ISSN: 2321-7782 (Online)
Volume 3, Issue 6, June 2015
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Survey Paper / Case Study
Available online at: www.ijarcsms.com

Productivity Aspects of Concrete Boom Placer in Hyderabad Metro Rail

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Abstract: ***In spite of the development in construction industry; the productivity in this sector is still considered as critical factor for most construction firms. This paper reviews current productivity measurement literature, particularly that pertaining to the construction sites, and offers recommendations/suggestions, for improvement of productivity at the site. It also shows the productivity of a concrete boom placer based on its planned/targeted concrete vis-a-vie actual consumption, wherein targeted machine hours are the input value and actual machine hours is the output of the productivity. Considering single factor type of productivity i.e. amount of concreting done, calculations of the productivity of the boom placer in Hyderabad metro rail project is made. This paper explains, why productivity at construction site is reduced due to improper shuttering, and unavailability of materials.***

Keywords: Boom placer, Productivity, Metro Rail project, concreting

I. INTRODUCTION

Many researchers have attempted to define precisely what is meant by productivity. One of the most generalized definitions of productivity is "effective and efficient utilization of all resources, labour, plant and materials" (Prokopenko, 1987). Oglesby make a clear distinction between performance and productivity. Performance as applied to associated works is a broad term, encompassing four main elements, namely productivity, safety, timeliness and quality. Productivity; which is measured primarily in term of cost, with satisfactory productivity usually implies work accomplished at reasonable price to the client and with a fair profit for the contractor (Oglesby et al., 1989).

The low technology and low skilled employments make construction industry seemed as low productivity sector. In order to raise the level of construction productivity, it is recommended that construction projects should have the following features (Saad D. Ali., 2002):

» High degree of standardization;

» Building system should be easy and simple to construct and repetitive;

» Design is preferred to use pre-fabricated units or pre-assembled forming system;

» Well managed constructing methods with detailed planning and specifications; and

» High level of mechanized methods and skilled workers.

The first three points are design related, which make the construction of project more buildable. The last two points are construction related and involve construction management and worker skills. The construction features that contribute to low productivity in this sector can be outlined as follows (Saad D. Ali, 2002):

» Presence of large number of unskilled workers and shortage of suitable trained and skilled workers;

» Poorly developed subcontractors and subcontracting sector role;

» Lack of site management and construction management skills in projects teams; and

» Inadequate mechanization and automation in some sectors of this industry.

Performance measurements and benchmarking of various construction activities and operations are the best methods that may help to develop the productivity of this industry

II. The Productivity of Construction Sector

Productivity is the ratio between inputs and outputs. It is important to specify the inputs and outputs to be measured when calculating the productivity because there are many inputs such as labors, materials, equipment, tools, capital and design in the construction system. The process of conversion from inputs to outputs associated with construction operations is also complex and influenced by the technology, government regulations, weather, economic conditions and management, and by various internal environment components (Jugdev K. et al., 2001).

In special case, the productivity is related to a single input (workers-hours) and single output (item as area in m2), and the simple productivity ratio index of these input and output can be calculated; this case has been assumed as closed system with all factors held constant except for the known input and output (Jugdev K. et al., 2001).

The change in productivity can be due to one or more internal or external influence including undefined disturbance. In addition, there could be different productivity indices for different purposes and these productivity indices are related to time and place.

III. Management Principles in Construction

The factors such as planning, scheduling, work-study and quality control can improve the productivity for construction projects. Several other factors related to construction management must also take into account when maximum effort is made to increase productivity. Some of these factors are (Project management institute, 2004):

1. Provide training to improve worker's ability and skills, reaching to assign the right people to do the job.
2. Human resources must be developed by motivation to improve the competition in the performance, and enlarge the jobs to include challenge, variety and self-regulation.
3. Use computer aided technique in project scheduling and construction management methods such as critical path method (CPM) to optimize the time of related activities and make that resource as well as methods allow continuous task performance to reduce the idleness of labour force to minimum.
4. Make the number of project teams know that they are important to the organization and involve them in the making of the decisions affecting their jobs such as methods improvement.
5. Conduct productivity and performance study for the activity or operation level to produce benchmarks and to develop scientific methods as a part of the study to describe the detailed tasks performed for an activity or operation by individual or group in order to find out problem area and propose ways to improve.

Studying the above factors for each project activity will lead to increase in the productivity. All of these factors have strong points as well as weaknesses but the greatest opportunity for the construction projects to increase productivity is by measure (points 4 & 5) factors. Performance measurements and benchmarking is a concentration on these two components helping to increase productivity through methods selection and productivity study.

