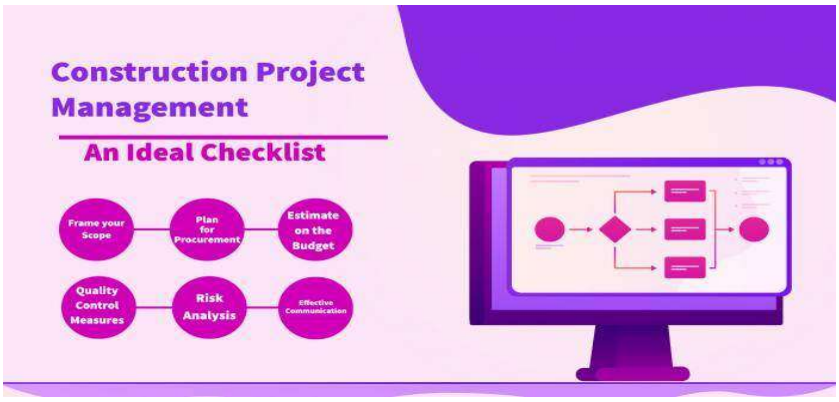
BHADRAK ENGINEERING SCHOOL & TECHNOLOGY (BEST),
ASURALI, BHADRAK

CONSTRUCTION MANAGEMENT

(Th-02)

(As per the 2019-20 syllabus of the SCTE&VT, Bhubaneswar, Odisha)



Sixth Semester

Civil Engg.

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CHAPTER NO. 01

INTRODUCTION

1.1 AIM AND OBJECT OF CONSTRUCTIONMANAGEMENT :

Signification of construction management:

Construction today is an on embracing term covering activities from conception to physical realization of a project. It is not limited only to the physical activities of developing man, material and machinery, this enlarged scope of variety and magnitude of construction activity.

The construction industry is major economic activity in India. Construction activity contributes annually 10% to GNP (gross national product). Thus, playing a major road in the development of the national economics.

Objectives of construction management: -

The main objectives of construction management are: -

i> Collecting the work within estimated budget and specified time.
ii> Involving a reputation of high-quality workmanship.
iii> Providing safe and satisfaction working condition for all personnel and workers.
iv> Taking sound decision at lowest practical management level through delegation of authority.
v> Motivation people of their best within their capacity.
vi> Creating an organization that works as a team.

1.2 FUNCTION OF CONSTRUCTION MANAGEMENT:

Construction process:

Construction process mainly it is divided into five stages: -----

i> Planning stage – The planning stage is when the project plans are documented, the project deliverable and requirements are defined, and the project schedule is created. It involves creating a set of plans to help guide your team through the implementation and closure stage of the project.

ii> Analysis and design stage – The analysis stage is where multiple collected and processed items are examined, correlated and given the necessary context the mark them useful. This is where intelligence goes from just being loosely related pieces of data to a finished product that is useful for decision- making.

It is the process of taking on and developing the approved concept design. By the end of the detailed design process, the design should be dimensionally correct and coordinated, describing all the main components of the building and how they fit together.

iii> Management stage – Construction management is the overall planning, coordination, and control of a construction process from the start to the end. The objectives of project management are to produce a project that meets client's requirements on budget and schedule, and at acceptable risk, quality, and safety.

iv> Construction stage – During the construction stage, a decision is generated stating the working hours of the labours, quality check, material storage and access to the site. A pre-construction meeting is arranged for problems that may arise among workers or at the site. The work begins keeping in mind the budget.

v> Handing over stage – Handover is a process not a date. Planning for it should be fro the start of the project and it should be viewed as an incremental transfer of knowledge and operation from project team to business-as-usual. The benefits and deliverables must be measurable and communication from the start.

1.3: CONSTRUCTION TEAM:

The construction team consist of owner, engineer, architect and contractor. The team formed to co-operatively plan, design and execute a particular project. the objectives of the team is to execute owners project in the best most economical manner within the limited/stipulated time. The owner forms the construction team to serve is interest through the service of both the contractors and engineer. The function of constituents of any construction tam depends upon the scope and nature of the work.

Owner: ------

The owner may be an individual, group of individuals private or public under taking. The owner is the finer holder of major decision-making power regarding managerial, financial and administrative aspect. He approximateschanges, if any in the project scope of or schedules. The owner controls the project resources such as main power funds and maintenance of the work, after the work has been completed.

Engineers and architect: --------

This includes structural, mechanical and electrical engineers, architect, quantity surveyors, specialist such as structural consultants, safety and maintenance planner, soil investigators etc.

The roles of the team members are as follows: -------

Architect: --------

The role of the architect is to assess the client's functional requirements, design for pleasing and to assess it the engineers for proper design.

Structural Engineer: -------

The role of the structural engineer is to prepare structural design of structure and to prepare the working drawings based on the architect planned.

Mechanical Engineer: -------

The role of the mechanical engineer mainly concerned with the preparation of working drawing for heating ventilating air condition and other mechanical services associated with the construction project activities during and after construction.

Electrical Engineer: -------

The electrical engineers are concerned with the design and preparation of working drawing for electrical power and distribution system during and after construction.

Quantity Surveyors: --------

Roles of the quantity surveyors are: -

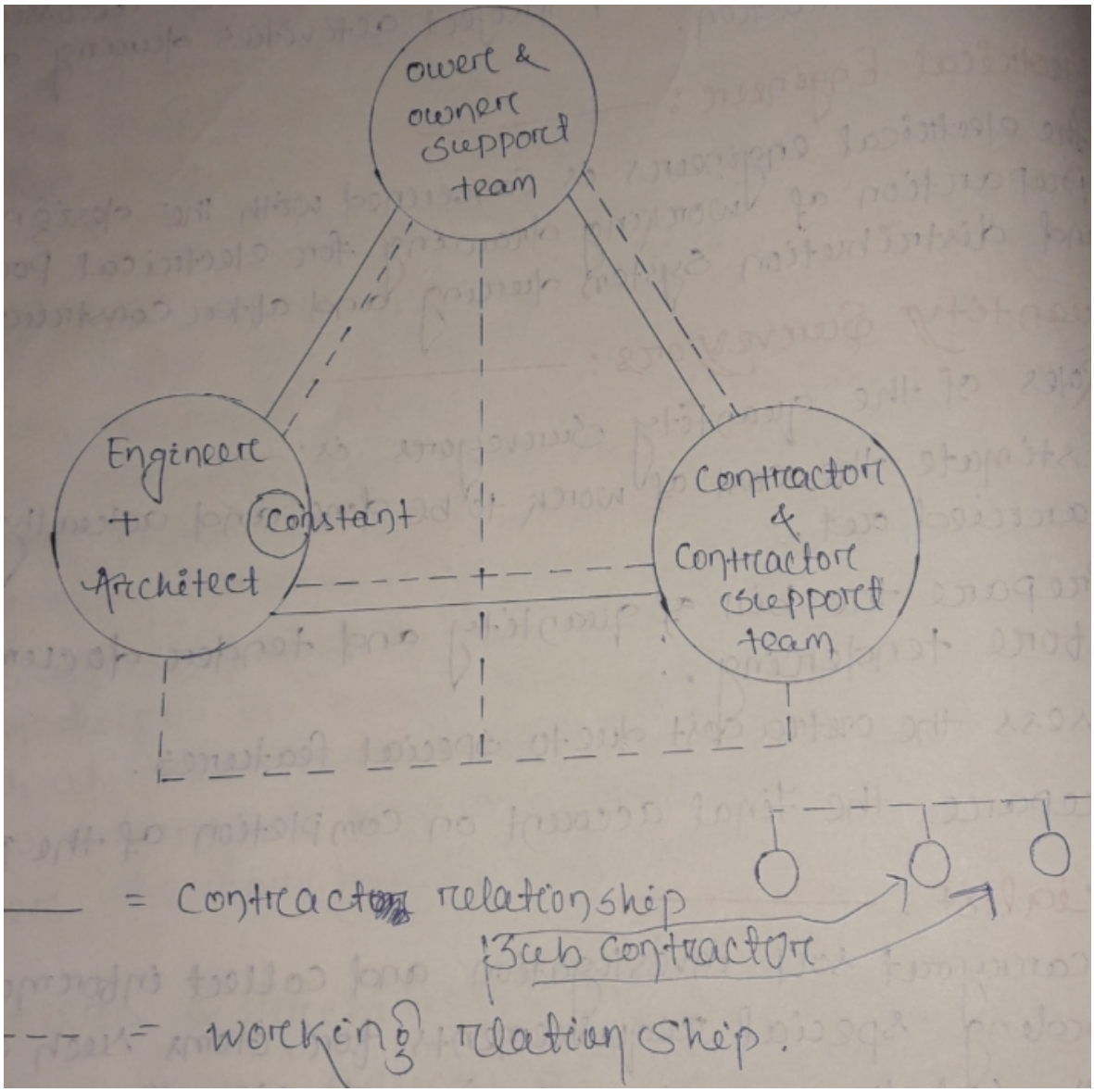
i> Estimate the cost of work to be done and actually carried out.
ii> Prepare the bill of quantity and tender documents before tending.
iii> Assess the extra cost due to special features.
iv> Prepare the final account on completion of the project.

Specialist: --------

The carryout soil investigation and collect information regarding special requirements for items such as health, safety, workshop equipment etc. They also suggest solutions to specific problem during construction.

Contractor: --------

The contractor may be an individual under taking small contracts or a larger construction company turn-key project. Construction weather small or big need the services of qualification engineers. In some project the contractor may sublet part of the work to the sub-contractor or petty contractor. The contractor has to execute various types of works and to make all necessary arrangements for labour,machinery,materials, power connection etc. In order to complete the project within stipulated time and cost. The contractor submits running bills for the payment based on the progress of the work and required of materials at site.



Proper interaction between the construction team leads to smooth and efficient execution of construction project. Proper understanding achieving speed, economic, efficiency and quantity in all construction project.

1.4: RESOURCES FOR CONSTRUCTION MANAGEMENT

The main resources for construction industries are;

- Material
- Man power
- Machinery(plant/equipment and power)
- Funds
- space

Material: -------

Materials such as bricks stones, cement, aggregates, steel, shuttering, scaffolding, timber, water supply, sanitary, electrical fittings, petrol, oil, lubricants etc. Are required for construction

Man power: ---------

Man power in the form of technical and managerial personnel and work force in various trades is essential in carryout project activities. Technical personnel include engineers,architects, quantity surveyors,supervisors, techniciansetc. The work force consists skilled and unskilled workers.

Machinery (plant/equipment and power):

For any construction work various plant/equipment and tools are required.Depending on the type and nature of a construction job, machinery required at site includes batching plants,mixture,tricks,tractor,excavator,cranespump,generators,workshop equipmentetc. For efficient construction activity this equipmentneeds to be properly maintained. Power is an essential resource required for lighting, running of equipment and plants and for other facilities.

Funds: -------

Adequate funds should be available for smooth implementation of the project. Financial planning is essential for smooth running in project activities. All the other resources are dependent on the availability of funds. Therefore, funds must be with special care.

Space: ------

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

*Strong Material

*Site office, Labour comp etc.

*Providing yard for bar benders, carpenters, installation of equipment, repair workshop etc.

POSSIBLE SHORT QUESTIONS WITH ANSWER.

No.1 What is the aim of construction management? (W-18, S-19,

Ans. The aim of construction management is that the construction work is an integral part of development projects in every sector of our economy. Construction activities account for more than 50% of the total outlay in any five-year plan. In view of the limited available resources for achieving national development goals, efficient construction management assumes paramount importance.

No.2 What the prime objective of construction management.? (W-14,

Ans. The prime objective of construction management is to complete the work within the estimated budget & stipulated time. High quality workmanship safety, team work, motivation & sound decision making are important elements of construction management.

No.3 Write the main function of construction management. (W-14,

Ans. The main functions of construction management include planning & schedule, organizing, staffing, directing, controlling & co-ordinating.

No. 4 What are the important resources of construction management?

Ans. The main resources required for construction activities are materials, manpower, machinery, fuel, funds & space.

No.5 Define construction team. (W-14, S-17,

Ans. The construction team includes, the owner, engineer/Architect & contractor. The team co-operatively plans, designs & executes the construction work. The objective of the team is to execute the work in the best & most economical manner within the stipulated time.

No.6 Write the duty of a structural engineer in a project.**(S-17,**

Ans. The role of the structural engineer is to prepare structure design of structures & to prepare the working drawing based on the architect plans.

No.7 What is working drawing? (S-17, W-18,

Ans. Construction drawing are sometimes referred to as working drawing. They are used by all involved in a project to work on the actual building of the design. These are providing all the information, both graphic & written about the project.

POSSIBLE LONG TYPE QUESTIONS: --

1. **Describe about importance& objectives of construction management? (S-18, W-18**
2. **State the main objectives of construction management? (S-17, S-18**
3. **Explain the major function of construction management?**
4. **Define construction team in construction management?**
5. **Explain the role of each constituent of the construction team?**
6. **Describe the various resources required for construction management?**
7. **List out factors involved in construction management? (S-18, W-18,**

_____ ******* _____

CHAPTER NO. 02
CONSTRUCTION PLANNING

2.1: IMPORTANCE OF CONSTRUCTION PLANNING: ---

Planning is the starting point of the management function. Planning leads to organisation and staffing followed by directing, controlling and coordinating. A graphic schedule known as programme forms the basis of the effective planning. The programme should include sufficient details to enable proper consideration to be given to the timing and duration of operation, types and quality of materials and equipment, delivery dates and man power requirements.

Essential characteristics of a good programme:-----

It must be suitable for use as a control tool against which programme can be measure.

It must be sufficiently accurate to enable its use for forecasting requirements of material, main power, machinery and money.

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

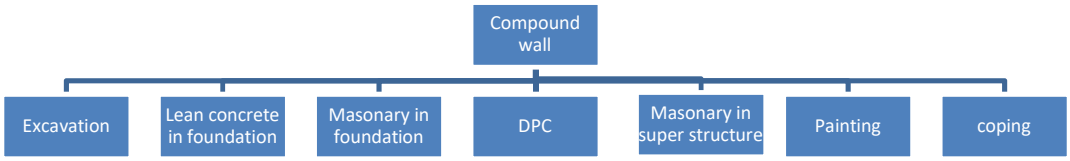
Construction Controlling: ------

The executive process in planning is essentially controlling without a proper plan the controlling process cannot take place because it is essential to have some means by which progress of working can measured against the planned requirements. Therefore, controlling must be proceed by planning without proper control the project work may not be completed within the stipulated time. As the work progress, performance is cheeked and adjustment whenever necessary in cooperated into the plans. The controlling process may even lead to replanning.

2.2: WORK BREAK DOWN STRUCTURE:----

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

The functional elements of a project and they are inter relationship isdetermining by technique known as work breakdown structure. Such a technique establishes to sequential order in a system by breaking the project into recognizable sub – system and discrete activities for example



In general system is broken down in a subsystem and each sub – system into major components and so on. The break down is continued till the system is reduced components or activities representing manageable units for planning. The objective is to identify tasks that can be planned,estimated,scheduled, executed controlled for completion.

2.3: STAGES OF PLANNING: --------

For efficient work the project activities planning is essential at various stages. It may broadly two stages.

Pre- tender stages.

Post – tender stage / contract stage.

Pre-Tender stage:------

- Pre tender planning broad – based and is carried out by the contractor. It is the stage in which a contractor has the opportunity of planning.
- Examining drawings and specifications to identify various items of work.
- Carrying out site investigation and markets survey to assess the availability and rates of materials main power, machinery and other facilities.
- Identifying alternative method for executing the work for section the most suitable and economical method.
- Estimating the qualities of different types of work and the time required for their completion.
- Preparing a tentative construction schedule with reference to the stipulated time to the completion.
- Deciding the overhead and margin of profit and finalizing the tender prices for completion the work within stipulated time.

Post-Tender 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 schedule time.
- Post tender stage planning involves the following steps: -----

- Establishing a good communication system between members of the construction team for the smooth running of the project work.
- Evaluating alternative construction method identity, the most economical efficient method.
- Studying inter-relationship of various items of work finalization of proper sequence of operation.
- Determining the phase requirements of plant and machinery including, repair and maintenance facilities.
- Calculating the phase requirements of construction material such as,cement,aggregate,bricks,sand,steel etc.
- Preparing details of man power requirements including labour, supervisor and management staff for various stage of work.

2.4:CONSTRUCTION SCHEDULING BY BAR - CHART: ---

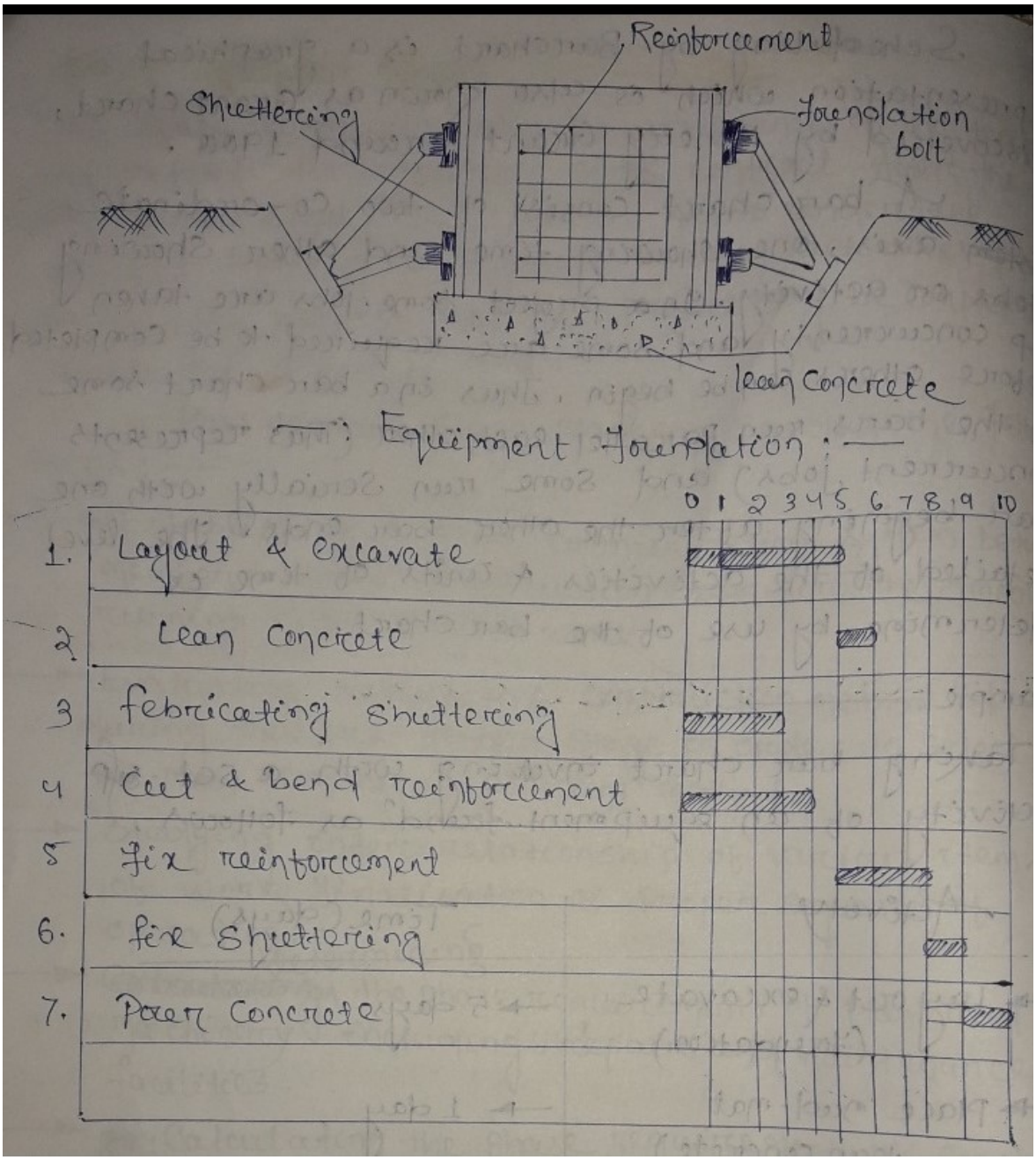
Scheduling is the process of fitting the work plan to a time frame indicating the start and completion of each activity.

Scheduling by bar chat is a graphical representation which is also known as Grant chart, discovered by ltenery Grant around 1900.

A bar chart consist of two co – ordinate axis, one showing time and other showing jobs or activity. In a project some jobs are taken up concurrently and some are required to be completed before others can be begin.Thus, in a bar chart some of the bars run parallel each other (Thus represents concurrent jobs) and some run serially with one detailed of the activities and units of time is determine by use of the bar chart.

Example: --- Taking bar chart involving with a set of activity of an equipment foundation as follows.

Activity	Time (Days)
Layout & exavate (foundation)	5 Days
Place mud mat (lean concrete)	1 Day
Fabricate shuttering	3 Days
Cut & bend reinforcement	4 Days
Fix reinforcement	2 Days
Fix shuttering	1 Day
Pour concrete	1 Day



In the above bar chart, the activities of layout excavation,fabricate, shuttering and cut and band reinforcement can start parallelly/simultaneously as these activities are concurrent activities (i.e., independent to each other). Activity lean concrete can only start after completing the activity layout and excavation.These two activities being in series and depicted in the bar chart one after another.

