Volume-8,Issue-2,(Aug-17)
ISSN (O) :- 2349-3585

DETAILED STUDY ON HEAVY EQUIPMENT WITH ITS LATEST TECHNOLOGIES FOR EXCAVATION OF ROAD PROJECTS

Prof S.S.Deshmukh[1],Mr.Princeojas N. Jangada[2]
H.O.D. Civil Department, Trinity Academy OfEngginering, Pune

Abstract- The infrastructure development is an important aspect for the overall development of country. India is considered as the hub for service industry for which the infrastructure development plays an important role. The major problem frequently faced by contractor in the selection of most suitable equipment. Under given conditions, one of the largest elements of investigation of contractor would be down and operating cost of plant and equipment. The capital investment on purchase / rental/lease, and operation of the plant and equipment being very high, it has to be managed so as to ensure maximum return on investment, productivity and minimum operating, maintenance and repair cost. Thus appropriate selection and planning is essential for successful completion of project and to secure maximum profit out of it. The type of equipment selected usually depends upon the characteristics of material to be handled. Whether to use wheeled equipment or track equipment; whether to use dragline excavator or power shovel, are some of the typical questions that are to be answered by the planner of construction equipment

Keywords-: Productivity Analysis; Optimization; Ownership and Operating Cost

INTRODUCTION

Contractors have been steadily increasing their investment in construction equipment to satisfy their needs in response to increased construction volume in recent years. The technical advancement of earthmoving equipment during the 20th century includes many improvements in key parts of machines making the machine mechanically more efficient. Hence major large construction operations and mega projects uses a large number of various construction equipments. This group of equipments collectively forms a Fleet. The fleet operations have become complex due to a large number of manufacturers, various capacity and sizes of equipment available which makes the equipment selection a crucial task. After equipment selection the complexity further increases to optimize the size and number construction equipments in the fleet. Moreover large and highly competitive markets for infrastructure projects especially BOT type of contract, enforces the contractors to complete the project as early as possible to start regaining the investments. This demands a continued improvement in the performance of construction equipments. Hence there is a need of application of management techniques and systems in managing the fleet to complete projects on budget, on schedule, safely, and according to plans and specifications. Construction Equipment fleet management at its basic level addresses the problem of managing fleets of various construction equipments stationary as well as mobile such as dumpers, excavators, shovels, scrapers, belt conveying systems, graders, pavers, rollers, cranes, etc. Use of Equipment fleet management increases the productivity of overall site and increases the profitability through a proper equipment selection & optimization, production monitoring, tracking of equipments, maintaining a maintenance schedule, etc. Fleet Management consist of conceptual sub-components such as equipment selection and assignment, equipment optimization, maintenance, production monitoring, material and position monitoring, etc. The scope of this work is limited to equipment optimization and benefit analysis at the site through equipment production analysis. The case selected for the project is a highway construction project where considerable amount earthwork is involved.

This project mainly aims to achieve optimum equipment utilization by construction equipment's fleet management.

AIM

This project mainly aims to achieve optimum equipment

utilization by construction equipment's fleet management.

OBJECTIVES

The main goal of the study is equipment optimization and benefit analysis at the site through equipment production analysis. The specific goals of the study included the following:

• Study the road construction site for current practices of equipment Management.

• Perform equipment productivity analysis to optimize the current composition of the earth/material moving fleet.

• Recommend changes to the company to assure the optimum level.

• Perform benefit analysis by comparing the current composition and the Recommended theoretical fleet and recommended available fleet

LIMITATIONS OF STUDY

There is lack of effective management of construction equipments even though large capital investments are made in procurement and operation of the equipment. The cost of construction equipment involved in a project may sometime exceed the cost of the project. Ineffective management of equipment leads to loss in production, delayed production and hence leads to reduced overall profitability of the firm. Moreover the current practice of equipment is based on experience and equipment availability. There arises problem of loading equipment waiting or hauling unit bunching Tipper bunching or queuing will reduce production 10 to 20 % of the ideal production Thus there is a scope for equipment optimization of assigned equipments on a construction project.

