MODULE I

Types of Projects based on the agency of execution

- *Public sector or Government projects:* Fully owned by State or Central Government
- *Quasi Government or public sector undertaking (PSU):* Major shares by the Government
- *Public Private Participation (Partnership) (PPP):* Major shares is with the public and Government will hold lesser share
- *Cooperative Sector:* Project by cooperative organizations
- *Private sector projects:* By private organization
- *Build Operate and Transfer (BOT)*
- *Turn Key Projects*
- *Consortium*

Types of Projects based on their nature

- *Infrastructure Projects* like roads, railways, airport, buildings communication and power networks etc
- *Housing projects* for residential purpose
- *Hydraulic structures* like dams
- *Industrial projects* like factories, production centers etc.
- *IT enabled projects*

Types of construction projects

- ***Light construction***

It does not require high plant and equipment for construction. Example: residential buildings, water tanks, culverts, small bridges etc.

- ***Heavy construction***

It requires heavy plant and equipment for construction. Example: railways, airports, harbours, tunnels, dams, multi storied buildings etc.

- ***Industrial construction projects***

It requires special technologies plant and equipment for construction. Examples: power plants, automobile and aircraft industry, chemical and fertilizer plants, refineries etc.

Elements of construction industry

Materials: stone, cement, aggregates etc

Man power: technical and managerial person

Machinery and power: pumps, mixers, excavators etc.

Money: funds available

Space: availability of space

Construction management

It is an act of planning, organizing and overseeing the various tasks involved in a construction project. It is a complex task. It is performed by an individual known as project managers.

Importance of construction management/ need of construction management/ objectives of construction management/ importance of planning

- To complete the work within stipulated time
- To complete the work within estimated budget
- To develop suitable method of effective quality of workmanship
- To provide safe and satisfactory working conditions
- To make high quality of decision making process
- To motivate the people for getting maximum capacity
- To create team spirit among the people
- To use improved technologies
- To give maximum benefit in terms of construction
- To Optimization of resource utilization
- To Minimizes the wastage
- To avoid the delay in project schedule
- To ensures quality through effective quality control
- To ensures safety at project site
- To provides better financial management
- To improves productivity and profitability
- Mainly, to get maximum out come by effective use of men, materials and equipment

Factors involved in construction management

- Planning, scheduling, organizing and controlling
- Selection of proper materials
- Availability of raw materials and its future demand
- Cost of materials
- Procurement of materials
- Appropriate time for using particular equipment
- Time delay due to natural conditions like flood
- Coordination between organizations
- Skills required in doing tasks
- Installed capacity and output obtained technology
- Efficiency of the system and adoption of appropriate
- Obsolescence of machineries and technology
- Absence of state of the art technology
- Availability of capital funds
- Resource optimization & Outturn of the human resource
- Wastages and pilferage
- Wage packages and incentives
- Low level of motivation
- Work culture of the employees and self-motivation
- Attitude, effectiveness and efficiency of management
- Quality control and quality assurance
- Reliability and availability of raw materials and power supply

Functions of construction management

Planning

- Formulations of a work plans by specific objectives
- It covers the aspects like what to do and how to do

Scheduling

- Fitting of final work plan to a time scale
- It deals with the aspect when to do it

Organizing

- Division of total construction project to various manageable departments systematically
- Their relationships are established

Staffing

- Recruiting the staffs for appropriate works

Directing

- Training sub ordinates to carry out the assigned task
- Supervising and guiding

Controlling

- Constant review and checking
- Discover and rectify problems

Coordinating

- Efficient system of communication

Stages of construction

Briefing stage

- Also called report stage
- In this stage, the idea is formulated
- Project, scope and necessity

Designing stage

- Also called planning stage
- Important stage
- How to implement it
- Make a detailed report

Tendering stage

- Invite tenders for construction work

Construction stage

- Execution of work

Commissioning stage

- Performance of the structure is evaluated
- To ensure the work is completed

The major steps involved in planning a project

- Collection of data
- Planning & scheduling
- Feasibility report
- DPR
- Obtaining Sanction
- Identifying contractor & vendors

Feasibility report

Before starting a new project it is necessary to convince the government by submitting a report giving the reasons for starting the project and its necessity and also convince people by educating their need for national; development. Such a report sent for the acceptance by concerned administrative authority is called feasibility report.

