Review Study on Improvement of Overall Equipment Effectiveness in Construction Equipments

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Abstract **- This paper will review the goals and benefits of implementing Total Productive Maintenance and it will also focusing on calculating the overall equipment effectiveness in construction equipments. In construction operations on a large scale require the standard Equipments for Effective operations especially in the area of infrastructural development. This is the true picture of large construction companies whose physical successful activities depends on men, materials and sophisticated machineries that will produce output of operations during a particular period use. Thus, the effectiveness of construction machineries is a major factor that differentiates construction companies in terms of heavy construction and light construction. In the today's era of intense global competition, construction industries are determined to improve and optimize their productivity in order to remain competitive. Overall Equipment Effectiveness (OEE) of a machine plays an important role where performance and quality of the product are of key importance to the company. The OEE intended at minimizing the breakdowns, increasing performance and quality rate and thus improving the effectiveness of the machine. The availability rate of the machine, performance rate of the machine and quality rate of the products are considered as parameters while maximizing the Overall Equipment Effectiveness (OEE) of a production system. The objective of the work is to enhance the overall equipment effectiveness (OEE) at a construction company.**

Keyword **- Earth moving construction Equipment, Maintenance, Overall Equipment Effectiveness, Availability, Quality Rate**

I. INTRODUCTION

In construction industry, the knowledge about principles of operation, management of construction equipment and their most efficient field of operation is essential. Construction equipment have assumed a role of great importance to Engineers in the modern construction industry particularly construction of roads (paved and unpaved), dams, runways, power plants, irrigation schemes, water and wastewater works, etc involve a lot of earth moving a lot of earth moving works, which are equipment intensive operations. The use of construction equipment for accomplishing construction tasks is increasing rapidly. Plant and equipment now constitute a substantial portion of the construction costs in every Civil engineering project. The cost component usually depends upon the nature of the project and the extent to which equipment is employed. In a building project, the equipment costs may vary from 5% to 10% of the direct costs. While in highway construction projects, the plant and equipment costs may touch as much as 40% of the project direct costs. Therefore, understanding the fundamentals of the equipment is of vital importance to contractors and practicing professional Engineers in the field.

OEE is important parameter in Total Productive Maintenance (TPM) which is fundamentally a maintenance program that involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum.

II. LITERATURE REVIEW

Bamber (1998) presents the definitions of TPM in his review about the literature of TPM he present two definitions the first one depend on the Japanese approach and the other depend on western approach. The Japanese approach to TPM is considered to be that a full definition which contains five main points:

1. To use the equipment more efficiently.
2. It establishes a total preventive maintenance system.
3. It requires a full participation from all department operator (equipment operator, designer, and departments workers)
4. It involves everyone in the company shop floor to the top management.
5. It promotes and implements preventive maintenance based on autonomous, small group activities.

Nakajima (1988) summarized these five points in briefly defining TPM as "Productive maintenance involving total participation in addition to maximizing equipment effectiveness and establishing a through system of PM" where PM is a comprehensive planned maintenance system.

III. Overall Equipment Effectiveness (OEE)

Overall equipment effectiveness (OEE) is described as one performance-measurement tool to materialize the quest for perfection of lean manufacturing into daily practices.

This is the origin of the Total Productive Maintenance (TPM) concept launched by Nakajima (1988), who believes that it is imperative to continuously improve all operational conditions.

The objective of TPM is to achieve zero breakdowns and zero defects related to equipment, which could lead to improvements in the production rate, reduction in inventory, reduction in costs and eventually increases in labor productivity. As analyzed by Muchiri and Pintelon (2008), this is especially true of highly automated processes.

IV. Methodology

1. This study was carried out within the major Construction Companies in India. These are companies that are majorly construction Engineering and are inclined in the execution of Infrastructural facilities development.
2. The visit to some of these companies in some local government within the country shows that these companies make use of construction Equipment for the execution of most of their projects. This is one of the reasons why these construction companies have a wider scope of operation and good performance in their construction activities.
3. The visit also awaits the opportunity of observing the practical operation of this construction Equipment with production and their effectiveness. The pictures taken for different construction Equipment were also reported for detail understanding and analysis.

V. Common construction equipments used on most civil construction sites

Table 1. Major equipments used in road construction project

Sr. No.	Equipment Description	Capacity
1	3 Stage Crushing Plant	200 / 300 TPH
2	Asphalt Paver 9 MTR Width	9 Mtr
3	Asphalt Plant	160 /240 /300 TPH
4	Backhoe & Front End Loader	
5	Batching Plant 30 CUM/HR	30 & 60 Cum
6	Concrete Boom Placer 42 MTR	42 Mtr
7	Concrete Pump	45, 60, 74 Cum
8	Dozer Crawler Type 160 HP	160 HP
9	Excavator 1 CUM	1 & 1.75 Cum
10	Motor Graders 145 HP	145 HP
11	Pneumatic Tyre Roller (PTR) 22 TON	22 Ton
12	Tandem Roller 10 TON	10 Ton
13	Verious Types of Cranes	30 & 60 Ton
14	Tipper/Dumper - 25 TON	25 Ton
15	Transit Mixers 6 CUM	4 & 6 Cum
16	Vibratory Soil Compactor 12 TON	12 ton
17	Wet Mix Plant 200 TPH	200 H

VI. OEE (Overall Equipment Efficiency)

The basic measure associated with Total Productive Maintenance (TPM) is the OEE. This OEE highlights the actual "Hidden capacity" in an organization. OEE is *not* an exclusive measure of how well the maintenance department works. The design and installation of equipment as well as how it is operated and maintained affect the OEE. It measures both efficiency (doing things right) and effectiveness (doing the right things) with the equipment. It incorporates three basic indicators of equipment performance and reliability.

