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EQUIPMENT MANAGEMENT FOR ROAD CONSTRUCTION PROJECT

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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. Road construction projects are the yardstick to measure the development of country. Now the road construction projects are changing their face due to "Public Private Participation" in road projects, it has become a challenging job to complete the project in stipulated time. Modem construction projects are complex in nature and success of a project depends greatly on proper and scientific planning. Before starting any project its planning is done with great care, as the efficiency of the whole project largely depends upon its planning. While planning each and every detail should be worked out in anticipation and should be considered carefully. Planning of a construction project involves deciding about the extent of mechanization, equipment planning, and execution planning etc. while planning a highway project equipment manager should be carefully decided the extent of mechanization so as to minimize the cost of project.

KEYWORDS:- [Equipment, planning, kolhapur, excavation, earthwork, highway]

I. INTRODUCTION

The area between Kolhapur and Sangli city is developing very fastly. The axle load traffic volume and traffic density on Kolhapur-Sangli stretch is increasing day by day, hence four laning of national highway (NH-166, Ratnagiri-Nagpur) stretch between-Kolhapur and Sangli has become mandatory. This project of four laning is assigned to one of the leading: construction firm Supreme Infrastructure Limited. The total estimated cost of project is Rs. 196 crore at time of its announcement and now this cost is 270 crore in December 2014. Now this project is delayed. Total length of stretch is 45 km. It would be executed on a Build, Operate and Transfer basis with a concession period of 23 years& 11 months, including the construction period of two and half years. To complete this project in stipulated time period with best quality, there is need of efficient and effective equipment management.

II. OBJECTIVES

Equipment is one of the important resource of highway construction project. To complete any highway project in stipulated time period, it has become important to manage this vital resource. Use of the right equipment at the right place with minimum operating and maintenance cost is the aim of equipment management, which is necessary to achieve. Considering this following points are studied in the dissertation,Need of equipment management in construction road project. Selection methodology of equipment for project. Estimation of different types of equipment required for various activities of road project.

New techniques of equipment management. Construction features of six laning of Kolhapur-Sangli section. Of(NH-166, Ratnagiri-Nagpur)project. The above mentioned objectives will be studied in depth with the actual case study of four laning of Kolhapur-Sangli section of (NH-166,Ratnagiri-Nagpur)project.

III. CASE STUDY

1. GENERAL

National Highways Authority of India has awarded the: subject project to Supreme Infra Pvt. Ltd. design and construction of the Works on a fixed price lump sum turnkey basis. For the Construction of 4 laning, of Kolhapur -Sangli road project (NH-166) from Km 140.000 to Km150.000 in the state of Maharashtra.

In this chapter the road section is considered and analysis work including the equipment estimation is carried out for earthwork and paving operation with respect to the section. The location map is as shown in fig.4.1. The planning programme is studied and bar charts are generated which includes in following pages.

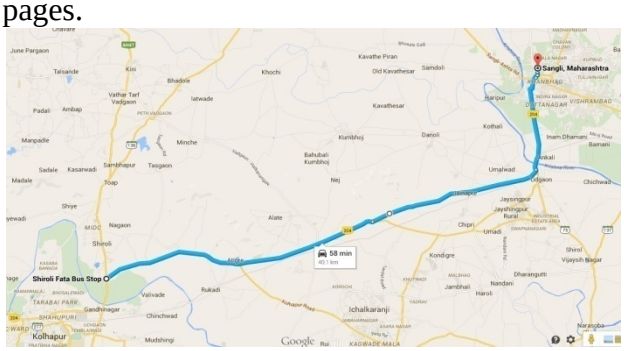

Fig. 4.1: Project Location Map

The major activities and their quantities of road from Halondi to SGI are as listed in following table 4.1

Sr. No.	Activity	Quantities
1.	Excavation	198264 Cum
2.	Earthworks	583339 Cum
3.	GSB	57877 Cum
4.	WMM	69049 Cum
5.	DBM	21281 Cum
6.	BC	13523 Cum

2 .PROJECT PLANNING

After studying the planning programme of Halondi to SGI road section data is listed out about earthwork and other activities as shown in following table.4.2.

