Lecture Note On Construction Management

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Date
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CONSTRUCTION MANAGEMENT

INTRODUCTION :-

→ Right from early ages when men decided to abandon a wondering lifestyle and settled down. The need for shelter has been one of its primary concerns.

→ Building a shelter was perhaps earliest construction activity under taken by man. construction is thus old professions.

→ The construction industry is a major economic activity in India.

→ construction activity contribute annually about 10% to the gross National product (GNP). thus splaying measure road in the development of the national economy.

→ on average about 50% of the total expenditure of 5 years plan is invested in construction plans.

OBJECTIVES OF CONSTRUCTION MANAGEMENT :-

The main objectives of construction management are :-

i. completing the work within estimated budget and specified time.

ii. Evolving a reputation for high quality work men ship.

iii. providing safe and satisfactory working condition for all personal and workers.

iv. Motivating people to give of their best within their capacities.

v. Creating an organisation that works as a team.

FUNCTIONS :- The functions of construction management are :-

i. planning and scheduling → planning involves formulation of a number of alternative realistic work.

→ plans for achieving specified objectives and finally selecting a plan which is best suited from the standing point of available resources.

→ It essentially covers the aspects of what to do and how to do it.

→ scheduling is the fitting of the final work plan to a time scale it shows the duration and order of various cost activities.

→ It deals with the aspect of when to do it.

ii. Organising ÷ Organising a function with division of it total construction work into managable departments or sections and symetrically arranging various operation by delegating specific tasks to individuals.

iii. staffing ÷ Organising involves the division of project work into sections and staffing is the provisions of people to fill the position so created.

→ Including the right people arranging staff training forces and carrying out proper staff assessment at all part of the staffing function.

iv. Directing ÷ The directing function is function with training subordinates to carry out assigned tasks, supervising their coorks and guiding their efforts. The essence of directing large in the ability to motivating people individually and as groups to utilize their creative efforts to achieving specified costs.

v. controlling ÷ controlling is necessary for ensuring effective and efficient working. It involves a constant review of the work plan to check on actual achievements and to discover and rectified deviation through appropriate corrected measures.

→ Measurement of actual performance interms of progress, quality and costs incurred.
→ comparison of actual and plan performance.

→ Analysis in short fall of in performance, when it occurs and identification and implementation suitable remedial measures.
→ Quick and accurate flow of information is a vital accept of the controlling function.
vi. co-ordinating ÷ since authority coverages to the top of the organisation pyramid.
→ It is necessary to bring together in coordinate a work of various departments and sections.
→ This requires an efficient system of communication so that each departments and section is aware of these notes and assistants to be expected from others.
→ Regular meeting of departmental section head which top management are fundamental to proper co-ordination so that plans, problems and remedies are determined to best solution.

Types of CONSTRUCTION ÷ construction works can be classified into three categories. These are ÷

1. Light construction.
2. Heavy construction.
3. Industrial construction.

1. LIGHT CONSTRUCTION ÷ This type of construction doesnot require the use of heavy plan and equipment.
→ such construction includes building and light structures of all kinds such as in schools, shopping centres, small industrial sheds, water tank, culverts and small edges.

2. HEAVY CONSTRUCTION ÷ This type of construction requires the use of heavy plan and equipment and the scope of work is large.

→ such construction includes multispan bridges with weight of pipe foundation, tunnels, dams, barriages, highways, railways, airports, harbours etc.

3. INDUSTRIAL CONSTRUCTION ÷ This type of construction requires the use of special technological plants and equipments.

→ such construction pertains to chemical and fertilizers plants, steel plants, petroleum refinderize atomic of super thermal power plants, automobiles and air craft industry.

RESOURCES FOR CONSTRUCTION INDUSTRY ÷
The main resource is needed for the construction industry are ÷
Materials → Materials such as bricks, stones, cement, aggregates, sanitary and electrical fittings, lubricants, oil, petrols required for construction.

MANPOWER ÷ Man power is the form of technical and managerial resources personal and workers in various strength is essential to carry out project activities.

→ Technical and managerial personal are essential for efficient use of human resources and to achieve project complition within estimated time and budget.

→ Technical personal includes engineer architects quality servier, supervisors technicials etc. The work force consist of skilled and unskilled workers.

MACHINERY (PLANT/EQUIPMENT) AND POWER :- For any construction work, various plant/equipment and tools are required. Depending on the type and nature of a construction job, machinery required at site includes batching plant, mixers, trucks, tractors, excavators, dumpers, cranes, pumps, generators, workshop equipment etc.

- For efficient construction activity these plant/equipment need to be properly maintained.
- power is an essential resources required for lighting, running the plant and equipment and for other facilities.

FUNDS :- Adequate funds should be available for smooth implement action of the project.

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

SPACE :- For any construction activity to proceed efficiently, it is essential to plan the available space at site for:

1. Storing materials.
2. providing yards for bar benders, carpenters, installation of equipment and plant, repair workshops, casting yards etc.
3. Site office, labour camps etc.

STAGES IN CONSTRUCTION :-

- Every construction work has the following distinct stages:

i. Briefly stage.
ii. Designing stage.
iii. Tendering stage.
iv. construction stage.
v. commissioning stage.

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

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

ACTIVITIES ÷ A civil engineering project should begin with a thoroughly investigation of its scope and economic feasibility.

- This is the preliminary stage and many factors at this staige are not clearly defined but are broadly stated.

- Various activities involved in the briefing stage are :

