

Analyze time-cost required for conventional and prefabricated building components

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Abstract - Now a day there is great boom in infrastructural development in the form of fast-track construction. Today the need is to save time and to optimize the utilization of resources. Conventional 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 and use of these techniques to reduce project duration, & costs.

Keywords: - Prefabrication, Precast, conventional.

1. INTRODUCTION

Precast and cast-in-situ are techniques that are used for quick construction. Pre-cast includes the wall-panel units and slab units directly added to building structure. The initial cost of the formwork is higher but the repetition of these formwork reduces the overall project cost of the structure in building work, and even higher in bridges, it is thus essential that the forms are properly designed to effect economy without sacrificing strength and efficiency.

1.1 Aim

The aim of this project is to analyze 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 before hand 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 analyze time cost for conventional and prefabricated building components by taking a case study.

1.3 Advantages of prefabrication are:

- 1.3.1 In prefabricated construction, as the components are ready made, self-supporting, shuttering and scaffolding is eliminated with a saving in shuttering cost.
- 1.3.2 In conventional methods, the shuttering gets damaged due to its repetitive use because of frequent cutting, nailing etc. On the other hand, the mould for the precast components can be used for large number of repetitions thereby reducing the cost of the mould per unit.
- 1.3.3 In prefabricated housing system, time is saved by the use of precast elements which are casted off-site during the course of foundations being laid. The finishes and services can be done below the slab immediately. While in the conventional in-situ RCC slabs, due to props and shuttering, the work cannot be done, till they are removed. Thus, saving of time attributes to saving of money.
- 1.3.4 In precast construction, similar types of components are produced repeatedly, resulting in increased productivity and economy in cost too.
- 1.3.5 Since there is repeated production of similar types of components in precast construction, therefore, it results in faster execution, more productivity and economy..

1.4 Disadvantages of prefabrication are:

- 1.4.1 Leaks can form at joints in prefabricated components.
- 1.4.2 Transportation costs may be higher for voluminous prefabricated sections than for the materials of which they are made, which can often be packed more efficiently.

1.4.3 Large prefabricated sections require heavy-duty cranes and precision measurement and handling to place in position.

1.4.4 Larger groups of buildings from the same type of prefabricated elements tend to look drab and monotonous.

1.4.5 Local jobs may be lost, if the work done to fabricate the components being located in a place far away from the place of construction.

2. METHODOLOGY

2.1 General

The traditional mode of construction for individual houses comprising load bearing walls with an appropriate roof above or reinforced concrete framed structure construction with infill masonry walls would be totally inadequate for mass housing construction industry in view of the rapid rate of construction. Further, such constructions are prone to poor quality control even in case of contractors with substantial resources and experience. Therefore the new technique is adopted for building construction based on the basis of mode of construction, namely, pre-cast construction or cast-in-situ construction. Pre-cast and cast-in-situ are techniques that are used for quick construction. Pre-cast includes the wall-panel units and slab units directly added to building structure.

2.1.1 Identification of problem

In the past decade construction is done with the help of traditional method. Traditional method means the use of form work and require more labour etc. Today's the need of fast-track construction. So the most of companies will go for the readymade components and construct the building within a stipulated timing. Using this fast-track construction saves the duration of project and automatically saves the cost. Thus the need is to be study of various precast building components which required less time for construction and get final results and to optimize the building components to conventional construction so that in conventional method we will reduce the project time as well as project duration.

2.1.2 Literature review

Once the problem is identified, survey was carried out with the help of various journals, books, taking case studies to have a deep knowledge about the problem, understand the concepts of problem. With the help of data get the idea to examine the site situation, how the optimization to be done using estimating the cost of different components of building in precast and conventional types.

2.1.3 Collection of data

The primary data was collected from the internet sources from which we know that the what is mean be precast construction, how they construct and gives the deep knowledge about that construction, how to prepare a planning. Also I have taken a one case study for detailed study on karad site and collecting all data required for project work. Such as precast column, beam, lintel, chajja, slab panels types which are to be used for construction. Collected data contains the cost and the time require to place the components by using such equipments.

2.1.4 Analysis of data

For analyzing the data for prefabrication method compared to conventional method by using Divisional schedule rate 2015-2016.

- a) Estimating column by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of column casted by connectional method and prefabricated method.
- b) Estimating beam by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of beam casted by connectional method and prefabricated method.
- c) Estimating Lintel-chajja by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of Lintel-chajja casted by connectional method and prefabricated method.
- d) Estimating Slab by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of slab casted by connectional method and prefabricated method

The cost includes transportation, erection and labor cost for casting and placing.