NEED

Construction equipment should ideally pay for themselves by helping the owner earn more than it costs to own, operate, maintain, store and use the machine. Operation costs are a recurring expense based on frequency of use while idle sitting machines are a drain to the income. Construction fleets should be evaluated continuously to determine wether paper tries to shows how productivity and profit optimization of these equipments can be achieved. To perform these optimization production capacity and cost of equipments, idle period is taken into consideration. To validate the results it is found that there is increase in profit.

SCOPE OF WORK

Fleet management consist of conceptual sub-components such as equipment selection and assignment, equipment optimization, maintenance, production monitoring, material and positioning monitoring ,etcThe scope of this work is limited to equipment optimization and benefit analysis at the site. The project site selected for performing the fleet management is "Four lanning construction of Hadapsar to Manjari section"

LITERATURE SURVEY

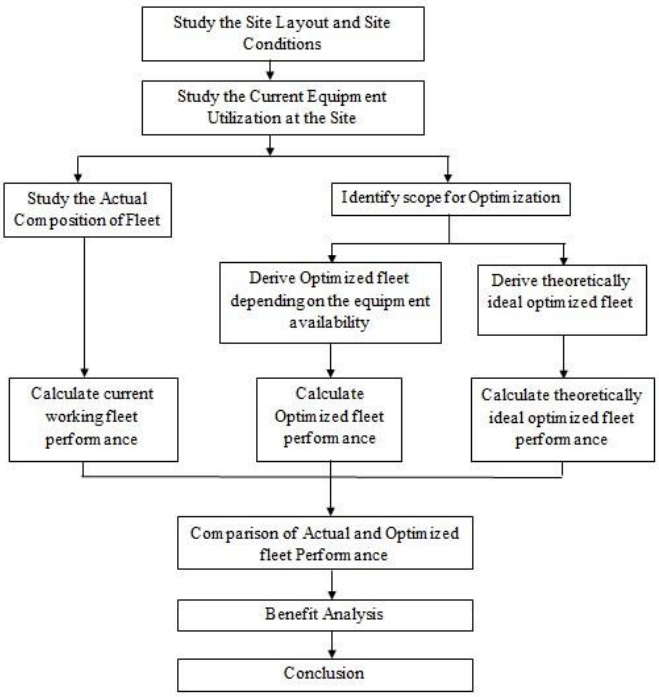
Any study cannot be fulfilled without taking reference of literature published. The topic I have chosen is completely particle based. Therefore it is highly needed to take review of work done previously in relevant subject. Construction equipment planning and selection plays crucial role for the success of construction firms. Inadequate manual processes of equipment planning and selection and the subjective decisions of equipment managers usually result in major losses in construction firms. An indispensable item of resources, it produces output at accelerated speed, enables completion of task in limited time. Equipment saves manpower, which is becoming costly and more demanding day by day. Equipment improves quality, productivity and safety. Construction equipment planning aims at identifying construction equipment for executing project tasks, assessing equipment performance capability, forecasting date wise requirement of number and type of equipment and finally participating in the selection of equipment to be acquired. To derive full benefits from the equipment, there should be proper selection and good planning of its operations. This paper deals with the planning and selection procedure for equipment adopted by a company to achieve its objective of timely project completion.[1] Large numbers of construction equipment are required on construction site. The efforts of contractors are to constantly push machine capabilities forward. As the array of useful equipment expand, the importance of careful planning and execution of construction equipment's increases. The objective of the project is to predict the fleet production rate and to optimize the number and size of equipment's in the

ISSN:-2349-3585 |www.ijrdt.org

fleet to match the equipment to project situations. Equipment economics is taken into consideration for the optimization.[2]Tremendous increase in the numbers of vehicle inroads causing delay in road transportation due to traffic, butwith the introduction of Metro Rail a huge number of passenger can travel in a much shorter time and also its very economical as compare to the travelling cost through private vehicle. To prepare this report first of all questionnaire survey and details regarding equipment was been collected from various construction site then it was converted in the form of Binary Variable for Cluster Analysis[3] Throughout this paper, we tried to discuss the overview of construction sector in Indian economy. Construction starts with planning, design, and financing and continues until the structure is ready for occupancy. The Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors.

