UNIT :- 1

Management :-

Management is an art of getting things done through and with the people in formally organized groups. It is an art of creating an environment in which people can perform and individuals and can co-operate towards attainment of group goal.

Management process is a process of setting goals, planning and/or controlling the organizing and leading the execution of any type of activity, such as a project.

Importance of Management :-

1) It helps in achieving group goals :- It arranges the factors of production, assembles and organizes the resources, integrates the resources in effective manner to achieve goals. It directs group efforts towards achievement of pre-determined goals. By defining objective of organization clearly there would be no wastage of time, money and effort.

2) Optimum utilization of Resources :- Management utilizes all the physical and human resources productivity. This leads to efficacy in management. Management provides maximum utilization of scarce resources by selecting its best possible alternate use in industry from out of various uses.

3. Reduces costs :- It gets maximum results through minimum input by proper planning and by using minimum input & getting maximum output. Management uses physical, human & financial resources in such a manner which results in best combination. This helps in cost reduction.

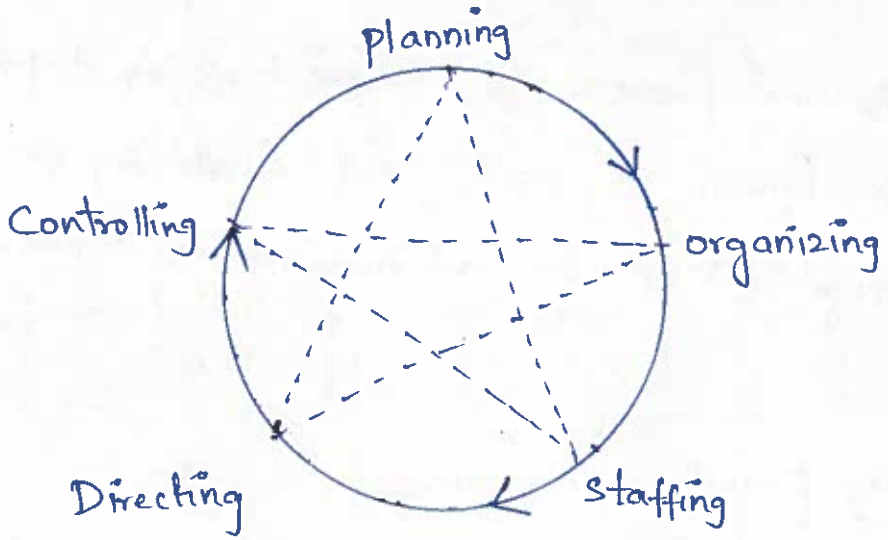
4. Establishes Sound Organization :- No overlapping of efforts. To establish sound organizational structure is one of the objective of management which is in tune with objective of organization and for fulfillment of this, it establishes effective authority & responsibility relationship i.e who is accountable to whom, who can give instructions to whom, who are Superiors & who are Subordinates. Management fills up various positions with right persons, having right skills, training and qualification. All jobs should be cleared to everyone.

5. Establishes Equilibrium :- It enables the organization to Survive in changing environment. It keeps in touch with the changing environment. It adapts organization to changing demand of market / changing needs of societies. It is responsible for growth and survival of organization.

6. Essentials for prosperity of society :- Efficient management leads to better economical production which helps in turn to increase the welfare of people. Good management

makes a difficult task easier by avoiding wastage of scarce resource. It increases the profit which is beneficial to business and Society will get maximum output at minimum Cost by creating employment opportunities which generate income in hands.

FUNCTIONS / ROLE OF MANAGEMENT :-



1. PLANNING :-

It is the basic function of management. It deals with chalking out a future course of action and deciding in advance the most appropriate course of actions for achievement of pre-determined goals.

According to KOONTZ, "planning is deciding in advance - what to do, when to do & how to do. It bridges the gap from where we are & where we

want to be".

A plan is a future course of actions. It is an exercise in problem solving & decision making. planning is determination of courses of action to achieve desired goals.

Thus planning is a systematic thinking about ways & means for accomplishment of pre-determined goals. planning is necessary to ensure proper utilization of human & non-human resources.

Organizing :- It is the process of ~~giving~~ bringing together physical, financial & human resources and developing productive relationship amongst them for achievement of organizational goals.

According to Henry Fayol,

"To organize a business is to provide it with everything useful or its functioning i.e. raw material, tools, capital and personnel's"

To organize a business involves determining & providing human and non-human resources to the organizational structure.

It involves

→ Identification of activities.
→ Classification of grouping of activities.
→ Assignment of duties.

→ Delegation of authority and creation of responsibility.
⇒ Coordinating authority and responsibility relationships.

2. Staffing :-

It is the function of manning the organization structure and keeping it manned. Staffing has assumed greater importance in the recent years due to advancement of technology, increase in size of business, complexity of human behavior etc.,

The main purpose of staffing is to put right man on right job i.e square pegs in square holes and round pegs in round holes. According to Kootz & O'Donell, "Managerial function of staffing involves manning the organization structure through proper and effective selection appraisal & development of personnel to fill the roles designed in the structure.

Staffing involves :-

(i) Manpower planning (estimating man power in terms of Searching, Choose the person and giving the right place).
(ii) Recruitment, Selection & placement.
(iii) Training & Development.
(iv) Remuneration
(v) Performance.
(vi) Promotions & Transfer.

3. Directing :- It is that part of managerial function which actuates the organizational methods to work efficiently for achievement of organizational purposes. It is considered life-Spark of the enterprise which sets it in motion the action of people because planning, organizing and staffing are the mere preparations for doing the work. Direction is that inext inter-personnel aspect of management which deals directly with influencing, guiding, supervising, motivating sub-ordinate for the achievement of organizational goals.

Direction has following elements.

- → Supervision.
- → Motivation.
- → Leadership.
- → Communications.

Supervision :- implies overseeing the work of Subordinates by their Superiors. It is the act of watching & directing work & workers.

Motivation :- Means inspiring, stimulating or encouraging the Sub-ordinates with zeal to work. Positive, negative, monetary, non-monetary incentives may be used for this purpose.

Effective leadership in Construction management is founded on having a fully motivated Supervisory staff and labour force. Success in this area will ensure a safer, more

Productive and smoother-running job which ultimately helps in achieving the project goals.

Leadership :- It may be defined as a process by which manager guides and influences the work of subordinates in desired direction.

Leadership is an area that touches on most of the other human factors area in Construction management. The following eight areas in management illustrates the leadership in project management :-

(i) peer skill.
(ii) Leadership skill.
(iii) Conflict - Resolution skill.
(iv) Information processing skill.
(v) Skills in unstructured decision making.
(vi) Resource allocation.
(vii) entrepreneural skill.
(viii) Skills of introspection.

Communications :- It is the process of passing information, experience, opinion etc from one person to another. It is a bridge of understanding.

It involves the interchange of thoughts or opinion by word, letters. or by similar means. It also involves the concept of combination system such as : Telephone,

Televisions, Computers, internet facilities, etc.

4. Controlling :- It implies measurement of accomplishment against the standards and correction of deviation if any to ensure achievement of organizational goals. The Purpose of Controlling is to ensure that everything occurs in conformities with the Standards.

An efficient System of control helps to predict deviations before they actually occur. According to Theo Haimann.

"Controlling is the process of checking whether or not proper progress is being made towards the objectives & goals and acting if necessary, to correct any deviation".

According to Koontz & O'Donell "Controlling is the measurement & correction of performance activities of Subordinate in order to make sure that the enterprise objectives and plans desired to obtain them as being accomplished.

Main steps involved in controlling are :-

(i) establishment of Standard Performance.

(ii) Measurement of actual Performance.

(iii) Comparison of actual performance with the standards & finding out deviation if any.

(iv) Corrective action.

Management theories.

It is a collection of ideas which set forth general rules on how to manage a business or organization.

Management theory addresses how managers and supervisors relate to their organizations in the knowledge of its goals, the implementation of effective means to get the goals accomplished and how to motivate employees to perform to the highest standard.

Not many managers use a singular theory or concept when implementing strategies in the workplace.

Contingency theory :- This theory asserts that managers make decisions based on the situation at hand rather than a "one size fits all" method. A manager takes appropriate action based on aspects most important to the current situation. Managers in a university may want to utilize a leadership approach that includes participation from workers, while a leader in the army may want to use an autocratic approach.

Systems theory :- Managers who understand systems theory recognize how different systems affect a worker and how a worker affects the systems around them.

A system is made up of a variety of parts that work together to achieve a goal. Systems Theory is a broad perspective that allows managers to examine patterns and events in the workplace. This helps managers to coordinate programs to work as a collective whole for the overall goal or mission of the organization rather than for isolated departments.

Chaos theory :-

Change is Constant. Although certain events & circumstances in an organization can be controlled. Others can't. Chaos Theory recognizes that change is inevitable (unavoidable) and is rarely controlled. While organizations grow, Complexity and the possibility for Susceptible events increase. Organizations increase energy to maintain the new level of Complexity, and as Organizations Spend more energy, more Structure is needed for stability. The system Continues to evolve and change.

Theory X and Theory Y :-

The management theory an individual chooses to utilize is strongly influenced by beliefs about workers attitudes. Managers who believe workers naturally lack ambition and need incentives to increase productivity lean toward the Theory X Management style. Theory Y

believes that workers are naturally driven and take responsibility. While Managers who believe in theory X value often use an authoritarian style of leadership. Theory Y leaders encourage participation from workers.

Management Roles :-

A well known researchee by the name of Henry-Mintzberg identified three general management roles. They are Interpersonal Role, Informational Roles & decision Roles.

Interpersonal Role :-

Management is largely about interpesonal relations betwe-n the manager and people both inside and outside the Organization. Such as employees, Superiors, Suppliers & customers As a Supervisor. Alexander will serve in his interpesonal Role which acting as a figure head, leader and liaison.

As a figurehead, he represents the face of the Company when interacting with people. He also serves as a leader to his team and acts as a liaison between his team members and upper management. He may occasionally act as a liaison between the company & suppliers or Customers.

Informational Role :-

Management is also about managing information. Alexander's "Informational Role" includes collecting information, receiving information and disseminating (spreading something) information.

For example, Alexander will receive production goals from his boss and will disseminate, or communicate, them to his team. He will also collect information on current production and send it to his boss for review.

Decision Role :-

Managers are decision makers. In fact, failure to make decisions will often lead to failure. Alexander's "decisional role" includes being an entrepreneur, disturbance handler, resource allocator and a negotiator. For example, manager must often seek creative solutions to problems just like an entrepreneur. He is also responsible for managing and allocating resources to accomplish his production goals. In addition he must handle unanticipated complications that disrupt his team and its goals, known as disturbance handling.

Social responsibility :-

In the words of Druckee, "Social responsibility requires managers to consider whether their action is likely to promote the public good, to advance the basic beliefs of our society, to contribute to its stability, strength and harmony".

According to Keith Davis, "Social responsibility is the obligation of the decision-makers to take decisions which protect and improve the welfare of the society as a whole along with their own interest".

Various social responsibility of any organization includes

(i) Moral responsibility :-

It is the moral responsibility of modern business corporations to denote some part of their overall resources for the betterment of society.

(ii) Public expectations :-

If business wishes to remain in the long-run, it must respond to society's needs and give society what it wants.

(iii) Public image :-

A firm which seeks better public image should support social goals. This way it can gain more customers, better employees, more responsive money market and other benefits.

(iv) Avoidance of Government Regulation :-

Government is a massive institution with long arms which seeks to regulate bussiness in public interest.

Before government streches its long arms, business should discharge its obligations to society.

(v) Better Environment for Business :-

Social responsibility creates a better environment for business and a better society produces environmental conditions more favorable for business operations.

(vi) Balance of Responsibility with power :-

Business responsibility should be more related to power. It is reasoned that business have social power. If each institution performs its social role in an orderly manner, it would benefit society & business.

(vii) Duty of Gratitude :-

Business units benefits from society. on the basis of commonly accepted principle that one owes debts of gratitude towards those from whom one benefits, the Corporation has certain debts that it owes to society.

PLANNING AND STRATEGIC MANAGEMENT

Planning :-

planning is the most important technique of the management. This is a mental process requiring the use of intellectual facilities, imagination, foresight and sound judgement, to decide in advance as to what is to be done, how and where it is to be done, who will do it and how the results are to be evaluated.

Steps involved in planning :-

(i) Crystalizing the opportunity or problem. The first

step in planning would be to find out the problem or identify the opportunity to be seized.

(ii) Securing and analyzing necessary Information. Adequate information is required on course of action possible. This information must be analysed to establish the relationship and tabulate them for adequate interpretation.

(iii) Establishing planning premises and constraints :- An analysis of the data so collected will result in the formulation of certain assumptions on the basis of which the plan will be made through a process of forecasting.

(iv) Ascertaining alternative course of action or plan :- Based on the above analysis, possible alternative course of action will be identified and examined.

(v) Selecting Optimum plan :- An evaluation of the above alternate course of action can be carried out either by judgement alone or with the help of quantitative techniques and staff assistants, to best suit the interest of the organisation.

(vi) Determining derivative plan :- The above selected plan will form the basic plan from which other plans will develop to support it.

(vii) Fixing the timing of introduction :- The question of timing - who will do, what will have to be decided and an appropriate time schedule drawn up with the details of construction work for Communication.

(viii) Arranging future evaluation of effectiveness of the plan.

Since the ultimate aim of the plan is to achieve the objective, result or goal, an evaluation at the earliest possible opportunity is necessary to evaluate the adequacy of cost & time & determining whether the planned objectives are reached as desired.

#Strategic Management :-

Strategic management involves the formulation and implementation of the major goals and initiatives taken by a company's top management on behalf of owners, based on consideration of resources and an assessment of the internal and external environments in which the organization competes.

Formulation of strategy involves analyzing the environment in which the organization operates, then making a series of strategic decisions about how the organization will compete. Formulation ends with a series of goals or objectives & measures for the organization to pursue.

→ Remote external environment, including the political, economic, social, technological, legal & environmental landscape (PESTLE)

→ Industry environmental, such as the competitive behaviour of rival organizations, the bargaining power of buyers/customers and suppliers, threats from new entrants to the industry.

→ Internal environment, regarding the strengths & weakness of the organization's resources.

Decision-making :-

"Decision making is a process of selection from a set of alternative courses of action which is thought to fulfil the objective of the decision problem more satisfactorily than others."

It consists of four interrelated phases.

(i) explorative :- Searching for decision occasions.

(ii) Speculative :- Identifying the factors affecting the decision problem.

(iii) evaluative :- {analysing and weighing alternative course of action.

(iv) selective :- choice of the best course of action.

Steps in Decision-making process :-

(1) Identify the problem :- The decision making process begins with the recognition of a problem that requires a decision.

(2) Diagnose the problem :- Diagnosing the real problem implies analysing it in terms of its elements, its magnitude its urgency, its course, and its relation with other problems.

(3) Discover alternatives :- the next step is to search for the various possible alternatives. Development of alternatives is a creative process requiring research and imagination. Management must ensure that the best alternatives are considered before a course of action is selected.

(4) Evaluate Alternatives :- Once the alternatives are discovered, the next stage is to evaluate or screen each feasible alternative. Considerable knowledge and judgement are required to measure the plus and minus points and to find out the net benefit of each alternative.

(5) Select the Best Alternative :- The ability to select the best course of action from several possible alternatives seperates the successful managers from the unsuccessful ones. past experience, experimentation, research and analysis are useful in selecting the best alternative.

(6) Implementation and follow-up :- once a decision is made, it needs to be implemented. The implementation of the decision should be constantly monitored. The effects of the decision should be judged through periodic progress reports.

Decision-making tools and techniques :-

while the basic principles might be the same. there are dozens of different techniques and tools that can be used when trying to make a decision.

1) Decision-matrix :- A decision matrix is used to evaluate all the options of a decision. when using the matrix, Create a table with all of the options in the first column and all of the factor that affect the decision in the fist row. users then score each option & weigh which factor are of more importance.

2) T-chart :- This chart is used when weighing the plusses and minuses of the options. It ensures that all the positives and negatives are taken into consideration when making a decision.

3) Decision tree :- This is a graph or model that involves contemplating each option and the outcomes of each.

4) Multi-voting :- This is used when multiple people are involved in making a decision. It helps whittle down a large list options to a smaller one to the eventual final decision.

(5) pareto analysis :- This is a technique used when a large number of decisions need to be made. This helps in prioritizing which ones should be made first by determi-ning which decisions will have the greatest overall impact.

(6) cost-benefit :- This technique is used when weighing the financial ramifications of each possible alternative as a way to come to a final decision that makes the most sense from an economic perspective.

(7) conjoint analysis :- This is a method used by busines leaders to determine Consumer preferences when making decisions.

Human Resource management :-

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, materials money & machinery which constitute the resources of an organisation.

In order to be effective, an organisation has to follow certain basic principles given below.

(i) principle of objectives :- The organisational objectives should be clearly defined. The structure of the organisation should be geared to achieve these objectives 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 first line supervisor at the bottom. This is known as scalar principle.

(iii) Principle of balance between Authority and Responsibility :- In order to perform work properly, it is essential that every one knows his duty, responsibility and authority or powers. Authority means right to act, decide & command. So, whenever a task is assigned to a person, he must be given sufficient powers to exercise control in order to achieve desired objectives

Responsibility is the obligation of a subordinate to perform any job alloted to him by his superiors. Thus authority and responsibility go hand in hand and must be balanced rationally to produce best results.

(iv) Principle of Unity in Command :- Each person in an organisation must know to whom he has to report and from whom he should receive orders. The principle that each subordinate should report to only one superior is called the 'Unity of Command'. This not only avoids confusion but also helps in maintaining a definite line of command.

(v) Principle of Span of control :- According to this principle, there is a limit to the number of subordinates an executive can effectively supervise. The optimum span of control varies from person to person and job to job.

(vi) Principle of Departmentation :- Departmentation means the division of organisation into several distinct departments or sections. This helps in increasing the efficiency and facilitates the execution of work.

(vii) Principle of Specialisation :- Activities of the organisation should be grouped as per the functions 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, instructions and suggestions from the chief executive level to the first line Supervisor.

(ix) Principle of Flexibility & Stability :- Flexibility and stability in an organisation are closely inter-related.

On the one hand, organisation should be flexible enough to assess the changes which often become necessary because of internal and external situations. 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 & 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.

(xi) Principle of Continuity :- The organisational structure should be dynamic so that it not only provides for the activities necessary to achieve its objectives but also for the continuation of such activities in the future.

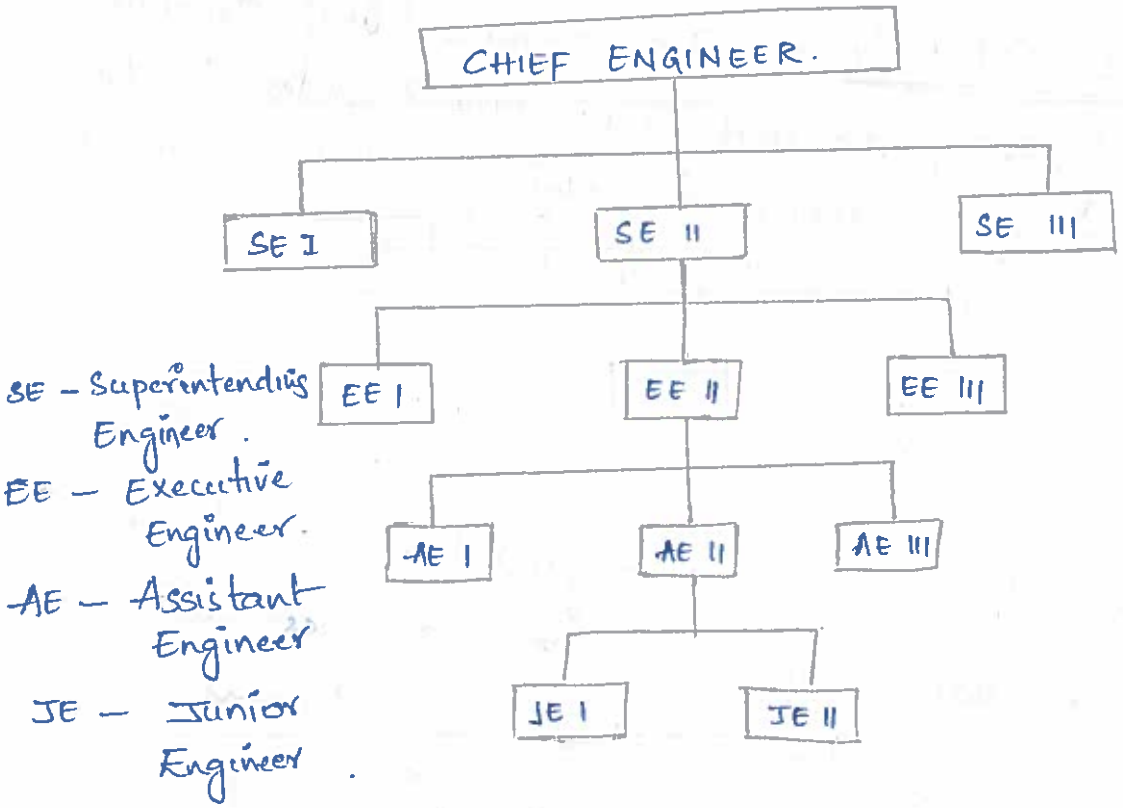
TYPES OF ORGANISATIONS :-

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.

1. Line organisation.
2. Line & staff organisation.
3. 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.



SE – Superintending Engineer.
EE – Executive Engineer.
AE – Assistant Engineer
JE – Junior Engineer.

Merits of Line organisation :-

(i) It is simple and easy to understand.
(ii) It permits quick decisions.
(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 & quickly detected.

