

# Productivity Analysis of Building Construction Using Mivan Formwork

Miss Manik Moholkar<sup>1</sup>, Prof. Dr. (Mrs.) Vidya Nitin Patil<sup>2</sup>

<sup>1</sup>Student, Civil Engineering Dept., Aissms COE Pune, India

<sup>2</sup>Professor, Civil Engineering Dept, Aissms COE Pune, India

**Abstract-** Nowadays, most of the clients expect the completion of the project in the shortest time possible to minimize the costs. For the high-rise buildings, the most effective way to speed up work is to achieve a very short floor cycle. Productivity has for many years been an issue for the construction site. Productivity enables the companies to monitor their own performance against site performance. Formwork systems are among the factors determining the success of a construction of a project in terms of speed quality, labour cost and safety. There are also signs of slowed productivity in India relative to other developed countries. The productivity of construction labour in other countries e.g. Japan increased by 6.6% a year, while Indian construction productivity rose by only 1.6%. In metro cities, few companies have started using faster construction techniques. Concrete formwork labour costs constitute over 1/3 of total concrete construction costs. Hence, in this paper Productivity of Mivan technology as compared to conventional technology will be analysed with respect to Labour efficiency, Cost and Time. One case study related to Mivan technology is discussed in this paper. This Project was successfully completed under the guidance of civil engineers at Kolte-Patil Developers Ltd.

**Index Terms-** Productivity, Mivan Formwork, Conventional Formwork, man-days

## 1. INTRODUCTION

With advancement in cost industry it has become necessary to keep account of expenditure made in the process. Productivity is one of the most important factors affecting the overall performance of any construction site, large or small. The view of productivity has become a major concern to deal with. In general terms, construction productivity can be simply illustrated by an association between an output and an input. High productivity refers to doing the work in a shortest possible time with least

expenditure on inputs without sacrificing quality and with minimum wastage of resources. Productivity measurement at construction site level enables companies to monitor their own performance against their site performance. Construction productivity at construction site level can be grouped under various departments likes productivity in Labour efficiency, Cost, concrete, steel work and shuttering.

However, Mivan Technology is one of the techniques that are used for quick construction. It includes the wall-panel units and slab units directly added to building structure. The use of aluminium is also evolved as one of the techniques for quick construction.

The human resource is extremely important in construction industry because construction projects are unique and complex. These characteristics inhibit full automation compared to other industries. The individual skill of each craftsman, the abilities to communicate, make decisions, work with others, and share information, makes this resource unique and irreplaceable in future.

Objectives of this study are to determine:

The productivity by comparing the labourers of Mivan and conventional formwork, thereby tracing variation of actual productivity from target productivity.

Determine productivity and efficiency of the project by comparison between material costs of Mivan formwork and conventional formwork and further provide a basis for understanding the present status and future direction of productivity measurement.

## 2. LITERATURE REVIEW

James D. Shumway (2001) concluded that Productivity is the labour work hours required to construct 100 square feet of contact area. He also

stated that Productivity influence factors provides a dimensionless quantitative basis of comparison for the impact of various general and system causes of finished formwork.

Gary Smith and Awad Hanna (1993) studied the factors influencing formwork productivity. They stated that constructability has proven be an important factor in formwork productivity. Here, in this report Estimates indicate that 30-70% cast-in-place concrete is attributable to the assembly and stripping of formwork and factors such as documental contracts and measureable factors such as engineering design have been proved to have a great effect on framework.

Osama Mosheli, Jaffer Khan (2010) studied the analysis of layout productivity of a single building. The used a neural network model to study the factors considered to impact layout productivity. Various types of common data was collected and analysed. Further, they concluded that productivity depends on factors like formwork assembly, panels, labourers, economics of the entire project.

Dozzi, Abou Rizk S.M. (1993), Productivity in construction, National research council, Canada and University of Alberta: studied the difference and importance between macro and micro level productivity factors in order to analyze cause or ffect of failures and further take appropriate action. They concluded that while measuring the productivity, it is important to know where the project stands. Improving productivity combines scientific understanding of issues affecting productivity.

