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# **CONSTRUCTION EQUIPMENT MANAGEMENT**

# CONTENT

- Introduction
- Factors behind the selection of construction equipments
- Types of construction equipments
- Selection criteria for various construction equipment
- Plant and equipment acquisition

# Introduction

Good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment.

The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades.

The selection of the appropriate type and size of construction equipment often affects the required amount of time and effort and thus the job-site productivity of a project.

It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction.

# Advantages of utilizing the construction equipments:

- Increase the rate of output through work progress with the best effective and efficient methods.
- Reduce the overall construction costs especially for large contracts.
- Carry out activities which cannot be done manually or to do them more economically and much faster.
- Eliminate the heavy manual work by human thus reducing fatigue and eliminates various other hazards and health issues.
- Maintain the planned rate of production where there is a shortage of skilled or unskilled labor.
- Maintain the high quality standards often required by present-day design and specifications (technical standards).

# FACTORS BEHIND THE SELECTION OF CONSTRUCTION EQUIPMENTS

- Economic Considerations
- Company-Specific
- Site-Specific
- Equipment-Specific
- Client And Project-Specific
- Manufacturer-Specific
- Labour Consideration

# Economic Considerations

The economic considerations such as owning costs, operating labour costs and operating fuel costs of equipment are most important in selection of equipment.

Besides, the resale value, the replacement costs of existing equipment, and the salvage value associated with the equipment are also important.

# Company-Specific

The selection of equipment by a company maybe governed by its policy on 'owning' or 'renting'.

While emphasis on 'owning' may result in purchase of equipment keeping in mind the future requirement of projects, the emphasis on 'renting' may lead to putting too much focus on short-term benefits.

## Site-Specific

Site conditions-both ground conditions as well as climatic conditions-may affect the equipment-selection decision.

For example, the soil and profile of a site may dictate whether to go for a crawler-mounted equipment or a wheel-mounted equipment. If there is a power line at or in the vicinity of site, one may go for a fixed-base kind of equipment rather than a mobile kind of equipment.



## Equipment-Specific

Construction equipments come with high price tags. While it may be tempting to go for the equipment with low initial price, it is preferable to opt for standard equipments.

Such equipments are manufactured in large numbers by the manufacturers, and their spare parts are easily available, which would ensure minimum downtime. Besides, they can also fetch good salvage money at the time of their disposal.

## Client And Project-Specific

The owner/client in a certain project may have certain preferences that are not in line with the construction company's preferred policies as far as equipment procurement is concerned.

The schedule, quality and safety requirements demanded of a particular project may in some cases force the company to yield to the demands of the client.

# manufacturer-Specific

A construction company may prefer to buy equipment from the same manufacturer again and again, and that too from a specific dealer.

This may be to bring in uniformity in the equipment fleet possessed by the company or because the company is familiar with the working style of the manufacturer and the dealer.

# Labour Consideration

Shortage of manpower in some situations may lead to a decision in favour of procuring equipment that is highly automated.

Further, the selection of equipment may be governed by the availability or non-availability of trained manpower.

# TYPES OF CONSTRUCTION EQUIPMENTS AND THEIR SELECTION CRITERIA

▶ EARTHWORK EQUIPMENTS

▶ CONCRETING EQUIPMENTS

▶ HOISTING EQUIPMENTS

# TYPES OF EARTHWORK EQUIPMENTS

Backhoe

- Front shovel
- Dragline
- Clamshell
- Dozers

➤ Roller compactor

➤ Scraper

➤ Dumper

➤ Grader

# Backhoe

Backhoes are mainly used to clean up construction areas, to dig holes in the ground, to smooth uneven ground, to make trenches, ditches and to help remove deep roots from trees.



# Front shovel

Front shovel are mainly used for excavation purposes above its own track or wheel level.

They are suitable for heavy positive cutting in all types of dry soils.





# Dragline

They are used for bulk excavation below its track level in loose soils, marshy land and areas containing water.



# Clamshell

It consists of a hydraulically controlled bucket suspended from a lifting arm. It is mainly used for deep confined cutting in pits and trenches.



# Dozers

They are used for moving earth up to a distance of about 100m and act as a towing tractor and pusher to scraper machines. They can be track-mounted or wheel-mounted.