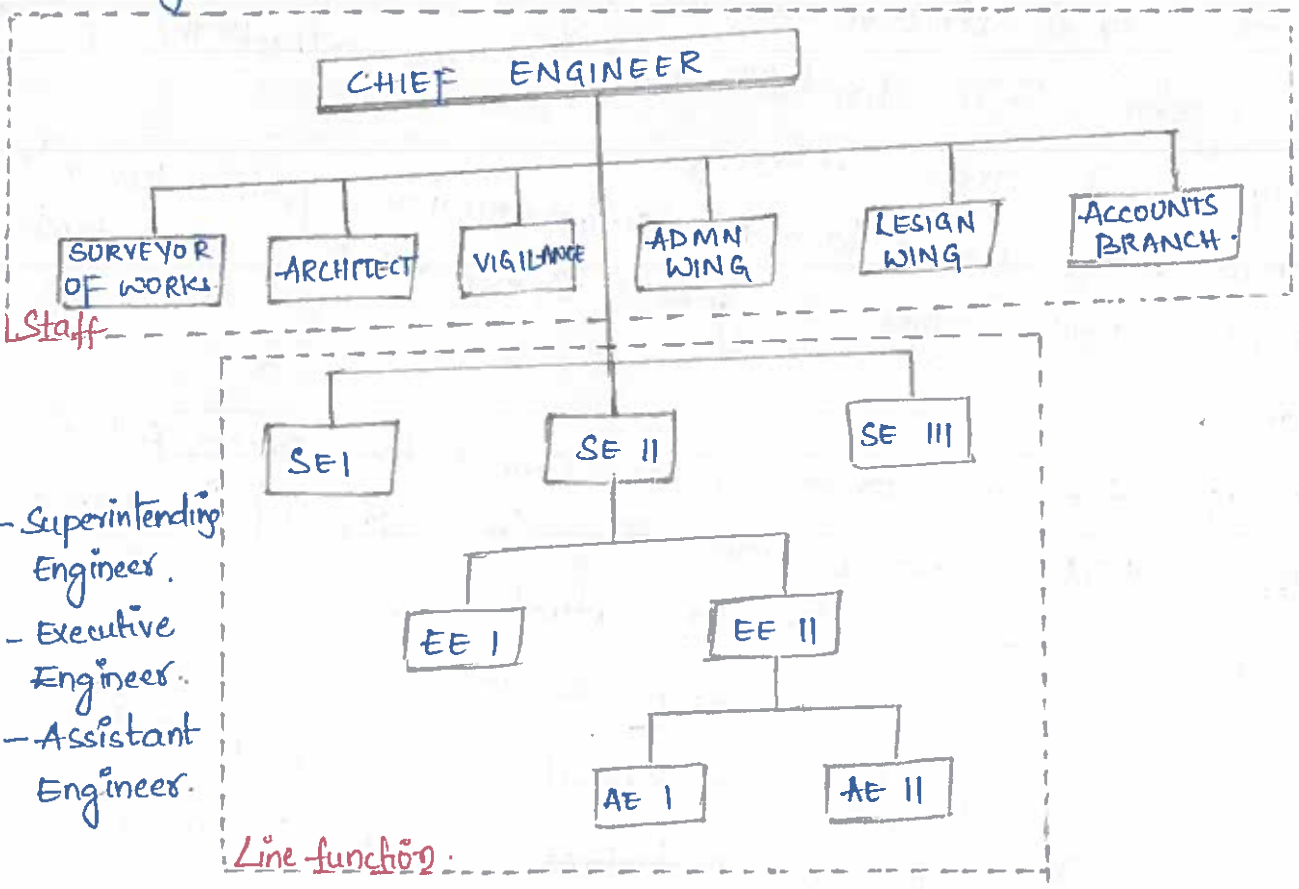
Demerits of line-organisation :-

(i) The departmental heads are over-burdened as all decisions have to be taken by them.
(ii) A delay in decision-making by top management may bring the system to a standstill and adversely affect the efficiecy-ency of the organisation.
(iii) There is a general lack of communication from lower levels upwards. while there is good communication from top to bottom.

Scope:- This type of organisation cannot be successful in a system which depends upon the ingenuity of its workers. It is efficient in following situations.
(i) where the work is of routine nature;
(ii) where subordinate and operational staff is limited.
(iii) In continous process industries such as refining, spinning, weaving, Sugar manufacture etc.,

(ii) Line and staff Organisation :-

Line ~~staff~~ organisations are unsuitable for large & complex Projects, where the key men need to be assisted by Specialists in different fields. The individuals who continue 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 functions such as research, design, planning, Scheduling & recording of performance etc., All these activities are performed by staff, while the line authority maintains discipline & stability in an Organisation.



Line & Staff organisation (Government)

MERITS OF LINE AND STAFF ORGANISATION :-

(i) functional expertise and experience is available from staff personnel.

(ii) Specialised work is done by staff personnel and line personnel can devote their time to achieve sectional targets.

(iii) It provides more job opportunities.

(iv) Due to staff specialisation, there is more efficient utiliza-tion of human and physical resources.

(v) Quality of product is better.

Demerits :-

(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 relationship of the line and staff personnel.

(iii) The overhead cost increases because of high salaries of staff personnel.

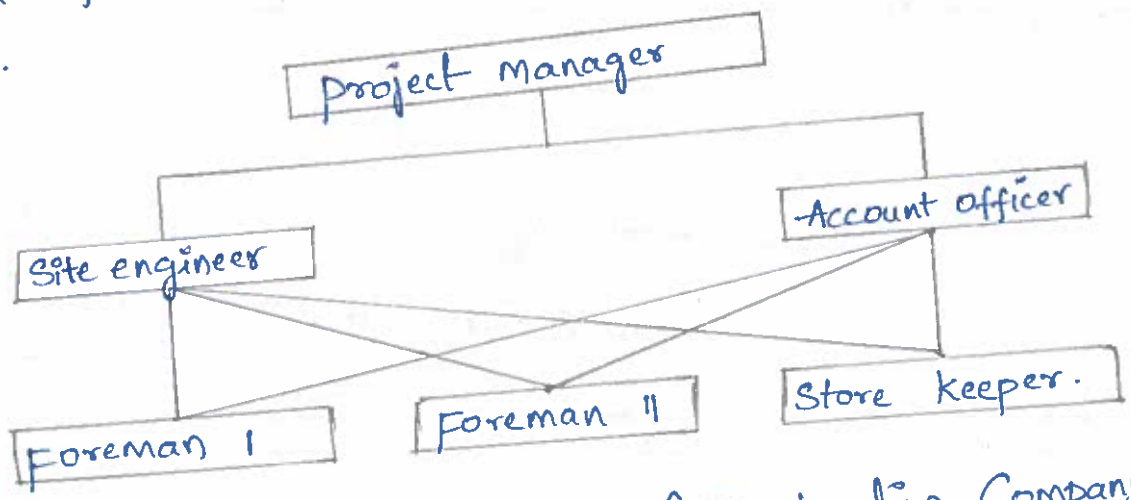
Scope :-

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.

(iii) 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.

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 aspects of work.

In order to perform his function effectively, a person has to ~~perform~~ ~~a~~ ~~minimum~~ ~~number~~ ~~of~~ ~~functions~~ ~~and~~ report to several superiors for different phases or aspects 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) Divison of labour is done on the basis of function specia-lisation
(ii) The functional efficiency of individuals increases due to limited number of Specialised activities.
(iii) Manual work is Seperated 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) There is no clear-cut line of authority and this leads to confusion among personnel working at lower levels.
(iii) It is difficult to pin-point responsibility which may adversely affect the morale of the organisation.
(iv) Co-ordination is more difficult.
(v) Overhead costs are increased due to a number of Specialists.

Scope :- Such type of Organisation is not commonly found in practice in its pure form. It is Suitable for large research and manufacturing Concerns.

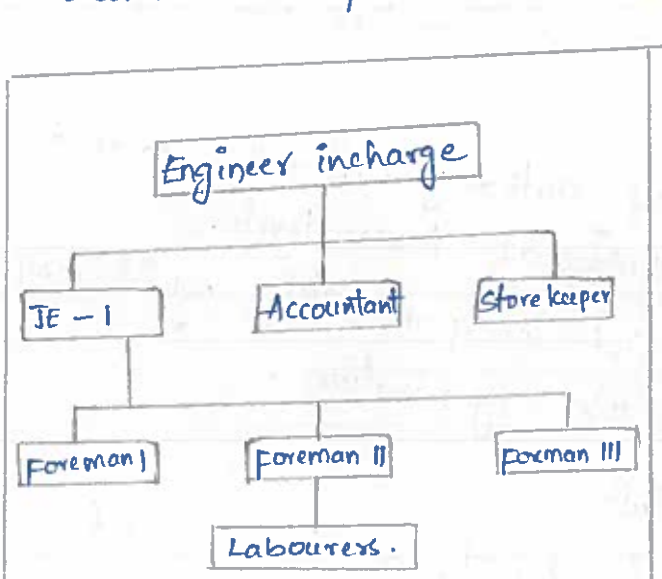
ORGANISATION FOR A CONSTRUCTION FIRM :-

Any organisational Structure proposed for a Construction firm should take into Consideration the nature of activities, scope & type of

Project work and the area(s) 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. (figure ①)

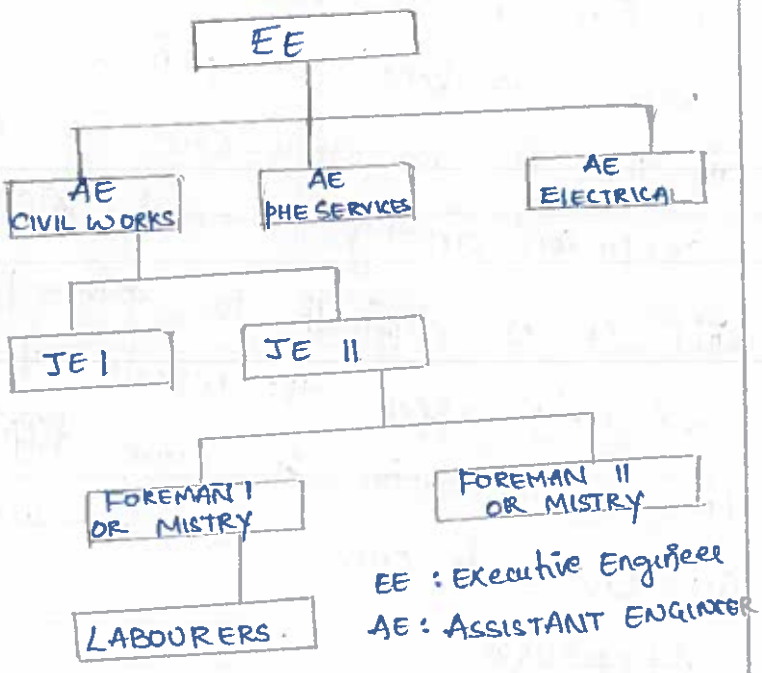
→ In very small works such as construction of a private residential house, the contractor has to himself perform the functions of the Engineer. In case of medium to large sized construction companies, a line and staff type of organisation is preffered. (figure ②)



JE :- Junior Engineer.

fig :- ①

Line staff organisation (small construction firm)



EE : Executive Engineer

AE : Assistant Engineer

Typical Site organisation for a Division (public works department)

Human Resource Management :-

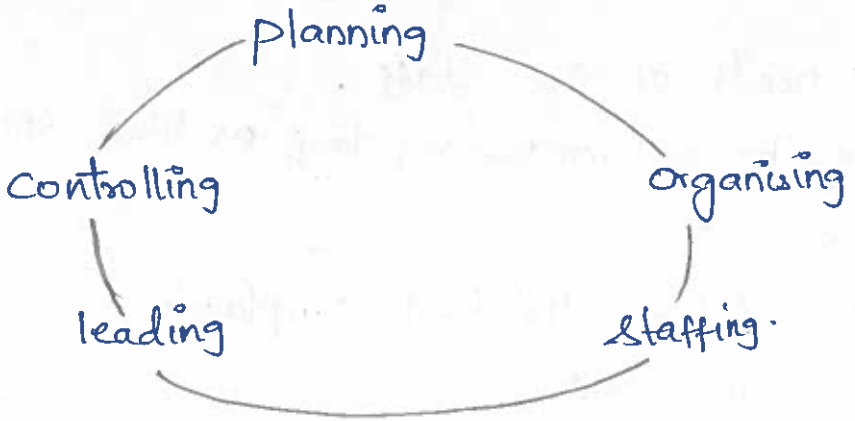
Human Resource management may be defined as the art of procuring, developing and maintaining competent workforce to achieve organizational goals efficiently.

→ According to Invancevich and Glueck, "HRM is concerned with the most effective use of people to achieve organizational and individual goals".

→ According to Flippo, "HRM is the planning, organising, directing and controlling of the procurement, development, compensation, integration, maintenance and seperation of human resources to the objectives are accomplished."

Functions of Human resource management are :-

Most experts agree that managing involves five functions :- planning, organizing, staffing, leading and controlling.



(Management process)

→ planning :- Establishing goals & standards, developing rules and procedures, developing plans & forecasting.

→ Organising :- Giving each subordinate a specific task; establishing departments; delegating authority to subordinate; establishing channels of authority & communications.

Staffing :- Determining what type of people you should hire ; recruiting prospective employees ; selecting employees; training and developing employees ; Setting performance standards ; evaluating Performance ; Counseling employees

Leading :- Getting others to get the job done ; maintaining morale ; motivating Subordinates .

Controlling :- Setting standards such as Sales quotas , quality Standards , or production levels ; checking to see how actual performance compares with these standards , taking corrective action , as needed .

Human resource manager has several functions in an Organization :

(i) Determine needs of the staff .
(ii) Determine to use temporary staff or hire employees to fill these needs .
(iii) Recruit and train the best employees .
(iv) Supervise the work .
(v) Harmonize relationship between company and workers .
(vi) Manage employee relations , unions and collective bargaining .
(vii) Manage employee relations , unions and collective bargaining .
(viii) Prepare employee records and personal policies .
(ix) Ensure high performance .

(x) Manage employee payroll, benefits and compensation.
(xi) Ensure Equal opportunities.
(xii) Deal with discrimination.
(xiii) Deal with performance issues.
(xiv) Ensure that human resources practices conform to various regulations.
(xv) push the Employee's motivation.

Motivation Performance :-

Motivation :- "Motivation is the process of attempting to influence or oneself to get a desired course of action, to push the right button to get the desired action."

— Flippo.

"Motivation is the complex of forces Standing and keeping a person at work in an organization"

— Robert dubin.

For effective utilization of organizational facilities it is very essential for the organization to motivate its employees. In an organization, all the Superiors / leaders should motivate their Subordinates so that they can make use of right type of behaviours.

The following helps us to know the importance of motivation in an organization.

1. Increases performance level of Employees :-

When the Employees are motivated, they will increase their performance level. The Performance of a motivated employee is higher than other employees.

According to study conducted by william james, it was revealed that motivated employees make use of 80 to 90% of their abilities.

2. Reduces Employee turnover & Absenteeism :-

In an organization, high turnover and absenteeism will lead to number of organizational problems. But, when the employees are motivated, they would want to remain in the organization and their absenteeism is also very low.

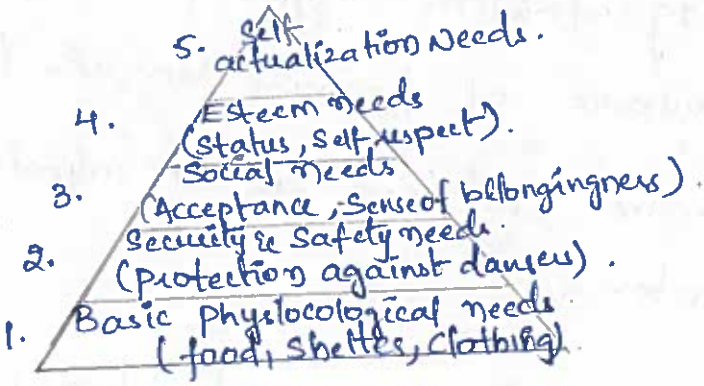
3. Accepts Organizational Changes :-

Organizational are established in a Society and in todays rapidly changing environment for dealing with the changes in Society, it is very essential for an organization to include changes. But, many employees in an organization resist change because of which change is not accepted. in an organization. So, the employees should be motivated, as motivated employees accepts, initiates & executes changes for maintaining the organization on a right track.

⇒ Maslows theory on motivation (Maslows Need hierarchy Theory)

Maslows hierarchy of needs is a theory in psychology proposed by Abraham Maslow in 1943 Paper. "A theory of Human motivation" in psychological Review. Maslow Subsequently extended the idea to include his observations of humans innate curiosity.

Maslow used the terms "physiological", "safety", "belonging and love", "esteem", "self-actualization & "Self-transcendence



Assumptions of Maslow's theory :-

1) People's behaviour is based on needs.
2) Needs are hierarchical.
3) A satisfied need no longer remains a motivator.
4) An individual moves to next level need only when his lower level need is satisfied.

Merits of Maslow's Theory :-

1) It is simple & logical

2) provides a good base to managers to act & motivate
3) widely accepted.

Demerits :-

1) Needs may not follow a hierarchy.
2) Needs cannot be tightly compartmentalised in 5 needs.
3) people may wish to satisfy many of their needs at the same time.

⇒ Herzberg Motivation theory :-

Herzberg Disagreed with Taylor (scientific management) about the importance of financial rewards (e.g. wages).

→ He is much more convinced about importance of non-financial factors.

Herzberg's divided his theory into two factors.

Motivators

* factors that directly motivate people to work harder

① Responsibility at work.
② Meaningful, fulfilling work.
③ Achievement & recognition

Hygiene

* Factors that can de-motivate if not present but do not actually motivate employees to work harder.

① pay & other financial rewards
② working conditions.
③ Appropriate Supervision & policies.

So Hence Herzberg Suggests that

① Motivate by using motivators.

② Ensure Hygiene factors are met.

Some possible Herzberg motivators.

Job enrichment

→ wider variety of tasks.
→ Greater complexity & challenge.
→ Manage own workload.
→ Greater sense of achievement.

Empowerment.

→ More responsibility and more autonomy.
→ Allow employees to make decisions independently
→ Less Supervision
→ Demonstrates trust.

Leadership :-

Leadership is needed for every project or organisation at different levels for various reasons given below.

→ To help in defining the mission of the group.
→ To create an environment in which group members become committeed to the objectives of the group.
→ To serve as an interpreter of messages 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 & consistent efforts towards the organisational goal acheivement.
→ To provide needed resources for the group.

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

Qualities of Successful leaders :-

Trait is defined as a relatively enduring quality of an Individual. The "Trait approach" seeks to determine what makes a successful leader from the leader own personal characteristics. It is emphasized that a particular individual becomes a successful leader because he possesses certain qualities or characteristics.

According to Stogdill, various trait theories have suggested.

1) physical & constitutional factors
2) Intelligence.
3) Self-Confidence.
4) Sociability.
5) Will (Initiative, persistence, Ambition).
6) Dominance.
7) Surgery (Talkative, cheerfulness, Geniality, Enthusiasm, Expressiveness, Alertness & Originality).

Construction management
Objective type

UNIT - I

(I) FILL in the Blanks

1. management can be defined as the art and science of planning, organizing and directing to control the forces.
2. The most ingredient of management is Human element.
3. planning, executing and controlling are the activities of the project management to achieve the goals of the project.
4. The responsibility of various degrees is given by the authority to the chief executive and then divided through the layers.
5. The arrangement of different department and the division of labour indicates organizational structure.
6. simple construction assignment were executed with the help of managers/supervisors.
7. Planning helps in involving determining the objectives of an enterprise.
8. F.W Taylor is recognized as the father of scientific managem
9. The process of matching the Jobs with other individuals is called as staffing
10. The concept of leadership lies in the creation of followers

(I) multiple choice:

① Briefing stage is also called as [b]

(a) project planning stage (b) project reporting stage

(c) project commisioning state (d) project construction stage

② The construction of steel plants and power plants are carried out by [a]

(a) public sector (b) private sector (c) Both a & b (d) None of abo

③ The manager were directly overseeing the works carried out by [c]

(a) owner (b) worker (c) subordinates (d) supervisor.

④ Addition of people in the large project with more staff responsibilities is led to [d]

(a) Functional organization (b) matrix organization

(c) project organization. (d) Line and staff organization

⑤ The decision among the competing alternatives in various situations such as [d]

(a) comparison of designs. (b) production/maintenance.

(c) Relative and location. (d) All the above.

⑥ The art of getting work done through the management and with people is called as [c]

(a) staffing (b) planning (c) Directing (d) coordinating.

(7) After the tender is accepted the contractor has to undertake further intensive planning is known as [a]

(a) contract planning (b) project planning (c) pre-tender planning (d) construction planning.

(8) The various resources being used in the construction project are. [d]

(a) men and machinery. (b) materials and money.

(c) men, materials and money. (d) Both (a) & (b).

(9) A set of various activities which are correlated and sequenced in a specified order is [b]

(a) activity (b) project (c) schedule (d) event.

(10) project management involves. [d]

(a) project planning (b) project scheduling (c) project monitoring (d) All the above.

(II) match the following

(1)	Line organization.	[c]	(a) To support a steady flow.
(2)	Line & staff organization	[e]	(b) vertical structure with project
(3)	Functional organization	[b]	(c) Line of authority from one level to another.
(4)	project organization.	[a]	(d) wide variety of specific forms depending on two extremes.
(5)	matrix organization.	[d]	(e) Addition of people with responsibilities to fulfill the objective

UNIT :- 2

Project :-

A project refers to a set of various activities which are correlated and sequenced in a specified order. Execution of which in the same order results in completion of a given task.

Any firm before starting up any project needs to undergo an analytical study of the market. Based on the knowledge and past experiences, management needs to choose a best suitable method from alternative methods.

Among all techniques, two of them are commonly applied to plan, schedule and control the projects. Those two techniques are PERT and CPM.

PERT – Program Evaluation and Review Technique.

CPM – Critical path method.

The aim of applying these techniques is to reduce the time and cost spent on the projects.

Classification of construction projects :-

Construction projects are classified as

1) Building Construction.
2) Industrial Construction.

3) Infrastructure construction

4) Special purpose projects.

Building Construction :-

→ These are considered as the largest division of Construction business. It includes educational facilities, hotels, recreational, residential complexes, commercial complexes, hospitals etc.,

→ These provide shelter and other services like education recreational, commercial and social needs to the mankind.

→ These buildings are mainly developed by engineers by providing various design and the construction of buildings is financially supported by public & private enteprises.

Industrial Construction :-

→ It includes industrial plants like petroleum refineries, steel mills various consumer-goods factories etc.,

→ These works also include human need facilities, Connected utility services etc.,

→ Heavy investments as well as highly specialized Equipments and workers are required. These are mostly funded by public, private & government sectors. Generally known as ppp (public private partnership).

Infrastructure Construction :-

→ These Construction mainly includes canals & dams, airports and highways, bridges and railways.

→ Construction of these works require heavy-equipment and also huge capital investments.

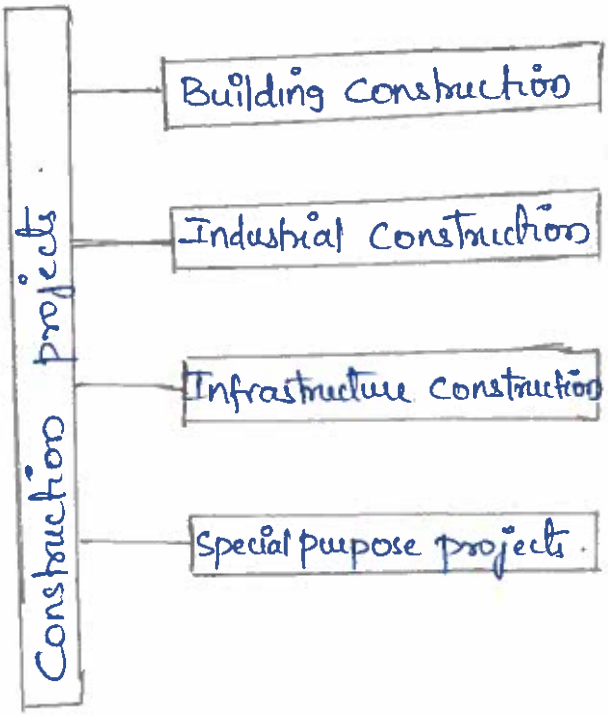
→ Transmission lines and pipelines, Sewage disposal networks, Supply of large water, harbours and docks.

