ESTIMATION AND COST EVALUATION II

(Diploma 5th sem)

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UNIT-1
INTRODUTION

Definition:

Estimating is the technique of calculating or computing the various quantities and the Expected expenditure to be incurred on a particular work or project.

Incase the funds available are less than the Estimated cost the work is done in parts or by reducing it or specification are altered, the following requirement are necessary for preparing an estimate.

a). Drawings like plan, elevation and sections of important points.

b). Detailed specifications about workmanship & properties of materials etc.

c). Standard Schedule of rates of the current year.

⇒ Need for Estimation and Costing :-

1). Estimate given an idea of the cost of the work and hence its feasibility can be determined i.e whether the project could be taken up with in the funds available or not.

2). Estimate gives an idea of time required for the completion of the work.

3). Estimate is required to invite the tenders and quotations and to arrange contract.

4). Estimate is also required to control the expenditure during the Execution of work.

5). Estimate decides whether the proposed plan matches the funds available or not.

6). To calculate no of different workers that are to be employed to complete the work according to programming.

7). To prepare Controlled materials like cement, steel etc, quantities of such materials can be worked out from Estimation.

⇒ Procedure of Estimating (or) methods of Estimating.

Estimating involves the following operations.

1). Preparing detailed Estimate.
2). Calculating the rate of each unit of work.
3). Preparing abstract of Estimate.

→ Data required to prepare An Estimate:-

They are three types of Data required to prepare an Estimate

1). Drawings ie, plans, Elevation, sections etc.
2). Specifications.
3). Rates.

1). Drawings:-

If the drawings are not clear and without complete dimensions the preparation of Estimation become very difficult. So it is very essential before preparing an Estimate.

2). Specifications:-

a). General specifications:-

This gives the nature, quality, class and work and materials in general terms to be used in various parts of work. It helps to form a general idea of buildings.

b). Detailed specifications:-

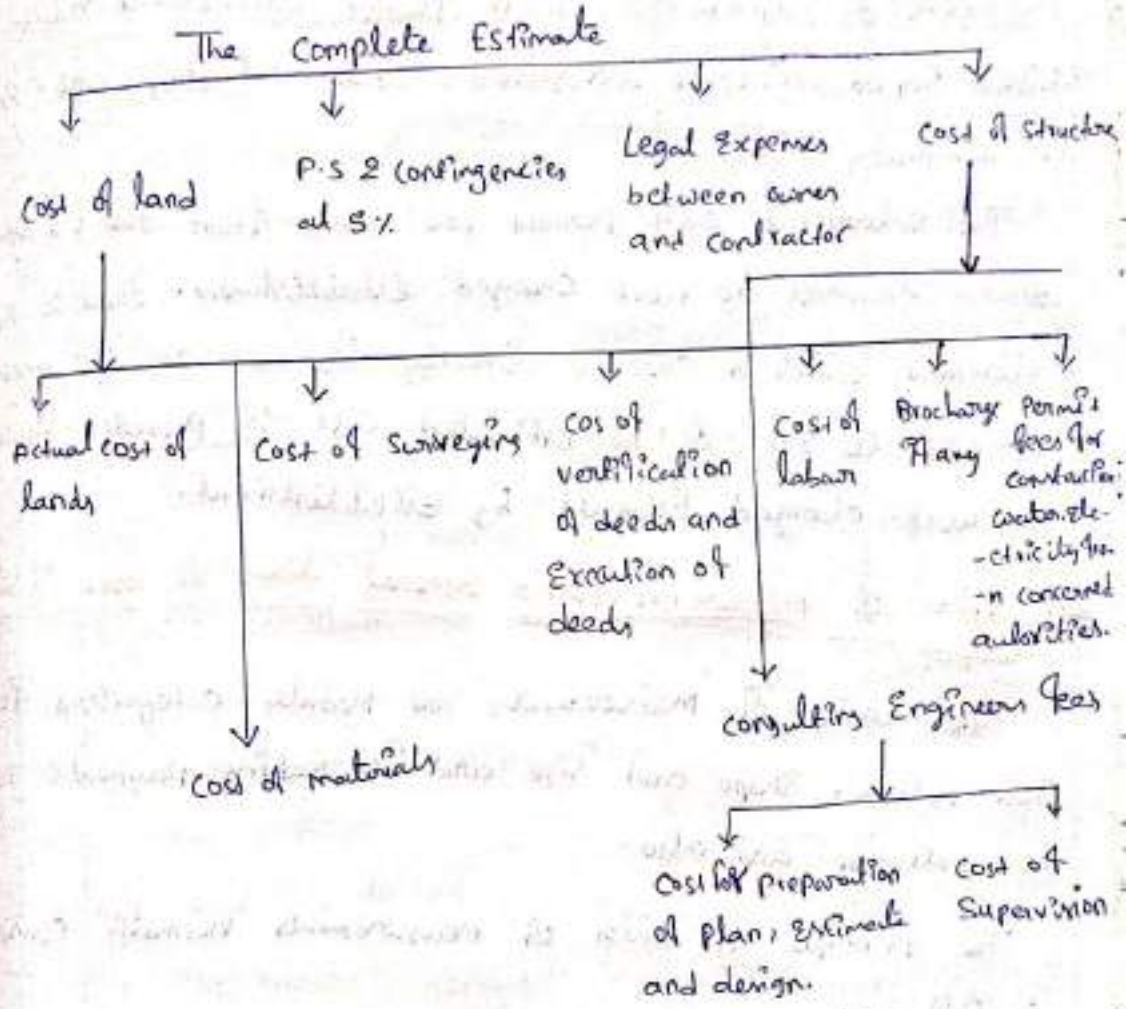
These gives the detailed description of the various items of work laying down the quantities and qualities of materials their proportions, the methods of preparation workmanship and Execution of works.

3). Rates:-

For preparing the Estimate the unit rates of each item of work are required.

1). for assuring the unit rates of each item.
2). The rates of various materials to be used in the construction.
3). The cost of transport materials.
4). The wages of labours, skilled or unskilled of masons, carpenters, mazdoor, etc.

⇒ Complete Estimate:-



⇒ Lumpsum:-

While preparing an Estimate, it is not possible to workout in details in case of petty items. others than civil Engineering such items are called lumpsum items or simply L.S items.

The following are some of L.S items in the Estimate.

* water supply and sanitary arrangements.
* Electrical installation like meter, motor, etc.
* Architectural features.
* Contingencies and unforeseen items.

In general, certain percentages on the cost of Estimate is allotted for the above L.S items.

Even if sub-estimates prepared at the end of Preparation of work, the actual cost should not exceed the L.S amount provided in the main Estimate.

⇒ Work charged Establishment:-

During the construction of a project considerable number of skilled supervisors, work assistance, watchmen 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 $1\frac{1}{2}$% to 2% of the estimated cost is provided towards the work charged Estimate by Establishment.

⇒ Units of measurements and General Items of work in building:-

The units of measurements are mainly categorised for their nature, shape and size and for making payments to the contractor and also.

The principle of units of measurements normally consists the following:

a). Single units work like doors, windows, trusses etc. are expressed in numbers.

b). Works consist linear measurement involve length like cornice, fencing, hand rail, bands of specified width etc. are expressed in running meter (RM).

c). Works consists areal surface measurements involve are like plastering, white washing, partitions of specified

thickness etc are expressed in square meters (m^2).

d). works consists cubical contents which involve volume like Earth work, cement concrete, masonry etc are expressed in cubic meters (cm).

[Based on IS-1200 Revised]

Sl No	Particulars of item	Units of Measurement	Units of Payment
I	Earth work:		
	1). Earth work in Excavation.	cum	Per % cum
	2). Earth work in filling in foundation trenches.	cum	Per % cum
	3). Earth work in filling in plinth.	cum	Per % cum
II	Concrete:-		
	1). lime concrete in foundation	cum	per cum
	2). cement concrete in lintels	cum	per cum
	3). R.c.c in slab.	cum	per cum
	4). cc or Rcc chujja, sunshade	cum	per cum
	5). L.c in roof terracing (thickness specified)	sqm	per sqm
	6). cement concrete bed	cum	Per cum
	7). R.c sunchade (specified width & Height)	cum	1 sm
III	Damp proof cource (D.P.C):- (Thickness should be mentioned)	sq.m	per sqm
IV	Brick work:-		
	1). Brick work in foundation	cum	Per cum
	2). Brick work in plinth	cum	Per cum
	3). Brick work in superstructure	cum	per cum
	4). Thin partition walls	sqm	Per cum

	5). Brick work in arches	Cum	Percum
	6). Reinforced brick work (R.B work)	Cum	Percum
V	Stone work:- Stone masonry	Cum	Percum
VI	Wood work:-		
	1). Door and windows frames or Chowkhats, rafters beams	Cum	Per cum
	2). Shutters of doors and windows (thickness specified)	Sqm	Per sqm
	3). Doors and window fittings (like hinges, tower bolts, sliding bolts, handles)	Number	Per number
VII	Steel work:-		
	1). Steel reinforcement bars etc in R.C.C and R.B work quintal.	Quintal	Per quintal
	2). Bending, binding of steel Rein-forcement	Quintal	Per quintal
	3). Rivets, bolts, & nuts, Anchor-bolts, Lewis bolts, holding down bolts.	Quintal	Per quintal
	4). Iron hold fasts	Quintal	Per quintal
	5). Iron railing (height and types specified).	Quintal	Per quintal
	6). Iron grills	Sqm	Per sqm

VII	**Roofing:-**		
	1). R.c.c and R.B slab roof (Excluding Steel)	Cum	Per cum
	2). L.c roof over and inclusive of tiles or brick or stone slab etc (thickness specified).	Sqm	Per sqm
	3). centering and shuttering form work.	Sqm	Per sqm
	4). A. c. sheet roofing.	Sqm	Per sqm
IX	**plastering, Points & Finishing:-**		
	1). plastering - cement or Lime mortar (thickness and Proportion specified).	Sqm Sqm	Per sqm
	2). pointing	Sqm	Per sqm
	3). White washing, Colour washing, cement wash (numbers of coats specified)	Sqm	Per sqm
	4). Distempering (number of coats specified).	Sqm	Per sqm
	5). Painting, varnishing (number of coats specified,	Sqm	Per sqm
X	**flooring:-**		
	1). 25mm cement concrete over 75mm lime concrete floor (including L.c).	Sqm	per sqm
	2). 25mm or 40 mm C.c floor	Sqm	per sqm
	3). Doors and windows sills (c.c or cement mortar plain)	Sqm	Per sqm

XI	Rain water pipe / plain pipe	1RM	Per RM
XII	Steel wooden trusses	1 NO	Per 1 No
XIII	Glass Pannels (supply)	Sqm	Per Sqm
XIV	fixing of glass panels or Cleaning.	NO	Per No

⇒ Types of Estimates :-

The Construction Cost Estimates can be prepared either in a detailed manner by taking in to consideration item by item or can be calculated approximately without going much into the details.

Based on these criterias, there are mainly 9 cost Estimates followed in Constructions.

* preliminary Estimate.
* Plinth area Estimate.
* Cube Rate or cubical content Estimate.
* Approximate Quantity methods Estimates.
* Detailed Estimate or Item Rate Estimate
* Revised Estimate.
* Supplementary Estimate.
* Supplementary and Revised Estimate.
* Annual Repair or maintenance Estimate (A.R or A.M Estimate).

* Preliminary Estimate :- (or) Approximate Estimate :

Preliminary Estimate is prepared by various ways for different structure as mentioned below.

→ Buildings :-

a). Per unit Basis :- per students for schools and hostels, per class room for school, per bed for hospitals, per seat for Cinema and theatre halls, per tenement for residential buildings.

b). Plinth area basis

c). Cubic content basis

d) Approximate Quality method.

→ Roads and highways :- Per km basis depending upon nature of road, width and thickness of metalling.

→ Irrigation channels.

a). Per km basis

b). per hectare basis (Area of Land commanded).

→ Bridges and Culverts :- Per running meter of span depending upon type of structure, type and depth of foundation

→ Sewerage and water supply project

a). Per head of population served.

b). Per hectare basis (Area covered).

→ over head water tank :- per liter or per gallon of tank depending upon type of structure and height of tanks.

* Detailed Estimate :-

The preparation of detailed estimate consists of working out quantities of various items of work and then determine the cost of each item. This prepared in two stages.

i). Details of measurements and Calculation of quantities :-

The complete work is divided into various items of work such as Earth work concreting, brick work, R.C.C plastering etc. The details of measure-ments are taken from drawings and Entered in respective columns of prescribed proforma the quan-tities are calculated by multiplying the values that are in number column to depth column as shown below:

Details of measurement form

S.No	Description of item	No	length (L) m	Breadth (B) m	Depth/ height (D/H) m	quantity	Explanatory Notes

ii) Abstract of Estimated Cost :-

The Cost of each item of work is worked out from the quantities that already computed in the details measurement form at workable rate. But the total cost is worked out in the prescribed form is known as abstract of Estimated form 4% of Estimated Cost is allowed for petty supervision, contingencies and unforeseen items.

Abstract of Estimation form

Item no.	Description/ particulars	Quantity	Unit	Rate	Per (unit)	Amount

The detailed Estimate should accompained with

(i) Report (ii) specification (iii) Drawing (plan, Elevation, section) (iv) design charts and Calculations (v) standard schedule of rates.

3) plinth Area Estimate:-

→ The cost of construction is determined by multiplying plinth area with plinth area rate. The area is obtained by multiplying length and breadth (outer dimension of buildings).

→ In fixing the plinth are rate, carefull observation and necessary Enquiries are made in respect of quality and quantity aspect of materials and labour, type of foundation, height of building, roof, wood work, fixtures, number of storeys etc.

As per Is 3861-1966, the following areas include while calculating the plinth area of building.

a). Area of walls at floor level.

b). Internal shafts of sanitary installation not Exceeding 2.0 m², lifts, air conditioning ducts etc.

c). Area of bargali at terrace level: Bargali means any covered space open on one side Constructed on one side constructed on terraced roof which is used as

Shelter during rainy season.

d). Porches of non-cantilever type: Areas

Areas which are not to include:-

(a). Area of lofts.

(b). Unenclosed balconies.

(c). Architectural bands, cornices etc.

(d) Domes, towers projecting above terrace level.

(e). Box louvers and vertical sunbreakers.

* Cube Rate Cost Estimate:-

→ Cube rate cost estimate of a building is obtained by multiplying plinth area with the height of building. Height of building should be considered from floor level to the top of the roof level. It is more suitable for multi storied buildings

→ This method of estimation is accurate than plinth area method. The rate per cubic meter is taken into consideration based on the costs of similar type of buildings situated in that location.

→ Foundation, plinth and parapet above the roof level are not considered in this type of estimate.

* Approximate Quantity method Cost Estimate:-

→ In approximate quantity method cost estimate, the total wall length of the structure is measured and this length is multiplied by the rate per running meter which gives the cost of the building.

→ The rate per running meter is calculated separately for the foundation and superstructure.

→ Incase of foundation, Rate per running meter is decided by considering quantities such as excavation cost, brick

work cost up to plinth

→ While in case of superstructure quantities like brickwork for walls, woodwork, floor finishing etc are considered for deciding rate per running meter.

* **Revised Cost Estimate:-**

Revised cost Estimate is a detailed Estimate and it is prepared when the original sanctioned Estimate value is exceeded by 5% or more.

The increase may be due to sudden increase in cost of materials, cost of transportation etc. The Reason behind the revision of Estimate should be mentioned on the last page of revised Estimate.

* **Supplementary cost Estimate:-**

Supplementary cost Estimate is a detailed Estimate and it is prepared freshly when there is a requirement of additional works during the progress of original work. The Estimate sheet should consists of cost of original Estimate as well as the total cost of work including supplementary cost of work for which sanction is required.

* **Supplementary and Revised Estimate:-**

→ When a work is partially abandoned and Estimated cost of remaining work is less than 95% of original Sanctioned Estimate

→ When there are material deviations and changes in the design

→ If at any time before or during the Execution of work, it is found that original Estimate is excessive then divisional officer may sanction a revised Estimate of reduced amount.

* **Annual Repair cost Estimate:-**

The annual Repair cost Estimate is also called as annual maintance Estimate which is prepared to know the maintenance

Cost of the building which will keep the structure in safe condition. White washing, painting, minor repairs, etc. are taken in to consideration while preparing annual repair estimate for a buildings.

* Standard unit principle of working out quantities (or) Items of work

The rules for different items of work are given in IS:1200.

1). long & thin works shall be taken in linear (or) Running meter and linear measurements shall be measured to nearest 0.01m.

2). Shallow, thin & surface works likes plastering, painting etc, shall be taken in square units or in area. Area shall be measured to nearest $0.01 m^2$.

3). mass, volume, thick works shall be taken in cubic meter unit. There shall be worked out to nearest $0.01 m^3$.

4). Piece work, job work etc, shall be taken in number.

5). Deduction of plastering, white washing etc, for doors & windows are to be made one side only as other side has to be accounted for area of Jambs & reveals.

→ Difference between Detailed Estimate and Abstract Estimate

Detailed Estimate	Abstract Estimate
1). Given quantity of Each item of work.	1). Given cost of Each item of work.
2). Given idea of procurement of materials.	2). Given idea for procurement of money for Entire project.
3). Drawings, designs, specifications are required.	3). data, analysis of rates are required.

→ Difference b/w Approximate Estimate and Detailed Estimate.

Approximate Estimate	Detailed Estimate
1). It is rough Estimate	1). It is Exact Estimate.
2). Detailed drawings are not Reauired.	2). Detailed drawings are reauired
3). To get administrative approval It is prepared	3). To get technical sanction it is reauired.
4). Time Consuming is less	4). Time Consuming is more

→ Methods of Preparation of Approximate Estimate:-

→ Preliminary or approximate Estimate is reauired for studies of various aspects of work of project and for its administrative approval.

→ It can decide, in case of commerical projects whether the rel income Earned justifies the amount invested or not

→ The approximate Estimate is prepared from the practical knowledge and cost of similar works. The Estimate is accompained by a report duely Explaining neccesity and utility of the project and with a site or layout plan.

→ A percentage 5 to 10% is allowed for contingencies. The

The following are the methods used for preparation of approxi-mate Estimates:

a) plinth area methods (I Explained previous topics in types)

b). Cubical contents methods

c). unit base method

b). Cubical Contents methods:-

→ The method is generally used for multistoreyed building
→ It is more accurate that the other two methods are plinth area method and unit bare method.
→ The cost of a structure is calculated approximately as the total Cubical contents (volume of buildings) multiplied by local cubic Rate.
→ The volume of building is obtained by length x breadth x depth (or) height.
→ The length and breadth are measured out to out of walls Excluding the plinth offset.

c). unit Bare method:-

According to this method the cost of structure is determined by multiplying the total number of units with unit rate of each item. In case schools and colleges, the unit considered to be as 'one student and In case of hospital, the unit is one bed' the unit rate is calculed by dividing the actual Expenditure incured or cost of similar buildings in the nearby locality by the number of units.

