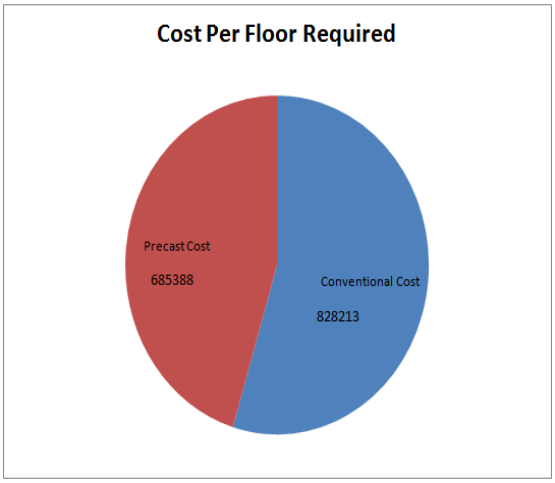
3.1 Cost calculation for Prefabricated and Conventional building Components

From that case study I have calculated cost for each precast and conventional framed structure like Column, Beam, Slab, Stair case, Lintels, Lintels with Chajja with the help of divisional schedule rate 2015-16, for precast components also include the erection cost per components. Basically cost is dependent on various factors such as material cost, labour cost, transportation cost, formwork cost, and erection cost etc.

Sr No	Components	Conventional Cost in Rs	Precast Cost in Rs	Differences in Cost
1.	Column	192420	165096	27324
2.	Beam	225385	190602	34783
3.	Lintel	11632	11133	499
4.	Slab	356044	281995	74049
5.	Lintel with Chajja	17316	16682	634
6.	Stair case	25416	19880	5536
7.	Total	828213	685388	142825

This table shows that the cost required for conventional and precast construction per floor using cost analysis and their cost differences are also shown in table.



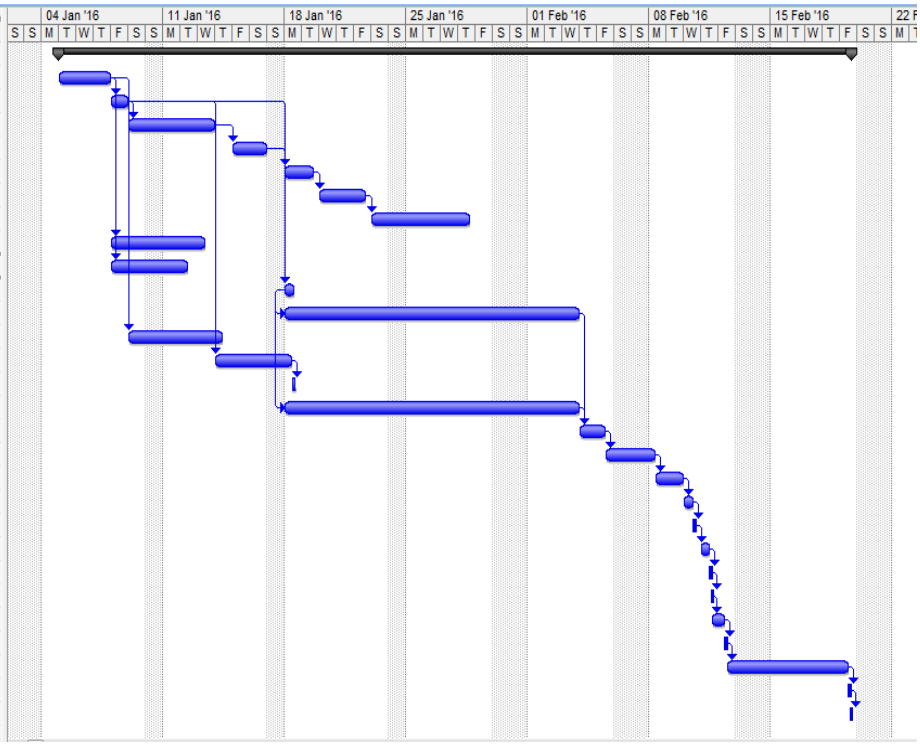


This pie chart shows cost between conventional and precast construction.