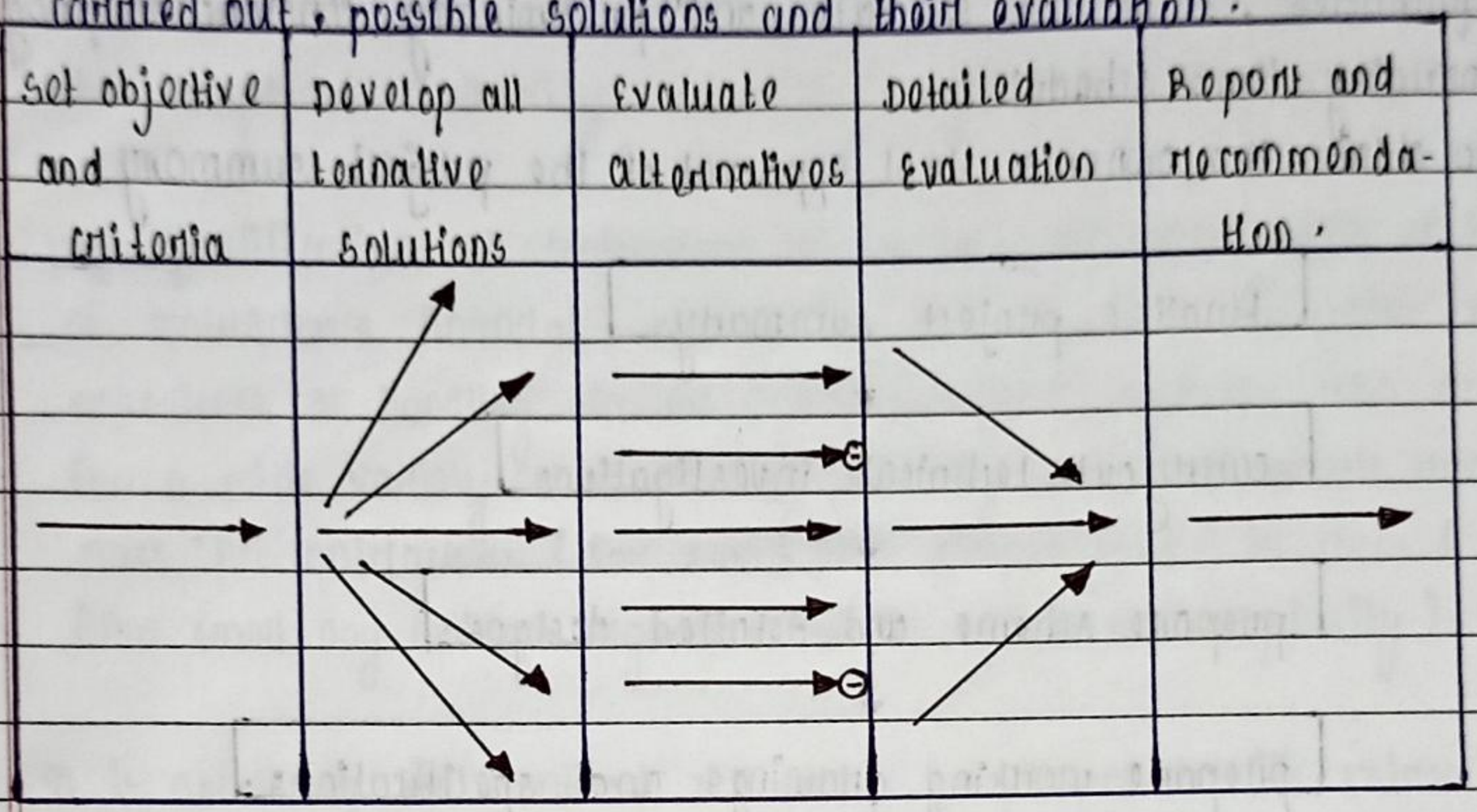
a) To appoint a project steering comitee if, necessary.
b) To appoint a project manager who will have a continuing responsibility to the client throughout the construction process.
c) To carry out extensive investigations which include both technical and non-technical investigations so that alternative proposals may be given due to construction.

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

- Technical investigations include land and geological surveys including site investigations 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 savings easier while fulfilling the objects of the project.

e) To prepare the project report which is the outcome of the first stage (i.e. briefing stage). The project report describes the investigations carried out, possible solutions and their evaluation.



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.

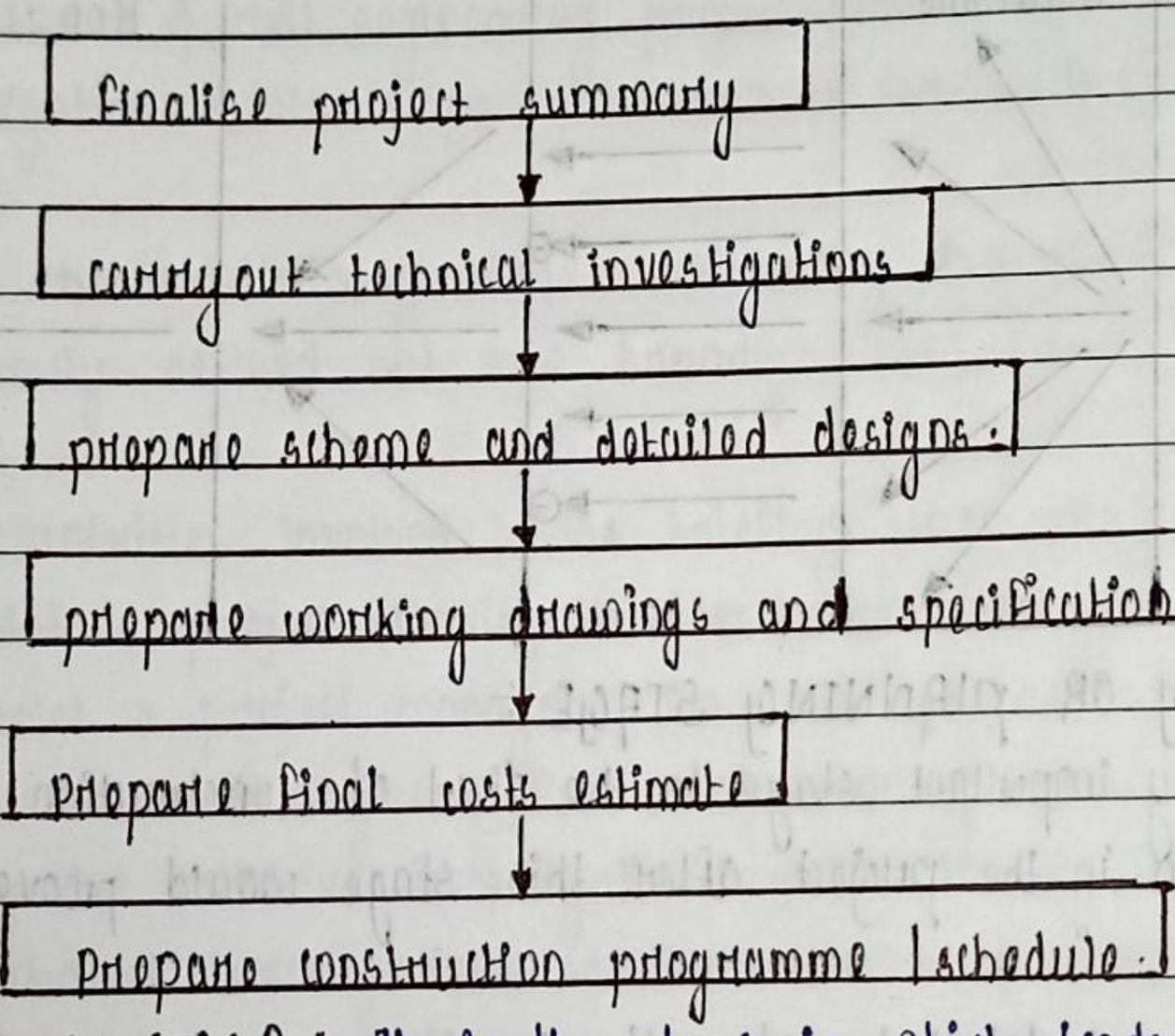
PURPOSE :- The purpose of this stage is to complete the project summary and determine the method of construction and estimate costs so as to obtain necessary approval from the client (s).

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

ACTIVIES :-

Activities at this stage are :-

1. To develop the project summary for final adoption of the most suitable alternative.
2. To carrily out technical investigations such as soil investigation, topographic investigation, material supply and market surveys etc
3. To prepare detailed design", working drawings specifications; bill of quantities, final cost estimate and preliminary construction programme including time schedule.
4. To obtain the owner's final approval of the project summary.



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

PURPOSE :- The purpose of this stage is to appoint a contractor or a no. of contractors who will undertake the construction work on the most suitable terms and conditions of quality, cost and completion time.

ACTIVITIES :-

1. 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 procedures of construction are carefully defined. Government tendering procedures are closely controlled to ensure that contracts are awarded in a uniform way. orders are issued by the competent authority authorising expenditure and execution of the work.

