ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 5, Issue 4, April 2016

Investigation on the Effective Usage of Prefabricated Elements in Construction Projects and developing a Module to reduce time and cost

K.V.Vinoth Kumar, R.Nagavinothini

Abstract - **Precast construction is one of the developing sectors in construction industry which has various advantages over conventional method of construction. The cost and time reduction are the most significant factors for adopting this technology. Due to the lack in the quantitative benefits of precast technology, its use in construction industry has not reached a prominent level. The main objective of this study is to compare the time and cost required for the construction of precast building and conventional building. A literature survey and field visits are carried out to predict the time and cost behaviour with respect to the percentage of precast elements used in the project. From the data analysis, it is found that 76% and 85% of precast elements will give 100% time performance and cost performance respectively. The results predict the immense advantage in adoption of precast technology in the current scenario quantitatively. In order to compare the time and cost required for the construction of precast building and conventional building, a single storey residential building is considered. The time and cost required at various stages of the construction for precast building and conventional building are compared. The results shows that the precast construction reduces the overall time and cost in the building project.**

Index terms: **precast, conventional, time, cost**

I. INTRODUCTION

The construction of buildings is increasing tremendously in the developing countries. Precast buildings are the fastest way of construction and advanced technique in construction industry at present scenario. Precast method of construction is durable, comfort, safe and versatile. Precast technology is independent of climatic weather conditions. So, the construction activities have been carried out as per scheduling without any delay. Detailed study has to be done about the production of precast elements whether the prefabrication is done offsite or onsite based on the location of the project. Production of various prefabricated elements has been done in controlled environmental conditions and transported to the site. It is necessary to consider both the transportation and erection cost of precast elements. Depending upon the usage of prefabrication content, time and cost will play an effective role in the construction project as compared to conventional mode of construction.

Hence, in this study the suitability of precast elements in enhancing the time and cost performance of the building projects has been studied through a case study approach. The data collected are analysed quantitatively to access the advantages in using precast elements. Then, the performance of precast construction and conventional construction is compared by considering a single storey residential building.

Manuscript received March, 2016.

K.V.Vinoth Kumar*, PG Srudent, Department of Civil Engineering, SRM University,., Kancheepuram, India, +919965850980*

R.Nagavinothini*, Assistant Professor, Department of Civil Engineering, SRM University, Kancheepuram,India, +919655786997.*

II. ADVANTAGES OF PRECAST CONSTRUCTION

The advantages of precast construction method over conventional in situ method are listed below:

1. Economical in big project with repetition in work execution.
2. Special architectural requirement in finishing
3. Quality control is consistent
4. Construction speed is fast
5. Constraints in availability of site resources.

The construction time is shortened, since structural work on the site is confined to constructing the foundations and erecting the prefabricated components. Because of the low moisture content the building dries out more rapidly than a building of conventional construction and is sooner ready for service. The quantities of materials required are reduced, as formwork and scaffolding are largely eliminated. Favourable weight -saving structural sections can be used, so that less concrete and steel is needed and the weight of the building as a whole is reduced.

Production of precast units in large series makes it practicable to use machines whereby the required amount of manual labour is substantially reduced. Besides, the units can be manufactured in the most convenient position on the casting bed. Less man power is needed, since the precast units are manufactured in a factory or, at any rate, under factory conditions on the building site.

Better quality of the products is obtained as a result of manufacture under factory conditions with constant Quality control, the use of machines, and the better Working environment provided by the factory. Construction can proceed almost independently of weather conditions, since the units can be manufactured in covered buildings which

can be heated and erection of the units can also carried out in winter.

III. Methodology

This project deals with the time and cost related factors of the prefabricated elements and so the various literatures have been studied to know about the prefabrication elements and its usage in construction projects. A detailed study was made about the production of precast elements whether the prefabrication is done offsite or onsite based on the need and location of the project. The data related to the specifications of the prefabricated elements used in the selected projects are collected and the difference between the prefabricated elements construction and the conventional projects is also studied. Estimating the quantities has to be done for precast construction in comparison to conventional construction. The project duration of selected precast construction with conventional type of construction has to be compared. Cost analysis also has to be done for selected precast project with conventional construction. So, the methodology is mainly based on the comparison of planning, networking and estimation of selected precast projects with conventional method of construction and developing a module to reduce time and cost by conducting detailed investigation on the effective usages of prefabricated elements in construction projects. The methodology is shown in figure 1.