It includes:

- History of the proposal
- Necessity of the proposed work
- Aspect and prospect consideration
- Cost and returns (cost benefit ratio)
- Existing road and their conditions
- Total cost
- Appropriate time
- Accommodation facilities
- Water supply scheme
- Stages of work plan
- Topography of site
- Nature of soil etc

Project report

Report which can be prepared to understand the complete picture of the project.

It includes:

- …… (All the points in feasibility report)
- Subsoil conditions
- Climatic conditions
- Equipments using
- Labour availability
- Availability of material
- Method execution of work
- Labour amenities

Types of estimate

- ***Preliminary or rough estimate***

To study various aspects of a project and to decide financial commitment involved, a rough estimate is prepared. It is for getting data about cost benefit ratio for deciding feasibility in case of commercial projects like estate, shopping complex etc. For non-commercial like hospital, schools etc, to know the amount of expense that we need.

Methods are: per unit basis, plinth area rate, cubic content basis etc.

- ***Detailed estimate***

It is the process of arriving actual cost of the project. It is prepared on basis of detailed drawing which includes plan, section, structural design etc. standard data book and schedule of rates will be available with the every department.

It includes:

- Estimating the quantities of items of work
- Preparation of standard data with the help of schedule of rates
- Preparation of abstract estimate

- ***Revised estimate***

Revised estimate is prepared whenever there is a change in the rates quantities of items or specifications. In government departments, once the agreement is signed, the contractor is not eligible for the rate revisions in force after that. However in certain long term project price escalations may be applicable based on specfic terms and conditions

- ***Supplementary estimate***

Supplementary estimate are prepared for additional work beyond the scope of the original project estimate. These additional works become necessary due to demands from the concerned department during the on going project.

Budget:

Budget is the statement of anticipated income and expenditure of the state. It is presented in the assembly or parliament by the finance minister. Budget proposals should be confidential and should not be revealed until it is presented in the legislative assembly or parliament. The highlights of the budget proposal, major fund allocations, new project proposals etc. will be presented in the budget speech of the finance minister. The financial year of our country is from April 1" of the current year to March 31 of the next year. Budget allocation is made to different head of accounts created by the finance department.

Administrative sanction (AS)

For any project by a particular department, an approval from the competent authority of department with respect to cost involved and work to be executed is necessary in the first instance. If an hospital is to expanded, the medical department prepares a rough estimate through the technical persons and is approved and counter signed by the medical department. The medical department authorized the construction under their budget. This type of sanction is called administrative sanction or approval.

Technical sanction (TS)

After administrative approval is obtained, the engineering department prepares detailed plan, design, calculations, quantities of work, estimate etc to be prepared by the competent authority. The work can be start up only after this sanction is obtained. This sanction is called technical sanction.

Organizational structure of PWD

Minister (Minster from legislative assembly)

Secretary every (department have a secretary as IAS officer)

Chief engineer

Circle I	circle II	circle III	circle IV
SE	SE	SE	SE

SE

Division I	division II	division II
Executive engr	Executive engr	Executive engr

EE

Sub division I	Sub division II	Sub division II
DEE	DEE	DEE

DEE

Section I	Section II	Section III
AEE	AEE	AEE
AE	AE	AE
Overseer	overseer	overseer

Chief engineer

Each engineering department has a chief engineer, who is the administrative head of the department. He manages to prepare annual budget estimation. He manages the expenditure and progress of works. He prepares important scheme reports and gets approval of government.

Duties of engineers

- He is responsible for following in respect of his circle/ division/ sub division/ section
- Exercise financial control and execution
- Inspects progress of work
- Prepare inspection report
- Exercise administrative control
- Gets sanction and approvals from concerned authority
- Should see the works are carried as per the plans and estimate
- Maintain proper accounts
- Prepare completed reports
- Guides the following persons under
- Checks the structural stability
- Invite tenders and fixes
- Arranges execution of works
- Monitoring of work
- Prepare plan, design, and estimation and finalize

Establishment

The employees or the human resources in an organization are generally reffered to as the establishment. \

Types of establishments

Permanent establishment

Government department sanctions number permanent posts like AE, AEE, DEE, EE etc. Their salary is drawn upon regular pay bill. They have service rules in respect of pay, allowances, leave, pension etc.

Temporary establishment

If at any time the magnitude of work in any division increases to an extent that is beyond the capacity of the permanent establishment, to cope with Govt may sanction additional temporary posts. These posts can be discontinued when the work load is reduced.