2. pre-qualification of contractor (s) involves an investigation of the potential of contractor's financial, managerial and physical resources and his experience of handling similar projects. Govt. agencies who awardcontracts for a wide variety of work may classify the contractors ranging from class 'F' contractors (for small and simple jobs) to class A contractors (for small any contract regardless of its value or complexity).

3. It is necessary that contract documents be prepared with extreme care and by experienced persons because the contract forms the basic on which the project management team exercises control of the project during the construction phase.

- The contract itself is defined as a large legal document which escribes the terms and conditions of executing the project.

- For construction work, standard forms of contract have been developed which are used with minor modifications to suit the circumstances of a particular project / job.

CONSTRUCTION STAGE :-

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

ACTIVITIES :- The construction stage consists of a no. of inter related activities. The failure of one activity may disrupt the entire production schedule. careful planning is, therefore, necessary as this 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 operations 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 preferred to the designers for appropriate solutions.

- During this stage, actual work is executed as per the design prepared earlier. The construction work has to be carried out in a planned manner to prevent wastage of man power, material and money and to avoid disruption of project schedules.

COMMISSIONING STAGE :- It is the stage in which the performance of the structures is evaluated and the proposed nature of maintainance and repair are considered.

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

- 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 ÷ Various activities involved in this stage are:

a) To keep various records of actual work.
b) To inspect the construction work thoroughly and have any defects removed.
c) To inspreparte operating instructions and maintainance manuals.

- The commissioning stage is the transition between the construction and final taking over of the structure. For large and complicated construction works, it is commonly practice to do commissioning in several stages. The commissioning stage must be planned well in advance.

CONSTRUCTION TEAM ÷

- The construction team consists 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 owners project in the best and most economical manner within the stipulated completion time.

OWNER ÷ The owner may be an individual, group of individuals, private under taking.

- The owner has an ultimate authority over the decision making power regarding managerial, financial and administrative aspects.

- He approves changes, if any, in the project scope or schedules. The owner controls the project resources such as manpower, funds and property.

ENGINEERS AND ARCHITECTS :-
This includes structural, mechanical and electrical engineers, architects, quantity surveyors, specialists such as structural constituents, safety and maintainance planners, soil investigations etc.
The Roles of the team members are as follows:

ARCHITECT :- The role of the architect is to assess the client's functional requirements, design for pressing and aesthetic appearance and to assist the engineers for proper design.

STRUCTURAL ENGINEER :- The role of the structural engineer is to prepare structural design of structures and to prepare the working drawings based on the architects plan.

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 and after construction

ELECTRICAL ENGINEER :- The electrical engineer is concerned with the design and preparation of working drawings for electrical power and distribution systems during and after construction.

QUANTITY SURVEYORS :- The role of the quantity surveyors is to:
a. estimate the cost of work to be done and actually carried out;
b. prepare the bill of quantities and tender documents before tendering.
c. assests the extra costs due to special features.
d. prepare the cash-flow statements during construction.

e. prepare the finan account on completion of the project.

Specialists / consultants ÷ They carrry out soil investigations are collect information regarding special requirements for items. such as health, safety, workshop equipment etc. They are also suggest solutions to specific problems encountered during construction.

CONTRACTOR ÷ The contractor may be an individual undertaking small contracts or a large construction company undertaking turn-key projects.

- contractors whether small or big need the services of qualified engineers. some of the engineers employed by the contractor deals with office work such as designing, tendering, and scheduling etc in the head office. others, known as site engineers, are concerned with the actual execution of work such as surveying, levelling, construction, billing etc.

- In some projects, the contractor may not have sublet part of the work to sub contractors or petty contractors.

- This is done because a contractor may not have the required infrastructure for certain works. The contractor has to execute various types 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 costs.

- 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, architects and contractor) leads to the smooth and efficient execution of a construction project.

- proper understanding of functions / activities of each team plays a vital role in achieving speed, economy, efficiency and quality in an all construction projects.

FINANCIAL SCHEDULING ÷ Financial schedule shows the amount of cash flow require at different stages of the construction project for the payment of materials, labours, equipment and others.

CPM → critical path method.

PERT → programme evaluation and Review Technique.

NETWORK TECHNIQUE ÷ Economic is the most important factors and is next only to safety in civil construction projects.

→ Even a little percentage of saving will lead into a substancial monetary gain.

→ The project cost is made of up two components that is material cost and construction cost.

→ The minimum cost on materials is achieved by providing optimum structural dimensions to the various components of the project.

→ For the minimum cost on materials is achieved by providing optimum structural dimensions to the various components of the project. As the construction cost is also a vital components which cannot be ignore.

→ While dealing with the construction project a construction engineer has to deal with resources like main materials, masonary and money.

→ So the most economical consumption the resources available at the disposals in the least possible time is the objective function of project construction management.

→ To derived this objective functions certain numerical techniques are available which are known as CPM and PERT.

→ contractors were asked to furnish there operational time requirements on 3 time instruments that is optimistic time, dessimistic time and the most likely times.

→ These estimates were the manufacturing mathematically access to determine the probable comprision time and the procedure was refers PERT which stands for programme evaluation and Review technique.

ADVANTAGES OF CPM AND PERT NETWORK :-

CPM and PERT Network are very powerful tools and facilities the work of management in the various ages of project by the following ways :-

i) planning phase → planning is the process of choosing a particular method and order of work to be adopted for a project form all the various ways and sequence in which its would be done.

→ The sequence of steps required achieve the optimum result is the proper plan for the works and is shown schematically on the network diagram.

→ It permits the comparison of alternative works and helps in choosing the based plan minimum cost and minimum time.

ii) Organising phase → It helps in awarding the contract to the best and effilient contractor because the network and of the projects furnished by the contractor along with the tenders is the mirror image of the resources capacity of the contractors.

iii) scheduling phase → scheduling is the determination of the timing of the operations comparising the project which helps in the preparation of various calenders.

→ From the starting date to the finishing date the delivery time of the materials used in the project is clearly mentioned on material calender.

→ The type quality and duration of equipments needed are indicated on equipment calendar date wise.

→ The classification, no of labours is needed and period during which they will be needed also mentionad on labour calender. the extend to which financial at aid for payment of labour materials.

Scheduling phase:

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→ The classification, number of labours needed and period during which they will be needed also mentioned on labour calender.

→ The extent to which fancial aid needed for payment of labour materials, equipments are written clearly on finanee calender.

Controlling and Monitoring phase:

→

→ The network faciliated in controlling the execution of project activities to ansure timely completion of the project to periodical review and applying corrective measures.

Evaluating phase:

After the complition of the process the planned and actual time and cost are compared the reasons for devalitions are analised and specific difficulties

while excavation are highlighted.

→ These reports are made available to the excavators for use in future projects.

Elements of network Techniques :

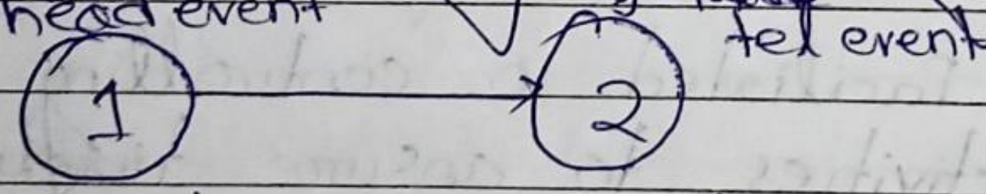
An acitivity is the performance of specific task such as bending of rainforcement placing of concrete etc.

