

Inference & Interpretation With Classification, & Comparison Of Construction Equipments prevailing To Site Conditions

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Abstract- *In the present days with globalization of Indian economy & introduction of multinationals in India for construction activities, it has become foremost to have speedy construction using new technologies & trends in construction equipments. Construction equipments play a vital role in making the project successful with respect to cost & duration required to complete it. Conventional methods viz. adopting manual handling of materials, excavation, hauling, loading & unloading cannot cope up with demand of infrastructural facilities with high degree of quality control & assurance thus extending the duration of project. Though conventional method proves to be economical but fails in providing required number of dwellings in time. Thus latest construction equipments with new technologies have eliminated these drawbacks thereby permitting speedy excavation, loading, unloading & hauling with reduction in time & labor cost. Thus it has become an important task to develop the automated services in this sector too whereby it will be covered by studying, classifying & detailing the construction equipments.*

Keywords- Construction Equipments, Equipment selection.

I. INTRODUCTION

Construction of any projects include basic operations such as Excavation, Digging of large quantities of earth, Moving them to fairly long distances, Placement, Compacting, Leveling, Dozing, Grading, Hauling, Construction equipments play an important role in construction sector. Proper selection and allocation of equipments at site enhance time management activity at site. Construction equipments are important focus centers at site for proper cash flow at project & maintain quality of work at site. The activities involved in Construction Projects where the magnitude of the work is on a large scale, Speedy Work and Timely Completion of Work with Quality Control are very vital. In order to achieve this, Mechanization of Work has to be done, where Construction Machinery & Equipment play a pivotal role. The need for Mechanization arises due to the following reasons:

- Material handling in large quantities at high rise building & major projects.

- Optimum use of Material, Manpower and Finance.
- High grade materials increasing complexity of Projects
- On site magnitude & shortage of skilled and efficient manpower.
- Importance of keeping the Time Schedules.
- High quality standards

Construction equipments are the daily used machineries at construction site may be mechanical or atomized in present days. The construction equipment costs 30% of total investment made at any project. Construction equipment planning & selection play crucial role for success of construction firms. Appropriate selection of equipments to their respective works helps to reduce duration & cost of project. Complexity of today's building projects makes it harder to evaluate alternatives of equipment and take the right selection from many alternatives. With the growing awareness of the role played by mechanization and industrialization in project execution, the decreasing availability of skilled manpower, and tight budget and schedule constraints in a competitive construction environment, companies and project management teams often lack the tools to select the best combination of grouped equipment suitable to meet project requirements. Proper use of appropriate equipment contributes to Economy, Quality, Safety, Speed and Timely completion of the Project. Construction equipment is an important part of any construction process. It is not always desirable or possible for the Contractor to own each and every type of Construction Equipment required for the Project. Considering the various aspects of the utility of particular Equipment, the Contractor has to economically justify whether to purchase the Equipment or to hire it.

1. Equipment Management System

The concept of equipment management system deals with proper planning, selection and optimum utilization of construction equipment. An overview of equipment management system is as described below

1.1 Proper Planning

Modern 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 project equipment manager should be carefully decided the extent of mechanization so as to minimize the cost of project.

1.2 Selection

Proper selection of equipment for a construction project is of vital importance for its speedy and economical completion. Problem of equipment selection has become more complicated, because large varieties of equipment are being manufactured now-a-days. For selection of equipment, a considerable experience in the operation and maintenance in the field is essential. Records kept for operation, maintenance and actual output obtained under comparable conditions of previous projects will greatly help in taking decision for equipment selection. With the undertaking of new projects and the retirement of old machinery and equipment, it becomes necessary to acquire new construction equipment. In this stage, sufficient knowledge base of current brands and products is necessary. It is also important to determine what sort of equipment and capacity is needed. In fact, selection of equipment for the project is one of the key decisions in planning and executing a construction project, which affects how the work will be done, the time required to complete the work, and the cost that will be accrued. Generally, an equipment manager is responsible of selecting the equipment, whereas it is the responsibility of the construction planning group to select equipment. Nevertheless, both the inventory of equipment in hand and the standard equipment policy play an important role in equipment selection. Therefore, final decision on the equipment required for the projects is generally given by equipment managers, project managers, and construction planning group together. Often, the decision making process can create tensions in the firm. Once the selection of equipment is made, a choice has to be made whether to buy, rent, or lease it. These decisions are given based on the economic standing and strategy of the firm, and the nature and frequency of equipment use.