3.2 Time calculation for Prefabricated and Conventional building Components

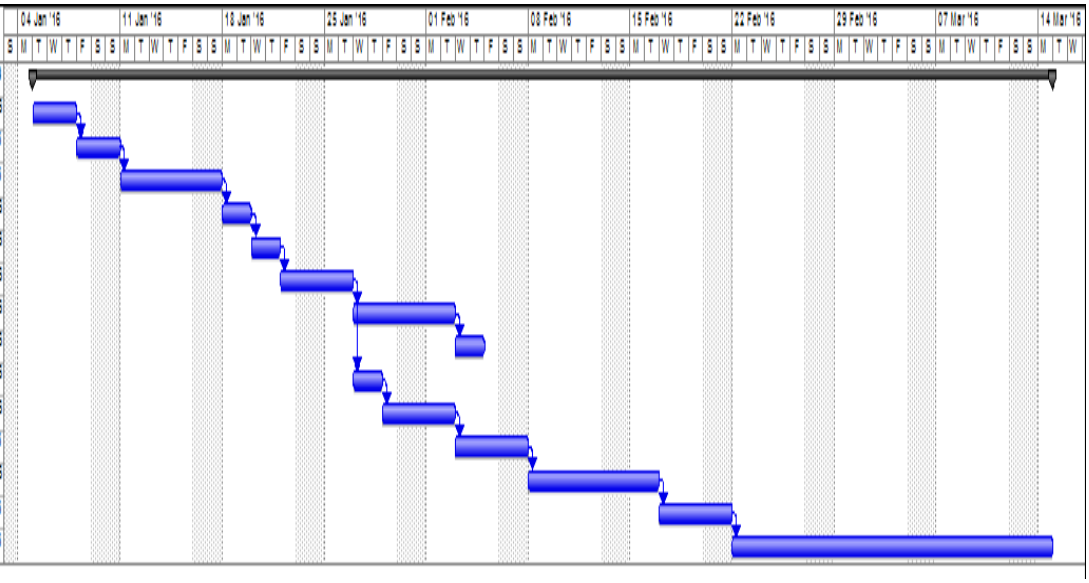
Total times required for Precast Frame Structure

	Task Name	Duration	Start	Finish	Predec
1	1.Maharashtra State Police Hc	36.88 days?	Tue 05/01/16	Fri 19/02/16	
2	1.1 Foundation Excavation	3 days?	Tue 05/01/16	Fri 08/01/16	
3	1.2 PCC	1 day?	Fri 08/01/16	Sat 09/01/16	2
4	1.3 Foundation Casting	4 days?	Sat 09/01/16	Thu 14/01/16	3
5	1.4 Column Shuttring Upto Pl	2 days?	Fri 15/01/16	Sat 16/01/16	4
6	1.5 Column Upto Plinth	2 days?	Mon 18/01/16	Tue 19/01/16	5
7	1.6 Tie Beam	3 days?	Wed 20/01/16	Fri 22/01/16	6
8	1.7 Murrum Filling	5 days?	Sat 23/01/16	Thu 28/01/16	7
9	1.8 Column Shuttring	34 hrs?	Fri 08/01/16	Wed 13/01/16	2
10	1.9 Steel cutting Binding	26 hrs?	Fri 08/01/16	Tue 12/01/16	2
11	1.10 Column Casting	4 hrs?	Mon 18/01/16	Mon 18/01/16	3
12	1.11 Column Curring	14 days	Mon 18/01/16	Thu 04/02/16	11SS
13	1.12 Beam Shuttring	34 hrs	Sat 09/01/16	Thu 14/01/16	2
14	1.13 Steel cutting Binding	26 hrs	Thu 14/01/16	Mon 18/01/16	3
15	1.14 Beam Casting	4 hrs	Mon 18/01/16	Mon 18/01/16	14
16	1.15 Beam Curring	14 days	Mon 18/01/16	Thu 04/02/16	11SS
17	1.16 Trasnportation Column,	11 hrs?	Thu 04/02/16	Fri 05/02/16	16,12
18	1.17 Erection of Column	6 hrs?	Fri 05/02/16	Mon 08/02/16	17
19	1.18 Erection of beam	15 hrs?	Mon 08/02/16	Wed 10/02/16	18
20	1.19 Column Level	4 hrs?	Wed 10/02/16	Wed 10/02/16	19
21	1.20 Half Column Column Gro	3 hrs?	Wed 10/02/16	Wed 10/02/16	20
22	1.21 Beam Level	4 hrs	Thu 11/02/16	Thu 11/02/16	21
23	1.22 Slab Erection	2 hrs?	Thu 11/02/16	Thu 11/02/16	22
24	1.23 Slab Level	1 hr?	Thu 11/02/16	Thu 11/02/16	23
25	1.24 Spreding Silicon On Slat	3 hrs?	Thu 11/02/16	Fri 12/02/16	24
26	1.25 Erection of Racker	2 hrs?	Fri 12/02/16	Fri 12/02/16	25
27	1.26 Over Slab Reinforcemer	5 days?	Fri 12/02/16	Fri 19/02/16	26
28	1.27 Full Column Column Grou	2 hrs?	Fri 19/02/16	Fri 19/02/16	27
29	1.28 40mm Screeding	2 hrs?	Fri 19/02/16	Fri 19/02/16	28