# Roller compactor

Roller compactor is mainly used to for compaction of earth and other materials in large works of highways, canals and airports.



# Scraper

They are used for site levelling, loading, hauling over distances varying between 150m-900m. They may be towed, two-axle or three-axle type.



# Dumper

It is used for horizontal transportation of materials on and off sites. Large capacity dumpers are used in mines and quarries.



# Grader

It is used for grading and finishing the upper surface of the earthen formations and embankments. They usually operate in the forward direction.



# SELECTION CRITERIA FOR EARTHWORK EQUIPMENTS

The selection of earthmoving equipment is mainly dependent on the following factors:

- Quantities of material to be moved
- The available time to complete the work the job conditions
- The prevailing soil types, the swell and compaction factors, etc.
- The job conditions include factors such as availability of loading and dumping area, accessibility of site, traffic flows and weather conditions at site.



In order to plan the number of Earthwork Equipment needed, the planner first determines the following:

- The suitable class of equipment for earthwork—for example, if the soil to be excavated is loose and marshy, and bulk excavation is involved in the project, one may opt for a dragline.
- The appropriate model of equipment based on different characteristics such as payload of bucket and speeds required. For example, draglines come in different capacities ranging from 0.38 cum to 3.06 cum; scrapers in capacities ranging from 8 cum to 50 cum and so on.
- The number of equipment needed for the project to carry out the given quantity.
- The number of associated equipment required to support the main equipment

# TYPES OF CONCRETING EQUIPMENTS

- Concrete batching and mixing plant
- Concrete mixers
- Concrete transit mixers
- Concrete pumps

# Concrete batching and mixing plant

They are mainly used for weighing and mixing large quantity of concrete constituents.

capacity:-

20cum/hr-250cum/hr



# Concrete mixers

They are mainly used for mixing small quantities of concrete constituents.

capacity:-

200lt/batch (small mixers)

200-750l/batch (large mixers)



# Concrete transit mixers

They are mainly used for transporting concrete from batching point.

capacity:-  
3cum-9cum



# Concrete pumps

They are used for horizontal and vertical transportation of large volumes of concrete in short duration.

capacity:-

30cum/hr (ordinary construction)

120cum/hr (specialized construction)



# SELECTION CRITERIA FOR CONCRETING EQUIPMENTS

Selection of concreting equipment can be complicated and difficult. The decision will involve many issues that have to be analysed. The following factors are noteworthy:

- Site characteristics such as boundary conditions, noise limitations and other restrictions.
- Equipment availability-local availability of equipments, whether the contractor owns that equipment
- Continuity of operation
- Effect of permanent work
- Weather conditions
- Temporary works
- Time restrictions
- Concrete specifications

***Concrete-mixing equipment*** selection will depend on factors such as the

- maximum and the total output required in a given time frame
- the method of transporting the mixed concrete
- the requirement of discharge height of the mixer.



*Concrete-placement equipment* selection depends on factors such as the

- capacity of the vehicle
- the output of the vehicle
- the site characteristics
- the weather conditions
- the rental costs, and the temporary haul roads.

# HOISTING EQUIPMENTS

It constitutes a group of equipment which are employed mainly for lifting or lowering of unit load and other . This group of equipment's can be further sub classified into:

## 1. Hoists

Boom hoists

Chain hoists

Electric hoists

Tractor hoists

## 2. Cranes

Derrick Crane

Mobile Crane

Tower Crane

# Boom Hoist

Boom hoists are used to lift weights on the hooks that are attached to the special metal ropes designed to bear maximum loads.

Boom hoist is mostly used as industrial machine where it loads the weight on containers.



# Chain Hoist

Chain hoists are quite common example of hoist system and it can be seen at most of the construction and industrial purposes. Basically, chain hoist consists of chain rope and pulley that is used to move the load from up to down.



# Electric Hoist

Electric hoist is modernized form of chain and boom hoist mostly used in the industries for fast working.

It is very much popular in material handling industries because it saves labor costs by handling maximum loads at a time with no damage threats.



# Tractor Hoist

Tractor hoist consist of a boom that is attached with base of tractor and a hook with rope is installed on this boom that can operated through driver controls.



# CRANES

Cranes are considered to be one of the most important equipment used in construction due to their key role in performing lifting tasks all over the construction site.