1.3 Optimum Utilization

This stage includes operations and maintenance of construction equipment. In this stage, the equipment in use should be maintained properly, by scheduling preventive maintenance periods. Scheduled maintenance reduces the incidents of failure, and thus minimizes costly breakdowns and stoppages on the project site. In manufacturing industry, preventive maintenance has increased the production level around 10–20 %, by reducing the break-down time of the equipment. For high utilization rates, the equipment should be kept in a good condition. Also, proper selection and training of operators and maintenance personnel is part of the responsibility of the equipment manager. In addition, safety of both the operators and the equipment should be considered and properly managed. Furthermore, proper registration and inventory records are part of the inventory process. Besides the equipment life cycle, equipment managers are also responsible or operating the equipment maintenance and storage facilities.

II. BRIEF DESCRIPTION OF FACTORS TO BE CONSIDERED WHILE SELECTING EQUIPMENTS

Typically, construction equipment is used to perform essentially repetitive operations, and can be broadly classified according to two basic functions:

1. Operators such as cranes, graders, etc. which stay within the confines of the construction site.
2. Haulers such as dump trucks, ready mixed concrete truck, etc. which transport materials to and from the site.

In both cases, the cycle of a piece of equipment is a sequence of tasks which is repeated to produce a unit of output. For example, the sequence of tasks for a crane might be to fit and install a wall panel (or a package of eight wall panels) on the side of a building; similarly, the sequence of tasks of a ready mixed concrete truck might be to load, haul and unload two cubic yards (or one truck load) of fresh concrete.

In order to increase job-site productivity, it is beneficial to select equipment with proper characteristics and a size most suitable for the work conditions at a construction site. In excavation for building construction, for examples, factors that could affect the selection of excavators include:

1. Size of the job: Larger volumes of excavation will require larger excavators, or smaller excavators in greater number.

2. Activity time constraints: Shortage of time for excavation may force contractors to increase the size or numbers of equipment for activities related to excavation.

3. Availability of equipment: Productivity of excavation activities will diminish if the equipment used to perform them is available but not the most adequate.

4. Cost of transportation of equipment: This cost depends on the size of the job, the distance of transportation, and the means of transportation.

5. Type of excavation: Principal types of excavation in building projects are cut and/or fill, excavation massive, and excavation for the elements of foundation. The most adequate equipment to perform one of these activities is not the most adequate to perform the others.

6. Soil characteristics: The type and condition of the soil is important when choosing the most adequate equipment since each piece of equipment has different outputs for different soils. Moreover, one excavation pit could have different soils at different stratum.

7. Geometric characteristics of elements to be excavated: A functional characteristic of different types of equipment makes such considerations necessary.

8. Space constraints: The performance of equipment is influenced by the spatial limitations for the movement of excavators.

9. Characteristics of haul units: The size of an excavator will depend on the haul units if there is a constraint on the size and/or number of these units.

10. Location of dumping areas: The distance between the construction site and dumping areas could be relevant not only for selecting the type and number of haulers, but also the type of excavators.

11. Weather and temperature: Rain, snow and severe temperature conditions affect the job-site productivity of labor and equipment.

II. CLASSIFICATION OF EQUIPMENTS

The basic operations involved in the construction of any Project are Excavation, Digging of large quantities of earth, Moving them to fairly long distances, Placement, Compacting, Leveling, Dozing, Grading, Hauling, etc. Construction Equipment can be classified as under:

1. Excavating Equipment
 - a. Power Shovel
 - b. Dragline
 - c. Hoe
2. Earthmoving Equipment
3. Hauling Equipment
4. Hoisting Equipment
 - a. Tower Cranes
 - b. Mobile Cranes
 - c. Crawler Mounted Cranes
 - d. Builders Hoist
 - e. Passenger Hoist
5. Conveying Equipment
6. Dredging Equipment
7. Pumping Equipment
8. Compacting Equipment
9. Pile Driving Equipment
10. Drilling Equipment
11. Equipment used for the Production of Aggregate
12. Equipments used in Hot Mix Batch Plant
13. Equipments used for Concrete Works
14. Material Testing Equipments

IV. NEED TO FOCUS ON CONSTRUCTION EQUIPMENT ISSUES ON SITE

Construction equipments though an important part of construction projects are ever ignored by owner & engineers thus leading to following problems as below-

- i) Expenditure of more amount of finance by contractors.
- ii) Increased duration of project as a result of unavailability of skilled labors for equipment operation.