IV. Objective of The Study

In this study, the following objectives are envisaged.

1. Study the productivity concept.
2. Measure the productivity aspects at Hyderabad metro rail.
3. Provide Suggestions to increase productivity of the same.

V. Productivity in Concrete

Concrete and concreting have generated great interest in the construction industry. Much research has been done in the field of concrete technology, much more than in formwork and steel reinforcement technology. However, most of the research is on concrete materials and techniques in the manufacture of concrete, with little research on the productivity aspects of concreting on the construction site. The Productivity of concreting operations will, to a large extent, depend on the following.

1. Methods of supply of concrete, including delivery times and intervals.
2. The shape and size of the structural member, since the ease or difficulty of pouring fresh concrete will depend not only on the state of the fresh concrete & the presence of steel reinforcement, but also on the shape and dimensions of the concrete member & levels.
3. The availability of machinery such as concrete mixers, batching plant, transit mixer, concrete pumps and tower cranes etc. They can determine the speed at which concreting can progress. This makes direct impact on productivity of concrete.
4. The presence of steel reinforcement, as the numbers, size and spacing of the bars can affect the pouring and proper compaction of fresh concrete.
5. The weather conditions on the day of concreting, as work can be affected by rains or cyclones.

VI. Type of Productivity

A. Single factor productivity.

Productivity calculated for single activity like labour, concrete or equipment is known as single factor productivity.

B. Multi factor productivity.

Productivity calculated for more than one activity like labour and equipment or Material, labour & equipment and concrete is called multi factor productivity.

C. Total Factor productivity.

Productivity calculations which include all the activity on the construction site is called as total factor productivity.

In this paper only single factor productivity for concrete during the construction is taken into consideration.

VII. Data Collected for Productivity

A. Detail Planning aspects of the project for the concrete work

B. Monthly Actual Consumption of Concrete.

C. Delay data collection analysis Reports from 1st Feb 2015 till month of 31st March 2015.

After data is collected, an analysis of the same is done, for determining the productivity of boom placer.

VIII. Measurement of Productivity

Productivity for individual projects can be measured upon project completion or during construction. Productivity can be calculated on a monthly basis by estimating the work completed at the end of each month and dividing this figure by the total manpower used for that month.

% Work completed per month=Monthly payment certified/Total contract sum

This equation is used by the Construction Industry Development Board [CIDB] Singapore to compute the monthly productivity figures of Individual projects. However productivity can be simply illustrated by an association between an output and an input. The Input and Output values are Targeted Quantity and Achieved Quantity for period of a month. By computing [Input/Output] industry can find out the productivity value in percentage. As it is easy to compute this formula is generally used to calculate the single factor productivity for any kind of activity whose input and output value are known.

Productivity=Amount of concreting done/Time required to perform the same

IX. Case Study

Due the wide range of equipment that would be used in a metro project the ongoing Hyderabad Metro Rail project was selected for the case study. Also the rate of construction and its demands would help in getting to know the construction standards being adopted on large infrastructure projects

To assess the aspects of productivity of boom placer the segment casting activity was selected. For the Metro Project L&T has developed two Pre Cast yards at Quthbullapur (64 acres) and Uppal (54 acres) on Government Commissioned land. Uppal Yard has capability to complete 450 segments per month and has facility to stock about 1800 segments. Most of the casting work is handled offsite and then shifted to project site for installation.

To minimize the inconvenience to road users during the metro rail constructions activity, 85 per cent of the metro rail works are converted to pre-casting method, other than laying of foundations and casting of pillars (piers). Around 14000 segments shall be constructed here over the period of project.

X. Data Collected

The details of the Boom placer used at site are tabulated in table I

TABLE I

DETAILS OF THE BOOM PLACER

Putzmeister 36 meter	Number of Strokes per min	26		
	Vertical Reach	35.6 m		
	Horizontal Reach	31.7 m		
	Reach Depth	22.7 m		
	Unfolding Height	8.7 m		
	Delivery Line Diameter	125 mm		
	Folding System	Z Fold		
	Cycle Time	24 min	Levelling	5 min
			Positioning of Boom	6 min
			Cleaning of Boom	3 min
			Slump Test	2 min
			Final Position	2 min
			Closing of boom	4 min
			Lifting of levels	2 min

Table II shows Planned and Executed number of segments cast in Feb-2015 and .March-2015

TABLE II

SEGMENT CASTING PLANED AND ACTUAL

Date of Casting	CASTING PER DAY(No.)	Average Casting(No.)	Total Cost (Rs)
1/2/2015 to 14/2/2015	10.50	15.00	232916.00
15/2/2015 to 28/2/2015	11.79	15.00	264998.00
1/3/2015 to 15/3/2015	7.00	15.00	175999.00
16/3/2015 to 31/3/2015	8.75	15.00	225299.00

Concreting makes major impact on the project and productivity of the project. Considering single factor productivity, analysis of concreting activity was done to find out the value of productivity of boom placer and also productivity of project.