Likewise, fixed reinforcement can only be taken up after placing lean concrete.

Poor concrete is the best activity which follow fixing of shuttering and being in series as shown in bar chart.

Advantages of Bar chart: -------

It is very simple to prepare and interpret

Each time of work and activity is shown separately.

It is very easy to compare the progress and original schedule.

It is easily to know for the time of resources activity.

The modification to the chart if required can be carried out easily.

2.5 PREPARATION OF SCHEDULE FOR LABOUR, MACHINERY AND FINANCE FOR SMALL WORK: -------

Preparation of Material schedule: -

A material schedule enables storage space to be adequately planned and necessary arrangement to be made for timely delivery of material.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 weak wise which depending on the nature of project and storage space.

Let's prepare a material schedule week wise for the construction of a temporary shed (8mx20m)

Name of the work ---------- prepared by----------

Materials	**Units**	**Weeks**				
		1	2	3	4	5
Cement bags	**Nos.**	110	100	115	120	130
Bricks	**Nos.**	4500	4000	5500	3000	2600
Sand	**Cubic**	20	20	35	25	15
Aggregate	**Cubic**	20	35	30	25	30
Steel	**Quintal**	_	02	10	02	_

Preparation of labourschedule: -

Labour schedule means the main power requirements of the project in a tabular from for various stages.

The purpose of labour schedule during construction stages are: ------

It provides the site in charge with ample warning of his future labour requirements.

By nothing the actual work course regularly on the chart, a direct measure of requirement a labour in the site can be obtained.

If a man power shortage is lively in a particular section of the project, it enables such type of labour force to be sort out from elsewhere before a delayoccurs.

It helps in efficient and optimum deployment of the labour force in the various section of the project.

Let's prepare a labour schedule week wise for the construction of temporary shed.

Name of the work ---------- prepared by ----------

Man power (Labour)	Week				
	1	2	3	4	5
Foreman	1	1	1	1	1
Carpenter	_	_	_	1	1
Welder	_	_	3	2	1
Concrete mixture operator	_	_	1	_	_
Mason	1	1	2	2	1
Bar Bender	_	2	1	_	_
Labour (unskilled)	3	3	10	6	3

Preparation of equipments(Machinery)Schedule :

An equipment schedule is prepared for all plants/equipment required to be developed on the project .From this schedule delays in the work that may occur either due to non-availability or break down of equipment can avoided .Such a schedule enables the officiant and optimum utilization in a project .Using this schedule timely arrangement cab be made for developing particular equipment at a particular time .

Taking a example for construction of a temporary shed (8m x 20m). Equipment schedule is as follows.

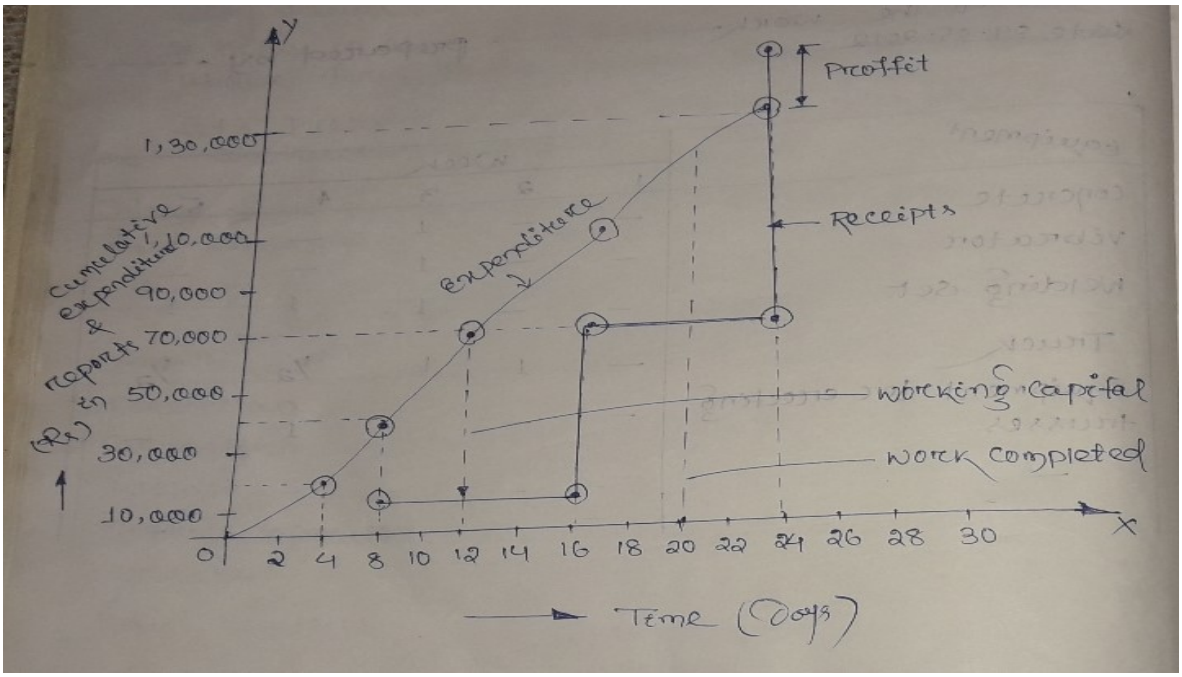
Name of the work -------- prepared by --------

Equipment	Week				
	1	2	3	4	5
Concrete mixture	-	-	1	-	-
Vibrator	-	-	1	-	-
Welding set	-	-	1	1	1
Truck	-	1	1	1/2	½
Equipment for erecting trusses	-	-	--	1	-

Preparation of finance schedule: -----

Finance schedules are most essential both for pre-tender and post tender stage. A finance schedule shows the amount 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 finance required for the successful completion of the project.

The finance schedule for the construction of temporary shed (8m x 20m) is shown.



Limitation of bar chart: --------

- Inability to deposit inter dependencies of activities:

  A construction project consists of a no. of activities which are inter-related and inter depended. This is the basics of character of network planning scheduling which is completely absent in the bar chart.

- Absence of critical and non-critical activities:

  Bar chart does not distinguish between critical and non-critical activities. So, maximum attention of construction failure.

- No cost optimization:

  Since exact critical path is not available with the bar chart. So, it is not possible to trace the activities to get maximum and minimum duration of the project.

- No controlling, monitoring and updating mention in the bar chart.
- No resource levelling mention in the bar chart.
- However, despite of limitation, bar chart extensively used in the construction industry due to their simplicity and easy of understanding.

Construction scheduling by network techniques-definition of terms: ------

Introduction: ----------

The main objective of construction management is to complete a given project within a specified time at a previously estimated cost. Planning is necessary to achieve this objective. Scheduling is the determination of the time required for executing various activities and sequence in which the activities have to be carried out.

Thus, network techniques are effective tools for planning, scheduling and controlling the construction job. The planning commission of government of India has bureau of public enter prices, Indian roads congress and many other professional organization s have been advocating the use of network technique for the project management.

Hence there are two types of network techniques:

i) CPMii)PERT

Provide a rational approach to the planning and controlling construction work.

PERT stands for Programme Evaluation and Review Technique.

CPM stands for Critical Path Method.

PERT and CPM techniques: ------

PERT (program evaluation and review technique)

PERT was developed by engineers of the United States navy while working on the Polaris missile program during 1957-1958.

Science then PERT has been in the use for various research and development project which are non-repetitive in nature. Such project is characterized development in the system and the time duration of various activities.

There are three-time estimates are used to determine the expected or average time of each activity. The expected time forms the basis of PERT network.

CPM (Critical path method)

CPM is an algorithm for planning, managing and analysing the timing of a project. The steps –by-step CPM system helps to identify critical and non-critical tasks from project's start to completion and prevents temporary risks.

Advantages and Disadvantages of PERT and CPM

Advantages (PERT): ------

PERT analysis improves planning and decision making by integrating and presenting data from multiple departments.

Gathering qualitative and quantitative data project multiple sources also helps co-ordinate project activities and improves communication among departments.

Disadvantages (PERT): -----

It can't effectively handle situations in which two or more projects share available resources.

It fails when there is a change in the precedence and sequential relationships of project activities.

It requires a lot of information as input to generate an effective plan.

Advantages (CPM): -------

- Reduce the risk of overlooking essential task and provides a blue-print for long range planning and co-ordination of the project.
- The CPM makes it easier for project managers to build a team and create human network for efficient handling of a multi tasked project.

Disadvantages (CPM): ------

- Skilled management and team philosophy is essential Useless may be limited in complex and large-scale operations.
- Necessity of having clear and reliable information.

.

Estimation of time: ------

Computation of expected time: -----

Optimistic time estimate(t_o)--

It is the shortest possible time for completing an activity if everything proceeds as planned without any problem i.e., the activity is performed under ideal condition.

Most likely time estimate(t_m or t_t)--

It is the time for completing an activity under normal condition i.e., in this case condition are not ideal and minor mishaps may occur.

Pessimistic time estimate(t_p) --

It is the maximum time required to complete an activity under ab-normal extremely adverse conditions in which everything goes wrong. They estimate however does not include such as fires earthquakes, flood etc.

The expected time estimate for each activity is computed on the basis of statistics.

T_e =(t_o+4t_m+ t_p) / 6

Where, T_e = Expected time or average time.

PROBLEM: --------

Estimate a expected time of each of the following activity from three time estimates.

Sl No.	Activity	Time estimate in days		
		t_o	t_m	t_p
1	Driving pre-cast piles for a bridge abuttment	22	30	50
2	Erecting roof truss for fqactory shed	11	14	17
3	Concrete foundation of Turbo generator	3	$5\frac{1}{4}$	6
4	Fqabricating sheet metal A.C ducts for an	12	16	17

	auditorium			

Solution: --

Driving precast piles for a bridge abutment,

Expected time T_e = (t_o+ 4t_m+ t_p) / 6

= (22 + (4x30) + 50) / (6) =32 days

Erecting roof truss for a factory shed,

Expected time, T_e = (t_o+ 4t_m+ t_p) / 6

= (11 + (4x14) + 17)/ (6)=14 days

Correcting foundation of turbo - generation,

Expected time, T_e = (t_o+ 4t_m+ t_p)

= (3 + (4x5(1/4)) + 6)/ (6) =5 days

Fabricating sheet metal A.C ducts for an auditorium.

Expected time T_e = (t_o+ 4t_m+ t_p) / 6

= (12 + (4x16) + 17) / (6) = 15.5 days

Application of PERT and CPM techniques insample construction works: - (Basic terms used in PERT and CPM): --

Merge and burst event: -------

It is not necessary for an event to be ending event of only one activity but can be ending event of two or more activity. Such event is defined as merge event. If the event happens to be beginning of event of two or more activity defined as burst event.

Preceding Activity: -------

Activity which must be accomplished before a given event can occur are known as preceding activities.

Succeeding Activity: ---------

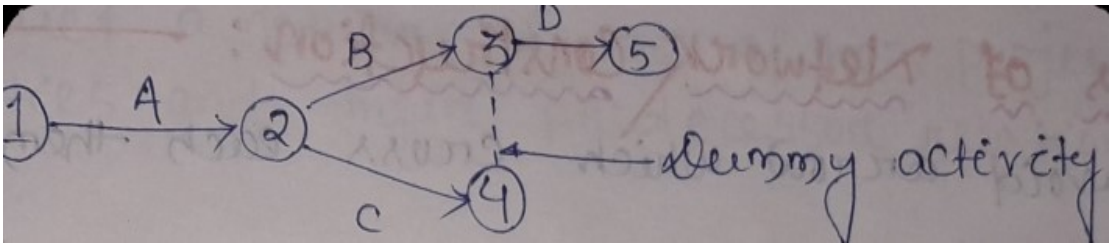
Activity which cannot be accomplished until the events has occurred are known as succeeding activity.

Concurrent Activity: --------

Activity which can be accomplished concurrently (meet in end event).

Dummy Activity: ----------

Certain activity which neither consume times nor resources are used simply to represent a connection or link between the events are known as dummy activities.



The purpose of dummy activity is to maintain a proper logic in the network. Tomaintain uniqueness in the numbering system.

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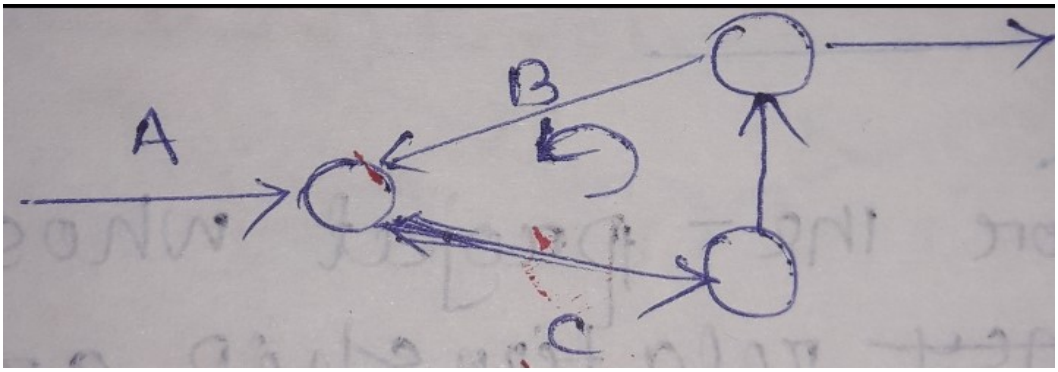
Common error: ------

There are mainly three error in a network construction.

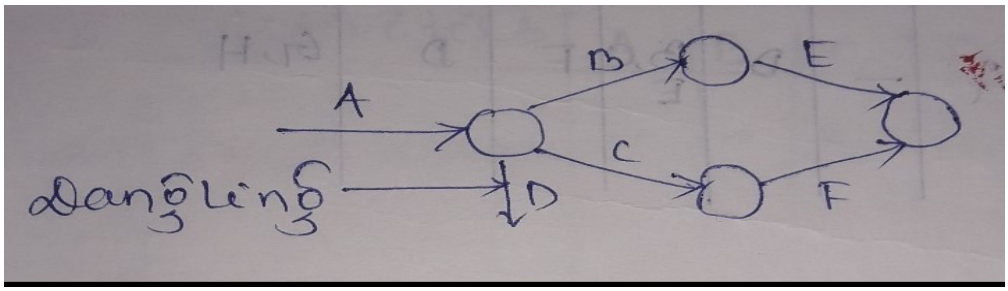
Looping (cycling): ----

In a network diagram looping error is also known as cycling error. Drawing an endless loop in a network is known as error of looping. A loop can be formed if an activity represented as going back in time.

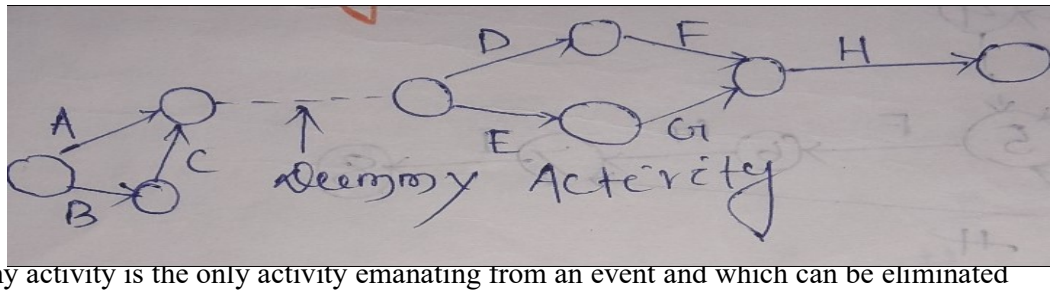


Dangling Error: -------

To disconnect an activity before the completion of all the activity in a network diagram is known a dangling error.



Redundancy Error: --------



If a dummy activity is the only activity emanating from an event and which can be eliminated is known as redundancy error.

Roles of network construction: ---------

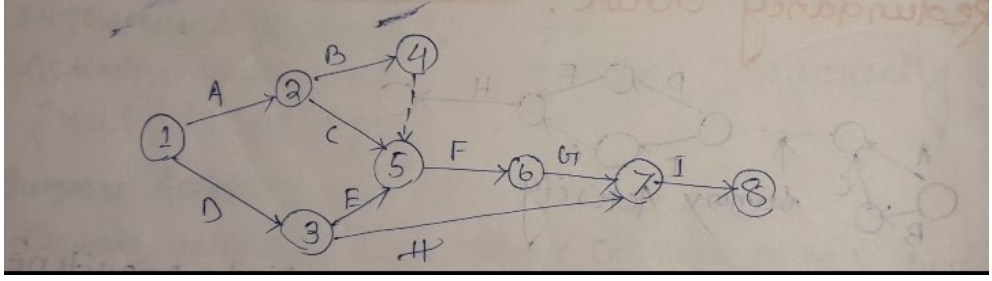
- ➔ Try to avoid arrow which cross each of them.
- ➔ Use straight line.
- ➔ No event can occur until every activity preceding it has been completed.
- ➔ An event cannot occur twice that is must be no loops.
- ➔ An activity succeeding an event cannot be started until the event is occur.
- ➔ Use errors from left to right avoid mining to direction, vertical and standing errors may be used if necessary.
- ➔ Dummies should be introduced if it is extremely necessary.
- ➔ Try to avoid the activities to the parallel.

Construction of network: ---------

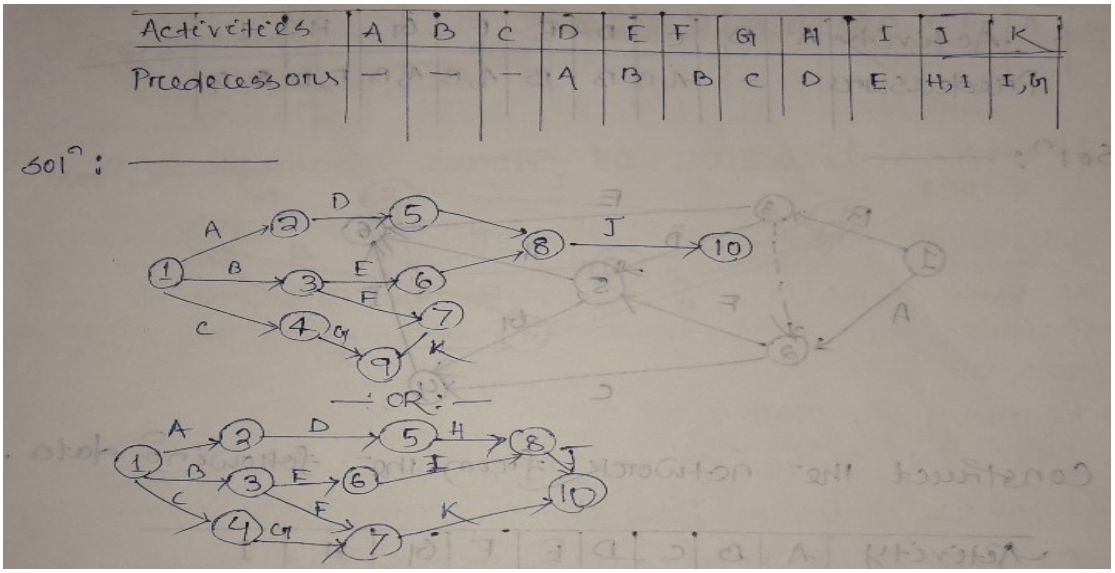
(1) Construct a network for the project whose activities and their predecessor relationship are given below.

Activity	A	B	C	D	E	F	G	H	I
Predecessors	–	A	A	–	D	B,C E	F	D	G, H

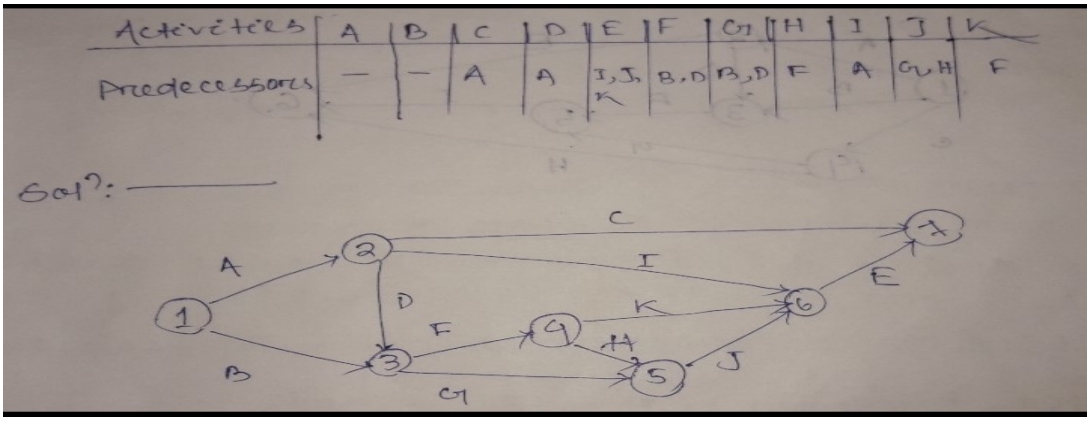
Sol^n: ———



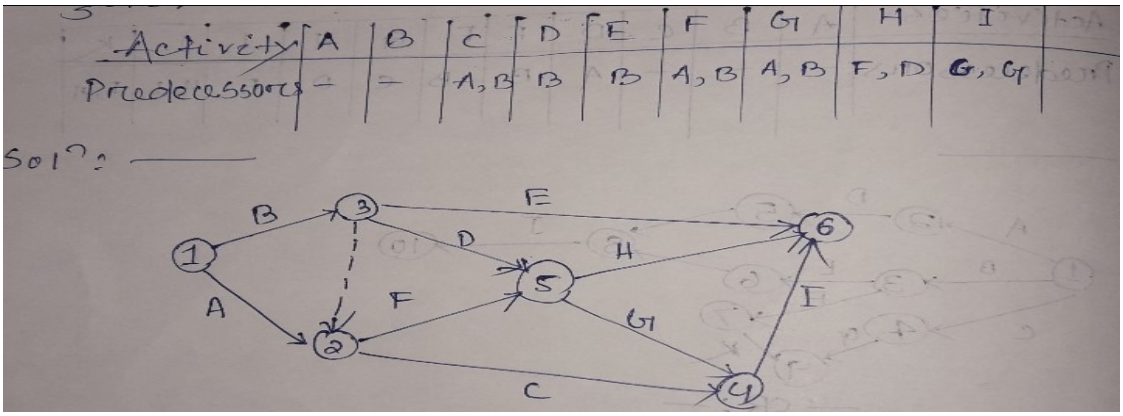
(2) Construct a network of each of the project whose activities and their predecessor relationship given below.