Thus OEE is a function of the three factors mentioned below.

(i) Availability or uptime (downtime: planned and unplanned, tool change, tool service, job change etc.)
(ii) Performance efficiency (actual vs. design capacity)
(iii) Rate of quality output (Defects and rework)

Thus, ***OEE = A x PE x Q***

Availability *of the machine: Availability is proportion of time machine is actually available out of time it should be available.*

$$\textbf{\textit{Availability}} = \frac{\textit{Planned production time} - \textit{unscheduled downtime}}{\textit{Planned production time}}$$

Production time = Planned production time – Downtime

Gross available hours for production include 365 days per year, 24 hours per day, and 7 days per week. However this is an ideal condition. Planned downtime includes vacation, holidays, and not enough loads. Availability losses include equipment failures and changeovers indicating situations when the line is not running although it is expected to run.

***PE - Performance Efficiency**: The second category of OEE is performance. The formula can be expressed in this way*:

$$\textbf{Performance (Speed)} = \frac{\textit{Number of products processed} - \textit{Number of products rejected}}{\textit{Number of products processed}}$$

A simple example on how OEE is calculated is shown below.

1. Running 60 percent of the time (in a 24-hour day)
2. Operating at 65 percent of design capacity (flow, cycles, units per hour)
3. Producing quality output 95 percent of the time
4. When the three factors are considered together *(60% availability x 65% efficiency x 95% quality),* the result is an overall equipment effectiveness rating of *37.0 percent.*

World Class OEE

World class OEE is a standard which is used to compare the OEE of the firm. The percentage of World Class OEE is given in Table.

Table 2 – OEE Factors & Class

OEE Factors	OEE world class
%	90.0
E	95.0
Q	99.9
E	85.0

VII. Implementation Of TPM Methodology

TPM focuses on optimizing planning and scheduling, Availability, performance and yield are other factors that affect productivity. Availability losses arise from breakdowns and change-over, *i.e.*, the situation in which the line is not running when it should be. Performance losses arise from speed losses and small stops or idling or empty positions. Yield losses consist of losses due to rejects and poor startup behavior in the line producing the products. These losses lead to low values of the overall equipment effectiveness (OEE), which provides an indication of how effective the production process is. TPM helps to raise the value of the OEE by supplying a structure to facilitate the assessment of these losses.

Application of TPM leads to both shorthand long-term improvements.TPM entails having a

(i) Linear organizational structure.
(ii) Multi-skilled workforce.
(iii) Rigorous reappraisal of the way, the thing is done and so improvements are introduced, resulting in simplification or standardization.

TPM seeks to encourage the setting of ambitious, but attainable, goals for raising the value of the OEE. The importance of maintenance has been increased than before, due to its role in maintaining and improving availability, performance efficiency, and quality products, on time deliveries, the environment, safety requirements and overall plant productivity at a high level. These are all the key factors of TPM methodology.

VIII. Six Loss Categories

1. ***Break down losses:*** These are losses of quantity via defective products and losses of time due to decreased productivity from equipment breakdowns.
2. ***Setup and adjustment losses:*** These losses stem from defective units and downtime that may be incurred when equipment is adjusted to shift from producing one kind of product to another.
3. ***Idling and minor stoppage losses:*** Typically, these kinds of small losses are relatively frequent. They result from brief periods of idleness when between units in a job or when easy to clear jams occur.
4. ***Reduced speed losses:*** These losses occur when equipment is run at less than its design speed.
5. ***Quality defects and rework:*** These are product related defects and corrections by malfunctioning equipment.
6. ***Startup losses:*** These are yield losses incurred during early production, from machine startup to steady state.

IX. Conclusion

1. Success of OEE depends on various pillars like 5-S, Jishu Hozen, Planned Maintenance, Quality maintenance, Kaizen, Office TPM and Safety, Health & Environment. The key factors for this implementation are workers involvement and top management support.
2. To improve productivity it is essential to improve the performance of the construction systems. The desired production output is achieved through high equipment availability, which is influenced by equipment reliability and maintainability.
3. TPM is a structured equipment-centric continuous improvement process that strives to optimize production effectiveness by identifying and eliminating losses associated with equipment and production efficiency throughout the production system life cycle through active team-based involvement of employees across all levels of the operational hierarchy.
4. Total productive maintenance (TPM) methodology is a proven approach to increase overall equipment effectiveness (OEE) of equipment. It consists of eight activities; focused improvement and autonomous maintenance are two important activities

to enhance equipment performance. These activities aim to educate the participants in the concepts and philosophy of equipment maintenance and give them an opportunity to develop their knowledge and skills.

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