→ Thermal & nuclear power plant.

These are mainly designed by experts & are financially supported by public/government Sectors.

Special purpose projects :-

Includes Emergencies, environmental works, complex key operations, remedial works, installation and commissing of construction equipments.



Construction projects are even classified based on time of Completion and value Basis.

Time of completion :-

1) Long duation projects :- Greater than 10 years.
2) Medium duation projects :- Between 3 to 10 years.
3) Short duation projects :- Between months and upto 3 years.
4) Special short-term projects :- Below 1 year.

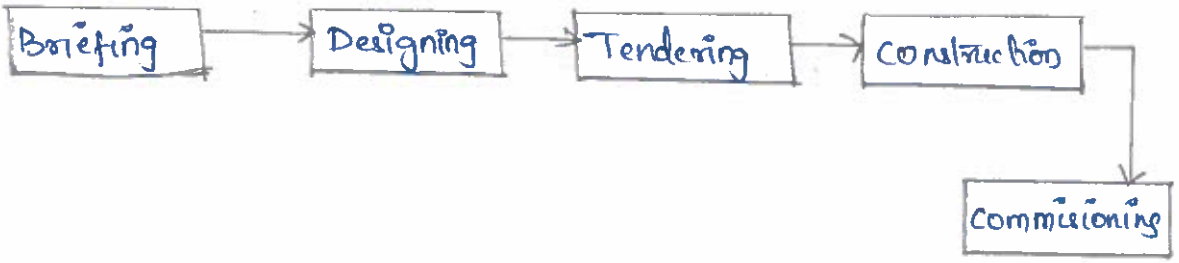
Value Basis :-

1) Mega value projects :- Around 1000 million dollars.
2) Large value projects :- Between 100 to 1000 Million dollars.
3) Medium value projects :- Between 10 to 100 million dollars.
4) Small value projects :- Below 10 million dollars.

STAGES IN CONSTRUCTION :-

Every construction work has the following distinct stages:

(i) Briefing stage.
(ii) Designing stage.
(iii) Tendering stage.
(iv) Construction stage.
(v) Commissioning Stage.



⇒ ① 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.

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

⊛ Activities :-

(i) To appoint a project steering committee

(ii) To appoint a project manager who will have a continuing responsibility to the client

(iii) To carry out investigations which include both
technical investigations – land & geological surveys
Non-technical investigations – Economic & Social factors.

(iv) To study various alternatives & identify the most feasible one.

⇒ ② Designing 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 & 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 approvals from the Client.

* activities :-

(i) To develop the project summary for final adoption of the most suitable alternative.

(ii) To carry out technical investigations such as soil investigation, topographic investigation, material supply & market surveys.

(iii) To prepare detailed design, working drawings, specifications, bill of quantities etc.,

(iv) To obtain the owner's final approval of the project summary.

③ 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 number of contractors who will undertake the construction work on the most suitable terms and conditions of quality, cost and completion time.

* activities :-

(i) The main activity involved in this stage is to obtain tenders from contractors for the construction work and to award the contract.

(ii) prequalification of contractor involves an investigation of the potential of contractor's financial, mangerial and physical resources and his experience of handling similar projects.

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

⇒ (4) 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 :- The construction stage consists of a number of Inter-related activities. The failure of one activity may disrupt the entire production Schedule.

→ Careful planning is therefore necessary at this stage.

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

→ Construction Schedule.
→ Manpower Schedule.
→ plant & 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 & equipment.
→ Coordination of sub-contractors / sections.
→ Supervision for quality control.

⑦ Commissioning Stage :-

It is the stage in which the performance of the structure is evaluated and the proposed nature of maintenance 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 and that all the facilities developed function properly as envisaged in the design.

⊛ **activities :-**

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 prepare operating instructions & maintenance manuals.

(d) To carry out tests for performance & envisaged functions such as test for water tightness or other functions.

Resources for construction Industry :-

Main Resources needed for construction industry are:

(i) **Materials :-** Materials such as bricks, stones, cement, aggregate, steel, shuttering, scaffolding, timber, water supply, sanitary & electrical fittings, petrol, oil, lubricants (P.O.L) etc,

(ii) **Manpower :-** Manpower in the form of technical and Managerial personnel and work force in various trades is essential to carry out project activities.

Technical and managerial personnel are essential for efficient use of human resources and to achieve project completion within estimated time and budget. Technical personnel include engineers, architects, quantity Surveyors, supervisors, technicians etc., The workforce consists of skilled & unskilled workers.

(iii) Machinery 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.

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

(iv) 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 form an important resource.

→ All other resources are dependent on the availability of funds. Financial resources should therefore be planned & managed with special care.

(v) Space :- For any construction activity to proceed efficiently it is necessary to plan the available space at site.

→ storing Materials

→ providing yards for bar benders, carpenters, repair workshops, casting yards etc.,

→ site office, labour camps etc.,

Functions of Construction Management :-

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 stand-point of available resources & constraints imposed upon the project.

It covers the aspects of 'what to do' '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 construction activities. It deals with the aspect of 'when to do it'.

(ii) Organising :- Organising is concerned with division of the total construction work into manageable departments/sections and systematically arranging various operations by delegating specific task to individuals.

The relationship between various personnel are established and the organisational structure of the project is depicted by a simple flow chart.

(iii) Staffing :- Organising involves the division of project work into sections and staffing is the provision of people to fill the positions so created.

→ Recruiting right people.

→ Arranging staff training courses.

→ Carrying out proper staff assessment

All the above three are part of the staffing function.

(iv) Directing :- The directing function is concerned with training subordinates to carry out assigned tasks, supervising their work and guiding their efforts.

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

(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 rectify deviations through appropriate corrective measures

The essential steps in Management control are.

→ Measurement of actual performance in terms of progress, quality & cost incurred.

→ Comparison of actual & planned performance.

→ Analysis of short fall in performance when it occurs,

and identification and implementation of suitable remedial measures.

(vi) Co-ordinating :- Since authority converges to the top of the organisational pyramid, it is necessary to bring together and coordinate the work of various departments and sections.

→ This requires an efficient system of communication so that each department and section is aware of its role and the assistance to be expected from others.

→ Regular meetings of departmental / section heads with top management are fundamental to proper coordination, so that plans, problems & remedies are discussed for determining the best solution.

Construction planning :- (or) Preliminary planning:-

Planning is the starting point of all management functions. planning leads to organising and staffing followed by directing, controlling and co-ordinating. The planning should include sufficient details to enable proper consideration to be given to the timing and duration of operations, type & quantity of materials & equipment, delivery dates and 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 ~~quality~~, ~~scope~~, ~~processes etc~~. material, manpower, machinery & money.

(iii) It must provide for difficulties likely to be encountered in future in respect of quality, scope, processes etc., and for taking remedial measures.

planning → policy planning.
planning associated with technical operations.

Construction of Large Project includes different agencies like designers, consultants, contractors, government officials and clients/owners. It is clear that each agency handles its own planning exercise. without any cross purposes, the proper coordination is important. 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

Planning for construction may be done in the following two stages.

→ a) pre-tender stage.
→ b) contract stage.

a) 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.

→ A pretender report is prepared which describes the comple circumstances of the work and the conditions under which the work is likely to be carried out.

The Report includes :-

→ details of Site investigation.
→ geography of the area.
→ Local weather records.
→ availability of resources like manpower, machinery, Space etc.,

Pre-tender planning includes the following steps :-

(a) Examining drawings & Specifications to identify various items of work.

(b) Carrying out Site investigation and market Survey to assess the availability and rates of materials, manpowa, machinery and othee facilities.

(c) Identifying alternative methods of executing the work for Selecting the most Suitable & economical method.

(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 overheads and margin of profits & finalising the tender price for completing the work within the stipulated time.

b) Contract Stage (or) Post-tender stage :-

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.

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.

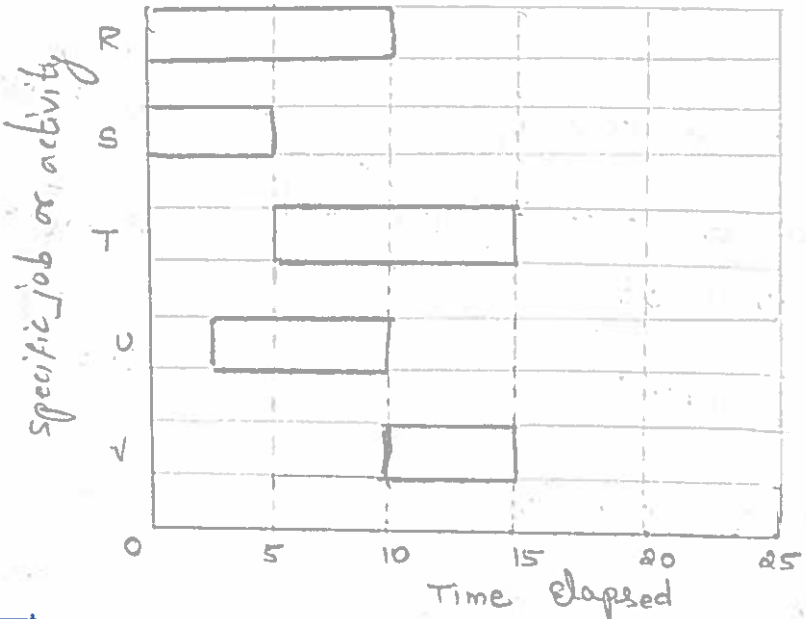
(b) Evaluating alternative construction methods identified during the pre-tender stage in order to select the most economical and efficient method.

(c) Studying inter-relationships of various items of work & finalisation of proper sequence of operations.

(d) Calculating the phased requirement of construction materials such as cement, aggregate, bricks, steel etc.,

Bar charts :- Bar charts were introduced by Henry Gantt around 1900 A.D

A bar chart consists of two co-ordinate axes, one (usually horizontal axis) representing the time elapsed and the other (the vertical axis) represent the jobs or activities to be performed. Each bar represents one specific job or activity of the project. The begining and end of each bar represent the time of start and time of finish of that activity, the length of bar, therefore represents the time required for the completion of that job or activity.



→ The above figure shows the bar chart for a project which has 5 district jobs or activities (P, Q, R, S, T, U, V) to be performed for its completion.

→ The time durations required for the completion of these activities are (10, 5, 10, 7, 5) respectively.

1) Activities 'R' and 'S' can start simultaneously, at zero time. Both are independent. However activity 'S' is completed much earlier than activity 'R'.

→ (ii) Activity 'T' starts only when activity 'S' is complete.

(iii) However activity 'Q' is independent of activity 't'. It starts earlier than 'T' and is completed earlier.

(iv) Activity 'V' starts only when activity 'U' is complete.

(*) Problem :-

(Q) Draw the bar chart for 'finalisation of designs and work order' for a building project.

Activity	Description	Time for completion.
A	Site selection and survey	4 weeks
B	Design	6 weeks
C	Preparation of drawings	3 weeks
D	Preparation of specifications and tender document	2 weeks
E	Tendering (NIT) Notice Inviting Tender	4 weeks
F	Selection of Contractor	1 week
G	Award of work order	1 week.

Sol:- Activities A and B can start concurrently, (since some parts of the architectural and structural designs can be done even if complete survey data is not available).

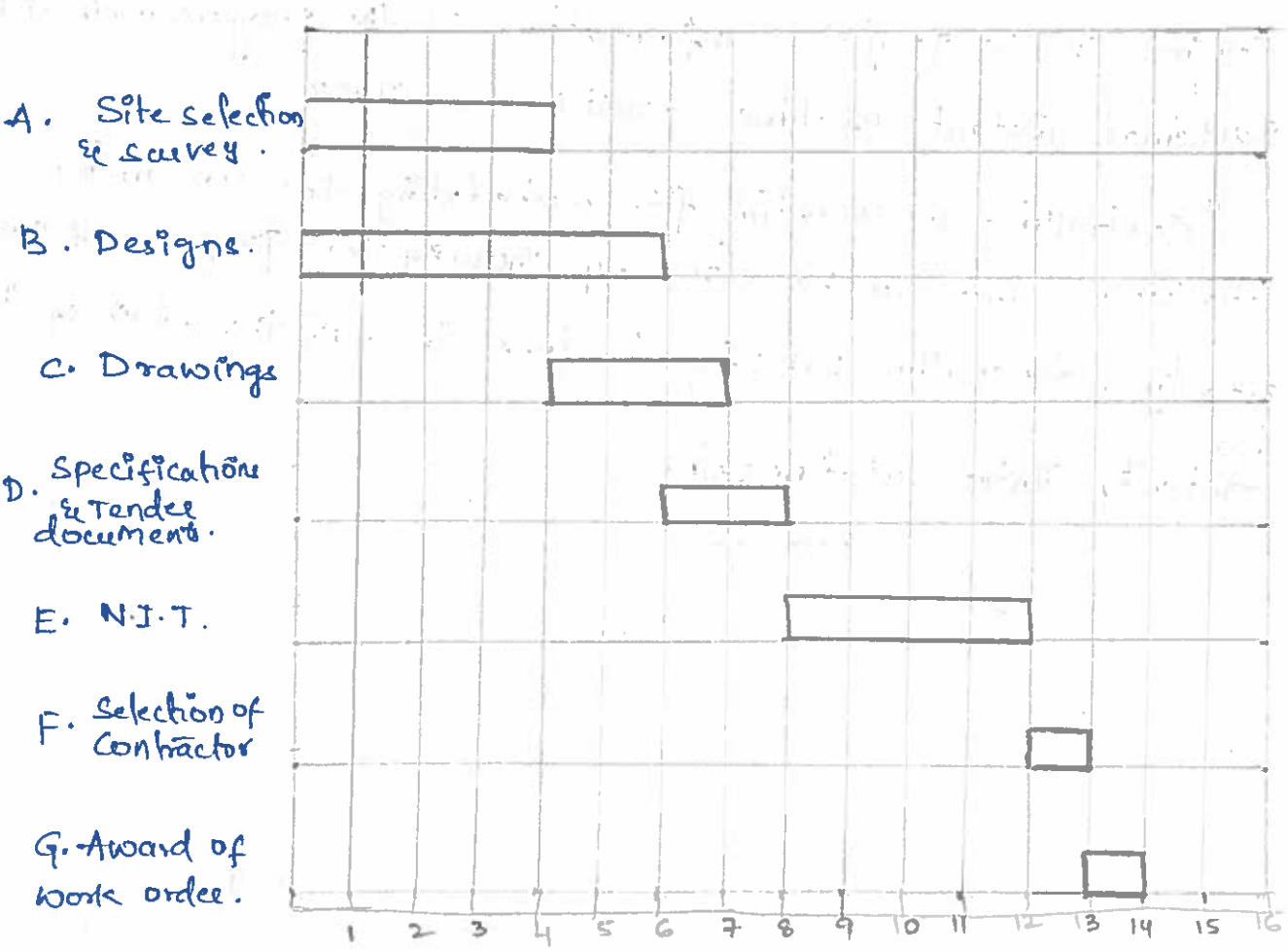
→ Similarly, drawing work can also be started, as soon as survey work is over, though all the designs are still not completed.

→ Specifications can be finalised when once the designs

are Complete.

→ Activity E can be started only when activity D is complete.

→ Activities E, F and G are to be Completed in sequential Order.



⇒ Limitations of Bar charts :-

Bar charts have following short comings.

1. Lack of degree of details :-

On bar chart, only major activities are shown. If too many activities or tasks are Speately shown, it becomes clumpsy.

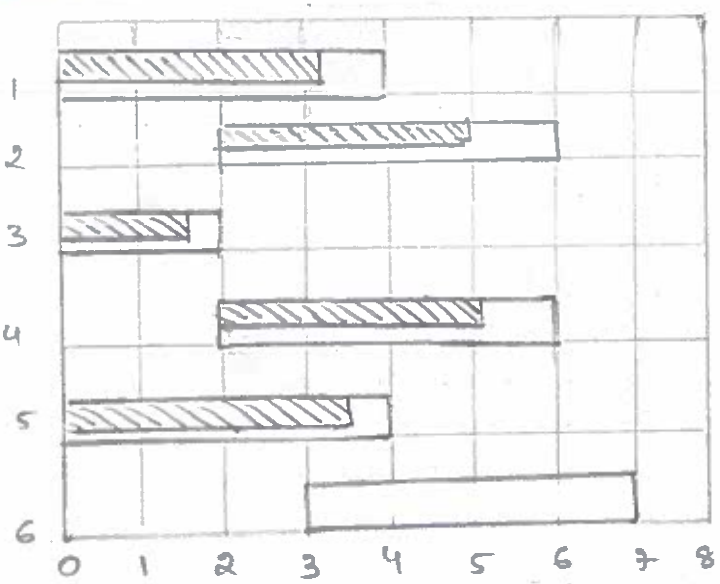
→ Due to this, bar charts are not very useful for big projects. A particular activity, whether big or small, is shown by one bar, without any details of sub-activities contained in it.

2. Review of Project progress :-

A "bar chart" does not show the progress of work & hence it cannot be used as a control device. For proper control of the project, information of the progress made at a particular instant of time should be available.

"Controlling is essential for rescheduling the remaining activities. This can be done by showing the progress of each activity. Generally hatching is done in half the width of the bar.

3. ~~Activity Inter-relationship~~ :-



3. Activity Inter-relationships :-

There are some activities of a project which are taken up concurrently (simultaneously), while there are others which can be taken up only after the completion of some other activity.

→ In a project, there may be large number of activities which can start with a certain degree of concurrency. The interrelationships between them cannot be clearly depicted.

This difficulty can be partly overcome by breaking each activity into a number of sections, so that the corresponding sections of various activities are precisely depicted inter-dependently.

4. Time uncertainties:-

Bar charts are not at all useful in those projects where there are uncertainties in determination or estimation of time required for the completion of various activities. Such uncertainties are always there in all research and development projects and for space vehicle launch projects.

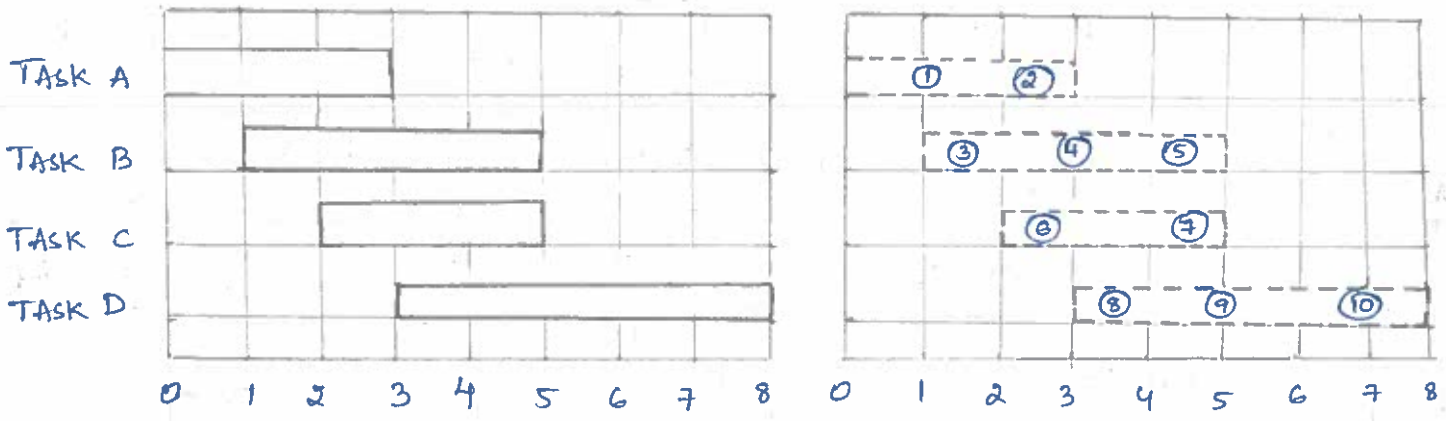
Hence bar chart diagrams are useful for only small size conventional projects, specially construction and manufacturing projects, in which time estimates can be made with fair degree of certainty.

Milestone Charts:-

Milestone chart is a modification over the original Gantt chart. Milestones are key events of a main activity represented by a bar: These are specific points in time

which mark the completion of certain portions of the main activity. These points are those which can be easily identified over the main bar. We have already seen that when a particular activity, represented by a bar on a bar chart is very long, the details lack.

If, however, the activity is broken or sub-divided into a number of sub-activities, each one of which can be easily recognised during the progress of the project, controlling can be easily done. and inter-relationships between other similar activities can be easily established. The begining & end of these sub-divided activities or tasks are termed as milestones.



Gantt Bar Chart

Gantt Milestone Chart.

(Modification of Bar chart into Milestone chart).

Contract planning :-

After the Acceptance of the tender, the contractor needs further intensive planning. This stage of planning is known as Contract planning

This planning involves the following steps:-

(i) Studying alternative methods of constructions.

(ii) working out the quantities of materials required at each stage of work, locating the sources of their supply and their comparative cost.

(iii) working out the requirements of the construction labour, Supervisory and managerial staff at various stages of work and arranging their selection & recruitments

(iv) working out the details of requirements of machinery & Equipments at various stages of work & arranging for them.

(v) Arranging repairs & maintenance of machinery and Equipments and Servicing facilities.

(vi) Planning for the location and other details of camp offices, Service roads, lay out of sites, etc.,

(vii) planning & arranging for transport of labour to the Site & back and other related matters.

(viii) To Study the interdependence of different items

of work and to decide their proper sequence of operation.

(ix) To finalise the work programme of difficult items of work & to decide the dates of their starting and operations.

#Network techniques in construction management :-

Network techniques provide a rational approach to the planning and controlling of construction works. The application of such techniques is inevitable when there is a constraint on resources and a need for higher Productivity.

The two commonly used network techniques are CPM and PERT.

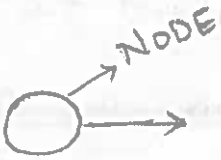
- CPM stands for critical path method.
- PERT stands for Program evaluation Review technique

TERMINOLOGY :-

a) ACTIVITY :- Performance of a specific task, operation, job or function which consumes time and resources and has a definite begining and end is called an activity.

For example :- Excavate foundation. → Description
→ Duration
Lay brick work.
backfill trench.
fix shuttering.
Concrete wall etc., are all activities

b) **Event :-** An instantaneous point in time marking the begining or end of one or more activities is called an "event". An event consumes no time or resources.