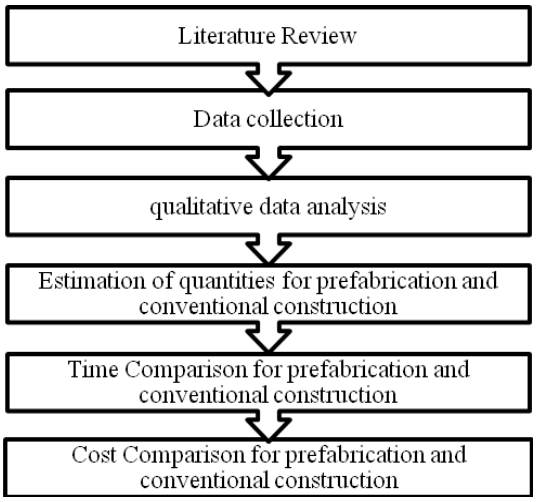

Fig. 1- Methodology Flow Chart

IV. Data Collection

In this study, a case study research methodology is followed to identify the effectiveness of using precast elements in construction of buildings. The data has been collected from different sites and from literature studies, provided the data for the study are cost, duration and precast element. In case of missing or incomplete data, the project manager and design engineer are contacted for the incomplete information. The information can be easily extracted through the flexibility of this method. The investigation is mainly focused on the prediction of performance efficiency of the construction projects in terms of cost and time savings through the implementation of the precast elements. The main information collected from all the projects for this study includes: total building area, estimated cost, actual cost, estimated time, actual time, type of precast elements used, size of the elements, installation charges and the percentage cost of precast elements.

V. Quantitative Data Analysis

A data analysis has been done for prefab content of building to find out the percentage of prefab content, cost performance and time performance in a precast project to find its effective usage in the whole project. The percentage of prefab content can be calculated by cost of prefab elements to total cost of project. Cost performance can be computed by ratio of estimated cost to actual cost. Time performance can be computed by knowing the ratio of estimated time and actual time. The data collected from different projects with their time performance and cost performance is given in table I and table II respectively.

Table I: Time performance of precast buildings

project	Prefab content (%)	Estimated time (weeks)	Actual time (weeks)	Time performance
1	44	32	48	67
2	49	21	30	70
3	51	16	22	71
4	57	18	25	72
5	59	24	32	74
6	60	54	64	85
7	64	33	45	74
8	65	25	32	79
9	66	41	52	78
10	68	22	26	84
11	70	55	60	91
12	71	42	47	90
13	75	33	36	91
14	78	57	58	99
15	81	62	54	114
16	85	80	68	118
17	88	58	48	121
18	90	63	52	122

Table II: Cost performance of precast buildings

Project	Prefab content	Estimated cost	Actual cost	Cost performance
1	44	799450	1355000	59
2	49	798002	1287100	62
3	51	1452410	2381000	61
4	57	3402000	5400000	63
5	59	2405700	3645000	66
6	60	15737700	22165775	71
7	64	3829414	5549875	69
8	65	1508425	2154893	70
9	66	32211826	44125789	73
10	68	4924809	6566412	75
11	70	35928377	45478958	79
12	71	20383170	25478962	80
13	75	4776944	5897462	81
14	78	47196125	54879215	86
15	81	67442806	65478452	103

16	85	93578905	87456921	107
17	88	59714696	54784125	109
18	90	61692037	55578412	111

Data analysis shows that 100% time performance in the building projects can be achieved by increasing the prefabricated elements content by 76%. The maximum cost performance can be obtained with 85 % prefabricated elements content. The exponential trend in the relationship between the content of prefabricated elements and the performance suggest that the increase in the content of the prefabricated elements can result in increased performance. The analysis results for time performance is shown in figure 2 and the cost performance is shown in figure 3.

