

# CONSTRUCTION MANAGEMENT

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# CONSTRUCTION PLANNING

- Objective of Construction Planning
- Work Breakdown Structure
- Construction Scheduling
- Classification of Construction Scheduling
- Methods of Construction Scheduling
- Bar Chart
- Bar Chart of a Residential Building

# IMPORTANCE OF CONSTRUCTION PLANNING

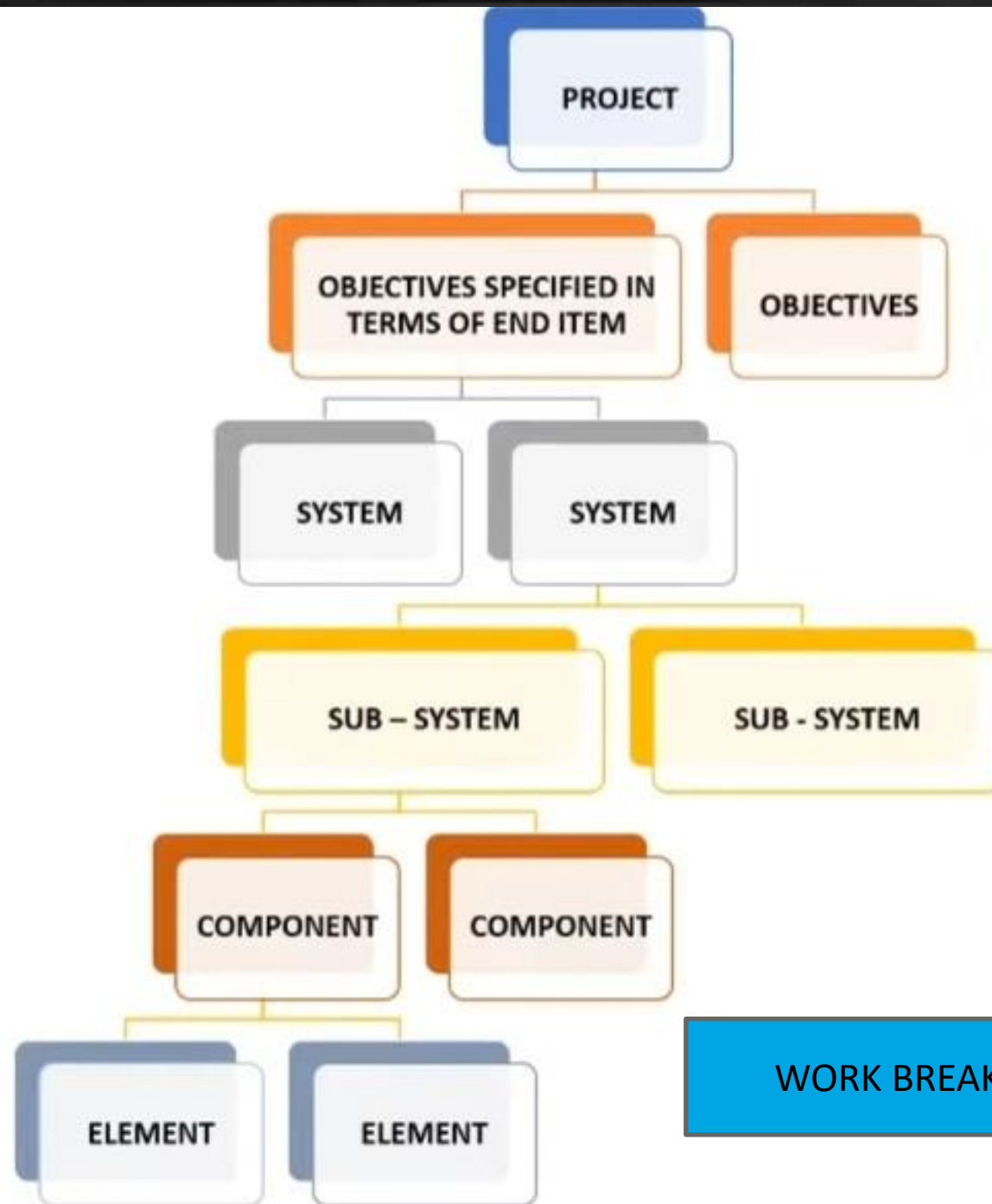
Importance of construction planning are as follows.

- The work may be completed within the scheduled time.
- The work may be executed most economically.
- The work will be both qualitative & quantitative.
- There shall be minimum wastage during construction work.
- The work should be completed as per specification.
- There will be a minimum cost of maintenance of machinery & equipment.
- There will be optimum use of available resources.
- Controlling of construction activities can be possible.

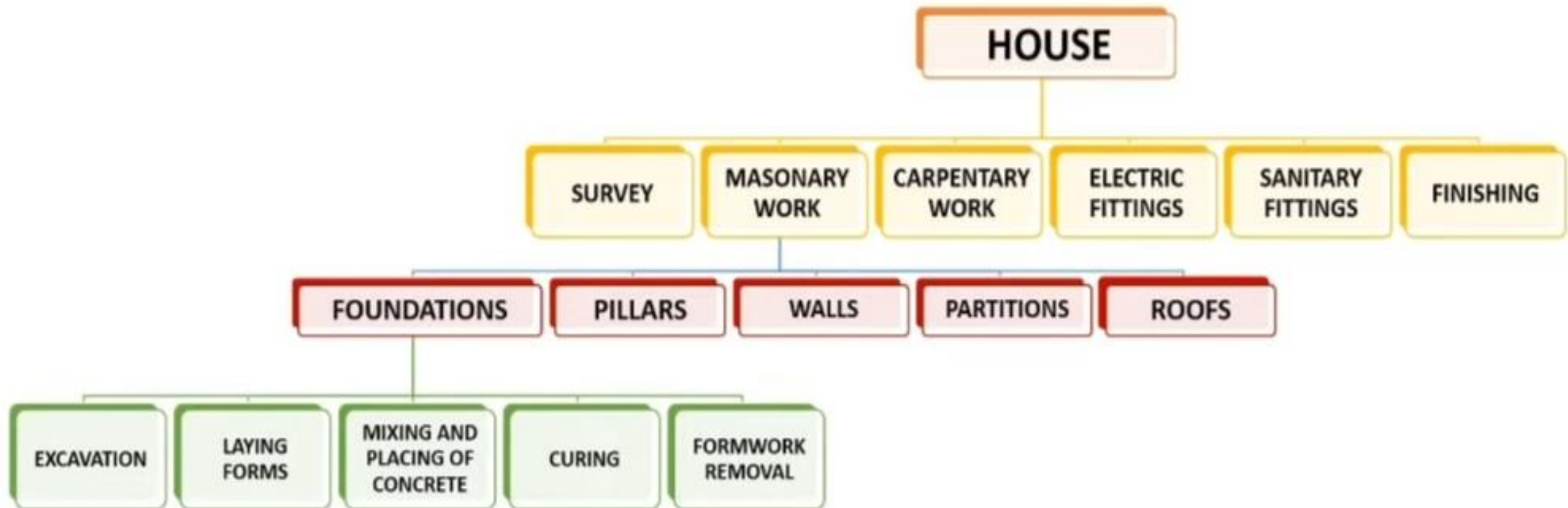
# WORK BREAKDOWN STRUCTURE

- It is the preliminary diagram which showing the breaking down a project into sub-systems and each sub-systems into major components and discrete activities.
- In WBS, top-down approach to planning is adopted. Such an approach ensures that the total project is fully planned and all derivative plan contribute directly to the desired end objectives.
- WBS aids in the identification of objectives and allows the planner to see the total picture of the project.
- WBS is developed by considering the end objective and breaking it into smaller manageable units on the basis of size, duration and responsibility.





WORK BREAKDOWN STRUCTURE



**WORK BREAKDOWN STRUCTURE OF CONSTRUCTION OF A HOUSE**

# CONSTRUCTION SCHEDULING

- Scheduling of a project is done after it is properly planned.
- A schedule for construction activity is a graphical representation which determines the time of starting and completing date of each activity in order to complete the whole construction project.
- In other words scheduling is the time table for executing each and every activity with its fixed starting and finishing date

# CLASSIFICATION OF SCHEDULING

Schedules can be classified into various groups such as;

- Material Schedule
- Labour Schedule
- Equipment Schedule
- Financial Schedule



## MATERIAL SCEDULE

- this type of schedule is prepared for moving and storing of material in advance before starting of construction schedule acts as a guide for preparing materials schedule.
- This schedule is done to avoid delay in the execution of the work
- The materials should be delivered at site at least one week before its use
- The materials at site should not remain on used for long
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- for example cement made its strength by 50% if stored for 6 months and steel may be attacked by corrosion due to long storage at site.

## LABOUR SCHEDULE

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# METHOD OF SCHEDULING

Depending upon the size of the project scheduling is done by different methods.

Following are the methods of scheduling.

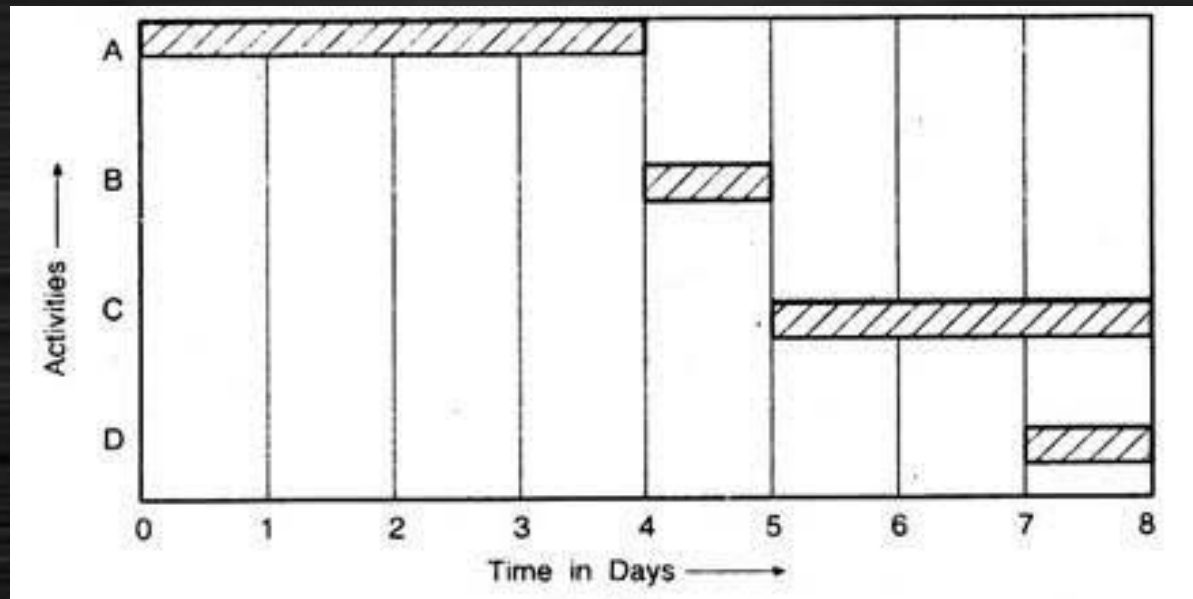
1. Bar chart or gantt charts.
2. Network analysis (CPM ,PERT)

# BAR CHARTS

- Bar chart is a graphical representation of various activities their duration start and period of a project.
- This method was developed by Henry Gantt around 1900.
- They consists of 2 co-ordinate axis, i.e., horizontal and vertical.
- Horizontal axis is used to represent the time required for the completion of activity and vertical axis is used to represent the activities required for the completion of the project.
- The start and end point of bar represents the time of start and finished time of the activity hence the length of bar represents the duration of activity.



- The bar chart or gantt chart represents the schedule of a project also represent the actual progress
- We can also check the accuracy of work and can compare the actual progress of work with the schedule.

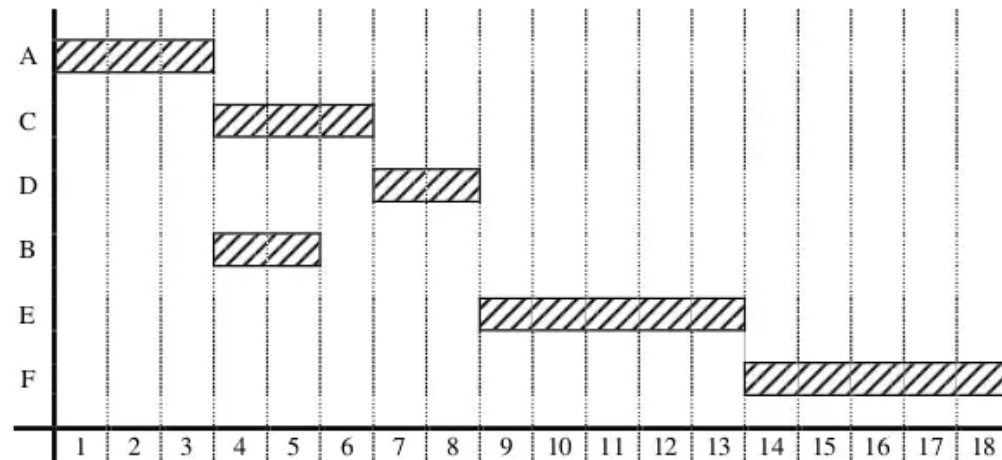


# Bar chart of a residential building

- Example:

Activity ID	Activity Description	Dependency	Duration
A	Excavation	-	3
C	Foundation	A	3
D	Column	B, C	2
B	Moving the soil out	A	2
E	Wall	C, D	5
F	Roof	E, D	5

## Solution



## Advantages of Bar Chart

- Very Graphical
- Easy to understand
- Most widely used

## Disadvantages of Bar Chart

- Difficult to Update.
- Difficult to find the Critical Path
- Difficult to setup and maintain a large project because it is essentially a manual graphical procedure.

# CONSTRUCTION ORGANISATION

1. CHARACTERISTICS AND STRUCTURE OF ORGANISATION
2. IMPORTANCE OF ORGANISATION
3. TYPES OF ORGANISATION
4. LEADERSHIP AND ITS IMPORTANCE
5. STYLES OF LEADERSHIP

# CONSTRUCTION MANAGEMENT

Topic- Construction Organisation



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## ORGANISATION

- For any successful business , a sound organisation is highly essential.
- Better the organisation the more is the achievement of the common business objectives.
- Organisation is the foundation upon which the business management is dependent.
- Organisation is a large group human association united together for the attainment of business objective.

# CHARACTERISTICS OF ORGANISATION

There should following characteristics or essential features of an organisation.

- (i) The organisation should have a common business objective.
- (ii) It should be executed by a proper leadership manner.
- (iii) It should be flexible by nature.
- (v) It should have a clear cut show of responsibilities and duties for the people associated with it.
- (vi) It maintains relationship between the administration and management.
- (vii) It should have a definite & fixed boundary of fixation of duties & responsibilities among employees.
- (viii) The organizational structure should be clear to have a coordination between different departments in it.
- (ix) Organisation should have a central co-ordination system.

# Structure of an organisation

- Organisation structure specifies the various job tasks and shows how job tasks are formally divided ;grouped;and co-ordinated.
- Organisational structure covers the overall arrangement of an organisation.
- It provides an appropriate framework for intra relationship and also indicates the hierarchy of authority and the reporting relationships.
- So organisational structure coordinates the relationship between the various positions in the organisation.

There are some elements with which each member of the organisation should be similar with following are the **main elements**

- Members of the organisation should understand about the well defined goal of the organisation.
- They should be familiar with the rules ,regulation, policies, procedures of the organisation.
- They should know with whom they have to work.
- They should understand their duties and responsibilities towards the organisation.
- They should understand the delegation of the authority and responsibility.



# Importance of organization

(i) For a successful business, a sound organisation is highly important.

(ii) Organisation enables a large group of people working effectively together for a common goal.

(iii) Only a sound and well designed organisation can maintain the co-ordination between the management and administration.

(iv) Organisational diversification or expansion of organisation can only be possible by a well-planned & well-designed organisation.

(v) Effective use of man power can also be possible by a sound organisation.

(vi) A sound organisation makes an optimum use of raw-materials and resources.

(vii) Wastage and expenditure is less in a sound organisation.

(viii) A sound organisation always stimulates the people for better, creative and innovative ideas.

# Types of organisations

- There are different types of organisational structure that have been developed and the following are more common
- Line or military organisation
- Functional organisation
- Line and staff organisation
- Matrix organisation.

# Line or Military Organisation

Line or military organisation is the simplest and earliest form of organisation.

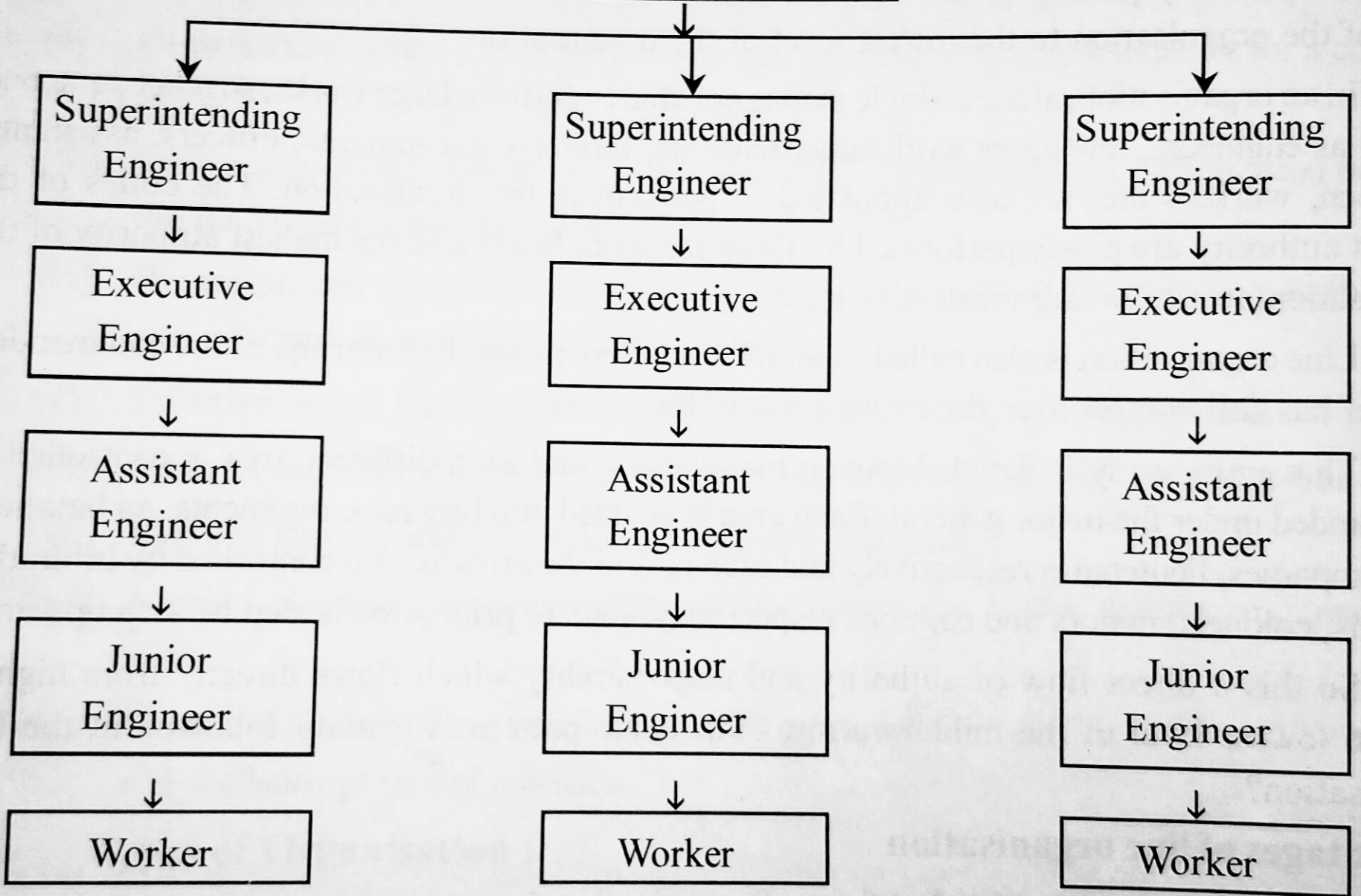
This system of organisation is based upon the scalar principle.

According to this principal when the level of authorities arranged in the structure from the chief executive at the top to the workers at the bottom the system is known as **scalar principle**.

- In this line structure the authority and the responsibility flows directly from the manager to foremen and from foremen to workers.
- In other words authority and responsibility should flow directly in a line vertically from the highest level of the organisation to the lowest level of the organisation.
- Line organisation is also called as military administration or **military organisation**.



**General Manager**



- Advantages

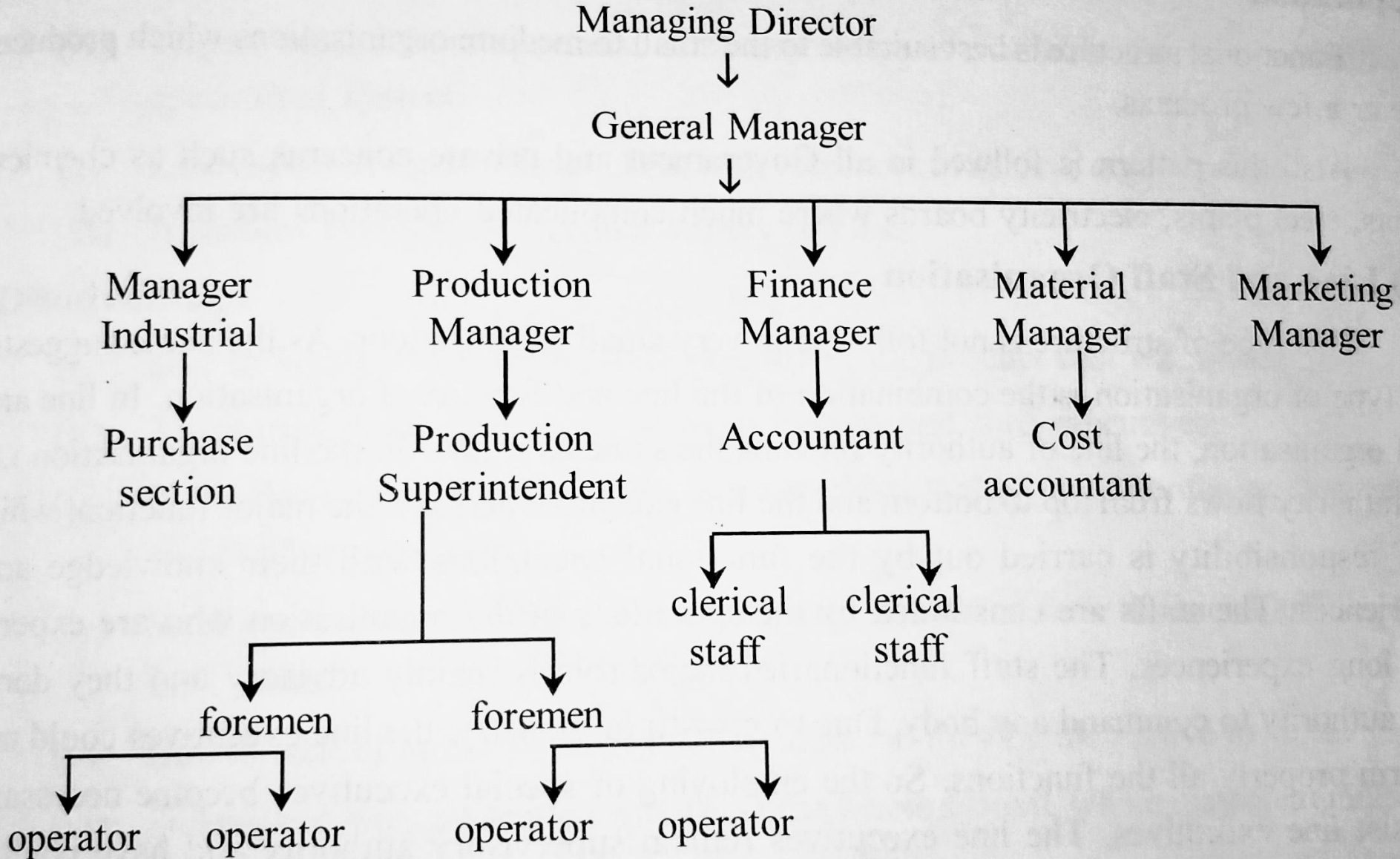
- It is the simplest form of organisational structure
- Facilitates decision making and execution
- An effective coordination is maintained within each department of organisation.

- Disadvantages

- Sometimes the top executives are overloaded with work
- the major disadvantages that if any wrong decision is made at the top level , the same is carried out simply without any objection down the line.

# Functional organisation

- This type of organisation structure is suggested by FW Taylor.
- In functional organisation the work of the management is divided in such a way that each man in the organisation should have a few functions as possible to perform
- Here the tasks are grouped together on the basis of common function.
- All productive activities or all financial activities are grouped into a single function and each person is fully responsible for the function assigned to him.



- Advantages

- Because of its simple logic and common sense appeal this type of organisation is most widely used.
- It makes use of specialist to give expert advice to workers .
- It also provides opportunities for promotion and career development.

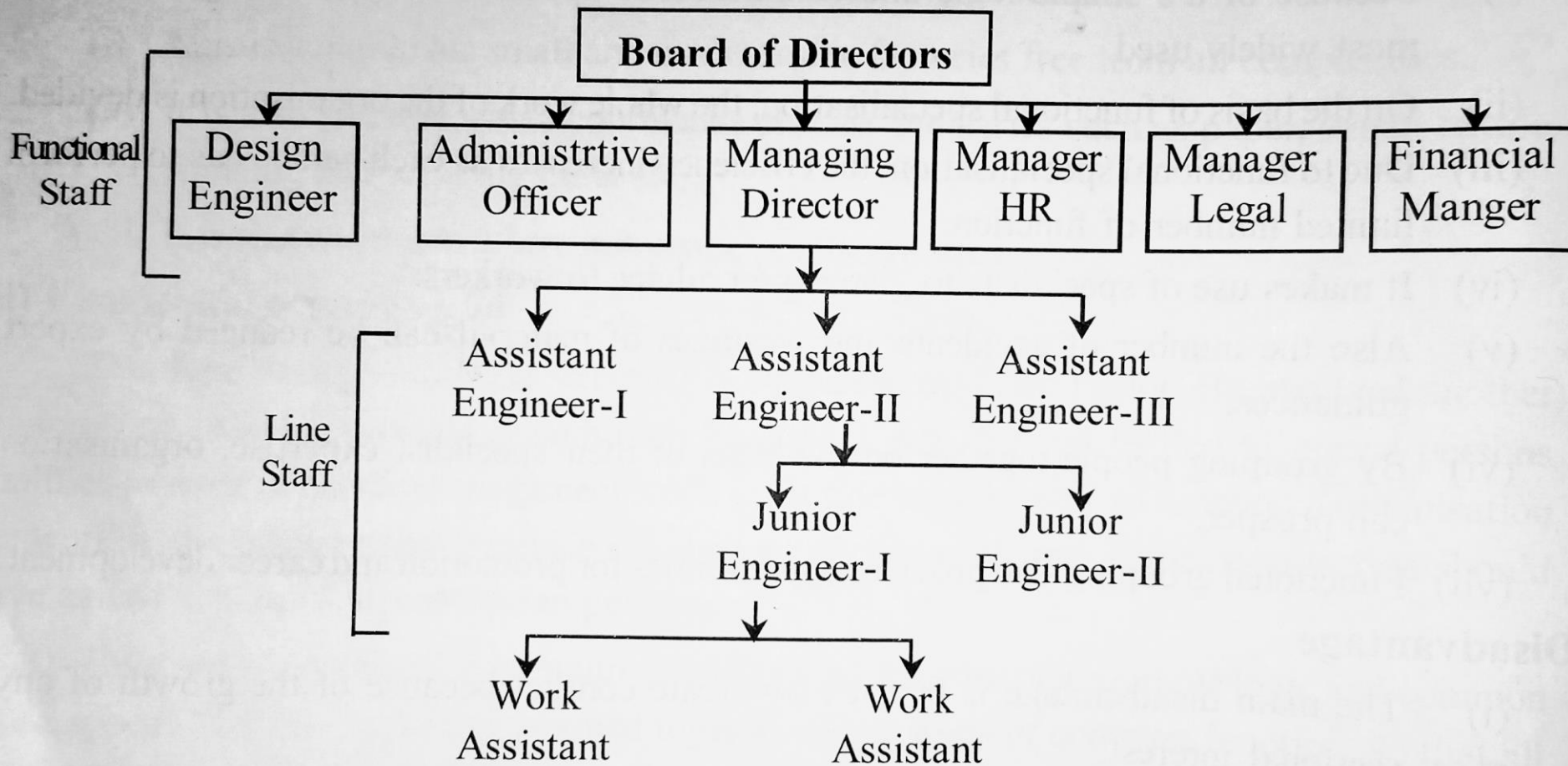
- Disadvantages

- It is difficult to maintain discipline in the organisation
- It makes the complex industrial relationship
- It is difficult to know who is the 'boss' of whom.



# Line and Staff Organisation

- As the name suggest this type of organisation is the combination of the line and functional organisation.
- Here the line of authority remains the same as it does in the line organisation i.e authority **flows from top to bottom** and the line executive perform the major function while staff responsibilities carried out by the **functional specialist with their knowledge and experiences.**
- The staffs are constituted by the specialists in the organisation who are expert with long experience.
- In this system staffs are are divided into functional staff and line staff as shown in the figure below.



**(Line and Staff Organisation)**

## Advantages

Line and staff organisation possesses all the advantages of the line and functional organisation

Discipline is maintained by the line authority.

It improves quality of product.

It enables availability a greater variety of jobs.

## Disadvantages

Due to high salary of the staff executive the product cost will increase.

There may develop jealousy between staff executives

Line staffs do not have direct authority to enforce their decision and implement their ideas

# Matrix Organisation.

- Matrix structure is the combination of two departments. One is functional and another is product responsibilities. Product manager is also known as project manager.
- In this system **every group of employees have two bosses** one is there functional department manager and another is there project manager.

The matrix structure allows for an efficient use of resources because teams include specialists from various departments.

# General Manager

Production Manger

Finance Manger

Marketing Manager

R & D Manager

Project A Manager

Production Group	Finance Group	Marketing Group	Personal Group
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Project B Manager

Production Group	Finance Group	Marketing Group	Personal Group
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Project C Manager

Production Group	Finance Group	Marketing Group	Personal Group
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- Advantages

- It ensures the effective utilisation of the services of the people with highly specialised skills.
- Communication improves by direct contact with different functional specialist.
- Employees can develop new skills

- Disadvantages

- decision making process may be slowed down.
- too much work can cause overload.
- Measuring employee performance might become difficult

# LEADERSHIP

- Leadership is the ability of a manager to build up confidence among the subordinates
- Leadership is a process of influence in a group in specific setup circumstances which encourages workers to work willingly to achieve organisation objective.
- when a group of employees in a project have a common goal performance objective then some sort of leadership is essential there to build up confidence among the employees.

# Importance of Leadership

- It leads the group to a higher level of performance.
- It implies a motive power to group efforts.
- Leadership acts as an way of influencing,inspiring , taking actions by the authority.
- Effective leadership creates a better understanding between the subordinates and the management.

# Styles of Leadership

According to the attitude and behaviour patterns, leaders are classified as the following

1. Autocratic or authoritarian style
2. Laissez-faire or free-rein style
3. Democratic or participative style leader
4. Paternalistic style leader.

## Autocratic or authoritarian style

- This type of leader is the absolute power with himself.
- Here the subordinates are completely obedient to the leader and the leader also centralised all the powers decision making in himself
- Here the subordinates have to follow the leader's orders, rules and regulation blindly or forcefully without any question.
- There is a threat of penalties and punishment to the subordinates in case of deviation.
- So this types of leader is not a real leader.



## Liassez-faire or free-rein style.

- This type of leadership maintains a good relationship between superordinates and its leader because under these type of leadership the superordinates allowed there maximum freedom.
- They are given the capacity to decide their policies and programs with their own style and take their independent decisions.
- But this type of leadership rarely exists because in these type of leadership the subordinates must be required to be **competent ,sincere and self disciplined.**

## Democratic or participative style.

- This type of leadership is the exactly middle position between two extremes of the autocratic and free-rein style of leader.
- By this process of decision making the subordinates are encouraged to make suggestions while taking decisions.
- Subordinates are given chance to explore their potential in strength to complete the challenging responsibilities.
- It creates a friendly working atmosphere and reduces conflicts like strikes ,industrial unrest ,employees complaints etc

## Peternalistic style or functional style.

- Under these style of leadership the subordinates become dependent upon the leader.
- Here the sentiments and emotions are given more priority
- And and the leader looks after is subordinates like a father looks after his children and family.
- He is supposed to help, guide and protect his subordinates.

# CONSTRUCTION SITE MANAGEMENT

# CONTENTS

- JOB LAYOUT
- REVIEW PLAN
- FACTORS AFFECTING SELECTION, DESIGN, LAYOUT OF CONSTRUCTION SITE
- LAYOUT OF EQUIPMENT
- LOCATION OF EQUIPMENT
- PRINCIPLES OF STORING MATERIALS AT SITE
- ORGANISING LABOUR AT SITE
- DIFFERENT JOB LAY OUTS

# JOB LAYOUT

- Job layout is drawing the prepared plan of construction site by the site engineer in-charge of the project.

The arrangements made at the construction site for different camps and the area around it, is known as job layout.

OR

- Job layout is a scaled diagram of the proposed construction site showing all the relevant features such as,

Entry point , Exit point

Storage areas of materials, Temporary services

Contractor's site office

Areas for keeping equipments such as mixers

Bar bending area , Labour Housing etc.



# Objective of preparing job layout

Following are the objective of job layout.

- It saves time in delivering the construction materials at the site.
- The best method of working may be adopted.
- It helps to complete the work within the minimum use of equipments.
- The maximum output from labour and machines can be taken.
- It provides safety to the workers.
- It helps to avoid damage to the nearby properties due to construction work.
- It plans for the construction materials to be placed as near as possible to the work

## REVIEW PLAN

- Before preparing a job layout the details of different plans for the execution of the work should be studied carefully.
- Site plan
- Working drawing
- Specification

## Site plan

The siteplan shows

- The boundaries of the site
- The adjacent area of the boundary of the construction site.
- Location of any existing building standing near site.
- Space left around the building to secure verification or free air condition.
- Space left around the building for cleaning and admission of light.
- Position of any natural drains, rivers, Wells located near the site.
- Any other information which are considered to be necessary

## Working drawing

- the working drawing consists of the building plans and other works to be constructed at the site. The working drawing include ;
- Floor plan of the building with covered area ,size of the room, opening of doors & windows, structural members, staircase ,lifts Etc
- Elevation of all sides are shown.
- Indication of direction of North line in the plan of buildings.
- Indication of rejected persons beyond the permissible building line.
- Locating exactly of the essential services like Water closet ,sink , bath etc
- Showing sectional details drawing of footing thickness of world current slabs with their material.

## Specifications

Specification indicates the details of the types and grade of the material to be used in construction work which was signed duly the authority or engineer and shall be available at the working place before start of any work.

Specification is an important document in the construction industry which helps the designer to come and get It is thought and ideas to the other construction team members.

## Factors affecting selection ,design & layout at construction site.

- i. Nature of project
- ii. Location of project
- iii. Services
- iv. Availability of material & equipments
- v. Availability of manpower
- vi. Medical facility
- vii. Availability of space
- viii. Other miscellaneous factors



## I) Nature of the project

The nature of the project plays an important role in its layout process. The camp layout depends on the nature and types of project.

For example the layout of camp for a highway construction project will differ from that of a building.

## II) Location of project

Location of the project also plays an important role in job layout plans the location project should be properly chosen such that there will be no difficulty for any type of climatic situation and transportation.

So transportation facility to the construction site is an important factor for job layout.

## IV) Services

There should be proper service of water supply ,sanitation and electricity.

If these services are not available then it will be badly affect the job layout..

## V) Availability of Material & Equipments

There should be sufficient availability of materials and equipments at the construction site. If the materials and equipments are not available locally then it will create problem in storage which will affect the shape of job layout.

## V) Medical facility

If the project is for a long time it is essential to have a field medical aid facility for the workers.

## VI) Availability of man power

Man power is an important resource in any construction site. The arrangement of manpower at construction site should be made locally otherwise it will be a great difficulty for their shelter .

So labour should be arranged locally.

## VII) Availability of Space

If less space available at the construction site, then it will be difficult for job layout because the storage should have to be located nearest the regular supply of material & equipment.

Urgent availability of material may not possible as required.

## VIII) Other miscellaneous factors

There should be availability of education facilities like schooling for the children of labours and staff ,daily necessities of life and other welfare facilities for the workers.

If these facilities are not available then it will also tend to change the layout of the project.

# Principles of storing materials at site

The materials should be stored in proper manner at the construction site. The following are the important principles which are to be considered for storing materials.

- Materials should be stored at the construction site so as to prevent mixing of foreign matter.
- Materials should be stored in such a manner as to protect it from any weathering agent like rain , sun and wind.
- Materials which are suspected to get fire easily should be prevented from fire hazards i.e the products like petroleum and explosives should be stored properly.

- Precast beams pieces of timber and slabs which are likely to be affected by the soil or support should be stored with properly adopted measures.
- Materials like cement bags which are easily affected by the contact of the moisture are to be stored with special precautions.
- The material regularly used are to be placed relatively nearer to the place of use.
- There should be proper arrangement of fire extinguisher and fire buckets wherever necessary for the safety measure.



# Location and layout of equipments

## Why equipments required?

As there is a increased cost of labour, the use of more & more mechanical equipments becomes necessary for construction work very often the available manpower is not sufficient for the completion of construction work with in stipulated time, so it is essential to use mechanical equipments along with the available manpower for the construction activity.

So there should be a careful consideration for correct choosing at right equipment. For a construction project to be completed with in the scheduled time economically, it is essential to choose the correct and well-operated equipments.

For the location of equipment following points are to be considered.

- (i) Equipments should be nearer to the construction work.
- (ii) Equipments should be near to the materials.
- (iii) The owned equipments may be provided near the entrance so that there will be no requirement of any additional guard.
- (iv) The hired equipments should be placed in suitable places and the vacant place may be left where it can be accommodated.
- (v) The maintenance ,repairing and fuel filling of equipment should be arranged at the construction site.

VII) There should be adequate space available for parking of the transport vehicles like trucks tractors etc.

VII) temporary sheds should be provided to safeguard the costly equipments from any type of weather condition.

## Organising labour at site.

Organizing labour properly at the working site is an important responsibility of the supervisory staffs.

The labours are divided into different groups by the supervisor under the guidance of effective leader who has the quality to control the labours.

Proper way of organising of labours results the completion of work within the stipulated time period.

So it is very essential to organize the labours at the construction site.

For example

Suppose 10 labours and one supervisor are put for beam casting the division of the labour may be.

- (i) For bringing the aggregates, three labourers are put.
- (ii) For mixing the ingredients one labour is put.
- (iii) Four labourers are put on some other work.
- (iv) For compaction purposes two labours are put.

There are some points which are to be considered while organising labour at construction

(i) Rehandling of material unnecessarily should be avoided.

(ii) Supply of material should be sufficient as per requirement of labour.

(iii) Labour supply should be uninterrupted.

(iv) The materials should be taken once for the whole day from the godown. It reduce the frequent movement of labour.

(v) There should be some permanent labours as it is economical.

(vi) Increasing and decreasing of labour should be done as per necessity.



(vii) To avoid wastage of time of labour, minimum facilities should be made available

(viii) Also to save wastage of time of labourers, drinking water facility should be made available at the site.

(ix) A record should be maintained about the progress of the labour.

(x) Record maintain once will help to compare the progress of work with the completion of work at right time at the site.

# Preparation of job layout

- The construction plans, specifications, contract documents and other available material describing the job should be studied carefully in order to get the idea of the nature and extent of the work.
- A scaled drawing with a scale of 1 in 100 should be prepared showing the out line of the work or job to be constructed.
- Also the position of entry and exit points as well as the areas of temporary facilities should be marked on it.
- In job layout plan

Moreover following information should be collected from the above study.

- Area needed for accomodation: This area includes the area required for office. stores and residential accomodation for officers, staff and labour.
- Area required for machines, sheds, repair shops and workshops etc.
- Area for security and fire fighting facilities.
- Area required for construction work.
- Area for miscellaneous amenities such as canteen, toilets, dispensary etc.
- Length of period for which area may be available.

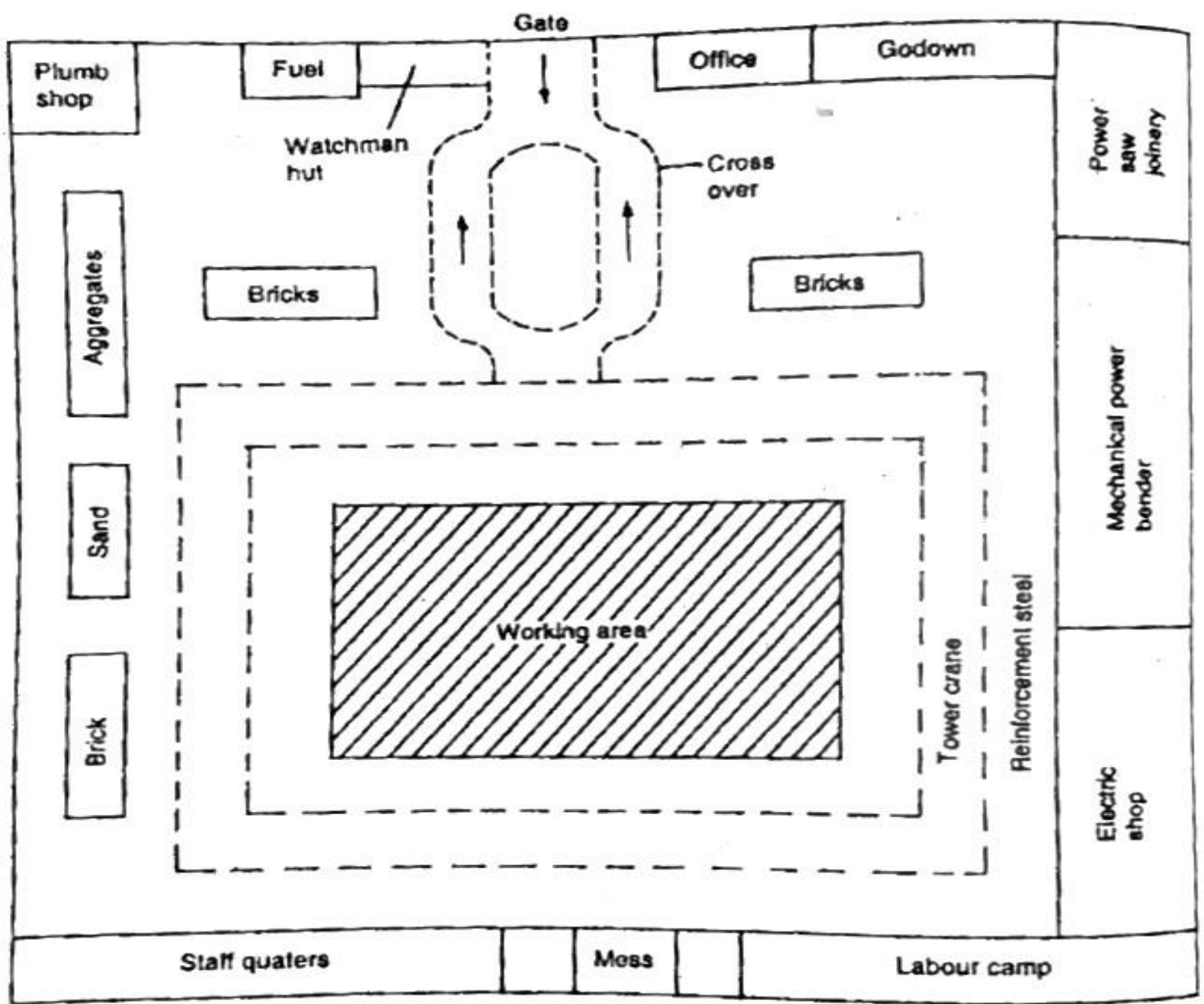


Fig. 1.2

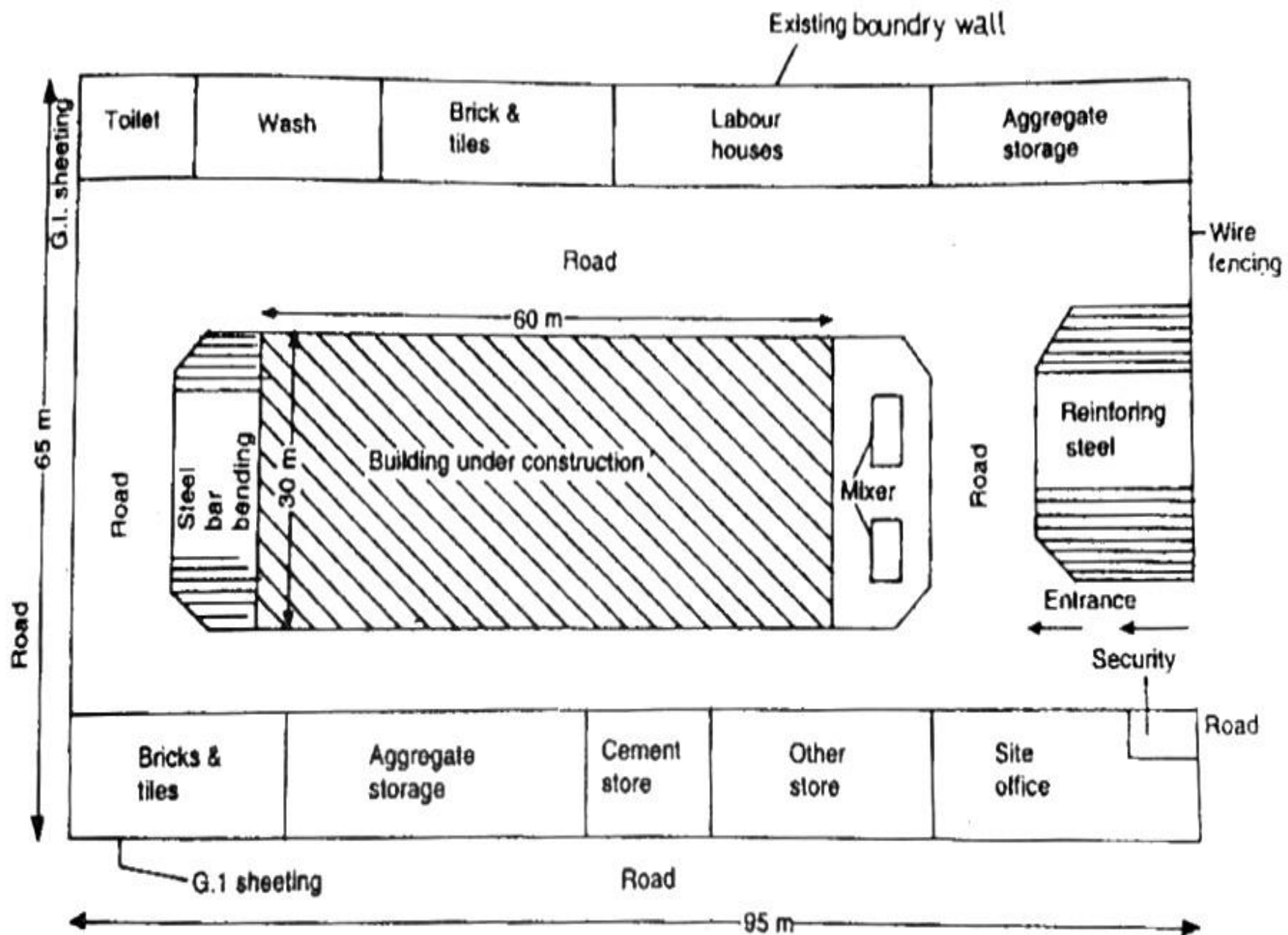


FIG. 4.1

## Important question

- What is job lay out.?
- What is specification?
- What is working drawing ?
  
- What is the principles at storing material at site ?
- For location of equipment at the site of work ,what are the points to be considered ?
- Explain various factors affecting the selection, design and job layout of construction site.
- What are the factors upon which the job layout depend ?



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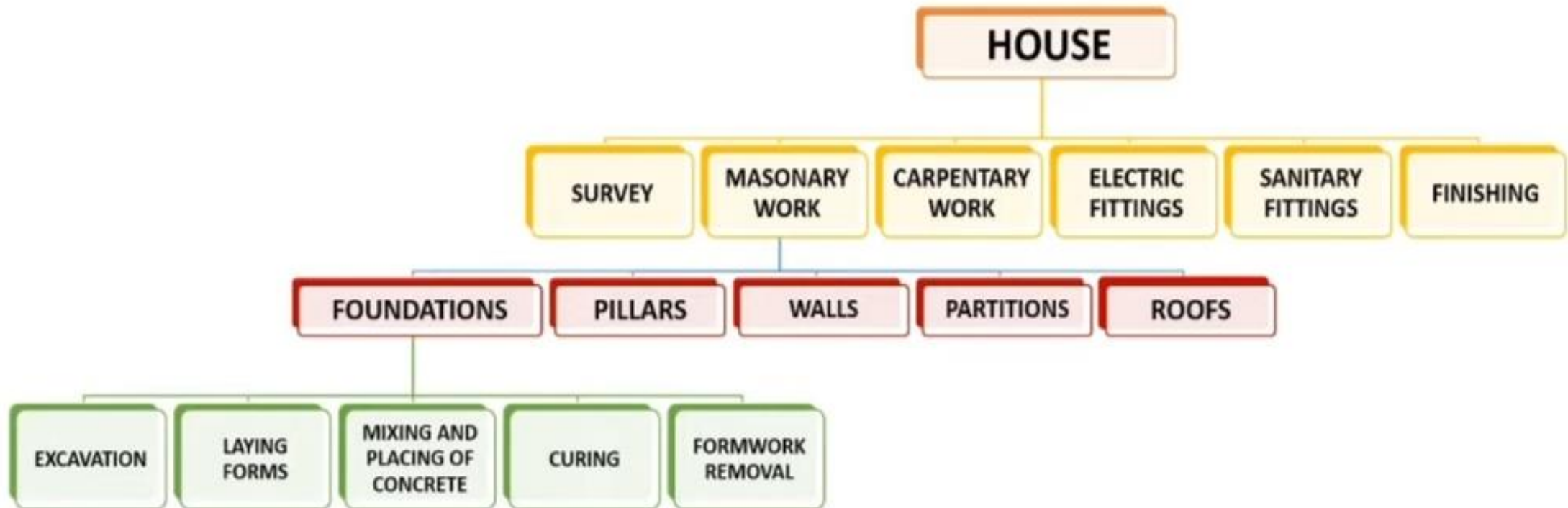
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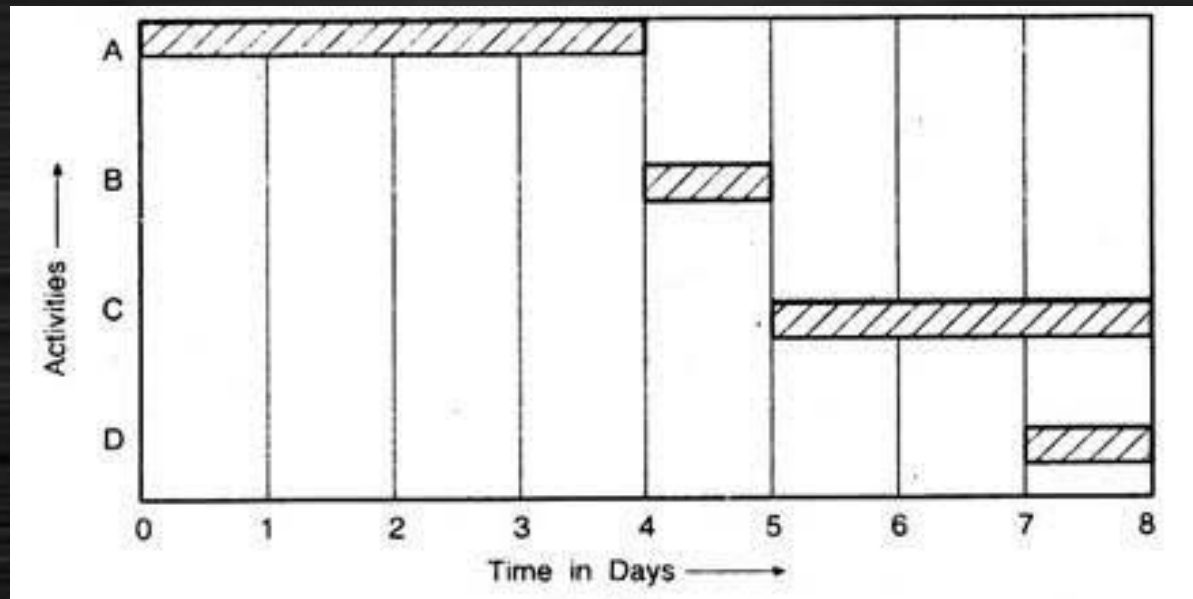


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- Horizontal axis is used to represent the time required for the completion of activity and vertical axis is used to represent the activities required for the completion of the project.
- The start and end point of bar represents the time of start and finished time of the activity hence the



- The bar chart or gantt chart represents the schedule of a project also represent the actual progress
- We can also check the accuracy of work and can compare the actual progress of work with the schedule.

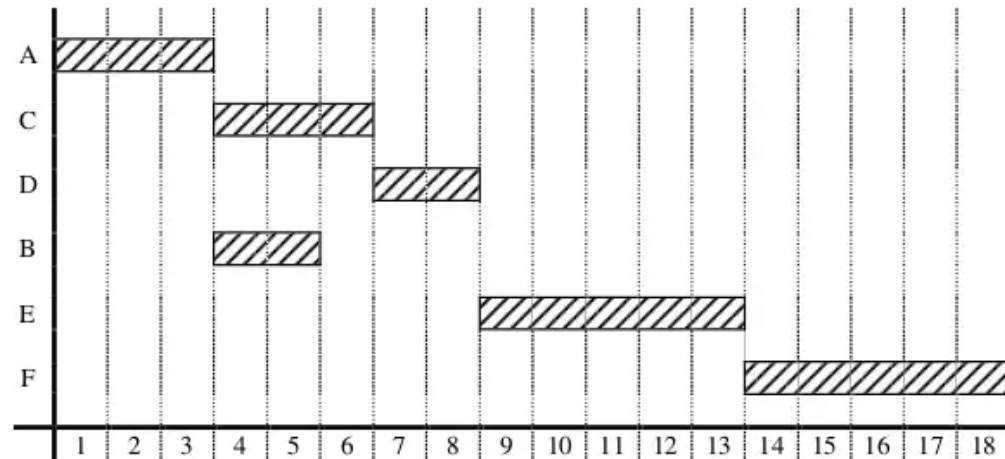


# Bar chart of a residential building

- Example:

Activity ID	Activity Description	Dependency	Duration
A	Excavation	-	3
C	Foundation	A	3
D	Column	B, C	2
B	Moving the soil out	A	2
E	Wall	C, D	5
F	Roof	E, D	5

## Solution



## Advantages of Bar Chart

- Very Graphical
- Easy to understand
- Most widely used

## Disadvantages of Bar Chart

- Difficult to Update.
- Difficult to find the Critical Path
- Difficult to setup and maintain a large project because it is essentially a manual graphical procedure.

# METHOD OF SCHEDULING

- Bar charts
- Network analysis (CPM , PERT)


Symbolic representation of essential characteristics of a project.

In other words the phase diagram or sequential arrangement of various events and activities.

## EVENTS

- An Event is either Start or Completion of an Activity.
- Events are Significant points in a project which act as control points of the Project.
- An Event is an Instant of time and does not Require time or Resources.
- It is Represented by NODE usually CIRCLE.

## ACTIVITIES

- It is actual performance of a task required for completion of the project.
- Activity Consumes time and resources.
- It is usually represented by
-  (Arrow) in Activity on Arrow Network (AOA).

## Examples

### Event

- Budget Prepared
- Construction Completed

### Activity

- Preparing Budget
- Mixing Concrete



## Types of event

- Tail event
- Head event
- Dual event
- Predecessor event
- Successor event

# CPM (CRITICAL PATH METHOD)

- Critical Path Method is an **activity oriented network**, i.e. based upon **deterministic** approach hence only single time estimate is made for each activity in this case.
- This method is generally suitable for repeatative type projects like those of construction, manufacturing and maintenance.
- CPM, the critical path is determined on activity-oriented float philosophy.

## Example -

- Manufacture of a new car
- Constructing a multi-storey building
- Extension of a factory building
- Building a new bridge over a river

## DIFFERENT TERMS USED IN CPM

### Early start time(EST)

The earliest possible time at which an activity may start is called Early start time.

### Early finish time(EFT)

The sum of the earliest start time of an activity and the time required for its completion it called early finish time.  $EFT = EST + t$

### Late start time (LST)

The latest possible time at which an activity may start without deleting the date of the project is called late start.

### Late finish time (LFT)

The sum of late start time of an activity and time required for its completion is called late finish time.  $LFT = LST + t$

## TOTAL FLOAT

It is the duration of time by which an activity can be started late without disturbing the total project schedule.

## FREE FLOAT

A duration of time by which the completion time of an activity can be delayed without affecting the start of succeeding activity is called free float.

## CRITICAL ACTIVITIES

The activities which have zero float are called critical activities.

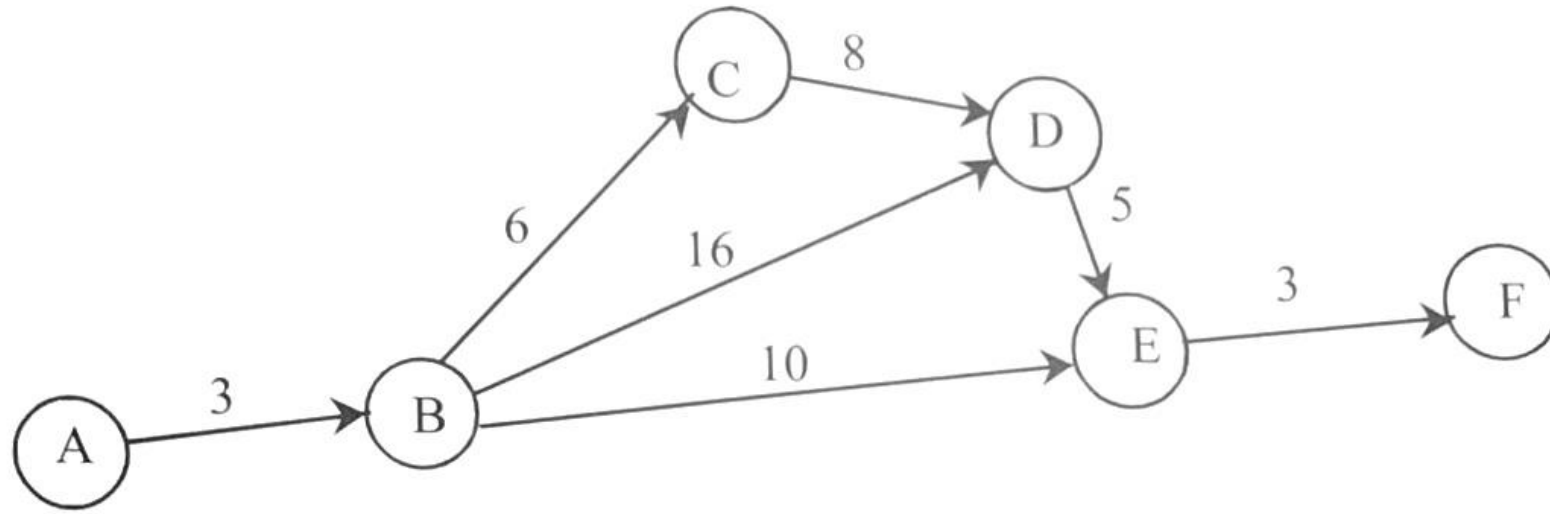
## CRITICAL EVENTS

The start or end points of critical activities are called critical events.

## CRITICAL PATH

The path in the network joining the critical events along which there is no float is called the critical path of the network.

# PROBLEM.





# PERT ( PROGRAMME EVALUATION AND REVIEW TECHNIQUE )

- PERT is an **event oriented network** that was developed by **U.S Navy**.
- PERT is a technique that statistically presents knowledge about the diversified activities of a project and their uncertainties.
- PERT is usually suitable for Research and Development type projects.
- It follows **non-deterministic** approach or **probabilistic** approach in which we may only state limits within which it is virtually certain that the activity duration will lie.
- Between these limits we must guess the probability of executing the activity.



## Optimistic Time Estimate

- It is the **shortest possible** time in which an activity can be completed, under ideal conditions.
- This represents the time of completion of any activity, if everything goes perfectly well, with no problems and adverse conditions.
- Better than normal conditions are assumed to prevail.
- Denoted by  $t_0$

## Pessimistic Time Estimate

- It is the best guess of the **maximum time** that would be required to complete the activity.
- This represents the time of completion of any activity, if everything goes wrong and abnormal situations prevailed.
- Does not include possible effects of earthquakes, floods and fires.

- Most Likely Time Estimate

- It is the time the activity would most often require, if normal conditions prevail.
- It lies between optimistic and pessimistic time estimates.
- It reflects a situation where conditions are normal, things are as usual and there is nothing exciting.
- Denoted by  $t_M$ .

## EXPECTED TIME -

- The combination of three time estimates into one single time-the average time taken for completion of an activity or job is called EXPECTED TIME.

- It is denoted by  $t_e$

$$t_e = (t_o + 4t_m + t_p)/6$$

- The above expression is based on weighted average method, is reasonable as the chance of completion of the job in  $t_o$  or  $t_p$  is much less than most likely time estimate  $t_m$ .

## Variance of an activity

- Important analysis the variance of an activity is calculated by the following formula

$$V_t = \{(t_p - t_o)/6\}^2$$

### Standard deviation of activity

In PERT analysis the standard deviation of an activity is calculated by the following formula.

$$St = (tp - to) / 6$$

### Variance of a project

The sum of the variance of all activities along the critical part of the network of a project is called variance of the project

### Standard deviation of the project

The square root of total variance of the project is calculated along the critical path of the network is called standard deviation of the project.

### Earliest expected time

- The earliest expected completion time of the event is equal to the sum of expected times of the preceding activities.

### Latest allowable time

- The largest possible time an event can take without delaying the final completion date of the project is called a latest allowable time.

### Slack

- The difference between latest allowable time and the earliest expected time is called slack time

### Critical path

- The path of the network of a project along which there is no slack is called critical path.



Problem :The three time estimates to , $t_m$ , $t_p$  of eavariance anity of a project is given below.

Activity	$t_o$ (days)	$t_m$ (days)	$t_p$ (days)
A-B	2	5	14
A-C	3	12	21
B-D	5	14	17
C-D	2	5	8
D-E	1	4	7
C-E	6	15	30

1. Draw the network diagram
2. Find expected duration ,variance ans standard deviation of each activity
3. Determine expected project duration
4. Find out standard deviation of entire project.



# DIFFERENCE BETWEEN CPM & PERT

## CPM

- IT IS DETERMINISTIC
- It is developed in 1957 by Du Pont.
- CPM is used for those projects which are repetitive in nature and where one has experience of handling similar projects.
- CPM is used in plant maintenance and construction work.

## PERT

- IT IS PROBABLISTIC
- It is developed in 1950 by US NAVY.
- PERT is used for those projects where time required to complete various activities is not known with certainty.
- PERT is used in R&D projects
- PERT analysis does not consider cost.

(MATERIAL AND STORE  
MANAGEMENT)

# Contents

- Introduction and Objective
- Classification of store-storage of stock
- Issue of materials(indent , invoice , bin card)
- Stores accounting procedures
- Inspection of stores
- Procedure of write off

## INTRODUCTION

For the execution of different kinds of works in public work department, different types of material and equipments required.

it is necessary to maintain a store of various types of construction material at one or more place in a division so that the execution of work will be efficient.

Before start of any work material should be arranged well in time.

So store and material management is an integral function of different sections of the organisation.

It deals with the supply of material and other related activities and aims at minimum expenditure on materials.

**Material management deals with the overall activities of materials such as type, amount, movement, purchase, location, timing of various materials which are used in an organisation.**

## Objective of material management

- To select the right quality
- To meet the production requirements
- Selection of suppliers
- Limit the Wastages
- Product enhancement
- Forecasting
- Standardization Process



# Classification of stores

Stores can be divided into four categories according to public work department.

1. Stock
2. Tool and plants
3. Road metals
4. Material charged directly to works.

## Stock

The stock is the store which is required for general work and kept under suspense head and finally issued for the work.

The items which are in common use in the construction activity for the execution of different works are kept in stores. Such materials of general use such as cement, timber, bricks, aggregates, steels, paints etc are kept in store are called as stock.

## Reserve stock limit

The maximum amount of materials that can be kept in a stock in a division is fixed and is known as the reserve stock limit.

The limit is fixed by the Government keeping into consideration the normal requirements of stock in the division.

### Note -

'Stock' is a suspense head of account. When an item of stock is purchased, its cost is debited to the suspense head 'Stock'.

When the item is issued for use in a work, the cost of the item issued is credited to the suspense, head 'Stock' and debited to the final head of the work concerned.

## Subhead of stocks

The various materials of similar nature grouped under different heads to facilitate the proper maintenance of stock account are known as sub-head of stock

The following are some of various sub heads of stocks

1. Small stores (like nails, screws, hinges, bolts, etc.).
2. Building materials (like cement, aggregates, bricks, lime, etc.).
3. Timber (like deodar, chir, plywood, hardboard, etc.).
4. Metals (like mild steel bars, rolled steel sections etc )
5. Fuel (like kerosene, coal, etc.).

6. Painter's stores (like paints, varnishes, etc.).
7. House fittings (like bathroom fittings, pelmets, etc.).
8. Miscellaneous stores (like cord, wood preservatives, fertilisers, etc.)
9. Lands, kilns, etc. (like road metal quarries),
10. Manufacture (i.e. manufacture in Government workshops).
11. Storage (i.e. charges incurred on the storage of articles, such as rent of godowns, payment to work charged store establishment

## Issue of materials

- ◆ The store keeper can issue the materials to different departments upon the receipt of a withdrawal form with proper authority and it is called as **material issue requisition form**.
- ◆ Depending upon the nature and amount of material to be withdrawn from stores the material requisition is prepared in duplicate by the manager.
- ◆ Both the copies are sent to the store keeper who issues and records the materials distributed.



## Material Issue Requisition form

**Material Requisition**

No. ....

Material requisition for.....

Department..... Date .....

Sl. No.	Description	Code No.	Quantity		Rate	Amount	Entered on store register Page No.
			Demanded	Supplied			

*Requisitioned by*

*Approved by*

*Material Issued by*

*Received by*

.....

.....

.....

.....

# Indent and Invoice

- ◆ The material from the stores are procured by the process of indenting.
- ◆ Materials received from the stock on demand in a proper form called indent form.
- ◆ Indent form consist in triplicate of counter foil ,indent and invoice.
- ◆ The counter foil and indent part of the indent form filled by the Indent officer.
- ◆ Then this form with blank invoice sent to the issuing officer in charge of the stock.

- Invoice is an indent having list of articles actually should and giving price and particulars of the articles.
- Then the issuing officer corrects the indent and fills up the invoice.
- Then the issuing officer sends it back to the indenting officer to sign the invoice and they return it to him as an acknowledgement.

## Rules for preparing indent and invoice

- There should be description of unit of supply and quantity of material
- The cost of materials of the head of account should be specified
- The name of work should be given when the material is issued.
- Full details of department ,division and any other person for which the metro Brijesh should should be given.

# Bin Card

- Bin Card is a card which maintains the details of quantities of each type of material received issued and on hand each day .
- The material and other items are kept in appropriate bins, drawers etc. The store keeper maintains the record on a Bin Card.
- A bin or shelf is attached to each bin card.
- Bin cards are made in duplicate
- One is attached to the bin and another is for the store keeper.





# Procedure for store accounting

## Final head

The cost of acquisition of stores is debited to the particular work for which they are required. This is known as final head of account.

## Suspense head

Suspense head includes the temporary booking of expenditure incurred for the purchasing of materials for the execution of work is debited to the final head of the expenditure is debited to the minor head i.e. suspense expenditure.

- a. The procedure for store accounting is done separately for various classes of stores such as stock, tools and plants, road metals and other miscellaneous material.
- b. When the stock is placed then the store is debited to suspense head .When the stock material is issued for the execution of a particular work then it is debited to the final head.
- c. The supply of tools and plants in the division and its expenditure is debited to the minor head sometimes for general use special items of tools and plants are not required but for a specific work they are debited to that work.

d. For certain road the road metal is required for the construction its cost is debited to the estimate of that road construction and once the road metal is required for the maintenance of the road it is debited to the sub head under **minor head**.

e. Similarly for other materials if the materials are purchased for general requirement then the cost is debited to the suspense head.

f. The initial account of all receipt and issues is maintained by the section officer

g. After closing the monthly account section officer forwards its to the sub divisional office.

# Difference between accounting of stock and tool&plants

## Stock

- It has consumable articles
- Both quantity and value account are kept.
- Stock is a suspense head
- The register of stock is closed each happy year ending 30th sep and 31march.

## Tool& plants

- It has usable articles
- Only quantity account is maintained
- Purchase of Tool &plants is a final head.
- The register is closed every year ending 30th September.

# Physical Verification And Inspection of stores.

## Necessity

Inspection of stores and its physical verification is essential for fulfillment of following

- (i) To ensure the correctness of stock held by comparing them with the balance shown in the store ledger or bin cards.
- (ii) To avoid shortage of materials in the stock.
- (iii) To check losses in inventory due to pilferage, improper storage or misplacement, deterioration etc.

- (iv) To correct and update store records.
- (v) To calculate the values of the stock carried for the balance sheet and profit and loss account.
- (vi) To calculate the rate of turn-over of an item.
- (vii) To ensure maximum economy in stock carrying.
- (viii) To effect insurance covers.



# Method of Physical Stock Verification

- Annual physical Verification
- Perpetual Inventory and Continuous Stock Taking System.

## Annual physical verification

The following procedure is adopted for carrying out the annual physical verification.

(i) By the end of the year, the stores are closed for a few days; no material etc. is issued to any project work/shop in the plant. In case it leads to plant shut down, the activities such as repair and over hauling of equipment and machineries are resorted to.

(ii) A team of stores inspectors or stores verifying officers physically check and count each and every item lying in the entire store. It is tallied with the quantities marked on bin cards and store ledgers.

(iii) Step (ii) above may lead to the formation of a list of surplus and short items. Damaged and obsolete items may also be traced and recorded.

(iv) Inspectors check a number of items every day as per a preplanned schedule and finish the complete work within a few days.

Advantages in the sense that all the items are checked at one time so there is no confusion about any item being left unchecked.

## Perpetual inventory and continuous stock taking

Perpetual inventory and continuous stock taking system is a more appropriated method for large plant with huge inventories which records store balances after every receipt and issue and facilitates regular checking.

(i) Under this system, store items are checked continuously **throughout the year**; a number of items are counted daily or at frequent intervals and compared with the bin cards and stores ledger.

ii) Discrepancies found if any, owing to in correct entries, breakage, pilferage, over issue, placing of items in the wrong bin etc. are investigated and corrected accordingly.

- This method is less costly
- In this method only few items are required to check every day as compared to annual physical verification.

# Procedure for write off

- The articles of tools and plants get worn out by continuous use and become unserviceable. They can be written off only with the approval of the competent authority. A survey report of all the unserviceable articles is prepared on D.F.R. (P.W.)-15 giving full particulars of their value, date of purchase and reasons for their becoming unserviceable.
- The survey report is submitted to the competent authority for approval. As a general practice, the articles which are written off are destroyed in presence of a gazette officer.
- As regards the articles of stock, which get deteriorated, an estimate for the loss of stock is prepared. The tools and plants articles are written off after preparation of survey report.
- **DFR- Document Filing and Retrieval Form**