KIIT POLYTECHNIC

LECTURE NOTES

ON

CONSTRUCTION MANAGEMENT

Compiled by

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CHAPTER-1

INTRODUCTION

1.1 AIMS AND OBJECTIVES OF CONSTRUCTION MANAGEMENT:

Construction management is a managerial process involved in construction industries like management of labour, material and equipment to minimize the project cost and project duration and also to optimize the quality of works. Construction management provides necessary leadership, motivates employees to complete the difficult tasks well in time and extracts potential talents of its employees.

Objectives:

The main objectives of construction management are:

- The work should be executed most economically.
- The work should be executed as per specifications.
- The quality and workmanship of the work should be good.
- The work should be planned and organized properly.
- The work should be properly supervised by qualified and trained staff.
- The work should be completed with in the specified estimated cost and time.

1.2 FUNCTIONS OF CONSTRUCTION MANAGEMENT:

The functions of construction management are:

(i) **Planning:** It is a process of determining in advance what is to be done, where, when and by whom. Defining goals, establishing a strategy for achieving those goals and developing a plan to integrate and coordinate activities.

(ii) **Organizing:** It is a process of determining what task are to be done, who is to do them, how the task are to be grouped who report to whom and where decision are to be made. The purpose of organizing is to help to create an environment for human performance.

(iii) **Staffing:** It involves filling and keeping filled the positions in the organization structure. Recruiting the right people, arranging staff training courses and carrying out proper staff assessment are all part of the staffing function.

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

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

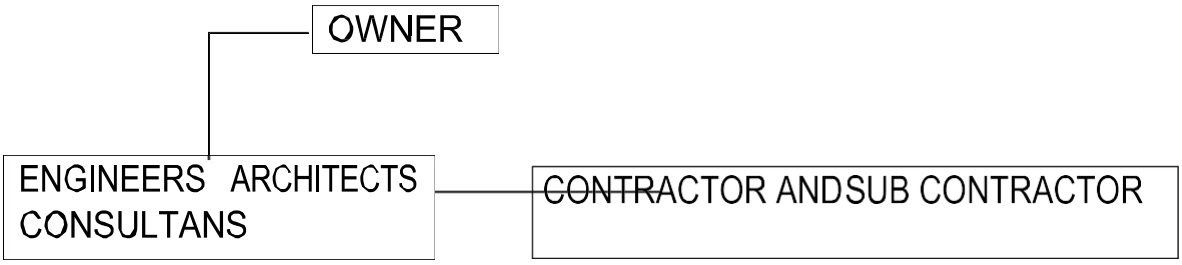
(v) **Controlling:** Controlling is necessary for ensuring effective and efficient working. It involves a constant review of the work plan to check on actual achievement and to discover and to rectify deviations through appropriate corrective measures. The essential steps in management control are:

- Measurement of actual performance in terms of progress, quality and cost incurred;
- Comparison of actual and planned performance

(vi) **Co-coordinating:** Since authority converges to the top of the organizational pyramid, it is necessary to bring together and co-ordinate the work various departments and sections. This requires and efficient system of communications that each department and section is aware of its role and the assistant to be expected from others. Regular meetings of departmental/sections head with top management are fundamental to proper coordination ,so that plans, problems and remedies are discussed for determining the best solution.

1.3 THE CONSTRUCTION TEAM COMPONENT:

- For civil engineering project a construction team is composed of owner, engineer/architects and contractor.
- The object of the team is convert owners conceptual into a reality.
- The owner forms the construction team to survey his interests through the services of both the contractor and the team of engineer.
- The function of the constituents of any team depends upon the scope and nature of the project.



Owner:

The owner may be an individuals or group of individuals, private or public sector company. The owner is the ultimate authority over the project. All the power of decision making regarding managerial financial and administrative aspects is invested in him. He is responsible for the fund and other resource of the project.

Engineer:

It includes the empowered construction engineers who are socially responsible for the project management, store control inspection and quality assurance, construction supervision, cost control and such similar assets. It also includes architect, structural engineer, quantity surveyor, mechanical and electrical engineer, specialists such as structural constant, safety and maintenance planner, soil investigator.

- Architects-The duty of architects is to assess the owner's functional requirements and prepare plans and specification for the purpose.
- Structural engineer-The structural engineer is to prepare structural design as for requisite loads through technical design and to prepare working drawing which is handed over to construction engineer.
- Mechanical Engineer-He is responsible for mechanical services associate with the project during and after construction.
- Electrical Engineer-He is concerned with the preparation of working drawing for electrical power and distribution system during and after construction.
- Quantity Surveyor-His duty is to,
    - Estimate the cost of work.
    - Prepare bill of quantities and tender document.
    - Asses the extra cost due to special features.
    - Prepare the cash flow statement during construction.
    - Prepare the final accounts on completion of the project.
- Specialist-They have to perform specialized work entrusted to them. such as soil investigator collect information regarding soil for the proper design of foundation.

Contractor:

- The contractor may be an individual undertaking small contracts or a large construction company undertaking turn –key projects.
- Contractor whether small or big needs the services of qualified engineers. Some of the engineers employed by the contractor deal with office work such as designing, tendering, scheduling etc. and others known as site engineers are concerned with the actual execution of work such as surveying, leveling, construction & billing.
- He has to collect rates of materials and labour to determine the time rate.
- It is duty and liability of a contractor to follow the labour act.
- It is duty of contractor to safeguard his own men and material.
- He should finally handover the completed work to the owner and get the final payment, adjusting the running bill accounts.

1.4 RESOURCES FOR CONSTRUCTION MANAGEMENT:

Constitutional i.e. creation in the form of finished product is the direct result of using various resources in the most effective ways. The various resources being used in the construction project can be enumerated as,

(i) MANPOWER
(ii) MATERIAL

(iii) MACHINARY
(iv) MONEY
(v) SPACE

(i) ***Manpower:***

- Manpower in the form of technical and managerial personnel and work force in various trades is essential to carry out project activities.
- Technical 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 work force consists of skilled and unskilled workers.

(ii) ***Materials:***

Materials such as bricks, stones, cement, aggregate, steel, shuttering, scaffolding, timber, water supply, sanitary and electrical fittings, petrol, oil, lubricant, etc. are required for construction.

(iii) ***Machinery:***

For any construction work, various plant/equipments and tools are required. Depending on the type and nature of the construction job, machinery required at site includes batching plant , mixer, tractor, excavators, dumpers, cranes, pumps, generator, workshop equipments etc .Power is an essential resource required for lighting, running the plant equipments 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.

(v) ***Space:***

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

- Storing materials.
- Providing yards for bar benders, carpenters, installation of equipment and plant, repair workshops, casting yards etc.
- Site office, labour camp etc.

CHAPTER-2

CONSTRUCTIONAL PLANNING

2.1 IMPORTANTS OF CONSTRUCTIONAL PLANNING:

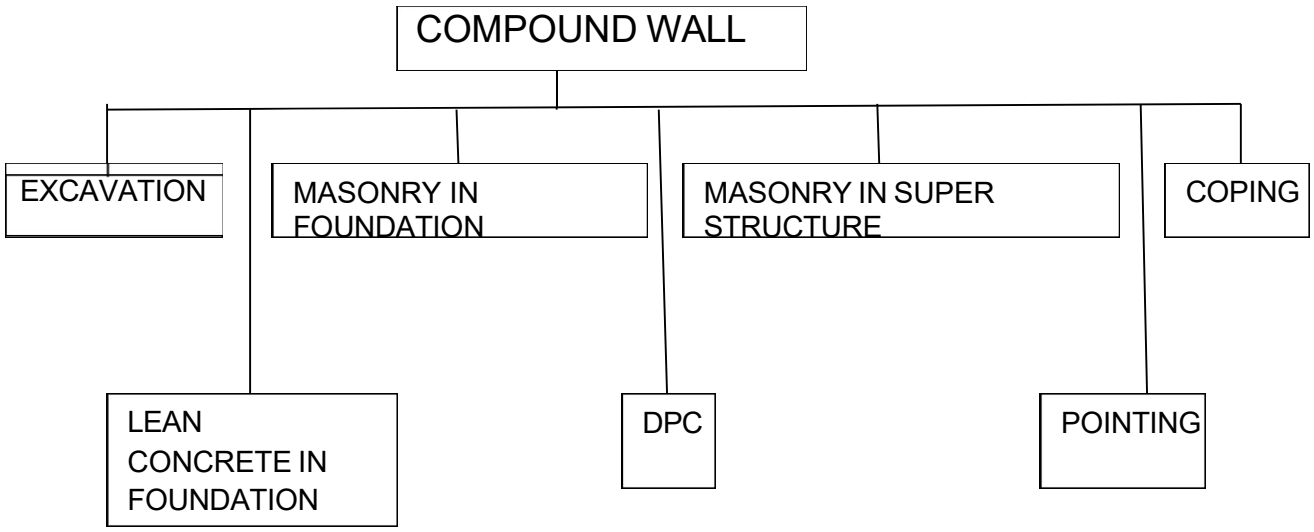
The need for better construction practice, systematized planning and programming of works and effective management in the industry is therefore the demand of the day.

Constructional planning is the first step of the construction management. The construction planning of a civil engineering project must consider the wide range of aspect involved, site investigation, market survey, bidding of the works, post tender negotiation and agreement planning for the works monitoring and controlling the progress of work during the execution up to the completion of the work, even its maintenance during the stipulated period.

2.2 DEVELOPING WORK BREAKDOWN STRUCTURE FOR CONSTRUCTION WORK:

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

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



(Work breakdown structure)

of a compound wall)

2.3

CONSTRUCTION PLANNING STAGES:

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

- *Pre-tender Stage*
- *Post tender Stage*

Pre-Tender Stage:

Pre-tender planning is broad based and is carried out by the contractor. It is the stage in which a contractor has the best opportunity of planning his likely method of construction for the future contract and prepares a realistic programme for carrying out the work. This stage enables the contractor to make a proper bid and prepare him for completing the work in the stipulated time. During this stage, the contractor's main aim is to see whether the contract under consideration is profitable or not. Before a contract is undertaken, the contractor is required to visit the site of construction work.

Pre –tender planning includes the following steps:

- Examining drawings and specifications to identify various items of work.
- Carrying out site investigation and market survey to assess the availability and rates of materials, manpower, machinery and other facilities.
- Identifying alternative methods of executing the work for selecting the most suitable4 and economical method.
- Estimating the quantities of different items of work and the time required for their completion.
- Preparing the tentative construction schedule with reference to the stipulated time of completion.
- Deciding the overheads and margin of profit and finalizing the tender price for completing the work within the stipulated time.

Post-tender stage:

Post-tender stage is also called Contract stage or construction stage. This stage commences with the acceptance of the tender and extends till completion of the contract. After the pre-tender stage, the contractor has to undertake detailed planning to organize various activities of construction work so that the project may be completed within the scheduled time. Post-tender planning is used in chalking out specific details for execution of the project. Inadequate planning at this stage inevitably results in delays leading to heavier expenditure than originally estimated.

Post-tender stage planning involves the following steps:

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

Good communication between various members of the construction team is essential to complete the project within scheduled time. Proper co-ordination between members of the construction team voids the possibility of delays at various stages of the work. Various alternatives have to be considered in derail to ensure proper utilization of project resources, leading to the greatest economy in cost. Construction programme is depicted in the form of charts which can be readily understood by workers, supervisors and construction managers. The programme provides information regarding the date and time of starting and completing different items and activities of work including working drawings, staff recruitment, supply orders, delivery of materials etc.

2.4 CONSTRUCTION SCHEDULING BY BAR CHARTS:

Scheduling is the process of fitting the work plan to a time frame indicating the start and completion each activity. It also shows sequential relationships among various activities.

The construction schedule is a tool that a contractor uses to manage time and execute activities in a proper sequence. To prepare a construction schedule, the project is divided into different activities or operations. The sequence of operations can be decided after knowing their inter-relationship as per the construction method adopted.

The conventional method of scheduling used in the construction industry is the bar chart. It is also known as Gantt Chart after Henry Gantt. Who developed this technique around 1900. A bar chart consists of two co-ordinate axes, one showing the time and the other showing jobs or activities to be performed. Each job is depicted in the form of a horizontal line or bar and the length of a bar indicates duration of the job or activity. In a project, some jobs are taken up concurrently and some are required to be completed before other can begin. Thus, in a bar chart, some of the bars run parallel to each other and some run serially with one bar beginning after the other bar ends. The level of detail of the activities and the unit of time is determined by the intended use of the bar chart.

Activities *Time (Days)*

Lay out and excavate (foundation)	5
Place lean concrete	1
Fabricate shuttering	3
Cut and bend reinforcement	4
Fix reinforcement	2
Fix shuttering	1
Pour concrete	1

The activities of 'layout and excavate foundation', 'fabricate shuttering' and 'cut and bend reinforcement' can tart simultaneously as these activities are independent of each other. These activities being concurrent are shown by parallel lines or bars in the chart (Fig. 33). Activity 'peace mud-mat(lean concrete)' can only start after completing the activity 'layout and excavate foundation'. These two activities being in series are depicted in the bar chart one after the other. Likewise, 'fix reinforcement' can only be taken up after placing mud-mat (lean concrete). 'fix shuttering' follows the fixing of reinforcement. These activities, being in series, are shown one after the other. 'pour concrete' is the last activity which follows the fixing of

shuttering and being in series, is shown as such in the bar chart.

Bar charts are easy to prepare and to understand. The progress achieved at site in respect of any activity may be shown on the bar chart by drawing a coloured line under the planned bar or line of that activity. The progress achieved is generally indicated on the coloured lined as a percentage. Bar chart may, therefore, be used for monitoring the progress of work.

Bar charts may also be used for depicting the resource requirements of a construction job.

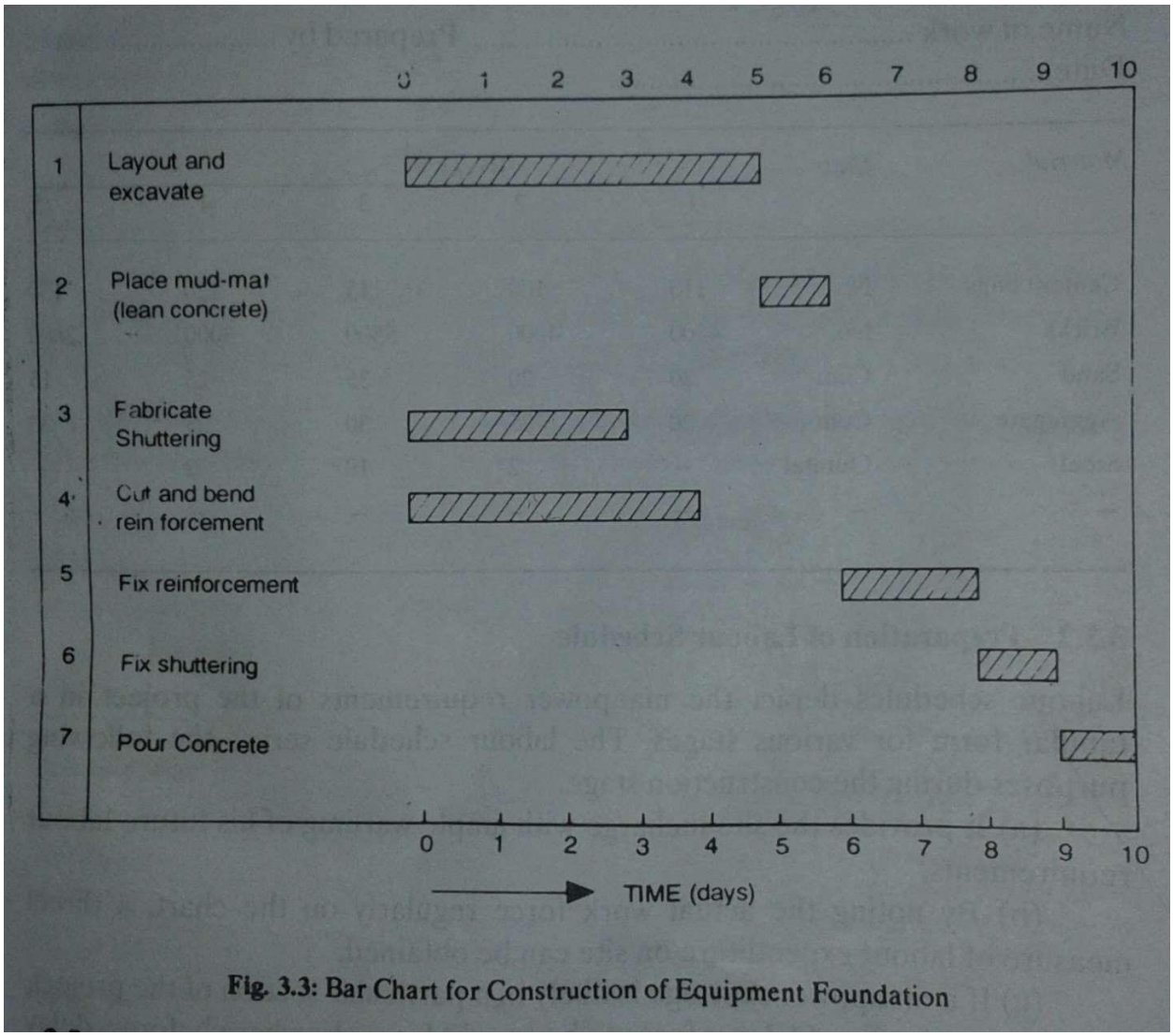


Fig. 3.3: Bar Chart for Construction of Equipment Foundation

2.5 PREPARATION OF MATERIAL, EQUIPMENT, LABOUR AND FINANCE SCHEDULES:

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

2.5.1 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 to shortage of materials can be avoided by using a material schedule. The material schedule may be prepared either month wise or week wise depending on the extent of the project and storage space.

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

Name of work..... Prepared by…….....
Date…….

Material	Unit	Weeks				
5		1	2	3	4	
Cement bags	No.	110	100	115	120	130
Bricks	No.	4500	4000	5500	3000	2600
Sand	Cum	20	20	35	25	15
Aggregate	Cum	20	35	30	25	30
Steel	Quintal	_	2	10	2	-
-	-	-	-	-	-	-

2.5.2 *Preparation of Labour Schedule*

Labour schedules depict the manpower requirements of the project in a tabular form for various stages. The labour schedule serves the following purposes during the construction stage.

- It provides the site in charge with ample warning of his future labour requirements.
- By noting the actual work force regularly on the chart, a direct measure of labour expenditure on site can be obtained.
- 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.
- It helps in efficient and optimum deployment of the labour force in various sections of the project.

Nameofwork……Preparedby……
……
……Date……..

Manpower	Weeks				
	1	2	3	4	5
Fore man	1	1	1	1	1
Carpenter	-	-	-	1	1
Welder	-	-	3	2	1
Mason	1	1	2	2	1
Mixer operator	-	-	-	-	-
Labourers	3	3	10	6	3
-	-	-	-	-	-

2.5.3 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.

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
-	-	-	-	-	-

Such a schedule enables the efficient and optimal utilization of plant and equipment on a project. Using this schedule, timely arrangements can be made for renting or deploying particular equipment at a particular time.

2.5.3 Preparation of Finance Schedule

Finance schedules are essential both for the pre-tender and construction stages. A finance schedule shows the amount of cash required at different stages of the construction project. It enables long-term financial planning for the entire project to be carried out in an efficient manner. It also considers cash inflow from the running bills and indicates finances required for the successful completion of the project. The finance schedule for the construction of a temporary shed.

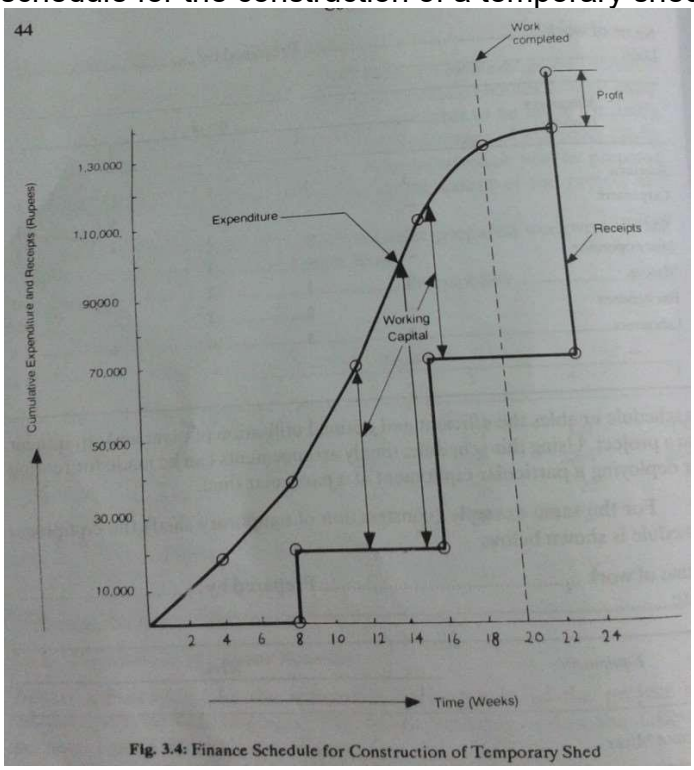


Fig. 3.4: Finance Schedule for Construction of Temporary Shed

2.6 LIMITATIONS OF BAR CHARTS:

Limitations of bar charts are as follows:

- *Interdependencies of activities*

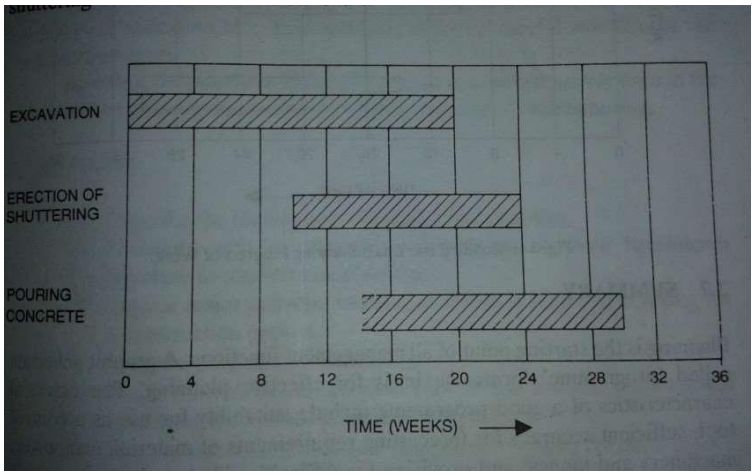
  A construction project consists of a large number of activities. The bar chart does not show clearly the interdependencies among the various activities. This is a major deficiency. The mere fact that two or more activities are scheduled to start at the same time, does not make them interdependent or completely independent.

