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 etc.*

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1. INTRODUCTION

Formwork is a term given to temporary or permanent matrix or a mold comprising of all supporting members, the whole and sole function of which is to give appearance and assist concrete till sufficient strength to carry its own weight is achieved. It should be able to bear all imposed and live loads apart from its own self weight. From past 3 decades the use of formwork systems for concrete construction has been developed appreciably. The upheaval till now concentrated on on-site production, health and safety, environmental issues which helped the concrete industry towards improved efficiency and better quality of construction. Different range of formwork systems offers wide solutions to concrete construction which aids to suit the requirements of a particular development. Traditional formwork techniques for formwork construction offer tailor made solutions requiring skilled labours. This formwork technique offers indigent safety features and slow rate of site construction and waste generation is also on large scale.

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, equipment's and techniques which are effective, durable and intensify the pace of construction. Some of the advanced construction formwork techniques used nowadays is 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, Plastech, 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 requirememt. 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 than 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 techniques 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^2 of the same.
- Prepare comparative statement including factors like economy, speed construction, strength etc.
- Calculate the overall cost required for various formwork techniques considering various cost stated in comparative statement.
- Evaluate the probable time on the basis of cycle time adopted in comparative statement.

3. DATA COLLECTION

The project undertaken for the study is Nathani Realty 22 storey building being constructed in Mumbai. The project is proposed to have spacious 1, 2, 3 BHK apartments and 4BHK penthouse on the topmost level of the project, along podium car parking, refreshing surroundings and other luxurious amenities.

Name of the Project: Nathani Square

Type of Project: Redevelopment

Structure Details: 3 podium + 22 storeys.

Name of Client: Nathani Realty

Name of Architect: Skyline Architects

Name of Contractor: Fame Construction

Name of Structural Consultant: 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

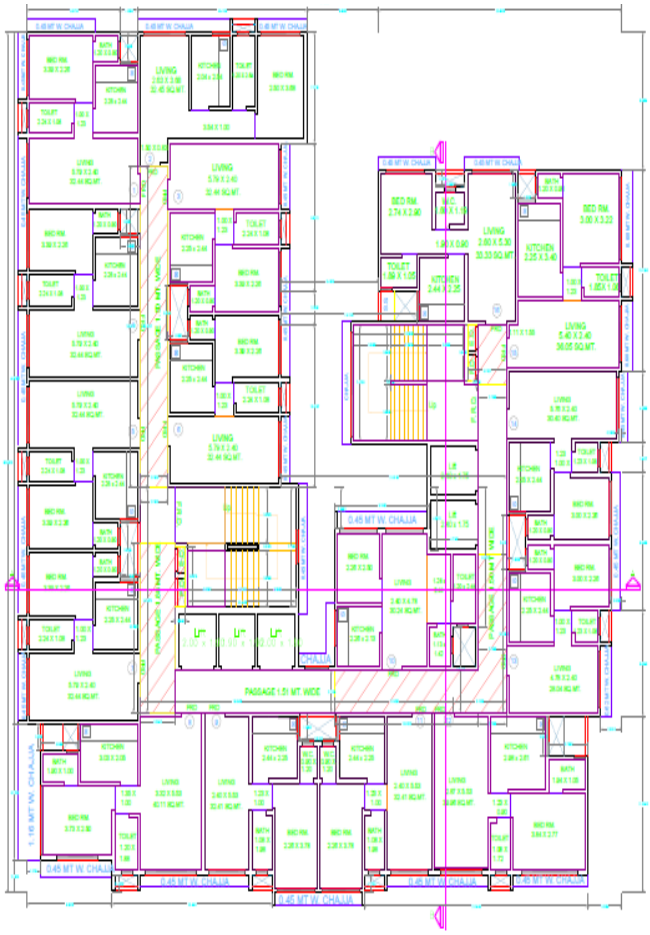

Fig -1: Typical Floor Plan (Nathani Square)

4. COMPARISON

Table -1: Comparative Statement of Various formworks.

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

5. CALCULATIONS

Total area of formwork required = 17,658 m^2

COST

Overall cost of conventional timber

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

= **Rs. 15, 71,652/-**

Overall cost of conventional steel

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

= **Rs. 11, 47,770/-**

Overall cost of Plastech

= 17658*8+17658*35

= **Rs. 7, 59,294/-**

Overall cost of Peri

= 16855.364*10+16855.364*40+802.36*57 +802.36*2+802.36*30@

= **Rs. 7, 96,191/-**

Overall cost of RMD

= 16855.364*9+16855.364*35+802.36*57 +802.36*2+802.36*30@

= **Rs. 8, 13,046/-**

Overall cost of Doka

= 16855.364*8+16855.364*40+802.36*57 +802.36*2+802.36*30@

= **Rs. 8, 80,468/-**

@ = Additional cost incurred because Doka, Peri, RMD etc. is installed after completing two levels of a building using conventional timber.

