



RESOURCE MANAGEMENT:

CONCEPT OF RESOURCE MANAGEMENT: A large construction project can be split into number of activities which can be performed by utilization of a particular type of materials, category of labor, class labor etc. all these activities requires resources for their successful completion. The main resources in a construction project are materials, manpower, money, machinery ad time.

It becomes essential to manage these resources so that these resources are effectively and efficiently used to achieve economy and save time in all construction activities. Some of the resources can be arranged during pre-construction stage. It includes preparation of drawings, site clearance, water supply, power supply, approach roads, storage facility, call or tenders, award of contracts etc. Resources required during construction stage are arrangement of materials, manpower, machinery, money etc.

A resource plan is an important tool in effective management of scarce resources. The timings of the need of those resources should be determined within the project schedules. As the project schedules changes the resouces plan must also be flexible enough to adjust as these changes occur.

Materials resources and management: Materials is one of the important resource in construction projects. Materials are obtained either naturally or by artificial production some of the important materials used are stones, bricks, cement, fine aggregates, coarse aggregates, timber, aluminium, steel, fiber, plywood etc.

The materials required are estimated by estimated techniques and time when they are required at construction is estimated storage capacity available at site is determined. Place or market where these materials are available, transport facility and cost is collected. Time required for supply is noted from suppliers. The materials are brought by purchase orders based on availability, storage space, cost etc.

Human resources: Any construction activity requires human resources for its completion. Basically human resources can be classified as technicians, skilled labour, and unskilled labour.

Technicians are top-level engineers, supervisors, skilled labour is one who has enough idea, skills and experience in a specified works, unskilled labour are helpers, men and women coolies, water mam etc. knowing quantity of



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particular activity and task of turn out from a skilled man and helpers required an experienced engineer or supervisor can calculate how many labour are required. Histograms of labour can be prepared and labour can be arranged. Resource smoothing and leveling can be made to facilitate peak requirement as well to avoid idle labour situations. Under circumstances of peak demand of labour from other localities. Critical activities should maintain peak requirement and where ever float slack is available for non-critical activities adjustment be made.

Machinery Resources: Due to development of science and technology, huge requirement of manpower and large constructional activities. It has given rise to invention of obstruction equipments increase the speed and quality of work reducing manpower requirement. Some of the common equipment used in large construction projects are concrete batch mixing plants, asphalt/tar batch mixing plants, earth excavators, bulldozers, rollers, hoisting machines, tippers etc. in some cases special equipments like tunnel boring machines etc are used.

Financial Resources: Any construction project involves huge financial support. For purchase materials payment of skilled and unskilled labour renting or owning of machinery heavy finance is to be invested by company. Based on requirement of above at different stages of project financial arrangements may be made. Making use of CPM and PERT networks one can drive how much money is required every week or month and suitable steps are to be taken for procurement of finance.

CLASS OF LABOUR

A construction activity is a very complex process, made up of many different systems. These systems can be broken down into many more subsystems. In this way, construction project is divided into number of work packages. These work packages can be assigned to and completed by an individual worker or a crew. A crew is a team of workers, which can be of the same trade or a composite of many differet trades.

In general there are 3 categories of manpower involved in this industry consisting of skilled/semiskilled, unskilled/technical workers.

It has been observed that every Rs 1 Crore, investment on construction projects, generates employments of 22,000 unskilled man-days, 23,000 skilled or semi-skilled man-days and 9,000 managerial and technical man-days approximately.



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IS10302: 1982, Indian Standards on ' Unified nomenclature of workmen for civil engineering', published by its

Construction Management section committee includes around 95 categories of labours.

TYPES OF LABOUR

Construction labour can broadly divided into two types

1. Casual labour
2. Regular establishment

Casual labour: Casual labour is employed as and when required for the execution of work, payment is made on the basis of the number of days the labour works. There is no provision of leave, except the weekly holidays. This is also known as daily labour.

Regular Establishment: Regular establishment generally includes supervisory personal that are required for more or less continuous period during construction. They are paid monthly wages and entitled to leave and other benefits. The employees may be temporary or permanent. Permanent employees have great security of service and may be entitled to more service benefits than the temporary employees.

WAGES AND STATUTORY REQUIREMENT

Construction workers constitute one of largest categories of workers in the unorganized sector.

The worker is hired as an when required and are retrenched on completion of the work. The economic condition of the construction labour is the worst on account of their poor bargaining power, illiteracy and the temporary nature of their employment. Construction workers have no job security and are least trained.

Construction workers are paid very low wages. There are 2 methods of making wage payment to lab our, namely the time rate system and the piece rate system. In the time rate system, a suitable rate of payment is fixed per unit time for which labour is engaged on the work. In the piece rate system payment is based on output or production of the work. In this system, payment is made at the agreed rate for the actual quantum of work carried out by each other.

Payment of Wages

The remuneration given to workers for work performed by them is known as wages. Wages are of two types.



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1. Nominal wage: This is the remuneration paid to the worker in the form of money, but it does not include the value of any other benefit that may be provided.
2. Real Wage: Labour is often entitled to different benefits, such as leave, medical care, house rent allowance, bonus etc. If the value of such benefits is added to the nominal wage, it is known as real wage.

Wages are paid to the labour based on two methods:

1. Depending upon time devoted to the work. This method is known as **time rate system.**
2. Depending upon the quantity of work performed. This method is known as **piece rate system.**

TIME RATE SYSTEM

In Time rate system of payment of wages, a suitable rate of payment is fixed per unit of time devoted to work by the labour. The unit of time can be hours, days, weeks or months.

The rate of payment for casual labour is fixed per day and that of regular employees per month in the construction industry.

The advantages of this system are:

1. It is simple and easily understood by labour.
2. The quality of work will be good.
3. The workers do not get overstrained.