The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field.[5] After the proposed Green Construction Policy is adopted by the LACMTA Board, staff will incorporate the requirements of this policy in all future procurement contracts. It is not retroactive. Staff will encourage Contractors that work on existing construction projects in LACMTA properties or rights-of-way to implement the provisions of this policy to the greatest extent feasible. Staff will develop a collaborative process to phase the implementation of this policy in other jurisdictions that receive/program LACMTA funding (in whole or in part) for construction projects.[6] Based on the international vulgate safety risk managing theory, the Guangzhou Metro Corporation (GMC) summarizes the standard system of safety risk management in metro rail transit project, integrating with criterion files about project on safety risk management promulgated by the Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD), according to the project practice. The result of application indicated that this system, which has been popularized in several other Chinese cities, effectively guaranteed personnel and project safety, and promoted the safety risk managing level of project participators in the same time.[7] Organization structure and projected staffing numbers will be developed for all tasks associated with the operations, maintenance, security, safety and Agency oversight of the CP/EV LRT Project. A preliminary organization and staffing table was developed and is included in the Preliminary Industrial Engineering Report for the Maintenance and Storage Facility. As currently envisioned, three Contract Operator will be hired and will be responsible for all daily operations functions including maintenance and service of the following system elements.[8] The objective of this paper is to present a pre-feasibility study conducted by carrying out household surveys and focusing on the short-comings of the Pune metro (India) to be faced in near future based on the available data and providing suggestions for the afore-mentioned problems. Construction, geological and the cost factors have also been considered in the paper. The proposals given can serve as a reference to avoid the future infrastructure conflicts and planned development for the Pune metro department.[9]

METHODOLOGY OF WORK AND RESULT ANALYSIS



QUANTITY STATEMENT FOR OGL TO HARD ROCK TOP (SOFT CUTTING)						
Chain	Dist	Cut Area	Fill Area	Cut Vol	Fill Vol	Cum. Cut
0	0	12.551	0			
0.195	0.195	27.25	0	3.881	0	3.881
2	1.805	38.152	0	59.025	0	62.906
4	2	38.896	0	77.048	0	139.954
6	2	38.331	0	77.227	0	217.181
8	2	37.958	0	76.289	0	293.47
10	2	38.756	0	76.714	0	370.184
12	2	40.003	0	78.759	0	448.943
14	2	38.818	0	78.82	0	527.763
16	2	38.485	0	77.303	0	605.066
18	2	36.697	0	75.182	0	680.248
20	2	34.539	0	71.236	0	751.484
22	2	35.636	0	70.174	0	821.658
24	2	33.855	0	69.49	0	891.148
26	2	34.266	0	68.12	0	959.269
28	2	33.58	0	67.846	0	1027.115
30	2	29.67	0	63.25	0	1090.365
32	2	22.44	0	52.11	0	1142.475
32.319	0.319	22.187	0	7.118	0	1149.592
34	1.681	22.366	0	37.447	0	1187.039
36	2	25.303	0	47.669	0	1234.709
38	2	27.641	0	52.943	0	1287.652
40	2	26.05	0	53.69	0	1341.342
42	2	25.22	0	51.27	0	1392.612
44	2	30.916	0	56.137	0	1448.749
46	2	35.289	0	66.206	0	1514.954
48	2	36.21	0	71.499	0	1586.454
50	2	37.827	0	74.037	0	1660.491
52	2	37.272	0	75.099	0	1735.59
52.243	0.243	36.175	0	8.924	0	**1744.514**

Table no-1:Quantity survey report for Soft cutting

Equipment Productivity Analysis

Production of each equipment involved in the fleet is manipulated as actual and theoretical using the performance charts and other parameters such as distance, speed, number of trips, capacity, cycle time etc. using various mathematical formulae. The unit of measure for the production is always quantity of material excavated or moved on hourly basis i.e. m3/hr. Various mathematical standard formulas are used for the direct production calculations for the respective equipment as follows:

1 Excavator output = 3600 * Q * F *E *V.C./ T

Q = capacity of bucket in m3 loose

F = fill factor

E = operator efficiency

V.C. = soil conversion factors

T = excavator cycle time (sec)

2 Tipper output = V * 60 /T

V = tipper body volume (m3)

T = tipper cycle time (min)