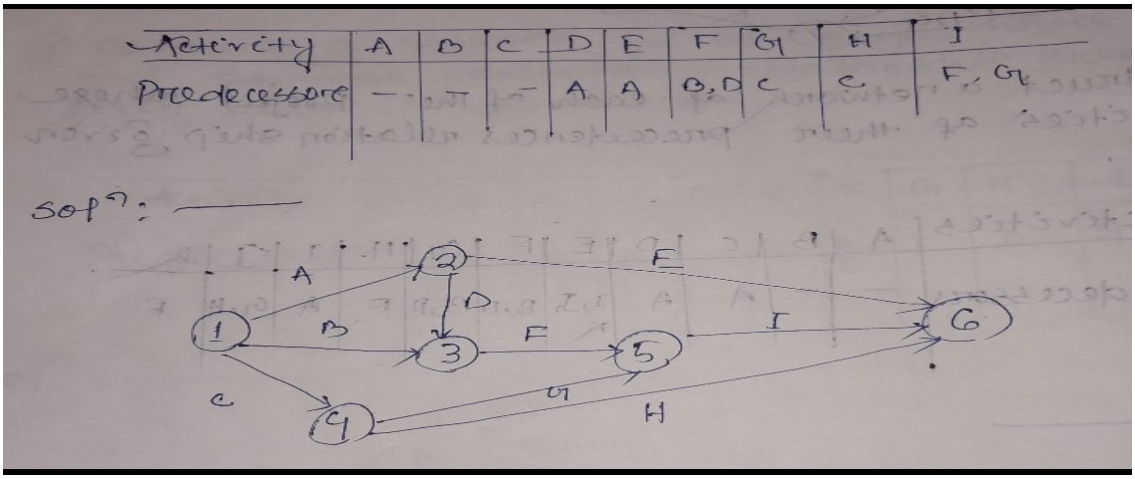
(3) Construct a network of each of the project whose activities of their precedencies relationship given below.



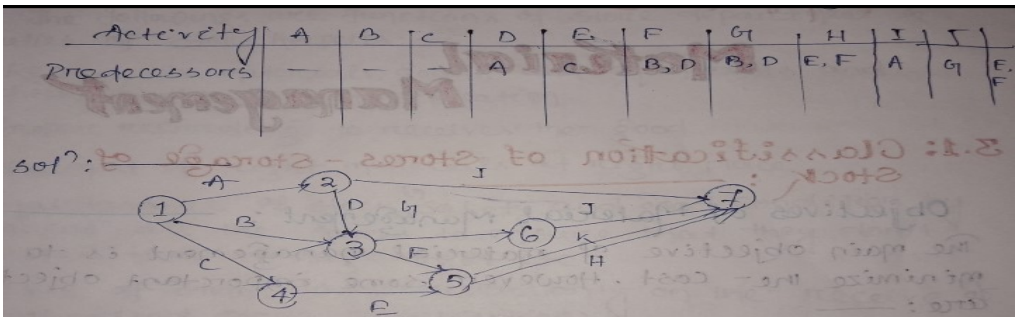
(4) Construct a network of each of the project whose activity and their precedencies relationship given below.



(5) Construct the network from the following data.



(6) Construct the network from the following data.



POSSIBLE SHORT QUESTIONS WITH ANSWER

No. 1) What is the importance of construction planning?

Ans. Planning is the starting point of all management function. Planning leads to organization & staffing followed by directing, controlling & co-ordinating.

No. 2) What is programme in construction planning?

Ans. A graphic schedule known as programme forms the basis of the effective planning. The programme should include sufficient details to enable proper consideration to be given to the timing & duration of operations, types & quantity of materials & equipment, delivery date & manpower requirements.

No. 3) What is breakdown structure?

Ans. For effective planning, it is necessary to breakdown the total project into subsection & activities. Each activity & jobs may further subdivide into smaller jobs for planning at various levels.

No. 4) What is material schedule & labour schedule?

Ans. A material schedule is a format which enables storage space to be adequately planned & necessary arrangements to be made for timely delivery of material.

Labour schedule is also a format which enables the manpower requirements of the project in a tabular form for various stages.

No. 5) Write the full form of PERT & CPM.

Ans. PERT stands for Programme Evaluation & Review Technique.

CPM stands for Critical Path Method.

No. 6) Define Activity & Event.

Ans. Performance of a specific task, operation, job or function which consumes times & resources & as a definite beginning & end is called an Activity.

An instantaneous point in the time marking the beginning or end one or more activities is called Event.

No. 7) What is Network?

Ans. A Network is the diagrammatic representation of a work plan showing the activities, step by step leading to the established goals. Its interdependence between the various activities.

No. 8) Define tendering stage.

Ans. It is the stage in which tenders are called & the contract is awarded at the best available terms mutually agreed between the owner's team & the contractors.

No. 9) What do you mean by bar chart? (S-17,

Ans. The bar chart or Gantt chart is a chart or graph that presents categorical data with rectangular bars with height or lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally.

No. 10) What is meant by Dummy Activity (S-17,

Ans. Certain activities which neither consume times nor resources are used simply to represent in connection or link between the events are known as Dummy Activity

No. 11) What is Cost index? (S-17,

Ans. Cost Index in construction is an indicator of the average cost movement over time of a fixed basket of representative goods & services related to construction industry.

No. 12) What is critical event? (S-18, S-19

Ans. A critical event is an event with specified, high consequence such as an event involving offsite community impact.

No. 13) Define Optimistic Time. (S-18,

Ans. Optimistic Time in Programme Evaluation Review Technique (PERT) is the shortest possible time for completing an activity if everything proceeds as planned without any problem i.e., the activity is performed under ideal condition.

No. 14) Define operating cost. (S-18, W-18,

Ans. Operating cost are expenses associated with the maintenance & administrative of a business on a day-to-day basis. The operating cost is a component of operating income & is usually reflected on a company's income statement.

No. 15) Define Owning. (S-19,

Ans. Ownership cost is the total cost associated with the construction equipment for owning it irrespective of the equipment is employed or not in the project. The ownership cost consists of the following.

(a) Initial cost

(b) Salvage value

(c) Taxes

(d) Insurance cost

& (e) Storage cost

POSSIBLE LONGTYPE QUESTIONS

No. 1) Describe work breakdown structure with example (S-17,

No, 2) Explain, 1) Pre tender stage. 2) Post tender stage.

No. 3) Write the limitations of Bar chart. (S-18, W-18, S-19

No. 4) Write the comparison between PERT & CPM. 9S-17, S-18, S-19

No. 5) Prepare a construction schedule with the help of Bar chart for a compound wall describing the various steps in its preparation

No. 6) Explain the purposes & important activities of different stages in construction work.

No. 7) Draw all networks problems as in your note book.

No. 8) Draw the network of a project having seven activities A, B, C… run concurrently. Activities predecessors' relationship are as follows

Activity	Immediate predecessor
D	A
E	B
F	C

Activity G is the last operation of the project & is also immediate successor to D, E, F

(S-19

CHAPTER NO. - 03

MATERIALS AND STORES MANAGEMENT

3.1: CLASSIFICATION OF STORES-STORAGE OFSTOCK: -

Objectives of material management: ------

The main objective of material management is to minimize the cost. However, some important objectives are: -----

- Economy in material cost.
- Efficient control of inventories.
- Ensure uniform flow of material for construction.
- Ensure right quantity and right price.
- Economical consumption of total important items and find their substitutes.

Store Management: ------

Store management is the important organ of material management. Various types of material are received at construction site and are to be stored properly in their consume works.

Objectives of store management: -------

The main objective of store management is: ------

- Minimum utilization of space of storage.
- Easy handling during the process of receive, inspection, storage and ensure on distributed flow.
- Preservation of store against theft, breakage etc.
- Proper maintenance of store accounts, haveto controlled over received and issues and to fix to accountability of any deficiency.

Function of store management: ---------

The following are the functions of store department and duties of store keeper: --

- Receive the materials, goods and equipment and checking them for identification.
- Proper recording to receive the goods.
- Placement of right materials at right place.
- Maintenance of stock in safety and good condition by taking all the cares to ensure that they don't suffer from damage, theft etc.
- Issue of items to the user only on the receiver of authorized store requisitions.
- Recording and updating receipts and issue material.
- Making sure that store is kept clean and in good order.
- Preventing unauthorized persons from entering the store.
- Planning of storage space.

Therefore, various types of stores – storage of stock.

Floor and space are

- Plat-form
- Racks
- Shelves
- Bins
- Trays
- Bunkers
- Barrels/ Tankers.

Storing and Stacking of Civil Engineering Materials: --

Storing and stacking of various materials used in project (Civil Engineering) needs the following consideration.

- Civil Engineering materials should not be affected by impurities or by atmospheric agencies like sun, wind, rain or moisture etc. Hence materials like cement and lime must be stored in cover sheds and stacked on timber raised platform.
- Reinforcing bars are to be stacked in yards away from moisture, to prevent rusting and also away from oils and lubricants. For easy handing each type of bar should be stacked separately.
- Timber is generally affected by sun and also by poor ventilation. Hence, they must be stand in a well ventilation shady place, and similar length to be stacked together.
- Each type and size of course aggregate and fine aggregate must be separately placed on hard and clean surface.
- Bricks, tiles and concrete/ stone blocks are stacked at ground level with limiting height of stacking from 1m. to 2m.
- Doors, windows, panels are to be stand vertically and fully supported.
- Water supply pipes and drains pipes are to be stand on timber platforms, raising them clear of ground with the pipe sockets rivers with alternate roofs.
- Sheet glass being extremely take care and to be stacked vertically with an inclination of 3° to 6° on hard bed.
- Explosive materials should be stock in safest place. They should be placed under lock and key and all type of caring must be taken.
- Very heave item of materials should be stack away from soft ground to prevent for any accident.

3.2:ISSUE OF MATERIALS: --

- Materials are issued only an received on a properly authorized withdrawn form which is usually called a material issue requisition form or stores issue voucher [SIV].
- On receipt of SIV, store department issue materials and record the quantity ofreleased.
- A copy of SIV entered by the store regarding issue of materials is then send through account department for entry in the stock register.
- One copy of SIV is send to the department who has initiated with drawl.

Indent on Stored: -

- It is also called material issue requisition.
- An important rule which should be strictly followed is not to allow any material to pass from the stored department into the work skilled expect the authority of written requisition.

- This indents on store are demand upon the store keeper signed by the authorized person to issue the bearer, to be charge a particularly job or department specified here. In such indent on stores are made out in duplicate from and supply to each department. As it is duplicate, original copy is sent to the cost department for costing, duplicate is written to the stored keeper may triplicate copy is used in permanent record.

A Sample of indent of store material issue requestion (Indent): --

Book No. …… Indent No……

Shop / Dept. ……. Date…….

To The, Store keeper

Please issue the required materials for the job no. ……

Sl.No.	Materials with specifications	Quantity supplied	Store ledger page no,	Cost	Remarks

No. of items……

Indenter

Received…….

Bin Card: -

This is a card which is attached to each bin, rack, selves or other container of stores. A record for all materials entering and leaving the bin and balance the material behind is recorded in this card. These cards are maintained by the store keeper and only the quantities recorded. To this bin card a store keeper balances the demand and supply.

In some factories duplicate bin cards are used. In such cases one pares is attached to the bin card and the duplicate card are kept by on his table for ready reference bin cards are checked from time to time by inspector.

Bin Card

Material code: Maximum Level:

Material Description: Minimum Level:

Location: Reorder level:

Unit of Measurement:

Date	Doc. No.	Received from/Issued to	Receipt	Issue	Balance	Verification with SL Date & Verified by

Invoice: -

An invoice typically contains contact information for the seller or service provider in case there is an error relating to the billing. Payment terms may be outlined on the invoice, as well as the information relating to any discounts, early payment details or finance charges assessed for later question

CONSTRUCTION INVOICE

Bill From
Name: _____
Company Name: _____
Street Address: _____
City, ST ZIP Code: _____
Phone: _____

Bill To
Name: _____
Company Name: _____
Street Address: _____
City, ST ZIP Code: _____
Phone: _____

Invoice No. _____

Invoice Date: _____

Due Date: _____

Description/Job Phase	Quantity / Hours	Price ($)	Total ($)
		Subtotal	
		Sales Tax	
		Other	
		Total	

Terms and Conditions

Thank you for your business. Please send payment within _____ days of receiving this invoice. There will be a _____% per _____ on late invoices.

POSSIBLE SHORT QUESTIONS WITH ANSWER

No.1 What are the objectives of material management?

Ans. Some important objectives are,

a) Economy in material cost.

b) Efficient control of inventories.

c) Ensure, uniform flow of materials for construction.

d) Ensure, right quantity & right price.

e) Economical consumption of total important items & to find their substitutes.

No.2 What is store management?

Ans. Store management is the important organ of material management. Various types of materials are received at construction site & are to be stored properly in their consume works.

No.3 what are the various types of store storage of stock?

Ans. There are different types of store storage of stock are as follows,

→ Floor & space. → Racks. → Shelves

➔ Platform → Bins → Trays

➔ Bunkers. → Barrels → Tankers

POSSIBLE LONG TYPE QUESTIONS: --

No.1 Explain the function of store management.

No.2 How to storing & stacking of civil engineering materials.

No.3 Define, a) Indent (W-18,

&b) Bin card (W-14,

No.4 What are the objectives of store keeping? (S-18,

No.5 What is material management & write the function of material management? (W-18,

No.6 What are objectives of store keeping? (S-18,

CHAPTER NO.-04

CONSTRUCTION SITE MANEGEMENT

4:1 JOB LAYOUT–

Objectives of job layout.

-→ Planning of the amount of space required for all kind of activities in construction site

i.e., equipment, storing of materials, offices, rest rooms, ware houses etc.

→ The primary objectives of job layouts are to minimize the moment of men & materials at sites

Thus, a job layout is prepared to promise that wok proceeds smoothly without any obstruction. A job layout can be defined as a site drawing of the proposed construction showing the location of entry, exist, temporary services, materials stores & stocks, plant or equipment & site offices.

Review plans –

The purpose of plan review is to assure the construction project is designed in compliance with the code. If there are issues of non-compliance, they may be addressed during the review process. This saves time & money as it is more economical to make revisions prior to the start of construction.

Specifications –

Construction specifications, also known as specs, detail the work & workmanship needed to complete a construction project. As required documents during the design phase, there are part of formal process. Specification is a written document describing in detail the scope of work, materials to be used, method of installation, & quality of workmanship for a parcel of work to be placed under contract with working drawings in project construction work.

Layout of equipment –

Equipment layout is just that, where pieces of equipment, such as displays & controls, are laid out in relation to everything else around them, including the person using them. Equipment can be clearly identified, easy & efficient to use. Errors are avoided, especially under emergency conditions

4.2 LOCATION OF EQUIPMENT ORGANIZING OF LABOUR AT SITE.

Proper tools equipment is essential for the eccentric for any civil work site. Equipping the construction site with the correct tools & equipment pledge an essential growth is achieving finally good quality result. For any construction activity, there is an optimal combination of tools, equipment and labour depending on nature & content of the works. The technical staff leads to number which tool use & how to effectively combine them with manual labour. Once on site, equipment requires train operator & supervisory staff who are which proficient in its operation & maintenance. Malty equipment is a common result on construction site, a major responsibility of the project is to ensure that tool & equipment are maintained in good connection in various work activities.

When applying labour-based work methods, the use of hand tool supported with selected items of life equipment & produced result comparably with those achieve, when using only heavy equipment. For every construction activity there is an optimum combination of equipment & labour.

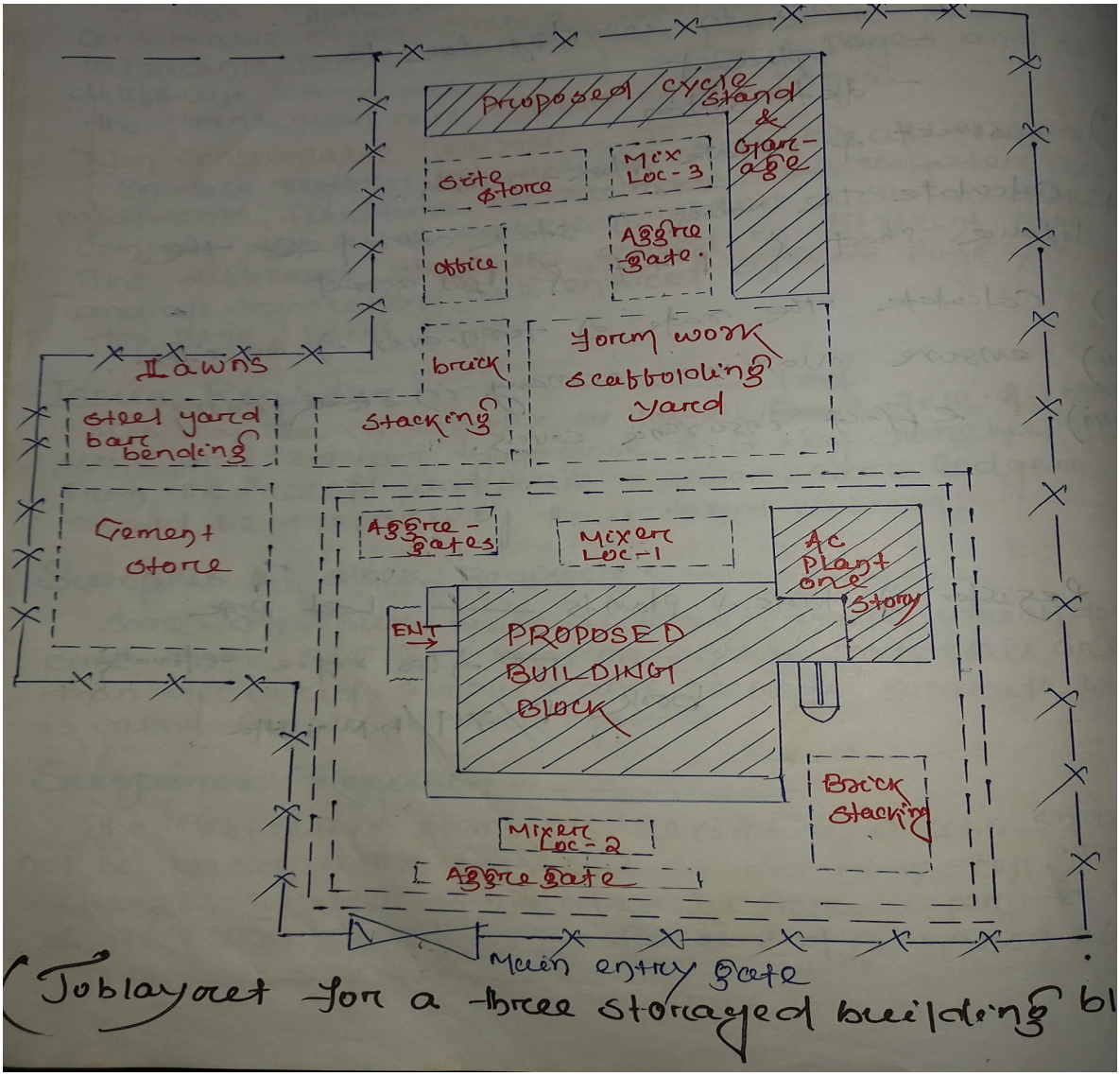
4.3 JOB - LAYOUT FOR DIFFERENT CONSTRUCTION SITE.

Every site weather large or small requires temporary services which are design and provided by the contractor.

- On a small site, the temporary services consist of access road, water supply, electric supply, sewer connection etc.
- On a large construction site, temporary services include a no. of facilities such as telephone connection, batching plants, service road, construction yards, materials storage yards, canteen, tube wells.

There is on specific or fixed pattern for the type of temporary services required at site. This service depends on the following factors.

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



4.4 PRINCIPLE OF STORING MATERIAL AT SITE

Storing and stacking of various materials used in project (Civil Engineering) needs the following consideration.

- Civil Engineering materials should not be affected by impurities or by atmospheric agencies like sun, wind, rain or moisture etc. Hence materials like cement and lime must be stored in cover sheds and stacked on timber raised platform.
- Reinforcing bars are to be stacked in yards away from moisture, to prevent rusting and also away from oils and lubricants. For easy handing each type of bar should be stacked separately.
- Timber is generally affected by sun and also by poor ventilation. Hence, they must be stand in a well ventilation shady place, and similar length to be stacked together.

- Each type and size of course aggregate and fine aggregate must be separately placed on hard and clean surface.
- Bricks, tiles and concrete/ stone blocks are stacked at ground level with limiting height of stacking from 1m. to 2m.
- Doors, windows, panels are to be stand vertically and fully supported.
- Water supply pipes and drains pipes are to be stand on timber platforms, raising them clear of ground with the pipe sockets rivers with alternate roofs.
- Sheet glass being extremely take care and to be stacked vertically with an inclination of 3° to 6° on hard bed.
- Explosive materials should be stock in safest place. They should be placed under lock and key and all type of caring must be taken.
- Very heave item of materials should be stack away from soft ground to prevent for any accident.

POSSIBLE SHORT QUESTIONS WITH ANSWER

No.1 Write the various temporary services require at site.

Ans. The various temporary services require at site are,

- Water supply
- Material stores
- Sewage and Sanitation arrangements
- Canteen
- Road services
- Electricity connection
- Site office
- Labour huts
- Medical facilities.

No.2 What is job layout? 9S-19,

Ans. A site drawing of the proposed construction showing entry, exist, temporary services, material stores and steak, equipment, site office etc., in known as job layout or site layout, or design of site layout.

No.3 What are the factors affecting site layout?

Ans. The factors affecting site layout are

- Access to sites.
- Temporary roads.
- Topography on ground.
- Construction plant/Machinery.
- Construction Method.
- Accommodation.
- Services

No.4 What do you mean by Progress of any work? (S-19,

Ans. Progress is the process of gradually improving or getting nearer to achieving or completing something. The term work-in-progress is a production and supply – chain management term describes precisely finished goods awaiting completion.

POSSIBLE LONG TYPE QUESTIONS: --

No.1 Draw a job-layout for a three storied building block.No.2 Write the principle of stories civil Engineering materials of site.No.3 Explain the factors affecting site layout.No.4 Write the factor influencing in selection, design and layout of temporary facilities at construction site. (S-17, W-18, S-19, No.5 Explain briefly about the methods of recording the progress of work. (W-18,No.6 Explain the various types of temporary services required for job layout.

CHAPTER NO.: - 05

CONSTRUCTION ORGANISATION

5.1: --- INTRODUCTION – CHARACTERISTICS, STRUCTURE, IMPORTANCECHARACTERISTICS

The characteristics of an organization are as follows: ---

- It should have a common goal.
- It should clearly fix the activities and responsibilities for everyone in the organization and associated with it.
- It should have a set structure and there should be good coordination between different departments of the organization. In different departments there should be a set of personnel.

Structure: ---

Organizational structure, whether in relation to a construction company or to any kind of company, comprises both the way roles are arranged and the relationships between those roles in terms of operations and reporting. These are the building blocks of the construction management hierarchy.

Importance: ---

Organization is an important means of creating coordination and communication among the various departments of the organization. Different jobs and positions are interrelated by structural relationship. It specifies the channel and mode of communication among different members.

5.2 ORGANIZATION TYPES-

Organization type: -----

An organization is a group of persons working together to achieve goal. It is the relationship which exist between the people working together. It defines the responsibility and authority of individual in relation to man, material, machinery and funds which constitute an organization.

The organizational structure is classified mainly three types: ---

- Line organization.
- Line and staff organization.
- Functional organization.

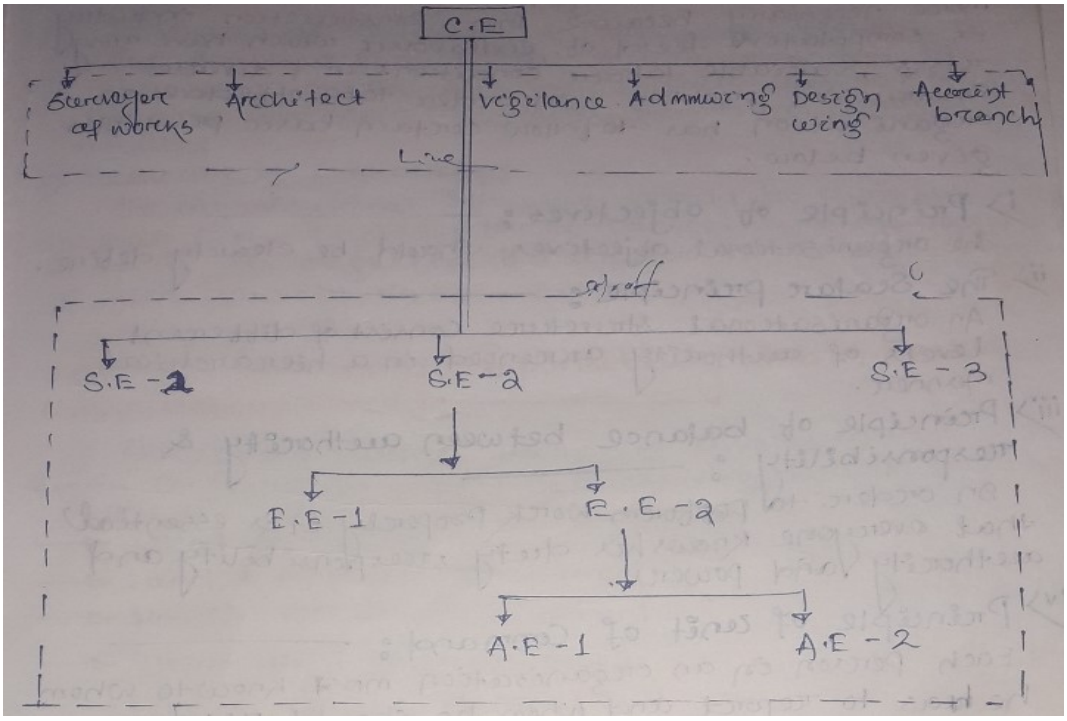
Function and characteristics of line and staff organization: -----In line and staff organization all the activities are performed by staff while the line authority maintains discipline and stability in organization. The authority by which the staff performs advisory functions are delegated by the line and their advice is generally accepted keeping in view and expertise.

Merits: ----

- ➔ Functional expertise and experience are available from staff personnel.
- ➔ It is based upon planned specialization.
- ➔ Specialized work is done by staff personnel and line personnel can divert their time to achieve sectional target.
- ➔ It provides more job opportunity.
- ➔ Due to staff specialization, there is more efficient of human and physical resources
- ➔ Quality of product id better.

Demerits: ----

- ➔ The staff may be ineffective due to lack of authority to enforce their decisions.
- ➔ As duties and responsibility are not clearly defined there is bound to some confusion in the relationship of the line and staff personnel.
- ➔ The overhead cost increases because of high salaries of staff personnel.



5.3: -PRINCIPLE OF ORGANIZATION

An organization can be defined as a group of persons united to achieve a common goal and defining the responsibilities and establishing the relationship with each other employed in the organization.

1. **Responsibility**:Authority should be equal to responsibility i.e.; each manager should have enough authority to accomplish the task.
2. **Specialization**:Effective organization must include specialization. Precise division of work facilitates specialization.
3. **Personal Ability**: Organization structure must encourage management development program and ensure optimum use of human resources.
4. **Flexibility**:It should be adaptable to changing circumstances. It should not be rigid or inelastic.
5. **Objectives**: Objectives must be clearly defined for the entire enterprise, for each position in the organization structure. There must be unity of objective so that all efforts can be concentrate on the set goals.
6. **Clear Unbroken Line of Authority**: The line of authority flows from the highest executive to the lowest managerial level and the chain of command should not be broken.

7. **Communication**:A good communication subsystem is essential for smooth flow of information and understanding and for effective business performance. The line of authority offers a standing channel for download and upward communication.
8. **Span of Control:**No superior at a higher and level should have more than six immediate subordinates. Average human brain can effectively direct three to six brain (i.e., subordinates).
9. **Co-ordination**:Organization involves division of work among people efforts must be co-ordinate to achieve common goals. Co-ordination is the orderly arrangement of group effort to provide unity of action in the pursuit of common purpose. A manager is mainly a coordinator. Chosen grouping of activities should minimize co-ordination problems.

Meaning and significance of terms- control, Authority, responsibility, job and task: -

There are various authority involves in implementing every construction project. So authorities bodies are: ----

➔ Local Authority
➔ Land and mineral department
➔ Public works department
➔ Department of environment
➔ Fire and rescue department
➔ Water authority
➔ Irrigation and drainage department
➔ Public health department
➔ Construction industry development board (CIDB).

➔ Local Authority: --

The responsibility local authority is: -

- Granting
- Planning
- Permission
- Approval

The roles are: -

i> Observe and makes the construction procedure obey the role and comply with the uniform project by laws.

ii>Prepare development, control, planning including providing structural plan.

iii> Plan development of new town.
iv> Manage garbage collection services and supervise the town cleanness.
v> Manage health services.
vi> Manage the construction and maintenance of drainage.
vii> Provide public facilities such as market, multipurpose complex, hawker area.
viii> Manage traffic, construction and maintenance of roads.

➔ Land and Mineral department: ---

The roles are: ---

i> Approve of the land title application, charge of mortgage and lease land.

ii>Approve charge of land, usage of public use.

iii> Set the land ownership.

➔ Public works department: --

This department is the largest and dynamic govt. energy the roles are: --

i> Prepare the structure development and public facilities such as road, water supply, building, airport, harbor etc.

ii> Plan design and construct infra structure project.

iii> Manage the operation and maintenance work for above project, special govt. sector.

iv> Provide technical advisory to the govt. act national, state and district level.

➔ Department of Environmental: --

The roles are: ---

i> Approved the environmental impact the assessment [EIA] for any construction project provided that the construction of the project fulfils the terms below.

a> Complied to the project development project.

b> Have control on the site preparation and earth work, flood, water, air, sound and pollution.

ii> Ensure all the approve terms and permission or conditions of EIA report are part of the tender department.

iii> Ensure the client carries out the EIA instruction at every stage of construction, as early as the planning stage of visibility study and design.

➔ **Fire and rescue Department**: --

The roles are: ---

i> Determine and proposes fire preventions system required based on location, key plan and layout plan as well as emergency fire escape.

ii> Ensure water supply facilities are available in the area to be build.

➔ Water Authority:--

Water authority is responsible to maintain water supply, the main role is: -

i> Approved application for supply clean water for construction work.

ii> Provide adequate quantity of water supply clean and set to use for domestic or industrial uses.

➔ Department of irrigation and drainage: --

The main role is: --

i) Provide omphalic structure for irrigation and drainage as well as improves services in river engineering hydrology.

ii) Install of river culvert, prevent deposition, update a river training work and provide other structure for flood prevention.

➔ Construction industry development board (CIDB): --

"CIDB" is board managing the construction industry. It is responsible to produce high quality construction work equivalent to the amount of money spent.

The main roles are: -

i)Develop and anchorage of improvement towards expansion of construction ` industry.

ii)Promote quality assurance and construction and building material industry.

iii) Manage and safety trained workers and site supervisor.

iv) Provide advisory and suggestion to govt. on matter related to construction industry.

5.4: LEADERSHIP-

Necessity: -

Leadership motivates the people to a higher level of performance through their strong human relations. It is an important function of management which helps to maximize efficiency & to achieve organizational goals, so managers must have traits of leader

Styles of leadership: -

A leadership style is a leader's method of providing directions, implementing plans, & motivating people. Various authors have proposed identifying many different leadership styles as exhibited by leaders in the construction field.

Common leadership styles are,

- ➔ Coach (motivational)
- ➔ Visionary (progress focused &inspirational)
- ➔ Servant (humble&protective)
- ➔ Autocratic (authoritarian& result focused)
- ➔ Democratic (supportive&innovative)
- ➔ Pacesetter (helpful &motivational)

Roles of leader: -

Roles of Leadership is need for every project or organization at different levels for various reasons; as follows: -----

a. To help in defining mission of the group.

b. To create on environment in which group member become committed to the objective of the group.

c. To serve as an interpreter of massages and behavior of other groups and individuals who may have some influence on the group.

d. To co-ordinate the activity of group members to ensure satisfied report towards the organizational whole achievement.

e. To provide needed resources for the group.

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

5.5: HUMAN RELATIONS.

Relations with subordinates, peers: -

The term human relation applies to all interaction good and bed among people. The behavior of people at work and how various elements of the workplace affect the people are important to the study of human relation in an organization or in project. Someone may be irregular at work due to health problem arising adverse site condition while another might be inefficient because of family problems. Human behavior in the work environment includes the interaction between superiors and sub-ordinate the interaction among peers and the ways in which individual interact with each other for human relation and behavior in the work environment covers more than just the activities involve with the actual work itself.

Supervisors: -

Supervision is the main function which is responsible for output. Its importance was neglected in pervious time. But now it is been felt that the supervision nearest to worker is of very much important. Supervision is responsible for improving discipline, moral of worker and makes worker feel interested in his work. Generally, people think that discipline can maintain, if supervision punished them. But psychological experiment shows that the punishment is not only the correct solution. It suggests that reward may be used as another method for promoting regulations. Reward may be in the form of money, medals certificates extra vacations etc. to in charge the discipline. Thus, punishment and rewards are techniques should be employed for maintaining the discipline. The method reward improves the moral of the workers.

Group behavior refers to people with a similar goal behaving in the same way, which might be different from how they would normally behave if they are alone or as individuals It is the type of behavior that takes place when individuals act together or collectively.

Characteristics of group behavior: -

1) Group behavior such as mass action is often based on a grievance or preference for change shared by members of worker group.
2) The mass action may be spontaneous, in the sense that it may not have been planned in advance but may have been based on perceived injury.
3) Group behavior sometimesrequires a formal organizational & administrative or leadership structure that organizes the diverse interest of members.
4) Group behavior is the means by which individuals make their ideas, opinions & feelings known in a group situation.
5) Group behavior is always undertaken primarily for the interests of members of a given group.

Mob psychology: -

Mob psychology is a theoretical approach attempting to explain collective behavior solely on the basis of the psychological states of people who participate. Mob psychology is similar to terms such as crowd psychology and group mentality. Mob psychology shows that individuals tend to behave in a different manner as part of a

group in contrast to acting independently. Members of a group are prone to acting in ways that they would deem immoral or unjust if in control of their behavior. This is not due to change in one's belief or principle, but rather the fact that individuals tend to ignore or avoid one's conscience or rational judgment. It can be said that individuals in a group defer their goals and take upon the identity of the group. Therefore, members of a group are likely to commit acts they would never commit alone. Being in a group allows individuals to defer blame, responsibility, accountability, and /or judgment upon the group.

Handling of grievances: --

Individual employ many times have some or other complaints called grievances, against the working rules or decision on an organization. It is necessary that they should be consistent to remove these grievances otherwise the employs will have felt that management does not look their problems and difficulties which is very harmful and for attaining good industrial relation.

A grievance is therefore essential to remove the feeling of the dissatisfaction.

A good grievance: --

- Adequate and effective
- Simple to understand and operate
- Prompt
- Permit to appeal

Absenteeism:

The reasons for absenteeism of different workers for different reasons. The loss due to absenteeism is great to the employer as compared to the worker and due to this both discipline and efficiency suffer. Every organization must therefore analysis the absenteeism. Find out the causes and then ways and means to reduce them. Generally, the following reasons are found for absenteeism.

- Sickness
- Occupational diseases
- Industrial accident
- Loss of interest in work
- Poor workingcondition
- Attitude due to sociological and environmental factor
- Undesirable habits like gambling drinking etc.
- Inadequate transport facilities

LabourWelfare: -

Labour welfare is a flexible and elastic concept. It meaning and implications different widely with times, regions, industries, countries, social values and customs, the general economic development of the people and the political ideologies prevailing at particular moments. As such, a precise definition is rather difficult.

Labour welfare implies the setting up of minimum desirable standards of the provision of facilities like health, food, clothing, housing, medical assistance, education, insurance, job security, recreation etc. Such facilities enable the worker and his family to lead a good working life, family life and social life.

5.6: CONFLICTS IN ORGANIZATION: --

Genesis of conflicts: ----

Genesis of conflicts is,

- Conflicts between individuals or between groups in the characteristics of human behavior.
- Conflicts is a type of behavior occurs when two or more parties are in opposition or battle.

These conflicts,

- Adversely affect the effectiveness of individual or groups.
- May breakdown the relationship between individuals or groups.
- May result in strike.
- This makes difficult to achieve objectives of an organization.

Types of Conflicts: -

Intrapersonal: -

Intrapersonal conflict occurs when a person is confronted with several mutually exclusive options and has difficulty making a decision. Many intrapersonal conflicts in the workplace centre on the conflict between personal values and organizational values.

Interpersonal: -

Interpersonal conflict refers to any types of conflict involving two or more people. It's different from an intrapersonal conflict, which refers to an internal conflict with yourself. Mind or severe, interpersonal conflict is a natural outcome of human interaction.

Intergroup: -

Intergroup conflict is when conflict between groups inside and outside an organization disagree on various issues. Conflict can also arise between two groups within the same organization, and that also would be considered intergroup conflict.

Resolving Conflicts: ---

Conflict is natural & happens in every ongoing relationship. There are different factors of resolving conflicts. Some factors are as follows.

- Adequate job definition
- Detailed specification of relationship between various position.
- Careful selection of people to fill up various post.
- To training the people for job assign to them.
- Be a calming agent.
- Listen actively
- Analyze the conflict.
- Model neutral language.
- Maintain a calm & respectful demeanor during heated conversion
- Get to the root of problem
- Find some middle ground.
- Agree to disagree & choose your battles.

POSSIBLE SHORT QUESTIONS WITH ANSWER

No.1) Define construction organization.

Ans. A construction organization a group of persons working together to achieve goal. It is the relationship which exist between the people working together. It defines the responsibility & authority of individual in relation to man,material, machinery & funds which constitute an organization.

No.2) Write the types of organization.

Ans. Construction organizations mainly three types. They are,

a) Line organization.

b) Line & staff organization.

c) Functional organization.

No.3) Write the various authority involves in implementing construction project.

Ans. Authority bodies are,

- ➔ Local authority.
- ➔ Land & mineral department.
- ➔ Public Works Department.(P.W.D)
- ➔ Fire & rescue department.
- ➔ Public Health Department.(P.H.D)
- ➔ Irrigation department.
- ➔ Water resource department, etc.

No.4) What is human relation in construction organization?

Ans. The term human relation applies to all interaction good & bad among workers. The behaviour of worker at work & how various elements of the work place affect the people are important to the study of human relation in an organization or in project

No.5) Explain about worker grievances.

Ans. Individual employee or groups many times have some complaints in work place is called grievances on decision of an organization. It is necessary that they should be consistent to remove these grievances.Otherwise, workers will have feel that management does not look their problems & difficulties which is very harmful & hamper a good industrial relation.

No.6) What do you mean by conflicts? (S-17, S-19,

Ans. i) Conflicts between individuals or between groups in the characteristics of human behaviour.

ii) Conflicts is a type of behaviour occurs when two or more parties are in opposition or battle. These conflicts: --

- Adversely affect the effectiveness of individual or groups.
- May breakdown the relationship between individuals or groups.
- May result in strike.
- This makes difficult to achieve objectives of an organization.

No.7) What is labour welfare?

Ans. Labour welfare implies the setting up of minimum desirable standards of the provision of facilities like health, food, clothing, housing, medical assistance, education, insurance, job security, recreation etc. Such facilities enable the worker and his family to lead a good working life, family life and social life.

No.8) What are the reasons of absenteeism?

Ans. Generally, the following reasons are found for absenteeism.

- Sickness
- Occupational diseases
- Industrial accident
- Loss of interest in work
- Poor working condition
- Attitude due to sociological and environmental factor
- Undesirable habits like gambling drinking etc.
- Inadequate transport facilities

No.9) What is the necessity of leadership?

Ans. Leadership motivates the people to a higher level of performance through their strong human relations. It is an important function of management which helps to maximize efficiency & to achieve organizational goals, so managers must have traits of leader.

No.10) What is Mob psychology?

Ans. Mob psychology is a theoretical approach attempting to explain collective behaviour solely on the basis of the psychological states of people who participate. Mob psychology is similar to terms such as crowd psychology and group mentality.

POSSIBLE LONG TYPE QUESTIONS:

1) Write merits & demerits of line & staff organization.

2) Explain the principle of organization.

3) What are the responsibility, job, & task of P.W.D?

4) What are the important duties of technical personnel involving in construction organization?

5) What are the technical knowledge of supervisor?

6) What are the reasons of absent among workers & how to improve absenteeism?

8) What is conflicts & the causes of industrial conflicts

9) What are the motivational needs of an entrepreneur? What are the risks &reward he Setout of the construction work?(S-19,

CHAPTER NO. – 06

CONSTRUTION LABOUR & LABOURMANAGEMENT

6.1: PREPARATION OF LABOUR SCHEDULE: -------

Labour schedule means the main power requirements of the project in a tabular from for various stages.

The purpose of labour schedule during construction stages are: ------

i> It provides the site in charge with ample warning of his future labour requirements.

ii> By nothing the actual work course regularly on the chart, a direct measure of requirement a labour in the site can be obtained.

iii> If a man power shortage is lively in a particular section of the project, it enables such type of labour force to be sort out from elsewhere before a delay occurs.

iv> It helps in efficient and optimum deployment of the labour force in the various section of the project.
Let's prepare a labor schedule week wise for the construction of temporary shed.