Table 4.2 : Activities and Duration of Section of road from Halondi to SGI

Activity No.	Activity	Duration	Early Start	Early Finish
Carriageway Works				
1	Clearing and Grubbing	3	2	4
2	Earthwork in Excavation and Filling	8	3	10
3	Subgrade	8	4	11
4	Granular Sub Base	7	5	11
5	Wet Mix Macadam	6	6	11
6	Dense Bituminous Concrete	6	7	12
7	Bituminous	4	10	13
8	Road Marking & Signing Fixing	2	12	14
9	Construction of Bus Bays & Truck Lays	2	12	14
10	Construction of Toll Plaza	2	12	14

Based on the date collected regarding the various activities of section-1 ofpackage-1 the

bar charts are generated separately for service road and main carriageway construction. The bar charts of service road and main carriageway construction are as shown in fig.4.3 and fig.4.4 respectively.

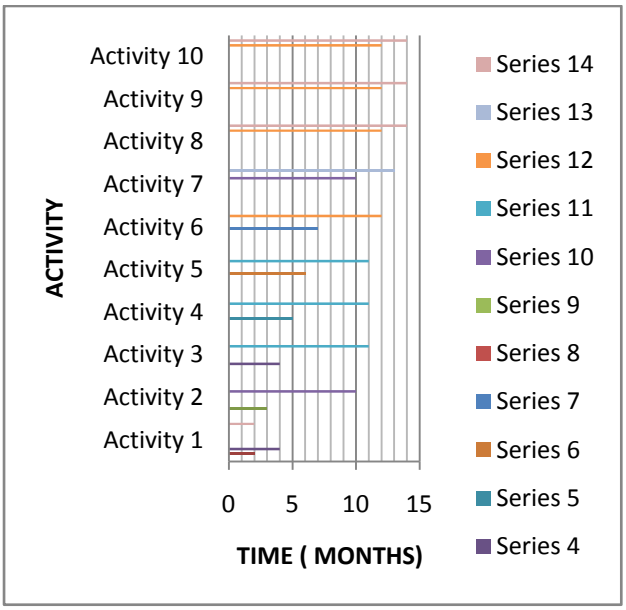

Fig.4.3.Bar Chart of Main Carriageway Construction of highway section

The above bar chart shows the construction programme of main road way of Halondi-SGI road. The bar chart is plotted activity v/s time in months. On X-axis the time required for each activity is given and on Y-axis the activities are plotted based on the data listed in table.4.2.

3.WORK WISE PERCENTAGE DISTRIBUTION

The following pie chart shows the work-wise percentage distribution of cost of package1.