3. Dozer output = 60 * L/ T * f *E

L = blade load (m3)

T = dozing cycle time (min)

f = material type correction factor E=Efficiency

4. Vibratory Roller Output= W * S * L * E * 0.9/ n

S = avg. roller speed (kmph)

L = compacted lift thickness (mm)

E= operator efficiency

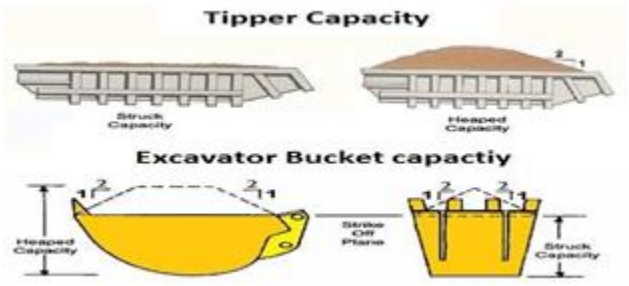
n = no. of roller pass

Parameters:

Following are the important parameters required for the productivity calculations;

Capacity:

The capacity for each equipment is denoted in m3 measure such as the bucket capacity in excavator or body capacity in case of tipper. This is found out by standard dimensions of each equipment given by the manufacturing company. The equipment's are generally filled at its heaped capacity and not at its struck volume. The struck capacity is that volume actually enclosed by the bucket, while for the heaped capacity an angle of repose is considered. According to standard conditions angle of repose 2:1 slope is considered.



Efficiency

Efficiency factor is the job efficiency of the operator. It is calculated as number of operating minutes per hour divided by 60 min. Job efficiency for each type of machine operator is calculated by taking mean of the daily machine working time divided by actual working time. The daily machine working time is taken from the timesheets being maintained by the site

ISSN:-2349-3585 |www.ijrdt.org

accountant. Illustrative calculation:

In the timesheet monthly total is 154.14.

Site working for the month= 27 days.

Avg. Daily working = 154.14 /27

= 6.70 = 6:42 hrs.

Daily efficiency out of 8hrs.working day = 6.7/ 8

= 0.83.

Fill Factor

According to the type of material being handled, fill factor corrections are applied. Fill factors account for the void spaces between individual material particles of particular type of material when it is loaded into an excavator bucket. Materials such as sand, gravel, or loose earth should easily fill the bucket to capacity with a minimum void space. At the other extreme are the bulky-shaped rock particles. If all the particles are of the same general size, void spaces can be significant especially with large size pieces. Fill factor are the percentage that, when multiplied by heaped capacity, adjust the volume by accounting for how the specific material will load into the bucket. Fill factor can also be called as bucket efficiency factor.

Cycle Time

The sum of time required to complete one production cycle is the cycle time for equipment. The cycle time consist of different elements for different equipment's. Typical cycle time elements for different equipment are as follows:

Excavator: 1.Excavate/load bucket 2.Swing with load 3.Dump load 4.Return swing

Hauler: 1. Load 2. Haul 3. Dump 4. Return

Dozer: 1. Push 2. Return 3. Maneuverer

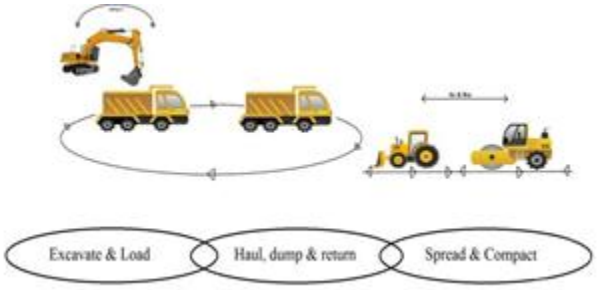
The cycle time for the equipment's involved in the operation are taken by the mean value of the actual observations taken.

Soil Conversion Factors

Soil Volume is measured in one of the three states: Bank volume: It is the measure of material as it lies in the natural state. Loose volume: It is the measure of material after it has been disturbed by a loading process. Compacted volume: It is the measure of material in the compacted state.