There are, however, the following disadvantages in the system

1. Constant supervision is required.
2. Effective cost control cannot be ensured.

PIECE RATE SYSTEM

In this system payment is made on the basis of the output or the production of the workers. The work done by each labour is measured and payment is made at the agreed rate. Thus a worker can make more money by increasing his output. The rate of each item of work is fixed on the basis of the past record of output. In this system a good worker can make more money by increasing the output.



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MINIMUM WAGES ACT, 1948:

The Minimum wages Act of 1948 was passed for the welfare of labour and provided for fixing the minimum rate of wages of labour. The Act aims at making provisions for the statutory fixation for the minimum rate of wages in number of industries where there are extensive chances for the exploitation of labour.

The **main provisions of Minimum wages Act** are:

1. The setting of advisory committees to collect information on which the minimum wages are based.
2. The wages of a worker in any scheduled employment shall be paid on a working day by:
 - (i) The 7th day after the last day of the wage period if the establishment has less than 1,000 employees.
 - (ii) The 10th day after the last day of the wage period if establishment has more than 1,000 employees.
3. The wages of an employee should be paid without any deductions except those items given below.
 - (i) Fines in respect of acts of omission.
 - (ii) Absence from duty.
 - (iii) Loss of goods directly attributed to the neglect of the employee.
 - (iv) House accommodation provided by the employer.
 - (v) Amenities and services provided by the employer.
 - (vi) Income tax
 - (vii) Subscription to the provident fund.
 - (viii) Recovery of advances.
 - (ix) Deductions ordered by the court.
 - (x) Payments to co-operative societies / Life Insurance Corporation.

WORKMEN COMPENSATION ACT, 1943:

The Workmen Compensation Act passed to protect the victims of accidents and their families from hardships out of and in the course of employment. The Act covers workers employed in hazardous occupations as specified in the schedule but excludes those employed in clerical or administrative work. The Act provides for payment of compensation in case of accidents on work sites. The compensation, however, is not payable for injuries due to



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- (i) Disobedience or negligence,
- (ii) Non observance of safety measures
- (iii) Consumption of liquor
- (iv) Diseases which are not contracted as a result of the occupation. In the case of the death of a worker, compensation is paid under all circumstances.

Accidents are due to,

1. Human causes such as poor eye sights, negligence, effect of toxicants.
2. Mechanical causes such as inadequate safety devices, live electrical equipment, unreliable scaffolding etc.
3. Environmental causes such as poor lighting, heat, noise etc.
 - Compensation to be paid depends on the result of the accidents.
 - Act appoints for the appointment of commissions for the quick disposal of claims of compensation.
 - Employers are required to notify fatal or serious accidents to the commissioner within 7 days.

CONTRACT LABOUR ACT, 1970

The contract labour Act, 1970 was passed to regulate the employment of contract labour in certain establishments. It also provides for improving the service conditions of contract labour. The Act is of importance to the construction industry where works are executed through contractors or by contract labour.

The Act applies to every establishment and contractor employing twenty or more workmen.

The Act does not apply to establishments in which only work of an intermittent or casual nature is performed.

The Act provides for the constitution of a Central Advisory Contract Labour Board under the Central Government and of state Advisory contract labour Board under each State Government to advise the Central and State Governments on matters arising out of the administration of the Act and to carry out the functions assigned to it under the Act.

CLASSIFICATION OF LABOUR LAWS

In India Labour Laws may be classified under the following heads:

I. Laws related to Industrial Relations such as:

1. Trade Unions Act, 1926



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2. Industrial Employment Standing Order Act, 1946.

3. Industrial Disputes Act, 1947.

II. Laws related to Wages such as:

4. Payment of Wages Act, 1936

5. Minimum Wages Act, 1948

6. Payment of Bonus Act, 1965.

7. Working Journalists (Fixation of Rates of Wages Act, 1958)

III. Laws related to Working Hours, Conditions of Service and Employment such as:

8. Factories Act, 1948.

9. Plantation Labour Act, 1951.

10. Mines Act, 1952.

11. Working Journalists and other Newspaper Employees" (Conditions of Service and Misc.Provisions) Act, 1955.

12. Merchant Shipping Act, 1958.

13. Motor Transport Workers Act, 1961. 28

14. Beedi & Cigar Workers

15. Contract Labour (Regulation & Abolition) Act, 1970.

16. Sales Promotion Employees Act, 1976.

17. Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979.

18. Dock Workers (Safety, Health & Welfare) Act, 1986.

19. Building & Other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996.

20. Building and Other Construction Workers Welfare Cess Act, 1996

21. Cine-Workers and Cinema Theatre Workers (Regulation of Employment) Act, 1981

22. Dangerous Machines (Regulation) Act, 1983

23. Dock Workers (Regulation of Employment) Act, 1948

24. Dock Workers (Regulation of Employment) (Inapplicability to Major Ports) Act, 1997

25. Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993



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26. Industrial Employment (Standing Orders) Act, 1946
27. Mines and Mineral (Development and Regulation Act, 1957
28. Plantation Labour Act, 1951
29. Private Security Agencies (Regulation) Act, 2005

LABOUR PRODUCTIVITY:

Productivity may be defined as the rate of transformation of inputs into outputs in a productive operation. In order that we may produce product or provide a service, we must have resources in the form of men, materials, machine, money etc. in a broad sense, productivity means goods and services produced in relation to the resource's utilized.

Productivity in construction is often broadly defined as output per labor hour. Since labor constitutes a large part of the construction cost and the quantity of labor hours in performing a task in construction is more susceptible to the influence of management than are materials or capital, this productivity measure is often referred to as *labor productivity*. However, it is important to note that labor productivity is a measure of the overall effectiveness of an operating system in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone. For example, by investing in a piece of new equipment to perform certain tasks in construction, output may be increased for the same number of labor hours, thus resulting in higher labor productivity.