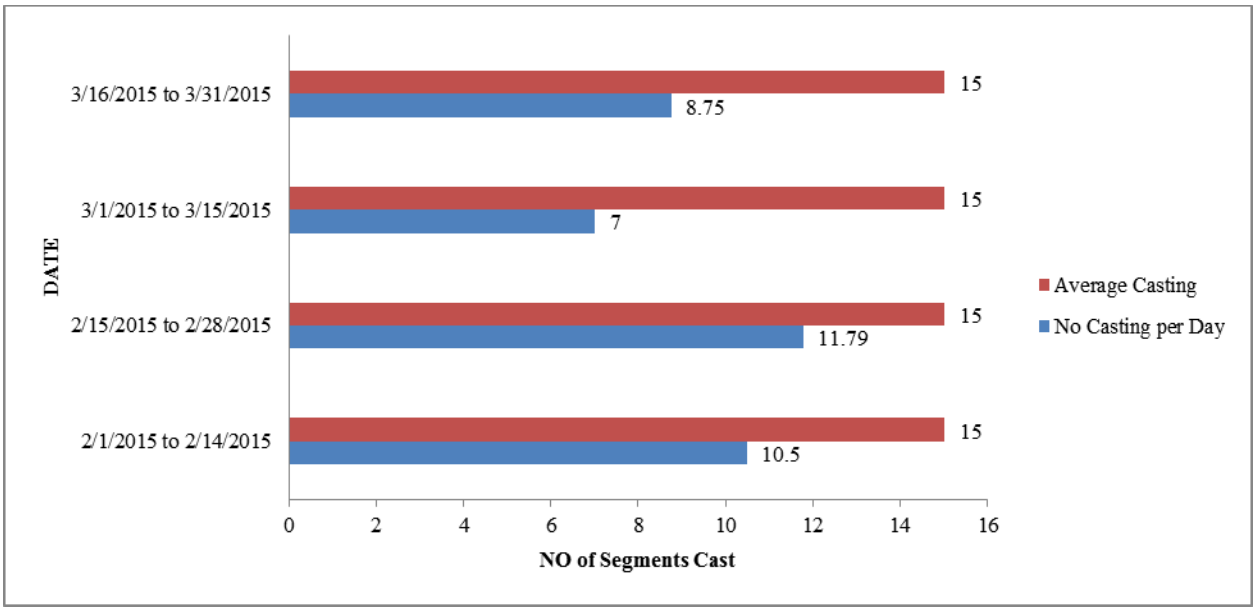
Table III shows the planned amount of concreting activity to be done in the two months and the actual amount of concreting work done during that period.