Plenty of crane models are available in different shapes

and sizes, though, they usually fall into three categories,

1. Derrick Cranes
2. Mobile Cranes
3. Tower Cranes

# SELECTION OF CRANES

Factors affecting the selection of cranes are—

## 1. Building Design

Building Height

Project Duration

## 2. Capability

Power Supply

Load lifting frequency

Operators Visibility

## 3. Safety

## 4. Economy

Cost of move in, setup, and move out

Cost for rent

Productivity

## 5. Site Conditions

Soil Stability and Ground Conditions

Access road requirement and site accessibility

Operating Clearance



# Mobile Cranes

- ▶ Adequate for all types of structures (up to 107 m)
- ▶ Used for shorter projects duration (less than 4 months).
- ▶ Not considered to be very safe due to lack of safety devices or limited switches prevent overloading.
- ▶ Can operate in muddy terrain but requires good ground conditions.
- ▶ Needs adequate operating clearance.

# Mobile Cranes



# Tower Cranes

- ▶ Preferable for high-rise (over 107 m).
- ▶ Used for longer project duration.
- ▶ Considered to be very safe due to the presence of limit switches.
- ▶ Can operate where ground conditions are poor.
- ▶ Does not need adequate operating clearance.

# Tower Cranes



# Derrick Cranes

- ▶ Preferable for high-rise and apartment buildings.
- ▶ Can be used for both long term and short term projects.
- ▶ Cheaper than mobile and tower cranes.
- ▶ Not considered to be safe.
- ▶ Used when clearance is inadequate for the other units and sufficient space is unavailable for the erection of a tower foundation.

# Derrick Cranes



## Plant and equipment acquisition

A construction company can acquire a construction plant and equipment through

- Cash or outright purchase
- Renting
- Leasing

# When It's Best to Buy

Buying or financing equipment is most sensible if the equipment is essential to your core fleet and expected to provide reliable service for a long time.

If you decide it's worth the large outlay of funds to buy or finance equipment, you'll find owning equipment can provide long-term tax benefits--principally from deduction of interest expense and depreciation of equipment.



# When It's Best to Rent

Renting entails a short-term agreement or contract to use capital equipment weekly or monthly, with the rental rate decreasing as the term lengthens.

Following are some other popular reasons for renting equipment:

- To fill in for peak periods, special projects, or broken machinery
- To try out equipment before buying or leasing it
- To lessen the risk of purchasing costly equipment that won't be needed later

# When It's Best to Lease

Leasing can be an attractive option if you use the equipment frequently but don't have the resources to purchase equipment outright or make an adequate down payment.

However, leasing carries higher interest rates and contractors usually are responsible for the insurance and personal property taxes on the equipment being leased.

# CONTENTS

- Introduction to Cost of Owning and Operating Construction Equipment
- Ownership cost
- Operating cost
- Effect of Depreciation & tax on selection of alternatives
- Equipment life & Replacement Alternatives
- Conclusion

# INTRODUCTION

The Plant, equipment and tools used in construction operations are priced in the following three categories

1. Small tools and consumables
2. Equipment usually shared by a number of work activities
3. Equipment used for specific tasks

Total equipment cost comprises two separate components

- Ownership cost
- Operating cost

# OWNERSHIP COST

Ownership costs are fixed costs. Almost all of these costs are annual in nature and include:

- Initial Cost
- Depreciation
- Investment Cost
- Insurance Tax and Storage Cost

# Initial cost

On an average, initial cost makes up about 25% of the total cost invested during the equipment's useful life. This cost is incurred for getting equipment into contractor's yard, or construction site, and having the equipment ready for operation. Many kinds of ownership and operating costs are calculated using initial cost as a basis, and normally this cost can be calculated accurately. Initial cost consists of the following items:

- ▶ Price at Factory + extra equipment + sales tax
- ▶ Cost of shipping
- ▶ Cost of assembly and erection

# Depreciation

The decline in market value of a piece of equipment due to age, wear, deterioration and obsolescence. Depreciation can result from:

- ▶ Physical deterioration occurring from wear and tear of the machine
- ▶ Economic decline or obsolescence occurring over the passage of time

In the appraisal of depreciation, some factors are explicit while other factors have to be estimated. Generally the asset costs are known which include:

- ▶ Initial cost
- ▶ Useful life
- ▶ Salvage value

# Depreciation

How ever, there is always some uncertainty about the exact length of the useful life of the asset and about the precise amount of salvage value, which will be realized when the asset is disposed. The Depreciation methods are

- ▶ Straight line method
- ▶ Sum of year digit method
- ▶ Sinking fund method
- ▶ Declining balance method



# Straight line method

It is the simplest to understand as it makes the basis assumption that the equipment will lose the same amount of value in every year of its useful life until it reaches its salvage value. The depreciation in a given year can be expressed by the following equation

$$D_n = (C - S) / N$$

Where  $D_n$  = Depreciation in year n

C = The initial cost

S = The salvage value

N = The useful life (years)

# Sum of year digit method

It tries to model depreciation that actual market value of a piece of equipment after 1 year is less than the amount predicted by SL method. Thus more annual depreciation in the early years of a machine's life and less in its later years. The depreciation in a given year can be expressed by the following equation

$$D_n = (\text{year n digit}) * (C - S) / \Sigma N$$

Where  $D_n$  = Depreciation in year n

year n digit = The reverse order

C = The initial cost

S = The salvage value

N = The useful life (years)

# Declining balance method

The depreciation for a given year is calculated on the basis of the undepreciated balance (instantaneous book value), rather than the original cost. Further the method does not take into account any salvage value of the asset. The factor can be determined using simple interest formula and also special tables developed for the purpose.

$$D_n = (M/N) * BV_{n-1} \quad BV_n = BV_{n-1} - D_n$$

Where  $D_n$  = Depreciation in year n

M = constant (Generally 2)

N = The useful life (years)

$BV_{n-1}$  = Opening book value at year n

# Sinking fund method

The method works in terms of a “sinking fund factor”, which is determined on the basis of the initial and salvage values of the asset, the service life and rate of (compound) interest. The factor can be determined using simple interest formula and also special tables developed for the purpose.

$$D_n = (C - S) * f$$

Where  $D_n$  = Depreciation in year n

C = The initial cost

S = The salvage value

f = sinking fund factor

N = The useful life (years)

# Investment cost

Investment (or interest) cost represents the annual cost (converted into an hourly cost) of capital invested in a machine. If borrowed funds are utilized for purchasing a piece of equipment, the investment cost is simply the interest charged on these funds. If it is purchased with company assets, an interest rate that is equal to the rate of return on company investment should be charged.

# Insurance tax and storage costs

Insurance cost represents the cost incurred due to fire, theft, accident and liability insurance for the equipment.

Tax cost represents the cost of property tax and licenses for the equipment.

Storage cost includes the cost of rent and maintenance for equipment storage yards, the wages of guards and employees involved in moving equipment in and out of storage, and associated direct overhead.

# Total ownership cost

The total equipment ownership cost is calculated as the sum of depreciation, investment cost, insurance cost, tax and storage cost.

This should be expressed as an hourly cost and used for estimating and for charging equipment cost to projects, it does not include job overhead or profit. Therefore if the equipment is to be rented to others, profit should be included to obtain an hourly rental rate.

# Operating COST

Ownership costs are also called “variable” cost. Because they depend on several factors such as the number of operating hours, the types of equipment used, and the location and working condition of the operation.

- Maintenance & Repair cost
- Tire cost
- Consumable cost
- Mobilization & Demobilization cost
- Equipment Operator cost
- Special Items cost



# The effect of depreciation and tax on selection of alternatives

The effect of depreciation and taxes is key factor on selection of alternative equipments.

# Equipment life and replacement alternatives

Once a piece of equipment is purchased and used, it eventually begins to wear out and suffers mechanical problems. At some point, it reaches the end of its useful life and must be replaced. The Equipment replacement decision involves determining when it is no longer economically feasible to repair.

- Equipment Life
- Replacement alternatives

# Equipment life

Construction equipment life can be defined in three ways.