FACTORS AFFECTING LABOUR OUTPUT OR PRODUCTIVITY

- 1) Overtime
- 2) Morale and attitude
- 3) Work complexity
- 4) Repetition of work
- 5) Quality control
- 6) Equipment intensive tasks
- 7) Supervision
- 8) Dilution of supervision
- 9) Labour availability
- 10) Stacking of trades



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- 11) Joint occupancy
- 12) Beneficial occupancy
- 13) Concurrent operations
- 14) Mobilize/ Demobilize
- 15) Errors and omissions
- 16) Start/ stop
- 17) Sit access
- 18) Hazardous work area
- 19) Climatic and weather conditions
- 20) Role of management

1. Over time - Scheduling of extended work days or weeks exceeding a standard 8 hour work day or 40 hour work week lowers work output and efficiency through physical mental attitude.
2. Morale and attitude – Spirit of workers based on willingness, confidence, discipline and cheerfulness to perform work or task can be lowered due to a variety of issues including increased conflicts, disputes, excessive hazards over time, over inspection, multiple contract changes, disruption of work rhythm, poor site condition, absenteeism and so on.
3. Work complexity – A simple familiar work is easier to execute than an unfamiliar, complex one.
4. Repetition of work – While the first time execution of an unfamiliar work needs extra effort and results in low output, the skill acquired in the process, when utilized over a period of time to execute similar works, improves productivity rate.
5. Quality control – Stringent quality control is sensitive projects, like in the construction of a nuclear reactor cells for frequent inspections which involve elaborate documentation and is a time consuming task.
6. Supervision – An efficient and effective supervisor can get a higher productivity from laborers’.
7. Labour availability – The labour productivity depends upon the employed opportunities available in the market. If jobs are plenty and labour is scarce, the labour productivity tends to be less. In scarce job situations, the overall productivity improves since the employers can then sort out labour with a light



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productivity.

8. Errors and omissions – Increase in errors and omissions impact on labour productivity because changes are then usually performed on a crash basis, out of sequence, caused dilutions of supervisions or any other negative impact.
9. Site Access – This is a result of interferences to the convenient or planned access to work areas. This can be due to blocked stairways, roads, walkways, insufficient man lifts, or congested work sites.
10. Hazardous work area – This is caused when working in an area that is classified as hazardous, requiring special safety equipment and clothing. Restrictions may limit time and exposure of workers to the area, resulting in less time on tools in the area.
11. Climatic and weather conditions – Performing work in a change of season, temperature zone or climatic change resulting in work performed in either very hot or very cold weather, rain or snow, or other changes in temperature or climate can impact workers beyond normal conditions.
12. Role of management – The project management has a key role to play in planning and controlling productivity. It is responsible for specifying the weekly target of work to be accomplished by the workers as well as how the works are to be executed and using which resources.

CONSTRUCTION EQUIPMENTS:

Construction equipment's are one of the important resources of a modern construction, especially in infrastructure projects. Such projects utilize equipment's for most of the works including earth moving operations, aggregate production, concrete production and its placement, so on.

There are different types of construction equipment suitable for different activities in a construction project. In order to select the right equipment including its rate of production and the associated cost to operate the equipment.

CLASSIFICATION OF CONSTRUCTION EQUIPMENT

1. Earthwork equipment

- i. Earth cutting and moving equipment: bulldozers, scrapers, front-end loaders, motor graders.
- ii. Excavation and lifting equipment: backhoes, power-shovels, draglines, clamshells.



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- iii. Loading equipment: loaders, shovels, excavators.
- iv. Transportation equipment: tippers, dump trucks, scrapers, conveyors.
- v. Compacting equipment: tamping foot rollers, smooth wheel roller, Pneumatic rollers, vibratory rollers, plate compactors.

2. Concreting plant and equipment's

- i. Production equipment: batching plant, concrete mixers.
- ii. Transportation equipment: truck mixers, concrete dumpers.
- iii. Placing equipment's: concrete pumps, conveyors, hoists, grouting equipment.
- iv. Concrete vibrating equipment: needle vibrators, plate compactors.

3. Material hoisting equipment

- i. Hoists: fixed, mobile, fork-lifts.
- ii. Mobile cranes: crawler mounted, self-propelled rubber-tyred, truck mounted.
- iii. Tower cranes: stationary, travelling type.

4. Special purpose heavy construction and equipment

- i. Aggregate production equipment: crushing plants, rock blasting equipment, screening plants.
- ii. Concrete paving equipment: concrete paver finishers.
- iii. Pile driving equipment: pile driving hammers.
- iv. Asphalt mix production and placement equipment : asphalt plants, asphalt pavers.
- v. Tunneling equipment: drill jumbos, muck-hauling equipment, rock bolters, tunnel boring machines.

5. Support and utility services equipment

- i. Pumping and Dewatering equipment.
- ii. Pipe laying equipment.
- iii. Generators.
- iv. Welding equipment.

CLASSIFICATION OF CONSTRUCTION EQUIPMENTS

- 1. Earth moving equipment
- 2. Earth compacting equipment
- 3. Earth hauling equipment



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4. Hoisting equipment
5. Conveying equipment
6. Aggregate production equipment
7. Equipment used in concrete production
8. Pile driving equipment

1. EARTHMOVING EQUIPMENT

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

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

Some of the earth moving equipment's are:

Excavators, back hoe, front shovel, Dragline , Clamshel, Bulldozers, scapers, gradr , loaders, trenching machines etc.

2. EARTH COMPACTING EQUIPMENT

Compactors are the machines frequently used to compact materials such as soil in order to increase the density for constructions.

- Vibratory pad foot compactors.
- Common varieties are plate tampers (also known as rammers)
- In addition, compactors are utilized in land fill tasks
- Vibratory plates, compactors(also known as tamping foot rollers) and the function of compaction equipment is to produce higher density in soil mechanically. The basic forces used in compaction are static weight, kneeding, impact and vibration.



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The degree of compaction that may be achieved depends on the properties of soil, its moisture content, the thickness of soil layer for compaction and the method of compaction.