→ It requires time and resource for its complition and is represented by an arrow.

→ The length shape oriantation of arrow has no significant.

EVENTS : (Node)

Starting of Acitivity and ending of activity.



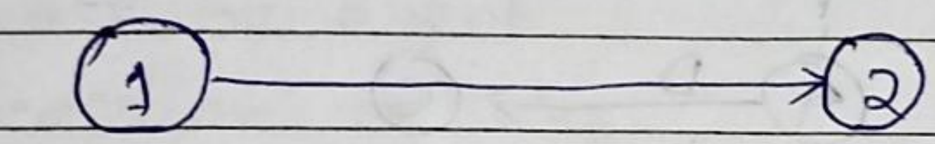
→ Event represents instant in time when certain acitivity has been starting or completed.

→ In other words we can say that an event describes trade or completion of a task.

→ It is represented by a circle.

→ The begining of an activity is a tale event also called I-Node by complition of a acitivty is a head event also called J-Node

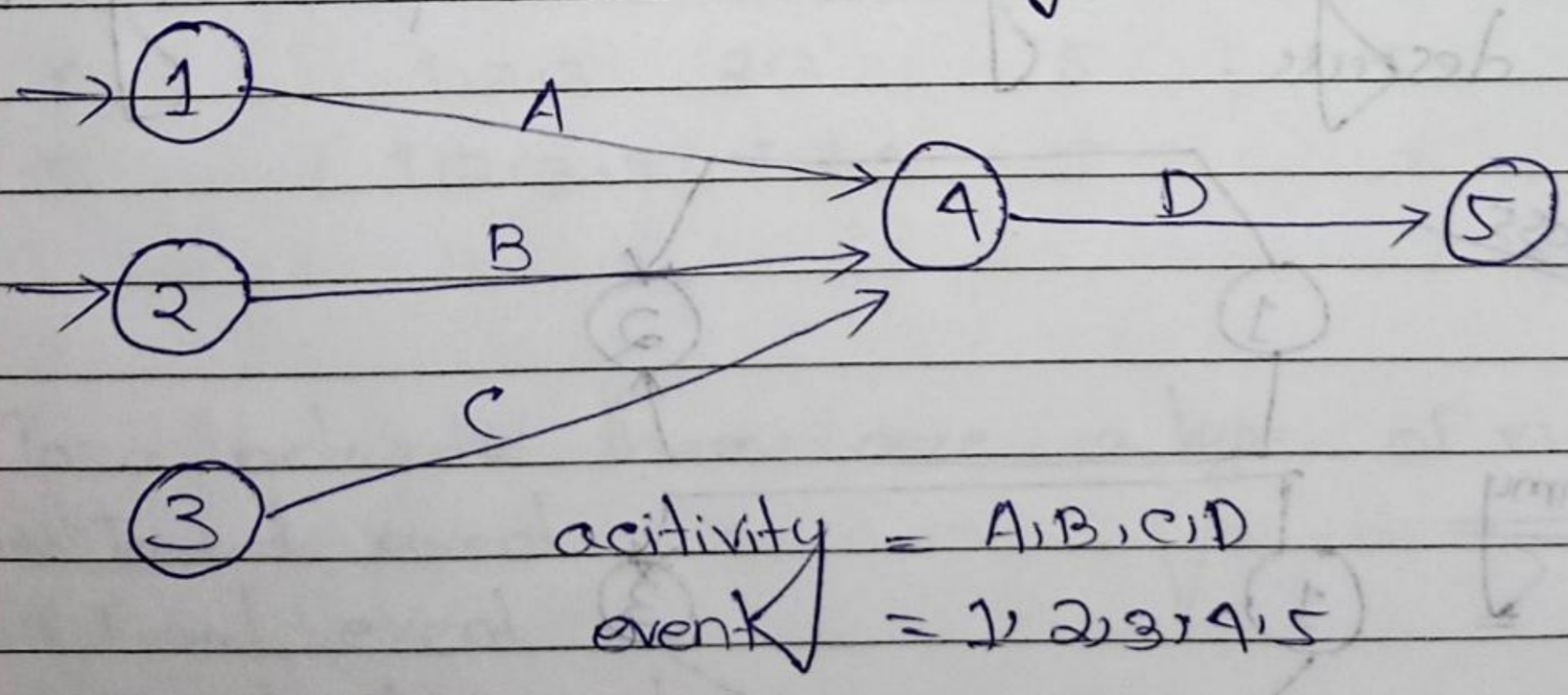
→ while drawing network it is assume that
(a) Time show to left and right
(b) All the events are number such that J-Node number as a higher value then I-Node number.



→ We have the following two properties of events.

⊙ An event is not completed untill all the activities Following in to it are completed.

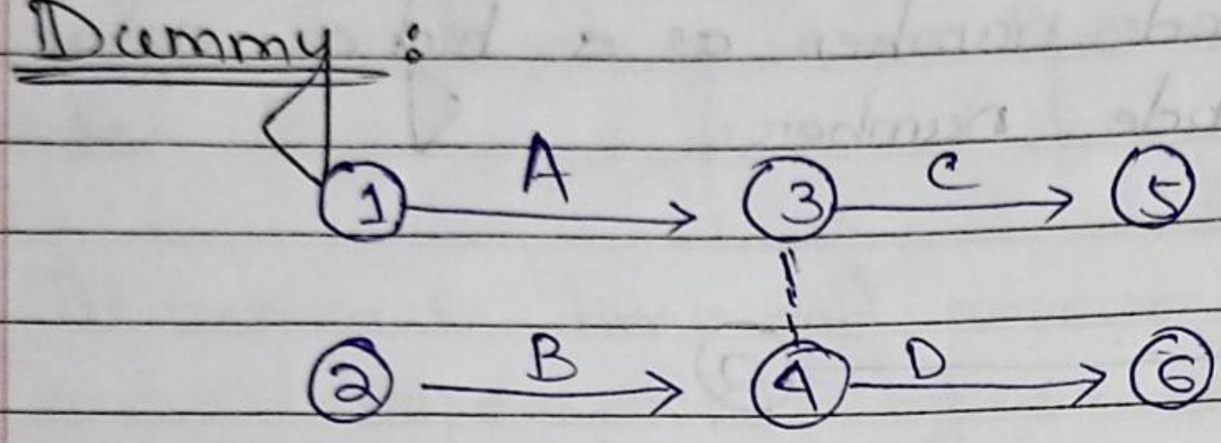
⊙ No subsequent acitivity instract untill its.



acitivity = A, B, C, D
event = 1, 2, 3, 4, 5

→ There activities A, B, C are following in to event number 4.