TABLE III

MONTHLY PLANNED PROGRESS OF PROJECT

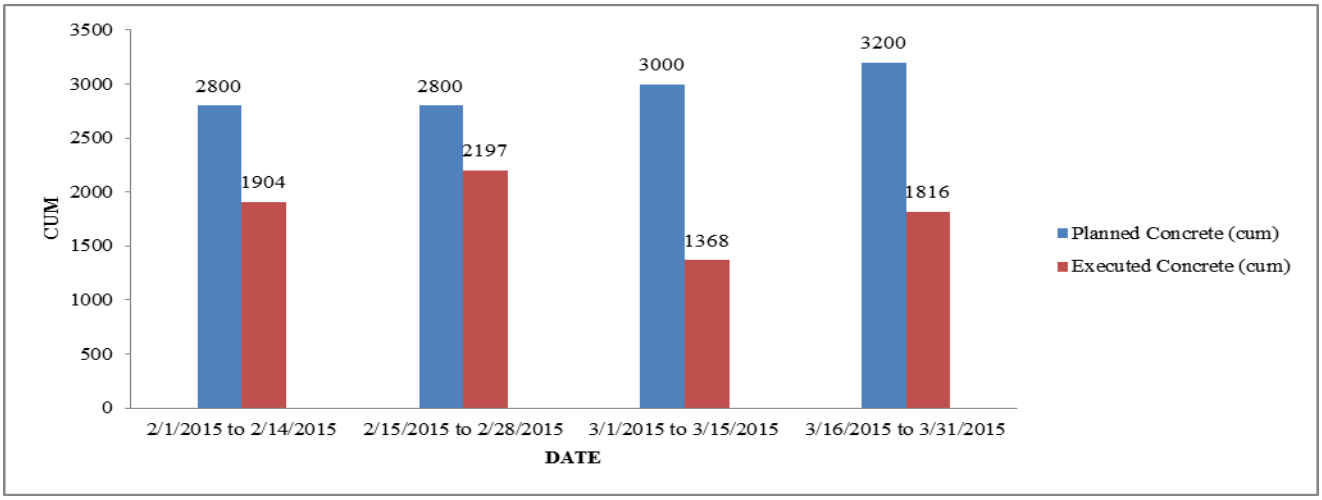
Date of Casting	Planned Concrete (cum)	Executed Concrete (cum)	Productivity Achieved (cum/hrs.)	Reasons
2/2/2015 to 14/2/2015	2800.00	1904.00	5.86	Boom placer unavailable at casting yard
15/2/2015 to 28/2/2015	2800.00	2197.00	5.87	
1/3/2015 to 15/3/2015	3000.00	1368.00	5.38	Reinforcement Issue(12mm & 16mm dia)
16/3/2015 to 31/3/2015	3200.00	1816.00	5.49	Issue regarding stock of cement

Graph I shows the comparison between the number of segments that were planned to cast and the actual number of segments that were cast during the period of Feb-2015 to March-2015



Graph I Planned no. Of Segments vs. Actual no of Segments Cast

Graph II shows the difference between the volume of concerting activity that was supposed to be completed in the two months and the actual completed work.



Graph II Planned Quantity vs. Actual Quantity of Concrete.

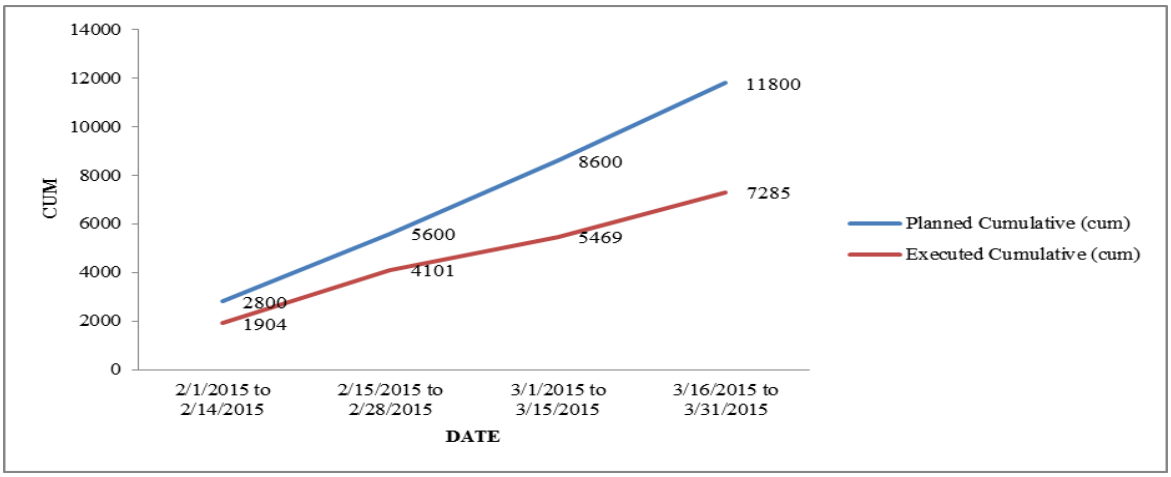
Table IV shows the cumulative quantity of work planned and work done in the two months and also the productivity of project achieved during the two months

TABLE IV

CUMULATIVE ACTIVITY

Date of Casting	Planned Cumulative (cum)	Executed Cumulative (cum)	Project Productivity %
1/2/2015 to 14/2/2015	2800.00	1904.00	70.00
15/2/2015 to 28/2/2015	5600.00	4101.00	78.57
1/3/2015 to 15/3/2015	8600.00	5469.00	46.67
16/3/2015 to 31/3/2015	11800.00	7285.00	58.33

