

# COMPARATIVE STUDY AND DECISION MAKING FOR A FORMWORK TECHNIQUE TO BE ADOPTED ON A CONSTRUCTION SITE IN MUMBAI

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## Abstract

To address the housing and transportation requirements of an exponentially increasing population, Indian construction industry has grown by leaps and bounds. Thus with the globalization of Indian economy & introduction of multinational companies in India for construction activities, it has become imperative to have precise & speedy construction projects. Conventional construction methods are not able to cope with the demand of infrastructural facilities with high degree of quality control & assurance. No doubt, conventional methods prove to be economical, but they fail in providing required number of dwellings in time; hence latest construction technologies by applying fast-track construction is the only remedy left to address this issue. Formwork is an important part of construction and it takes 25-30 % of total cost of construction. Thus with the use of new technologies in formwork, construction permits casting of larger elements in a single pour, which reduces time and labour requirement as compared to conventional methods. Thus, the various new systems have promised to achieve overall economy with faster as well as high quality construction. In this paper, an attempt is made to have a comparative study of established conventional formwork technology with a set of new formwork techniques, which are currently not used much in Indian construction industry; and hence suggest which method is superior for the construction project under consideration.

**Key Words:** Fast-track Construction, Formwork, Cost, quality control, quality assurance, correlation etc.

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## 1. INTRODUCTION

Formwork is a term given to temporary or permanent die or a mold including all supporting members, used to give shape and support concrete till it attains sufficient strength to carry its own weight. It should be capable of carrying all imposed dead and live loads apart from its own weight. Formwork systems used for concrete frame construction have continued to develop significantly since the early 1990s. The major innovations till date have focused on on-site efficiency of production, health and safety, and environmental issues, driving the concrete construction industry towards ever-increasing efficiency and quality of construction. Different formwork systems provide a wide range of concrete construction solutions that can be chosen to suit the needs of a particular development. Traditional formwork for concrete construction normally consisted of made to order solutions requiring skilled craftsmen. This type of formwork often had poor safety features and gave slow rates of on-site construction and huge levels of waste also being generated.

## 1.1 ADVANCED TECHNIQUES IN FORMWORK

As time progressed, the use of advanced techniques of formwork for construction of structures has gained wide acceptance. In the present competitive market, speed and efficiency are of prime importance; thus by use of advanced technology, the duration of project is reduced by using latest materials, equipments and techniques which are effective, durable and intensify the pace of construction. Some of the advanced construction formwork techniques used nowadays are viz...

- H-Beam
- Plastic formwork
- Fiber-reinforced polymer formwork system
- Aluminum panel system formwork
- Jump form or Slip form system

As the use of the techniques gained prime importance in the market, many organizations like MIVAN, Doka, Plasteck, and RMD etc., started producing such techniques under their own brand, which is widely used in the Indian Construction Industry now-a-days.

## 1.2 LITERATURE REVIEW

With the introduction of advanced techniques for formwork there has been much comparison of the conventional techniques and advanced techniques of formwork. Swapnali Karke et al. (2010) analyzed that by using MIVAN system & Tunnel Form system we can achieve cost & time reduction. They have proved that, such techniques reduce cycle time as compared to conventional methods, and hence overall cost saving can be achieved. Sangale et al. (2015) through their study concluded that IBS is costly, but such system can be used to enhance quality, reduce time, labour, and material requirement. Md. Rahim (2013) compared conventional system and IBS system in Malaysia and concluded that conventional system is still better than IBS system. Ganar et al. (2015) compared conventional formwork technique and MIVAN technology and concluded that technology is better than conventional technique.

From the above works, it is clear that there has been some research done for comparing conventional and MIVAN formwork techniques. But, there has not been thorough comparison with other techniques available in the market and also there is no decision tool or method available to choose the best feasible method from the various options available. Hence an attempt has been made in this paper, for comparing various formwork technique and deciding the best in particular situations.