Work charged establishment

It becomes necessary to employ lower levels of supervisory staff. These persons are employed on a monthly basis and their pay is charged to the works. It includes gunman, maistries, inspectors etc.

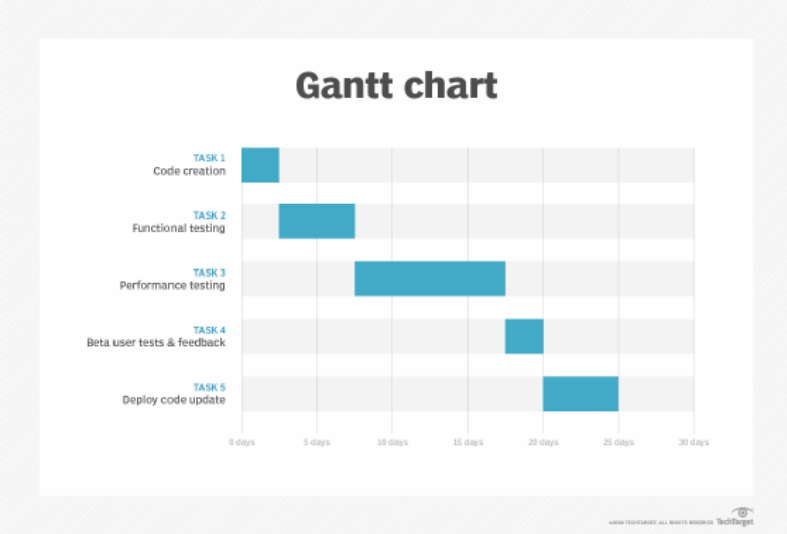
Daily wage labour

These are employed in departmental execution of works. Payment is made by their attendance. It includes masons, mazdoor, drivers etc.

Different management tools

- ***Bar Chart or Gantt Chart***

A Gantt chart is a horizontal type of bar chart that illustrates a project schedule. This chart lists the tasks (activities) to be performed on the vertical axis (Y-axis), and time intervals on the horizontal axis (X-axis). The width of the horizontal bars in the graph show the duration of each activity. It is named after as inventor, Henry Gantt, who designed such a chart around the years 1910-1915



- **Modern Gantt charts** also show the dependency relationships between activities and current schedule status

Advantages:

- Easy to construct
- All activities can be visualised at a glance.
- Simple and easy for common man to understand.
- The graphical representation gives an overall view of activities
- Shows the earliest start and earliest finish of activities.
- Suitable for limited number of activities (Usually less than 30)
- The progress chart can be overlaid on the planned chart and it is easy to understand delayed activities.
- Easy to make presentations with

Limitations:

- Bar chart is not suitable when the number of activities is more
- It does not clearly show the logical relationship between activities.
- Re-scheduling during delay in the project execution cumbersome
- Spare time associated with an activity is not known
- Difficult to implement in projects involving multidisciplinary activities
- Impact of project delay is not known
- Only earliest start and earliest finish time of activity is known. The latest start and latest finish time remain unknown
- Size of the bar shows only the duration of the task, and not the quantum of work
- Critical or important activities cannot be identified
- Needs large chart or display arrangement when the number of activity and duration is more.
- A Gantt Chart is difficult to update during delays and deviations in activities.
- This approach does not consider optimisation of project duration, resources or cost.

- ***Mile stone Chart:***

It is an improvement over the bar chart it partially shows the relationship between activities. A milestone is used to represent groups of activities, significant events or commitments in a project. A milestone chart shows a group of milestones in an organized way similar to a Gantt chart, with one milestone per line vertically with a description on the left and the milestone located horizontally along a time scale showing when it occurs. Milestones differ from the bars in a Gantt chart in the fact that they show only a single date and are usually depicted as a triangle instead of a bar

- ***Network Model***

  All projects comprise a large number of activities, some of which may be independent but most of them interdependent. So, network model is convenient.