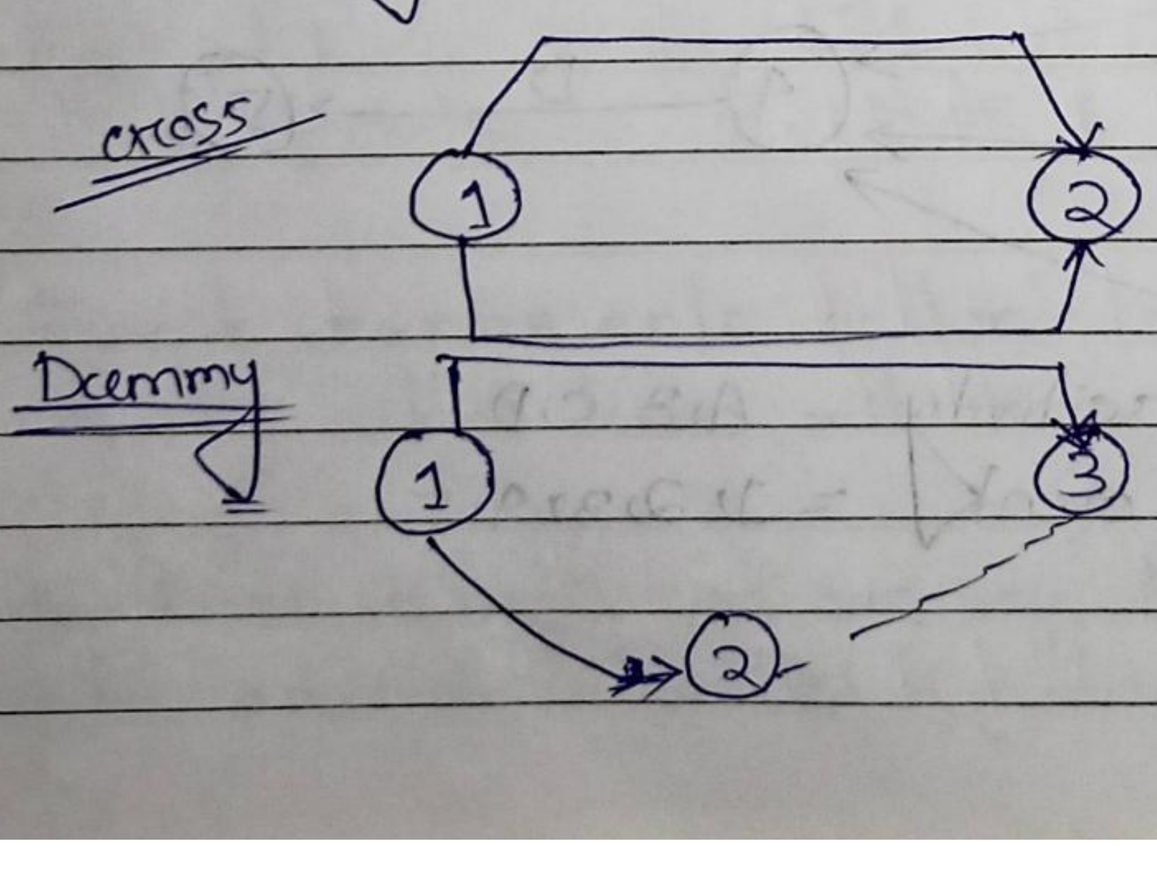
So the event four is appear only when all the 3 activities are completed in all respects and as soon as the event 4 is completed the subsequent activity D will start



→ A dummy is an artifical activity represented on the arrow diagram by doted arrow.

→ which indicates that an activity following the dummy can not be started untill the activity are presiding the dummy are completed.

→ The dummy activity does not repair any time and deseuss.



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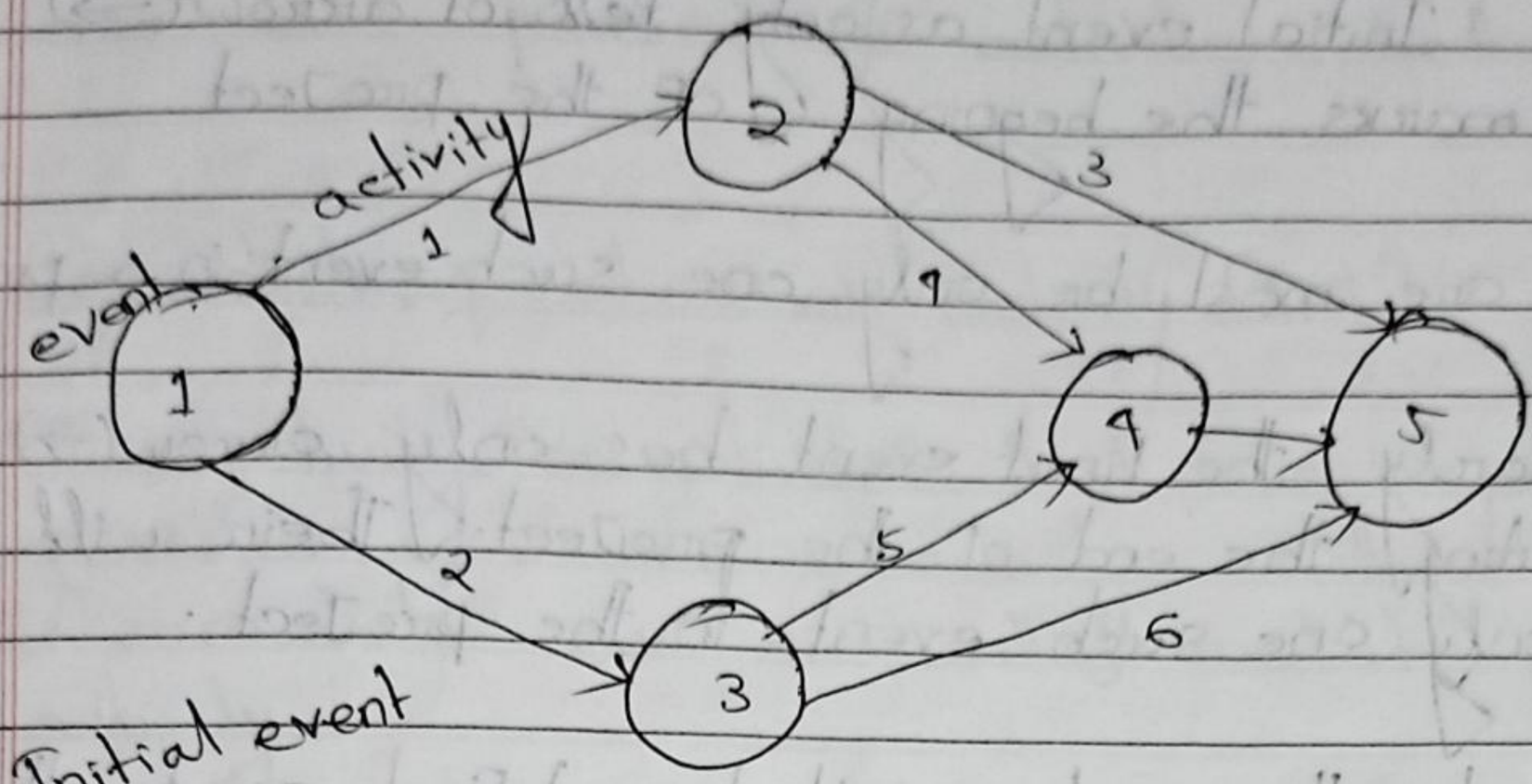
Network rules :



1. process or event
   process or activity

2. Successs event
   Successess activity

Event	PE	IPE	SE	ISE
1	-	-	2,3,4,5	2,3
2	1	1	4,5	4,5
3	1	1	4,5	4,5
4	1,2,3	2,3	5	5
5	1,2,3,4	2,3,4	-	-

In a network there are 3 type of event -
(a) Inital event
(b) Final event
(c) Dualrole event

Initial event :

→ Initial event as only tells of arrow (→) and marks the begning of the project

→ They are most be only one such event in a project.