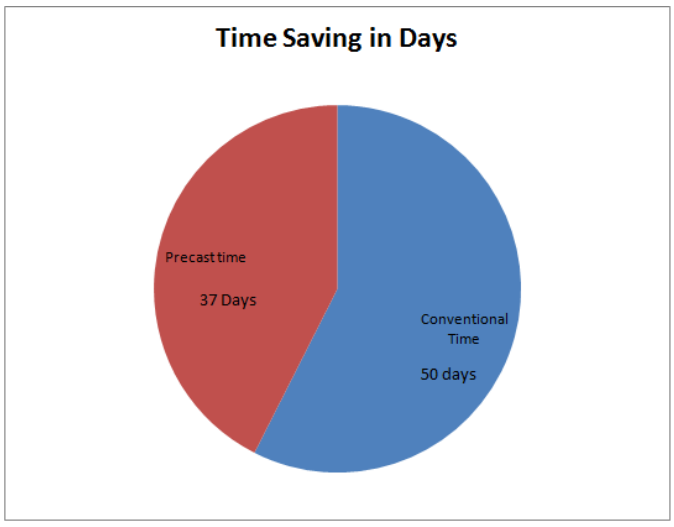


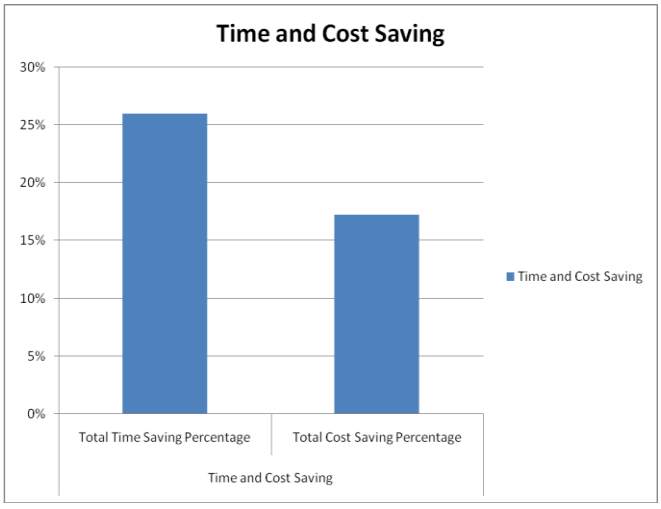
Total times required for Conventional Frame Structure

ID	Task Name	Duration	Start	Finish
1	Conventional Construction Method	60 days?	Tue 05/01/16	Tue 15/03/16
2	Foundation Excavation	3 days?	Tue 05/01/16	Fri 08/01/16
3	PCC	1 day	Fri 08/01/16	Mon 11/01/16
4	Foundation Casting	5 days	Mon 11/01/16	Mon 18/01/16
5	Column Shuttring upto Plinth	2 days	Mon 18/01/16	Wed 20/01/16
6	Column Upto Plinth	2 days	Wed 20/01/16	Fri 22/01/16
7	Tie Beam	3 days	Fri 22/01/16	Wed 27/01/16
8	Murrum Filling	5 days	Wed 27/01/16	Wed 03/02/16
9	Ground Floor Column Shuttring	2 days	Wed 03/02/16	Fri 05/02/16
10	Steel Cutting Binding	2 days	Wed 27/01/16	Fri 29/01/16
11	Column Casting	3 days	Fri 29/01/16	Wed 03/02/16
12	Column Curring	3 days	Wed 03/02/16	Mon 08/02/16
13	Beam Bottom, Slab and Staircas	7 days	Mon 08/02/16	Wed 17/02/16
14	Steel Cutting Binding	3 days	Wed 17/02/16	Mon 22/02/16
15	Beam Slab Staircase Casting	16 days	Mon 22/02/16	Tue 15/03/16