Also use the software that is Microsoft project 2007 for planning of both precast and conventional construction.

2.1.5 Suggestions and recommendation

On the basis of results and conclusion it is derived that the precast construction is a time and cost effective technique only for a mass production. But we use few components from precast method in conventional method the duration of conventional construction reduces.

3. CASE STUDY

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: 18.3Cr
 Site location: F.P.NO.:Karad: 394
 Address: Karve road, Tal-Karad, Dist- Satara.



Fig -1: Maharashtra state police housing and welfare corp.ltd Site Visit.

3.1 Various precast building components are as follows:-

- 3.1.1 Columns
- 3.1.2 Beams
- 3.1.3 Staircase
- 3.1.4 Lintel and chajja
- 3.1.5 Siporex slabs and block

3.1.1 Column-

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



3.1.2 Beam

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



3.1.3 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.



3.1.4 Lintel and Chajja

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



3.1.5 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.



4. RESULTS AND DISCUSSIONS

4.1 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.

4.1.1 Erection Cost

Erection cost includes the cost of transportation cost, placing the entire precast building component i.e. column, beam, rakers, lintel, chajja, lintel with chajja, slab panels etc. leveling all the precast building components.

Table-1: Erection cost

Sr. No	Precast building component	Cost (Rs)	Total no component of building per floor (Nos)	Total cost per floor (Rs)
1	Column	46	36	1656
2	Beam	22	57	1254
3	Lintel	40	50	2000
4	Chajja	75	28	2100
5	Slab panel	15	92	1390
6	Component shifting	-	-	3000
7	Incentives	-	-	5000
	Total			16400

4.1.2. Column

4.1.2.1 Precast method

Precast column for M25 Grade

- Column Size = 0.35x0.35x2.820 M
- Total volume = 0.35 m3
- Steel required = 46 kg
- R.M.C rate for 1m3 concrete =5531 Rs.
- for 0.35 m3 concrete cost = (5531*0.3)=1936 Rs
- Labour cost for 1 column =125 Rs.
- Erection cost for 1 column =46 Rs
- Total cost required for 1 column

Concrete=1936 Rs

Steel cost=46*53.9(Rate/KG)= 2479 Rs

Labour cost =125 Rs

Erection cost =46 Rs

Total column cost= 4586Rs

- Total no of column required for 1 floor 36 No's
- Total cost =4586*36 =165096 Rs
- 1m3 Rate for column =13103 Rs

4.1.2.2 Conventional Method

- Column Size = 0.35x0.35x2.820 M
- Total volume =0.35 m3
- Steel required=46 kg
- Conventional rate for 1m3 concrete= 8188 Rs.

For 0.35 m3 concrete cost=8188*0.35 =2866 Rs

Total cost required for 1 column

Concrete=2866 Rs

Steel cost =46*53.9=2479 Rs

Total column cost=2866+2479=5345 Rs

- Total no of column required for 1 floor 36 No's
- Total cost =5345*36 =192420 Rs
- 1m3 Rate for column =15271 Rs

4.1.3 Beam

4.1.3.1 Precast method

Precast Beam for M25 Grade

- Total volume of Beam =14.202 m3
- Steel required 2011.18 kg
- R.M.C rate for 1m3 concrete =5531 Rs.

For 14.202 m3 concrete cost 78551Rs

- Labour cost for 57 beam = 42x57 =2394 Rs.

- Erection cost for 1 beam =22 Rs.
- Total 57 no's of Beam = 22x 57= 1254 Rs.
- Total cost required for 57 no's of beam

Concrete=78551Rs
 Steel cost =108403Rs
 Labour cost=2394 Rs
 Erection cost=1254 Rs
 Total beam cost =190602 Rs
 1m3 Rate for Beam =13421Rs

4.1.3.2 Conventional Method

- Total volume of Beam =14.202 m3
- Steel required = 2011.18 kg
- Conventional rate for 1m3 concrete 8237 Rs.
- For 14.202 m3 concrete cost =116982 Rs
- Total cost required for 57 no's of Beam

Concrete=14.202*8237=116982 Rs
 Steel cost =2011.18*53.9=108403Rs
 Total Beam cost =225385 Rs
 o 1m3 Rate for Beam =15870 Rs

4.1.4 Lintels

4.1.4.1 Precast method

- Total volume of lintels=0.94 m3
- Steel required =72.16 kg
- R.M.C rate for 1m3 concrete =5531 Rs.

