R.C.Patel College Of Engineering & Polytechnic, Shirpur

Department of Civil Engineering

Course Title- Construction Management **Course Code -** 313010

Programme Name -Civil Engineering **Semester-**Third

Unit	Title	COs	Learning hours	R Level	U Level	A Level	Total Marks
II	Project Management and Scheduling	CO2	05	0	0	0	0

2.1 Broad Activities in Construction Work:

- Construction work is completed step by step each activity has its own purpose and time requirement.
- The duration depends on construction work, which type of work, then size, labour strength, weather, condition, machinery and material availability.

1) Earthwork: 1st activity in construction. It includes cleaning the site, removing unwanted soil, excavation for foundation & filling. Duration: weeks.

2) Foundation Work: Foundation is the substructural part which transfers building load safely to the soil. Duration: 1 to 2 months

3) RCC Work: It is main structural framework of the building. component parts are column, beam & slab. Duration: 7 to 15 days

4) Brick Work: Brick work is used for wall construction and partition work. Duration: 1 to 2 months.

5) Scaffolding: Temporary structure made to support workers and materials at height. Duration: 1 to 3 days.

6) Pastering Work: This process of applying cement mortar on walls and ceilings. for smooth surface. Duration: 1 to 2 weeks.

7) Flooring Work: It gives a finished walking surface inside the building. Duration: 1 to 3 weeks.

8) Painting Work: It is the final finishing activity carried out after plastering and surface preparation. 2-4 weeks

9) Plumbing and Sanitary work: Installation of water suppy and drainage systems. Duration: 1 to 3 weeks

10) Electrical Work: Includes wiring & installation of electrical fittings. Duration: 1 to 2 weeks.

2.2 Methods of Scheduling in construction.

- Scheduling means planning the sequence and timing of construction activities.
- It helps engineers know what work should be done, when it should start, and how long it will take.

Two common scheduling methods are:

1) Bar chart
2) Gantt chart.

1) Bar chart :

- A Bar chart is a simple chart used to show construction activities and their duration with the help of horizontal bars.
- It is one of the oldest and easiest planning methods used in construction projects.
- It is introduced by Henry Gantt in 1990.

- Development of Bar chart:
  1) Study the project
  2) List Activities
  3) Estimate duration
  4) Draw time Scale
  5) Draw Bars
  6) Review the schedule
- Merits of Bar chart :
  1) Very simple & easy to understand.
  2) Easy to prepare & modify.
  3) Useful for small projects
  4) Requires less technical knowledge.

2.3 Concept of CPM & PERT :

- CPM and PERT are important project planning and scheduling techniques used in construction management.
- These methods help engineers plan activities, control project time, reduce delays and complete work systematically.

They are mainly used in:

- Building construction
- Highway projects
- Bridge works
- Industrial projects.

1. Critical path method :

- CPM is planning techniques and activities on the critical path must be completed on time because any delay in them will delay the entire project.
- CPM is used for repetitive type project for accurate estimated time of activity can be found.

- **Steps in CPM project planning**

1) Describe : Plan the project
2) Determine : Schedule of activities.
3) Predict : Those activities which control significant target dates of the project.
4) Analyse : The schedule developed.
5) Replan : The project, if analyse so shows.
6) Allocate : Resources efficient manner for schedule development. OR make.
7) Develop : Cost & Time relationship for activities & for optimize purpose.

- Limitations of Bar chart:

1) Does not clearly show relationship between activities
2) Difficult to use for large projects
3) Delays are not easily identified.
4) Resource planning is difficult.

2. Gantt chart:

- A Gantt chart is an improved from of Bar chart developed for better planning and control of projects.
- Actual work and planned work can be compared.

- Development of Gantt chart

1) Identify Activities
2) Arrange Sequence
3) Estimate time
4) Prepare time scale
5) Draw Activity Bars
6) Show progress
7) Update Regularly.

- Merits of Gantt chart:

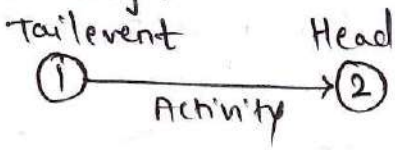
1) Helps compared planned and actual work.
2) Useful for monitoring construction activities.
3) Improves project control.
4) Helps identify delays quickly.

- Limitations of Gantt chart:

1) Activity dependency is not clearly shown.
2) Difficult to manage very large schedules
3) Frequent updating is required.
4) Critical path cannot be identified easily.
5) Not suitable for highly complex projects.