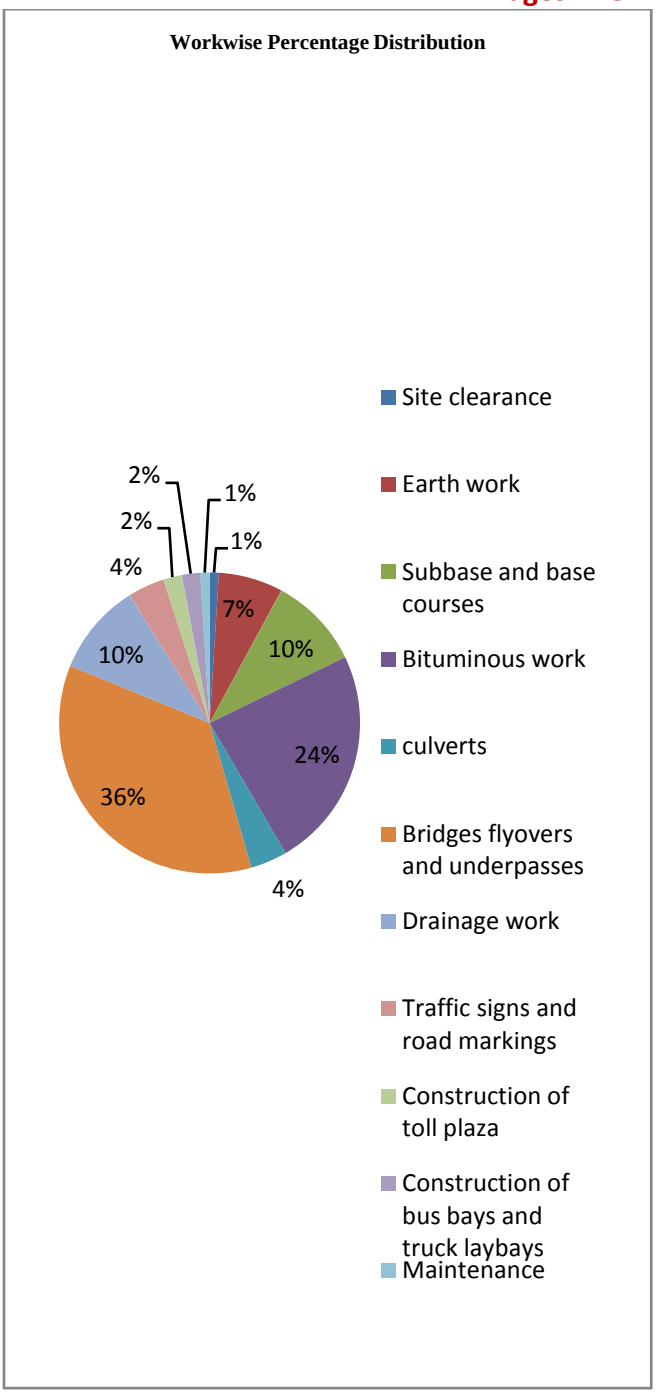

Fig.4.4: Chart of Work-wise percentage Halondi-SGI road

4. EQUIPMENT ESTIMATION AND CYCLE TIME STUDY

As far as the highway construction projects are concerned every activity of highway construction requires a particular group of equipment to complete it within the time constraint. Here the earthwork and pavement construction operations of Halondi to SGI road are considered and attempted to complete them

within the schedule time. Now 'in following sub-points we attempt to estimate equipment requirement for earthwork and pavement construction activities of service road of section-1 by keeping in mind the time constraint of each activity.

4. CLEARING AND GRUBBING (ACTIVITY-1)

Clearing and grubbing of whole service road site along the length is required to facilitate the further construction activities. Here service road is present on both sides of median.

Total area of clearing and grubbing = 2 x (Total length of service road x width of Service road).

Therefore, total area of clearing and grubbing = 2 x (10000 x7) = 140000sq.m.

The total time available for activity-1 is 3 months i.e. 84 working days (excluding Holidays).

Therefore, work to be completed per day = total area /total time.

= 140000/84 =1666.66 sq.m. (120 m Length per Day on both Sides).

Equipment requirement:

Here we decide to do work in two shift in first shift work is done on right hand side (R.H.S) and in second shift the work will be done oh (1 H.S). Each shift will be of 4 hours. Top vegetation cover of 50mm is to be made clear. Hence we have to achieve 120 m length i.e. 42.1 cum clearing and grubbing in 4hours.

Equipment deployed for this activity-1 are:

1) 3 dumpers of 7 cum capacity.

2) 1 Excavator loader (wheel track). TATA TH 76 : Here the available Excavator loader to contractor is of 014:5 cum (back hoe) and1 cum (loader) bucket capacity. We want the production' 61' 10.68 cum per hour. Bucket fill factor considered is 1.Cycle time observed Ts 15 sec or 0.25 min of backhoe and .58 min of loader with haul distance 25 ft.

Hence, the production of available backhoe/hr = (60 min-hr/0.25 min cycle)x 0.25 x 1 =60 cum/hr.

Therefore, calculated production for backhoe = 60 cum/hr> required production.

Therefore the equipment selected is ok.

The production of loader/hr == (60 min-hr/.58 min cycle) x 1 x 1 = 103.45cum/hr.

Therefore, production of loader/cycle = 1 cum. (for 0.58 cycle time)

Hence, to load the dumper of 7 cum the loader has to perform 7 cycles.