Serdar Ulubeyli, AynurKazaz, BayramEr, (2014). Stated that lower performance of skilled and unskilled labourers is directly related to the change of work, disruptions and rework. However, almost 30% loss of efficiency occurs when changes are done. The most common types of issues which can create obstacles in the project are lack of materials and information and when the project sequence is not followed systematically. These factors can result in daily loss of efficiency in range of 25% - 30%. They also stated that:

Productivity = Total output ÷ Total work hour

Stephen Weber and Barbara Lippiatt measured and concluded that the comprehensive total factor productivity (TFP) method is preferred to the single factor productivity method.

James D. Whiteside, explains that Productivity is the average direct labour hours to install a unit of material.

Varma Santosh and Prof. M. R. Apte (2014) they carried out research and analysis for daily planned vs actual turnout of the project using certain parameters such shuttering, reinforcement and concrete. They concluded that productivity can be illustrated by an association between an output and an input. The Input and Output values are Targeted Quantity and Achieve Quantity respectively.

### 3. DATA COLLECTION AND METHODOLOGY

The data for study is collected from two different sites i.e. Mivan formwork and Conventional formwork. Quantity of work done by labourers in 8 months individually. Labour reports are updated on daily basis in the Project System Software SAP from which monthly report is prepared.

The plywood shuttering is known as conventional type of formwork. It is economical for small scale construction. Since it can be moulded in any shape but not economical for repetitions.

Here, Quantity of work done in a month is determined using quantity estimation .Constraints which will affect the overall productivity are also noted. Unit of productivity is square meter per man-day's (Sq.m/man-day's). Productivity for mivan and formwork are calculated separately. Also commonly estimated target productivity for any Project is 2.5 Sqm/man-day's for conventional formwork and 10 Sqm/man-day's for Mivan Formwork. Labourers work on an average 10hrs/day.

Also, Costs of various materials and estimates of tasks were obtained and summarized as per the current market rates for further analysis.

Base for analysis :

Productivity = (Quantity of work done)/(No.of man-days)

(1 man-day =8 hrs)

(Note: Productivity of Mivan and conventional formwork are calculated separately and they are tracked against target productivity)

### 4. CASE STUDY

In order to achieve the objective, data was collected from two different construction Projects. Also on the

basis of previous studies on labour productivity & suggestions from Local Industry Professionals, this case study consists data from the following:

A multi-storey 12 public residential building with 90 flats in each building at Pune, for Conventional Formwork system.

A Multi-storey building township of more than 24 buildings Hinjewadi, Pune, for Mivan Formwork System.

Cost analysis and data collection with respect to time and labour.

5. DISSCUSSIONS

Analysis of plywood shuttering i.e conventional formwork system.

S r. N o.	Mont h	Work done (sq.m) (a)	Labou r per month (b)	Man-days/ month c=(bx10)/8	Productiv y (sq. m/ Man-days) d = a /d
1	Jan	5464	2149	2682.5	2.03
2	Feb	6360	2155	2693.7	2.36
3	Mar	6930	2678	3347.5	2.07
4	Apr	7735	2360	2950.0	2.62
5	May	3376	864	1080.0	3.12
6	June	1049	687	858.75	1.22
7	July	229	183	228.75	1.0
8	Aug	215	150	187.5	1.14

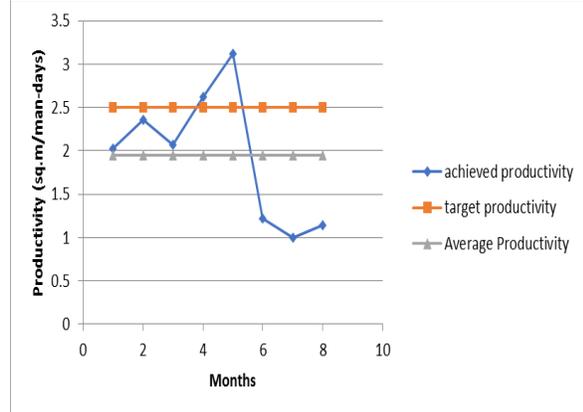


Fig 1. Variation of productivity of conventional formwork from target productivity

B. Analysis for Mivan shuttering i.e Aluminium type of formwork:

This formwork is used in construction mainly to increase the pace of construction i.e. decrease in duration of slab cycle. It is also applicable in cases where there are typical floors.

S r. N o.	Mont h	Work done( sq. m)(a)	Labours per month (b)	No. of man-daysc = (bx10) /8	Producti vity d=a /d
1	Jan	17314	2500	3125	5.54
2	Feb	16440	2203	2753.75	5.97
3	Mar	21002	3100	3875	5.42
4	Apr	31670	2570	3212.5	9.86
5	May	21230	2400	3000	7.08
6	June	18524	2567	3208.75	5.77
7	July	6512	1670	2087.5	3.12
8	Aug	2890	1200	1500	1.93

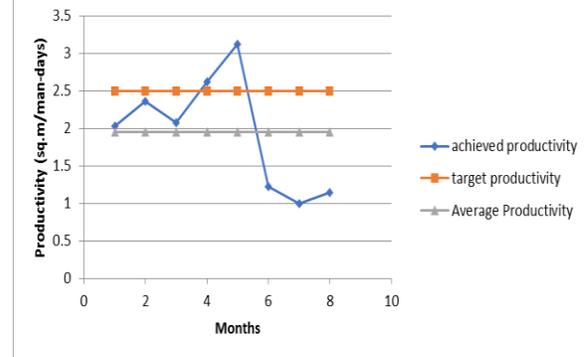


Fig 2. Variation of productivity of Mivan formwork from target productivity

C. Productivity Analysis with respect to cost and time:

Conventional Formwork V/S Aluminium formwork			
Target - 50 Repetitions/70 sq. m/ staircase			
Sr. No	Title	Conventio n l formwork	Mivan Formwork
1.	Material cost per sq. m	2000	10,500
	Project cost for 70 sq. m	1,40,000	7,35,000
2.	No of Repetitions can be achieved	10	150
3.	No of times material to be purchased for 50 repetitions	5	1
4.	Material cost for 50 Repetitions for 70 sq. m	7,00,000	7,35,000
5.	Labour cost for fitting and dismantling of formwork for one pour	15 man-days 15*450=6750	15x450=6750 10 man-days 10*450=4500
6.	labour cost for completing 50 repetitions	3,37,500	3,37,5000
7.	Time required for one repetition	10-15 days	4-5 days
8.	Savings		
	Total(SR no 4+6)	10,37,500	9,60,000

9.	Scrap price after 200 repetitions	125050	62500
		Savings 1,40,000	

Capital cost:20,85,000 Total savings:43,47,500  
Profit: 22,62,500

### 6. CONCLUSION

There have been substantial gains in both labour and capital productivity and efficiency in construction industry over the past 50 years in India. This paper examines the productivity measures currently available, some of their limitations, and what attempts are being made to improve them.

Selection of formwork for the project is an important criteria as far as productivity is concerned. Good and efficient formwork increases productivity, saves time and also contributes in overall profit of the entire project. As per the analyses, one can clearly see that Conventional formwork is well suited for small scale constructions. It is observed that for the given site condition average productivity of 1.9 Sqm/man-day's is achieved. Conventional formwork productivity mainly depends on factors such as shuttering material, period of De-shuttering and dimension of the elements, efficient planning and following the prescribed procedure. However, above study shows that Mivan formwork is best suited for large scale construction with typical floors, and constant repetition. It is observed that site condition average productivity of 5.8 Sq.m/man-day's is achieved. Hence, here there is a gradual increase in productivity as compared to Conventional formwork. Average productivity is less than target productivity because the progress of all tasks and floors is different. This may bring variations in average productivity. Initial cost of mivan is high when compared with conventional formwork. But as work gains strength and speeds up, costs nearing to final stage may reduce and create a scope for profit. For typical floors Mivan formwork is economical since number of repetitions are high and labour cost is comparatively less when compared with conventional formwork.

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