For example :- Excavation completed.
brick work laid.
Shuttering fixed.
wall concreted etc.,

c) **Network :-** A Network is a diagrammatic representation of a work plan showing the activities, step-by-step., leading to the established goal. It depicts the inter-dependence between the various activities, i.e., which activities can be done together and which activities must precede (before) or succeed (advance) others.

CPM (Critical path Method) :-

The C.P.M or Critical path method was discovered jointly by Dupont and Remington Rand Univac in 1957. The Research team was trying to determine how best to reduce the time required to perform routine plant overhaul, Maintenance & construction work. CPM is found to be of much use in the construction industry with applications in the construction of massive structures like dams, bridges, tunnels, high-rise buildings etc.

CPM networks are usually used for repetitive type

~~type~~ of projects, where fairly accurate estimates of time can be made for the activities of the project. The activities of these projects are characteristically subject to relatively small amount of variation. Hence cpm is not suitable for research and development type of projects

PERT (Program evaluation Review technique)

PERT is a management tool used for planning, controlling and reviewing a project. It was developed by the U.S. Navy along with a management consultancy firm for its polaris Missile program.

An important characteristic of any project is its duration. The effectiveness and economy of the project is often dependent on the project duration. The total project duration depends on the time taken for each event to occur, it requires the planner to have a wide experience, with similar projects.

PERT is an event oriented network method.

PERT has been used in R & D type projects such as Space industry, defence industry etc., Such projects are of non-repetitive type or once-through type in which correct time estimates cannot be made.

⇒ Three time estimates are used to determine the expected or average time of each activity

The Three time estimates used in PERT are

a) Optimistic Time estimate :- (t_o) :- It is the Shortest possible time for completing an activity if everything proceeds as planned without any problem i.e., the activity is performed under ideal conditions.

b) Most likely time estimate:-(t_1) It is the time for completing an activity under normal conditions. In this case, conditions are not ideal and minor mishaps may occur.

c) Pessimistic Time estimate :-(t_p) It is the maximum time required to complete an activity under abnormal or extremely adverse conditions in which every thing goes wrong. The estimate, however, does not include Catastrophes Such as fires, earthquakes, floods etc.,

The expected time estimate (t_e) for each activity is computed on the basis of statistics as under:

$$t_e = \frac{t_o + 4t_1 + t_p}{6}$$

t_e = expected time of the activity

t_o = optimistic time estimate.

t_1 = most likely time estimate.

t_p = Pessimistic time estimate

Ex:- (1)

Estimate the expected time of each of the following activities from the three time estimates.

Sl. No.	Activity	Time estimate in days. (t_o)	(t_l)	(t_p)
1.	Driving precast piles for a bridge abutment	22	30	50
2.	Erecting roof trusses for a factory shed	11	14	17.
3.	Concreting foundation of Turbo-generator	3	5 1/4	6.
4.	Fabricating sheet metal A.C ducts for an auditorium	12	16	17

Sol:- 1. Driving precast piles for a bridge Abutment:-

$$\text{Expected time } (t_e) = \frac{t_o + 4t_l + t_p}{6}$$

$$\Rightarrow \frac{22 + 4\times 30 + 50}{6} = 32 \text{ days.}$$

2. Erecting roof trusses for a factory shed:-

$$t_e = \frac{11 + 4\times 14 + 17}{6}$$

$$= 14 \text{ days}$$

3. Concreting foundation of Turbo-generator:-

$$t_e = \frac{3 + 4\times 5\,1/4 + 6}{6}$$

$$= 5 \text{ days.}$$

4. Fabricating sheet-metal A.C ducts for an Auditorium

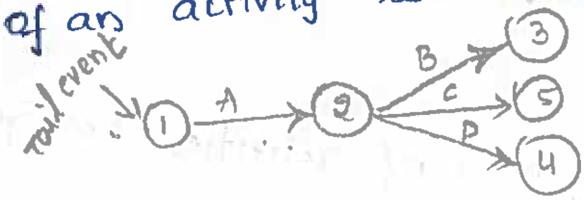
$$t_e = \frac{12 + 4 \times 16 + 17}{6}$$

$$= 15\frac{1}{2} \text{ days}$$

Dummy Activity :- A dummy is similar to an activity but it does not consume any resources. It is merely a method by which interdependence of activities or events can be clearly shown. A dummy is represented by a dotted/dashed arrow as shown below.

⇒ Types of Events :-

1. Tail event :- An event which marks the begining of an activity is called Tail event



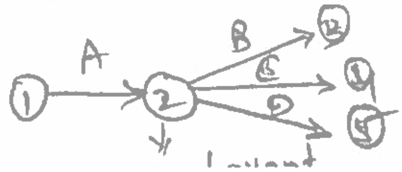
(fig ①)

Event ① is said to be a tail event of activity A. as it indicates the begining of Activity A.

Event ② is said to be a tail event of activities B, C, D.

2. Head event :- It is that event which marks the Completion of an activity.

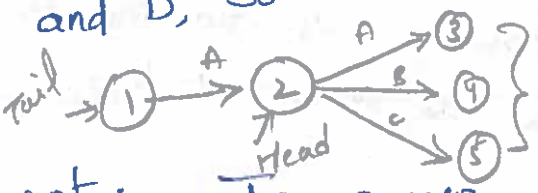
In fig ① event 2 is said to be a head event of activity A as it indicates the completion or end of activity A.



Events 3, 5, and 4 are said to be head event to activities B, C and D respectively.

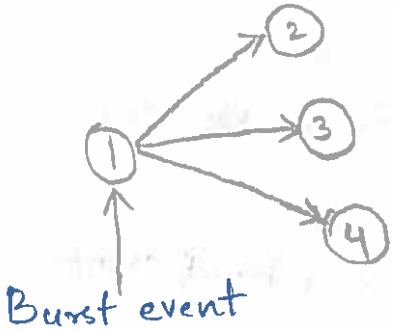
3. Dual role events :- If an event acts as the tail event for some activity and as the head event for some other activity or activities, it is called a dual role event.

In fig (1) event 2 acts as the head event for activity A but acts simultaneously as the tail event for activities B, C and D, so event 2 is said to be a dual role event.

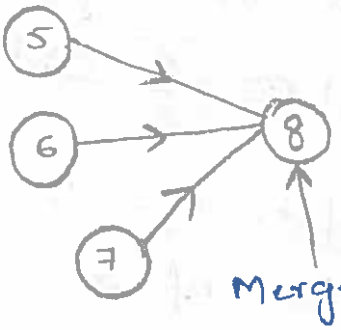


4. Burst and Merge events :- In arrow diagrams, there are some nodes to which a number of activities converge, and there ~~are many~~ may be others from which a number of other activities may diverge. The nodes to which a number of activities converge are called as merge nodes or Merge events.

The nodes from which number of activities emerge are called Burst events or Burst nodes.



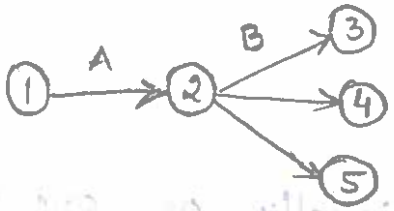
Burst events



Merge events

Interrelationship of Events :-

1. Successor events :- The event that follows a particular event in the sequence of their completion is called a Successor event to that event.



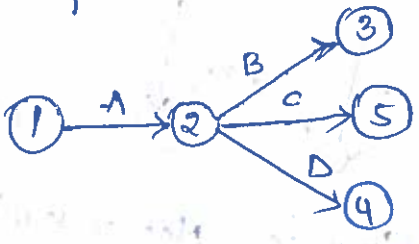
Event (2) is a Successor of event (1) In the above fig.

2. predecessor events :- The event that occurs before a particular event in the sequence of their completion are called predecessor events of that event.

Event (1) is said to be predecessor event to event (2).
Event (2) is said to be predecessor event to events (3), (4), (5) In the above fig.

Interrelationships of Activities :-

1. Parallel activities or Concurrent activities :- Parallel activities are activities which can be carried out simultaneously and independent of each other.



In above figure activities B, C and D can be started simultaneously once the activity A is completed which is indicated by event 2. Here ~~indicated by event~~ x,

activities B, C and D are said to be parallel activities.

2. Serial activities :- These are activities which can be performed only in succession i.e one after the other sequentially.

Serial activities.

Activities A and B occur serially or one after the other i.e., to say activity B can start only after activity A is completed and not any earlier.

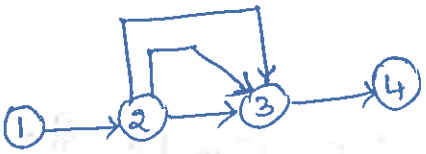
⇒ USES OF DUMMIES :-

Dummies are used to serve two purposes

① Grammatical purpose.

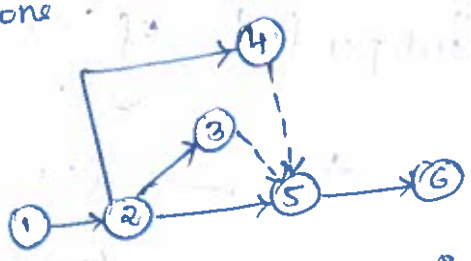
② Logical purpose.

Grammatical purpose :- In a project, a situation may arise that two activities have the same begining and end point. Such situations lead to a lot of inconvenience as the identity of the activities are lost. This results in errors during network computations.



Incorrect representation

fig(a)



Corrected Network using dummies.

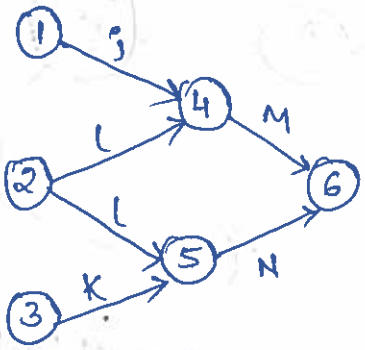
fig(b)

Two activities cannot have the same starting and end event.

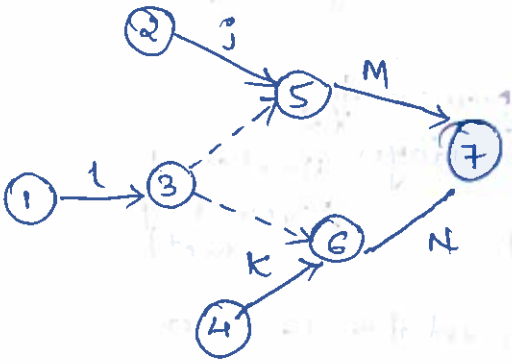
The change in the above fig is given as fig(b) we see that dummies connecting 3-5 and 4-5 give a correct grammatical representation.

2) Logical purpose :- Dummies are also used to clearly represent the logic of the network, where an activity is common to two sets of operations running parallel to each other.

Below figure shows two activities M and N having Common end nodes. If the predecessor activities of M are I and L and that of N are K and L it is changed to serve the logical purpose as shown in fig below fig(b)



fig(a)



fig(b)

⇒ Types of Networks

1) Activity on Arrow (A-O-A) or Arrow diagrams.
2) Activity on Node (A-O-N) or precedence diagrams.
3) Event oriented Networks (PERT Type).

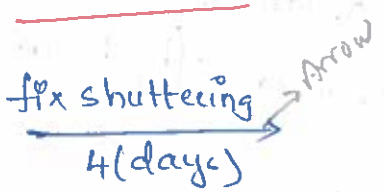
1) (A-O-A) Networks :- It is composed of arrows and Nodes. The arrows represents the activities and nodes

represent the events. Each activity carries a brief description usually printed on the logical diagram, the activity name or Symbol and the time duration.

2) (A-O-N) Networks or Precedence diagrams :- In this System activities are represented on the nodes, and arrows are used to show the dependency relationships between the activity nodes. The time required to complete an activity is also indicated in the node.

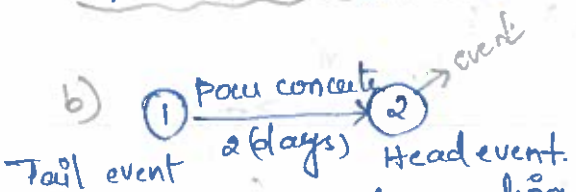
(A-O-A)

a)

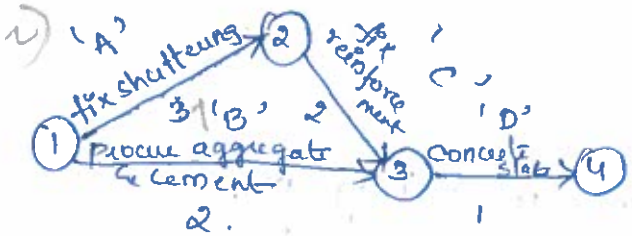


representation of Activity

b)

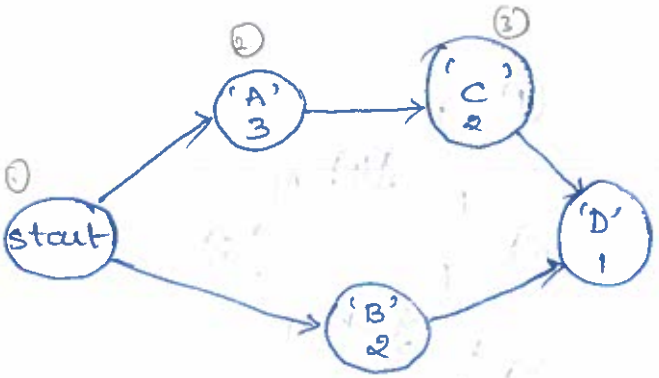


Representation of Event.



Network on A-O-A Network.

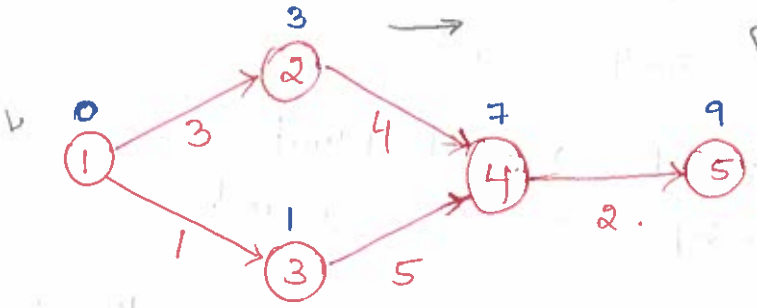
(A-O-N.)



Network on A-O-N system.

a) **Forward pass :-**

For calculating the earliest event times (T_E), computations are made in forward direction (left to right). This process is called the '**forward pass**'.



In the above figure it is assumed that event no. 1 occurs at zero unit of time.

T_E of event no. 2 = 0 + 3 = 3 units of time.

T_E of event no. 3 = 0 + 1 = 1 unit.

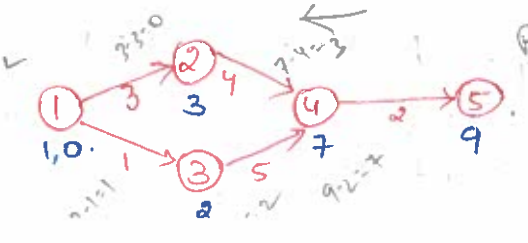
T_E of event no. 4 depends of both the activities 2–4 & 3–4.

Activity 2–4 ⇒ 3 + 4 = 7.
3–4 ⇒ 1 + 5 = 6.
} which ever value is higher
7 > 6
we have taken (7) units

∴ T_E of event 4 is "7 units"

T_E of event 5 = 7 + 2 = 9 units.

b) **Backward pass :-** For calculating the latest event times (T_L), Computations are made in a backward direction (right to left). This process is called the "**backward pass**"



Event no. 5 is the last event representing Project completion.

T_E of event no. 5 = 9 units.

$\therefore T_L$ of event no. 5 = 9 units of time.

T_L of event no. 4 = 9 − 2 = 7 units.

T_L of event no. 3 = 7 − 5 = 2 units.

T_L of event no. 2 = 7 − 4 = 3 units

T_L of event no. 1 $\rightarrow$ 3 − 1 $\Rightarrow$ 2 − 1 = 1 units.

$\Rightarrow$ 2 − 1 $\Rightarrow$ 3 − 3 = 0 units

Hence T_L for event no. 1 is 0 as otherwise the overall Completion of the project will be delayed.

$\therefore T_L$ of event no. 1 = 0 units.

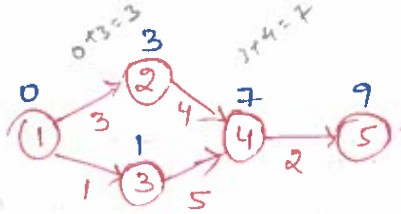
⇒ Earliest start time and Earliest finish time :-

a) **Earliest start time of an Activity (EST) :-** It is the earliest time when an activity can commence. Since the starting point of an activity is the 'tail event', the earliest start time of an activity is the T_E of the 'tail event'

* [Earliest start time of an activity (EST) = T_E of the tail event = T_E^i] *

b) **Earliest finish time of an Activity (EFT) :-** It is the earliest time when an activity can be finished.

Earliest finish time of an activity = Earliest start time of the activity plus duration of the activity. * [$EFT = T_E^i + t^{ij}$] *



EST of 2-4 = T_E of tail event no. 2
= 3 units.

EFT of 2-4 = T_E of tail event no. 2 + duration of activity 2-4
⇒ 3+4 = 7 units.

c) Latest finish time (LFT) & Latest start time (LST) of Activities

(i) Latest finish Time of an Activity (LFT) :- It is the Latest time when an activity may be finished without delaying the completion time of the Project. Since the finishing point of the activity is the 'head event', the latest finish time of the activity is the same as T_L of the head event.

* [Latest finish time of an activity (LFT) = T_L of the head event = T_L^j] *

(ii) Latest start time of an activity (LST) :- It is the latest time when an activity may be started without delaying the completion time of the project.

* [Latest start time of an activity (LST) = latest finish time of the activity minus duration of the activity = LFT − t_{ij} = $(T_L^j - t_{ij})$] *

FLOATS IN ACTIVITIES :-

Float indicates the range within which the start and finish times of an activity may vary without affecting the completion time of the Project.

Most commonly used floats are.

(i) Total float
(ii) Free float
(iii) Independent float.

(i) Total float (F_T) :- Total float is the maximum time by which an activity can be delayed without delaying the completion time of the project.

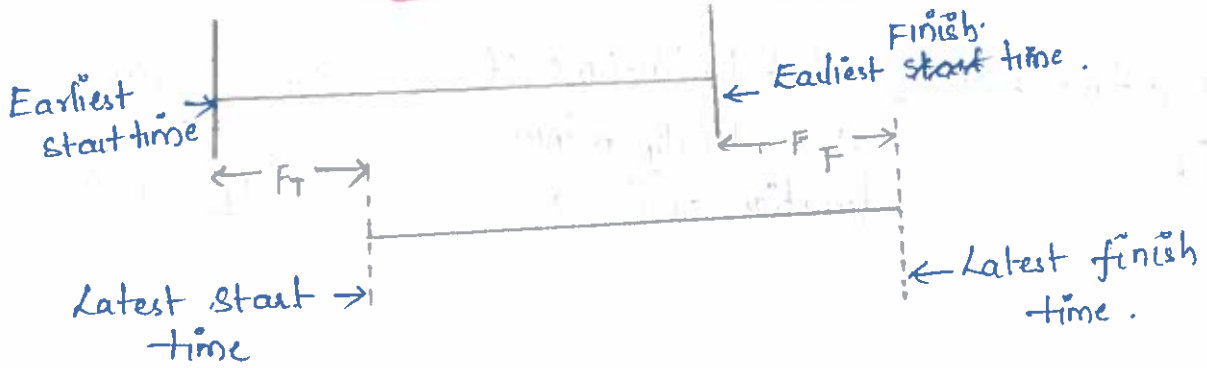
* [Total float (F_T) = Latest finish time - Earliest Finish time of an activity] (or)

* [(F_T) = Latest start time - Earliest start time of an activity.]

[(F_T) = (LFT - EFT)] (or)

[F_T = (LST - EST)]

$\Rightarrow [T_L^j - (T_E^i + t^{ij})]$ or $[(T_L^j - t^{ij}) - T_E^i]$.



(Total float)

(ii) Free float (F_F) :- Free float for an activity is the difference between EST of the Succeeding activity and EFT of the activity under Consideration. It is the float available for an activity without affecting the total float of the Succeeding activity. Free float is based on the assumption that all events occur at their earliest event times.

[Free float (F_F) = EST of Succeeding activity minus EFT of activity under Consideration.]

$$= T_E^j - EFT$$

* $\left[F_F = T_E^j - (T_E^i + t_{ij})\right]$ *

(iii) Independent float (F_I) :- Independent float is the excess of minimum available time over the activity duration

It is based on the assumption that preceeding activity finishes as late as possible and the Succeeding activity starts as early as possible.

* [Independent float (F_I) = Minimum available time minus activity duration]

$$\left[F_I = (T_E^j - T_L^i) - t^{ij}\right]$$

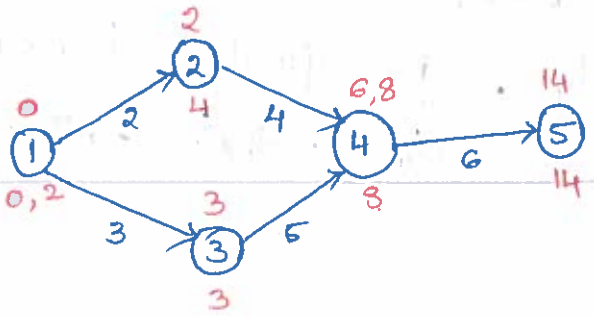
(iv) Interfering Float:-

the difference b/w total float and free float

$$\left[F_{IT} = F_T - F_F\right]$$

Problem :-

Calculate the earliest Start time, earliest finish time, latest start time, latest finish time, and total, free and independent floats in respect of all the activities of the network



Sol:- T_E and T_L are computed by forward & backward pass and shown on the network.

Activity (i,j)	Duration Days (t_{ij})	Earliest time		Latest time		Float		
		Start (EST)	Finish (EFT)	Start (LST)	Finish (LFT)	Total (FT)	Free (FF)	Independent (FI)
		T_E^i	$T_E^i + t_{ij}$	$(LFT - t_{ij})$ or $(T_L^j - t_{ij})$	(T_L^j)	$(T_L^j - t_{ij}) - T_E^i$	$T_E^j - (T_E^i + t_{ij})$	
1-2	2	0	2	2	4	2	0	0
1-3	3	0	3	0	3	0	0	0
2-4	4	2	6	4	8	2	2	0
3-4	5	3	8	3	8	0	0	0
4-5	6	8	14	8	14	0	0	0

Total Float (F_T) = $(LFT - EFT) = (LST - EST)$

Free float $(F_F) = T_E^j - EFT$.