3. HAULING EQUIPMENT

The equipment used for transportation of material are known as hauling equipment or simply haulers. Haulers may operate on the roadways or railways.

It involves,

- Transportation of building materials
- Carriage and disposal of excavated earth
- Haulage of heavy construction equipment

Some of the hauling equipment's are truck, dump truck, dumpers, etc.

4. HOISTING EQUIPMENT

Hoisting is the lifting of weight from one location and moving it to another location which is at a reasonable distance.

- Hoisting equipment includes jacks, winches, chain, hoists and cranes.
- Crane is the only simple machine which has a single piece, is capable of providing 3 dimensional movement of a weight.
- Big projects such as construction of dams, industrial building etc. requires hoisting equipment.
- These equipment's are used for lifting the loads, holding them on suspension during transfer from one place to other and placing them at designated locations.
- It constitutes a group of equipment which are employed mainly for lifting or lowering of unit load and other.

5. CONVEYING EQUIPMENT

- A conveyors system is mechanical handling equipment that moves materials from one location to another.
- Conveying is mainly used in mining, construction and in some of the industries.
- In construction industries, conveyors are mainly used for concreting purpose.



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- Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor system allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries.
- Can be done horizontally, vertically, inclined.

Examples: Belt conveyors, screw conveyor and aerial transport.

6. AGGREGATE PRODUCTION EQUIPMENT

- Aggregate production consists of 2 stages i.e. recovery and processing
- In any project, where concrete requirement is very high and aggregate preparation and processing plant is essential to complete the concreting operations.
- Aggregate has to be produced at the site, if the quantity needed is very large.
- Basic materials such as stone, is recovered from a rock quarry or from the river bed and processing is done , which consists of crushing, grading, washing and stock piling of aggregate .
- Crushing consists of pressure, impact and combination of these operations.
- Crusher are used mainly to reduce the size of large stone or rock to smaller uniform sized aggregates required for concrete mix.

7. EQUIPMENT USED IN CONCRETE CONSTRUCTION

- Concrete is basically cement, aggregate and water mixed together and then deposited and permitted to solidify.
- They are mainly used for waving and mixing large quantity of concrete constituents.
- Operation involved in concrete production batching, mixing, handling and transportation, placing, finishing, curing.
- In huge concreting concrete and quantity depends on time of mixing, so mixers are used.
- Examples: concrete production plants, concrete mixers, concrete transit mixers, concrete pumps and vibrators.

8. PILE DRIVING EQUIPMENT

- The process of pile driving involves lifting the piles into position, holding it to refusal or to a specified depth.
- Driving is accomplished through hammering the pile top with a hammer.



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- Equipment are so designed for driven effectively at an economical cost.
- Major pile driving equipment are pile driving rigs, pile driving hammers

SELECTION OF CONSTRUCTION EQUIPMENT

1. Site condition
2. Nature of the work
3. Size of the equipment
4. Standardization
5. Availability of equipment
6. Availability of spare parts
7. Multi-purpose equipment's
8. Client and project specific
9. Labor considerations
10. Use in future projects
11. Economic consideration
12. Reliability of equipment's
13. Service support
14. Operating requirements
15. Past performance

1. Site Condition: Primary site condition factors are: types of material to be handled, physical constrains onsite and hauling distance. An example of a type of material handled could be the number of trees and their sizes. In the clearing of a site, if there are only shrubs, then a dozer with traditional dozer blade may work fine. However if big trees are present and needed to be cleared, then a more powerful dozer with specialized V-tree cutter blade may be needed. Another example that can influence equipment selection is the type of soil encountered. For example, the compaction of clayey soil is done best with a sheep's foot roller, whereas more sandy soil is best compacted with a vibratory roller.



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2. Nature of work: some factors relating to the nature of the work include pay load, the total quantity of work and the construction schedule. Payload has the direct relation to the capacity of the equipment selected. For example, the particular crane selected must be able to lift maximum load the work may require.
3. Size of the equipment: size of the equipment should be such that it must be able to use with other matching units. If the equipment selected is of larger size that will remain idle for most of the time, or shall work on part loads which means production cost will be more. On the other hand, if the equipment is of smaller size than desired, the equipment will not to able to work with matching equipment's and hence other equipment will have to remain idle or to be allowed to work on part loads, which shall again be uneconomical.
4. Availability of equipment: The equipment which is easily available in the market should be purchased. It should also be ensured that the equipment is of repute and is likely to be continued to be manufactured in the future also. This is necessary for future standardization and ensuring spare parts supply.
5. Availability of spare parts: while selecting a particular type of equipment, it should be ensured that the spare parts will be available at reasonable price throughout the working life of the instrument. It should also be ensured that the downtime of the equipment for want of spare parts may not be may not be more. This is all the more necessary in case of imported equipment's.
6. Multipurpose equipment's: there are certain type of equipments which are not utilized fully. Therefore if possible, they must be capable of performing more than one function. For example, excavator with wheel loader bucket arrangement or with rock breaker attachment.
7. Use in future projects: when a equipment completes only a part of their useful life in a project, it should be kept in view that the equipment can be used in future projects and may not become waste.
8. 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.
9. Reliability of the equipment: equipment selected for the project must be reliable one.



10. Service support: service support should be available in the area of project where the equipment shall be used. Service after sales is a major criteria for selection of equipment.
11. Operating requirements: The equipment selected should be easy to operate and maintain, acceptable to the operator and should have lesser fuel consumption.
12. Past performance: if the equipment being purchased is of new make and model, it is desirable to enquire about its performance from other users, who are using this make and model.
13. Reputation of the manufacture, warranty or guarantee offered by the manufacturer, use of standard components in the equipment, etc also considered while selecting equipment's.

ESTIMATION OF OWNERSHIP COST

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

- i. Initial capital cost
- ii. Depreciation
- iii. Investment (or interest cost)
- iv. Insurance cost, taxes 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 the contractor's yard, or construction site and having the equipment ready for operation. Many kinds of ownership and operating costs.

