COURSE TITLE

CONSTRUCTION ENGINEERING AND MANAGEMENT

Chapter 7

CONSTRUCTION PROCESS AND SITE MANAGEMENT

Lecture 7 (week 7)

Site Surveying and Preparation, Arrangement of Job Layout, Roles and Responsibilities of Site Engineers, Record Keeping and Documentation, Site Order Book, Procedures to Prepare Bills, Measurement book and Muster roll

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Learning Objective

The main objective of this lecture is to understand about:

- Site surveying and preparation.
- Arrangement of facilities/job layout.
- Roles and responsibilities of site engineers.
- Record keeping and documentation.
- Site order book.
- Procedure to prepare bills.
- Measurement book and muster roll.

7.1 SITE SURVEYING AND PREPARATION

Site is a place or area where the construction activities are being carried out which includes surveying, grading, levelling, clearing land, earthmoving and demolition etc. Construction work is different from each other because of construction site even its design and drawing are the same. Site preparation is the preparation work done before construction work can begin, which includes evaluating the site, soil testing, locating boundary lines, clearing etc. [1] Site preparation is the process of preparing the site for future construction work.

It is a critical step in the construction process as it lays the groundwork for a successful and safe construction project. Without proper site preparation, the construction work will be of poor quality and will not meet the required standards. Temporary services are necessary to execute the construction work. It includes temporary offices, electricity, telecommunication, roadways (access road), drinking water, sanitation system, etc. Also, spaces should be allocated for heavy and costly equipment in and around the site for their safety.

Site Surveying is an inspection of an area where work is proposed, to gather information for initiating construction work, to stake out reference points and marks that will guide the construction of structures. It can determine a precise location, access, best orientation for the site and the location of obstacles. Land surveys and surveys of existing conditions are generally performed according to the coordinates system. Surveying equipment such as Levels, Total Station, Theodolites, and electronic distance measurement (EDM), GPS with computerization are used for accurate measurement of angular deviation, horizontal, vertical and slope distances.

Elements of the construction survey

- Survey existing conditions of the future work site, including topography, existing buildings and infrastructure, and underground infrastructure whenever possible.
- Stakeout reference points and markers that will guide the construction of new structures.
- Verify the location of structures during construction;
- Conduct an As-Built survey: a survey conducted at the end of the construction project to verify that the work authorized was completed to the specifications set on plans.

Factors to be considered for the construction site preparation

- Remove all the scrubs or jungle if there exists any on the site for building construction.
- The whole area will be roughly leveled.
- As a part of site preparation, the trees will be cut off and their roots are totally uprooted as directed.
- Before starting the work, permanent benchmarks established at a suitable point in the construction site.
- The orientation and trench lines of the building should be correctly laid out in the construction site and the location for the storage and stacking of the materials should be definitely set on the ground in the site.

- Fixing position of the site office, godowns, the guard and the labor shed, the access and existing roads for trucks and carts, etc.

7.2 ARRANGEMENT OF FACILITIES/JOB LAYOUT

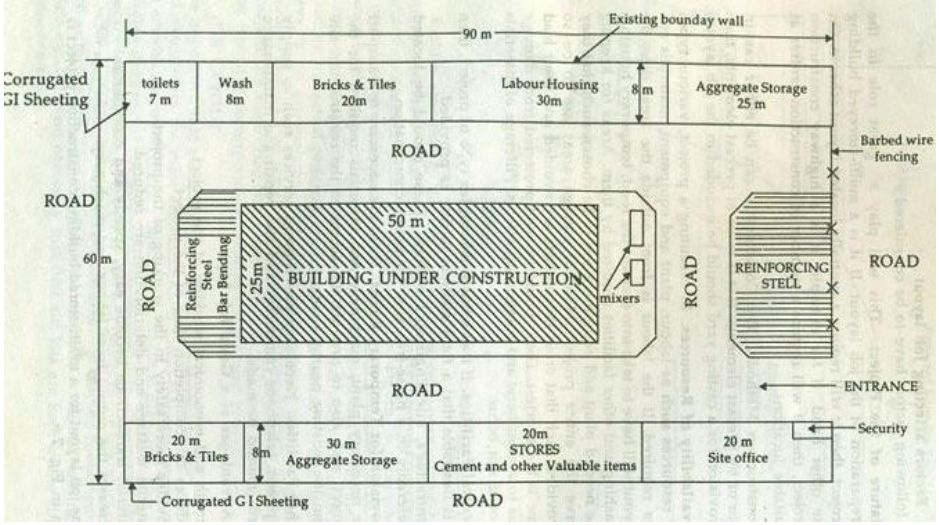
Facility layout refers to the arrangement of machines, departments, workstations, storage areas, and common areas within an existing or proposed facility. Before starting construction, a job layout plan is prepared which indicates the site arrangements to facilitate the work to proceed in a smooth and ordinary manner. A job layout is prepared to promise that work proceeds smoothly without any obstruction. Job layout can be defined as a site drawing of the proposed construction showing the location of entry, exit, temporary services, material stores and stocks, plant or equipment and site offices. [2]

Facility Layout is simply the way a facility is arranged in order to maximize processes that are not only efficient but effective towards the overall organizational goal. The basic requirements of construction job mainly man, material, the machine must be controlled and placed at a site in such a manner that

- Machines are placed in the most advantageous position.
- Materials are placed/stored near the place of their utilization
- General site circulation to manpower is orderly and their site accommodation is available

Good site layout planning leads to

- Provide a uniform flow of material about the site, free from bottlenecks.
- Provide adequate control on equipment theft.
- Facilitate movement of equipment on the jobsite.
- Promote a safe working environment.
- Provide safe, non-destructive access to the jobsite for visitors.



Source: [3]

Factors to be considered in construction site planning/job layout

1. **Access to site**

- There should be a separate entrance and exit to the site. Besides, there should be a track on the site for easy and efficient movement of all site traffic.

2. **Storage of material**

- Cement bags should be stacked on a raised platform covering with waterproofing material.
- Bricks, tiles and concrete blocks are stacked at ground level/ height of stack should not exceed 2 m.
- Inflammable materials must be stacked separately from other materials and should be protected from fire hazards.
- Re-bars should be kept away from moisture to prevent rusting.
- Timbers must be stacked in well ventilated shady areas.
- The material of common use must be stacked near the place of their use to minimize handling.
- Heavy items must be stacked away from trenches, soft ground or unsure support.
- Cement should be kept constantly moving by using the earliest arrival first.
- Materials must be stored/stacked in a secured place.

3. **Location of machinery and equipment**

- Equipment should be kept near the material it utilizes and as well as near the place of its use.
- For costly equipment, the temporary shed should be provided for weather protection.
- Provision should be made for essential fuel and lubrication.
- Adequate space should be left for scaffolding as well as erection, removal, and shifting.
- Adequate parking facility should be provided.
- Location of security checkpoints should be in such a place so that materials/equipment could not pass in or out without proper authorization.

7.3 ROLES AND RESPONSIBILITIES OF SITE ENGINEER

Site engineers perform a technical, organizational and supervisory role on construction projects at site. An engineer can be liable for failure to exercise their duty of care to all persons lawfully on the premises they have designed or constructed. The engineer should function in their duties, diligently with technical soundness, contractual fairness, promptly coordinating with employer and contractor. A site engineer works as part of the site management team liaising with and

working alongside architects, engineers, construction managers, supervisors, planners, surveyors, and subcontractors. They share responsibility for site security, health and safety, and the organization and supervision of material and human resources.

Technical Function

- Studying the work plan submitted by the contractor and suggests any modifications.
- To watch and inspect the construction work and assure that it is done in full accordance with the drawings, technical specifications, and bills of quantities.
- Supervising the works on-site in accordance with the contract documents and using the template and procedure established by the consultant.
- Inspecting and testing materials prior to their use at the site as per sample approved by the consultant and ensuring removal of rejected material out from the site.
- Ensuring the correct implementation of the works according to technical specifications, to designs and quality of materials
- Checking of layout and setting out of buildings w.r.t. existing structures and site levels.
- Preparing a list of tests that may be required and following these tests to be carried out at the site and keeping a log of all test conducted at the site.
- Checking and testing of completed works before they are covered by the contractor, taking photos on a regular basis and also on account of defective work.
- Checking and ensuring that the site is arranged as per the site management plan and that all measures are taken for site safety and the safety of the third parties in the vicinity of the site
- Ensuring that health and safety measures are adopted and followed to the full extent and prepare the weekly report and suggest and instruct additional safety measures if needed.
- Preparation of the list of critical items and its close monitoring.
- Maintain a filing system for all site memos and instructions, measured quantities of work and materials on-site, reports and other documents and correspondence pertaining to the construction activities.
- Maintain a site order book to be made available for the consultants and senior officers to write comments or defects in construction noticed during site visits and carrying out compliance at the site.

Administrative Functions

- He/she will be required from time to time to assist the Administrative head/consultants.
- Interacting with local authorities/ departments for statutory approval/certificates as and when instructed.
- Performing other relevant duties as assigned Administrative head/consultants.

Deliverables

- Weekly progress reports per each project/contract assigned.
- Compliance of comments on defective or rejected work in the site order book.
- Update of the work plan of the contracts – monthly.
- Duly maintain an electronic library of photos of the progress of the works.

Required Qualities of site engineer

1. Knowledge of technology
2. Social understanding
3. Economic realities
4. Legal awareness
5. Environmental skills
6. Management
7. Leadership and innovation

7.4 RECORD KEEPING AND DOCUMENTATION

Every activity relating to the work execution and procurement should be recorded and documented separately. Record is a document required to prove any construction activity has taken place at site during billing or any other claims. These records have all the data of various construction activities carried out at site. [5] These documents helps to defend any claims such as liquidated damages or false claims or violations of any guidelines by authorities or clients. A separate file index is necessary for every action regarding the execution of the works.

Records at Construction Site

The following are the various records that need to be maintained at construction site: [5]

1. Drawings (Architectural, structural, electrical, plumbing etc.)
2. Contract Agreement (approval of municipality or development authorities, drawings and its amendment)
3. Time and Progress Charts or CPM Charts (approved from concerned authorities)
4. Work Orders Book (orders given by client to contractor including date and signature)
5. Work Diary (weather condition, material arrival date and quantity, visit of VIPs, types of tools and plants used etc.)
6. Test Result Record (Cube test, sieve analysis, slump test, compressive strength, tensile strength etc.)

7. Cement Register (manufacturing date, daily consumption, initial final setting time, remaining balance etc.)
8. Labour Attendance Record and Daily Wages Sheet
9. Periodic Bills Record
10. Records of Changes, Deviation Orders and Amendments

Documentation is a tool to reduce and resolve contract disputes. It also maintains proper communication. Few Situations of Documentation: [6]

A. Bidding and Negotiation

- delay in supplying bid documents (Correspondence, prebid meetings)
- Findings of site inspection
- Rate analysis of major items
- Construction schedule with critical activities
- Negotiation during finalization of award

B. During Signing of Contract Agreement and Mobilization Period

- Extension of validity of tender documents
- Delay in payment of mobilization amount
- Delay in the supply of necessary drawings and documents
- Site position date should be recorded
- Site order book, MB

C. During Construction period for Delays and Extra Costs:

The contractor should be aware to maintain proper documents to establish facts that caused the delay.

- Changes in contract work
- Variation in quantities
- Unusual site conditions
- Force majeure
- Unusual inflation

7.5 SITE ORDER BOOK

Every worksite should have a site order book in the prescribed format so as to record the comments of the higher official while inspecting the work. It is a book of record of all the orders given by the client to contractor to perform the activities in a construction site. A Site

Order Book is a register duly certified by the Client regarding the number of pages it contains, each page is numbered, Name of work, name of the contractor, reference of a contract/work order, etc. Site Order Books shall be maintained on the sites of works and should never be removed therefrom under any circumstances.

The Engineer-in-Charge or his authorized representative shall duly 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. [6] The contractor shall promptly sign the Site Order Book and note the orders given therein 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.

7.6 PROCEDURE TO PREPARE BILLS

A bill or invoice is a typical payment document or a billed list of items that are submitted or sent by a contractor or a subcontractor to the client to receive payment as discussed before for the work which they have completed. It is a written record of the purchase agreement between the client and the contractor that ensures cash flow for the contractor. Usually, the payment to the contractor is made on the basis of the statement of work done, these are called running bills. It is also called an Interim Payment Certificate (IPC). The bills are prepared and submitted by the contractor to the client for the payment by following the below-listed steps:

Measurement of book

Entry in Measurement Book

Preparing a bill

The most common construction billing methods are: [7]

1. Advanced billing in construction

Advanced billing in construction is a method where payments are finalized before a project begins — usually in the form of a lump sum payment. This invoicing practice can be risky for the stakeholders in charge of the project. Advanced payments mean they are putting a lot of trust into the parties responsible for working on the project. This method can also be risky for the contractor involved in the build, as projects often run over budget.

2. Arrears billing in construction

Arrears billing in construction is the process of billing at the end of a project. Payment is sent out as a lump sum once all stakeholders have signed off and approved the final product. This billing method can be especially risky for the contractor as the construction business is essentially floating the costs of the job. Contractors will have to pay out of pocket for materials and labor and count on their clients to pay fully and on time. However, it's common for payments in the construction industry to take weeks or months to be sent out.

3. Progress billing in construction

Progress billing in construction is the invoicing practice of billing incrementally throughout a project. More complicated than billing before the project begins or after a project ends, progress

billing invoices are created based on the percentage of completion of work to-date. Payments are made at agreed points in the project completion. The progress billing method is ideal for major construction projects that are lengthy and typically have big budgets.

7.7 MEASUREMENT BOOK AND MUSTER ROLL

Measurement Book is a book showing an original record of work done or supply of materials received duly weighed, measured or counted. It includes finance, so the record should be lucid, clear such that if necessary it can be checked with the entries made. It is evidence of work done and measurement, so act as valid documents. It serves as a detailed record of the measurements taken during various stages of construction, including excavation, foundation, structural work, finishes, and other related activities.

A Sample of MB

Location ……. Item number……. Description of Works ….

Date of start….. Date of Completion…….. Date of measurement…

Drawing number… Reference data.

S.No	Items	unit	Measurement			Total Quantity	Remarks
			L	B	H / D		

Measurement Taken By:…….

Contractor's Representative:……

Checked By:……

Approved By:……

Source: [6]

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
- Category(Designation): Management/Supervisor/Skilled/Semi-Skilled/Unskilled
- Rate of payment
- Shift (if applicable)
- Attendance

Muster roll has three parts [6]

- Part I: Detailed information about labor engaged, attendance, rate, the total amount to be paid, signature columns, etc.
- Part II: Record of unpaid Wages
- Part III: Record of completed works for which payment is to be made.

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