So, the total loading time of dumper == cycle time of loader 7 =4 min.

Cycle time of dumper = load time + (up+ down) + unloading time =4+ (10+8) +2=24min

Like-wise the whole activity is to be completed in two shift working alternately.

4.2 EARTHWORK IN EXCAVATION AND FILLING (ACTIVITY-2)

Earthwork in excavation and filling is second activity of the road construction. Major material found in soil survey along the existing two lane highways far as the ofpackage-1 is concerned is sand and gravel and at some places the black cotton/clay soil is also found.

Total quantity of excavation in ofpackage-1 =448938cum.

Total time available to complete activity-2 is 8 months i.e.200 working days

(Excluding holidays).

Therefore, work to be completed per day = Total quantity/ total time = 198264/200 = 991.32 cum.

Equipment requirement*: (Excavation at chainage 140 km)*

At chainage 140.000 km excavation is to be done for slab culvert. The quantity of excavation is to be done is 150 cum in one shift of 4 hours. The excavated material is to be dump at chainage 150.000 km for construction of earthen shoulder. We required here 37.5 cum production rate per hour.

Now, equipment deployed for this job as per availability are :

1) 1 Hydraulic excavator (hoe) TATA 210.
2) Dumper (4 no.).

Here the available hoe has bucket capacity of 1.1 cum. We require the production of 37.5 cum/hr. The material to be excavated is sandy clay. The bucket fill factor considered is 1.

Cycle time of hoe = loading the bucket + swing loaded bucket + dump bucket +swing empty bucket.

=8+6+4+5= 23 sec = 0.37 min. (observed values at site)

Therefore, the production of hoe TATA 210 = (60 min-hr/0,37 min cycle) x 1.1 x l
= 178.38 cum/hr.
Hence, calculated production of hoe TATA 210 = 178.38 cum/hr> required
Therefore the equipment selected is ok.
Now, production of hoe/cycle = 1.1 cum/cycle (for 01.37mm cycle time).
Hence, to load 10 cum of dumper required cycles = capacity of dumper/production of hoe per cycle.
= 10/1.1 = 9 cycles.
Therefore, total time required to load the 10 cum dumper = cycle time of hoe x 9
= 0.37 x 9 = 3.5 min.
Cycle time of dumper = loading time + (up + down) + unloading time
= 3.5 + (25 + 20) + 2 = 60 min =4hr.
In this way proper deployment of equipment for excavation operation is important.

4.3. SUBGRADE CONSTRUCTION (ACTIVITY-3)

Construction of subgrade satisfying me requirements, of minimum 10% CBR and compacting to 97% of modified proctor density. The required thickness of subgrade is 500mm. considering the following case:

Here subgrade construction 500 m stretch along the service road from chainage 145.000 km to 145.500 km is considered. The work is planned to complete in a day.
Total quantity of material required to dump for sub grade; construction = 500 x 0.5x7
= 1750 cum.

Therefore, it is required to excavate 1750 cum of material at borrow area which is 10 km away from road site and same to be transported and necessary to spread about 3.5 cum at interval of 100m. Here we required to complete this job in a day i.e. in two shifts of total 8 hours of working. So, excavator has to excavate 218.75 cum of material per hour and the sane is to be transported to site with suitable capacity of dumpers.
Now, equipments deployed for this job as per availability are:

1) 2 Hydraulic excavators (hoe) TATA 210.
2) Dumper (6 no.).
3) Motor Grader.
4) Water Bowser with Sprinklers.
5) Vibratory roller of 8 ton capacity.
6) Dozer.

Here the available hoe has bucket capacity of 1.1 cum. We require the production of 218.75 cum/hr. The material to be excavated is sandy clay. The bucket fill factor considered is 1.
Cycle time of each hoe = loading the bucket + swing loaded bucket + dump bucket + swing empty bucket.
= 8 + 6 + 4 + 5 = 23 sec = 0.37 min. (observed values at site).
Therefore, the production of hoe TATA 210 = (60 min-hr/0.37 min cycle) x 1.1 x l
= 178.38 cum/hr.
So, we deployed 2 excavators of same capacity.
Hence, calculated production of both excavators = 2 x 178.38 cum/hr
= 356.76 cum/hr> required production per hour.
Therefore the equipment selected is ok.
Now, production of each hoe/cycle = 1.1 cum/cycle (for 0.37mm cycle time).