Name of the work ---------- prepared by ----------

Men power (Labour)	Work(in days)				
	1	2	3	4	5
Fore Man	1	1	1	1	1
Carpenters	-	-	-	1	1
Welders	-	-	3	2	1
Mixture Operator	-	-	1	-	-
Masons	1	1	2	2	1
Bar Benders	-	2	1	-	-
Labours	3	3	10	6	3

6.2: ESSENTIAL STEPS FOR OPTIMUM LABOUR OUTPUT: ----

Improving labour productivity within hospitals and health-care system has become a core element that complete organization to seek new to working more efficiently.

There are so many steps for labour productivity –

1> Measure performance and set target: - It is often claimed that, what gets measured, gets done.

2> Streamline construction process.

3> Invest in capital equipment.

4> Invest in employee training.

5> Make the workplace conductive to productive effort.

Thus, optimum labour output can be increased if the worker has prospects of promotion, honour and reward. The desire to work better and improve oneself must be stimulated by providing sufficient incentives to work. It is also possible to raise productivity by motivating the workers properly.

6.3: LABOUR CHARACTERISTICS: ---------

- ➔ Quality of work--Caliber of work produced or accomplished.
- ➔ Quantity of work—Volume of acceptable work.
- ➔ Job Knowledge –Demonstrated knowledge of requirements, methods, techniques and skills involved in doing the job and in applying these to increase productivity.
- ➔ Related work knowledge—Knowledge of effects of work upon other areas and knowledge related areas which have influence on assigned work.
- ➔ Judgment—Soundness of conclusions, decisions and actions.
- ➔ Initiative—Ability to take effective action without being told.
- ➔ Resource Utilization—Ability to delineate project needs and locate, plan and effectively use all resources available.
- ➔ Dependability—Reliability in assuming and carrying out commitments and obligations.
- ➔ Analytical Ability—Effectiveness in thinking through a problem and reaching sound conclusions.
- ➔ Communicative Ability—Effectiveness in using oral and written communications and in keeping subordinates, associates, superiors and others adequately informed.

6.4: WAGES AND THEIR PAYMENT: -------

Labour wages and their payments made by employer for the efforts put in the worker in production. These are the payments made for the services rendered by labour.

There are different types of wages: -------

- ➔ Normal Wages
- ➔ Real Wages
- ➔ Living Wages
- ➔ Fair Wages

Normal Wages: --

It is the amount of money trade to the workers for the effects put in by him in a industry and no other advantage to the worker is made.

Real Wages: --

It refers to the amount of necessary, comforts, luxurious and cash payments which a worker can get in return for his effort and work.

Living Wages: --

When the rates of the wages are such that they can meet some of the requirements of family like education, food, clothes and some insurance along with the prime necessity of the life are called living wages.

Fair Wages: --

It is the actually wages which must be fair the work of a worker and should providing with other necessities of life are called fair wages.

6.5: LABOUR INCENTIVES: -------

Labour incentives are some kinds of monitoring reward which is closely related to the performance of a worker result increase in wages corresponding to an increase to output.

Types of Incentives: --

Here extra payment out of wages is known as incentives. The method of incentives is: -

- Pipe rate system
- Cent percent premium
- Halsey Premium plan
- Weir Premium plan
- Bedaux Premium plan

- **Pipe rate system: --**

  If a worker completes the job earlier, he can safe his time and that save time he can make jobs and whatever extra money is get for extra work is known as pipe rate system.

- **Cent percent premium: --**

  In this system the standard time for the completion of a job is fixed and its rate of completion during this period is also fixed. Now the worker to completes the job in the standard time is not given any incentives but those complete the job earlier get full payment for the time save.

- **Halsey premium plan: --**

  In this system are hourly rate or daily rate is granted to the workers. A standard time is fixed for the performance of each job and the worker is paid the agreed rate per hour for the time spent plus a fixed percentage (33.5%) of the time he can save on around the standard time. This plan is known as Halsey premium plan.

- **Weir premium plan: --**

  This is also like Halsey. But in this worker given at the rate of 50% of the extra output along with standard day rate.

- **Bedaux premium plan: --**

  This is also Halsey. But in this worker given at the rate of 75% of the extra output along with standard day rate.

6.6: MOTIVATION: --

Motivation is a psychological at which attract the workers to do more work and instigates. If the workers are instigating, they will try to do more than standard work and earn then more for themselves which increase their leaving standard.

Classification of motive: --

There are two types of motivation: -

- Positive Motivation
- Negative Motivation
- **Positive Motivation: --**

Positive motivation means worker may be instigate to do work with some facilities or giving some prize so that they may do the good and more work than done previously and with less supervision. Prize or may financial and non-financial to give more wedges for work is the financial motivation while workers work, promotion, apparition etc. are non-financial positive motivation.

- **Negative Motivation: --**

This is based on punishment or fine if the labour is discouraged for the work, For the work. For less work or for not doing work or continuous irregularity must be punished or fine.

This is up two types: -

1. Financial
2. non-financial

In financial punishment, cut is made wedges of the labour.

In Non-financial punishment, consist of in giving less facilities such as do work for many times reduction to do in the facilities to leave etc.

Generally, these are for improving him and the object of this is to motivate to do more work. Positive or negative motivation are two ends of two ends of row. As motivation is a psychological aspect and this relation is consult with the persons brain to its through and behavior hence, they should be motivated in different ways. A good manager should both use positive and negative motivation.

Different approaches to motivation: -------

Motivation can achieve a good relation in the organization and by avoiding there will be a dissatisfaction.

The different approaches motivation are: -

- ➔ Satisfaction through achievement.
- ➔ Advancement.
- ➔ Growth
- ➔ Responsibility
- ➔ Recognition
- ➔ Company Polishes
- ➔ Job Security
- ➔ Salary benefits

- ➔ Status
- ➔ Interpersonal relation
- ➔ Personal life

POSSIBLE SHORT QUESTIONS WITH ANSWER

1)Write the types of wages& their payments

Ans. bour wages and their payments made by employer for the efforts put in the worker in production. These are the payments made for the services rendered by labour.

There are different types of wages: -------

- ➔ Normal Wages
- ➔ Real Wages
- ➔ Living Wages
- ➔ Fair Wages

2) what isincentives?

Ans. Labour incentives are some kinds of monitoring reward which is closely related to the performance of a worker result increase in wages corresponding to an increase to output.

3) Write the methods of incentive.

Ans. Here extra payment out of wages is known as incentives. The method of incentives is: -

- Pipe rate system
- Cent percent premium
- Halsey Premium plan
- Weir Premium plan
- Bedaux Premium plan

4) What is motivation?

Ans. Motivation is a psychological at which attract the workers to do more work and instigates. If the workers are instigating, they will try to do more than standard work and earn then more for themselves which increase their leaving standard.

5) Write the different approaches of motivation.

Ans. The different approaches motivation is: -

- ➔ Satisfaction through achievement.
- ➔ Advancement.
- ➔ Growth

- ➔ Responsibility
- ➔ Recognition
- ➔ Company Polishes
- ➔ Job Security
- ➔ Salary benefits
- ➔ Status
- ➔ Interpersonal relation
- ➔ Personal life

6) What is Trade Union Act? (W-18,

Ans. Trade Union Act is the principle act which control & regulates the mechanism of Trade Union. In India the main purpose is maintaining or improving the condition of employment.

POSSIBLE LONG TYPE QUESTIONS:

1)Prepare a labour schedule by choosing activities of a boundary wall of size5m×0.3m2) Write the essential steps of optimum labour output .3) What are the labour characteristics in construction organization?4) Explaindifferent wages & their payments.5) Explain the types of motivation in construction work
6) Differentiate between Time rate & Piece rate system. (S-17, S-18
7) Explain the time work system & wage payment. (S-19,

CHAPTER NO. -07

EQUIPMENT MANAGEMENY

7.1 PREPARATION OF AN EQUIPMENT SCHEDULE

It is prepared for all plants/equipment required to be developed on the project. From this schedule delays in the work that may occur either due to non-availability or break down of equipment can avoided .Such a schedule enables the efficient and optimum utilization in a project .Using this schedule timely arrangement cab be made for developing particular equipment at a particular time .

Equipment schedule is as follows Name of the work -------- prepared by ----

EQUIPMENT SCHEDULE FOR PIPE RACK WORK

SL NO	EQUIPMENT DESCRIPTION	UNIT	QTY	DURATION	PERIOD IN MONTH 1	2	3	4	5	6	7	8
1	EXCAVATOR / JCB	NO	1	45 DAYS								
2	DUMP TRUCK	NOS	2	75 DAYS								
3	LOADER	NO	1	60 DAYS								
4	BOBCAT	NOS	3	45 DAYS								
5	PLATE COMPACTOR	NOS	5	90 DAYS								
6	CRANE, 100T	NOS	2	135 DAYS								
7	CRANE, 50T	NO	1	90 DAYS								
8	TRAILER	NO	1	90 DAYS								
9	MAN BASKET	NOS	2	135 DAYS								

7.2 IDENTIFICATIONS OF DIFFERENT ALTERNATIVE EQUIPMENT

Types of Heavy Equipment Used in Construction

Heavy construction equipment is used for various purposes in large projects. Selection of different types of heavy equipment depends on the size of the work and economy of the project. These make construction process easier and faster.

Types of Heavy Construction Equipment

Different types of heavy equipment commonly used in the construction are as follows:

1. Excavators
2. Backhoe
3. Dragline Excavator
4. Bulldozers
5. Graders
6. Wheel Tractor Scraper
7. Trenchers
8. Loaders
9. Tower Cranes
10. Pavers
11. Compactors
12. Telehandlers
13. Feller Bunchers
14. Dump Trucks
15. Pile Boring Machine
16. Pile Driving Machine

1. Excavators

Excavators are important and widely used equipment in construction industry. Their general purpose is to excavation but other than that they are also used for many purposes like heavy lifting, demolition, river dredging, cutting of trees etc.

Excavators contains a long arm and a cabinet. At the end of long arm digging bucket is provided and cabinet is the place provided for machine operator. This whole cabin arrangement can be rotatable up to 360^{o} which eases the operation. Excavators are available in both wheeled and tracked forms of vehicles.

Fig 1: Tracked Excavator

2. Backhoe

Backhoe is another widely used equipment which is suitable for multiple purposes. The name itself saying that the hoe arrangement is provided on the back side of vehicle while loading bucket is provided in the front.

This is well useful for excavating trenches below the machine level and using front bucket loading, unloading and lifting of materials can be done.

Fig 2: Back Hoe

3. Dragline Excavator

Dragline excavator is another heavy equipment used in construction which is generally used for larger depth excavations. It consists a long length boom and digging bucket is suspended from the top of the boom using cable.

For the construction of ports, for excavations under water, sediment removal in water bodies etc. can be done by dragline excavator.

Fig 3: Drag line Excavator

4. Bulldozers

Bulldozers are another type of soil excavating equipment which are used to remove the topsoil layer up to particular depth. The removal of soil is done by the sharp-edged wide metal plate provided at its front. This plate can be lowered and raised using hydraulic pistons.

These are widely used for the removal of weak soil or rock strata, lifting of soil etc.

Fig 4: Bulldozer

5. Graders

Graders also called as motor graders are another type of equipment used in construction especially for the construction of roads. It is mainly used to level the soil surface. It contains a horizontal blade in between front and rear wheels and this blade is lowered in to the ground while working. Operating cabin is provided on the top of rear axle arrangement.

Motor Graders are also used to remove snow or dirt from the roads, to flatten the surface of soil before laying asphalt layer, to remove unnecessary soil layer from the ground etc.

Fig 5: Motor Grader

6. Wheel Tractor Scrapers

Wheel Tractor Scrapers are earth moving equipment used to provide flatten soil surface through scrapping. Front part contains wheeled tractor vehicle and rear part contain a scrapping arrangement such as horizontal front blade, conveyor belt and soil collecting hopper.

When the front blade is lowered onto the ground and vehicle is moved, the blade starts digging the soil above the blade level and the soil excavated is collected in hopper through conveyor belt. When the hopper is full, the rear part is raised from the ground and hopper is unloaded at soil dump yard.

Fig 6: Wheeled Tractor Scraper

7. Trenchers

Trenchers or Trenching machines are used to excavate trenches in soil. These trenches are generally used for pipeline laying, cable laying, drainage purposes etc. Trenching machines are available in two types namely chain trenchers and wheeled trenchers.

Chain trenchers contains a fixed long arm around which digging chain is provided. Wheeled trenchers contain a metal wheel with digging tooth around it. To excavate hard soil layers, wheeled trenchers are more suitable. Both types of trenchers are available in tracked as well as wheeled vehicle forms.

Fig 7: Wheeled Trencher

8. Loaders

Loaders are used in construction site to load the material onto dumpers, trucks etc. The materials may be excavated soil, demolition waste, raw materials, etc. A loader contains large sized bucket at its front with shorter moving arm.

Loader may be either tracked or wheeled. Wheeled loaders are widely used in sites while tracked or crawled loaders are used in sites where wheeled vehicles cannot reach.

Fig 8: Loader

9. Tower Cranes

Tower cranes are fixed cranes which are used for hoisting purposes in construction of tall structures. Heavy materials like pre-stressed concrete blocks, steel trusses, frames etc. can be easily lifted to required height using this type of equipment.

They consist mast which is the vertical supporting tower, Jib which is operating arm of crane, counter jib which is the other arm carries counter weight on rear side of crane and an operator cabin from which the crane can be operated.

Fig 9: Tower Crane

10. Paver

Paver or Asphalt paver is pavement laying equipment which is used in road construction. Paver contains a feeding bucket in which asphalt is continuously loaded by the dump truck and paver distributes the asphalt evenly on the road surface with slight compaction. However, a roller is required after laying asphalt layer for perfect compaction.

Fig 10: Asphalt Paver

11. Compactors

Compactors or Rollers are used to compact the material or earth surface. Different types of compactors are available for different compacting purposes.

Smooth wheel rollers are used for compacting shallow layers of soil or asphalt etc. sheep-foot rollers are used for deep compaction purposes. Pneumatic tyred rollers are used for compacting fine grained soils, asphalt layers etc.

Fig 11: Smooth Wheel Compactor

12. Telehandlers

Telehandlers are hoisting equipment used in construction to lift heavy materials up to required height or to provide construction platform for workers at greater heights etc. It contains a long telescopic boom which can be raised or lowered or forwarded.

Different types of arrangements like forklifts, buckets, cabin, lifting jibs etc. can be attached to the end of telescopic boom based on the requirement of job.

Fig 12: Telehandler

13. Feller Bunchers

Feller buncher is tree cutting heavy equipment used to remove large trees in the construction field. They cut the tree and grab it without felling, likewise gathers all the cut down trees at one place which makes job easier for loaders and dump trucks.

Fig 13: Feller Buncher

14. Dump Trucks

Dump trucks are used in construction sites to carry the material in larger quantities from one site to another site or to the dump yard. Generally, in big construction site, off-road dump trucks are used.

These off-road dump trucks contain large wheels with huge space for materials which enables them to carry huge quantity of material in any type of ground conditions.

Fig 14: Off-Road Dump Truck

15. Pile Boring Equipment

Pile boring equipment is used to make bore holes in the construction site to install precast piles.

Fig 15: Pile Boring machine

16. Pile Driving Equipment

Another heavy equipment used in construction site is pile driving equipment in case of pile foundation construction. This equipment lifts the pile and holds it in proper position and drives into the ground up to required depth.

Different types of pile driving equipment are available namely, piling rigs, piling hammer, hammer guides etc. in any case the pile is driven into the ground by hammering the pile top which is done hydraulically or by dropping.

Fig 16: Hydraulic Pile Driving

7.3 IMPORTANCE OF OWING & OPERATING COST IN MAKING DECISIONS FOR HIRING & PURCHASE OF EQUIPMENT: -

Guidelines for Computing.

Machine Ownership Costs incurred for machinery ownership and operation are usually divided into two categories: fixed costs and operating or variable costs. Guidelines for estimating the costs in eachof these categories are as follows.

Fixed Costs

Fixed costs generally include the costs that are incurred regardless of whether the machine is actually used in production. These costs do not vary with the amount of machine use. Fixed costs are sometimes referred to as ownership and/or overhead costs.

Depreciation

Depreciation is a non-cash expense of machinery ownership that must be recognized. Depreciation expense accounts for the deterioration in the value of machinery because of age or technological obsolescence. Depreciation is usually estimated using a straight-line method for the purpose of estimating budget costs. To use this method, simply subtract the trade-in or salvage value of the machine from the purchase price and divide by the number of years of useful life. The number of years of useful life will depend upon the rate of use for the machine and/or how quickly advances in technology will make a particular machine obsolete. The time from purchase until the machine is worn out or technically obsolete varies from one kind of machine to another. An acceptable rule of thumb is 6 to 8 years.

Interest

Investment in machinery requires capital and should therefore be assigned a capital cost regardless of whether or not dollars are borrowed to purchase the machinery. If the money to purchase machinery is borrowed, the calculated interest cost should be at least large enough to cover the interest paid on the loan.

The average annual interest charges computed by subtracting the trade-in or salvage value from the purchase price, multiplying this difference by the rate of interest in your area, and dividing by 2.

((**Purchase price - salvage value) x rate of interest) / 2**

Shelter, Insurance, Taxes

For most machines these three costs are usually less than depreciation and interest, but they still need to be acknowledged. Some researchers indicate that a quick guideline would be to charge an amount equal to 2% of the purchase price to estimate the expense of all three of these costs. However, a better method would be to calculate the storage space required by machinery and then charge an appropriaterate per square foot of storage space required considering the cost of building and maintaining the machinery shed. Costs for insurance coverage need to be included as insurance provides protection from risks associated with theft, fire, flood, or other natural disasters. The cost of insurance(premium payment) is based on the initial cost and type of machinery as well as the type and extent of protection desired.

Operating Costs

Operating costs generally include those costs that are incurred as a direct result of the machine being used. These costs vary as machine use varies. Fuel, Lubrication, and Lebbo Fuel and lubrication costs can be figured either by the hour or by the acre with knowledge of (1) the fuel consumption rate/hour and (2) the number of acres completed in one hour.

Fuel cost/acre = consumption per hour/numberof acres completed/hour

Lubrication

According to Nebraska Tractor Test data, a general rule ofthumb can be applied for estimating the cost of lubrication. For example, the rule of thumb that is applied for power machinery is 15% of fuel costs. For non-power equipment 5% of the purchase price is used.

Labour

Labour cost is calculated using the cost of labour per hour. Labour charges should be included in machinery cost calculations and should cover the total cost of labour including the average wage rates as well as benefits, taxes, and payroll overhead costs paid to the machine operator. Labour hours per acre are based on field capacity of machinery. A labour adjustment factor is used to calculate total labour hours for machinery operation, including time for locating, hookingup, adjusting, and transporting machinery.

Labour cost/acres completed/hour = wage rate perhour x number acres x labour adjustment factor For example; a labour adjustment factor of1.1 would increase the time required to complete a task by 10% account for the additional time required for hooking upadjusting, and transporting machinery.

Repairs

Repairs are fixed costs in some respects and operating costsin other respects. Major repairs such as engine overhauls may be regarded as fixed costs if the owner knows in advance and budgets for the expense. As a result these should be included under depreciation in the fixed cost category. Minor repairs such as replacement of belts, chains, diskblades, or chisel shanks are included as operating costsbecause they are incurred as a direct result of using the machine. The best source for estimating annual repair cost is the Agricultural Machinery Management Standard published by the American Society of Agricultural Engineers. A simplified rule of thumb for estimating the annual cost of repairs is as follows:

• 3% of purchase price for machines owned for 5 years or less 0•5% of purchase price for till age machines with replaceable parts.

For machines that are more than 5 years old, or machines that are subjected to harder-than-average use, it is better to use actual farm records as a base on which to estimate annual repair costs. Estimates of all costs should be adjusted based on past experience and management judgment. When figuring costs there is no substitute for good records of expenditures, rates of fuel consumption per hour, and number of acres completed per hour for each field operation. These can be of great value in making realistic cost estimates and comparisons. Good record expenditures, rates of fuel consumption per hour, and number of acres completed per hour for each field operation are also important when considering different machinery investment strategies such as ownership, leasing, or hiring a custom operator. A detailed discussion of the own, lease, or custom hire decision can be found in SDSU Extension publication decisions an estimate of machinery costs is sufficient. To geta

quick and fairly accurate estimate of costs, the following categories can be used It is very important to use good judgment when deciding which category to use. A realistic judgment must be made concerning the amount of use and moving parts. If the machine is placed in the wrong classification, it is likely that the cost estimate will be inaccurate.

Low-Cost Category

For machines that are used infrequently and/or have few moving parts, annual total cost of operating the machine can be approximated by taking 15% of the purchase price.

Average Cost Category

For machines that are used about the average amount and/or have only a moderate number of wearing parts, 20% of the purchase price will approximate your annual total cost.

High-Cost Category

For machines that have a large number of wearing parts and/or more than average use, 25% of the purchase price will approximate annual total cost. After the annual total cost of operating and owning machinery is estimated by using this method, the average total cost per acre or hour can be found. To calculate the average total cost per acre, divide the annual total cost by the total number of acres for which the machine is used. To calculate the average total cost per hour, divide the annual total cost by the number of total hours that the machine is used.

7.4 INSPECTION & TESTING OF EQUIPMENT

Industrial equipment and machinery are subject to some of the world's most extensive conformity requirements, with added complexity as automation and robotics become integral to operations. You need timely and efficient solutions to help you stay compliant and competitive within the industrial equipment industry, as well as a partner for testing, inspection, certification, and quality assurance that has your goals in mind. We help you overcome challenges and reach global markets.

Power Equipment

You have a trusted brand and have customers who rely on you to provide equipment designed for efficiency and productivity. We understand your unique challenges and provide the speed and efficiency you need to meet your customers' needs.

Machinery and Tools

Whether you are building a large-scale, heavy-duty piece of equipment, or a highly complex and electrically sophisticated machine, our experts are here to help ensure your products meet regulatory requirements.

Process and Control Equipment

Going to market with new and innovative industrial and process control products keeps you ahead of your competitors and a compliance partner who is aligned with your goals is integral to your success.

Functional Safety

From early design stages through to production, our modular FS solutions provide flexible options for manufacturers, and our FS Mark provides stakeholders with visibility for products they purchase, install, or utilize in operations.

7.5 EQUIPMENT MAINTENANCE

Different Types of Maintenance Activities

1. Preventive maintenance

Preventive maintenance (PM) is “a routine for periodically inspecting” with the goal of “noticing small problems and fixing them before major ones develop.” Ideally, “nothing breaks down.” The main aim of preventive maintenance is to make to next maintenance activity without any breakdown and failures of machines and equipment. It includes activities such as partial or complete servicing at specified periods, oil changes, lubrication, etc.

2. Predictive maintenance

This maintenance activity is also done in advance which means to solve issues in advance. This activity is more like a precaution to escape problems. The main objective of predictive maintenance is to determine the condition of equipment & machines in order to know when maintenance activity can be done.

This is one of the promising ways of cost-saving. It also helps is estimating of degradation stage of an asset, equipment, and machine. (Both of the above are proactive maintenance activity takes place after a particular period of time such as 30 days or 45 days especially predictive maintenance).

3. Corrective maintenance

This is a reactive activity in nature. It is executed, when any defect or fault occurs in an asset, machine or equipment. Corrective maintenance restores the equipment depending on the fault. It includes various steps after failed equipment such as diagnosis, cause of failure then ordering replacement part & installing new part then testing functionality and continuation of the process.

The corrective maintenance can be divided into two parts immediate corrective maintenance and deferred corrective maintenance. In the Immediate corrective maintenance process, one has to take quick action right after the failure.

On the other hand, deferred corrective maintenance, in this process the maintenance activity is scheduled for later, there can be many reasons behind it. Such as, replacement parts might not be available, it may take a long time or technicians are required on some other high priority cases.

4. Routine maintenance

The main objective of routine maintenance activity is cleaning, oiling, lubricating, replacing batteries & changing the oil. Routine maintenance activity can take place on a weekly or half month basis. It depends on the equipment work.

As a professional equipment maintenance practice, one should keep an emphasis on maintenance rather than repairment. In simple words, to keep your equipment in good working condition, routine maintenance should be done on a regular basis.

5. Emergency maintenance

This activity is a reactive equipment maintenance activity. The main objective of emergency maintenance is to prevent a threat to lives, the property of a company. Emergency maintenance can be applied to keep the facility operational and safe. Emergency maintenance is mostly used in chemical plants, tenant buildings, etc.

POSSIBLE SHORT QUESTIONS WITH ANSWER

No.1 Define equipment schedule.

Ans. equipment schedule is a schedule prepared for all plants/equipment required to be developed on the project. From this schedule delays in the work that may occur either due to non-availability or break down of equipment can avoided. Such a schedule enables the efficient and optimum utilization in a project. Using this schedule timely arrangement cab be made for developing particular equipment at a particular time.

NO.2 what is operating cost & fixed cost in equipment management?

Ans. Operating costs generally include those costs that are incurred as a direct result of the machine being used. These costs vary as machine use varies. Fixed costs generally include the costs that are incurred in regardless of whether the machine is actually used in production. These costs do not vary with the amount of machine use. Fixed costs are sometimes referred to as ownership and/or overhead costs.

No.3 what is the main objectives of predictive maintenance?

Ans. The main objective of predictive maintenance is to determine the condition of equipment & machines in order to know when maintenance activity can be done.

No.4 What is corrective maintenance

Ans. Corrective maintenance restores the equipment depending on the fault. It includes various steps after failed equipment such as diagnosis, cause of failure then ordering replacement part & installing new part then testing functionality and continuation of the process.

No.5 Name five numbers of heavy equipment use in construction sites

Ans. The equipment are as follows,

ExcavatorsBackhoeDragline ExcavatorBulldozersGraders

POSSIBLE LONG TYPE QUESTIONS:

No.1 what are the factors to be considered while identifying & selecting equipment? (S-18,

No.2 what are the information to be known for a owner about the equipment purchased by him? (W-18,

No.3 Briefly described the factors to be considered for identifying of different alternative equipment. (S-19,

CHAPTER NO.–08

QUALITY CONTROL

8.1CONCEPT OF QUALITY IN CONSTRUCTION.

Quality in construction industry can be defined as the attainment of acceptable levels of performance from construction activities. This performance would be attained when the activity meets or exceeds the requirement of the client or the owner. The quality of any product or service is achieved when it conforms to the desired specifications.

Achieving quality in construction industry in long run is a tough issue and has been a problem. Inefficient or no practice of quality management procedures will result in great loss of time, money, material, resources.

For example, in construction site, the designer would specify a particular grade of concrete. The contractor will use the ingredients of the concrete such that the desired grade of concrete is obtained.

Objective of Quality in Construction

The quality in construction relates to the following objectives

1. Satisfaction of Contract Specifications
2. Completion of Project within Time
3. Enhancing Customer/ Owner Satisfaction
4. Motivation and Empowerment of Employees
5. Avoiding Disputes and Claims
6. Performance based on Purpose

The Quality schemes will carry out the studies for

1. Selection of types of material and methods to be included in design,
2. Ensure design in accordance with all applicable codes and regulation
3. Control construction on the project based on standards and contracts

8.2: QUALITY STANDARD DURING CONSTRUCTION: ----

Quality standard and inspection should be carried out at appropriate stage as the construction work proceeds. Any defects noticed during inspection should be pointed out and

rectified immediately in order to avoid unnecessary wastage of time and effort. In construction work there are certain stages in which individual items are required to be inspected and maintaining quality standard.

The important items are required to be inspected during constructions are : -

- Earthwork
- Masonry
- R.C.C
- Sanitary and water supply services
- Electrical Services

- **Earthwork: ---**
  Earthwork in excavation should be carried out after proper layout. The trenches in excavation should be protective suitably depending on the type of soil and depth of excavation. The excavation earth should be stacked at a suitable distance from the edge of the trenches. Proper earthwork in filling should be checked for compaction in layers so as to avoid settlement at a last stage once the foundation is constructed and bank filling completed, it will be very difficult to detect faults in the foundation structure. Thus, it is the important stage of inspection.

- **Masonry: ---**
  All masonry work should be inspected for the type of masonry, materials, bond, alignment and vertically etc. Any defect detected should be promptly corrected. The proportion ofmortar is checked before mixing. The strength of bricks, curing of masonry should be checked and ensured.

- **R.C.C: ---**
  The inspector should be checked the correctness of reinforcement at the time of its installation.
  The following points are: --
  - ➔ Splicing of reinforcement should be avoided at the point of maximum stress. At splices the bar should be properly lapped for sufficient length to transfer the stress by bond.
  - ➔ Too much welding across the main bar should be avoided.
  - ➔ The stirrups in beams and columns should not be positioned until after completion of the erosion of the main steel in the form work.
  - ➔ Proper cover to reinforcement should be check and ensure.
  - ➔ Checking of correctness of reinforcement and its measurement must be done before concreting.

- **Sanitary and Water supply Services: --**
  In modern construction most of the sewage and water supply lines are concreted under floor and in walls. It is very difficult to detect defects at the latest

stage and rectification is very costly. All sewage lines and water pipes line should be maintained slope and gradient checked, ensured. Suitable arrangement of roof drainage in all buildings should be checked and ensured during construction.

Complete layout of all these services should be shown as built drawings for future reference.

- **Electrical Services: --**

For providing domestic electrical services cable, switches, panels and meters should be provided as per specification and designed. The cable layout should be designed and indicated on the drawings.

While inspecting the layout of electrical works, it should be ensured that no chance is cut in the structural components for embedding the cables. Position of lights, fans and switches should be ensured at appropriate heights and locations, free from dampness.

Quality Standard After Construction: ----

After construction it is required to test all the parts of structure. So, the following are the main methods of testing structural component or structures for safety, stability and soundness.

- Destructive Test

i) Full scale load test

ii) Leak proof and dampness test

- **Non-Destructive Test**

- **Destructive Test: ---**

The following are main methods of testing structural components of stability and soundness.

i. Full Scale Load Test: -

Load test are generally done in case of suspended slabs and beams including supporting columns. This method of testing is adopted when all other methods fail to give satisfactory results as to whether the structure under consideration or not; Load testing is tedious and should be adopted only when the engineer is faced with a discussion to demolish the structure due to suspicion of structural safety.

ii. Leak-Proof and Dampness Test:-

Certain water retaining structure are tested for leak-proofing by filling water to the full level. Through the leak proof test, the quality of concrete can also be judged. In building roof, slabs are tested for damp proofing before the building is accepted for occupancy. Leaking roof are caused due to lack of quality control. Various equipmentis available for detecting presence of dampness in the body of the walls such test are checks and necessary to ensure durability of the structure.

- **Non-Destructive Test: --**

  There are different methods in non-destructive test. Followings are: -

  ➔ Ultrasonic Pulse Velocity Test
  ➔ Gamma Radiography Test
  ➔ Electromagnetic Cover meter Test
  ➔ Elastosonic Test
  ➔ Core Test

  ### ➔ Ultrasonic Pulse Velocity Test: -

  The ultrasonic pulse velocity method is useful for testing concrete in completed structure. It is particularly suitable for water retaining structure. The basic assumptions in ultrasonic testing of concrete in the structure is that concrete is an elastic material and transmits longitudinal, compression and shear waves. The velocity with which these wave travel through the body of concrete is dependent on its elastic modulus which is controlled by properties of the concrete. These properties of concrete are in termed related to the strength of the concrete.

  ### ➔ Gamma Radiography Test:-

  This method of inspection of hardened concrete is suitable for thickness up to 450mm. It is used for checking the efficiency of grouting in cable ducts in post-tensioned prestressed concrete, to detect voids in concrete and to determine the position and size of reinforcement.

  This method is not used extensively because it is expensive and requires specialist interpretation of photographs.

  ### ➔ Electromagnetic Cover meter Test: -

  It is comparatively simple equipment which determine whether there is steel reinforcement in the concrete or not. The depth of the steel below the surface of the concrete also indicated in the instrument. It is normally calibrated for mild steel and for use with Portland cement concrete.

  ### ➔ Elastosonic Test:-

  Elastosonic equipment is a microprocessor best instrument and works on the analysis of the vibrational behaviors of specimen. The instrument provides direct values of natural frequency, modulus of elasticity, bulk modulus, density Poisson's ratio etc. The equipment is costly due to its recent development.

  ### ➔ Core Test: -

  Core testing of concrete is generally the last resort, when cube results are significantly below the specifications and concrete has very low compressive strength. Core cutting is difficult and requires good equipment, tools and high degree of skill. It is an expensive and time-consuming method.

  Here the difference is the cube and core strength results may be due to: -

- Presence of reinforcement in the core.

- Difference in age, course is taken usually latter than 28 days after casting of concrete.
- Position of the structure.
- Presence of curing membrane influencing the drying out process.
- Core test indicate the strength, type and quality of concrete in the structure.

POSSIBLE SHORT QUESTIONS WITH ANSWER

No-1 What is the object of inspection and quality control in a project.

Ans→The object of inspection and quality control in to achieve sound construction work which results in structure of good quality at a reasonable cost.

No-2 What are the important items are required to be inspected during construction.

Ans→The important items are required to be inspected during construction are,

- Earth work.
- Masonry.
- R.C.C.
- Sanitary and water supply services.
- Electrical services.

No-3 Write the type of destructive test.

Ans→There are mainly two types of destructive test

- Full scale load test.
- Leak proof and dampness test.

No-4 Write the types of non-destructive test.

Ans→There are different methods of non-destructive test are as follows: --

- Ultrasonic pulse velocity test.
- Gamma radiography test.
- Electromagnetic cover meter test.
- Electronic test.
- Core test.

No-5 Explain full scale load test.

Ans→Loads test are generally done in case of suspended slabs and beams including supporting columns. This method of testing is adopted when all other methods fail to give satisfactory result that whether the structure under consideration or not. Load testing is tedious and should be adopted only when the engineer is faced with a decision to demolish the structure for safety.

No-6 What do you mean by quality control? (S-18,

Ans→A system of maintaining standards in manufacturing the product by testing a sample of the output against the specification.

No-7 What do you mean by quality management? (W-18,

Ans→Quality management is the act of overseeing all activities and tasks needed to maintain a desired level of excellence. This includes the determination of a quality, policy, quality control and quality improvement.

POSSIBLE LONG TYPE QUESTIONS:

No-1 Write the concept of quality in construction work.

No-2 Why inspection and quality standards during construction project.

No-3 How to inspect the quality standards during construction in different stages.

No-4 Explain destruction test about,

- **Full scale load test.**
- **Leak proof and dampness test.**

No-5 Explain about non-destructive test.

No-6 What qualities are required for a construction entrepreneurship? (S-18,

No-7 Explain the quality control process in various construction activities. (W-18,

No-8 Explain the need for inspection and quality control in construction works. (S-19,

No-9 Write a short note on quality assurance. (S-19,

No-10 Explain the importance of leadership in managing a construction project. (S-19,

CHAPTER NO. – 09

MONITORING PROGRESS

9.1 PROGRAMME & PROGRESS OF WORK.

Monitoring your project **progress** involves keeping **track** of lots of moving parts. Most projects involve multiple team members handling various aspects of the project at the same time. You have to monitor elements such as the budget, scope, schedule, resources and tasks to be completed.

Monitoring mostly involves keeping track of what is going on. By undertaking this regularly, the Management Committee have the opportunity to adjust the project to ensure that the above concerns are addressed. This is usually carried out through consideration of regular

operational and financial reports on the organisation's activities. For purposes of accountability, the Management Committee should ensure that this reporting is regular and that discussions on these are properly minute.

Organisations evaluate in order to:

- encourage ongoing improvement;
- provide evidence of the impact of their activities; and
- provide an informed basis for decision making and planning.

Evaluation and review should be an ongoing process of learning, continual improvement and development. The key to evaluating is knowing what you are measuring. A Management Committee cannot monitor and evaluate the organisation and its activities effectively without clear advance planning of what they want to do and to achieve.

9.2 WORK STUDY.

Meaning: - Work study or work analysis is the discipline of industrial engineering that uses various techniques to quantitatively measure or estimate work to increase the amount produced from a given quantity of resources by improving the use of existing resources.

Definition: - Work study is defined as that body of knowledge concerned with the analysis of the work methods and the equipment used in performing a job, the design of an optimum work method and the standardization of proposed work methods. } Work study is also understood as a systematic objective and critical examination of the factors affecting productivity for the purpose of improvement. It makes use of techniques of method study and work measurement to ensure the best possible use of human and material resources in carrying out specific activity.

WORK ANALYS IS **Method Study**&**Work Measurement**enhance Productivity To simplify the job Develop better methods Quantitatively measure work
Method study: - the systematic recording and critical examination of existing and proposed ways of doing work as a means of developing and applying easier and more effective methods and reducing costs. •

Work measurement: -the application of techniques, deigned to establish the time for a qualified worker, to carry out a specified job at a defined level of performance.

Objectives of Work Study • To analyse the present method of doing a job, systematically in order to develop a new and better method • To measure the work content of a job by measuring the time required to do the job for a qualified worker and hence to establish standard time. • To increase the productivity by ensuring the best possible use of human, machine and material resources and to achieve best quality product/service at minimum possible cost. • To improve operational efficiency.

9.3ANALYSIS & CONTROL OF PHYSICAL & FINANCIAL PROGRESS CORRECTIVE MEASURE

Analysis& control of physical progress.

The objective and realistic measurement of physical progress during a construction project is a key element for a successful project management. Progress measurement helps to determine the earned value, the cost at completion and the estimated finished date. The method for measuring the physical progress made on-site must reflect the correct phase of the project.

The principle is to establish a list of milestones milestone. The advantage of this method is that it measures how the work is progressing between two different milestones and, thus, provides realistic information on the progress.

If we consider a state of progress at a time T for a work package that contains several types of objects, then the consolidation formula is:

Analysis & control of financial progress.

Determining the cost of a project is one of the most important initial steps for a project manager. If a project manager cannot stay within a controlled budget, they may not have the funds to complete the project. The budget and financial plan is typically created during the initial stage of project development. Costs and resources should be set during the initiation stage to adequately plan and allocate costs.

$$\text{Progress} = \frac{\text{Earned Value}}{\text{Planned Value}} = \frac{\text{Sum (Ev * Wt)}}{\text{Sum (Pt * Wt)}}$$

Sum of all (weighted object earned values)
Sum of all (weighted planned objects)

where Ev is the earned value of each object measured
Wt is the object type weight
Pt is the number of planned objects for each object type

Some tools that project manager can use to control finances and budget include payback period and other financial forecasting calculations, and budgeting techniques, including variance analysis. These tools are critically important for project managers who need to control resources to ensure project completion. If resources are mismanaged, the project will be characterized by sunk costs (i.e., investments that procure no returns).

Budgeting Techniques

Budgeting involves determining how much money will be needed to complete a project and the timeframe for spending it. The budget may be determined on an annual or monthly basis depending on how long the project is projected to run. An important part of budgeting is setting a plan that can be followed over the course of the project.

POSSIBLE SHORT QUESTIONS WITH ANSWER

1)What is progress of work?

Ans. progress involves keeping track of lots of moving parts. Most projects involve multiple team members handling various aspects of the project at the same time.

2) What is work study? (S-18,

Ans. Work study or work analysis is the discipline of industrial engineering that uses various techniques to quantitatively measure or estimate work to increase the amount produced from a given quantity of resources by improving the use of existing predetermine.

POSSIBLE LONG TYPE QUESTIONS:

1) **Explain the objective of work study & method of work analysis.**
2) **Explain the analysis& control of financial progress.**

CHAPTER NO.– 10

SAFETY MANAGEMENT IN CONSTRUCTION

10.1 IMPORTANCE OF SAFETY.

A **safe** and healthy workplace not only protects workers from injury and illness, it can also lower injury/illness costs, reduce absenteeism and turnover, increase productivity and quality, and raise employee morale. In other words, **safety** is good for business. Plus, protecting workers is the right thing to do.

10.2 CAUSES& EFFECTS OF ACCIDENT IN CONSTRUCTION WORK.

Some causes of construction accidents are:

a. Scaffolding and ladders

Most of the accident occurs due to falling from certain heights. Workers fall from scaffolding or ladders while working for large scale projects at certain heights.

Mostly accidents and injuries (like fractures of bones, spines, head, etc.) are caused due to lose and incorrect placement of ladders and unguarded scaffolding in walkways.

b. Insecure Objects (Equipment)

Various sharp and solid objects used at elevation during construction may fall and these falling objects can cause injuries like cuts, head bruises, and even death.

To reduce such falling of objects, the workspace should be clean and well organized with safety measures.

c. The deficient immediate health facility

At the construction site, there should be the provision of first aid and various health facilities for immediate treatment of injuries. Lack of immediate facilities can lead to the worst circumstances of accidents.

Some workers may have health issues like respiratory problems, phobia from heights, photophobia, etc. Inadequate supervision of such workers by project manager can lead to accidents.

d. Faults in Equipment

Before starting to work, equipment should be well checked and repaired either it is working properly or not. The durability of the equipment should be recognized properly. If it is not working smoothly, it should be checked out by technicians for repair. Thus, faulty equipment is one of the causes of accidents.

e. Deficient of proper training

There are many hazardous types of equipment used in the construction site. Workers should be well trained or guided to use equipment securely by applying safety measures.

Lack of knowledge and expert advice to use heavy equipment is also the main cause of construction accidents.

f. Heavy Equipment

With the advancement of technology for efficient and fast operation of work, small equipment can be replaced by single equipment of multi-functioning capacity. And single equipment may be heavy in size and weight. To use such heavy equipment; proper guidance and skilled manpower are required.

Heavy equipment like cranes, dodgers, rollers, trucks, etc. at the site needs adequate communication between drivers, safety staffs, teams, workers, pedestrians around, etc. during operation. Operation of heavy equipment is difficult in its own. Thus, it is also considered as the cause of construction accidents like struck, crash, etc.

g. Improper Way of Sequencing

Some workplace has risks of on-site erosion and sedimentation problems and thus causes difficulties in executing the project work in time as scheduled and installation problems may arise in site to operate various construction works that have been sequenced in project analysis of equipment and materials. Thus, this creates psychological pressure and may result in different accidents.

h. Inaccurate construction planning and scheduling

For proper time management of project duration and resources required for the construction, it is scheduled with the proper plan of cost estimation, recognition of hazards possibilities and complications.