PROBABLE TIME

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

Duration with Conventional Timber

= (17658*5/100) /365

= **2.42 yrs.**

Duration with Conventional Steel

= (17658*5/100) /365

= **2.42 yrs.**

Duration with Plastech

= (17658*2/100) / 365

= **1 yrs.**

Duration with Peri

= (17658*1/100) /365

= **6 months**

Duration with RMD

= (17658*1/100) / 365

= **6 months**

Duration with Doka

= (17658*1/100) /365

= **6 months**

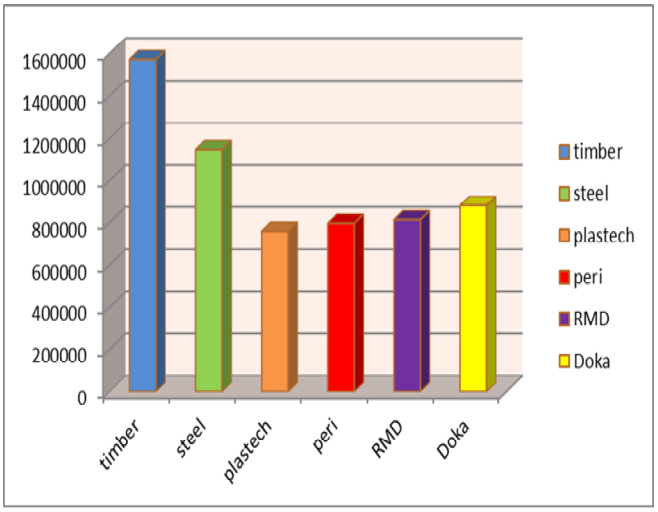

Chart -1: Cost Comparison of various formworks

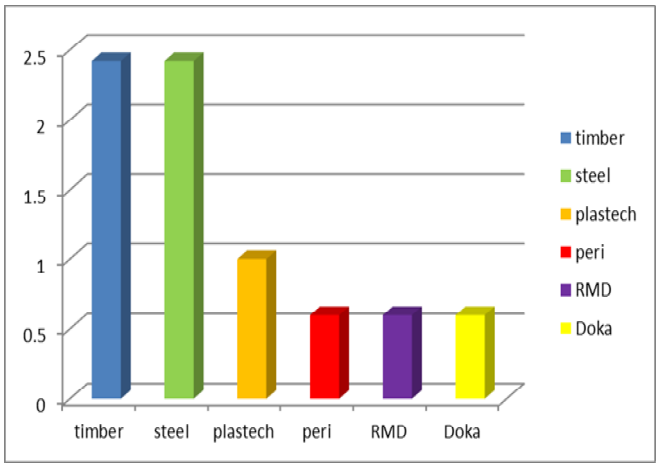

Chart -2: Time Comparison of various formworks

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. Also Plastech functions same as conventional timber and does not required any additional equipments for installing, if work is stopped due to certain reason the losses incorporated will not be huge as in case of other techniques. 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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REFERENCES

[1]. Amrut Manvi, Sandeep Gouripur1, Pooja Sambrekar, Ramanjeetkaur, Dr. Kishor S. Kulkurni “Cost Comparison between Conventional and Flat Slab Structures” Irjet Volume: 02 Issue: 03 | June-2015

[2]. "Emerging Trends in Formwork And Scaffolding", CE & CR, Sep 92, Pg.46-49.

[3]. H.G.VIVEK PRASAD, H.N.RAJENDRA PRASAD "Case Study on Conventional and Fast Track Construction Techniques", International Journal of Science, Engineering & Technology, Vol.3 Issue 5, 2015.
[4]. Ganar A.S, Patil S.D "Comparative analysis on cost and duration of MIVAN formwork building and Conventional Formwork building", International Journal on Recent and Innovation Trends in Computing and Communication, Vol.3 Issue 12
[5]. Ketan Shah, (2005) "Modular formwork for faster, economical and quality Construction", Indian Concrete Journal, Vol-79, pg. 6-23.
[6]. Mohd Syazwan Md. Rahim, Nuzul Azam Haron "Construction Cost Comparison Between Conventional and Formwork System for Condominium Project" IJASCSE, Volume 2, Issue 5, 2013.
[7]. S. Poon, Robin C.P. YIP, (2005) "Comparison of conventional and low waste formwork in Hong Kong" World Sustainable Building Conference, Tokyo,27-29 September 2005, pg. 42-48.
[8]. Swapnali M. Karke, M.B. Kumathekar "Comparison of the use of Traditional and Modern Formwork Systems", Civil Engineering Systems and Sustainable Innovations ISBN: 978-93-83083-78-7
[9]. Y.B. Sangale, Prof. R.V. Devalkar "Construction cost Comparison between Conventional and Industrialised Building System in Nashik", International Journal of Modern Trends in Engineering and Research, 720 -725, 2014.
[10]. http://www.concretecentre.com

BIOGRAPHIES

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