For 0.94 m3 concrete cost =5199 Rs

- Labour cost =125 Rs.
- Erection cost for 1 lintel =40 Rs.
- Total 48 no's of lintels = 48x40 =1920 Rs.
- Total cost required for 48 no's of lintel

Concrete=5199 Rs.
 Steel cost =3889Rs.
 Labour cost =125 Rs.
 Erection cost =1920 Rs.
 Total lintels cost =11133 Rs.
 o 1m3 Rate for lintels=11844Rs.

4.1.4.2 Conventional Method

- Total volume of lintels =0.94 m3
- Steel required =72.16 kg
- Conventional rate for 1m3 concrete 8237 Rs

For 0.94 m3 concrete cost =7743Rs.

- Total cost required for 48 no's of lintels
 Concrete=7743Rs.

Steel cost =3889Rs.
 Total lintels cost =11632 Rs.
 o 1m3 Rate for lintels=12374 Rs

4.1.5 Slab

4.1.5.1 Precast method

Siporex slab Panels
 Total no of Siporex slab panels required for per floor 92 No's
 Cost given in per panel

Table No-2: No of slab required for floor slab of project building and cost

Sr. No.	Size	Reqd. No's per floor	Cost per panel (Rs)	Total cost (Rs)
1	3000 X 600 X 125	20	2190	43800
2	2500 X 600 X 125	20	1825	36500
3	2000 X 600 X 125	16	1460	23360
4	3500 X 600 X 150	24	3066	73584
5	2700 X 600 X 125	1	2190	2190
6	2700 X 350 X 125	2	2190	4380
7	2500 X 600 X 125	4	1825	7300
8	2500 X 500 X 125	4	1825	7300
9	2700 X 600 X 125	1	2190	2190
		92		200640

- Total cost Required for 92 panels =200640 Rs
- Erection cost for 1 panel =15 Rs.
- Total 92 no's of panels = 15x92 =1380 Rs.
- Total cost required for 92 no's of panels

Cost for slab panels=200640
 Erection cost =1380 Rs
 Total slab panel cost =202020 Rs
 Screeding of 40 mm
 Total volume of screeding =8.32 m3
 For 1 m3 m 25 grade rate of concrete=5531 Rs

- Steel required =630 kg
- Total Screeding cost

Concrete cost=8.32*5531=46018 Rs.
 Steel cost=630*53.9=33957 Rs
 Total cost=46018+33957 =79975 Rs
 Total cost for slab =281995 Rs

5.6.2 Conventional Method

- Total volume of Slab =23.44 m3

- Steel required =2760 kg
- Conventional rate for 1m3 concrete =8843Rs.For 23.44 m3 concrete cost =23.44*8843=207280 Rs
- Total cost required for Slab Concrete=207280Rs
Steel cost =148764Rs
Total Slab cost =356044 Rs

4.1.6 Lintel with Chajja

4.1.6.1 Precast method

- Total volume of lintels=0.78 m3
- Steel required =188.19 kg
- R.M.C rate for 1m3 concrete =5531 Rs.

For 0.78 m3 concrete cost =4314 Rs

- Labour cost =125 Rs.
- Erection cost for 1 lintel with chajja=75 Rs.
- Total 28 no's of lintels with chajja = 2100 Rs.

Total cost required for 28 no's of lintels with chajja
Concrete=0.78*5531=4314Rs
Steel cost=188.19*53.9=10143Rs
Labour cost =125 Rs
Erection cost=2100 Rs
Total lintel with chajja cost =16682 Rs
o 1m3 Rate for lintel with chajja 21387Rs

4.1.6.2 Conventional Method

- Total volume of lintel with chajja =0.78 m3
- Steel required =188.19 kg
- Conventional rate for 1m3 concrete =9196Rs.

For 0.78 m3 concrete cost =7173Rs

- Total cost required for 28 no's of lintel with chajja

Concrete=0.78*9196=7173 Rs
Steel cost =188.19*53.9=10143Rs
Total lintels cost =17316 Rs
o 1m3 Rate for lintels 22200 Rs

4.1.7 Stair case

4.1.7.1 Precast method

- Total volume of staircase = 0.48 m3
- Steel required = 36 kg
- R.M.C rate for 1m3 concrete =5531 Rs.