- Activity and Event with their type :

A) Activity :



- Any operation which utilizes resources & has an end and beginning is known as activity.

- Types of Activity :

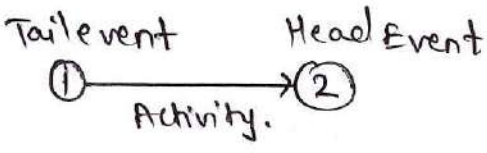
1) Predecessor Activity : Activity started & completed immediately before another start of activity.

2) Successor Activity : This Activity not started until 1 & more activity completed but immediately succeed.

3) Concurrent Activity : Accomplished concurrently.

4) Dummy Activity : It does not consume any kind of resource but which have technical dependance.

B) Event :

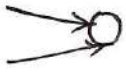


An event represents a point in time shows the comple-tion of some activities and the beginning of new one.

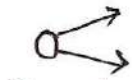
- It represent as Circle in network also known as node or connector.

- Types of Event.

1) Merge Event : When more than activity joint an event.



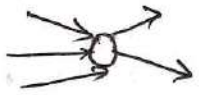
2) Burst event : When more than one activity leaves an event.



Burst event.

3) Merge and Burst event :

An activity may join & leave event.



Merge & Burst

C) Activity Time :

1) Earliest start time : $EST = T_E$

It is earliest time of an activity by which activity can start.

2) Earliest finish time : $EFT = EST + Duration$.

3) Latest start time : without delay of completion of project as whole.

$LST = LFT = Duration$.

4) Latest finish time : completed without delay.

$LFT = T_L$

- Float and its type :

Floats are slack times by which an activity can be delayed. The float is associated with activity time and slack is associated with the event.

- Types of float :

1) Total float : The total float of an activity is the amount by which the start time of the activity can be delayed without delaying the completion of the project.

Total float $T_F = LFT - EF$

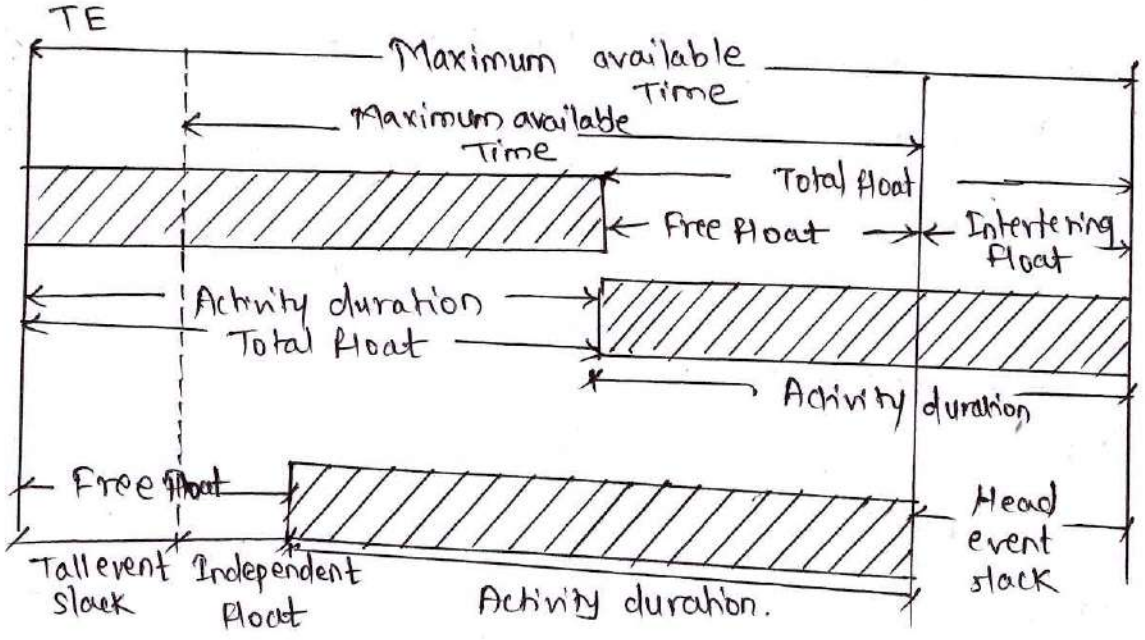
2) Free Float : Free float is the extra time by which an activity can be delayed without delaying the earliest start of the next activity.