- iii) Risk in construction projects as a result of unavailability of equipments spare parts & maintenance.
- iv) Unnecessary inculcated cost in improper equipment selection leading to extra labor & equipment cost.

Thus it has become a foremost need to avoid these risks in project & extra cost by detail studying & making available all required specifications to common people.

V. METHOD OF ANALYSIS

The main methodology i.e. techniques, tools, methods used here are classified under four phases as follows:

- 1) Classification & study of construction equipments according to their work & family classes.
 - The construction equipments focus centre of work is primary stage classified & studied in detail so as provide a datum to project.
 - Various equipments have been considered for detail view of all classes of equipments use in construction from primary stage of planning of project till concreting phase.

- 2) Select sites & consultancies to gather construction equipment details.

- 3) Collection of data from site & office.

- After the selection of sites & consultancies further the approach towards these locations is carried out for collection of details such as Cost of equipments, Duration of work & the working efficiency.

- Following equipment details have been collected:
 - a) Material handling equipments
 - b) Concreting solutions
 - c) Mechanization equipments

- 4) Preparing excel sheet giving all details of cost, duration & efficiency of equipments.

- After the overall data collection, the collected data is plotted in Ms Excel sheet..

VI. DATA COLLECTION

1. Material Handling Equipments:

- The details of material handling equipments are collected from various sites & consultancies.

- The data with respect to rates, work duration & load carrying capacity is collected.
- The details of lifting materials are classified into two types depending on the working condition & features as follows.
 - a) Passenger cum material lift cabin
 - b) Column
- Further various cost & working capacity range will be considered as input.

SR NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	EQUIPMENTS	BASIC PURCHASE COST EXCLUDING TD AND COST/TAX	WORK DURATION (HRS)	LOAD CARRYING CAPACITY
1	MATERIAL HANDLING EQUIP	PASSENGER CUM MATERIAL LIFT	PASSENGER CUM MATERIAL LIFT CABIN	Speedo 101-delux (5HP*2Nos) (Suitable for maximum 50 mt)	8,32,000	8 hrs	800 Kg
2				Speedo 101 (12.5HP*2Nos)	10,10,000		1000 Kg
3				Speedo 101.2 (12.5HP*2Nos)	10,50,000		1200 Kg
4				Speedo 101.5 (12.5HP*2Nos)	11,25,000		1500 Kg
5				Speedo 102 Top (12.5HP*3Nos)	13,25,000		2000 Kg
6				Speedo 201.5 (12.5HP*2Nos+2)	22,10,000		3000 Kg
7				Speedo 202(12.5HP*3Nos+2)	25,30,000		4000 Kg
8				Speedo Urja(7.5 HP*2Nos)	13,50,000		400 Kg
9				Speedo MPMH 101	3,15,000		1000 Kg
10				Speedo MPMH 102	12,40,000		2000 Kg
11			Coloma SMR 0.8T-Delux	15,500	88 Kg		
12			Coloma TMR 1 T	18,500	98 Kg		
13			Coloma SMR 1.2 T	21,000	128 Kg		
14			Coloma SMR 1.5 T	21,500	130 Kg		
15			Coloma SMR 2 T	23,000	140 Kg		
16			Coloma SMR 1.2 T twin cage	25,000	148 Kg		
17			Coloma SMR 2 T twin cage	26,000	155 Kg		
18			H-Frame	12,000	—		

Table No.1
(Details of Material Handling Equipments)

2. Concreting Equipments:

- The collected details of materials are classified into two types depending on the working condition & features as follows.

- a) Concrete mixers
- b) Batching plant
- c) Concrete pump
- d) Boom placer

- Concreting solution-
In concreting solution, concrete mixers, concrete batching plant and concrete pump are considered for the preparation of database.