  Consider a construction project involving excavating foundation, fixing shuttering and concreting in which the time consumed by each activity is as under:

Excavating foundation	20 weeks
Fixing shuttering	14 weeks
Concreting	16 weeks

If the activities are taken up in a series, the total time taken for completion of project will be 50 weeks. As we can easily see, fixing of shuttering may start after the completion of say half of foundation excavation. Similarly, concreting may start say 5 weeks

after fixing of shuttering. The bar chart of these activities is shown in figure 3.5. As per the bar chart, fixing of shuttering still has 4 weeks of work after excavation is over. If, however, excavation is delayed by 1 or 2 weeks due to unexpected difficulties, its effect on fixing of shuttering is not clear from the bar chart.



- *Project Progress*

  A conventional bar chart cannot be used as an efficient control device because it does not show the progress of work. A knowledge of the quantum of work completed or progress achieved is essential in any project. A conventional bar chart can be made more useful by modifying it as shown in figure 3.6. In the modified bar chart, the progress of work can be depicted by colouring/hatching blank bars. For example, on reviewing the progress after 16 weeks of the project, excavation work is observed to be 2 weeks behind schedule as shown in figure 3.6.

- *Quantities of items of work*

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

- *Critical Activities*

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

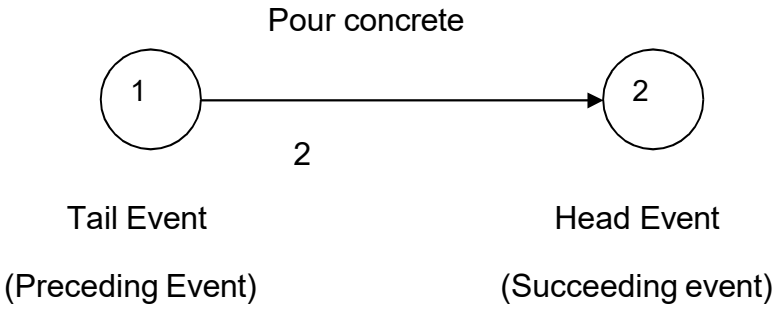
2.7 CONSTUCTION SCHEDULING BY NETWORK TECHNIQUES:

Defination of terms:

(a) ***Activity:*** An activity is the performance of a specific task, operation, job or function which consumes times and resources and has a definite beginning and end. An activity is graphically represented by an arrow drawn from left to the right. The length, shape and orientation of arrow have no significance. For example excavate foundation, lay brick work, backfill trench, fix shuttering etc are all activities.

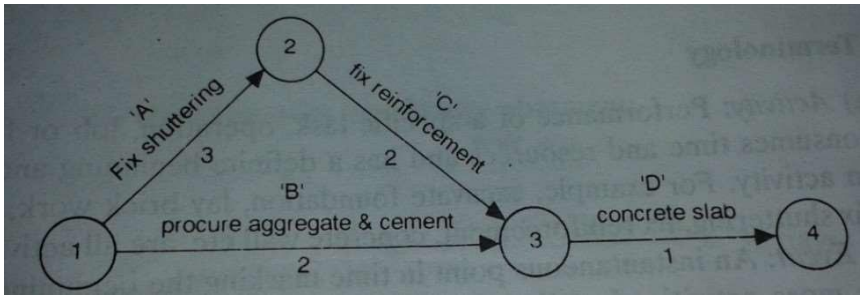
(Representation of Activity)

(b) ***Event:*** Event (also called NODE) represents instant in time when certain activity has been started or completed. In other words an event describes start or completion of task. It is represented by a number enclosed in a circle. The beginning of an activity is marked by a tail event or preceding event and the end by a head event or succeeding event. While drawing network, it is assumed that, time flows from left to right.



(Representation of Event)

(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 or succeed others.



PERT AND CPM TECHNIQUES:

Network techniques are effective tools for planning and scheduling and controlling construction jobs. Network techniques provide a rational approach to the planning and construction work. The allocation of such techniques inevitable when there is a constrain or resources and need for higher productivity. The two commonly used network technique are CPM and PERT.

- CPM Stands for Critical Path Method
- PERT stands for Programme Evaluation and Review Technique.

Advantages of CPM and PERT network:

CPM and PERT network are very powerful tools and facilitate the work management in the various phases of the project by the following ways:

Planning Phases: Planning is the process of choosing a particular method and order of work to be adopted for a project from all the various ways and sequences in which it could be done. The sequence of steps required to achieve the optimum result is the proper plan for the works and is shown schematically on the network diagram. Furthermore, it permits the ready evaluation and comparison of alternative works and helps in choosing the best plan based on minimum cost and minimum time.

Organizing Phase: It helps in awarding the contract to the best and efficient contractor because the network of the project furnished by the contractor along with the tender is the mirror image of the resource capacity of the contractor and the methodology of the project.

Scheduling Phase: Scheduling is the determination of timing of the operations comprising the project which helps in the preparation of various calendars, such as; from the starting date to the finishing date, the delivery time of the materials used in the project is clearly mentioned on material calendar.

Controlling and Monitoring Phase: Network facilitates in controlling the execution of the project activities to ensure timely completion of the project through periodical reviewing and applying corrective measures.

Evaluating Phase: After the completion of the project, the planned and actual tie and cost are compared, the reasons for deviation are analyzed and specific difficulties while execution are highlighted. These reports are made available to the executive for use in future projects.

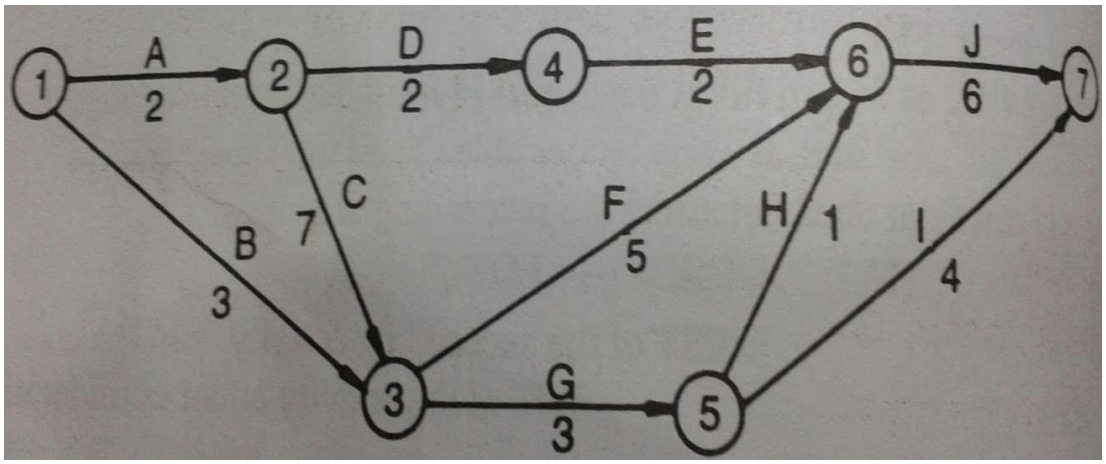
A comparison between CPM and PERT is given below:

CPM	PERT
(a) CPM is activity oriented.	(a) PERT is event oriented
(b) Single time estimates are used for the various probabilistic. The activities i.e. the time estimates are determi- used for nistic.	(b) The time estimates for activities are following three type of time estimates are each activity: (i) Optimistic time (ii) Pessimistic time (iii) Likely time
(c) CPM is used for repetitive types of projects i.e. projects where the time estimates for various activities prior are either known or can be determined accurately.	(c) PERT is used for pioneering type of project which are the first of their one kind
(d) CRM places emphasis upon optimizing alloca-	(d) PERT lays emphasis on reducing project completion

tion of resources and minimizing overall constraint.	time without cost project cost.

NETWORK ANALYSIS:

(a) *Earliest start time (EST):* The earliest start time is the earliest possible time at which an activity can start.
(b) *Earliest finish time (EFT):* The earliest finish time is the earliest possible time at which an activity can finish.
(c) *Latest start time (LST):* The latest start time is the latest possible time by which an activity can start without any delay of project time forecast on the basis of earliest occurrence time to the final event.
(d) *Latest finish time (LFT):* The latest finish time is the latest possible time that an activity can finish without any delay in completion of the project.
FLOATS: Float indicates the range within which the start and finish time of an activity may vary without affecting the completion time of the project.
(a) *Total float (TF*) of an activity is the excess of the maximum available time over the activity time.
(b) *Free float (FF)* of an activity is the excess of available time over the activity time when all jobs start as clearly as possible. The term “free” indicates that the use of this float does not affect the succeeding activities.
(c) *Independent float (IF)* of an activity is the excess of minimum available time over activity time. In some cases the absorption of this float neither predecessor nor successor activity that’s why, it is called independent.
Exp. 1. Find the critical path and project duration of the given CPM project. Also calculate EST, EFT, LST, LFT and TF, FF, IF in a tabular form.


1
A
2
2
D
2
4
E
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C
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H
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Solution:

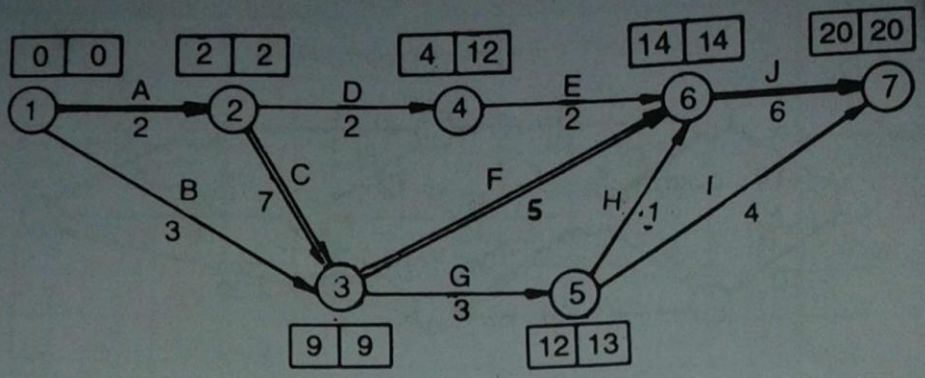


Fig. 1.29

Project duration = 20 days

Critical path = 1 – 2 – 3 – 6 – 7 or A – *C* – *F* – *J* .

(Shown by double line in the Fig. 1.29)

Event time comprising EOT & LOT has been indicated in the respective time box of each event.

Calculations of EST, EFT, LST, LFT & TF, FF, IF, INT. F are presented in the following tabular form: (Table 1.4).

TABLE 1.4 SCHEDULING

Activity	I-Node	J-Node	Duration (days)	Activity Time (days)				Float (days)				Remarks
				EST	EFT	LST	LFT	TF	FF	IF	INT.F	
A	1	2	2	0	2	0	2	0	0	0	0	Critical
B	1	3	3	0	3	6	9	6	6	6	0	
C	2	3	7	2	9	2	9	0	0	0	0	Critical
D	2	4	2	2	4	10	12	8	0	0	8	
E	4	6	2	4	6	12	14	8	8	0	0	
F	3	6	5	9	14	9	14	0	0	0	0	Critical
G	3	5	3	9	12	10	13	1	0	0	1	
H	5	6	1	12	13	13	14	1	1	0	0	
I	5	7	4	12	16	16	20	4	4	3	0	
J	6	7	6	14	20	14	20	0	0	0	0	Critical

CHAPTER-3

3.0 MATERIALS AND STORES MANAGEMENT

Definition

The International Federation of Purchasing and Materials Management accept the definition of materials management given below.

According to it, materials management is a total concept having its definite organization to plan and control all types of materials, its supply , and its flow from raw stage to finished stage so as to deliver the product to customer as per his requirements in time. This involves materials planning , purchasing , receiving, storing, inventory control, scheduling, production, physical distribution and marketing. It also controls the materials handling and its traffic. The materials manager has to manage all these functions with proper authority and responsibility in the material management department.

3.1 CLASSIFICATION OF STORES.

Scientific classification of various items of stores is essential for a good system of store keeping. Materials in stores are classified either on the basis of their nature or on their basis of their use. The former method of classification is most commonly used. For example the material may be classified as construction materials, consumable stores, spare parts, abrasives, lubricating oils , etc. After dividing all items of stores into various classifications, the next step is to codify alphabetically or numerically each item of stores by giving it a distinctive stores code number. Decimal system of codification is more commonly used. Under this method of codification, the whole numbers are used to indicate the main group and decimals to indicate primary, secondary and other groups. For example materials may be classified as follows.

Section body -1 i.e., main code consists of first two digits.

Section body -2 i.e., sub-code consists of the next two or three digits depending upon the requirement.

Section body -3 i.e., details of the sizes, quality etc. Last one or two digits depending upon the requirement

Following are the advantages of a system of classification and codification.

(i) It helps in material control.

(ii) It gives the advantages of abbreviation because lengthy description of an item of stores replaced by a distinctive store code number.

(iii) A coding system helps, in the maintenance of mechanised accounts.

(iv) Secrecy of descriptions can be maintained because a distinctive store code number (amd not description of the item of stores) is used.

(v) The biggest advantage of codification is the distinctive code given to each item of stores and avoidance of duplication due to multiple names which results in a reduction of items of stores carried.

(vi) It facilitates the identification of various items of stores resulting into prompt issue of stores. This is particularly useful in those cases where the same material is known by more than on name.

TYPES OF STORES

There are two types of stores contingent on the following considerations;

1 . FUNCTIONAL – depending on the use to which material is put –chemicals, tool, raw materials stores etc.

2 . PHYSICAL – depending upon its size and location- central stores, decentralises store and central stores with sub-stores. These are discussed below;

(A) Centralised Stores: - The usual practice in most of the concerns is to have a central store. In case of such a store, materials are received by and issued from one stores department. All materials are kept at one central store. The advantages and disadvantages of this type stores are as follows;

Advantages :-

1. Better control can be exercised over stores because all stores are housed in one department.

2. Better layout of stores is possible.
3. Less storage space as store are kept to a minimum.
4. Investment in stocks is minimised.
5. Economy in cost. Examples are reduced clerical costs and economy in records are stationery
6. Economy in staff and concentration of experts in one depertment will lead to development of high technical skill.
7. Less botheration in inventory checks as the stores are located in one place.

Disadvantages :-

1. This system of stores increases transportation costs because one central store may not be near to the every department of the factory.
2. Delay and inconvenience may be caused to departments (situated at a distance from the central store) in drawing materials from the central stores.
3. Greater risks of loss in case of fire because all items of stores are kept at one place.
4. Breakdown in transport may stop production in departments because of difficulty of getting materials from the central stores.

(B) Decentralised Stores:-

Under this type of stores , independent stores are situated in various departments. Handling of stores is undertaken by the shopkeeper of each department. This department requiring stores can draw from them their respective stores situated in their departments. The disadvantage of centralised stores can be eliminated if there are decentralised stores. Such type of stores set up to meet the requirements of materials of each production department are not popular because of the heavy expenditure involved.

(C) Centralised Stores with Sub Stores

In large factories, departments are situated at a distance from the central stores; so in order to keep the transportation cost of handling charges to minimum, sub-stores (in addition to the central stores near the receiving department) should be situated near the production department.

For each item of materials, a quantity is determined and this should be kept in stock in sub-store at the beginning of any period. At the end of a period, the shopkeeper of each sub-store will requisition from the central store the quantity of the material continued to bring the stock upto the predetermined quantity. In short, this type of store operates in a similar way to a petty cash system ; so this system of stores is also known as the imprest system of store control.

3.2 Issue of Materials

Purchase requisition or indent

The purchase officer does not initiate any action for the purchase of items on his own accord. With the help of purchase requisitions, the purchase officer comes to know the types of materials or items needed in the organization.

The purchase requisition is received from the following sections.

(i) from office section to purchase the office equipment.

(ii) from advertising department or sales or research section.

(iii) from planning and pattern department for castings.

(iv) from production department to purchase the plant and machinery or any other equipment.

(v) from store section for regular stock materials

A purchase requisition is a form used as a formal request to the purchasing department to purchase items. This form is prepared by the storekeeper for regular stock materials and by the department head for special items not stocked as regular items. The requisition is provided by an executive, such as the plant superintendent or works manager.

The purchase requisition is generally prepared in triplicate. The original copy is sent to the purchasing department, the duplicate is kept by the storekeeper or the department which initiates the requisitions and the triplicate is sent to the authorising executive.

The purchase requisition initiated by the storekeeper for regular items of materials is called regular purchase requisition and the purchase requisition and purchase requisition prepared by the department head for special materials is known as special or occasional purchase requisition. Regular purchase requisition are prepared when the item of materials reach at the ordering levels, i.e. the level at which the order for fresh supply should be placed. This is done so that there may be no shortage of materials and production may not be held up for want of materials. The specimen form of a purchase requisition is given below.

It is clear from the specimen of the purchase requisition that it provides the following three basic informations which assist in the work of purchase department

a. What type of material is to be purchased?

b. When is to be purchased?

c. How much is to be purchased?

The purchase department is to make timely purchases to avoid the situation of rush orders to the extent possible because it costs more to make purchases by rush orders. The purchase department should be in constant touch with the suppliers, the market trends and socio-political conditions so that timely steps may be taken to procedure the items. Anticipating advance needs will determine the kind of order.

Swadeshi Company Ltd.

Purchase Requisition or Indent Regular

No. .... Date .....

Special

Date by which materials are required .....

Serial No.	Description of Articles	Store Code No.	Quantity Required	Remark

Requested by ..... Approved by .....

For use in purchase Department
Quotations invited on .....
From : 1. .....
2. .....
3. .....
Other Action .....

Purchase Officer

Purchase Budget

Purchase budget is mainly dependent on production budget and material requirement budget. The material requirement budget gives information about the quantity of materials required during the budget period to attain the production target. The following factors are should be taken into consideration while preparing a purchase budget:

I. Quantity and quality of each material needed according to the production target.

II. Capital items, tools and general supplies required during the budget period.

III. The present stock position and materials expected to arrive, already covered by purchase orders.

IV. The dates on which purchase items are required.

V. Prices of items to be bought and positive quantities of discounts.

VI. Sources of supply.

VII. Availability of cash to settle accounts of suppliers.

VIII. Transport requirements.

IX. Inspection and receiving arrangements.

X. Storage capacity.

3.3 Stores Accounting Procedures

Need for Stores Accounting

There are two aspects of store accounting i.e., value of the materials stored and quantity of the materials stored. Stores accounting is necessary is regard to value due to the following reasons:

(i) It is necessary to indicate the value of stocks

(being assets of the company) in the accounts of the company.

(ii) It provides a means in calculating the cost of goods manufactured.

(iii) It provides a basis for control of inventory by value.

As regards quantity of materials, it is necessary to ensure, that all the materials received have been accounted for. Similarly all receipts and issues have been entered in stock ledger or register and have been accounted for.

The following are main purposes for which stock records are necessary:

(i) They indicate the amount of any material in stock at any time without any physical checking.

(ii) They help to tally the stock as shown by stores accounts. All receipts and issues and issues entered in stock records are subsequently posted in value to stores accounts.

(iii) They help in determining, the ordering quantity in order to maintain the stocks at the required level.

(iv) They help in comparing the quantities of all items in the stores ascertained by physical checking with that of quantity balances as per stores records.

(v) They help the stores staff in locating the goods in the store house.

(vi) They serve the purpose of a price list, as unit prices given in stores can be used for pricing all stores documents which are ultimately posted to the records.

STORES RECORDS

The following are the most important records used in the stores :

(i) BINCARD :- the card is generally kept in the bin along with particular item. To hold the bincard, usually there is a metal holder attached to the bin. These cards are very simple and give details regarding code number, the unit of issues, the quantity of the received and issued and the balance remaining in the bin.

(ii) STOCK CARD: - stock cards are kept together at one place in the stores office. This office should be within the stores building and not far away from the other offices of the company. This is necessary to keep the proximity between the stores documents and the stores themselves. Stores cards can be of three types i.e., (i)showing only quantities , (ii)shoeing quantities, and unit price , and (iii)showing quantity , unit price , value of each transaction and the value of balance in stock, (iv)is the best as it gives all details but it requires greater effort and expertise to maintain. Entry of every receipt and issue of store must be done in time and not postponed to the next day.

(iii) STORES TRANSFER NOTE :- this form is used for transfer of materials from one store to another store.

(iv) MATERIAL RETURN NOTE :-this form is used for return of items of surplus material from production or engineering department to the stores department.

(v) GOODS INWARD OR RECEIPTS NOTE:- this form is used for recording receipts of various items of stores in the receipt section.

(vi) MATERIAL REJECTION NOTE:- this note is issued by the inspection department and gives various reasons or rejecting an item of store.

(vii) SCRAP NOTE :- This note is used for sending the scrap to the stores.

(viii) MATERIAL REQUISION FORM :- this form is used for indenting or requisition of materials from the stores.

(ix) GATE PASS :- in order to prevent pilferage , it is necessary that a gate is issued for taking any item out of the stores and must be presented at the gate. Usually material requisition form or material transfer note can be used as a gate pass.

(x) INVENTORY FORM :- this form is used in stock taking

(xi) STOCK VALUATION FORM:- this form is usually used for valuation of stocks in hand at the end of the year so that it's value may be included in the annual accounts.

(xii) TEMPORARY LOAN VOUCHER :- this voucher is used for issuing tools to the workers which are to be returned to the stores at the end of the day.

(xiii) PERMANENT LOAN VOUCHER :- this voucher is used for issuing tools required for daily use or for a long period by an employee or section.

BIN CARD

A bin card makes a record of the receipt and issue of material and is kept for each item of stores carried. Quantity of stores received is entered in the receipt column of the bin card and the quantity of stores issued is recorded in the store column of the bin card and a balance of the quantity of the stores is taken after every receipt or maintained by the storekeeper and the store keeper is answerable for any difference between the physical stock and the balance shown in the bin card. These cards are used not only for recording receipts and issues of stores but also assist the storekeeper to control the stock. For each items of

stores, minimum quantity, maximum quantity and ordering quantity are stated requisition for the purchase of material in time.

A bin card is also known as bin tag or stock card and usually bung up or placed in shelf, rack, bin where the materials has been kept. Bin cards can also be in the form of loose sheets which can be maintained in the ledger kept in the stores.

Swadeshi Company Limited
BIN CARD

Bin Card No.....
Name of the Article.....
Code No.....
Stores Ledger Folio.....

Bin No.....
Maximum Quantity.....
Minimum Quantity.....
Ordering Quantity.....

Date	Receipts		Issues		Balance	Date of Checking	Remarks	Goods on Order		
	Goods Received Note No.	Quantity	Stores Requisition Note No.	Quantity	Quantity			No. and Date of Order	Quantity	Date of Goods Received

STORES LEDGER

This ledger is kept in the costing department and is identical with the bin card except the receipts, issues and balances are shown along with their money values. This contains a account for every items of stores and makes a record of receipts, issues and balances, both in quantity and value. Thus, this ledger provides the information for the pricing of materials issued and the money value at any time of each item of stores.

Swadeshi Company Limited
STORES LEDGER

Name of the Article .....
Code No.....
Bin No .....

Minimum Quantity.....
Maximum Quantity.....
Ordering Quantity.....

Date	Receipts				Issues				Balance			Remarks
	G.R. No.	Qnty.	Rate	Amount	S.R. No.	Qnty.	Rate	Amount	Qnty.	Rate	Amount	

Bin Card vs. Stores Ledger –

The difference between a bin card and the stores ledger can be summarised as follows:

Bin Card	Stores Ledger
1. A record of quantities only.	1. A record of both quantities and values.
2. Maintained by the storekeeper.	2. Maintained by the Costing Department.
3. Normally posted just before the transaction takes place.	3. Always posted after the transaction transaction takes place.
4. Each transaction is individually posted.	4. Transactions may be summarised and posted periodically.
5. Usually kept inside the stores.	5. Kept outside the store.

3.4 Inspection of Stores :-

In every enterprise it is possible that the balance of stock shown by stock cards maydiffer from the actual balance of stock ascertained by physical verification. It may be due to the following reasons:

Avoidable causes

(i) Clerical mistakes i.e., wrong posting non-posting of entries, wrong casting etc. Such errors can be corrected and actual balance can agree with book balance by makingthe required correction in cards or stores ledger :

(ii) Pilferage and thefts.

(iii) Carelessness in material handling.

(iv) Short or over –issue of materials.

Unavoidable causes:

(i) Actual balance may be less due to shrinkage and evaporation.

(ii) Actual balance may be more due to absorption of moisture.

(iii) Actual balance may be more due to break down of fire, riots etc.

(iv) Material may be lost due to breaking of bulk material into smaller parts for issue.For example, some iron is lost due to breaking up big iron rods into smaller parts.

Physical stock taking is very important for a concern as it serves the following purposes:

(i) It verifies the accuracy of stock records.

(ii) It supports the value of stock shown in the balance sheet by physical verification.

(iii) It helps to disclose the possibility of fraud, theft or loss.

(iv) It helps to reveal the weakness in the system for the custody and control of stock.

In short the difficulty and effectiveness of store keeping methods, controls and procedures can be revealed by the size and number of surpluses and efficiencies by stock taking.

CHAPTER-4

CONSTRUCTION SITE MANAGEMENT

4.0 Factors influencing selection ,design and layout of temporary facilities and services at construction site

Every site, whether large or small, requires temporary services which are designed and provided by the contractor. On a small site, the temporary services co nsi s t of a c c e s s roads, water supply, electric supply, sewer connections etc. On a large construction site, temporary services include a number of facilities such as telephone connection, batching plant, tube wells, service roads, repair and construction yards, material storage yards, canteen and medical facilities etc. There is no specific or fixed pattern for the type of temporary services required at a site. These services depend on the following factors:

- Size and nature of the project
- Location of the project
- Project cost
- Specific needs
- Number of working shifts per day.

Various temporary services required at the site are briefly described below:-

(a) Water Supply

Water supply is essential for all construction sites. For large construction sites, tube wells may be bored which could be later used on a permanent basis. Water supply is required for industrial and drinking purposes. Industrial water supply is required for rock drilling, pile driving, feed water for boiler plant and transporting materials by pipe lines etc. Drinking water supply is required for the work areas, offices, canteen etc. To obtain water supply connections, the contractor or project manager has to apply to the public Health Engineering Department stating the purpose and quantity of water required.

(b) Electricity connection

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

(c) Repair and Constntction Yards

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

(d) Material Stores

Such stores are usually constructed with brick walls and G.l. Sheet roofing. G.I. sheets are preferred for roofing purposes because of their high re- usability. The stores are used for the storage of cement, electrical materials, hardware, paints, tools, spare parts, stationery etc. Sometimes A.C. sheets are also used for roofing purposes.

(e) Approach and Service Roads

Approach and service roads are provided for trucks to transport construction materials such as sand, aggregate, cement etc. to the site. These roads are usually provided on the periphery of the construction site. In large projects, these roads may also run through the construction site so that materials may be dumped at the required locations avoiding re-handling shifting of materials.

(f) Sewerage and Sanitation arrangements

Appropriate sewerage and sanitation arrangements are essential at all work sites. Adequate arrangements should be made for the disposal of sewage to some suitable place.

(g) Site Office

Depending on the size and nature of the project, a site office is established for technical and supporting staff. For large projects, the site office of the Executive Engineer, Assistant Engineer and other staff is constructed for coordination, supervision and control of the construction activity. A project conference/display room is also provided for large projects. Site offices are temporary structures provided with G.I. or A.C. sheet roofing.

(h) Labour Huts

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

4.1 Principles of storing material at the construction site

The materials at the site should be stored in such a manner so as to prevent deterioration or mixing of foreign matter. So following are the points of prime importance to be considered for storing and stacking of materials.

(i) Materials stored at the site should be protected from the atmospheric agencies such as rain, sun, wind and moisture.

(ii) Materials susceptible to fire should be stored so as to prevent fire hazards. Petroleum products and explosives should be stored according to the existing rules and regulations.

(iii) Materials like precast beams, slabs and pieces of timber, which are likely to be affected by the subsidence of soil or support, shall be stored by adopting suitable measures against this risk.

(iv) For the storage of materials which are easily and immediately affected by the contact of moisture, special precautions are to be taken. For example cement bags are should be stacked on raised platform, with adequate water proof cover , having not more than 12 bags in a stack and at least 30 cm clearance from any wall.

Similarly lime should be stored in a suitable shed to protect it from dampness.

Brick and tiles should be stacked on a level ground limiting the height of stacks to 1.5m and one metre.

Fine and coarse aggregate shall be stacked on a hard surface in regular stacks of size 2m × 2m ×5 m and in such a way so as to prevent the admixture of vegetable and other foreign materials.

(v) Materials constantly in use shall be relatively nearer to the place of use, but not too close. Similar materials should be stacked close by.

(vi) Heavy units should be stacked near the hoist and the ramp.

(vii) Perishable materials which normally deteriorate during storage shall be kept constantly moving, by replacing old materials with fresh stocks. Freshly arrived materials shall never be placed over materials which had arrived earlier.

(viii) Fire extinguishers and fire buckets should be provided wherever necessary for safety.

The following basic factors should be taken in respect of receipt, storage and issue of stores :

1. There should be only one in-gate and one out-gate for entry and exit of stores unless the stores themselves are classified into separate groups and are handled by separate sections such as iron, steel , timber, brick, cement and aggregates and miscellaneous section in which case each group may have its own entry and exit gates and connected security arrangements .
2. Entry of all consignments is recorded at the in-gate.
3. No stores/consignments are taken out unless authorised by a supporting out pass/gate pass slip.
4. That total storage accommodation should be divided into the following three sections.
    a. Receipt Depot
    b. Holding Depot
    c. Issue Depot

The following factors should taken into consideration so that the stores are protected from the weathering action of elements such as wind, rain and sun and that the sequence of arrangement should provide first in first out principle so that stores do not deteriorate due to long storage.

(i) Inflammable material (POL, explosives) should be stored separately and storage license for such commodity should be obtained and bylaw/storage regulation prescribed from time to time should be adhered to.

(ii) Stores more frequently require to be issued should be stored relatively near to the exit end.
(iii) Storage yard for timber and similar other materials should have adequate anti-fire measures such as fire extinguishers, sand bucket etc.
(iv) Coarse and fine aggregates should be stacked in bin and underground pits respectively.
(v) Materials like cement, lime should be protected from contact of moisture.
(vi) Cement bags should be stacked clear off the ground by providing donnge of stone slabs, steel girders or timber beams / ballies. They should be stacked at least 30 cm away from the wall and the height should be restricted to 12 bags.

4.3-(I)Location of Equipment

With the ever- increasing cost of labour , it becomes necessary to use more and more mechanical equipment in association with the available man power for construction work. Only by very careful consideration the right type of equipment is chosen for any particular project. Correctly chosen and well operated plant will enable a construction project to be completed quickly and economically.

At the same time no contractor or owner can own all type of equipment needed for the job, due to limited resources and also due to the reason that some of equipments may remain idle, when they are not in use. Thus the owner or the contractor will purchase some of the equipments and others he will hire or he will give further contract for such items which will involve the use of equipments to such an organizations taking such works.

The following points may be considered for the location of equipment.

1. For the owned equipments suitable sheds may be provided near the entrance so that it can be guarded without any additional chowkidar.
2. It should be near to the construction site.
3. It should be near to the materials.
4. For the hired equipments, suitable place may be left vacant where it can be accommodated as per the equipment schedule
5. For the repair of equipment provision may be made in the shed itself.
6. The project equipment should be provided permanent shed for static equipment and temporary garages for mobile equipment.
7. All equipments received in the project should have initial inspection carried out. In the case of new equipment this inspection is carried out jointly by the project workshop and the representative of the firm from which it is obtained. The equipment should be taken complete with history sheet, log book, maintenance manual and operation manual. A trial demonstration should invariably be insisted upon.

8. Adequate provision for fast moving parts as spares should be made along with the procurement.

9. Washing ramps, platforms should be provided.

10. Responsibility for workshop cover and regular inspection should be fixed.

4.3-(II) <u>Organizing labour at site</u>

This is another task for the supervisory staff to organize the labour properly so that the maximum output may be taken from them. The supervisor may divide the labour into groups with a proper leader who can easily control and pass instructions to them clearly.

Suppose one and ten labourers are put for laying foundation concrete. The division of the labourers will be:

(i) Say three labourers are put for bringing the aggregates.
(ii) Two labourers will be deputed for bringing cement.
(iii) Two for mixing the ingredients for the first batch.
(iv) Two for the tamping purposes.
(v) One for bringing water.

After the material is put on the platform for mixing, these three labourers can be put on some other work if another batch is not to be prepared. Similarly after mixing , one labourer out of two and one who is bringing water is now free, can be put for carrying the mixed concrete to the site.

From this it is clear that it is the duty of supervisor to organise the labour in such a way so that there should be no wastage and work should be done efficiently.

However, the following points may be kept in mind, while organising labour at site.

(i) The supply of labour should be uninterrupted when needed.
(ii) Un-necessary rehandling of material should be avoided.
(iii) The material required during the day should be taken once for all from the go-down as it will avoid frequent movement of labour.
(iv) Labour should not remain idle for want of material.
(v) It is economical to have some permanent labour.
(vi) Increase and decrease of labour should be suitably done.
(vii) Drinking water should be made available at site to avoid wastage of useful time of labourers.
(viii) The progress of the labourer should be recorded and compared in order to complete the job at the right time.

The organisation of labour for a project involves the following:

1.**recruitment of labour**

This is particularly important in the case of departmentally run projects. If local labour is available, it saves considerable amount of expense and administrative arrangements. In projects in remote areas or in the forward areas where local labour is not possible, labour recruiting zones have be established and a special training cell in the project to take care of the labour from the recruiting zone to the work site has to be established.

2. provision of accommodation, and welfare activities including medical facilities.

When labour is an imported one, the transit cell makes the transit arrangement whereas the administrative cell makes arrangement for their living, eating and medical treatment. Sometimes all such facilities consisting of transport , accommodation , messing and clothing are provided free as part of agreement with the workers and entire expenditure is debited to the project.

3. Arrangement for training

Labour is primarily classified into skilled and unskilled. Whereas the unskilled labour can be deployed directly on the job under supervision of technical supervisory personnel, the workers required to do specialised/skilled jobs such as carpenters, masons and other trades-men have to be trade tested at the time of recruitment. In case skilled trademen are not available semi-skilled are initially recruited on a lower grade, given training and then deployed on job on higher grade after qualifying in the trade test.

4. While deploying workmen on production jobs the following points should be considered :

(a) Work should be divided into a number of teams doing similar work.
(b) Production of such teams is regularly assessed and reasons for short fall if any investigated.
(c) Work incentive for higher production is provided. A small incentive helps increase output considerably.
(d) Grievance/ complaints of workers are heard from time to time by having open meetings where every individual can bring out his points.
(e) Proper welfare activities are provided.

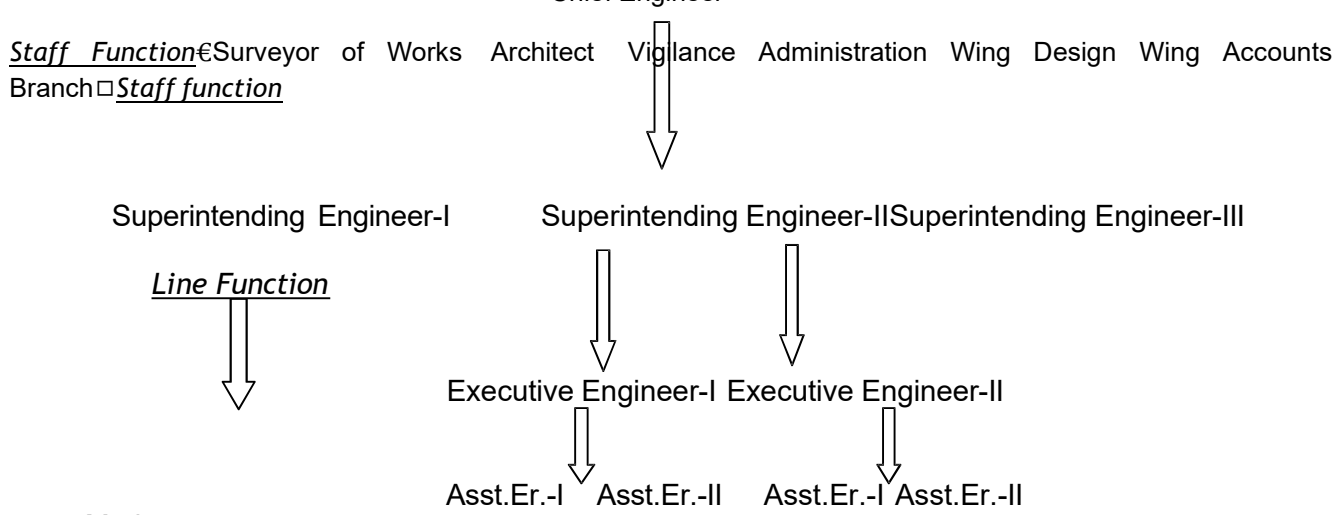
Chapter-5.0
Construction Organisation

Line and Staff Organisation:

Line organisation aims at having direct responsibility for attaining the objectives of the enterprise while staff organisation refers to those elements of the organisation that help the line to work more effectively in attaining the primary objectives of an enterprise. Line functions cover production, sales and sometimes finance whereas staff functions cover purchase, accounts, personnel, plant maintenance and quality control. Line organisation establishes a direct relationship of authority and responsibility between the superior and subordinates.

When the size of organisation expands for large and complex projects, the key men are to be assisted by specialists in different fields. Staff people in an organisation are experts who do not have line authority but whose function is largely advisory. The activities such as research, design, planning, scheduling & recording of performance are executed by staff. Line people maintain discipline and stability in an organisation.

The structure of line and staff organisation is illustrated below for better understanding of line and staff relationship.



Merits:

1- Effective use of expert advice.
2- Line executives are relieved of some of their loads and may devote more attention towards production.
3- Wastage of materials and machine hours are eliminated. 4- Improved product quality.
5- Due to staff expertise, efficient use of human and physical resources is possible.

Demerits:

1- Increase of cost due to high salaries of staff people
2- Staff people do not have authority to enforce their decisions.
3- There may be conflict between line and staff people since duties and responsibilities are not clearly defined.
4- Excess dependence of line people on staff may result in losing their initiative and drive.

5.2 : Principles of Organisation:

Organisation principle is a general rule or truth applied under similar conditions anywhere to achieve effective result. A few common principles followed in an organisation are:

1- Consideration of objectives- Objective should be determined and defined clearly.
2- The scalar principle- The line of authority from top to bottom should be clearly indicated
3- Principle of balance between authority and responsibility- Authority is the right to work, act, decide and power to command. Responsibility is the obligation of a sub-ordinate to do any job allotted to him by his superior. Hence, authority and responsibility should go hand in hand and must be balanced rationally to produce the best results. Authority without responsibility is meaningless or vice-versa.
4- Principles of unity of command- Unity of command states that each sub-ordinate should report to only one superior. In order to avoid indiscipline, delay, disorder, a sub-ordinate should receive orders from only one superior and not from a number of superiors.
5- Principle of span of control- This principle states the number of sub-ordinate who can effectively be supervised by a superior. An ideal span of control depending upon the complexity of work should be adopted to obtain optimum result.
6- Deparmentation- This refers to division of work in an organisation into several sections or department. The functions and scope of works in each department should be clearly defined.
7- Principle of specialisation- Activities of the organisation should be grouped as per the functions and assigned to individuals in accordance with their specialisation.
8- Communication- Transmitting information and instructions within the organisation and to out side persons connected with the organisation is essential to achieve the goals.
9- Flexibility and stability- Flexibility specifies the capacity to adjust work assignment, personnel and facilities to temporary changes in the volume of work. Stability, on the other hand, refers to the capacity to withstand the losses of key personnel without serious loss to the effectiveness of the organisation.
10- Effective Delegation: Effective Delegation gives a change to sub-ordinates to think and develop any task which they can decide themselves and perform efficiently and effectively.
11- Continuity- The organisation structure should be dynamic so as to maintain a link between the past and the future.

5.3 Leadership

Leadership is the process of influencing the activities of an individual or a group towards the achievement of goal in a given situation. Since all the successful manages must have leadership quality, it thus becomes absolutely necessary to know about leadership.

Styles of Leadership- Styles are the ways in which the leader influences the followers and the various styles in this respect are:

1- Autocratic or Authoritarian Leadership- The leader concentrates all the authority and all the decision making powers in himself. There is no participation by his sub-ordinates. He is the sole unifying force in the organisation.
2- Democratic or Consultative or participative Leadership- The leader takes decision after consulting his followers with their active participation in decision making process. He works through the people instead of working over the people. He develops a team spirit among the followers.
3- Free-rein or Laissez faire Leadership- This is described as “No leader at all” because the leader delegates the authority for decision making in to the hands of the sub-ordinates completely.
4- Bureaucratic Leadership- It is characterised by high degree of reliance on rules, regulations and procedures. The process of administration, thus, is reduced a series of routine actions.

5- Manipulative Leadership- It is based upon the belief that employees should be manipulated by the leader so that the goal of the leader may be attained. It exploits the aspirations of the employees.
6- Expert Leadership- Such leadership exhibits the knowledge, skill and ability of the leader irrespective of his age, gender, physical and other related attributes. The sub-ordinates are treated as fellow employees with the mix of skills and their needs in a situation.

Role of a Leader

1. To help in defining the mission of the group.
2. To create a congenial working environment committed to attainment of goals.
3. To act as an interpreter of the message and behaviour of other groups and individual who may have some influence on the group.
4. To Co-ordinate the activities of group members towards the achievement of organisational goal .
5. To provide the needed resources for the group.
6. To plan, organise the work, delegate authority and control position activities.
7. To quickly adjust to changing condition in environment.
8. To have foresight and to foresee new trends and opportunities.
9. To understand individuals and recognise their problems, motivate them to work together.
10. To make decisions without the influence of personal and emotional interests.

5.4 : Principle of Effective Supervision:

1- Co-ordinate the activities of the group engaged in accomplishment of task assigned. 2- Serve as a vital link between management and working force.
3- Implement the policies of the organisation with the help of the employees.
4 No communication gap both vertically upward and downwards
5 To plan and devise methods to boost productive efficiency and product quality.
6 Develop ways to minimise waste and scrap.
7 To listen patiently the employees and incorporate their suggestions and complaints.
8 To encourage interchange of good employees through promotion and transfer to the befitting positions.
9 To ensure smooth flow of works as per the scheduled plan.
10 To keep abreast with modern developments in the field of work.

5.5 : MOTIVATION:

Motivation refers to the way on which urges, drives, desires, aspirations, and strivings or needs direct, control or explain the behaviour of human beings"

Classification of Motives:

1- Power Motive: The ability to induce or influence behaviour is power. People with a high power need have a great concern for exercising influence and control. Such people generally seek positions of leadership and they are forceful, outspoken and hard headed and demanding in nature.
2- Affiliation Motive: People like to interact and be with others in situations where they feel they belong to and are accepted since they are social animals. Affiliation motive plays a very complex but vital role in human behaviour. People with high need for affiliation usually derive pleasure from being loved and tend to avoid the pain of being rejected. They maintain pleasant social relationship, enjoy a sense of intimacy and understanding and enjoy consoling and helping others in trouble.

3- Achievement Motive: Some people have an intense motive to achieve. It is based on the n- Ach hypothesis developed by David McClelland. He has identified four basic characteristics of high achievers
(i) Moderate Risk: Moderate Risk situation is within one's reach as against high risk situation which may not fulfil one's mission.
(ii) Immediate feedback: Immediate and precise feedback information is necessary to evaluate the progress of work towards achieving goal.
(iii) Accomplishment: Accomplishment of task intrinsically satisfying not necessarily associated with material rewards is the motive behind the people with affiliation motive.

Different approaches to Motivation:

1- Carrot and Stick approach: The carrot and stick approach of motivation comes from the old story that the best way to make a donkey move is to put a carrot out in front of him or jab him with stick from behind. The carrot is the reward for moving and stick is the punishment for not moving. In motivating people for desirable behaviour, some rewards such as money, promotion and other financial and non-financial factors and some sticks i.e. punishments are used to push the people for desired behaviour or to refrain from undesired behaviour.
2- Contingency approach: Since individuals differ, it is not possible to motivate them by a single method. Depending on the situation, the contingency approach is made to motivate people. This approach suggests that in motivating people, all the contextual variables must be specified and their inter relationship should be established. What would be the best motivational strategy, depends on the factors like individual personality, organisational climate and type of incentives available.
3- Theory 'X' Approach:
   i) Theory 'X' assumes human beings do not like to work.
   ii) People do not have ambitions and try to avoid responsibility.
   iii) People have little capacity for creativity.
   iv) People lack self motivations and require external control.
   With the above assumptions, it is difficult to extract work from the people. Work can be extracted by way of directing, controlling, threatening and punishing. Accordingly, a leader has to act in an authoritarian style.
4. Theory 'Y' Approach:
   i) Doing work, physical or mental, is the inherent quality of the average human beings.
   ii) People exercise self-direction and self-control.
   iii) People have a mission for ego-satisfaction and self- actualisation.
   (iv) People like to learn new things while working.

The assumptions of theory 'Y' suggest a new approach in management. It emphasises on the co-operative endeavour of management and employees to get maximum output with minimum control and direction.

5.6 HUMAN RELATIONS:

Individuals in an organisation are much more than a productive factor. They are the members of social systems of every enterprise. Human relations assume that happy employees are productive employees. Due recognition must be given to the skill, experience and qualification of employees. The employees need good pay, job security, better future prospects, better service condition and living environment, opportunity to participate in management and other incentives. Employees are distinguished from non-human factors such as capital, machine, building etc since they have feelings, sentiments, rationality and ambitions which should be duly recognised by management.

Human relations in an industry comprises of relations with sub-ordinates, peers(co-employees) and supervisors. A cordial and congenial human relations not only maintains discipline but also boost the morale of the employees to attain more productivity. Management is a function of assistance rather than dominance. If any problem faced by the employees, management must develop a mechanism to realise the traits/feelings of each employee so as to find out an amicable solution to the problems. Duties and responsibilities of the employees should be clearly indicated so that there will be no difficulties in finding out the erring employees resorting to indiscipline.

GROUP BEHEAVIOURS:

Groups consist of individuals. Group behaviour means behaviour of its members. Practically, each member of the group affects the behaviour of other members and, in turn, is also affected by them. The factors to be understood while studying group behaviour are group norms, group cohesion, group role, group conflict and group decision making.

1- Group norm is a rule that tells the individual how to behave in a particular group.
2- Group cohesion means the degree to which group members are attracted to each other and remain within the group. Cohesiveness binds all the group members to work as one man to attain the set goals.
3- Group Role is briefly indicated by position title and elaborately specified by job description. Group roles are prescribed by the organisation in order to make division among workers and assign them responsibility.
4- Inter-group behaviour – Organisation being a system, both individuals and groups both individuals and group cannot remain independent but dependent on each other. One group may depend on others for raw materials, information and other assistance.
5- Inter-group conflicts- Inter-group conflicts arise due to inconsistency. One union vs. another union, one functional group like production vs. another functional group like marketing are the examples of inter-group conflicts.
6- Group Decision making- Decision making is a process whereby a final but best choice is made among alternatives available. Group decision is made through consensus mood or through majority vote.

CHARACTERISTICS OF GROUP BEHEAVIOUR:

I. Two or more persons
II. Collective identity
III. Interaction
IV. Common purpose

MOB PSYCHOLOGY

Mob psychology is the study of men at works in groups and relationship between groups. It studies human behaviour in groups to obtain information that can be applied to resolve industrial/organisational problems. It aims at resorting the mental health of upset and confused groups.

HANDLING OF GRIVANCES

A grievance is defined as any feeling of discontent or dissatisfaction, expressed or not and whether valid or not, arising out of anything connected with the working place that an employee thinks, believes or even feels is unfair, unjust or inequitable.

STEPS INVOLVED IN GRIGANCE HANDLING PROCEDURE:

1- An aggrieved employee presents his grievances in writing to his foreman or supervisor and to union representative who is also a full time employee of the organisation.
2- The grievance is looked into by the middle management and, if not settled, is forwarded to the top management and to union officials.

3- Top management or top union official discuss the grievance and, if fail to settle the issue, the next step is to submit the same to an impartial arbitrator for a final decision.
4- Failure to settle the issue timely may result in strikes, picketing, gherao or lock out.
A good grievance handling procedure should be i) simple, easy to understand and operate ii) settle grievances of the lower level iii) depending upon the nature of grievance, refer it to the appropriate authority.

LABOUR WELFARE: Labour Welfare may be categorised into three classes, such as:
(1) Economic (a) Group insurance (b) Retirement and Pension Plans (c) Health and Accident Services (d) Credit Unions (e) Paid holidays (f) Profit sharing
2. Recreational (a) Sports (b) Social get- together (c) Special interest groups such as athletic programmes, dramatics, flying and particular hobbies.
(3) Facilitative (a) Housing (b) Transport (c) Educational facilities and Library services (d) Medical Services (e) Canteens, Cafeteria and Lunch Wagons (f) Company cheap stores (g) Discount on purchase of company products (h) Rest rooms and Locker rooms (g) Legal and Financial counselling.

5.7 CONFLICTS IN ORGANISATION

Genesis of conflicts: Conflict arises when individuals or groups encounter goals that both parties cannot obtain satisfactorily. The various sources of conflicts are:
(a) Structural factors (i) Specialisation (ii) Interdependence (iii) Common resources (iv) Goal differences (v) Authority Relationships (vi) Status inconsistencies
(b) Personal factors (i)Skills and Abilities (ii) Personalities (iii) Perception (iv) Values and Ethics (v) Emotions (vi) Communication barrier (vii) Cultural differences.

Intra Personal Conflict :When conflict occurs within an individual, it is called inter personal conflict. For example, when a child gets seek at school, the parents often must leave work to care for the child.

Inter Personal Conflict: Conflict between two or more people is called inter personal conflict. Individual differences create inter personal conflict. Wide differences are noticed between people in terms of personalities, perceptions, values and attitudes.

Inter group conflict:When conflict occurs between groups or teams, it is known as inter group conflict. Such conflict arises when one group sets out to undermine others, gain power and improve its image. Such group conflict of negative consequences like aggression, hostile and prejudice towards the other groups.

Resolving conflicts:

Several techniques have been envisaged for resolving conflict. The styles to resolve conflicts are:
(1) Avoiding (2) Accommodating (3) Competing (4) Compromising (5) Collaborating

(1) Avoiding is a deliberated decision to side step a conflictful issue, postponed addressing it till later or withdraw from a conflicting situation. When parties are very much angry and need time to cool down, it may be the best to use avoidance.
(2) Accommodating: In this style one party is willing to self-sacrifice in the interest of other party.
(3) Competing: This style tries to meet one's goals at the other party's expense.
(4) Compromising: Each party tries to give up something to reach a solution to the conflict. Give and take policy dominates the behaviour of conflicting parties.
(5) Collaborating: It involves attempts to satisfy the needs of both the parties.

TEAM BUILDING

A team is a group whose members have complementary skills and are committed to a common purpose or set of performance goals for which they hold themselves mutually accountable. Team building involves certain stages to proceed from beginning to its building

1. Problem Sensing & Identification with a view how to solve the problem and improve team effectiveness.
2. Examining perceptual differences: Efforts are made to reduce for remove individual differences in realising the problems through specially designed communication and training sessions.
3. Feedback: The feedback given to members may include their feelings, approach, and way, staying with the topic and going off on tangents. Feedback provides the members opportunity to evaluate, introspect, understand and know themselves.
4. Developing Argumentative skills: The basic objective of this stage-cum-process is to increase the ability among people as to how they should interact with others and engage in constructive behaviour.
5. Follow up Action:-The total team is convened to review what has been learnt and to identify what the next steps should be. Follow-up action also helps in overcoming the drawback involved at the initial stages of team building.

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CHAPTER 6:

Construction Labour and Labour Management:

Labour management in building construction means controlling the manpower problems, improving labour productivity and reducing time and cost overrun of projects. To improve the labour performance, there will be needed a good labour management practice.

6.1 Preparing labor schedule: In any construction project, it is necessary to estimate the required labour, required for completion of the project. This can be done with the help of construction schedules. Separate schedules are prepared for labour, material and equipment. These schedules help in procurement of labour, material and equipment at proper time and their efficient usage and storage. Labour Schedule (MLS) shows the construction project standard specification of the quality of manpower required for the execution of project. Labour schedule, helps in providing future labour requirements and efficient and optimum deployment of labour force where ever necessary.

6.2 Conventionally, productivity in many industries including construction has been evaluated as the ratio of input versus output i.e. the quantity of the input delivered by a certain resource against the quantity of the value created by that resource. Quantitatively, there are many ways to define productivity including physical metrics such as the quantity of concrete poured in an hour by a single unit of labor.

The two key metrics of labor productivity include:

- Effectiveness – how much work a unit of labor can accomplish in a certain construction process.
- Efficiency – the quantity of work completed by a unit of labor in a given period of time.

More than labor effectiveness, labor efficiency is used in the construction industry to calculate overall output with respect to the resources spent. Efficiency is generally used to measure and monitor performance.

To overcome the barriers and challenges in improving labor productivity in the construction industry, below steps can be adopted:

- Providing adequate and timely training to laborers
- Motivating workers continued to maintain efficiency until the project completion
- Acquiring materials and services in advance through smart procurement
- Reimbursing workers as well as vendors on time
- Organizing and implementing a methodical workflow to ensure efficiency
- Providing appropriate and on-time supervision throughout the project
- Ensuring preparation of site layout in advance and maintaining work discipline
- Providing basic facilities to the laborers working on the site
- Completing legal documentation prior to the start of the project
- Planning and implementing funds management in advance
- Determining optimal machinery usage and automation through advanced equipment planning

6.3 Labor characteristics

Some of the top characteristics of a construction worker are as below:

- Safe: Keeping everyone safe on construction sites should always be a number one priority. With heavy materials and potentially dangerous equipment all around, it is very easy for someone to be accidentally injured. Therefore, it is crucial that all construction workers are completely up to date on their health and safety training and know how to behave competently in any situation.
- Physically fit: Construction can be a very demanding job so it is essential that staff are healthy and capable of carrying out their work in a safe manner that isn't going to cause them any physical damage or injuries – an on-site accident could lead to huge compensation claims that an employer will want to avoid!
- A hard worker: It doesn't matter whether a construction worker has decades of experience or none at all, if they are willing to work hard all day then they are an asset to a business and their attitude will be greatly appreciated.
- Passionate: An employer will be looking for staff who are genuinely passionate about what they do as this will guarantee a happy, motivated workforce and more productive work days.
- Friendly: For most projects a construction worker will be required to work in teams, and most likely have to deal with the client as well. For this reason, it is essential that the worker is happy, friendly and polite. While it is impossible to expect everyone to get on at all times, being able to be civil when you disagree with someone and get along with people is a big part of the job and will make everyone's lives easier.

6.4 Wages and their payments

The following points highlight the top three methods of wage payments. The methods are: 1. Time Rate System 2. Piece Rate System

Method # 1. Time Rate System:

Under this method of wage payment, the workers are paid the wages on the basis of time. In this system of wage payment, the workers are paid the wages on the basis of time as, per hour, per day, per week, per fortnight or per month etc. This system does not consider the production of the employees during this time.

The amount of wages under this system is calculated as under:

Wages = Time spent by the worker × Rate of wages according to time.

Suitability of Time Rate System:

This system of Wage Payment is particularly suitable in the following circumstances:

1. When it is not possible to measure the production in terms of units or in any other terms.
2. When the work is of high standard.
3. When it is not possible to divide the production into units.
4. When the production is of the nature that it requires efficiency more than the speed.
5. When the worker is undertraining.

Merits of Time Rate System:

1. Simplicity:

It is very easy to calculate the amount of wage under this system.

2. Certainty of the Amount of the Remuneration:

This system of wage payment provides certainty of the amount of wage payment to the employee. It develops the feeling of confidence and certainty among them.

3. High Quality of Production:

As this system of wage payment has no concern with quantity of production, quality of production produced by the workers under this system is very high.

4. Proper Utilisation of the Factors of Production:

As this system is not related with speed, the workers perform their work in very confident manner. They make the best Utilisation of the factors of production.

5. Co-Operation between Labour and Capital:

This system of wage payment brings the industrial peace because it satisfies the workers and the industrialists. Thus, it develops harmony and cooperation between labour and capital.

6. Best System for Artistic Work:

This system of wage payment is most suitable for artistic work.

7. Co-Operation and Unity of Workers:

As all the employees doing the work for same nature get the same amount of wages, this system develops the feeling of co-operation and unity among the workers.

8. Suitable for the Health of Workers:

This system of wage payment is suitable from the point of view of health of workers.

Demerits of Time Rate System:

1. Need of Intensive Supervision:

This system requires intensive supervision over workers. It increases the cost of supervision.

2. Lack of Incentive:

This system of wage payment makes equal payment to both the efficient and inefficient workers. Therefore, efficient workers do not get any incentive for more production.

3. Encouragement of Labour Unions:

This system encourages labour unions. Sometimes, these labour unions misuse their powers.

4. Misuse of Time by Workers:

Under this system of wage payment, the workers do not make proper Utilisation by their time.

5. Fall in the Quantity of Production:

Under this system of wage payment, the quantity of production decreases because the workers do not get any incentive for increasing the production.

6. High Cost of Production:

As the production is low and the payment to the worker is more, this system increases the cost of production.

7. It Kills the Efficiency of Workers:
As this system does not make any difference between efficient and inefficient workers, it kills the efficiency of efficient workers.

8. Increase in Cost Per Unit:
This system increases the cost per unit of production. Under this system, the cost per unit of production is uncertain because the quantity of production differs from time to time.

9. Difficult to Measure the Efficiency:
Under this system of wage payment, it is very difficult to measure the efficiency of workers because all the workers of equal status are paid the wages at equal rate.

Method # 2. Piece Rate System:
Under this system of wage payment, the workers are paid the wages on the basis of quantity and quality of work performed by them. Under this system, the rates of wages are determined according to quantity and quality of work and the workers are paid according to these rates.

The amount of wages to be paid to a worker under this system is calculated as under:
Wages = Units of production × Rate per unit.

Suitability of Piece Rate System:
This system of wage payment is very suitable in the following conditions:

1. When the work is of standard nature.

2. When the work can be measured easily.

3. When there is a great need of increase in the production.

Merits of Piece Rate System:

1. Incentive to More Work:
This system encourages the workers to do more and more work because they get their wages according to their work.

2. Proper Utilisation of Machines:

Under this system, the workers use their machines and equipment with proper care because they feel that if their machine is out of order, their work will be held up and their wages will be low.

3. Increase in the Quantity of Production:
The system of wage payment gets more production because all the workers make their best efforts to increase the production.

4. Best Utilisation of Time:
As the workers are paid according to their work, they make the best possible utilisation of their time. They do not want to waste their time.

5. Decrease in the Cost of Production:
This system decreases the cost of production because the maximum production is done by the workers in the minimum time. It decreases the cost per unit of production also.

6. Decrease in the Cost of Supervision and Administration:
This system of wage payment minimises the needs of supervision. It reduces the cost of supervision.

7. Easy and Simple:
This system of wage payment is very easy to understand and very simple to calculate.

8. Improvement in the Standard of Living of Workers:
Workers get more wages because they produce more. It increases their efficiency and productivity. It increases their remuneration also which improves their standard of living.

9. Mobility of Workers:
This system of wage payment increases the mobility of workers because they can change their enterprise easily.

10. Measurement of the Efficiency of the Workers:
This system provides an opportunity to measure the efficiency of the workers. It makes proper distinction between efficient and inefficient working staff of the enterprise.

11. Justified:
This system of wage payment justified also because the workers are paid the wages according to the work performed by them.

12. Helpful in Maintaining Industrial Peace:
This system brings industrial peace also because it satisfies both the workers and the employer.

Demerits of Piece Rate System:

1. Lack of Unity among Workers:
This system lacks the unity and mutual co-operation among workers. They feel themselves competitor to each other.

2. Loss of Workers on the Failure of Machines etc.:
It because of any reason, the machines fail or the power fails, the work of workers is held up and they lose their wages.

3. Misuse of the Factors of Production:
The workers do not pay proper attention towards the factors of production. They only want to increase the speed of production.

4. Adverse Effect on the Health of Workers:
This system motivates the workers to do more and more work. It affects the health of workers adversely.

5. Low Quality of Production:
This system of wage payment does not pay any attention on the quality of production. As a result of it the quality of production falls down.

6. Unsuitable for Artistic Work:
This system is not suitable for artistic work because artistic work cannot be paid only on the basis of quantity of production.

7. Uncertainty of Wages:
As the amount of wages depends upon the quantity of production, the actual amount of wages to be paid is always uncertain. The workers also cannot estimate their remuneration in advance.

6.5 Labor incentives

Under these systems, both the time and speed are considered as the basis of wage payment.
These systems provide incentives to the workers to produce more and more maintaining the quality as well. The workers are paid bonus or premium for the additional work. It is important to note that almost all the systems incentive wages provide for minimum guaranteed wages to the workers.

Characteristics of an Ideal Incentive Wage System:

Important characteristics of an Ideal Incentive Wage System are as under:

1. It must be easy to calculate and to understand.
2. The standards of work must be determined on scientific basis.
3. It must establish direct relationship between efforts and remuneration.
4. It must give a guarantee of minimum wage to all the workers.
5. It must be in the interests of both the employers and the employees.
6. It must be flexible but stable.
7. It must be framed in the manner so that it may be used widely for all the activities of the enterprise.
8. It must be helpful in increasing the production as well as productivity.

Advantages of Incentive Wage System:

i. There is increase in the prospect of workers to earn more. As shown by F. Herzberg good salary is one of the hygiene factors in the absence of which people are unhappy and dissatisfied. Wage incentive offers them the prospect of earning more.

ii. The scientific work study which is done before introducing a wage incentive plan brings about improvements in methods, workflow, and man-machine relationship and so on.

iii. There is effective reduction in the supervision costs Closer supervision of employees becomes unnecessary because workers become more responsible. Rather than the supervisor chasing the workers the workers themselves sometimes chase the supervisor for materials, tools, etc.

iv. Employees promptly expose all such problems before management which retard their earnings. Management becomes more alert in areas such as flow of process materials, adequate spares, etc.

v. Employees are encouraged to become "inventive". They invent and adopt ways and means to achieve their production targets with lesser exertion and lesser expense of energy. They come forward with new ideas and suggestions.

vi. There is improvement in discipline and industrial relations. Go-slow and similar other techniques are not resorted to by the workers to express their dissatisfaction with management policies and practices. There is increase in workers' punctuality and decrease in absenteeism.

vii. There develops a feeling of mutual co-operation among the workers as their operations are interdependent and any hold-up at one point may affect the production and earning at other points.

Effects of Incentive Wage System:

Experience has shown that incentive compensation is not an unmixed blessing. It may produce certain ill-effects unless precautionary steps are taken to check them in advance.

These ill-effects are as under:

i. There is tendency among the workers to sacrifice quality for the sake of quantity. This calls for a very strict system of checking and inspection.

ii. In the absence of adequate provisions incentive payment brings about certain rigidity in the operations. This makes it difficult for the management to revise norms and rates following changes in technology, methods, machines, materials etc.

iii. Employees very often ask for compensation whenever production flow is disrupted due to the fault of management.

iv. Unless greater vigilance is exercised there is a danger of workers disregarding safety regulations.

v. Unless a maximum ceiling on incentive earning is fixed some workers tend to overwork and

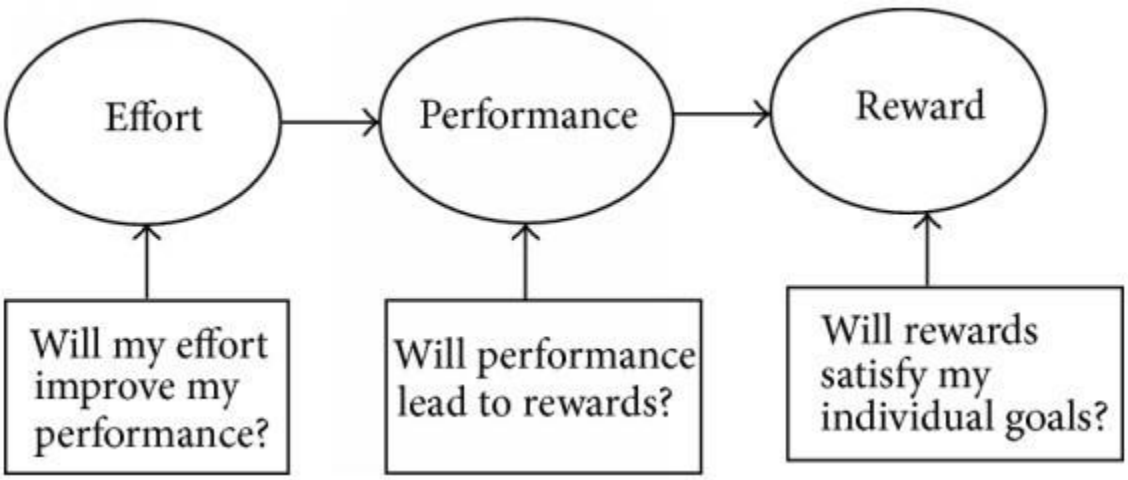
undermine their health.

vi. Jealousies may arise among workers because some are able to earn more than others. In the case of group systems, the fast workers may be dissatisfied with the efforts of the slower members of the group; where heavy work is involved older workers in particular are likely to be criticised for being too slow. One likely effect of this is the splitting up of trade unions.

vii. The introduction of a system by results increases the amount and cost of clerical work since it involves considerably more bookkeeping. This is particularly true when the production is subdivided into many processes.

6.6 Motivation- Classification of motives, different approaches to motivation

Motivation has been defined as "providing a drive to act to satisfy needs or desires". Within the context of work, Pinder stated that work motivation is a set of energetic forces that originate both within as well as beyond an individual's being, to initiate work-related behavior and to determine its form, direction, intensity, and duration. Motivation is intangible, a hypothetical construct that is used to explain human behaviour. Motivation is commonly sourced from intrinsic or extrinsic motives. Intrinsic motivation involves people doing an activity because they find it interesting and derive spontaneous satisfaction from the activity itself. Extrinsic motivation, in contrast, requires an instrumentality between the activity and some separable consequences such as tangible or verbal rewards; hence, satisfaction comes not from the activity itself but rather from the extrinsic consequences to which the activity leads



Classification and different approaches

Worker motivation can be based on below 5 main categories and related sub categories:

(1) Employee development:

(a) job advancement;
(b) variety of knowledge;
(c) participative decision making;
(d) high level of knowledge;
(e) developing competencies;

(f) sense of achievement.

(2) Work climate:
- (a) variety of tasks;
- (b) social interaction;
- (c) feedback from work;
- (d) significant job;
- (e) communication flow.

(3) Perceived equity:
- (a) adequate pay;
- (b) adequate recognition;
- (c) freedom at work;
- (d) feedback from colleagues.

(4) Work objectivity:
- (a) complete piece of work;
- (b) clarity of goal.

(5) Job security:
- (a) job security.

Different approaches for motivation:

(1) employee attitudes can be positively influenced through staff-orientation programs and an overall atmosphere of trust;
(2) achievement challenges are easily built into project work;
(3) appreciation for effort should be clearly expressed through a variety of means;
(4)responsibility reduces boredom and frustration, if work is properly allocated;
(5) money acts as a strong or weak motivator, according to economic circumstances;
(6)advancement possibilities are reduced for employees where work is short-term or overspecialized;
(7) participation in decision making can generate a strong commitment from employees;
(8) competition stimulates innovation and affects greater output;
(9) social relationships at work are improved by company-sponsored events and courses.

CHAPTER NO-7

EQUIPMENT MANAGEMENT

INTRODUCTION

Good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment.

The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades. The selection of the appropriate type and size of construction equipment often affects the required amount of time and effort and thus the job-site productivity of a project.

It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction.