Hence, to load 10 cum of dumper required cycles = capacity of dumper/production of each hoe per cycle.
= 10/1.1 =9 cycles.
Therefore, total time required to load the 10 cum dumper = cycle time of hoe x 9
=0.37 x 9= 3.5 min.
Cycle time of dumper = loading time + (up + down) + unloading time
=3.5+(25+20)+2=60min=l hr.

At road construction site the transported material is to be dump at 3.5 cum for100m interval the same is spread with dozer and graded with grader and then to achieve the required thickness the material is compacted after sprinkling water by 8ton of vibratory roller.

4.4 COST COMPARISON OF EQUIPMENT TRIAL:

Under this heading the cost comparison of equipment; trial is made to justify the selection done for the activities viz. Clearing and Grubbing, Earthwork in Excavation and filling and Sub grade Construction.

I) Clearing and grubbing activity:

It is very much important to complete the activity within the given time with minimum

operating cost. At the time of execution of this activity there were TATATH 76 AND cat excavator loaders are available of same capacity. Hence the following is the comparison between two combinations.

a) Trial-1:

In this trial based on the availability of equipments. The combination of TATA TH76 excavator loader (lyr.) and three dumpers is taken for first trial. Here the operating cost is calculated as below of excavator loader,

Operating cost/hr= Maintenance cost (negligible) + fuel consumption cost/hr + labour cost/hr.

= 0 + 9x 56 +60= Rs.564/-

b) Trial-2

In this trial based on the availability of equipments. The combination of cat excavator loader (life- 8 yrs.) and three dumpers is taken for first trial. Here the operating cost is calculated as below of excavator loader,

Operating cost/hr= Maintenance cost (negligible) + fuel consumption cost/hr + labour cost/hr.

=0+11x 56 +60

= Rs.676/-

Hence, the first trial is selected. The cost saving is as follows,

Cost savings operating cost oftrial-2 - operating cost of trial-1

= 676-564= Rs. 112/- (nearly 16% cost is saved).

Hence the trial-1 is selected for execution of Clearing and grubbing activity

II) Earthwork in Excavation and filling:

Here the available equipment are TATA Zaxis excavator and kobelco SK-210ofsame capacity. The operating cost of each trial is as follows:

a) Trial - l:

In this trial based on the availability of equipments. The combination of TATA Zaxis 210 excavator (2yr) and four dumpers is taken for first trial. Here the operating cost is calculated as below of excavator,

Operating cost/hr = Maintenance cost (negligible) + fuel consumption cost/hr +labour cost/hr.

=0+ 11x 56 +60

= Rs.676/-

b) Trial-2:

In this trial based on the availability of equipments. The combination ofKobelcoSK-210 excavator (life-6yrs) and four dumpers is taken for first trial. Here the operating cost is calculated as below of excavator,

Operating cost/hr = Maintenance cost (negligible) + fuel consumption cost/hr. + labour cost/hr.

= 0+13x 56 +60

= Rs.788/-

Hence, the first trial is selected. The cost saving is as follows,

Cost saving = operating cost oftrial-2 - operating costoftrial-1

= 788 - 676 = Rs. 112/- (nearly 15% cost is saved).

Hence the trial-1 is selected for execution of Earthwork in Excavation and filling activity

III) Subgrade construction activity:

Here also the available equipment for earthwork are two TATA Zaxis excavator and kobelco SK-210 same capacity. The operating cost of each trial is as follows:

a) Trial-1:

In this trial based on the availability of equipments. The combination of two TATA Zaxis 210 excavators (2yrs and 5yrs) and six dumpers is taken for first trial. Here the operating cost is calculated as below of excavator,

Operating cost/hr = 2 x (Maintenance cost (negligible) + fuel consumption cost/hr + labour cost/hr.)