For 0.48 m3 concrete cost =2655 Rs

- Labour cost =125 Rs.

- Erection cost for 1 staircase =250 Rs.
- Total 4 no's of staircase = 4x250 =1000 Rs
- Total cost required for staircase

Concrete=0.48*5531=2655 Rs
Steel cost =36*53.9=1940 Rs
Labour cost =125 Rs
Erection cost =250 Rs
Total staircase cost =4970 Rs
Total no of Staircase required for 1 floor 4 No's
Total cost =4970*4 =19880 Rs
o 1m3 Rate for lintels 10354Rs

4.1.7.2 Conventional Method

- Total volume of Stair case =0.48 m3
- Steel required =36 kg
- Conventional rate for 1m3 concrete =9196Rs.

For 0.48 m3 concrete cost =4414 Rs

- Total cost required for stair case

Concrete=0.48*9196=4414 Rs
Steel cost =36*53.9=1940Rs
Total staircase cost=4414+1940=5354Rs
o 1m3 Rate for lintels 13238Rs
• Total no of Staircase required for 1 floor 4 No's
o Total cost =5354*4 =21416 Rs

Table No-3 : Total No. of Component Required For Per Floor

Sr. No	Description of item	Project qty (Nos)	Moulds available (Nos)	Max. Days required for total building components for casting
1	Columns	36	17	3
2	Beams	57	33	3
4	Rakers	4	8	2
5	Lintels	48	22	3
6	Lintel With Chajja	28	5	6
	TOTAL	173		17

The above table shows that the total quantity required per floor such as column, beam, staircase, lintels, lintel with chajja etc. and for that total days required for casting of these components, and available moulds.

Table No -4: Cost required for per floor

Sr. No .	Components	Conventi- onal Cost in Rs	Precast Cost in Rs	Differences in Cost (Rs)
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
	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.

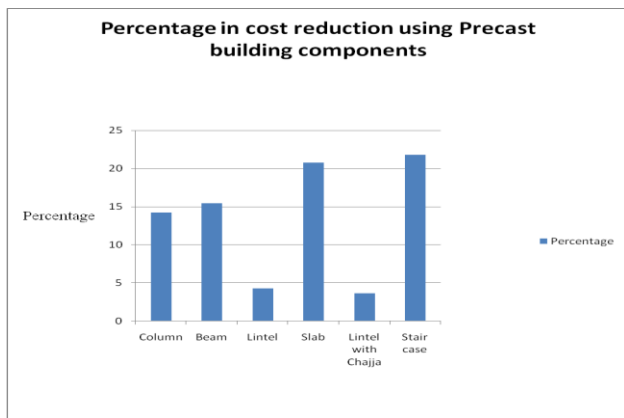
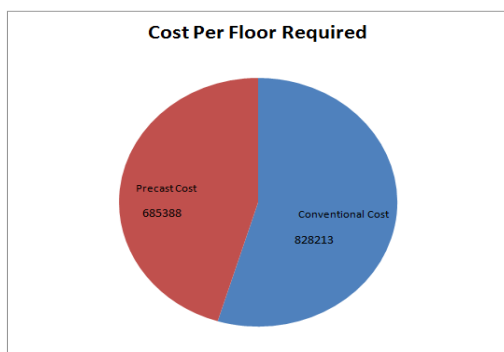


Chart-1: Percentages in cost reduction

This graph shows that the components wise cost comparison in percentage. Column reduces 14.2%, Beam 15.433%, lintel 4.29%, Slab 20.8%, lintels with Chajja 3.66% and Staircase 21.78%.



This pie chart shows cost between conventional and precast construction.

4.2. Time Savings in construction Activities on site

After casting the entire precast building component the various activities start from starting of transportation of precast building component, erection of column, beam, slab, rakers, lintel, and chajja etc. This duration calculated from the actual time required on site by using stop watch for the entire components. And the Microsoft project 2007 software used for both conventional and precast construction.

