COURSE FILE

COURSE CODE: CE 15037

ESTIMATION AND PROFESSIONAL PRACTICES (3-1-0)

SPRING 2018

Dr. Bharadwaj Nanda,

Room C-220, Department of Civil Engineering

Veer Surendra Sai University of Technology, Burla

Email: bnanda_ce@vssut.ac.in, Mobile: (+91) 96-924-18265

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Bharadwaj Nanda

1. COURSE OBJECTIVES

a. Graduates will have the ability to prepare an estimate for a building or a bridge by taking off quantities with appropriate unit from drawings.

b. Graduates will be able to write detailed specifications for different types of work required for estimating, tenders and supervision.

c. Graduates will be able to compute rates of different items of work from the first principles.

d. Graduates will understand various professional practice issues and departmental procedures.

e. Graduates understand what valuation is and why is it necessity and will be able to compute present value of a building.

2. COURSE OUTCOMES

CO CE15037.01 Ability to work out approximate and detailed quantity estimation of any building or bridge from the given plan

CO CE15037.02 Ability to understand and define the general and detailed specifications for various types of building works

CO CE15037.03 Ability to analyse rates for various items of various civil engineering structures

CO CE15037.04 Ability to understand and evaluate contracts, tenders and other legal requirements in construction

CO CE16037.05 Ability to estimate the value of a building structure

3. RELATED PROGRAMME OUTCOMES:

PO ID	PO Name	Relationship
A.	Ability to apply knowledge of mathematics, science and engineering to solve complex problems in civil engineering	Low
B	Ability to identify, formulate, and solve complex civil engineering problems using first principle of mathematics, basic science & engineering	-
C	Ability to design, implement & evaluate civil engineering projects to meet societal and environmental needs	Low

D	Ability to design and conduct complex civil engineering experiments as well as to analyze and interpret the experimental data	-
E	Ability to use the techniques, skills, and modern engineering tools necessary for relevant engineering practices	-
F	Ability to assess impact of contemporary social issues on professional practice	Low
G	Ability to recognize the sustainability and environmental impact of the engineering solutions	-
H	Ability to follow prescribed norms, responsibilities and ethics in engineering practices	High
I	Ability to work effectively as an individual and in a team	Medium
J	Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large	Medium
K	Ability to recognize the need for and to engage in life-long learning	-
L	Ability to understand and apply engineering and management principles in executing projects	High

4. COURSE SYLLABUS

Module I: Quantity Estimation: Principles of Estimation, Methods and Units, Estimation of Materials in Buildings, Culverts and Bridges. (**14 Hours)**

Module II: Principles of General and Detailed Specification for Various Types Building Works, Specifications of Different Items. **(07 Hours)**

Module III: Analysis of rates: Description, Prime cost, Schedule of Rates, Analysis of Rates for Various Types of Works. **(07 Hours)**

Module IV: Contract Management: Legal Aspects, Different Types Of Contacts: their Relative Advantages and Disadvantages, Elements of Tender Operation, Evaluation of Tenders and Award of Work; Laws Related to Land Acquisition, Labour Safety and Welfare Disputes and Arbitration, Valuation of Civil Engineering Structures. **(12 Hours)**

5. RECOMMENDED BOOKS

Text Book:

- B. N. Dutta, Estimating and Costing in Civil Engineering, 27th Revised Edition, New Delhi: UBS Publishers & Distributors Ltd.
- M. Chakraborti, Estimating, Costing, Specification & Valuation in Civil Engineering, Kolkatta.

Reference Books:

- D. D. Kohli, and R. C. Kohli, A Text Book of Estimating and Costing (Civil), S Chand Publishers.
- S.C. Rangwala, Estimating, Costing and Valuation, 15th Edition, Charotar Publishing House Pvt. Ltd.
- G. S. Biridi, Textbook of Estimating & Costing, Dhanpat Rai & Sons.
- U.K. Shrivastva, Construction Planning and Management, Galgotia Publications.
- P.S. Gahlot and B.M. Dhir, Construction Planning and Management, New Age Publishers.

Referred Indian Standards

- IS : 1200 (Part 1 to 28), Methods of Measurement of Building and Civil Engineering Works, Bureau of Indian Standards

Additional Reading Materials

- B.N. Suresh and B. H. Reddy; Estimating & Costing; State Institute of Vocational Education Andhra Pradesh, Hyderabad.
- L. M. Krishna and P. V. Rao, Construction Management and Accounts, State Institute of Vocational Education Andhra Pradesh, Hyderabad.

6. PREREQUISITES

- Basic knowledge on civil engineering, Engineering drawing and Civil engineering materials and construction (CE 15004)

7. COURSE GRADING

This paper will have 100 marks which will be assessed as follows:

• Assignments/Homework	=	10 Marks
• Mid semester Examination (2 hour duration)	=	20 Marks
• End semester examination (3 Hour duration)	=	70 Marks
Total	=	100 Marks

The marks will be converted into respective grading system, as per the norm of the university, given bellow:

Score on 100 percentage marks	Grade Points	Grade	Qualification
≥ 90%	10	O	Outstanding
≥ 80% & < 90%	09	A+	Excellence
≥ 70% & < 80%	08	A	Very Good
≥ 60% & < 70%	07	B+	Good
≥ 50% & < 60%	06	B	Above Average

≥ 40% & < 50%	05	C	Average
≥ 35% & < 40%	04	P	Pass
< 35% or <25% in End sem.	00	F	Failure
Absent	00	Ab	Non-appearance in End sem. Exam

Homework should be submitted as a PDF file. Grading of the periodic homework/assignments uses a letter grade system. The letter grade system is:

- A = 5 out of 5 points : correct procedure and calculations
- B = 4 out of 5 points : correct procedure with some calculation errors
- C = 3 out of 5 points : partially correct procedure and calculations
- N = 0 out of 5 points : insufficient knowledge or not submitted

8. PEDAGOGY OR COURSE DELIVERY

The Estimation and Professional Practice course is meant for B. Tech. students of civil engineering specialization. This course is designed to develop the techniques required to measure, quantify and cost the construction works. During the course schedules, the graduates will be introduced to the process of taking off quantities from a drawing and to IS 1200 measurement rules. Furthermore, the graduates will understand various professional practice issues including contract, tendering process, departmental procedure and related legal issues. This will enable them to conduct their affairs in a highly ethical manner holding paramount the safety, health and welfare of the public. Overall this course will help the graduates to enter the profession of Civil Engineering and to contribute to society at large.

The detailed pedagogy for covering the course is given bellow:

Concepts	**Reference**	**No. of Lectures**	**Delivery Methodology**
Module 1:			
• Introduction to Estimation o Types of Estimation o Terminology o Principles of Measurement o Approximate Estimation o Detailed Estimation	1. Chap. 1, 2 and 3, (Chakraborty). 2. Chapter 1 and 10 (Dutta)	05	*Content delivery in Theory class through lectures*
• Detail estimation of buildings o Long wall and short wall method o Center line method	1. Chap. 5 (Chakraborty). 2. Chapter 2 and 3 (Dutta)	03	*Content delivery in Tutorial class through problem solving aided by faculty member*

• Reinforcement quantity estimation	1. Chap. 6 (Chakraborty). 2. Chapter 5 (Dutta)	02	*Content delivery in Tutorial class through problem solving aided by faculty member*
			Assignment 1
• Quantity estimation in bridges and culverts	1. Chap. 10 (B) (Chakraborty). 2. Chapter 8 (Dutta)	04	*Content delivery in Tutorial class through problem solving aided by faculty member*
			Assignment 2
Module 2:			
• Specifications o Types of specifications o General specifications of buildings o Detailed specifications for common items	1. Chap. 15 (Chakraborty). 2. Chapter 13 (Dutta)	07	*Content delivery in Theory class through lectures*
			Assignment 3
Module 3:			
• Rate Analysis o Introduction o General procedure for rate analysis o Rate analysis for common items	1. Chap. 13 (Chakraborty). 2. Chapter 11 (Dutta)	07	*Content delivery in Theory class through lectures*
			Assignment 4
Module 4:			
• Contract o Types of contract o Contract documents o Tender o Tender operations	1. Chap. 19 (Chakraborty). 2. Chapter 17 (Dutta)	03	*Content delivery in Theory class through lectures*
• Carrying out of work o Methods o Muster roll o Measurement book	1. Chap. 19 and 20 (Chakraborty). 2. Chapter 17 (Dutta)	02	*Content delivery in Theory class through lectures*
• Land and Labour Laws o Land acquisition Act (LARR Act) o Types of labour o Labour laws related to	1. Chapter 28 (Chakraborty).	02	*Content delivery in Theory class through lectures*

construction			
• Valuation of Vuildings	1. Chap. 28 (Chakraborty). 2. Chapter 15 (Dutta)	05	*Content delivery in Tutorial class through problem solving aided by faculty member*
			Assignment 5

9. MEASUREMENT OF COURSE ATTAINMENT

Course Attainment will be measured from the CAR for the theory subjects form Course analysis report survey collected form given bellow. The simple logic to estimate the attainment value is:

A-Score will be 3 if 2nd column of Part A Table is marked "Y". The Score will read 2 or 1 depending on "Y" mark in 3rd or fourth column. The B-Score will be 3 if 2nd column of Part B Table is marked "Y". The Score will read 2 or 1 depending on "Y" mark in 3rd or fourth column. The Attainment score will be computed as ratio of sum of score products obtained in A and B to maximum possible score of 27.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA,ODISHA							
Course Assessment Report and Score sheet							
Name of the course:							
Name of the faculty:							
Please 'Tick' the appropriate box							
Part A				**Part B**			
	> 70%	>50 and <70	<50		Strong	Modorate	Weak
% of students getting 'A' grade (≥7) in the assignment and quiz				Compactibility of assignment and quiz questions to meet the intended CO's			
% of students getting 'A' grade (≥14) in the midsem				Compactibility of Mid term questions to meet the intended CO's			
% of students getting 'A' grade (≥49) in the end sem				Compactibility of End term questions to meet the intended CO's			
							Signature

CHAPTER 1

INTRODUCTION

1.1 Estimation

Estimation is a process of calculating quantities and costs of various items required in connection with a work. It is prepared by calculating the quantities from the dimensions on the drawing for various items required to complete the project and multiplied by unit cost of the item concerned.

1.1.1 Purpose of estimation

- To assess the volume of work involved in the project.
- To arrange and organize material, manpower, equipment and tools-and-plant necessary for the project.
- To fix the project completion period.
- To ascertain the fund required for completing the purpose to work.
- To justify the investment from cost benefit ratio.
- To invite tenders and preparation of bill of quantities.
- To obtain necessary administrative approval, necessary technical sanction and arrangement and allocation of funds required for the project.
- For valuation of an existing property.

1.2 Quantity Surveyor

Quantity surveyor is a person who is responsible on estimating the quantities from the design drawings, and measurement of the quantities in the site during the project implementation, and preparing the current and final payments

1.2.1 Duties of quantity surveyor:

- Preparing bill of quantities (Taking off, squaring, Abstracting and billing)
- Preparing bills for part payments at intervals during the execution of work.
- Preparing bill of adjustment in the case of variations ordered during the execution of work
- Giving legal advice in case of court proceedings

1.2.2 Essential qualities of a good surveyor

- The quality surveyor must be well versed with the drawings of work.
- He should be able to read the drawing correctly and bill the quantities accurately

- He should have a thorough knowledge of the construction procedure to be adopted, the various items of works involved in the execution: and the different materials to be used in the work.
- He should be able to prepare schedule to be priced by tenderor.

1.3 Types of Estimation

There are five types of estimate:

a. Approximate Estimate
b. Detailed Estimate
c. Quantity Estimate
d. Revised Estimate
e. Supplementary Estimate

a. Approximate Estimate: This is also known as preliminary/rough estimate. This estimate is prepared to work-out an approximate cost of the project in a short period without going into details. This estimate is done for preliminary financial evaluation of different alternatives and for administrative sanctions.

b. Detailed Estimate: This estimate is prepared by working out the quantities of different items of work and then working out the cost by multiplying the quantities by their respective rates. In detailed estimate provisions for any other expenses like contingencies, T&P, work-charged establishment etc. are added to the above cost to calculate the total amount required for project completion.

c. Quantity Estimate: Quantity Estimate/Quantity Survey is a part of detailed estimate which list the quantities of all the items required to complete the project. These quantities are worked out from the drawings. The purpose of Quantity Estimation is to prepare bill of quantities.

d. Revised Estimate: It is a detailed estimate for the revised quantities or revised rates of items of work originally provided in the estimate without any deviation in original design and specifications approved for the project. It is required when the material cost or the material quantities deviates significantly (> 5%) from sanctioned value.

e. Supplementary Estimate: This estimate is worked out during progress of work due to any changes or addition of works to originally approved. A supplementary estimate is different from the revised estimate in the aspect that, the former is worked out for the works which are not present in the original design whereas the latter is worked out when there is a deviation of materials from original proposal.

f. Abstract Estimate: This is the third and final stage in a detailed estimate. The quantities and rates of each item of work, arrived in the first two stages, are now

entered in an abstract form. The total cost of each item of work is now calculated by multiplying the quantities and respective rates.

1.4 Data Required for Estimation:

To make an estimate following data are necessary: *i.e*. drawings, specifications and rates.

Drawings: For calculating quantities of various items for the work, various drawings like plan, profile, section and elevation are required.

Specifications: Specifications contains detailed descriptions of all workmanship, materials, and methods of preparation and execution for different items of the work.

Rates: The rates per unit of various items of work, the rates of various materials to be used in the construction, the wages for various categories of labors are required for cost estimate. Moreover the distance between location of work and source of materials and cost of transportation of materials are required for calculating cost of materials at work site.

1.5 Terminology

1.5.1. Taking off in quantity surveying:

This is the process of finding out the quantities for various items of works involved in a project by taking off various dimensions from the plan, sections of the drawings and tabulating in a measurement seat. The measurement sheet contains following columns like description, number, length, breadth, thickness/height and quantity.

1.5.2. Contingencies:

There are certain expenses which are incidental in nature and it is not possible to predict them with reasonable accuracy. To cater all such expenses an additional amount of 3% to 5% of estimated cost is provided in the total estimate.

1.5.3. Lump sum items:

These are small items, such as, front architectural or decoration work of a building, fire-place, site-cleaning and dressing, etc., for which detailed quantities cannot be taken out easily or it takes sufficient time to find the details. For such items a lump-sum rate is provided in the estimate.

1.5.4. Work charged establishment:

During the construction of a project considerable number of skilled supervisors, work assistance, watch men etc., are employed on temporary basis. The salaries of these persons are drawn from the L.S. amount allotted towards the work charged establishment.

That is, establishment which is charged directly to work. An L.S. amount of 1½ to 2% of the estimated cost is provided towards the work charged establishment.

1.5.5. Tools and plants (T&P):

Use of special type of tools and plants, like concrete mixture, batching plants or WMM plant, etc., may be required for efficient execution of large projects. To cater such expenses about 1% to 1.5% of the estimated cost is allotted under the head tools and plants (T&P).

1.5.6. Day work:

During execution of a project there may be certain type of works, for which the actual quantities of labor required is difficult to measure. For example fine architectural works, and drawings in the wall. The payments towards such items are made on the basis of actual number of days or actual quantity of materials required. Such works are known as day works.

1.5.7. Sub work:

A large project may consist of several independent small works. Such small works are known as sub work. For example setting of a university may contain the construction of administrative building, classrooms, faculty chambers, hostels and faculty residences. Estimations for each of the sub works are done separately and accounts of expenditure are kept sub work wise.

1.5.8. Deposit work:

The construction or repair works whose cost is not met through government funds but through some non-government sources is called deposited work. The cost is deposited in cash or placed at disposal of the divisional officer. The works executed for municipalities or other bodies fall under this category.

1.5.9. Provisional quantities:

During preparation of an estimate if it is apprehended that additional quantities against some items may be required due to variation of site conditions, then those quantities are estimated separately from the dimensions of the drawing and kept separately in the estimate under a heading Provisional Quantities.

1.5.10. Provisional sum:

While preparing the estimate some amount is provided in it for items whose details regarding cost or specifications are unknown during the preparation. For example the cost and specifications for a lift may be unknown during estimation for the building. Such amounts are known as provisional sum. However the payments for these provisional items are done as per actual rate.

1.5.11. Prime Cost:

Prime cost is the purchase cost of articles at a shop. Prime cost is generally referred to the supply of a particular article and not for carrying out a work. The prime cost includes the

cost for carriage but excludes the cost of fixing or fitting. For example: the door and window fittings are purchased from the shop at a cost of Rs 1000.00. The transportation cost is Rs.50.00 and the cost for fixing and fitting is Rs.100.00. Then the prime costs of the fittings are Rs. 1050.00.

1.5.12. Actual Cost:

The actual cost is the actual expenditure incurred in completing a work excluding profit but including other incidental, establishment and travelling charges. The actual cost is the cost incurred by the contractor to complete the project.

1.5.13. Capital Cost:

Capital cost is the actual amount incurred in completing a work. This includes expenditure incurred in surveying, designing, planning, drawing, cost of material, equipment, laborers, supervision, legal expenses, travel expenses, taxes, electricity and water charges, contingencies and any other expenses related to the work but excluding profit.

1.5.14. Work value:

This is the total amount provided for all scheduled items of work in the estimate. Thus work value is the estimated value for the work excluding the amount for contingencies, work charged establishment, tools and plants etc. as per actual rate.

1.5.15. Abstracting in quantity surveying:

In abstracting the works of a similar description are assembled, grouped and transferred from the measurement seat to a special rolled abstract paper where they are totaled and reduced to their specified unit of measurement.

1.5.16. Summary of estimated cost:

This is the summation of abstract of estimated costs for different sub-works involved in the project and is drawn up separately. Such a summary page is prepared when a project contains different sub-works.

1.5.17. General abstract of cost:

This is the summarization of abstract of costs of several individual items of sub-works or works as a whole, like: cost of land, earthwork, bridges, pavement, retaining wall, etc. required to complete a road project. The amount required for contingency, work charged establishment, T&P, maintenance are added on percentage basis to the general abstract of a cost.

1.5.18. Bill of quantities (BOQ):

This is defined as a list of brief descriptions and estimated quantities. This lists in a tabular form all the items of work involved in connection with estimate for a project with the description, corresponding quantity, unit rate and amounts column. The columns indicating unit rate and amounts are kept blank. BOQ is provided in a tender form for item rate tenders. Contractors' put up their own competitive rates and calculate the totals

to offer their estimate amount to complete the whole work. The BOQ is also required to calculate the quantities of different materials required for the project.

1.6 Principles of Measurements

1.6.1. Units of measurement

The units of measurements are mainly categorized for their nature, shape and size and for making payments to the contractor. The principle of units of measurements normally consists the following:

Measurement Type	Unit	Characteristics of Item	Example
Length	M.R	Works have specific length and width	As pipes
Area	M^2	Works with specific thickness,	as plastering, painting,
Volume	M^3	Variable dimensions	Footings, columns, stairs,
Lump-sum (L.S)	Lump-sum (L.S)	Works have details difficult to be calculated	Earth work, earthling system (electrical).
No.	No.	Works have 3 dim. fixed	Windows, doors,
Weight	Ton / kg	Have specific width	As steel
Time	Day / hrs	Labor / equipment	Workers' wages, equipment,

1.6.2. Rules for measurement

The rules for measurement of each item are invariably described in IS- 1200. However some of the general rules are listed below.

- Measurement shall be made for finished item of work and description of each item shall include materials, transport, labor, fabrication tools and plant and all types of overheads for finishing the work in required shape, size and specification.

- In booking, the order shall be in sequence of length, breadth and height or thickness.

- Same type of work under different conditions and nature shall be measured separately under separate items.

- All works shall be measured subject to the following tolerances.
  - Linear measurement shall be measured to the nearest 0.01m.
  - Areas shall be measured to the nearest 0.01 sq.m
  - Cubic contents shall be worked-out to the nearest 0.01 cum

- In concreting works any opening more than 0.1 m^2 (for items measured by area) or 0.1 m^3 (for items measured by volume) are deducted in the quantity calculation.

- The bill of quantities shall fully describe the materials, proportions, workmanships and accurately represent the work to be executed.

- In case of masonry (stone or brick) or structural concrete, the categories shall be measured separately and the heights shall be describe.

1.6.3. Measurement for common items of work

Item	Unit	Method of measurement
Measurements for earthwork		
Site leveling	Lump sum	It takes into consideration all site leveling including the excavation, fill, till reach 0+B.M according to design drawing.
Excavation (cut)	m^3	Measured by 2 methods : 1. Footing areas according to blinding area × depth of excavation according to drawings. 2. External dimensions of the building × depth of footings
Fill (backfill)	m^3	= Excavation – concrete work for footings and columns under ground level. = Ground plan × depth of ground beams – (concrete for ground beams and ground floors)
Concrete Work		
Blinding concrete, ground concrete, benching, and slabs concrete with fixed thickness	m^2	= Length × width (the thickness should be specified in the drawings and specifications) Ribs blocks don't subtract from the slabs concrete.

Item	Unit	Method of measurement
Footings, columns, ground beams, stairs, and canopies,	m^3	= length × width × thickness o Ground beams are measured from its connection with columns o Concrete stars include the stairs, steps, stair slabs, walls supporting the stairs.
Concrete decoration works as curves.	No.	The dimensions must be specified in the drawings.
Plastering and Painting work		
Plastering and Painting	m^2	= length × width o Engineering measurement after subtracting the openings, more than 0.1 m^2 o The area is measured above the skirting (terrazzo chips)
		Internal plastering = walls + slabs
Miscellanies Work		
Block works	m^2	= length × width (the thickness should be specified in the drawings and specifications) - Subtract all openings more than 0.1 cm^2.
Terrazzo, marble, ceramic	m^2	= length × width (engineering measurement)
Doors/ Windows	No.	The exact dimensions should be specified in the design drawings. *Sometimes carpentry works measured in m^2 or m length according to the item described in BOQ.*
Electrical and sanitary pieces / accessories	No.	The dimensions should be specified clearly in the design drawings as the sockets, lamps, fluorescent lighting, etc. W.C., washing basins, sinks, manholes, pumps… etc.
piping	M.R	The dimension and details should be specified in the drawings, as (cables, pipes, etc.)
Works with special detail	Lumps sum	All details should be specified in the drawings, as earthing, gas network, etc.

1.7 Approximate Estimate

Approximate Estimate is made to find out an approximate cost in a short time and thus enable the administrative authorities to evaluate the financial aspects of various schemes and subsequently allows them to sanction them.

1.7.1. Importance

Approximate estimate is prepared with preliminary investigation and survey. It does not require detailed surveying design, drawing etc. It is basically done to evaluate feasibility of a project. If it is observed from approximate estimate that the cost of the project is very high then the project may be abandoned without preparing a detailed estimate. Thus the cost required for detailed surveying design or drawing required for preparation of detailed estimate is saved.

1.7.2. Purpose of approximate estimate

- Approximate estimate provides an idea about the cost of the project, which enables the authority to check the feasibility of the projects considering the funds available for the project.
- Approximate estimate does not require any detail investigation, design or drawing and hence saves both time and money.
- If several alternatives are available for the original works, a comparison is done from approximate estimate and the decision is made to select the project according to this comparison.
- Approximate estimate is required for getting the administrative approval for conducting detailed investigation, design and estimation.
- Approximate estimate for a property or project is required for insurances and tax scheduling.

1.8 Methods of Approximate Estimate

There are seven methods used for approximate estimate of the building.

- Plinth area or square meter method
- Cubic rate or cubic-meter method
- Approximate quantities with bill
- Service unit or Unit rate method
- Bay Method
- Cost comparison method
- Cost from materials and labor

1.8.1. Plinth area or square meter method:

This is prepared on the basis of plinth area of the building. The rate for unit plinth area is deducted from the cost of a building having similar specifications and dimensions in the locality. The plinth area is calculated for the covered area by taking external dimensions of the building at the floor level. Plinth area does not include the courtyard or any other open spaces.

1.8.2. Cubic rate or cubic-meter method:

In this method the cost is estimated by multiplying the cubical contents of the building (length × breadth × height) with the rate calculated in cubic meter which is deducted from a building having similar specifications and dimensions in the locality.

1.8.3. Approximate quantities with bill:

In this method the total length of walls is calculated from the plant. Length of different sections of the wall like foundation including plinth and super structure and area of wood work, flooring and roofing is calculated separately. These items are then multiplied by their cost per running meter length or area in sq. to obtain the total cost.

1.8.4. Service unit or Unit rate method:

In this method all costs of a unit quantity such as per km. (highway), per meter (bridge), per classroom (may be school or colleges), per bed (hospitals), per cubic meter (water tank) is calculated and multiplied with the cost per unit deducted from similar structures in the locality.

1.8.5. Bay Method:

The rate for one additional bay is calculated. Then the approximate estimated cost for the building is worked out by multiplying the number of bays in the proposed building with the cost of one such bay.

1.8.6. Cost comparison method:

When a number of dwellings of similar specification and dimensions are constructed as a part of a larger project for example staff quarters, the approximate estimates for all such dwellings can be estimated by multiplying the quantities of various items for a prototype structure with present market rates.

1.8.7. Cost from materials and labor:

Here approximate quantities of materials and labor per sq. of plinth area are calculated with some empirical equations or from past experience. This is then multiplied by total plinth area of the building to calculate the total quantity of materials and labor required

for the building. The total cost is calculated by multiplying these quantities with prevailing unit rate.

Practice question:

Q.1: Prepare approximate estimate of a building having Plinth Area of 1700 sqm using following data: Plinth Area Rate @ Rs. 7500/- per sqm; Contingencies @ 5%; Work Charged Estb @ 2%; Water Supply & Sanitary Arrangement @ 15% on cost of building; Electrification @ 8% on building cost; Architectural Fee @ 1.5% on cost of building.

1.9 Detailed Estimate:

Detailed estimate is prepared by working out the quantities of different items of work and then working out the cost by multiplying the quantities by their respective rates. The unit-quantity method is followed to prepare a detailed estimate where, the rates per unit work of one item including profit are estimated first and the total cost for the item is found, by multiplying the cost per unit of rate by the quantity of items. In detailed estimate provisions for any other expenses like contingencies, T&P, work-charged establishment etc. are added to the above cost to calculate the total amount required for project completion. The procedure for the preparation of a detailed estimate is divided into 2 parts:

a) Details of measurement and calculation of quantities
b) Abstract of estimated cost

1.9.1. Details of measurement and calculation of quantities

Representative measurements for dimensions of all individual items involved in the whole work are taken off from the drawing of the work and entered in respective columns of a standard measurement form as shown below. Then multiplying, item wise respective dimensions of the quantities of all items are worked out in the measurement form.

Details of measurement form:

Item No.	Description	Nos.	Length	Breadth	Height/ Depth	Quantity	Remark

1.9.2. Abstract of estimated cost

The cost of each item is calculated by multiplying the quintiles computed in the measurement form with a specific rate in a tabular form known as abstract form as shown below:

Abstract of estimate form

Item No.	Descriptions	Unit	Quantity	Rate	Amount

A percentage of 3% to 5% is added for contingencies, to allow for petty expenditures, unforeseen expenditures due to changes in design, changes in rate, etc. which may occur during execution of the work. Further, a percentage of 2.0% to 2.5% is also added to meet expenditure of the work charged establishment. For big projects an amount of 1% to 1.5% of the estimated cost is also provided to purchase special tools & plants for specific purpose.

The main functions of an abstract of estimate are as follows:

- The total estimated cost and the different items of works required to complete project can be known.
- Basis on which percentage rate tenders are called after excluding the amount for contingency and work-charged establishment.
- A part of tender document and a contractor can arrive at his own rates from the schedule of work described in the description column.
- This is the basis on which bills are prepared for payment.
- Comparative costs of different items of works can be known.

1.10 Data Required for Detailed Estimate

Following data are required for calculation of detailed estimate:

- **Drawing:** The quantities of various items are taken off from the drawings mainly: plans, sections, and other relevant details for the works.
- **Specifications:** The specification of the work describes the nature, class, workmanship, method of preparation etc. which are required to calculate the cost of various items.
- **Rates:** The rates for different items of work are derived from schedule of rates or from rate analysis. The estimated cost is calculated by multiplying the rates with the quantities of various items.
- **Standing circulars:** The taxes and insurance etc. prevailing at the locality of the work is required to fix up rates of various items.

1.11 Steps in Detailed Estimate

A detailed estimate can be analyzed in five distinct steps:

- Divide the whole project or work in various items.

- Divide the various items and group them under different sub heads.
- Enter the detailed of measurement of each item of work in measurements form and calculate the total quantity of each of them.
- After the quantities are taken off, the numbers, length, area or volumes are estimated and entered in last two columns of measurements sheet. All these values must be checked by different persons by tick-mark in other color ink. If any correction is done it must be cross checked.
- Finally, the cost under item of work is calculated from the quantities computed at workable rates. These costs along with rates are entered in '*Abstract Form'*. Therein, expenditures towards contingencies, work charge establishment and tools and plants are added to the estimated cost and then totaled. This grand total gives the estimated cost of work.

1.12 Factors Affecting the Cost of a Project

- **Quantity of materials:** For a large project, the quantity of materials required is large and thus it can be procured at a lower price.
- **Availability of materials:** The cost of materials, which are easily available, is comparatively lower.
- **Transportation of materials:** The cost of transportation is added to the cost of the material at site. Thus more is the transportation cost; the more is the cost of material.
- **Location of Site:** If the site is located at an odd place for which loading, unloading, staking and restacking of materials are necessary for several times. Thus, apart from cost incurred by such operations the possibility of damage or loss in transit is more which affects the cost.
- **Labor charges:** The skill and daily wage of the local labor affects the rate of a item.