Inadequate planning and scheduling can cause improper management of workers, equipment and resources. This can cause various accidents in construction sites.

i. Noise Hazards

Heavy machinery and equipment used at site produce vibration and loud noise. And loud non-audible sound can cause deafness & numbness to the workers and vibration causes various internal injuries of limbs and nerves. Thus, the loud non-audible sound is considered as noise and is hazardous to human health. This is also the cause of accidents in the construction site.

j. Hazardous Construction Site

Some sites may have various deficiencies like natural disaster-prone areas, unsuitable land and climate for construction, etc. Thus, the workplace should be chosen very wisely before planning and scheduling for construction.

Experts and civil engineers should permit to start works at the site. Improper selection of construction site causes failure, demolition of structures during construction and workers may have to be injured and died. Thus, the hazardous workplace is also a cause of construction accidents.

Then the most possible **effects** of accidents in the construction industry were cost of medical expenses, time loss of project execution, productivity loss, distrust of firm, cost of training given to new workers.

10.3 SAFETY MEASURES IN WORK SITES FOR,

Excavation: -

Excavation work is an important activity in the construction sites. However, many fatal accidents do occur in excavation work, if proper precautions are not taken. Many lives are lost being buried alive in the trenches. It should be remembered here that there is no safe ground that will not collapse and therefore, any trench sites can collapse without any warning.

- All excavation work deeper than 1.25 meters must be shored or battered.
- Excavation deeper than 2 meters must be guarded by rails or barriers.
- Vehicles working, too close to the side of the trench or rubble piled on the sides may cause collapse and therefore at most care should be taken.
- Vehicles tipping into the excavation work must use stop blocks, so as to avoid the collapse of the trench.
- Make sure that the excavation work is inspected daily.
- Make sure that you know where the position of underground pipes and electric cables are laid in the site, so that you will not hit them during the excavation work.

Scaffolding.

Scaffolds are temporary structures of steel work, timber or bamboo. The criteria for their erection are the same as those for permanent structures. The strength of the scaffolding depends upon the combined strength of individual members. Failure of one or two of them can result in the collapse of the entire structure. Modern scaffolds are invariably made of steel tubes, pre-fabricated in convenient units.

They are safer and turn out good quality work. Of course, the steel scaffolds are too costly, but it would be cheaper in the long run. In spite of the fact that the steel scaffolds are much safer, many of the smaller and medium size builders in India, neglect the safety aspects and prefer to use timber or bamboo scaffolds (See Fig.02) in order to cut the cost. In any case, while erecting the scaffolds, the workers should be forced to wear necessary safety belts with fall arrestors and helmets, so that the fall accidents can be avoided.

Form work

A safe practice for formwork during construction at site is important for safety of workmen. Improper erection of formwork can cause damage to structural element as well as pose threat to the safety of workmen

Following are the safe practices checklist for formwork:

Formwork Safety Checklist during Design:
1. Formwork should be properly designed for the structural element considered and its working drawing should be available at site.

2. Design of formwork should consider all the loads it will experience during casting of concrete structural members.

3. Strength of materials used for formwork should be adequate to support structural load as well as other loads imposed on it.

4. Guarding of peripheral edges and floor openings.

5. Adequate space for safe working.

6. Safety training of workmen involved in formwork and concreting works.

7. Use of all personal protective equipment (PPEs).

8. Formwork, rigging inserts and connections checked for correct installation and periodically checked for wear and correct position.

9. Removal of all unused and hanging forms, loose materials etc. stored on exposed floors.

10. Inspection of all props and shores for adequacy to handle all the loads.

11. Removal of defective props.

Fabrication & erection

Following safety measures should be adopted during fabrication & erection.

- ➔ All equipment such as gas cutting, welding sets, drills, power hacksaws, grinders should be checked periodically to ensure their safe working.
- ➔ Moving parts of all equipment should be provided with safety guards.
- ➔ Rubber pipe lines for oxygen and acetylene gas should be regularly checked for leakage and damage and should be rectified immediately.
- ➔ Workers engaged in gas cutting and welding. Operations should wear suitable globes and aprons and used proper welding screens.
- ➔ Power cable for all equipment should be properly insulated and protected from damage and cuts.
- ➔ Danger signs should be eminently displayed on all poles of overhead electric lines used at site.
- ➔ Cut pieces and scraps should be stored at an appropriate place to avoid accidents.
- ➔ All erection equipment such as cranes, derricks, hoists should be thoroughly checked before use.
- ➔ Workers engaged in erection work should wear helmets and use safety belts to avoid accidents.

Demolition.

- ➔ On every demolition work, danger signs should be provided all around the structures. Barricades should be erected around the structure and at least two exist must be provided for the escape of workman during any emergency.
- ➔ During night time red light should be provided around the barricades and entry of unauthorized persons restricted.
- ➔ At the time of demolition work workers should use all safety appliance such as helmets, goggles, globes etc.
- ➔ The process of demolition weakens the side walls of an adjoining structure and to prevent possible damage, these walls should be supported until permanent protection is provided.
- ➔ All gas, water and other services lines must be shut off before the demolition work is started.
- ➔ No demolition work should be carried out at night especially when the structure to be demolished id in an inhabited area.

10.4 Development of safety consciousness

Learning Outcomes of Construction Safety training

By the end of this training participants would be familiarized with:

- Accidents in construction industry.
- Statutory Regulations pertaining to Indian Construction industry.
- Construction Safety Management.
- Safety in Excavations and Trenching.
- Safety in Work at Height.
- Scaffolding Safety.
- Electrical Safety.

- Safety in Material Handling.
- Safety in Welding & Gas Cutting.
- Accident case studies at construction site.

Training would help participants understand following aspects of construction safety:

- Identify legal obligations in workplace health & safety,
- Identify hazards in a construction site,
- Understand the Permit-to-Work system,
- Practice safety precautions when working with different hazards,
- Competent in wearing Personal Protective equipment (PPE),
- Respond in case of fire emergency,
- Understand and respond to all industrial safety signs,
- Working safely at height, in and around excavation, hot work,
- Knowing the rights and responsibilities of workers.

The Training sessions would be as per international standard, using audio visual presentation and past case studies.

Who can take the Construction Safety training?
Construction workers or any other workers who need to enter a construction worksite.

Benefits of Construction Safety training

At the end of the course, participants will be able to:

- Recognize the common safety hazards at construction site,
- Know the preventive measures to be adopted,
- Confident in working at height,
- Understand the importance of observing safety signs and safe work procedures,
- Understand importance of PPE and its limitations,
- Know their rights and responsibilities.

10.5 Safety legislation.

Workmen's compensation act

The Workmen's Compensation Act, 1923 is among the earliest social security legislations in India, enacted with the purpose of making the employer liable to pay compensation to employees who are affected, or to their dependents in case of death. Compensation is payable in case of injury and accident (including certain occupational disease) arising out of and in course of employment and resulting in partial or total disablement, or death. Compensation in case of death ranges from Rs. 80000 to Rs. 4.56 lakh and in the case of permanent total disability from Rs. 90000 to Rs. 5.48 lakh.

The Act is equally applicable to women employees too.

Contract labour act.

This act has been enacted to regulate the employment of contract labour in certain establishments and to provide for its abolition in certain circumstances and for matters

connected therewith. It applies to all establishments employing 20 or more contract labour and to all contractors who employs 20 or more contract labours. It applies to all establishments 20 or more contract Labour and to all contractors who employer, 20 or more Contract Labour. The Act provides for the constitution of Central and State Advisory Boards to advise the concerned governments on matters arising out of the administration of the Act. The Central Government has issued a number of notifications prohibiting employment of Contract Labour in different categories of works, job and process as in mines, Food Corporation of India's god owns, port trusts and many other industries/ establishments for which it is the Appropriate Government. The Central Advisory Contract Labour Board has also constituted a number of committees to enquire into the question of prohibition of contract labour system in different establishments.Central Government is the Appropriate Government in respect of industries and establishments for which it is Appropriate Government under the industrial Disputes Act, 1947.

POSSIBLE SHORT QUESTIONS WITH ANSWER

No-1 Write the importance of safety in construction.

Ans→ Safety in construction in a prime factor but it gets neglected on the work sites proper steps should be taken to improve safety on construction sites, so that loss of limb and life suffers and damage from avoidable accidents in prevented.

No-2 How to measure safety in work sites.

Ans→ In order to prevent accidents at work sites certain safety measures need to detected in the

following major activities:

- Excavation.
- Scaffolding.
- Formwork.
- Fabrication and erection.
- Demolition

POSSIBLE LONG TYPE QUESTIONS

No-1 Write the causes and effect of accidents in construction works. (S-17,

No-2 Write safety measures during excavation.

No-3 How to measure safety for scaffolding,ladders, formwork and other equipment during construction.

No-4 Explain the safety measure for demolition.

No-5 Explain the safety measure for fabrication and erection.

No-6 Explain the importance of safety in construction work. Describe the safety measure required for drilling

and blasting works.

No-7 Explain the causes of accident on a construction site. Describe the safety measures required in excavation, demolition work. (S-18, S-19,

No-8 What are the causes of accident in construction industry (W-18.

No-9 What is the effect of accident in construction work. (S-19,

CHAPTER NO.-11

(ROLE OF VULNERABILITY ATLAS OF INDIA IN CONSTRUCTION PROJECTS)

11.1 INTRODUCTION TO VULNERABILITY ATLAS OF INDIA, CONCEPT OF NATURAL HAZARDS AND DISASTERS & VULNERABILITY PROFILE OF INDIA. DEFINITION OF DISASTER RELATED TERM.

As per prevalent geo-climatic conditions, Indian sub-continent is prone to natural hazards such as earthquakes, wind storms & cyclones, landslides, floods, thunderstorms. India has witnessed several disasters leading trail of destruction, irreparable loss of lives and properties. Recognizing the vulnerability of Indian sub-continent, Disaster Management Act was enacted in 2005 followed up by National Policy for Disaster Management in 2009 and National Disaster Management Plan in 2016.

BMTPC since its inception in 1990 was committed towards promoting disaster mitigation measures through preparedness and brought out its first Vulnerability Atlas of India in 1997 under the auspices of Expert Group set up by the Ministry of Housing & Urban Affairs (erstwhile Ministry of Urban Development) (Annex-1). It was first of its kind tool for the Disaster Management authorities, agencies, related stake holders and citizens of India for identifying the level of damage risk (degree of vulnerability) of housing stock with respect to

earthquakes, floods and cyclones, in any part of the country. The data from Government nodal agencies such as Indian Meteorological Department (IMD), Survey of India (SOI), Geological Survey of India (GSI), Census of India, Bureau of Indian Standards (BIS), Central Water Commission (CWC) was assimilated and natural hazards maps were prepared up to district level in each State of India. The expected loss from a given hazard and related depends upon the hazard intensity, population exposed and vulnerability of housing stocks. A simplified way of projecting the inter-dependencies of these factors and risk at a place is :

Risk at any place = [(Hazard x Vulnerability) x exposure] / Capacity,

where various terms are defined as Risk is combination of probability of an event and its negative consequences Hazard is a threatening event i.e. Earthquakes/Wind storm/ Cyclones/Floods/Landslides Vulnerability is Characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard Exposure is in terms of People, buildings, businesses, infrastructure Capacity is combination of all the strengths, attributes and resources available within a community, society or organization

DEFINITIONS OF SOME DISASTER RELATED TERMS

For the sake of easy understanding, a few of the terms commonly used in dealing with natural disasters are defined here below:

Hazard1: a threatening event, or the probability of occurrence of a potentially damaging phenomenon (e.g., an earthquake, a cyclonic storm or a large flood) within a given time period and area.

Disaster1: a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses which exceed the ability of the affected society to cope using only its own resources. Disasters are often classified according to their speed of onset (sudden or slow) or according to their cause (natural or man-made).

Disaster2: means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected areas.

Disaster Management2: means a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for:

i) prevention of danger or threat of any disaster;

ii) mitigation or reduction of risk of any disaster or its severity or consequences;

iii) capacity building;

iv) preparedness to deal with any disaster;

v) prompt response to any threatening disaster situation or disaster;

vi) assessing the severity or magnitude of effects of any disaster;

vii) evacuation, rescue and relief;

viii) rehabilitation and reconstruction.

Risk1: the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon, and consequently the product of specific risk and elements at risk

Vulnerability1: the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon (or man-made event) of a given magnitude and expressed on a scale from 0.0 (no damage or loss) to 1.0 (total loss).

Mitigation1: measures taken in advance of a disaster aimed at decreasing or eliminating its impact on society and on environment.

Mitigation2: means measures aimed at reducing the risk, impact or effects of a disaster or threatening disaster situation.

Preparedness1: activities designed to minimise loss of life and damage, to organise the temporary removal of people and property from a threatened location and facilitate timely and effective rescue, relief and rehabilitation.

Preparedness2: means the state of readiness to deal with a threatening disaster situation or disaster and the effects thereof.

Prevention1: encompasses activities designed to provide permanent protection from disasters. It includes engineering and other physical protective measures, and also legislative measures controlling land-use and urban planning

Since the publication of Vulnerability Atlas of India (2006), there has been invaluable feedback from users on the Atlas. Also, Vulnerability Atlas of India was brought out in digitized CD form in 2008 and was also uploaded on National Informatics Centre (NIC) platform. National Institute of Disaster Management (NIDM), Government of India also used the Atlas for training SAARC countries so as to prepare the region towards disaster risk reduction. There have been subtle changes in the available knowledge and information in the area of disaster mitigation and management. New datasets with respect to earthquake occurrence, cyclones, wind storms, landslides, thunderstorm etc. have been brought out by nodal government agencies. There are demographic changes also on account of formation of new States and new districts. During this period, the country has also experienced some damaging earthquakes, cyclones, floods and landslides. Thunderstorms, urban flooding, flash floods have also caused significant damages to lives and properties.

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.**

Earthquake and Seismic Zones

The entire Indian landmass, susceptible to different levels of earthquake hazard, has broadly been classified into four distinct seismic Zones, referred to as Zones II to IV as per the Seismic Zoning Map of India contained in IS 1893:2002 (Part-1). As per the Foreword to the Seismic Code IS 1893:2002, the general basis of the zones is as follows:

Zone V: Covers the areas liable to seismic intensity IX and above on MSK (1964) Intensity Scale. This is the most severe seismic zone and is referred here as Very High Damage Risk Zone.

Zone IV: Gives the area liable to MSK VIII. This zone is second in severity to zone V. This is referred here as High Damage Risk Zone.

Zone III: The associated intensity is MSK VII. This is termed here as Moderate Damage Risk Zone.

Zone II: The probable intensity is MSK VI or less. This zone is referred to as Low Damage Risk Zone.

It may be mentioned here that the new Intensity scale, called as MSK Intensity Scale 1964, is much more detailed and quantitative in nature as compared to the Modified Mercalli (MM) though almost similar in intensity magnitude earthquakes have been recorded in several parts of the country through local, small aperture networks of high gain instruments by some organizations and institutions, but the non-uniformity of the data and time gaps as well, may convey an unrealistic picture of relative seismic activity in different areas, that is, areas having dense local instrument network showing more activity than those where such networks do not exist. No attempt was therefore made to present this available information on the general-purpose hazard maps which are meant here specifically for prevention, mitigation and preparedness concerning housing and related infrastructure. As recommended in the Code itself, in the case of special structures, detailed investigations (site related geologic, seism tectonic, geotechnical) should be undertaken. Such special structures will include very tall buildings, say more than 90 m in height; very long span, special type and important bridges, major dams, major power plants, hazardous/risky structures, etc. The seismic risk to such structures cannot be worked out from the data presented in this Atlas.

Epicentres of Earthquakes of M >5.0

All earthquakes of M > 5.0 on Richter open ended logarithmic scale have been plotted along with the seismic intensity zones. The catalogue of earthquakes prepared by India Meteorological Department (IMD), Government of India has been utilized for the purpose. The Magnitude of the earthquake as well as the year of occurrence are shown along with the location on the maps. With regard to earthquakes of lower magnitudes, it is known that their frequency of occurrence is much higher than the larger earthquakes. Also lower the magnitude, the closer must be the installations of seismological instruments and better should be their installation to permit higher gain, so as to be able to record the shocks and find their location. The present seismological network in India is not so capable and is non-uniform in its capability as well. No doubt, small magnitude earthquakes have been recorded in several parts of the country through local, small aperture networks of high gain instruments by some organizations and institutions, but the non-uniformity of the data and time gaps as well, may convey an unrealistic picture of relative seismic activity in different areas, that is, areas having dense local instrument network showing more activity than those where such networks do not exist. No attempt was therefore made to present this available information on

the general-purpose hazard maps which are meant here specifically for prevention, mitigation and preparedness concerning housing and related infrastructure. As recommended in the Code itself, in the case of special structures, detailed investigations (site related geologic, seism tectonic, geotechnical) should be undertaken. Such special structures will include very tall buildings, say more than 90 m in height; very long span, special type and important bridges, major dams, major power plants, hazardous/risky structures, etc. The seismic risk to such structures cannot be worked out from the data presented in this Atlas

Earthquake Magnitude and Intensity

The magnitude M of an earthquake is denoted by a number which is a measure of energy released during the earthquake occurrence. It is now measured in different ways, the most commonly used is the Richter Scale according to which "the magnitude of an earthquake is the logarithm to the base 10 of the maximum trace amplitude, expressed in microns, with which the standard short period torsion seismometer (with a period of 0.8 second, magnification of 2800 and damping nearly critical) would register the earthquake at an epicentre distance of 100 km". The scale being logarithmic, the energy of earthquake magnitude 'm+1' is about 31 times the energy released in earthquake of magnitude 'm'. Magnitude scale is open ended, denoted numerically to one place of decimal (5.6, 8.3, etc.)."The intensity of an earthquake at a place is a measure of the effects of the earthquake". A number of intensity scales have been in vogue in different times, namely Rossi-Forel (RF), Modified Mercalli (MM), MSK 1964 and Japan Meteorological Agency (JMA) scales. All the scales are close-ended stepped scales, RF having 10 points (I to X), MM and MSK with 12 points (I to XII) and JMA with 7 points (I to VII). Presently MSK 12-point scale is the most used, JMA being used in Japan. In historical earthquakes in India such as 1905 Kangra earthquake and 1934 Bihar- Nepal earthquake, RF intensity scale was used for drawing the isoseismic. While for a given earthquake, the magnitude has one unique value and epicentre location, the intensity varies from the maximum in the epicentre area to smaller values at increasing distances from the epicentre. Isoseismics derived from the observed damages in an earthquake as per the intensity scale show the intensity distribution caused in the earthquake.

Damage Risk Levels for Earthquakes

The damage risk to various house types is defined under various seismic intensities on MSK scale. The following damage risks are defined based on this Intensity Scale.

Very High Damage Risk (VH)

Total collapse of buildings

High Damage Risk (H)

Gaps in walls; parts of buildings may collapse; separate parts of the building lose their cohesion; and inner walls collapse.

Moderate Damage Risk (M)

Large and deep cracks in walls fall of chimneys on roofs.

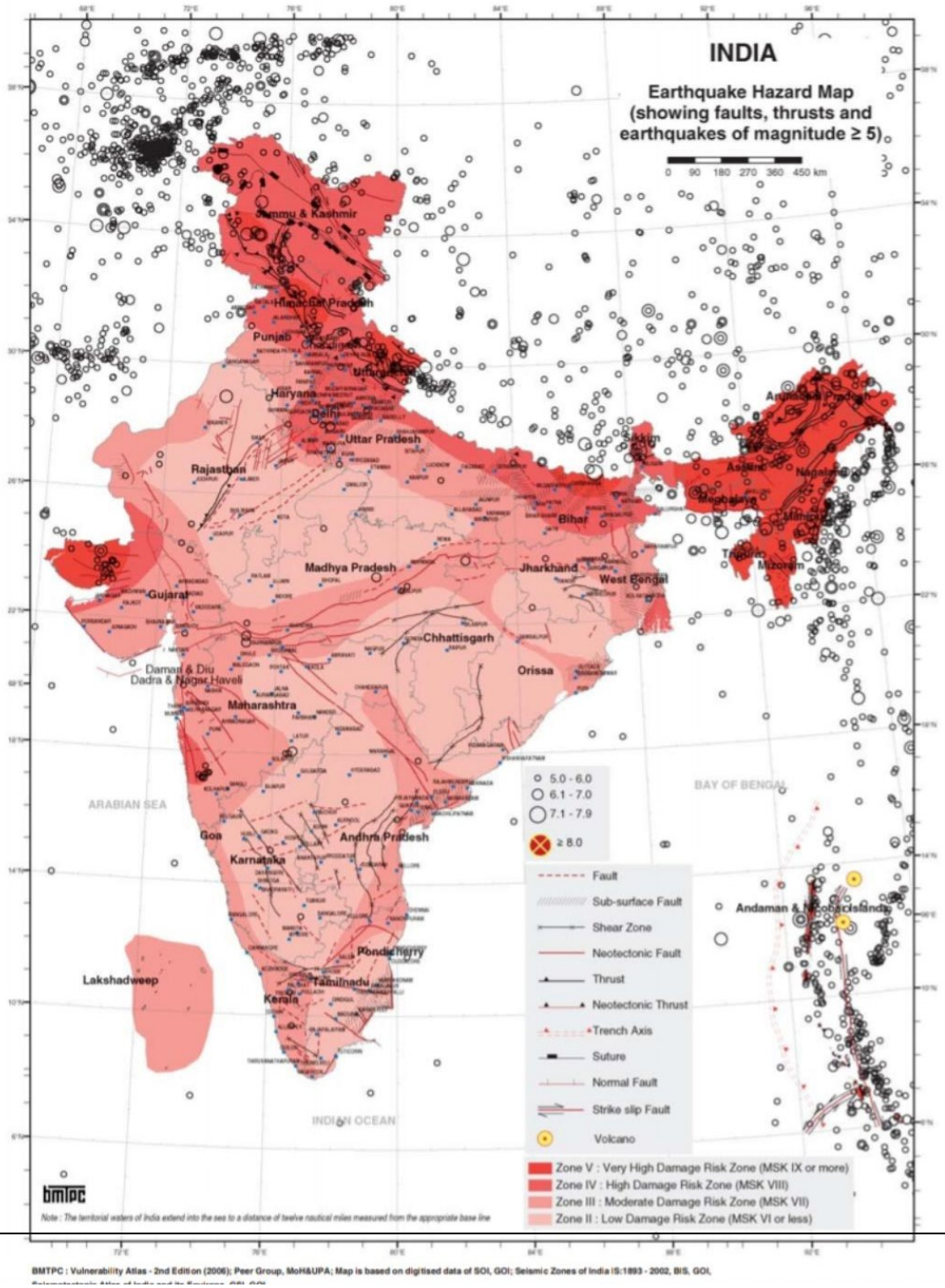
Low Damage Risk (L)

Small cracks in walls; fall of fairly large pieces of plaster, pantiles slip off; cracks in chimneys, part may fall down.

Very Low Damage Risk (VL)

Fine cracks in plaster; fall of small pieces of plaster

11.3 WIND / CYCLONE HAZARD AND VULNERABILITY, WIND SPEED AND PRESSURES, WIND HAZARD AND CYCLONE OCCURRENCE MAPS, STORM SURVEYS AND CYCLONE RESISTANT MEASURES



WIND HAZARD MAPS

The state wise wind hazard maps contain the following information:

Basic Wind Speed Zones

The macro-level wind speed zones of India have been formulated and published in IS 875 (Part 3):2015 - "Indian Standard Code of Practice for Design Loads (other than earthquakes) for Buildings and Structures, Part 3 Wind Loads". There are six basic wind speeds 'Vb' considered for zoning, namely 55, 50, 47, 44, 39 and 33 m/s. From wind damage view point, these could be described as follows:

55 m/s (198 km/h) - Very High Damage Risk Zone - A

50 m/s (180 km/h) - Very High Damage Risk Zone – B

47 m/s (169.2 km/h) - High Damage Risk Zone

44 m/s (158.4 km/h) - Moderate Damage Risk Zone – A

39 m/s (140.4 km/h) - Moderate Damage Risk Zone – B

33 m/s (118.8 km/h) - Low Damage Risk Zone

Design Wind Speed and Pressures

The basic wind speed is reduced or enhanced for design of buildings and structures due to factors like (i) the risk level of the structure measured in terms of adopted return period and life of structures (5, 25, 50 or 100 years), (ii) terrain roughness determined by the surrounding buildings or trees and, height and size of the structure, (iii) local topography like hills, valleys, cliffs, or ridges, etc., and (iv) Importance factor for the cyclonic region.

This basic wind speed shall be modified to include the above effects to get design wind speed, Vz as follows:

$Vz = Vb\ k1k2k3k4$

where Vz = design wind speed at height z, in m/s;

k1 = probability factor (risk coefficient);

k2 = terrain roughness and height factor;

k3 = topography factor; and

k4 = importance factor for the cyclonic region.

Thus, basic wind speed being the same in a given zone, structures in different site conditions could have appreciable modification and must be considered in determining design wind velocity as per IS 875 (Part 3):2015.

The design wind pressure at height z above ground level on a surface normal to the wind stream is given by

. $Pz= 0.0006\ Vz2$

where Vz = design wind velocity, m/s

. Pz = design wind pressure, kN/m2

This value of wind pressure gets very much modified when applied to a given house: the windward vertical faces being subjected to pressure, the leeward and lateral faces getting suction effects, and the inclined roofs getting pressures or suction effects depending on their inclination. The projecting window shades, roof projections at eave levels are subjected to uplift pressures several times the intensity of Pz. These factors play an important role in determining the vulnerability of given building types in given wind speed zones.Over the Indian continent, the average wind speed is reported on the basis of 3 minutes average. Wind speed increases manifold in of a squall or low-pressure systems over the region. The highest wind speed recoded at the station during the past due to any weather system may be considered as the maximum probable wind for that region or a station.

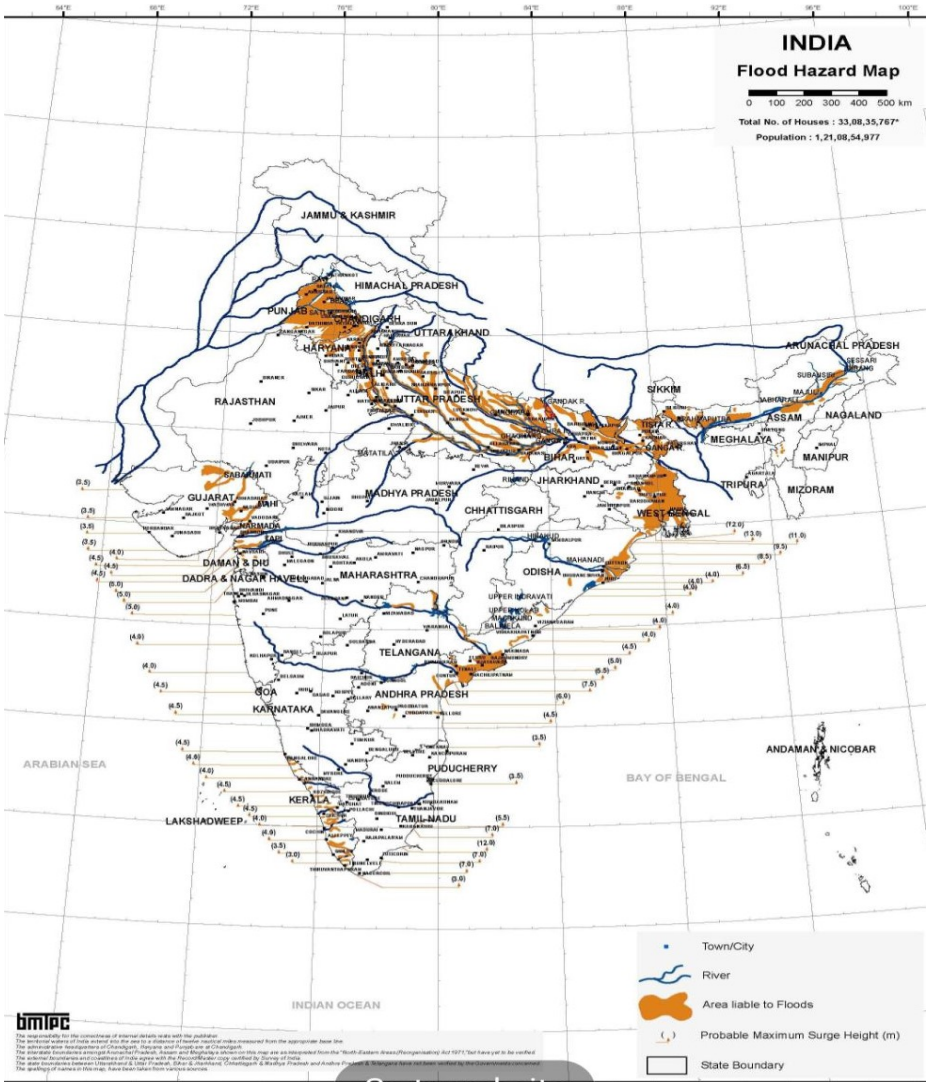
Coastal Areas

The coastal areas are subjected to severe wind storms, cyclonic storms and tsunamis. It is known that in certain events, the wind gusts could appreciably exceed the given basic wind speeds (by as much as 40 to 55%)1. But for design of normal structures and classification of vulnerability and risk to buildings, the above macro-level zoning is considered as sufficient. Higher wind velocity may be adopted for the 50-60 km wide cyclonic belt on the east and west coasts as per the provisions in IS 15498:2004. The frequency of occurrence of cyclones on the different portions of the coast has been different. Even for the same design wind speed in some areas, the risk of damage per year will be higher in areas subjected to more frequent cyclones. Therefore, for the States having coastal areas, the number of cyclones having crossed the coastline from the year 1891 to 2017 has also been shown as cyclonic storm (C.S.) with wind speed between 34 and 47 knots. Under the S.C.S. Category all cyclones with wind speeds greater than or equal to 48 knots have been included. It is to be noted that the cyclones crossing West Bengal coast shown on the map include those up to Longitude 90°E that is a part of Bangladesh coast.

Storm Surge

Besides the very high velocity winds, the coastal areas suffer from the onslaught of sea water over the coast due to storm surge generated by cyclones. A storm surge is the sudden abnormal rise in sea level caused by cyclone. The surge is generated due to interaction of air, sea and land. The cyclone provides the driving force in the form of very high horizontal atmospheric pressure gradient that leads to very strong surface winds. The sea water flows across the coast as well as inland and then recedes back to the sea. Great loss of life and property takes place in the process. Scientists from India Meteorological Department have estimated the probable maximum heights of storm surge in various sections of the sea coast. These are shown in the relevant States' wind hazard maps. While calculating Probable Maximum Storm Surge (PMSS) the presumption has been made that there is a possibility of highest intensity storm generated in the adjacent sea/area during past 100 years may strike any part of the coast touching that sea. The height of the storm surge is over and above the concurrent sea level, hence added to the normal astronomical tide level existing at the time of the cyclonic storm for calculating the maximum level to which the surge could strike under the storm.

11.4 FLOOD HAZARD AND VULNERABILITY, FLOOD HAZARD AND FLOOD PRONE AREAS OF THE COUNTRY, GENERAL PROTECTION OF HABITANTS AND FLOOD RESISTANT CONSTRUCTION



FLOOD HAZARD MAPS

The state wise flood hazard maps cover the following information:

Areas Liable to Flooding

The "Flood Atlas of India" brought out by Central Water Commission (CWC), shows pictorially the areas liable to floods, expenditure made and the achievement of flood protection measures. The Atlas was first published in 1962 and again published in 1977 and updated up to March 1985. A further revision is in process now. As per the information collected from CWC, a total area of 14.37 million hectares is reported to have been protected in various states out of the total flood prone area of the country of about 40 million hectares as assessed by Rashtriya Barh Ayog (RBA) 1980. The protectable area has been considered

to be of the order of 32 million hectares. The area liable to floods is the aggregate of different areas flooded in any year during the period of record. This, therefore, include the unprotected and protected areas. The protected area is also vulnerable to floods as the flood control structures, mainly embankments, may breach during a severe flood and the so-called protected areas may also get flooded due to wrong alignment or breach of embankments. However, because of the protective measures adopted, vulnerability of houses, etc., in such areas, are considered to be comparatively less in usual circumstances.

The areas outside the flood prone areas are generally not vulnerable to flood. But experience shows that heavy rains in some of these areas can result in flood condition and at times flooding in such areas may be very severe and create more acute problem than in the identified flood prone areas. The economic loss and disruption to normal life in urban areas could be very high as seen in recent floods of Mumbai and Chennai (2006) which were unprecedented. These aspects may be kept in mind while using the vulnerability tables as mentioned in the note below the Risk Tables.

The State-wise flood hazard maps in this Vulnerability Atlas are based on the Flood Atlas of India (1987), and updated flood prone areas of Assam and other neighbouring States including Bihar, West Bengal and Eastern Uttar Pradesh included in the Task Force Report (2004). These maps mark the areas which are liable to flooding. Since these maps given herein also show the district boundaries and the location of the district towns along with the rivers, district wise identification of the vulnerable areas will be easy

As regards latest data on flood prone areas is concerned, the scientific assessment of flood prone area in India is under progress by CWC. The existing flood maps presented here are of 2006 Atlas and will be updated as and when the data is made available by CWC

Probable Maximum Precipitation

Besides the problem of flooding in the river plains, heavy intensity rains could cause local flooding in certain areas where the drainage is either naturally poor or the drains are choked due to various reasons such as careless dumping of refuse in the drains and lack of maintenance. Much of the flooding problems in towns and cities occur due to such causes. The Central Water Commission and India Meteorological Department have compiled statistics on Probable Maximum Precipitation (PMP) over the country considering one day rainfall data. The design of drainage should consider such PMP values, the catchment areas of the drain and the characteristics of the catchment area to avoid flooding

Flooding in Coastal Areas

As stated earlier under cyclonic winds in coastal areas, the sea coast of India can be flooded due to heavy downpour on the one hand and the storm surge on the other. Whereas the PMP values give the probable intensity of raining, the probable maximum storm surge heights worked out by IMD and shown on the state wise maps will give an idea of height of water which could flow from the sea towards the coastal plains in extreme cases and the levels to which protection will be required. The depth of inland inundation could be worked out by taking the storm surge heights, where high resolution coastal maps with half metre contours are available

11.5 LANDSLIDES, TSUNAMIS AND THUNDERSTORM HAZARDS AND VULNERABILITY, LANDSLIDE &THUNDERSTORM INCIDENCE MAPS, MEASURES AGAINST TSUNAMI HAZARDS

Landslides

and magnitudes. In India, the landslide prone areas represent a wide spectrum of topography, geology and geomorphic set up and thus cause landslides of varying types, magnitudes and failure mechanisms. All sorts of landslide failure mechanisms – deep-seated, shallow In India, landslides are perennial hazards in the hilly/mountainous terrains that directly inflicts irreparable losses of precious human lives and properties, including un-ending indirect miseries to the society at large. Landslides are caused mainly by two factors – pre-disposing causal geofactors and the triggering factors (e.g., rainfall, earthquake, sudden slope cutting etc.). The pre-disposing causal geo factors such as variation in topographic gradient, topographic shape, aspect (direction of slope), geomorphology and its prevalent processes, geology, structure, lithology of the overburden material, changes in land use, and land cover are the main controlling geofactors which are instrumental in causing the landslides, including its varying types of movements, material translational slides, flows involving varying material, movement type and magnitudes are observed in India (Fig. 1) which are strongly influenced by prevalent topography, geology and geomorphology of the terrain.

The landslides can be rapid or slow and occur in a wide variety of geological environs including under water. The secondary or domino/ cascading effects of landslides can also be very disastrous. Waves generated by landslides entering rivers, lakes, reservoirs and other water bodies have caused substantial damage to engineering and civil infrastructures in many parts of the world. The artificial landslide debris-dammed lakes can flood upstream areas and also on breaching can generate Landslide Lake Outburst Flow (LLOF) having enormous amount of discharge and energy that can suddenly trigger flash flood or inundation in downstream, low-lying areas and can also trigger many new landslides due to toe cutting and excessive rate of erosion by the flowing debris-laden flood discharge downstream along the narrow mountainous rivers. The examples of such type of cascading hazards are plenty in Indian Himalayas (e.g. the deluge of 2013 in Uttarakhand).In India excepting the permafrost terrain in the Himalayas, 12.6 percent of landmass (~0.42 million km2) in the mountainous/ hill regions are landslide prone spreading mainly over 18 States. The main landslide prone areas belong to the Himalayan States in the north occupying about 53% of landslide prone areas of India. In the Northeast, the Meghalaya plateau, the Tertiary hills of Assam, Mizoram, Manipur, Tripura and Nagaland occupies about 25% of the landslide prone landmass, and the rest 22% are occupied by the Western Ghats and Konkan Regions in States of Maharashtra, Tamil Nadu, Karnataka, Kerala, Goa respectively. In all the above 18 States, landslides with varying frequencies are reported. These landslides of varying magnitudes are mostly triggered by the high/ extreme rainfall events during monsoon (June-October in Northern and North-eastern States; July-August and November-March in the Western Ghats and Konkan Regions). However, many of the above landslide-prone areas in India, especially the Himalayas and Northeast India also belong to the maximum earthquake-prone areas (Zone-IV and V of Seismic Zoning Map given in IS 1893 (Part1):2002), where earthquakes of MSK VIII to IX or more can occur, and thus are also prone to earthquake-induced/ triggered

landslides. Amongst these18 landslide prone States, landslides are quite frequent in the Himalayan States like Uttarakhand, Jammu & Kashmir, Himachal Pradesh, Sikkim, West Bengal, and Arunachal Pradesh, followed by fragile Tertiary Hills in the North-eastern States and The Nilgiris in the southwest within the Western Ghats. In this revised version of Vulnerability Atlas of India, 9883 nos. historic landslide data, that have been mapped and field validated till 2016 by the Geological Survey of India (GSI) – the nodal department of landslide studies in India, are incorporated to depict the landslide vulnerability of the above mentioned States of India.

Fig. 1: Different types of landslides and failure mechanism that are prevalent in India

Tsunami

A tsunami is a series of waves with a long wavelength and period (time between crests). Time between crests of the wave can vary from a few minutes to over an hour. They are often incorrectly called tidal waves; they have no relation to the daily ocean tides. Tsunami (soo-NAH-mee) is a Japanese word meaning harbour wave. They can occur at any time of day or night.

Tsunamis are generated by any large, impulsive displacement of the sea bed level (Fig.2). Earthquakes

generate tsunamis by vertical movement of the sea floor. If the sea floor movement is horizontal, a tsunami is not generated. Earthquakes of Magnitude larger than M 6.5 are critical for tsunami generation. Tsunamis are also triggered by landslides into or under the water surface, and can be generated by volcanic activity and meteorite impacts

Source: International Tsunami Information Centre - Geologic Hazard

Fig.2 Wave train of Tsunami

Thunderstorm

Thunderstorm is a severe weather phenomenon, the impact of which is felt by all the sectors of society including aviation service; it occurs all over the world. In general, the orographically dominant regions as well as the coastal areas are more prone to thunderstorm activities. In Indian scenario, most thunderstorm prone area is north-eastern states and adjoining east India. Thunderstorm is popularly known as 'Nor 'westers' over these regions because most of them move from northwest to southeast over these regions. Frequency of thunderstorms is the maximum during pre-monsoon season (April-May). It is accompanied with lightning, squalls and sometimes heavy rain and hailstorms.

Squalls in association with thunderstorm occurs when wind speed significantly increases and last for short duration of time (at least one minute) with wind speed reach 22 kts or more. As per IMD criteria, squalls with surface wind (in gusts) up to 80 kmph are known as "moderate squall", greater than 80 kmph as "severe squall" and greater than 100 kmph as "very severe squall" due to their appreciably more damaging effects.

11.6. HOUSING VULNERABILITY RISK TABLES AND USAGE OF VULNERABILITY ATLAS OF INDIA, INCLUSION OF VULNERABILITY ATLAS IN TENDER DOCUMENTS.

HOUSING VULNERABILITY TABLES

House Types

The Census of Housing, 2011 Census of India, gives the following details of houses based on materials of construction for walls and roofs:

a) Type of Roof:) Pitched or sloping including tiles, stone/slate; corrugated iron, zinc or other metal sheets; asbestos cement sheets; plastic polythene, thatch, grass, leaves, bamboo, etc.

ii) Flat including brick, stone and lime; reinforced brick concrete/reinforced cement concrete.

b) Type of Wall:

i) Mud, unburnt bricks, stone packed and not packed with mortar

ii) Burnt bricks laid in cement, lime or mud mortar

iii) Cement concrete

iv) Wood or Ekra walling

v) Corrugated iron, zinc or other metal sheets

vi) Grass, leaves, reeds or bamboo or thatch, plastic polythene and others

c) Type of Flooring:

Various types like mud, stone, concrete, wood or bamboo, mosaic floor tiles, etc. The distribution of houses based on Predominant materials of roof and wall over whole of India according to 2011 Census is shown in Table-3. From the point of view of vulnerability to the earthquake, wind or flood hazards, it was seen that the type of flooring had hardly any significance, hence omitted from consideration, and that the roof types and wall types could not be grouped together. The appropriate grouping for the whole

of India is shown in Table-4, wherein the wall and roofing groups are categorized as follows:

Wall Types

Category - A: Buildings in field-stone, rural structures, unburnt brick houses, clay houses

Category - B: Ordinary brick building; buildings of the large block and prefabricated type, half- timbered

structures, building in natural hewn stone

Category - C: Reinforced building, well-built wooden structures

Category - X: Other materials not covered in A, B and C. These are generally light structures.

Roof Types

Category - R1: Light Weight (Grass, Thatch, Bamboo, Wood, Mud, Plastic, Polythene, GI Metal, Asbestos

Sheets, Other Materials)

Category - R2: Heavy Weight (Tiles, Stone/Slate)

Category - R3: Flat Roof (Brick, Concrete)

With these groupings, the vulnerability of each subgroup could be defined separately for any given intensity of earthquake, wind or flood hazard. The risk levels of the various categories of houses for the three hazards are shown in Table-5, and explained in the following sections.In the 1991 Census of Housing, roof and wall combinations were available for each house type. Therefore,

the combined vulnerability of the complete house was indicated which is not possible for the data available in Census of Housing 2001 and 2011. For convenience of reference to those

who may be studying existing houses taking wall and roof together Table 5A is reproduced from Vulnerability Atlas of India 1991