⇒ factors to be considered while preparing detailed E-

* Estimate:-

1). Quantity and transportation of materials:-

The requirement of materials are taken for bigger project, the requirement of materials is more, such that bulk volume of materials will be purchase and transported definitely a cheaper rate.

(ii) Location of site:-

The site of work is selected, such that it should reduce damage or in transit during loading, unloading, stocking of materials

(iii) Local Labour charges:-

The skill, suitability and wages of local labours are considered while preparing the detailed Estimate.

* Data:-

The Process of working out the cost or rate per unit of Each item is called as Data. In preparation of Data, the rates of materials and labour are obtained from current Standard schedule of rates and while the quantities of materials and labour required for one unit of item are taken from standard Data Book (S.D.B).

⇒ fixing of Rate per unit of an item:-

The Rate per unit of an item includes the following:-

(i): Quantity of materials & cost:-

The requirement of materials are taken strictly in accordance with Standard data book (S.D.B). The cost of these includes first cost, freight, insurance and transportation Charges.

(ii): cost of labour:-

The exact number of labourers required for unit of work and the multiplied by the wages/day to get of labour for unit item work.

(iii): Cost of Equipment (T2P):-

Some costly need special types of Equipment, tools etc; Plan. In such case an amount of 1 to 2% of Estimated Cost is provided.

(iv): Overhead Equipment Charges:-

To meet Expenses of Office rent, depreciation of Equipment Salaries of Staff Postages, lighting an amount of 4% of Estimate cost is allocated.

* Problems on plinth area method:-

1). Prepare an approximate Estimate of building Project with total plinth area of all building's 800 sqm. and from following data.

i). plinth area rate Rs. 4500 per sqm

ii). Cost of water supply @ 7½% of cost of buildings.

iii) Cost of Sanitary and Electrical Installations Each @ 7½ % of cost of building.

(v). Cost of architectural features @ 1% of building cost.

vi. Cost of roads and lawns @ 5% of building cost.

vii). Cost of PS and Contingencies @ 4% of building cost.

Determine the total cost of building project.

Sol:- Given data

plinth area = 800 m²

plinth area rate = Rs. 4500 per sq.m

∴ Cost of building = plinth area × plinth area rate

= 800 × 4500

R = Rs. 36,000,00

(i) Add the cost of the water supply charges @ 7½ %.

$= \frac{36,000,00 \times 7.5}{100} =$

= 2,70,000

(ii) Add the cost of sanitary and electrical installation @ 15 %.

$= \frac{36,000,00 \times 15}{100}$

= 5,40,000

(iii) Add the cost of architectural features @ 1%.

$= \frac{36,000,00 \times 1}{100}$

= 36,000

(iv) Add the cost of Roads Lacon @ 5%.

$= \frac{36,000,00 \times 5}{100}$

= 1,80,000

(v) Add the cost P.S and Contingencies @ 4%.

$= \frac{36,000,00 \times 4}{100}$

= 1,44,000

Total cost = Cost of building + (i) + (ii) + (iii) + (iv) + v

= 36,000,00 + 2,70,000 + 5,40,000 + 36,000 + 1,80,000 + 1,44,000

$= 47,70,000$

Assume Add Supervision Charges 8% on overall cost

$= 47,70,000 \times \frac{8}{100}$

$= 3,81,600$

Grand total Rs = $47,70,000 + 3,81,600$

$= 51,51,600$

2). The plinth area of an appartment is 500 sqm. Determine the total cost of building from the followins data:

(a). Rate of Construction = Rs. 1230/- per m^3

(b). The height of appartment = 16.25m

(c). water supply, sanitary and electrical installation Each at 6% of buildins cost.

(d). Architectural apperance @ 1% of building cost.

(e). Unforeseen item @ 2% of Building cost.

(f). P.S and Contingencies of 4% of building.

Sol:- Given data

(i). The Cost of building = Cubic Content x Cubic rate

$= 500 \times 1230/-$ Per m^3

$= 500 \times 16.25 \times 1230$

$= 99,93,750$ Rs.

(ii) Provision for water supply, Sanitary and Electrical Installations water supply and Sanitation Each @ 6%.

$= \frac{99,93,750 \times 18}{100}$

$= 17,98,875/- Rs$

i.e, total percent $= 3 \times 6 = 18\%$ building cost

(iii). Architectural appearance @ 1%

$= \frac{99,93,750 \times 1}{100}$

$= 99,937/- Rs$

(iv) unforeseen items @ 2% $= \frac{99,93,750 \times 2}{100}$

$= 1,99,875/- Rs$

(v) P.S and contingencies @ 4% $= \frac{99,93,750 \times 4}{100}$

$= 3,99,750/- Rs$

∴ Total Cost = (i) + (ii) + (iii) + (iv) + (v)

$= 99,93,750 + 99,937 + 17,98,875 + 1,99,875 + 3,99,750$

$= 1,24,92,187/-$

Sundries $= 7,813/-$

Total cost of the building Project = Grand total

$= 1,25,00,000/-$

3). The plinth area and plinth area rate of a residential building are 100 sq.m and Rs. 5000/- respectively. Determine the total cost of building assuming suitable provisions.

Sol:-

(i) Cost of building $= 100 \times 5000 = Rs\ 5,00,000$

(ii). Cost of water supply and sanitary fittings @ 15%.

$= 75,000\ Rs$

(iii). Cost of Electrification @ 7½% = Rs. 37,500

(iv). Cost of Roads & Lawns @ 5% = Rs. 25,000

(v) Cost of P.S & Contingencies @ 4% = Rs. 20,000

Total cost = (i) + (ii) + (iii) + (iv) + (v)

= 6,51,500/-

4). Prepare an approximate Estimate of a proposed building from the following:

(a). Plinth area of the building = 226 sqm

(b). Cost of the structure = 2500 per sqm

(c). Water supply and sanitary arrangements = 12½%

(d) Electrification = 7%

(e). Fluctuation of rate = 5% petty

(g). supervision charges = 3%

* Problems on Cubical Content method:-

1). Prepare the rough Estimate for a proposed commercial complex for a municipal Corporation for the following data:

(i). plinth area = 500m²/floor

(ii). height of Each storey = 3.5m

(iii). No of storeys = G+2

(iv). Cubical content rate = Rs. 1000/m3

Provided for a following as a percentages of structural Cost:

a). water supply & sanitary arrangements - 8%

b). Electrification - 6%

c). Fluctuation of rates - 5%

d). Contractors Profit - 10%

e). Petty Supervision & Contingencies - 3%

Sol:- Given data

(i). Cubical Content = No. of Storeys (P.A x height of Each Storey)

$= 3 \times (500 \times 3.5) = 5250\ m^3$

(ii) Structural Cost = Cubical Content x Cubical Content rate

$= 5250 \times 1000$

$= 52.5$ lakhs

Other provisions:-

a). water supply and sanitation $= \frac{52.5 \times 8}{100} =$

$= Rs.4.2$ lakhs

b). Electrification $= \frac{52.5 \times 6}{100} = Rs.3.15$ lakhs

c). Fluctuation of rates $= \frac{52.5 \times 5}{100} = Rs.2.625$ lakhs

Total = Rs.9.975 lakhs

Structural Cost = 52.500 lakhs

Total = 62.475 lakhs

d). P.S/2 Contingencies $= \frac{62.475 \times 3}{100}$

$= Rs.1.874$ lakhs

e). Contractors Profit $= \frac{62.475 \times 10}{100}$

$= Rs.6.247$ lakhs

Grand Total Cost = 70.596 lakhs Rs [62.475+1.874+6.247]

* Problems on unit Rate method:-

1). Prepare an approximate Estimate or rough cost Estimate of a hospital building for 50 beds. The cost of construction altogether for each bed is Rs. 60,000/-. Determine the total cost of hospital building:-

Sol:- Given data

Cost of Construction for each bed = Rs 60,000/-

No of beds = 50

Total cost of hospital building = 50 × 60,000

= Rs. 30,00,000/-

2). To prepare the rough cost Estimate of a hostel building which accommodate 150 students. The cost of construction including all provision is Rs. 15,000/- per student. Determine total cost of building.

Sol:- Given data

No of students = 150

Cost of Construction including all L-S Provisions

Rs 15000/-

Total cost of hostel building = 150 × 15000

= Rs. 22,50,000/-

STANDARDS SPECIFICATIONS:

* Specifications of items in buildings:-

Specifications specifies or describes the nature & class of work, materials used in work, workmanship Etc.

Specification they are two types

(1). General specifications

(2). Detailed specifications

(1). General (or) brief specifications:-

→ It is a short description of different parts of work specifying materials, proportions, qualities etc.

→ General specifications gives nature & class of work materials from foundation to super structure.

→ It gives general idea of whole work and are use-full for preparing Estimate.

a). General specifications of first class Buildings:-

b). General specifications of second class Building:-

c). General specifications of third class Building:-

d). General specification of fourth class Buildings:-

a). General specifications of first class Building:-

→ Foundations & Plinth should be 1-class brick in lime lime mortar or 1:6 cement mortar over lime concrete (or) 1:4:8 cement concrete.

→ Damp proof course should be 2.5 cm thick with 1:1.5:3 cement concrete.

→ Superstructure shall be 1 class brick work with

lime mortar (or) 1:6 cement mortar.

→ Roof shall be R.C.C. Slab supported over R.C.C beams height of rooms shall not less than 3.7m

→ Floors shall be polished of 2.5cm cement concrete over 7.5cm lime concrete.

→ Inside & out side walls shall be 12mm cement lime plastered 1:1:6

→ Doors & windows should be painted two coats

(b): General Specifications of second class Building :-

→ Foundation & Plinth shall be IST - class Brick work with lime mortar over lime concrete.

→ D.p.c Shall be 2cm thick cement concrete 1:2

→ Super-structure shall be 2nd class brick work in lime mortar.

→ Roof shall be R.B (Reinforced Brick) Slab with 7.5cm lime concrete

→ Floors shall be 2.5cm cement concrete over 7.5cm lime concrete verandah floor.

→ Chaukal shall be R.C.C (or) well seasoned sal wood.

(c). General specification of Third class Buildings:-

→ Foundation & plinth shall be 2nd class brick work in lime mortar.

→ D.p.c shall be 2cm thick cement mortar.

→ Super-structure shall be of second class brick work in mud mortar.

→ Roof shall be of mud over tiles or bricks (or) wooden planks.

→ Floor shall be brick on edge floor over well rammed Earth.

→ Inside or outside coall shall be plastered with lime mortar.

→ Chaukal shall be of sal wood, & Shutters of country wood.

(d): General specification for fourth class building:-

→ Foundation & superstructure shall be sundried or kutcha bricks in mud mortar.

→ Roof shall be tile roof over bamboo supports

→ Floor should be Earthen floor.

→ Doors & windows shall be chir or margo (or) country wood.

(2): Detailed specifications:-

we are discuss about previous topics are General items of building check it once.

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UNIT-II

ESTIMATION BUILDINGS

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* Separate Wall (or) individual wall (or) Longwall - short wall Methods:-

In this method, find out the external length of walls running in longitudinal direction generally long walls and the internal length of walls running in transverse direction i.e short walls.

The simple method is take longwalls & short walls separately and to find out centre to centre lengths of longwalls & short walls.

For longwalls add to centre length one breadth of wall, which given length of wall out to out, multiply this length by the breadth & height and get the quantities. Adopt same procen for foundations concrete and for each footing and excavation also.

> Longwall length out to out = (centre to centre length) + (half breadth of one side) + (half breadth on other side).

For short or cross walls substract from the centre length one breadth of wall, which gives length in to in

> Short length (or) short wall length = (centre to centre length - (1/2 breadth of one side) - (1/2 breadth of other side).

= centre to centre length - one breadth

This method is simple, accurate and there is no chance of any mistake. This method is also called as "general method".

* Centre line method:

In this method, sum-total length of centre lines of walls (both long & short), of same type, same type of foundations and footings and then find the quantities by multiplying the total centre length by respective breadth and height.

In this method, length will remain same for Excavation concrete in foundation, for all footings for superstructure.

This method is quick but requires ~~special~~ for special attention, considerations at Junctions etc, for each junction half breadth of respective item of footing is to be deducted from the total centre long.

for Rectangular, Circular, Polygonal etc, buildings having no inter or cross walls, this method is quite simple.

In case of building having different types of walls say outer wall of 'A' type & inter cross walls of 'B' type, then all 'A' type walls shall be taken jointly first, and then all 'B' type walls so to be taken separately.

In such cases, no deduction is made for 'A' type walls but when B type walls, for each junction deduction half breadth of 'A' type wall shall have to be made from total centre length of walls.

It may be noted that at corners of buildings, where two walls are meeting, no substraction or no addition is required.

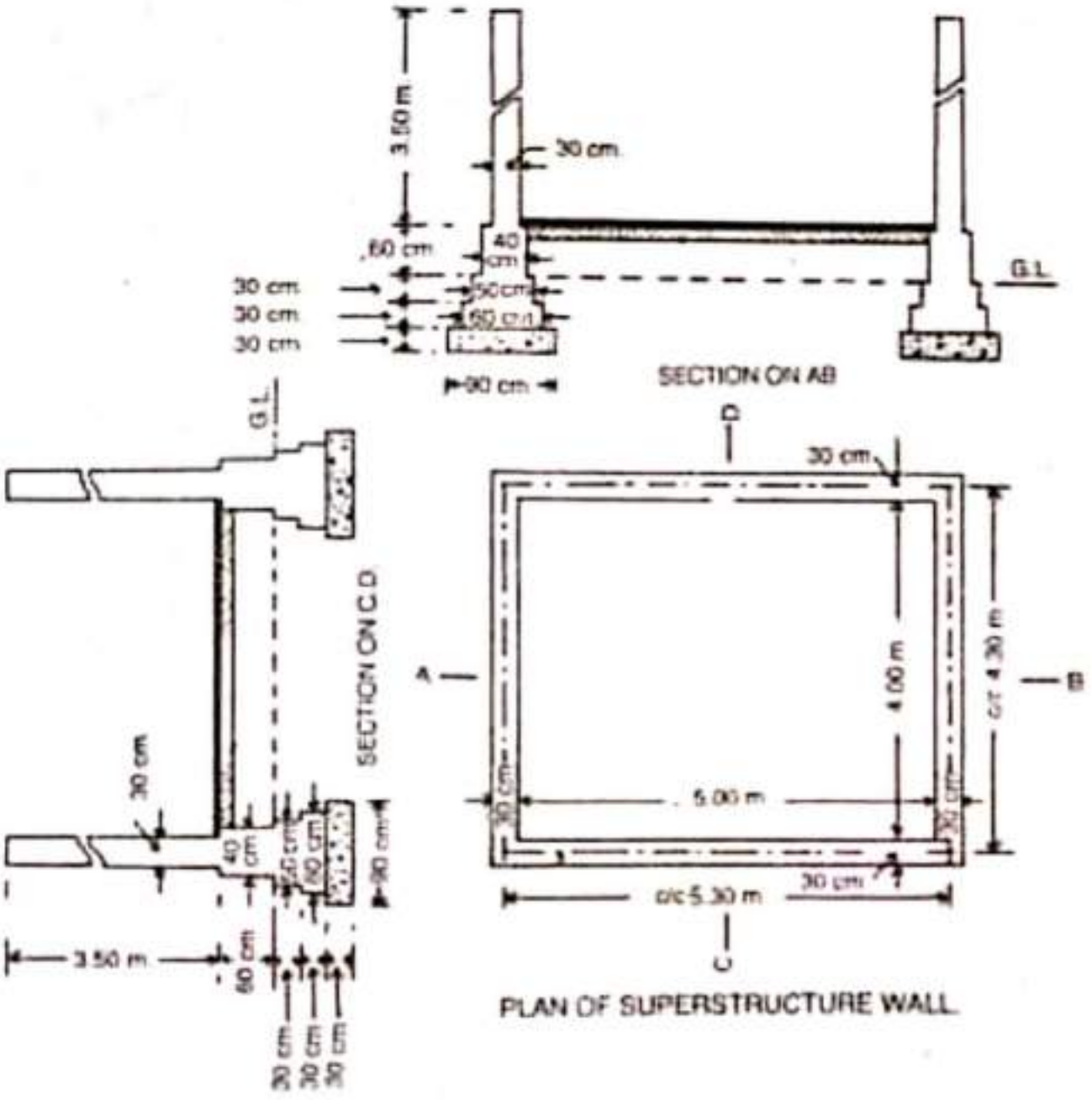
Important formulae:

* Radius of segment $R = \frac{h}{2} + \frac{s^2}{8h}$ (h: Ian length at centre
* straight length of step $s' = 2\sqrt{R^2-(R-h)^2}$
* Area of segment $= \frac{2}{3}sh + \frac{h^3}{2s}$
* volume: (Area of segment) x (height)
* curved length of step $= \frac{8b-2a}{3}$

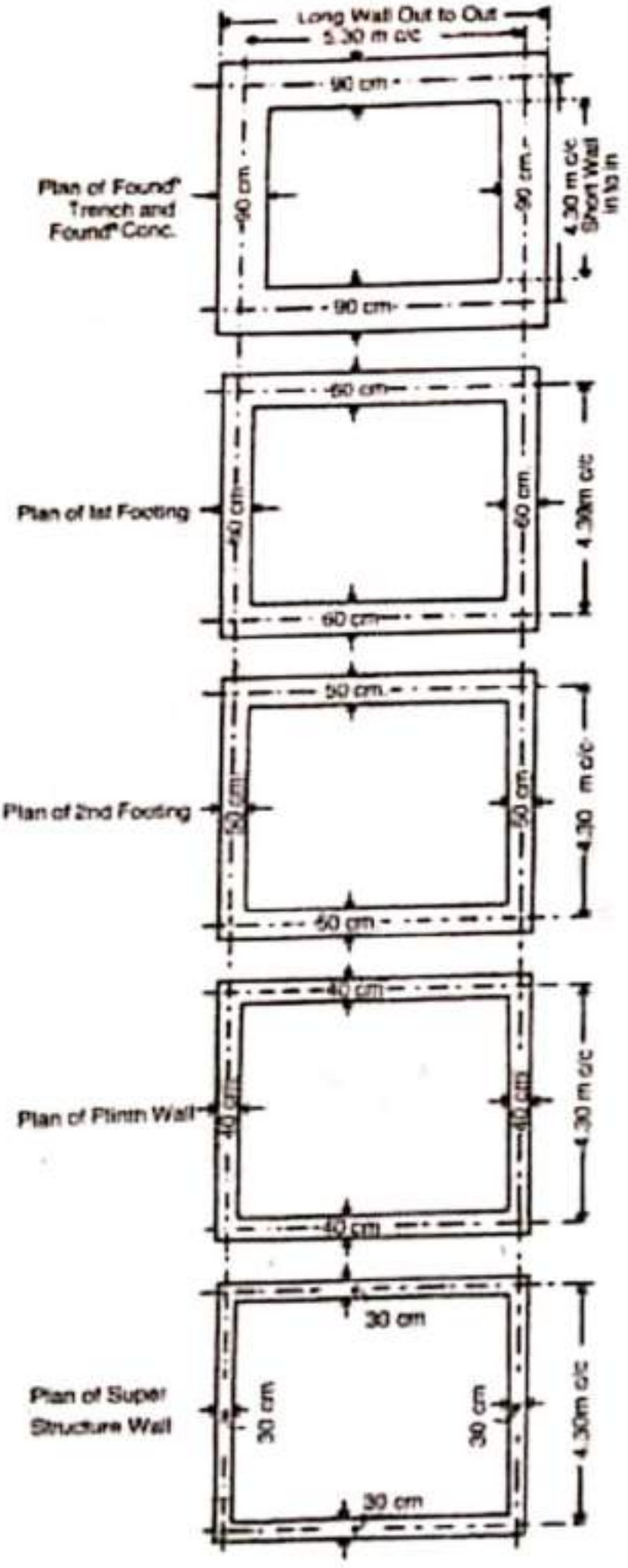
a = half of straight length $= \frac{s}{2}$