1.13 Documents Accompanying Detailed Estimate

The detailed estimate is generally accompanied by following supporting documents:

a. Report on the design
b. Specifications
c. Working drawing (Plans, section, elevation and other details)
d. Design charts and calculations
e. Particulars of scheduled rates or rate analysis

CHAPTER 2

DETAIL ESTIMATION OF BUILDINGS

2.1. Building Estimate:

The quantities like earth work, foundation concrete, brickwork in plinth and super structure etc., can be workout by any of following three methods:

a. Long wall - short wall method
b. Centre line method.
c. Partly center line and partly cross wall method

2.3.1. Long wall-short wall method

In this method, the wall along the length of room is considered to be long wall while the wall perpendicular to long wall is said to be short wall. To get the measurement of materials and works length of long wall or short wall, calculate first the center line lengths of individual walls. Then the length of long wall, (out to out) may be calculated after adding half breadth at each end to its center line length. Thus the length of short wall measured into in and may be found by deducting half breadth from its center line length at each end. The length of long wall usually decreases from earth work to brick work.in super structure while the short wall increases. These lengths are multiplied by breadth and depth to get quantities.

2.3.2. Center line method

This method is suitable for walls of similar cross sections. Here the total center line length is multiplied by breadth and depth of respective item to get the total quantity at a time. When cross walls or partitions or verandah walls join with main all, the center line length gets reduced by half of breadth for each junction. Such junction or joints are studied carefully while calculating total center line length. The estimates prepared by this method are most accurate and quick.

2.3.3. Partly center line and partly cross wall method

This method is adopted when external (*i.e.,* around the building) wall is of one thickness and the internal walls having different thicknesses. In such cases, center line method is applied to external walls and long wall-short wall method is used to internal walls. This method suits for different thicknesses walls and different level of foundations. Because of this reason, all Engineering departments are practicing this method.

2.2. Main items in building work:

Main items of work are given below:

Sl. No.	Particulars	Unit	Remarks
1	Earthwork	Cum	Earthwork in excavation and in filling should be taken out separately under different types. Foundation trenches are usually dug to the exact width of foundation with vertical sides.
2	Bed concrete in foundation	Cum	It is calculated by taking length, breadth and thickness of concrete bed.
3	Soiling	sqm	When the soil is soft, one layer of brick or stone is laid below the bed concrete.
4	Damp proof course	Cum	It is a course provided at the plinth level under the wall for the full width of plinth wall. It is not provided at the sill of door and verandah openings for which deduction is made which calculating length of D.P.C.
5	Masonry		Masonry for foundation and plinth is taken under one item and masonry for superstructure is taken under separate item. In case of wall footing, masonry for steps is calculated separately and added together. In buildings having more one floor, the masonry for superstructure for each floor is computed separately. Deductions for openings like lintels, doors, windows, cupboards, etc. is done. Thin partition walls of thickness less than 10 cm, honeycomb brickwork is taken under separate item in square meter and no deduction for holes is done.
6	R. C. C. works	Cum	R.C.C. Work is calculated for beams, lintels, columns, footing, slabs etc. No deduction for steel is done while calculating the quantity of concrete, which includes centering, shuttering and fixing of reinforcement in position. Reinforcement (quantity of steel) is taken under separate item.
7	Reinforcement	Ton	The reinforcement quantity is taken off from detail drawing and bar bending schedule. If detail drawings are not available 0.8 to 3% of concrete may be taken by volumes as a quantity of steel which is further multiplied by density.

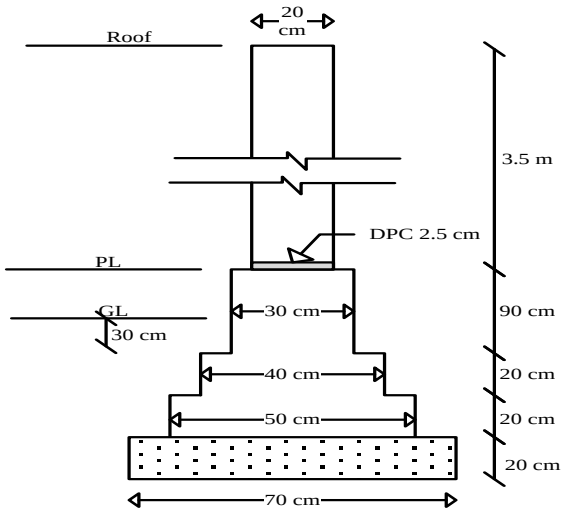
8	Flooring	Sqm/ Cum	For grounds floor, cement concrete and floor finishing of stone, marble or mosaic tiles taken under one item and quantity is calculated in square meter. For upper floors, bed of R.C.C. is taken cubic meter and other member is calculated in cubic meter.
9	Roof	Cum/ Sqm	In case of roof, flat roofs are calculated in cubic meter like slab and for pitched roof. Quantity of trusses and other members is calculated in cubic meter. In case of roofing material tiles, G.I. sheets or A.C. sheets are measured in square meter. Tiles on hip and valley are measured running meter.
10	Plastering and pointing	Sqm	Plastering is expressed with specified thickness. For masonry the measurements are taken for whole face of wall for both sides as solid and deduction for openings are made. External and internal plastering for building are taken out separately, under different items.
11	Doors and Windows	Cum/ Squm	It consists of frame and shutter. Doors and windows framers are calculated in cubic meter. Quantity is obtained by calculating length including jamb, head and sill and multiplied by cross-section of frame. Doors and window shutters are calculated in square meter. Shutter of different types should be taken separately because the rates differ. Hold-fast are taken as a separate item.
12	Painting, Varnishing, white washing and distempering	Sqm	-
13	Electrification	LS	Generally 8% of estimated cost of building works is taken for this item.
14	Sanitary and water supply works	LS	Generally 8% of estimated cost of building works is taken for this item.

2.3. Example 1: (Quantity estimation of a symmetrical wall)

The plan and cross section of a wall is given in Fig. 2.1. Estimate the quantities of following items per meter length of the wall.

a. *Earthwork in excavation in foundation trench*
b. *Lime concrete in foundation*
c. *First class brick work in 1:4 mortar mix in foundation and plinth*
d. *1st class brick work in superstructure wall*

e. 2.5 cm thick DPC (1:2:4) with water proofing compound



(Fig. 2.1)

Answer

(i) Earthwork in excavation (Length × Breadth × Height) = 1 × 0.7 × 0.9 = 0.63 cum

(ii) Lime concrete in foundation (L × B × H) = 1 × 0.7 × 0.2 = 0.14 cum

(iii) 1st class brickwork in foundation and plinth:

i. 1st footing (L × B × H) = 1 × 0.5 × 0.2 = 0.10 cum

ii. 2nd footing (L × B × H) = 1 × 0.4 × 0.2 = 0.08 cum

iii. Plinth wall (L × B × H) = 1 × 0.3 × 0.9 = 0.27 cum

Total = 0.45 cum

(iv) 1st class brickwork in superstructure (L × B × H) = 1 × 0.2 × 3.5 = 0.70 cum

(v) 2.5 cm thick DPC (L × B) = 1 × 0.2 = 0.20 sqm

Quantities can be estimated as above. But to denote the respective length, breadth and height against the dimensions estimates are prepared after ruling out measurement sheets as below.

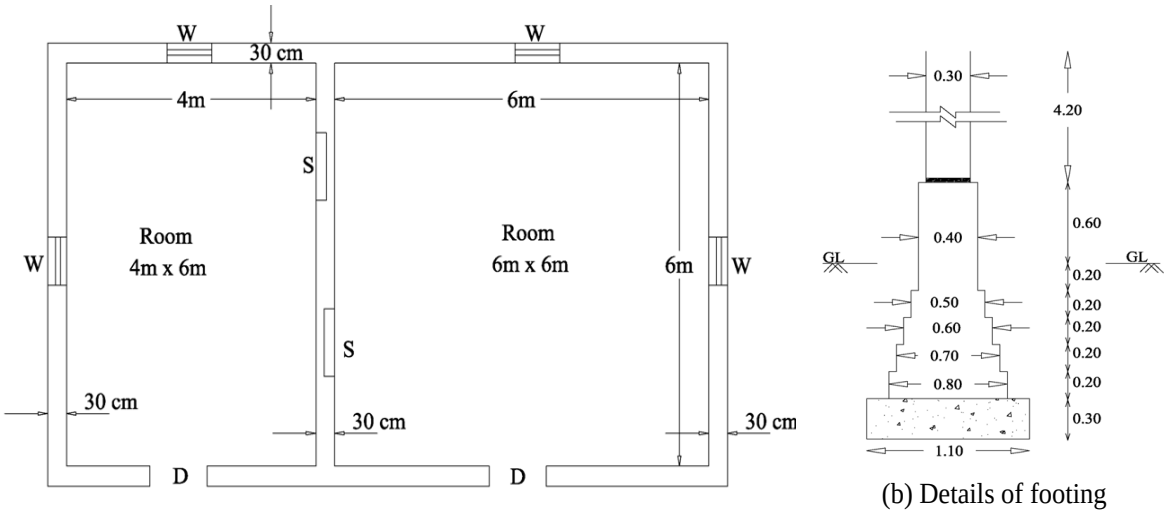
Detail Measurement and Calculation of Quantities

Item No	Description	Unit	No.	L	B	H	Quantity
1	Earthwork in excavation	cum	1	1	0.7	0.9	0.63
2	Lime concrete in foundation	cum	1	1	0.7	0.2	0.14
3	1st class brickwork (1:4) in foundation and plinth	cum					
	1st footing		1	1	0.5	0.2	0.10
	2nd footing		1	1	0.4	0.2	0.08
	Plinth wall		1	1	0.3	0.9	0.27
	Total =						0.45
4	1st class brickwork in superstructure	cum	1	1	0.2	3.5	0.70
5	2.5 cm thick DPC	sqm	1	1	0.2	-	0.20

2.4. Example on long wall - short wall method

Estimate the quantities of following items of a two roomed building given in Fig 2.2.

a. *Earthwork in excavation in foundation trench*
b. *Lime concrete in foundation*
c. *First class brick work in 1:6 cement mortar in foundation and plinth*
d. *2.5 cm thick DPC (1:2:4) with water proofing compound*
e. *1st class brick work in cement mortar superstructure*



(a) Plan

(b) Details of footing

(Fig. 2.2)

The dimensions of doors, windows and selves are

Door D = 1.20 m × 2.10 m.
Windows W = 1.00 m × 1.50 m
Shelves S = 1.00 m × 1.50 m

Answer: Given in next page

Detail Measurement and Calculation of Quantities

Item No.	Description	Unit	No.	L	B	H	Quantity	Explanation
1	Earthwork in excavation in foundation	cum						Long wall, c/c. length= $4+6+.30+2\times\frac{0.30}{2}=10.60m$
	Long wall		2	11.70	1.10	1.00	25.74	L = 10.60+1.10=11.70
	Short wall		3	5.20	1.10	1.00	17.16	L=6.30-1.10=5.20m
						Total =	42.90	
2	Lime concrete in foundation	cum						Length same for excavation
	Long wall		2	11.70	1.10	0.30	7.72	
	Short wall		3	5.20	1.10	0.30	5.15	
						Total =	12.87	
3	First class Brickwork in 1:6 cement mortar in foundation and plinth	cum						
	Long wall							
	1st footing		2	11.40	0.80	0.20	3.65	L=10.60+.80=11.40m
	2nd footing		2	11.30	0.70	0.10	1.58	L=10.60+.70=11.30m
	3rd footing		2	11.20	0.60	0.10	1.34	L=10.60+.60=11.20m
	4th footing		2	11.10	0.50	0.10	1.11	L=10.60+.50=11.10m
	Plinth wall above footing		2	11.00	0.40	0.80	7.04	L=10.60+.40=11.00m
	Short wall							
	1st footing		3	5.50	0.80	0.20	2.64	L=6.30-.80=5.50m
	2nd footing		3	5.60	0.70	0.10	1.18	L=6.30-.70=5.60m
	3rd footing		3	5.70	0.60	0.10	1.03	L=6.30-.60=5.70m
	4th footing		3	5.80	0.50	0.10	0.87	L=6.30-.50=5.80m
	Plinth wall above footing		3	5.90	0.40	0.80	5.66	L=6.30-.40=5.90m
						Total =	26.10	

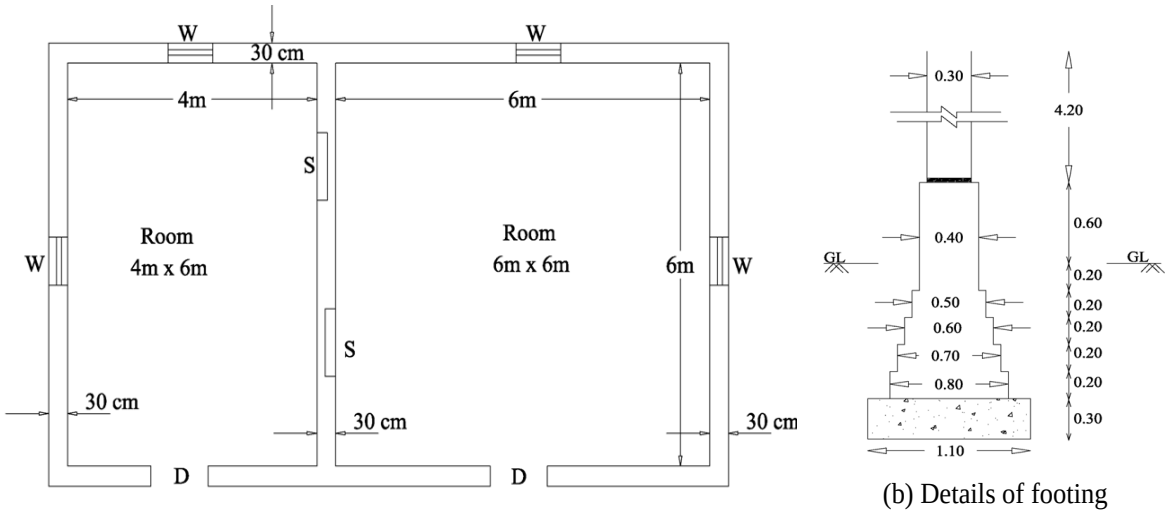
Detail Measurement and Calculation of Quantities

Item No.	Description	Unit	No.	L	B	H	Quantity	Explanation
4	2.5 mm thick DPC	sqm						
	Long Walls		2	11.00	0.40	--	8.80	L=10.60+.40=11.00m
	Short wall		3	5.90	0.40	--	7.08	L=6.30-.40=5.90m
	Deduct door sills		(-) 2	1.20	0.40	--	(-) 0.96	
						Total =	14.92	
5	1st class brick work in lime mortar in superstructure	cum						
	Long Walls		2	10.90	0.30	4.20	22.47	L=10.60+.30=10.90m
	Short wall		3	6.00	0.30	4.20	22.68	L=6.30-.30=6.00m
	Deduct for door opening		(-) 2	1.20	0.30	2.10	(-) 1.51	
	Deduct for windows opening		(-) 4	1.00	0.30	1.50	(-) 1.80	
	Deduct for shelves		(-) 2	1.00	0.20	1.50	(-) 0.60	Back of shelves 10 cm thick wall
	Deductions for lintel over doors		(-) 2	1.50	0.30	0.15	(-) 0.14	Bearing 15 cm
	Deductions for lintel over windows		(-) 4	1.30	0.30	0.15	(-) 0.23	Bearing 15 cm
	Deductions for lintel over shelves		(-) 2	1.30	0.30	0.15	(-) 0.12	Bearing 15 cm
						Total =	45.75	

2.5. Example on center line method

Estimate the quantities of following items of a two roomed building given in Fig 2.3.

a. *Earthwork in excavation in foundation trench*
b. *Lime concrete in foundation*
c. *First class brick work in 1:6 cement mortar in foundation and plinth*
d. *2.5 cm thick DPC (1:2:4) with water proofing compound*
e. *1st class brick work in cement mortar superstructure*



(a) Plan

(b) Details of footing

(Fig. 2.3)

The dimensions of doors, windows and selves are

Door D = 1.20 m × 2.10 m.
Windows W = 1.00 m × 1.50 m
Shelves S = 1.00 m × 1.50 m

Ans:

Total center length of the wall = 2 × c/c of long wall + 3 × c/c of short wall
= 2 × 10.60 m + 3 × 6.30 m = 40.10 m

It may be noted that, the above length includes some over lapped portions at the joints and these excess quantities shall have to be deducted. This is accomplished by reducing the center length by half breadth for each junction. The same principle applies to foundation concrete, to footings, plinth wall and superstructure wall. At every stage deduction of half breadth of the main wall at that particular level shall have to be made per junction from the total Centre length, and this net Centre length after deduction shall be multiplied by the respective breadth and height or depth to get quantities.

Detail Measurement and Calculation of Quantities

Item No.	**Description**	**Unit**	**No.**	**L**	**B**	**H**	**Quantity**	**Explanation**
1	Earthwork in excavation in foundation	cum	1	39.00	1.10	1.00	42.90	Center length $(L) = 40.10 - 2 \times \frac{1.10}{2} = 39.00\ m$
2	Lime concrete in foundation	cum	1	39.00	1.10	0.30	12.87	Length same for excavation
3	First class Brickwork in 1:6 cement mortar in foundation and plinth	cum						
	1^{st} footing		1	39.30	0.80	0.20	6.29	$L = 40.10 - 2 \times \frac{.80}{2} = 39.30m$
	2^{nd} footing		1	39.40	0.80	0.10	2.76	$L = 40.10 - 2 \times \frac{.70}{2} = 39.40m$
	3^{rd} footing		1	39.50	0.60	0.10	2.37	$L = 40.10 - 2 \times \frac{.60}{2} = 39.50m$
	4^{th} footing		1	39.60	0.50	0.10	1.98	$L = 40.10 - 2 \times \frac{.50}{2} = 39.60m$
	Plinth wall above footing		1	39.70	0.40	0.80	12.70	$L = 40.10 - 2 \times \frac{.40}{2} = 39.70m$
						Total =	26.10	

Detail Measurement and Calculation of Quantities

Item No.	Description	Unit	No.	L	B	H	Quantity	Explanation
4	2.5 mm thick DPC	sqm	1	39.70	0.40	--	15.88	$L = 40.10 - 2 \times \frac{.40}{2} = 39.70m$
	Deduct door sills		(-) 2	1.20	0.40	--	(-) 0.96	
						Total =	14.92	
5	1st class brick work in lime mortar in superstructure	cum	1	39.80	0.30	4.20	50.15	$L = 40.10 - 2 \times \frac{.30}{2} = 39.80m$
	Deduct for door opening		(-) 2	1.20	0.30	2.10	(-) 1.51	
	Deduct for windows opening		(-) 4	1.00	0.30	1.50	(-) 1.80	
	Deduct for shelves		(-) 2	1.00	0.20	1.50	(-) 0.60	Back of shelves 10 cm thick wall
	Deductions for lintel over doors		(-) 2	1.50	0.30	0.15	(-) 0.14	Bearing 15 cm
	Deductions for lintel over windows		(-) 4	1.30	0.30	0.15	(-) 0.23	Bearing 15 cm
	Deductions for lintel over shelves		(-) 2	1.30	0.30	0.15	(-) 0.12	Bearing 15 cm
						Total =	45.75	

CHAPTER 3

REINFORCEMENT QUANTITY ESTIMATION

3.1. Reinforcement

In RCC works, steel reinforcement may be used in the form of (a) plain round steel bars, (b) deformed bars, (c) cold twisted bars and (d) hot drawn steel tendons (in pre-stressed concrete structures) and the estimation of quantities for each type should be done separately. Accurate quantities of steel works can be calculated from the detail reinforcement drawings. However, if working drawings and schedules for the reinforcement are not available it is necessary to provide an estimate of the anticipated quantities which generally is estimated in accordance with the requirements of the standard method of measurement of building works.

The reinforcement quantities can be estimated by two methods:

(i) Approximate method, and
(ii) Estimation from bar bending schedule

3.2. Approximate method

There are two approximate methods for estimation of steel quantities. The crudest method is based on the cubical content of the structure and type. Typical values are:

- For warehouses and similarly loaded structures: 1 ton per 10.5 m^3 of structure
- For offices, shops, hotels: 1 ton per 13.5 m^3 of structure
- For residential, schools, temples: 1 ton per 15.05 m^3 of structure

The second approximate method is by estimating the cubical content of various members of the structure. Following table (Table 3.1) gives the estimated quantities of reinforcement and its size generally used for various building works. The volume of various reinforced concrete members such as footings, beams, columns, slabs, lintels etc. are estimated first. Then the approximate quantities of reinforcement can be calculated by multiplying this volume with the approximate reinforcement required by the member.

Table 3.1 (Approximate reinforcement quantity required for various concrete members)

Sl. No	RCC Member	Quantity in kg/m^3	Size of reinforcement required
1	Column footings	75	10mm or 12mm
2	Grade beams	100	12mm, 16mm – 85% Stirrups – 6mm or 8mm– 15%
3	Plinth beams	125	8mm diameter – 85%, Stirrups 6mm – 15%
4	Columns	225	16mm, 20mm and 25mm – 90% Ties – 6mm or 8mm – 10%
5	Lintel beam	125	12mm, 16mm dia – 85% Stirrups – 6 mm or 8mm – 15%
6	Sunshades	60	8mm dia – 75% Distributer – 6mm – 25%
7	Canopy slab up to 2.0 m span	125	10mm dia – 80% Distributor bars – 6mm or 8mm – 20%
8	Staircase waist slab	150	12 or 16mm dia – 80% Distributor 8mm dia – 15%
9	Roof slab		
	(a) One way slab	80	8mm dia – 70% Distributor – 6mm – 30%
	(b) Two way slab	100	8mm dia – 100%
	(c) Square slab – 4m to 6m size	150	10 – 12mm dia – 100%
10	Main beams above 6m	250	20mm, 16mm, 12mm – 80 – 85% Stirrups – 8mm – 15 – 20%

3.3. Reinforcement quantity estimation from bar bending schedule

Bar bending schedule (or schedule of bars) is a list of reinforcement bars, vis-à-vis, a given RCC work item, and is presented in a tabular form for easy visual reference. This table summarizes all the needed particulars of bars – diameter, shape of bending, length of each bent and straight portions, angles of bending, total length of each bar, and number of each type of bar. This information is a great help in preparing an estimate of quantities as the weight of each reinforcement type can be estimated by directly multiplying the length and number of each bar type with its the per meter weight. This method has the advantages that:

- The sketches are representative of the actual structure
- The sketches include the intended form of detailing and distribution of main and secondary reinforcement
- An allowance of additional steel for variations and holes may be made by inspection.

Fig. 3.1 depicts the shape and proportions of hooks and bends in the reinforcement bars – these are standard proportions that are adhered to:

- Length of one hook $= (4d) + [(4d + d)] = 9d$, where, $(4d + d)$ refers to the curved portion [Fig. 3.1 (a)].
- The additional length (l_a) that is introduced in the simple, straight end-to-end length of a reinforcement bar due to being bent up at Φ^0.

$$\therefore \text{ The additional length} = \frac{D}{\sin\theta} - \frac{D}{\tan\theta}$$

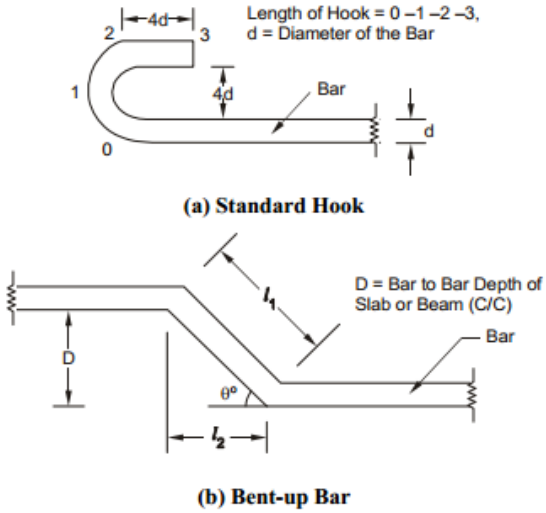


Fig. 3.1: Reinforcement detail at hook and bent-ups.

From Fig. 3.1 (b), $tan\theta = D/l_2$ and $sin\theta = D/l_1$

Thus, $l_a = \left(\frac{D}{sin\theta} - \frac{D}{tan\theta}\right)$

For a 45^o bent up bar, the additional length is given by $l_a = l_1 - l_2$ [Fig. 3.1 (b)]

Table 3.2 the additional reinforcement lengths, for different angles of bent up. Further, Table 3.3 tabulates some typical bar bending schedules along with their lengths.

Table 3.2 (Additional length of bent up bars)

Sl. No.	θ°	$\frac{D}{\sin\theta}$	$\frac{D}{\tan\theta}$	Additional Length of Bent-up Bar, l_a
1	30°	$\frac{D}{0.5}$	$\frac{D}{0.5733}$	**0.27 *D***
2	45°	$\frac{D}{0.707}$	$\frac{D}{1.0}$	0.414 *D* ≈ **0.42 *D*** (0.42 *D* is generally the value that is adopted)
3	60°	$\frac{D}{0.866}$	$\frac{D}{1.732}$	0.577 *D* ≈ **0.58 *D*** (0.58 *D* is usually adopted)

Table 3.3 (Typical Bar Bending Schedule)

Sl. No.	Details of Bar Shape	Length of Hooks	Total Length of Bar
1.	Diameter, 4d, [Straight bar], 4d, *l*	2[9d] = 18 d (both hooks together)	[*l* + 18 d]
2.	[Bent-up at one end only]], x = $\frac{l}{4}$ to $\frac{l}{6}$, D, 45°, x, *l*, D = Vertical distance (C/C) between bars	2[9d] = 18d (both hooks together)	[*l* + 18 d + 0.42 D]
3.	(Double bent-up bar), x = $\left(\frac{1}{4}\right.$ to $\left.\frac{1}{6}\right) l$, *l*, D, 45°, 45°, x, x	2[9d] = 18d (as for above cases)	[*l* + 18 d + 2 × 0.42 D]
4.	(Overlap of bars), 40 d to 45 d, (Joint)	2[9d] = 18d	Overlap length at joint = [(40 d to 45 d) + 18 d]
5.	l_1, l_2	[Here, one hooks height = 14d] 2 × (14d) = 28 d	[l_1 + 2l_2 + 28 d]
6.	l_1, l_2	2(12d) = 24 d	[2(l_1 + l_2) + 24 d]

3.4. Calculation for weight of reinforcement

The density of tor bars may be taken as 7850 kg/m^3.

Thus the weight for 'd' mm diameter tor bar of unit length is $= \left(\frac{\pi}{4} d^2 \times 10^{-6}\right) \times 7850$ $= 0.00618 \times d^2$ kg. Table 3.4 provides the weight per running meter for common tor steel bars.

Table 3.4 (Weight and areas of common tor steel round bars)

Diameter (mm)	Sectional area (mm^2)	Weight (kg/meter length)
5	20.00	0.16
6	28.30	0.22
8	50.30	0.39
10	78.60	0.62
12	113	0.89
16	201	1.58
20	314	2.47
22	380	2.98
25	491	3.85
28	616	4.83
32	804	6.31
36	1118	7.99
40	1257	9.86
45	1590	12.49

3.5. Example on reinforcement quantity estimation

Prepare a bar bending schedule for a RCC beam of 4 m. clear span, 300 mm width and 450mm depth. It consists of $2-12mm\ \phi$ *hanger bars,* $2-16mm\ \phi$ *main longitudinal bars and* $2-12mm\ \phi$ *bent up bars at the bottom as shown in Fig. 3.2.* $8\ mm\ \phi$ *Stirrups at a spacing of 180 mm c/c are provided though out the length of the beam. The clear cover to the reinforcement is 40 mm.*

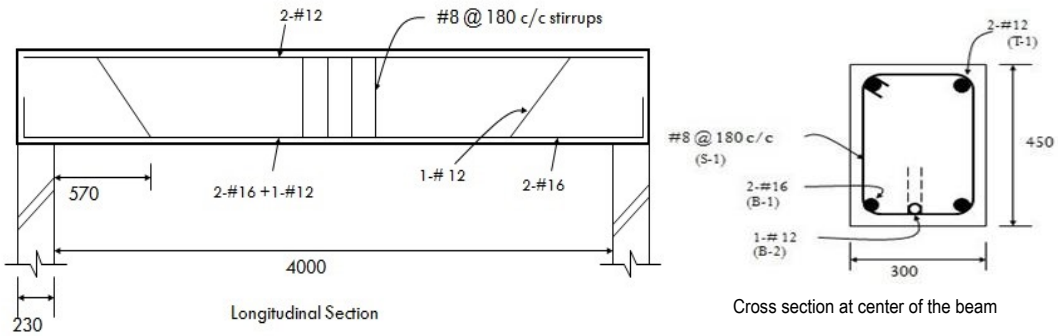


Fig: 3.2 (Reinforcement Details for the RCC beam)

***Answer*:**

The first step in bar bending schedule is to calculate the length of various reinforcement types.

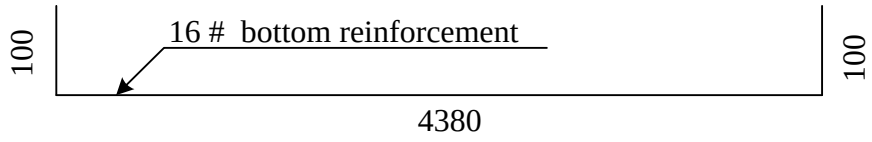
(i) *Calculation for 16 # bottom reinforcement (T1)*

The length for this T1 type reinforcement will be:

Length of T1 = clear span of the beam + 2 × support width – 2 × clear cover to reinforcement + 2 × bond length.

As per IS: 1786-1961, minimum bond length required $= 6\phi$. Where, ϕ is the diameter of the reinforcement. Thus, for present example, the bond length is 6×16 = 96 mm or 100 mm (say).

The length of T1 = 4000 + 2×230 - 2×40+2×100 = 4580 mm.



Details of T1 type reinforcement

(ii) *Calculation for 12 # bent up bars (T2)*

Length of T2

$= \text{L} + 2 \times$ additional length due to bent up $+ 2 \times$ length of hooks,

L = clear span of the beam + 2 × support width – 2 × clear cover to reinforcement

= 4000 + 2× 230 – 2 × 40 = 4380 mm

$$The\ vertical\ distance\ of\ the\ bent\ up\ bar\ (H) = depth\ of\ the\ beam - 2 \times clear\ cover\ to\ reinforcement - 2 \times stirrup\ diameter - 2 \times (diameter\ of\ bent\ up\ bar/2)$$

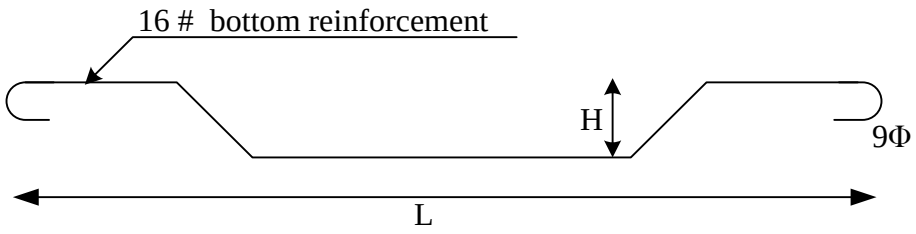
Or, H = 450 – 2 × 40 - 2 × 8 - 2 × (12/2) = 342 mm.

$L_a =$ additional length due to bent up $= (1.414\,H - H)$ = 141.6 mm = 142 mm.

Length of hooks = 9 × Φ = 9 × 12 = 108 mm

Thus, the Length of T2 $= \text{L} + \text{L}_\text{a} + 2 \times$ length of hooks,

= 4380 + 2 × 142 + 2 × 108 = 4880 mm

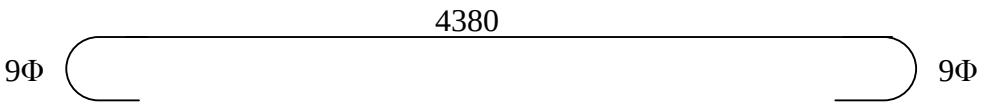


Details of T2 type reinforcement

(iii) *Calculation for 12 # hanger bars (T3)*

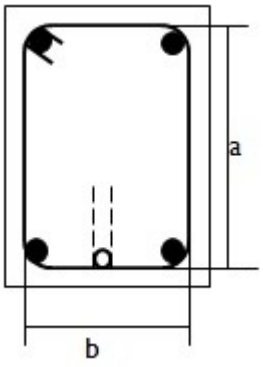
Length of T3 = clear span of the beam + 2 × support width – 2 × clear cover to reinforcement + 2 × length of hooks.

Length of T3 = 4000 + 2 × 230 – 2 × 40 + 2 × 9 × 12 = 4596 mm



Details of T3 type reinforcement

(iv) *Calculation for 8 # stirrups (T4)*



Details of stirrups (T4)

The spacing between two stirrups is 180 mm center to center. Thus the number of stirrups will be required is:

$$n = \frac{4000}{180} + 1 = 23.22\ (\text{Or}, 24)$$

The length (a) and width (b) of the stirrups are:

$$Length\ (a) = 450 - 2 \times 40 - 8 = 362$$

$$Width\ (b) = 300 - 2 \times 40 - 8 = 212$$

The hook length of the stirrups is $12\phi \; or \; 90 \; mm \; which \; is \; maximum$

Therefore, the hook length is at least 96 mm (say 100 mm).

Thus, the length of one stirrup is $T4 = 2 \times (a + b + \text{hook length})$.

Or, length of 1 stirrup = $2 \times (362 + 212 + 96) = 1340 \; mm$

Bar Bending Schedule for RCC Beam

Bar Type	Shape	Numbers	Length	Diameter	Unit Weight (kg)	Total Weight (kg)
T1		2	4580	16	1.58	14.47
T2		1	4880	12	0.89	4.34
T3		2	4596	12	0.89	8.18
T4		24	1340	8	0.39	12.54
					Total =	39.53

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CHAPTER 4

QUANTITY ESTIMATION IN BRIDGES AND CULVERTS

4.1. Terminology:

Culvert: A culvert is a cross-drainage structure having a total length (liner waterway) of 6m or less between the inner faces of the dirt wall or extreme vent-way boundaries measured at right angles thereto. As a general rule, a minimum of 6m of linear waterway should be provided per 15.km of the road for efficient drainage. The types of culverts are:

- Hume pipe culvert
- Slab culvert
- Box culvert

Bridge: A bridge is a structure having a total length above 6m between the inner face of the dirt walls for carrying traffic or other moving loads over a depression or obstruction such as channel, road or railway. They are classified as minor or major bridges as per the criteria given below:

- Minor Bridge: Span greater than 6m up to 60m
- Major Bridge: Span greater than 60m

Abutment: Abutment is the structures at the ends of a bridge whereon the structure's superstructure joins the bank of waterway. Abutments function as both a vertical load carrying structure and as an earth retaining structure.

Pier: Single-span bridges have abutments at each end. However, multi-span bridges require piers to support the ends of individual spans between these abutments.

Retaining Wall: A retaining wall is a structure that holds back the soil and prevents it from sliding or eroding away when there is a drastic change in elevation. It is designed so that to resist the material pressure of the material that it is holding back.

Return Wall: A return wall is retaining wall built parallel to the center line of a road to retain the embankment.

Wing Wall: Wing wall is a retaining wall which sustains the embankments of the approaches where they join the bridge.

Curtain Wall: Cross walls are built across the stream on the up-stream or down-stream in order to protect the structure from erosion due to strong current of water induced by the restriction of free passage of water through the water way.

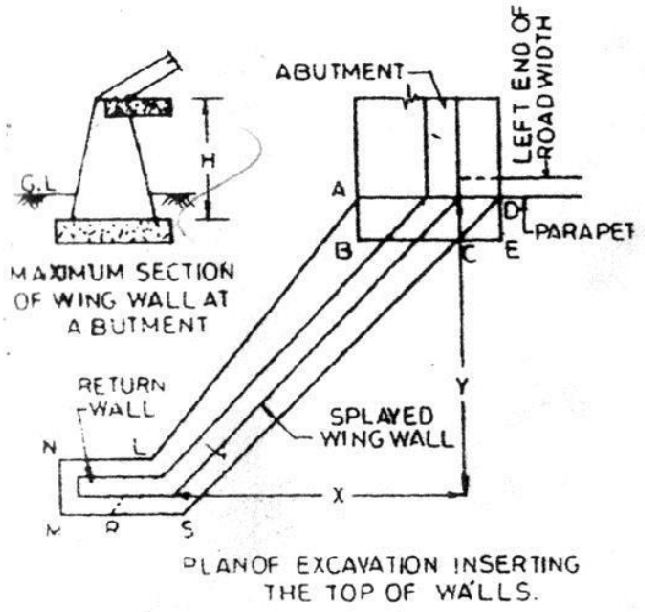


Fig. 4.1 (Plan showing abutment, wing wall and return wall)

4.2. Quantity estimation

4.2.1. Abutment

For each or concrete work:

- Length = Road width+2 (parapet thickness + one side end efforts).
- Breadth and depth are shown in the section of the abutment.

For masonry work below G.L.:

- Length = same as concrete work as above – 2 x offset of concrete.

  (*Length for each individual offset differs and should be calculated individually by deduction of the projections from the each end.*)

- Breadth and depth for each individual offset are shown in the section of the abutment.

For masonry work above G.L.:
With vertical inner face:

- Length = Road width + 2parapet thickness (outer face battering should not be accounted if any).

Breadth and depth are as shown in the section.

With battered inner face :

When the inside the face of Abutment is continued to wing wall the extra bottom length due to batter may be considered as if included in the wing wall i.e. the two walls join on a vertical plane.

- Length = Road width + 2 parapet thickness.

When the width of abutment at the ends is not equal to the inclined width of the wing wall joining with abutment:

- Length = ½ (Top length + Bottom length).
- Bottom length – Top length + 2 x offset due to inner batter face of Abutment.

4.2.2. Wing wall

The thickness and height of the wall is the maximum at the junction with its abutment and both the dimensions are gradually reduced to the section as that at return wall with which it joins.

For earth or concrete work:

- Length = Y + offsets from the outer edge of return wall
- Breadth = ½ × (AD+RS)
  - Where, AD is the inclined trench width of wing wall parallel to the center line of the road and generally the trench width of the abutment. If not equal, the offset (as shown in Fig. 11-1) is mentioned.
  - RS = Inclined foundation trench width of Return wall parallel to the center line of the road

    $= \text{Foundation width of Return wall} \times \sqrt{\sum \text{sq. of prop. of splay.}}$

    Usually, proportion of splay = X : Y = 1 : 1 (*for 45^0*)

    Then, $\sqrt{\sum \text{sq. of prop. of splay.}} = \sqrt{1^2 + 1^2} = 1.414$
- Depth = usually the same depth of excavation as that of abutment is provided.

Deduction for end offset of abutment:

During excavation for abutment, a part for wing wall (the portion ABCD in Fig. 11.1) has already been excavated. Therefore, the volume of work for this portion should be deducted from the volume of work for the wing wall.

Deduction for Abutment offset

$$= \frac{1}{2} \times \left[\text{trench width} + \left(\text{trench width} - \text{offset} \times \frac{X}{Y}\right)\right] \times \text{depth}$$

For concrete work the depth of concrete instead of depth earthwork shall be considered.

For masonry work below G.L.:

- Length = Y + offset of masonry in foundation of return wall
- Breadth = same process as that of earthwork
- Depth = thickness of the footing.

The construction of wing wall may be with its battered inner and outer faces starting from the top of the foundation concrete up to top. In such cases the whole mass shell is calculated in one operation considering this as *Frusta of Pyramid*, erected vertically on AD as base.

- $Volume = {}^{h}/_{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$,

Where, A_1 and A_2 are the areas of the ends, *i.e.* vertical sectional area at the abutment and the vertical sectional area at the end; *h* is the measurement of Y.

Deduction for end offset of abutment:

Following the same procedures as in the case of earthwork deduction for Abutment offset for the corresponding footing of wing wall $= ½ \times \left[\text{width of Abut. Footing} + \left(\text{width of Abut footing} - \text{projection}\right) \times {}^{\text{X}}/_{\text{Y}}\right\} \times \text{depth}$. The projection is form top face of the Abutment up to the edge of the corresponding footing.

For masonry work above G.L.:

Wing walls above G.L. may have the following shapes:

1. Inside face vertical or battered but at the outer face with offsets;
2. Both the faces are battered.

Inside face vertical with offsets at the outer face:

Before starting the estimate, let us clarify how offsets are provided at the outside face of the wing wall. Let the top plan of wall is ABCD with three offsets, D_1D, E_1E and F_1F of lengths L_1, L_2 and L_3 respectively as shown in Fig . 11.2.

The height of the wing wall is h_1 at the end and h_2 at Abutment. The top of ABCD of the wing wall is sloped downward uniformly from AB to DC. To have a clear picture regarding the shape of the outside offsets, let us assume that, we are to reach the inclined level AF of the from the left side ground level. For this purpose three numbers steps ADD_1, AEE_1 and AFF_1 are constructed with uniform rise h_1 and $h_2 = 4h_1$.

But, actually these triangular steps are known as offsets of the wing wall. The projections are shown on plan and height on elevation drawn by the side of section of the Abutment. The purpose of these offset is to strengthen the core part ABCD of the wing wall.

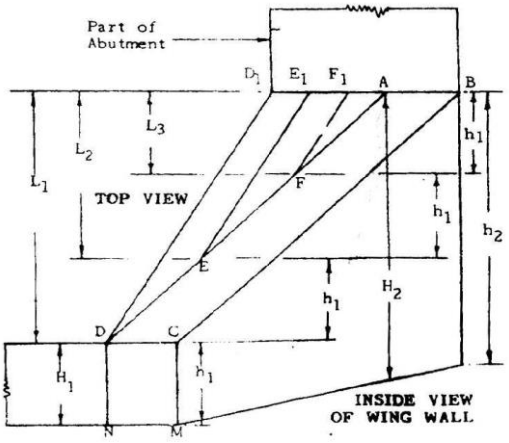


Fig. 4.2 (Inside view of wing wall)

Masonry work above G.L. excluding offsets but including inside batter:

Considering mass as a Frusta of Pyramid, $Volume = {}^{h}/_{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$. The notations are same as before. When there be no battered at the face, the volume for the rectangular mass within the same inclined width through its length shall be calculated for different heights at the ends by ordinary method, *i.e.*, average depth × inclined breadth × straight length.

- $Vol.of\ 1^{st}\ offset = \frac{h}{2} L_1 \times AD_1 \times h_1$
- $Vol.of\ 2^{nd}\ offset = \frac{h}{2} \times L_2 \times AE_1 \times h_1$
- $Vol.of\ 3^{rd}\ offset = \frac{h}{2} \times L_3 \times AF_1 \times h_1$

Deduction of Abutment offset:

When the width of Abutment at the ends is not equal to the inclined width of the wing wall as the well as the inside face of the Abutment is battered then the length of the Abutment includes the offsets at the end. In this case deduction for the offset projection is made from the volume of wing wall.

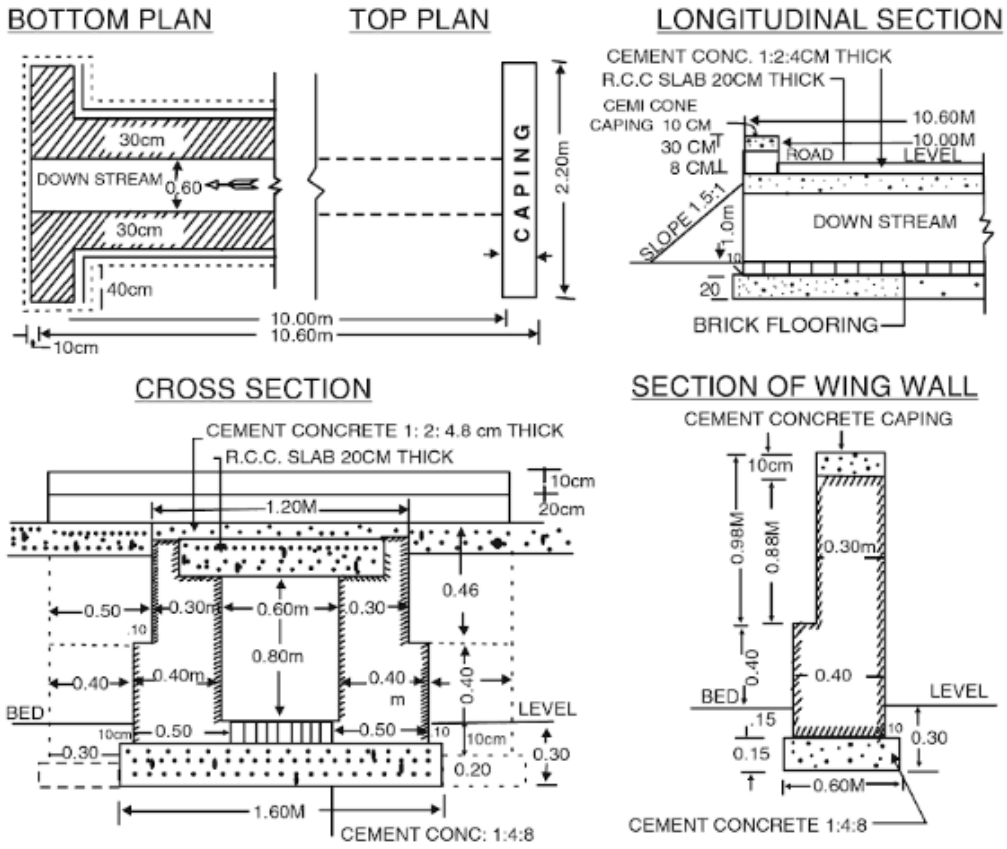
4.2.3. Return wall

For earthwork in excavation (Refer Fig. 11.1)

- Length = Average length for the RMNL = ½ (RM + NL)
- RM = MS − RS, where length of RS is same as calculated before.
- NL = RM + MN $\times \frac{X}{Y}$, where, MN is the trench width.

4.3. Example 4.1

Prepare a detailed estimate for a 60 cm span slab culvert of the given details and plans, and elevation as shown in Fig. 4.3.



Minimum offset for abutment = 10 cm

Fig 4.3 detailed drawings of the slab culvert

Detail Measurement and Calculation of Quantities

Item No.	Descriptions	Unit	No.	Length	Width	Ht./Th.	Quantity
1	**Earthwork Excavation of Foundation**	Cum					
	Abutments and floors (10.60+0.10×2)		1	10.80	1.60	0.30	5.18
	Wing walls		4	0.40	0.60	0.30	0.29
	Total Quantity =						**5.47**

2	**Cement Concrete 1:4:8 in foundation**	Cum					
	Abutments and floors		1	10.80	1.60	0.30	3.46
	Wing walls		4	0.40	0.60	0.15	0.14
	Total Quantity =						**3.60**
3	**Cement Concrete 1:2:4**	Cum					
	In parapet coping		2	2.20	0.30	0.10	0.13
	Wearing coat over the slab		1	10.00	1.20	0.08	0.96
	Total Quantity =						**1.09**
4	**Reinforced Cement concrete 1:2:4 including reinforcements**	Cum					
	In Slab		1	10.60	1.00	0.20	2.12
	Total Quantity =						**2.12**
5	**First class burnt brick laid in cement mortar (1:5) in foundation and superstructure**	Cum					
	Abutment 1st step		2	10.60	0.50	0.10	1.06
	Abutment 2nd step		2	10.60	0.40	0.40	3.39
	Abutment 3rd step		2	10.60	0.30	0.60	3.82
	Wing walls 1st step		4	0.30	0.50	0.50	0.24
	Wing walls 2nd step		4	0.40	0.30	0.50	0.32
	Wing walls 3rd step		4	0.50	0.30	0.88	0.53
	Parapet walls on the slab		2	1.20	0.30	0.28	0.20
	Deductions						
	Bearing of the slab		(-) 2	10.60	0.20	0.20	(-) 0.85
	Total Quantity =						**8.71**
6	**Brick flooring laid in cement mortar (1:6)**	Sq.m	1	10.60	0.40	-	4.24
	Total Quantity =						**4.24**

7	**Cement pointing deep variety (1:2)**	Sq.m.					
	Inside the abutment		2	10.60	-	0.80	16.96
	Outside the faces (1.28+0.20)		2	2.20	-	1.48	6.51
	Deductions						
	Side openings		(-) 2	0.60	-	0.80	(-) 0.96
	Side faces		(-) 2	1.00	-	0.20	(-) 0.40
	Total Quantity =						**22.11**
8	**Cement pointing flush floor**	Sq.m.	1	10.60	0.60	-	6.36
	Total Quantity =						**6.36**

Abstract of Estimation

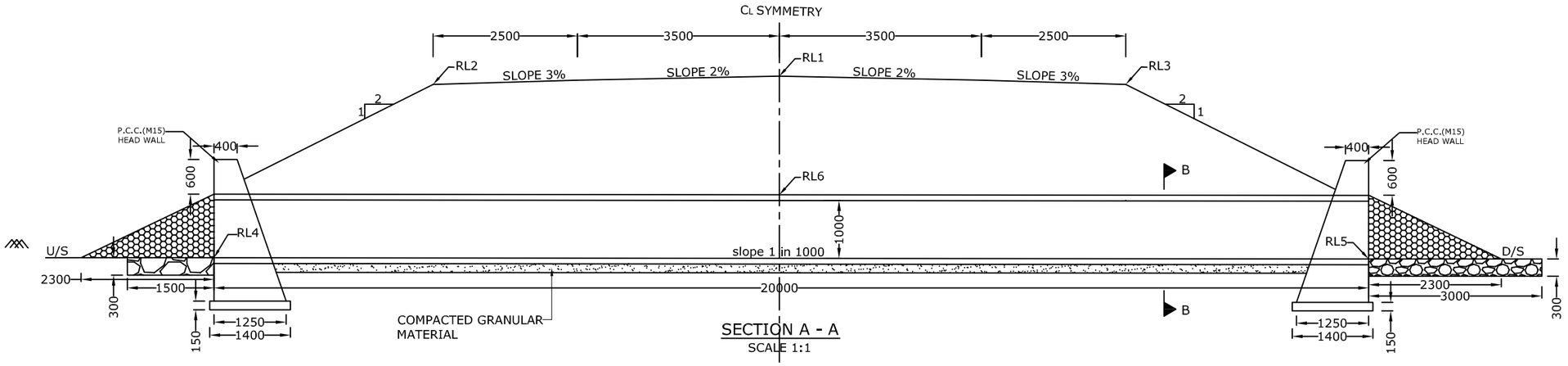
Details of work	**Unit**	**Quantity**	**Rate**	**Amount**
Excavations for foundation	Cu m	5.47	22.50	123.10
Cement Concrete 1:4:8 in foundation	Cu m	3.60	170.00	612.00
Cement Concrete 1:2:4	Cu m	1.09	322.00	351.00
Reinforced Cement concrete 1:2:4 including reinforcements	Cu m	2.12	750.00	1590.00
First class burnt brick laid in cement mortar (1:5) in foundation and superstructure	Cu m	8.70	165.00	1435.00
Brick flooring laid in cement mortar (1:6)	Sq. m	4.24	16.00	68.00
Cement pointing deep variety (1:2)	Sq. m	22.11	5.80	128.50
Cement pointing flush floor	Sq. m	6.36	6.10	39.00
			Total Amount =	**4346.60**

4.4. Example 4.2

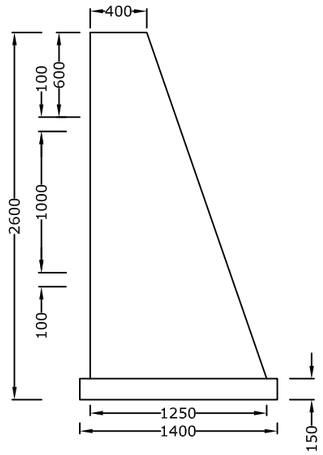
Prepare a detailed estimate for a HP culvert of 100 cm diameter from the given details and plans, and elevation as shown in Fig. 4.4. Foundation concrete shall be of 1:3:6. Concrete at head wall will be of M15 grade.

Table 4.1 (Details for HP culvert)

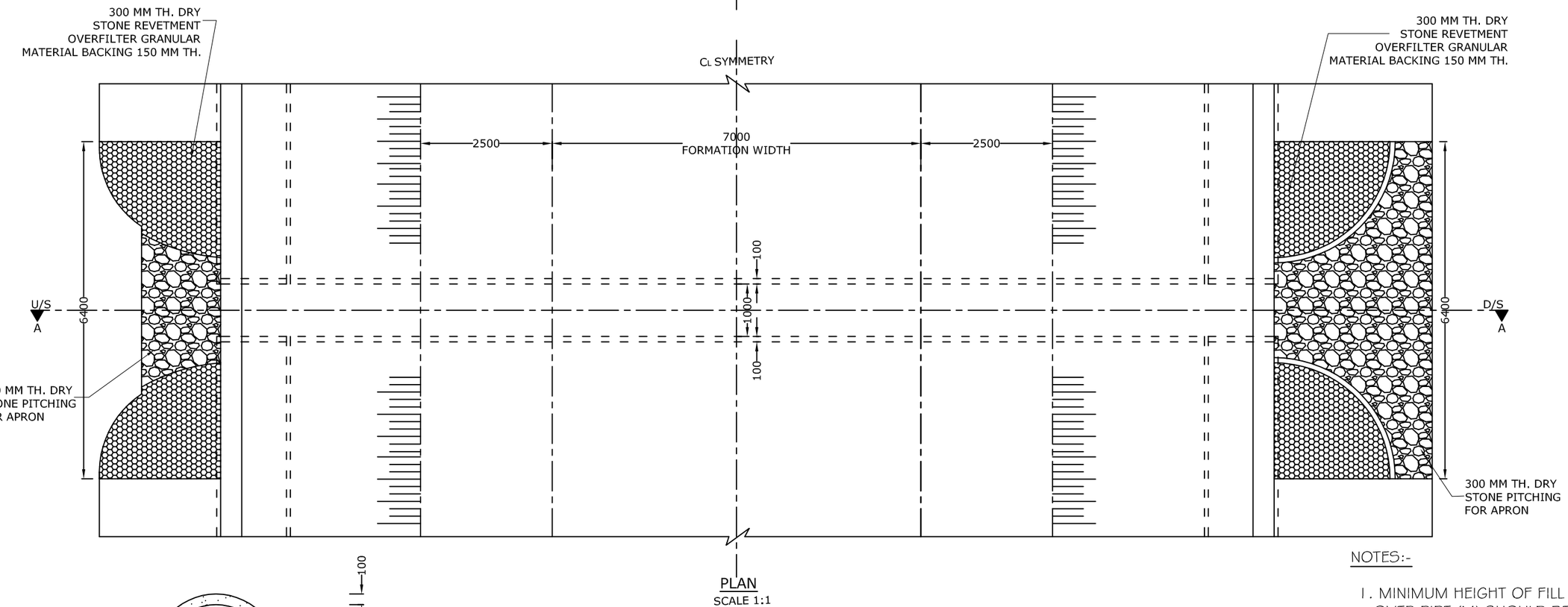
Pipe Internal Dia (mm) :	*1000*
Pipe Thickness (mm) :	*100*
No. of Row :	*1*
RL1/FRL :	*273.750*
RL2 :	*273.605*
RL3 :	*273.605*
RL4 :	*270.608*
RL5 :	*270.588*
RL6 :	*271.698*
Total Thickness of crust (mtr) :	*0.625*
Existing Road Lvl :	*272.970*
Top width of existing road (mtr) :	*5.0*
Present Side Slope :	*1.5*
Head wall Position (No of sides to be provided) :	*1*
Head wall Length (mtr)	*6.4*
Depth of concrete cradle	*0.45*
Length of Pipe (Outer to Outer of Head wall (mtr) :	*20.00*
Width of Concrete Cradle (mtr) :	*2.40*
Pitching :	
D/S:	
Length (mtr) :	*6.40*
Breadth (mtr) :	*3.00*
U/S:	
Length (mtr) :	*6.40*
Breadth (mtr) :	*1.50*



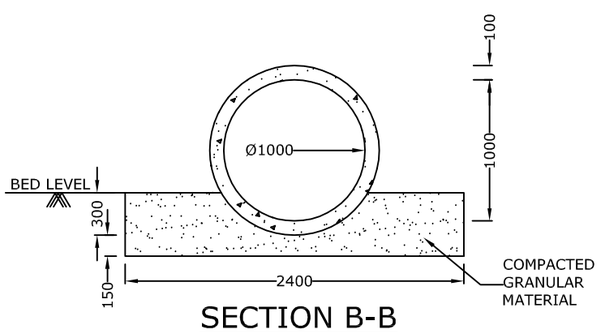
SECTION A - A
SCALE 1:1



DETAILS OF HEAD WALL
SCALE 1:2



PLAN
SCALE 1:1



SECTION B-B
SCALE 1:2

LEVELS DETAIL

RL1	RL2	RL3	RL4	RL5	RL6
273.750	273.605	273.605	270.608	270.588	271.698

NOTES:-

1. MINIMUM HEIGHT OF FILL H (EXCLUDING CRUST THICKNESS) OVER PIPE (M) SHOULD BE 600MM.
2. FIRST CLASS BEDDING SHALL BE USED FOR H UPTO 4.0M. THE BEDDING MATERIAL SHALL BE WELL GRADED SAND OR GRANULAR MATERIAL PASSING 75MM SIEVE.
3. LONGITUDINAL SLOP OF PIPE SHALL BE MIN. 1:1000.
4. LOOSE / UNSUITABLE SOIL BELOW CULVERTS IS REPLACED WITH SAND OR GRANULAR MATERIAL.
5. ALL DIMENSION ARE IN MM.

Details of Measurement and Calculation of Quantities

Item No.	Descriptions	Unit	No.	Length	Width	Ht./Th.	Quantity
1	**Earthwork Excavation of Foundation**	Cum					
	Head Wall		1	6.4	1.4	1.25	11.200
	Pipe Portion		1	17.35	2.40	0.60	24.984
	D/S Pitching		1	6.40	3.00	0.3	5.760
	U/S Pitching		1	6.40	1.50	0.3	2.880
						Total Quantity =	**44.824**
2	**Sand filling as per technical description and drawing including watering**	**Cum**					
	Head Wall		1	6.4	1.4	0.15	1.344
	Pipe Portion		1	17.73	2.4	0.15	6.381
	In Road Portion		1	7.808	2.4	2.362	44.262
	Length (mtr)= (5+10.616)x0.5=7.808						
	Height= 272.97-270.608						
	Deduction for pipe portion		**1**	**10.616**		**0.874**	**9.28**
						Total Quantity =	**42.707**
3	**Providing and laying of PCC 1:3:6 concrete including watering and curing as per drawing and technical specification.**	**Cum**					
\	a) For Concrete cradle bedding bellow HP		1	17.775	2.4	0.45	19.197
	Deduction for Pipe Portions						
	Area= 1x 0.257			17.775	0.257		4.568
						Total Quantity =	**14.629**
4	**Providing and laying of PCC M15 concrete including watering and curing as per drawing and technical specification.**	**Cum**					
	a) Head Wall		1	14.549		0.825	**12.003**
	Area (in sqm)= 6.4x2.45 =15.68						
	Deduction for Pipe Portions= 1x1.131 = 1.131						
	Average Thickness= 0.825						

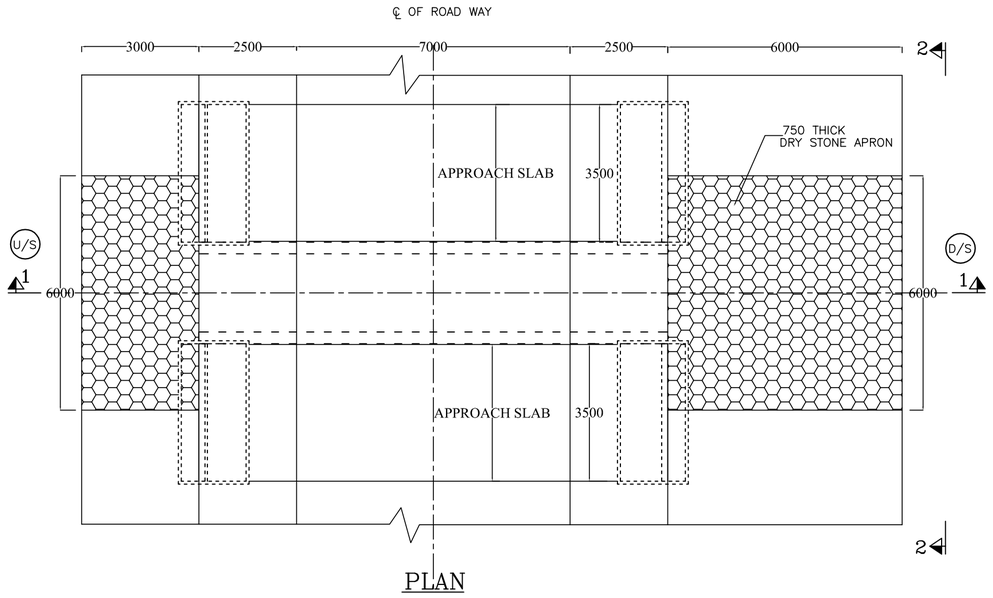
Item No.	Descriptions	Unit	No.	Length	Width	Ht./Th.	Quantity
5	**Providing, Laying &Fixing of 1000mm Dia Pipe**	**Lm**	1x8	2.5			**20.000**
6	**Pitching Apron &Rivetment**	Cum					
	a) Pitching of Apron=						
	D/S Side		1	6.40	3.00	0.3	5.760
	U/S Side		1	6.40	1.50	0.3	2.880
	b) Rivetment						
	a)Surface area for single one= 0.25xpi()x2.3xsqrt(2.3^2+1.5^2) = 4.96		2	4.96		0.3	2.976
						Total Quantity =	**11.616**

4.5. Example 4.3

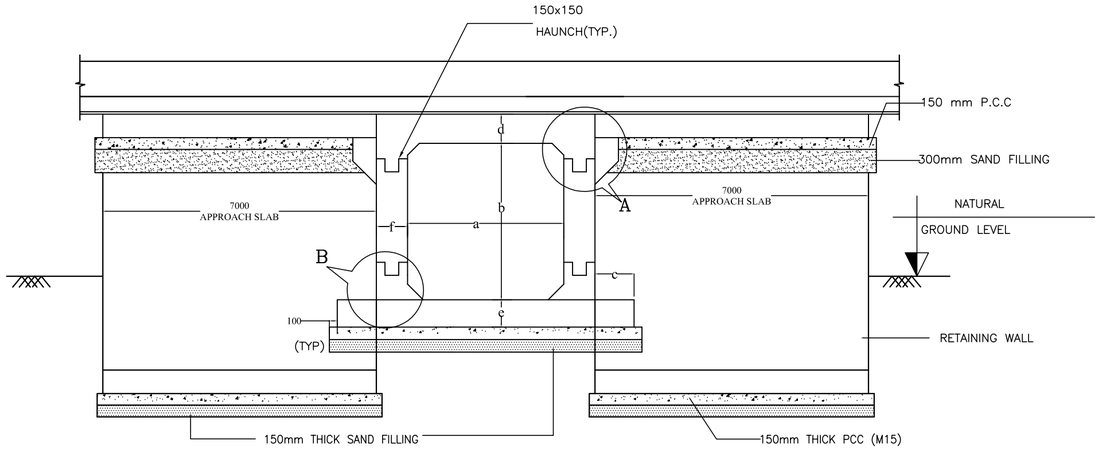
Prepare a detailed estimate for a box culvert for the given details, plans and elevations as shown in Fig. 45. The following table provides the details for the box culvert. Assume the reinforcement quantity provided in the box portion is 65 kg per cum of concrete, and in the retaining wall portion is 70 kg per cum of concrete.

Table 4.2 (Details for Box culvert)

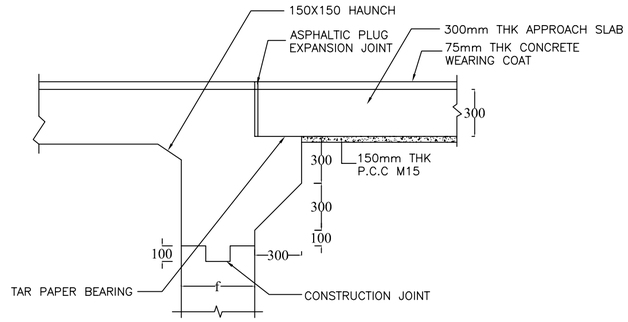
	Road way Width =	12
	Existing Road Lvl (Mtr) =	336.52
	Existing Road Width (mtr) =	4.35
	Existing Ground Slope =	2 in 1 (V:H)
	FRL (mtr)	337.380
	Camber	-2.00%
	NGL (mtr)	336.07
Culvert dimensions (mtr)	a	1.000
	b	1.185
	c	0.500
	d	0.350
	e	0.380
	f	0.300
Retaining Wall details	Length ($\mathbf{R_L}$)	3.500
	Height(H)	**0.785**
	A	1.500
	B	0.000
	C	1.500
	Base Raft Thickness	0.000
	D=E	0.000
	F	0.000
	h3	0.000
	Thk. Of R.wall at top	0.300
	Apron @ U/s, Length (a)	3.000
	Apron @ U/s, width (b)	6.000
	Apron @ D/s, Length (a)	6.000
	Apron @ U/s, width (b)	6.000
RLs of Various components of Retaining Wall	RL-1 =	337.380
	RL-2 =	337.271
	RL-3 =	337.271
	RL-4 =	335.782
	RL-5 =	335.770



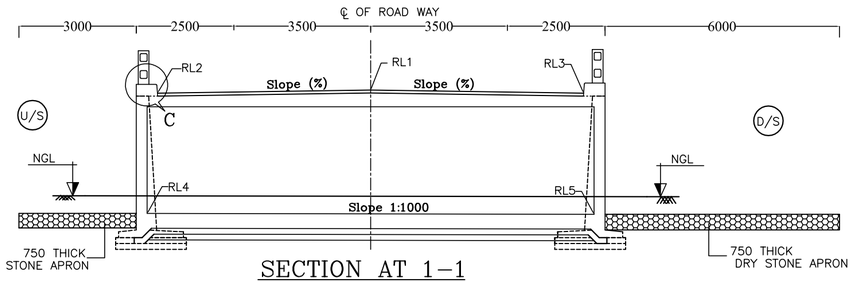
PLAN



VIEW 2–2



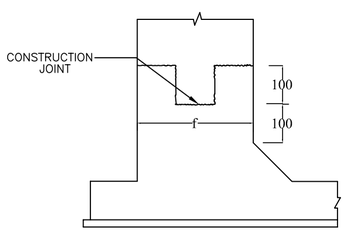
DETAIL AT–A



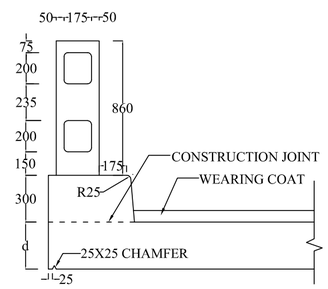
SECTION AT 1–1

Detail Schedulling of the box culvert

Formatlon Level	Existing Level	Height	Slope Left	Slope Right	Dimensions						RLS				
					a	b	c	d	e	f	RL-1	RL-2	RL-3	RL 4	RL-5
337.38	336.07	1.310	-2	-2	1	1.185	0.5	0.35	0.38	0.3	337.38	337.271	337.271	335.782	335.770



DETAIL – B



DETAIL AT- C

NOTES :–

1. ALL DIMENSIONS ARE IN MM. UNLESS MENTIONED OTHERWISE.
2. FOR GENERAL NOTES REFER DRG NO. SD/101.
3. REINFORCEMENT DETAIL REFER DRG NO. SD/108 SHEET NO 1 OF 6.
4. FOR BAR BENDING SCHEDULE RATE REFER DRG NO. SD/108(SHEET 1 TO 5 OF 6)
5. MATERIALS :–

   CONCRETE :–
   M25 – FOR R.C.C.
   M25 – FOR RCC RETAINING WALL.
   M15 – FOR P.C.C.
6. Nc / ab / Ec STANDS FOR NO. OF CELLS / CLEAR WIDTH –CLEAR HEIGHT / HEIGHT OF EARTH CUSHION.

7.HERE 'f' VALUE IS CALCULATED ACCORDING TO HEIGHT WHERE AS c,d,e VALUES ARE CALCULATED ACCORDING TO SPAN REFER TO DRG NO. SD/102

8.RETAINING WALL DETAILS REFER TO DRG NO–ATCPL/DPR/PKG–4/RW/RET_01

Details of Measurement and Calculation of Quantities							
Item No	**Description**	**Nos**	**Unit**	**Length (L)**	**Breadth (B)**	**Height (H)**	**Quantity**
1	Earthwork in excavation for foundation structure complete as per drawing and technical specification Clause 301.						
	For Structure (For NGL to Founding Lvl)	1	Cum	12.200	2.800	0.980	33.480
	For Structure (For NGL to Existing Formation Lvl)	1	Cum	4.463	2.800	0.450	5.620
	For Appron U/S	1	Cum	3.000	6.000	1.038	18.680
	For Appron D/S	1	Cum	6.000	6.000	1.050	37.800
	For Retaining Walls	4	Cum	3.500	1.700	2.300	54.740
						Total =	**150.320**
2	Providing and laying of good and clean course sand bellow levelling course of foundation trench including watering complete as per drawing and technical specification.						
	Bellow PCC of Box structure	1	Cum	12.200	2.800	0.150	5.120
	Bellow Retaining Walls	4	Cum	3.5	1.7	0.150	3.570
	Bellow Approach Slab	2	Cum	12	3.3	0.150	11.880
						Total =	**20.570**
3	Plain cement concrete M-15 Levelling course below foundation footings etc complete as per drawing and technical specification Clause 1100 & 1700 including all leads and lifts complete.						
	Below Raft	1	Cum	12.200	2.800	0.150	5.120
	Bellow Retaining Walls	4	Cum	3.500	1.700	0.150	3.570
	Bellow Approach Slab	2	Cum	12.000	3.300	0.150	11.880
						Total =	**20.570**
4	Providing and Laying of Reinforced Cement Concrete (M25 Grade) in Box Portion and retaining Wall.						
	Box Portion						
	For Raft	1	Cum	12	2.6	0.38	11.860
	For Walls	2	Cum	12	0.3	1.185	8.530
	For Slab	1	Cum	12	1.6	0.35	6.720
	For Hunch	4x1/2	Cum	12	0.15	0.15	0.540
	Brackets (Breadth=(.3+.6)/2)	2	Cum	12	0.45	0.3	3.240
	Retaining Wall						
	For Raft (Base)	4	Cum	3.500	1.500	0.000	0.000
	Trapezoidal section (Width=(1.5+1.5)/2)	4	Cum	3.500	1.500	0.000	0.000
	For Walls (Width=(1.5+0.3)/2	4	Cum	3.500	0.900	1.735	21.860
						Total =	**52.750**
5	Providing and Laying of Reinforced Cement Concrete (M30 Grade) in Approach Slab	2	Cum	12.000	3.500	0.300	25.200
6	Supplying fitting and Placing HYSD bar reinforcement complete as per drawing and technical specifications.						
	a) For Box Portion						
	Providing @65 kg/Cum		MT	=(30.89x65/1000)=2.008 Ton			2.008
	a) For Retaining Wall						
	Providing @70 kg/Cum		MT	=(21.86x70/1000)=1.53 Ton			1.53
						Total =	**3.538**

Details of Measurement and Calculation of Quantities							
Item No	**Description**	**Nos**	**Unit**	**Length (L)**	**Breadth (B)**	**Height (H)**	**Quantity**
7	Providing and laying of filter media with granular materials/stone crushed agregates as per Drawing and Technical Specification						
	Behind Wall of Box Portion	2	Cum	11.489	0.300	1.079	7.440
	Behind R.wall	4	Cum	3.500	0.300	1.079	4.530
						Total =	**11.970**
8	Providing and Laying 300 mm thick sand filling including watering and curing etc. complete as per Technical Specification.	2	Cum	11.400	3.200	0.300	21.890
9	Providing and Backfilling behing the walls with approved material as per Drawing and technical Specification		Cum				
	a) Total Vacant Space behind wall	2	Cum	12	0.809	1.079	20.950
	b) Deduction for Filter media	11.970					11.970
						Total =	**8.980**
10	Providing and Laying of Boulder appron on Nallah bed as per Clause 2503 of MoRTH.						
	U/S	1	Cum	3.000	6.000	0.75	13.500
	D/S	1	Cum	6.000	6.000	0.75	27.000
						Total =	**40.500**
11	Providing and Laying of Reinforced Cement Concrete (M-20 Grade) in Kerbs as per Drawings and Technical Specifications	2	Cum	8.6	0.525	0.3	2.710
12	Construction of Precaste railings M30 grade including raing posts of M30 grade concrete as per drawing and as per technical specification	2	RM	8.6			**17.2**
13	Providing and laying of Ashphaltic plug expansion joints	2	RM	12			**24.0**
14	Providing and fixing of Weep Holes (150mm AC pipe @1m C/C) as per Technical specification and Drawings		Nos				
	In walls of Box culvert	2x(1x[12-(0.9x2)(or ≈ 1)]-5x1)=12					12
	In walls of Retaining Wall	4x(1x3-2x1)=4					4
						Total =	**16**
15	Painting and figuring culvert detail as per Technical Specification.	4					**4**
	Providing and Fixing of Tar paper bearing for resting of Approach Slab As per Drawings and Technical reference.	2	Sqm	12	0.3		**7.2**
16	Providing and fixing of Drainage Spouts (150mm dia 450m CI pipes)		No.s				**4**
17	Providing and laying of Cement concrete wearing coat M-30 grade including Reinforcement complete as per drawing and technical specification.	1	cum	11.50	8.6	0.075	**7.42**

4.6. Example 4.4

Prepare a detailed estimate per 1000 meter length for the concrete drain (1:3:6) proportion having the dimension as shown in the Fig. 4.6.

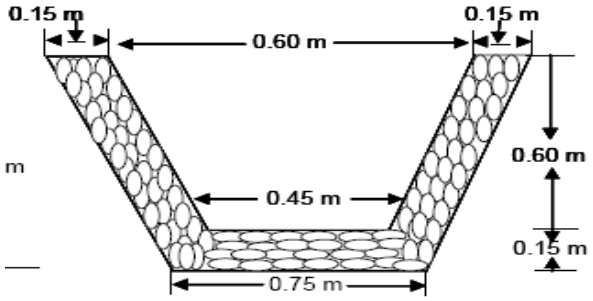


Fig. 4.6 (Details of RCC drain)

Ans:

The items of estimation are:

1. Earthwork in excavation
2. Cement concrete work (1:3:6)
3. Centering and shutting.

The detail estimates per 1000 mtr length of drain for these items are as follows:

1. Earthwork in excavation:

$= \frac{1}{2} \times (top\ width + bottom\ width) \times depth \times 1000 = \frac{1}{2} \times (0.9 + 0.75) \times 0.75 \times 1000$

= 618.75 Cum

2. Cement concrete work (1:3:6)

$= (1 \times 0.75 \times 0.15 + 2 \times 0.76 \times 0.15) \times 1000$ = 340.5 cum

3. Centering and shutting works

$= 4 \times 0.76 \times 1000$ = 3040.00 sqm

4.7. Example 4.5

Prepare a detailed estimate per 10 meter length for the concrete retaining wall having the dimension as shown in the Fig. 4.7.

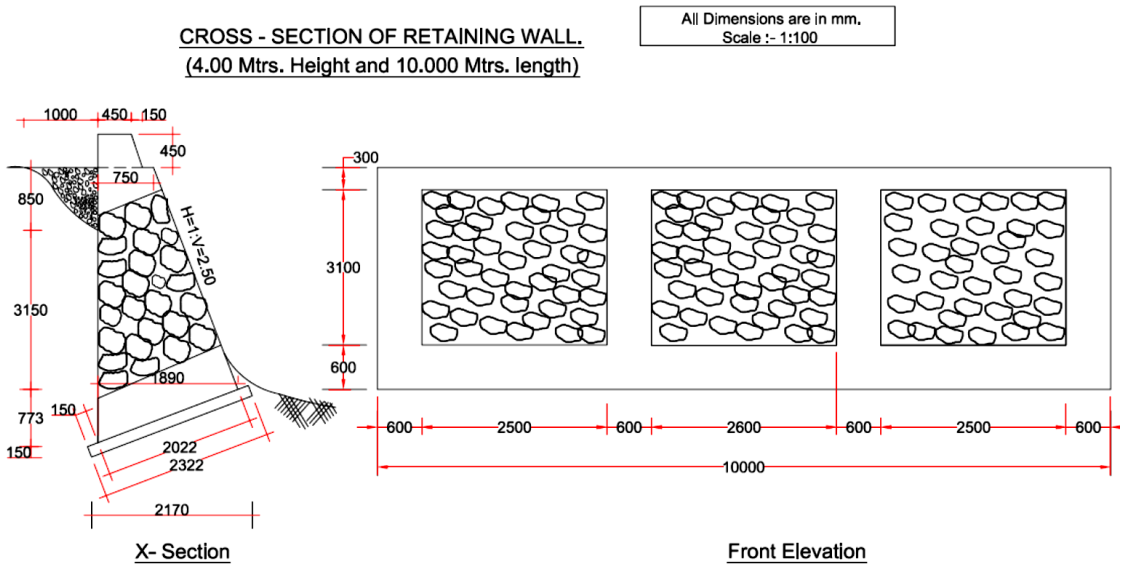


Fig. 4.7 (Details of retaining wall)

Ans:

The items of estimation are:

1. Earthwork in excavation
2. Cement concrete work (1:3:6)
3. RR Masonry in cement mortar 1:3 in horizontal and vertical bonds and parapet
4. Dry RR masonry
5. Back filling behind the wall with granular material
6. Providing weep hole 75 mm dia with AC pipe

The detail estimates per 10 mtr length of drain for these items are as follows:

1. Earthwork in excavation

$= 0.5 \times 2.02 \times 2.75 \times 10 = 27.775$ Cum

2. Cement concrete work

$= 2.02 \times 0.15 \times 10 = 3.03$ Cum

3. RR Masonry in cement mortar 1:3 in horizontal and vertical bonds and parapet

Horizontal bond (bottom) = $(1.81 + 1.70) \times 0.5 \times 0.6 \times 10$	= 10.53 cum
Horizontal bond (top) = $(0.80 + 0.75) \times 0.5 \times 0.6 \times 10$	= 4.65 cum
Vertical bond = $(1.70 + 0.80) \times 0.5 \times 3.8 \times 10$	= 23.75 cum
Parapet = $0.6 \times 0.6 \times 0.6 \times 11$	= 2.38 cum
	Total = 41.31 cum

4. Dry RR Masonry

$= (1.81 + 0.75) \times 0.5 \times (4.44 + 4) \times 0.5 \times 10$ = 54.02 cum

Deduction for bands $= (-)\ (10.53 + 4.65 + 23.75)$ =(−) 38.93 cum

Total = 15.09 cum

5. Back filling behind the wall with granular material

$= 0.5 \times 4 \times 0.75 \times 10$ = 15.00 cum

6. Providing weep holes 75 mm diameter with AC pipe

= 2 ×8 = 16 Nos.

4.8. Example 4.6

Prepare a detailed estimate for a RCC slab having dimensions and reinforcement details as shown in Fig. 4.8.

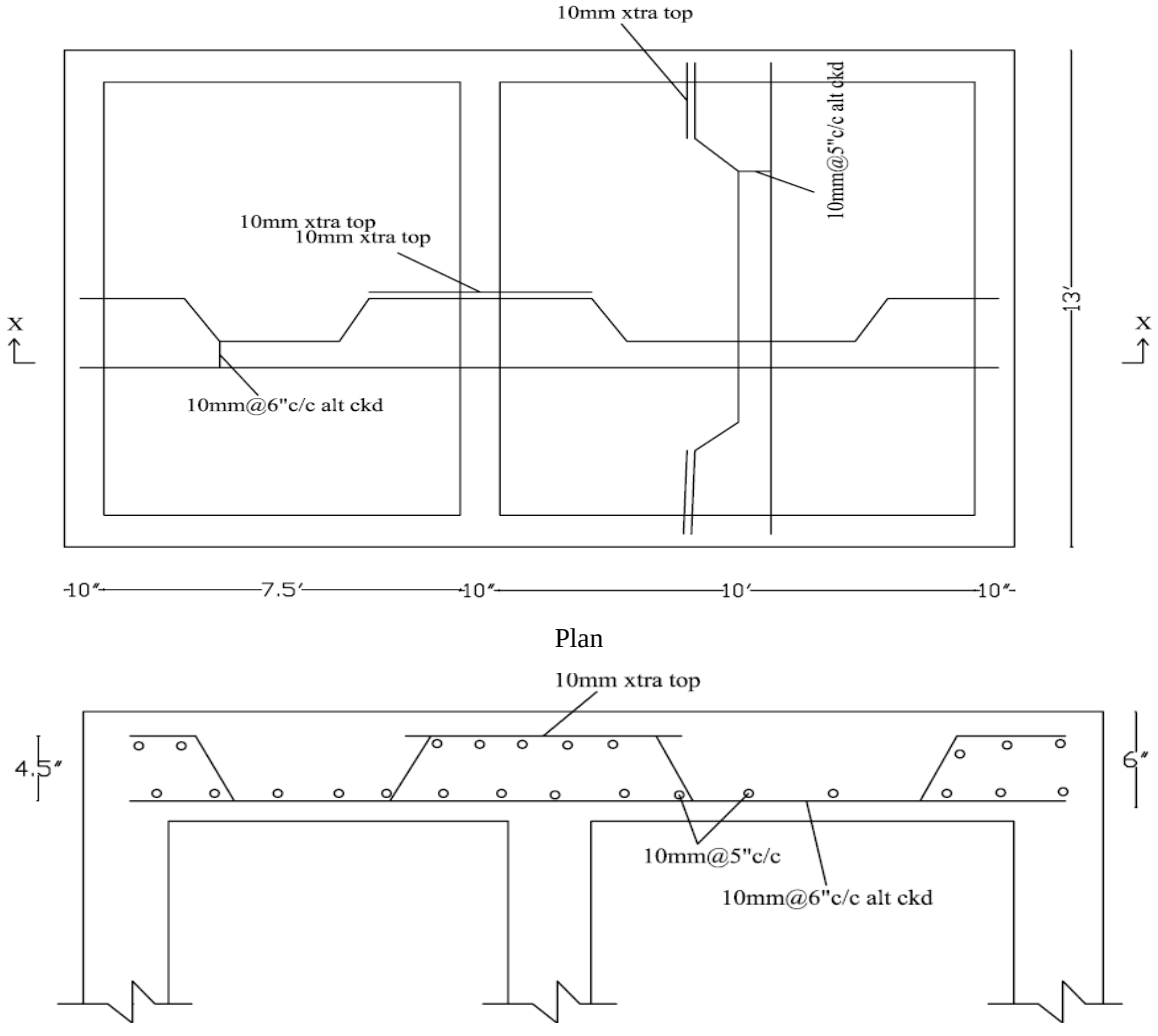


Fig. 4.8 (Plan and Sectional view for the RCC Slab)

Answer:

Calculation of steel:

Steel in long direction:

10mm @6" c/c alt ckd: No of bar = $(13' \times 12 - (10" \times 2)/6) + 1 = 24$
Straight bar = 12, cranked bar = 12
Length of straight bar = $20' - 4" \times 2(wall) + 6"(hook) = 19.83'$
Additional length required for one cranked = $0.42 \times 4.5 = 1.89"$
Length of one cranked bar = $19.83' + 4 \times 1.89" = 20.46'$
Total length of straight bar = $12 \times 19.83' = 238\ ft = 73m$
Total length of cranked bar = $12 \times 20.46' = 246\ ft = 75m$

Steel in short direction:

10mm@5"c/c alt ckd : No of bar = $(20' \times 12 - (10" \times 2)/5) + 1 = 45$
Straight bar = 22, cranked bar = 23
Length of straight bar = $13' - 4" \times 2 + 6" = 12.83'$
Length of one cranked bar = $12.83' + 2 \times 1.89 = 13.15'$
Total length of straight bar = $22 \times 12.83' = 283\ ft = 87m$
Total length of cranked bar = $23 \times 13.15' = 303\ ft = 93m$

For extra top:

Long direction: $L = (10'/3 + 7.5'/3) + 6"\ (hook) = 6.33'$
Total length = $12 \times 6.33' = 76\ ft = 23.5m$
Short direction: $L = (13'/3) + 6" = 4.83'$
Total length = $2 \times (23 \times 4.83) = 223\ ft = 68m$
Grand total length of 10 mm bar
$= (73 + 75 + 87 + 93 + 23.5 + 68)m = 419.5m$
$= 419.5 \times 0.00618 \times (10)^2 = 260\ kg$

Calculation of concrete (1:2:4):

Volume of concrete = $20 \times 13 = 260\ cft$

Material Requirements:

Amount of cement = $1/7 \times 260 \times 1.55 = 57.57\ cft = 46\ bag$
Amount of sand = $2/7 \times 260 \times 1.55 = 116\ cft$
Amount of Aggregate = $4/7 \times 260 \times 1.55 = 231\ cft$

CHAPTER 5

SPECIFICATION

5.1. Definition

Specification is a statement of particulars for execution of any item of work. It describes the nature and the class of the work, materials to be used in the work, the workmanship and the tools and plants which are required to complete an engineering project in accordance with its drawing and details. Specifications are written by experts of a particular field.

5.2. Necessity of Specification

A specification is a statement of particulars. An engineering specification contains the details about nature and class of the work, quality of the material to be used, workmanship and tools and plants required for the project. The drawings show the proportions and relative positions of the various components of the structure. It is not possible to furnish the information on the drawings regarding the quality of materials to be used and the quality of workmanship to be achieved during construction, due to shortage of space. Thus details regarding materials and workmanship are conveyed in a separate contract document which is known as the specifications of the work. In general, the drawings showed what is to be done, whereas the specifications state how it is to be accomplished.

5.3. Importance of Specification

- The specification describes the quality and quantity of a materials, workmanship and equipment required for execution of the project and hence it directly affects the cost of the project. Moreover, it allows the contractor to make programs for their procurement beforehand.
- Specification provides specific guidelines for the workmanship and the method of doing work. Thus, it serves as a guideline for supervising staff to execute the work.
- Specifications enable the employer to check the quality of the materials and workmanship.
- The contractor bids the tender as per the specification and is paid as per the tendered price. Any change in specification changes the tender rate.

5.4. Legal Aspects of Specifications:

- Specifications form a part of contract document, without which the contract document becomes invalid. On each page of the specifications both the parties *i.e.,* owner and contractor should sign so that these specifications, where clear instructions, regarding the quality and procedure of works etc., are given will be binding on both the parties.
- If any dispute arises between the parties, the specifications will help the arbitrator or the court to settle the dispute. If the contractor's work deviates from the specifications, he will be liable for penalty.
- The specification also mentions the mode of measurements, quality and procedure of item, which is binding on both the parties to adhere to it. The contractor cannot ask for extra measurements or owner cannot give less measurements.
- The general character and the scope of the work in illustrated and defined by the specifications and signed by both parties. So it becomes a legal binding on both the parties to adhere strictly to the agree specifications.
- In the absence of complete specification, the contractor's obligation is limited to performance of only what is called for in such incomplete specifications. As such great care has to be taken in preparing specifications.

5.5. Types of Specifications:

The specifications can be broadly classified as:

- General specification
- Detail specification
- Contract specifications
- Standard specification
- Special specification
- Open or manufacturer's specification

5.5.1 General Specification

In general specifications nature and class of the work, names of materials, and the proportions that should be used in the various items of the work are described. Only a brief description of each and every item is given. It is useful for estimating the project without going through lengthy detailed specifications general information for the quantities of the materials nature and class of the work can be known from the general specifications, but they don't form a part of the contract document.

5.5.2 Detail Specification

The detailed specifications describe the item of work in details, accurately and complete in all respects in relation to the drawings of the works. Detailed specification for a particular item specify the qualities, quantities and proportion of the materials and the method of preparation and execution and mode of measurements for that particular item of work in a project. The method and duration of protection of finished works as required are specified in the detailed specifications. The detailed specifications are arranged in the same sequence of order as the work carried out. The detailed specifications form an important part of contract document.

5.5.3 Contract specification

The specifications written for a particular construction project given contract to accompany the detailed drawings are called contract specifications or project specifications.

5.5.4 Standard specification

Preparation of detailed specification for an item is a time and labor extensive job. Also, there are scopes for deviations and omissions while writing lengthy specifications. Thus, the standardized specifications for most of works are prepared by the engineering department which serves as a standard guide to the department. These standard specifications are numbered. After standardizing specifications, it is not necessary to write detailed specifications, with all the contract documents. While preparing the contract document only the serial number of standard specifications is written. This saves time, labor and other expenditures.

5.5.5 Special specification

Some items that are not covered or work not well covered by the departmental standard specifications, special specifications for such items are drawn up by engineer-in-charge approved and included in the tender paper under a heading special specifications.

5.5.6 Open or manufacturer's specification

Open specification/manufacturer's specification is specifications of products of manufacturers which state both physical and chemical properties and such other information of the product but not description of workmanship to be achieved during construction. The physical properties specify mainly the strength weight thickness or size and such other physical properties of the product. The chemical properties specify mainly the composition of chemical contents of the product and the precautionary measures if any required for storing the product.

5.6. How to Write Specification

While writing specifications following principles shall be adopted:

1. **Description of materials:** The quality and size of materials required to do an item of work shall be fully described for checking up at site according to the clauses provided in the specifications. The proportion of mixing or treatment of materials if required before use shall be really described.

2. **Workmanship:** The complete description of workmanship. The method of mixing and proportion, the method of laying, preparation of base or surface, compaction, finishing and curing etc. specially applicable to the item of work shall be stated in different clauses.

3. **Tools and Plant (T&P):** The tools and plant to be engaged to carry out a work shall be described. The method of operation and by whom to be supplied shall be stated.

4. **Protection of New Work:** The method of protection of new works against damage or the method of curing if required, the test of completed work if necessary shall be described in separate clauses.

5. **Expression:** While writing a specification endeavor shall be made to express the requirements of the specification clearly and in concise form avoiding repetition and unusual words. The style of the tense shall remain same throughout. As the specifications are legal documents, terms such as suitable, proper and words having more than one meaning shall be avoided. The sentience shall be short simple and concise because fewer words will involve less risk or legal difficulty.

6. **Clauses of the specification:** As far as possible, the clauses shall be arranged in the order in which work shall be carried out. This does not mean to follow the works according to the order of arrangement, but it facilitates references. While framing the clauses for quality of materials, workmanship, tools and plants etc. practical possibilities should be realized. Correct and complete but not repeated information shall be given so that the owner and the contractor carryout the work following the specifications. Abbreviations which are familiar can be used.

5.7. Arrangement of Specification Paragraph

The paragraph of a particular specification should be arranged in the following sequences:

- Materials that is required for work.
- Specifications for materials.
- Preliminary work, before the construction.

- Procedure for executive the work.
- Tests, if any.
- Clearing on completion.
- Mode of measurements.

5.8. General Specification of Building

Buildings are classified in four categories depending superiority of their construction specifications: Class A (First class buildings) are having highest specification while class D (fourth class) are having lowest specifications.

5.8.1 General specifications for first class building

1. **Foundation and plinth:** Foundation and plinth shall be of first class brick work in 1:6 cement mortar over 1:4:8 cement concrete.
2. **Damp proof course:** DPC shall be of 25 mm thick cement concrete (1:1.5:3), mixed with one kg of Impermo (or any water proofing material) per bag of cement.
3. **Superstructure:** Superstructure shall be of 1st class brickwork with 1:6 cement mortar. Lintels over doors and windows shall be of R.C.C.
4. **Roofing:** Roof shall be of 100 mm thick R.C.C. (1:2:4) slab with 100 mm lime terracing above over RCC lab as required. Height of the room shall not be less than 3.5 m.
5. **Flooring:** Mosaic/Marble flooring shall be provided in all floors including staircase.
6. **Finishing:** Inside and outside wall shall be finised with 12 mm cement mortar plaster (1:8). Inside shall be distempered over 2 coats of white wash. Outside shall be snowcem washed two coats over one coat of white wash.
7. **Doors and windows:** Chaukhats shall be seasoned teak wood and shutters shall be 40 mm paneled glazed. All fittings shall be provided with iron grills. All wooden and grills shall be painted with enamel paint over one coat of priming.
8. **Miscellaneous:** Rain water pipe shall be of cast iron. Building shall be provided with 1st class sanitary, water fittings and electrical installations.

16.3.2 Comparison of General specifications various building classes

Name of work.	**'A' Class Buildings.**	**'B' Class Buildings.**	**'C' Class Buildings.**	**'D' Class Buildings**
a) Foundation	Cement concrete or brick blast.	Brick blast.	Brick foundation with mud mortar.	Brick foundation with mud mortar.
b) Damp proof course	1 ½" thick cement concrete with any damp proof material.	1 ½" thick cement concrete with or without any damp proof material.	No damp proofing.	No damp proof course.
c) Walls	First Class burnt brick with Cement mortar with cement plaster on both sides or deep pointing on outer wall.	First class burnt bricks in mud mortar, cement plaster inside and outside or cement pointing inside and outside.	B or C Class bricks with mud mortar mud plaster inside and or outside or pointed outside.	Katcha/pucca walls with or without mud plaster.
d) Floors	Conglomerate/chips/ marble flooring.	Cement concrete flooring.	Brick flooring.	Katcha flooring
e) Roof	R.C.C./R.B. Slabs.	Tile roofing over mud plaster, over brick over wooden battons or Tangle iron over steel girder or wooden shatir.	Katcha pucca masonary roofs supported in wooden ballies/country wood battens.	Thatched flooring with wooden shatir/wooden Balas/ Sirki and earth work.

Name of work.	**'A' Class Buildings.**	**'B' Class Buildings.**	**'C' Class Buildings.**	**'D' Class Buildings**
f) Wood work	Deodar/Sagwan wood Joinery, Aluminum fittings & water supply.	Deodar wood joinery.	Country wood joinery.	Poor class wood work with country wood joinery.
g) Fitting	C.T.S. / concealed wiring complete sanitary fittings & water supply.	Wire fittings, no water supply and sanitary fittings.	Wire fittings outside, No water supply and sanitary fittings.	No wire fittings/wire fittings outside, No water supply and no sanitary fittings.
h) Age of buildings	Up to 25 years.	i) 25-50 or age of building with 'A' class specifications. ii) Upto 25 yrs. Of buildings with 'B' class specifications.	i) 50-75 yrs. of building with 'A' class specifications. ii) 25-50 yrs. of building with 'B' class specifications. iii) 25 yrs. if buildings with 'C' class specifications.	i) Above 75 years of building with 'A' class specifications. ii) Above 50yrs. of building with 'B' class specifications. iii) Above 25 'C' class specifications.

5.9. Writing the Detailed Specifications for Construction Work

The detailed specifications of any work consist of two sets of provisions: General provisions and Technical provisions.

5.9.1 General provision

These are also known as conditions of contract and they apply to the work as a whole. In this document, the conditions governing the contract are written. The following groups of conditions of contract are generally accommodated under the general provisions.

a) **Conditions a relating to documents:** These pertain to Bill of quantities and schedule of prices, Drawings, Standard specifications

b) **Conditions relating to the general obligations of the contractor:** These pertain to, Acts, bye-laws and regulations, fencing, watching and lighting of the work spot, Insurance.

c) **Conditions a relating to labour and personnel:** These pertain to Accidents to workmen, Contractors representative, Rates of wages paid to the employees, Removal of the employees of the contractor.

d) **Conditions a relating to the execution of the work:** These provisions are related to Alterations, additions and omissions during the progress of work, Amount of extra items, Damages, Defective work, Work at night and on holidays, Workmanship etc.

e) **Conditions a relating to measurements and payments:** These pertain to Method of measurement of completed works, Method of payments etc.

f) **Conditions a relating to default and non-completion:** These pertain to Failure to complete the work in time, Right to suspend the work Time of completion etc.

g) **Conditions a relating to settlement of dispute:** These pertain to arbitration, Jurisdiction of court etc.

5.9.2. Technical provisions

These specifications describe the technical requirements of each type of constructions. The technical provisions contain detailed instructions regarding the desired quality of the final product. The technical provisions are of three types.

a) Specifications for materials and workmanship

For materials the following properties should be included in the specifications:

- **Physical properties** such as size, shape, grade, strength, hardness etc., Chemical composition of the material, Electrical, thermal and acoustical properties, Appearance of the material

- A clear statement regarding the **inspection and procedure of test** of the material.

- For **workmanship**, the following important features should be included in the specifications; the results desired, the tools and plants to be engaged, detailed description of the construction method for each item, Instructions regarding the protection of the finished work as well as of the adjacent property.

b) Specifications for performance

These specifications are written for the overall performance of the finished product and hence they are written if the contract is for the supply of equipment and machinery such as pumps, motors etc. In these specifications, general description, design and installation and guarantee etc., of the equipment are specified.

c) Specifications for proprietary commodities

Commercial products which are standardized or patented are called proprietary commodities. The specifications written for such materials should include the name of a particular brand or firm. (eg. Sun brand, Everest brand etc.) However, it is not desirable in case of public works to specify certain trade names or brands. To avoid monopoly and favoritism, it is general practice to specify the selected brand and then it is followed by the phrase "or equal".

5.10. Detailed Specifications of Civil Engineering Materials

5.10.1. Detailed specification for first class brick

The earth used for molding the bricks shall be free from organic matters salts and chemicals. The size, weight and colour of the burnt bricks should be uniform. The adjacent faces of the bricks are to be right angles to each other. The bricks shall be free from cracks, flaws and lumps. They should not break where dropped, from 1 meter height, on the ground. They should not absorb water by more 15 % of their self-weight when immersed in water for one hour. The average compressive strength of the bricks shall be not less than 7.5 N/mm^2. The dry weight of one brick shall not be less than 3 kg.

5.10.2. Detailed Specification for cement

Ordinary Portland cement or rapid hardening Portland cement confirming to IS: 269 – 1989 and IS:8041 – 1990 shall be used. The fineness of the cement shall not be less than 30 minutes and the final setting time shall not be greater than 10 hours. The average

compressive strength, after 7 days curing, of 1:3 cement mortar cubes shall be not less than 33 N/mm2 (33 grade).

5.10.3. Detailed Specification for sand for mortar

The sand used for mortar shall be clean, sharp, heavy and gritty. It should be free from clay, salt, mica and organic impurities. It shall not contain harmful chemicals in any form. Medium and fine sand are to be used in mortars. Coarse sand shall be sieved through 600 micron sieve and used in mortars for plastering works.

5.10.4. Detailed Specification for coarse aggregate

The aggregate to be used in reinforced cement concrete shall be of blue granite stone, machine crushed and well graded with a nominal size of 20 mm. It shall be hard, dense, durable strong and free from flakes. The aggregate shall not contain harmful materials such as coal, mica clay, shells, organic impurities etc. The compressive strength, crushing value etc. of the aggregate shall be in accordance with the requirements of IS: 383 – 1970.

5.10.5. Detailed Specification for water for concrete

Water used for mixing and curing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water may be used for mixing concrete. The suspended organic solid matter in the water shall not exceed 200 mg/l and inorganic solid matter shall not exceed 3000 kg/l, the pH value of water shall be not less than 6. Water sued for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds in the water is objectionable.

5.10.6. Detailed Specification for reinforcement

The reinforcement shall be of high strength deformed steel bars confirming to IS: 1786 – 1985. It should be bendable, wieldable and have the modulus of elasticity not less than 200 kN/mm^2. The yield strength of the steel used shall not be less than 415 N/mm^2. All reinforcement bars shall be free from loose mill scales, loose rust and coats of paints, oil, mud or other coatings which may destroy or reduce bond.

5.10.7. Detailed Specification for wood for doors and windows

The wood shall be teak, well-seasoned and dry. It should be free from cracks, knots, defects and disease. It should be sawn in the direction of grains so that the edges are perfectly straight and square. The dimensions of the frames/scantlings/planks shall be as prescribed in the drawings. Patching or plugging of any kind is not permitted.

5.11. Detailed Specifications of Common Construction Works

5.11.1. Detailed specification of for earth work excavation for foundation

[**Sequence**: Leveling the surface; Dimensions; Shoring; Fencing; Dumping the soil; Water in foundation; Treatment of the bottom; Trench filling; Measurement]

a) Leveling the surface

The whole area of construction is to be cleared of tees, grass, roots of trees etc., complete and leveled horizontally to enable easy marking of centre line of the building.

b) Dimensions

The excavation shall be done in accordance with dimensions of trenches shown in the working drawings.

c) Shoring

The sides of the trenches should be vertical and the bottom of the trenches should be flat. In the case of loose soils the sides of the trenches should be shored with steel sheets.

d) Fencing

Suitable temporary fencing is to be provided around the site of excavation to avoid any accidental fall into the trenches.

e) Dumping the soil

The excavated soil is to be dumped and heaped at a minimum distance of 1.5 metre away from the trenches so that it does not slide again into the trenches.

f) Water in Foundation

Water, if any accumulated in the trench, should be pumped out without any extra payment and necessary precaution shall be taken to prevent surface water to enter into the trench.

g) Treatment of the bottom

The bottom of the trench shall be watered and compacted by ramming before the foundation concrete is laid. Excessive excavations should not be adjusted by filling with loose excavated soils. Sand or plain concrete may be used for the adjustment of levels, that too with proper compaction.

h) Trench filling

After the concrete has been laid and masonry has been constructed the remaining portion of the trench shall be filled up with earth free from rubbish and refuse materials, in layers of 15 cm and watered and well rammed.

i) Measurement

The measurement of the excavation shall be taken in cu. m. as for rectangular trench bottom width of the concrete multiplied by the vertical depth of the foundation from the ground level and multiplied by the length of trench even though the contractor might have excavated with slopping side for his convenience. The rate shall be for complete work for 30 m lead and 1.5 m lift, including all tools and plants required for completion of the works.

5.11.2. Detailed specification of for lime concrete in foundation

[**Sequence**: Lime; broken bricks; fine aggregate; proportioning; mixing; laying and compacting; curing; measurement]

a) Lime

The lime used for the concrete shall be freshly burnt and slaked. It should be free from clayey particles and ashes. Unslaked stone particles should be removed by shifting.

b) Broken bricks

The over burnt bricks and the pieces of well burnt bricks are to be broken to sizes ranging from 20 mm to 40 mm and stacked for easy measurement. The brick bats shall be free from dirt, dust, rubbish, leaf etc.

c) Fine aggregates

Surki made from well burnt brick bats is to be used as fine aggregate. It should pass through I.S. sieve no.48 and free from dust and dirt.

d) Proportioning

Lime, surki and broken bricks are to be mixed in the proportion of 1:2:5 by volume. The materials are to be measured loose without shaking or ramming.

e) Mixing

The mixing shall be done only by mechanical mixer. The broken bats are to be soaked in clean water for at least 2 hours before mixing. The materials are first mixed

to get uniform distribution and then water is gradually added. The mixing process is to be continued till all the brick bats are coated with mortar uniformly and a workable concrete is obtained.

f) Laying and compacting

The concrete shall be laid to the required thickness, not more than 200 mm and a time, and compacted by ramming with rammers weighing 4.5 to 55 kg.

g) Curing

The lime concrete, so laid, is to be kept wet for at least 7 days.

h) Measurement

The measurement shall be taken in cu. m. for the finished concrete. The length and breadth shall be measured correct to 1 cm and depth correct to 05 cm.

[**Similar Item:** Detail specifications for lime concrete in roof terracing]

5.11.3. Detailed specification of random rubble masonry in foundation and basement

[**Sequence**: Materials; preparation of mortar; method of laying; curing; measurement]

a) Materials

The stone shall be obtained from the approved queries. It shall be sound, free from cracks and decay and shall have a specific gravity of not less than 2.5. [Include detail specification for cement and sand]

b) Preparation of mortar

The materials (cement and sand), with ratio 1:6, shall be first mixed dry thoroughly till uniform colour is obtained and then shall be mixed wet adding water slowly and gradually for at least turning three times to give uniform consistency.

c) Method of laying

The stones are to be laid on broadest face which gives better opportunity to fill the spaces between stones by the mortar. The stones are laid layer by layer with sufficient mortar in between them for better binding. The outer face of the basement should be vertical and the joints are to be staggered. There shall be no gap, between the stones, unfilled by mortar.

d) Curing

The masonry should be kept in we condition by sprinkling water thrice daily for at least 7 days after construction.

e) Measurement

The measurement shall be taken in cu. m. for the finished concrete. The length and breadth shall be measured correct to 1 cm and depth correct to 05 cm.

[**Similar Items:** Detail specifications for random rubble masonry in super structure]

5.11.4. Detailed specification for 1st class brickwork in super structure

[**Sequence**: Materials; preparation of mortar; soaking of bricks; method of laying; curing; scaffolding; measurement]

a) Materials

[Include detail specification for first class brick, cement, and sand]

b) Preparation of mortar

[Similar to 5.11.3, but the ratio of cement to sand is 1:3 or as specified.]

c) Soaking of bricks

Bricks shall be well soaked in water for at least 12 hours before their use, preferably in a tank provided at site of work.

d) Method of laying

Bricks shall be well bonded and laid in English bond unless specified. Every course shall be truly horizontal and shall be truly in plumb. Broken bricks shall not be used except as closers. All corners shall be truly in plumb. Mortar joints shall break for bonding and shall not exceed 10 mm in thickness. Only skilled masons shall be employed on the work. Brick shall be laid with frogs upward except in the top course. Brickwork shall be carried out not more than 1 m height at a time. When one part of the wall has to be delayed, stepping shall be left at an angle of 45^0. All joints shall be racked and faces of the wall cleaned at the end of each days' work.

e) Curing

The work shall be kept well watered for at least 15 days.

f) Scaffolding

Necessary and suitable scaffolding shall be provided to facilitate the construction of brickwork. It shall be sound and strong enough to sustain all loads likely to come upon them.

g) Measurement

The measurement shall be taken in cu. m. The rate shall be for the complete work inclusive of scaffolding and all tools and plants.

[**Similar items:** Detailed specifications of 1st class brick work in foundation and plinth, 2nd and 3rd class brick work, brickwork in mud mortar and Reinforced Brick (R.B.) work.]

5.11.5. Detailed specification for Reinforced Cement Concrete

[**Sequence**: Materials; form work; proportioning; mixing of concrete; laying of concrete; curing; formwork; measurement]

a) Materials

[Include detail specification for cement, sand, course aggregate, water and reinforcement]

Reinforcement shall be hooked and bent (cold) and placed in position as per design and drawing and bound together tight with 20 S.W.G binding steel wire.

b) Centering and shuttering

Centering and shuttering shall be made of timber and tight with necessary wedges and sufficiently strong and sable not to yield under laying of concrete. A coat of oil washing or a thin layer of paper shall be spread to have a smooth finished surface preventing adherence of concrete.

c) Proportioning

Proportions of cement, sand and course aggregate shall be 1:2:4 for slab, beam and lintels and 1:1.5:3 for columns unless otherwise specified. The sand and course aggregate shall be measured by volume with boxed and cement by number of bags.

d) Mixing of concrete

Concrete shall be mixed by concrete mixture. Cement, sand and course aggregate shall be put into the as per the required proportions for one batch. The total quantity shall not exceed the manufactures rated capacity. The machine shall be revolved to mix materials dry and then water shall be added up to the required quantity. After 2

minutes rotation for through mixing, the mixed concrete shall be discharged on a masonry platform or iron sheet.

e) Laying of concrete

Concrete shall be laid gently in layers not exceeding 150 mm and compacted by wooden thapi or some mechanical vibrator until a dense concrete is obtained. While concreting, steel bars shall be given side band bottom covers of concrete by pacing the precast concrete blocks of 1:2 cement mortar 25x25 mm in section and thickness of specified cover. Concreting shall be laid continuously. If laying is suspended for rest or the following day, the end shall be slopped at an angle of 30^0 and made rough for future jointing. When the work is resumed, the previous slopped surface shall be roughened, cleaned and a coat of neat cement paste shall be applied and then the fresh concrete shall be laid.

f) Curing of concrete

Freshly laid concrete shall be protected from rain by suitable covering. After 24 hrs of laying of concrete the surface shall be cured by flowing with water of above 25 mm depth or with covering by wet gunny bags. The curing shall be for a minimum period of 14 days or otherwise specified.

g) Removal of form work

The centering and shuttering shall be removed after 14 days of casting. It shall be removed slowly and carefully so that no part is disturbed.

h) Measurement

The measurement shall be taken in cu. m. The rate shall be for the complete work inclusive of form work and all tools and plants but excluding steel.

[**Similar Item:** detailed specification for plain cement concrete]

5.11.6. Detailed specification for damp proof course (D.P.C.)

[**Sequence**: Materials; preparation of mortar; Application of DPC; measurement]

a) Materials

Damp Poof Course shall be of plain cement concrete of 1:2:4 mix and 30 mm thickness. 12 mm size hard and dense stone chips shall be used as coarse aggregate and river sand of 5 mm nominal size shall be used as fine aggregate. The aggregate shall be clean and free from dust, dirt, mud, organic matter etc. The coarse aggregate is to be washed well before mixing. Fresh port land cement of I.S.I. approved brand

of 43 grades is to be used as the binding material. Potable water, free from harmful salts, shall be only used for mixing the concrete.

b) Preparation of mortar

The coarse aggregate and sand are to be measured separately by volume and mixed dry in a clean and stable platform to get a mixture of uniform colour. This mixture is stacked to a uniform height and the cement of required quantity is spread over the stack, turned over in dry state first, and with water twice to get a workable and uniform concrete.

c) Application of DPC

The brickwork in basement is stopped at plinth level, cured will for 7 days, top surface cleaned well for dust by wire brushes. Form work is provided along the two sides of wall by wooden planks, to the required height. Gauge plates are to be provided at one metre interval, connecting the two side planks by nails, keeping at a clear distance equal to the width of wall at plinth level. The concrete, mixed as mentioned above, shall be placed and compacted well by tamping rods to have a net thickness of 30 mm. Damp proof course shall not have any joints, the whole concreting be completed without any break, and it need not be provided over door openings. The top surface of concrete, when starts to dry, shall be roughened to provide bondage with the super structure. The side planks shall be removed on the next day and the concrete shall be cured for 7 days by keeping the surface constantly wet.

d) Measurement

The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

5.11.7. Detailed specification of for plastering with cement mortar

[**Sequence**: Materials; preparation of mortar; preparation of surface; application of mortar; curing; measurement]

a) Materials

[Include detail specification for cement and sand]

b) Preparation of mortar

[Similar to 5.11.3, but the ratio of cement to sand is 1:4 for inner wall and 1: 6 for outer wall or as specified.]

Mortar for plastering shall be prepared at a time of such amount which can be used within the initial setting of cement.

c) Preparation of surface

The joints of brick work shall be racked out a depth of 18 mm and the surface shall be brushed, cleaned, watered and kept wet for two days before plastering. In case of cement concrete surface, the face shall lightly roughen, cleaned, washed and wetted.

d) Application of mortar

Plastering shall be started from the top and proceed towards the bottom. The plastered surface shall be made level and flush with wooden straight edges and rubbed thoroughly with wooden floats to ensure smooth and even surface.

e) Curing

The work shall be kept well watered for at least 15 days.

f) Measurement

The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

5.11.8. Detailed specification for form work and centering to R.C.C. Roofing

[**Sequence**: Strutting; formwork; centering]

a) Strutting

Props used for strutting shall be of casuarinas posts of 100 to 130 mm diameter. The props are to be vertical and rest on firm ground or on wooden sole plates of thickness not less than 40 mm. All props shall be provided with double wedges to facilitate tightening and loosening of shuttering. The horizontal spacing of props in both directions shall not exceed 750 mm. When the height of strutting exceeds 3.5 m, suitable horizontal bracings should be provided. Splicing of props shall be as per the approved drawings. The props shall be constantly watched, by a carpenter, during the process of concreting and immediate remedial measures are to be taken in any of them get loosened.

b) Form Work

The formwork shall be of stiff and strong wood, easily workable with nails and light in weight. The form work shall be true to shape and size specified in the structural drawings and strong enough to with stand the forces caused by vibration of concrete

and the incidental loads imposed on it during concreting. The unsupported length of the planks, particularly of the side plates shall not exceed 1.0 m to avoid buckling. The levels of the form work are to be checked before placing the reinforcement bars in position.

c) Centering

Well-seasoned wooden planks or steel sheets are to be used for the shuttering work. The joints shall be water tight to avoid leakage of cement slurry during compaction. The surfaces of planks and sheets which would come into contact with concrete shall be cleaned well and coated with oil of approved quality to the prevent adhesion of concrete. The complete centering work shall be assembled so that it can be removed, on completion of the specified period, easily without causing any demand to the concrete surfaces and edges.

5.11.9. Detailed specification for cement concrete flooring

a) Bottom Layer

The base shall be of cement concrete of 1:2:4 mix, 25 mm thick. The coarse aggregate, 12 mm size stone chipping, shall be hard, durable strong and free from dust and organic matters. The fine aggregate, 5 mm size river sand, shall be also free fromdirt, clay, mud etc. Fresh Portland cement having initial setting time not less than 30 minutes and of grade 33 shall be used. Portable water, free from harmful substances shall be used for mixing and curing. The concrete mixed as mentioned above shall be spread over the well prepared base, to a uniform thickness of 25 mm, compacted and leveled using wooden floats. The top surface shall be roughened with 2 mm deep lines at 100 mm intervals, with scratching sticks, to provide bond to the top layer. The bottom layer shall be cured for at least 3 days before the tope laying being laid over it.

b) Top Layer

The top layer is of 1:3 cement mortars, 12 mm thick finished with a floating coat of neat cement. Find sand, sifted through 5 mm size mesh and free from clay and dust shall be used. To have a red coloured finish, 3 kg of red oxide of approved quality may be mixed with 50 kg of cement and is used in preparing the mortar. The cement with red oxide is mixed with sand in the ratio 1:3 by volume in dry state to obtain a uniform colour. Water is then added slowly; a paste of uniform consistency is prepared and laid over the base layer to a uniform thickness of 12 mm. It is leveled and smoothened by wooden floats. In the process of finishing cement slurry mixed with enough red oxide is sprayed on top of cement mortar layer. The surface should be covered with a thin layer of water constantly from next day for at least seven days for better curing.

c) Measurement:

The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

5.11.10. Detailed specification for mosaic tile flooring

a) Base Course

The basic course shall be of 25 mm thick cement concrete of a 1:2:4 mix using 12 mm size granite stone chips as coarse aggregate and sand as fine aggregate. The top of flooring concrete or R.C.C. slab shall be cleaned well and applied with cement slurry of 2 kg/m^2 before placing the chips concrete. The base course is to be compacted, leveled and smoothed by wooden floats.

b) Mosaic Tiles

Precast tiles of 200 mm x 200 mm x 20 mm size are to be used. They shall be manufactured under hydraulic pressure of not less than 14 N/mm^2 and given the first grinding with machine before laying. The proportion of cement to sand in the backing of the tiles shall not be leaner than 1:3 by weight. Similarly the proportion of cement to marble power to marble chips in the wearing layer of the tiles shall be not leaner than 3:1:7. The marble chips shall be hard, dense sound and homogeneous in texture.

c) Laying of Tiles

The bedding for the tiles shall be with cement mortar 1:3. The average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall be not less than 10 mm. Cement bedding shall be spread, tamped and corrected to proper levels and allowed to harden before the tiles are set. Neat cement slurry of honey like consistency shall be spread over the bedding at the rate of 4.4 kg/m2. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1.5 mm and in straight lines.

d) Curing, Polishing and Finishing

The day after the tiles are laid, all joints shall be cleared of the grey cement grout with a wire brush to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grounded with whit e cement mixed with pigment to match the shade of tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat. The floor shall then be kept wet for a minimum period of 7

days. The surface shall thereafter be grounded evenly with the polishing machine fitted with coarse grade grit blocks, adding required water during the process. After grinding, the surface shall be washed clean and covered with thin coat of cement slurry with pigment. The surface shall be again cured and polished with machine fitted with medium grade grit blocks. Similarly a third grinding shall be done by fine grade grit blocks. After the final polish, the surface shall be cleaned using diluted oxalic acid and wiped with a soft cloth. The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

5.11.11. Detailed specification for distempering

The distemper shall be of the approved colour and quality. Water shall be added as prescribed by the manufacture, stirred well often during use, to maintain uniform colour and consistency.

The plastered surface of the wall is scraped and cleaned with wire brushes and rubbed smooth with sand papers. Distemper shall not be applied in wet weather. It shall be applied with good brushes, first horizontally and then immediately crossed off vertically which together shall constitute one coat. The second coat will be also applied in the same manner after the first coat has dried. The finished surface shall be even and uniform and shall show no brush marks. The measurement shall be taken in sq. m. The rate shall be for the complete work inclusive of all tools and plants.

[**Similar Items**: Detail specifications for white wash and colour wash]

5.11.12. Detailed specification for Pointing

The joints of the brickwork shall be raked out to a depth of 20mm (3/4") and the surface of the wall washed and cleaned and kept wet for two days before pointing.

The materials of mortar cement and sand, or lime and surkhi or sand, or kankar lime as specified, shall be of standard specification. The materials of mortar shall be first dry mixed by measuring with boxes to have the required proportion as specified (1:2 or 1:3 for cement sand mortar, 1:1 for lime surkhi mortar or kankar lime mortar), and then mixed by adding water slowly and gradually and thoroughly mixed.

Mortar shall then be applied in the joints slightly in excess and pressed by a proper tool of the required shape. Extra mortar if any is removed and surface finished. Mortar shall not spread over the face of bricks, and the edges of the bricks shall be clearly defined to give a neat appearance. After pointing the surface shall be kept wet for seven days.

Flush pointing

The mortar shall be pressed into the ranked, cleaned and wet joints and shall be finished off flush and level with edges of brick to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

Ruled pointing

The mortar shall be passed into the ranked, cleaned and wet joints and a groove of shape and size of 5 to 6mm deep shall be formed running a forming tool of steel along the center line of the joints. The vertical joints also shall be finished in a similar way at right angles to the horizontal line. The finished work shall give a neat and clean appearance with straight edges.

Weather or truck pointing

The mortar shall be applied on the cleaned and wet joints and horizontal joints shall be pressed and finished with a pointing tool so that the joints is sloping from top to bottom. The vertical joint shall be finished as ruled pointing.

Raised or trucked pointing

The mortar shall be applied in raked, cleaned and wet joints in excess to from raised bands. The mortar shall be pressed and run with proper tool to from bands of 6mm(1/4") raised and 10mm (3/8") width or as directed.

5.11.13. Detailed specification for wood work for door and window frames

a) Materials

Timber shall be of teak, sal, deodar etc., as mentioned, well-seasoned, dry, free from sap, knots, crack or any other defects or diseases. It shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The scantling shall be planned smooth and accurate to the full dimensions, rebates, rounding and mouldings as shown in the drawing made, before assembling. Patching or plugging of any kind shall not be permitted except as provided.

b) Joints

These shall be mortise and tenon type, simple, neat and strong. Mortise and tenon joints shall fit in fully and accurately without wedging or filling. The joints shall be glued framed, put together and pinned with hardwood or bamboo pins not less than 10 mm dia. after frames are put together pressed in position by means of a press.

c) Surface Treatment

Wood work shall not be tainted, oiled or otherwise treated before it has been approved by the Engineer-in-Charge. All portions of timber abutting against masonry or concrete or embedded in ground shall be painted with approved wood primer or with boiling coal tar.

d) Gluing of Joints

The contract surface of tenon and mortise joints shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer-in-Charge.

e) Fixing in position

The frame shall be placed in position truly vertical before the masonry reaches half the highest of the opening with iron clamps or as directed by the Engineer-in-Charge. In case of door frames without sills, the vertical members shall be embedded in the flooring to a depth of 40 mm or as directed by the Engineer-in-Charge. The door frames without sills while being placed in position shall be suitably strutted and wedged in order to prevent warping during construction. The frames shall also be protected from damage, during construction.

5.11.13. Detailed specification for wood work for door and window shutters

a) Materials

Specified timber shall be used, and it shall be well seasoned, dry, free from sap, knots crack or any other defects or disease. Patching or plugging of any kind shall not be permitted except as provided.

b) Joinery work:

All pieces shall be accurately cut and planned smooth to the full dimension. All members of the shutters shall be straight without any warp or bow and shall have smooth, well planned faces at right angles to each other. In case of panelled shutters the corners and edges of panels shall be finished as shown in drawings, and these shall be feather tongued into styles and rails. The panels shall be framed into groovers to the full depth of the groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove. In case of glazed shutter, sash bars shall have mitred joints with styles. Styles and rails shall be properly and accurately mortised and tenoned. Rails which are more than 180 mm in width shall have two tenons. Styles and end rails of shutters shall be made out of one piece only. The tenons shall pass through styles for at least 1 th of the width of the style. When

assembling a leaf, styles shall be left projecting as a horn. The styles and; rails shall have 12 mm groove in panelled portion for the panel to fit in.

The depth of rebate in frame for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm. The rebate shall be splayed. The joints shall be presses and secured bybamboo pins of about 6 mm diameter. The horns of styles shall be sawn off.

c) For battened shutters:

Planks for batten shall be 20 mm thick unless otherwise specified and of uniform width of 125 to 175 mm. These shall be planned and made smooth, and provided with minimum 12 mm rebated joints. The joint lines shall be chamfered. Unless otherwise specified the battens for ledges and Braces shall be 30 mm thick and fixed with the battens on the inside face of shutter with minimum two number 50 mm long wood screws per batten. The ledges shall be 225 mm wide and braces 175 mm wide, unless otherwise specified. The braces shall incline downwards towards the side on which the door is being hung.

d) Gluing of joints for paneled or Glazed shutters :

The contact surfaces of tenon and mortise joints shall be treated before putting together with bulk type synthetic resin adhesive of a make approved by the Engineer-in-Charge.

Shutters shall not be painted, oiled or otherwise treated, before these are fixed in position and passed by the Engineer-in-Charge.

For glazed shutters, mounting and glazing bars shall be tub-tenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less.

e) Fittings:

Details of fittings to be provided shall be as per the schedule of fittings supplied by the Engineer-in-Charge in each case. The cost of providing and fixing shutters shall include the cost of hinges and necessary screws for fixing the same. All other fittings shall be enumerated and paid for separately. The fittings shall conform to their respective IS specifications. Where fittings are stipulated to be supplied by the department free of cost, screws for fixing the fittings shall be provided by the contractor and nothing extra will be paid for the same.

5.11.14. Detailed specification for painting new wood work

a) Paint

Ready mixed paint of approved quality and colour shall be used

b) Preparation of surface

The surface to be painted shall be rubbed down smooth with medium and fine sand papers and cleaned off any dust. Knots, cracks holes etc., shall be filled with putty made of 2 parts of whiting. 1 part of white lead mixed together in linseed oil and leveled to the surface. A primer coat is applied to the surface with ready mixed wood primer of best quality.

c) Application

Painting shall be carried out at the driest season of the year. Paint shall be applied with brushes, smoothly spread without any visible brush mark. The second coat shall be applied when the first coat is perfectly dried. The paint shall be stirred often with stick so that it does not settle down.

[**Assignment:** write specifications for varnishing, and polishing new wood work]

CHAPTER 6

RATE ANALYSIS

6.1. Rate Analysis

The process of determining rate per unit of any work in Civil Engineering project like earthwork, concrete work, brickwork, plastering, painting etc. is known as Analysis of Rates or simply Rate Analysis. The rates of materials and labour vary from place to place and hence the rates of different items of works also vary from place to place. The rates of these works further help in determining cost of particular work and in turn cost of the project.

6.2. Necessity of Rate Analysis

- To determine the actual cost per unit of the items.
- To work out the economical use of materials and processes in completing the particulars item.
- To calculate the cost of extra items which are not provided in the contract bond, but are to be executed as per the directions of the department.
- To revise the schedule of rates due to increase in the cost of material and labour or due to change in technique.

6.3. Factors Deciding Rate of Items

The various factors that are involved in determining rate of any item, process or work are mentioned below:

- Specifications of works and material about their quality, proportion and constructional operation method.
- Quantity of materials and their costs.
- Cost of labour and their wages.
- Location of site of work and the distances from source and conveyance charges.
- Overhead and establishment charges
- Profit and miscellaneous expenses of the contractor

6.4. Procedure of Rate Analysis

The analysis of rates is worked out for the unit payment of the particular item of work under two heads: Materials and Labour.

- The cost of items of work = Material cost + Labour cost
- Other costs included to the above cost of items of work are:
  - Tools and Plants (T & P) = 2.5 to 3 % of the labour cost
  - Transportation cost (if conveyance more than 8 km is considered.)
  - Water charges = 1.5 to 2 % 0f total cost
  - Contractor's profit = 10 %

6.4.1 Material cost

The rate of various materials as per specifications for the items under consideration can be chalked out from market survey. The costs of materials are taken as delivered at site of work. This is inclusive of:

- The first cost (cost at origin),
- Cost of transport, railway freight (if any), etc.
- Local taxes and other charges.

a) Lead statement

The distance between the source of availability of material and construction site is known as "Lead" and is expressed in Km. The cost of conveyance of material depends on lead. This statement is required when a material is transported from a distant place, more than 8kms (5 miles). The lead statement will give the total cost of materials per unit item including first cost, conveyance loading-unloading, stacking charges etc.

A typical lead statement is provided as follows:

Sl. No.	Materials	Unit	Cost at Source (per unit)	Lead (in Km)	Conveyance charges (Per Km/ Per Unit)	Total Conveyance charges (/Per Unit)	Total Cost (In Rs. /Per unit)
1	Rough Stone	Cum	250.00	25	5.00	125.00	375.00
2	Sand	Cum	12.00	20	4.00	80.00	92.00
3	Cement	Bag	370.00	Local	-	-	-

6.4.2. Labour cost

To obtain labour cost the number and wages of different categories of labourers, skilled (Skilled 1st Class), semi-skilled (Skilled 2nd Class) and unskilled, required for each unit of work should be known and this number is multiplied by the respective wage per day. The labour charges can be obtained from the standard schedule of rates. 30% of the skilled labour provided in the data may be taken as 1st class, remaining 70% as 2nd class.

The length of time required to do a certain piece of the work may vary according to the skill and mental development of the workmen and working conditions to the particular job.

a) Task or out-turn work

This is the quantity of work which can be done by an artisan or skilled labour (with the help of semiskilled and unskilled labours) of the trade working for 8 hours a day. The out-turn of work per artisan varies according to the nature, size, height, situation, location etc. Out-turn is more in larger cities, as the more specialized and experienced labours are available, than the small cities and country sides.

OUT-TURN OR TASK

Particulars of items	Quantity of work per day (8 hrs a day)
1. Earthwork in excavation in foundation in ordinary soil, lead up to 50m and lift up to 1.5 m	3.00 cum per mazdoor/Beldar
2. Earthwork in excavation in hard soil for 100m lead and 1.5 m lift.	2.00 cum per mazdoor/Beldar
3. Excavation in rock	1.00 cum per mazdoor
4. Sand filling in plinth	4.00 cum per mazdoor
5. Breaking of brick ballast 40mm gauge	0.75 cum per labour/breaker
6. Breaking of stone ballast 40mm gauge	0.40 cum per labour
7. Breaking of stone ballast 20mm gauge	0.25 cum per labour
8. Brickwork in cement mortar in foundation and plinth	1.25 cum per mason
9. Brickwork in cement mortar in superstructure	1.00 cum per mason.
10. Half brick wall in partition	5.00 square meter per mason
11. Brick work in cement mortar in arches	0.55 cum per mason
12. Lime concrete in foundation/ flour	8.50 cum per mason
13. Lime concreting in roof terracing	6.00 cum per mason
14. Cement concrete (1:2:4)	5.00 cum per mason
15. R.C.C. work	3.00 cum per mason

16.	12 mm plastering with cement morter	8.00 square meter per mason
17.	Pointing with cement/line mortar	10.00 sq.m. per mason
18.	25 mm I.P.S. (cement concrete) floor	7.50 sqm per mason
19.	Terrazo floor 6 mm thick mosaic work over 20 mm cement concrete (1:2:4)	5.00 sq.m. per mason
20.	Brick flat floor in cement or lime mortar	8.00 sq. m per mason
21.	Timber framing sal or Teak wood	0.07 cum per carpenter
22.	Timber framing in country wood	0.15 cum per carpenter
23.	Door and window shutters panelled or glazed	0.15 sq.m. per carpenter
24.	White washing or colour washing one coat	200 sq.m. per white washer
25.	White washing or colour washing 3 coats	70 sq.m. per white washer
26.	Painting or varnishing doors or windows one coat	25 sq.m. per painter
27.	Distempering one coat	35 sq.m. per painter
28.	Amount of work done by a mazdoor (helper) per day.	
	i) Mix	3 cum per mazdoor
	ii) Delivery bricks	4000 to a distance of 15 m per mazdoor
	iii) Delivery mortar	5.5 cum of brick work

The recommendation of All India Standard Schedule of Rates and various other govt. reports are used to work out approximate quantity of labour required to prepare the analysis of rates. IS: 7272 (part 1)-1974, provides recommendations for labour output constants for building work which can be used to fix up the labour cost.

A typical labour output constant issued by **National Building Organization** is provided bellow:

LABOUR REQUIREMENTS

	Description of work	Quantity	Labour
1.	Earthwork in excavation in foundation, trenches etc. in ordinary soil including disposal up to 30 m and lift of 1.5 m	28.30 m^3 (1000 cft)	Beldar - 5 nos. Mazdoor-4 nos.
2.	Refilling of excavated earth in foundation, plinth etc. including consolidation in 150 mm layer.	28.30 m^3 (1000 cft)	Beldar-3 nos. Mazdoor-2 nos. Bhisti-0.5 nos.
3.	Laying cement concrete	2.83 m^3 (100 cft)	Beldar-2 nos. Mazdoor-3 nos. Bhisti-3/4 nos. Mason-1/4 nos.
4.	Laying of R.C.C. work	2.83 m^3 (100 cft)	Beldar-3 nos. Mazdoor-3 nos. Bhisti-1.5 nos. Mason-0.5 no.
5.	Reinforcement work for R.C.C.	1 quintal	Blacksmith-1 no. Beldar-1 no.
6.	First class Brickwork in 1:4 cement morter in superstructure	2.83 m^3 (100 cft)	Mason-2.25 nos. Mazdoor-4.5 nos. Bhisti-0.5 no.
7.	Wood work in door/window fromes	0.18 m^3	Carpenter-2 nos. Beldar-1 nos.
8.	Wood work in panelled, glazed shutters etc.	0.30 m^3	Carpenter-15 nos. Beldar-4 nos.
9.	40 mm cement concrete flooring	40 m^2	Mason-5 nos. Beldar-4 nos. Mazdoor-3 nos. Bhisti-1 no.
10.	12 mm cement mortar plastering	40 m^2	Mason-3 nos. Mazdoor-3 nos. Bhisti-1 no.
11.	Three coats white washing/colour washing	60 m^2	White washer-1 no. Mazdoor-1 nos.
12.	Two coats painting on wood or steel	10 m^2	Painter-3 nos. Mazdoor-2 nos.

6.4.3. Miscellaneous cost

a) Cost of equipment, Tools and Plants (T & P)

The cost of equipment and ordinary tools and plats and miscellaneous petty items (sundries) are added to the specific item rate as lump-sum. A provision of 2.5 to 3 % of the labour cost is made for such items. In certain tools and plants if it is difficult to allocate their use for a particular item of rate; then the cost of such tools or plants may be allocated to the over-head expenditure.

For big works and projects where it becomes necessary to use special types of equipment like batching plants or WMM plant or dumpers or cranes for transportation of concrete mix, provisions of an amount 1% to 1.5% of the estimated cost is provided in the estimate under the head "special tools and plants".

b) Water charges

For drinking purpose of the workers and for the work, arrangement of water is made sinking tube well; bore well or from temporary connection from municipality. For this purpose a provision of 1.5 to 2 % of total cost (Material + Labour+ Sundries) is made in the estimate.

c) Over head charges

Overhead charges include general office expanses, rents, taxes, supervision and other cost which are indirect expanses on the job. Expanses for small tools such as planks, ladders, ropes and other hand tools are also included in the over-head charges. A provision of 2.5% to 5% is made in the rate analysis as overhead charge. Overhead charges can be divided under two categories: General Overhead and job overhead.

General overhead:

These are the expanses made throughout the year irrespective to running works in hand. These include:

- Establishment charge including rent of office space and taxes
- Salaries to office staff
- Purchase of stationary, Printing, postage etc.
- Electricity, telephone and water bills
- Travelling expanses

Job overhead:

These are the expanses indirectly incurred for the job or the project. These include:

- Salaries of personnel engaged for the work (Site engineers, Surveyors or site office staff)
- Rent of temporary site office space, electricity, telephone and water bills
- Handling of materials
- Repairs, carriage and depreciation of T & P.
- Labour welfare, safety measures and insurance etc.
- Interest on investment
- Thept and other losses.

c) Contractor's profit

Generally a provision of 10% is made in the rate analysis as contractor's profit for ordinary contracts. For small jobs 15% profit and for large jobs 8% profit may be considered as reasonable. Contractors profit is not included in rate analysis if material is supplied by the department.

6.5. Rate Analysis of Important Items

6.5.1. Earthwork in excavation in foundation including filling in trenches up to 30m lead and 1.5 m lift

Assume volume of excavation = 100 cu m

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges	-	-	-
Labour Charges			
1. Head Mason	$1/2$ Nos.	450.00 per day	225.00
2. Beldar	18 Nos.	250.00 per day	4500.00
3. Mazdoor	14 Nos.	220.0 per day	3080.00
T&P, Sundries, etc.	LS	240.00 LS	240.00
		Total Materials and Labour	**8045.00**
		Add 1.5% water charges	120.67

Add 10% Contractors profit	804.50
Grand Total	**8970.17**
Rate per cu m	**Rs. 89.70**

6.5.2. First class brickwork in super structure with cement mortar (1:6)

a) Estimation of Materials

Assume volume of brickwork = 10 cu m

Nominal size of modular brick = 10 cm×10 cm× 20 cm

Hence, the number of bricks required = $\frac{10}{0.1\times0.1\times0.2} = 5000\ nos.$

Actual size of modular brick = 9 cm× 9 cm× 19 cm

The remaining space is filled by mortar, hence the volume of mortar required for 10 cum

= 10 – (5000 × 0.09 ×0.09 × 0.19) = 2.3 cu m.

Additional mortar required for frog filling, brick bonding and wastages @ 15%.

Thus volume of set mortar = 2.3 + 2.3 × 15\100 = 2.64 cum.

But, 1.25 cu m of dry volume of mortar materials produces 1.0 cu m set mortar.

Hence, volume of dry materials required for 2.64 cu m of set mortar

= 1.25 × 2.64 cu m = 3.30 cu m.

[Note: As a thumb rule, dry volume of mortar materials is 30% of brick work]

Sum of proportion of cement and sand = 1+6 = 7

Hence, volume of cement = 3.3/7 = 0.47 cu m.

However, cement is available in 50 kg bag whose volume is 0.0347 cu m.

[*Mass = 50 kg; Density =1440 kg/m3; Thus, Volume = 50/1440 = 0.0347 cu m*]

[*Thumb rule: 1 cu m of cement = 30 bags of cement.*]

Therefore, number of bags required = 0.47 / 0.0347 ≈ 13.5 bags.

Volume of sand required = 0.47 × 6 = 2.82 cu m.

b) Rate Analysis

Assume, the volume of brickwork = 10 cu m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Brick	5000 Nos.	250.00 (/100 nos.)	12500.00
2. Cement	13.5 bags	320.00 per bag	4320.00
3. Sand	2.82 cu m	350 per cu m	987.00
Labour Charges			
1. Head Mason	2 Nos.	450.00 per day	900.00
2. Mason	6 Nos.	350.00 per day	2100.00
3. Mazdoor	16 Nos.	220.00 per day	3520.00
4. Bhisti	08 Nos.	220.0 per day	1760.00
T&P, Sundries, etc.	LS	200.00 LS	200.00
		Total Materials and Labour	**26287.00**
		Add 1.5% water charges	394.30
		Add 10% Contractors profit	2628.70
		Grand Total	**29310**
		Rate per cu m	**Rs. 2931.00**

6.5.3. 12 mm thick plaster with cement mortar (1:6)

a) Estimation of Materials

Assume plastering area = 100 sq m

Hence volume of mortar for 12 mm plaster = 100 m × 0.012 m = 1.2 cum

Add 30 % more to the above volume for filling of joints, for making un uniform surface well and for wastages

Thus total set volume of mortar including wastages and joint filling etc.

$= 1.2 + 1.2 \times 30\backslash 100 = 1.56$ cu m.

As, 1.25 cu m of dry volume of mortar materials produces 1.0 cu m set mortar;

Volume of dry materials required for 1.56 cu m of set mortar is

= 1.25 × 1.56 cu m = 1.95 cu m,

Hence, volume of cement = 1.95/7 = 0.28 cu m.

Number of bags required = 0.28 / 0.0347 ≈ 8 bags.

Volume of sand required = 0.28 × 6 = 1.68 cu m.

b) Rate Analysis

Assume, the area of plastering = 100 sq. m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	8 bags	320.00 per bag	2560.00
2. Sand	1.68 cu m	350 per cu m	588.00
Labour Charges			
1. Head Mason	2 Nos.	450.00 per day	900.00
2. Mason	6 Nos.	350.00 per day	2100.00
3. Mazdoor	08 Nos.	220.00 per day	1760.00
4. Bhisti	02 Nos.	220.0 per day	440.00
T&P, Sundries, etc.	LS	200.00 LS	130.00
		Total Materials and Labour	**8478.00**
		Add 1.5% water charges	127.17
		Add 10% Contractors profit	847.80
		Grand Total	**9452.97**
		Rate per sq m	**Rs. 94.53**

6.5.4. Cement Concrete (1:2:4) for RC work excluding reinforcement and form work

a) Estimation of Materials

Assume volume of R.C.C. = 10 cu m (Set volume)

1.54 cu m dry volume of concrete making materials produces 1.0 cu m set concrete

Therefore volume of dry materials required for 10 cu m of set concrete is 15.4 cu m.

Sum of proportion of cement, sand and course aggregate = 1+2+4 = 7

Hence, volume of cement = 15.4/7 = 2.2 cu m.

Number of bags required = 2.2 / 0.0347 ≈ 64 bags.

Volume of sand required = 2.2 × 2 = 4.4 cu m.

Volume of course aggregate required = 2.2 × 4 = 8.8 cu m.

b) Rate Analysis

Assume, volume of R.C.C. = 10 cu m.

Particulars	**Qnty/Nos.**	**Rate (Rs.)**	**Cost (Rs.)**
Material Charges			
1. Cement	64 bags	320.00 per bag	20480.00
2. Sand	4.4 cu m	350 per cu m	1540.00
3. C. aggregate	8.8 cu m	800 per cu m	7040.00
Labour Charges			
1. Head Mason	$^1/_2$ Nos.	450.00 per day	225.00
2. Mason	2 Nos.	350.00 per day	700.00
3. Beldar	10 Nos.	220.00 per day	2200.00
4. Mazdoor	10 Nos.	220.00 per day	2200.00
5. Bhisti	05 Nos.	220.0 per day	1100.00
T&P, Sundries, etc.	LS	200.00 LS	200.00
Scaffolding	LS	400.00 LS	400.00
		Total Materials and Labour	**36085.00**
		Add 1.5% water charges	541.28
		Add 10% Contractors profit	3608.50
		Grand Total	**40234.78**
		Rate per sq m	**Rs. 4023.50**

Note: If concrete mixture is employed for mixing of concrete, hiring and running charges may add @ Rs. 100.00 per cu m of concrete; but the labour may be reduced by 2 beldars per 10 cu m of concrete.

6.5.5 Lime Concrete in foundation with 25 mm down brick chips (or jhama chips) with lime surki mortar (1:2:5½)

a) Estimation of Materials

Assume volume of lime concrete = 10 cu m (Set volume)

1.54 cu m dry volume produces 1.0 cu m set concrete

Therefore volume of dry materials required for 10 cu m of set lime concrete is 15.4 cu m.

Sum of proportion of cement, sand and course aggregate = 1+2+5½ = 8½

Hence, volume of slaked lime = 15.4/8½ = 1.8 cu m.

Volume of surki required = 1.8 × 2 = 3.6 cu m.

Volume of jhama brick chips required = 1.8 × 5½ = 10 cu m.

b) Rate Analysis

Assume, volume of R.C.C. = 10 cu m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Slaked lime	1.8 cum	600.00 per cum	1080.00
2. Surki	3.6 cu m	250.00 per cu m	900.00
3. Brick chips	10.0 cu m	350.00 per cu m	3500.00
Labour Charges			
1. Head Mason	$^1/_2$ Nos.	450.00 per day	225.00
2. Mason	1 Nos.	350.00 per day	350.00
3. Mazdoor	18 Nos.	220.00 per day	3960.00
4. Bhisti	02 Nos.	220.0 per day	440.00
T&P, Sundries, etc.	LS	300.00 LS	150.00
		Total Materials and Labour	**10605.00**
		Add 1.5% water charges	159.08
		Add 10% Contractors profit	1060.50
		Grand Total	**11824.58**
		Rate per sq m	**Rs. 1182.50**

Note: In case of cement concrete in foundation, the labours and T&P will be same as this item. The materials like cement, sand and course aggregate can be calculated by the example 21.5.6 and accordingly rate analysis can be made.

6.5.6 Providing cold twisted steel reinforcement in R.C.C. slab including bending, binding and placing in position complete.

a) Estimation of Materials

If bar bending schedule is available, then reinforcement quantity may be estimated from the schedule. Alternatively, reinforcement steel for beams and slabs may be taken as @ 1% of volume of concrete and for columns @ 2% of volume of concrete. The weight of 1 cum of steel is 78.5 quintals.

Consider, first 10 m × 10 m of continuous slab of thickness 100 mm.

The volume of reinforced concrete = 10 m × 10 m × 0.1 m = 10 cu m

Reinforcement required by volume = 10×1/100 = 0.1 cu m

Weight of reinforcement required = 0.1 × 78.5 qu. = 7.85 qu.

Increase this amount by 5% for wastages.

Thus the volume of reinforcement required = 7.85 × 5/100 = 8.25 qu.

Black iron wire @ 1kg per quintal = 8.25 kg.

b) Rate Analysis

Assume, volume of R.C.C. slab = 10 cu m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Reinforcement	8.25 qu.	3800.00 per qu	31350.00
2. Black Iron wire	8.25 kg	45.00 per kg	371.25
Labour Charges			
1. Blacksmith	8.25 Nos.	450.00 per day	3712.50
2. Mazdoor	8.25 Nos.	220.00 per day	1815.00
T&P, Sundries, etc.	LS	300.00 LS	130.00
		Total Materials and Labour	**37378.75**
		Add 1.5% water charges	560.70

Add 10% Contractors profit	3737.88
Grand Total	**41677.33**
Rate per cu m	**Rs. 4167.75**

Note: R.C.C. works are paid separately for cement concrete work; for steel reinforcement and for centering and shuttering as per the PWD practices.

6.5.7 25 mm thick cement concrete (1:2:4) damp proof course.

a) Estimation of Materials

Assume area of DPC is = 100 sq m

The volume of concrete will be = 0.025*100= 2.5 cum.

Following example 21.5.4, the quantity of cement, sand and course aggregates required for 2.5 cu m concrete are estimated as:

Number of cement bags required = 16½ bags.

Volume of sand required = 1.10 cu m.

Volume of course aggregate required = 2.20 cu m.

Quantity of water proofing compound required = 3% by weight of cement =

= 3% of 16½×50 kg = 25 kg.

b) Rate Analysis

Assume, area of DPC = 100 sq m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	16½ bags	320.00 per bag	5280.00
2. Sand	1.1 cu m	350.00 per cu m	385.00
3. C. aggregate	2.2 cu m	800.00 per cu m	1760.00
4. Water proof compound	25 kg	25.00 per kg	625.00
Labour Charges			
1. Head Mason	$^1/_2$ Nos.	450.00 per day	225.00
2. Mason	08 Nos.	350.00 per day	2800.00
3. Mazdoor	08 Nos.	220.00 per day	1760.00

4. Bhisti	01 Nos.	220.0 per day	220.00
T&P, Sundries, etc.	LS	500.00 LS	100.00
		Total Materials and Labour	**13155.00**
		Add 1.5% water charges	197.33
		Add 10% Contractors profit	1315.50
		Grand Total	**14667.83**
		Rate per sq m	**Rs. 146.70**

6.5.8. Random Rubble Masonry in cement mortar (1:6) in foundation and plinth.

a) Estimation of Materials

11.7 cu m of undressed stone and 0.80 cu m of through stone (header) is required for 10 cu m of RR masonry. Further, 4.2 cum of dry mortar materials (cement and sand) are required for same volume of RR masonry work.

b) Rate Analysis

Assume, volume of RR masonry = 10 cu m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	17 bags	320.00 per bag	5440.00
2. Sand	3.6 cu m	350.00 per cu m	1260.00
3. Undressed Stone	11.7 cu m	200.00 per cu m	2340.00
4. Through Stone	0.8 cu m	250.00 per cu m	200.00
Labour Charges			
1. Head Mason	$^1/_2$ Nos.	450.00 per day	225.00
2. Mason	10 Nos.	350.00 per day	3500.00
3. Mazdoor	17 Nos.	220.00 per day	3740.00
4. Bhisti	2 Nos.	220.0 per day	440.00
T&P, Sundries, etc.	LS	200.00 LS	200.00
		Total Materials and Labour	**17345.00**
		Add 1.5% water charges	260.17

	Add 10% Contractors profit	1734.50
	Grand Total	**19339.67**
	Rate per cu m	**Rs. 1934.00**

6.5.9 Rule pointing in cement mortar (1:3) on brickwork on wall.

a) Estimation of Materials

An empirical quantity of 0.63 cu m (dry) mortar is required for 100 sq. m of Rule and Tuck pointing. In case of Flush pointing 75% of above quantity is required.

b) Rate Analysis

Assume, area of Rule pointing = 100 sq m.

Particulars	Qnty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	4.8 bags	320.00 per bag	1536.00
2. Sand	0.48 cu m	350.00 per cu m	168.00
Labour Charges			
5. Head Mason	$^1/_2$ Nos.	450.00 per day	225.00
6. Mason	10 Nos.	350.00 per day	3500.00
7. Mazdoor	09 Nos.	220.00 per day	1980.00
8. Bhisti	1 Nos.	220.0 per day	220.00
T&P, Sundries, etc.	LS	120.00 LS	120.00
Scaffolding	LS	360.00 LS	360.00
		Total Materials and Labour	**8109.00**
		Add 1.5% water charges	121.64
		Add 10% Contractors profit	810.90
		Grand Total	**9041.54**
		Rate per sq m	**Rs. 90.42**

CHAPTER 7

CONTRACT

7.1. Contract

A contract is the agreement entered into voluntarily by two or more parties who promise to exchange money, goods, or services according to a specified schedule and are legally enforceable.

Contractor: A person or a firm who undertakes any type of contract.

7.2. Essentials of a Valid Contract

- There must be mutual agreement between the two parties,
- There must be an offer made by one party called the promisor.
- The other party called the "promise" must accept the offer.
- There must be considerations, which usually, payments in the form of money for doing of an act or abstinence from doing a particular act by promisor for promise.
- The offer and the acceptance should relate to something that is not prohibited by law.
- The offer and acceptance constitute an agreement that when enforceable by law becomes a contract
- The contracting parties entering into agreement should be competent, *i.e.* not disqualified by either infancy or insanity to make such agreement

7.3. Legality of Contracts

Some of the legal aspects of contracts are given below.

- For a contract to complete a definite piece of work, recovery is possible only after completion.
- The impracticality of a work cannot be excuse for nonperformance.
- A contractor who refuses to carry out the work before completion can be subjected for breach of contract.

- When an employer makes it impossible for contractor to complete the work in accordance with the contract, the contractor can sue for the rate of the completed work.
- The penalties described in the penalty clause will not be applicable if the execution of the contract is delayed because of the fault of the employer.
- In case of the contractor's inability to complete the work, after part execution the employer can consider the contract as rescinded and take an action for the damages. The contractor under such circumstances has no lien for the money spent on the work by the contractor.
- When a contractor has finished part of a work and refused to complete the entire work and the employer without the consent of the contractor takes the work in his own hands for completion. In this case the law implies that the employer has to pay for the work, which has done by the contractor.
- When a contractor without lawful excuse, refuses to carry on the work after part performance, the employer may have to pay for the materials delivered on the site by the contractor as distinguished from the materials, which have become fixed in to the work.
- When a contract is formed and it becomes impossible to perform the work immediately or at a later date, it may be possible to adjust the rights and liabilities of the parties.

7.4. Types of Contract:

Contracts offered by PWD departments are mostly of following types:

1. Lump sum contract
2. Schedule contracts or Item Rate contract
3. Percentage Rate Contract
4. Labour contract
5. Materials supply contract

7.4.1. Lump sum contract (/Drawings and Specifications Contract)

In this type of contract, the contractor undertakes the construction work or the execution of the specified work and completes it in all respects for a fixed amount of money. detailed specifications of all items of works, detailed drawings, plans etc., are supplied by the department to the contractor. The contractor on the basis of given details, works out the total cost of the construction and quotes it in lump sum. The design, shape and

materials are as per the choice of contractor, but they have to be got approved before the start of the work.

Advantages:

- The final price is known, by the owner, before the work commences.
- The contractor has more incentive to reduce his cost to increase the profit.
- The contractor hopes to complete the job as quickly as possible, to minimize overhead, to maximize profit and to move to the next Job.
- When level of risks is low and quantifiable, and
- When the client does not wish to be involved in the management of his project.
- That can be accurately and completely described at the time of bidding such as residential and building construction.
- When limited variation is needed.
- The materials used on the temporary works during construction are relieved earlier resulting in their effective use in other works also.

Disadvantages:

- The owner tries to get the maximum work out of money he spends, whereas the contractor tries to get the maximum profit, this causes conflicting interests.
- It becomes very difficult to adjust the additions and alterations in the plan and the specifications at a later stage.
- If the plans and specifications are not clear, the contractors will quote higher rates, resulting in high cost of the work.
- The contractor carries much of the risks. The tendered price may include high risk contingency.
- Competent contractors may decide not to bid to avoid a high-risk lump sum contract.

7.4.2. Item Rate Contract (unit price)

In this type of contract, the contractor undertakes the work on the item rate basis. The payment is done on the basis of quantities of items done and payments are made on the basis of their respective rates. The quantities of various items are worked out by detailed measurements. This type of contract is also known as unit price contract. The approximate quantities of all possible items of work are worked out and are shown in the

tender form. Every contractor quotes his rates against each item are arrives at the final total amount of the work. This is the most common type of contract system, which is widely adopted.

Advantages:

- The additions and alterations in the plan and specifications can be easily made at any stage.
- As the contractor gets the payment against the actual quantities of items done by him, the method is economical. No possibility for excess payment.
- As the rates are item-wise the contractor is not worried regarding the uncertainties in the plan and specifications.
- The work can be started after accepting the tenders without waiting for all the detailed drawings and specifications.

Disadvantages:

- The total cost of the work can only be computed after completion of entire project. In such case the owner may face financial difficulties if final cost increases abnormally.
- Before preparing the bills for payment of money to the contractor, all measurements of various items of work have to be carefully taken and suitably entered in the measurement book.
- Great care shall be taken by the department officers to strictly enforce the specifications during execution of work to avoid the using of substandard materials by the contractor.
- Contractor raises prices on certain items if he apprehends the quantity of those items is likely to increase during execution and make corresponding reductions of prices on other items, whose quantity likely to reduce during execution. This increases total cost of the project.

7.4.3. Percentage Rate Contract (cost-plus percentage)

In this type of contract the contractor agrees to take the work of construction for fixed percentage over the actual cost of construction. This type of contract is given when no contractor is agreeing to do work on other types due to uncertainties and fluctuations in the market rates of materials and labour. The department keeps the actual up to date records of the expenditure incurred on the work and pays the fixed percentage as agreed over it to the contractor. The contractor arranges for the labour, materials required for completion of the work, and maintains proper account of the construction costs.

The cost plus or percentage contracts can be of the following types:

a. Fixed Percentage of Cost

Contractor is paid the actual cost of the work and agreed percentage in addition to allow for profit.

b. Cost plus a fixed sum

The contractor gets actual cost of construction plus an amount of fee (in percentage of construction cost) which is inversely variable according to increase or decrease of estimated cost agreed first by both the parties.

c. Cost plus a fixed sum with profit sharing

In this type of contract the contractor is reimbursed at cost with an agreed upon fee up to the GMP (Guaranteed Maximum Price) which is essentially a cap. Beyond this point the contractor is responsible for covering any additional cost within the original project scope. Additionally an incentive clause is there, which specifies that the contractor will receive additional profits as reward to the contractors who minimizes the cost.

d. Cost plus variable percentage

Contractor is paid the actual cost of the work and a variable percentage in addition to allow for profit. Variable percentage allows the contractor to get better profit for completing the work at minimum cost.

7.4.4. Labour contract

In this type of contract, all materials for the construction are arranged and supplied at the site of work by the department or owner. The labour contractor engages the labour and gets the work done according to specifications. The contract is on item rate basis for labour portion only.The contractor is paid for the quantities of work done on measurement of the different items of work at the stipulated rate as in agreement. Contractor uses his own tools for working. Plants and machineries are arranged by the department or owner. This system of contract is not generally adopted in government works but preferable for private sectors

7.4.5. Materials supply contract

In this form of contract, the contractors have to offer their rates for supply of the required quantity of materials, inclusive of all local taxes, carriage and delivery charges of materials to the specified site within the time fixed in the tenders.

7.5. Factors Influencing Selection of Contract System

- Quantity and quality of work
- The appropriateness for providing an adequate incentive for efficient performance by the contractor
- The ability to introduce changes
- The allocation of risks
- The start and completion date of the project

7.6. Contract Documents

Following documents are included in the contract documents.

1. **Title page**: Name of work, contract bond number, etc.
2. **Index page**: Content of the agreement with page references.
3. **Tender notice:** Giving brief description of work, etc. Usually 2% of the estimated cost is deposited along with tender.
4. **Tender form**: Contractor's rates and time of completion, penalty clause, etc.
5. **Bill of quantities**: Giving quantities and rates of each item of work and the total cost of the whole work.
6. **Schedule of issue of materials**: Giving list of materials to be issued to the contractor with rates and place of issue.
7. **General specifications**: Specifying the class and type of works.
8. **Detailed specifications**: Each item of work and of each material to be used in the work.
9. **Drawings**: Complete set of drawings like plans, elevations, etc. and site plan, of fully dimensioned

7.7. Conditions of Contract

Both parties of a construction team should be fully acquainted with their rights and duties. So while preparing the contract agreement, certain clauses related to the work are laid down and these will be binding on both parties. The main purpose of the conditions of

contract is to avoid dispute and keep the parties as far as possible out of the court of law. Therefor it is imperative that all the clauses of conditions of contract must be precise and definite and there should not be any room for ambiguity or misconstruction therein.

The conditions of contract mainly depend upon the nature of the work. For most of the civil engineering construction projects following clauses are mostly provided in the contract documents:

1. Rates inclusive of materials, labour, etc.
2. Amount of security money
3. Time for completion of work
4. Progress to be maintained
5. Penalty for bad work
6. Mode of payment
7. Extension of time limit for delay
8. Termination of contract
9. Compensation to labour, minimum wages, etc

7.8. Tender

A Tender is the contractor's bid in writing offering to execute the specified work of construction, supply of materials etc., at the rates and amounts indicated, within the time limit and under conditions specified and agreed to.

Tenderer: A person or a firm who tenders bid in response to invitation for tenders.

Tendering: The process of inviting bids and accepting them is known as tendering.

Tender form: It is a printed standard form of contract giving standard conditions of contract, general rules and directions for guidance of contractors. There is also a memorandum for giving: general description of the work, estimated cost, security deposit, time allowed for the work from the start date of written order of commence, columns for signature of the contractor before submission of tender, signature of witness to contractors signature and signature of the officer by whom tender is accepted. This is a part of the tender document.

7.9. Necessity of Tender

- To carry out the work in a fair and transparent way.
- To ensure the work is awarded to a competent contractor at a fair price. The lowest bid is generally accepted, unless there are good reasons for not doing so.
- Once client/government accepts a tender, it is binding on both parties. This means that the person or company that won the tender has to provide the goods or services in the manner agreed to and at the price offered, and client/government must pay the agreed price at the agreed time.

7.10. Earnest Money Deposit (EMD)

It is the amount, which the contractor has to deposit with the department at the time of submitting a tender. This accompanies the tender form and this is usually 2% of the total estimated cost of the project. This serves as a check to prevent the contractor from refusing to accept the work when the tender has been accepted. The other objects of collecting earnest money are:

- **To reduce unnecessary competition:** If no earnest money is collected, heavy competition may start among the tenderers. The contractors who do not have sound financial status may also offer their tenders, which increase the unnecessary competition among the tenderers.

- **To act as a tool for punishment:** In case the contractors quote lower without intention of doing work, the earnest money shall be forfeited by the department as a punishment to such contractors.

- **To act as compensation:** When the lowest contractor refuses to take up the work, the work can be allotted to the second lowest contractor. The earnest money forfeited from the first lowest contractor compensates to loss of the department.

7.11. Security Money Deposit (SMD)

The contractor has to deposit about 10% of the tendered amount with the department as soon as his tender is accepted. This is inclusive of the earnest money already deposited by the contractor. This money is kept as a check so that the contractor fulfils all the terms and conditions of the contract and carries out the work satisfactorily in accordance with the specification and maintains satisfactory progress for completion of the work. In case he fails to fulfill the terms of the contract, the whole of the security money or part of it is forfeited by the department. When the contractor completes the work as per drawings,

specifications and directions of the department within the specified time, the security money is refunded to the contractor. Normally the security deposit is refunded after the maintenance period, which may be 6 to 12 months after the completion of work, and it's handing over to the department.

7.12. Retention Money

Retention money is described as the sum of money held by the employer as a safeguard for any defective or non-conforming work by the contractor. Retention money safeguards the employer by defects which can occur during the defects liability period if the contractor doesn't response according to the contract terms. Retention Money provides additional safeguard to the employer. Retention money gives the idea of importance of completing the signed project as per it's terms and designs. With such retention held, the contractor takes the responsibility to complete the construction project as per the design and quality stated in the initial contract.

Difference between SMD and Retention Money

Security money deposit	Retention money
• This is compulsory to be deposited before entering into a contract.	• This is not compulsory and very rarely arises out of the contract.
• The amount deposited on the basis of tendered amount.	• It has no relation with the tendered amount but depends on the amount of claims against a contractor.
• This is refundable after the maintenance period is over.	• This has no relation with the maintenance period and can be only released after finalization of or adjustment of the claim.
• The amount cannot be collected from any other contract even under the same engineer-in-charge.	• The amount can be withheld from any other contract under the same engineer in charge.
• This is meant for nonfulfillment of conditions of contract against a tender.	• This is meant for fulfillment of any claim against this tender or other tender under the engineer in charge.
• This is a compulsory cause of the conditions of contract.	• This is not a compulsory clause and is provided in some tendered as an additional clause.

7.13. Tender Documents

The following tender documents are made available along with the tender forms to enable contractors to bid for the job.

1. Notice inviting tenders (NIT) in a standard approved form of a department.
2. General conditions of the contract including time limits.
3. Special conditions of the contract that may have to be highlighted.
4. Amount of Security deposits to be paid /deducted.
5. Bill of quantities
6. Schedule of tools and plant and other facilities to be made available by the owner, indicating the conditions, hire changes and the place of delivery.
7. Schedule of stores to be issued by the owner indicating the rates and their place and issue.
8. Detailed specifications or reference to standard specifications for each item of work.
9. Set of approved drawings, including Layout plan and working drawings

7.14. Elements of Tender Operation

7.14.1. Tender notice

Whenever works are to be let out on contract, tenders are to be invited from the registered contractors or both registered and unregistered contractors depending on the magnitude and nature of the work by issuing notice in newspapers. The notice that includes various particulars of work is named as Tender Notice. It is essential that tenders be given adequate publicity so that a sufficient number of contractors may bid and the most attractive offer may be obtained. At the same time it is also necessary that bids be obtained from contractors who have the capability and capacity to undertake the work

Tenders are publicized by the issue of a notice inviting tenders, which indicates (1) name and description of the work (2) estimated cost (3) completion time (4) earnest money payable indicating the manner in which payment is to be made (5) security deposit (6) time and place where tender documents may be inspected or obtained (7) last date and place of obtaining tender papers and submission thereof (8) time and place of opening the tenders (9) authority competent to accept tenders. The tender notice may be advertised in newspapers and issued to registered contractors by post. Copies of the tender notice are

also put up on the notice boards of various offices of the organization. For very large works or those involving special techniques, which may not be within the capacity of the construction industry in the country, global tenders will be issued all over the world inviting bids for the work. Contractors are given a reasonable period of time, depending upon the size of the work to prepare and submit their tenders. Tender documents are usually priced and are issued on payment of the prescribed amount. The sale of tender papers starts and closes at the time notified in the tender notice.

Typical Notice Inviting Tenders

Tender No.:_____

i. Sealed tenders are invited for the following work:

Name of the work	: _____
Estimated cost	: _____
Price of the tender form	: _____
Ernest money deposit amount	: _____
Time for completion	: _____

ii. Tender form and documents can be obtained from Office of the Executive Engineer, PH Division, Sambalpur from 20/12/2015 to 28/12/2015 except Sunday and public holidays during 10 AM to 6PM at a price of Rupees. 1000/- per set.

iii. Each tender must accompany with earnest money in the form of treasury challan, demand draft in favor of EE, PH division, Sambalpur.

iv. Bids must be delivered in the tender box to be kept in the office of the Office of the EE, PH division, Sambalpur by 31/12/2015 till 06 PM.

v. The authority reserves the right to reject any tender /all tenders without assigning any reason.

vi. Other details can be seen in the RFP document.

Date: 19/12/2015.

S/d-

Executive Engineer,

PH division, Sambalpur

Time limits for tender notice

Following time limits between date of call for tenders and the date of opening of the tenders are followed by central public works department.

Cost of the work	Time limit
Up to 1 lakh	10 days
Between 1 lakh to 10 lakh	2 weeks
More than 10 lakh	3 weeks

Necessity of including tender notice in contract document

Tender notice includes several information and conditions such as time of completion, earnest money, refund of earnest money, period of validity of rates quoted by the tender, site inspection, etc. which are not included in the conditions of contract/ Without performing as agreement for the above such particulars the contract is invalid. So the tender notice paper is a very important document on which tenders and subsequent agreements with the contractor are based. Hence tender notice must be a part of the contract document.

7.14.2. Submission of tender and deposit of earnest money

According to the directions contained in the notice inviting tenders, the contractor are required to submit their tender on or before the date and hour fixed for the same duly filled in, signed and witnessed. Before that he has to deposit the earnest money deposit usually 2 to 2.5% of the estimated cost put to tender.

7.14.3. Opening of the tenders

The sealed tenders are received are to be opened in the presence of the contractors or their representatives tendering for the wok at the time and place already notified. The divisional accountants should also be requested to be present on such occasion wherever possible. The officer opening the tenders has to read out the rates offered in case of item rate and percentage ate tenders and the amount in case of the lump sum tenders for the information of all those present.

To avoid tampering of rates etc. the original tenders, before a comparative statement is made out and put up to him by the office, he has to attest the corrections, overwriting etc. in red ink, number them and put his initials at the foot of each page of the documents attached to the tenders. Tenders containing unauthorized corrections and mutilations are

liable to reject. The tenders which are not received in proper form duly filled in or signed or are not supported by requisite earnest money are to be summarily rejected and a record of such cases to be kept in the register of the tenders received.

7.14.4. Comparative statement of tenders

Comparative statement of percentage rate and lump sum tenders are made out by the officer opening the tender. It contains the information regarding the name of the contractor, date of receipt of tenders, percentage above or below the rates entered in the tender document, amount in case of lump sum tenders. The recommendations or orders regarding acceptance or rejection of the tender are recorded on it.

7.14.5. Acceptance of tender

After investigation the comparative statement the lowest tender shall be accepted as a rule by the competent authority. If for any reason, economical or otherwise, the lowest tender is not accepted, reasons should be recorded confidentially and reference shall be made to the tender committee or next higher authority for order as to which of the contractors the work should be given. No tender can be accepted or the circumstances under which lowest tender may be rejected.

Followings are the conditions under which the lowest tender may be rejected:

1. When the tender is informal (*i.e.* not submitted in the form as prescribed by the department or within due date),
2. If it is not technically sanctioned or exceeds the sanctioned amount for the work.
3. If it involves liabilities exceeding the amount of the expenditure sanctioned.
4. If there is any uncertainty or any condition of an unusual character.
5. If it exceeds the amount up to which he is empowered to accept tenders.
6. If any provision infringes any standard rule or order of higher authority.
7. If adequate competition and fair rates are not received.
8. In case a contractor has quoted abnormally low rates, analysis of rates may be asked from the contractor and thorough investigation with necessary remarks and recommendations in respect of the tender should be forwarded to the next higher authority for his approval. The lowest tender in such a case may or may not be accepted.

If the rates quoted are on the high side, all tenders may be rejected and re-invited to obtain a reasonable bid. In order to ensure that there is no legal complication in not accepting any tender, a clause is added in the tender notice reserving the right to reject any or all tenders without assigning any reason. The tenderer whose bid is accepted is intimated in writing and asked to sign the contract documents within a specified period of time. If he fails to do so, the offer is cancelled; the security deposit forfeited and the work allotted to the contractor whose tender is the next highest.

After signing the contract agreement, the site of the work is formally handed over to the contractor, and then he can start the work. The time for completion is reckoned from the day the site is handed over to the contractor.

CHAPTER 8

CARRING OUT OF WORK

8.1. Terminology

Administrative Approval: This term denotes the formal acceptance by the Administrative department concerned, of the proposal for incurring expenditure in the PWD.

Technical sanction: It is an order by a competent authority sanctioning a properly detailed estimate of the cost of a work to be carried out by the PWD.

Detailed Estimate: An estimate prepared on the basis of the detailed quantities of all items worked out from the designs and drawings are known as a detailed estimate.

Major Estimate: An estimate whose sanctioned amount exceeds a certain fixed limit is known as major estimate. In PWD this limit is fixed at Rs.1 lakh.

Minor estimate: An estimate whose sanctioned amount is lower than a fixed limit is known as minor estimate. In PWD this limit is fixed at Rs.1 lakh.

Petty Work: A work, which does not cost more than Rs.7500 is known as a petty work.

Debit and Credit: In simple terms, ‘debit’ means expenditure and ‘credit’ means a receipt.

Cash: The term ‘cash’ as defined in the CPWD code includes legal coins, notes, cheques, deposit-at-call receipts of scheduled banks, drafts and payments on demand.

8.2. Methods for Carrying out the Work

Public works are carried out either departmentally or through contractors. Complicated and important works, where a high degree of reliability in the quality of work is essential, are generally executed departmentally by engaging contractual labours. This method requires intensive planning and supervision, so that the output of labours and machines is commensurate with the expenditure incurred. For most works, however, the contract method is employed. Through this method the department, taking advantage of competitive bidding by rival contractors, is able to get the work executed at the lowest possible rates. Moreover, the risks involved in construction and the day-to-day problems are the headaches of the contractor and the departmental staff can devote sufficient time

to ensure that the contractor's work is in accordance with the designs, specifications, time schedule and other conditions laid down in the agreement.

These are the different methods for carrying out the works:

1. Contract methods
2. Employment of daily labor on muster roll
3. Piece work agreement
4. Work order

In certain cases due to its situation or nature or due to being not susceptible to measurements the works cannot be carried out by contract. The work in such cases is got done by departmental labour and supply of materials, usually the day to day maintenance work is attended to by the work charged establishment. The work is done by them are not measured. They are monthly paid staff employed more or less on the same footing as the regular establishment except that their pay and allowance are charged directly to the work.

8.2.1. Contract methods

In this system the whole work is done by a contractor who arranges all materials required and employ the workers required for completion of projects in time. The contract system may be lump sum contract, item rate contract, cost plus percentage contract, labour contract or materials contract. Details about contract system are provided in previous lectures.

8.2.2. Employment of daily labor on muster roll

Work may be executed departmentally through employment of daily labours such as mason, coolies, bhisties, carpenters, etc. The materials required for the construction such as bricks, cement, sand, lime, surki, timber steel etc., and tools and plants required for the operations are got issued from the store by indent or purchase directly chargeable to the work. The attendance of the labours is kept in Muster Roll by the overseer or by his authorized agents.

a) Payments to daily labours through muster roll

Except for the regular and work charged establishments, all persons engaged departmentally for the execution of works are considered as casual labour. Their wages

are drawn on "Muster rolls". Muster rolls are prepared in the prescribed form (Form 21). The Nominal Muster Roll (N.M.R) form consists of two parts.

Part I of N.M.R. form consists of necessary columns for entering the names of labour, designation, father's name, their attendance particulars, rates of wages and the total amount payable for each labour. N.M.R form has the provision for entering the total amount of the muster, signature or left hand thumb impression of the labour as a receipt. At the bottom of this form, the person preparing such N.M.R form should sign before submitting to A.E / D.E.E who in turn verifies the details entered and makes the payment.

Part II of the muster roll is used for recording the name of work, amount of work done in cases in which the work is susceptible to measurements. Other details like the number of measurement book, pages in which the measurements are recorded will also be entered in this part. If the work is not susceptible to measurement, a remark to that effect is recorded.

Some important instructions regarding the preparation of Muster rolls are:

- Duplicate copies of muster rolls should not be prepared.
- Separate muster rolls are prepared for each period of payment. Labour may be paid more than once a month depending upon local conditions and practices.
- The daily record of attendance and times should be recorded in such a way as to leave no possibility of tampering or making unauthorized entries.
- After the muster roll has been passed, payment should be made as early as possible.
- A record of wages that remains unpaid must be kept in a register of unpaid wages.
- Subsequent payment of unpaid wages is recorded in the hand receipt. A note of the same is recorded in the register of unpaid wages as well as in the muster roll.
- Wages that remain unpaid for three months must be reported to the divisional office.
- Progress of work done by the labour is recorded and is to be compared with departmental rates.
- Muster rolls are checked with reference to entries in the measurement book to the extent of 50% in the sub-divisional and 50% in the division office, when the divisional engineer makes payments.

Form 21--Muster Roll

Cash Book Voucher No. . . . . Date . . . . . .

Name of work . . . . . .

Part I—Nominal Roll

Designation Description	No. (Sl.No.)	Name grouped according to classes	Father's Name	Dates. . . . . Month	Total	Rate Rs. P.	Amount Rs. P.	Dated initial of paying officer
Daily Total								
Initial of person marking daily attendance ...								
Initial of Inspecting Officer ...								

Passed for Rs. . . . . (Rupees. . . . .) Signature. . . . . Rank. . . . . .

	Rs.	P.
Grand total of this muster roll	...	...
Deduct—Payment not made as per details transferred to register of arrears	...	...
Total amount paid in words Rupees	...	...

Date . . . . . Signature. . . . . Rank. . . . . .

Part II--Details of measurement of work done by this labour employed as per this Nominal muster roll in cases in which the work is succeptible to measurement.

Description of work (Grouped sub-headwise)	Quantity	Deduct as shown on the last muster roll	Balance

Measurement of taken on (. . . . . date . . . . .) Signature : . . . . . Rank . . . . . .

Measurement Book No. . . . . page. . . . . Date . . . . . .

Fig. 8.1. Typical muster roll form

8.2.3. Piecework agreement

These are agreements for doing the work at agreed rates, without reference to the total quantity of work or time. Small works or piecework up to Rs.5000/- are got done through the contractors by piecework agreement. In piece-work, the quantity of work is not mentioned and only the rate is mentioned. This agreement is used (i) for small works (ii)

when it is necessary to start work in anticipation of the formal acceptance of the contract and (iii) for running contract. This type contract can be terminated by both parties at any instance without any penalty. Piece work agreements are:

Advantages:

- Urgent small work can be carried without any tenders
- If a contractor leaves, another can take the work

Disadvantages:

- Only petty contractors are interested in this contract.
- Hence careful supervision is required

8.2.4. Work order

Work order is used for petty works; work orders may sometimes also mention the time limit within which the work is to be completed. No formal agreement is drawn up with the contractor as in the case of piece-work when the work is awarded by a work order.

8.3. Measurement Book (M.B.)

The measurement of all works and supplies are recorded in the measurement book and the payments of all works and supplies are made on the basis of the measurements recorded.

Form 23 (measurement Book)

Particulars	Details of actual measurement				Contents of area
	(1) No.	(2) L.	(3) B.	(4) D.	

The measurement book is a most important record since it is the basis of all accounts and quantities whether the work is done by daily labour, piece work, Schedule contract, lump-sum contract or of materials received. As this is the original record of actual measurements or accounts and forms a reliable record; it may have to be produced as evidence in court of law in case any dispute arises. It is therefore preserved carefully and

the movement between officers and persons is also watched continuously. The loss of M.B. is a serious issue and in such conditions it should be reported to the next higher authority citing the incident and for orders for sanction to its write off.

The following instructions should be observed carefully while recording detailed measurements in the M. B.:

- All entries to the measurement book should be made in a continuous chain and in chronological order.
- The pages of the measurement book are machine numbered. If any page left blank through mistake should be cancelled by diagonal lies and cancellation being initialized and dated.
- Entries to the measurement book should be recorded in ink directly at the field.
- At the end of each set of measurement, the officer recording them has to certify "measured by me" and to put his full signature with date.
- Any lines not required should be carefully scored out in order to prevent additional entries being made later on.
- No entry should be erased. If a mistake is made, it should be corrected by crossing out and inserting the corrections. The corrections made should be initialized with date.
- Separate measurement book has should be used to record the works done by contractor and the works done by departmental labour.
- After completion of the detailed measurement, the abstract of quantities is drawn up in the M.B.

Check of measurements of works

Entries recorded by the section officer are always subjected to test check by sub-divisional officer to the extent of 50% by their money value. Similarly, the divisional officer is required to test check at least 10% of the measurements, recorded by his subordinate and to accept responsibility for general correctness of the bill as a whole.

The object of check measurement is to detect errors in measurements and to prevent fraudulent entries. Check measurements should therefore be conducted on such items:

- Which appear obviously incorrect
- Which would be more easily susceptible of fraud
- Which would more seriously affect the total amount of the bill if inaccurate

After completion of abstract, the M.B. is sent to the sub-divisional officer for entering the rates of items of the bills by assistant engineer, and for arithmetical and other checks by the Sub-Divisional clerk. The bill thereafter is typed out in the prescribed form and made ready for payment and submitted to the divisional office for further check and payment. Any corrections to or calculations of rates needed is made in red ink by the sub-divisional or divisional officer. In case of the final bill, the corrections should be confirmed by the person making the original entries before authorizing the payment.

The bill after scrutiny is endorsed with a pay order both on M.B. and bill forms and signed by the divisional officer or executive engineer or engineer in charge. The bill having been accepted and receipted by the contractor, a crossed cheque for the net amount is drawn ad handed over to the payee by the disbursing officer.

8.4. Standard Measurement Book:

A set of M.B. containing detailed measurement of specific buildings and structure maintained by each sub-division is kept to facilitate framing annual repairs estimate and for payment to the contractors for jobs connected therewith. Their M.Bs are known as standard measurement books (S.M.B). The S.M.Bs saves time and labour of the departmental officers from repeated work of taking detailed measurements of the same building again and again.

CHAPTER 9

LAND AND LABOUR LAWS

9.1. Land Acquisition Act

Land acquisition is defined as the process of getting back the land by the government with the certain compensation. Land is needed by the government for:

- Strategic purposes like armed forces and
- Industry and Infrastructure
- Planned development
- Residential purpose for poor, educational & health schemes
- Land for private companies for public purpose
- Needs that arise from natural calamity

9.1.1. Procedure for land acquisition

In India Land can be acquired by the Government according to Land Acquisition, Rehabilitation and Resettlement (LARR) Act, 2013 (Land Acquisition Act, 2013).

When the Government requires land for any of the stated purposes, a notification to that effect shall be published in the Official Gazette and in two daily newspapers circulating in that locality of which at least one shall be in the regional language. Thereupon it will be lawful for any officer and for his workmen to enter upon and survey and take levels, to dig or bore into the subsoil in such locality.

9.1.2. Objection

Any objection by any person to the process should be made in writing to the Collector within 30 days of publication of the notice.

9.1.3. Enquiry and award by the Collector

When government declares public purpose and shall control the land directly, consent of the land owner shall not be required. However, when the government acquires the land for private companies, the consent of at least 80% of the project affected families shall be obtained through a prior informed process before government uses its power under the

Act to acquire the remaining land for public good, and in case of a public-private project at least 70% of the affected families should consent to the acquisition process.

On the day so fixed, the Collector shall proceed to enquire into the objections (if any) and being satisfied that all the persons interested in the land who appeared before him have agreed in writing on the matters to be included in the award of the Collector in the form prescribed by rules made by the appropriate Government, make an award according to the terms of such agreement.

On making an award, the Collector shall tender payment of the market value compensation awarded by him to the persons interested and entitled thereto according to the award. If there be any dispute as to the title to receive the compensation or as to the apportionment of it, the Collector shall deposit the amount of the compensation in .the Court.

9.1.4. Dispute and delay for acquiring land

The Owner of the land who has not accepted the award may move to the court of law hence causing delay for acquiring a land for even several years.

9.1.5. Matters to be considered in determining compensation:

- The market value of the land on the date of the publication of the notification;
- The damage sustained by the person interested, by reason of the taking of any standing crops or trees which may be on the land at the time of taking possession thereof;
- The damage sustained at the time of taking possession of the land, by reason of separating such land from his other land;
- The damage sustained at the time of taking possession of the land, by reason of the acquisition injuriously affecting his other property, movable or immovable, in any other manner, or his earnings;
- If, the person interested is compelled to change his residence or place of business, the reasonable expenses incidental to such change; and
- The damage bonafide resulting from reduction of the profits of the land between time of the publication of the declaration and the time of taking possession of the land.

In addition to the market value of the land an amount calculated at the rate of twelve percent per annum of such market value as interest for the period commencing on and from the date of publication of the notification in respect of such land to the date of the award or taking possession of the land, whichever is earlier

9.2. Types of Labour

Construction labour can broadly be divided into two classes namely casual labour and regular establishment.

9.2.1 Casual labour

Casual labour is employed as and when required for the execution of work, payment is made on the basis of the number of days the labour works. There is no provision of leave, except the weekly holidays. This is also known as daily labour.

9.2.2 Regular Establishment:

Regular establishment generally includes supervisory personal that are required for more or less continuous period during construction. They are paid monthly wages and entitled to leave and other benefits. The employees may be temporary or permanent. Permanent employees have great security of service and may be entitled to more service benefits than the temporary employees.

9.3. Labour Laws Related to Construction Industry

Construction is the largest industry in India and most of the employees who are working in construction industry are labours and skilled workers. As the nature of construction work is temporary the workers are recruited as and when required for the execution of work and are retrenched when no longer needed. Construction labour is migratory in nature, moving from one site to another site, and the labour attached to big contractors tends to migrate to new work sites taken up by them.