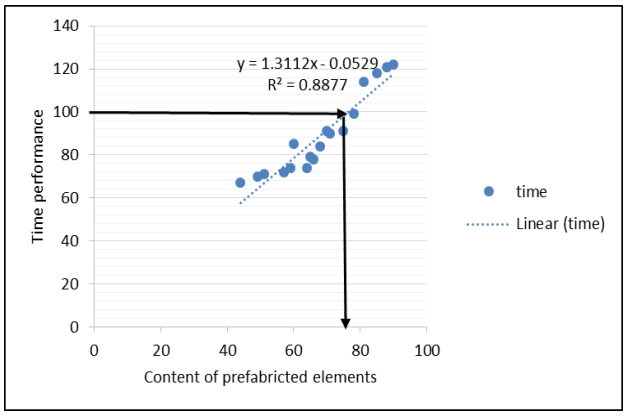

Fig. 2- Time performance of prefabricated buildings

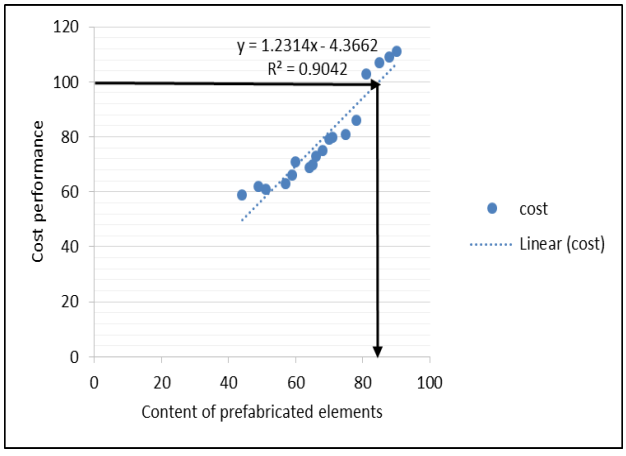

Fig. 3- Cost performance of prefabricated buildings

VI. COMPARISON OF PREFABRICATED AND CONVENTIONAL BUILDINGS

A plan is made for a single storey residential building and the quantity and time required for the construction of the building are estimated for both precast construction and conventional construction. The data collected through literature survey and field visits are used for estimating and scheduling. The plan of the residential building is shown in figure 4. The time and cost required for the construction of precast buildings and conventional buildings are calculated at three stages of construction: Substructure, superstructure and finishing works. During the estimation and scheduling, due consideration is also given to the labour charges, erection charges, erection time, installation charges, installation time, material and machineries.