Free Float = Total Float - slack of head event

$EF = E_{Snext} - EF$

3) Independent Float : It is the additional time available ends as late as possible and the succeeding activity starts as early as possible.

Independent float = Total Float - Free float.

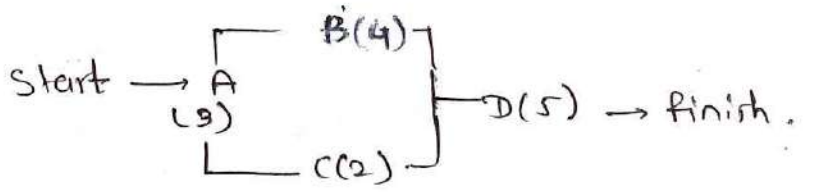


Example :

The following activities are involved in a small project.

Activity	Predecessor	Duration (days)
A	-	3
B	A	4
C	A	2
D	B, C	5

Network diagram:



Path duration:

$A \rightarrow B \rightarrow D = 3+4+5 = 12$ days.

- Forward Pass (find ES and EF)

EF = ES + duration

(A) → ES = 0, EF = 3

(B) ES = 3, duration = 4, EF = 3+4 = 7

ES = 3, EF = 7

(C) Start after A, EF = 3+2 = 5

ES = 3, EF = 5

(D) starts after both B & C

EF of B = 7, EF of C = 5

Largest finish, ES = 7

EF = 7+5 = 12

Total project duration = 12 days.

- Backward Pass (find LS & LF)

LS = LF − duration

Activity D, LF = 12 & duration = 12

LS = 12 − 5 = 7

So, LS = 7 & LF = 12

Activity B, LF = LS of D = 7, duration = 4

LS = 7 - 4 = 3

LS = 3, LF = 7

Activity C, LF = LS of D = 7, duration = 2

LS = 7 - 2 = 5. , LF = 7

Activity A, Take smaller LS from B & C

LS of B = 3, LS of C = 5, smaller value = 3

LF = 3, duration = 3,

LS = 3 - 3 = 0

LS = 0, LF = 3,

To calculate Total Float. , $\boxed{TF = LS - ES}$

Activity	ES	EF	LS	LF	TF
A	0	3	0	3	0
B	3	7	3	7	0
C	3	5	5	7	2
D	7	12	7	12	0

So, critical path is,

A → B → D

Project duration = 12 days

Float of Activity C = 2 days

Critical Activities = A, B, D

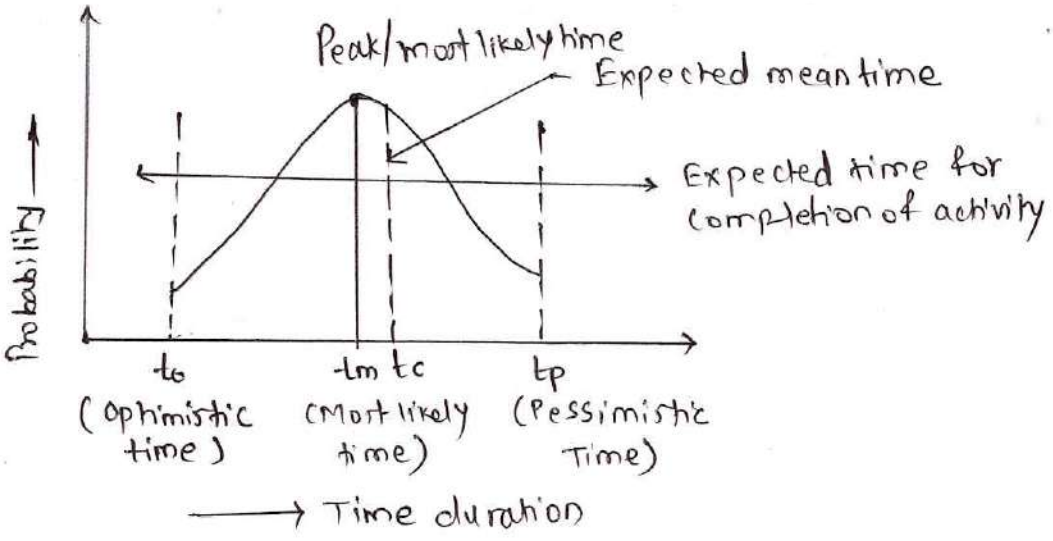
PERT (Project Evaluation and Review Technique)

- PERT was developed by the US Navy for the planning and control of the polaris missile program.
- PERT is used when activity duration is uncertain or difficult to predict.