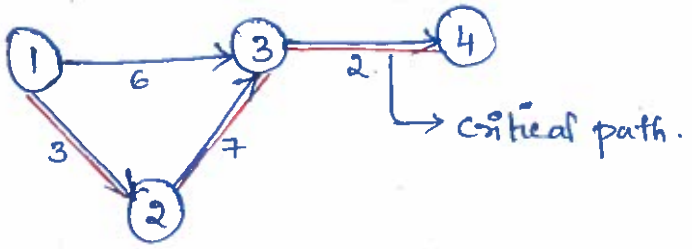
Independent Float $(F_I) = (T_E^j - T_L^i) - t^{ij}$

2)8. Determination of Critical Path :-

For any network considered, total float in respect of all the activities is calculated. Activities having "Zero float" are identified. These activities are the 'Critical activities' and the chain which joins these critical activities is the "Critical path".

Problems :-

(1Q) Determine the project completion time and critical path for the network shown in fig below.

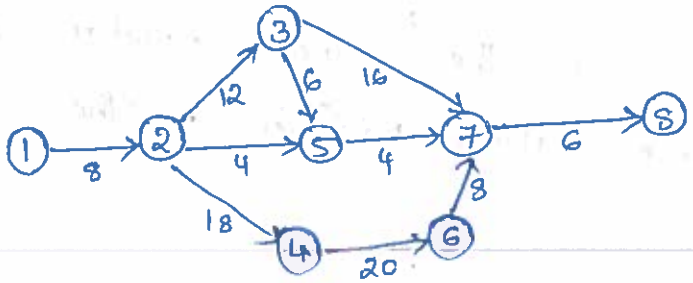


Activity (ij)	Duration (t_{ij})	Earliest time. Start (EST)	Earliest time. Finish (EFT)	Latest time. Start (LST)	Latest time. Finish (LFT)	Total float (FT)	Remarks
1-2	3	0	3	0	3	0	critical
1-3	6	0	6	4	10	4	—
2-3	7	3	10	3	10	0	critical
3-4	2	10	12	10	12	0	critical

Project completion time = 12 days.

Critical path is shown in double line in figure.

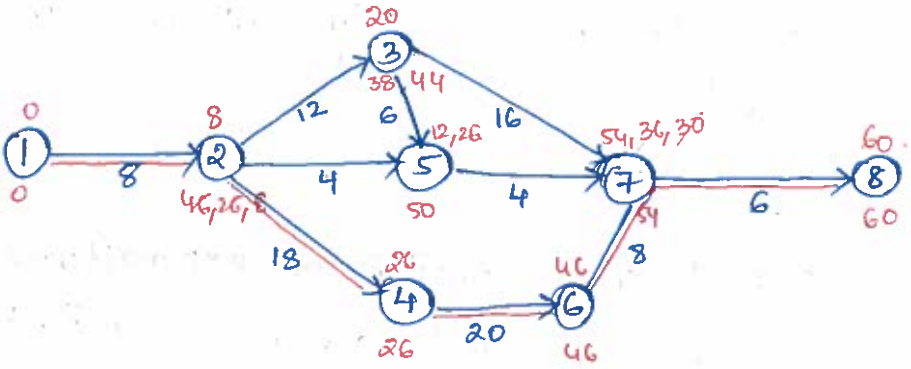
(2a) Identify the critical path in the network shown below and determine the project completion time.



Activity (ij)	Duration days (tij)	Earliest time		Latest time		Total float (FT)	Remarks
		Start (EST)	Finish (EFT)	start (LST)	Finish (LFT)		
1–2	8	0	8	0	8	0	critical
2–3	12	8	20	26	38	18	—
2–4	18	8	26	8	26	0	critical
2–5	4	8	12	46	50	38	—
3–5	6	20	26	44	50	24	—
3–7	16	20	36	38	54	18	—
4–6	20	26	46	26	46	0	critical
5–7	4	26	30	50	54	24	—
6–7	8	46	54	46	54	0	critical
7–8	6	54	60	54	60	0	critical

Project completion time = 60 weeks.

The critical path for the figure is shown below.



Time - Cost Analysis :-

The main objective of network planning is to complete the job within the stipulated time and at minimum overall cost. At times it becomes necessary to accelerate the completion of work. This can be made possible only by reducing the duration of critical activities. The duration of critical activities can be reduced by the deployment of additional resources e.g.. additional labour, shuttering, centring etc..

While exploring the possibility of accelerating project completion by deploying additional resources on critical activities, the following questions merit careful consideration :

→ To what extent can the project duration be reduced?

→ What is the lowest cost for reducing the project duration to the specified date?

→ What is the project duration for which the total project cost is the lowest?

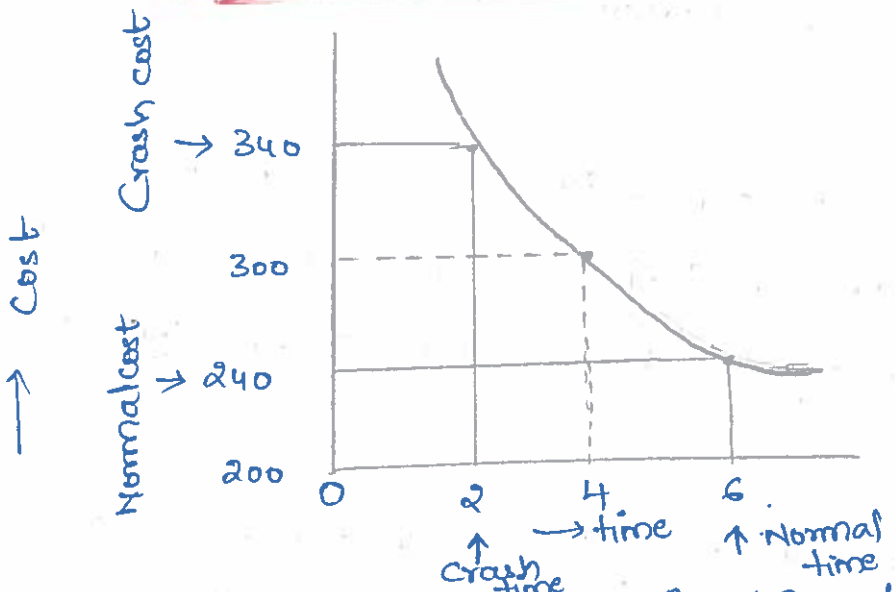
⇒ Project Cost :-

The project cost can be broadly divided into
(i) direct cost and
(ii) Indirect cost.

a) Direct cost :- Direct cost consists of expenditures which are directly chargable to and can be identified specifically with the activities of the project e.g. material cost and labour cost.

b) Indirect cost :- Indirect cost consists of expenditures which cannot be clearly allocated to individual activities of the project e.g. establishment charges, insurance charges, administration charges etc.,

⇒ Variation of direct cost with time.



a) Normal time (T_n) :- It is time for performing an activity with the normally available resources.

b) Normal cost (C_n) :- It is the minimum direct cost when the activity is performed in normal

c) Crash time (T_c) :- It is the minimum time in which an activity can be performed.

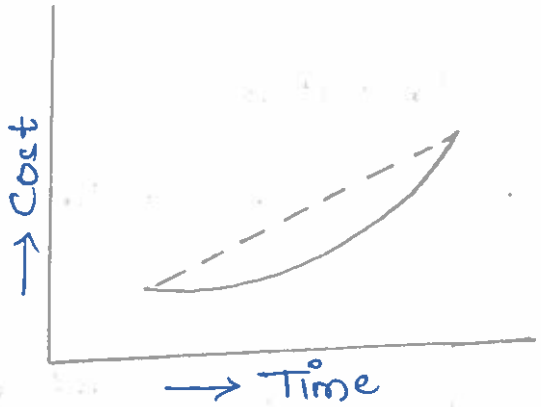
d) Crash cost (C_c) :- It is the direct cost corresponding to the crash time.

$$\text{Cost slope} = \frac{\text{Crash cost } (C_c) - \text{Normal cost } (C_n)}{\text{Normal Time } (T_n) - \text{Crash Time } (T_c)}$$

$$= \frac{\text{Difference b/w crash \& Normal cost}}{\text{Difference b/w Normal \& crash time}}$$

⇒ Variation of Indirect Cost with Time.

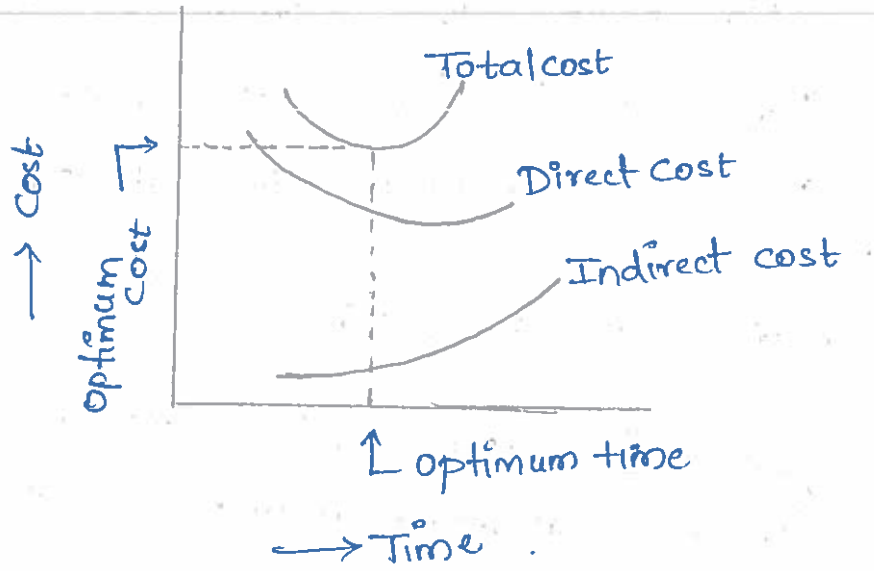
Indirect cost generally increases with time as shown in figure. A linear relationship may be assumed between time and indirect cost



⇒ Cost optimization :-

The total cost Vs time curve can be obtained by plotting both the direct cost and Indirect cost curves with respect to time on the same graph-sheet and combining them.

The curve for total cost has a point where the tangent is horizontal. At this point, the total cost is minimum and is called the "optimum cost". The time duration corresponding to the optimum cost is called the "optimum time".



Total Cost Vs. Time curve

⇒ Procedure for Cost optimization

The steps for carrying out cost optimization are given below:

(i) from past project cost records, determine the cost-time relationship for different activities. Calculate the cost slopes of the various activities.

(ii) From the network of normal durations, determine the total cost (direct cost + Indirect cost).

(iii) prepare the "all crash" network and determine

the total cost

(iv) The optimum duration will generally lie between all crash duration and normal duration. Starting with the network of normal durations, crash the critical activity with the least cost slope.

(v) Redraw the network considering the above crashing & determine Project duration & total cost.

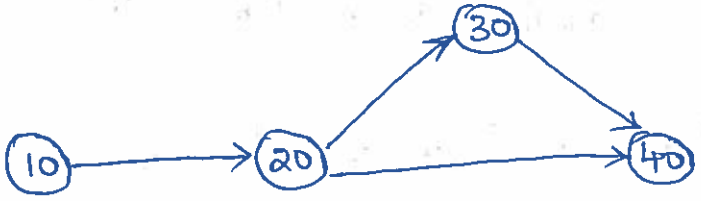
(vi) Successively, keep on crashing critical activities as in (iv) above and determine respective project durations & total costs. In case more than one path becomes critical, crashing will have to be done along all such critical paths, simultaneously.

(vii) Tabulate various project durations and the corresponding total costs. Draw the total cost Vs time curve.

(viii) The least total cost is the optimum cost and the time duration corresponding to this cost is the optimum duration.

Problems:-

(Q1) for the project network shown below and data given below, determine the optimum time duration & optimum cost. Also plot a curve of total cost Vs time & Indicate on it the optimum time & optimum cost.



Data :-

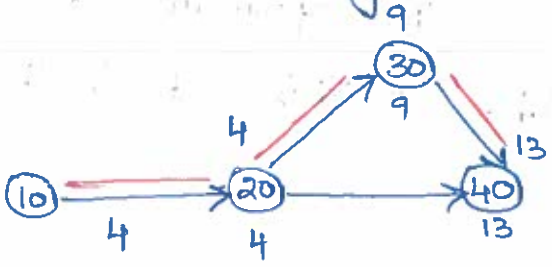
Activity	Normal time (T_n) days	Crash time (T_c) days	Normal cost (C_n) Rs.	Crash cost (C_c) Rs.	Cost slope Rs. per day
10-20	4	3	400	600	200
20-30	5	2	300	750	150
20-40	7	5	360	540	90
30-40	4	2	500	1000	250

Indirect cost = Rs. 250/- per day.

Sol:-

Step 1 :- Cost slopes are taken from the given data.

Step 2 :- Consider the network of normal duation as shown in figure.



Time duation = 13 days.

Total cost = Direct cost + Indirect cost

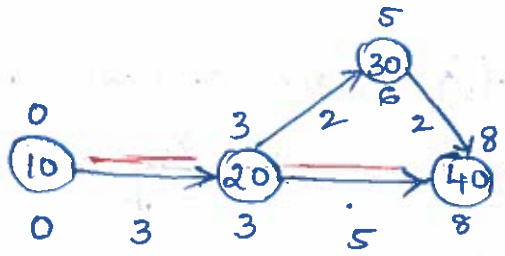
$= (400 + 300 + 360 + 500) + (250 \times 13)$

$= 1560 + 3250$

$= 4810$.

Point on the Total cost Vs. Time curve is (13, 4810).

Step 3 :- Consider the "all crash" network shown in figure below.



Time duration = 8 days.

For computing total cost, the activity 30-40 may be completed in 3 days instead of 2 days without altering the time duration of 8 days.

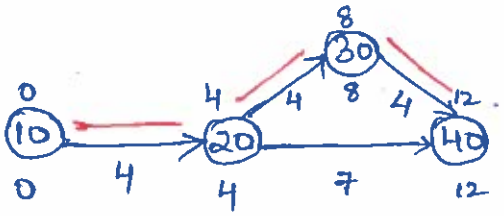
Total cost = (400+200) + (300+150x3) + (500+250) + (360+90x2) + (250x8)

= 2640 + 2000

= 4640.

Point on the total cost Vs time curve is (8, 4640).

Step:-4:- In the network of normal durations, fig (a), Critical activity 20-30 has the least cost slope. Crash 20-30 by one day as shown



Time duration = 12 days

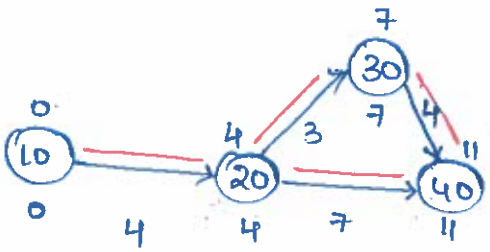
Total cost = 400 + (300+150) + 360 + 500 + (250x12)

= 1710 + 3000

= 4710.

Point on the Total Cost Vs time curve is (12, 4710)

Step:-5 :- In the network fig crash critical activity 20-30 by one more day. as shown in fig:



Time duration = 11 days.

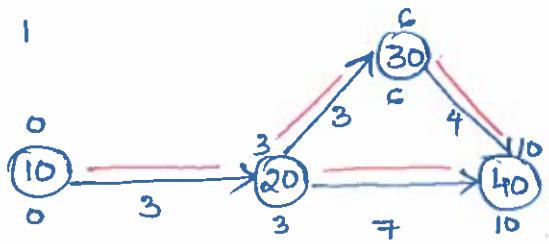
Total cost = 400 + (300+150x2) + 360 + 500 + (250x11)

= 1860 + 2750

= 4610.

Point on the total cost Vs Time curve is (11, 4610).

Step:-6:- In the above figure both paths have become critical and hence further crashing will have to be done on both paths. Crash activity 10-20, Common to both paths by one day as shown in the below figure.



Time duration = 10 days.

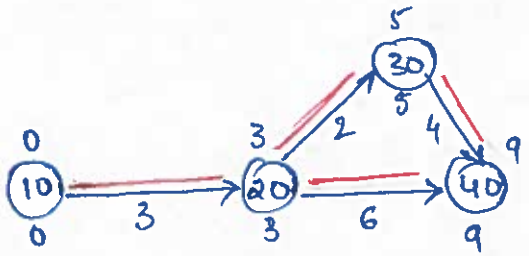
Total cost = (400+200) + (300+300) + 500 + 360 + (250x10)

= 2060 + 2500

= 4560

point on the total cost Vs. time curve is (10, 4560)

Step 7:- In the network shown in the figure above below crash activity 20-30 by one more day and activity 20-40 also by one day as shown in the figure below as both paths are critical.



Time Duration = 9 days

Total cost = (400+200)+(300+450)+500+(360+90)+(250×9)

= 2300+2250

= 4,550

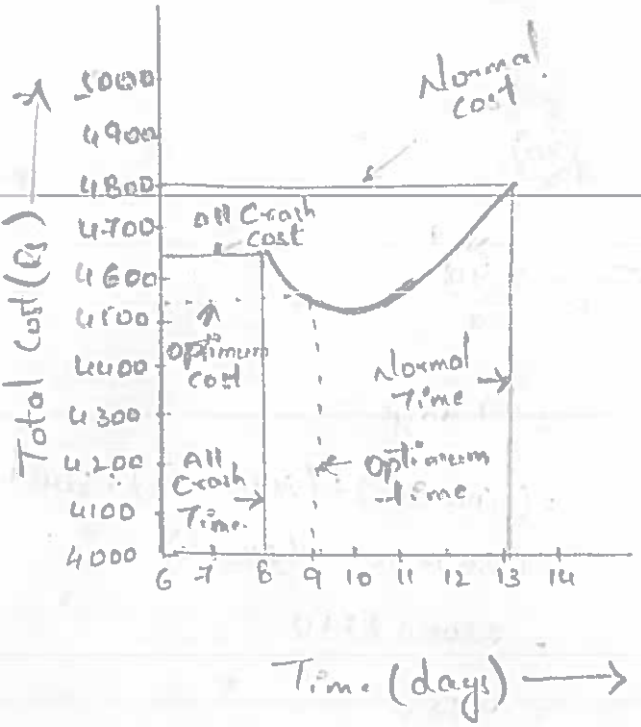
Point on the Total Cost vs. Time Curve is (9, 4550).

Step 8:- Prepare table of Total cost and Corresponding Time:

Total Cost (Rs.)	Time (days)
4810	13
4710	12
4610	11
4560	10
4550	9
4640	8

Plot the Total Cost vs. Time Curve as shown in fig. 6.5 (g)

Cost - Time Analysis in Network Planning.



CONSTRUCTION MANAGEMENT

UNIT-1

MANAGEMENT PROCESS

Learner will be able to:

1) Describe various resources required for construction works
2) Explain different stages and activities involved in construction projects.
3) Recognise the importance of construction team and state the role of each.
4) State the purpose of various types of drawings required for construction activities.

Construction Management:-

→ The main objective of construction management is to complete a prescribed quantum of work with in a specified time at a previously estimated cost.

→ In order to achieve this objective, "planning" is necessary to execute the project in a various possible ways.

Management Process:-

It is a process of setting goals, planning or controlli the organization and leading the execution of any type of activ

Importance of Management:-

a) Achieving group Goals:-

Arranges the factors of production, assembles and organizes the resources, integrates the resources in effective manner to achieve goals with no wastage of time, money & effort.

UNIT :- 3

Resource :- A Resource is a physical Variable quantity Such as Manpower, Material, money, Equipment, time or Space, which are required for carrying out a project. But in real practice, resources are always limited and limitation on resources can significantly affect the initiation, Performance and completion of activities on the scheduled time and can cause the project to be extended beyond the scheduled duration.

Therefore, the various activities of the project are to be scheduled in such a manner that there is best possible utilisation of available Resources.

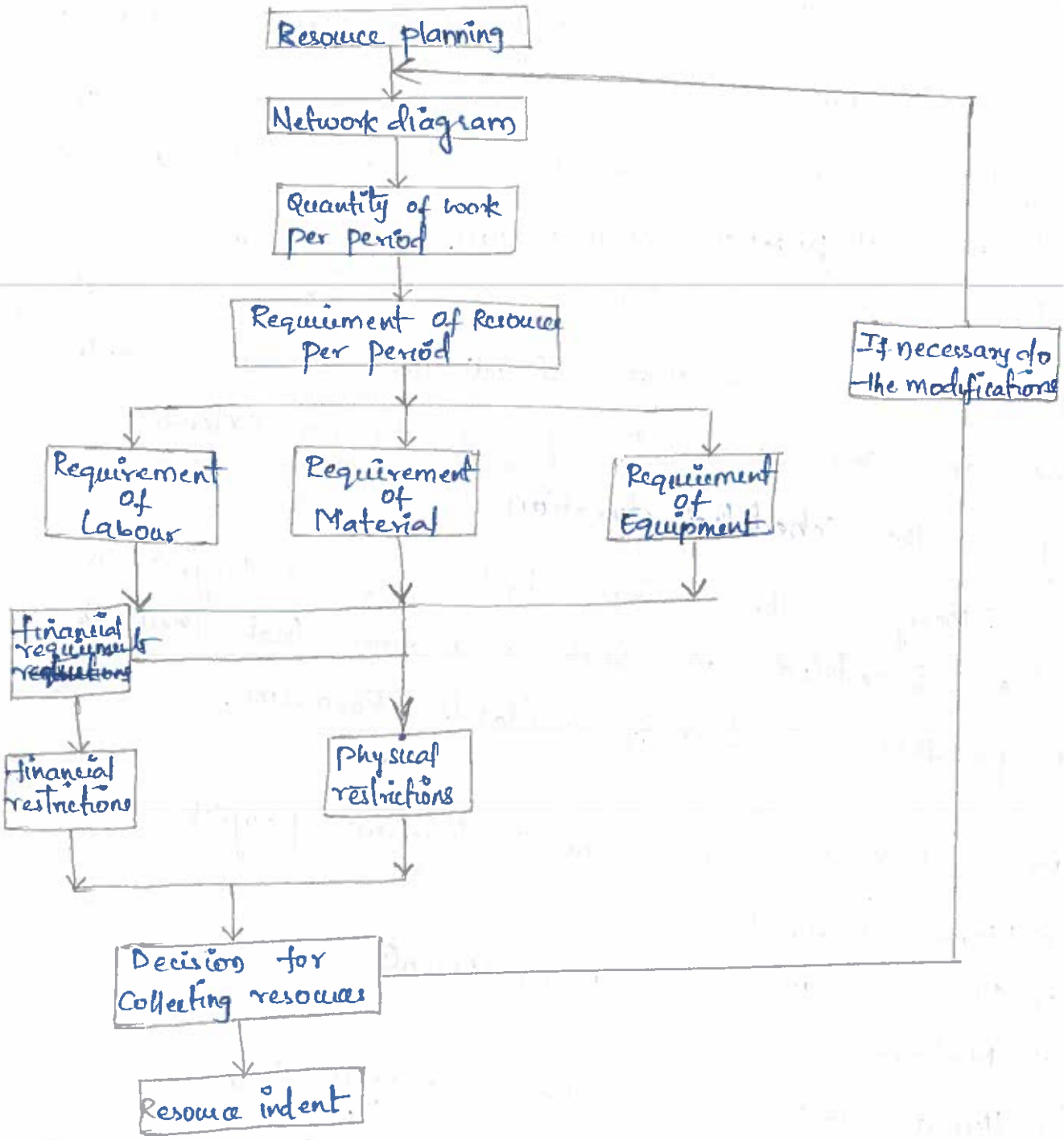
⇒ Various resources used in the construction project

(i) Money (or) funds
(ii) Machinery (or) construction equipments.
(iii) Materials.
(iv) Human resources i.e., labour, managers etc.,

⇒ Infrastructure resources essential in construction projects are :-

(i) Land &
(ii) Area (or) Space.
(iii) Water
(iv) power.