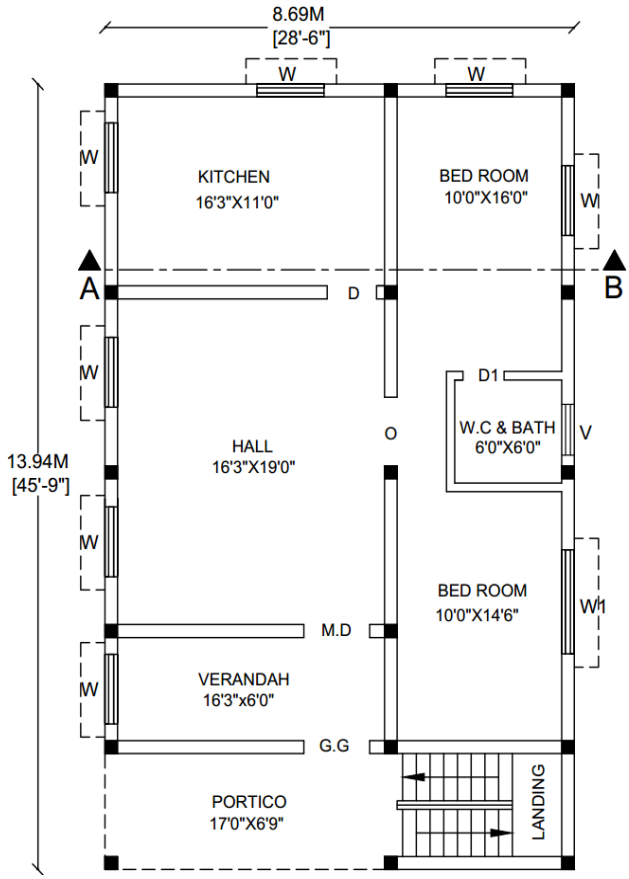

Fig.4 - Plan of the residential building

VII. RESULTS AND DISCUSSION

A. *Time Comparison*

The duration of the construction is given in table III. The time required for the construction of the substructure is the same in conventional and prefabricated buildings. The time varies in the stages of the superstructure construction and the finishing works. The better time performance can be seen during the progress of superstructure as the prefabricated elements reduce the time required for construction to a greater extent. The duration in finishing work is also reduced in prefabricated construction as the elements does not require plastering. The total duration of the conventional project is 120 days and that for the prefabricated project is 69%. By the usage of precast elements in construction, the total duration of the project can be reduced by 42.5%. The time comparison at different stages during construction is shown in figure 5.

. Table III: Time comparison of conventional building and Precast building

Stages of construction	Time (days)	
	conventional building	precast building

Substructure	20	20
superstructure	55	25
Finishing work	45	24
Total	120	69

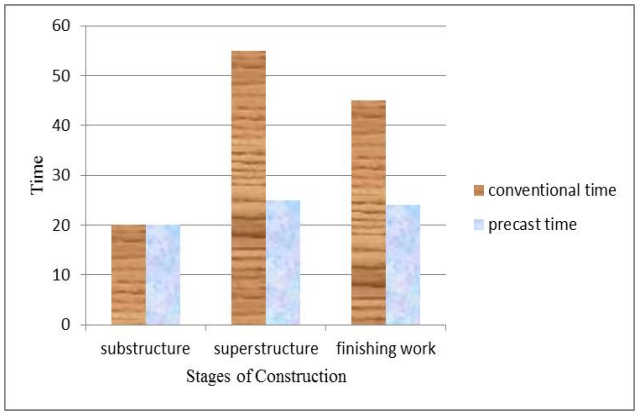

Fig.5 - Time comparison of conventional and precast buildings

B. *Cost Comparison*

The cost required for the construction is given in table IV. The cost required for the construction of the substructure is same for the conventional and precast buildings. The cost required for the construction of prefabricated buildings is higher than the conventional buildings due to the installation and erection cost. The total cost of the prefabricated construction is 20% more than the conventional method of construction. The cost comparison is shown in figure 6.

Table IV: Cost comparison of conventional building and precast building

Stages of construction	Cost (Rs)	
	conventional building	precast building
Substructure	2,13,000	2,13,000
superstructure	7,85,000	11,70,384
Finishing work	14,00,600	16,00,500
Total	23,98,600	29,83,884

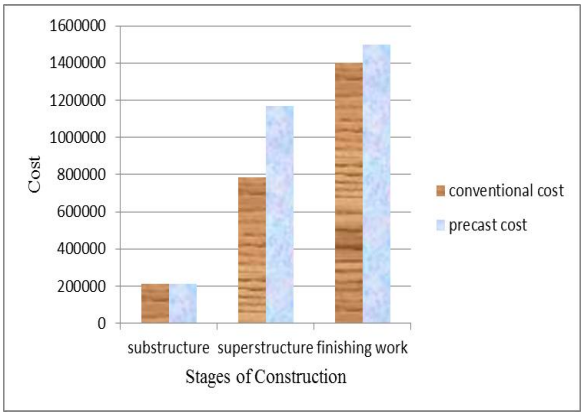

Fig.6 - Cost comparison of conventional and precast buildings

VIII. Conclusion

The quantitative analysis established that the usage of the prefabricated elements in the construction will result in increased time and cost performance. The study quantified the benefits of the prefabrication technology with the conclusion that 76% and 85% of precast elements will give 100% time performance and cost performance respectively. The comparative study on the prefabrication and the conventional construction reveals that the total duration of the project can be reduced upto 42.5% with the adoption of prefabrication technology. The comparison also showed the increase in cost of construction of the prefabricated building construction.

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