Table No -5: Time required for each activities

Sr. No.	On Site Activities	Duration
1	Transportation of column and beam	11 hrs
2	Erection of column	6 hrs
3	Erection of beam	7 hrs
4	Column level	4 hrs
5	Half column grouting	3 hrs
6	Beam level	4 hrs
7	Slab erection	2 hrs
8	Slab level	1 hrs
9	Spreading silicon oil over slab	3hrs
10	Erection of rakers	2 hrs
11	Slab reinforcement (mesh and all rend)	5 days (40hrs)
12	Full column grouting then 40mm screeding	2hrs

Table No -6: Total times required for Precast Frame Structure

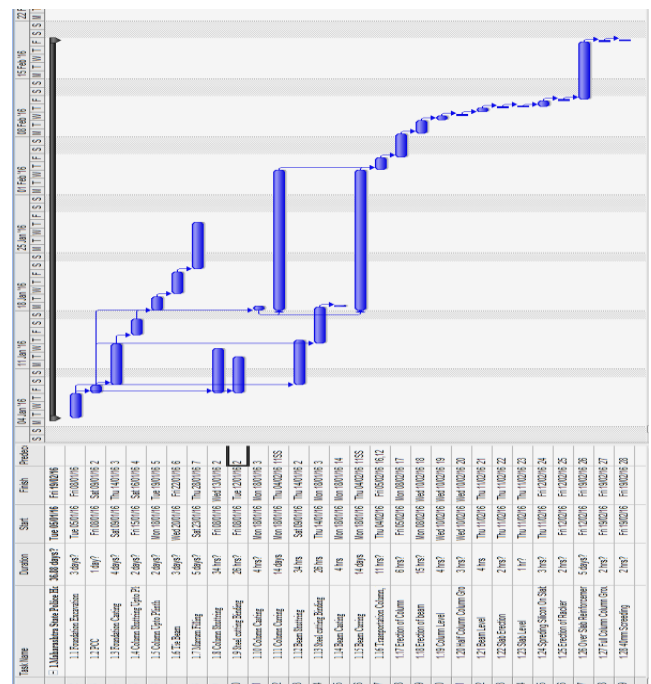
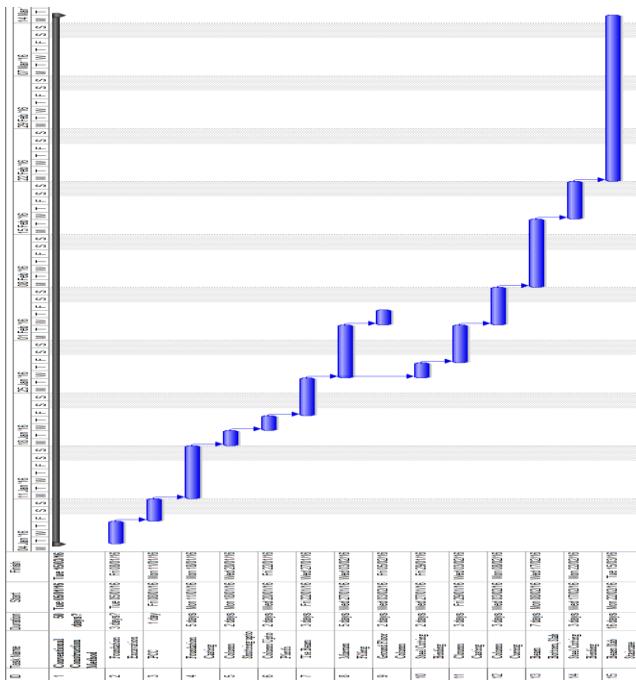
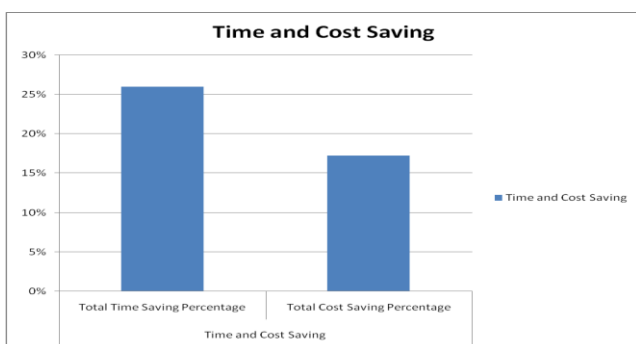


Table No -7: Total times required for Conventional Frame Structure



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%.

5. CONCLUSIONS

Utilizing the precast building components we reduce the cost up to 17.24 %, using the methodology we can reduce the project duration up to 26 %. Construction of various elements by use of precast methodology helps us to achieve economy and fast track construction which is need of construction industries. It is found that the time required in case precast construction is quite less as compared to conventional. Quality obtained in precast construction is better as compared to in-situ construction. Development of selection criteria for select appropriate methodology to optimize the cost and time with respect to particular projects depending upon the existing site condition.

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BIOGRAPHIES



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