=2x (0+11x 56 +60)

= Rs.l352/-

b) Trial-2:

In this trial based on the availability of equipments. The combination of KobelcoSK-210 excavator (life-6yrs), TATA Zaxis 210 (2yrs) and six dumpers is taken for first trial. Here the operating cost is calculated as below of excavator,

Operating cost of kobelco excavator/hr.

=Maintenance cost (negligible) + fuel Consumption cost/hr. + labour cost/hr.

=0+13x 56 +60,

= Rs.788/-

Operating cost of TATA excavator/hr

=Maintenance cost (negligible) + fuel Consumption cost/hr + labour cost/hr.

= 0+ 11x 56 +60
= Rs.676/-
Therefore, total cost in trial-2
= 788 + 676 = Rs. 1464/-
Hence, the first trial is selected. The cost saving is as follows,
Cost saving= operating cost oftrial-2 - operating cost oftrial-1
= 1464-1352= Rs.112/- (nearly 8% cost is saved).
Hence the trial-1 is selected for execution of Earthwork in subgrade construction activity

CONCLUSION

Equipment plays an important role in today's infrastructure projects as they are more demanding and highway projects are need to be complied in stipulated time with best quality. The cost of equipment in a project varies from 10-30% of the total cost of project, depending upon the extent of mechanization. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for successful completion of project. With the growing use of machinery it has become necessary for construction engineers to be thoroughly familiar with the construction application and upkeep of the wide range of modem equipment.

Equipment is one of the important resource of highway construction project. To complete any highway project in stipulated time period, it has become important to manage this vital resource. Use of the right equipment at the right place with minimum operating and maintenance cost is the arm of equipment management. In the project work the equipment estimation and cycle time study is done with reference section-l of four laning of Kolhapur-Sangli Section of NH-166, (Ratnagiri-Nagpur) project. It has been attempted to chase the project planning by calculating equipment requirement for earthwork and pavement operation considering the short time constraints of 27 months of project completion.

Based on the data observed from planning programme the bar charts are prepared for service road and main carriageway construction. Major activities cited are as follows:
1) Clearing and Grubbing Activity.
2) Earthwork in Excavation and filling Activity.
3) Earthwork in Subgrade construction.

For each activity listed above the trials combinations of equipment as per availability are performed. For clearing and grubbing activity comparison between two trial combinations of equipment is done. In first trial combination one excavator loader (TATA TH 76) and three dumpers (TATA) is considered and in second combination one excavator loader (CAT) and three dumpers (TATA) is considered. After calculating the 'hourly operation cost of both combinations it is noted that nearly 16% cost is saved when the first combination is adopted. This will leads to the saving Rs.108/hr.

For earthwork in excavation and filling activity comparison between two trial Combinations of equipment are done. In first trial combination one excavator (TATA Zaxis210) and four dumpers (TATA) is considered and in second combination one excavator loader (Kobeico SK-210) and four dumpers (TATA) is considered. After calculating the hourly operation cost of both combinations it is noted that nearly 16% cost is saved when the first combination is adopted. This will leads to the saving Rs. 108/hr. For earthwork in subgrade construction activity comparison between two trial combinations of equipment is done. In first trial combination two excavators (TATAZaxis210) and six dumpers (TATA) is considered and in second combination one excavator loader (Kobeico SK-210), one excavator (TATA Zaxis 210) and six dumpers (TATA) is considered. After calculating the hourly operation cost of both combinations it is noted that nearly 16%cost is saved when the first combination is adopted. This will leads to the saving Rs.l08/hr. In this way proper equipment requirement is estimated and optimum equipment utilization is achieved with 16% cost saving in clearing land .grubbing, earthwork in excavation and filling and subgrade construction activity respectively.

SCOPE FOR FUTURE WORK:

The project work is carried out by considering available equipment and its proper selection for achieving its optimum utilization.

Study can be further extended by adoption of modem equipment such as slip forms for rigid pavement.

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