Fleet Concept

To accomplish a task, machines usually work together and are supported by auxiliary machines. To accomplish a loading, hauling and compaction task would involve an excavator, several haul units, and auxiliary machines to distribute the material on the embankment and achieve compaction.Such groups of equipment are referred to as equipment fleet/spread.An excavator and a fleet of trucks can be thought of a linked system, one link of which will control the fleet production. If spreading and compaction of the hauled material is required a two linked system is created. Because the systems are linked, the capabilities of individual components of the fleet must be compatible in terms of overall production i.e. the compaction equipment used on a project must have production capability matched to that of excavation, hauling, and spreading equipment.



LIST OF FEW EQUIPMENT USED WHILE EXECUTION OF METRO PROJECT.

Earth Moving Equipments

Earth moving equipment is one of the most important heavy machinery that is used in construction businesses. The basic function of these machines is to remove sand, wood, rocks, demolition debris and other unwanted elements from the site of construction and dump it onto some other machinery, which them carries it off. These equipments have wheels or tracks on which they move. The earthmoving equipment market in India is estimated at about US$ 1.4 billion. The predominant sub-segment in this is excavators, which account for just over half the market. Backhoes account for 26 per cent and loaders for another 5 per cent share. The prime driver for earthmoving equipment is mining activities and construction industry. Within these industries, the key demand drivers going forward are likely to be road construction, urban infrastructure, irrigation, real estate. Construction and mining .

Heavy loaders- the range of loaders that we supply is wide and includes L&T Komatsu PC 200-6, Kawasaki 95ZV-2,

ISSN:-2349-3585 |www.ijrdt.org

John Deere 844K, Volvo L120E, Case 921E and Caterpillar 950H. Compact track loaders and multi terrain loaders are the two main types of loaders that we work with. The power range that these machines use extends from 42 kW to 61 kW. The type of machine you choose depends upon the area in which you are working.

Hydraulic Excavators- excavators are also called diggers or shovels. These machines are used for digging trenches and foundations, demolitions, landscaping, and mining projects. Excavators can come in four sizes- mini, small, medium and large.

1.Lifting equipment:

Bearing heavy weights is something that you must do only with reliable equipment. The cranes and other lifting equipments that we provide on rent are: Cranes (from 10 to 1000 tonnes) Tower Cranes Hoists Winches All heavy lifting tools, tackles and spares Constructing a structure in and around water bodies is not easy. Contact us for the following floating equipments:

1. Constructing a structure in and around water body
2. Jack Up Platforms
3. Grab Dredgers
4. Submersible Dock Barge
5. Hydro clam Barge
6. Multipurpose Hopper Barge
7. Lifting Assembling Barge
8. Tug
9. Drilling & Blasting Pontoons
10. Cutter Suction Dredger

We also supply Construction Work Support Equipments, like Compressors Emergency Diesel Generator Sets, Temporary Lighting (with circuits and local MCB boards), Start-up transformers, Tremmy pipes, Compactors, Welding sets (electrical and diesel driven), Filling Pumps, Dewatering Pumps, Booster Pumps, Diesel Pumps, X Ray Machine with crawler, Mobile lab testing vehicles, Submersible Pumps, Caravans, Blasting Gun, Spray Guns, Elcometer, Distomat, Theodolite, Infrared Testers, Ultrasonic Concrete Testers

FIELD APPLICATIONS

Application of excavtaion equipment management

Quality improvement- Among the most significant criteria for evaluating a construction equipment company's performance is the reliability and quality of the construction. Using construction and earth moving equipment in complex and heavy construction activities significantly improves both these measures. Employing earth moving equipment as opposed to manual labour allows contractors to complete work with minimal quality defects, shielding them from claims arising from poor workmanship.

Project efficiency- Earth moving equipment overcomes many of the limitations associated with manual labour, from its inconsistency—due to weather, attendance, health, socio-economic conditions and a variety of other factors—to the time it takes to complete projects. In fact, usage of earth moving equipment can reduce a project's completion time significantly.

Cost savings and profitability- Increased productivity and the reliability of earth moving equipment ultimately translate into higher profitability from fewer defect-related claims and

ISSN:-2349-3585 |www.ijrdt.org

Case	*Quantity [m]^3*	*Cost of Excavation (Rs)*
A	2453.84	85585.98
B	1350.96	50618.48
C	1652.40	45231.40
D	10150.00	149088.63
E	2639.80	33537.16

the avoidance of delay penalties. In addition, using earth moving equipment can significantly reduce the cost of large-scale projects. It also makes it easier for the companies to complete their projects within budget at a reduced overall cost.