## 2. METHODOLOGY

Since cost is one of the most important factors for successful implementation of a construction project, there is quite a dilemma for construction contractors in deciding formwork on a construction site. Hence, to highlight the importance of formwork selection, an attempt has been made in this paper to decide the best suitable technique for a particular project by comparatively studying these techniques and then establish a correlation w.r.t time and cost parameters between these techniques. This will be achieved in following stages:

- Choose a typical floor plan and calculate the no. of columns, beams, slabs along with their respective areas.
- Decide the various formwork techniques that can be adopted and analyze cost/m<sup>2</sup> of the same.
- Prepare comparative statement including factors like economy, speed construction, strength etc.
- Evaluate the time required for various levels/floors to be completed using various formwork techniques
- Establish correlation between time and cost for various formwork techniques.

## 3. DATA COLLECTION

The project undertaken for the study is Commercial developers 22 storey building being constructed in Mumbai. The project is destined to have large 2-Bhk, 3-BHK and 4-BHK penthouses with premium amenities and finishes,

along with stilt and podium car parking and refreshing surroundings.

<b>Name of the Project:</b>	Nathani Square
<b>Type of Project:</b>	Redevelopment
<b>Structure Details:</b>	3 podium + 22 storeys.
<b>Name of Client:</b>	Nathani Realty
<b>Name of Architect:</b>	Skyline Architects
<b>Name of Contractor:</b>	Fame Construction
<b>Name of Structural Consultant:</b>	Hanware Consultants

In addition to this, survey was carried out on 15 different projects in and around Mumbai, with all the factors leading to the cost of various types of formworks, like cost of materials, labours, props, accessories etc., based on which a comparative statement is prepared. Some of these projects are Nathani Heights, Lodha New Cuff Parade, Marathon group and Monte South



**Fig -1:** laying of slab bottom at site



**Fig -2:** Concrete filling at level 1

#### 4. COMPARISON

**Table -1:** Comparative Statement of Various formworks.

Sr. No.	Parameters	Conventional	Conventional	Fast Track			
		Timber	Steel	Plastech	RMD	Doka	Peri
1	<b>Cost</b>						
	Initial Investment	Low	High	High	High	High	High
	Average Cost (Rs.)	400/sq.m	1000/sq.m	1200/sq.m	1300/sq.m	1200/sq.m	1400/sq.m
	Props & Accessories Cost (Rs.)	2/sq.m	2/sq.m	Included in formwork cost	Included in formwork cost	Included in formwork cost	Included in formwork cost
	Labour Cost (Rs.)	30/sq.m	30/sq.m	35/sq.m	35/sq.m	40/sq.m	40/sq.m
2	<b>Repetition Cycle</b>	7	30	150	150	150	150
	Repetition Cost /sq.m	57	33	8	9	8	10
3	<b>Cycle time for casting atleast 100 sq.m (days)</b>	5	5	2	1	1	1
4	<b>Strength (Permissible Fresh Concrete Pressure) in KN/sq.m</b>	30	-----	100	80	60	50
5	<b>Durability</b>	Low	Low	High	High	High	Medium
6	<b>Surface Finishing</b>	Rough	Average	Smooth	Smooth	Fair Faced surface	Average
7	<b>Wastage of materials</b>	High	Average	Nil	Nil	Nil	Nil
8	<b>Planning of System</b>	Not Required	Not Required	Required	Required	Required	Required
9	<b>Accuracy in Construction</b>	Very Less	Very Less	Good	Good	Good	Good
10	<b>Aesthetics</b>	Not good	Not good	Good	Good	Good	Good
11	<b>Manpower requirement (including supervisors and engineers)</b>	Medium	Medium	High	High	High	High
12	<b>Training Programs</b>	Not Provided	Not Provided	Required	Required	Required	Required

**5. CALCULATIONS**

$$= 16855.364*8+16855.364*40+802.36*57$$

$$+802.36*2+802.36*30$$

Total area of formwork required = 17,658 m<sup>2</sup>

$$= \text{Rs. 8, 80,468/-}$$

**COST**

Overall cost of conventional timber

$$= 17658*57+17658*2+17658*30$$

$$= \text{Rs. 15, 71,652/-}$$

Overall cost of conventional steel

$$= 17658*33+17658*2+17658*30$$

$$= \text{Rs. 11, 47,770/-}$$

Overall cost of Plastech

$$= 17658*8+17658*35$$

$$= \text{Rs. 7, 59,294/-}$$

Overall cost of Peri

$$= 16855.364*10+16855.364*40+802.36*57$$

$$+802.36*2+802.36*30$$

$$= \text{Rs. 7, 96,191/-}$$

Overall cost of RMD

$$= 16855.364*9+16855.364*35+802.36*57$$

$$+802.36*2+802.36*30$$

$$= \text{Rs. 8, 13,046/-}$$

Overall cost of Doka

11111

**PROBABLE TIME**

It is calculated on the basis of cycle time showed in comparative statement

Duration with Conventional Timber

$$= (17658*5/100) / 365$$

$$= \text{2.42 yrs.}$$

Duration with Conventional Steel

$$= (17658*5/100) / 365$$

$$= \text{2.42 yrs.}$$

Duration with Plastech

$$= (17658*2/100) / 365$$

$$= \text{1 yrs.}$$

Duration with Peri

$$= (17658*1/100) / 365$$

$$= \text{6 months}$$

Duration with RMD

$$= (17658*1/100) / 365$$

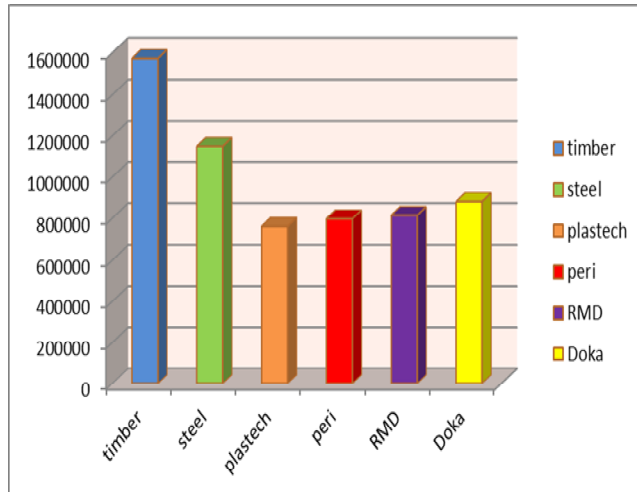
$$= \text{6 months}$$

Duration with Doka

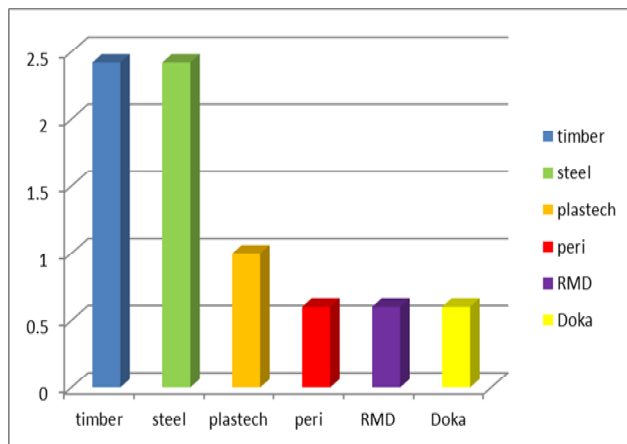
$$= (17658*1/100) / 365$$

$$= \text{6 months}$$





**Chart -1:** Cost Comparison of various formworks



**Chart -2:** Time Comparison of various formworks

## CONCLUSIONS

On the basis of results obtained it can be concluded that for the study project, Plastech formwork seems to be the best feasible solution for the project. Although Doka, Peri, RMD etc. seems to consume less time but the overall cost is quite large and in India, where there are many uncertainties involved in a project, any stoppage of work due to whatever reason, leads to a huge impact on the pockets of developers; as Doka, Peri and RMD needs additional equipment along with its own infrastructure to perform its functions. For this study, MIVAN formwork technique was not taken under consideration, as its initial cost is very high. Also recent studies have shown that MIVAN shuttering becomes economical only if it is used in Mass Housing Projects. The decision was made on parameters like cost, quality, speed of construction etc. but the aspects like safety, uncertainties, site restrictions and constraints must be studied in detail to have a complete picture of reality and hence arrive at a more precise and trustworthy decision.

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## BIOGRAPHIES



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