## ➤ Physical life:

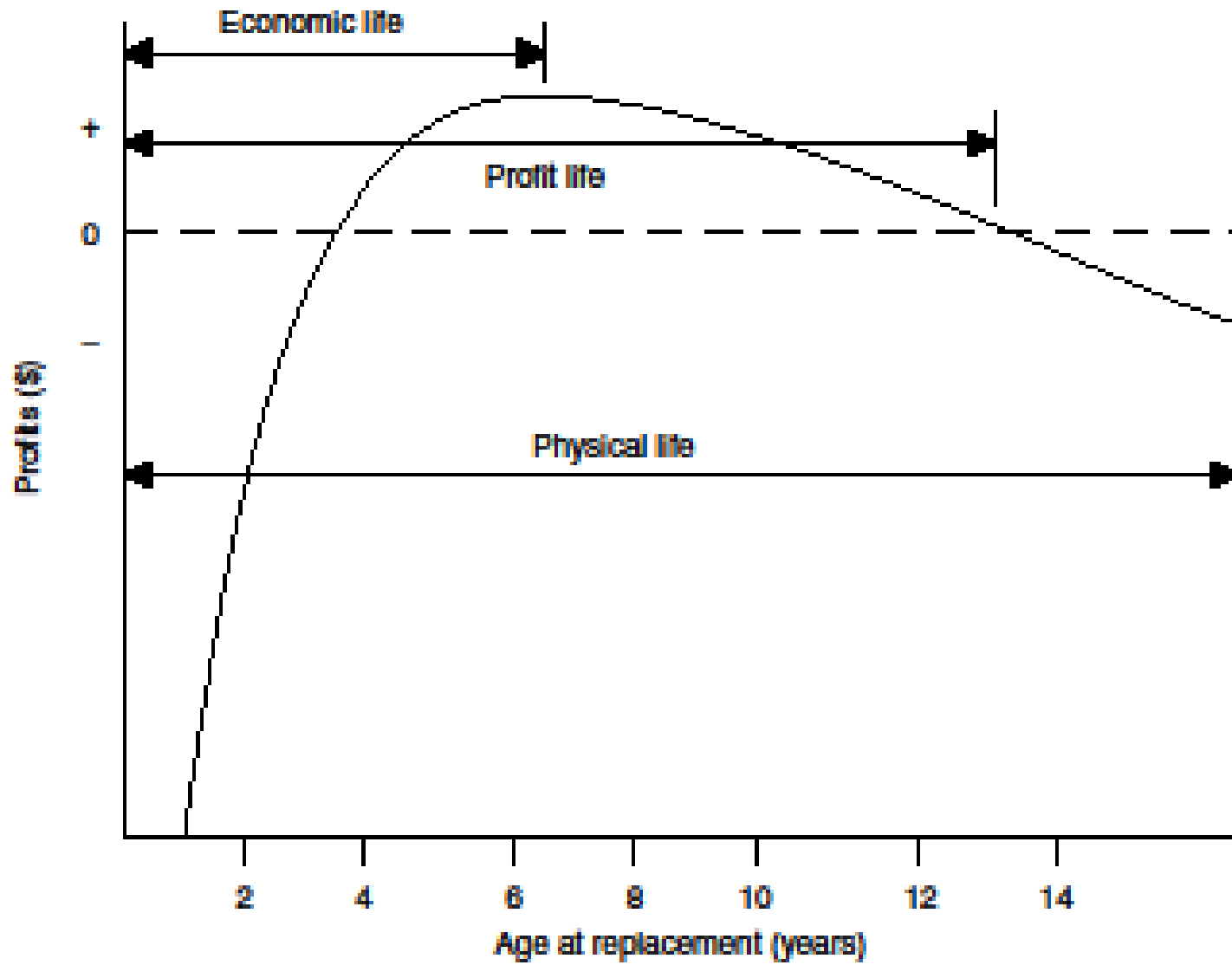
Age at which the machine worn out and can no longer reliably produce.

## ➤ Profit life:

The life over which the equipment can earn a profit.

## ➤ Economic life:

Time period that maximizes the profit over the equipment life.



# Replacement alternatives

The owners have to take replacement decision in correct time to avoid losses. As there are many factors involved, adopting the most appropriate method is also important. In determining the optimum replacement timing some analysis minimum cost, maximum profit and payback period are to be consider.

# conclusion

The selection of the appropriate type and size of construction equipment and its operation, maintenance affects the required amount of time and effort and thus the job-site productivity of a project.

It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction.