Construction Management

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Chapter- 1 Introduction to construction management

Management

Management is the art of getting things done through others. It is an activity which co-ordinates the human and non-human resources (men, material, machines etc.) for achieving the desired results. According to F. W. Taylor- "Management is an art of knowing what is to be done and seeing that it is done in the best possible manner."

Construction management

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

Needs of construction management

- For effective project management and handling.
- For reducing delay due to human and non-human reason and hence increasing the efficiency.
- To ensure that the project in on the budget.
- To ensure quality control at different stages.
- To improve and ensure safety at site with better working condition.
- To avoid disputes among the team.
- To make the project economical
- To avoid the wastage of resources.
- To motivate the peoples to give their best working outputs

Construction management responsibilities

Construction management is in charge of building sites. Their responsibilities vary depending on the project and company, but here are some of their most common responsibilities:

1. **Managing costs**: Construction management is in charge of setting a budget and ensuring that they complete the project within their financial expectations.
2. **Quality assurance**: Construction managers make sure that subcontractors and contractors are completing their tasks completely and up to codes and regulations.
3. **Contract oversight:** These professionals ensure that contracts are fulfilled and that everyone involved in the contract is satisfied with the project. This could include giving time and financial quotes for changes that the client requests.
4. **Safety management:** Construction managers make sure to find and minimize hazards on construction sites for employee safety. They also ensure that team members carefully follow safety regulations and guidelines on site.
5. **Communication:** As project leaders, construction managers are often the primary contact for everyone involved, and they ensure that everyone is informed about expectations and changes.
6. **Permitting and paperwork:** Construction management tracks and handles all the paperwork and permits required to have construction projects in compliance with federal, state and local regulations.

Construction management functions

Here are the functions of construction management:

- **Planning:** A construction manager uses planning to optimize resource use, reduce conflicts and solve problems creatively.
- **Scheduling:** Construction managers determine how much time the total project will take, tracking labor hours and how long each stage will take.
- **Organizing:** Management professionals divide the construction project into departments and assign specific tasks to individual team members.
- **Staffing:** An important function of construction managers is to ensure employees are assigned to departments and tasks that are best suited to them.

- **Directing:** Construction managers train, support and correct employees so their tasks are completed entirely and correctly.
- **Controlling:** They compare active achievements to the project plan and make adjustments to meet deadlines and objectives.
- **Coordinating:** Construction managers make sure each department understands their role, what kind of help they can expect from each other and have clear communication about plan changes.

Function of construction management

1. **Planning and scheduling**
   Planning and scheduling are two important steps in project development that allow companies to develop the project's goals and deliver quality results. It is the first step to develop a new project. During the scheduling phase, companies examine their resources and determine which ones are necessary to complete the project's goal. Planning majorly covers "what to do" and "how to do" The major steps of planning and scheduling are
   - Establishing project scope
   - Develop the action plan
   - Determine resources
   - Create the schedule
2. **Organizing**
   Organizing can be defined as a process that initiates implementation of plans by clarifying jobs, working relationships and effectively deploying resources for attainment of identified and desired results (goals). Organizing involves the following process:
   - Identification and grouping of activities
   - Assignment of duties
   - Delegation of authority and creating responsibility.
3. **Staffing**
   It is the process of managing the organization structure. The staffing function includes recruiting, selecting, appointing, training, appraising, and maintaining employees in the organization. The main idea behind the staffing function is to hire skilled employees in the organization on the basis of the requirement to achieve defined goals.
4. **Directing**
   Direction is an aspect of management that deals directly with influencing, guiding, supervising, and motivating staff for the achievement of organizational goals Directing Elements
   - **Supervision:** To oversee the work of staff. Supervision is the act of coaching, reflecting, and directing work and workers.
   - **Motivation**: To inspire, stimulate, and encourage staff.
   - **Leadership:** To guide and influence the work of staff in a purposeful direction
5. **Controlling**
   The meaning of controlling function can be defined as ensuring that activities in an organization are performed as per the plans. Controlling also ensures that an organization's resources are being used effectively & efficiently for the achievement of predetermined goals. Some of the parameters of controlling are
   - Cost control
   - Time control
   - Quality control
6. **Co-ordination**
   It is most necessary part that a project needs. The convey of message or task from managerial to workers needs coordination among the project staff. Coordination is integral element of all the managerial function. Coordination through planning, organizing, staffing, directing and controlling is needed.

Project

A project is a series of individual or collaborative task that is carefully planned to achieve a particular set of goals. A project is defined as a specific, finite activity that produces an observable and measurable result under certain preset requirements.

Objective/Goals of project Each and every project has a objective which is responsible for achieving the goal. The major objectives of a project are SMART

1. Specific: unique well defined
2. Measurable: as we can be certain that we got what we want, can be measured the end results and can compare.
3. Achievable: can be achieved
4. Realistic: not a ideal
5. Time bounded: bounded by a certain time frame.

Characteristics of a project

A project has following characteristics

1. **Objective**: A project has clearly defined specific objective. No project exists without any objectives. The objectives must be measurable, realistic, time bounded.
2. **Lifespan:** project must have a specific time. Its beginning and ending must be well known. From lifespan we can be sure that a project is short or long. All project is temporary so they are time bounded.
3. **Unique:** Every project is unique in their own terms. No two project are same in all aspects. People, place, infrastructure, tools and equipment's, series of activity makes project different form others.
4. **Teamwork:** A project consists of workers of different designation from project manager to the security guard. The collaboration and coordination of different workers makes a project successful. So, the teamwork is necessary among people of different discipline, department and experience.
5. **Scheduled:** A project has schedule in different terms like time, cost, materials etc. variety of resources needed to be committed on the project and step by step action is needed for commencement of the project. A well scheduled project gives the time of completion of a project, materials needed, manpower needed in fact overall project got economized.
6. **Resources:** A project comprise of resources which makes it complete. Resources: 5M
    - ☞ money
    - ☞ materials
    - ☞ manpower
    - ☞ machine
    - ☞ minute (time)

chapter- 2 Project planning and Scheduling

Planning

Planning is the mental process of deciding the future activities to achieve the personal as well as organizational goal. It is the most important part for a project to achieve its target as it is the first step Normally planning is done to eliminate the future risk and deficiency or resources.

Principle of planning

- The plan should be understandable.
- The plan must be realistic.
- The plan must be flexible.
- The plan must be comprehensive.
- The plan should incorporate the system of monitoring and controlling.

Planning is done

- Eliminate or reduce uncertainty.
- Improve the efficiency of the plan.
- Better understanding the objectives and goal of the project.
- Provide a basis of monitoring.

Importance of planning

Following are the key importance of planning

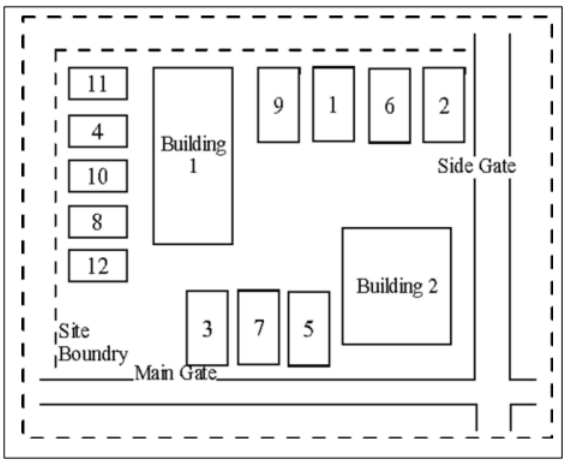
1. To make the objective clear planning makes the goal clear and specific, as the goals are set after planning
2. Reducing risk and uncertainty Planning helps in predicting the future events and also helps to analyses the event along with the risk on it.
3. Making plan economic Pre planned projects are economical in sense of time money and resources. Helps to complete the project in time.
4. Provide the basis of control planning provides the standards, specification which can evaluate the performance of the project.
5. Facility for decision making planning is the most important step for making decision whether to proceed or to hold or stop. Helps to decide in every activity.
6. Makes easy coordination well planned projects helps in coordination among each other as well as others
7. Reducing of conflict If the project is well planned the conflicts at various stages are reduced.

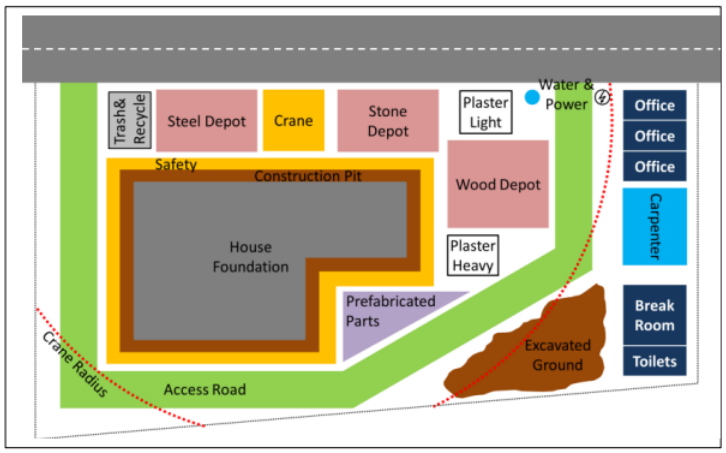
Steps in planning

Construction site planning

Site planning is the art of arranging structures on the land and shaping the spaces between, an art linked to architecture, engineering, landscape architecture, and city planning. It refers to the site preparation and arrangement of facility for construction. The basic requirement for construction must be placed in such a way that

- Machine are placed in most advantageous or most used place.
- Materials are placed/stored near their utilization area
- Site circulation with access road and site accommodation





Factors to be considered in construction site planning

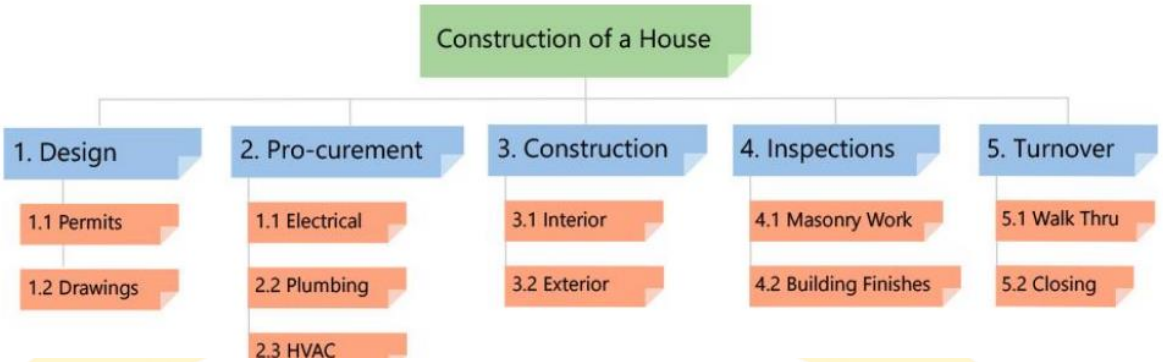
- Access to the site.
- Storage of materials.
  - Cement bag should be kept in a raised platform with covering, 30cm away from walls and stack should not exceed 12 bags.
  - Bricks, tiles and concrete blocks are stacked at ground level maximum height of stacking is 2m.
  - Flammable materials should be kept away from others which are supposed to be protected from fire.
  - Explosives are kept safe.
  - Rebar is placed away from moisture preventing corrosion.
  - Commonly used materials are kept near the working area.
  - Cement should be kept constantly moving using FIFO method.
- Location of machineries.
  - For costly equipment's the temporary shed must be provided.
  - Equipment's should be kept in maximum utilization area.
  - Adequate space and parking facility must be provided.
- The main office should be provided near the entrance.
- Guard room must be provided at entrance for security provision.
- Accommodation should be provided for site staffs.

Work breakdown structure

Work breakdown is a concept in which the large and tedious works are break down in small and easy pieces of work which are much convenient to plan and operate. The concept behind WBS is that a person is competent in a individual skills rather than a work of multiple skills. The formation of work is divided into number of works and it is further subdivided into number of works which makes work to be done in easy manner and also to monitor and control the work in a systematic way with competency.

Generally, the project manager is responsible for work breakdown structure formation should be such that

- Risk Management, Resource Management, Task Management and Team Management
- Project Planning, Project Scheduling and Project Budgeting.



Advantages of work breakdown structure

- Planning can be performed
- Costing and budgeting
- Risk analysis can be done
- Monitoring and control can be done
- Schedules can be prepared
- Coordination can be established.

Bar chart

Bar chart is the oldest planning and scheduling tools. It is developed by Henry Laurence Gantt (1917), an American mechanical engineer, so called Gantt chart. However, many sources consider William Playfair (1759-1824) to have invented the bar chart. It is the most traditional, conventional method and most used method till today. Generally, bar chart provides a series of activities/task which have graphical illustration. It is useful for planning and control functioning.

Advantages of bar chart

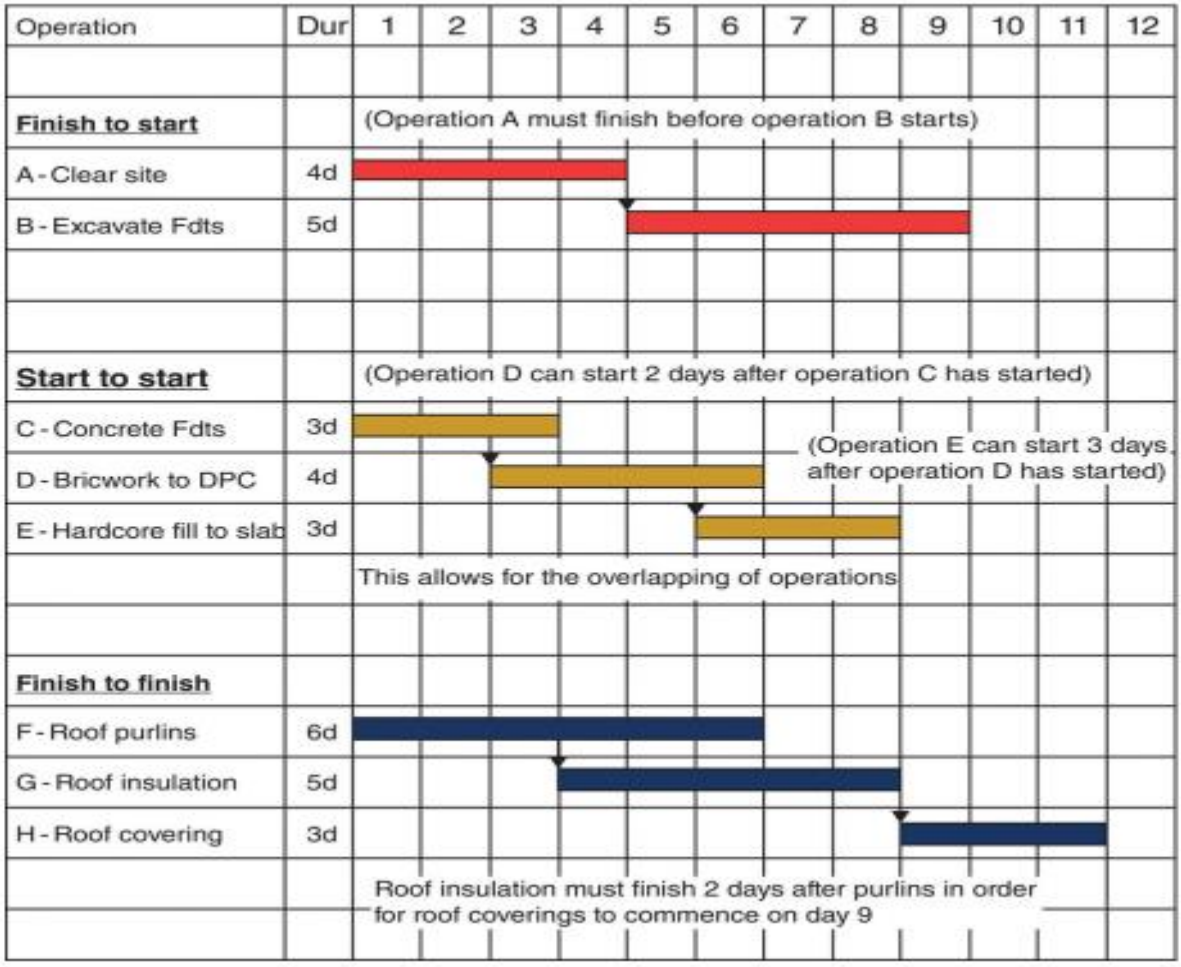
1. Simple and easy to prepare, read.
2. The start and end dates are predefined.
3. Very easy to compare the actual work with prepared schedule.
4. Bar chart shows simple and easy graphs of different activities which are easily understood able to common people. 5. Bar chart shows a picture of a plan and comparative progress.
5. It can be used for resources planning such as materials planning, manpower planning, budgeting etc.
6. It gives a clear pictorial model of a project.

Disadvantages of bar chart

1. It is not considered to be suitable for large projects.
2. It is difficult to show critical path, critical activities.
3. Data is hard to manipulate, cannot easily cope with frequent changes or updating.

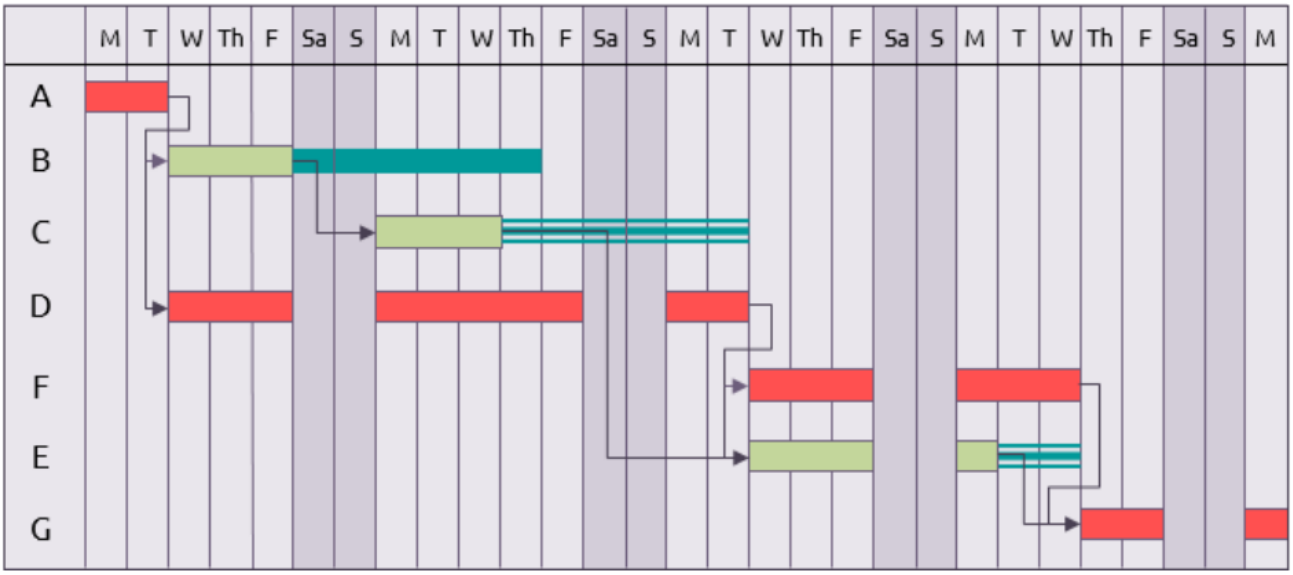
Method of preparation of bar chart

1. The activities involved for the project are determined in a sequential manner.
2. Put the activities in a time frame considering the resources available.
3. Note the date of start of that activity and other sequential activities.
4. Draw a bar for the start date to end date of the activity with time scale.
5. The duration of the particular activity was indicated.



Linked bar chart

A link bar chart is modified version of a bar chart which uses arrows and lines to tie the activities in a sequential form specifying the predecessors and successors. The previous activities are linked one to another to demonstrate that one activity must be completed before the other activity can start. It somehow overcomes the limitations of bar chart as there is no linkage between the predecessors and successors activities. It is also complex to design and study for large project so suitable for small projects.



Milestone chart

A milestone chart is improved form of Gantt chart which uses milestone. Milestones are one which shows the relationship between different activities. Milestones are generally represented by a triangle, dot, flag and other representation. It overcomes the disadvantages of linked bar chart as no line need to be drawn. So it can be used in large project of multiples activities.

Scheduling

Scheduling is the process of arranging the various activities as per the scheduled time so that the project can complete in the given time frame. A construction schedule is a graphical representation which shows the construction progress with start and end dates in a sequential manner.

Why scheduling?

- ⇨ The quantity of work involved, labor, equipment's, materials and money can be determined.
- ⇨ The actual progress of the work can be monitored and controlled time to time
- ⇨ The project can be carried out in a systematic manner.

Why construction schedule?

Following are the advantages of construction schedule:

- ⇨ By studying the schedule of work, alternative methods of execution can be examined and the most economical method can be selected. Further, the effect of likely constraints can be evaluated at the planning stage.
- ⇨ It gives a clear picture of quantity and type of materials, manpower, machines at different stages of construction
- ⇨ As the time of starting of an activity is known, the arrangements of adequate resources can be done in advance
- ⇨ The resource utilization can be optimized
- ⇨ The actual progress of each activity can be evaluated with reference to the planned program
- ⇨ The interrelationship between the activities is known hence their priorities can be set up
- ⇨ Application of value engineering can be adopted.

Preparation of construction schedule

Before preparing the construction schedule, the following information must be known

- ⇨ Various operations to be done in a particular project
- ⇨ Quantum of works to be done in each operation
- ⇨ Unit of measurement
- ⇨ Rate of the progress of work with a due allowance of weather conditions
- ⇨ Number of labors required
- ⇨ Number and types of plants and equipment required
- ⇨ Date of starting and completing the activity
- ⇨ Correlation between different operations.

The procedure for preparing the construction schedule is as follows:

- ⇨ The work or project is divided into the number of operations and their interdependence or relationship is studied.
- ⇨ After the careful study of their interdependence, the sequences of operation is decided
- ⇨ The quantity of work involved in each operation is determined
- ⇨ The time required for the completion of each operation as well as the completion of the total project is determined.

Materiel Schedule

Project Name …… Year ……

Project ID …… Location ……

S.N.	Description of material	Quantity	Month			
			I	II	III	IV

Labor Schedule

Project Name …… Year ……

Project ID …… Location ……

S.N.	Description of labor	Time required	Month			
			I	II	III	IV

Equipment Schedule

Project Name …… Year ……

Project ID …… Location ……

S.N.	Description of equipment's used	Total no required	Time of operation	Month			
				I	II	III	IV

Chapter-4 Contract administration and account

Contract

A contract is a legal document/agreement between two or more than two parties whether to do or not to do in any business, service or work which can be enforceable by law.

In short, a contract is a process of shifting responsibilities of execution of work through third party. When two or more people are required to perform a job, there occurs and understanding among them for doing and not doing the job or task by binding each other, the binding document is known as contract.

Essential/Elements of valid contract

- ⇨ Offer and acceptance
- ⇨ Free consent
- ⇨ Legal relationship
- ⇨ Lawful consideration
- ⇨ Possibility of performance
- ⇨ Competent parties
- ⇨ Certainty
- ⇨ Written

1. **Offer and acceptance:** A one person must offer and another must accept the contract to be valid. Any party can reject the contract if mentioned terms and condition of contract are not suitable for the party to accept.
2. **Free consent:** To be a valid contract it should not be involved in fraud, undue influence, deceit.
3. **Legal relationship:** A contact must hold the legal relationship between the parties.
4. **Lawful consideration:** A contract must not cross the country law, otherwise it get invalid by law.
5. **Possibility of performance:** A impossible contract is not valid. (e.g. If a contract is done to build a house in air, which is practically impossible).
6. **Competent parties:** The party which do not have a authority to perform the task must not perform the task.
7. **Certainty:** the contract which cannot be carried out because of various reasons (vague/ambiguous, etc.) is not valid.
8. **Written:** A written contract is valid rather than verbal because it carries out all the terms and condition to be followed by all parties involved in it.

Types of Contracts

Two or more parties can enter into the contract as per types project. According to the public procurement act 2063 and public procurement regulations 2064 contract has been categorized as follows:

⇨ Lump-Sum Contract

This type of contract is the one in which the contractor based on the available complete set of plans and specifications quotes one single price which covers all works and services required by the contract plans and specifications. The lump-sum price includes all direct costs of the contractor for labor, machines, materials and indirect costs such as field and front office supervision, secretarial support and equipment maintenance and support costs and also includes the profit of the contractor. The contractor agrees to perform a stipulated job of work in exchange for a fixed sum of money. In other words, a single tendered price is given for the completion of a specified work to the satisfaction of the client by a certain date.

Advantages

- ⇨ Actual cost of the construction is known before the project is completed.
- ⇨ Accounts and record keeping are not necessary
- ⇨ All the planning and profit will be the contractors own

Disadvantages

- ⇨ For large and complicated works, it is not suitable
- ⇨ For project having possibilities of addition and alternation during implementation this is not suitable.

Item rate or unit price contract

In this type of contract, contractor agrees to execute the work on the item rate or unit price basis. Construction work is divided into several activities and rate is fixed for each unit of such activities. It is suitable for those types of work which can be broken down into several activities and measurements of quantity are possible.

Advantages

- ⇨ Saving the heavy cost of preparing the bills of quantities by the contractor.
- ⇨ Contractor is paid for the actual work done at agreed rates.
- ⇨ Fair basis for competition
- ⇨ Unanticipated and extra work can be performed easily

Disadvantages

- ⇨ Actual cost of the project will be unknown until the project is completed.
- ⇨ Up to date account and record keeping are necessary
- ⇨ Possibility of submitting unbalanced tender by a contractor.

Cost plus contract

Under this procedure contractor is paid for the actual work performed at an agreed percentage of fixed sum or a fluctuating fee to the contractor.

Following are common fee structure in cost plus contract

a) Cost + percentage of cost
b) Cost + fixed fee
c) Cost + fixed fee + profit sharing
d) Cost + sliding fee

Advantages

- ⇨ It has advantage of early completion of work, good quality of a work and eliminates the dispute arising due to extra work
- ⇨ This type of contract is considered suitable for the world in emergency situation

Disadvantages

- ⇨ Final cost of the project is not known until the project is completed
- ⇨ Detail account keeping is necessary.

Target contract

In this type, first a target of cost for execution of the work is fixed. Then if the word is completed as per target contractor is paid the targeted amount at agreed percentage. In addition to this contractor receives a percentage plus or minus on saving or on extra expenditure of the targeted value.

5. BOOT contract

Build-own-operate-transfer (BOOT) or Build-operate-transfer (BOT) or BOO (Build Own-Operate) is a form of project financing, wherein a private entity receives a concession from the private or public sector to finance, design, construct, and operate a facility stated in the concession contract. The major components of a BOOT Project include:

- ☞ **Build:** Design, manage, project implementation, procurement, construct and finance
- ☞ **Own:** Own the asset for the concession period and the license for the equipment used.
- ☞ **Operate:** Manage and operate plant, carryout maintenance, deliver product or service and receive off take Payments.
- ☞ **Transfer:** Handover plant in operating condition at the end of the concession period.

Advantages

- ⇨ Promotion of private investment.
- ⇨ Completion of projects on time without cost overruns.
- ⇨ Good management and efficient operation.
- ⇨ Transfer of new and advanced technology.
- ⇨ Utilization of foreign companies' resources.

Example: khimti hydropower, cargo complex at TIA, city parking etc.

Information given in a tender notice

Tender Notice

Tender notice is the information of inviting bids from competent contractors. It should be widely published in important daily newspaper. When all the preliminaries i.e. development of project have been completed and owner has decided to proceed with the work, tenders are invited.

Detail information in Tender Notice

- The name and address of the Public Entity inviting bid
- Date of first date of publication
- Nature of work and its location
- The place of delivery of the goods to be supplied, the services to be delivered and the construction work to be performed
- The amount of bid security and validity period of the bid
- Date, time and place where and when the tender document is available
- Cost of tender document
- The place, manner, deadline for the submission of the bidding documents
- Provision of e-bidding and its process
- The place, date and time for the opening of bids
- Expected date of acceptance of successful bids etc.

In publishing a notice for invitation of national level bidding, a period of at least 30 days shall be given and at least 45 days shall be given in the case of international level bidding. The bidding documents shall have to be made for obtaining from two or more than two public entities.

Sample tender notice

LUCKNOW CANTONMENT BOARD
31, Nehru Road, Lucknow Cantt
Ph: 0522-2480037, Fax- 0522-2480610

TENDER NOTICE

Online tenders through two bid system are invited from the Contractors having work experience in MES/ Cantt. Board/Central or state government departments through the Government e-procurement portal http://eprocure.gov.in/cppp/ by the Cantonment Board, Lucknow for one year contract for Supply & Installation of street light poles, fitting, P.A. System and other electrical accessories at Kasturba Road, Cantt Lucknow.

Sl. No.	Name of the Contract/Tender	Estimated Cost	Earnest Money	Cost of tender form
1.	Supply & Installation of Street light poles, fittings, P.A system and other electrical accessories at Kasturba Road Cantt Lucknow	Rs 89.90 Lacs	Rs. 179800/-	Rs .1500/-

The period of Contract will be one year from the date of commencement of the Contract Agreement. Bidders may download the "Tender Document" and the other terms and conditions as available on the website http://eprocure.gov.in/cppp/

S.N.	Activity	Date	Time in IST
1.	Date of Tender published on http://eprocure.gov.in/cppp/ and in news paper.	18.09.2017	10:00 AM
2.	Bid Document Download / sale start date	22.09.2017	10:00 AM
3.	Bid submission start date	25.09.2017	10:00 AM
4.	Bid Documents Download / Sale End date	10.10.2017	05:00 PM
5.	Bid Submission End Date (Technical as well as Financial)	10.10.2017	05:00 PM
6.	Technical Bid opening Date	12.10.2017	10:30 AM

No. LCB/05/E/M/Walking Plaza/2017
Office of the Cantonment Board
Lucknow, Dated 16 Sept 2017

(N.V. Satyanarayana)
Chief Executive Officer
Lucknow Cantt.

Tender document

Bidding Document is a document prepared by the concerned firm making invitation to bid for submission by bidders by filling up the price or rate. This includes instructions to bidders, specifications, drawing, design, terms of reference, schedule of work, evaluation criteria, bill of quantities, conditions of contract and similar other documents. Matters to be stated in Bidding Documents. The below listed format is based on the PPMO's 1S2E in NCB bidding procedures for Procurement of Works.

- Invitation for bids (not a part of bidding document)
- Bidding Procedures
  - Instruction to Bidders
  - Bid Data Sheet
  - Evaluation and Qualification Criteria
  - Bidding Forms
    - Letter of Technical Bid
    - Letter of Price Bid
    - Table of Price Adjustment
    - Format of Bid Security
- Eligible Countries
- Employer's Requirement
  - Scope of Works
  - Specifications
  - Drawings
  - Supplementary Information
  - Bill of quantities
- Conditions of Contract
  - General Conditions of Contract
  - Special Conditions of Contract
- Contract Forms
- Format of Letter of Intent
- Format of Letter of Acceptance
- Format Contract Agreement
- Format of Commitment for Bank's Undertaking for Line of Credit
- Format of Performance Security
- Format of Advance Payment Security

Bid bond/bid security/earnest money

During the tender process a certain amount of money is deposited as a guarantee of the party willing to work out the job. In Nepal the bid security amount is kept 2-3% (2.5%) of estimated amount. The bid bond is kept before the award of tender and the unsuccessful bidder are refunded. If a successful bidder fails to carry out the contract the amount is forfeited.

Performance security

It is the amount of money deposited by the successful bidder as a security for satisfactory performance. The extra 2.5% of total estimated amount is kept for security deposit. This is refunded after the completion of defect liability period. If the work is not satisfactory or contractors fails to perform the amount is forfeited. In Nepal it is 5% for Nepali firm and 10% for foreigner contractor.

Contract documents

The project Manager/Division Chief shall ensure that all provisions in the bidding documents and any additional provisions agreed upon with the bidder are complied with before signing the agreement. A contract may consist of number of documents which contain collectively all the essentials of contract and which are usually linked together by cross-reference. Engineering contract document usually contains the following:

- ✓ The Letter of Acceptance;
- ✓ The Letters of Technical and Price Bid
- ✓ The Special Conditions of Contract;
- ✓ The List of Eligible Countries as specified in the bidding document,
- ✓ The General Conditions of Contract;
- ✓ The Specification;
- ✓ The Drawings;
- ✓ The Bill of Quantities (or Schedules of Prices for lump sum contracts), and
- ✓ Table of Price Adjustment Data
- ✓ List of Approved Subcontractors for GoN funded
- ✓ Any other document

Condition of contract

Any contract is bounded by the certain terms and condition of between the parties that bind them to reach to an agreement. Those terms and references are known as condition of contract. The main function is easy and smooth functioning of work and minimizing disputes. Generally, these are classified into two categories.

1. General condition of contract
2. Special condition of contract

Some of the common conditions of contract are:

1. Definition of term of use

The terms used in the contract documents like client, contractor must be clearly defined so that misunderstanding and misinterpretation cannot be made.

2. Contract duration

The work must be finished in a specified time as the time is important factor governing economy. So contract duration must be clear and if delayed, the particular party will be responsible.

3. Engineers' duty and authority

The authority and duty given to a engineer must be clearly specified so as to bound him by work, not creating interference.

4. Payment procedure

The contractor must be paid time to time as per condition so as to easy and smoth operation of work.

5. Security deposit

The security deposit amount is taken from contractor and refunded at the end of defect liability period and forfeited if the contractors fails to work. The fact must be clearly stated.

6. Defective work

The work shall be executed as per design drawing and specification under supervision of engineer. If the works got defective the owner can ask to re-execute the work or a compensation for the defective work.

7. Addition and alternation

Some works are added and some works needs to be changed in some situation. In such cases there must be provision of such activities in the contract.

Supervising the work of contractor

To ensure the work are carried out at an acceptable level of quality, the supervision is very important. It is often found that the contractor tries to save money which compromises the quality of work. In order to prevent this deviation of quality of work site supervision is very necessary.

A good supervision team includes:

- ⇨ Chief engineer/project manager
- ⇨ Deputy engineer
- ⇨ Site engineer
- ⇨ Site supervisor
- ⇨ Material engineer

Objectives of supervision

- ⇨ The progress of work is regularly monitored.
- ⇨ The quality of the work can be examined.
- ⇨ The progress of work is checked as per schedule periodically.

- ⇨ Periodic discussion and meeting on the ongoing work can be done
- ⇨ The work, materials, equipment can be tested to be in working condition.
- ⇨ The health and safety of the workers can be ensured.

Duties and responsibilities of site supervisor

Duties

a) Plan the execution of work
b) Divide the work among the workers and direct, assist them.
c) Improve working methods and procedure.
d) Improve own knowledge and train the juniors
e) Evaluate the performance of the employee.
f) Correct the mistakes and problems and develop discipline among them.
g) Keep the information of work and forward it to the higher authority.
h) Prepare the testing of materials at site
i) Ensure the correct implementation of work as per schedule and specification.
j) Check and ensure the site management plan.
k) Prepare the list of critical items.

Responsibilities

a) Responsible for all the work to be executed.
b) Responsible for information between higher authority and sub ordinate
c) Responsible for better coordination and improving sound and healthy environment at site.
d) Responsible for quality control and to ensure the actual work to be done as per specification.
e) Responsible for making the activities/project economical.

Site Order Book (Site Instruction Book)

A Site Order Book is a register properly certified by the Client regarding number of pages it contains, each page being numbered, Name of work, name of contractor, reference of contract/work order etc. Site Order Books shall be maintained on the sites of works and should never be removed there from under any circumstances. The Engineer-in-Charge or his authorized representative shall properly record his observations regarding any work which needs action on the part of the contractor like improvement in the quality of work failure to adhere to the scheduled program etc. as per contract agreement/work order. The contractor shall promptly sign the Site Order Book and note the orders given by the Engineer-in-Charge or his representative and comply with them. The compliance shall be reported by the contractor to the Engineer in Charge or his authorized representative in time so that it can be checked and recorded.

A sample of site order book

Name of project……. Contract ID…….
Name of implementing agency……
Name of contractor……

Site Order Book

SI.NO	Date	Instruction issued on the Inspection of work with signature and design	Contractors/contractor's representative acknowledgement with signature name and Date	Compliance report by contractor/ contractor's representative with signature Name, Date	Final remarks of site engineer with signature, designation and date
1	2	3	4	5	6

Materials at site account

The execution of any construction project involves procurement or materials, tools, plants, equipment etc. Certain materials are procured by Contractor while others may be supplied by the owner in compliance with the contract conditions. All these materials need to be accounted for, to plan their further procurement as well as to know the balances at any time and at the end of the contract. The unused materials belonging to the owner are required to be returned on completion. The Material at Site Accounts give an idea of consumption of materials in the project which can be cross checked from the estimates to find out that right quantities of materials have been incorporated in the work as per specifications. In order to keep account of consumption, a "Register" is maintained at site which describes date wise the voucher number, total quantity received, location of work where consumed and quantity consumed, thus enabling it to work out the balance in hand daily, at site which can be physically checked and signed by both parties. A typical format of "Register for Daily Cement Consumption is shown below:

Sample: Register for daily cement consumption

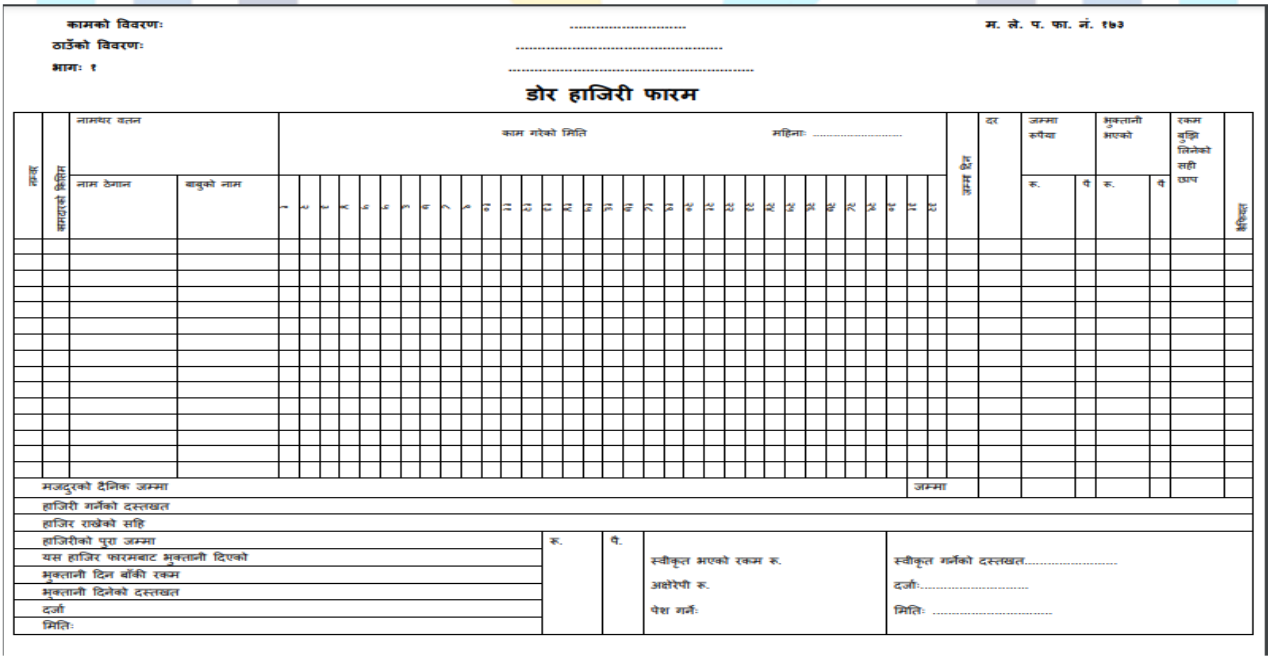
Name of Project ……..
Contract ID …….
Name of Contractor ……...

Date	consumption			Blanca in hand in contractor's Go-down	Signature			
	Qty in bag	Location of works	Qty consumed		Site Engineer	In-charge	Contractor	Remarks

Muster roll

Muster Rolls actually the register of employee data which is usually kept in the factory or establishment. Muster Roll is commonly used in the department to make payment to the labor engaged in daily wages. It should be clearly maintained as payment to the labor is done on the basis of this roll. It usually consists of the following:

Name of employee ……..
Age …….
Sex ……
Date of joining …….
Roll/Employee number……
Type of employment: Regular/ Contract /Casual etc.
Category (Designation): Management/Supervisor/Skilled/Semi Skilled Unskilled
Rate of payment
Shift (if applicable)
Attendance



कामको विवरण: ..... म. ले. प. फा. नं. १७३
ठाउँको विवरण: .....
भाग: १ .....

डोर हाजिरी फारम

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			अक्षरेपी रु.	दर्जी:.....
			पेश गर्ने:	मिति: .....

Measurement book

Measurement book is a book of record of periodic measurement of completed works prepared jointly by the representatives and properly checked and verified. It is an important book on construction in which work executed is recorded regularly and periodically. Contractor is paid at certain interval on the basis of running bills prepared from measurement book.

Sample of MB

Location …… Starting date ……
Item number …… Completion date ……
Description of work …… Date of measurement ……..

S.N	Item of work	Unit	Measurment			Total quentity	Remarks
			L	B	H		

Measurement taken by ……..
Checked by ……

Contractors
Representative……
Approved by ……..

Chapter- 5 Quality

5.1.Introduction

Quality refers to how good something is compared to other similar things. In other words, its degree of excellence Quality could be defined as a basic tool for a natural property of any good or service that allows it to be compared with any other good or service of its kind.

- Quality is not a grade
- Quality cost more but lack of quality costs even more
- Quality is not a goal but it is the path to success
- For better quality proper planning and implementation is necessary.

5.2.characteristics of quality

Eight dimensions quality (Characteristics) can be used at a strategic level to analyze quality characteristics.

Performance: Performance refers to a product's primary operating characteristics. This dimension of quality involves measurable attributes, brands can usually be ranked objectively on individual aspects of performance.
Features: Features are additional characteristics that enhance the appeal of the product or service to the user.

Reliability: Reliability is the likelihood that a product will not fail within a specific time period. This is a key element for users who need the product to work without fail.

Conformance: Conformance is the precision with which the product or service meets the specified standards.

Durability: Durability measures the length of a product's life. When the product can be repaired estimating durability is more complicated. The item will be used until it is no longer economical to pirate it. This happens when the repair rate and the associated costs increase significantly.

Serviceability: Serviceability is the speed with which the product can be put into service when it breaks down, as well as the competence and the behavior of the serviceperson.

Aesthetics: Aesthetics is the subjective dimension indicating the kind of response a user has to a product. It represents the individual's personal preference.

Perceived Quality: Perceived Quality is the quality attributed to a good or service based on indirect measures.

5.3. Factors affecting Quality

The nine fundamental factors (9 M's), which are affecting the quality of products and service are:

Market: Because of technology advancement, we could see many new products to customer wants. At the same time, the customer wants are also changing dynamically So it is the role of companies to identify needs and then meet it with existing technologies or by developing new technologies.

Money: The increased global competition necessitates huge outlays for new equipment's and process. This should be rewarded by improved productivity. This is possible by minimizing quality costs associated with the maintenance and improvements of quality level.

Management: Because of the increased complex structure of business organization, the quality related responsibilities lie with persons at different levels in the organization.

Men: The rapid growth in technical knowledge leads to development of human resource with different specialization. This necessitates some groups like, system engineering group to integrate the idea of full specialization.

Motivation: If we fix the responsibility of achieving quality with each individual in the organization with proper motivation techniques, there will not be any problem in producing the designed quality products.

Materials: Selection of proper materials to meet the desired tolerance limit is also an important consideration. Quality attributes like, surface finish, strength, diameter etc., can be obtained by proper selection of material.

Machines and mechanization: In order to have quality products which will lead to higher productivity of any organization, we need to use advanced machines and mechanize various operations.

Modern information methods: The modern information methods help in storing and retrieving needed data for manufacturing, marketing and servicing.

Mounting product requirements: Product diversification to meet customers taste leads to intricacy in design, manufacturing and quality standards. Hence, companies should plan adequate system to tackle all these requirements.

5.4. Stages of quality control

The different stages of quality control are:

Stage I: Product oriented

- ⇨ Inspection after production.
- ⇨ Audits of finished product.
- ⇨ Problem solving activities.

Stage II: Process oriented

- ⇨ Quality assurance/control during production.

Stage III: System oriented

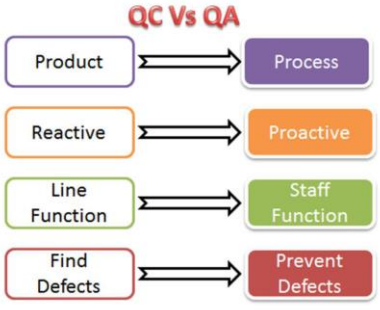
- ⇨ Quality assurance involving all departments.

Quality Control

Quality Control is the operational techniques and activities that are used to fulfill requirements for quality. Quality Inspection is done first for quality control. Activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing these with specified requirements to determine conformity is quality inspection.

Quality Assurance

QA is applied to physical products in pre-production to verify what will be made meets specifications and requirements, and during manufacturing production runs by validating lot samples meet specified quality controls. QA is a way of preventing mistakes or defects in manufactured products and avoiding problems when delivering solutions or services to customers, which ISO 9000 defines as "part of quality management focused on providing confidence that quality requirements will be fulfilled"



S. N	Quality Control	Quality Assurance
1.	QC is a process which deliberates on fulfilling the quality request.	It is a process which deliberate on providing assurance that quality request will be achieved.
2.	A QC aim is to identify and improve the defects.	A QA aim is to prevent the defect.
3.	QC is method to verify the quality.	QA is the technique of managing the quality
4.	QC always involves executing the program	QA does not involve executing the program.
5.	QC is the process to verify that deliverables	QA is the process to create deliverables.

Chapter-6 Monitoring and Controlling

Concept of Monitoring and Evaluation

Monitoring and evaluation (M & E) are of critical importance for achieving the objectives of project. They are related but distinct activities. The key things for M & E are time, cost and performance standards. Monitoring is usually an on-going activity throughout the life of the project. Evaluation is periodic. It is undertaken at certain times, such as mid-term or termination of project.

6.1. Introduction to monitoring

Monitoring refers to the timely gathering of information to review of project implementation. It is on-going management review key factors of project implementation performance. It aims to ensure that project inputs, schedules, outputs and other actions are proceeding according to the project plan. It is done during the project implementation phase. It is concerned with results. Benefits can also be monitored.

6.2. Purpose of Monitoring

- Monitoring provides information that will be useful in analyzing the situation or the project i.e. measuring its status.
- Determining whether the inputs/ resources in the project are well utilized
- Identifying problems facing the project and finding its solutions in advance
- Ensuring all activities are carried out properly by the right person at the right time
- Determining whether the way the project was planned is the most appropriate way of solving the problem in hand
- Collect and analyses the information.
- For rescheduling the project if the project runs behind schedule.
- For re-budgeting.
- To make program and activity active.
- To collect and analyses the information for best utilization of resources.

6.3. Introduction to control

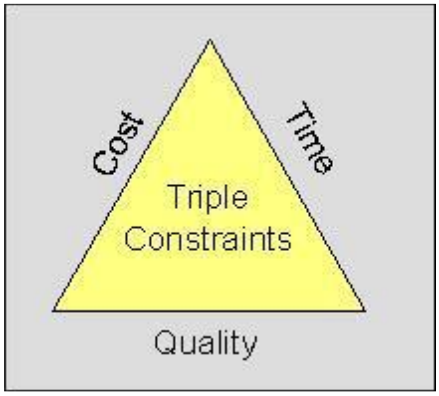
Control is an essential function of management. It ensures that the right things are done in right manner in right time. Planning helps in deciding in advance necessary steps to achieve the goal where control helps in following the plan for successful execution of the project. It is important because it helps to check the error and take necessary corrective action. Generally, control includes following three processes.

- Measuring
- Evaluating
- Correcting

6.4. Elements of Control: Quality, Cost, and Time

The basic three elements of control are quality, cost and time.

- Quality refers to the distinctive attribute or characteristic possessed by a project. It is a measure of properties with the amount of deviations.
- Cost refers to the total financial investment on a plan to develop and operate it.



- Time refers to the time taken by any product or activity to get completed.

Quality Control

Quality control is checking errors during project implementation. Quality control inspectors are used for checking quality. Statistical quality control techniques are also applied for monitoring quality. Conformity to agree specifications are monitored. Adjustments are made for deviations. Project outputs not meeting the standards are rejected, scrapped or reworked. The elements of project quality are:

- The project's product
- Management process
- Quality planning
- Quality assurance
- Quality control
- Corporate culture

Cost Control

Project cost estimation and budgeting serves as a foundation for cost control. Evaluation and control of project costs are important components of project evaluation and controlling. It involves the following:

- Establishing a project cost baseline plan
- Developing standard costing and budgetary control system for the project
- Establishing authority, responsibility and accountability for cost control at task level
- Ensure proper allocation of cost to project codes, authorization for decision making
- Measuring actual cost and comparing with standards
- Tracing out deviations
- Maintain financial discipline through internal auditing and external auditing
- Taking remedial and corrective actions.

Time /schedule Control

Time control can be of two types:

- **Normal Time Control:** It is the estimated time for completion of an activity. Increase beyond this time is not likely to result in cost reduction.
- **Crash Time Control:** It is the estimated time of completion of an activity which cannot be reduced further irrespective of cost considerations.

Every project has an optimal time schedule which is effectively controlled to check time overruns. Time delays result in cost overruns. Bar Chart and Network analysis are used to control schedules.

Chapter -7 Construction Equipment's

Those equipment's that are used in different types of work in civil engineering for easy and fast work progress are termed as construction equipment's. The construction industry uses different types of equipment for different purposes. Equipment relating to earthwork, transportation, aggregate production and handling, concrete production equipment for road pavement, tunnel construction, hydraulic construction, etc are the examples for such industry.

Advantages of using equipment

- ⇨ Large and complex works can be carried out easily.
- ⇨ The faster rate of work progress can be achieved.
- ⇨ High quality of work can be achieved.
- ⇨ Equipment can work in adverse weather, climatic condition, and topography.
- ⇨ Equipment is free from social and emotional factors.
- ⇨ The equipment helps to maintain construction site safer and cleaner.

Disadvantages

- ⇨ Required huge capital investment.
- ⇨ Needs costly repair and rehabilitation.
- ⇨ Unavailability of a trained and skilled operator.
- ⇨ Replaces large numbers of labors and raise unemployment.
- ⇨ Consumes a considerable quantity of fuel which in turn increases the project cost.
- ⇨ A high rate of equipment depreciation.
- ⇨ Less environmentally friendly than green technology.

Equipment for excavation

Excavation is the first and basic task needed in each and every construction works. The foundation works are to be done beneath the ground level, so the excavation of soil is much important and following are the basic commonly used equipment's in excavation.

1. **Excavator**

It has a hoe in its back. Hoe is teeth attached bucket. It is capable of excavating to a depth. Excavation is done by teeth attached to a bucket, which is also capable of loading the excavated material directly to the transporting vehicle. By changing the bucket, it can be converted to the driller, power shovel, etc. Excavators are classified on the digging motion. An upward motion unit is known as shovel and downward motion is Hoe.

2. **Dozer/ bull dozer**

Dozer is the instrument for scrapping and excavating the soft as well as hard soil. Generally it is used for removing top soil, site clearance, sallow excavation, transportation of materials. Dozer is often of two types: wheeled and crawler type

3. **Power shovel/ loader**

It is a bucket-equipped machine, used for digging and loading earth or fragmented rock and for mineral extraction.

4. Back hoe loader

Backhoe loader falls under the group of power shovel group. It has a long handle and one digging unit. It is known by several names as Hoe, backhoe, back shovel, and pull-shovel. A hoe is found more advantageous for digging below machine level as trenches, footings, pits which require precise control on depths. A small version of front end loaders are attached or equipped with a dipper on its rear side hence called backhoe loader or backhoes.

5. Drag Lines

A dragline is a multipurpose machine capable in a wide range of operations. It works on soft to medium-hard material. It has a long light crane boom with buckets so that it can dig and dump the excavated materials over long distances eliminating the need for hauling equipment. It can handle digging wet material or underwater digging standing on the firm soil from the pit. Generally, the draglines are of three kinds track-mounted, wheel mounted, truck-mounted and walking draglines.

6. Clamshells

It has a bucket attached which performs the tasks Such as digging exaction and lifting the material. Clamshells are used to handle the loose material such as Sand, aggregate, gravel, and crushed stones. They can be used for lifting the material from the deep foundation like cofferdam, pier foundation, manholes, etc. They can be specially used to lift the material vertically. Clamshell has most of the characteristics as of drag line and some of the cranes.

7. Scrappers

They are the machines capable of cutting a thin layer of earth and taking some excavated material in its bowl to be discharged in depressions uniformly. They can cut, haul and discharge materials by themselves. Scrapper can be self-propelled or tractor-pulled type. Self-propelled can be crawler mounted type or rubber tire mounted. These are not suitable in such location where the cutting blade cannot work, like gravely and rocky strata.

8. Grader

Graders are basically the equipment meant to grade the road surface and other large area With the help of teeth attached to them, they can scarify earth surface to loosen the material which can eventually be shifted forward or to the sides by grading blades. These blades rotate up to 270 in the central ring making it unique to shift the material on all sides. The self-propelled grader is also known as a motor grader and can be classified in four different types:

- ⇨ Light Grader up to 9 tons
- ⇨ Medium Grader- 10-12
- ⇨ heavy grader 13-15 tons and
- ⇨ Very Heavy Grader 17-24 tons.

Equipment of concrete mixing A widely used material in civil construction is concrete. It consists of cement, sand, aggregate and water. Its versatility, adaptability, available, economic and modern concept makes concrete useful across the world. Being a advantageous material many equipment are used and some of them are:

1. **Concrete batching plant** A concrete batching plant is a machine in which ingredients of concrete are mixed and blended homogeneously to obtain concrete of desired strength and quality. Concrete batching plants can be classified as stationary concrete batching plants and mobile concrete batching plants, based on the location of the plant.

2. **Concrete mixing equipment**

Drum Types Mixer

a) Tilting drum mixers the mixture consists of a conical drum with vanes inside which rotate in a inclined axis. It discharges the mix by tilting the drum.

b) Non-tilting drum mixer

c) Reversing drum mixer

Pan Type Mixer It is stationary and hence used either in central mixing plant or large concrete project or laboratory.

Equipment for transportation and compaction

1. Trucks and trippers

They are the equipment's providing hauling facility of different materials within minimum cost. The dump truck can be of self-emptying capacity.

2. Loader

They are generally used to load the materials in the transportation vehicle. They are also used to excavate the materials like soil and load

3. Belt conveyer

It is generally a fixed type of transportation equipment which transports the materials in a guided path.

4. Ropeway

It is also a fixed type of transportation system which is used to transport the materials from one place to another through a cable.

Compaction equipment

Roller Roller is one of the compaction equipment that is used to compact the soil earth for preparation of field. Following are the type of roller

- Smooth wheeled roller
- Sheep footed roller
- Vibratory roller
- Pneumatic roller

Equipment's for lifting of materials and parts

Lifting equipment includes any equipment or machinery used at work for lifting or lowering loads or people, including accessories and attachments used for anchoring, fixing or supporting the equipment. There is a wide range of lifting equipment in the construction industry. It is necessary to lift up the instrument, materials in different storey while construction of a multi-story building. Generally, crane are the versatile equipment's used in lifting. So the necessary equipment for lifting are necessary and some of them are:

1. **A hoist:**

It is a device used for lifting or lowering a load by means of a drum or lift-wheel around which rope or chain wraps. It may be manually operated, electrically or pneumatically driven and may use chain, fiber or wire rope as its lifting medium.

2. **A crane:**

is a type of machine, generally equipped with a hoist, wire ropes or chains, and sheaves, that can be used to lift and lower heavy materials and to move them horizontally. Different types that can be found in construction are:

- A tower crane: is a balance crane that consist of the same basic parts. Fixed to the ground on a concrete slab, tower cranes offer height and high lifting capacity. The base is then attached to the mast which gives the crane its height. The mast is attached to the slewing unit (gear and motor) that allows the crane to rotate.
- All terrain crane: is a mobile, truck mounted crane with the necessary equipment to travel at speed on public roads, and on rough terrain at the job site using all-wheel and crab steering.

Chapter-8 Safety

Safety may be defined as the control of recognized hazards to attain an acceptable level of risk. Safety is one of the most important parts in construction which ensure that the working environment and workers are safe. It also creates a motivation to work for workers. Being a civil engineer, we have to consider the construction site safety to prevent the loss of life and property.

8.1 Accident

An accident is a unplanned and unexpected occurrence which disturbs the planned sequence of activities, events and action resulting injury to person, loss of production, damage to plants and equipment. Accident may cause loss of life and property, so we must consider the safety on the site, note out the critical activities and event and make the activities safe as far as possible. For e.g. A man falling from a height, falling of tools and equipment while working, structural failure etc.

8.2 Causes of accident

Normally the causes of accident are classified into following types based on the nature:

1. Physical causes
2. Physiological causes
3. Psychological causes

Physical causes

Related with tools, machines, material, environment for example

a. Machines are not properly adjusted and guarded
b. Tools used are sharp or too small or short, not suitable for work
c. Explosive and poisonous materials are not handled with care.
d. The shoes are slippery and too small.
e. Poor lightning, ventilating and loose electric wires at the site.

Physiological causes

Due to poor eye sight, overwork, poor health, old age.

Psychological causes

Due to mental tension, overconfidence, fear, negative emotional attitude.

8.3 Importance of safety

Safety is the most important thing that must be considered in a construction site. Unsafe working condition not only causes minor accident but also leads to the loss of life. It is necessary to assure the safe working condition in site for a better performance and efficient work. Following are some importance of safety:

- Saving human life.
- Prevention of permanent and temporary injury of workers.
- Prevention of damage to tools and equipment's.
- Saving the compensation cost.
- Minimizing the risk in work field.
- Motivating to the workers to work in safe environment.

8.3 Safety measures

Safety measures are the important factors to be considered at any site. In order to maintain the safety practices at site one must aware about the risk, uncertainty and problems at different activities that may occur at site. Some of the safety measures to be considered at site are:

1. Excavation

- Workers should be provided all the necessary safety/protective devices while manual excavation.
- Beyond the depth of 2m trench should be shore, timbered and sheathed in case of loose and soft soil.
- Proper safety on excavation must be needed on machine excavation.

2. Drilling

- The operator must be strong enough to handle the manual drill machine whereas the operator must be competent more to operate the hydraulic drill machines.
- Ventilation should be provided and sufficient quantity of water must be provided.

3. Blasting

- Expertise person is needed for blasting.
- The blasting area must be cleared off by people
- Special care during handling must be done.
- Firing is done from a safe distance.
- Site signal should be kept and unauthorized people must be restricted.

4. Scaffolding/Formwork

Scaffolding and formwork are the important part of construction which needs special consideration while constructing it. Its services to workers to work at a height, needs special safety measures. Some of the safety measures are:

- All scaffolding and platform are hold tight at every level.
- Frequent checking of scaffolding is done
- Workers should wear all the safety gears while working on scaffolding.
- Naked electric lines must be avoided while constructing the scaffolding.
- The formwork should be made strong enough to bear the load on it.
- Formwork should be properly leveled and made water tight.
- The props and standards are placed in hard surface.
- Failure of formwork may cause major accident.

4. Bitumen works

Special consideration and protection measures must be done while working with hot bitumen as it results in thermal burn. Bitumen is safe in normal temperature but while working at high temperature special care on handling is done. Some of them are:

- Workers must have boots, gloves, goggles, helmet, dress kit and other protective accessories.
- Fire extinguisher and first aid kit must be at site
- Equipment must be handled properly

- ⇨ A good understanding of their chemical and physical properties;
- ⇨ Proper procedures and safe systems of work;

Construction Personal protective equipment's