Initial costs consists of the following items

- Price at factory +extra equipment+ sales tax
- Cost of shipping



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- Cost of assembly and erection

Depreciation –

Depreciation represents 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.

Generally, the asset costs are known which include:

- Initial cost: The amount needed to acquire the equipment.
- Useful life: The number of years it is expected to be of utility value.
- Salvage value: The expected amount the asset will be sold at the end of its useful life.

Methods of depreciation

- Straight line method
- Declining Balance method
- Sum of year (SOY)
- Sinking Fund Method

Investment (Interest) cost-

This cost represents the annual cost of the capital invested in a machine. If borrowed funds are utilized for purchasing a piece of equipment, the equipment cost is simply the interest charged on these funds.

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

OPERATIONAL AND MAINTAINENCE COST OF CONSTRUCTION EQUIPMENTS

1. Cost of operating construction equipment-



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Operating cost of construction equipment are the costs associated with the operation of a piece of equipment. They are incurred only when the equipment is actually used. They depend on the number of operating hours, the types of equipment used, and the location and working condition of the operation.

2. Maintenance and repair costs-

The cost of maintenance and repairs usually constitutes the largest amount of operating expense for the construction equipment. Construction operations can subject equipment to considerable wear and tear .Generally, the maintenance and repair costs get higher as the equipment gets older.

Equipment owner will agree that good maintenance, including periodic wear measurement, timely attention to service and daily cleaning will extend the life of the equipment.

3. Tire cost-

Tire cost represents the cost of tire repair and replacement. Because the life expectancy of rubber tires is usually far less than the life of the equipment on which they are used on, the depreciation rate of tires will be quite different from the depreciation rate of the rest of the vehicle .

4. Consumable cost-

Consumable cost is the items required for the operation of a piece of equipment that literally gets consumed in the course of its operation.

- a) Fuel cost-
- b) Lubricating oil cost

5. Mobilization and Demobilization cost-

This is the cost of moving the equipment from one job site to another.

6. Equipment operator cost-

Operators wages are usually added up as separate item and added to other calculated operating costs. They should include overtime or premium charges, workmen's compensation insurance, social security taxes, bonus in hourly wage figure



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DEPRECIATION COSTS: Depreciation is the loss in value of equipment resulting from use or age (useful life".

Assume a unit of equipment will decrease in value from its original total cost at a uniform rate. There are / three methods for influential the cost of depreciation.

METHODS OF CALCULATING DEPRECIATION

1. Straight line method
2. Declining Balance method
3. Sum of year (SOY)
4. Sinking Fund Method

1) STRAIGHT LINE METHOD

- It is the most widely used and easiest method.
- Here, it is assumed that a machine loses its value by same depreciation (D_m) for any year (m) for a constant value and thus for book value (BV_m) decreases with uniform rate over the useful life of machine.

Depreciation Rate i.e $R_m = I/N$

Depreciation, $D_m = R_m (P-F)$

OR $D_m = (P- F/N)$

The book value (BV_m) at the end of 'n' years ,

$$BV_m = P -m.D_m$$

P=purchase rate

N= economic life

B = Purchase Rise

F= Salvage value

PROBLEM (Straight line method)



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- 1) An equipment is available for the purchase of Rs 8,00,000/- which has a useful life of 5 years and has an estimated salvage value of Rs 80,0000/- . Calculate the depreciation, total depreciation and Book value for each of 5 year by using STRAIGHT LINE METHOD.

Solution:

$P = \text{Rs } 8,00,000/-$

$N = 5 \text{ Years}$

$F = \text{Rs } 80,0000/-$

Depreciation at the end of 5 Years,

$D_m = (P-F/N)$

$= 8,00,000 - 80,0000/5$

$D_m = \text{Rs } 1,44,000$

Therefore, every year the equipment loses Rs 1,44,000

Year (m)	Depreciation (Dm)	Total Depreciation	Book Value (BVm)
0	- No depreciation in 0 year	-	8,00,000
1	1,44,000	1,44,000	6,56,000 (8,00,000- 1,44,000)
2	1,44,000	2,88,000 (1,44,000+1,44,000)	5,12,000 (8,00,000-2,88,000)
3	1,44,000	4,32,000 (2,88,000+1,44,000)	3,68,000 (8,00,000-4,32,000)
4	1,44,000	5,76,000 (4,32,000+1,44,000)	2,24,000 (8,00,000-5,76,000)
5	1,44,000	7,20,000 (5,76,000+1,44,000)	80,000 (8,00,000-7,20,000)



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OR

We can directly find out the book value of the equipment at the year using the formua,

$$BV_m = P - m \cdot D_m$$

For Example: Book value at the 5th year= 8,00,000-5*1,44,000
 =80,000

2) DECLINING BALANCE METHOD (DB Method)

- This is an accelerated method that provide a large portion of cost of equipment to b return of earlier years
- This method gives approximately the loss in market value with time.
- This declining balancing method ranges **1.25 – 2 times** market value

NOTE-

All though the estimated salvage value (F) is not included in the calculation but, the book value cannot go below the salvage value.

The depreciation rate for DB is given by,

For 1.25 DB Method, **R = 1.25/ N**

For 1.5 DB , **R = 1.5 /N**

For 1.75 DB, **R = 1.75/N**

For 2 DB, **R=2/N**

Allowable Depreciation for any year ‘N’ is given by $D_m = R \cdot P(1 - R)^{m-1}$

$$D_m = (BV_{m-1} - 1)R$$

The book value for any year ‘m’ is given by $BV_m = P(1 - R)^m$

$$=BV_{m-1} - D_m$$



DEPARTMENT OF CIVIL ENGINEERING

MODULE-2

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For balancing, depreciation at 'm' year is given by = (P-Total depreciation of previous year – Salvage value)

PROBLEM (Declining Balance Method)

1) Solve by 2 DB Method.