This method is useful in,

1) Research projects
2) New technology projects
3) Defence and software projects.

- PERT network suitable for non-repetitive or once through Projects.
- To decide activity duration pert uses the following three types of time estimates:



1) Optimistic Time (t_o) = It is shortest possible time in which activity can be completed when working goes smoothly. there is no provision for delays or setbacks.

2) Pessimistic Time (t_p) = It is the longest time the activity if everything goes wrong.

3) The Most likely time Estimate (t_m) - Activity under normal circumstances. Going in normal ways, with few setbacks, no excitements, & no dramatic breakthroughs.

Formulae :

1) The expected mean time

$$te = to + 4tm + tp$$

2) standard deviation, $$\sigma t = \frac{tp - to}{6}$$

3) Variance, $$Vt = (\sigma t)^2 \frac{(tp-to)^2}{36}$$

Assumption of PERT

1) A project can be subdivided into a set of predictable, independent activities.

2) The precedence relationship of project activities can be completely represented by a non-cyclical network graph in which each activity connects directly to its immediate successors.

3) Resources may be shifted to meet the need.

Example :

The following tables gives the time estimates of the various activity of a project.

Activity	1-2	2-3	2-4	3-5	4-6	5-6	5-7	6-7
to	1	3	2	4	4	0	3	2
tm	2	6	4	6	6	0	4	5
tp	3	9	6	8	8	0	5	9

formula,

$$te = to + 4tm + tp$$

$$\sigma t = \frac{tp - to}{6}$$

$$Vt = (\sigma t)^2 \quad \frac{(tp-to)^2}{36}$$

Calculation,

Activity	to	tm	tp	te	σ	V
1-2	1	2	3	12	0.33	0.111
2-3	3	6	9	36	1	1
2-4	2	4	6	24	0.66	0.444
3-5	4	6	9	37	0.83	0.69
4-6	4	6	8	36	0.67	0.444
5-6	0	0	0	0	0	0
5-7	3	4	5	24	0.33	0.111
6-7	2	5	9	31	1.16	1.36

critical path = 1-2-3-5-6-7

Duration = 19.33 days.

Sum of variance along critical path = 0.111 + 1 + 0.69 + 0 + 1.36

= 3.16

Network:

- A network is graphical representation of activities arranged according to their sequence.
- It helps in: . Understanding project flow
  - Finding critical path
  - Monitoring project progress

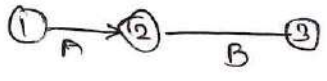
Network Terminology :

There are two types of network:

1. Activity on Arrow (A-O-A)
2. Activity on Node (A-O-N)

1. Activity on Arrow:

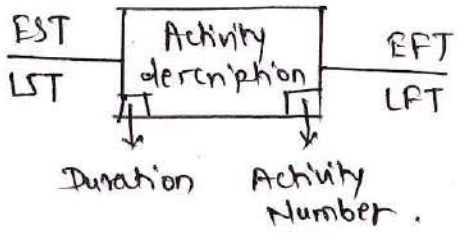
- Arrow represents activity
- Circle represents event.



where, A & B are activities.
①, ② ③ are events.

2. Activity on Node (A-O-N)

- In A-O-N networks, the Nodes represent the activities and the arrows, their interdependencies or precedence relationship.
- Nodes are usually represented by square or rectangles, but circles and other convenient geometrical shapes may also be used.



Project Scheduling :

Early start (ES) and Late start (LS) schedules as limits.

- Project scheduling means arranging activities according to -① sequence
  ② Duration
  ③ Resources.

It helps complete projects in a systematic way.

• Early start (ES) schedule:

Activities start as early as possible.

- The ES schedule indicates the earliest time a task can begin without delaying the project. It is calculated based on the earliest possible start times of preceding tasks.

• Late start (LS) schedule:

Activities start as late as possible without delaying the Project.

- better resource utilization
- Reduced idle labour and machines.

Resource scheduling :

Resource scheduling means proper arrangement of,

- Labour
- Materials
- Machines
- Equipment

Objectives – Avoid shortage of resources
- Reduce wastage
- Improve Efficiency.

Time - cost Trade off:

sometimes project duration can be reduced by spending extra money.

This is called Time-cost Trade off.

- Methods
- Hiring extra labour.
- using advanced equipment.
- working overtime.