→ Similarly the final event has only arrow (→) head indicating the end of the project. Their will also be only one such event in the project.

→ Escept these two initial and final event all intermediate event are called atleast one tell and atleast one head. They are head event to some activity and tell event other activity.

Predicessor event :

→ The event or events that happen before another event are called predecessor event to that event.

→ The event or event's that immediately happens before another event are called imedate predecessor event.

Succession event :

→ The event or events that follows another event are called successor event to that event.

→ The event or events that imediately follows another event are called imediate successor event.

1. Predicessor activity :

→ activity or activities that are required to be

preformed an activity ~~order~~ under are called predicessor activities to that activity.

Immediate predicessor activity (IPA)

→ The activity or activites that are required to be perform before an activity without any intermediate once are called imediate predecessor activity.

Succession activity : (SA)

Activity or activities that are required to be perform after competion of an activity under consideration are called succession activity

Immediate Succession activity (ISA) :

→ The activity are that are required just immediatly after an activity with out any intermediate once are called Immediate Succession activity (ISA) to that activity.

→ It is ~~cross~~ costomary to assume that time closed form left to right which gives the direction of arrows.

→ Arrow should normaly not cross each other if the situation is un avoidable the length of the arrow should be broken to bridge over the other.

→ It is assential to ncember that events in a distraict manner.

→ Critical path analysis of CPM network.

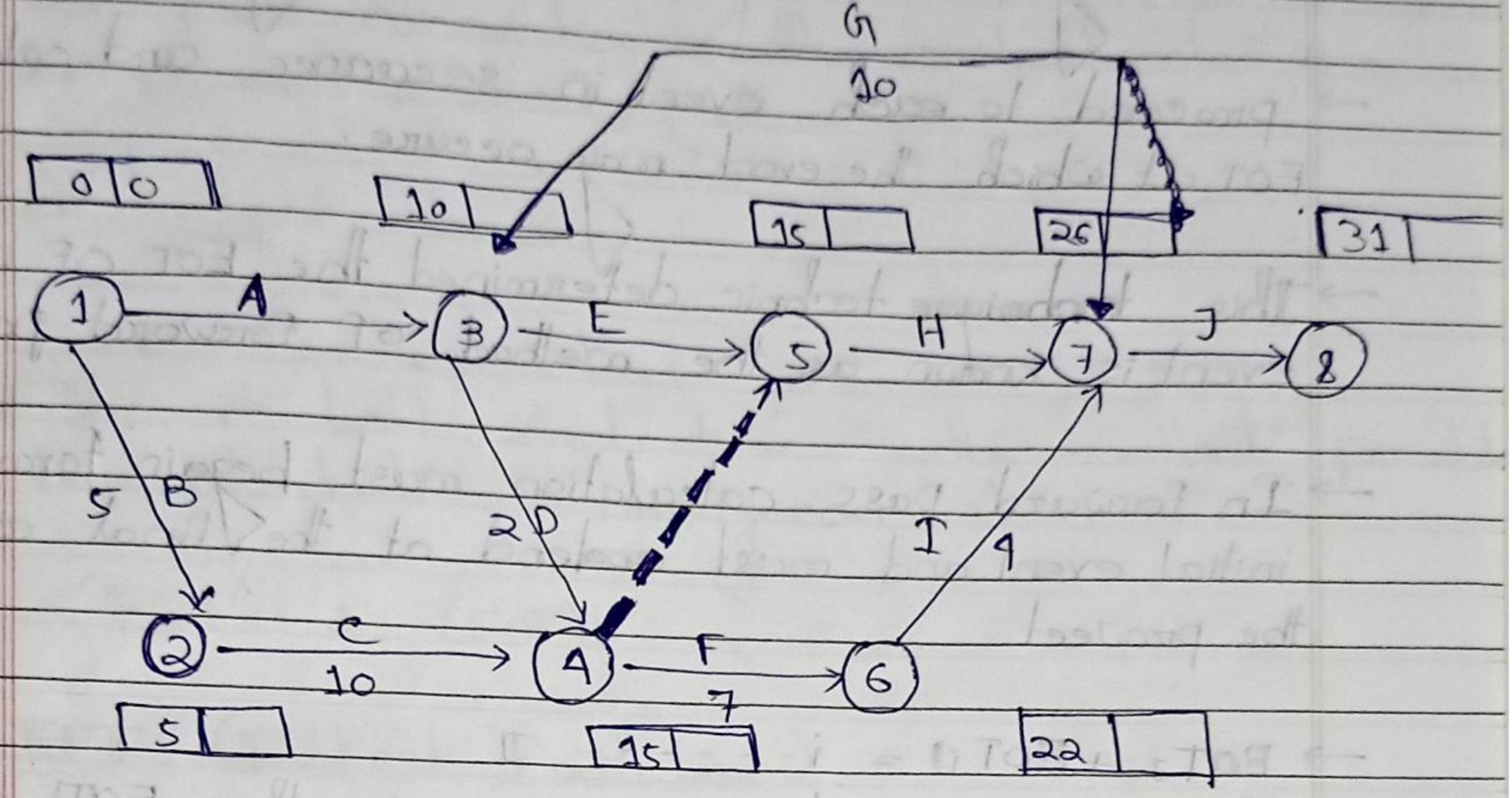
→ Each activity connecting 'I' Note event with 'J' note event requirke a duration time for compression the duration may be determinastive in the case of CPM or prokbability in case of PERT network.

→ The path of longest direction is define as cretical path and the activity line in this path critical activity will reseult in a consiqeenical dealy in the complesion of the entire project the project can not finished eardyer than this project. time given by the

→ So the time taken by the cretical path is the shortest possible time to finished the project

→ The project time is calculated by the event time measure in box of each event on the network.

→ The time box consists of two compatment the value in the lebt compantement stands for (EOT) earlyest occurcance time and the value of right compantment stands for (LOTC) Latest occurent time.



calculation of EOT ?

EOT - Earliest occurant time.

Path

1 - 3 - 7 - 8 = 25

1 - 3 - 5 - 7 - 8 = 30

1 - 2 - 4 - 6 - 7 - 8 = 31

1 - 3 - 4 - 6 - 7 - 8 = 28

critical path - longest duration (denoted by)

EOT:

Begain in the initial event Following Zero time.

→ proceed to each event in seccuance and calculate EOT at which the event may occure.

→ This technic determined the EOT OF an event is known as the method of forward pass.

→ In forward pass calculation must begain form the initial event and must end at the final event on the project

→ $EOT_J + EOT_{ij} = i - - - - - - J$

→ The maximum valcee is given by the EOT of the last event.

calculation of LOT (Latest occurant time)

LoT is defined as the latest possible time into each anevent and take place without offseting the total project time calculated by the method of forward.