Because of such frequent migration construction labour has not been able to organize itself to the extent that labour in factories and other organized sectors of trade has. Consequently, construction labour has extremely poor bargaining power and this situation is fully exploited by employers. The construction labour beside low wages, they live in crowded unsanitary temporary huts built at the construction sites in unhygienic surroundings without basic amenities of life. For the welfare of the labour, the Governments have, from time to time, brought out labour laws.

Labour laws are classified into the following types

- Laws concerning the working conditions of labour.
- Laws concerning wages and other payments to labour.
- Laws concerning the social security of labour.

These laws are proved very much helpful to the labour for improving their living conditions.

9.4. Trade Unions Connected With Construction Industry

Trade unions are voluntary group of workers which are formed with the objective of protecting and promoting the interest of workers. Trade unions have both legal status and social approval. The main functions of Trade unions are:

i. Improving working conditions at site
ii. Improving wages of workers
iii. Promoting welfare activities such as health plans, life insurance, bonus, provident fund etc. for workers
iv. Providing legal assistant to workers where ever required.
v. Establishing cordial relation between employers and workers

Important trade unions connected with construction industry in India are:

- **All India Trade Union Congress (AITUC):** founded by congress party in 1919. Presently under influence of Communist party of India
- **Indian National Trade Union Congress (INTUC):** formed in 1947 by congress party.
- **Bharatiya Mazdoor Sangha (BMS):** set up by Jan Sangh (Bharatiya Janata Party) in 1955
- **United trade Union Congress (UTUC):** founded by left parties in 1949
- **Hind Mazdoor Sabha (HMS)** set up in 1948 by socialist party.
- **Center of Indian Trade Unions (CITU)** funded in 1970 having 2,231 affiliated unions. Functioning under influence of communist party of India (Marxist)

9.5. Labour Insurance

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

9.6. Payment of Wages

The remuneration given to workers for work performed by them is known as wages. Wages are of two types.

Nominal wage: This is the remuneration paid to the worker in the form of money, but it does not include the value of any other benefit that may be provided.

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

Wages are paid to the labour based on two methods:

- Depending upon time devoted to the work (Time rate system)
- Depending upon the quantity of work performed (Piece rate system)

Time Rate system:

In Time rate system of payment of wages, a suitable rate of payment is fixed per unit of time devoted to work by the labour. The unit of time can be hours, days, weeks or months. The rate of payment for casual labour is fixed per day and that of regular employees per month in the construction industry.

Advantages

- It is simple and easily understood by labour.
- The quality of work will be good.
- The workers do not get overstrained.

Disadvantages

- Constant supervision is required.
- Effective cost control can not be ensured.

Piece Rate System

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

Advantages:

- The overall productivity is increased.
- The need of supervision is reduced.
- Effective cost control can be ensured.
- The system is fair to the workers and employers.
- The better workers with higher outputs get higher payment.

Disadvantages:

- The system is unsuitable for works which cannot be measured.
- The quality of work is lowered.
- There are no guaranteed wages for workers.

Whatever the system may be, there must be an adequate compensation for the labour put in and this is known as "fair wages"

9.7. Minimum Wages Act, 1948

The Minimum wages Act of 1948 was passed for the welfare of labour and provided for fixing the minimum rate of wages of labour. The Act aims at making provisions for the statutory fixation for the minimum rate of wages in number of industries where there are extensive chances for the exploitation of labour.

The main provisions of Minimum wages Act are:

- The setting of advisory committees to collect information on which the minimum wages are based.
- The wages of a worker in any scheduled employment shall be paid on a working day by:
    - The 7th day after the last day of the wage period if the establishment has less than 1,000 employees
    - The 10th day after the last day of the wage period if establishment has more than 1,000 employees
- The wages of an employee should be paid without any deductions except those items given below
    - Fines in respect of acts of omission
    - Absence from duty
    - Loss of goods directly attributed to the neglect of the employee

- House accommodation provided by the employer
- Amenities and services provided by the employer
- Income tax
- Subscription to the provident fund
- Recovery of advances
- Deductions ordered by the court
- Payments to co-operative societies / Life Insurance
- Corporation

9.8. Workmen Compensation Act, 1923

The Workmen Compensation Act passed to protect the victims of accidents and their families from hardships out of and in the course of employment. The Act covers workers employed in hazardous occupations as specified in the schedule but excludes those employed in clerical or administrative work. The Act provides for payment of compensation in case of accidents on work sites. The compensation, however, is not payable for injuries due to

1. Disobedience or negligence,
2. Non observance of safety measures
3. Consumption of liquor
4. Diseases which are not contracted as a result of the occupation.

In the case of the death of a worker, compensation is paid under all circumstances.

Accidents are due to

1. Human causes such as poor eye sight, negligence, effect of intoxicants,
2. Mechanical causes such as inadequate safety devices, live electrical equipment, unreliable scaffolding etc. and
3. Environmental causes. Such as poor lighting, heat, noise etc.

The result of an accident may be:

1. Temporary disablement, which may be total or partial.
2. Permanent total disablement.
3. Permanent partial disablement.
4. Death.

The Compensation to be paid is depends on the result of the accident. The Act provides for the appointment of Commissioner for the quick disposal of claims for compensation. The employers are required to notify fatal or serious accidents to the commissioner within seven days. Civil courts are debarred from considering cases arising out of the Act and these are under the jurisdiction of the commissioner.

9.9. Contract Labour Act, 1970

The contract labour Act, 1970 was passed to regulate the employment of contract labour in certain establishments. It also provides for improving the service conditions of contract labour. The Act is of importance to the construction industry where works are executed through contractors or by contract labour.

The Act applies to every establishment and contractor employing twenty or more workmen. The Act does not apply to establishments in which only work of an intermittent or casual nature is performed.

The Act provides for the constitution of a Central Advisory Contract Labour Board under the Central Government and of state Advisory contract labour Board under each State Government to advise the Central and State Governments on matters arising out of the administration of the Act and to carry out the functions assigned to it under the Act.

The main provisions of the Act are:

9.9.1 Registration of establishments

Every principal employer of an establishment to which the Act applies is required to make an application to the registering officer on the prescribed form for the registration of the establishment.

9.9.2 Licensing of Contractors

Every contractor executing any work through contract labour is required to obtain a license

9.9.3 Welfare and Health of Contract Labour

Under the Act, the following facilities are required to be provided for the welfare and health of the contract labour:

- For works likely to continue for more than three months, where labour is required to halt at night in connection with the working of the establishment, the contractor should provide rest rooms. Separate rooms should be provided for women.

- For works likely to continue for more than six months and employing more than 100 or more labour, an adequate canteen should be provided.
- Latrines and urinals must be maintained in clean and sanitary conditions.

9.9.4 Payment of wages

Responsibility for the payment of wages rests upon the contractor

CHAPTER 10

DISPUTE AND ITS RESOLUTION

10.1. Dispute

Given the uncertainties involved in a constructuion project and the magnitude of funds involved it is only natural to have disagreement between the parties, but these needs to be resolved. While most such day-to-day differences are resolved in an amicable manner, without having to resort to a more formal mechanism, the parties at times agree to disagree and seek redressal through independent intervention.

10.2. Causes of Disputes

Following are the main causes of disputes between the owner and the contractor:

- Incorrect or different site conditions
- Use of faulty and ambiguous provision in contracts
- Change orders/extra or out-of-scope work
- Suspension of works
- Poor quality of work and construction defects
- Default by the contractor
- No publicity involved
- Unfair distribution of risk
- Delay in payments and over payment
- Levy of compensation for delay
- Termination of work-order

10.3. Various Dispute Resolution Mechanisms

10.3.1. Negotiation

Parties themselves or their representatives try to resolve the dispute without involving any neutral third party.

10.3.2. Mediation

Mediation is a private, quick, cheap process (compare to either arbitration or litigation) where a third party makes possible dialogue between the parties in order that the parties can reach their own decision that is initially non-binding. The parties can however, agree to be bound by their final decision.

10.3.3. Conciliation

It is a process similar to mediation except that the conciliator can express an opinion on the merits of the case and is required to recommend a solution if the parties fail to agree.

10.3.4. Mini-trial

In Mini-trial, the case is heard not by judges, but by the senior professional or other high level business people having full settlement authority from both sides. A third party neutral usually joins the party representatives listening to the proofs and arguments, an can make any necessary decision to regulate the process.

10.3.5. Adjudication

The dispute is referred to an adjudicator, an eminent person with sound legal knowledge, who is appointed to provide speedy legal decision without going through time consuming court proceedings.

10.3.6. Arbitration

Arbitration is a process where a third party who is independent of parties, but may be appointed by them, makes a decision on the dispute. The decision is binding and can be enforced by the courts. Thus arbitration is a out-of-court proceeding where the arbitrator acts as judge. The outcome is one of a win/lose situation.

10.3.7. Litigation

Litigation (used when all other venues fails) is a dispute resolution method that is inquisitorial and adversarial, where by the disputants initiate legal action against the other party by going to the court. It is costly and results into much delay for the disputants and may not do justice to the parties. However, the benefit the litigation is that the court has the authority to find out the “truth” from the parties and the enforcement of the order or the judgment is supported by other law enforcement agencies.

10.4. Advantages of Arbitration over Litigation

- **Cost**: Arbitration is less expensive than court proceeding.
- **Speed**: Disputes are settled much faster through arbitration as compared to law suit in the court.
- **Convenience**: Arbitration hearings are fixed considering the convenience of both the parties.
- **Technical knowledge**: Both parties have the distinct advantages of appointing arbitrators having technical knowledge and expertise which facilitates satisfactory judgment.
- **Informality**: Arbitration is conducted in a relatively informal atmosphere observing certain minimum prescribed legal formalities.
- **Proceedings in the private premises**: Arbitration proceedings are held in the private premises; consequently business activities of the parties do not suffer.
- **Confidentiality of awards**: The arbitral proceedings and an arbitral awards are generally non-public and can be made confidential.
- **Finality of award**: The award given by the arbitration is final except in exceptional cases.

10.5. Disadvantages of Arbitration

- Arbitration may be subjected to pressure from powerful law firms representing the stronger and wealthier parties.
- Arbitration agreements are sometimes contained in ancillary agreement or small print in other agreements and consumer or the employees often do not know in advance that they have agreed to mandatory binding pre-dispute arbitration b purchasing a product or taking a job.
- The awards of arbitration by large is final and binding. There is very Limited Avenue for appealing against erroneous decision of arbitrators.
- In some arbitration agreement, the parties are required to pay for the arbitrator, which adds an additional layer of legal cost that can be prohibitive, especially for small consumer disputes.
- Arbitration in most countries has fewer enforcement options than the litigation. A party seeking to enforce an arbitration award has to resort to judicial remedies, called an action to confirm an award.

- Matters like; matters related to crime, status, family law, etc., cannot be resolved by arbitration as power of parties to enter into an agreement upon these matters is least restricted.

10.6. Types of Arbitration

10.6.1 Arbitration without intervention of a court

It arises from the execution of an arbitration agreement. The court may set aside the award of arbitrators only in exceptional cases. After the award by the arbitrator is declared, the parties concerned can apply for a decree on the award, same as any other decree of a court of law.

10.6.2 Arbitration with intervention of a court

The selection of the act gives an alternative right to the parties to an arbitration agreement. The appointment of arbitrator can be done jointly by the parties or one arbitrator by each party or the court.

10.6.3 Arbitration in suits (Cases)

When the suit is pending before the court and when the parties desire to settle the same through arbitration before the judgment is pronounced, they can apply for the same and in such cases the court may refer the matter to the arbitrator, appointed in such a manner as may be agreed upon between the parties.

10.7. Arbitrator

Arbitrator is a person chosen by the parties themselves to whom the disputes and differences are referred to the arbitrator acts as judge and gives his judgment which is binding to both parties.

When both the parties mutually agree upon a single person to act as a judge, he is known as sloe arbitrator. But when each party forwards own arbitrator, it is called Joint arbitrator. For joint arbitrator an umpire is selected with the consent of both parties.

10.7.1 Qualification of an Arbitrator

a) An arbitrator must be an expert in the particular branch of profession and the matter in the dispute.

b) He should not be related to any of the parties.

c) He must be impartial, unbiased and free from ill feelings against nay of the parties.

d) He must have unquestionable character, high integrity and unshakable faith in justice.

e) For engineering project, an arbitrator should be a person not bellow the rank of superintending engineer. Preferably, he must be from the panel of arbitrators provided by the high court.

10.7.2 Powers of arbitrator

a) To administer oath to the parties and witness appearing,

b) To state a special case for the opinion of the court or any question of law involved or state the award wholly or in part in the form of a special case of such question for the opinion of the court

c) To make the award conditional or in the alternative

d) To correct in an award any clerical mistake or error arising from the accidental slip or omission.

e) To administer to any party to the arbitration interrogatories as may in the opinion of the arbitrator or umpire, be necessary.

10.8. Procedure to Settle of Dispute by Arbitration

The beginning of the arbitration process involves one party giving notice to another of their intent to arbitrate a dispute, informing them of the nature and basis for the proceeding. The other party then gets a period of time to respond in writing, indicating whether they agree to resolve this dispute via arbitration. Once it is established that the disagreement will be resolved in an arbitration, the arbitration process itself begins, based on the rules and procedures selected by the parties or specified by contract.

After this, the process is somewhat similar to a courtroom trial. Parties make arguments before the arbitrator(s), call witnesses, and present evidence to establish and defend their respective cases. The rules for an arbitration hearing may differ from those of a courtroom, however, and opportunities to question or cross-examine witnesses may be more limited. Once the hearing is concluded, an arbitrator or panel is given a certain amount of time in which to consider the decision and make a ruling.

One of the reasons that arbitration is often thought of as quicker as and cheaper than litigation is that the paperwork involved in a dispute is cut down sharply when compared to litigation. The procedures for many arbitrations cut down sharply on some of the burdensome and expensive litigation tools collectively known as "discovery". The discovery process is intended to allow for exchanges of documents and evidence between

parties in a dispute. However, this can often lead to costly and time-consuming disputes, with mountains of paperwork. The arbitration process usually cuts down significantly on discovery, allowing an arbitrator to take a more active role and possibly curtail excesses.

a) Steps in Arbitration

1. Dispute arises between two parties

2. One party submits a formal request for resolution of dispute through arbitration (This may be to a specific arbitrator or to an arbitral institution. Choices may be predicated by a pre-contractual term in an agreement which has given rise to the dispute.

3. The other party then gets a period of time to respond in writing, indicating whether they agree to resolve this dispute via arbitration. Arbitration process begins once the other party agrees.

4. Parties agree on an arbitrator or an arbitrator is appointed by an arbitral institution or a court.

5. Arbitrator accepts appointment.

6. Preliminary meeting at arbitrator's request. This may be a joint session with everyone present or may be conducted by telephone conference.

7. Arrangements for the arbitration including hire of venue and travel arrangements, usually done by the parties with or without the assistance of an arbitral institution.

8. Preliminary hearings and interim awards possible in respect of security of costs, scope of arbitration agreement etc.

9. Arbitrator directs to the claimants to submit his statement of facts containing detail grievances and claims against respondents within a specified time period. The claimant submits his statements of facts along with copies of all documents justifying his claims. The arbitrator next directs the respondent to submit his counter statement of facts within a specified date. Respondents prepare the defense, duly supported by adequate documentary evidence and witnesses, and submit before arbitrator.

10. Then the hearing of the case starts. The claimant’s representative (often a lawyer) reads the statement of fact. Then the arbitrator directs the respondent or his representative of to counter the statement by claimants with evidentiary proof. During hearing if representative of respondent or claimants wants arbitrator may provide permission to cross examine the witness.

11. After the completion of pleading of both the parties, each party is given the permission to argue his case on the basis of findings in course of the sitting held in the case. Arbitrator hears the pleadings and arguments of both the parties scrutinize and examine all documents and papers produced in the course of the sittings and then close the case and publish the awards. As per the prevailing law arbitration must complete within four months from the date the arbitrator first enters in to reference.

12. The arbitrator has to made his award on a non-judicial stamp paper, sign it and shall give notice to the parties for signing it thereof and the amount of fees and charges payable in respect of the arbitration award.

13. After the award is written on the stamp paper, it should be examined if it is acceptable to both the parties. Once it is decided to accept the award, immediate action should be taken to have the award made a rule of the court by taking necessary steps before the court by either party although it is not necessary for arbitrations out of court. This is made to ensure the award of arbitration is enforceable.

CHAPTER 11

VALUATION

11.1. Definition

Valuation is the technique of determination of fair price of a property such as land, building, factory or other structures. Valuation determines present value of the property for sale or renting purpose.

11.1.1 Difference between Cost, Price and Value

- Cost means the original cost of construction minus the loss due to its age and change in taste or fashion.
- Price is the amount calculated adding the cost of the production, interest on investment and profit to the producer or the owner.
- Value is the worth or utility of a property. Value of a property depends largely on the demand and supply.

For example the cost to draw a painting may be 1,000/- rupees, but by adding profit for the painter the price may be fixed at 1,500/- rupees. Let us consider the painting is a very famous painting whose demand is more (like Monalisa by Leonardo da Vinci) then the value of the painting may be significantly high.

11.2. Purpose of the Valuation

The main purposes of valuation are as follows:

- Sale or Purchase of a property
- To fix up the municipal taxes, wealth tax and estate duty on a property
- To fix up the gift tax payable to the govt when the property is gifted to somebody else.
- To probate, i.e. to prove before a court that the written paper purporting to be the will of a person who has died is indeed his lawful act the official copy of a will is to be presented along with court stamp fees. The stamp fee depends on the value of a property and for this valuation is necessary.
- To divide the property among the shareholders in case of the partition.
- Assessment of income or stamp duty.

- To pay the capital gains tax when a capital asset is disposed of and the proceeds exceed the costs incurred in acquiring the asset.
- Rent Fixation
- To work out the insurance value of a property
- To determine the quantum of loan that can be sanctioned against a property as mortgage or security
- For compulsory acquisition of the property by govt. for public purpose.
- To determine the speculative value of a property, *i.e.* the purchase of a property with intention to sale at a later date and to make some profit.
- To fix up the betterment charges, *i.e.* construction of new road, providing market complex, community hall etc. so that the value of the property will increase.

11.3. Terminology

11.3.1. Incomes:

a) **Gross income**: Total income from all sources.

b) **Outgoings**: these are the expenses which are required to be incurred to maintain the property. These includes: Taxes, periodic repairs, management and collection charges, sinking fund, and loss of rent (for the period when the property is not occupied).

c) **Net income**: The amount left after deducting all outgoings from the gross income.

d) Net income = gross income- outgoings.

e) **Perpetual income**: It is the income receivable for indefinite period of time.

f) **Deferred Income**: it is the income receivable after a lapse of certain period.

11.3.2. Scrap value

If a building is to be dismantled after the period its utility is over, some amount can be fetched from the sale of old materials. The amount is known as scrap value of a building. Scrap value varies from 7% to 10% of the cost of construction according to the availability of the material.

11.3.3. Salvage value

If a property after being discarded at the end of the utility period is sold without being into pieces, the amount thus realized by sale is known as its salvage

Scrap value	Salvage value
This is the dismantled sale value of the materials of an asset at the end of its useful life.	This is the estimated value of an asset as a whole without dismantling at the end of its useful life.
Scrap value is counted in the calculation of depreciation of a property at the end of the useful life and usually this is considered 10% of the cost of the structure or on lump sum basis.	Ordinarily the salvage value factor in the calculation is omitted by accounting scrap value
Scrap value of an asset is merely sale of scarp and has a limitation.	Salvage value deposition may take the form of a sale of the asset to a purchaser who will continue to use it for the function for which it was originally designed. In this case salvage value dominate scrap value in the calculation of depreciation
Scarp value is not counted as a minus quantity.	There are time when it may be a minus quantity

11.3.4. Year's purchase

It may be as the figure which when multiplied by the net income from a property gives capitalized value of the property. It can also be defined as "a certain amount of capital whose annuity of Rs.1/- at a certain rate of interest can be received"

Year's purchase = 100/rate of interest = 1/i

11.3.5. Capitalized value

It is defined as that amount of money whose annual interest at the highest prevailing rate will be equal to the net income received from the property. To calculate the capitalized value, it is necessary to know highest prevailing on such properties and income from the property.

Example:

Calculate the capitalized value of a property fetching a net annual rent of 25000 and the highest rate of interest prevalent being 7%.

Ans:

Net annual rent = 25,000

Rate of interest = 8%

In order to get an annual interest equal to the net annual rent of Rs. 25,000

(8/100) * X = 25000

X = 25000 * (100/8) = 3, 12, 500.00

Capitalized value = Net annual income * Year's purchase (Ans.)

11.3.6. Obsolescence

The value of property decreases if its style and design are outdated *i.e* rooms not properly set, thick walls, poor ventilation etc. The reason of this is fast changing techniques of construction, design, ideas leading to more comfort etc.

11.3.7. Market value

The market value of a property is the amount, which can be obtained at any particular time from the open market if the property is put for sale. The market value will differ from time to time according to demand and supply.

11.3.8. Book value

Book value is the amount shown in the account book after allowing necessary depreciations. The book value of a property at a particularly year is the original cost minus the amount of depreciation up to the previous year.

Market Value	Book Value
Value is fixed by the purchaser	Value is fixed by the depreciation
Value is higher during the subsequent years due to increase in price index	Book value cannot be higher during subsequent years even due to the increase of price index.
Value may be constant for a period	Value cannot be constant, rather there is a gradual fall
Applicable to any type of property	This cannot be applicable in case of land or metal articles like steel copper or gold etc.
Market value is considered for the valuation	Book value is considered for the accounts book of a company
Depends on the forces of demand and supply	Book value does not vary due to demand and supply

11.3.9. Annuity

It is defined as the return of capital investment in the shape of annual instalments monthly, quarterly, half-yearly and yearly. It is the annual payments for the repayment of the capital amount invested by a party. These annual payments are made at the beginning or end of a year, usually, for a specific number of years.

- **Annuity Certain**: If the amount of the annuity is paid for a definite number of years. The lesser the number of year higher the annuity and vice versa
- **Annuity Due**: If the amount of annuity is paid at the beginning of each period or year and payments are continued for definite number of periods
- **Deferred Annuity**: If the payment of the amount of annuity begins at a future date after a number of years.
- **Perpetual Annuity**: If the payment of the annuity continues for an indefinite period.

Though annuity means annual payment, the amount of annuity may be paid by 12 monthly instalments, quarterly or half-yearly instalments.

11.3.10. Sinking fund

It is an amount which has to set aside at fixed intervals of time (say annually) out of the gross income so that at the end of the useful life of the building or the property, the fund accumulated should be equal to the initial cost of the property. The sinking fund may also be required for payment of the loans.

Sinking fund, $I = \frac{Si}{(1+i)^n-1}$, Where, S = Total amount of sinking fund to be accumulated, n = useful life of the property or nos. of years required to accumulate the sinking fund, i= rate of interest in decimals and I = is the annual instalments paid.

Example:

A pumping set with motor has been installed in a building at a cost of 2500.00. Assuming the life of the pump as 15 years, find the annual installment of sinking fund required to be deposited to accumulate the whole amount of 4% compound interest.

Ans:

Annual Sinking fund, $I = \frac{Si}{(1+i)^n-1}$

$= I = 2500x\frac{0.04}{(1+0.04)^{15}-1}$

= 2500 * 0.05 = Rs. 125.00 (Ans.)

11.4. Factors Affecting Value of a Building

- Type of the building
- Location
- Building structure and durability
- The quality of materials used in the construction
- Size of the building

11.5. Depreciation

It is the loss in value of a building or property due to structural deterioration, wear and tear, decay and obsolescence. It depends on use, age, nature of maintenance etc. A certain percentage (per annum) of the total cost may be allowed as depreciation to determine its present value.

The percentage rate of depreciation is less at the beginning and increases with age. Annual depreciation is the annual decrease in the value of the property.

11.6. Comparison Between Depreciation and Obsolescence

Depreciation	Obsolescence
This is the physical loss I the value of the property due to wear & tear, decay etc.	This is the loss in the value of the property due to the change in design, fashion, in structure of the other, change of utility and demand.
Depreciation depends on its original condition, quality of maintenance and mode of use.	Obsolesce depends on normal progress in the arts, inadequacy to present or growing needs etc.
This is variable according to age of the property. More is the age, more will be the amount for depreciation	This is not dependent on age of the building. A new building may suffer in its usual rent due to obsolescence.
There are different methods by which the amount of depreciation can be calculated	At present there is no method of calculation of obsolescence

11.7. Calculation of Depreciation

The amount of depreciation being known, the present value of the property can be calculated after deducting the total amount of depreciation from the original cost.

- Straight line method
- Constant percentage method
- Sinking fund method
- Quantity survey method

11.8.1. Straight line method

It is assumed that the property loses its value by the same amount every year. A fixed amount is deducted every year, so that at the end of the utility period, only the scrap value remains. Therefore, the annual depreciation "D" is estimated as:

$$D = \frac{Original\ value - Scrap\ value}{Life\ in\ years} = \frac{C - S}{N}$$

And the book value after 'n' years = Original cost – n x D

11.8.2. Constant percentage method (declining balance method)

It is assumed that the property will lose its value by a constant percentage of its value at the beginning of every year.

Annual Depreciation, $D = 1 - \left(\frac{Scrap\ value}{\text{Original cost}}\right)^{1/n}$

Or, $D = 1 - \left(\frac{S}{C}\right)^{1/n}$

Value of property of depreciated cost = C – DC

11.8.3. Sinking fund method

It is assumed that the depreciation is equal to the annual sinking fund plus the interest on the fund for the year, which is supposed to be invested on interest bearing investment.

If A is the annual sinking fund and b, c, d etc. represent interest on the sinking fund for subsequent years, then the depreciation at the end of various years can be calculated as:

Year	**Depreciation for the Year**	**Total Depreciation**	**Book Value**
1st year	A	A	C - A
2nd year	A + b	2A + b	C - (2A + b)
3rd Year	A + c	3A + b + c	C - (3A + b + c)
			And so on……

11.8.4. Quantity survey method

The property is studied in detail and loss in value worked out. Each step is based on some logical reasoning without any fixed percentage of the cost of the property.

Only an experienced valuator can work out the amount of depreciation and the present value of the property using this method.

11.8. Determination of Depreciation of a building

After deciding the cost using the previous measures, it is necessary to allow a suitable depreciation on the cost. The following table provides a reasonable depreciation of a building whose life if 80 years and well maintained.

Age of the building	Depreciation per year	Total depreciation
0-5 years	Nil	Nil
5-10 years	@ 0.50%	2.5%
10-20 years	@ 0.75%	7.5%
20-40 years	@ 1.00%	20%
40-80 years	@ 1.50%	60%
Total depreciation after 80 years		**90%**

The balance 10% is the net scrap value on dismantling at the end of the utility period.

11.9. Methods of Valuation of Building.

The valuation of a building is determined by working out its cost of construction at the present day rate and allowing a suitable depreciation.

Following data are required for valuation of a building

- Cost of incurred if the building to be constructed in present day
- Age of the building should be determined
- Visual inspection of its present condition
- Future life span should be determined

11.9.1. Estimation of present day cost

Present day cost may be estimated from the records, Estimates and Bill of Quantities. If the actual cost of construction is known, this may increase or decrease according to the percentage rise or fall in the rate obtained from the PWD Schedule of Rates. Following are the methods to ascertain the present day cost of a building:

a) Cost by detailed measurement

Cost of construction may be calculated by preparing the BOQs of various items of works by detailed measurement at site and taking the rate of each item of work as per the current PWD SOR. All the items of work shall be thoroughly scrutinized and their detailed specification ascertained as per original.

b) Cost by plinth area

The plinth area of the building is measured and the present day plinth area rate of similar buildings in the locality is studied, and the cost calculated. It is necessary to examine thoroughly the different parts of the building including the foundation, structure, doors & windows, finishes etc.

11.9.2. Estimation of present day value of the building

Following methods are available to determine value of a building:

a) Direct comparison method/ Plinth area method:

It is the simplest form of valuation. The cost of the property is derived from the cost of property sold recently at its neighbourhood. Plinth area cost prevailing in the locality is then worked out. Finally value of the property can be derived from Plinth area cost multiplied by the plinth area of the property. Similarly Cost may be estimated by Cubical content method.

b) Depreciation rate method:

After deciding the cost of the building or structure by any one method, described in 11.9.1, it is necessary to allow a suitable depreciation on the cost.

c) Rental method

In this method, the net income by way of rent is found out by deducting all outgoings from the gross rent. A suitable rate of interest as prevailing in the market is assumes and the years purchase is calculated. The net income multiplied by Y.P. gives the capitalized value or valuation of the property.

d) Land and building method

In this method, the market value of land and the depreciated value of building are determined individually. Then these two values are added to determine the final value of the property.

e) Development method

This method of valuation is used for the properties which are undeveloped or under developed. Those properties were brought, developed and then offered for the sale. The valuation in that case would depend on initial investment, development cost and expected profit.

11.10. Mortgage

Mortgage is the conditional conveyance of property as security for the repayment of a loan. Money borrowed against the security of mortgaged property. Amount of loan sanctioned against a mortgaged property is usually 50 – 70% of the of the property cost.

Mortgagor: The person who takes the loan.

Mortgagee: The person who gives the loan.

Mortgage Deed: Documents required for the mortgage transaction

11.11. Types of Property

a) Freehold property

When the owner is in absolute possession of the property and can utilize it in any which manner he likes. He can use the property for himself, grant lease or tenancies for any period of time.

b) Leasehold Property

It indicates the physical possession of the property, but the use of it may be allowed by the original owner (lessor) as per the lease documents.

11.12. Easement

Privileges and rights that one owner of the property enjoys through or over the property of another. The person who enjoys the easement is the Dominant owner and the owner over whose property the easements are enjoyed is the Servant owner.

1. Right to use light and air from an adjoining property.
2. Right of flow of rain water over the other's land.
3. Right of access from the adjoining owner's land.
4. Right to run services through the neighbor's land.
5. Right of support for a building from the adjoining owner's land.

Easement rights may be granted through documents for uninterrupted periods of 20 years.