P=8,00,000, F= 80,000, N= 5 Years

Solution: $R= 2/N$

$$= 2/5 = 0.4$$

m	R	Dm	Total Depreciation	BVm
0	-	-	-	8,00,000
1	0.4	3,30,000 (0.4*8,00,000)	3,20,000	4,80,000 (80,00,000-3,20,000)
2	0.4	1,92,000 (0.4* 4,80,000)	5,12,000 (3,20,000+1,92,000)	2,88,000 (80,00,000-5,12,000)
3	0.4	115200 (0.4*2,88,000)	6,27,200 (5,12,000+ 115200)	1,72,800 (8,00,000-6,27,200)
4	0.4	69120 (0.4*1,72,800)	6,96,320 (6,27,200+69120)	1,03,680 (8,00,000-6,96,320)
5	0.4	41472 (0.4*1,03,680)	7,37,792 (6,96,320+41,472)	62208 (8,00,000-7,37,792)

62208 is less than the salvage value , so that ha to be corrected.

Dm= P – Total depreciation of previous years – Salvage Value

$$= 8,00,000- 6,96,320 – 80,000$$

$$=23680 \text{ (Corrected Dm)}$$



5	0.4	23680	7,20,000 (6,96,320+23680)	80,000 (8,00,000-7,20,000)
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3. SUM OF YEAR (SOY) METHOD

- This is an accelerated method which is applied to accounting method which computes the rate of depreciation faster than straight lie method.

SOY=N (N+1)/2

Depreciation Rate , Rm= N-M+1/ SOY

Annual Depreciation, Dm = Rm (P-F)

PROBLEM (SOY)

1) P = 7,00,000, F =70,000 , N =7 Years

Solution:

SOY=N (N+1)/2

Depreciation Rate , Rm= N-M+1/ SOY

Annual Depreciation, Dm = Rm (P-F)

SOY = 7(7+1)/2

= 28

m	Rm	Dm	Total Depreciation	BVm
0	-	-	-	700000



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1	7/28 (7-1+1/28)	157500 (7/28*(7,00,000-70,000))	157500	542500 (7,00,000-157500)
2	6/28 (7-2+1/28)	135000 (6/28*(7,00,000-70,000))	292500 (157500+135000)	407500 (7,00,000-292500)
3	5/28 (7-3+1/28)	112500 (5/28*(7,00,000-70,000))	405000 (292500+112500)	295000 (7,00,000-405000)
4	4/28 (7-4+1/28)	90000 (4/28*(7,00,000-70,000))	495000 (405000+90,000)	205000 (7,00,000-4,95,000)
5	3/28 (7-5+1/28)	67500 (3/28*(7,00,000-70,000))	562500 (495000+67500)	137500 (7,00,000-562500)
6	2/28 (7-7+1/28)	45000 (2/28*(7,00,000-70,000))	607500 (562500+45000)	92500 (7,00,000-607500)
7	1/28 (7-7+1/28)	22500 (1/28*(7,00,000-70,000))	630000 (607500+22500)	70000 (7,00,000-6,30,000)

4. SINKING FUND METHOD (PRESENT WORTH METHOD)

In this method, the annual depreciation of an equipment is assumed to be equal sinking fund plus interest on the fund for that year.

Thus, the capitalizing value of annual sinking fund for the age passed represent the depreciation of an equipment.



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$$I = S * i / (1 + i)^N - 1$$

Where, S=Amount of sinking fund to be created

$$S = P - F$$

N = Useful life of the equipment

I = Annual installment or annual sinking fund

i = Rate of interet per annum

PROBLEM. (SINKING FUND METHOD)

1) P = 8,00,000, F = 80,000 ,N= 5 Years , I = 6%

Solution:

$$I = S * i / (1 + i)^N - 1$$

$$S = P - F$$

$$= 8,00,000 - 80,000$$

$$S = 7,20,000$$

$$I = 7,20,000 * 0.06 / (1 + 0.06)^5 - 1$$

$$I = 127725$$

Year	Annual Sinking Fund (a)	Interest on Sinking Fund (b)	Depreciation (a+b)	Total Depreciation	BVm
0	-	-	-	-	8,00,000



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1	1,27,725	-	1,27,725	1,27,725	6,72,275 (8,00,000-1,27,725)
2	1,27,725	7664 (1,27,725*6%)	1,35,389 (127725+7664)	2,63,114 (1,27725+135389)	5,36,886 (8,00,000- 2,63,114)
3	1,27,725	15,787 (2,63,114*6%)	1,43,512 (127725+15787)	4,06,626 (2,63,114+1,43,512)	3,93,374 (8,00,000-4,06,626)
4	1,27,725	24,398 (4,06,626*6%)	1,52,123 (127725+24398)	5,58,749 (4,06,626+1,52,123)	2,41,251 (8,00,000-5,58,749)
5	1,27,725	33,525 (5,58,749*6%)	1,61,250 (127725+33525)	7,19,999 (5,58,749+1,61,259)	80001 (8,00,000-7,19,999)

BASIC CONCEPT OF EQUIPMENT MAINTAINENCE:

Maintaining includes all labour (both direct and indirect), material, plant, and overhead required to sustain equipment in good serviceable condition. It includes periodic inspection , lubrication, servicing, repairs and overhauls. The key to entire program is scheduled maintenance. Maintenance can be controlled only if the bulk of it is scheduled.

Communication is very important in operating such a maintenance system. Management must keep all necessary personnel informed.

The function of equipment maintenance organization is to establish the schedules for equipment and to keep the operating departments advised of these schedules. This scheduling must be accomplished with top management



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stressing on maintenance philosophy. Maintenance should be scheduled o minimize the effect of any downtime on regularly scheduled operations. Operating divisions should keep the maintenance supervisor informed of any inability to comply with the schedule established, so that the maintenance can be rescheduled at an early, more convenient time.