Safety- Any construction site is the locus of multiple high-risk activities. There are obvious safety concerns associated with workers operating on the ground, particularly within confined spaces when heavy materials are being moved around. Using earth moving equipment for construction activities helps mitigate or even prevent many of these risks.

DATA COLLECTION FROM FIELD

Table no 1- cost of excavation/hr

Equipment	Cost per hour
Volvo EC210 B	1100.00
Lntkomatsu PC 200	950.00
TATA haiwa 2518	400.00
Layland 2516	450.00
Volvo SD110 Soil	800.00
Volvo EC210 B	1000.00

Table 2: Production potential of current

CASE	*Current fleet*			
	Equipment	*Nos.*	*Individual Productivity m3/hr*	*Overall production m3/hr*
A	Volvo EC 210B	1	59.57	50.95
	Tata HAIWA 2518	2	25.54	
B	Volvo EC 210B	1	34.50	34.45
	Tata HAIWA 2518	5	8.58	
C	LnT Komatsu PC200	1	68.56	61.25
	Tata HAIWA 2518	3	20.50	
D	Volvo EC 210B	1	74.58	74.58
	Tata HAIWA 2518	5	25.50	
E	Komatsu PC200	1	63.45	63.45
	Tata HAIWA 2518	6	20.485	

Table 3: Cost of excavation of current fleet

Table 4: Cost of excavation of optimized fleet

Case	*Quantity (m3)*	*Cost of Excavat(Rs)*
A	2453.84	37655.09
B	1350.96	29507.75
C	1652.40	18325.33
D	10150.00	58954.20
E	2639.80	27947.64

Result and Discussion

Cost comparison

Following table shows the comparison between total cost of excavation between current fleet and optimized fleet. It can be seen that the cost has decrease in case of optimized fleet. This happened because of change of fleet from tipper control to excavator.

Table 5: Cost of excavation of optimized fleet

Case	Cost of current fleet	Cost of optimized fleet	% reduction in cost
A	85585.98	37655.09	58.00
B	50618.48	29507.75	48.71
C	45231.40	18325.33	58.49
D	149088.63	58954.20	59.46
E	33537.16	27947.64	15.67
Total	364061.66	172390.013	51

CONCLUSION

From the above discussed results it can be concluded that The optimized fleet gives more productivity than current fleet employed at site Cost comparison shows the up to 50% reduction in the cost of excavation for optimized fleet than current fleet.

REFERENCES

[1]Mr.Nilesh D. Chinchore, Prof. Pranay R. Khare(2014): Planning and Selection of Heavy Construction Equipment in Civil Engineering

[2] SaurabhRajendraKadam, “Construction Equipment Fleet Management: Case Study of Highway Construction Project” , International Journal of Science and Research (IJSR), Value

(2013): 6.14 | Impact Factor (2013): 4.438:

[3]Ritesh Kumar Biswas, S. Kesavan (2016): Detailed Study on Heavy Equipment with Its Latest Technologies and Recommendations for Its Usage for Different Metro Project

[4] GREEN CONSTRUCTION POLICY, Metropolitan Transportation Authority, CONSTRUCTION COMMITTEE, JULY 21, 2011

[5] Guangwu Liu, "The Metro Project Construction Safety Risk Managing System of GMC", FengxiaLuo, Gang Zeng, Open Journal of Safety Science and Technology, 2014, 4, 36-41

[6] RAIL OPERATIONS & MAINTENANCE PLAN, DRAFT, September 2007

[7]PriyankaChib," Optimization of Pune Metro Rail", International Journal of Engineering Trends and Technology (IJETT) – Volume17 Number7–Nov2014

[8] Ritesh Kumar Biswas, Kesavan, "Detailed Study on Heavy Equipment with Its Latest Technologies andRecommendations for Its Usage for Different Metro Projects", International Journal of Engineering Research, Volume No.5, Issue No.5, pp : 386-388: