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Th-2 Construction Management

6TH Semester , Diploma

Lecture Notes

Prepared by

Ashish Nayak

Lecturer in Civil Engineering

Department of Civil Engineering

CHAPTER-1 INTRODUCTION TO CONSTRUCTION MANAGEMENT

Management

Management is a setup principle relating to the function of planning, organizing, directing and controlling.

Aims and Object of Construction Management

→ At studying in chapter we will be able to

To explain the significance of management.

→ State the objective and explain the function of construction management.

→ Describe the various resources required for construction work.

→ Explain the different stages and activities involved in construction projects:

→ Recognise the importance of construction team and state the role of each of its constituents.

→ State the purpose of various types of drawings required for construction activities.

2. Objects and Function of Construction Management

OBJECTS

The main objective of construction management are:

→ Completing the work within estimated project hence specifying time.

→ Revolving reputation high quality workmanship.

→ Providing safe and satisfactory working conditions for all personnel and workers.

→ Taking sound decisions at the lowest practical management level through delegation of authority.

- Motivating people to give of their best within their capacities.
- Creating an organisation that works as a team.

Function of Construction Management

Function of Construction Management are:-

(1) Planning and Scheduling:-

- Planning involves formulation of number of alternative realistic work plans for achieving specified objective and finally selecting a plan which is best suited from the stand-point of available resource and constraints imposed upon the project.

- It sources the direction and order of variation activity.

(2) Organising:-

Organising is ^{concerned} with division with total construction work into manageable departments/sections, and systematically assigning various operations by delegating specific tasks to individuals.

(3) Staffing:-

Staffing is the provision of people fill the positions so created. Recruiting the right people, arranging staff training forces and carrying out proper staff assessment are all part of the staffing function.

(4) Directing:-

Directing function each function with training submajor carry out assigned case supervising their work and guiding effort.

→ The essence of directing lies in the ability to motivate people individually and as groups to utilise their creative efforts in achieving specified objectives.

(5) Controlling:-

→ Controlling is necessary for ensuring effective and efficient working.

→ It involves constant review of the work plan to check on actual achievements and to discover and rectify deviation through appropriate corrective measures.

(6) Co-ordinating:-

→ Since authority converges with the top of organisational pyramid, it is necessary to bring together and co-ordinate the work of various department and sections.

→ This requires efficient system of communication so that each department and section is aware of forms.

Types of Construction

Construction works can be classified into light, heavy and industrial construction.

(a) Light Construction:-

→ This type of construction does not require the use of heavy plant and equipment.

→ construction includes building and structure of all kinds like residential house, shopping centres, schools, small industrial, shade, water tanks, culverts, small bridges etc.

(i) Heavy Construction

This type of construction requires the use of heavy plant and equipment and the scope of work is large.

Construction includes multi-span bridge with well on pile foundation, tunnels, dams, barrages, highways, railways, airports, harbours etc.

(ii) Industrial Building

This type of construction requires the use of special technology, plant and equipment.

Construction pertains to chemical and fertilizer plants, steel plants, petroleum refineries, atomic power plants, automobile, aircraft, thermal power plants, industry etc.

Resources for Construction Industry

The main resources needed for the construction industry are:-

- (1) Materials
- (2) Manpower
- (3) Machinery (Plant / Equipment)
- (4) Funds / Money
- (5) Space

(1) Materials

Materials such as bricks, stones, cement aggregate, steel, shuttering, scaffolding, timber, water supply, sanitary and electrical fittings, petrol, oil, lubricants (P.O.C) etc. required for construction.

(2) Manpower:

- Manpower in the form of technical and managerial personnel and work force in various trade is essential to carry out project activities.
- Technical and managerial personnel are essential for efficient use of human resource and achieve project completion within estimated time and budget.
- Technical personnel include engineers, architects, quantity surveyors, supervisors, technicians etc. The work force consist of skilled and unskilled workers.

(3) Machinery (Plant/Equipment) and power

➤ For any construction work various plant/equipment and tool are required. Depending on the type and nature of construction job, machinery required at site including batching plant, mixture, trucks, tractors, excavators, dumpers, cranes, pumps, generators, workshop equipments etc.

➤ For efficient construction activity these plant/equipment need to be properly maintained.

Power is an essential resource required for lighting running the plant and equipment and for other facilities.

(4) Funds

- Adequate funds should be available for smooth implementation of the project.
- Financial planning is essential for smooth cash inflow and outflow to avoid delays in project activities.
- Funds for important resource. All other resource should therefore be planned and managed with special care, are dependent on the availability of funds. financial resources should therefore be planned and managed with special care.

(5) space

For any construction activity to proceed effectively it is essential to plan the available space of site for:

(a) Storing materials

(b) Providing yards for bar benders, carpenters, installation of equipment and plant, repair workshop, casting yards etc.

(c) site office, labour camps etc.

✓ Stages in construction

Every construction work has the following distinct stages

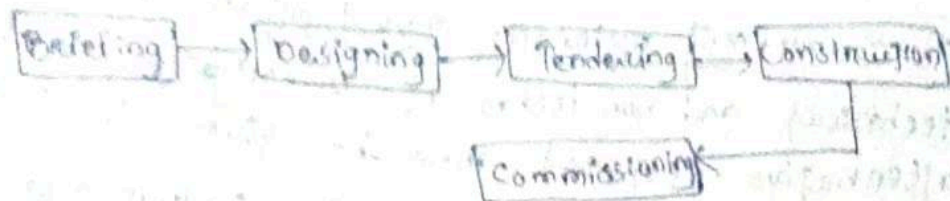
(i) Briefing stages

(ii) Designing stage

(iii) Tendering stage

(iv) Construction stage

(v) Commissioning stage



Briefing stage:

Also called the 'Report stage', it is the stage where ideas originated by individuals are studied with regard to cost and benefits so as to establish the economic viability or social utility of a project.

Briefing purpose

The purpose of this stage is to enable the client (owner) to specify project function and permissible costs so that architects, engineers and other members of construction team can correctly interpret the owner's wishes and provide a likely estimate of cost.

It also leads to an objective decision on the scope and feasibility of the project.

Activities of Briefing

Various activities involved in the briefing stages are :-

- (a) To appoint a project steering committee, if necessary.
- (b) To appoint a project manager who will be have a continuing responsibility to the client throughout the construction process.

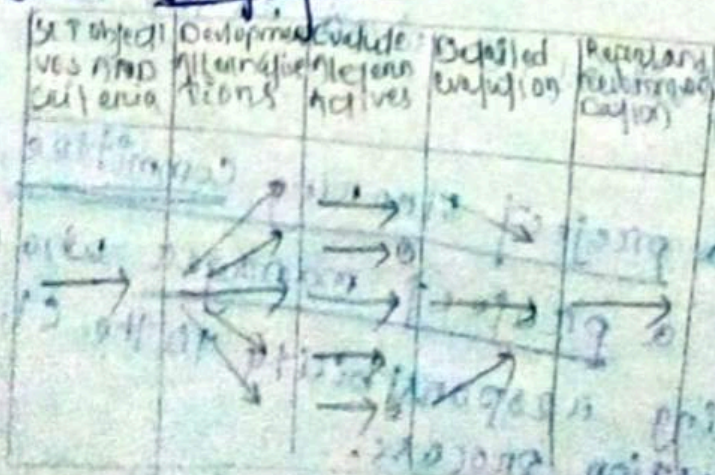
(c) To carry out extensive investigation which include both technical and non-technical investigation so that alternative proposals may be given due consideration.

Non-technical investigation include economic and social factors which may define the basic requirements on scope of the project. These also include market surveys for resource identification.

Technical investigation include land and geological surveys including site investigation such as soil samples and ground water levels from bore holes.

(d) To study various alternatives and identify the most feasible one. This is done so that a careful study of various alternatives at the briefing stage makes substantial cost saving easier while fulfilling the objectives of the project.

(e) To prepare the project report which is the outcome of the finest stage. The project report describe the investigation carried out possible solution and their evaluation.



Briefing or report stage

Designing or planning stage

- It is a very important stage in the field of construction because any modification in the project after this stage would prove expensive.
- A realistic and detailed cost estimate of the project can be prepared during the design stage.

Purpose of Designing or planning stage

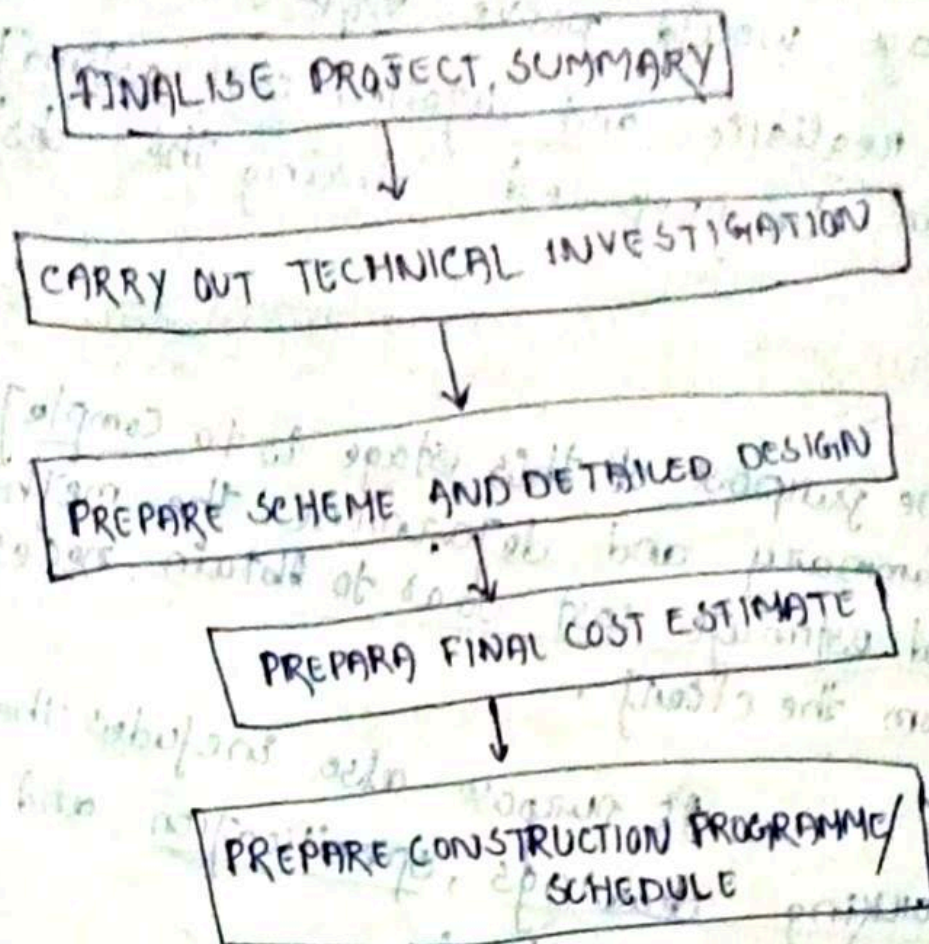
The purpose of this stage is to complete the project summary and determine the method of construction and estimate cost so as to obtain necessary approvals from the client.

Its purpose also includes the preparation of working drawings, specification and all arrangements for inviting tenders.

Activities of Designing

- To develop the project summary for final adoption of the most suitable alternative.
- To carry out technical investigations such as soil investigation, topographic investigation, material supply and market survey etc.
- To prepare detailed design, working drawings, specifications, bill of quantities, final cost estimate and preliminary construction programme including time-schedule.

(d) To obtain the owner's final approval of the project Summary.



Tendering Stage

It is the stage in which tender are called and the contract is awarded at the best available terms mutually agreed between the owner's team and the contractors.

Purpose of Tendering

The purpose of this stage is to appoint a contractor on a number of contractors work on the most suitable terms and conditions of quality, cost and completion time.

Activities of Tendering Stage

(a) The main activity involved in this stage is to obtain tenders from contractors for the construction work and to award the contract. During this stage, the owner enters into a firm commitment regarding the project expenditure and the procedure of construction are carefully defined.

Government tendering procedure are closely controlled to ensure that contracts are awarded in a uniform way. Some works may be done departmentally orders are issued by the competent authority authorising expenditure on execution of the work.

(b) Pre-qualification of contractor involves an investigation of the potential of contractor's financial, managerial and physical resource and his experience of handling similar projects. Governments agencies who award contracts for a wide variety of works may classify the contractors ranging from class 'F' contractors to class 'A' contractor (for any contract regardless of its value or complexity).

(c) It is necessary that contract documents be prepared with extreme care and by experienced persons because the contract form the basis on which the project management team exercises control of the project during the construction phase. The contract itself is defined as a legal documents which describe the term and conditions of executing the project. For construction work, standard forms of contract have been developed which are used with minor modification to suit the circumstances of a particular project / job.

(iv) Construction Stage:-

This stage involves the execution of construction work as per the design and within the agreed limits of cost, time and specified quality.

Activities of Construction Stage:-

(a) Construction / production planning includes the preparation of:

- Construction schedule
- manpower schedule
- plant and equipment schedule
- material delivery schedule.

(b) The other main activity in this stage is the control of site operation including:

- Temporary and permanent works.
- Supply of materials and equipment
- Coordination of sub-contractors / sections
- Supervision for quality control

The construction stage is the most resource-intensive and difficult stage of any project. The problems encountered during this stage may have to be referred to the designer for appropriate earlier. The construction work has to be carried out in a planned manner to prevent wastage of manpower, material and money and to avoid disruption of project schedules.

(V) Commissioning Stage:-

It is the stage in which the performance of the structure is evaluated and the proposed require of maintenance and repair are considered.

Purpose of Commissioning Stage

The purpose of this stage is to ensure that the construction work has been completed as specified in the contract documents.

and that all the facilities developed function properly as envisaged in the design.

During this stage records are prepared of the actual construction work finally carried out at site.

During construction certain difficulties might have arisen leading to changes in the original design. These changes are recorded for reasons of technical performance and financial implications.

Activities of Commissioning Stage

Various activities involved in this stage are:

(a) To keep various records of actual work thoroughly and have work inspected the construction any defects removed.

(c) To prepare operating instruction and maintenance manuals.

(d) To carry out tests for performance and envisaged test for water tightness on joints such as other function.

The commissioning stage is the transition between the construction and final taking over of structure.

For large and complicated construction works, it is common practice to do commissioning in several stages. The commissioning stage must be planned well in advance so that training and recruitment of staff and deliveries of equipment match the commissioning schedule.

Construction Team

→ The Construction team consist of owner, engineers/architects and contractor.

→ The team is formed to co-operatively plan design and execute a particular project.

→ The objective of the team is to execute the owner's project in the best and economical manner within the stipulated completion time.

→ The owner forms the construction team to services his interests through the services of both the contractor and engineers. The function of construction team depend upon the scope and nature of the work.

Owner

→ The owner may be an individual, group of individuals, private or public under-taking. The owner has an ultimate authority over the project.

→ The owner is the final holder of major decision-making power regarding managerial, financial and administrative aspects. He approves changes, if any in the project resources such as scope or schedule.

→ The owner controls the project resources such as manpower, funds and property. The owner also arranges for proper maintenance of the work, after the work has been completed.

Engineer and Architects

→ This includes structural, mechanical and electrical engineers, architects, quantity surveyors, specialists such as structural consultants, safety and maintenance planners, soil investigations etc.

→ The roles of the team members are as follow:

(i) Architects:

The role of the architect is to assess the clients functional requirements, design for pleasing and aesthetic appearance and to assist the engineers for project design.

(ii) Structural Engineer:

The role of the structural engineer is to prepare structural design of structural and to be prepare the working drawing based on the architect's plans.

(iii) Mechanical Engineer:

The role of the mechanical engineer is mainly concerned with design and preparation of working drawings for heating ventilating air conditioning and other mechanical services, associated with the construction project activities during the and after construction.

(iv) Electrical Engineer:

The electrical engineer is concerned with the design and preparation of working drawings for electrical power and distribution system during and after construction.

(v) Quantity Surveyors

The role of the quantity surveyors is to

- (a) Estimate the cost of work to be done and actually cost out;
- (b) prepare the bill of quantities and tender document before tendering.
- (c) assess the extra costs due to special features.
- (d) prepare the cash-flow statement during construction.
- (e) Prepare the final account on completion of the Project.

(vi) Specialists/Consultant

They carry out soil investigation and collect information regarding special requirements for item, such as health, safety, workshop, equipment etc. They also suggest solution to specific problems encountered during construction.

Contractor

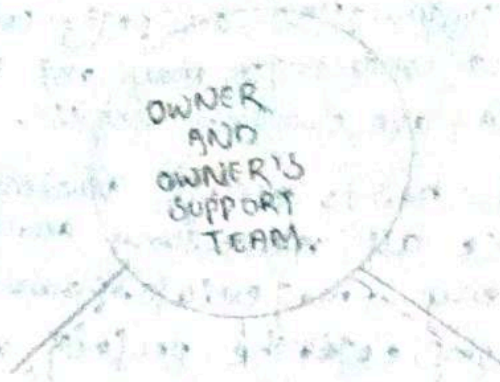
→ The contractor may be individual undertaking, individual small contractor or large construction company undertaking turn-key projects.

→ Contractors, whether small or big need the service of qualified engineer. Some of engineers employed by the contractor deal with office, others known as site engineers are concerned with the actual execution of work such as surveying, levelling, construction etc.

- ⇒ In some projects, the contractor may sublet part of the work to sub-contractors or petty construction. This is done because a contractor may not have the required infrastructure for certain works.
- ⇒ The contractor has to execute various type of works and has to make all necessary arrangements for labour, machinery, materials, power connection etc. in order to complete the project within stipulated time and cost.
- ⇒ The contractor submits running bills for payment based on the progress of work and material brought at site.
- ⇒ Proper interaction between the construction team (owner, engineer, architect and contractor) leads to the smooth and efficient execution of a construction project.
- ⇒ Proper understanding of function / activities of each team plays a vital role in achieving speed, economy, efficiency and quality in all construction projects.

OWNER
AND
OWNER'S
SUPPORT TEAM

ENGINEERS
AND
ARCHITECTS
CONSULTANTS



ENGINEERS
AND
ARCHITECTS

CONSULTANTS

CONTRACTOR
AND
CONTRACTOR'S
SUPPORT
TEAM

KEY

— CONTRACTUAL RELATIONSHIP

- - - WORKING RELATIONSHIP

ENGINEER
AND
ARCHITECTS

CONSULTANTS

OWNER
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Contractors

QUESTION

1. What is construction Management and explain the factors involved in construction Management.
2. Describe the objective of construction Management.
3. Describe about the type of organisation with merits and demerits.
4. Write down the different resource required during project management explain the importance of manpower.
5. What are the different stages of construction planning explain briefly the imp and purpose of different stages of construction planning.
6. Explain the following terms with respect to construction management
 - (1) Planning
 - (2) Directing
 - (3) Organising
 - (4) Controlling
7. Explain what is meant by project management and give example of its contents.
8. Explain the benefits of using a work breakdown structure.
9. What is construction
10. Explain different steps involved in construction management.
11. Describe the various stages of planning for construction.

CONSTRUCTION PLANNING

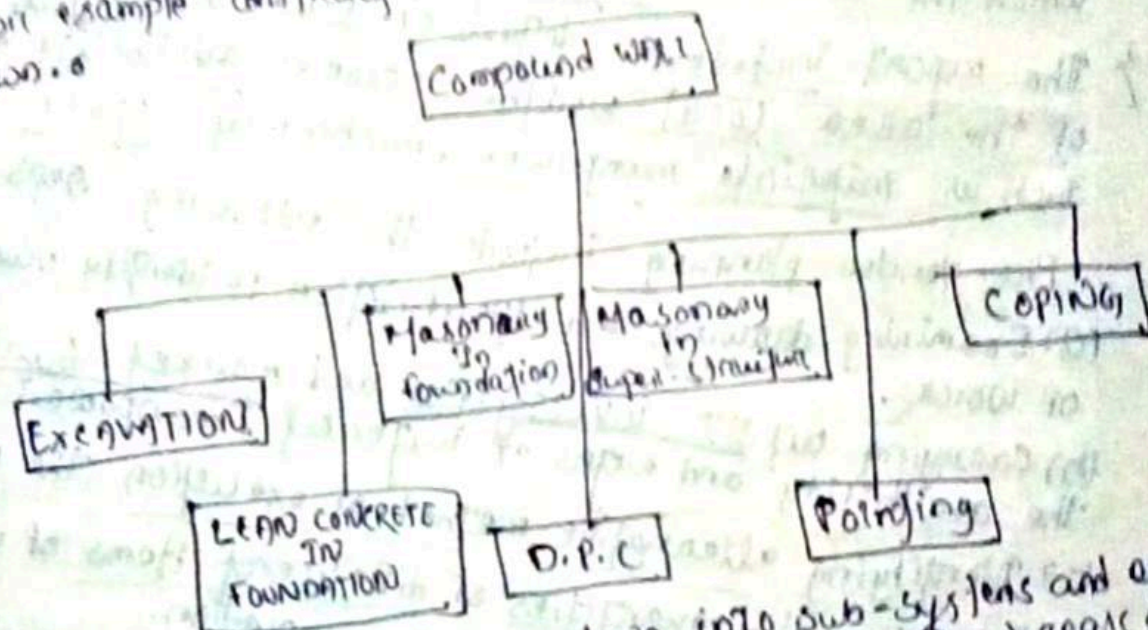
Importance of Construction Planning:-

- Planning is the starting point of all managerial functions.
- Planning leads to organising and staffing followed by directing controlling and co-ordinating.
- A graphic should know as a programme forms the basis for effective planning. The programme should include sufficient detail to enable proper consideration to be given to the timing and duration of operation type and quantity of material and equipment, delivery dates manpower requirements.
- The essential characteristics of a good programme are:
 - (i) It must be suitable for use as a control tool against which progress can be measured.
 - (ii) It must be sufficiently accurate to enable its use for forecasting requirements of material manpower masonry and money.
 - (iii) It must provide for difficulties likely to be encountered in future in respect of quality scope, processes of ^{broad} planning.
- There are two ^{broad} division of planning, namely policy planning and planning associated with technical operations. Planning is interpreted in different ways by different people.
- The executive process in planning is essentially controlling without a proper plan the controlling process cannot take place because it is essential to have some means by which the progress of work can be measured against the planned requirements.

For effective planning it is necessary to break down the total project into sub-section and activities. Each activity or job may further be sub-divided into smaller jobs for planning at various level.

Work Breakdown Structure:

- The functional of a project and their inter-relationship are mined by a technique known as work breakdown structure. Such technique establishes the hierarchical order in a system by breaking the project into recognizable system sub-system and discrete activities.
- For example construction of a compound wall may be broken down as



In general, a system is broken down into sub-systems and each sub-system into major components and so on. The break down is continued till the system is reduced to components or activities representing manageable unit for planning.

STAGES OF PLANNING

For efficient implementation of project activities, planning is essential at various stages. Planning for construction may be done in the following two stages

- (1) Pre-tender stage
- (2) contract stage/post-tender stage

Pre-Tender stage:-

- Pre-tender planning is broad-based and is carried out by the contractor. It is the stage in which a contractor has the best opportunity of planning his likely method of construction for the future contract and prepare a realistic programme for carrying out the work.
- This stage enable the contractor to make a proper bid and prepares him for completing the work in the stipulated time.
- A pre-tender report is prepared which describes the complete circumstance of the work and the conditions under which the work is likely to be carried out.
- The report includes detail of site investigation, geography of the area, local weather records, availability of resources such as materials, manpower, machinery, space etc.

Pre-tender planning include the following steps:-

- (a) Examining drawings and specification to identify various items of work.
- (b) Carrying out site investigation and market survey to assess the availability and rates of material, manpower, machinery.
- (c) Identifying alternative method of execution the work for.
- (d) Estimating the quantities of different items of work and the time required for their completion.
- (e) Preparing a tentative construction schedule with reference to the stipulated time of completion.
- (f) Deciding the overhead and margin of profit and finalising the tender price for completing the work within the stipulated time.

Contract stage / Post-Tender stage:-

The contract stage is also called post-tender stage or construction stage. This stage commences with the acceptance of the tender and extends till completion of the contract.

→ After the pre-tender stage, the contractor has to undertake detailed planning to organise various activities of construction work so that the project may be completed within the scheduled time.

→ Post-tender planning is used in chalking out specific detail for execution of the project. Inadequate planning at this stage inevitably results in delays leading to heavier expenditure than originally estimated.

Contract stage planning involves the following steps:

- (a) Establishing a good communication system between members of the construction team, for the smooth running of project work.
- (b) Evaluating alternative construction method identified during the pre-tender stage in order to select the most economical and efficient method.
- (c) Studying inter-relationship of various items of work and finalisation of proper sequence of operation.
- (d) Calculating the phased requirement of construction materials such as cement, aggregate, bricks, steel, etc.
- (e) Determining the phase requirement of plant and machinery including repair and maintenance facilities.
- (f) Preparing details of manpower requirement, including labour, supervisors and managerial staff for various stages of the work.

→ Good communication between various members of the construction team is essential to complete the project within scheduled time.

→ Proper co-ordination between members of the construction team avoids the possibility of delays at various stages of the work. Various alternatives have to be considered in detail to ensure proper utilisation of project resources, leading to greatest economy in cost.

- Construction programme is depicted in the form of chart which can be readily understood by workers, supervisors and construction managers.
- The programme provides information regarding the date and time of starting and completing different items and activities of work including working drawing, staff requirement of men, machinery materials etc.

SCHEDULING

- Scheduling is the process of fitting the work plan to a time frame indicating the start and completion of each activities.
- It also shows sequential relationship among various activities. Schedules are also prepared for construction resource such as labour, material, machinery and money required at various stages of the work.
- Actual progress of each activity can be monitored with reference to the planned programme.
- To prepare a construction schedule, the project is divided into different activities or operation.
- The sequence of operation can be decided after knowing their inter-relationship as per the construction method adopted. The construction schedule serves the following purposes:
 - (a) Making available a time-table showing the schedule and sequence of each activity.
 - (b) Providing a schedule for monitoring the progress of work and taking corrective measure, if required.
 - (c) Providing a means for establishing and maintaining time goals and prioritising activities.

SCHEDULING BY BAR CHART

- The conventional method of scheduling used in the construction industry is the bar chart.
- A bar chart consists of two co-ordinate axes one showing the time and in the form of horizontal line or bar and the length of a bar indicates duration of the job or activity.
- In a project some jobs are taken up concurrently and some are required to be completed before others can begin. Thus in a bar chart, some of the bars run parallel to each other and some run serially with one bar beginning after the other bar ends. The level of detail of the activities and the unit of time is determined by the intended use of bar chart.

<u>Activities</u>	<u>Time (days)</u>
Layout and excavate	5
Place mud-mat (lean concrete)	1
fabricate shuttering	3
Cut and bend reinforcement	4
fix reinforcement	2
fix shuttering	1
Pour concrete	1

- The activities of layout and excavate foundation, 'fabricate shuttering' and cut and bend reinforcement can start simultaneously as these activity are independent of each other.
- These activity being concurrently are shown by parallel lines or in bar chart. Activity 'place mud-mat' can only start after completing the activity 'layout and excavate foundation'.
- These two activities being in series are depicted in the bar chart one after the other.

- If the activities are taken up in a series, the total time taken for completion of project will be 50 week.
- Fixing of shuttering may start after the completion of say half foundation.
- Similarly concreting may start say 5 week fixing of chord.
- Excavation is delayed by 1 or 2 week due to unexpected difficulties from the base chert.
- Effect on fixing of shuttering is not clear.

(ii) Project Progress:- Preparation of material, Equipment LABOUR and Finance Schedules:-

- For any given work the resource required are material, manpower, machinery and money. The resources have to be utilized in a planned and efficient manner in order to derive the maximum benefit.
- The right type of labour or equipment may not be available at the required time due to labour unrest or breakdown of machinery.
- Thus to execute the construction work in an efficient manner and without wastage of any of the input schedules for various project resources need to be prepared.

Preparation of material schedule

- material schedule showing weekly requirement of commodities are prepared from the construction program. A material schedule enables storage space to be adequately planned and necessary arrangement to be made for timely delivery of material.
- The material schedule may be prepared either monthly or weekwise depending on the extent of the project and storage space.

consider a typical material schedule prepared weekwise for construction of temporary shed (8m x 20m)

Name of work		Prepared by				
Date:-						
material	unit	week				
		1	2	3	4	5
Cement bag	NO	100	100	115	120	130
Bricks	NO	4500	4000	5500	3000	2600
Sand	Cum	20	20	25	25	15
Aggregates	Cum	20	35	30	25	—
Steel	Quintal	—	—	—	2	—

Prepared Labour Schedule:-

- Labour schedules depict the manpower requirements of the project in a tabular form from various stage.
- The labour schedule services the following purpose:-

It provides the site Incharge with ample warning of his future labour requirements.

- (b) By plotting the actual work force regularly on the chart, a direct measure of labour expenditure on site can be obtained.
- (c) If a manpower shortage is likely particular section of the project enables such type of labour force to be sought from elsewhere before the a delay occurs.
- (d) It helps in efficient and optimum deployment of the labour force in various section of the project.

Preparation of Equipment (Machinery) Schedule

- An equipment schedule is prepared for all plant/equipment required to be deployed on the project.
- From this schedule, delays in the work that may accrue either due to non-availability or breakdown of equipment can be averged.

Name of work -

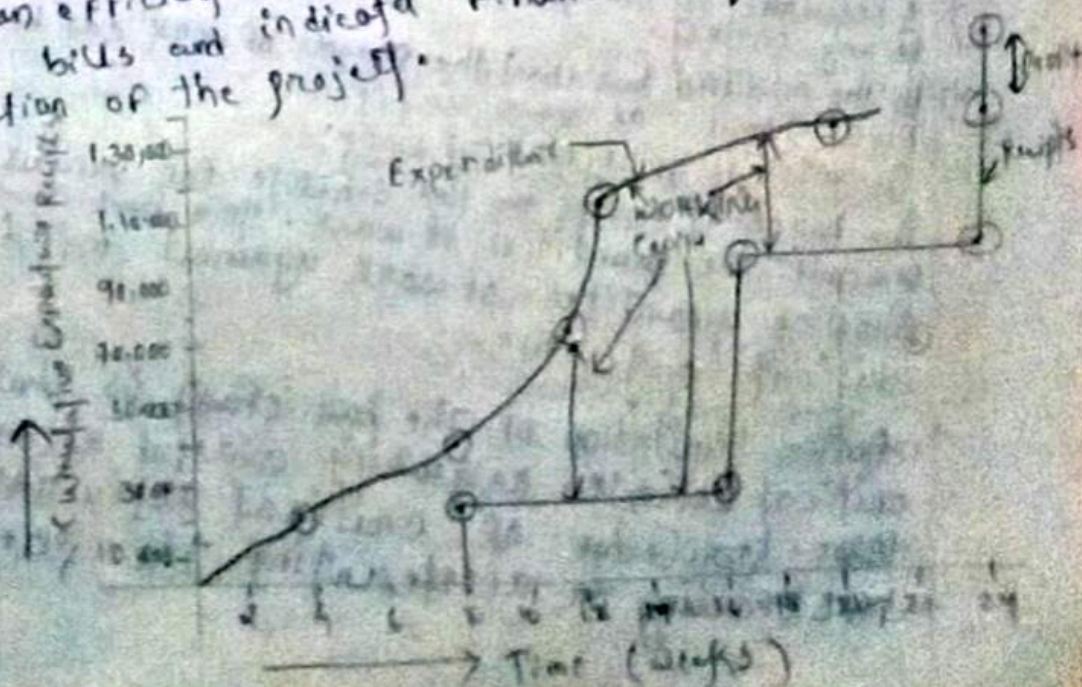
Rate

	Week				
Manpower (Labour)	1	2	3	4	5
Foreman	1	1	1	1	1
Carpenters	-	-	-	1	1
Welders	-	-	3	2	1
Mixture operator	-	-	1	-	-
Masons	1	1	2	2	1
Bar bender	-	2	1	-	-
Laborers	-	-	-	-	-

Such a schedule enables the efficient and optimal utilisation of plant and equipment on a project.

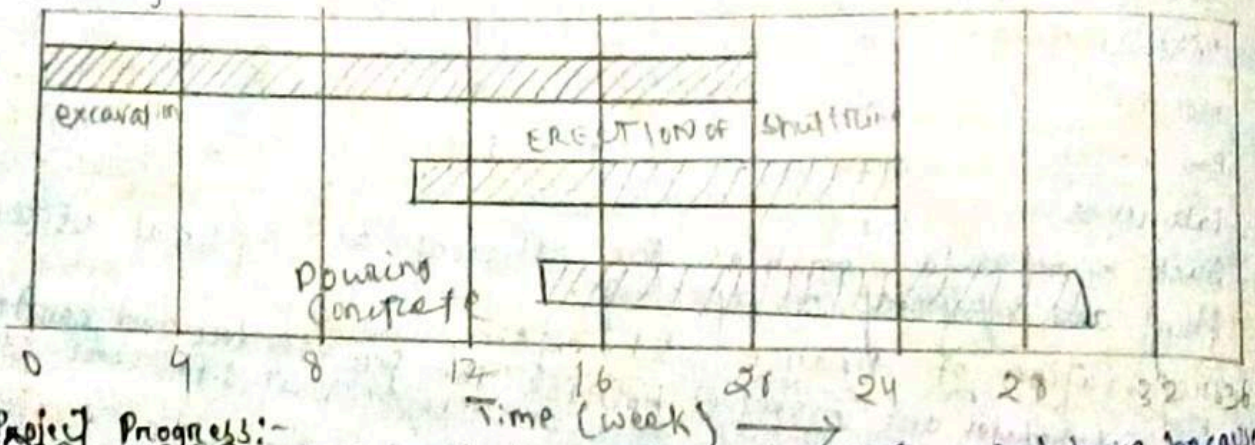
Preparation of Finance Schedule:-

- Finance schedules are essential both for the pre-tender and construction stage of a financial year.
- It enables long-term financial planning for the entire project to be carried out in an efficient manner. It also considers cash inflow from the running bills and indicates finance required for the successful completion of the project.



Limitations of Bar charts

- A construction project consists of a large number of activities. The bar chart does not show clearly the interdependencies among the various activities. Two or more activities are scheduled to start at the same time does not make them independent or completely independent.
- Construction consider a construction project involving excavating foundation, fixing shuttering and concreting in which the time consumed by each activity is as under
 Excavating foundation 20 weeks
 fixing shuttering 14 weeks
 Concreting 16 weeks
- If the activities are taken up in a series the total time taken for completion of project will be 50 weeks.
- Fixing of shuttering may start after the completion of say half of foundation excavation. Similarly concreting may start say 5 week after fixing of shuttering.
- The bar chart of these activities is, as per the bar chart fixing of shuttering still has 4 weeks of work after excavation is over.
- excavation is delayed by 1 or 2 week due to unexpected difficulties in on fixing of shuttering is not clear from the bar chart.



Project Progress:-

- ④ A conventional bar chart cannot be used as an efficient control device because it does not show the progress of work.
- A knowledge of the quantum of work completed or progress achieved is essential in any project.
- In the modified bar chart the progress of work can be depicted by colouring/shading blank bar, as shown in fig.

(iii) Quantities of Items of Work:-

The bar chart depicts the time schedule for various activities but it does not indicate the quantities of work. The bar chart may be improved by showing quantities of work against individual item.

Critical Activity:-

Another limitation of the bar chart is that it does not indicate critical activities requiring careful attention of the construction team. Knowledge of critical activities is essential for rescheduling or accelerating the project completion.

NETWORK Diagram

This is improvement over mile stone chart it is to be used on big project under complex condition
→ the limitation of bar chart are eliminated
→ network is a pictorial representation of activity in which activity interrelationship is maintain during parallel and series activity if dummy required then it may be introduced there are two types of network diagram

- (1) A-O-A network diagram (Activity on arrow) (PERT & CPM)
- (2) A-O-N network diagram (Activity on Node) (CPM)

Using network diagram or project duration float and slacks can be calculate either using PERT analysis CPM analysis

→ PERT uses only A-O-A network where CPM may used A-O-A and A-O-N network

→ There is no use of dummy in A-O-A network.

Different between A-O-A and A-O-N diagram.

A-O-A

(i) Activity are represented by arrow.

(ii) Events are represented by Nodes.

(iii) dummy are used to established logical relation if required

A-O-N
(i) Activity are represented by nodes.

(ii) Events are no plays on configuration in.

(iii) dummy are no rule or no used of dummy

Elements of A-O-A Network

- ① event:- An event is either a start or completion stage of an activity. It is a instantaneous steps which occurs either starting on activity or completion of activity. It doesn't required resource and time and these are represented by nodes which may circular, rectangle, square, oval.

Types of Events:-

There are three types of events

- (1) Start event or initial event
- (2) finish event / final event
- (3) dual role event / intermediate events



Where ^(Fig 1) i = initial event / Tail event / start event for activity 'A'.
 j = finish event / final event / head event for activity 'A'



event where i = initial event / Tail / starting event of activity 'A'

(j) = final / head / finish event of activity (A)

~~(j) = final event of activity (B)~~

(j) = int / Tail / starting of activity (B)

k = final events of activity (B)

j = Dual / intermediate events

(2) Activity:-

Activity is the actual performance of work it required time and resource for both for completion.

It is the work under progress
Exm: Building construction going on

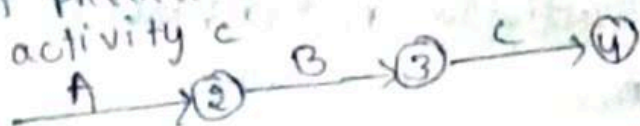
Types of Activity

Date: 4.4.22

① Predecessor

Activity that required to be perform before another activity are on predecessor activity.

Exm: - Activity 'A' predecessor activity of 'B' activity
'B' predecessor activity 'C'



② Successor

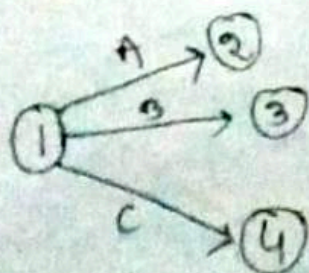
Activity that can be perform after the performance of another activity is known as successor activity

That activity immediately follow another activity without any other activity in between them is known as immediate successor activity to the activity

Exm: Activity 'B' is immediate successor activity of activity 'A'; activity 'C' is immediate successor activity of activity 'B'; activity 'A' is immediate predecessor of activity 'B'

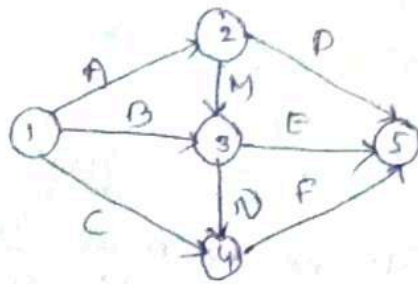
* NOTE:-

(3) Parallel Activity / concurrent Activity



A, B, C are parallel activity (A, B, C started simultaneously)

* NOTE:- There can be more than one start activity and more than one finish activity but there can only on start event and only one finish event.



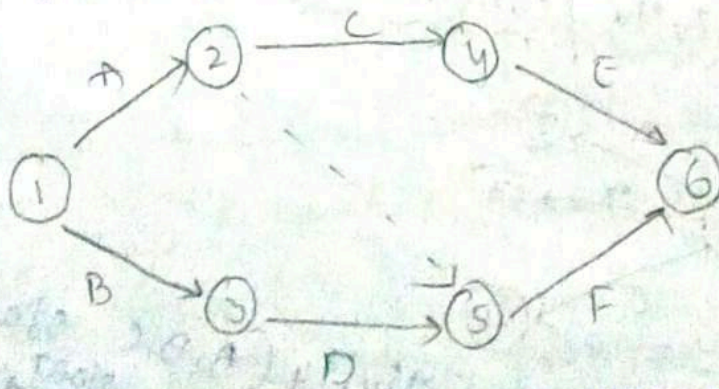
(but only one start event)
 more than one start activity 'A', 'B' & 'C' more than one
 finish activity D, E, F (but only one finish event (5))
 loop on

14) Dummy Activity:-

- It is an activity is required neither resource
nor time for its completion
- ⇒ It is used to establish logical relationship before
 to activity
- ⇒ Dummies are also used for geometrical purpose
- ⇒ It is used only in A-on network.

Uses of Dummy:-

Logical purpose:- Dummy used to establish
interrelationship between specific activity.



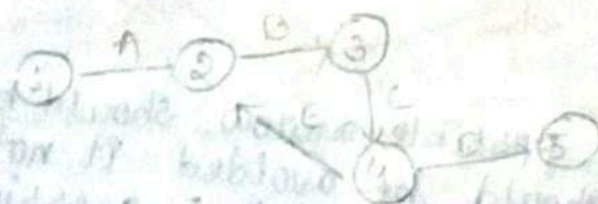
Activity A depends on completion of activity A
 dummy will be introduced between A and F.

Grammatical Purpose

As to network more than one activity can't have common starting point and common finishing event.

Rules for Drawing a Network

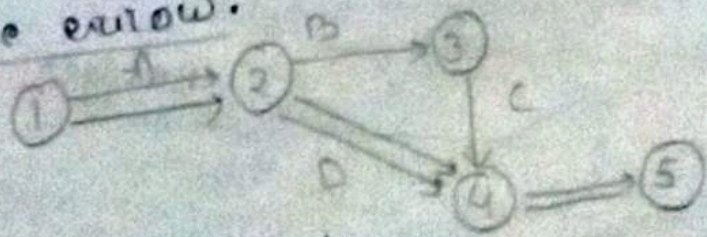
- There can be only one start & one finish event in network & remaining other & dual role event.
- An event can't occur till all the preceding activity are completed.
- An event can't occur two times in a network & means there can't be a cyclic loop in a network.



cyclic error

No formation of cyclic loop in network.

- Length of arrow have no significance it is according to the good representation of network.
- The number of arrow & the no. of activity in A-O-A network is exactly same.
- The non critical activity are represented by single arrow where as critical activity are represented by double arrow.

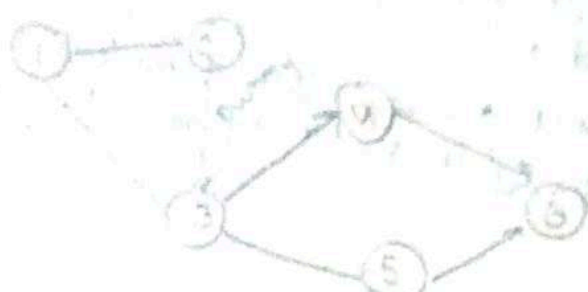


1-2-4-5 critical path.

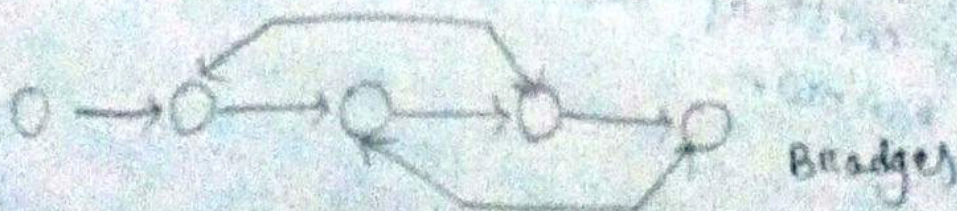
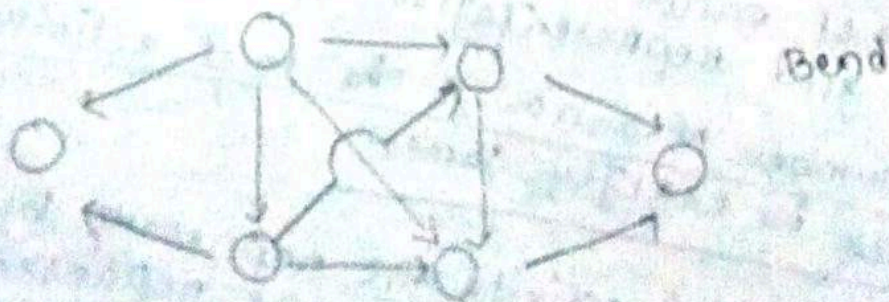
→ In a network there can be only one finish event



⇒ No activity can be a start until all the preceding event are completed.

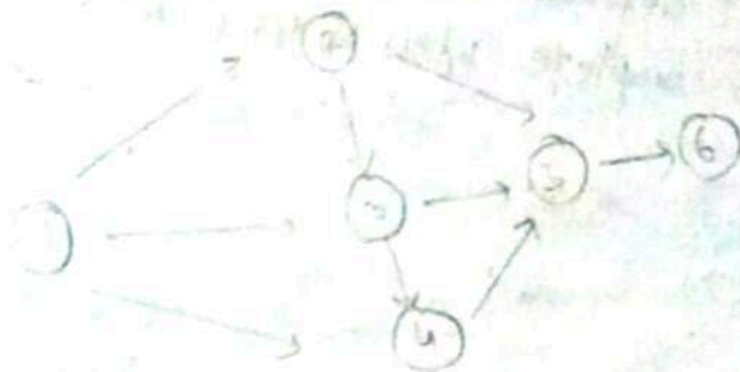


* NOTE:- As per possible arrow should be a straight & crossing should be avoided. If not possible then arrow may be bend & crossing may be bridged.



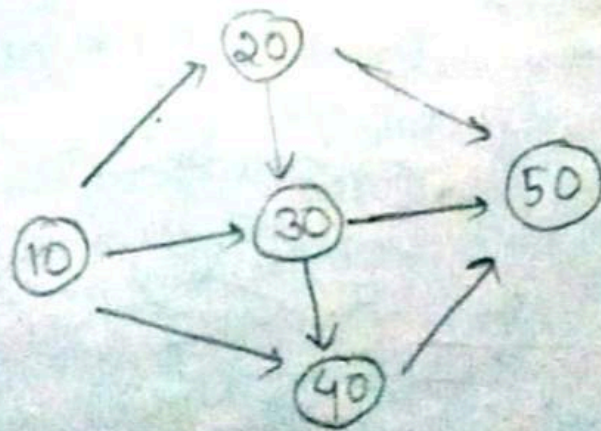
Fulkerson Rule for Numbering the event:-

- Initial event is numbered as one or starting number.
- Ignore all the out going arrows from initial events which are already numbered.
- Some more initial event will be created as it is represented by next no.
- Repeat step 2 until all the events are numbered.



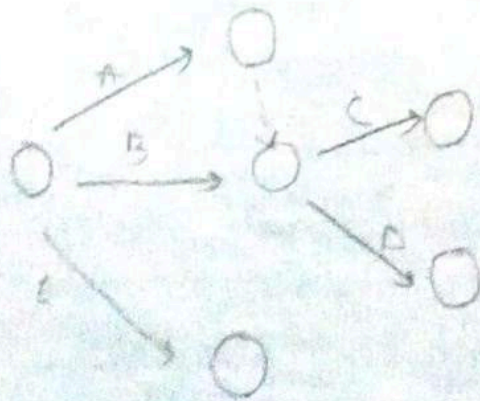
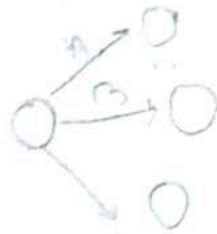
Skip Numbering

→ Skip numbering is used for bigger project in which a major activity may be divided into more than one subactivity in future.



Draw the network diagram for the following relation

- (i) A, B, E can start together
(ii) C and D are concurrent & depends on completion of both A & B.
(iii) Activity F & G are concurrent & depends on completion of C
(iv) Activity it depends on completion of D, E & F the project is complete when G, H & I are done.

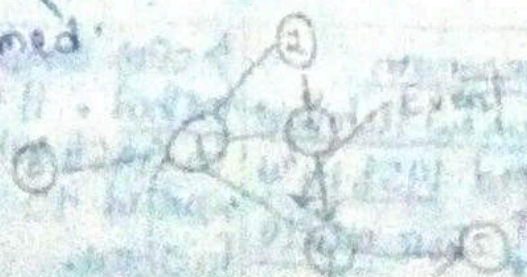


Error in Network diagram

Error in Network Diagram

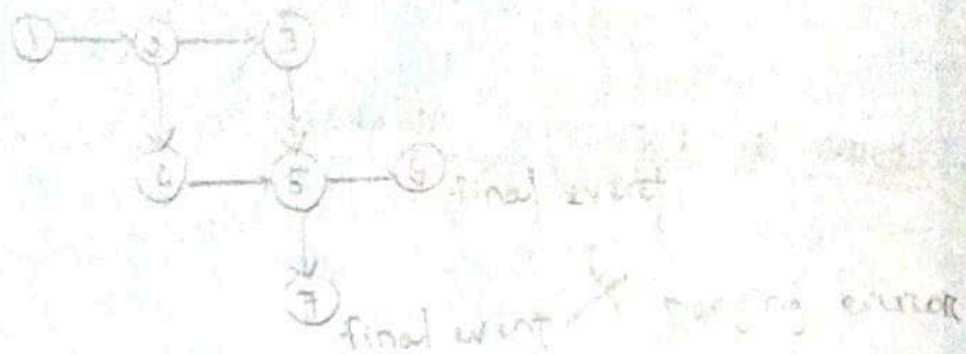
Looping error / cyclic error

In a network every can't repeat, as closed loop should not be formed.



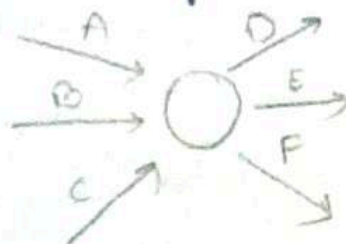
Dangling Error

The network can't have more than one final ends (more than final events)



Wagon Wheel Error

If several activity complete at the same time & other setup several activity start at the same time then the network diagram have following relation.



In this process succeeding activity D, E, F are dependent on preceding activity A, B & C but in real practice all the succeeding activity may not be dependent on the preceding activity.

Difference betⁿ PERT & CPM

Time

PERT	CPM
⇒ PERT stands for <u>Program Evaluation and Review technique</u> & it was 1st developed 1958 by US Navy department for missile development. ⇒ It is based on <u>probabilistic approach</u> in which "three time estimates" are made for each activity.	⇒ CPM stands for <u>critical path method</u>. It was first developed in 1956 when <u>harman company</u> wanted to construct a <u>chemical factory</u>. ⇒ It is based on <u>deterministic approach</u> in which accurate calculation of time estimate can be made which is called <u>activity time (t_a or t_p)</u>.

- (i) optimistic time (t_o)
- (ii) Most likely time (t_m or t_c)
- (iii) pessimistic time (t_p)

Activity (i)-(j) is based to t_o & t_p based on these three estimates expected completion-time of an activity (i)-(j) is given by weighted avg of all the three time.

Expected completion-time of

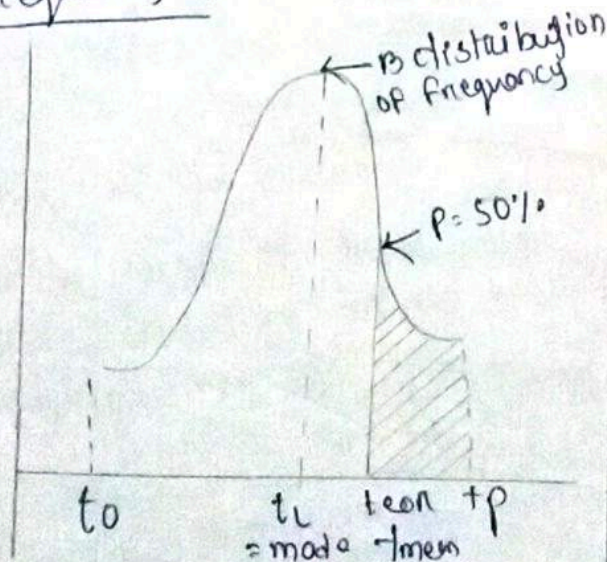
an activity (i)-(j) is

$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

t_e or t_e''

In this time ' t_e ' the probability of completion of an activity is only 50%.

→ In PERT each activity assumed to follow β -distribution of frequency.

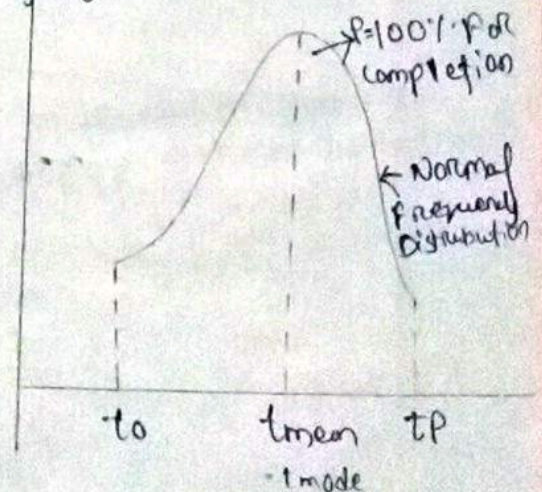


Standard deviation

$$\sigma = \frac{t_p - t_o}{6}$$

In this activity time the probability of completion of an activity is approximately 100%.

→ In CPM each activity is assumed to follow normal to follow distribution of frequency / Gaussian curve in which standard deviation is negligible



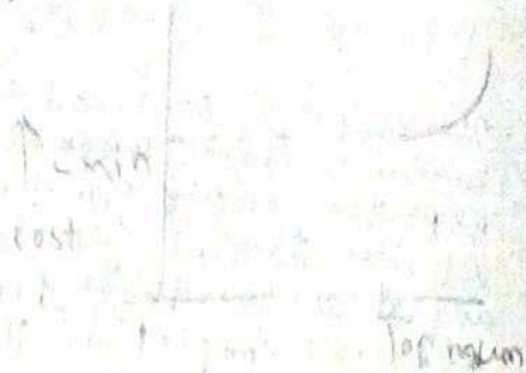
$$t_o = t_p - t$$

or $t_o \approx t_p$

$$\sigma = \frac{t_p - t_o}{6} \quad \sigma = 0$$

→ In PERT time is directly proportional to cost. There fore to minimise cost time of completion should be minimum

→ Time & cost are related as per cost model curve in which minimum for minimum cost.



→ PERT is an event oriented diagram

→ CPM is activity oriented diagram.

→ PERT Mtd is suitable for new or non repetitive type of project (Research & devp type project)

→ CPM is suitable for repeatable nature of work such as construction project.

PERT

It is based on three time estimates for each activity.

(i) Optimistic time (t_o):-

It is the minimum time in which an activity is expected to complete when conditions are most favorable or ideal.

(ii) Pessimistic Time:-

It is the maximum time when may be required for completion of an activity when condition are adverse or most unfavorable.

NOTE:-

In adverse condition while estimating pessimistic time natural disaster like earth quake, floods fire etc are not considered.

(iii) Most likely time (t_m or t_i)

It is the time in which an activity is expected to complete under normal conditions.

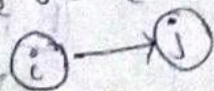
In frequency curve it represents the mode or Peak of the curve.

* On the basis of these time estimate mean expected completion time of an activity (t_e) is obtained by taking weighted avg of

$t_o, t_m \text{ \& } t_p$

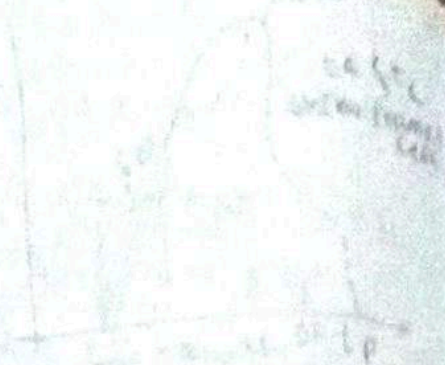
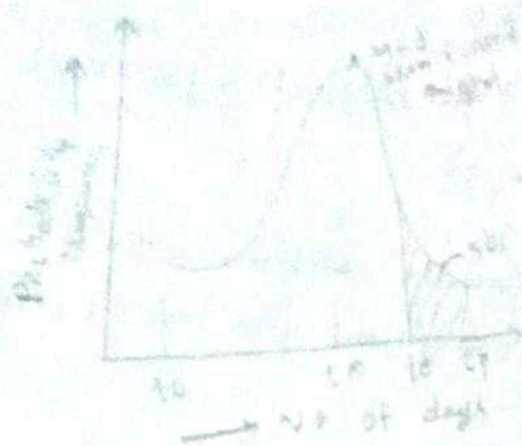
$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

t_e or t_e



* In pert analysis each activity is assumed to follow β distribution of frequency.

* In β distribution mean is not different



Characteristic of frequency curve

(i) Mean of the frequency distribution

It is defined as the ratio of algebraic sum of time needed for completion of an activity to the no. of time the activity is analysed.

$$t_{\text{mean or } te} = \frac{\sum_{i=1}^n t_i p_i}{n} \quad * * *$$

$$t_e \text{ or } t_{\text{mean}} = t_o + 4t_i + t_p$$

↳ expected completion time of an activity

Deviation

It is defined as the difference of the time needed for completion of an activity with the mean of that activity.

(p) → (i)

$$\text{Deviation } \sigma = t_i - t_e \quad * * *$$

Time required for completion of an activity

mean time or expected completion time of an activity

Variance (σ^2)

It is the square of standard deviation & is defined as mean squared deviation. It is used to represent uncertainty in completion of an activity. Greater variance means greater uncertainty in completion of an activity.

$$\sigma^2 = \sum_{i=1}^n (t_i - t_e)^2 \quad **$$

$$\sigma^2 = \left(\frac{t_p - t_o}{6} \right)^2 \quad ***$$

Standard deviation

It is a square root of variance & its significance is similar to that of variance.

$$\sigma = \sqrt{\sum_{i=1}^n (t_i - t_e)^2}$$

$$\sigma = \left(\frac{t_p - t_o}{6} \right)$$

Ex
2.10

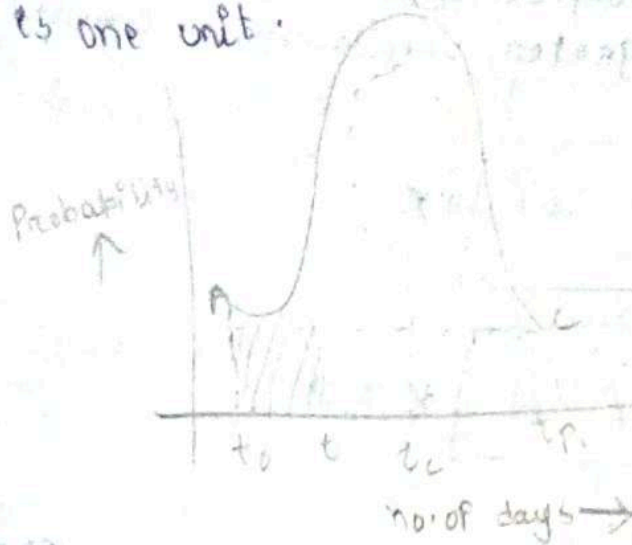
	t_o	t_L	t_p	σ^2
P	5	10	13	1.77
Q	6	9	12	1
R	5	10	14	2.25
S	4	10	13	2.225

Variance $\uparrow$ uncertainty $\uparrow$

Variance $\downarrow \rightarrow$ Project will be certain $\rightarrow$ a

Probability Distribution Curve

Probability distribution curve similar to frequency curve in which total area bounded by the curve is one unit.



Total area bounded by ABC is unit

$$\text{Area bounded} = \int_{-\infty}^{+\infty} f(x) dx = 1 \text{ unit}$$

Probability of completion of an activity in time t : $\frac{\text{Area bound by } f(x)}{\text{Area bounded by } ABC}$ $x \rightarrow t$

The probability distribution curve have following characteristics:-

- (i) Area bounded betⁿ $(t_c - \sigma)$ to $(t_c + \sigma)$ is 68% of total area.
- (ii) Area bounded betⁿ $(t_c - 2\sigma)$ to $(t_c + 2\sigma)$ is 95% of total area.
- (iii) Area bounded betⁿ $(t_c - 3\sigma)$ to $(t_c + 3\sigma)$ is 99.7% of total area.

Normal range of completion of one activity is $(t_e - \sigma)$ to $(t_e + \sigma)$

Maximum range of completion of an activity is $(t_e - 3\sigma)$ to $(t_e + 3\sigma)$

$$t_e - 3\sigma \geq t_o$$

$$t_e + 3\sigma \leq t_p$$

$$t_p - t_o = t_e + 3\sigma - t_e - 3\sigma$$

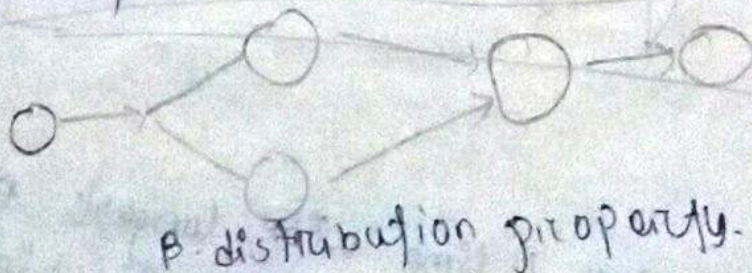
$$\sigma = \left(\frac{t_p - t_o}{6} \right) \times \times \times$$

↓ standard deviation for an activity.

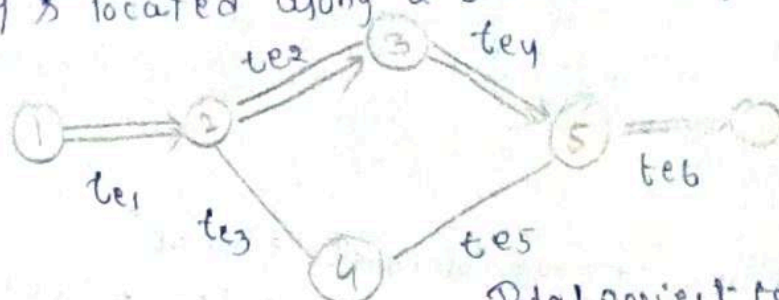
Central Limit Theorem

If there are several activities in a project network which have β distribution of frequency then project as a whole is found to have normal distribution of frequency.

↓ overall project will according to normal distribution of frequency.



→ The total expected project duration is equal to sum of expected completion time of these activity which are critical & located along a critical path.

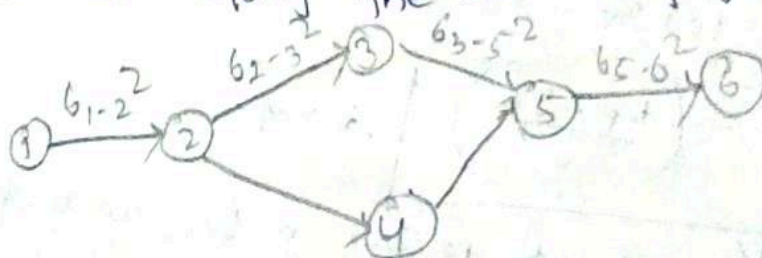


critical path - 1-2-3-5-6, Total project time $T_E = t_{e1} + t_{e2} + t_{e4} + t_{e6}$

T_E = earliest expected duration of project

Crits probability is 50% along critical path

→ The variance of the project is equal to sum of all the variance or along the critical path.



Variance of the project

$$\sigma^2 = \sigma_{1-2}^2 + \sigma_{2-3}^2 + \sigma_{3-5}^2 + \sigma_{5-6}^2$$

Standard deviation of project

$$\sigma = \sqrt{\sigma_{1-2}^2 + \sigma_{2-3}^2 + \sigma_{3-5}^2 + \sigma_{5-6}^2} \quad \text{along critical path}$$

NOTE

Critical path is time wise longest path which is connecting starting event to finishing event.

In a project network there may be one or more than one critical path.

All critical path will give same project duration but it may give different variance or different standard deviation.

The critical path which have greater σ^2 or σ will be least reliable or most uncertain or least probability to finish on time.

Hence such path are required greater accuracy.

Along the critical path each activity has just appropriate resource hence any delay in any of the critical activity will result in the delay of the project. It means each activity & each event is critical along its path.

Hence Total float for each activity is zero & slack for each event is zero.

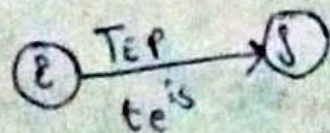
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Calculation event time:-

Earliest expected completion time of an event (T_E)

It is the time in which an event is expected to occur as early as possible.

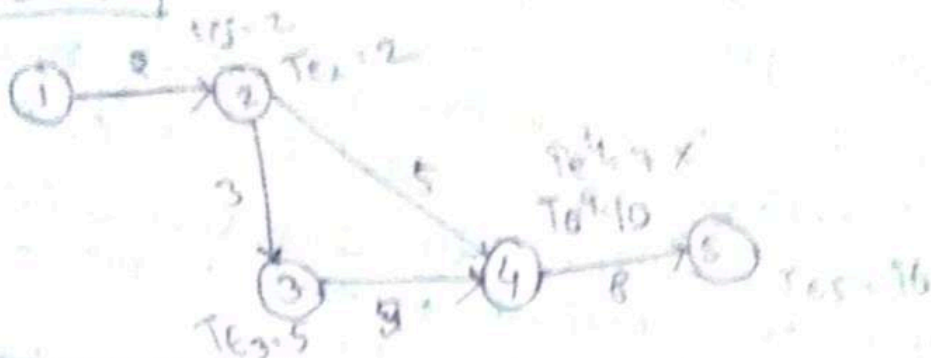
It is calculated by using "forward path" and event occurs when all the preceding activity are completed.



Earliest expected completion time of event i

$$T_E^i = T_E^{j-1} + t_{Ej}$$

$$\star \quad T_{E'} = 0$$



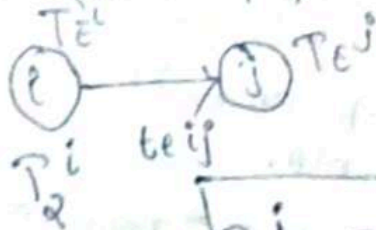
$$\tau_e^i = (\tau_e^p + t_e^{ij}) \text{ max}$$

For more than one path.

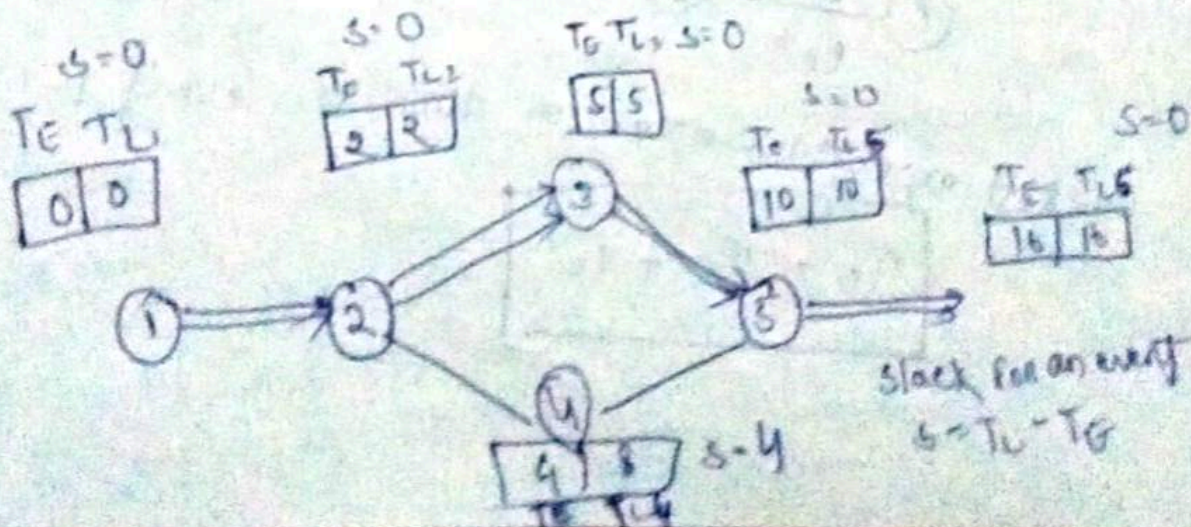
It TE for starting every is not given then it may be taken as zero.

(2) Least allowable occurrence time of an event (T_L)

It is the latest time by which an event may be allowed to occur without delay in the project. It is calculated by using backward pass.



$$T_L = T_L^j - t_e^j$$



stack for an event
 $S = T_u - T_g$

$$T_L^i = (T_L^j - t_{ij}) \text{ minimum}$$

for more than one path

SLACK

Slack of an event represent ~~represent~~ the excess time which may be available to delay the, occurrence of event without affecting the project duration.

It is given by

$$S = T_L - T_E$$

There are three cases

Case: 1

If $S = 0$, then event is critical such that event can't be allow delay the path connecting event of zero slack is called critical path, which is generally represented by $(\Rightarrow)$ It means that there is no excess time by which event may be delay. If any of the event the entire project end will delay hence path joining critical event is called critical path. Critical path is time wise longest path.

Case: 2

If $S > 0$ then it is then it is sub-critical in this case the occurrence of an event may be delay without delay in the project duration it means that activity along these path have extra time of excess resources which are non critical.

Case: 3

If $S < 0$ such an event is called super critical it is already ~~be late~~ ^{behind} the schedule & it delay the project & resource in these path are in appropriate.

For completion of project on time extra resource are need.

Calculation of probability of completion of a project

Step:-1

Draw the PERT network & find expected duration each activity (T_E). Calculate T_E & T_C of each event & then find project duration (at this time probability of completion is only 50%).

Step:-2

Find slack of each event & mark the critical path it is the path connecting the event of zero slacks.

Step:-3

Calculate variance & standard deviation of project by using activity along critical path.

Step:-4

Calculate probability factor the given completion time of the project

$$Z = \frac{T_S - T_E}{\sigma}$$

σ = Standard deviation of project along critical path
if there is more than one critical path then maximum of σ is taken

T_E = Expected completion time of project.

T_S = given scheduled completion time of project

STEP 5

Find the probability of completion which is related to probability of factor z .

z	P
0	50%
1	84.13%
2	97.72%
3	99.87%

z	P
0	50%
-1	15.87%
-2	2.28%
-3	0.13%

The intermediate value z is obtained linear interpolation

Linear interpolation

Linear interpolation

Linear interpolation

Linear interpolation

CPM

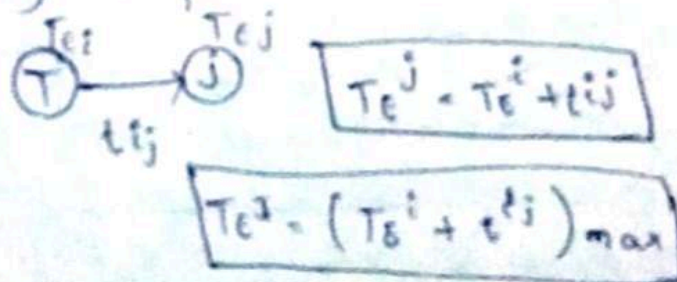
CPM stands for Critical path method

- This is based on deterministic approach in which only one time estimate is made for activity completion.
- The network diagram in CPM is activity oriented.
- The cost is most imp criteria in CPM. therefore optimum time is calculated which will result in minimum.
- For each activity single time estimate is made which is called activity duration or estimated duration of activity or time of occurrence of activity.
- The probability of completion of activity at this time is approximately equal to 100%. It is suitable for respective type of project.

Event times

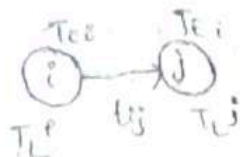
Earliest event occurrence time (T_E)

This is the time at which an event may occur as early as possible.



Latest allowable occurrence time (T_L) for more than one path

This is the time by which an event may occur as late possible without delay on the project completion time.



$$T_{Li} - T_{Lj} - t_{ij}$$

$$T_{Li} = (T_{Lj} - t_{ij}) \min$$

For more path

Activity time:-

Earliest start time of an activity (EST)

It is the earliest possible start time for an activity (say (i,j)) it is equal to earliest occurrence of tail event of that activity.

Earliest finish time of activity

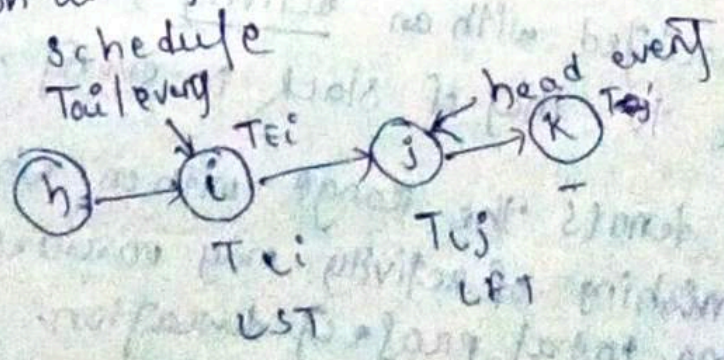
It is the earliest possible time of an activity for EFT an activity should be started at EST

Latest start time of an activity (LST)

for latest start an activity should be started as late as possible.

Latest finish time:-

It is the time in which an activity may allow to finish as late as possible without delay in the project schedule



$$EST = TE^P$$

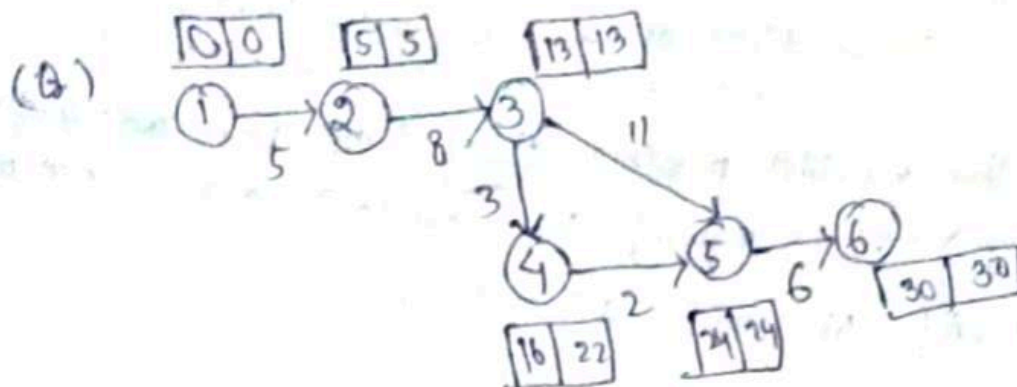
$$EFT = TE + t^j$$

$$LST = TL^j - t^j$$

$$LFT = TL^j$$

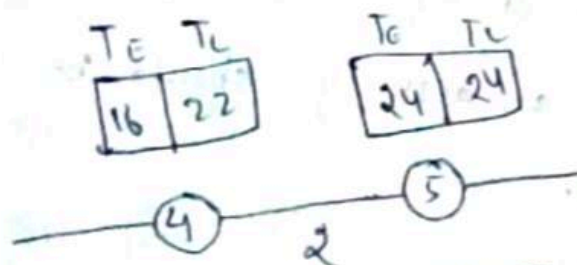
EST & EFT are calculated by using forward path

LST & LFT are calculated by using backward path.



for activity (4) → (5)

final EST, EFT, LST, LFT



$$EST = 16$$

$$EFT = 16 + 2 = 18$$

$$LST = 24 - 2 = 22$$

$$LFT = TL^j = 24$$

Float :-

It is associated with an activity & its significance is similar to that of slack in event.

Float denotes the range within which a starting or finishing of activity may vary without affecting total project duration.

ed by

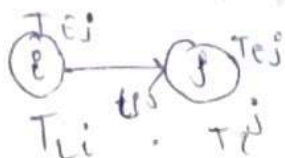
There are four type of float

(i) Total float (F_T)

It is the maximum time by which either a starting activity or completion of an activity may be delay without affecting the project duration.

$$\text{Total float} = \text{Maximum available Time} - \text{Time need for completion of activity}$$

$$F_T = (T_L^j - T_E^i) - t_{ij} \quad * * *$$



(ii) $F_T = LFT - EFT$

$$= T_L^j - (T_E^i + t_{ij})$$

$$F_T = (T_L^j - T_E^i) - t_{ij}$$

$$F_T = LST - EST$$

$$= T_L^j - t_{ij} - T_E^i$$

$$F_T = T_L^j - T_E^i - t_{ij}$$

* Total floats of an activity affect preceding & succeeding activity both.

Free float

It is that portion of the total float which can be used by an activity for starting delay or completion delay without affecting total project duration.

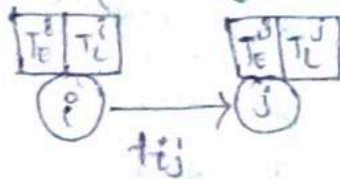
To calculate FF, all activities are assumed to start at their earliest time.

free float affect only preceeding activity but not the subceeding activity.

free float is always +ve

$$\text{free float} = \text{Total float} - \text{Head over slack}$$

$$F_F = (T_L^j - T_E^i - t_{ij}) - (T_L^j - T_E^j)$$



$$SF = T_E^j - T_E^i$$

$$F_F = T_E^j - T_E^i - t_{ij} \quad * * *$$

(3) Independent Float (F_{IO})

It gives about excess time over activity duration when preceeding activity completing as late as possible & subceeding start as early as possible

Independent float can neither affect the succedent activity nor effect the predecessor activity

$$F_{IO} = (T_E^j - T_L^i) - t_{ij}$$

$$F_T = (T_L^j - T_E^i) - t_{ij} \quad (\text{Both})$$

$$F_F = (T_E^j - T_E^i) - t_{ij} \quad \text{preath} \begin{matrix} \uparrow \\ E \\ \downarrow \\ E \end{matrix}$$

$$F_{IO} = (T_E^j - T_L^i) - t_{ij} \quad (\text{neither})$$

$$F_{ID} = F_F - \text{Tail every slack}$$

$$F_{ID} = T_E^j - T_E^i - t_{ij} - S_i$$

$$= T_E^j - T_E^i - (T_L^i - T_E^i) - t_{ij}$$

$$= T_E^j - T_L^i - t_{ij}$$

(4) Interfering float (F_I)

It is difference betⁿ total float & free float

$$F_I = F_T - F_F$$

$$= F_T - (F_T - S_j)$$

$$F_I = S_j$$

Interfering float = Head every slack

✓ Critical path

→ The path which connects activity with zero total float are called critical path. Time with it is longest path.

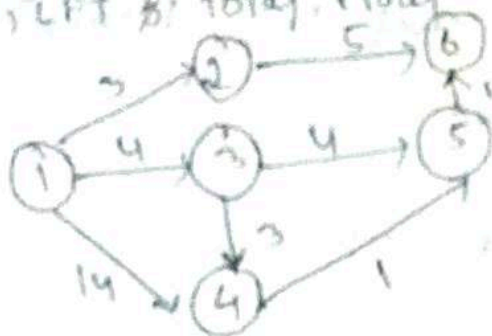
→ Along the critical path, all the activities are critical hence total float $F_T = 0$

* If F_T is less than zero than activity is super critical & the path connecting super critical activity are called super critical path.

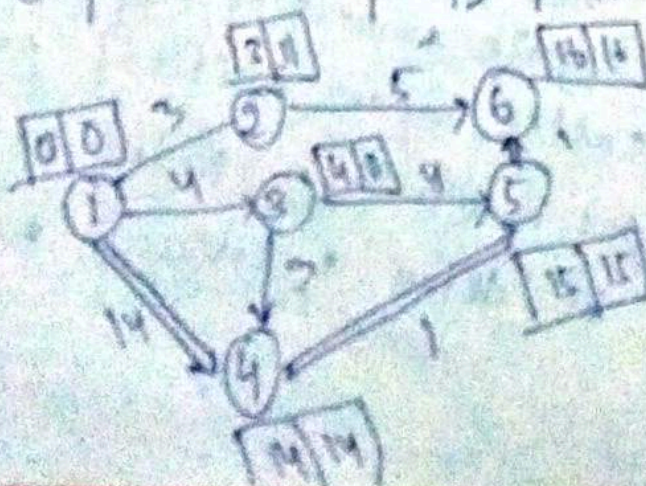
So $F_T > 0$; $F_T < 0$ then total project duration will be delay & resource are insufficient

* If $F_T > 0$ then activity is sub critical. A path joining these activity are called sub critical path. Such activity will have excess resource & if these are delay will in the total float then total project duration will not be affected.

(Q) for the network with activity duration as shown calculate project duration, critical path, EST, EFT, LST, LFT & total float for each activity.



Activity	duration(tij)	EST - Tei	EFT - Tef	LST - Tli	LFT - Tlf	Total float $F_T = T_{li} - T_{li}$
1-2	3	0	3	8	11	8
1-3	4	0	4	7	11	7
1-4	14	0	14	0	14	0 (critical)
2-5	4	4	8	11	15	7
3-5	4	4	8	11	15	7
4-5	1	14	15	14	15	0 (critical)
5-6	1	15	16	15	16	0 (critical)



Project duration 16 days
critical path 1-4-5-6

GATE
2012

For a particular project 8 activities are given
their relationship & estimated duration are mentioned
In the table the critical path for the project

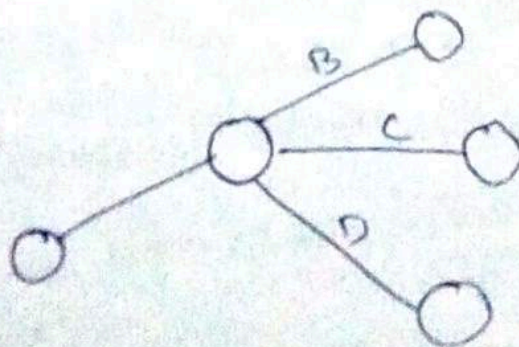
(a) A-B-D-H

(b) A-C-G-H

(c) A-B-C-F-H

(d) A-B-C-F-H

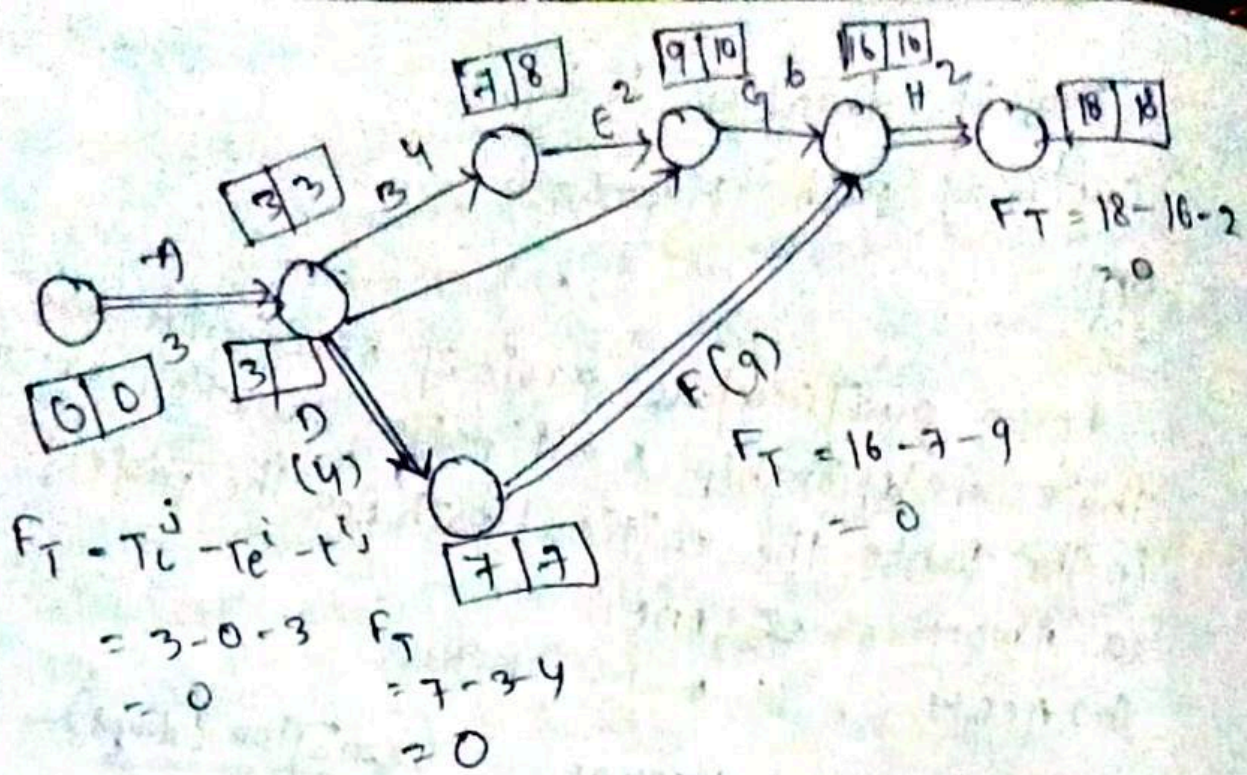
<u>Activity</u>	<u>Predecessor</u>	<u>Duration (days)</u>
A	—	3
B	A	4
C	A	5
D	A	4
E	B	2
F	D	9
G	C, E	6
H	F, G	2



objective

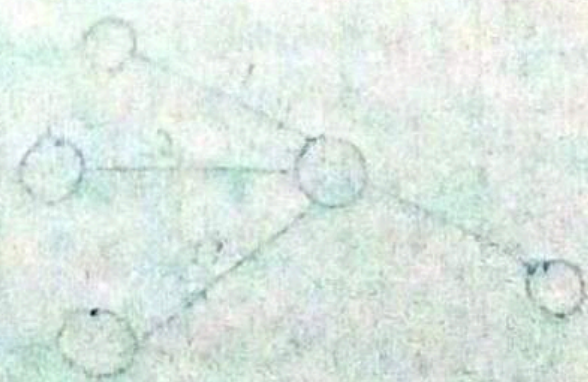
$$F_T = T_C^J - T_E^I - 15$$

$$= 3 - 0$$



activity

activity



1. Classification of stores - storage of stock
2. Issue of Material - indent, invoice, bin card.

Store Management:-

Store Management is an important aspect in a construction site. Material requirement should be calculated and the orders should be placed in advance so that material is readily available when work begins. The site stores in this site mainly manage receiving, issuing & storing of material and maintenance of plant and equipment.

Characteristics of a well managed store

- Availability of material whenever required.
- The storage quantity should neither be too much as it would increase the storage cost and the material may get deteriorated on the other hand the stock levels should not too low as a material shortage may lead to delays of the project.
- Material should be stored in such a manner that they are easily accessible, not subjected to environmental damages and would not obstruct the site area.
- Using the FIFO basis in issuing materials whenever possible.
- Properly maintained recording system facility the preparation of usage report regular stock counts monitoring the inward and outward movements.

STORES

A store is a place where material of construction are properly arranged. The location and layout of stores should be carefully decided for achieving better efficiency.

The store can be classified in the following two categories.

Project stores:-

For big construction projects the requirements of materials are more and hence a separate organization is set up at the site of work to look after the management of construction materials. These are also referred to as material at site stores and their cost is directly debited to the project.

Stock stores:-

These are the general stores for the storage of common building materials. These stores are suitable for big organization having construction works or maintenance work going on at a number of place. The material from these stores are issued as required for different jobs by the process of indent.

✓ Points to be remembered while storing materials at site

Different types of material will have different storage requirements, in particular depending on whether they are durable or non-durable.

Bricks: Bricks may be delivered to site loose or strapped in unit loads and stored on timber

pallets to be transported using a forklift. Bricks should be stacked on edge in rows to a maximum height of 2.4m. It is important that they are stored on level well-drained ground and covered with a polythene sheet to protect against efflorescence.

For storage allowance of around 5m should be given for the forklift approach.

Blocks: Blocks may be delivered to site loose or strapped in unit loads on timber pallets. They

should be stacked in column to a maximum height of 8 courses & covered with a protective sheet.

Roofing tiles:

Tiles may be delivered to site loose in plastic-wrapped packs or in unit loads on timber pallets. They should be stacked vertically in rows to a maximum of 6m height. The tiles at the end of the row should be laid flat and staggered. Ridge tiles should be stored vertically on end.

Drainage pipe:

These are usually supplied loose or strapped together on timber pallets. They should be stacked horizontally with ends reversed in alternate rows. Adapters in timber stack or column of loose bricks can be used to form end restraints.

Corrugated and similar sheet materials:-

These should be stored flat on a level surface and covered with a protective polythene sheet.

Timber:-

Timber and other joinery items should be stored horizontally and covered in a scaffold rack although provision should be made for free air flow usually by the rack having open ends and sides while having a top that is covered if it is available. For different timber sizes to be kept separate.

Cement:-

Since any contact with direct or air borne moisture can cause cement to set, it must be kept dry. In terms of organisation it is advisable for a rotational system to be used, where by the first batch of cement delivered is the first to be used.

Small quantities of bagged cement should be stacked to a height no more than 1m on a raised dry platform such as a timber pallet. A polythene sheet should be used as cover with care being made to ensure that it is weighted down around the edge.

Medium quantities of bagged cement may need to be stored in a water tight and fire proof shed with galvanized steel sides and adjustable legs on bearing plates. Large quantities of loose cement should be stored in a cement storage silo.

Aggregates:-

It is essential for different aggregate type and size to be kept separate. They should be stored on a clean, hard free drainage surface, surrounded by retaining & separating walls of bulk timbers. stored aggregates should be regularly monitored for moisture content.

Stone accounting procedure:-

The term stone keeping is very wide in sense and it includes all operations involved in the management and handling of building material which flow in and out of the stores of a big construction company.

The function of stone-keeper may broadly be divided into the following three categories.

Ordering:-

The requirements of different material by various department are collected and forwarded to the purchasing department.

Receiving:-

As soon as the materials are received, they are checked and stored properly.

Issuing:-

The material are issued to the department as required. Following are the general principles to be strictly observed in stone keeping.

Accounting:-

The account of material should be kept in such a way that it should be possible to ascertain the expenditure on stores during a certain period.

If the material are purchased for a particular job the cost may directly be debited to that job.

Checking

Suitable checking procedure for physical verification of the materials should be established and followed at regular intervals.

Golden Rule:-

The golden rule that no material should enter or leave the stores without documentary evidence should be strictly enforced.

Issuing materials:-

The standard requisition forms should be developed by the department and materials should only be issued against requisition forms duly signed by the authorised person of the organization.

Indent:-

✓ Indent is basically raised by stores, asking for materials needed which are present in the store. A privileged employee can raise indent, requesting for items that may be required by store. After an indent is raised the indent is sent to the authority for approval.

Invoice:-

A construction invoice is used when companies have completed work for their clients and are ready to get paid.

- They generally include lists of
- work completed and time put in, written in the 1st section.
 - what products have been used, written in the materials section.
 - finally how much is being charged for other services such as costs of getting council/finance department approval.

[When a supplier directly supplies goods to the site he will produce a copy of an invoice raised by him. The invoice are filed and sent to head office for billing. The details are used to update a book of receipt as well as weekly materials progress reports]

Bin Card:-

This is maintained in the stores to record the movement of the stock level of all the items. A bin card is maintained for each item in the site. The purchase of bin card is to record the receipt and issues and the stock level of the item and any moment can readily be found from this the bin card in this site service the function of stocks ledger. The updating of this is done using the entries of the materials issues book.

Difference between Bin Card and Stores Ledger.

✓ Basis for comparison	BIN CARD	STORES LEDGER
(i) Meaning	Bin card implies a quantity record of the receipt issue and balance of material in stores	Stores ledger attached to a subsidiary ledger that keep track of each and every transaction relating to material in the stores.
(ii) What is it.	It is recording documents	It is an accounting record.
(iii) Responsibility	Storekeeper	Cost accounting department
(iv) Location	Kept inside the stock room	Kept outside the stock room.
(v) Details	contains quantitative details only	contains both quantities and monetary details
(vi) Interdepartmental transfer	are not shown in bin card.	Indicated in stores ledger
(vii) Entries	Entries are posted when transaction takes place.	Entries are posted after transaction took place.
(viii) Recording	Transactions are recorded individually.	Summarized transactions are recorded.

CHAPTER 4 CONSTRUCTION SITE MANAGEMENT pg: 55-22

1. Job lay out - objective, Review plans, specification lay out of equipment.
2. Location of equipment, organizing labour of site.
3. Job layout for different construction sites.
4. Principle of storing material at site.

Job layout / site layout

Site layout is the plan of the construction site. It shows the area and the exact location for placing the resources required in the work. It also indicates the place for office, workshop, accommodation etc. Beside this it shows the existing relationship of the site with its surrounding in respect of communication, approaches and existing facilities.

- * A job layout is a scaled drawing of the purpose construction site showing all relevant features.
- Entry point
- Exit point
- Storage area of materials - bricks - cement - sand - aggregate
- Temporary Service - washing / toilet
- Contractor's office
- Area of keeping equipment such as mixer.
- Bar bending area
- Labour housing.

Purpose of preparing sub layout:-

- To save time in delivering construction material at the side of construction.
- To safeguard construction material from damage & deterioration.
- To keep the lead of cartage minimum, so that cartage expenses may be minimum.
- To adopt the best mode of working.
- To complete the work with the minimum use of equipment & machinery.
- To provide safety to workers & present by.
- To store constn material as near the place of utilization as possible.

Advantage of a good layout

- Smooth & economical working of the project.
- Reduces the completion time of the project.
- Provide more safety in the working of the project.
- Material wastage & deterioration are reduced.
- Material transsection become easy, speedy & economical.
- Increased the output from labour & Machinery.

Factor Affecting Job layout:-

1. Nature of the project:-

This will play a great role in the preparation of the job layout. If it is a multi-storied building project then it will require a centrally located layout scheme. On the other hand, if for example, it is highway construction project then it will require a number of construction centres at suitable location.

2. Construction Method:-

The construction can be either cast-in-situ or by precast elements. If it is to be cast-in-situ then the provision for casting yard must be included ^(on the place) in the job layout.

3. Availability of Resource

The layout of the project is prepared by keeping in mind the availability of resources such as manpower, labour, Plant, equipment, materials for instance if the project demand labour from outside the layout will have to accommodate for the food, shelter & other facilities of labour.

4. Location of project

The layout of a project is governed by its location with respect to topographical feature climatic condition distance from mode of transportation.

5. Medical facility

It is desirable to provide a field medical aid facility for big project.

6. Method of execution

The construction project can either be executed through the agency of the contractor or by employing the labour directly by the owner.

7. Services:-

If the essential services like water supply, sanitation & electricity are not locally available the same will have to be accommodated in the layout of the project.

8. Welfare facilities:-

If the project is to last for a long time, it is the study of project management includes in the layout the welfare recreation & religious facility for the workers. If the same are not locally available.

9. Construction's site engineer's office:-

There should be located preferably in a noise free area for better co-ordination.

10. Provision for temporary roads:-

These are necessary to transport the necessary plant machinery & material required for the project & also be provide the access to the construction site from the existing nearby roads.

Principal preparation of job layout

1. Administrative block:-

The administrative block should be located near the main entrance of the project site so that the visitors do not required to move long in construction area. In the reduction chance of accidents to the visitors.

2. Warehouse:-

Warehouse - should be preferably located near the administrative block so that incoming material can be easily stored & outgoing material can be watch properly.

3. Entry & Exits:-

For easy flow of traffics entry & exit should be at different location.

4. Location for Workshop:-

Workshop for welding fitting electrician carpenter & mechanical etc should be located near the site of work & easily roads.

5. Services:-

Services like temporary petrol pump temporary substation, telephone line water supply line should be properly planned in job layout.

6. Temporary Roads:-

Temporary Roads should be planned in job layout for easy handling of materials & equipment.

7. Staff accommodation:-

In the job layout staff quarters should be located away from the actual work site at

Siting place all the staff should be located at one place so that service can be made available easily.

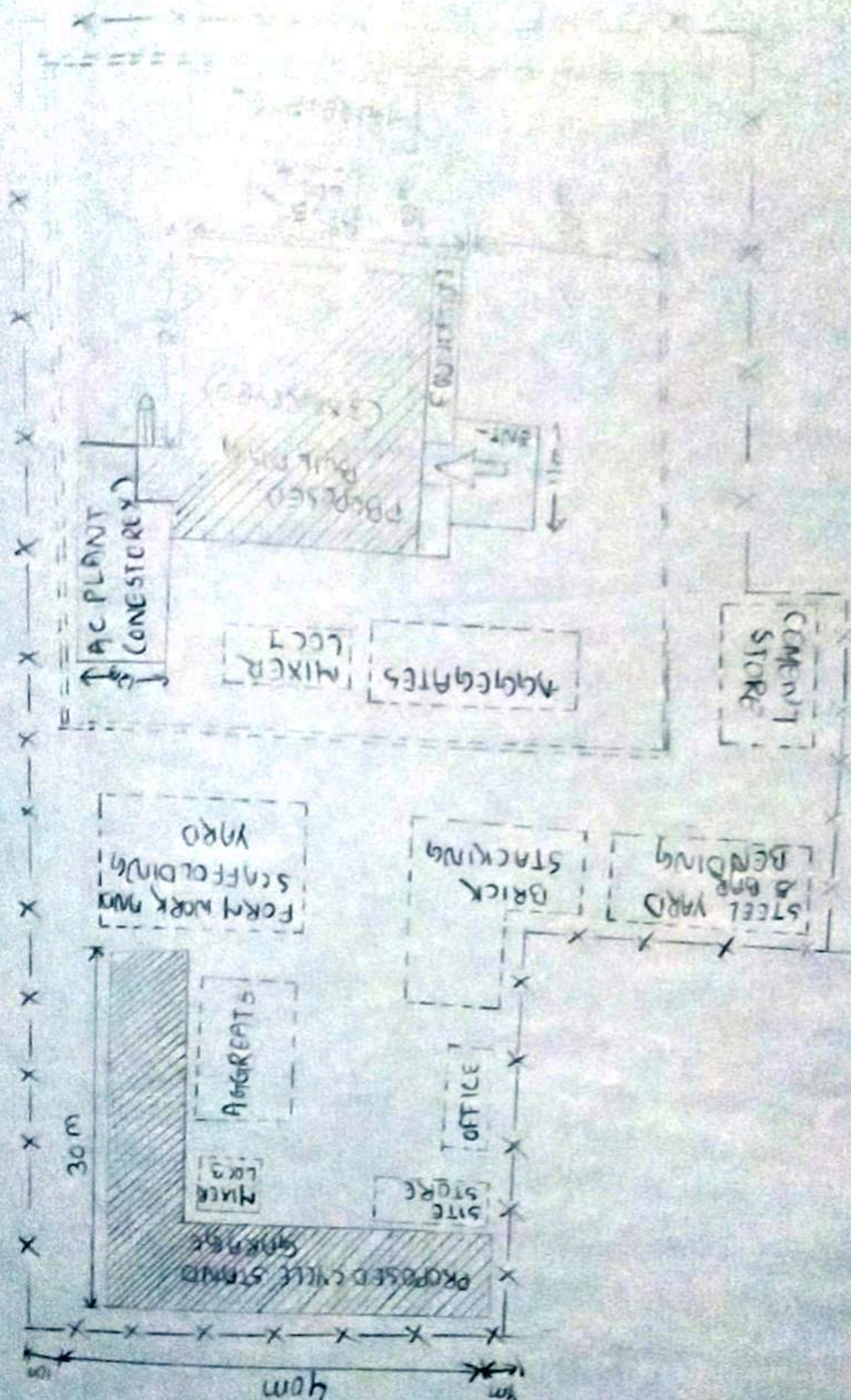
Preparation of Job Layout

→ The job layout is prepared by the engineer in-charge or the site engineer. In order to prepare the job layout, the contract documents, layout plans, drawings, specification and other available documents are studied carefully to assess the nature and extent of the work.

→ A scaled drawing is then prepared which shows the outline of the job to be constructed, entry and exit point, various facilities such as storage yard, office, repair and maintenance sheds, toilets, canteen, labour huts, temporary service including water and power supply etc.

Essentials of Site Layout / Job layout

1. Plot for work boundary.
2. Purpose outline plan of construction
3. Adjoining properties and its ownership
4. External road approaching to site
5. Entry and exit gate.
6. Place for equipment
7. Place for material
8. Place for parking loading and unloading of material
9. Place for preparing like concrete / mason work bending
10. Toilets
11. Place for refuse
12. Hutments for labour
13. Site office
14. Security arrangement.



Typical Job Layout for a Three storied Building Block

CHAPTER-5 CONSTRUCTION ORGANIZATION

Principles of organisation

- An organisation is a group of persons working together to achieve an established goal. It is the relationship which exists between people taking part in a group activity.
- It defines the responsibilities and authority of individuals in relation to men, material, money and machinery which constitute the resource of organisation.
- An organisation is needed because a manager at any level can effectively manage the functions of only a limited number of person working directly under him.
- The setting up of a suitable organisation for various civil engineering works is all the more necessary because the construction industry is a competitive field of endeavour which is susceptible to many risk, variable labour condition and diverse construction problems. In order to be effective, an organisation has to follow certain basic principle given below:-

(i) Principle of objectives:-

The organisational objectives should be clearly defined. The structure of the organisation should be geared to achieve these objective at minimum cost and effort.

(ii) The scalar principle:-

An organisational structure consists of different levels of authority arranged in a hierarchical manner. The line of authority

should be clearly defined from the chief executive at the top to the lowest line supervision at the bottom. The know as scalar principle. The importance of scalar principle lies in the fact that the understanding of authority relationships within an organisation becomes easier. It also throws light on how different parts of an organisation are created and held together.

Principle of Balance Between Authority and Responsibility
In order to perform work properly, it is essential that every one know his duty responsibility and authority or power. Authority means right to act, decide and command. The delegate will not be able to perform his task properly unless he is given necessary power (i.e. authority). So whenever a task is assigned to a person, he must be given sufficient power to exercise control in order to achieve desired objective.

Responsibility is the obligation of a subordinate to perform any job allotted to him by his superiors. A person, who is assigned responsibility to do a certain job, must be given appropriate authority to achieve the same. Thus authority and responsibility go hand in hand and must be balanced rationally to produce best result.

For example, if a civil engineer in a construction firm is asked to carry out construction of different structure, and is not given corresponding authority to produce the various resource, responsibility given to the civil engineer would be illogical and unbalanced.

(iv) Principle of Unity of Command:-

Each person in an organisation must know to whom he has to report and from whom he should receive orders.

He should also know the persons both upwards and downwards whom he is to consult.

- The principle that each subordinate should report to only superior is called the Unity of command.
- This not only avoids confusion but also helps in maintaining a definite line of command. In order to avoid indiscipline, delay, disorder and undermining of authority, a subordinate should receive orders from only one superior and not from a number of superiors.

(V) Principle of span of control

- According to this principle, there is a limit to the number of subordinates an executive can effectively supervise.

- There are many factors on which the span of control depends, such as the type of work, whether routine or repetitive, level in the organisation, type of problems encountered and abilities of the person involved. The optimum span of control varies from person to person and ~~to~~ job to job. Sometimes the number six is taken as the effective span of control.

(VI) Principle of Departmentation

- Departmentation means the division of an organisation into several distinct departments or sections. This helps in increasing the efficiency and facilitates the execution of work. In order to obtain optimum result, the functions and scope of each department must be clearly defined.

(vii) Principle of Specialisation:-

According to this principle activities of the organisation should be grouped as per the function and assigned to individuals according to their specialisation.

(viii) Principle of Communication:-

- The number of supervisory levels in an organisation must be kept as small as possible. This helps in shortening the line of communication for passing on information, instruction and suggestions from the chief executive level to the first line supervisor.
- The temptation to go too far in either direction (i.e. horizontal and vertical) means increased lines of communication may result in lower overall efficiency and profit.

(ix) Principle of flexibility and stability:-

Flexibility and stability in an organisation are closely inter-related. On the one hand, an organisation should be flexible enough to assess the changes which often become necessary because of internal and external situations. While on the other hand, the organisation must be stable enough to withstand any organisational change which becomes necessary for the accomplishment of its objectives.

(x) Principle of Motivation and stability:- Professional growth

The organisational structure should be such that it provides enough opportunities to its personnel for their professional growth and upward or lateral mobility. Job roles should

- be such that each member of an organisation achieves professional growth and upward or lateral mobility.
- Job roles should be such that each member of an organisation achieves professional satisfaction and is motivated towards loyalty for the organisation.

(ii) Principle of continuity

The organisational structure should be dynamic so that it not only provide for the activities necessary to achieve its objectives but also for the continuation of such activities in the future. This maintains a link between the past and the future.

COMMUNICATION, LEADERSHIP AND HUMAN RELATIONS

- (i) Communication: - Communication means sharing of ideas in a condition of mutual understanding. The message conveyed by the initiator may be verbal written or visual and the receiver may listen, see or examine and react in other ways.

→ In the absence of proper communication between the various groups and within group member working on a construction site, the desired progress of work would not take place.

→ In some cases the construction work may not even start due to a communication gap between the planners and implementors.

To safeguard against this effort should be made to use better communication style and techniques to promote a congenial atmosphere at the construction site.

(ii) Leadership: Leadership is needed for every project or organisation at different levels for various reasons.

- To help in defining the mission of the group.
- To create an environment in which group members become committed to the objective of the group.
- To serve as an interpreter of message and behaviour of other groups and individuals who may have some influence on the group.
- To co-ordinate the activities of group members to ensure compatible and consistent efforts towards the organisational goal achievement.
- To provide needed resources for the group.

Thus, heads of different groups working on the project should provide appropriate leadership to achieve the established objectives.

(iii) Human Relations:

→ The term human relations applies to all interaction, good and bad, among people. The behaviour of people at work and how various elements of the workplace affect the people are important to the study of human relations in an organisation or project. Someone may be irregular at work due to health problems arising out of adverse site conditions while another might be inefficient because of family problems.

→ Human behaviour in the work environment includes the interaction between superiors and subordinates, the interaction amongst peers and the way in which individual interact with each other in formal and non-formal groups. Human behaviour in the work

environment covers more than just the activities involved with the actual work itself.

Types of organisations

- The basic structure of an organisation depends upon its size, the nature of its business activities and the complexity of the problems faced by it.
- Depending upon how responsibility and authority in any enterprise can be distributed, the organisational structure can be classified into three types:

- Line Organisation
- Line and staff Organisation
- functional Organisation.

Line Organisation:-

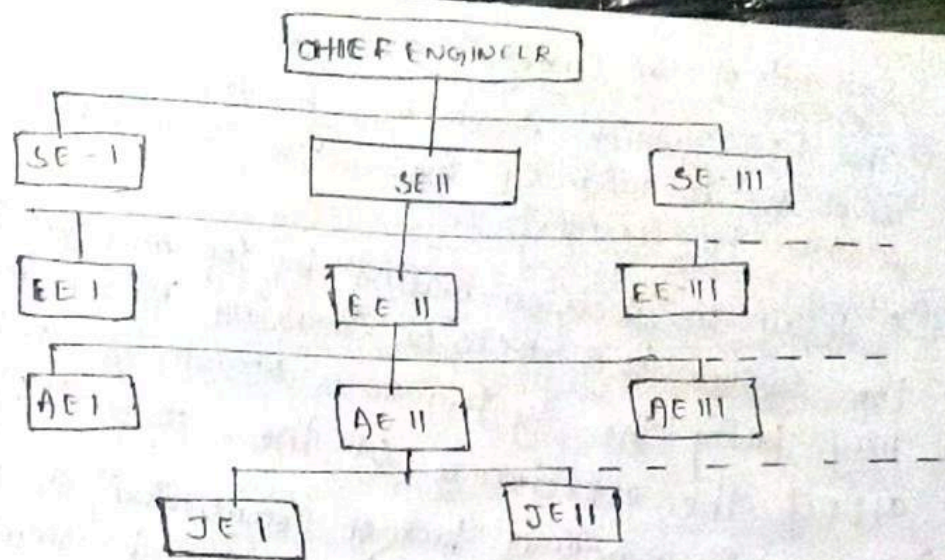
- It is one of the simplest forms of organisation and is commonly adopted in civil engineering projects.
- Its significant feature, as the name implies, is that there is a clear line of responsibility and authority right through the management structure.
- Line organisation is also called military organisation, scalar organisation or vertical organisation.
- A direct relationship of authority and responsibility is established between the superior and the subordinate. This type of organisational structure is followed in most government departments and autonomous engineering organisations.

SE: Superintending Engineer

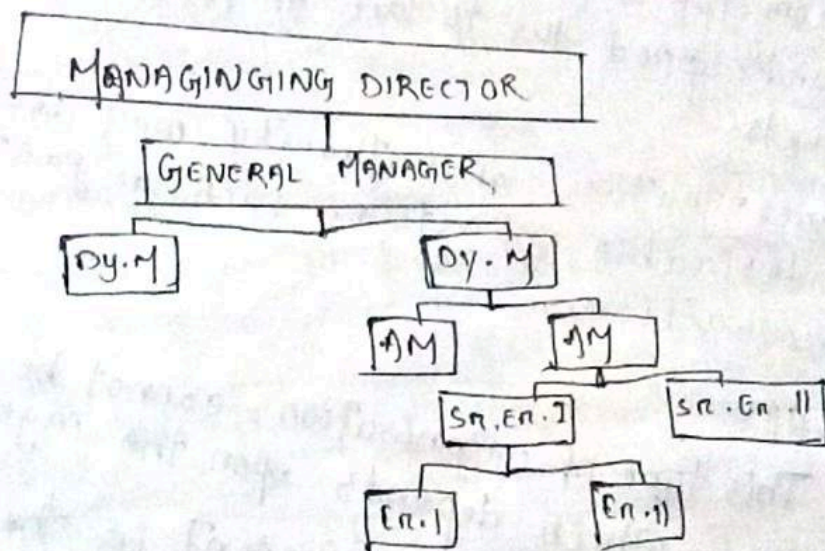
EE: Executive Engineer

AE: Assistant Engineer

JE: Junior Engineer



(a) Line Organisation (Government Engineering Organisation)



Line Organisation (Autonomous Engineering Organisation)

Merits of line Organisation

- (i) It is simple and easy to understand.
- (ii) It permits quick decision.
- (iii) In this type of organisation each individual is responsible to a single person and there is no scope for the shifting of responsibility.
- (iv) It promotes discipline among the employees.
- (v) Faults can be easily and quickly detected due to fixed responsibilities of various individuals.

Demerits of Line Organisation

- (i) The departmental heads over-burdened as all decisions have to be taken by them. Due to this personnel are unable to innovate.
- (ii) A delay in decision-making by top management may bring the system to a decision-making by top management may bring the system to a standstill and adversely affect the efficiency of the organisation.
- (iii) There is a general lack of communication from lower levels upwards. While there is good communication from top to bottom the top management is handicapped due to lack of feedback from lower levels.
- (iv) Concentration of authority may lead to certain undesirable practices such as partiality or favouritism.

Scope

This type of organisation cannot be successful in a system which depends upon the ingenuity of its workers. It can be efficient in the following

Situations:

- (i) Where the work is of routine nature
- (ii) Where subordination and operational staff is limited;
- (iii) In continuous process industries such as refining spinning weaving sugar manufacture etc.

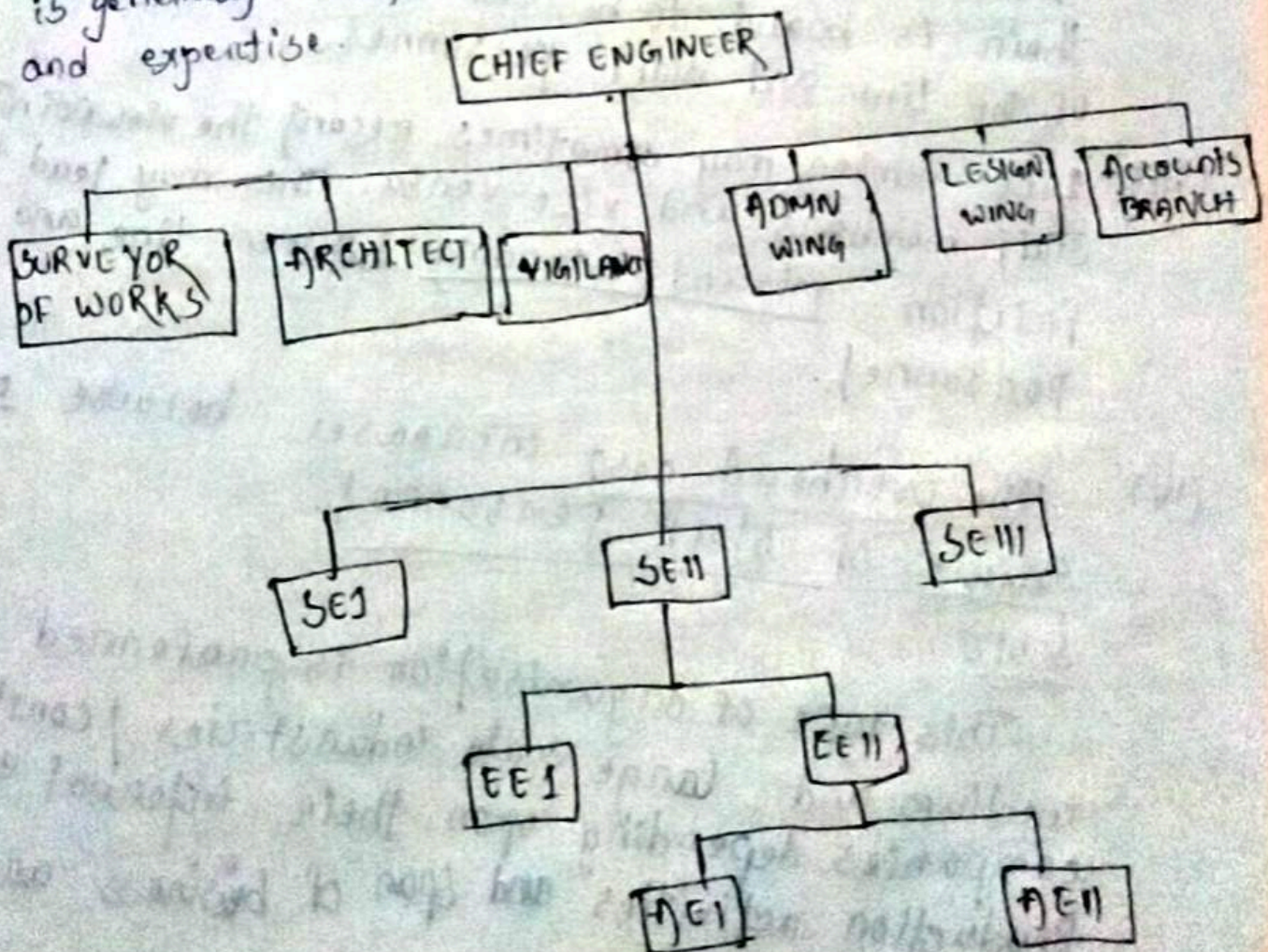
Line and Staff Organisation

Line Organisation are unsuitable for large and complex projects, where the key men need to be assisted by specialists in different fields. The individuals who constitute the staff in an organisation are experts, who have no line authority but whose function is largely advisory.

This type of organisation comes into existence because line authority cannot assume direct responsibilities for all function such as research, design, planning, scheduling and recording of performance etc.

All these activities are performed by staff, while the line authority maintains discipline and stability in an organisation.

The authority by which the staff performs its advisory functions are delegated by the 'Line' and their advice is generally accepted keeping in view their experience and expertise.



Merits of Line and Staff Organisation

- (i) Functional expertise and experience is available from personnel.
- (ii) It is based upon planned specialisation.
- (iii) Specialised work is done by staff personnel and personnel can devote their time to achieve better targets.
- (iv) It provides more job opportunities.
- (v) Due to staff specialisation, there is more efficient utilization of human and physical resources.
- (vi) Quality of product is better.

Demerits of Line and Organisation

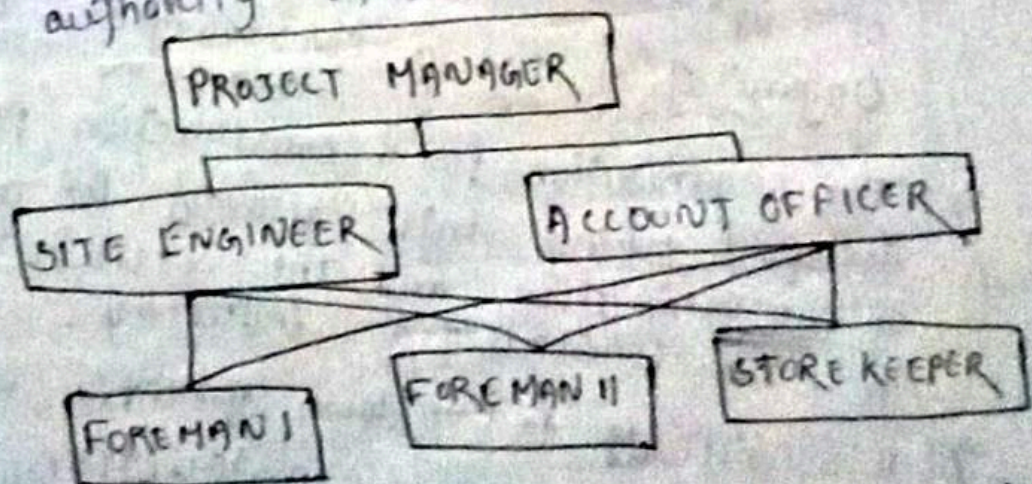
- (i) The staff may be ineffective due to lack of authority to enforce their decisions.
- (ii) As duties and responsibilities are not clearly defined, there is bound to be some confusion in the relation of the line and staff personnel.
- (iii) Line members may sometimes regard the viewpoint of staff members and vice-versa. This may lead to friction misunderstanding between line and staff personnel.
- (iv) The overhead cost increases because of high salaries of staff personnel.

SCOPE

This type of organisation is preferred for medium and large scale industries / construction companies depending upon their internal structure, production activities and span of business area.

Functional Organisation

- The basis of a functional organisation is specialisation. In such an organisation work is carried out on a functional basis and each function is carried out by a specialist.
- According to Taylor, the ideal situation in such an organisation would be when each person performs a specified function only.
- This removes the staff personnel from his assisting capacity and gives him authority and responsibility for supervision and administration.
- The idea behind this type of organisation is to divide the work in such a manner that each person has to perform a minimum number of functions and is fully responsible for those aspect of work.
- All similar and related work is grouped together under one person. In order to perform his function effectively, a person has to report to several superiors for different phase or aspect of the work.
- Thus a subordinate anywhere in the organisation will be commanded directly by a number of superiors each with authority in his own field.



FUNCTIONAL ORGANISATION (construction company)

Merits of functional Organisation

- (i) Division of labour is done on the basis of function, specialisation.
- (ii) The functional efficiency of individuals increases due to limited number of specialised activities.
- (iii) Manual work is separated from mental work.
- (iv) Quality of work is enhanced due to specialisation.

Demerits of functional Organisation

- (i) Each person has to report to a number of superiors which weakens discipline.
- (ii) This type of organisation is at variance with the principle of unity of command.
- (iii) There is no clear-cut line of authority and this leads to confusion among personnel working at lower levels.
- (iv) It is difficult to pin-point responsibility which may adversely affect the morale of the organisation.
- (v) Coordination is more difficult.
- (vi) Overhead costs are increased due to a number of specialists.

Organisation for a Construction Firm:-

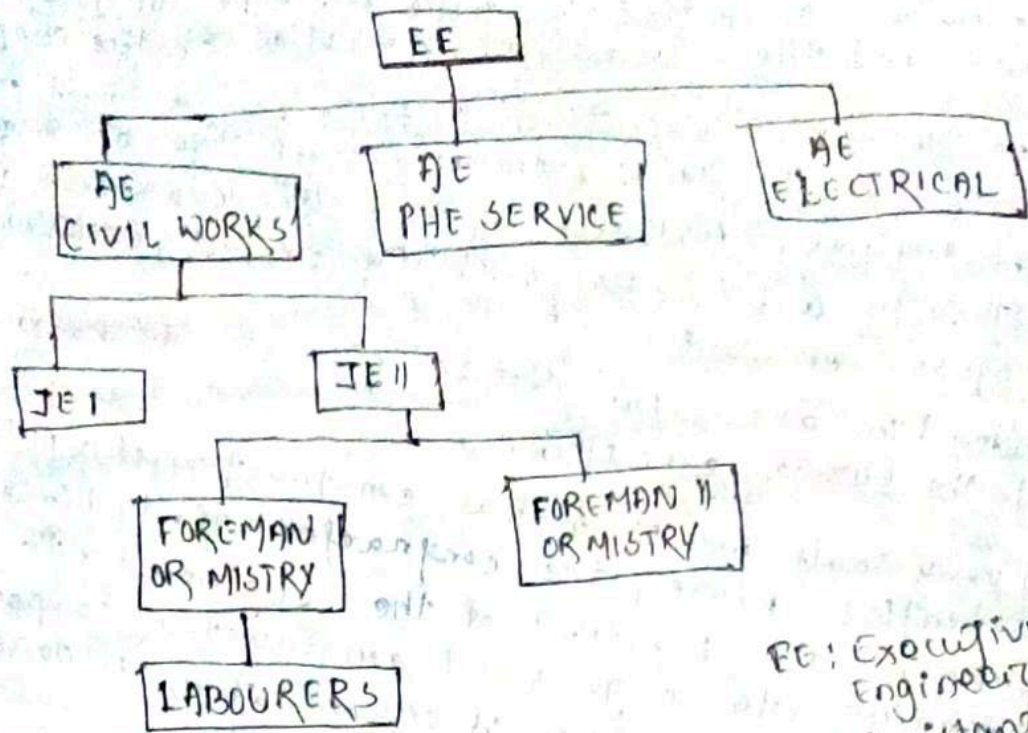
- The organisation for a construction firm has to be developed taking into account the general principles of organisation and the special characteristics of the construction industry.
- It is difficult to lay down specific rules for organising the structure of a construction company.
- Any organisational structure proposed for a construction firm should take into consideration

the nature of activities, scope and type of project work and the area of operation of the company.

- The type of organisation suitable for a small construction firm is a simple line or line staff type of organisation.
- The engineer in charge at the site exercises full authority and is responsible for the execution and progress of work.
- Under him are a few section officers or foremen who get the work executed.
- In very small works such as construction of a private residential house, the contractor has to himself perform the functions of the engineer. In the case of medium to large sized construction companies a line and staff type of organisation is performed.

Site Organisation:

- After having decided the organisational structure in a construction company the next step is to spell out the tasks, power and responsibilities of all its functionaries.
- Telling an accountant that is to look after the accounts works or telling the foreman that he is to supervise the daily wage workers at the site is not enough. Specific job detailing i.e. what is to be done by whom, at what time and how is it to be done is the starting point of site organisation. Site organisation in simple terms means how to organise the construction activity on site.
- A typical site organisation for a division, headed by an executive engineer, is shown in fig.



EE: Executive Engineer
 AE: Assistant Engineer

JE: Junior Engineer.

Important Duties/Roles of the Executive Engineer

- To coordinate the work of various contractors and to check whether all necessary instructions have been provided to the contractors.
- To check the progress of work regularly and to arrange for rectification of faulty workmanship or inferior quality material.
- Clearing all bills related to construction work for which he is the final authority.
- To carry out technical audit and settlement of final contractual dues.

Important Duties/Roles of the Assistant Engineer

- (i) To check the specification of construction job in regard to the quality of materials, methods and workmanship.
- (ii) To plan and organise construction work in his section in order to avoid delay in the process of work.
- (iii) To keep a record of all measurements of work done and tests carried out at site.
- (iv) To report regularly to the executive engineer on all the above matters.

Important Duties/Roles of Junior Engineer/Supervisor/Foreman

- (i) To supervise the execution of work at the site in their respective section.
- (ii) To place orders for material well in advance to avoid delay in the progress of construction work.
- (iii) To control and provide technical guidance to workers.
- (iv) To check and test materials for quality and quantity.
- (v) To measure the quantity of work done for the purpose of payment and progress.
- (vi) To report regularly to the assistant engineer on all matters related to the site.

Role of Mistry/Skilled Workers

➤ This category includes carpenters, steel fixers, machine operators, drivers fitters, pipe joiners etc. They are usually recruited locally for their respective jobs.

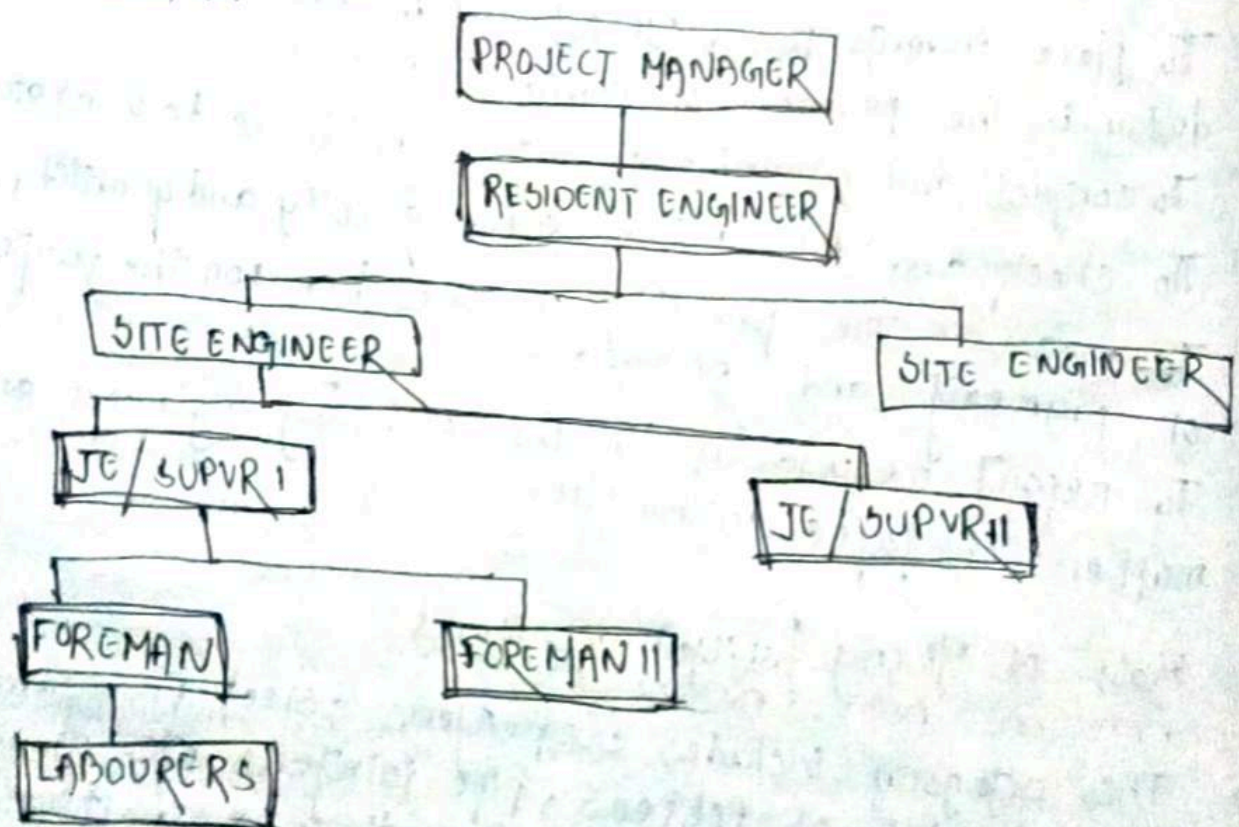
➤ These skilled workers are usually employed on daily wages at the work site. Their job is to keep the work going at the right speed and in the right manner in their sections.

Role Labourers:-

- They are the ones who assist skilled workers and perform many unskilled jobs at the site.
- They expect the right payment and need to be given clear instruction regarding what to do.
- In a contractor's site organisation, the key persons involved in a project are shown in fig.

Important Duties/Role of the Project Manager in a Contracting firm.

- (i) To coordinate the entire construction work on site and with the head office.



- (ii) To direct and control the construction work on site.
- (iii) To employ work force, hire machinery, engage sub-contractors and material suppliers with or without reference to head office depending on the size of the project, policy of the firm, distance from head office and also his standing within the firm.

- (iv) To organise directly and control men working under him.
- (v) To check the progress of work regularly in order to avoid delay in construction work.
- (vi) To call periodically a joint meeting of several key personnel working at the site to review progress and to issue instructions for speeding up work, if required.

The duties of the Resident Engineer, Site Engineer etc. are similar to those of the Executive Engineer, Assistant Engineer etc.

TEMPORARY SERVICES:-

- Every site, whether large or small, requires temporary services which are designed and provided by the Contractor.
- On a small site, the temporary services consist of access roads, water supply, electric supply, sewer connection etc.
- On a large construction site, temporary services include a number of facilities such as telephone connection, butchering plant, tubewells, service roads, repair and construction yards, material storage yards, canteen and medical facilities etc.
- There is no specific or fixed pattern for the type of temporary services required at a site. These services depend on the following factors:
 - Size and nature of the project
 - Location of the project
 - Project cost
 - Specific needs
 - Number of working shifts per day.

(a) Water Supply

- Water supply is essential for all construction site. For large construction sites, tubewells may be bored which could be later used on permanent basis.
- Water supply is required for industrial and domestic purpose.
- Industrial water supply is required for rock drilling, pile driving, feed water for boiler plant and transporting materials by pipe lines.
- Drinking water supply connections, the contractor or project manager has to apply to the public health Engineering Department stating the purpose and quantity of water required.

(b) Electricity connection:-

It is required for both large as well as small projects. In order to obtain an electricity connection the contractor or project manager has to apply to the Electricity Board / Department stating the quantity of electricity required and the place where the transformer is to be installed. From the transformer the contractor has to make his own arrangement for supply of power to various location on the site.

(c) Repair and construction Yard:-

- Such type of yards are essential for repair and maintenance of equipment and machinery and as working area for bar bender, carpenters, welders etc.
- These yards are set up on the construction site for smooth and unobstructed construction activity.

(4) Material Stores:-

Such stores are usually constructed with brick walls and G.I. sheet roofing. G.I. sheet was preferred for roofing purpose because of their high reusability.

The stores are used for the storage of cement, electrical materials, hardware, pumps, tools, spare parts, stationary etc. Sometimes A.C. sheet are also used for roofing purpose.

(5) Approach and Service Roads:-

Approach and service roads are provided for truck to transport construction materials such as sand, aggregate, cement etc. to the site.

These roads are usually provided on the periphery of the construction site. In large project, these roads may also run through the construction site so that material may be dumped at the required locations avoiding re-handling / shifting of material.

(6) Sewerage and Sanitation Arrangements:-

Appropriate sewerage and sanitation arrangements are essential at all work site.

Appropriate arrangements should be made for the disposal of sewage to some suitable place.

(7) Site office:-

Depending on the size and nature of the project, a site office is established for technical and supporting staff.

For large projects, the site office of the executive Engineer, Assistant Engineer and other staff. For large projects, the site office of the executive engineer.

Assistant Engineer and other staff is constructed for coordination, supervision and controls of the construction activity.

→ A project conference / display room is also provided for large projects. Site office are temporary structure provide with C.I. or A.C. sheet roofing.

(b) Labour Huts:-

For medium and large project temporary huts are constructed with brick masonry in lean cement mortar or mud mortar and C.I. sheet roofing to provide shelter for labourers. These huts should be located away from the construction activity zone for safety reasons.

JOB LAYOUT

→ A site drawing of the proposed construction showing the location of entry, exit, temporary services, materials and stacks, plant / equipment and site office is known as the job layout or site layout.

→ A job layout is prepared to ensure that work proceed smoothly without interruption. The various construction resources such as men, machinery, material, space etc. should be organised for their optimal utilisation. The larger and more complex the project, the greater the need for planned job layout and detailing of site.

Purpose of Job Layout:-

The purpose of job layout is to facilitate the need of

- More economical method of working
- Shorten leads for material.

- Reduction in wastage and deterioration of materials.
- Higher productivity from labour and machinery.
- Greater safety.

Factor Affecting Job Layout

The following factors affect the job layout of a construction site:

- Access to site
- Temporary Roads
- Topography of ground
- Construction plant / Machinery
- Construction method
- Construction Material
- Accommodation
- Services

LABOR MANAGEMENT AT CONSTRUCTION SITE

Types of construction workers:-

- (1) Pipe fitter
- (2) Layers sheet metal worker
- (3) Steam fitters
- (4) Painters
- (5) Paper hangers
- (6) Drywall installers
- (7) Tile installers
- (8) Tapers
- (9) Cement masons
- (10) Concrete finishers
- (11) Segmental pavers
- (12) Brick masons
- (13) Stonemasons
- (14) Insulation workers
- (14) Duct workers

* They are employed in the construction industry and work predominantly on construction sites and are typically engaged in aspects of the industry other than design or finance.

Construction Labour and Labour Management

1. What are the characteristics of labour and explain it.

Characteristics of Labour

Labour has the following peculiarities which are explained as under

1. Labour is perishable:- Labour is more perishable than other factors of production. It means labour cannot be stored. The labour of unemployed worker is lost forever for that day when he does not work.
2. Labour cannot be separated from the labourer
Land and capital can be separated from their owner but labour cannot be separated from a labourer. Labour and labourer are indispensable for each other.
3. Less Mobility of Labour
As compared to capital and other goods, labour is less mobile. A labourer is not ready to go too far off place leaving his native place. Therefore labour has less mobility.
4. Weak Bargaining power of Labour
A labourer sells his labour for wages and an employer purchases labour by paying wages. Labourers have a very weak bargaining power, because their labour cannot be stored and they are poor ignorant & less organised.
5. Inelastic supply of labour:-
The supply of labour is inelastic in a country at a particular time. It means their supply can neither be increased nor decreased if the need demands so.

6. Labour is a Human being and not a machine

Every labourer has his own tastes habit and feelings therefore labourers cannot be made to work like machines. Labourers cannot work round the clock like machines. After continuous work for few hours leisure is essential for them.

7. A labourer sells his labour and not himself

A labourer sells his labour for wages and not himself. The ~~worker~~ worker sells work but he himself remains his own property.

8. Increase in wages may reduce the supply of labour

The supply of goods increases, when their prices increase but the supply of labour decreases, when their wages are increased.

9. Labour is both the Beginning and the End of production

The presence of land and capital alone cannot make production. Production can be started only with the help of labour. It means labour is the beginning of production. Goods are produced to satisfy human wants. When we consume them production comes to an end. Therefore labour is both the beginning and the end of production.

10. Difference in the efficiency of labour

Labourers differ in efficiency. Some labourers are more efficient due to their ability, training and skill, whereas others are less efficient on account of their illiteracy, ignorance etc.

11. Labour is an active factor of production. Land and capital are considered as the passive factors of production, because they alone cannot start the production process. Production from land & capital starts only when a man makes efforts. Production begins with the active participation of man. Therefore labour is an active factor of production.

2. Explain about different methods of wage payment system of method of wage payments:-

Any worker who puts some labour produce some result, the quantity of which shall vary with the efficiency of the individual. Better the efficiency of any workers, more will be the output. The wages thus can be calculated on the basis of the work of the output or it can be calculated on the basis of the output irrespective of the time taken in completing it. The first system is called day wage system the second system is piece work wage system.

So there are two systems of wage payments in common use.

1. Time work or Day work or time rate system.
2. Piece work or piece rate system.

1. Time work system:-

This is probably the oldest and more commonly employed system of wage payment chiefly adopted in India. In this system the worker, regardless of his

output, is paid a fixed remuneration per unit which may be an hour, day, week or month.

Advantage:-

- (1) It is easy for wage calculation and can be understood by the worker easily.
- (2) All workers of one class who do the same work get the same wages.
- (3) Better quality of work can be achieved.
- (4) It avoids the workers over-straining themselves mentally and physically thus causing less fatigue.
- (5) This is suitable method where work cannot be measured.
- (6) It ensures regular employment and greater security of service for the workers.

Disadvantage:-

- (i) It requires constant supervision.
- (ii) There is a loss of labour. Production efficiency can be increased easily.
- (iii) Accurate cost forecasting is impossible.

(b) Piece work system:-

In this system, payment is based on output. Production of workers. Payment is made of the rate for the actual quantum of work done by each labourer. In this system, a good worker can earn more money by increasing his output. This system is used when the quality of work is of less importance than quantity.

Labour Management:-

Labour Management is a managerial discipline that involves or organizes the policies, rules, regulations, procedure & competencies which govern and regulate workforce (unskilled, semi-skilled & skilled workforce) in organisation or companies.

Function:-

Future forecasting of labours possible

Total cost on labour can be estimated

Optimum use labours

Scarcity can be overcome.

Essential steps for optimum labour output

1. Examine the operations.
2. Gather employee feedback
3. Examine available data
4. Build process (use Technology to our adv)
5. Employee Training programs.
6. Motivate the labour force
7. Set goals for employees & provide performance based incentives.

Labour Incentives

The national Commission of labour defines incentives as follow:-

Wage incentives:-

Wage incentives are extra financial motivation. They are designed to stimulate human effort by rewarding the person over and above the time rated remuneration for improvements in the present & targeted results.

Financial Incentives:-

A financial incentive is money that a person, company or organization offers to encourage certain behaviors or actions. Specifically, behaviors or actions that would not otherwise have occurred. The financial incentive or monetary benefit, motivates certain behaviors or actions.

Direct Financial Incentives:-

- Productivity Linked wage incentives
- Bonus
- Profit sharing
- Co-partnership / stock option
- Attendance Bonus.

Indirect Financial Incentives

- Leave Encashment
- Gratuity scheme
- Leave Travel concession
- Subsidized means.

Non-financial Incentives:-

- Non-financial incentives inspire & engage employees in ways that money is incapable of doing. Non-financial incentives are the types of rewards that are not a part of an employee's pay.