⇒ Neat flow diagram of resource planning.



Manpower planning :- Proper and timely manpower planning is a key factor in the efficient execution of projects. Unless proper manpower is made available to meet the Organisational needs in time, the progress of the work would undoubtedly suffer and the performance would be adversely affected.

* In manpower planning, it is very essential to have a proper classification of various categories of posts, so that the right men can be deployed on the right jobs, which is very essential for the efficient and timely completion of the project. Serious attempts should be made to estimate at least the manpower required at the various levels of management - junior, middle and at the top for the present projects in hand and for the immediate future projects that will be taken up.

Materials planning :-

* Materials planning involves calculation of required quantities, determination of required materials, explaining specification and forecasting material requirement. Besides determination of suitable source, procurement plans, inventory control and supervising the usage of materials.

* Materials of poor standards and ineffectively quality control will cause delay in the implementation of the project and the resources may also get wasted, thus increasing the overall cost of the project. These can be reduced by a sound procurement organisation, planning and procedures.

→ The following approaches to materials procurement will

be highly beneficial.

(i) choice of right Suppliers.

(ii) Proper and well defined Specifications.

(iii) Classification, coding and cataloging process.

⇒ Preparation of Material Schedule.

Material Schedules showing weekly requirements of commodities are prepared from the construction programme. A material schedule enables storage space to be adequately planned and necessary arrangements to be made for timely delivery of materials. Disruption of work due shortage of materials can be avoided by using a material schedule.

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

* Name of work _____ prepared by _____

Date _____

Material	units	Weeks			
		1	2	3	4
Cement bags	No.	110	100	115	120
Bricks	No.	4500	4000	5500	3000
Sand	Cum.	20	20	35	25
Aggregate	Cum	20	35	30	25
Steel	Quintal	—	2	10	2.

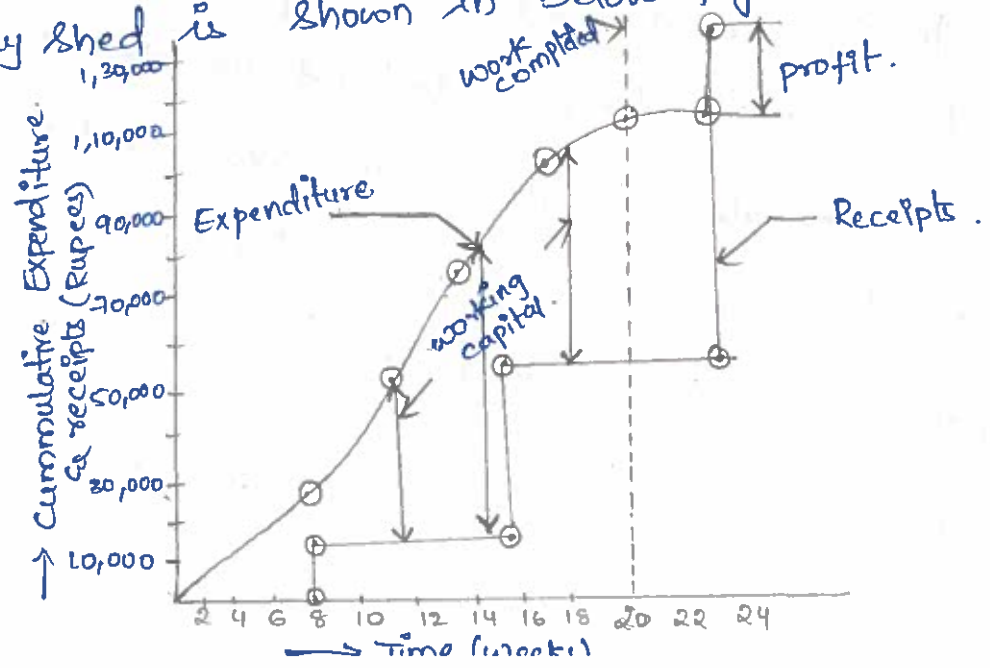
Planning of costs (or Money :-

Fund (or money is considered as the most important resource of all the available resources since all the remaining resources are directly dependent on money. Therefore, the financial resource planning must be carried out carefully and must be available at any time for smooth implementation of the ongoing project. Hence, financial planning is very essential for smooth inflow and outflow of cash thereby, avoiding holds in the construction project.

Financial Schedule :-

* Financial schedule completely shows the amount of cash needed at various stages of construction project such as payment of labours, materials equipment and for other sources. It represents the finances required for the successful completion of the project.

* The finance schedule for the construction of a temporary shed is shown in below figure.



Planning of construction equipment :-

* When one wants to consider the planning of mechanization of any part of the work, the need is to consider not in isolation but in interrelationship. It is necessary to examine different methods — whether one centralised mixing plant or many at the site are necessary? whether placement of concrete by crane method or by power of manual? whether building by wagon or hand drill? These are to be analysed in the planning stage to find out the most suitable equipment.

* It is not just the total quantity produced during a particular number of days that matters. But it is to be taken on yearly, monthly, weekly days, working hours available, number of shifts planned, mobilization time, shortage of operators, shortage of necessary equipment, labour loss etc., If none of these factors are considered and used in progress schedule, then it is not a good management.

⇒ 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 occur either due to non-availability or breakdown of equipment can be averted. ~~Such~~.

⇒ Name of work :- _____ prepared by :- _____

Date :- _____

Equipment	Weeks				
	1	2	3	4	5
Concrete mixer	–	–	1	–	–
Vibrator	–	–	1	–	–
welding set	–	–	1	1	1
Truck.	–	1	1	1	1
Equipment for erecting trusses	–	–	–	1	–

Planning of Labour :-

Labour schedule depict the manpower requirements of the project in a tabular form for various stages. It serves the following purposes.

(a) It provides the site incharge with ample warning of his future labour requirements.

(b) By noting 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 in a particular section of the project, it enables such type of labour force to be sought from elsewhere before a delay occurs.

⇒ Labour Schedule :-

Name of work :- _____ Prepared by :- _____

Date :- _____

Manpower (Labour)	Weeks				
	1	2	3	4	5
Foreman	1	1	1	1	1
Carpenters	—	—	—	1	1
welders	—	—	3	2	1
Mixer operator	—	—	1	—	—
Masons	1	1	2	2	1
Bar benders	—	2	1	—	—
Labourers	3	3	10	6	3

Scheduling :-

* Scheduling is the allocation of resources. These resources, in conceptual sense are time and energy, but in practical sense are time, space, equipment and effort applied to Material.

* Scheduling is the mechanical process of formalising the planned functions, assigning the starting and completion dates to each part (or activity) of the work in such a manner that the whole work (or project) proceeds in a logical sequence and in an orderly and systematic manner.

⇒ Preparation of construction Schedules :-

① The project is divided into number of operations and the sequences of these operations can be derived after knowing their relationship properly.

(2) The quantity of work involved in each operation has to be calculated

(3) The time required for completion of the project as well as the different activities are to be calculated.

⇒ Advantages of Scheduling :-

(1) By studying the Schedule of any work and the many alternative methods of execution, we can choose the best one.

(2) It gives a clear idea regarding the required men, materials and equipments at different stages of work.

(3) Since the starting time of each work is known, proper arrangements and requirements can be done prior to the starting of the work.

(4) Resource utilisation is optimised

(5) Actual progress of work is monitored with the actual plan. If there is any delay, proper remedial measures can be taken to avoid such delays.

(6) Inter-relationship of various activities at different stages are known; thus we will be able to fix them according to their priority.

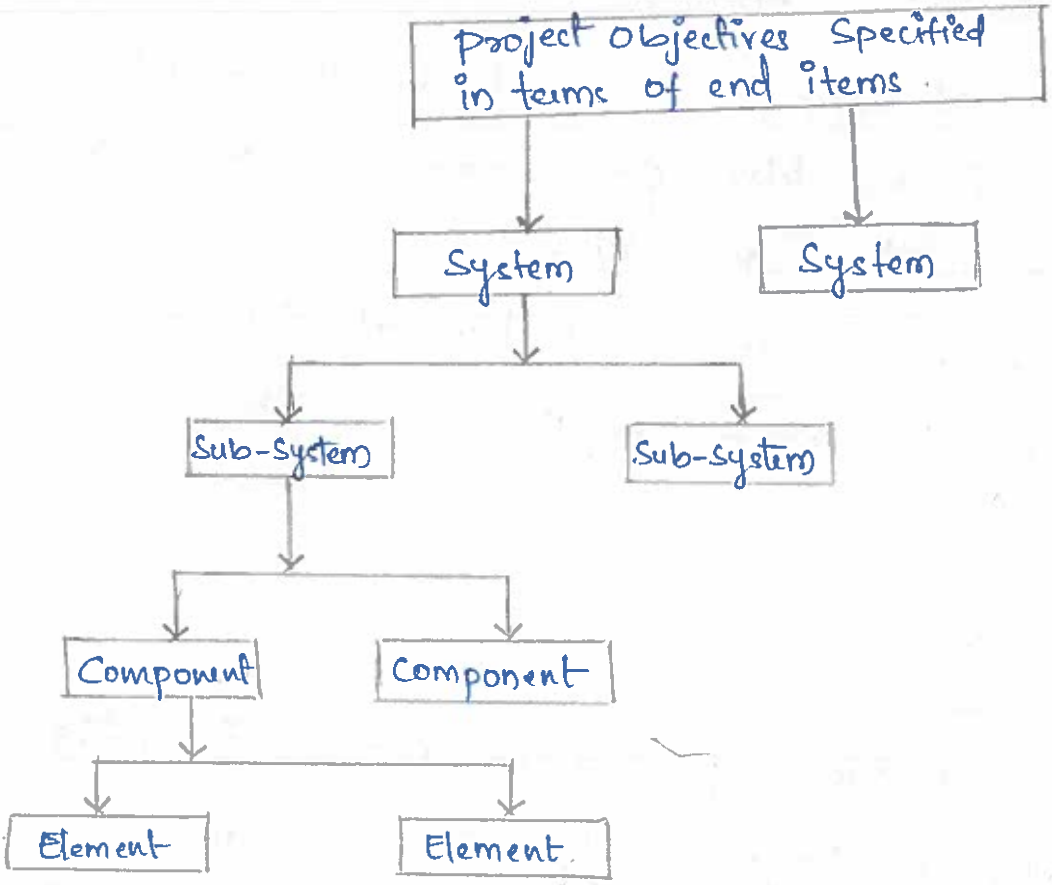
⇒ Methods of Scheduling :-

Scheduling can be done by different methods depending on the size of the project. The methods used are :

(i) Bar charts or Gantt charts.
(ii) Milestone charts
(iii) Network analysis.

#Work breakdown Structure :-

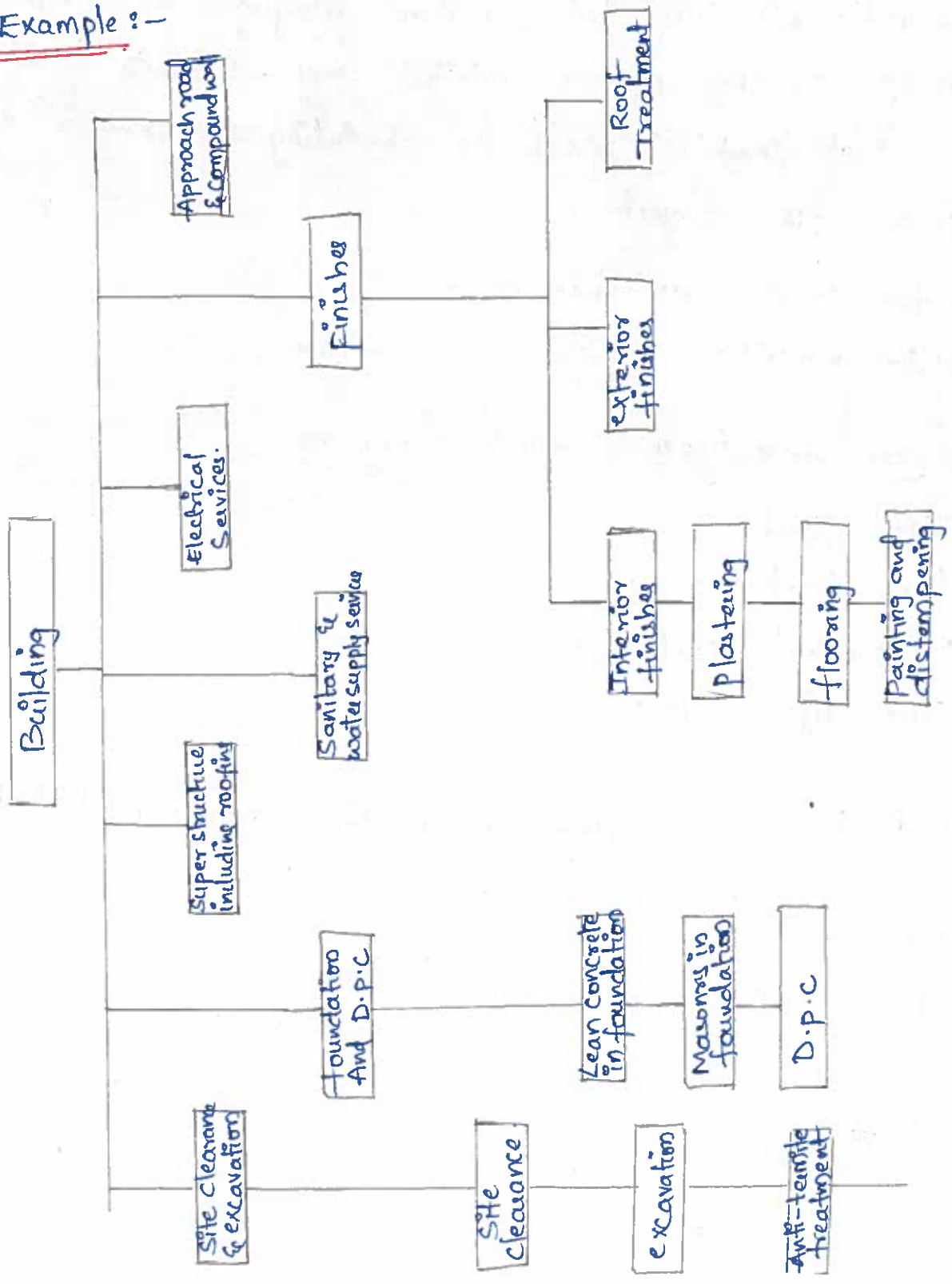
* The functional elements of a project and their interrelationship are determined by a technique known as work breakdown Structure. Such a technique establishes the hierarchical order in a system by braking the project into recognizable Systems, Sub-systems and discrete activities is called the work breakdown Structure. The major project is first identified in terms of its end items, then split into systems, sub systems, then their components and elements.



(work breakdown Structure of a project)

⊛ Work breakdown structure is a device that identifies the functional elements of a project and their inter-relation-ship. When the project is split up in this way into its various functional elements, this will not only help in preparing the network for the project but also in planning and scheduling the activities.

⇒ Example :-



(Work breakdown structure of a building)

Float :- Floats represent the flexibility in Scheduling. The concept of floats is useful for the management in representing underutilized resources and flexibility of the schedule and the extent to which the resources will be utilized on different activities.

* The critical activities cannot be scheduled later than their earliest schedule time, without delaying the project duration. So they do not exhibit any flexibility in scheduling. But flexibility exists for scheduling the non-critical activities of the project.

(i) for critical activities zero.
(ii) for noncritical activities non-zero.

⇒ There are four types of floats. They are :-

1) Total float.
2) Free float.
3) Independent float and
4) Interfering float.

1) Total float :- Total float is the time span by which the starting or finishing of an activity can be delayed without affecting the overall completion time of the project. It is sometimes found that certain activities have a difference between the maximum time available for completion and their actual duration. This difference is termed as total float.

Consider an activity $i-j$. The time available for this activity is equal to the difference between its earliest start time of the tail event T_E^i and the latest finish time of the head event T_L^j

$\therefore$ Max. available time $= T_L^j - T_E^i$

while the activity duration $= t^{ij}$

$\therefore$ Total float $F_T^{ij} = (T_L^j - T_E^i) - t^{ij}$

i.e; $F_T = T_L^j - (T_E^i + t^{ij})$

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

but $T_L^j - t^{ij} = LST$

and $T_E^i = EST$

$\therefore F_T = LST - EST$.

Similarly $F_T = LFT - EFT$.

2) Free float :- Free float is that duration by which an activity can be delayed without delaying any other succeeding activity.

Consider two activities $i-j$ and its successor $j-k$.

Earliest start time for activity $i-j = T_E^i$

for $j-k = T_E^j$

let t^{ij} be the duration of activity $i-j$.

Therefore activity will be completed by $T_E^i + t^{ij}$.

The succeeding activity $j-k$ can start only by T_E^j.

If T_E^j is greater than $T_E^i + t^{ij}$.

There will be a gap between the completion of activity $i-j$

and activity j-k. This duration is called free float.

$$\therefore \text{free float} = F_E^{ij} = T_E^j - (T_E^i + t^{ij})$$

but $T_E^i + t^{ij}$ is the EFT of activity i-j.

$\therefore$ F_F of activity i-j $= T_E^j -$ EFT.

Also $F_F = T_E^j - (T_E^i + t^{ij})$

Substituting in the equation $F_T = T_L^j - (T_E^i + t^{ij})$

$$F_F = T_E^j - (T_L^i - F_T)$$
$$= F_T - (T_E^j - T_E^i)$$
$$\therefore F_F = F_T - S_j$$

free float is difference b/w the total float & the head event slack.

Independent Float:- It is the excess time available if the preceding activity ends as late as possible and the succeeding activity starts as early as possible.

Consider activity i-j with a predecessor activity i-j and Successor activity j-k.

If activity i-j finishes by the latest time i.e T_L^i and.

If activity j-k can start by the earliest time T_E^j.,

then the minimum time available is $T_E^j - T_L^i$.

Therefore $\text{Independent float} = (T_E^j - T_L^i) - t^{ij}$.

This independent float is a part of the free float.

i.e., $F_{ID} = T_E^i - T_L^i - t^{ij}$ [Substituting $T_E^i - t^{ij} = F_F + T_E^i$]

$$F_{ID} = F_F + T_E^i - T_L^i = F_F - (T_L^i - T_E^i)$$

$$FID = F_F - S_i$$

∴ Independent float is equal to free float minus tail event slack.

Intefering float :- Interfering float is the difference between the total float and free float. This is equal to head event slack. This is the potential downstream interference

$$F_{IT} = F_T - F_F$$

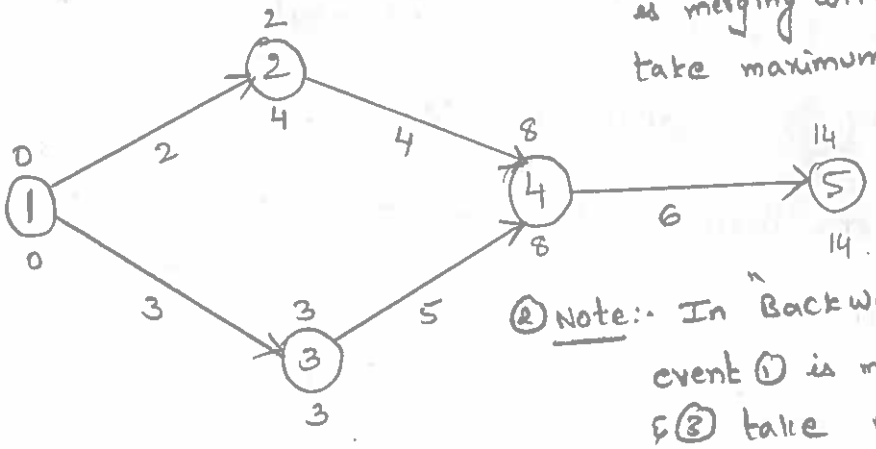
$$= F_T - (F_T - S_i)$$

$$F_{IT} = S_j = T \cdot F - F \cdot F$$

Ex:-

(Q) Calculate the earliest start time, earliest finish time, latest start time, latest finish time, and total, free and independent floats in respect of all the activities of the network.

① Note:- In forward pass → when event ④ is merging with event ② & ③ take maximum value



② Note:- In Backward pass → when event ① is merging with event ② & ③ take minimum value.

T_E and T_L are computed by forward and backward pass and shown on the network.

← Forward pass → ← Backward pass →

Activity (ij)	Duration Days (tij)	Earliest time start (EST)	Earliest time finish (EFT)	Latest time start (LST)	Latest time Finish (LFT)	Float Total (FT)	Float free (FF)	Float Independent (FI)
		event@1	0+2=2		event@2			
1-2	2	0	2	2 (4-2) } 2 min	4	2	0	0
		event@1	0+3=3	0	event@3			
1-3	3	0	3	3-3=0	3	0	0	0
		event@2	2+4=6		event@4			
2-4	4	2	6	4 (8-4=4)	8	2	2	0
		event@3	3+5=8 Max		event@4			
3-4	5	3	8	3 (8-5=3)	8	0	0	0
		event@4	8+6=14					
4-5	6	8	14	8 (14-6=8)	14 (EFT=14)	0	0	0

(∵ Total float (F_T) = (LFT − EFT) = (LST − EST)

Free float (F_F) = T_E^j − EFT

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

Resource Allocation :-

Resources include physical variables such as men (skilled/unskilled labour, technical/supporting staff etc.), materials, plant/machinery, finance and space.

(*) → when there is a constraint on resources and competing demands are made by various activities for the same resource, a systematic method of resource allocation/levelling assumes great importance.

(*) → Resource allocation usually involves a 'trade-off' or compromise in view of the competing demands as

ability of resources is generally restricted. Large fluctuations in the demand for resources is generally may cause problems in project execution. Project activities have, therefore, to be scheduled in such a manner that the demand for various resources is fairly uniform over the entire project duration.

- In a given project each activity consumes resources.
  - → Many activities may have to be undertaken simultaneously
  - → The requirement of resources for undertaking a number of activities simultaneously may exceed the available resources
  - → when demand for a particular resource exceeds its availability, levelling is carried out by delaying some of the non-critical activities to cut down the demand for the particular resource.

BUDGET :-

- According to Brown and Howard of Management Accountant it is defined as "A budget is a predetermined statement of managerial policy during the given period which provides a standard for comparison with the results actually achieved".

(or)

- "A financial and/or quantitative statement, prepared and approved prior to define period of time, of the policy to be pursued during that period for the purpose of attaining a given objective".

⇒ The various types of budgets are :-

(i) Annual sales budget
(ii) operating budget
(iii) Capital expenditure budget

Budgetary control :-

Budgetary control is the process of establishment of budgets relating to various activities and comparing the budgeted figures with the actual performance for arriving at deviations, if any. Accordingly, there cannot be budgetary control without budgets. Budgetary control is a System which uses budgets as a means of planning and controlling.

⇒ Objectives of Budgetary control :-

Budgetary control is planned to assist the management for policy formulation, planning, controlling and co-ordinating the general objectives of budgetary control and can be stated in following ways

* (1) planning :- A budget is a plan of action. Budgeting ensures a detailed plan of action for a business over a period of time.
* (2) Co-ordination :- Budgetary control co-ordinates the various activities of the entity or organization and secure co-operation of all concerned towards the common goal.

(*) 3) control :- control is necessary to ensure that plans and objectives are being achieved. control follows planning and co-ordination.

Thus budgetary control makes control possible by continous measures against predetermined targets. If there is any variation between the budgeted performance and the actual performance, the same is subject to analysis and corrective action.

⇒ Parameters that monitor Project Cost budget.

(i) Budget cost of work scheduled (BCWS) indicates a time phased schedule of the budget.
(ii) Budgeted cost of work performed (BCWP) it represents the approved for the work performed on data date.
(iii) Actual cost for the work performed (ACWP) it includes the amount / cost for completion of work on data date.

⇒ Advantages of Budgetary control :-

There are a numerous advantages of budgetary control.

(i) promotes the allocation of resources which are very less in quantity.
(ii) Budget plan is compared with actual results to maintain budget control.
(iii) Management focuses on the upcoming activities, which is considered to be the most important aspect of budgetary control system.

Disadvantages of Budgetary Control :-

(i) To control the budget, management imposes pressure on labour, thereby resulting in poor labour relations and inaccurate record maintenance.

(ii) Departmental conflicts are arises when targets are not attained by the departments due to variations in resources allocation

(iii) Reunion of personal and corporate goals becomes quite difficult.

UNIT :- 4

Contract :- In construction, it is universal practice for the Contract to be formalised in the form of a written document. Its main pupose is to define exactly the rights and obligations of each party.

→ It describes precisely the legal, financial and technical provisions of the work.

→ It contains the clauses that specify Completion time of the project, liquidated damages, Particulars Concerning Payments to the contractor, Scope & nature of the work to be done etc.,

→ It is signed by both the parties (owner & the contractor).

Types of Contract :-

Contracts for the execution of civil engineering works are of following types:

(i) Lumpsum contract.
(ii) Item rate contract.
(iii) Lumpsum and schedule contract.
(iv) Cost plus fixed fee contract.
(v) Cost plus percentage of cost contract.
(vi) Special contracts.

(i) Lumpsum contract :- In this type of contract, the

Contractor offers to do the whole work as shown in drawings and described by specifications, for a total stipulated sum of money. There are no individual rates quoted, thus it becomes difficult to make adjustments in the contract value if any changes are to be made in the work later on.

Suitability :- A lumpsum contract is more suitable for works for which contractors have prior construction experience.

Merits :-

(i) The owner can decide whether to start or shelve the project knowing the total lumpsum price quoted by different contractors

(ii) The contractor can earn more profit by in-depth planning and effective management at site.

Demerits :-

(i) Before the contract is awarded, the project has to be studied thoroughly and the complete contract document has to be prepared in advance.

(ii) Many additional items may have to be undertaken as the work progresses, giving opportunity to the contractor for claiming higher rates for the extra items not included in the contract agreement.

(ii) ITEM RATE CONTRACT :- In this type of contract, the contractor undertakes the execution of work on an item rate basis. The amount to be received by the

Contractor, depends upon the quantities of various items of work actually executed. The payment to the contractor is made on the basis of detailed measurements of different items of work actually done by him.

Suitability :- It is suitable for works which can be split into various items and quantities under each item can be estimated with accuracy.

Merits :- (i) detailed drawings can be prepared after the contract is awarded.

(ii) Changes in drawings & quantities of items can be made as per required within agreed limits.

(iii) The payments to the contractor is made on the actual work done by him at the agreed rates.

Demerits :-

(i) The total cost of work can only be known upon completion. As such the owner may incur financial difficulty in the final cost increases substantially.

(ii) Additional staff is required to take detailed measurements of work done for releasing payments to the contractor.

(iii) LUMP SOM AND SCHEDULED CONTRACT :- In this type of contract the contractor offers to do a particular work at a fixed sum within a specified time as per plans and detailed specifications. The schedule of rates for various items is provided

which regulates the extra amount to be paid or deducted for any additions or deletions made during the progress of work.

Suitability :- This type of contract is more suitable for construction works for which contractors have prior work experience and can consequently estimate the project cost more realistically.

Merits :- (i) In this type of contract, additional staff for recording detailed measurement of original item of work is not required for making payment to the contractor.

(ii) The owner can know from tenders as to what the project will cost him.

Demerits :-

(i) Before the contract is awarded the project has to be studied thoroughly and all the contract documents are required to be completed in every aspect.

(ii) The non-scheduled extra items arising out of changes made in the drawings and specifications are often a source of dispute because the contractor presses for rates higher than the prevailing market rates.

(iv) COST PLUS FIXED FEE CONTRACT :-

Cost plus fixed fee contract is desirable when the scope and nature of the work can atleast be broadly defined. The amount of fee is determined as a lumpsum from a

from a consideration of the scope of work, its approximate cost, nature of work, estimated time of construction, manpower & equipment requirements etc., In case of cost plus percentage contract, the contractor has a tendency to increase his profit by increasing the cost of work. But this drawback is over come in cost plus fixed fee contract because here the contractor's fee is fixed and does not fluctuate with actual cost of work.

Suitability :- Suitable for important structures where the cost of construction is immaterial.

Merits :-

(i) In this type of contract, actual cost is to be borne by the owner. Therefore, the contractor performs the work in the best interest of the owner resulting in good quality work.

(ii) The work can be taken in hand even before the detailed drawings & specifications are finalised.

(iii) work can be executed speedily.

Demerits :- (i) This form of contract cannot be adopted normally in case of public bodies and Government departments.

(ii) The final cost of the work is not known in advance and this may subject the owner to financial difficulties

(v) COST PLUS PERCENTAGE OF COST CONTRACT :-

In this type of contract, instead of awarding the work on lump sum or item rate basis, it is given on certain percentage over the actual cost of construction.

The actual cost of construction is reported by the contractor and is paid to him by the owner together with a certain percentage as agreed earlier. In this type of contract, proper control has to be exercised by the owner in the purchase of materials and in arranging labour.

The suitability, merits & demerits of this type of contract are similar to cost plus fixed contracts.

Special Contracts :-

1) Turn-key contract.
2) Package contract.
3) Negotiated contract.
4) Continuing contract.
5) Running contract.

1) TURN KEY CONTRACT :- A turn key contract is an integrated contract in which all works pertaining to various disciplines such as civil, electrical, mechanical etc., are in the hands of a single contractor, called the main contractor. The main contractor can sublet the contract to sub-contractors who

are Specialists in their respective fields.

In this contract, the main advantage to the owner is that he need not coordinate the work of different contract-ors.

(ii) PACKAGE CONTRACT :-

In a package contract, two or more related jobs, each of which could form a Seperate contract are combined in a Single contract. In the field of civil engineering, generally design and development are combined with construction & supply or maintenance.

(iii) NEGOTIATED CONTRACT :- In this type of contract, negotiation across the table takes place between representatives of the owner and the main contractor for project cost and other conditions of contract.

(iv) Continuing Contract :-

In this type of contract, new or additional work is awarded to the Contractor on the basis of agreed terms & conditions of an existing contract.

(v) Running Contract :-

Such contracts provide goods & Services at Specified intervals or as and when required by the owner. The Contact price is not fixed and payment is based on actual goods Supplied and services rendered as specified

in the Contract document.

Contract document :- Construction works intended to be awarded to contractors are given wide publicity so that a sufficient number of interested parties may bid for the work. Usually the lowest bid is accepted unless there are valid reasons for not following this practice. Every written contract which clearly describes the work should also define the rights and obligations of the parties. The rights and obligations of the owner and the contractor are defined in a document called the Contract document.

The Contract document consists of the following set of documents. Contract agreement and the following set of documents.

(a) Cover/title page :- It contains the name of work, name of owner, contractor, Contract agreement number, Contents etc.

(b) Contents page :- It contains the Contents of the agreement with page references.

(c) Notice inviting tender :- (NIT) :- It contains a brief

description of work.
→ Estimated Cost of work.
→ date and time for receiving the ~~work~~ tender,
→ amount of earnest money.
→ Security money.

→ Time of Completion etc.,

(d) Tender form :- It Comprises

→ bill of quantities.
→ Contractor's rates.
→ total Cost of work.
→ time for completion.
→ Security money to be deposited
→ Penalty clauses etc.,

(e) Schedule of issue of materials :- It contains the list of materials to be issued by the department or owner to the contractor with rates and place of issue.

(f) Drawings :- These Comprise a Complete set of fully dimensioned drawing including plans, elevations, Sections detailed drawings and site plan.

(g) Specifications :- Specifications should be clear and precise covering all items of the bill of quantities.

(h) Conditions of contract :- It should all the conditions of the contract.

SPECIFICATIONS :-

Specifications are statements which describe the nature and class of work, materials to be used, labour to be employed, Method of work, Precautions to be taken, quality of workmanship etc.,

→ Cost of the work depends mostly on specifications.

Specifications serves for the following purposes:-

(i) Guide the bidder at the time of tenclering for arriving at a fair price for the work involved.

(ii) Provide guidance for execution and supervision of work and purchase of work.

(iii) State the acceptance criteria for different items of work.

§ Types of Specifications :-

a) Contract Specifications.

b) Guide Specifications.

c) Standard Specifications.

d) Manufacturer's Specifications.

Contract Specifications :- The Specifications prepared for a particular job to accompany the working drawings are called Contract Specifications.

They are further clasified as:-

→ General Specifications.

→ Detailed Specifications.

General Specifications are also called brief Specifications. These give a general ideas of the class and type of work giving brief descriptions of materials, quality & workmanship.

Detailed Specifications provide a detailed description of each item as per schedule of quantities, Method of work, quality of workmanship etc.,

(b) Guide Specifications :- These Specifications provide a guideline for preparing Contract Specifications and give a broad idea about the class & type of construction for a Particular Purpose.

(c) Standard Specifications :- These Specifications are prepared for various materials or group of materials for the guidance of all Concerned with construction or construction industry. Indian Standards institution and other such institutions have prepared a wide range of Standard Specifications.

(d) Manufacturer's Specifications :- Manufacturers prepare Specifications of their products for the guidance of users.

IMPORTANT CONDITIONS OF CONTRACT :-

Following are the important conditions of contract.

(a) Time of completion.
(b) Delay and extension of time.
(c) Penalty.
(d) Compensation for delay in completion of work.
(e) Liquidated damages.
(f) Debitable agency.
(g) Valuation of variations.
(h) Settlement of disputes.
(i) Force Majeure and natural disasters.
(j) Price escalation.
(k) Termination of contract

(a) Time of completion :- The contractor is required to complete the work within the agreed time of completion which is specified in a suitable unit of time.

(b) Delay and extension of time :- Delay in completion of work not attributed to the contractor should be brought to the notice of the owner by the contractor in writing, within the time specified in the contract.

(c) Penalty :- It is a fine imposed on the contractor for non-fulfillment of his contractual obligations such as failure to maintain required progress of work, delay in completion, poor quality of work etc.

(d) Compensation for delay in completion of work :- The contractor is liable to pay compensation to the owner for delay attributed to him in completion of work.

(e) Liquidated damages :- It is a fixed stipulated sum payable by the contractor on account of penalty for delays

(f) Debitable agency :- Whenever the contractor fails to fulfill his contractual obligation in respect of progress or quality of work even after giving due notice by the owner, it becomes necessary to appoint a debitable agency which works at the cost and risk of the contractor. This agency is in the form of labour or other contractor to fulfill the contractual obligations of the main contractor.

The expenses incurred are charged from the bill or security of the original contractor.

(g) Valuation of Variations :- The Valuation of variations is based on change orders issued in writing by the owner. Generally, the variation in individual items of work should not be more than 25% and variation in total cost should not exceed 10%.

(h) Settlement of disputes :- Efforts should be made to resolve disputes amicably between the owner and the contractor through mutual discussions and negotiations. "Arbitration clause" may be incorporated in the contract to settle disputes not resolved through mutual discussions & negotiations.

(i) Force majeure and natural disaster :- Natural disasters are acts of nature, such as unprecedented floods/rainfall, earthquake, hurricanes, typhoons, fire etc. are beyond the control of the contractor and may lead to financial & time loss.

(j) price escalation :- During execution of the work, labour wages and material prices may increase as a result of Inflation. Generally, escalation payment is made for increase in the cost of labour, materials & petrol, oil & lubricants (POL) and the percentages of three components are taken as under:

Labour.	30% of contract price.
Materials	65% of contract price
POL	5% of contract price.

The central public works development (CPWD) adopt the following formulae for Computing escalation.

(i) The Compensation for escalation for "labour" is worked out as per the formula given below.

$$V = W \times \frac{Y}{100} \times \frac{(LI - LI_0)}{LI_0}$$

V = Variation in labour cost i.e increase or decrease in the amount in rupees to be paid or recovered.

W = Value of workdone

Y = Component of labour expressed as percent of the total value of work (30%).

LI_0 = Minimum daily way in rupees of an unskilled adult male Mazdoor.

LI = Minimum wage in rupees of an unskilled adult maze Mazdoor.

(ii) The Compensation for escalation of "Materials" is worked out as per the formula.

$$V_M = W \times \frac{X}{100} \times \frac{(MI - MI_0)}{MI_0}$$

V_M = Variation in material cost i.e., increase or decrease in the amount in rupees to be paid or recovered.

W = Cost of work done.

X = Component of materials expressed as percent of the total value of work (65%).

MI & MI_0 = All india whole sale index for commodities. as

Published by the Economic Advisor of Govt. of India.

(iii) The Compensation for escalation for 'POL' is worked out as per given below:

$$V_F = W \times \frac{Z}{100} \times \frac{(FI - FI_0)}{FI_0}$$

V_F = Vaciation in cost of fuel, oil & lubricant.

W = Value of work done.

Z = Component of P.O.L expressed as percent of total value of work as indicated under the Special conditions of contract (5%)

(FI & FI_0) = Average index number of wholesale price for group (fuel, power, oil & lubricants).

(K) Termination of Contract :- The owner can terminate the Contract in the event of default or bankruptcy of the Contractor and may impose Penalty as per the Contract agreement.

TENDER :- The written offer for the execution of some Specified work under Specified terms & conditions, is called as a tender. Tender vary from contract to contract. Some tender may be lump-sum tender or some may be item-rate tender or cost plus tender or labour tender etc.,

→ Tender is given in the form of a notice in newspapers or any other government gazetted places or at public places.

The tender notice should contain the following cases in it,

(a) Details about the Contract documents, blank forms of tender obtained and amount of the tender.

(b) After a month of publishing the first advertisement or notice the place where the tenders are to be opened and submi-tted is mentioned.

(c) Earnest money to be deposited and the required security deposit amounts in the tender accepted or taken.

(d) Authorization of acceptance of the tender.

There is a fixed time period for opening the tenders, which is done by the authorized officer in the presence of intended contractors and agents.

TYPES OF TENDERS :-

(1) open tenders :- The tenders which are openly advertised in the journals and newspapers of India or abroad are termed as open tenders.

→ open tenders are invited for the articles purchase or work of estimated value of Rs 10,000/- or over.

(2) Limited tenders :- The tender, which is open for only limited number of contracting corporations to give the rates for the supply of articles is termed as limited tenders. The estimated value of work is less than Rs 10,000/- only.

(3) Single tender :- The tender which is given to a single

Contracting firm which are Specially Certified for some Specified Supply of articles or to be of a proprietary nature.

(4) Rate Contract Tender :- In this type of contract only rates are mentioned in the tender but quantities are not Mentioned. The quoted rates should be the final rates and the Contractor shall accept any order of quantity which may be placed to him.

(5) Running Contract tender :- In this the Supply of approxi-mate quantity of stores at a Specified price is mentioned during the period of contract.

ARBITRATION :-

Indian Arbitration Act "1940"

Disputes may arise between the Contractor and the owner because of several factors such as recovery on account of alleged delays, defective work, or excess consumption of materials etc., Arbitration is method or mechanism employed for resolving a dispute in a construction project. In this disputes are Solved by arbitrators. who acts as judge for dispute resolution. The arbitrator have the power to help and suggest the parties to come up with a Compromise and may settle the case himself without any legal actions.

Main provisions of the arbitration clause :-

(i) All disputes or claims arising out of relating to the contract, or the breach thereof, will be settled through arbitration in accordance with the Indian Arbitration Act, 1940.

(ii) The parties may agree to the appointment of a single arbitrator or each party may nominate an arbitrator and the two nominated arbitrators may mutually select and umpire.

(iii) The parties will mutually agree regarding the sharing of arbitration fees and expenses.

(iv) The arbitration proceedings will be conducted by the arbitrators in accordance with laid down procedures at mutually convenient dates and places.

(v) The arbitration award will be final and binding upon both parties.

NEGOTIATION :-

The Aim of setting differences on the dispute among the engineers, by a focused conversation from all interested parties without involvement of third parties is known as negotiation. The process of negotiation is fast and does not have additional cost. The discussions between the parties are held in a friendly and peaceful atmosphere.

Measurement book :-

A book in which all the measurements of works and supplies are noted down is called as a measurement book. Based on the measurements recorded in this book, the payment of all works and supplies are made. It acts as an important accound recorded.

particulars.	Actual Measurement details				contents of Area.
	S.No	L	B	D	

Important points while recording measurements in measurement book :-

Earnest money deposit - 2%
Total security deposit 10%
Retention amount - 5%

→ Accurate measurement of the works are taken and noted down neatly for various items of works for the respective units.

→ All the measurements must be recorded in ink directly after necessary calculations.

→ When a mistake is made, entries should not be erased but should be crossed out and corrections should be inserted.

→ No blank pages should be left or torn out in the measurement book as it is machine numbered. If any pages are left blank by mistake, they should be cancelled by diagonal lines and cancellation must be initialled, attested and dated

→ An index of contents of different entries should be provided in each measurement book at the space provided at the beginning and it should be kept up-to-date.

→ When a number of officers are using a single measurement book, they should enter their name at the beginning of the M.book.

→ Measurements should be taken with correct metallic tape.

→ while recording the received quantities for the supply of materials, the description of items of supplies should be clearly noted to avoid ambiguity.

Nominal muster roll :-

The recruitment of casual labour for accomplishment of a particular work for a short duration of time through a muster roll is known as nominal muster roll. This format is adopted when large scale of casual labour are required in execution of a specific work.

The nominal muster roll form is divided into two sections. Among them, the first section includes the following details.

1) Names of labour.
2) Designation.
3) Father's name.
4) Attendance particulars.
5) Rates of wages.
6) Total amount payable for each labour etc.

The labour employed should sign (or imprint his/her ~~hand~~ left hand mark at the bottom of form ~~before giving~~ it to.

The second Section of the form consists of columns for filling the following details.

1) Name of work.
2) Amount of work done and its measurement.
3) Number of Measurement book.
4) Pages in which the measurements are recorded etc.

Deposits by the Contractor :-

i) Earnest money deposit :-

The tenderer shall be required to deposit earnest money with the tender for the due performance with the stipulation to keep the offer open till such date as specified in the tender, under the conditions of tender.

Value of the work	Earnest money deposit (EMD)
A. For works estimated to cost up to Rs. 1 crore	2% of the estimated cost of the work.
B. For works estimated to cost more than Rs. 1 crore.	Rs. 2 lakh plus 1/2% (half percent) of the excess of the estimated cost of work beyond Rs. 1 crore subject to a maximum of 1 crore.

To Ensure that a bidder doest not submit a Dummy Bid or bidder does not submit a Dummy bid or back

out at time of tender opening. Department collects a small refundable fee from each bidder, which is called (EMD).
(Contractor)

→ EMD is always in the form of demand draft.

Security deposit:- Once it is decided that a tender is awarded to a bidder, he has to deposit a security deposit with the Buyers such that if he does not complete the task as per the work order, the Buyer can recover the loss by forfeitting his security Deposit.

→ Security deposit is generally of 10% of value of Contract.

Eg:- If a bidders gets Rs. 10 Cr Contract to construct a bridge within 12 months, than he has to deposit a security deposit of 10% i.e 1 crore with Buyers. Now if he does not complete the bridge on time or leaves it incomplete, the department can forfeit his 1 crore as penalty.

Retention deposit:- Retention is a percentage (5%) of the amount certified as due to the contractor on an interim Certificate, that is deducted from the amount due and retained by the client. The purpose of retention is to ensure that the contractor properly completes the activities required for them under the contract.

STORES :-

Stores Management :-

A store plays an important role in the organization tools, as its functions include physical control of materials, Store preservation, preventing damages and reducing the obsolescence, by efficiently handling the materials etc.,.

A store is also held responsible, for maintaining proper stores record, making them available whenever required, for verification of records, reconciling the records with the book figures.

*Characteristics of a well managed store.

→ The store quantity should neither be too much as it would increase the storage cost and the material may get deteriorated.

→ The stock levels should not be 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 traffic.

Documents maintained :-

(i) Goods received Note (GRN) :- After receiving a stock of material the store keeper would issue a GRN acknowledging the receipt.

(ii) Gate pass :- A gate pass is raised every time a site vehicle goes out of the site.

(iii) Material Requisition Note (MRN) :-

The Subcontractors and any other person have to produce a MRN to get material from the stores. The form has to be authorized by the Supervisor incharge of the work.

(iv) Purchase order / Request order :- When a particular work has to be started the engineer in charge of the work prepa- -res a list of material required. If the list includes items that are not in the site stores it will either be transfered from another site or puchased by the head office and transfered. This requisition is placed by a puchase order prepared by the Engineer and includes all the details required to place the order.

(v) Bin Card :- This is maintained in the stores to record the movements of the stock level of all the items.

(vi) Invoices :- When a supplier directly supplies goods to the site he will produce a copy of an invoice raised by him. The invoices are filled and sent to the head office for billing.

(vii) Material storage :- More attention should be given to the material storage within the site premises. This should be done in order to prevent any damage, wastage

and to maintain working delays.

(viii) Storing of Cement :- Cement should be stored on a stage raised above the floor level to avoid hardening due to dampness of the floor.

(ix) Storing of reinforcement :- Care should be taken when storing steel to avoid mixing them with different sizes of steel bars and different sizes. They should be prevented from corrosion & mud.

(x) Storing of tools :- Tools & Equipments should be stored with security. This is because of these items are small and valuable.

→ According to public works department, the stores are classified into as following ~~classes~~ :-

(i) Stock.
(ii) Road Metal.
(iii) Machinery & equipment.
(iv) Materials charged to works.

UNIT :- 5

Management Information System :-

* Management information System is the endproduct of deliberate, Conscious and organised effort to determine and make available to the managers, the relevant and timely information in the desired form at reasonable cost in order to improve the mangerial effectiveness.

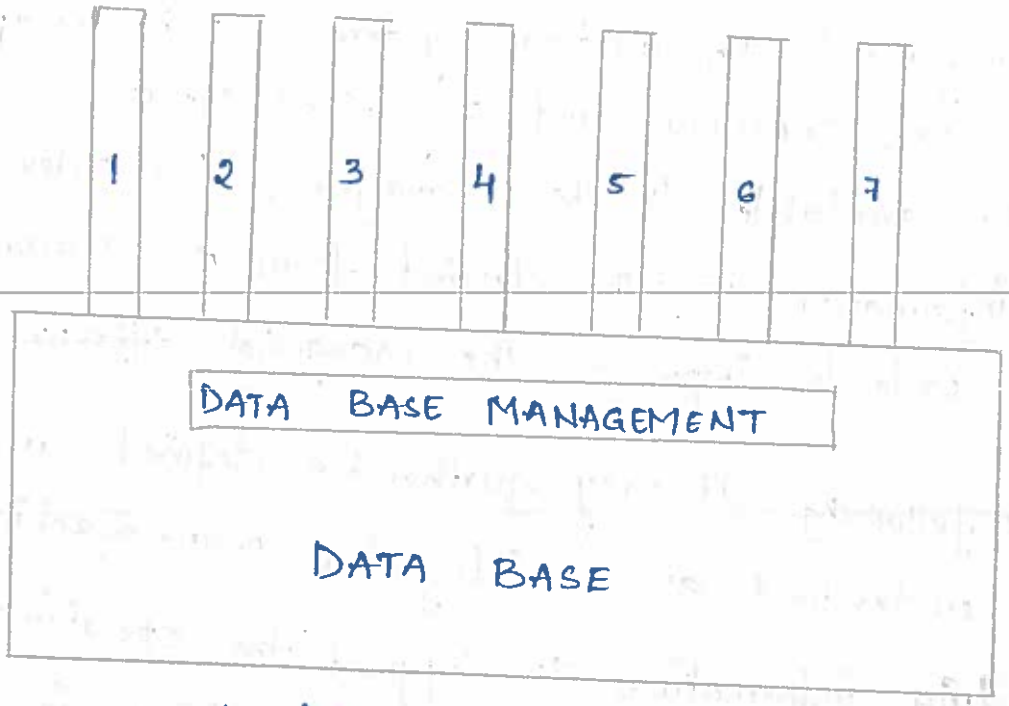
* The following It may further be defined as a term generally understood as an integrated man-machine System for providing information to support the operations of management and decision-making functions in an organisation. The System utilises Computer hardware and Software, Manual Procedures, management and decision models and finally database.

* The following diagram shows the Structure of MIS, emphasising the function of Organisational Subsystems.

⇒ Functional Subsystems Information :

1. Management.
2. Production.
3. Logistics.
4. Personnel.
5. finance and accounting.
6. Information processing.

7. Top Management



Structure of MIS

OUTLINES OF MIS :-

The management information System Consists of the following physical elements.

1. Computer hardware
2. Software. (a) Generalised System Software.
   (b) Generalised application software.
   (c) Application Softwares.
3. Data base.
4. Procedures.
5. operating personnel.

→ Protection against hazardous operation.
→ Protection for vital organs of the workers and other factors.

In general, legislation is necessary for the following reasons.

(i) To fix the terms of employment.
(ii) To provide proper working conditions.
(iii) To provide social security.
(iv) To maintain a cordial relationship between the employer and employees.

Laws relating to wages :-

This is regulated by the payment of wages Act (1936, amended-amended 1982) and minimum wages Act (1948, amended-1986).

Payment of wages Act :-

This Act was introduced to regulate the payment of wages, imposition of fines etc. The term 'wages' includes all remuneration including all allowances, bonus, notice pay etc., According to this Act, wages are to be paid promptly on a monthly basis and if any person is terminated from service, his wages should be settled within two days of the termination. this Act is applicable to employees having a salary less than Rs. 1600 per month.

This Act covers workers employed in hazardous jobs but does not include clerical and administrative staff. The Act provides for payment of compensation to the worker in case of accidents occuring at the work site.

However, the employer is not required to pay the compensation if the injuries are due to.

(i) negligence on the part of a worker by wilful disobedience of Safety and Security regulations.
(ii) non-observance of Safety measures and not using Safety guards.
(iii) Influence of liquor or drugs.
(iv) diseases which are not caused as a result of working on the job.

Welfare legislation :-

The various types of legislation available are more Suited for the organised manufacturing industries. Due to various reasons, the government is unable to come forward with legislation exclusively for the Construction industry. Legislation is important atleast to Safeguard some important provisions like daily

→ daily hours of work.
→ Rest periods.
→ Adequate Sanitary facilities.

Social Security :- It is regulated by following Acts:

Labour welfare fund act, 1965 and the workmen's Compensation Act, 1923 (amended 1984).

The provisions in the above acts are now discussed.

(i) Labour Welfare fund Act, 1965.

This Act provides for the constitution of a fund for the financing of activities to promote the welfare of labour. Establishment of state welfare Board, appointment of welfare commissioner and inspectors are all envisaged in this Act. The accumulations in the fund come from: all fines realised from Employees, unpaid wages to workers including gratuity and Bonus, grants and loans towards the fund, and any voluntary donations.

The amount in this fund is spent for welfare of the workers such as: Creating community and social education Centers, games and sports, tours and excursions, recreation and entertainment, developing home industries for women and unemployed labour.

(ii) Workmen's Compensation Act, (1923, amended - 1984)

This Act workmen's Compensation Act of 1923 provides for payment of compensation to workmen for injury by accidents sustained during the course of employment.

→ To deliver the information to them in time for consideration and decision making so that if necessary, corrective action may be taken on those operations that generated the data in the first place.

STATUS OF CONSTRUCTION LABOUR :-

The Construction industry is one of the largest industries in india and employs about 50 million skilled and unskilled workers.

→ workers in the construction industry are hired as and when required and are retrenched on completion of the work. Labour however is hired on a temporary basis and leads a migratory life, working on different sites.

→ The Economic Condition of Construction labour is the worst in our country on account of their poor bargaining power due to lack of unions, illiteracy and temporary nature of their employment.

→ Nobody Cares for the education of their children.

→ Article 24 of the constitution lays down that no child below the age of 14 years shall be employed to work in any factory or mine but still we have a large number of child workers in our country.

Computer as an Information System :-

Computers have become closely related to information System because data processing can be carried out much quickly.

1. Rapid data processing :- Computers can process data in a few minutes that would otherwise take days. This means that information data is reduced and that the Management has more information available in time to help in decision making.

2. Accuracy :- The computers can do many things with accuracy unlike manual methods that are more likely to get into errors.

3. Avoiding duplication :- A computer storage device can act as a common database for the entire organisation. Once information is collected, it can be stored and then used by any department needing it, thereby, avoiding any duplication of the information.

4. forecasting outcome :- Using mathematical models, computers can sometimes tell management what will be the results of the decision before it is actually made and this technique is, generally called "simulation".

5. Making Decisions for Management :- In some cases, many types of decisions are taken by computer instead of

the management, following a series of logical steps. These Systems are called "Expert Systems"

Requirements Of Management Information System :-

→ To provide an organised and efficient means of measuring, collection, verifying and qualifying data, reflecting the progress and status of operations on the project with respect to progress, cost, resources and quantity.

→ To provide a standard against which progress and cost can be compared.

→ To provide an organised, accurate and effective means of converting the data from the operation into Information.

(a) The means of processing the information

(b) The skills available.

(c) The value of the information compared with the cost of obtaining.

→ To report the correct and necessary information in a form which can be interpreted by management and at a level of detail most appropriate for the individual manager or Supervisor who will be using it.

→ To identify and isolate the most important and critical information for a given situation and to get it to the correct manager and Supervisor.

i) Deductions :- deductions are done for the following reasons on wages.

→ fines.
→ deductions for absence from duty.
→ deductions for damage or loss of goods by the Employee.
→ deduction for house rent, income-tax, water, electricity, provident fund, insurance.

(ii) Appointment of inspectors :- The state government may appoint inspectors of factories to inspect the implementation of the payment of wages Act and the employer shall provide necessary facilities for inspection.

(iii) Safeguards against fines and other Deductions :-

→ No fine shall be imposed on any employed person until he has been given an opportunity of showing cause against the fine.
→ No fine shall be imposed on persons below the age of 15 yrs.
→ fine should not exceed 3 percent of the wages payable to him.

(iv) Claims Arising out of Deductions from wages :-

The state Government can appoint a presiding officer of any labour court for the investigation and settlement of industrial disputes in force in the state or any Commissioner for workmen's Compensation or any other officer such as a judge of a civil court to hear and decide any claims arising out of deductions from the

wages or delay in payment of wages.

(v) Penalty for offences under the Act :-

If any person fails to pay the wages of any employed person by the date fixed by the authority in this behalf, he shall be punishable with a fine which may extend to Rs.100 for each day for which such failure or neglect continues.

Laws Relating to Bonus :-

Incentive is defined as "the stimulation of effort and effectiveness by offering monetary inducement or enhanced facilities". An incentive may be monetary or non-monetary depending on the requirement.

In the construction industry, many financial incentives schemes have been developed with the intention to motivate workers. These financial incentives may vary with the type of project, nature of task & employment teams of workers. Broadly, the financial incentive schemes can be divided in the following categories.

→(i) Time-related Schemes :- Employee is paid according to the overtime worked in proportion to the basic hourly wages and regulatory measures.

→(ii) Job-related Schemes :- Employee is paid according to the

Measurable Complete job.

(iii) Lump-sum work payment :- Employee is paid according to.

→ Time saved from standard time fixed for completing the job

→ A Lump-sum amount paid for completing the fixed quantity of a specified job.

(iv) Saving Sharing bonus :- These can be paid as bonus after a pre-determined time, Say, quarterly, half-yearly or yearly.

Labour insurance :-

Insurance laws are applicable only to regular employees In Construction industry most of the labour is of Casual nature and insurance laws are not applicable to them. For the welfare of casual labour, different Acts such as Minimum wages Act, compensation Act etc., are passed by the Government.

Payment of wages :-

The remuneration given to workers for work performed by them is known as wages.

There are two types of wages.

(i) Nominal wage :- This is the remuneration paid to

to the workee in the form of money, but it does not include the value of any other benefit that may be provided.

(ii) Real wage :- Labour is often entitled to different benefits such as leave, medical care, house rent allowance, bonus etc. If the value of such benefits is added to the nominal wage, it is known as real wage.

Wages are paid to the labour based on two methods:-

1) Depending upon time devoted to the work — This method is known as time rate system.

2) Depending upon the quantity of work performed — This method is known as piece rate system.

(1) Time rate system :- In time rate system of payment of wages, a suitable rate of payment is fixed per unit of time devoted to work by the labour. The unit of time can be hours, days, weeks or months.

advantages :-

(i) Simple & easily understood by labour.

(ii) Quality of work will be good.

(iii) workers do not get overstrained.

disadvantages :-

(i) Constant supervision is required.

(ii) Effective Cost Control cannot be ensured.

2) Piece Rate System :- In this system payment is made on the basis of the output of the workers. The work done by each labour is measured and payment is made at the agreed rate. Thus a workee can make more money by increasing his output. The rate of each item of work is fixed on the basis of the past record of output.

Social Security :-

Social Security covers the worker's dependents with certain payments. These can be the spouse, dependent children, and dependent parents.

Amount of the payments depends on several factors such as

(i) workee's earnings
(ii) Age and number of recipients other than workee.
(iii) State of health of dependents, etc.

Legislations related to Social security are

(a) Employee's State insurance Act 1948.
(b) workmen's Compensation Act 1923.
(c) The payment of gratuity Act 1972.
(d) The employee's provident fund and miscellaneous provisions Act 1952.

These are the important social security provisions in india.

Provisions for the welfare of the workers laid down by the factories Act 1948 :-

(i) Facilities for sitting :- Every factory must arrange suitable sitting and maintenance facility for all workers who are usually required to work in a standing position so that they may benefit out of the opportunity for rest which would take place in the course of work. (Section 44)

(ii) Washing facilities :- Facilities to the worker for washing must be given and maintained for the worker's use in the future. These must be conveniently used and shall be kept clean.

(iii) Facilities for storing & drying :- Provision of appropriate places for maintaining cloth not worn during the period of wet clothing.

(iv) First Aid Appliance :- According to (section 45) all the factories should possess at least one first-aid box with certain specified contents. In addition, to this there should be atleast one first-aid box for among 150 ordinary employed at the same time.

(v) Canteens :- According to Section 46. Canteens needs to present in those factories who holds more than 250 workers.

(vi) Shelter, Restroom & lunch rooms :- Every factory where its ordinary employed workers are more than 150 shall be provided with adequate and appropriate Shelters (or)

rest rooms and a proper lunch room with the facility of good drinking water where in the workers can eat meals brough by them.

→ These shelters, rest rooms, lunch rooms should be properly ventilated and lighted and shall must be managed in a well and clear conditions

(7) Creches :- According to section 48 every factory where its ordinary employed workers are more than ~~150~~ 30 shall ~~shall~~ be provided with ~~adequate and appropriate~~ ~~shelters or rest rooms and a proper lunch~~ suitable rooms for the use of children under the age group of 6 years.

→ Facilities must be provided to mothers such as feeding their children at appropriate time intervals.

(8) Welfare Officers :- (According to section 49)

→ The factory where its ordinarly employed worker are either 500 (or) more must appoint in the factory like the number of welfare officers as specified.

Objectives of Labour Welfare Measure :-

The primary aims of "Labour welfare work" is to provide the facilities and services to the workers which allow them to perform their job in healthy & sociable environment.

→ It aims to allows the workers to live the best of life with enjoyment, the workers to improve the efficiency.

Overcome the scarce to make oneself available.

→ It ensures the sense of responsibility and respect among workers so that the workers can become the worthy citizen of the nation.

⊛ Employee State Insurance act 1948 :-

→ The Employee State insurance Act, (ESIC) 1948 is a part of Social-welfare legislation which has approved mainly with the aim of offering benefits to the Employees during sickness, maternity and employment injury and also to make provision for some others matters.

→ Articles 41, 42 and 43 which encourage the state to make provisions which are effective in securing the right to work, to education and public assistance in cases of unemployment, old age, sickness and disablement.

→ The main objective of ESI Act is to give security to the give the employees during uncertainties which effect their earning capacities both temporarily & permanently.

⊛ Industrial disputes Act, 1947 :-

This Act came into force on 1st April, 1947.

The main objectives of this Act are :-

1) To prevent illegal strikes and lockouts

2) To promote measures for securing and preserving amity and good relations between the employer & the

and the employees, to minimise the differences and to get the dispute settled through adjudicatory authorities.

3) To provide relief to workmen in matters of layoffs, retrenchment, wrongful dismissals and victimization.

4) To provide a suitable machinery for investigation & settlement of industrial disputes between employers and employees, b/w employers & workmen, b/w workmen and workmen with a right of representation of employee registered trade union or by an association of employers.

(5) To give the workmen the right of collective bargaining and promote conciliation.

⇒ Authorities under the Act :-

The various authorities under the Industrial disputes Act are :-

(i) Works Committee.
(ii) Conciliation officers.
(iii) Board of Conciliation.
(iv) Courts of Enquiry.
(v) Labour Court.
(vi) Industrial Tribunals.
(vii) National Tribunals.

⇒ Strikes & lockouts :- A cessation of work by body of persons employed in any industry acting in combination or a concerted refusal under a common understanding of a

number of persons whose are or have been so employed to Continue to work or to accept employment.

⊗ Lockout :-

Lockout is the weapon of employer which is often used as a counter threat to the striking workers. A lockout means sto-pping the work and preventing the employees from working. If a part of trade union goes for strike then the employer declare a lockout till the worker end up the strike.

⊗ Layoff & retrenchment :-

Layoff means the inability or refusal of employer to Continue to employ the workers due to shortage of power, raw material or machinery or any other reason.

Retrenchment refers to the Stoppage of the services of a worker by an employer for different reasons other than disciplinary action.

⊗ Labour Administration :-

Labour administration deals with many activities such as preparing basic work, actual preparation, networking, Cooperating and coordination, facilitating communication, Verifying, assessing and monitoring labour policies and progra-mmes, the preparation and enforcement of labour laws and regulations and development enactment of standards in the labour field.

A strong and powerful labour administration system would,

(a) Be competent enough to respond to the rapidly changing economic and social conditions.

(b) Sustain the confidence level of employers and workers.

(c) Make a substantial contribution for enhancing the working conditions and also the national development.

(d) Build participation by social communication and tripartism.

(e) Gain credibility due to fairness of labour policies.

(f) uniformly applys the laws and regulations and makes everyone aware of it.

(g) Display the transpareney elements by openness in decision making.

(h) Offeithe labour administration services without any ~~admini~~ discrimination.

Different types of labour laws :-

The different labour legislations are divided in many ways based on the object of study.

They can even be divided on anyone of the arbitrary bases which are as follows.

(1) Purpose

(i) The working conditions regulation.

(ii) Social security i.e., protection against loss in earning & risks.

(iii) wages and bonus regulation.

(iv) Industrial relations & Conflict protection.

2. Legislature :-

Legislature involves central (or) state (or) even both.

3. Period of enactment :-

The period of enactment represents early days, pre-indepen-dence, and post-Independent.

The National labour Commission in its report has explained the labour laws under the following classification.

(i) Employment relations

(ii) Contract labour.

(iii) Laws on working conditions & welfare

(iv) Laws relating to wages

(v) Laws on social Security.

(vi) Miscellaneous matters.

Some of the Acts are

(1) The Regulation of working conditions

(a) The factories Act, 1948.

(b) The Shops and establishments Act, 1953.

(c) The Contract labour Act 1970.

The other legislations which are included under this are

→ The Indian Rock Labourers Act, 1934,

→ The inter state Migrant workmen Act, 1979,

→ The motor transport workers Act 1961.

→ The Sales promotion employees Act 1976,
→ The mines Act, 1952.
→ The child labour Act, 1986,
→ The plantation labour Act 1951,
→ The Beedi & cigar workers Act 1966,
→ The cine workers and cinema theatre workers Act 1981.

2. Legislations Related to wage and Bonus.

(a) The payment of wages Act 1936.
(b) The minimum wages Act 1948.
(c) The payment of bonus Act 1965

3. Industrial Relations and Conflict prevention

(a) The Industrial disputes Act, 1947.
(b) The Industrial employment Act, 1946.
(c) The Trade unions Act, 1926.

OBJECTIVES OF LABOUR LAWS :-

(1) To create justice relating to social, political & economic.
(2) To protect the weaker sections of the community.
(3) To develop economic growth conditions.
(4) To protect & improve the standards of labour.
(5) To safeguard the workers from any form of exploitation.
(6) To assure human rights and human dignity.
(7) To maintain industrial peace.

#Construction industry and Safety :-

Construction is a high hazard industry that comprises a wide range of activities involving construction, alteration, and/or repair. Examples include residential construction, bridge erection, Roadway paving, excavations, demolitions, and large scale painting jobs.

Construction workers engage in many activities that may expose them to serious hazards, such as

→ falling from rooftops.
→ unguarded machinery
→ being struck by heavy construction equipment, electrocutions, Silica dust and asbestos.
→ Injury caused due to projects reinforcing steel bars.

Various Hazards Associated with construction are :-

(1) The usage of defective and unsafe equipment.
(2) If the labours don't use helmets they may get injured by the stones, timber blocks and other materials falling from high construction levels.
(3) The heavy equipments like excavating machinery, trucks, dumpers should be handled carefully and maintain sufficient distance from the quarried area.
(4) The condition of the vehicles used to transporting explosives should be good.
(5) In the process of blasting, if the wires are not insulating properly, then the persons handling it may get

Electric shocks.

(6) The hot bitumen may cause Severe accidents to the workers if they don't use protective wares like gloves, goggles, boots and helmets

(7) negligence in checking the equipments used like cranes, derricks, hoists during erection works may cause accidents to the workers.

(8) In high rise buildings, the risk of the fire hazard is more.

(9) Demolition works done at night times in the inhabited area may lead to Secure accidents.

(10) If danger sign is not displayed at the required locations for example at poles, over head electric lines, conductors used at the site, it may lead to accidents.

Types of hazards at construction sites :-

(i) chemical hazards :- A heath hazard can affect the entire body or many organs, or affect only specific tissues, organs, or parts of the body.

(ii) physical hazards :-

- → Noise
- → Vibration
- → Temperature extremes
- → Radiation

(iii) Biological hazards :-

- → Soil
- → water
- → Insects
- → animals
- → structures

⇒ Ergonomic Hazards :-

Ergonomic hazards can cause painfull and disabling injuries till example Muscoleskeletal disorders (MSDs)

This following Situation may cause these injuries.

→ heavy, frequent or awkwaid lifting.
→ repetitive tasks.
→ awkwaid grips, postures.
→ using excessive force, overexcaltion.
→ using impropely maintained tools.
→ hand intensive work.

⇒ Precautions to be taken for safety are :-

→ precautions against fire safety
→ precautions against transportation
→ Precautions against handling the material
→ precautions against excavation
→ precautions for concreting.
→ prepcautions for flooring.
→ precautions against blasting works
→ Precautions against electrical safety
→ precautions against pesonal safety.
→ precautions against welding & flame cutting. etc.,

Costs of Accidents :-

(i) Direct costs &
(ii) Indirect costs.

→ Direct costs :- The direct costs are insurance. These include medical costs and other workers' compaison insurance benefits as well as liability & property-damage insurance

→ Indirect costs :-

→ Transportation costs :- include the cost of emergency transportation together with the cost of other personnel that were necessary.

→ wages paid to injured worker fortime not worked :- include all the time in which the worker was not acttually doing his or her job and for the wages paid.

→ cost Incurred because of delays which resulted from accident.

→ Costs of overtime necessiated by accidents :- overtime occu-rred because of the accidents

→ Loss of efficiency of crew :- decrease of crew efficiency due to low morale or reshuffling that might occur to replace an injured worker.

→ cost to break in and/or teach replacement worker - Hiring new worker would include training and orientation Costs for clean-up, repair or replacement and stand-by costs.

→ costs to reschedule work :- Include time spent to review and reschedule the project due to investigations or project being temporarily Suspended by the authorities.