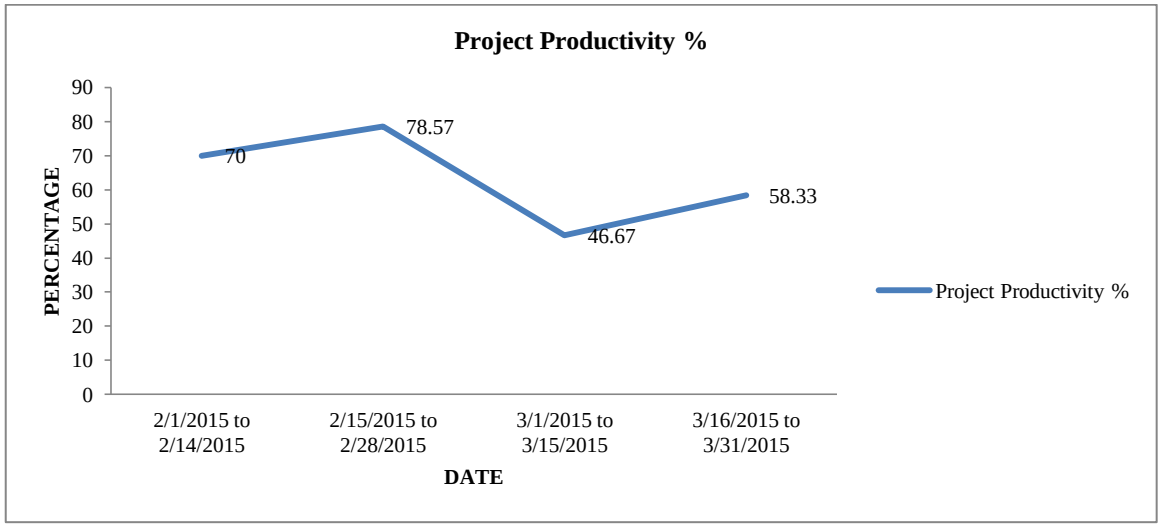
As we can observe that productivity of the project was around 75% in the month of Feb 2015. The graph III below shows the differences between monthly planned and actual executed quantities of the concrete.



Graph III Cumulative Differences Between Planned & Actual Quantity of Concrete

As it is a prestigious project and concrete is the final output for the segment activity of the project. So in the above table IV project productivity was calculated considering the value of planned quantity of concrete and actual consumption of the concrete during the 2 months period of the project.

Graph below shows the productivity value in months of Feb-2015 and March-2015



Graph IV Project Productivity

The project had a productivity of 75% in the month of February 2015, but in the month of March 2015 the productivity dropped to about 54%. This is nearly about 20% drop in productivity of the segment casting activity. The reasons behind the drop are non-availability of materials such as cement and steel allocated to segment casting activity. Also due to advancement in the project the priorities given to segment casting activity was also reduced. This led to directing of resources to other activities such as construction of expansion joints, pier works and foundation works. Also due to weather limitations in the month of March the project productivity got reduced. Even though there was a drop in project productivity the drop in the productivity of boom placer was not significant. During the two months at site boom placer did not have a break down nor was not in a situation of not performing. This is due to the weekly maintenance activity which was carried out on all equipment every Monday

XI. CONCLUSION

This study highlights the basic concepts of construction productivity and its characteristics through assessing the productivity of boom placer, then summarizes on how and where it can be improved through construction management concepts especially performance measurements. Even though the Hyderabad metro rail is achieving a substantial rate of project progress and high productivity form its equipment the following recommendations are made to further improve the productivity.

- Increase the shuttering material quantity.
- Provide storage for reinforcement so that cutting and bending of steel is done in advance.
- Make sure that all the Material are available at site based on lead time calculations
- Ensure availability of funds
- Increase resources/labour and sub-contractors.
- Increase the working time to cover the delays.
- Offer incentives to labour & subcontractors for meeting the targeted production per week/ per month.
- Short out difficulties if any/ disputed/ weekly meeting with clients, consultant.
- Provide more supervisory staff to control the production.

ACKNOWLEDGMENT

We are highly indebted to L&T HEAVY CIVIL INFRASTRUCTURE IC, for their guidance, support and constant supervision as well as for providing necessary information regarding the project. We would like to express our special gratitude to PLANNING, QUALITY, SAFETY, PC YARD, RMS PLANT, EXECUTION AND ERECTION DEPARTMENTS.

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