Objectives of maintenance:

- To maximize availability of plant, equipment and machinery for productive purposes.
- To extend the lifespan of plant, equipment and other facilities.
- To ensure operational readiness of equipment at all times.
- To reduce the cost of lost production due to break-down.
- To provide information to the management on the cost and effectiveness of maintenance.
- To ensure safety through regular inspection and maintainence of plant, equipment and other facilities such as compressor, elevators, material handling equipment etc.

Types of Maintenance:

1. Breakdown maintenance
2. Preventive maintenance

Breakdown maintenance: Breakdown of a machine can occur due to the following 2 reasons: (1) Due to unpredictable failure of components which cannot be prevented; (2) Due to gradual wear and tear of the parts, which can be decided that, when a part should be replaced, so that breakdown can be avoided. In breakdown maintenance, defects are rectified only when the machine cannot perform its function any longer, and the production department is compelled to call on the maintenance engineer's for the repairs. After repairing the defect, the maintenance engineers do not attend the machine again until another failure occurs. This method is much expensive due to increase of depreciation cost, payment to idle operators, overtime to the maintenance staff for doing the emergency repairs, and idling of matching equipment.

Preventive Maintenance: Preventive maintenance is termed as "planned maintenance" or "scheduled maintenance" or "systematic plant maintenance". It is an extremely important function for the reduction of maintenance cost and to keep the good operational condition of equipment and hence increases the reliability. Preventive maintenance aims to locate the sources of trouble and to remove them before the breakdown occurs.



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Thus it is based on the idea-Prevention is better than cure. Scheduled maintenance is always economical than unscheduled maintenance. Best safeguard against costly breakdowns is to inspect, lubricate and check up the equipment as frequently as possible. To take full use of equipment and to maintain it in reliable condition, necessary measures should be taken to prevent overloading, dampness, negligence and misuse of machines

MATERIAL MANAGEMENT:

Material management is the management system for planning and controlling all efforts necessary to ensure that correct quality and quantity of materials are specified in a timely manner, obtained at a reasonable cost, and available at the point of use when required.

Material management can also be defined as “the function responsible for the co-ordination of planning, sourcing, moving, storing and controlling materials in an optimum manner so as a pre-decided service can be provided at a minimum cost.

More recently the construction industry given more importance on the management of project materials and equipment, which can amount to 50% or more of project costs. Some companies in construction industry, for example, the large engineering procurement and construction contractors are aware of the importance of material management and have established computerized material tracking system. They realized the need for better material management , especially for large complex projects that use thousands of components. The negative cost impact of shippings delays and poor procurement procedures became increasingly important to the project, and therefore these companies had to lead the way in integrating good material management systems into their operations.

The general building industry is beginning to appreciate the importance of material management and the tremendous potential for increasing productivity and safety on construction projects. Smaller construction projects do not require material management system.

But regardless of size, some system, whether manual or computerized , is necessary. As part of overall material management , some database systems track the status of major pieces of equipment and critical items. S

Its objectives are:



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1. Maximise the use of the firm's resources.
2. Provide the required level of customer service.

Manufacturing creates wealth by adding value to goods. To improve productivity and wealth, a company must first design efficient and effective systems for manu-facturing. It must then manage these systems to make the best use of labour, capital and material. One of the most effective ways of doing this is through the planning and control of the flow of materials into, through, and out of manufacturing.

There are three elements to a material flow system: supply, manufacturing planning and control and physical distribution. They are connected what happens in one system affects the others.

Traditionally, there are conflicts in the objectives of a company and in the objectives of marketing, finance and production. The role of materials management is to balance these conflicting objectives by coordinating the flow of materials, so customer service is maintained and the resources of the company are properly used.

Materials management is a body of knowledge which helps the production/op-erations manager to improve the productivity of capital by reducing the materials cost. About two-thirds of any company's sales turnover are spent to purchase materials. It is, therefore, of considerable importance to reduce this materials bill as much as possible, since any such reduction will result in greater profit.

Materials management refers to management of materials. It broadly covers purchases of materials purchased or acquired from outside sources, transporting the materials to its place to use, keeping the materials in stock, maintaining an optimum level of inventory of materials, issuing the materials as and when required and, finally, keeping an overall account of the materials whether in process or in stores.

Objectives and Fuctions of Material Management:

- Efficient materials planning
- Buying or purchasing
- Procuring and receiving
- Storing and inventory control
- Supply and distribution of materials



- Quality assurance

Importance of material management:

- Lower prices for material and equipment
- Faster inventory turn-over
- Continuity of supply
- Reduced lead time
- Reduced transportation of costs
- Less duplication of efforts
- Improved supplier relationship and better records and information
- Better inter-department co-operation and Personnel development

FUNCTIONS OF MATERIAL MANAGEMENT:

All activities concerned form the materials part of the materials management func-tion.

These functions are:

1. Purchasing:

Purchasing is one of the basic functions of materials management.

The objectives of industrial purchasing are the following:

- (a) To maintain continuity of production.
- (b) To buy for the best ultimate value, not necessarily always at the lowest price.
- (c) To increase profits.

Effective functioning of the purchasing function is vital to the smooth operation of many other departments.

2. Inventory Control:

The word 'inventory' is defined as the 'materials lying in storage or idle materials'.



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Inventory control is the technique of maintaining all classes of inventory at optimum levels, with the minimum investment of capital. In other words, inventory control means balancing the two opposite forces, i.e., overstocking with all financial hazards and under stocking leading to operational bottlenecks.

3. Stores Management:

Proper receipts, inspection, storage and preservations, safety and issue of materials with efficient documentation assist in good house-keeping of materials in a ware-house. This avoids shortage and surplus during annual or continuous stock taking and prevents loss or deterioration of materials in hand.

4. Disposal of Surplus/Scrap/Obsolete Materials:

Another important area where materials management can play an effective role is in the disposal of surplus/obsolete materials. Over a period of time manufacturing units accumulate large amounts of obsolete and surplus materials. Since the materials department is in constant touch with the market, the disposal of such materials is always to the advantage of the materials department.