→ LOT on the final event of the project the and seen as the EOT of the last event.

So the calculation of the LOT is bracted for the final event and moves in the backward directions by subtracting the activity time form It's J Note this is also known as method of backward fast.

→ All the notes having same EST and EOT and EOT are identify as critical notes and the path connecting the critical notes this known as critical path.

Acitivity :

EST - Earliest start time.

(1) The earliest start time is the earliest possible time at which arctivity can start.

$(EST)_{i-j} = (EOT)_i$

EFT. (Earliest finish time)

The Earliest finish time is the earliest possible time it which on activity can finish.

$(EFT)_{i-j} = (EOT) + t_{i-j}$

LST. (Latest start time)

The Latest start time is the Latest possible time by which an activity can start without only delay of project time Forecast on the basis of earlies occurance time to the Final event.

$(LST)_{i-j} - (LOT)_{i-j} - t_{i-j}$

LFT. (Latest finish time)

The Latest finish time is the Latest possible time than a activity can finish without any daily in complition of project.

LOT (i to j) = LOT j

Floats do denotes the flesibilant range within which the start time or finish time with a activity can fortunate without ebbective the complision of project.

Total Float (TF):
Total float in an activity is the excess of maximum availa time over the activity time.

TF(i-j) = [LOT] j - EOT i] - ti-j

LST - EST
LFT - EFT

FREE FLOAT
Free float on activity is the access of available time over the activity time all jobs start as earlist as possible

EFi-j = [(EOT)j -(EOT)i] - Ti-j

EST of a subscriding activity EFT of a activity under consideration.

SLACK:
The fresibility range within which can event can occure.

→ Slack of an event is eqeal to LOT - EOT of a event

→ In a cpm network for minimum value of slack is o and the o slack event is the critical event.

Shedaling :

shedaling of a cpm network consists of the calculation event time (EOT and LOT) activity time EST, EFT, LST, LET) and Floate (TF and FF)

→ Generally the event time is marked in the time box on the error diagram. An activity time and floats presentated in a tebular from.

Fourth and Free time estimate :

→ Fourt introduces on in to the account by three kinds of time estimates of time duration which are as follow.

The opptimisty time is the estimating (ta)

→ The optimating time is the estimating of the minimum time required for an activity is nothing exceptionally goes wrong

Perrimistic time estimate : (tp)

→ The perrimistic time is an estimate of the maximum time required for an activity of aswally everything goes wrong.

→ Abnormal situations are assume to prevent during the execution such as major casastrops lake labour strike.

→ Acts god etc are excluded form this estimate.

The most Lightly Time estimate (Tb) :

→ Most lightely time is best experience and Judgement being based on the time required it the activity repeats, a number of times under essentially the same conditions.

→ If reflex a situations things are usual nothing exicting.

Critical path Analysis of port network :

→ Form conversion of 3 time estimates in to an expected mean time of each activity, the same treatment Form calculations of critical path is given to the port network as that of network.

→ A systematic and scientific method of finding critical path like in the calculations of event time which is prescribed by

(i) Earliest Expected occurance time (T_E)
(ii) The latest Allowable occurance time (T_L)

Earliest expected occurance Time (T_E) :

T_E is the time when an event can be expected to be occure earliest.

→ The calculations of T_E of an event is same as calculations of EOT of cpm network.

$$(T_E)_j = (T_E)_i + T_{i-j}$$

→ If more than one activity are directed to the event maximum time along various path, that keep the expected mean time of the event.

→ Expected mean time of the initial event is taken as zero.

→ The method is usually called the Forward pass.

Latest Allowable occurance Time (T_L):

→ The latest time by which an event most occure to keep the process unschedule is called latest allowable occurance time.

→ The calculations of T_L of an event is same as that of CPM network by the method known as backward pass

$(T_L)\, i = (T_L)\, j - T_{i-j}$

Scheduled completion Time (T_s):

→ Whenever a port network is taken in events decision is made a regarding the complition time of the project and accepted Figure. is called scheduled complitions time.

→ T_s reffers to be latest allowable occurance time (T_L) for the last event of project i.e $T_s = T_L$

Slack :

→ Time box having two compatment is made at each event, the valcee in the left compatment indicating the valcee of T_E and that of right compatment indicating the T_L event.

→ The slack is event given by $S = (T_L - T_E)$

→ slack may be postive, zero or nagetive depending cepon the value of $T_E = T_L$ that is event.

Positive slack :

→ When T_L is more than T_E, positive slack is obtain.

→ It indicate the project is schedule is meaning there by excess resources.

Zero slack :

→ When T_L is equal to T_E : Zero slack is often.

→ It indicating the project is going on schedule meaning there by adeqaate resourcess.

Negative slack :

→ When T_L is less than T_E, nagetive slack is obtain.

→ It indicates the project is behind the schedule meaning there by the lack of resourcess.

Critical Event :
The event having the least to slack value is known as a critical event.

Critical path :
→ The path joining the critical events of called a critical path of the port network.

→ Time wise the critical path is the longest path, connecting the initial event to final event.

→ The critical path is districtly marked in the network usually by a thick line or double lines.

Imp 15 Difference between CPM and port ?

CPM	PORT
→ It is basically having determinesations approach in the design of network.	It is basically having probability approach in the design of network.
→ only one time estimate is required for each activity.	Free time estimate in the form of pesimestric time and most lightly time for each activity.
→ Time and cost both are controlling Factor	There is an optimum duration of the project at which the project cost is minimum and this can be often by crashing the network.

→ It is built of activity oriented program.	→ It is built up event oriented program.
→ Time is both the controlling and the cost is assume properational to the project dcreation.	
→ Critical event most have zero slack.	critical events may be positive or zero or nagetive depanding upon the project shedule completion time
→ It is recomeded for a repetative nature of work when past experience where adequately available	It is recomeded for research and development project where no past eblerrence are available or where geton uncentive life in the time estimated

Imp The bar chart process Network :

→ It is this simple chart displaying the activity schedule and it is also refer as grant chart.

→ In this type of chart. the time duration of an activity it represented by the horizontal line.