  The common network models are,
  - CPM (Critical Path Method)
  - PERT (Programme Evaluation and Review Technique)

CPM (Critical Path Method)

Critical Path Method is commonly used with all forms of projects, including construction, aerospace and defense, software development, research projects, product development, engineering and plant maintenance, among others. Any project with interdependent activities can apply this method of mathematical analysis. The first time CPM was used was for a major skyscraper development in 1986 while constructing the former World Trade Centre Twin Towers in New York City

PERT (Programme Evaluation and Review Technique)

PERT was developed primarily to simplify the planning and scheduling of large and complex projects. Program Evaluation and Review Technique (PERT) is an operation to understand the planning, arranging, scheduling, coordinating and governing of a project. PERT and CPM are complementary tools, because CPM employs one time estimation and one cost estimation for each activity. PERT may utilize three time estimates (optimistic time), most likely time), and pessimistic time) and no costs for each activity it is a probabilistic model.

Terms used in network method

Activity

An activity is the performance of specific task such as concreting, painting etc. it requires time for completion. It is represented by an arrow. Its length has no significance.

Event

Event is called node. It represents an instant of time when certain activity has been started or completed. In other words, event describes start or completion of task. It is represented by a circle. The beginning of an activity is a tail event and completion of an activity is a head event.

Dummy

This is an artificial activity represented on network diagram by dotted arrow which indicates that an activity following cannot be started until the activity preceding the dummy is completed. It has no duration. The purpose of dummy is to provide logical relationship between the activities.

Restraint

It is similar to dummy activity but has duration. It is used to fix intermediate dates within the network and there by fix the relative start or finish of the parallel activities.

Types of Float

Total float

It is also called slack or spare. It is the difference between the maximum time allowed for an activity and its duration. It is represented by T_F.

$$T_F = LST - EST \text{ OR } LFT - EFT$$

Free float

It is an amount of time by which an activity completion time can be delayed without interfering with the start of

succeeding activities.

FF=TE-EFT

Independent float

It is the excess of minimum available time over activity time.

Interfering float

It is the difference between total float and free float.

Critical path

The events have no float are called critical events. The path joining such critical events is called critical path

Critical activities

The activities lying on the critical path are called critical activities.

Difference between CPM and PERT

Critical Path Method (CPM)	Programme Evaluation and Review Technique
Network model	Network model
Deterministic model. Time required for the activity can be assessed with some amount of accuracy from past experience.	Probabilistic model. Time required for the activity is uncertain. Expected time is determined based on probability.
Developed mainly for the projects of DuPont	Developed for the Polaris project of the US Navy
Involves predicable activities	Involves unpredictable activities
Activity oriented	Event oriented
Single time estimation	Three time estimation
Applied to projects with previous experience or repetitive jobs like construction projects	Applied to R&D, research, or one-time projects where past experience is little.
Time is equated as money	Happening of events given emphasis
Crashing concept or time cost trade off concept is applicable	Crashing concept not applicable. Money and time are not interlinked.
Differentiates critical and non-critical activities	No differentiation between critical and non-critical path
The excess time associated with an activity is called Float.	The term used to indicate spare time with an activity is called slack time.
It is basically a project planning tool for cost and time	It is basically a project time control tool

Fast tracking and Project Crashing

Fast tracking is a technique of reducing project duration by adopting partially or fully parallel processing of activities to the farthest possible extent. Typically, this is decided at the beginning of a project, organising it so that the design and construction phases can overlap. This means the activities normally performed sequentially are rescheduled to be performed in parallel or partially in parallel. This will reduce the overall programme, but is likely to increase costs and risks. When fast tracking does not yield the results to the expected level, crashing techniques are adopted

Project crashing is another technique for shortening or compressing the project duration by reducing the time required for one or more critical activities by putting in more resources at the least cost possible. Cost and schedule trade-offs are analysed to determine how to obtain the greatest amount of compression of project duration for the least incremental cost. Crashing is the technique to be used when fast tracking has not saved enough time on the schedule. The aim of crashing is to achieve the maximum decrease in schedule for minimum additional cost. Project crashing is achieved by putting more resources in the critical path, increasing productivity, working overtime with additional supervision, outsourcing of work, and modification of specification and design, such as changing to pre-fab construction early procurement of items etc. Project crashing should not, however, Compromise with safety or quality

Normal cost and normal time

Normal cost is the lowest cost of completion of an activity in minimum time employing the normal resources

Normal time is the minimum time required to complete a project at the normal cost.

Crash cost and crash time

Cost of completing an activity by employing all possible means like overtime, extra resources, special material etc is called crash cost

Absolute minimum possible time associated with the crash cost is called crash time.

Methods of resource collection

Resource allocation: means deciding what resources each activity of the project requires.