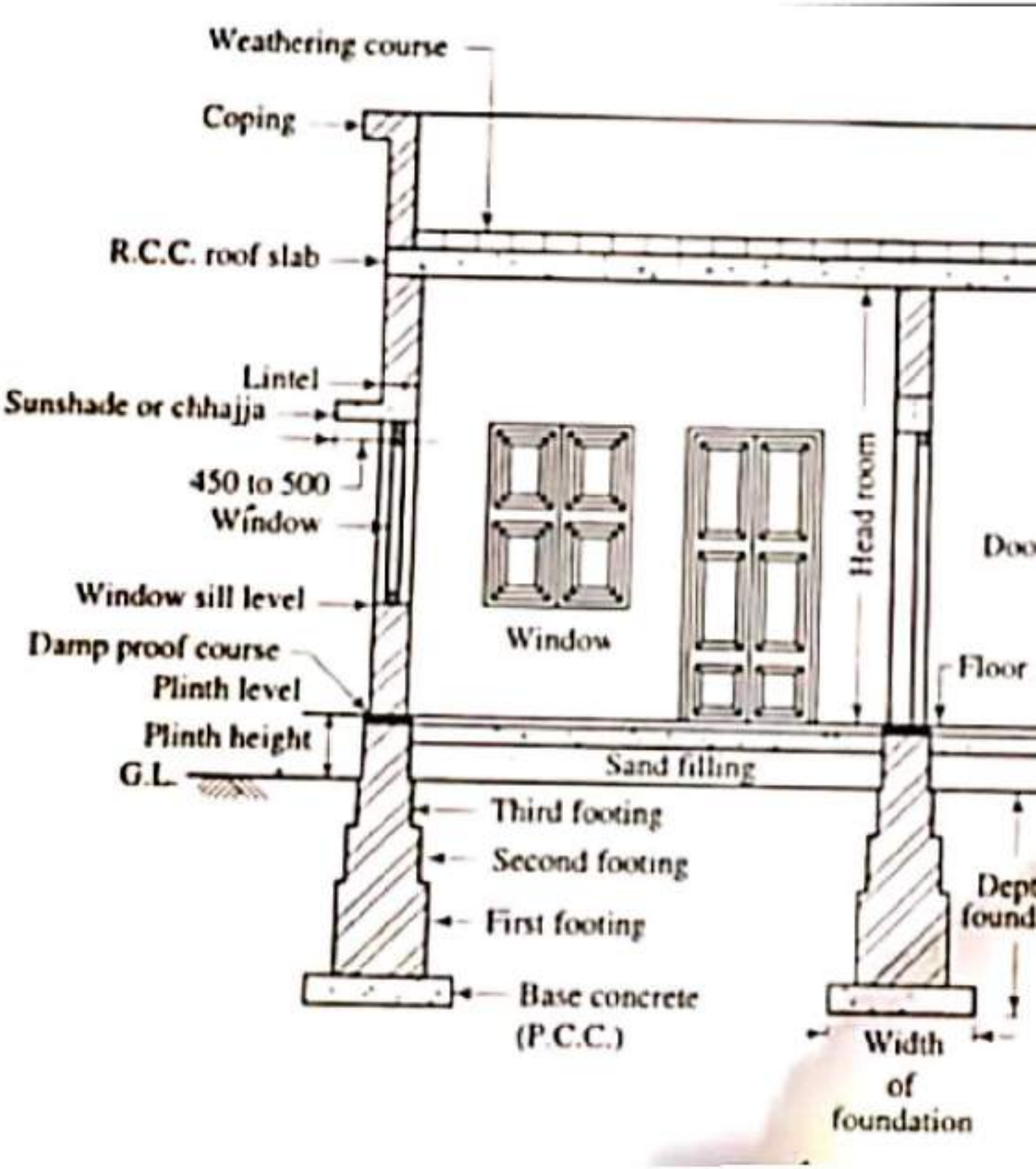
$b = \sqrt{a^2+h^2}$

* Surface area of risen = (curved length) x (height of risen
* Surface area of tread = (mean curved length) x (breadth of tre



PLANS AT DIFFERENT LEVELS





Problems:-

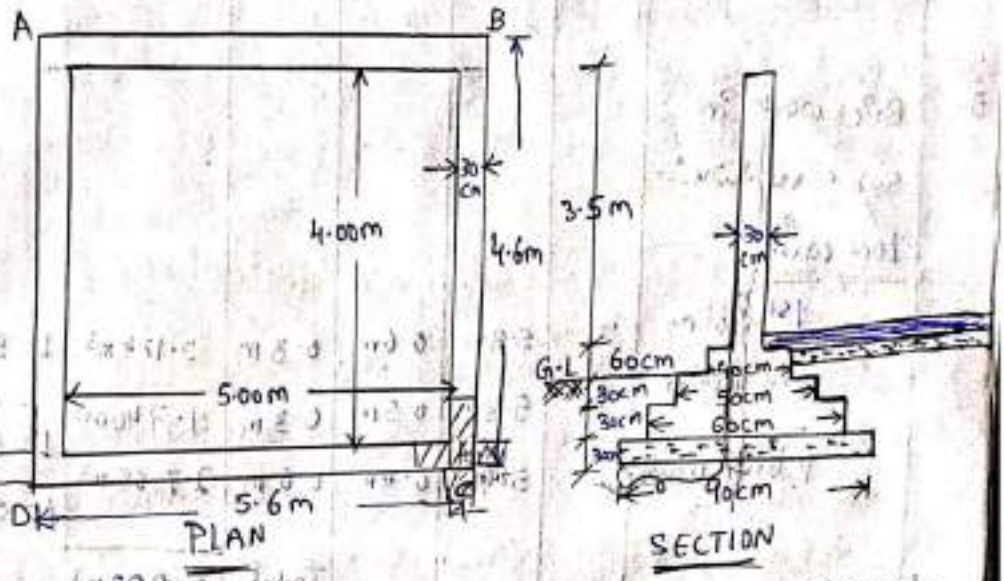
1. The plan represents the superstructure wall of a single room building of 5m x 4m and section represents C/s of walls with foundation Estimate quantities of

(i) Earth work in Excavation in foundation

(ii) Concrete in foundation.

(iii) Brickwork in Substructure.

(iv) Brickwork in Superstructure.



Sol: (i) Longwall - Shortwall Method:-

centre to centre length of long wall = $\frac{0.3}{2} + 5 + \frac{0.3}{2}$

= 5.3m

centre to centre length of short wall = $\frac{0.3}{2} + 4 + \frac{0.3}{2}$

= 4.3m

-> long wall = 5.3+0.15+0.15 = 5.6m

-> short wall = 4.6 - (0.3+0.3) = 4m

(a): Details of measurement & calculation of quantities:-

Item No	Description of Items	No	Length (m)	Breadth (m)	height (or) depth	quantity (NxLxBxH)	Explanatory Notes
1	Earthwork in Excavation in foundation:						L = 6.20m
	long walls	2	6.2	0.9	0.9	10.4	L = 5.6+0.9-0.3 / 2 x2

	Short walls	2	3.4	0.9	0.9	5.50 m³	L = 4 - 0.9 - 0.1/2 x2 = 3.4m
					Total	15.54 m³	
2.	concrete in founda-tion						
	Long wall	2	6.2m	0.9m	0.3m	3.34m³	
	Short wall	2	3.4m	0.9m	0.3m	1.83 m³	Explanation same as Excavation Explanation.
					Total	5.170	
3.	Brick work in Sub structure:-						
	Long walls:-						5.6 + 0.15+0.17
	1st footing	2	5.9m	0.6m	0.3m	2.124m³	L = 5.6 + 0.6-0.3/2 x2 = 5.9m
	2nd footing	2	5.8m	0.5m	0.3m	1.740m³	L = 5.6 + 0.5-0.3/2 x2
	Plinth walls	2	5.7m	0.4m	0.6m	2.736 m³	L = 5.6 + 0.4-0.3/2 x2
					Total	6.600m³	
	Short walls:-						
	1st footing	2	3.7m	0.6m	0.3m	1.332m	L = 4 - 0.6-0.3/2 x2 = 3.7m
	2nd footing	2	3.8m	0.5m	0.3m	1.140m	L = 4 - 0.5-0.3 x2/2 = 3.8m
	plinth wall	2	3.9m	0.4m	0.6m	1.872	L = 4 - 0.4-0.3/2 x2 = 3.9m
					Total	4.344m³	
					Grand	10.940m³	
4).	Brick work in Super structure						
	long wall	2	5.6m	0.3m	3.5m	11.76m³	L = 5.6 (out to out)
	Short wall	2	4m	0.3m	3.5m	8.40m³	L = 4 (inner to inner)
					Total	20.16m³	

(b): Abstract of Estimated cost:-

Item No	Particular of Item	quantity (m^3)	Unit	Rate Rs-P	Per	Amount Rs-P
1.	Earth work in Excavation in foundation	15.54	Cum	350.00	% Cum	5439.00
2.	concrete in foundation	5.17	Cu.m	220.00	Cu.m	1137.40
3.	Brick work in sub-structure	10.94	Cu.m	300.00	Cu.m	3282.00
4.	Brickwork in super-structure	20.16	Cu.m	300.00	Cu.m	6048.00

Total = 15,906 Rs

Add 3% Contingences - 477.18 Rs

Add 2% Electrical installation - 318.12 Rs

Grand total = 16,701.3 Rs

(ii): Centre-line method:-

C/c length of AB (or) CD wall = $5.0 + \frac{0.3}{2} + \frac{0.3}{2} = 5.3m$

C/c length of BC (or) DA wall = $4.0 + \frac{0.3}{2} + \frac{0.3}{2} = 4.3m$

∴ Total centre length of walls = AB + BC + CD + DA

$= 5.3 + 4.3 + 5.3 + 4.3$

$= (2 \times 5.3) + (2 \times 4.3)$

$= 19.2m$

Details of measurement & calculation of quantities:-

Item No	Description of items	No	length (m)	breadth (m)	height (m)	quantity m^3	Explanation notes
1.	Earthwork in Excavation in foundation	1	19.2	0.9	0.9m	15.54	Total centre length of wall

2.	Concrete in foundation	1	19.2	0.9	0.3	5.17
3.	Brickwork in foundation & plinth					
	1st footing	1	19.2	0.6	0.3	3.46
	2nd footing	1	19.2	0.5	0.3	2.88
	Plinth wall	1	19.2	0.4	0.6	4.61
					total	10.95
4.	Brickwork in superstructure	1	19.2	0.3	3.5	20.16

Abstract & Estimation cost same as in long wall - short wall method.

2). Estimate the quantities of the following item of a two storied building from the given plan and section as shown below.

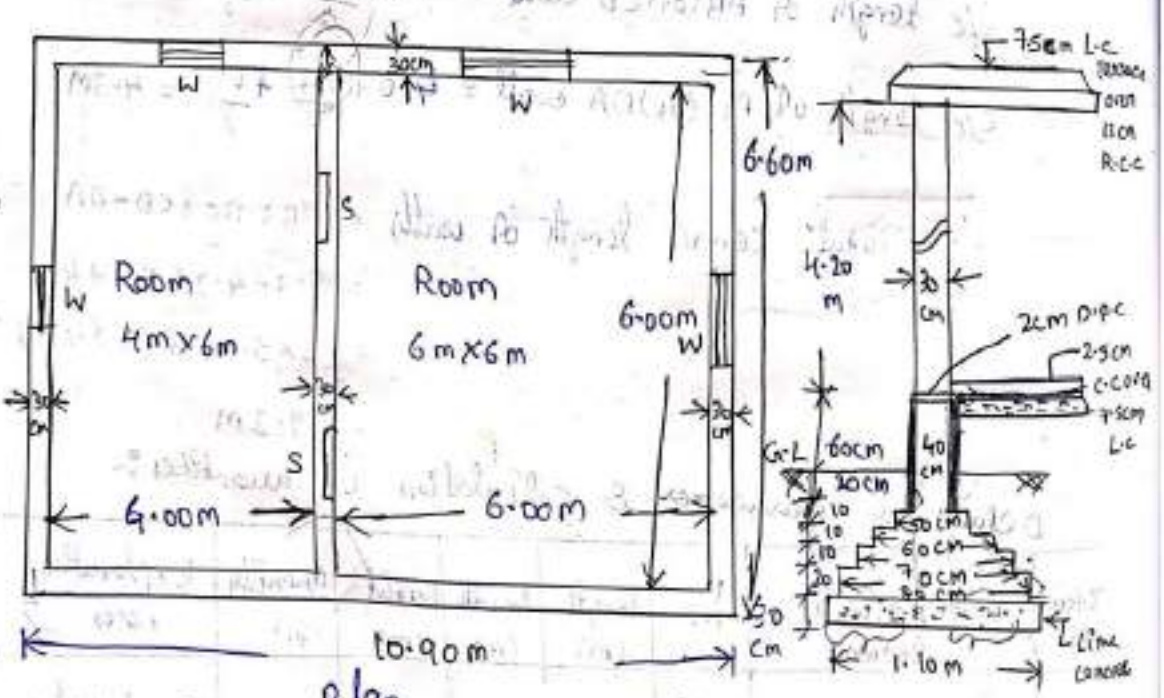
(1) Earth work in Excavation in foundation.

(2) Lime concrete in foundation.

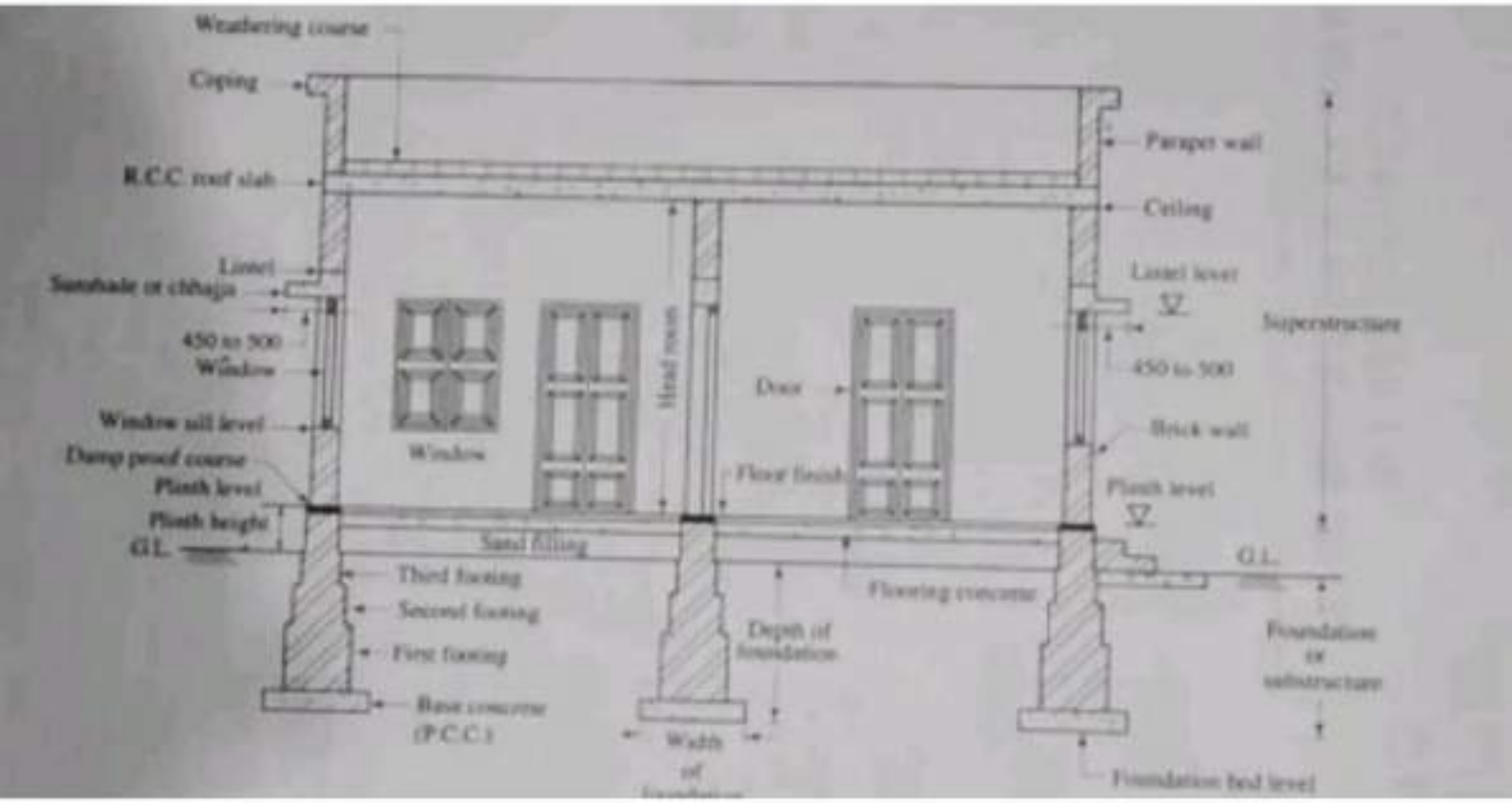
(3) 1st class brick work in cement mortar 1:6 in foundation and plinth.

(4). 2.5m c.c damp proof course thick.

(5). 1st class brick work in lime mortar in superstructure.



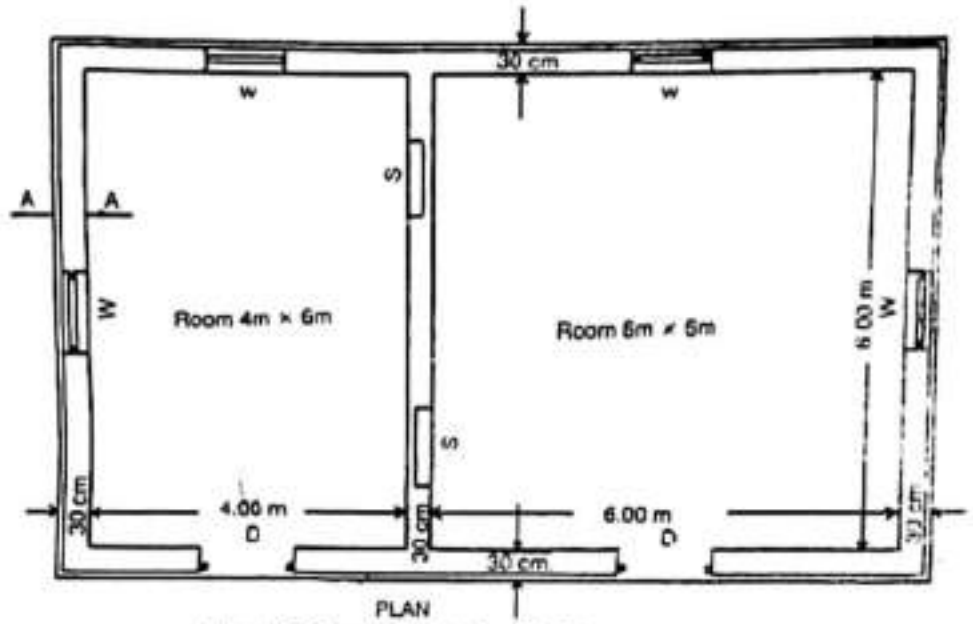
C/s section of wall on

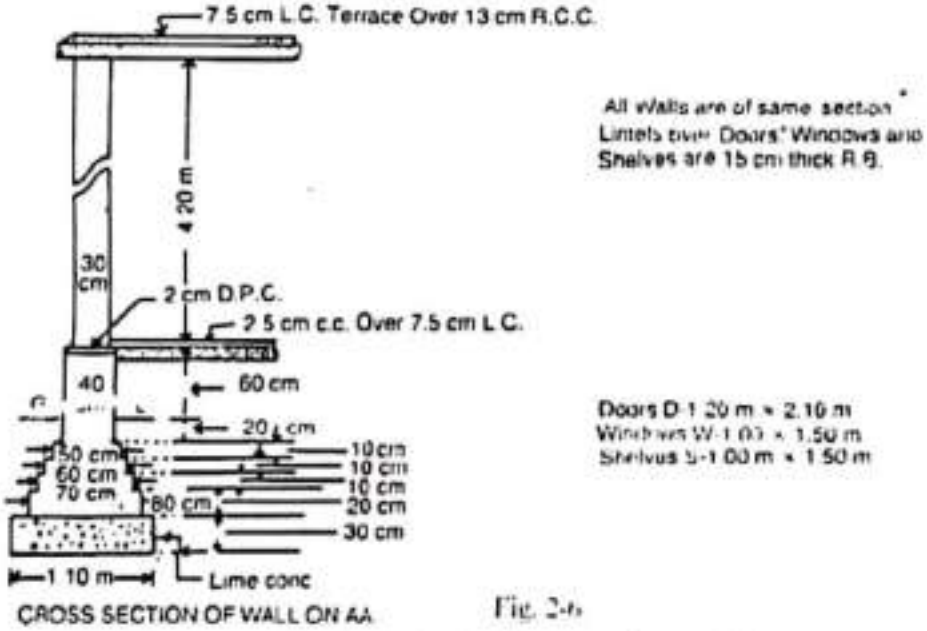


Example 4(a). — Estimate the quantities of the following items of a two roomed building from the given plan and section (Fig. 2-6) : —

(1) Earthwork in excavation in foundation, (2) Lime concrete in foundation, (3) 1st class brickwork in cement mortar 1 : 6 in foundation and plinth, (4) 2.5 cm c.c. damp proof course, and (5) 1st class brickwork in lime mortar in superstructure.

TWO ROOMED BUILDING





All Walls are of same section
Lintels over Doors, Windows and Shelves are 15 cm thick R.B.

Doors D-1.20 m × 2.10 m
Windows W-1.00 m × 1.50 m
Shelves S-1.00 m × 1.50 m

Fig. 2-6

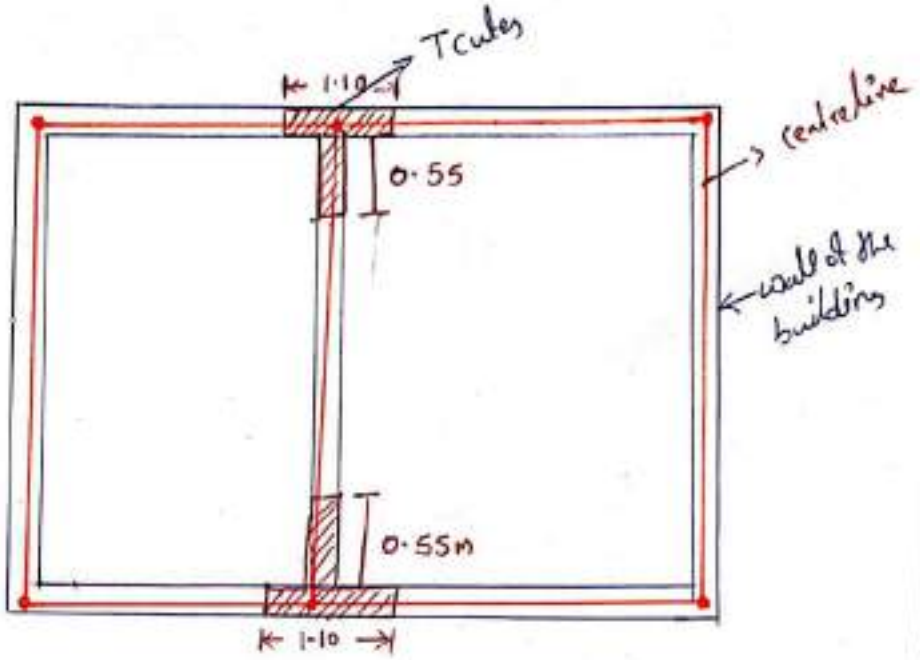
Note : — *No beam has been shown in the plan as the object of this example is to explain the method of estimating the walls only.*

Sol: (i) Longwall - Shortwall Method:-

Longwall c/c length = $\frac{0.3}{2} + 4 + 0.3 + 6 + \frac{0.3}{2} = 10.6\,m$

Shortwall c/c length = $\frac{0.3}{2} + 6 + \frac{0.3}{2} = 6.3\,m$

Two Room Building

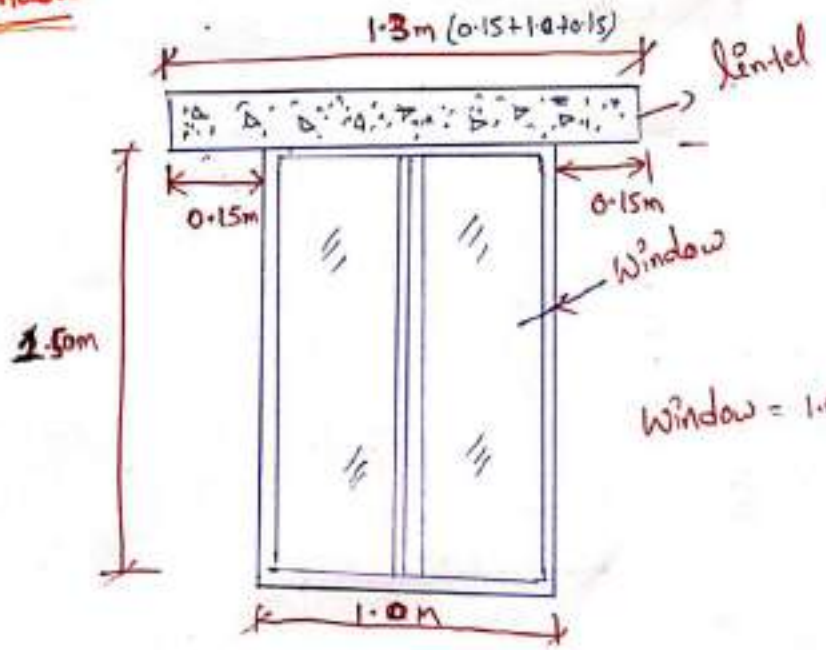


Length formula = centre/centre of total wall $-\frac{2(\text{B} \times 1/2)}{2}$

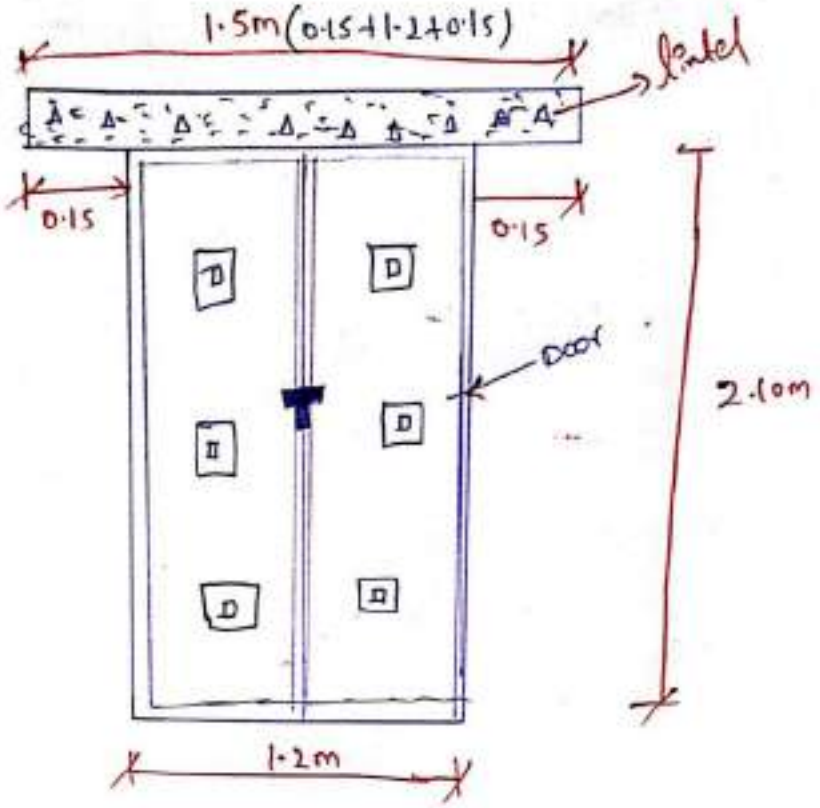
(or)

= Total centre wall of the building − width of partition

Window

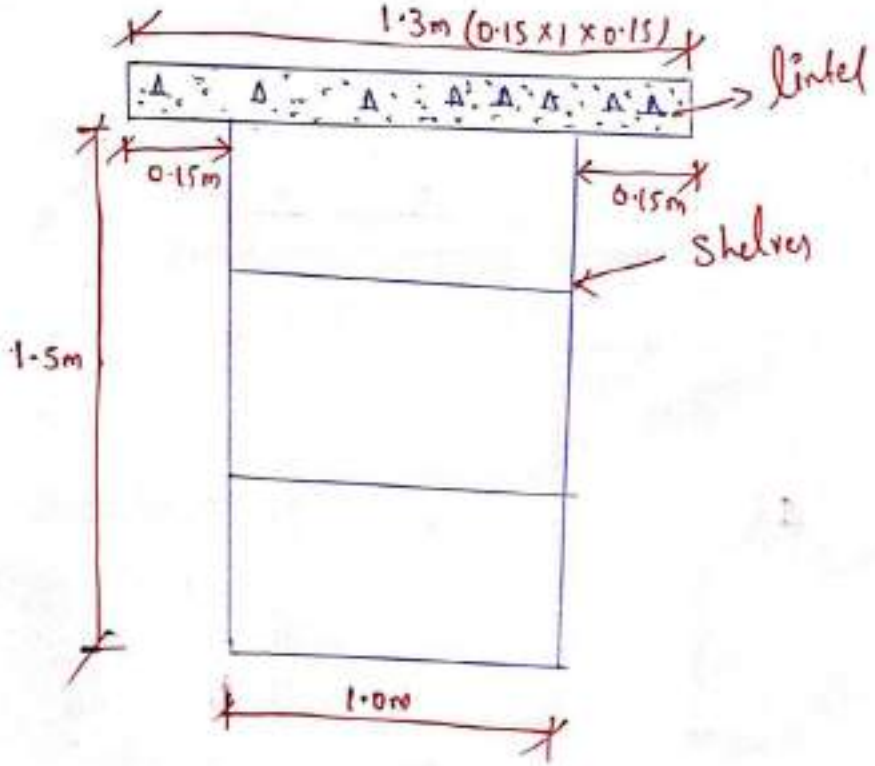


Window = 1.00 X 1.50m



(ℓ) (D)

Door = 1.2m × 2.10m



(ℓ) (B)

Shelves = 1.0m × 1.5m

Details of measurements & calculation quantities:

Description (or) Particulars of item	NO	length (m)	breadth (m)	depth (m)	quantity	Explanation note
Earthwork in Excavation in foundation:-						
Long wall	2	11.7	1.10	1.00	25.74	$L = 10.90 + \frac{0.3 + 1.10}{2} \times 2$ $= 11.7$ m
Short wall	3	4.8	1.10	1.00	15.84	$L = 6 - \frac{1.1 - 0.3}{2} \times 3$ $= 4.8$ m
				Total	41.58 m^3	
Lime concrete in foundation						
Long wall	2	11.7	1.10	0.3	7.72	Same as Excavation.
Short wall	3	4.8	1.10	0.3	4.752	
				Total	12.472 m^3	
1st class brick work in 1:6 cement mortar in foundation & plinth						
Long walls:-						
1st footing	2	11.4	0.8	0.2	3.65	$L = \frac{10.9 + 0.8 - 0.3}{2} \times 2$ $= 11.4$ m
2nd footing	2	11.3	0.7	0.1	1.58	$L = \frac{10.9 + 0.7 - 0.3}{2} \times 2$ $= 11.3$ m
3rd footing	2	11.2	0.6	0.1	1.34	$L = \frac{10.9 + 0.6 - 0.3}{2} \times 2$ $= 11.2$ m
4th footing	2	11.10	0.5	0.1	1.11	$L = \frac{10.9 + 0.5 - 0.3}{2} \times 2$ $= 11.1$ m
plinth wall above footing	2	11.0	0.4	0.8	7.04	$L = \frac{10.9 + 0.4 - 0.3}{2} \times 2$ $= 11.0$ m
Short walls:-						
1st footing	3	5.25	0.8	0.2	2.52	$L = 6 - \frac{0.8 - 0.3}{2} \times 3$ $= 5.25$ m
2nd footing	3	5.4	0.7	0.1	1.134	$L = 6 - \frac{0.7 - 0.3}{2} \times 3$ $= 5.4$ m
3rd footing	3	5.55	0.6	0.1	0.999	$L = 6 - \frac{0.6 - 0.3}{2} \times 3$ $= 5.55$ m^2
4th footing	3	5.7	0.5	0.1	0.855	$L = 6 - \frac{0.5 - 0.3}{2} \times 3$ $= 5.7$ m^2
plinth wall	3	5.85	0.4	0.8	5.616	$L = 6 - \frac{0.4 - 0.3}{2} \times 3$ $= 5.85$ m
				Total	25.847 m^3	

Item No	Particular Item	No	L	B	D	quantity	Explanation Note
4)	Damp proof course 2.5cm thick						
	Long wall	2	11.0	0.4	—	8.8 m²	length scaled as plinth wall
	Short wall	3	5.85	0.4	—	7.02m²	
					Total	15.82m²	
	deduct door Sills (Godaly)	2	1.2	0.4 (P.W breadth)	—	0.96m²	
					Total	14.92 m²	
5)	1st class brickwork mortar in superstructure.						
	long wall	2	10.9	0.3	4.2	27.47	L=10.9+0.3-0.3/2 X2 = 10.9m²
	Short wall	3	6.0	0.3	4.2	22.68	L=6+0.3-0.3/2 X3 = 6.0m
					Total	50.15 m³	
	Deductions						
	door opening	2	1.2	0.3	2.1	1.51	
	Windows "	4	1.0	0.3	1.5	1.80	
	Shelves "	2	1.0	0.2	1.5	0.6	Back of shelf 10cm thick
	Lintels over doors	2	1.5m	0.3	0.15	0.14	Bearing 15cm L=1.2+0.15+0.15 =1.5m
	Lintels over windows	4	1.3	0.3	0.15	0.23	
	Lintels over shelves	2	1.3	0.31	0.15	0.12	L=1+0.15+0.15 =1.3m
					Total	4.40cm	L=1+0.15+0.15 =1.3m
					Grand =	45.75 m3	

(iii) centre - line method:-

Total centre length of walls = 2 (Long walls) + 3 (Short wall)
= 2 (10.6) + 3(6.3)
= 40.10m

Formula for centre line method of length -

c/c length of building
-(B/2) x No of T section

Details of measurement & Calculation of quantities :-

Item No	Particular of item	No	L (m)	B (m)	D (m)	Quantity (m³)	Explanation note
1)	Earth work in excavation in the foundation	1	39.0	1.10	1.0m	42.9	L = 40.1 − 2x(½ x 1.1) = 39 m
2)	Lime concrete in foundation.	1	39.0	1.10	1.0	12.87	L = Same as Excavation.
3)	1st class brick work in 1:6 cement mortar in foundation & plinth						
	1st footing	1	39.3	0.8	0.2	6.29	L = 40.1 − (2 x ½ x 0.8) = 39.3
	2nd footing	1	39.4	0.7	0.1	2.76	L = 40.1 − (2 x ½ x 0.7) = 39.4
	3rd footing	1	39.5	0.6	0.1	2.37	L = 40.1 − (2 x ½ x 0.6) = 39.5
	4th footing	1	39.6	0.5	0.1	1.98	L = 40.1 − (2 x ½ x 0.5) = 39.6
	plinth wall above footing	1	39.7	0.4	0.8	12.70	L = 40.1 − (2 x ½ x 0.4) = 39.7
					Total	26.1 cm	
4)	D.P.C 25mm c.c	1	39.7	0.4	—	15.88	L = 40.1 − 2(½ x 0.4) = 39.7
	door sill deduct	2	1.2	0.4	—	0.96	
					Net	14.92	
5)	1st class brick work in lime mortar in superstructure	1	39.8	0.3	4.2	50.15	L = 40.1 − 2(½ x 0.3) = 39.8
	Deductions } Lintels }	Same as L.W & S.W				= 4.40	
					Net	45.75 m³	

(b): Abstract of Estimated cost:-

Item No	Particular of Item	quantity	unit	Rate Rs-P	Per	Amount Rs-P
1)	Earthwork in excavation in foundation	42.9	Cu.m	350.00	%.cum	15,015
2)	Plain concrete in foundation.	12.87	Cu.m	220.00	%.cum	2831.4
3)	1st class B.W in cement mortar 1:6 in foundation & plinth	26.10	Cu.m	7814.00	%.cum	203945
4)	DPC Proof course	14.92	Sq.m	335.0	%.sqm	4998
5)	1st class brick work in lime mortar in a superstructure	45.75	Cu.m	80270	%.cum	3,67235

Total = 5,94024 Rs

Add 3% Contigences - 11880.48 Rs

Add 2% Electrical installation - 17820.73 Rs

Grand total = 594024.4 + 11880.48
+ 17820.73

= 6,23,725.36

Example 9. — From the attached plan and the detail of wall section (Fig. 3-13) estimate the quantities of —

(1) Earthwork in foundations.

(2) Concrete in foundations.

(3) Brickwork in foundation and plinth in 1:6 cement mortar.

(4) 2 cm Damp proof course at plinth level.

(5) Brickwork in superstructure in lime mortar.

(6) 2.5 cm c.c. over 7.5 cm L.C. floor.

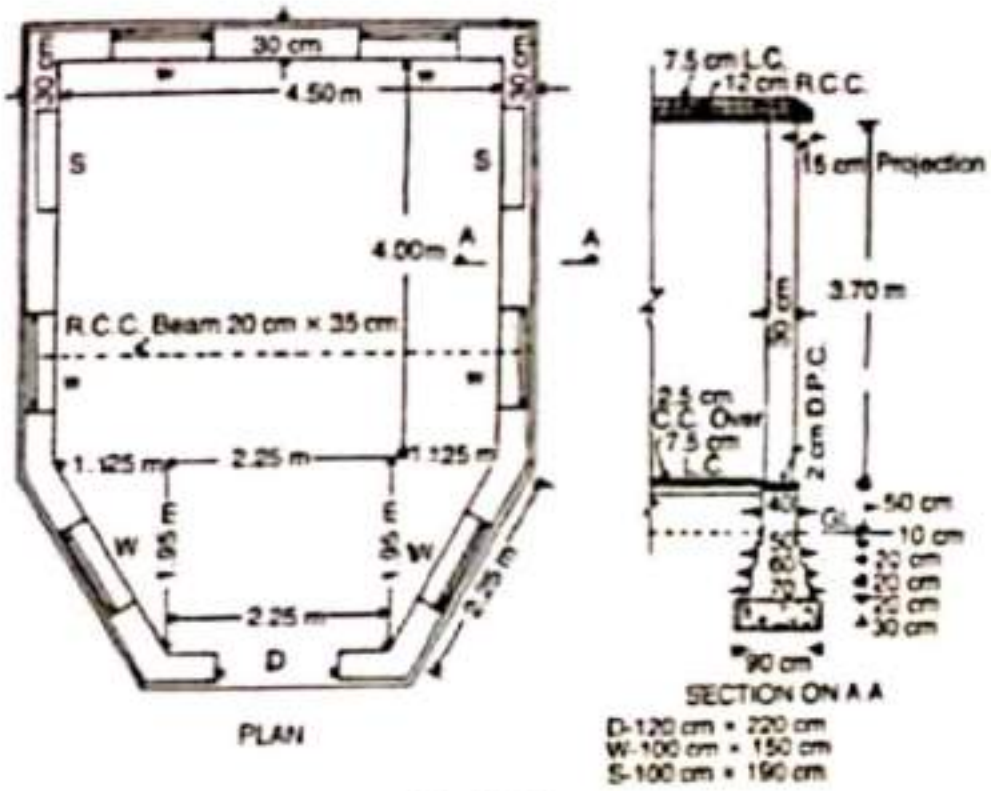


Fig. 3-13

Centre to centre length of inclined wall

$$= \sqrt{(1.95 + .15)^2 + (1.125 + .15)^2}$$

$$= \sqrt{(2.1)^2 + (1.275)^2}$$

$$= \sqrt{6.04} = 2.46 \text{ m (approximately)}$$

Total centre line length of walls = 4.80 + (2 × 4.15) + (2 × 2.46) + 2.25 = 20.27 m.

The centre length of front hall hexagonal portion may be calculated by trigonometrical method as per Example No. 8 on page 130. But the length as has been found above is sufficient for practical purpose.

Item No	Particulars of Item	NO	L	B	H	quantity	Remarks
1.	Earth work in Excavation	1	20.27	0.9	0.9	16.42 m³	
2	Concrete in foundation	1	20.27	0.9	0.3	5.47 m³	
3.	Brickwork in foundation & plinth:-						
	1st footing	1	20.27	0.7	0.2	2.84	
	2nd footing	1	20.27	0.6	0.2	2.43	
	3rd footing	1	20.27	0.5	0.2	2.03	
	Plinth wall above G.L & below G.L	1	20.27	0.4	0.6	4.86	
					Total	12.16 m³	
4.	2cm D.P.C	1	20.27	0.4	–	8.11	
	Deduction (door sill)	1	1.2	0.4	1	0.48	
					Total	7.63 m²	
5.	Brickwork in super structure	1	20.27	0.3	3.7	22.50 m³	
	deduction:-						
	Door opening	1	1.2	0.3	2.2	0.79	
	window "	6	1.0	0.3	1.5	2.70	
	shelves "	2	1.0	0.2	1.90	0.76	
	Lintel over door	1	1.4	0.3	0.1	0.042	10cm thick lintel L = 1.2+B.1+0.1
	" over window	6	1.2	0.3	0.1	0.216	L = 1.0+0.1+0.1
	" " shelves	2	1.2	0.3	0.1	0.072	L = 1+0.1+0.1
					Total deduction	4.58	
					Net total	17.92 m³	
6.	2.5cc over 7.5cm L.c						
	Rectangular portion	1	4.5	4.0	–	18.00	
	Hexagonal portion front half	1	$\frac{4.5+2.25}{2}$	x 1.95	–	6.58	
	Door sill	1	1.2	0.35	–	0.42	b = 0.3+0.05 ↓ plinth
					Total	25 m²	

(b): Abstract of Estimation cost:-

Item NO	Particular of Item	quantity	unit	Rate Rs.P	Percent	amount Rs.P
1	Earthwork in foundation	16.42 m^3	Cum	350.00	% Cum	5,747.-
2	Concrete in foundation	5.47 m^3	Cum	220.00	% Cum	12,03.4
3.	Brickwork in foundation & plinth	12.16 m^3	Cum	300.00	% Cum	3,648
4).	2-cm D.P.C	7.63 m^2	Sq.m	200.00	% Sqm	1526
5)	Brickwork in Super Structure.	17.92 m^3	Cum	300.00	% Cum	5376
6).	7-5cc over 7.5cm L.C floor	25.00 m^2	Sq.m	250.00	% Sqm	6,250

Total = 23,750.4 Rs

Add 3% contigences = 712.512 Rs = 712.51 Rs

Add 2% of Electrical installation = 475.00 Rs = 475.00

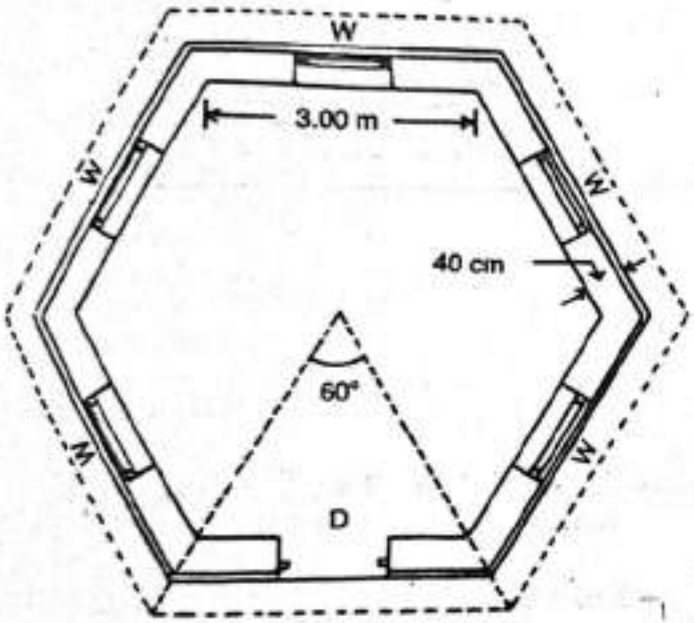
Grand total = 24,937.91 Rs

= 24,937.91 Rs

... separately.

ESTIMATE OF A HEXAGONAL ROOM

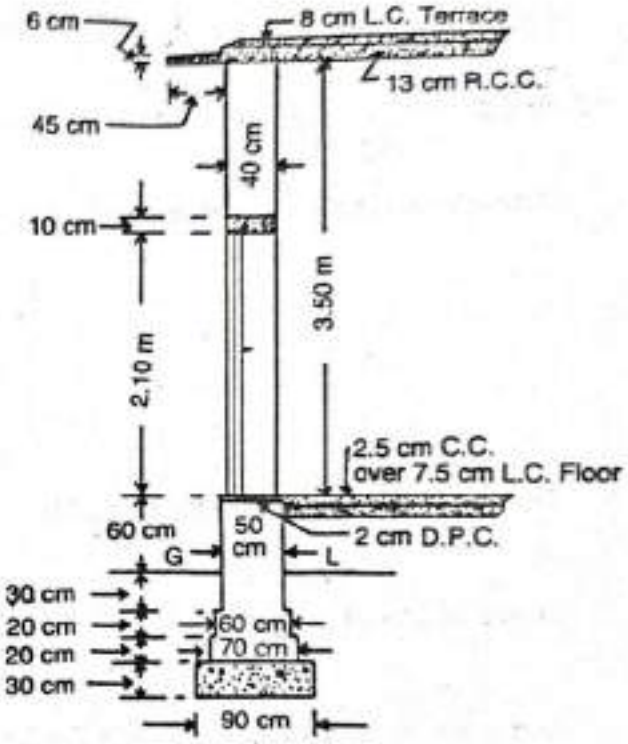
Hexagonal Room



Plan

SCHEDULES :-

D-120 cm × 210 cm(1.20 m × 2.10 m)
W-110 cm × 150 cm(1.10 m × 1.50 m)

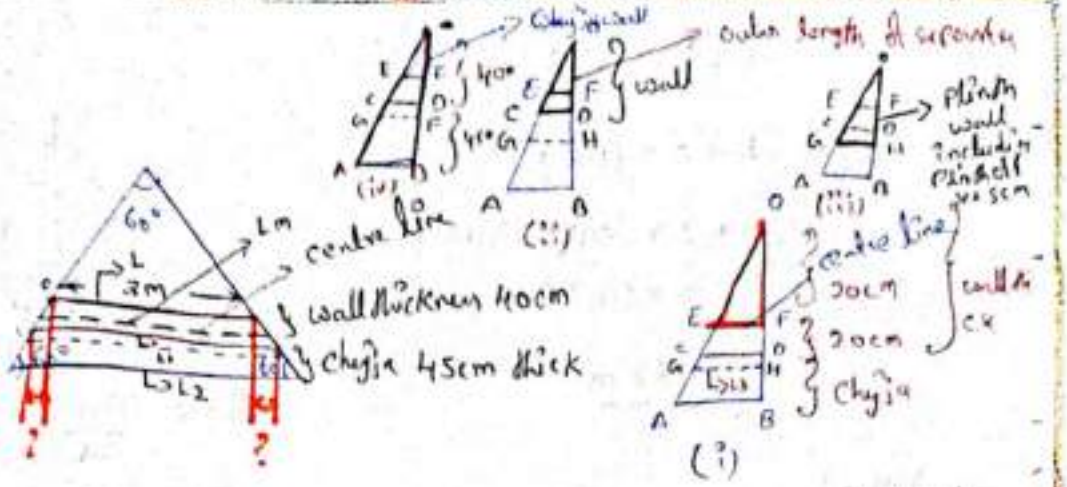


CROSS SECTION OF WALL THROUGH DOOR

* Estimation of hexagonal Room :-

→ The plan and roof c/s of a hexagonal room are given in figure Estimate the quantities of

(1) Earth work in excavation in foundation.
(2) lime concrete in foundation.
(3) I^st class work in foundation and plinth in lime mortar
(4) Damp proof course.
(5). I^st class Brick work in superstructure in lime mortar.
(6). RCC work in roof including chajja and lintels.
(7) lime concrete in roof terracing.
(8). 2.5 cm C.C over 7.5 cm L.C floor and
(9) 12 mm cement plastering 1:6 inside and outside wall.



Take 1/6 of Hexagon represented by 1/6 it is Equilateral triangle at the centre for all sides.

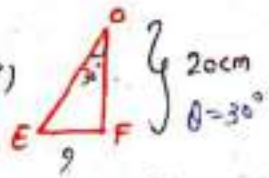
6 triangles.

Lengths:-

(i) Length of centre line $l_m = L + 2(EF)$

$= 3 + 2(0.2 \times \tan 30^\circ)$

$= 3.23\,m$



Total centre line length $= 6 \times 3.23\,m$

$= 19.38\,m$

$\tan\theta = \frac{\text{opposite side}}{\text{adjacent side}}$

$\tan\theta = \frac{EF}{OF}$

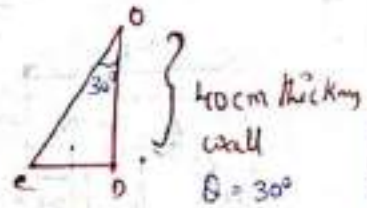
$EF = (OF)\tan\theta = (0.2)\tan 30^\circ$

(ii) outer length of super structure wall $L_1 = L + 2(CD)$

$L_1 = L + 2(CD)$

$= 3 + 2(0.4)\tan 30^\circ$

$= 3.46\,m$



$\tan\theta = \frac{CD}{OD}$

$CD = (OD)\tan 30^\circ$

$= (0.4)\tan 30^\circ$

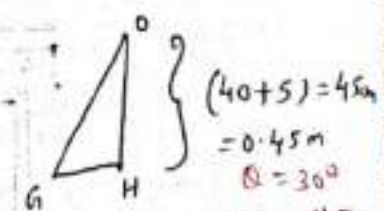
(iii) outer length of plinth wall:-

$L_3 = L + 2(GH)$

$= 3 + 2(OH)\tan 30^\circ$

$= 3 + 2(0.45 \times \tan 30^\circ)$

$= 3.52\,m$



$\tan\theta = \frac{OH}{GH} \Rightarrow GH = OH\cot\theta$

$= OH \times \tan\theta$

$GH = OH \times \tan 30^\circ = (0.45)\tan$

(iv) outer length of Chajja:-

wall thick = 40 cm
Chajja = 45cm

$L_2 = L + 2 \times (AB)$

$= 3 + 2 \times (OB \times \tan\theta)$

$= 3 + 2 \times (0.85 \times \tan 30^\circ)$

$= 3.982\ m$

$\tan\theta = \frac{AB}{OB}$

$AB = OB \times \tan\theta$

⇒ Areas:-

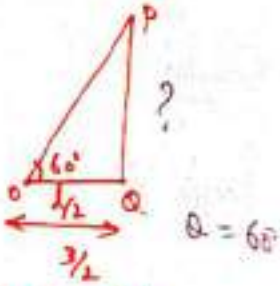
(i) Floor area = 6 × (area of Parallelogram)

$= 6 \times (\frac{1}{2} b \times h)$

$= 6 \times (1/2 \times 3 \times PQ)$

$= 6 \times (1/2 \times 3 \times 3/2 \tan 60^\circ)$

$= 23.38\ Sq.m$



θ = 60°

$\tan\theta = \frac{PQ}{OQ}$

$PQ = OQ \tan\theta$

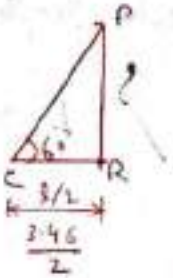
$= 3/2 \tan 60^\circ$

(ii) Roof area = 6 × (area of side triangle)

$= 6 \times (\frac{1}{2} \times b \times h)$

$= 6 \times (\frac{1}{2} \times 3.46 \times \frac{3.46}{2} \times \tan 60^\circ)$

$= 31.10\ Sq.m$

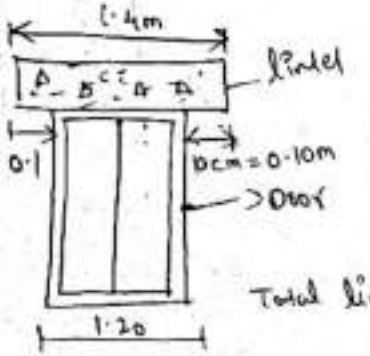


θ = 60°

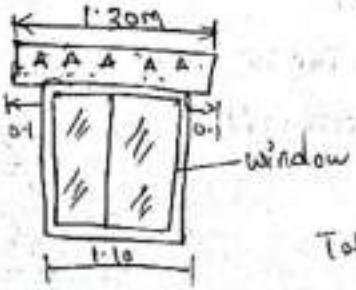
$\tan\theta = \frac{PR}{CR}$

$PR = CR \times \tan\theta$

$= \frac{3.46}{2} \times \tan(60^\circ)$



Total lintel = 1.2 + 0.1 + 0.1
= 1.4



Total lintel for window = 1.10 + 0.10 + 0.10
= 1.30 m

(A): Details of measurement and calculation of quantities:-

Item No	Particulars of Item	No	(L) (m)	(B) (m)	(D) (m) (cm) (m)	Quantity	Remarks
1	Earthwork in Excavation in foundation	1	19.38	0.90	1.00	17.44 m³	L = 6×3.23 = 19.38
2	Lime concrete in foundation	1	19.38	0.90	0.30	5.23 m³	3 Same length for excavation
3	1st class Brick work in foundation and plinth in lime mortar:-						
	1st footing	1	14.38	0.70	020	2.71 m³	
	2nd footing	1	19.38	0.60	020	2.33 m³	
	plinth wall	1	19.38	0.50	0.90	8.721 m³	
					Total	13.76 m³	
4	2cm Damp proof Course	1	19.38	0.50	—	9.69 m²	
	Deduction						
	Door sill	1	1.20	0.50	—	0.6 m²	
					Total	9.09 m²	
5	1st class Brick work in superstructure in lime mortar	1	19.38	0.40	3.50	27.13m³	
	Deduct:-						
	Door openings	1	1.20	0.40	2.10	1.08	10cm bearing thickness
	window "	5	1.10	0.40	1.50	3.30	
	lintel over door	1	1.40	0.40	0.10	0.056	
	lintel over window	5	1.30	0.40	0.10	0.26	
					Total	4.696 m²	

Item	Particulars of Item	No	(L)	(B)	(D)	Quantity	Remarks
5	I class B.w in Superstructure in Cm mortar						
					Total	22.434 m³	
6.	R.C.C work Complete with steel Reinforcement:-						
	Roof slab	$6 \times 1/2$	$\times 3.46 \times \frac{3.46}{2} \times 1.732$		$\times 0.13$	$= 4.043$	6 x median of triangle of above x thickness Thickness = 13cm
	Chajja	6	$\frac{3.46+3.98}{2} \times 0.45$		$\times 0.06$	$= 0.603$	6 x mean length x breadth x thickness. Thickness = 0.06m = 6cm
	Lintels	Same as above in item			(5)	$= 0.320$	
					Total	4.966 m³	
7.	8cm lime concrete in roof terracing	$6 \times \frac{1}{2}$	$\times 3.46 \times \frac{3.46}{2} \times 1.732$			31.10 m²	Same area as for R.C roof
8.	2.4cm C.C over ant Including 7.5cm L.C floor	$6 \times \frac{1}{2}$	$\times 3 \times 3\frac{1}{2} \times 1.732$			23.38 m²	6 x area above + Perimeter of Wall of Inner length
9	12mm Cement plastering 1:6 in wall:-						
	→ Inside	6	3.00	–	3.50	63.00	
	→ Outside above plinth	6	3.46	–	3.50	72.66	
	→ Out side plinth wall	6	3.52	–	0.70	14.78	Including 10cm below G.L
					Total	150.44	
	Deduct door opening	1	1.20	–	2.10	2.52	} on the
	Deduct window	5	1.10	–	1.50	9.25	
					Total	10.77 m²	
				Net	Total	139.67 m²	

having various types of

ESTIMATING OF STEPS

Problem — Estimating the quantities of Earthwork, Concrete, Brickwork and Finishing work of different types of steps from given drawings.