- a) Concrete mixers-
 - i) 100 ltr mixer
 - ii) 200 ltr mixer
- b) Concrete batching plant-
 - i) Mobile batching plant
 - ii) Stationary batching plant
- c) Concrete pump

Table No.2
(Concreting Equipments)

SR NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	EQUIPMENTS	LOAD CARRYING CAPACITY	
1	CONCRETING SOLUTIONS	CONCRETE MIXER	100 LTR MIXER	5/3 Concrete Miser (Hand/Electrical)	5 Cu. Ft. / 3 Cu. Ft.	
			200 LTR MIXER	1017 GEN X Model	10 Cu. Ft. / 7 Cu. Ft.	
				1017 Concrete mixer self start	10 Cu. Ft. / 7 Cu. Ft.	
				1017 concrete mixer hydraulic hopper	10 Cu. Ft. / 7 Cu. Ft.	
				1017 concrete mixer mechanical hopper	10 Cu. Ft. / 7 Cu. Ft.	
				1017 Super 09 VH without hopper	10 Cu. Ft. / 7 Cu. Ft.	
				1017 Concrete mixer cum hoist	10 Cu. Ft. / 7 Cu. Ft.	
		BATCHING PLANT	MOBILE BATCHING PLANT	Pan type plant	22/30 Cu. Mtr/Hr.	
			Reversible type plant	15/20 Cu. Mtr/Hr.		
				20-30/30 Cu. Mtr/Hr.		
			STATIONARY BATCHING PLANT	Boom Scraper	12/15/20 Cu. Mtr/Hr.	
			CONCRETE PUMP	CONCRETE PUMP	Concrete Pump	48/30 and 75/45 Cu. Mtr/Hr.
				BOOM PLACER	Boom Placer	120/70 and 100 Cu. Mtr/Hr.

3. Mechanization Equipments

- The details of material handling equipments are collected from various sites & consultancies.
- The data with respect to rates, work duration & load carrying capacity is collected.
- The details of lifting materials are classified into two types depending on the working condition & features as follows.

- Compacting solutions
- Bar processing solutions
- Sand purifying machines
- Block making machines

Further various cost & working capacity range will be considered as input where classification is carried out as follows.

- Compacting solutions
 - Concrete compaction
 - Soil compaction
- Bar processing solutions
 - Bar cutting
 - Bar bending
 - Bar cutting & straightening
- Sand purifying machines
 - Sand screening
 - Sand washing
- Block making machines
 - Manual
 - Vibrator
 - Autoramming
 - Hydraulic

Table No.3
(Mechanization Equipments)

SR NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	EQUIPMENTS	WORK DURATION (HRS)	LOAD CARRYING CAPACITY
1	MECHANIZATION SOLUTIONS	COMPACTING SOLUTIONS	CONCRETE COMPACTION	Concrete Compactor Floater	8 hrs	600 Itr batch capacity
			SOIL COMPACTION	Earth Compactor		30cm/20 cm compactor
				Tamping Rammer		8.5 cm jumping stroke
			BAR PROCESSING SOLUTIONS	BAR CUTTING MACHINE		Bar Cutting UTS 65
		BAR BENDING MACHINE		Bar Cutting UTS 55		42mm/52mm
				Bar Bending UTS 65		36 mm
		BAR CUTTING AND STRAIGHTENING		Bar Cutting and Straightening		50-65mtr/min. wire traction
		SAND PURIFYING MACHINES	SAND SCREENING	Rotary Sand Screening		2 Cu. m/Hr or 4 Cu. m/Hr
			SAND WASHING	Vibratory Sand Screening		6 Cu. m/Hr
				Portable Sand Washing		6 Cu. m/Hr
		BLOCK MAKING MACHINES	MANUAL	Stationary Sand Washing		15 Cu. m. Input Capacity
				Manual Block Making Machine		400 Blocks/shift
				Vibratory Block Making Machine		640 Blocks/shift
				Autoramming Block Making Machine		500 Blocks/shift
		HYDRAULIC	Hydraulic Block Making Machine	400Hr		

4. Excavation Equipment

- The collected details of materials are classified into two types depending on the working condition & features as follows.
 - JCB Excavator
 - Drilling method & Blasting method
- Various methods for excavation has been considered depending upon the required capacity, nature of soil & type of work.