Resource smoothing: in this, project duration is no changed, but start of activity are shifted by their float

Resource leveling: in this, start times are so rescheduled that the peak demand does not exceed the available limit of resource.

Job layout

Job layout is the detailed layout of the project site, earmarking the construction area, locations for various construction activities, places for stocking of materials, locations of plants & equipment, layout of roads, entry & exit points, emergency assembly area, service points like water, electricity, fire hydrants, locations of temporary buildings like workers rest area, site office, stores, watchmen shed etc. prepared based on a detailed planning. It is usually displayed as a legend or display board at major locations for the information of everyone involved in the project

A job layout ensures safety at work place as it avoids conflicting actions and helps in scheduling activities as per planning. Efficient job layouts will economise the activities by decreasing the lead distance and saving more in terms of time and money. Accidents can be better controlled by strictly enforcing activities as per the job layout.

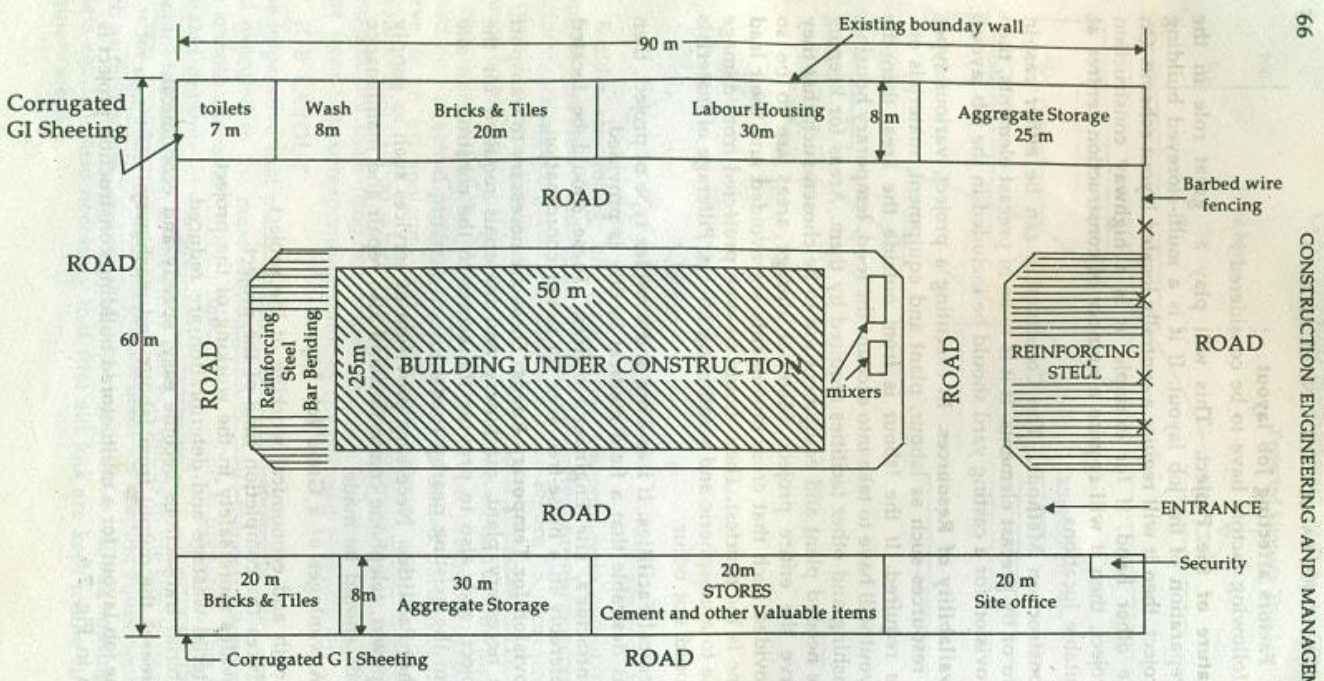


Fig. 7.6. Job Layout for a Multi Stoteyed Building

Time and Motion Study

Time and motion study is a work measurement technique for recording the times of performing a specific job or its elements carried out under specified conditions. Time is the duration of activity and motion refers to the effort taken for that activity, which is measured in terms of motion. Work measurement is required to assess the human requirement for a work and to fix the wages or charges for that activity. Work study is also carried out to explore better means of doing a work with lesser effort in order to improve the efficiency through increased productivity.