7.1 PREPARING EQUIPMENT SCHEDULE

An civil engineering project needs a variety of equipment and it is imperative for engineer or contractor to know what type of equipment and what number of the equipment and for how many days (with exact dates) for each will be needed for the purpose. So that he may arrange them timely by hiring/purchasing or by any other means and the work may not be delayed because of non-availability of equipment. So an equipment schedule is to be prepared to ensure the efficiency in stipulated time.

EQUIPMENT SCHEDULE

This schedule indicates the number of equipments of various types to be used during different periods. Such an arrangement ensures efficient use of equipments. It also contains information such as ownership of equipment, rent to be paid for hired equipment, condition of working etc.

An equipment schedule format is given below.

NO. UNITS	DESCRIPTION OF EQUIPMENT	MODEL NUMBER	SERIAL NO. OR COUNTY ID NO.	ACQUISITION COST	DATE PURCHASED	CONDITION OF EQUIP. NEW OR USED	EQUIPMENT ASSIGNED TO: (*Name or Position*)

7.2 IDENTIFICATION OF DIFFERENT ALTERNATIVE EQUIPMENT

Factors behind the identification of alternative equipment

- **Economic Considerations**
- **Company-Specific**
- **Site-Specific**
- **Equipment-Specific**
- **Client And Project-Specific**
- **Manufacturer-Specific**
- **Labor Consideration**

Economic Considerations

The economic considerations such as owning costs, operating labour costs and operating fuel costs of equipment are most important in selection of equipment.

Besides, the resale value, the replacement costs of existing equipment, and the salvage value associated with the equipment are also important.

Company-Specific

The selection of equipment by a company may be governed by its policy on 'owning' or 'renting'.

While emphasis on 'owning' may result in purchase of equipment keeping in mind the future requirement of projects, the emphasis on 'renting' may lead to putting too much focus on short-term benefits.

Site-Specific

Site conditions-both ground conditions as well as climatic conditions-may affect the equipment-selection decision.

For example, the soil and profile of a site may dictate whether to go for a crawler- mounted equipment or a wheel-mounted equipment. If there is a power line at or in the vicinity of site, one may go for a fixed-base kind of equipment rather than a mobile kind of equipment.

Equipment-Specific

Construction equipments come with high price tags. While it may be tempting to go for the equipment with low initial price, it is preferable to opt for standard equipments.

Such equipments are manufactured in large numbers by the manufacturers, and their spare parts are easily available, which would ensure minimum downtime. Besides, they can also fetch good salvage money at the time of their disposal.

Client And Project-Specific

The owner/client in a certain project may have certain preferences that are not in line with the construction company's preferred policies as far as equipment procurement is concerned.

The schedule, quality and safety requirements demanded of a particular project may in some cases force the company to yield to the demands of the client.

Manufacturer-Specific

A construction company may prefer to buy equipment from the same manufacturer again and again, and that too from a specific dealer. This may be to bring in uniformity in the equipment fleet possessed by the company or because the company is familiar with the working style of the manufacturer and the dealer.

Labor Consideration

Shortage of manpower in some situations may lead to a decision in favour of procuring equipment that is highly automated. Further, the selection of equipment may be governed by the availability or non-availability of trained manpower.

7.3 IMPORTANCE OF OWNING & OPERATING COSTS IN MAKING DECISION FOR HIRING & PURCHASE OF EQUIPMENT

Total equipment cost comprises two separate components

- Ownership cost
- Operating cost

1. OWNERSHIP COST

This should expressed as an hourly cost and used for estimating and for charging equipment cost to projects, it does not include job overhead or profit. Therefore if the equipment is to be rented to others, profit should include to obtain an hourly rental rate. Ownership costs are "fixed" costs. Almost all of these costs are annual in nature and include:

- Initial Cost
- Depreciation
- Investment Cost
- Insurance Tax and Storage Cost

INITIAL COST

On an average, initial cost makes up about 25% of the total cost invested during the equipment's useful life. This cost is incurred for getting equipment into contractor's yard, or construction site, and having the equipment ready for operation. Many kinds of ownership and operating costs are calculated using initial cost as a basis, and normally this cost can be calculated accurately. Initial cost consists of the following items:

- Price at Factory + extra equipment + sales tax
- Cost of shipping
- Cost of assembly and erection

DEPRECIATION

The decline in market value of a piece of equipment due to age, wear, deterioration and obsolescence. Depreciation can result from:

- Physical deterioration occurring from wear and tear of the machine
- Economic decline or obsolescence occurring over the passage of time

However, there is always some uncertainty about the exact length of the useful life of the asset and about the precise amount of salvage value (i.e. the demand for equipment after its useful period), which will be realized when the asset is disposed.

INVESTMENT COST

Investment or interest cost represents the annual cost (converted into an hourly cost) of capital invested in a machine. If borrowed funds are utilized for purchasing a piece of equipment, the investment cost is simply the interest charged on these funds. If it is purchased with company assets, an interest rate that is equal to the rate of return on company investment should be charged.

INSURANCE TAX AND STORAGE COSTS

- Insurance cost represents the cost incurred due to fire, theft, accident and liability insurance for the equipment.
- Tax cost represents the cost of property tax and licenses for the equipment.
- Storage cost includes the cost of rent and maintenance for equipment storage yards, the wages of guards and employees involved in moving equipment in and out of storage, and associated direct overhead.

2. OPERATING COST

Operating costs are also called "variable" cost. Because they depend on several factors such as the number of operating hours, the types of equipment used, and the location and working condition of the operation.

- ➢ Maintenance & Repair cost
- ➢ Tire cost
- ➢ Consumable cost (Ex- fuel/energy consumption, lubricating oil)
- ➢ Mobilization & Demobilization cost
- ➢ Equipment Operator cost
- ➢ Special Items cost

7.4 INSECTION AND TESTING OF EQUIPMENT

Inspection and testing , including cleaning is required in order to keep work equipment in good working order and to ensure that it remains safe. If inspection and testing is not

carried out properly, two types of risk can be created:

• The performance of the equipment, including any safety features, may deteriorate to the where the users are put at risk;

• The persons carrying out the inspection, testing and maintenance may be put at risk

It is essential that an appropriate 'competent person', conducts the inspection and/or testing of equipment. But there remains a responsibility on all personnel to identify defective or potentially defective equipment, whenever this may come to their attention and to take appropriate action.

Equipment failing to meet the requirements of a specific inspection and/or test shall be dealt with immediately either by rectifying the fault or reporting it as appropriate. Consideration shall be given as to whether the equipment may remain in service.

It is essential that all inspections and/or tests together with any maintenance activities or repairs of equipment be recorded. As a minimum, such records shall include the following:

- information on the type and model of equipment;
- any identification mark or number that it has;
- its normal location;
- the date that the inspection was carried out;
- who carried out the inspection;
- any faults found as a result of the inspection;
- any action taken regarding such faults;
- to whom, and by whom, these faults have been reported;
- the date when repairs or other necessary action were carried out

The inspection and/or test frequency/schedule identified for each particular item of equipment shall be regarded as a minimum requirement and should be increased for equipment that is used extensively or where an item of equipment may have been used beyond its recommended working limits or for a purpose for which it was not intended. When determining the frequency of inspection and/or test, consideration should also be given to the following:

• Intensity of use – frequency and maximum working limits;
• Operating environment, for example, marine, outdoors;
• Legislative requirements;
• Manufacturers guidance;

• Variety of operations – is the equipment performing the same task all the time or does this change?

• Risk to health and safety from malfunction or failure.

JOB LAYOUT FOR DIFFERENT CONSTRUCTION SITES EGO DAM SITE, MULTISTORIED BUILDINGS, BRIDGE CONSTRUCTION SITE ETC.

The controlling contractor must consider many factors when laying out a site to support construction operations

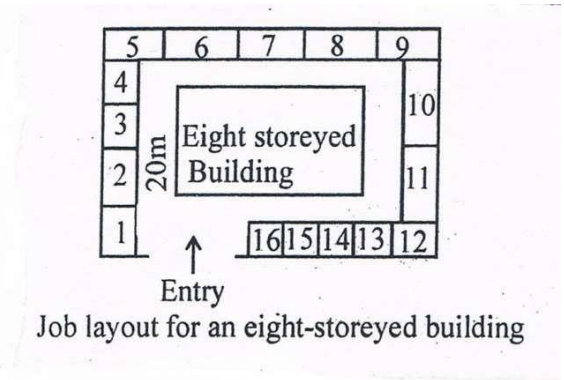
- Site and building size and configuration
- Location of adjacent roads, buildings, and utilities
- Soil conditions and excavation requirements
- Construction sequence and schedule
- Location of underground utilities
- Equipment requirements
- Material quantity, storage and delivery
- Worker parking
- Tool and equipment storage
- Construction operations facilities and trailers
- Sanitary facilities

Q1. Prepare the job layout for an eight storeyed building scheme with the following data:

Plot area .....**50m X 36m**

Building area.....**30m X 20m**

Ans.



Job layout for an eight-storeyed building

Fig.1 shows the layout of the project under consideration. The entry is one-way and the notations on the figure indicate the following:

1 : Watchman room or cabin

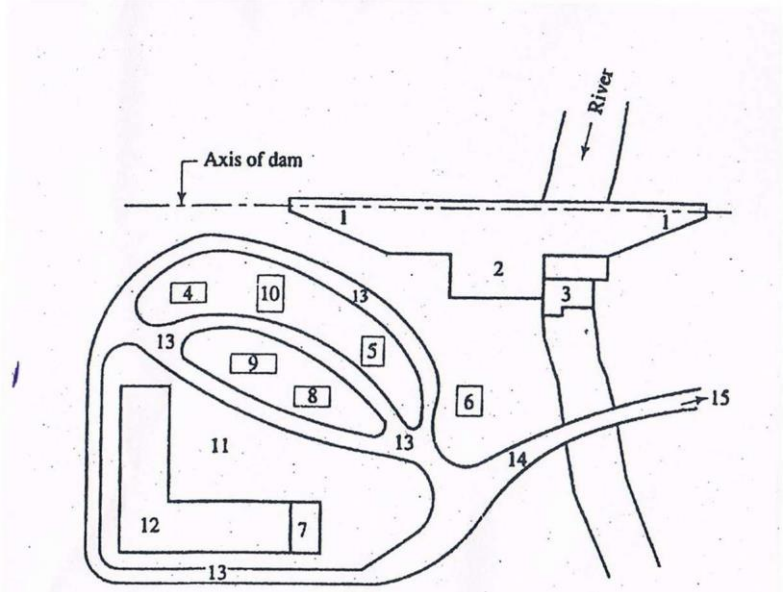
2 : Offices for contractors, engineers, etc.

3 : Store for plumping items, wood, electric fittings, etc.

4 : Store for cement
5 And 12 : Space for surplus earth
6 : Store for less costly miscellaneous items
7 And 14 : Space for coarse aggregate
8 And 15 : Space for sand
9 And 16 : Space for bricks
10 : Space for centring material
11 : Space for construction material
13 : Space for steel

Q 2. Prepare the job layout for a dam site.

Ans.



Job layout for dam site

The notations on the figure indicate the following

1	Abutments	7	Services like water supply,	12	Colony for staff
2	Spillway		electricity, etc	13	Link road
3	Power station	8	Project office	14	Bridge
4	Cement silos	9	Workshop	15	Site for local materials
5	Warehouses	10	Equipments and tools		such as aggregates,
6	Contractor's office	11	Community centre		sand, etc

EQUIPMENT MAINTAINANCE AND MINOR REPAIRS

OBJECTIVES

- To optimize utilization to obtain maximum return for capital invested.
- Cost efficiency.
- Better utilization result in quick time.
- Optimal service handling and rapid turnover minimizes cost.
- Quality care and satisfaction
- User safety

Performances to be carried out for maintainance and repair of equipment

- **Maintenance schedule** is reviewed to determine maintenance requirements .
- Tools and materials required for maintenance and repair are identified and obtained and used according to manufacturer specifications. .
- Lock-out or isolation procedures are followed prior to conducting plant maintenance according to manufacturer specifications, **organizational requirements** and **legislation and codes.**

(There are many types of potentially hazardous energy including, electrical, thermal, chemical, pneumatic, hydraulic, mechanical and gravitational energy. All such forms of energy must be locked out/isolated, blocked or released to ensure that machinery or equipment does not turn on or move during installation, repair or maintenance.)

Supervisory processes and checks and measures are implemented to ensure work is completed within **time available**.

Lubrication is applied to moving parts according to manufacturer specifications.

STUDY MATERIAL

Sub: Construction Management

6th semester Civil Engineering

CHAPTER 8: QUALITY CONTROL

8.1 Meaning

Quality may be defined as fitness for purpose as lowest cost. Quality means degree of perfection. It can be determined by some characteristics such as design, size, materials, chemical composition, machine functioning, work man ship finishing and other properties.

Quality control is concerned with making things right rather than discovering and rejecting those made wrong. Quality control is techniques of management for achieving required standard of products.

Factors affecting quality:-

- Market research, i.e., demand of purchases
- Money i.e. capability to invest
- Management i.e. Management policies for quality level
- Production methods and product design

Objectives of quality control:-

- To set up standards of quality acceptable to the customer an economical to achieve an maintain
- To locate an identify the process faults so as to control effectives scrap an waste

- To take necessary corrective measures so as to maintain the quality of the products
- To ensure that sub standard products do not reach the customers.

Advantages:-

- Quality of product is improved which in turn increases sales
- Good quality product improves reputation
- Inspection cost reduces to a great extent
- Uniformity in quality can be achieved
- Improvement in manufacture an consumer relations

Concept of quality in constructions:-

Def.

According to Philip Crosby “quality is performance to customer requirements” According Avi Garrin “quality is excellence in certain dimensions”

Basic features of quality:-

- Quality is what customer says, perceives an believes it is
- Quality satisfies both internal and external customer
- Quality should be present in the process as well ass the product or service
- Quality is going things right the first time, every time
- Quality is a way of life.

Quality is the essence of a construction work. The main objectives of the inspection and quality control is to achieve sound construction work which results in a structure of good strength and good life at a reasonable rate.

Major items of control:-

Major items of construction should be controlled like materials, equipment and construction work.

- Materials
  All the materials should be inspected and tested a per standard specifications laid own. The samples of materials should be selected at random and checked.
- Equipment
  The equipment purchase should confirm to the specifications and laid standards, as per terms and conditions given in supply order.
- Construction work
  Different standards and specifications are followed in different types of works. The inspection checking and testing of construction work is carried out at suitable intervals during course of construction.

8.2 Quality standards during constructions:

- Execution of work as per specifications
- Preparing test cubes for strength of concrete and them tested on due dates.
- Testing of other materials incorporate in the work as per i.e. standards. Indian Standard Institution (I.S.I rename as BIS) Bureau of Indian Standards.

1. Inspection
   It is a process of sorting well from a lot.
2. Quality assurance
   It means to provide the necessary confidence to the customer as well as to top management that all concerned are carrying out their job effectively and that the product quality is as per customer's satisfaction with economy.

STUDY MATERIAL

Sub: Construction Management

6th semester Civil Engineering

CHAPTER 9: MONITORING PROGRESS

9.1
Progress of any work may be defined as an achievement at regular intervals of time when compose with the estimated work. Progress reports are prepared at regular intervals to have better control of progress.

Purpose

- It gives information to the planner as to whether the work is being one as per schedule
- It gives assurance to the owner as to whether he is getting back for what he is spending.
- It permits collective action to bring the work on schedule if the same is behind schedule.
- It forms the basis of making payments.

Programme:
It is a comprehensive plan designed to implement the policies and accomplish the objectives. It is a combination of goals, policies, task assignments, resource flows, etc. It is a concrete well defined scheme designed to accomplish a specific objective. In business programmes are used in various areas,
e.g. developing a new product, training programme, advertising programme, expansion programme, etc.

Features of a programme:

- It is a single use but comprehensive plan.
- It is based on the objectives and policies of the organisation
- It is an action plan indicating the activities to be performed and time for activities to be performed and time for each activity.
- It is designed to ensure smooth and efficient functioning of the organisation.

A programme serves as a useful guide in day to day operations. It is action based and result oriented.

Methods of recording progress of work:

- C Job dairy: it is most important documents. It records attendance record, progress of work one, record of payments made, receipt an issue of materials to the work, inspection report, office correspondence record etc. It helps in solving disputes with contractors and can be produced as evidence in the court of law.
- C Register of instructions: The site engineer records his observations regarding quality and progress of work in this register. This is the channel of communication between the engineer and the contractor at the site of work.

- Progress reports: The engineer prepares the progress report, progress charts at regular intervals to keep the owner and home office fully informed. The reports can be submitted daily, weekly, fortnightly and sometimes monthly.
- Construction reports: The daily reports regarding progress of construction material used are to be entered in prescribed forms regularly. The construction reposts are intended to recorded time, quality and quantity of work and general conditions to ensure satisfactory progress on work as per laid specifications.
- Abstract of quantities and cost: The materials issued to the work are also recorded in this register. These are further posted on registers and indicate the up to date progress of work.

9.2 Work Study:

Work study is to determine the best method of performing each operation and to eliminate wastage so that production increases with less fatigue. According to the British standard institution, work study is a general term for those techniques, particularly method study and work measurement and which lead systematically to the investigation of all the factors which affect the efficiency an economy and the situation being reviewed in order to effect improvement.

Work study is the study of human. Work in all aspects in order to improve productivity. Work study is a systematic an analytical study of work process and work methods with the objective of increasing efficiency and reducing costs.

Objectives of work study:

- The optimum use of plant and equipment
- The most effective utilisation of human effort
- Determination of efficient work methods
- The evaluation of human work
- Establishment f stands of performance

Work study is a vital tool of improving productivity and cost effectiveness. Work study makes improvements in the areas of:

- Work environment
- Plant layout
- Material handling
- Employee safety
- Equipment utilisation

Procedures of work study

- Define the problem
- Obtain all relevant fact
- Examine the facts critically and objectively
- Consider the alternative an decide which one to follow
- Act on the decision
- Follow up the development

WORK STUDY

1. METHOD ANALYSIS
2. WORK MEASUREMENT

1. Method analysis/method study: It is to find out better ways of doing work. It leads to standardization of methods and procedures. It is also known as work improvement.

2. Work measurement: it refers to the study of work content of a job so as to lay down fair days. It is closely related to method analysis.

Work study is further divided into two groups:

- Method/motion study: the analysis during the execution of the project would invariably slow slackness or comparatively less output in certain fields

C Method adopted for the job
C Quality of finished products
C Specifications of materials

- Work measurement/time study

C Details of working conditions i.e. altitude of place, humidity of atmosphere, source of power etc
C Record of failures during collection of data/observation and cause of failure
C Record of actual hours of work done during the data collection or period of observation
C Specified time of continuous operation.

9.3 Analysis of progress:

The stages of analysis of progress as follows:

- Proper accounts of the material purchased, and consumed on the work as per material schedule is kept.
- Proper record of labour employed, payment made to them and progress of work one b them are recorded and compared with the labour schedule and corrective action taken.
- The deployment of equipment as per equipment schedule must be checked.
- Progress of construction should be compare with construction schedule and in case the work behind schedule the causes must be investigated.

Taking corrective action:
Some of the steps taken are mentioned below:

- The stores must be procured well ahead of requirement.

- If any equipment is not received in time, alternate arrangements should be made promptly to procure the some from other sources.
- Proper watch and ward should be arranged to eliminate the chances of pilferage of materials, etc.
- Incentive scheme should be introduces for achieving higher outputs and better efficiency.

Analysis of Financial Progress Corrective Measure

- Administrative approval of the work. The expenditure of each item of work is restricted by its administrative approval.
- Inviting open tenders/ bids so that as far as possible only the bid involving minimum expenditure is accepted.
- Keeping overheads or unproductive elements to the bare minimum.
- Providing regular accounts and getting the expenditure audited at regular intervals.

CHAPTER 10: Safety Management in Construction

10.1 Importance of safety

Construction is one of the most dangerous industry sectors. Millions of construction industry accidents occur in the world causing damages and injuries to workers and consequently economical losses in every year. Construction sites are dynamic and complicated systems. The movement and interaction of people, goods, and energy make construction safety management extremely difficult. Due to the ever- increasing amount of information, traditional construction safety management has operated under difficult circumstances. The construction industry has traditionally been considered as hazardous occupation due to the high incidence of occupational injuries and fatal accidents.

10.2 causes and effects of accidents in construction works

Causes of accidents

- Lack of proper training
- Deficient enforcement of safety
- Lack of safety equipment
- Unsafe methods or sequencing
- Unsafe site conditions
- Not using provided safety equipment
- Poor attitude toward safety
- Isolated freak accident

Effects of construction accidents

- Time loss of project execution
- Reputation of firm
- Mental illness of workers
- Cost of medical expenses
- Cost of recruiting new worker
- Cost of training given to new worker
- Compensation Cost
- Repairs
- Additional Supervision cost
- Productivity loss
- Cost of accident investigation time

10.3 Safety measures in worksites for excavation, scaffolding, formwork, fabrication and erection, demolition

Use Proper Safety Equipment

First of all, personal protective equipment (PPE) is a must when working in any industrial or construction setting, especially at height.

Many scaffold-related injuries involve falling objects, so wearing a hard hat can go a long way toward preventing serious injury. Non-slip footgear and fall arrest equipment are also essential when working on platforms.

2. Mind Load Limits

Scaffolding materials and designs are made with specific load-bearing capabilities in mind. Choosing components that aren't sufficient for the types of loads you intend to use in your work will pose a serious risk to employees. Platforms may crack, break, or otherwise collapse entirely, causing severe injuries for anyone working in the vicinity.

3. Know Relevant Regulations and Standards

Each industry has its regulations and standards to follow, and those may vary from state to state (or even city to city). Many of those regulations involve scaffolding, so it's important to know what the laws in your area dictate before setting up platforms.

You could prevent an accident and, at the very least, avoid liability for failing to meet prescribed standards. In addition, you should train your workers to recognize and minimize the associated risks and hazards of the type of scaffolding that you're using.

4. Inspect Scaffolding Materials

Before setting up your work platforms, you must inspect all of your materials before construction. Make sure none of the parts you use have any defects or damage that could compromise the structural integrity of your scaffolds.

Also, all parts should be sourced from the same manufacturer and designed to be used together. Mismatching parts can pose a significant scaffolding hazard and lead to structural failure.

5. Build Properly

Follow instructions provided by the manufacturer when building your scaffold. Check the types of bracing and fasteners and ensure that you're building the scaffold according to the manufacturer's exact specifications—do not take shortcuts nor create your own design.

When building scaffold, you also want to ensure the area is completely safe. A level ground surface works best (if possible), and you should try to avoid intersecting with power lines on your way up.

Whenever you build, move, or dismantle a scaffold, OSHA regulations require a competent person to be present and supervise. A competent person is someone who has received OSHA-approved training and the accompanying title.

Be sure to check for the following:

Leg braces should be correctly installed to the frame of the scaffold.

The standards, planks, and scaffold are level and true.

Planks, brackets, toeboards, and tubes should be installed rigidly, and the wedges should be very tight.

Mud sills and base plates should be the correct size and installed rigidly to the scaffold frame.

There should be at least 10' of clearance between electrical hazards and scaffolds as per OSHA regulations. If the distance is less than 10', then you'll need to shut off the line.

6. Inspect the Site and Equipment—Again

After the scaffold has been erected, the need for inspections doesn't go away. The area should be checked over regularly for hazards, defects, debris, or other factors that could cause a problem.

A good time to perform these inspections is at the start of the workday to ensure the area is clear for that day's shift.

7. Keep Vehicles and Heavy Equipment Clear

Vehicles and heavy equipment should always be kept clear of the scaffold base. Setting up barriers can keep the whole structure from toppling. It may be necessary to have heavy equipment nearby. In those situations, make sure the equipment has clearance.

8. Stay Organized

Tools and equipment should be kept organized and put away after use. At the end of each day, check that there are no tools or materials left on the platform—clutter could lead to trip and fall injuries, or they may pose a hazard for those working on lower levels.

9. Mind the Weather

When working at height, you want to make sure the working conditions are safe. Working during harsh weather conditions or other environmental hazards can increase the risk of serious injury. For instance, high winds could risk injury to those working on the scaffold. If a storm has brought down a power line, that could also create a scaffolding hazard.

10. Be Fully Licensed

Being fully licensed—and working with licensed contractors—helps prevent injuries since everyone working on the site is aware of the potential hazards and the best ways to avoid them. The process of becoming licensed often involves education and training, which helps your team work safely.

11. Climb Responsibly

Those who scale your scaffolding should exercise proper safety techniques when doing so. One tip is to make sure employees always have at least three points of contact with the structure at all times, meaning either one hand and two feet or two hands and one foot.

In addition, some parts of the scaffold, such as cross braces, shouldn't be used for climbing—they're not usually designed to support sheer weight on their own.

10.4 Development of safety consciousness

Quality and safety are key issues in the present construction industry. ISO 9000 has been promoted in the construction industry to ensure the quality of construction work done by the contractors. Besides, a safe work environment is very necessary to erase the high-risk image that is closely associated with the construction industry. Safe work environment may also be referred to as construction safety which is a standard of quality that is indicated in the contract and required by the client. Often projects are becoming more complex, and safety has become the main focus in ensuring the safety of the construction personel and properties. Developed countries such as the UK and Australia have enforced safety rules in contractors' works on site. Revolution and changes in safety system management have become a mandate in practicing safety action that can be managed interminably. The construction industry is labour intensive based on wet trades. This factor contributes to the low quality of work due to the workers' lack of expertise and training, while at the same time exposes them to accidents easily.

Overall safety culture can be described as a set of beliefs, norms attitudes and social technical practices that are concerned with minimizing the exposure of individuals, within and beyond an organization, to conditions considered dangerous or injurious.

Safety is looked into from the cultural point of view as shared characteristics of a group dynamic relating to a system (e.g., group, community, race, nation, religion) which include beliefs, values, attitudes, opinions and motivations. Organizations with good safety cultures have employees with positive patterns of attitudes towards safety practice. These organizations have mechanisms in place to gather safety-related information, measure safety performance and bring people together to learn how to work more safely. Employees' perceptions of safety culture as follows:

- management attitudes towards safety;
- perceived level of risk;
- effects of work pace;
- management actions towards safety;
- status of safety adviser and safety committee;
- importance of health and safety training;
- social status of safety and promotion.

Steps to promote safety awareness:

- Leadership - Improved safety culture can be achieved through close cooperations between leaders and the workers;
- Involvement - An important indicator to a positive safety culture in an organization is the involvement of the leaders and the workers in safety management.
- Recognition systems and acknowledgement - The recognition received would only be effective if it is meaningful and given as an acknowledgement to the work produced.
- Training - Training has always been a high priority, and the effectiveness of safety training has been proven to increase knowledge and awareness of workers on safe working culture;
- Communication - Communication involves all aspects of work in an organization and is able to

connect all entities at all levels on safety aspects;

- Teamwork - Team members are involved in conveying their opinions on works that they do and strategies to solve problems
- Motivation - Leaders that consider the ideas of the workers and sensitive to their needs will be able to elevate the motivation level of the workers to produce work of better quality;
- Health and Safety Committee - Functions to improve certain aspect of the work environment and develop safety values in everyday work practice, and establishing safety as the main goal to be achieved by the committee
- Work environment - The work environment should conform to the standard of safety and health at all times
- Policy and safety planning - Policy pertains to the principle that supports behavior towards safety, as in making safety policies as a marketing advantage for the organization.

10.5 Safety legislation- Workman's compensation act, contract labor act

The compensation act for workmen was formed after it came into notice that the laborers were becoming exposed to the danger by using more sophisticated and advanced machinery. According to the compensation act of 1884, the employer would take responsibility for the compensation of its workmen only when some major or fatal accidents occur on road. However, in 1885, the mining and factory inspectors realized that this Fatal Act, 1885, is not sufficient. The Government gave it a hearing ear, when the Legislative Assembly members, representatives of employer, experts in medicine, workers, and insurance experts formed a committee that provided a report that led to the Workmen's Compensation Act, 1923.

When this act was passed, it put a stop and provided relief to the workers who would have gone through the processing of court that is generally expensive. It was an effort to seek compensation whenever they encounter some injury during employment.

Scope of Workmen's Compensation Act

The workmen's compensation act, 1923, is applicable for those workers who are working with an industry that is mentioned in the act. Under this act, the protection of workmen from injuries and losses caused through an accident in course of and arising out of the employment subject to specific expectations as mentioned in the act.

The objective of the Workmen's Compensation Act

The Workmen's Compensation Act, 1923 was majorly formed to provide compensation to the workmen at the time of an accident.

The act mentions that it is the duty and responsibility of the employer to include the welfare of the workers when an injury is the result of the employment in the same way the employer has reserved the right of making profits. The main aim of this act is to ensure that the workmen have sustainable life even after encountering an employment-related injury.

The Liability of the Employer for Compensation

To make the employer pay the workers compensation at the time of injury or death suffered by the employee or workman should be a consequence of some accident in course of or out of his/her employment depends on the following four conditions.

Applicability of the Workmen's Compensation Act

This act is applicable across India except for Jammu and Kashmir. This act does not apply to the areas that are covered by the Employees State Insurance Act, 1948.

Contract Labour Act:

The act applies to all those firms which have twenty or more workmen, presently employed or previously employed on any day of the past twelve months. It also applies to every contractor who employs or employed twenty or more workers on any day of the past twelve months. It does not apply to firms where casual or irregular work is performed. This again has sub-sections: -

- If the establishment performed for more than one hundred and twenty days in the past twelve months, it cannot be considered as an intermittent one.
- If the establishment performs for more than sixty days in a year and is seasonal, it cannot be considered as an intermittent one.

Procedure for Registration of the Companies Hiring Contract Labours

Every firm which employs contract labours for its work has to acquire a certificate of registration from the appropriate government. Given below is the procedure for the registration of such companies:

The employer should go to the registration office with the application for registration in Form no. 1 along with the receipt representing the payment of the prescribed fee.

If the application received is complete in all respects, the registration officer registers the company and grants the copy of the registered certificate in Form-II.

LABOUR LAW ADVISOR IN INDIA

Details of The Certificate of Registration

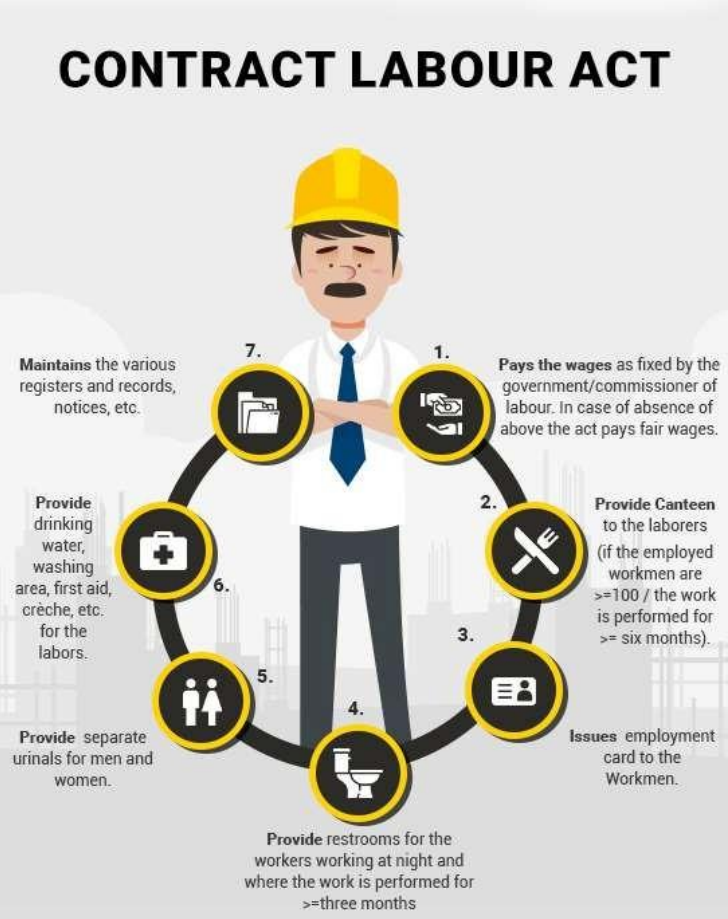
Name and address of the establishment.

A maximum number of workers to be hired as contract labours.

Type of business and any other relevant information.

License for The Contractor

Every contractor working for an establishment who hires twenty or more workers on any day of the past twelve months has to obtain a permit for engaging **contract labour registration**. The licensing officer provides this license as per the provisions of section 12 of the contract labour act. Under such section, a permit may contain conditions about the hours of work, fixation of wages, and other necessary facilities to the contract labours.



Procedure for Grant of License

Given below is the process for applying for a license from a licensing officer: -

The contractor has to request the Licensing Authority along with the application for the grant of a license in Form no. IV

A security fee of Rs. 20 has to be deposited at the time of application.

The receipt of the fee paid to the licensing officer has to be retained.

A certificate by the employer in Form V stating that he has employed the concerned contractor for his establishment.

The licensing officer may make further necessary investigations and grant the license in Form VI, which has to be renewed before 30 days of the expiry date along with the prescribed fee, failing which the contractor will have to pay 25% more fee than the ordinary amount.

Duties of the Contractor and The Employer

The employer should ensure that the contractor does the following: -

- Pays the wages as fixed by the government or
- Pays the wages as fixed by the commissioner of labour.
- In their absence, pays fair wages to the labours.
- Provides the following facilities:
  - Canteen to the labours (if the employed workmen are 100 or more and the work is performed for six months or more).
  - Issues employment card to the labours.
  - Restrooms for the workers working at night and where the work is performed for three months or more.

- Required number of separate urinals for men and women.
- Drinking water, washing, first aid, crèche, etc. for the labours.
- Maintains the various registers and records, notices, etc.

Violations To the Contract Labour Act

Any person who violates any part of any clause of the act will be punished with custody for more than three months or with a fine of Rs 1,000 or maybe both, depending on the severity of the violations. If a person breaks any rules under the act for which no additional fine is provided, then he or she shall be sentenced to three months imprisonment or a fine of one thousand rupees or both.

CHAPTER 11: **Role of Vulnerability Atlas of India in construction projects**

11.1 Introduction to Vulnerability Atlas of India, Concepts of natural hazards and disasters and vulnerability profile of India. Definition of disaster related terms.

The Indian sub-continent, like many other regions in the world, is vulnerable to a number of natural hazards such as earthquakes, landslides, tsunamis, floods, cyclones, storm surges and thunderstorms. High vulnerability of its physical and socio-economic profile characterize the disaster scenario of the subcontinent which has been, traditionally, facing different types of natural calamities that often turn into disasters, causing high loss of life and property. India has witnessed several disasters leaving a trail of destruction and irreparable loss of lives.
BMTPC has prepared the third edition of the Vulnerability Atlas of India which includes hazard maps of earthquakes, wind, cyclones, floods, landslides, thunderstorms and vulnerability risk tables based on available latest data in order to help in enhancing preparedness of Governments and various other agencies in mitigating natural disasters. The Atlas is a useful tool not only for public but also for urban managers and National and State Authorities dealing with disaster mitigation and management.

Natural Hazards are elements of circumstances in the Natural environment that have the potential to cause harm to people or property or both. These may be swift or permanent aspects of the respective environmental settings like currents in the oceans, steep slope and unstable structural features in the Himalayas or extreme climatic conditions in deserts or glaciated areas.

Natural disaster is an undesirable occurrence resulting from forces that are largely outside human control, strikes quickly with little or no warning, which causes or threatens serious disruption of life and property including death and injury to a large number of people, and requires therefore, mobilisation of efforts in excess of that which are normally provided by statutory emergency services".

Vulnerability profile of India

India has been vulnerable, in varying degrees, to a large number of natural, as well as, human-made disasters on account of its unique **geo-climatic** and socioeconomic conditions. It is highly vulnerable to floods, droughts, cyclones, earthquakes, landslides, avalanches and forest fires. Out of 36 states and union territories in the country, 27 of them are **disaster prone**.

India is one of the ten most disaster-prone countries of the world. The country is prone to disasters due to a number of factors; both natural and human induced, including adverse Geo- climatic conditions, topographic features, environmental degradation, population growth, urbanization, industrialization, non-scientific development practices, etc.

Disaster related terminology:

- **Acceptable risk:** The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.
- **Capacity:** The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.
- **Capacity development:** The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.
- **Climate change:**
- The Inter-governmental Panel on Climate Change (IPCC) defines climate change as:
    - "a change in the state of the climate that can be identified (e.g., by using statistical tests)
    - by changes in the mean and/or the variability of its properties, and that persists for an
    - extended period, typically decades or longer. Climate change may be due to natural
    - internal processes or external forcings, or to persistent anthropogenic changes in the
    - composition of the atmosphere or in land use".
- The United Nations Framework Convention on Climate Change (UNFCCC) defines
    - climate change as "a change of climate which is attributed directly or indirectly to human
    - activity that alters the composition of the global atmosphere and which is in addition to
    - natural climate variability observed over comparable time periods".
    - Contingency planning: A management process that analyses specific potential events or
    - emerging situations that might threaten society or the environment and establishes arrangements
    - in advance to enable timely, effective and appropriate responses to such events and situations.
- **Coping capacity:** The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.
- **Critical facilities:** The primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency.
- **Disaster risk:** The potential disaster losses, in lives, health status, livelihoods, assets and
- services, which could occur to a particular community or a society over some specified future time period. Disaster risk management: The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.
- **Disaster risk reduction:** The concept and practice of reducing disaster risks through systematic efforts, to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.
- **Early warning system:** The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. Emergency management: The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.
- **Emergency services:** The set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.
- **Environmental degradation:** The reduction of the capacity of the environment to meet social and ecological objectives and needs.

- **Environmental impact assessment:** Process by which the environmental consequences of a proposed project or programme are evaluated, undertaken as an integral part of planning and decision-making processes with a view to limiting or reducing the adverse impacts of the project or programme.
- **Forecast:** Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.
- **Hazard:** A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
- **Mitigation:** The lessening or limitation of the adverse impacts of hazards and related disasters.
- **Natural hazard:** Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
- **Preparedness:** The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from, the impacts of likely, imminent or current hazard events or conditions.
- **Prevention**: The outright avoidance of adverse impacts of hazards and related disasters.
- **Public awareness:** The extent of common knowledge about disaster risks, the factors that lead to
- disasters and the actions that can be taken individually and collectively to reduce exposure and
- vulnerability to hazards.
- **Recovery:** The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.
- **Response:** The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.
- **Retrofitting:** Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.
- **Risk:** The combination of the probability of an event and its negative consequences.
- **Sustainable development:** Development that meets the needs of the present without
- compromising the ability of future generations to meet their own needs.
- **Vulnerability:** The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

11.2 Earthquake hazard and vulnerability, Magnitude and intensity scales of earthquake, seismic zones, earthquake hazard maps, types of structures and damage classification, effects in housing and resistant measures.

The seismic vulnerability of a structure is **a quantity associated with its weakness in the case of earthquakes of given intensity**, so that the value of this quantity and the knowledge of seismic hazard allows us to evaluate the expected damage from future earthquakes.

Magnitude is a measure of earthquake size and remains unchanged with distance from the earthquake. **Intensity** describes the degree of shaking caused by an earthquake at a given place and decreases with distance from the earthquake epicentre. Magnitude measurement requires instrumental monitoring for its calculation, however, assigning an intensity requires a sample of the felt responses of the population. This is then graded according to the EMS intensity scale.

Intensity	Shaking	Description/Damage
I	Not felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest,especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

A seismic zone is used to describe an area where earthquakes tend to focus; for example, the New Madrid Seismic Zone in the Central United States. A seismic hazard zone describes an area with a particular level of hazard due to earthquakes.

Seismic hazard is the hazard associated with potential earthquakes in a particular area, and a seismic hazard map shows the relative hazards in different areas. The maps are made by considering what we currently know about: Past faults and earthquakes.

Types of structure and damage classification:

Name of scale	Organizer	No. of class	Building type
Damage grade	***EMS-98***	6	Masonry buildings
Grade 0:Nodamage Grade 1:Slight damage (Hair-line cracks in few walls) Grade 2:Moderate damage (Fall of large pieces of plaster) Grade 3:Heavy damage (Large and extensive cracks in walls) Grade 4:Very heavy damage (Serious failure of walls) Grade 5:Destruction (Total collapse)			
Damage statistics	**Japan Prime Minister's Office**	4	Wood frame buildings
No damage Moderate damage (A part of building is damaged) Heavy damage (Structural damage cost occupies from 20 to 50% of total repair cost) Major damage (Structural damage cost occupies over half of total repair cost)			
Damage rank	***Architectural Institute of Japan***	6	RC buildings
Rank 0:No damage Rank 1:Negligible damage (Hair line cracks in columns and beams of frame) Rank 2:Slight damage (Shear cracks in non-structural walls) Rank 3:Moderate damage (Shear cracks in columns and beams and in structural walls) Rank 4:Major damage (Spalling of concrete cover, Buckling of reinforced rods) Rank 5:Collapse (Collapse of total or parts of building)			

Earthquake effect in buildings:

1. Inertia Forces in Structures

The generation of inertia forces in a structure is one of the seismic influences that detrimentally affect the structure. When an earthquake causes ground shaking, the base of the building would move but the roof would be at rest. However, since the walls and columns are attached to it, the roof is dragged with the base of the building.

The tendency of the roof structure to remain at its original position is called inertia. The inertia forces can cause shearing of the structure which can concentrate stresses on the weak walls or joints in the structure resulting in failure or perhaps total collapse. Finally, more mass means higher inertia force that is why lighter buildings sustain the earthquake shaking better.

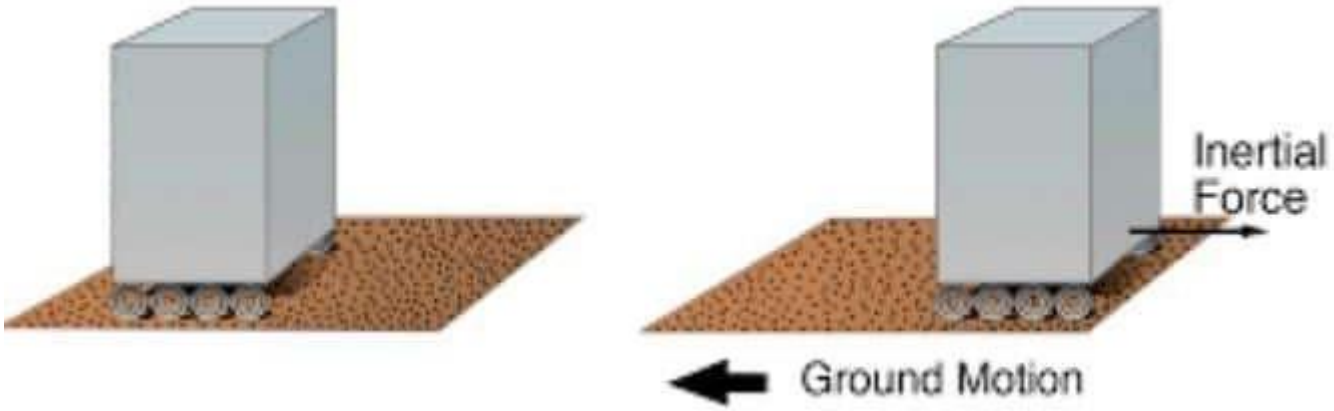


Fig. 1: Direction of Inertia Forces

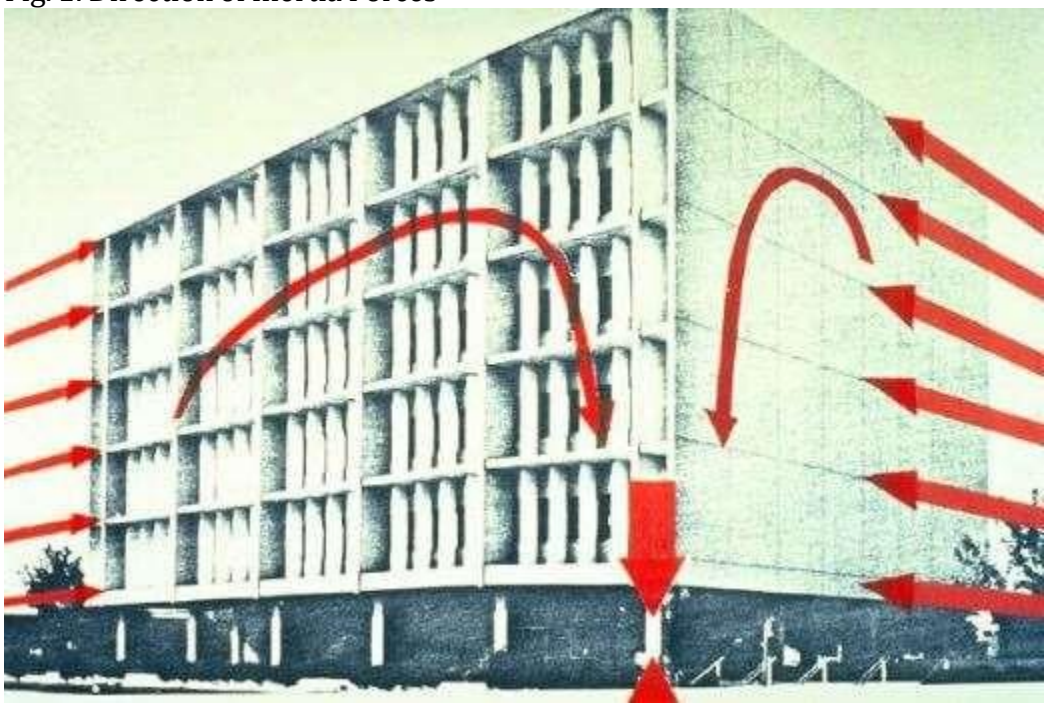


Fig. 2: Development of Great Inertia Forces in the Six Storey of Imperial County Services Building

2. Effect of Deformations in Structures

When a building experiences earthquake and ground shaking occurs, the base of the building moves with the ground shaking. However, the roof movement would be different from that of the base of the structure. This difference in the movement creates internal forces in columns which tend to return the column to its original position.

These internal forces are termed stiffness forces. The stiffness forces would be higher as the size of columns gets higher. The stiffness force in a column is the column stiffness times the relative displacement between its ends.

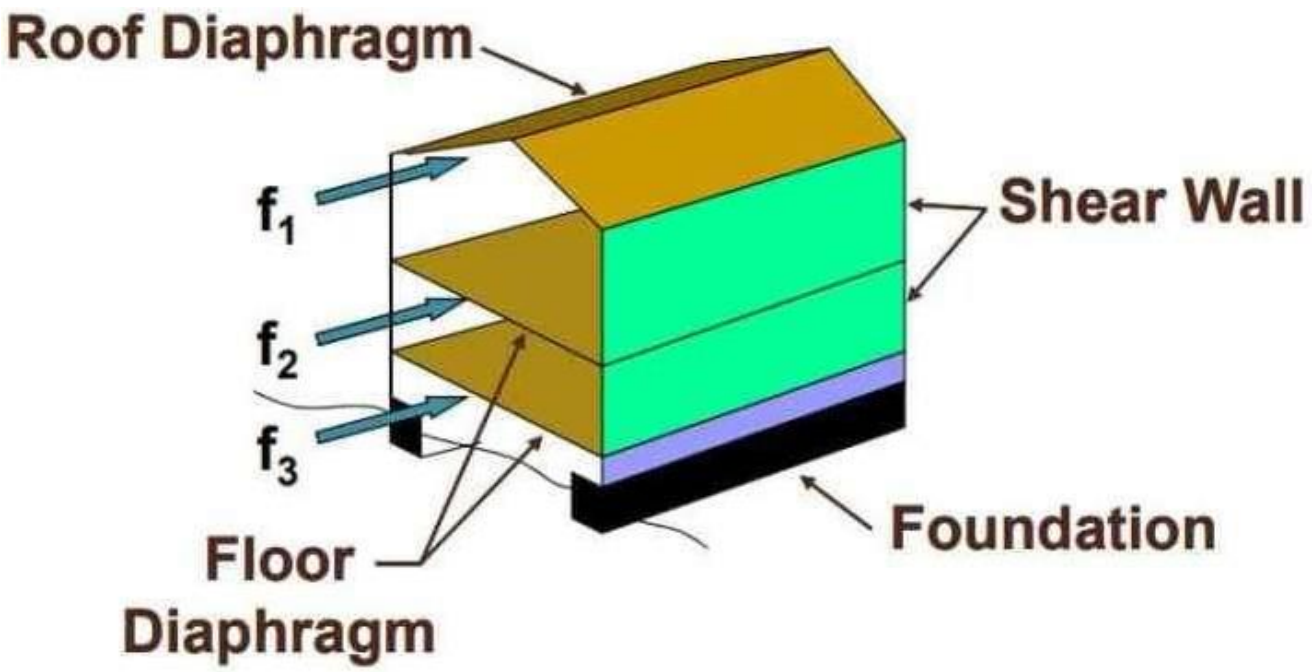


Fig. 3: Lateral Force Resisting System in a House

3. Horizontal and Vertical Shaking

Earthquake causes shaking of the ground in all the three directions X, Y and Z, and the ground shakes randomly back and forth along each of these axis directions. Commonly, structures are designed to withstand vertical loads, so the vertical shaking due to earthquakes (either adds or subtracts vertical loads) is tackled through safety factors used in the design to support vertical loads.

However, horizontal shaking along X and Y directions is critical for the performance of the structure since it generates inertia forces and lateral displacement and hence adequate load transfer path shall be provided to prevent its detrimental influences on the structure.

Proper inertia force transfer path can be created through adequate design of floor slab, walls or columns, and connections between these structural elements. It is worth mentioning that the walls and columns are critical structural members in transferring the inertial forces. It is demonstrated that, masonry walls and thin reinforce concrete columns would create weak points in the inertia force transfer path.

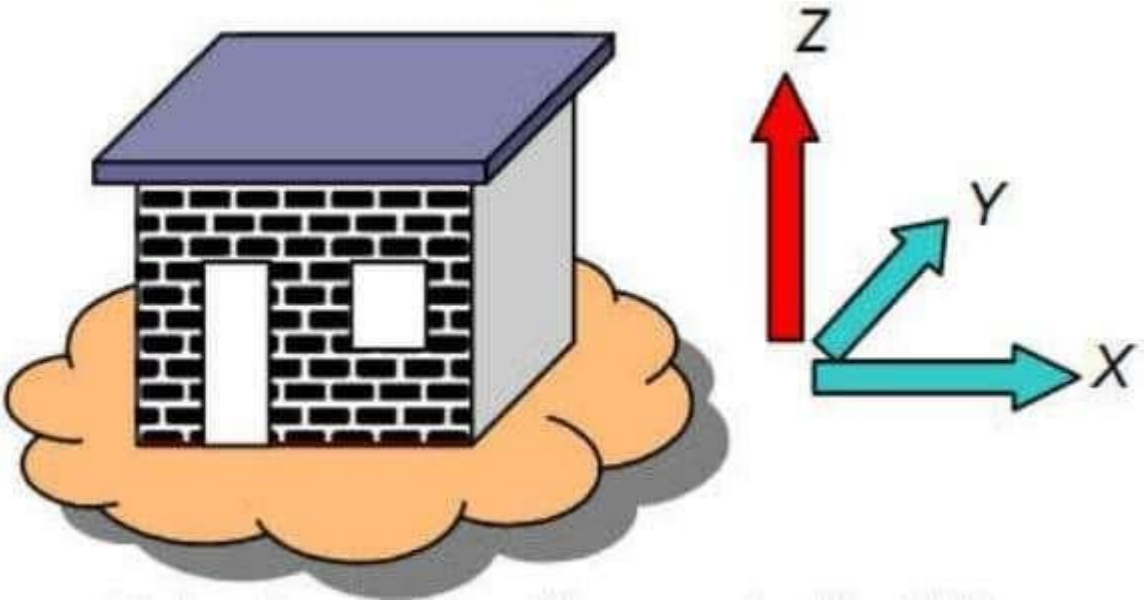


Fig. 4: Principal Directions of a Building

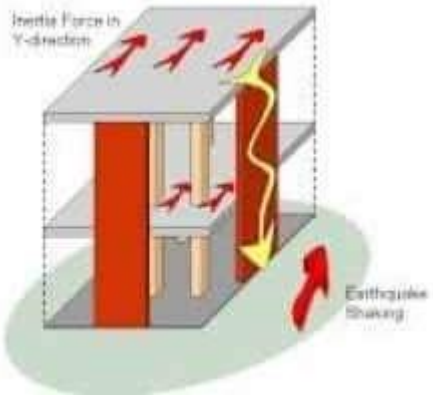


Fig. 5: Load Path for Lateral Inertia Forces

Principles of Conceptual Design of Earthquake Resistant Structures

The basic principles of conceptual design of earthquake resistant structures includes:

- Structural simplicity
- Uniformity, redundancy and symmetry
- Bi-directional resistance and stiffness
- Torsional resistance and stiffness
- Adequacy of diaphragms at each storey level
- Adequate foundations

Structural Simplicity for Earthquake Resistant Design

Structural simplicity pertains to the provision of obvious, simple and straightforward load path to transfer seismic forces from different part of the structure to its foundation. Not only does the load path need to be clear and simple but also its components must have sufficient stiffness, ductility and strength.

This requirement should be examined by a structural designer who commonly designs the load path. One of the significant advantages of direct load path is that it would contribute in the decrease of doubts and uncertainty in the evaluation of strength, ductility and dynamic behavior. In contrary, complicated load path is likely to cause stress concentration and toughen the estimation of strength, ductility and dynamic response of structures. It should be bore in mind that, acceptable structures with complex load path can be designed.

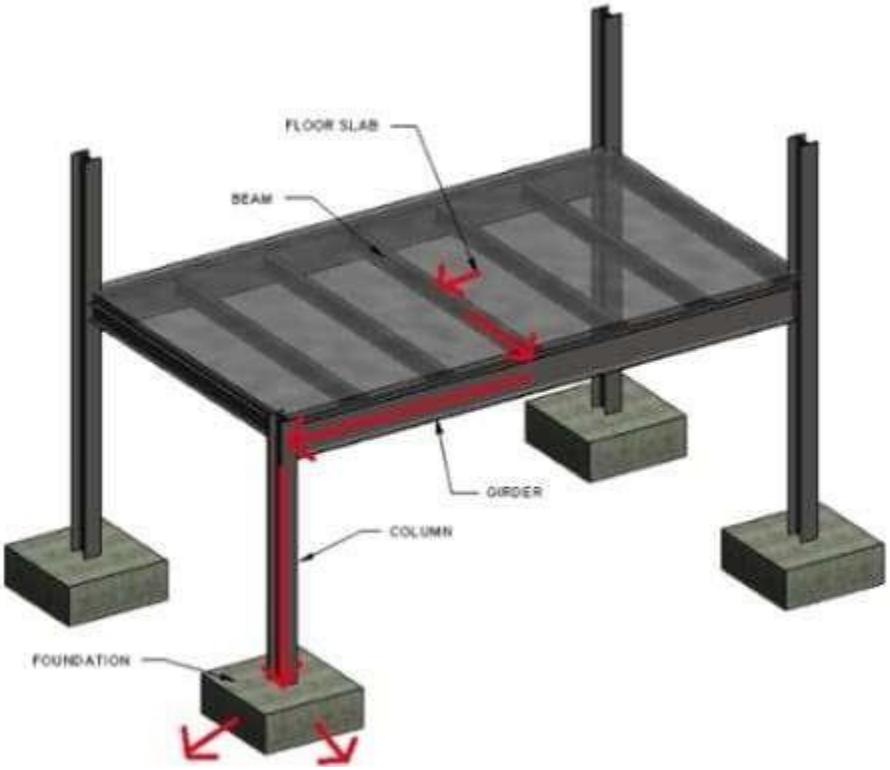


Fig.2: Simple and Straight Forward Load Path of Structure

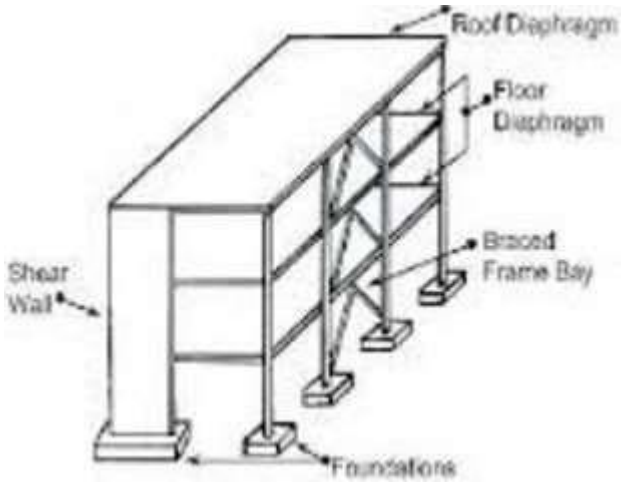


Fig.3: Seismic Load Path Component

Structural Uniformity, Redundancy and Symmetry

It is proven that, if the strength, stiffness and mass of a structure is spread symmetrically and uniformly in elevation and plan, it would show far better seismic performance in comparison with structure that does not have such properties. As far as strength and stiffness uniformity in elevation is concerned, it prevents the creation of soft storey in the structure. It should be bore in mind that non-uniformity does not mean bad seismic performance, for instance, if such structure is isolated seismically then it would show satisfactory seismic performance.

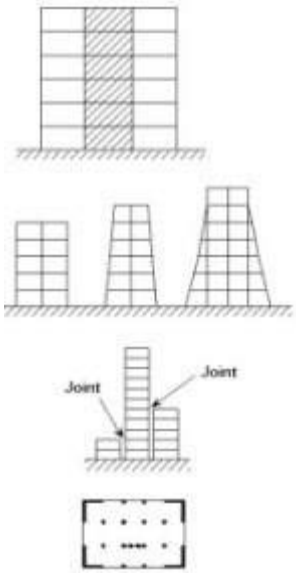


Fig.4: Structural Uniformity in Elevation and Plan

Regarding building uniformity in plan, it would put an end to the torsional response and hence enhance dynamic performance of the structure. For the structures with irregular shape like T shape, it is recommended to introduce joints to create regular shapes as illustrated in Figure 7 Figure 8. Regarding Figure 5 and Figure 6, they explain regular plan shapes for building in seismic prone areas which are favored plan shape and irregular plan shapes which should be avoided to in seismic areas unless proper seismic joints are provided like in Figure 7 and Figure 8.

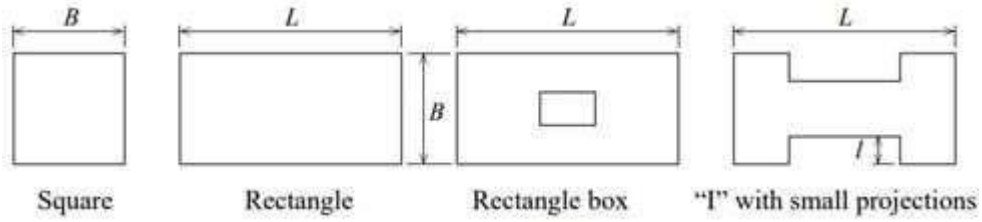


Fig.5: Desirable Symmetrical Shape Plan for Building in Seismic Prone Areas

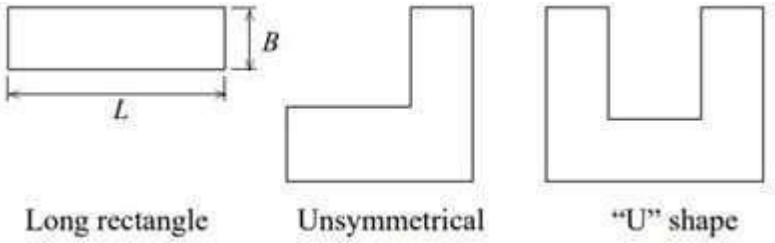


Fig.6: Undesired Shape Plan for Structure in Seismic Regions

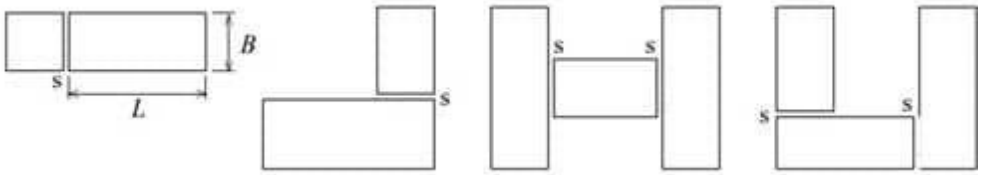


Fig.7: Provision of Seismic Joints for Decrease or Eliminate Torsional Motion due to Earthquakes

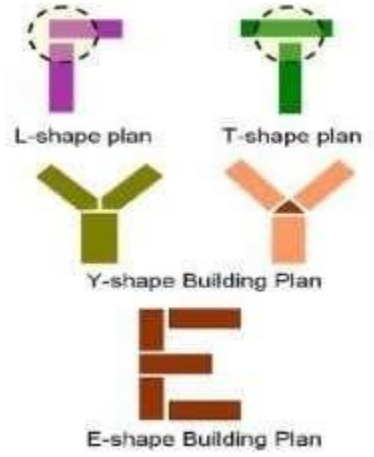


Fig.8: Provision of Seismic Joints to Decrease or Eliminate Torsional Motion due to Earthquakes

However, certain design problems at joints due to seismic movements may come-up and need to be tackled. Detailing of finishes, cladding, services across joints and impacts at the joint are examples of design problems which are likely to occur due to joint provision. A structure is said to be redundant if there are more than one load path in the building to transfer imposed seismic loads. So, if strength or stiffness of a specific load path is deteriorated, the load will be transferred though other load path. Therefore, redundancy would make the structure more reliable.

Bi-Directional Resistance and Stiffness of Structures during Earthquakes

Normally, seismic loads on both horizontal axes of structures are similar, that is why the provision of similar resistant systems in both direction is recommended. So, the structural members need to be configured orthogonally guaranteeing similar resistance property in both major directions.

Torsional Resistance and Stiffness of Structures

Lateral torsional deformation, which might stress various structural members in an un-uniform manner, could occur during earthquakes. The factor that leads to lateral torsional motion is the eccentricity between center of mass and stiffness. So, this problem need to be tackled at the design stage.

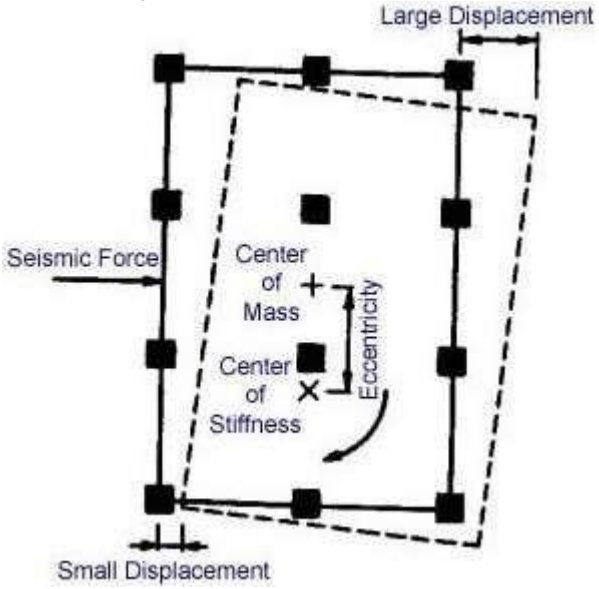


Fig.9: Center of Mass and Center of Stiffness in a Structure Subjected to Earthquakes and Suffered Displacements

The eccentricity could be decreased at design stage but it may not be completely eliminated because of number of factors which are out of designer control. For example, non-uniform mass distribution and uneven stiffness deterioration of structural elements during earthquakes. Finally, this problem can be dealt with by arranging stiff and resistant members close to the periphery of the structure.

Adequacy of Diaphragms at Each Storey Level

The influence of diaphragms on the seismic response of a structure is considerably crucial. Not only does it transfer seismic inertia load to the vertical structure members but also prevents considerable lateral movement of the such vertical elements. So, in order for the floors to perform their function properly, adequate in plan stiffness should be provided. In addition, to attention to the joint between floors and vertical structural members. These measures are specifically important if there is sizable opening diaphragm or in the case of considerably long in plan floor shapes. Finally, if the floor is constructed from precast concrete, it is necessary to provide sufficient bearing to avoid the loss of bearing during earthquakes.

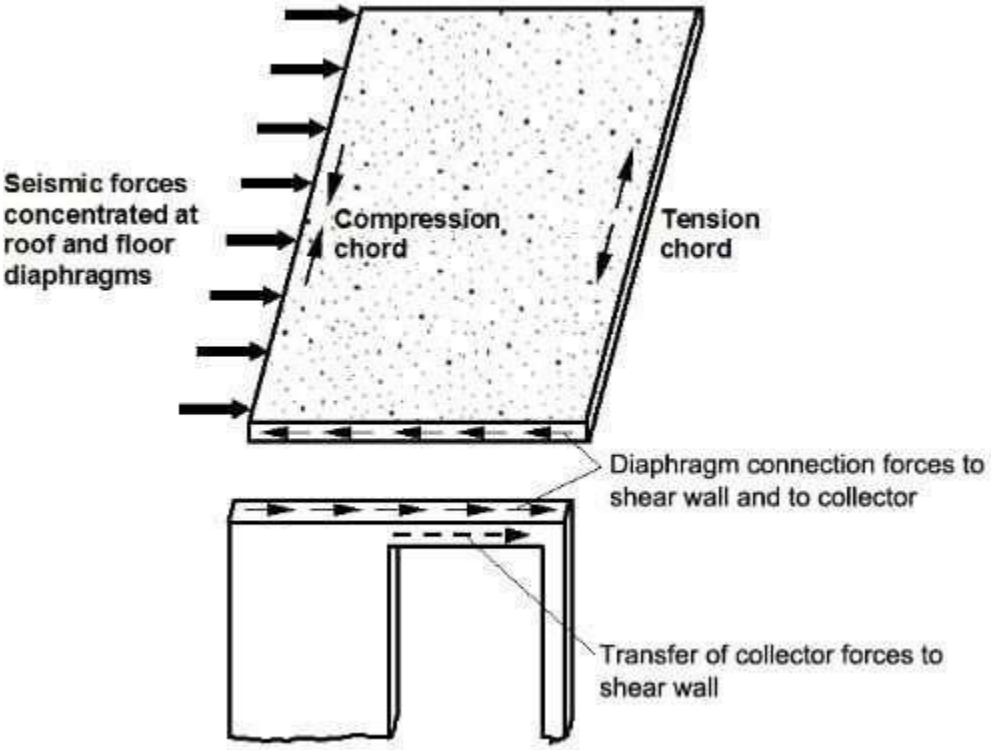


Fig.10: Floor and Roof Diaphragm Action

Adequate Foundations for Earthquake Resistant Structures

It is required to design and construct foundation and its connection to the superstructure, so as for the entire structure to experience uniform excitation during earthquakes. That is why it is advised to provide proper linkage between individual piles such as slabs or beams between piles. Added to that, when superstructure is composed of discrete walls with various stiffness then it is recommended to use tough cellular foundation.

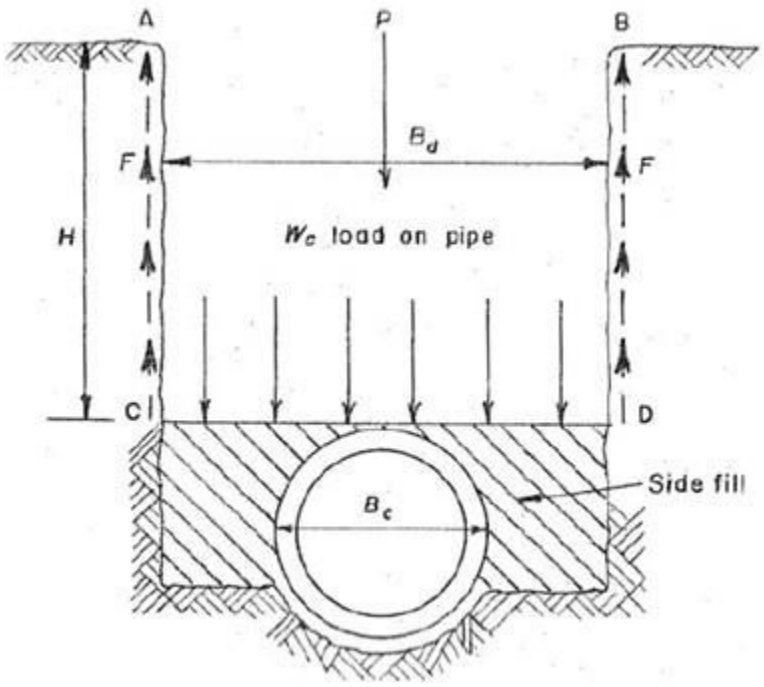


Fig.11: Connection of individual footing with tie beams or structural slabs to prevent possible relative movement during earthquakes

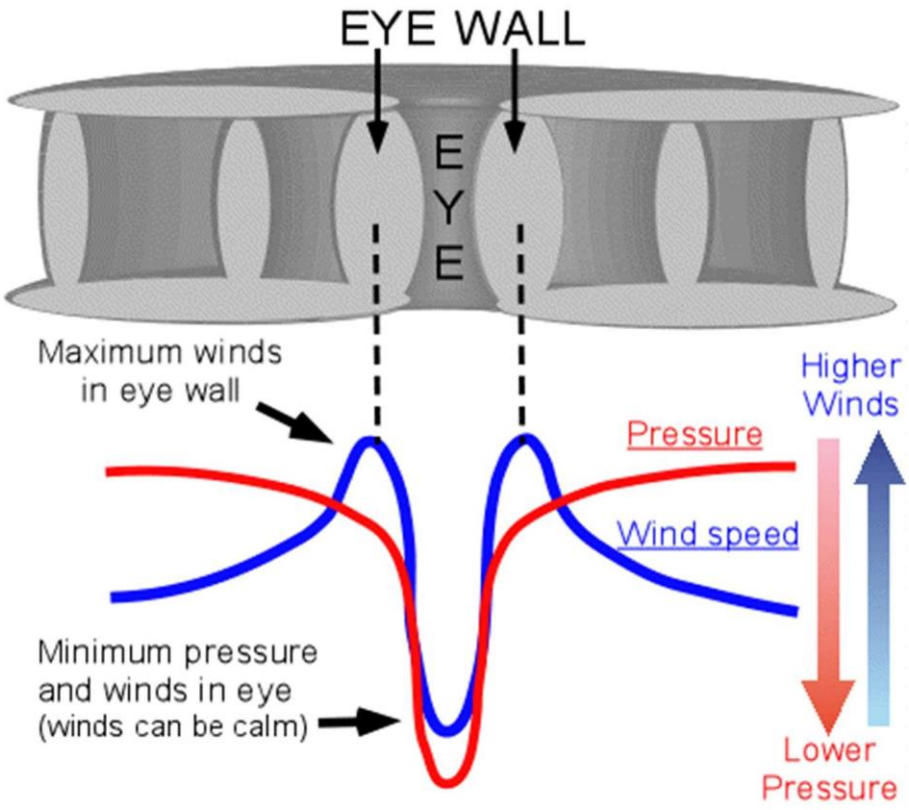
Wind / Cyclone hazard and vulnerability, wind speed and pressures, wind hazard and cyclone occurrence maps, storm surveys and cyclone resistant measures.

11.3 Wind / Cyclone hazard and vulnerability, wind speed and pressures, wind hazard and cyclone occurrence maps, storm surveys and cyclone resistant measures.

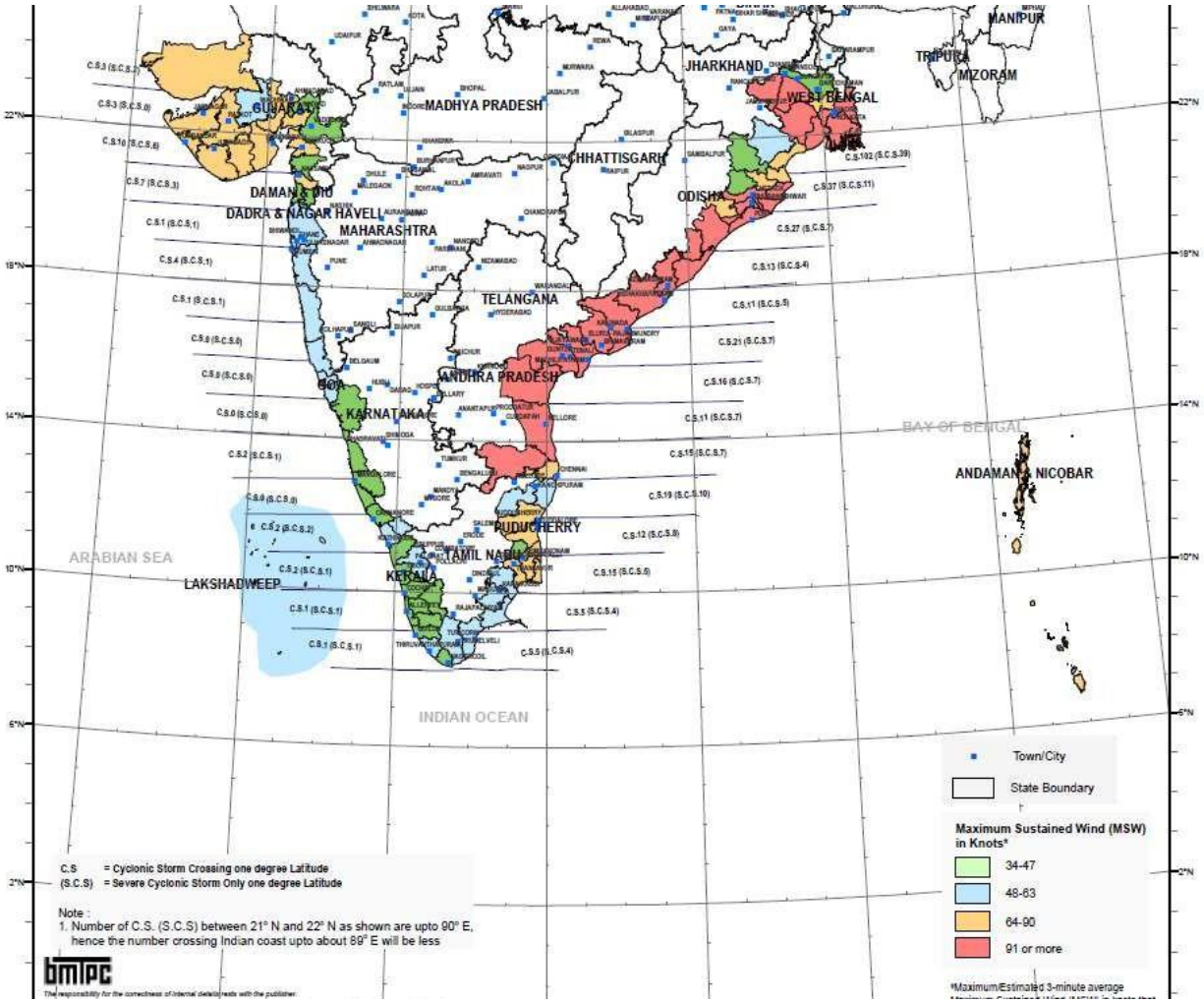
Indian sub-continent is the worst affected region of the world, having a coast line of 7516 kms. (5400 kms along the mainland, 132 kms in Lakshadweep and 1900 kms in Andaman and Nicobar Islands) is exposed to nearly 10% of the world's Tropical Cyclones. There are 13 coastal states/UTs encompassing 84 coastal districts which are affected by Saffir-Simpson Hurricane Scale Source: NWS, NOAA cyclones (Fig. 1). Four States (Andhra Pradesh, Odisha, Tamil Nadu and West Bengal) and one UT (Pondicherry) on the East Coast and One State (Gujarat) on the West Coast are more vulnerable to cyclone disasters. 40% of the total population lives within 100 km of coastline. Analysed data for the period 1980-2000 shows that on an average, annually 370 million people are exposed to cyclones in India.

Atmospheric pressure and wind speed change across the diameter of a hurricane. To demonstrate, the diagram below shows a rough profile of wind speed (blue) and surface pressure (red) across a hurricane. Between 100 and 200 kilometers from the eye, the winds are fast enough to qualify as tropical storm force. The atmospheric pressure here will still be relatively high compared to the storm's center at about 990 to 1010 millibars. However, the

pressure gradually falls and the wind speed rises upon getting closer to the eye wall. It is only over the last 50 to 100 kilometers that the large changes in pressure and wind speed occur.



Cyclone Occurrence map



Storm survey:

A survey team's mission is to gather data in order to reconstruct a tornado's life cycle, including where it occurred, when and where it initially touched down and lifted (path length), its width, and its magnitude.

Cyclone resistant measures:

- Choose the location carefully to avoid the full force of the wind or flood
- Use building layout with a simple regular shape, to avoid concentration of pressure.
- Build the roof at an angle of 30° to 45° to prevent it being lifted off by the wind.
- Avoid wide roof overhangs; separate the veranda structure from the house.
- Make sure the foundations, walls, and roof structure are all firmly fixed together.
- Reinforce the bracing in the structure; strengthen walls and joints/ junctions to increase stiffness.

- Make sure the roof covering is firmly attached to the roof structure to prevent it from lifting.
- If doors & shutters cannot be shut, make sure there are opposing openings to reduce pressure build up.
- Use doors and shutters that can be closed.
- Plant trees around the house as wind breaks and reduce flow of water, but not too close.

11.4 Flood hazard and vulnerability, Flood hazard and Flood prone areas of the country, General protection of habitants and flood resistant construction

Five factors that determine flood vulnerability include the nature of soil, dwelling type, employment status, education and rainfall. All these factors were ranked according to their importance by using a five-point ranking scale, from most important to second, third, fourth and least important. The nature of the soil was ranked as the most important factor, followed by dwelling types. Respondents' rankings were influenced by the collapsed and cracking of their houses that occurred during the flood event.

Flood prone areas in India:

Though the north-Indian plains prone to flood more, the "India flood prone areas" can be broadly categorized

in three divisions:

- **Ganga Basin**: The Ganga Basin gets flooded mostly in the northern part by its northern tributaries. The badly affected states of the Ganga basin are West Bengal, Bihar and Uttar Pradesh. Besides the Ganga, rivers like Sarada, Rapti, Gandak and Ghagra causes flood in eastern part of Uttar Pradesh. The Yamuna is famous for flooding Haryana and Delhi. Bihar experiences massive dangerous flood every year. River Burhi, Bagmati, Gandak, Kamla along with many small rivers contribute to that. In West Bengal, rivers like Mahananda, Bhagirathi, Damodar, Ajay etc. causes floods because of tidal effects and insufficient river channels.

- **Brahmaputra and Barak Basins**: The river banks of Brahmaputra and Barak gets flooded due to the Surplus water found in the Brahmaputra basin and the Barak basin. These rivers along with their tributaries flood the northeastern states like West Bengal, Assam and Sikkim. Jaldakha, Teesta and Torsa in northern West Bengal and rivers in Manipur often overflow their banks.

- **Central India and Deccan Rivers Basin**: In Orissa, spilling over of river banks by Mahanadi, Baitarni and Brahmani causes havoc. The deltaic area formed by these three rivers is thickly populated. Even some small rivers of Kerala and mud stream from the nearby hills add on to the destruction. Southern and central India observes floods caused by Narmada, Godavari, Tapi, Krishna and Mahanadi due to heavy rainfall. Cyclonic storms in the deltaic regions of Godavari, Mahanadi and Krishna even floods the coastal regions of Andhra Pradesh, Orissa and Tamil Nadu occasionally.

Flood resistant construction:

Elevate Above the Flood Level

To start, architects should build the structure above the flood level to minimize damage if a flood does occur. One common way of elevating is by building the structure on columns or stilts. In other cases, the solid foundation can simply be raised higher.

Build with Flood Resistant Material

Flood resistant materials are those which can last in contact with flood waters for at least 72 hours without significant damage. Flood water can be both hydrostatic (standing water) and hydrodynamic (flowing water), and in most cases will result in displaced foundation walls, collapsed structures, floating fuel tanks, scouring, and more. ‘Significant damage’ suggests any damage requiring more work that cleaning or low-cost cosmetic repair, such as painting. To prevent these damages, flood resistant materials must be durable and resistant to excessive humidity. Examples include concrete, glazed brick, closed-cell and foam insulation, steel hardware, pressure-treated and marine-grade plywood, ceramic tile, water-resistant glue, polyester epoxy paint, and more.

Raise or Floodproof HVAC Equipment and Mechanical, Plumbing, and Electrical System Components

ocating service equipment above the flood protection level is generally the best way to protect it. Such equipment includes heating, ventilating, air conditioning, plumbing appliances, plumbing fixtures, duct systems, and electrical equipment including service panels, meters, switches, and outlets. If these components are inundated in floodwater for even a short period of time, they can become severely damaged and will need to be replaced. Electrical equipment in particular can potentially cause fires if short circuited. It is best that these components are raised above the flood level, but if necessary, they may be designed to prevent damage from flooding, whether through waterproof enclosures, barriers, protective coatings, or other techniques to protect vulnerable components. For precise requirements, architects should consult municipal codes.

Anchor Fuel Tanks

Unanchored fuel tanks are easily moved by flood waters, which could drive the tank into walls, damage other property, and cause contamination if the supply line tears free and fills the water with oil. Even buried tanks can be pushed to the surface due to buoyancy. Thus, it is imperative that fuel tanks are anchored, either by attaching them to concrete slabs that are heavy enough to resist flood water forces, or by running straps over them and attaching them to ground anchors.

Install Foundation Vents or a Sump Pump

An example of wet floodproofing is to install foundation vents, which allow flood water to flow through the home rather than pool around it. While this solution may seem like a counterintuitive one due to the damage it could do to the interior of the property, it actually provides an outlet for the flood water and relieves the damaging pressure that flood water puts on the windows and walls. If the interior – usually a subgrade basement – is prepared using flood damage resistant materials, hydrostatic openings, and protected key equipment, the damage can be limited, although post-flood clean-up will be necessary. Similarly, a sump pump is a type of equipment that pumps water out of basements where flooding happens regularly. Sump pumps with battery backup are highly recommended to allow them to continue functioning when the power goes out.

Construct Permanent Barriers

Placing a permanent barrier around the structure in question can prevent flood waters from reaching it. Such barriers should be constructed using a floodwall made of concrete or masonry, or by using a levee made of compacted layers of soil with an impervious core. While this solution may seem like the simplest or most obvious, both floodwalls and levees require extensive maintenance, and levees need a significant amount of land and usable soil materials for construction.

Install Sewer Backflow Valves

Sewer backflow valves prevent flooded sewage systems from backing up into a home. In certain flood-prone areas, this issue is common, and can cause damage that is both difficult to repair and hazardous to occupants' health. Generally, gate valves are preferred over flap valves because they provide a better seal against flood pressure.

Grade the Lawn Away from the House

One final method that architects can use to mitigate damage from flooding is to grade the lawn away from the house. If the lawn tilts toward the house, rainwater will pool around the home. Conversely, tilting it outward directs rainwater away. To this end, the lawn should use a heavy soil that contains clay content and sand, allowing the surface runoff to empty into a more appropriate place such as a street gutter.

11.5 Landslides, Tsunamis and Thunderstorm hazards and vulnerability, Landslide & Thunderstorm incidence maps, Measures against Tsunami Hazards

Landslide, which is the rapid sliding of large mass of bedrocks.

Landslide Vulnerability Zones

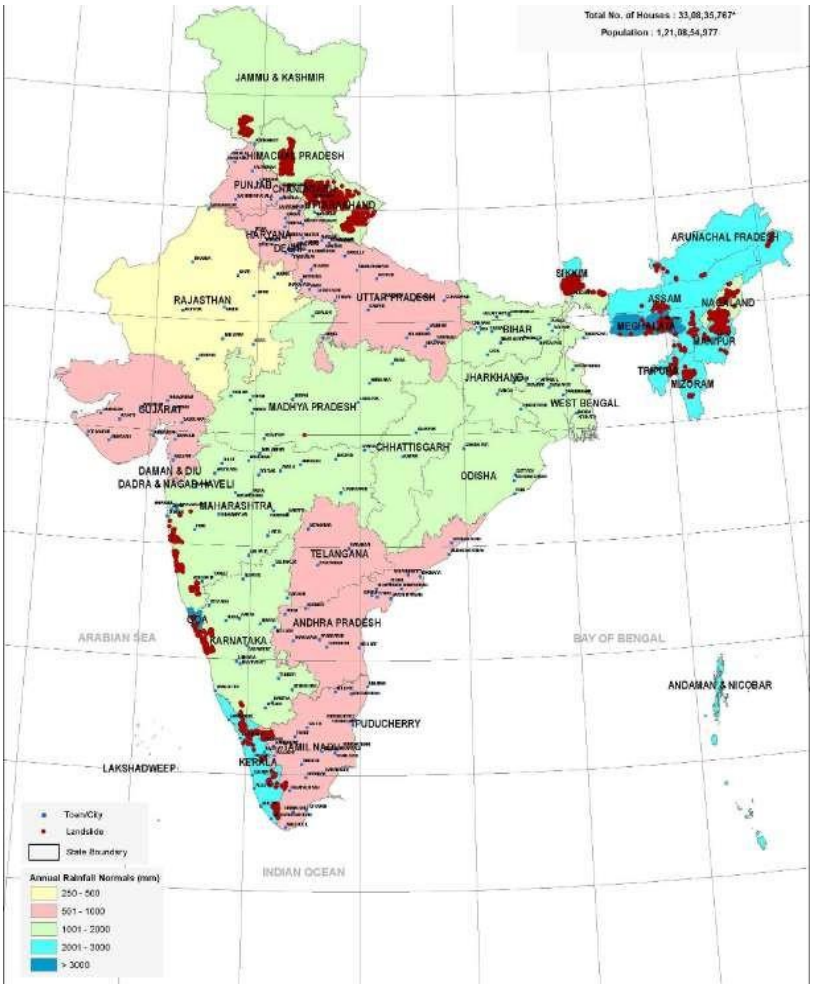
Very High Vulnerability Zone: Highly unstable, relatively young mountainous areas in the Himalayas and Andaman and Nicobar, high rainfall regions with steep slopes in the Western Ghats and Nilgiris, the north-eastern regions, along with areas that experience frequent ground-shaking due to earthquakes, etc. and areas of intense human activities, particularly those related to construction of roads, dams, etc. are included in this zone.

High Vulnerability Zone: Areas that have almost similar conditions to those included in the very high vulnerability zone are also included in this category. The only difference between these two is the combination, intensity and frequency of the controlling factors. All the Himalayan states and the states from the north-eastern regions except the plains of Assam are included in the high vulnerability zones.

Moderate to Low Vulnerability Zone: Areas that receive less precipitation such as Trans Himalayan

areas of Ladakh and Spiti (Himachal Pradesh), undulated yet stable relief and low precipitation areas in the Aravali, rain shadow areas in the Western and Eastern Ghats and Deccan plateau also experience occasional landslides. Landslides due to mining subsidence are most common in states like Jharkhand, Odisha, Chhattisgarh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Goa and Kerala.

Earthquakes and volcanic eruptions that cause the sea-floor to move abruptly resulting in sudden displacement of ocean water in the form of high vertical waves are called tsunamis (harbour waves) or seismic sea waves. Normally, the seismic waves cause only one instantaneous vertical wave; but, after the initial disturbance, a series of afterwaves are created in the water that oscillate between high crest and low trough in order to restore the water level.



Measures for Tsunami hazards:
Communities that understand their tsunami risk are better prepared to protect the public in the event of a tsunami. Protective measures include:
Planning and practicing for response to tsunamis;
Warning the public;
Establishing, marking, and publicizing evacuation routes; and
Educating the public (residents and visitors) about tsunamis and tsunami safety before a tsunami strikes.

Other ways to prepare for and mitigate the potential impacts of a tsunami emphasize thoughtful land-use planning and building design in tsunami hazard zones and include the following:
Improving evacuation routes
Building tsunami evacuation structures
Limiting new development in tsunami hazard zones
Designing, siting, and building structures to minimize tsunami damage
Adopting building codes that address tsunamis
Protecting and strengthening existing structures and infrastructure that if damaged would negatively affect response and recovery
Moving important community assets and vulnerable populations out of tsunami hazard zones
Planning for post-tsunami recovery

11.6 Housing vulnerability risk tables and usage of vulnerability atlas of India, Inclusion of vulnerability atlas in Tender documents.

Vulnerability Atlas of India, brought out by BMTPC, is collation of the existing hazard scenario for the entire country and presents the digitized State/UT-wise Hazard Maps with respect to Earthquakes, Winds & Floods for district-wise identification of vulnerable areas. The latest edition contains additional digitized maps for Thunderstorms, Cyclones and Landslides.

The Atlas also presents the district-wise Housing Vulnerability Risk Tables based on wall types and roof types as per 2011 Census Housing data. The Atlas is a useful tool not only for public but also for urban managers, State & National Authorities dealing with disaster mitigation and management.

The Vulnerability Atlas created by Building Materials and technology Promotion Council (BMTPC) was updated in 2019. It was released by the Hon. Prime Minister on 2nd March, 2019 at New Delhi. This atlas gives the latest information regarding vulnerability of housing stock to earthquakes, cyclones; floods, landslides and thunderstorms. The State Governments have the basic mandate for management of disasters and the executive actions are taken at the district levels with the District Collector playing the pivotal role. This Atlas provides some ready information, though at macro-level, for use of the authorities involved in the tasks of disaster mitigation, preparedness and preventive actions. A glance at the hazard maps will bring to the notice of the district authorities, the location and percent areas of the districts most susceptible to hazard occurrence, the probable maximum hazard intensities, the type of housing and its vulnerability and risk to the hazards. Knowing the extent of the problem of future disasters, the district authorities can formulate development plans for (a) preventive actions like hazard resistant construction, retrofitting and upgrading/retrofitting of existing buildings, (b) mitigating the intensity and extent of the disasters, (c) early warning system installation and drills for its use, (d) instituting a hierarchical structure for preparedness down to the village level, (e) training of manpower in various tasks in the emergency (f) implementation of land zoning regulations in flood plains and coastal areas, and building bylaws with disaster resistant features in various towns and cities, etc. (g) supporting land use zoning and urban planning (h) integration of DRR with development and (i) supporting in locating industries and other development projects. Similarly, various Ministries can use this atlas to make all the structures under their jurisdiction disaster resilient, infrastructure constructed and maintained by them hazard resistant and people/economic activities less susceptible. It is urged by the Hon. Prime Minister that all the construction and building related tenders may utilise this vulnerability atlas as a guiding factor, to arrive at the cost which will include Disaster Resilience.