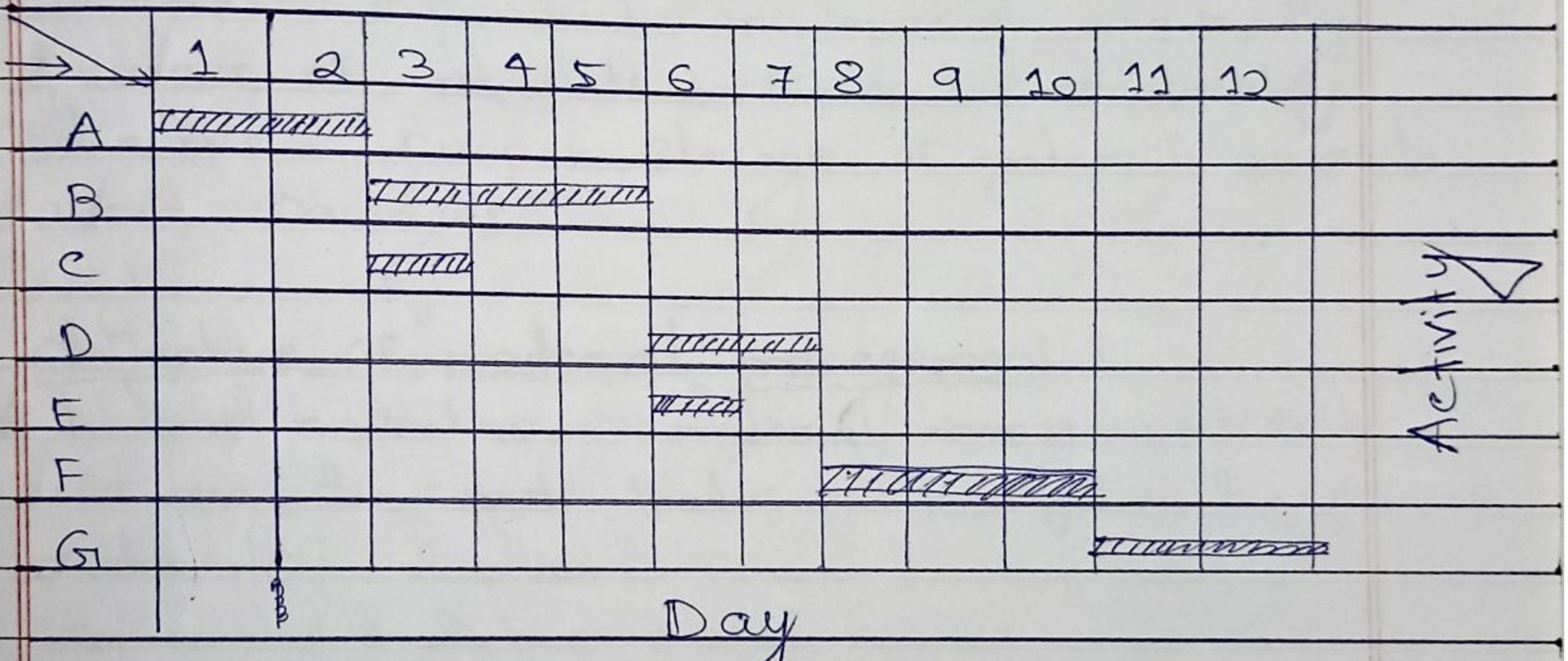
→ The length of line is properational to the time duration of an activity.

→ The activities are listed form top to bottom on

The extream Left hand side of the Fromer. An activity duration Flows Form left to right.

Question

Activity	Depends on	Duration
A	–	2
B	A	3
C	A	1
D	B	2
E	B and C	1
F	D and F	3
G	F	2



Advantages of barchart:

→ It is a simple to draw easy to understand and can be drawn quickly.

→ No trained of skill personal care required to make the chart.

→ The progress achieved at site is expressed in items of percentage.

Materials Management :

Introduction :

→ The main object of materials management is cost reduction and ethicient handling of materials at all stages and all sections of undertaking.

→ Scope of materials management aplicable to construction Industry involves planning materials, process storing of materials and handling of materials.

→ proper materials management can contribute ~~soto~~ substantially to the ebbiejency the trophic machine potential of the contracting organisations.

→ The most Important considerations are kindly process of materials to Fit on the construction schedule proper storage of materials so as to avoid wastages.

objective of material management :

→ the main objective of material management is to minimise the cost that is to incurred on the part of materials.

(i) Feonomic in material cost.
(ii) Ebbicient control of enventories.
(iii) Ensure uniform flow of material for production or construction.
(iv) Ensure right quality at right prices in establish and maintained good relation with customer.
(v) Feonomical conjuction of the important Item and finding the substituted.

Date
Page

Functions of material Department:

→ To achieve best and optimum result it is imperative to place all the function related to the material under a single Department known as material management Department.

→ The functions of these Department are as follows

(i) Estimating the time of material, there actual quantity and the time which they will be required.

(ii) Treshing New sources of supply and developing cordial relation with them in oder to ensure continious material supply at reasonable fair rate.

(iii) coating down cost through significations standardisation value analysis, impact substitution.

(iv) Reporting changes in marking condition and other factors affecting the concern.

(v) Modifying and simplyfying paper work procedure in order to minimise delay procuring materials.

(vi) Providing proper storage and distribution system So as to reduce wastages.

(vii) Arranging transpotations in the most economical way for a incoming and outgoing material.

(viii) Development of co-ordination between various Departments.

→ conducting resources and development with respect to material.

→ Trening personal in the Field of material management.

→ In oder to increase operational to efficiency.

Common construction material:
Materials required in any civil engg project that is Building hydraulic structure etc. can be broadly classified in flowing group

Cement and steel:
→ Normally clients in India take the responsibility for the supply of these essential material mainly because of on shutteren availability of materials an also to have quality control of material Sometimes owner or contractors has to produced them for local specified agency.
→ In that case it requires proper planning in book time so that arrival this material a site most match with construction schedule.

Bricks, lime and stone chips:
→ This common building materials are locally available can be locally fanufactare.

Steel windows, grills and Rails and steel Fabricated items:
They are locally fabricated by specified agencies

For specific requirements:

Timber Items :

The timber items such as door or window frame and shutters, partion walls etc. can be manufactured at site or can be available at readimade sizes.

Sanitary and electrical material :

→ They can be obtain specified agencies.

Mixture and fastenings :-

→ All mixtures and fastenings any materials can be obtained form local agencies.

Finishing Item :

paint, varniess, Distemper and other decorative items can be available for specified agencies.

Coaldar or bitumen, water proofing materials :

They also can be obtained form suppliers and clients

Store Management :

→ Store management is an important part of material.

→ Varicues type of materials are recived at a construction site and are to be stored properly till they are consume on works or disposed.

→ Any Laxity in the care and the store material will add to the cost of the project.

Objective of stores management :

The main objective of store management should aim of the following.

→ Minimum utilaization of space for the storage.

→ Easy handling and during the process of recieve inspection, storage and insure on distributed flow of materials.

→ preservation of stores against spillage, teavage

→ proper maintain of store accounts to have controle over receive and issued in to fix accountability of any defficiency.

Function of store management :

→ The following are the function of store department and duties of store creeper.

(i) Reciving materials, goods and equipment and checking them for identification.

(ii) Proper recording to recives of goods

(iii) placement of right materials at right place.

(iv) Maintance of stocks safely and in good conditions by taking all precassions to ensure that they don't suffer form damage.

(v) Issue of items to the users only on the receive of authorize store requisitions.

(vi) Recording and ~~abstracting~~ updating recipts and issue of materials making sure that stores are kept clean and in good order.

(v) Preventing unathaursed person form entering the stores.

Location and Layout of store :
The proper location and effieient layout of store ensures the best management of store.

(i) Location :-
→ Location of store should be carefully decided and plan so as to ensure maximum effiecieney.

→ The best location of store is one that minimises total handling cost and other cause related to store operation and at the same time provides the needed protection for store items and materials.

→ storm location depending nature the value of items to be stored at the frequency with quize the items are recived and issue.

Classification of stores :
The various type of storage space are -
(i) Floor space
(ii) plat form
(iii) Racks
(iv) shelves
(v) Bins
(vi) Trays
(vii) Barrage etc.