Not only is the materials departments in touch with the market, it is also aware of the consumption of materials in the various divisions of the company and also in similar units in the industry. By virtue of this knowledge, the materials department is in a position to sell the surplus materials to advantage or dispose it off as per the company's policy.

Objectives of Materials Management:

“The objectives of materials management department are:

A. Primary Objectives:

1. Low price.
2. High inventory turnover (Inventory turnover = Sale/Average Inventory)
3. Low cost of acquisition and possession.
4. Continuity of supply.
5. Consistency of quality.



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6. Low payroll (wage) cost.
7. Favourable supplier relations.
8. Development of personnel.
9. Maintenance of regular records.

These objectives may now be briefly described:

Low price:

This is one of the most important objectives of materials management. It means that the materials or services as received by the company should be purchased at the lowest possible cost.

High inventory turnover:

This means that the average inventory locked up is low compared to the sales volume. Inventory means idle money and, therefore, the lower it is, the higher will be the profit. Storage and carrying cost of inventory will, therefore, also be lower if the volume is small. Low cost acquisition and possession

This means that the materials are acquired and kept in stores at a low cost.

Continuity of supplies:

One of the main objectives of proper (scientific) materials management is to ensure that there is no disruption in supply which might hamper the smooth flow of production. Continuity of supply is necessary to ensure uninterrupted production.

Consistency of quality:

Materials of the right quality have to be bought. Otherwise the quality of the end-product may suffer. Hence, the quality will have to be good and consistent.

Low payroll cost:

Like any other department, the materials department should be run at the lowest possible cost.

Favourable supplier relations:



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As the name signifies, in order to ensure continuity of supply and consistency of quality, it is necessary to have a favourable supplier/buyer relation.

Development of personnel:

Regular developments are taking place in the materials management field. It is necessary that the persons dealing with materials management are appraised of the latest ideas and trends. Hence, the development and training of personnel engaged in materials functions is absolutely essential.

Maintenance of regular records:

For any efficiently run department it is necessary to have good, updated and easily accessible records.

B. Secondary Objectives:

1. Favorable reciprocal relations.
2. New materials and products.
3. Make or buy decision.
4. Standardization.
5. Product improvement.
6. Inter-departmental harmony.
7. Forecast.

Favourable reciprocal relations:

It sometimes pays to buy materials from the companies to whom the end products are sold. This is called reciprocal relationship. A good materials management department should encourage such reciprocal relationships with other companies.

New materials and products:



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The materials manager is always in touch with the outside world. He acts as an information centre for the management and informs the management, not only about the materials and products which his company requires, but also about the development of new products produced by its competitors.

Make or buy decision:

The decision as to whether an item should be made from within the company, i.e., with its own resources, or purchased from outside (external) sources is a very important one.

The materials department, along with the help of the engineering department, by taking the pros and cons of making or buying, should buy from outside sources only if it is economical to do so.

Standardization:

Materials required by the company and bought from outside should be standardised so as to have a fewer number of materials. This will reduce total inventory.

Product improvement:

The materials department should also help the company in improving the quality of the end product by suggesting various alternative methods.

Inter-departmental harmony:

The materials department should have a good relationship with the other departments inside the company.

Forecast:

The materials department has to prepare the materials budget and forecast of payments. The department will also forecast the prices of materials to be purchased.

INVENTORY MANAGEMENT:

Inventory is simply a stock of physical tests having some economic value which can be either in the form of material, money or labour. Inventory is also known as an idle resource as long as it is not utilized. Inventory may be regarded as those goods which are procured stored and used for day-to-day functioning of the organization.



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Inventory control is the technique of maintaining stock items at delivered levels. In other words, inventory control is the means by which material of the correct quality and quantity is made available as and when it is required with due regard to economy in the storage costs, ordering costs, set up costs, manufacturing costs, purchase prices and working capital.

These are following 3 main issues involved in inventory management and control:

- How and how to prioritize for procurement?
- How much to order?
- When to order?

Need for Inventory control in Construction

Out of the total cost of a construction project, above 50%-75% cost is associated with the cost of materials used. Therefore, an effective control over the materials cost is required for reducing the overall cost of construction.

Periodical inventory of the tools, equipment and materials should be taken up in every site to know the exact position and condition of the materials, tools and plant.

Its main advantages are:

- Any excess material not presently required can be shifted to other site for use,
- Any shortfall or damages to the material can be brought to notice of the higher authorities.
- Consideration of percentage of wastage for various materials can be studied.
- Purchasing of material in stages as per work programme can be followed to avoid additional burden due to excess inventory.
- Repairs and modifications to storing system can be done if required, inventory management and control cross checking of the records maintained by the store keeper can be done.

Objectives of Inventory control:

- To maintain the overall investment in inventory at the lowest level, consistent with operating requirements
- To supply the product, raw materials, sub-assemblies, semi-finished goods etc
- To its users as per their requirements at right time and at right place.



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- To keep inactive, waste, surplus, scrap and obsolete items at minimum level.
- To reduce risk inherent inventory as an investment which is risky.

Factors affecting inventory:

1. Purchase price or production cost
2. Selling price
3. Procurement costs
4. Carrying or holding costs
5. Cost of operating the information processing system
6. Shortage cost
7. Demand ordering cycle
8. Delivery lag or lead time

EXPECTED QUESTION:

1. Explain basic concepts of resource management.
2. List and explain the class of labours.
3. List out the laws of wages act.
4. What are the factors affecting labour output and productivity
5. List out and explain the different types of equipment are used in construction.
6. Explain the concept of equipment maintenance
7. Explain the factors considered in selection of construction equipment's.
8. Describe the estimation of ownership cost and operational cost.
9. Explain the objectives and functions of material management.
10. Explain the maintenance of equipment's.
11. Explain inventory management