Above two MSP schedule shows that the each activities require how much time for their completion of task. With the help of precast construction the total time required for construction of a framed structure is **37 days** from the starting of foundation up to first slab. And using conventional construction the total time required is **50 days** for the framed structure starting from foundation to first slab. Also it is observe that in both the cases like conventional and precast construction is; when we start the foundation excavation, at that time precast components are to be casted so the time requires will be less as compared to the conventional construction. But in other case, that is in conventional construction each activity is started simultaneously means after completion of foundation we start the next activity such as casting of column, beam, etc. The similarity between these two conventional and precast constructions is the up to foundation level procedure has been same and time





The above graph shows that the combination of cost saves per floor and time saving. From that the total time saving is 26% and the average components cost saving is 17.24%.

4. CONCLUSIONS

From the above study and based on the preceding chapters the important conclusions are as follows.

1. By utilizing the precast building components we reduce the cost up to 17.24 %.
2. By using this methodology we can reduce the project duration up to 26 %.
3. Construction of various elements by use of precast methodology helps us to achieve economy and fast track construction which is need of construction industries.
4. It is found that the time required in case precast construction is quite less as compared to conventional.
5. Quality obtained in precast construction is better as compared to in-situ construction.

REFERENCES

1.Avifriedman and Vince Cammalleri (1997), "*Cost reduction through prefabrication A design approach",* Journal Housing Education and Research Association, Vol 24 ,No-1,pp. 2-10.

2.Azman M.N.A., Ahamad and Wan Hussin (2012) *"Comparative Study on Prefabrication Construction Process,"*International Journal of Innovative Science, Engineering & Technology, Vol 2, No-4,pp. 45-58.

3.Baldwin. A.,Heng Li., Huang.T., Kong, C.W., Guo, H.L., Chan, N., and Wong, J. (2009).*"Supporting pre-tender construction planning with virtual prototyping, Engineering"*, Building and Real Estate Workshop Paper, Vol. 16 No-2, pp. 18-44.

4.Dabhade.UD, HedaooN.A, Gupta L. M.and Ronghe G. N. (2009) *"Time and Cost Evaluation of Construction of Steel Framed Composite Floor with Precast Concrete Floor Structure*" International Association for automation and robotic construction (IAARC) Vol-1 , No-1, pp.139-148.

5.Haas Carl T. James T.O Connor Richard L. Tucker, Jason A. Eickmann, Walter R. Fagerlund, (2000*),"Prefabrication And Preassembly Trends And Effects On The Construction Workforce"*, Journal Construction management and Economics .Vol-1, No-14, pp. 14-22.

6.Girmscheid, G. & Krocher, M. May (2007*). "Innovative sales concept and knowledge-platform for prefabricated building construction,"*CIB World Building Congress, Vol-1, No-59,pp.14-18.

7.Huanga, R., Chen, J. J. & Sun, K. S. (2004).*"Planning gang formwork operations for building construction using simulations.Automation in Construction"* International Association for automation and robotic construction.Vol-13, No.6, pp. 765-779.

8.Nuzulazamharon, Salihuddinhassim, Mohd Razali Abd .Kadir & Mohdsalehjaafar (2005) *"Building cost comparison between conventional and formwork systems"*,American Journal of Applied Sciences, Vol-2, No-4, pp.819-823.

9. PWD, Divisional Schedule Rate Pune Division 2015-2016, PP. 31,36,42,47,260.

10.Raymond W M ,Wong Jane J,Hao Christabel M F Ho (2009)*"Prefabricated Building Construction Systems Adopted in Hong Kong"*; Division of Building Science & Technology City University of Hong Kong, Vol-3, No-18,239-248

11.Sivapriyaand, Senthamilkumar (2016), *"Building Cost Comparison of Precast Concrete Construction with Conventional Construction";*International journal of innovative research in science engineering technology,Vol-5, No-5,pp. 8037-8044

12. Taur Rinkuand Devit Vidya (2009) *"Low Cost Housing"*, India, Advances in Concrete, Structural and Geotechnical Engineering , Vol-1, No.-1, pp.1-11.

BIOGRAPHIES

Lakhi M Chavan
BE Civil ME (Construction Management),JJMCOE, Jaysingpur. Having 5 years of Highway, SWD Site Execution Experience.

Prof . D.B Desai
(ME CM PhD Pursuing)
Asso. Professor & Dean Faculty Development, JJMCOE, Jaysingpur, Having 21.6 Years Teaching Experience