Steps are usually constructed when the construction of the building has progressed sufficiently and the earthwork in foundation for step needs excavation afresh. The earthwork in excavation for step is usually neglected.

1. Estimate of simple step given in Fig. 2-16.

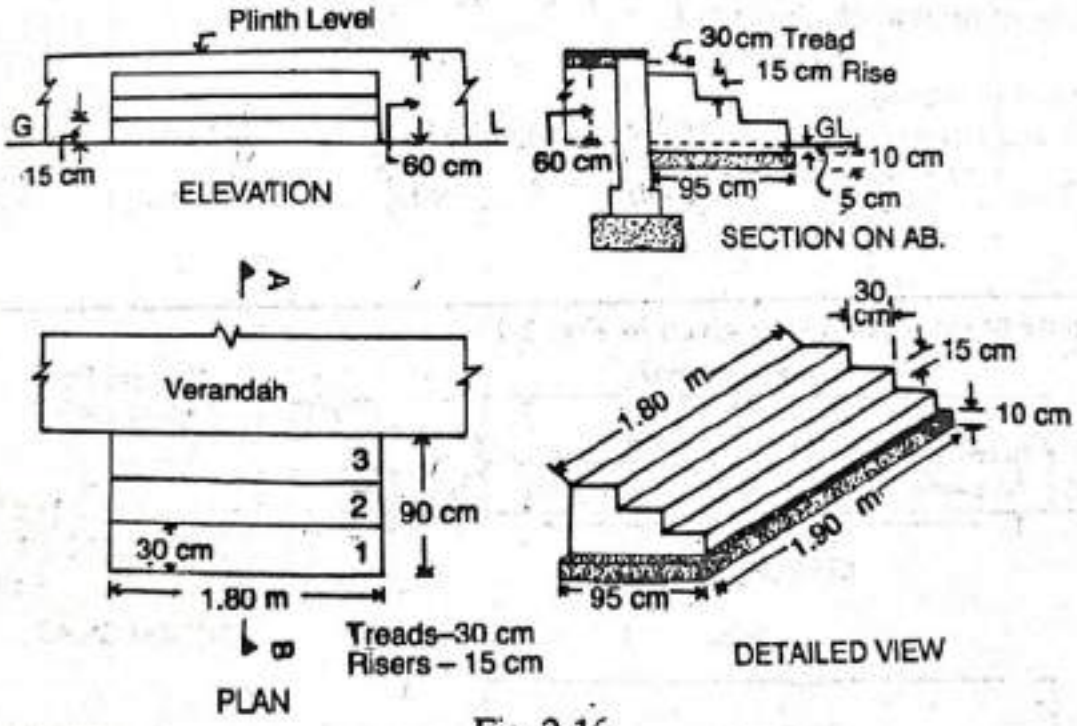


Fig. 2-16

Surface in steps 20 mm plastered with 1 : 3 cement sand mortar finished neat cement rendering.

Item No	Particular of Item	No	length (m)	Breadth (m)	Height (m)	quantity
1	Earth work in Excavation	1	1.9	0.95	0.15	0.27 m3
2	Concrete in foundation	1	1.9	0.95	0.10	0.18 m3
3.	Brick work :-					
	1st step	1.	1.8	0.9	0.2 (0.15+0.05)	0.324 m3
	2nd "	1	1.8	0.6	0.15	0.162 m3
	3rd "	1	1.8	0.3	0.15	0.081 m3
					Total	0.567 m3

4	Plastering:-					
	Treads	3	1.8	0.3	—	1.62 sq.m
	Risers	4	1.8	—	0.15	1.08
	Ends Step(1)	2	0.9	—	0.15	0.27
	Step(2)	2	0.6	—	0.15	0.18
	Step(3)	2	0.3	—	0.15	0.09
					Total	3.24 Sq.m

Standard Inside Measurement 3-1/4"
Other sizes available

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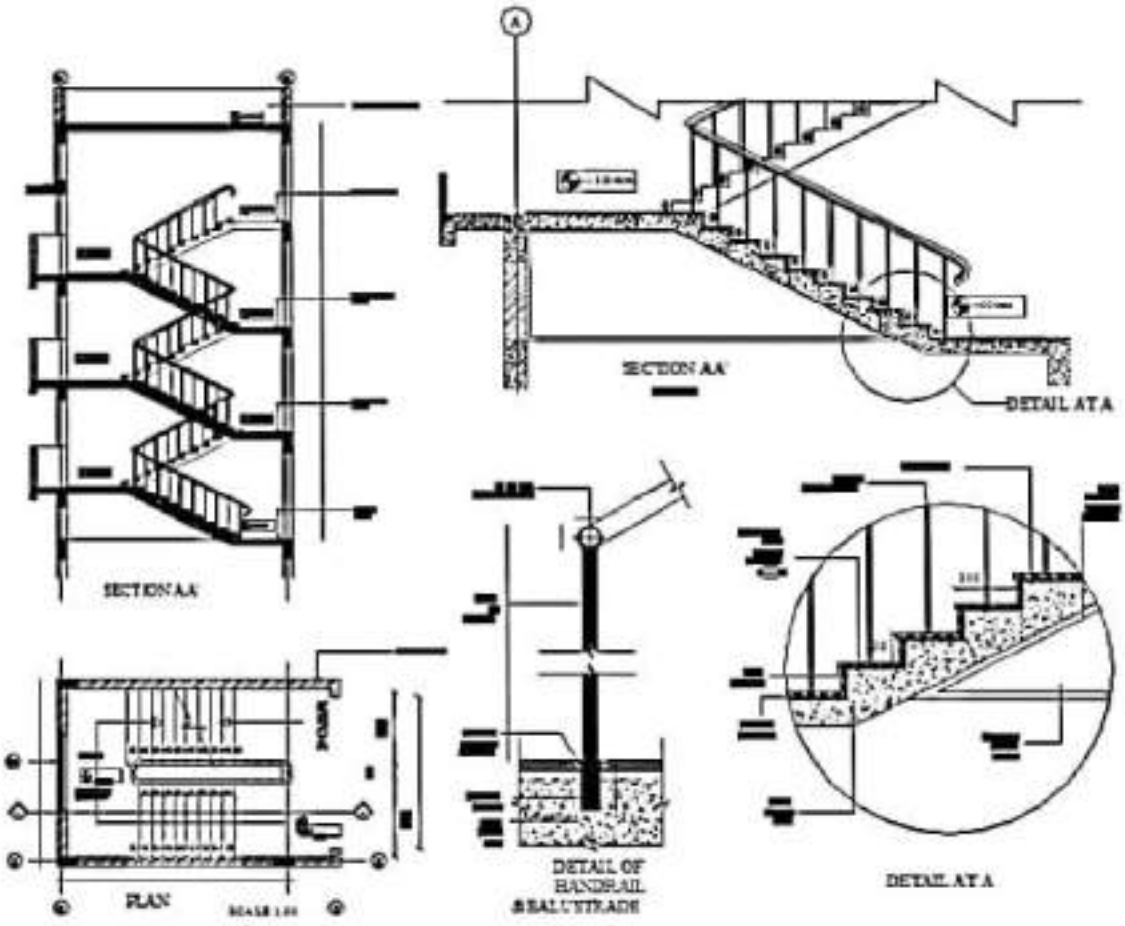


11. Estimate of three sides step given in Fig. 2-17.

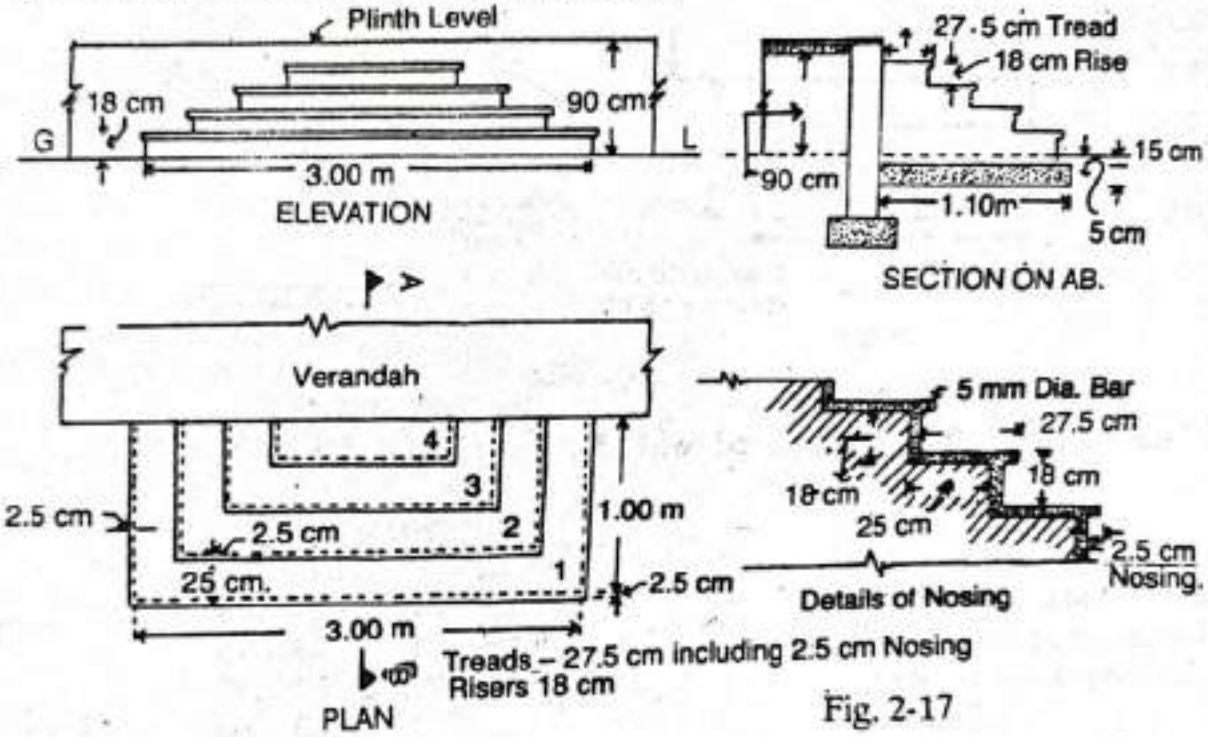


Fig. 2-17

Surface of steps is provided with 2.5 cm c.c. 1 : 1½ : 3 finished with neat cement.

Item No	Particular of Item	No	L	B	H	quantity	Explanation Notes
1	Earthwork in Excavation	1	3.2	1.1	0.20 (0.15+0.05)	0.71m3	(3+0.1+0.1) = 3.2m
2	concrete in foundation	1	3.2	1.1	0.15	0.53m3	Same as
3.	Brick work:-						
	1st step	1	3.0	1.0	(0.15+0.08) 0.23	0.69 m3	
	2nd step	1	2.5	0.75	0.18	0.338	
	3rd step	1	2.0	0.5	0.18	0.180	
	4th step	1	1.5	0.25	0.18	0.068	
					Total	1.276m3	

Item No	Particular of Item	No	L	R	H	Quantity	Explanation
4)	**Plastering :-**						
	1st step						
	Tread, Front, Side	1	4.5	0.25	–	1.125	3+(0.75+0.75) = 4.5m
	Risers, Front, Side	1	5.0	–	0.18	0.9	3+(1+1) = 5m
	2nd step						
	Tread	1	3.5	0.25	–	0.875	2.5+0.5+0.5 = 3.5m
	Riser	1	4.0	–	0.18	0.72	2.5+0.75+0.75 = 4m
	3rd step						
	Tread	1	2.5	0.25	–	0.625	2+0.25+0.25 = 2.5m
	Riser	1	3.0	–	0.18	0.540	2+0.5+0.5 = 3m
	4th step						
	Tread	1	1.5	0.25	–	0.375	1.5+0
	Riser	1	2.0	–	0.18	0.360	1.5+0.25+0.25 = 2m
	Plinth Riser	1	1.5	–	0.18	0.270	
					Total	5.79 m^2	
5)	**Nosing :-**						
	1st step	1	5m	–	–	5.0	
	2nd "	1	4m	–	–	4.0	
	3rd "	1	3m	–	–	3.0	
	4th "	1	2m	–	–	2.0	
					Total	14.00 running	meter

CONSTRUCTION PRO TIPS

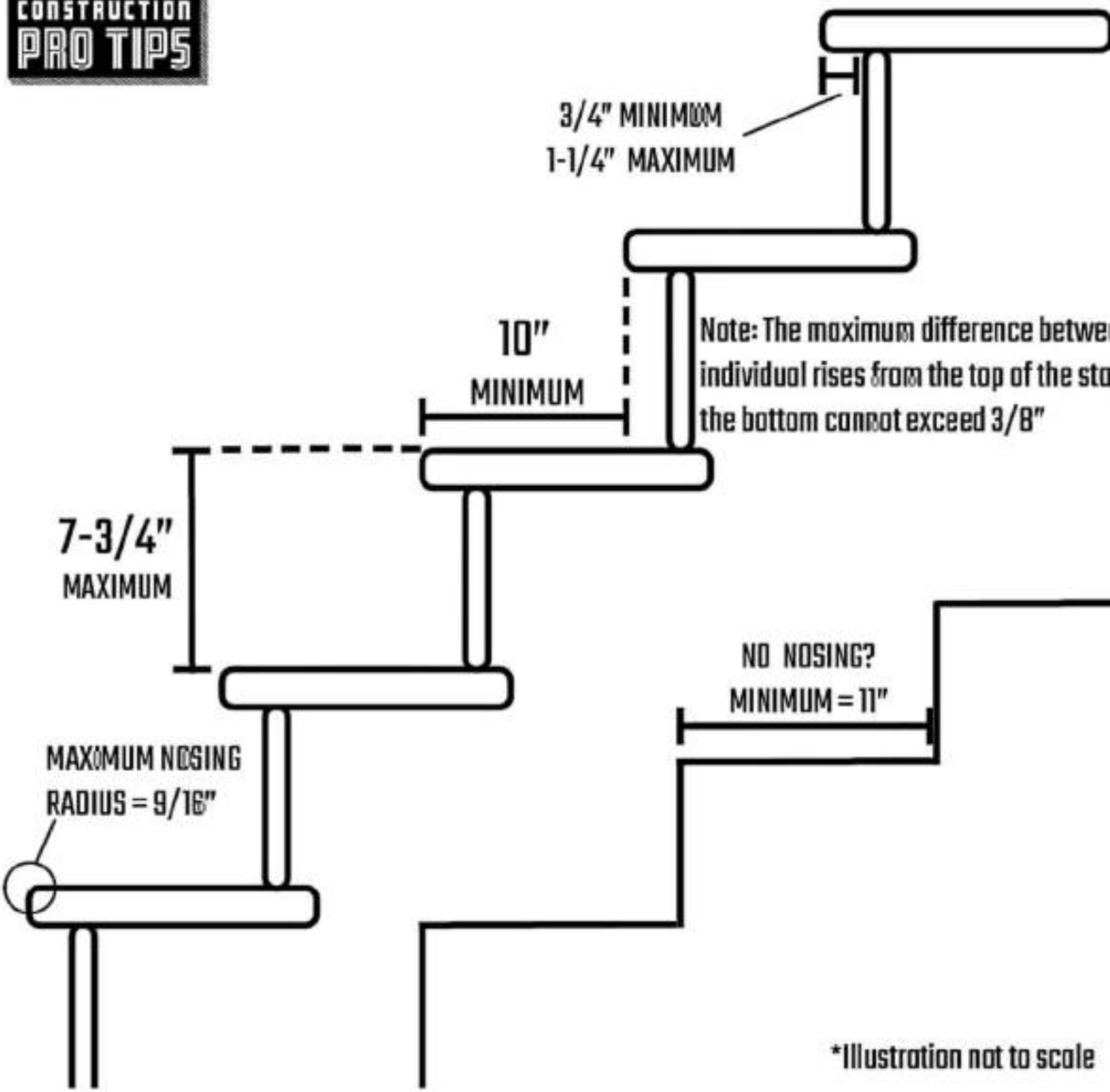
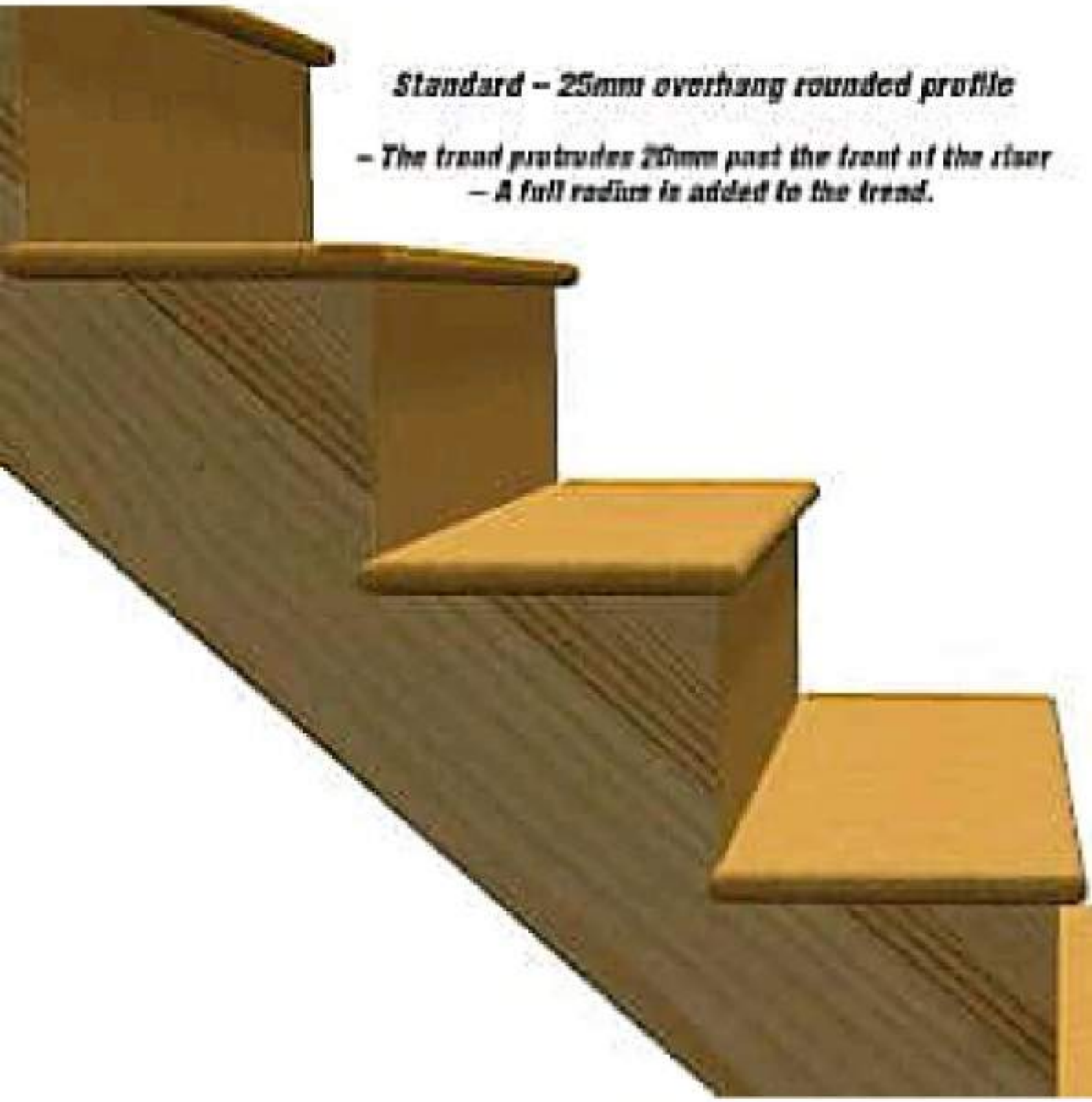
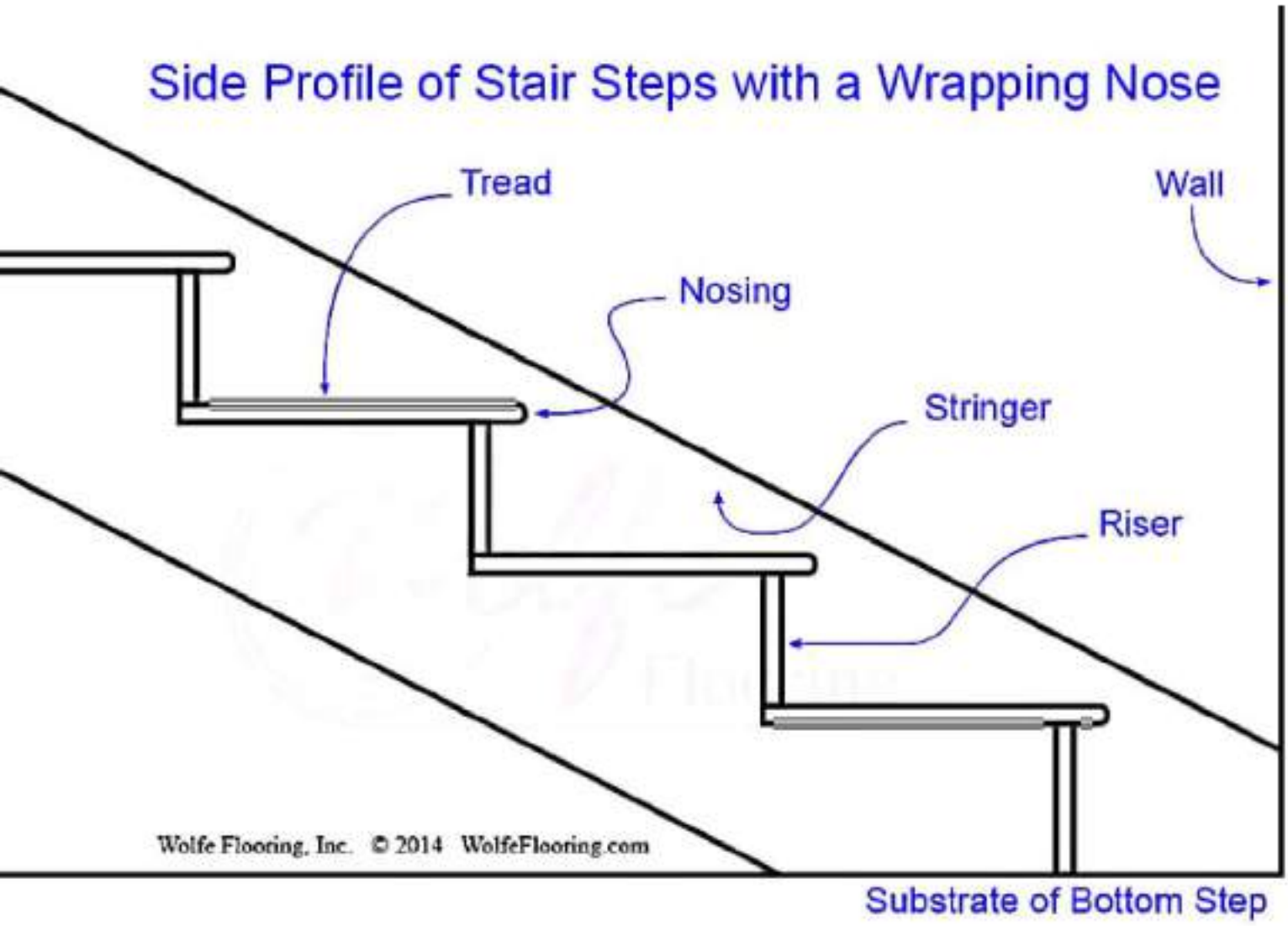