Table No.4
(JCB Excavators)

SR NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	EQUIPMENTS	BASIC PURCHASE COST (RS)	MAX DIG DEPTH (M)	MAX WORK HEIGHT (M)	MAX DUMP HEIGHT (M)	LOAD OVER HEIGHT (M)	BELOW GROUND DIG. (DEPTH)(M)	DUMP ANGLE (DEGREE)
1	EXCAVATORS	JCB	BACKHOE LOADER & FRONT EXCAVATOR	JCB 2DX	1450000	3.02	3.88	2.2	2.81	0.1	46
2				JCB 3DX	1950000	4.77	5.97	2.24	3.23	0.07	43
3				JCB 3DX XTRA	2350000	5.05	6.01	2.90	3.37	0.12	41
4				JCB 430 ZX	2486000	6.08	1.22	2.89	1.431		43

Table No.5
(JS Excavators)

SR NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	EQUIPMENTS	BASIC PURCHASE COST (RS)	MAX DIG DEPTH (M)	MAX DIG HEIGHT (M)	MAX DUMP HEIGHT (M)	MAX VERTIC AL SWING WALL RADIUS (M)	BUCKET ROTAT ION SPEED (DEGREE)	TRAVEL SPEED (KM/HR)	TRACTOR EFFORT (KGF)	CAPACITY (CUM)	
1	EXCAVATORS	JCB	BACKHOE LOADER & FRONT EXCAVATOR	JS 120	1000000	4.83	6.302	6.12	4.275	2.136	182	4.6	9000	12
2				JS 81	1000000	4.007	7.094	5.401	3.675	2.841	184	5.1	5000	11

Table No.6
(Drilling & Blasting Equipments)

SR NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	BASIC PURCHASE COST (RS)	CAPACITY
1	EXCAVATORS	DRILLING	TRACTOR + COMPRESSOR + JACK HAMMER	750000	2.5 ft - 12 ft
2		BLASTING	JELLETIN	5000/BOX (200 JELLETIN EACH BOX)	2.5 ft - 12 ft

5) Compaction Equipment

The details of compaction equipments are collected from various sites & consultancies. The data with respect to rates, working speed & load carrying capacity is collected.

SR.NO	CLASS	TYPE OF EQUIPMENT	COMPONENT	EQUIPMENTS	BASIC PURCHASE COST (RS)	CAPACITY (Centrifugal force)KN	WORKING SPEED KM/HR	TRAVEL SPEED KM/HR
1	COMPACTION	COMPACTORS	ROLLERS	MINI TANDEM ROLLER VMT 330	1000000	261	6	11.8
2				SOIL COMPACTOR VM115/D	1000000	282	4.5	10
3				SOIL COMPACTOR VM115PD	1000000	45	5	10.2
4				TANDEM ROLLER VMT360	1000000	71	5.5	11.5

6) Hauling Equipments

Various hauling equipments details are collected as explained further

Dump trucks – Used to move clay, dirt, soils, and sands. Side and rear dump trucks dispose of materials through the body attached to the chassis of the truck. Bottom dump trucks have two gates that open from the bottom to dispose of materials. For tougher terrain, articulated dump trucks are used.

Hauling trucks – Used to transport a fleet of equipment (for general, military, or service construction) from one location to another.

Table No.3
(Hauling Equipments)

SR.NO	NAME OF EQUIP	MATERIAL	CAPACITY	RATE
1	TRUCK	Cement	10 Tonne	10 Lakh - 15 Lakh
2	Hyva Truck	Sand	3 Brass-4 Brass	25 Lakhs
3	Hyva Dumper	Sand	6 Brass	30 Lakhs
4	Tractor with Trolley	1 Brass	7 Brass	Lakhs
5	Trailer	Cement	20 Tonne - 25 Tonne	25 Lakhs

VII FLOW CHART FOR PROCESS:



VII. CONCLUSION

In the present work all the details of construction equipments regarding their Costs, Rates & Efficiency have been gathered which has been further formulated in excel sheet in such a format that it becomes easy to all class workers to read it study & conclude about proper equipment selection. Thereby by it reduces & prevent any of the risks approaching the construction project regarding construction equipments.

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