*Illustration not to scale





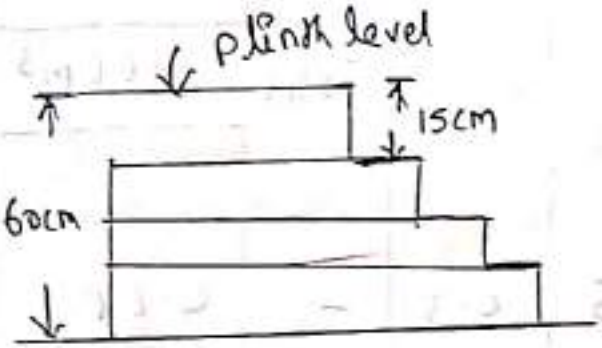
BULLNOSE CAPPING

OFFSHORE NOSING

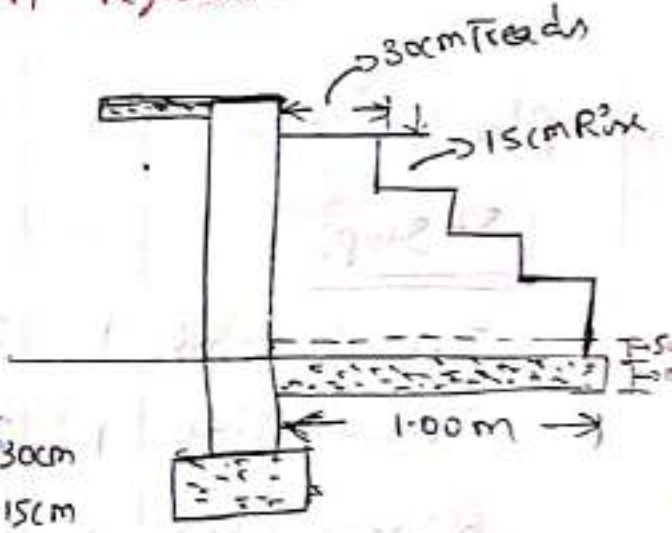
STAIR CAPPING

STAIR NOSING

). Estimate of corner steps given in figure.

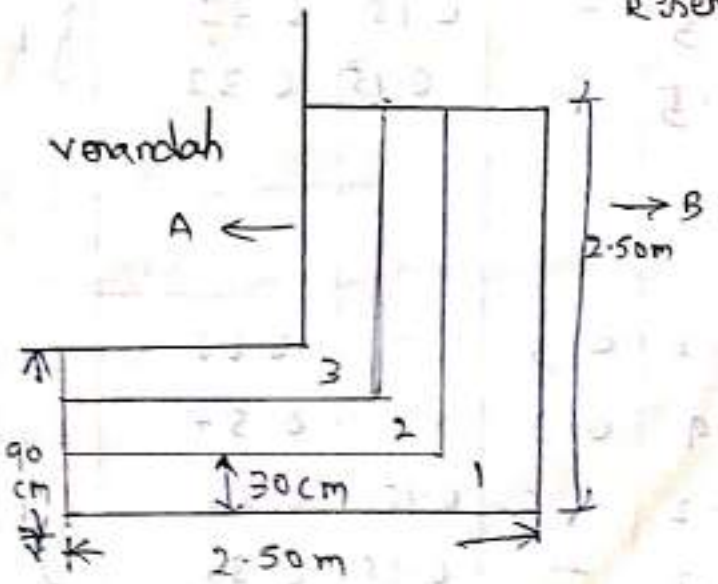


Elevation



Section

Treads: 30cm
Risers: 15cm



Plan

Item No	Particulars of item	No	L (m)	B (m)	H (m)	quantity (m^3)	Explanatory Notes
1-	Earthwork in Excavation						
2	front	1	2.7	1.0	0.2	0.54	L = 2.5+0.1+0.1=2.7
	sides	1	1.7	1.0	0.2	0.34	B = 0.9+0.1=1m
					Total	0.88 m^3	L = 2.5 - 0.9+0.1
2)	Concrete in foundation						
	front	1	2.7	1.0	0.15	0.405	length same as Excavation
	side	1	1.7	1.0	0.15	0.255	
					Total	0.66 m^3	
3).	Brick work:-						
	1st step:- front	1	2.5	0.9	0.2	0.45	
	side	1	1.6	0.9	0.2	0.216	L = 2.5-0.9
	2nd step:- front	1	2.2	0.6	0.15	0.198	L = 2.5-0.3
	side	1	1.6	0.6	0.15	0.144	L = 2.2 - 0.6 (or) (2.2-0.9)
	3rd steps:- front	1	1.9	0.3	0.15	0.086	L = 2.5-0.6
	side	1	1.6	0.3	0.15	0.072	L = 1.9-0.3
					Total	1.166 m^3	
4).	plastering:-						
	1st step:-						
	Tread - front	1	2.5	0.3	—	0.75	L = 2.5-0.3
	Tread - side	1	2.2	0.3	—	0.56	L = 2.5-0.3
	Riser - front	1	2.5	—	0.15	0.37	L = 2.5-0.3
	Riser - side	1	2.5	—	0.15	0.33	L = 2.5-0.3
	2nd step:-						
	Tread - front	1	2.2	0.3	—	0.66	L = 2.5-0.3
	Tread - side	1	1.9	0.3	—	0.57	L = 2.5-0.3
	Riser - front	1	2.2	—	0.15	0.33	L = 2.2-0.3
	Riser - side	1	2.2	—	0.15	0.33	L = 2.2-0.3

3rd step:-

Tread - front	1	1.9	0.3	–	0.57	
Tread - side	1	1.6	0.3	–	0.48	L = 2.2 - 0.3
Riser - front	1	1.9	–	0.15	0.285	L = 1.9 - 0.3
Riser - side	1	1.9	–	0.15	0.285	L = 2.5 - 0.6
Plinth:-						
Riser - front	1	1.6	–	0.15	0.24	} L = 1.9 - 0.3
Riser - side	1	1.6	–	0.15	0.24	
				Total	6.15 m²	

UNIT-3 (PART-(1))

EARTH WORK

* Introduction:-

Generally all the Civil Engineering project like roads, Canal bunds, railways, Earth dams, building etc. Involves the Earth work. This Earth work may be either Earth Excavation or Earth filling or some times both will get according to the desired shape and level. Basically the volume of Earth work is computed from length, breadth, and depth of Excavation or filling. is known as Embankment.

An Estimate of Earth works involves (calculation for)

1). volume of Earth works.

2). Lead and lift.

1). Volume of Earth works:-

It is calculated by multiplying the cross-sectional area and length. it is denoted by the letter v and its units are in m^3.

2). Lead and Lift:-

* Lead:- Lead is the horizontal distance over which the Earth is conveyed. It is measured from the centre of the area of Excavation / borrow pit to the centre of spoil bank / bund / heap.

Standard Values:- Initial lead is 10m and for every additional 10m or part there of one Extra lead is to be paid. Schedule of rates provides rates for different leads.

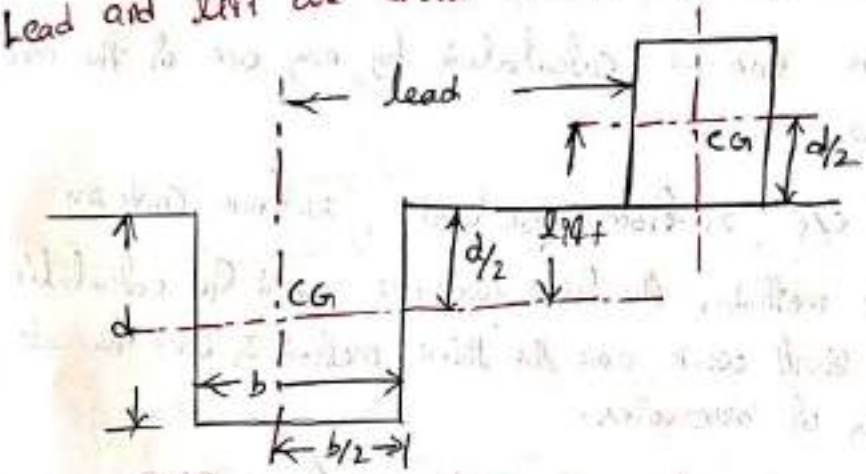
Eg:- If Earth work carried over a distance of 25m three lea-ds are to be given (one Initial lead and two additional lead

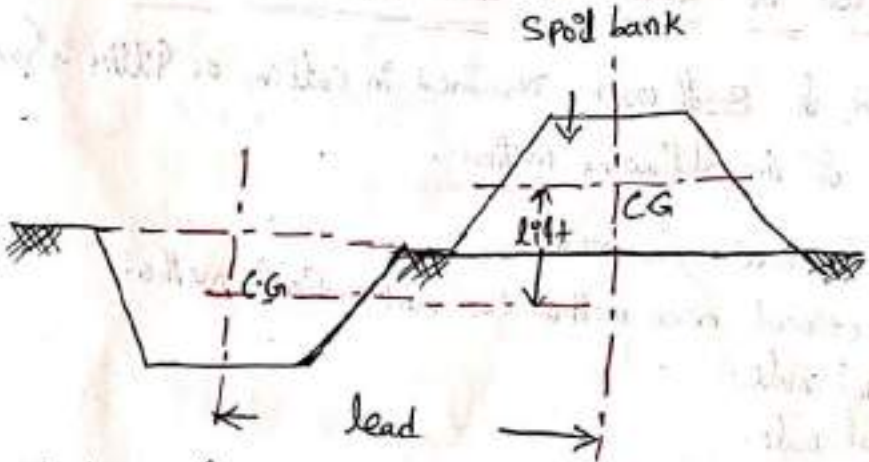
Lift:- Lift is the vertical distance over which the Earth is conveyed. It is measured from centre of Excavation to the centre of spoil bank or heap.

Standard Values:- Initial Lift is 2m and for additional 1m or part there of one Extra lift is to be paid. Schedule of rates Provides rates for different leads.

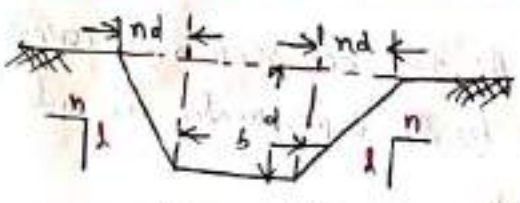
Eg:- If Earth work carried to a height of 3.8m three lifts are to given (one initial lift of 2m and two additional lifts).

Lead and lift are shown in the following diagrams:-

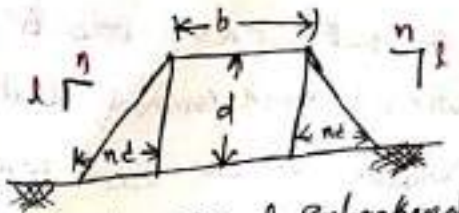




Calculation of c/s area of Earth work:-



c/s area of cutting



c/s area of Embankment

Area of c/s = Average width x depth

$$A = \frac{b+b+2nd}{2} \times d = \frac{2b+2nd}{2} \times d$$

Trapezium area, $A = \frac{2(b+nd)d}{2} = (b+nd)d$

Similarly area of c/s of rectangle $A = bd$

Normally trapezoidal shape is used for Earth work. In case where very hard soil is there we can cut the section perfectly vertical is possible or side drains of streets are used in rectangular shape.

Calculations & volumes:-

The volume can be calculated by any one of the methods given below.

1). from c/s, 2). from spot level, 3). from contours

Out of three methods, the first two are used for calculating the volume of Earth work and the third method is used for calculating the capacity of reservoirs.

* Calculation of volume of Earth work from c/s:-

The volume of Earth work required in cutting or filling is found by any one of the following methods.

→ Mean sectional area method.
→ Mid sectional area method (or) mid ordinate method.
→ Trapezoidal rule.
→ Prismoidal rule.

→ Mean Sectional Area method:-

In this method average area of the two end sections are considered. This method is most commonly used by the departments for calculating the volume of the Earth work.

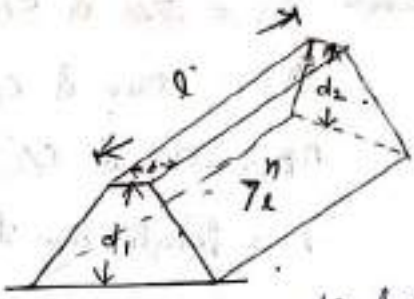
Volume of Earth work = mean sectional area

$A_1 = (b + nd_1)d_1$

$A_2 = (b + nd)d_2$

mean sectional area = $\frac{A_1 + A_2}{2}$

Distance b/w sections = l



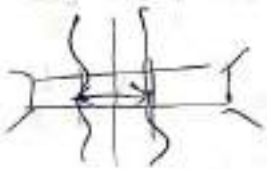
⇒ Mid sectional Area method:-

In this method volume of the Earth work is found by multiplying the Mid section area with distance b/w the sections. This method is used when the ground is fairly level and the sections are taken at closed intervals.

volume of Earth work = Area at Mid section x distance b/w the section

Area of Mid section = $(b + ndm)dm$

where depth at Mid section = $dm = \frac{d_1 + d_2}{2}$



Distance b/w two sections = l

⇒ Trapezoidal Rule:-

This method is the Extension of mean sectional area method and is applicable to a series of sections taken at Equal intervals.

If $A_1, A_2, A_3 - - - - A_n$ are the c/s area along the LS and L is the Equal Interval b/w the sections.

Total volume $V = \frac{\text{Interval b/w sections}}{2}\{[\text{First area} + \text{Last area}] + 2(\text{Sum of remaining areas})\}$

(or) $V = L\{[\frac{A_1 + A_n}{2}] + [A_2 + A_3 + A_4 + - - - A_{n-1}]\}$

(or) $V = L\{\frac{A_1}{2} + A_2 + A_3 + A_4 + - - - A_{n-1} + \frac{A_n}{2}\}$

⇒ Prismoidal Rule:-

It is also known as Simpson's rule. This method is used when the shape of the solid b/w two parallel c/s is in the shape of Prismoid. Volume Enclosed b/w the two sections by Prismoidal

Sulls is given by

$$V = \frac{1}{6}[A_1 + 4A_m + A_2]$$

where A_1 = area of c/s at one End

A_2 = area of c/s at the other End

A_m = area of c/s at the middle

L = length blw the sections.

Note:- A_m = is the area of c/s at the middle and no the average area.

In case series of section are given. The formula can be extended only when there are odd number of c/s and the intervals blw them are Equal!

$$V = \frac{L}{3}[(\text{First area} + \text{last area}) + 4 \times \text{sum of Even areas} + 2 \times \text{Sum of odd areas})]$$

or $$V = \frac{L}{3}\{(A_1 + A_n) + 4(A_2 + A_4 + A_6 + -- + A_{n-1}) + 2(A_3 + A_5 + -- + A_{n-2})\}$$

* Some of the Terms used in Earth work Calculations:-

1) **BORROW PITS:-** for the formation of Embankment like roads or Earth dams large quantities of Earth/gravel/sand borrowed from a different place away from the alignment pit Excavated is called borrow pit (or) a pit from which construction materials as Earth/gravel/sand is taken for use as fill at another location.

2) **Spoil Bank:-** An Earthen bund formed by deposition of Earth disposed off from an Excavation is called spoil bank. (In Canals digging, road formation in ghat roads etc leads to Excavate soil and are to be disposed off away from the alignment.

⇒ Dead Men:- To know the volume of Earth taken from the pit a cylindrical part (about 40mm dia) of Earth left over without Excavation is called dead men.

* They are used for check measurements, when the ground is fairly level.
* After check measurement is over these dead means were also removed.

⇒ Thandas:- When borrow pits are excavated in undulated area long stretches of rectangular of c/s of 300 to 400mm wide are left over across the pits without Excavation are called Thandas.

* They are removed after check measurement is over.

* Calculation of volume of Earth work by using Spot levels:-

⇒ Spot levels:- In this method area is divided in to number of squares or rectangulas and spot levels are taken before and after the Earth work and volume of Earth work is calculated.

* Computation of Earth work for filling Depression / capacity of the Reservoirs from contour maps:-

→ Contour maps are used for calculating the Earth work required in filling the depression or for calculating the capacity of the reservoir up to the required level by using Trapezoidal rule or prismodial rule.

→ Contour area can be calculated by using planimeter / electronic planimeter / by some other means (drawing softwares).

⇒ Some of the Terms used in capacity & Reservoir problems:-

1) Sluice:- An opening is provided in a dam / tank for supply of water to canals.

2) Sill level:- The bottom most level of the opening is called ~~Earth Work level~~.

Sill or crest. The water below the sill level cannot be drawn out from reservoir/tank.

3). F.T.L:- The water level upto which water can stored is called Full Tank level. The water above F.T.L cannot be used as it is discharged as surplus flow.

4). Active Storage:- The volume of water stored b/w sill level and F.T.L is called active storage or live storage.

5). Dead storage:- The volume of water below the Sill level of sluice is called as Dead storage.

6. Gross Storage:- Total volume of water below the F.T.L is Called Gross storage (Active storage + Dead storage).

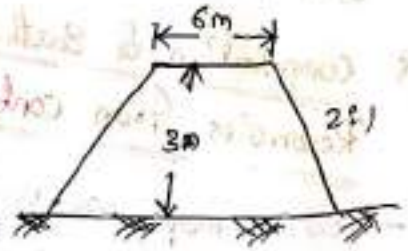
Problems on Area:-

1. Find the area of Embankment, if the top width of the road is 6m and depth is 3m. The side slopes are 2:1.

Sol:- Given data

Top width $b = 6m$

depth of Embankment $d = 3m$



Area of Embankment $A = (b+nd)d$

$= (6+2\times3)3$

$= 36m^2$

$A = (b+2nd)$

$= (6+2\times2\times3)$

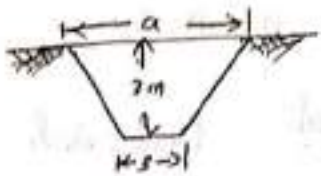
$= 18m$

Area of Embankment $= \frac{1}{2}\times(a+b)h$

$A = \frac{1}{2}\times(18+6)3$

$= 36m^2$

2) Find the area of cutting if the bottom width of the canal is 3m and depth is 3m side slopes are 1½:1.



Sol:- Given data

$b = 3m$; $n = 1\frac{1}{2}$; $d = 3m$

Area of cutting $= (b + nd)d$

$= (3 + 1.5 \times 3) \times 3$

$= 22.5 m^2$

Top width of cutting $= (b + 2nd)$

$a = \left[3 + 2 \times 1\frac{1}{2} \times 3\right]$

$a = 12m$

$b = 3m$; $n = 1 \cdot \frac{1}{2}$; $h = 3m$

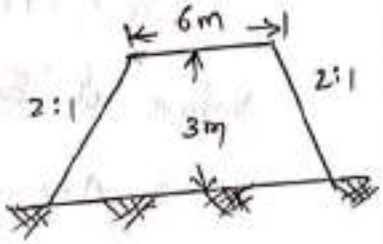
Area of cutting $= \frac{1}{2} \times (a + b)h$

$A = \frac{1}{2} \times (12 + 3) \times 3$

$= 22.5 m^2$

Problems on volume calculations :-

1) Find the volume of Earth work in an Embankment of length 1 km. Top width of a road is 6m and a depth is 3.0m, The side slopes are 2:1.



Sol:- Given data

Top width of a road $b = 6m$

Depth $d = 3m$

Side slope $= n : 1 = 2 : 1$, $n = 2$

length of a road $L = 1 km = 1000 m$

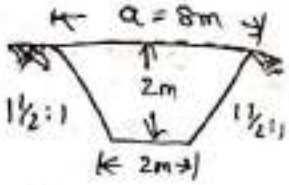
volume of Earth work = C/s area × length of a road

$= (b + nd)d \times L$

$= (6 + 2 \times 3) \times 3 \times 1000$

$= 36000 m^3$

2). Calculate the volume of Earth work in a canal of depth 2m and bottom width 2m for a length of 1 km. The side slope one $1\frac{1}{2}:1$.



Sol:- Given data

The bottom width of Canal = 2 m

Depth of Canal = 2m

Side slope = n : 1 = $1\frac{1}{2}:1$ = $1\frac{1}{2}$

length of Canal L = 1 km = 1000 m

Volume of Earth in Cutting = Area C/S × length of Canal

$V = (b + nd)\, d \times L$

$= (2 + 1\frac{1}{2} \times 2)\, 2 \times 1000$

$= 10000\ m^3$ (or)

Top width $a = (b + 2nd)$

$= (2 + 2 \times 1\frac{1}{2} \times 2) = 8m$

$h = 2m$; $b = 2m$

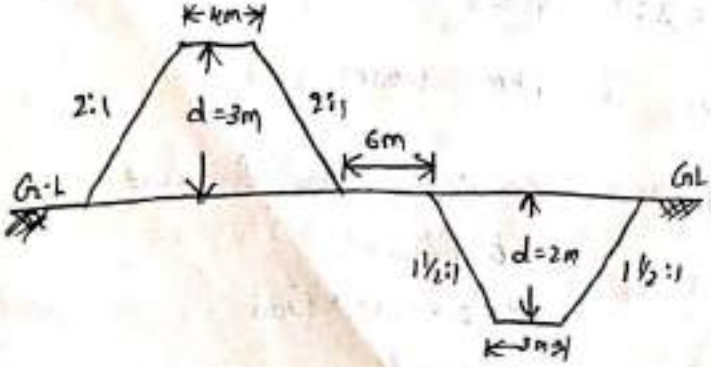
By using trapezium area formula

$A = \frac{1}{2} \times (a+b)h = \frac{1}{2} \times (8+2)\, 2 = 10m^2$

Volume of Earth work in cutting

$\therefore V = A \times L = 10 \times 1000 = 10,000 m^3$

3). find the lead and lift of the following.



Sol: (a) lead $= \frac{4}{2} + 2\times 3 + 6 + 1.5 \times 2 + \frac{3}{2}$ $\left[\frac{b'}{2} + nd_1 + \text{distance} + [illegible] \times d' [illegible]\right]$

$= 18.5m$

(b) Lift $= \frac{3}{2} + \frac{2}{2} = 2.5\,m$ $\left[\frac{b_r}{2} + \frac{b_e}{2}\right]$

1) Estimate the quantity of Earth work for an Embankment 120m long. 8m wide at crest and side slopes is 2:1 one central height from (0 to 30)m Intervals are 0.6m, 1.2m, 1.6m, 2m, 1.3m use the mid sectional area method.

for Every 2m of wide 1m of height is consider

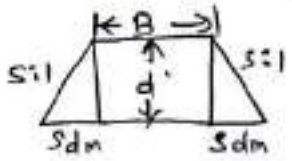
Sol:- Given data

Embankment length = 120m

b = 8m; S = 2:1; n = 2

height = 0 to 30 m

depth = 0.6m, 1.2m, 1.6m, 2m, 1.3



d = dm

Station	depth or height	mandepth (dm)	Central area (b x dm)	Side area (S x dm²)	Total area = (CA + SA) (Area)	Intervals (L)	Quantity (m³) (A x L) Filling (+)	Cutting (-)
0	0.6							
		0.9	7.2	1.620	8.82	30	264.60	
30	1.2							
		1.4	11.2	3.920	15.12	30	453.60	
60	1.6							
		1.8	14.4	6.480	20.88	30	626.40	
90	2							
		1.65	13.20	5.445	18.645	30	559.35	
120	1.3							
						Total	1903.95	

dm = mean depth; $d_1 = 0.6$, $d_2 = 1.2$, $d_3 = 1.6$, $d_4 = 2$; $d_5 = 1.3$

$dm_2 = \frac{d_1+d_2}{2} = \frac{0.6+1.2}{2} = 0.9m$; $\frac{d_2+d_3}{2} = \frac{1.2+1.6}{2} = 1.40m$

$= \frac{d_3+d_4}{2} = \frac{1.6+2}{2} = 1.80m$; $\frac{d_4+d_5}{2} = \frac{2+1.3}{2} = 1.65m$

Central area = $(b \times dm_1)$

$= 8 \times 0.9 = 7.2\ m^2$

$CA_2 = (b \times dm_2) = 8 \times 1.4 = 11.2\ m^2$

$CA_3 = (b \times dm_3) = 8 \times 1.8 = 14.4\ m^2$

$CA_4 = (b \times dm_4) = 8 \times 1.65 = 13.20\ m^2$

Sides area = (S x dm1) = (2 x 0.9²) = 1.620 m²

= (S x dm2) = (2 x 1.4²) = 3.920 m²

= (S x dm3) = (2 x 1.8²) = 6.480 m²

= (S x dm4) = (2 x 1.65²) = 5.445 m²

= (S x dm5) = (2 x .

Total area = (CA + SA)

A1 = 7.2 + 1.620 = 8.82 m²

A2 = 11.2 + 3.920 = 15.12 m²

A3 = 14.4 + 6.48 = 20.88 m²

A4 = 13.20 + 5.445 = 18.645 m²

Quantity = Intervals x Total area

= 30 x 8.82 = 264.60 m³

= 30 x 15.12 = 453.60 m³

= 30 x 20.88 = 626.40 m³

= 30 x 18.645 = 559.35 m³

Abstract of Estimated Cost

Item NO	Particulars of Item	Quantity	Unit	Rate Rs.P	per	Cost
1	Earthwork banking	1903.95	Cu.m	275.00	% Cum	5,23,586
2	Earthwork cutting	-	-	-	-	-

2). Estimate the Quantities of Earth work for an Embankment 100m long. 10m wide at crest and slopes in 2:1 one central height from (0 to 20)m intervals are 0.9m, 1.5m, 1.8m, 2.2m, 1.3m use the mid sectional area Method.

2) Prepare a detailed Estimate for Earthwork for a portion of road from the following data:

Distance in m	0	100	200	300	400	500	600	700	800	900	1000	1100
R.L of ground	114.50	114.75	115.25	115.20	116.10	116.85	118.00	118.25	118.10	17.80	17.95	117.75

Distance	1200
R.L of ground	119.50

R.L of formation:- 115 upward gradient 1 in 200 up to 600m → ← Downward gradient 1 in 400

formation width of road is 10 meter side slope 2:1 in banking and 1½:1 in cutting Adopt suitable rates.

From the data given L-section can be plotted and height of bank and depths of cutting of different stations can be calculated. The height of bank, and depths of cutting are the difference of R.L of ground, R.L of formation, and Even without plotting L-section the height and depth can be calculated.

Sol:- Given data

B = 10m

Slope for banking = 2:1; S = 2

Slope for cutting = 1.5:1; S = 1.5

Calculation of R.L formation of Ground:-

$= \frac{1}{200} \times 100 = 0.5$ upward Gradient

$= \frac{1}{400} \times 100 = 0.25$ Downward "

height or Depth = R.L of formation − R.L of Ground

$= 115.00 - 114.50 = 0.5$

Detailed Estimate for Earthwork for road:-

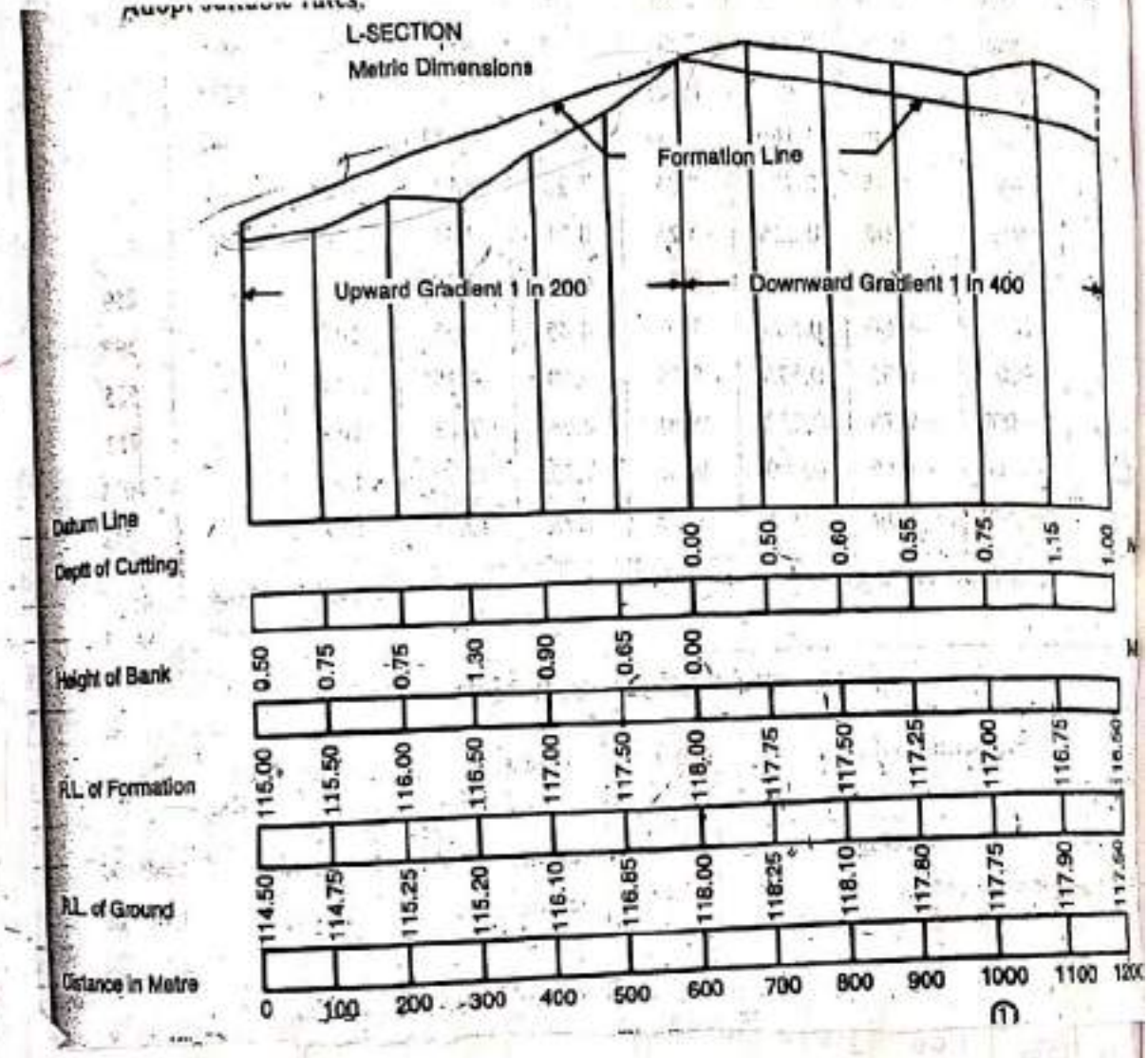
Station	Distance in Km.m	height or Depth of G.L and F.L	Mean height or mean depth (dm)	central area (b x dm)	Area of Sides (S x dm²)	Total area = (CA+SA)	Distance b/w Station (L) m	Quantities (Ad + Sd²) x L Banking m³	Quantities (Ad + Sd²) x L Cutting m³
0	0	0.50	—	—	—	—	—	—	—
1	100	0.75	0.625	6.25	0.78	7.03	100	703	—
2	200	0.75	0.750	7.50	1.13	8.63	100	863	—
3	300	1.30	1.025	10.25	2.10	12.35	100	1235	—
4	400	0.90	1.100	11.00	2.42	13.42	100	1342	—
5	500	0.65	0.775	7.75	1.20	8.95	100	895	—
6	600	0.00	0.325	3.25	0.21	3.46	100	346	—
7	700	0.50	0.250	2.50	0.09	2.59	100	—	259
8	800	0.60	0.550	5.50	0.45	5.95	100	—	595
9	900	0.55	0.575	5.95	0.50	6.25	100	—	625
10	1000	0.75	0.650	6.50	0.63	7.13	100	—	713
11	1100	1.15	0.950	9.50	1.35	10.85	100	—	1085
12	1200	1.00	1.075	10.75	1.73	12.48	100	—	1248
							Total	5384	4525

Abstract of Estimated Cost

Item No	Particulars of Item	Quantity	Unit	Rate Rs. P	Per	Cost Rs P
1	Earthwork in banking	5384	cum	275.00	1 cu.m	14806.00
2	Earthwork in cutting	4525	cum	350.00	1 cum	15837.50
					Total	30643.50

Add 5% (3% for contingencies and 2% for work charged establishment = 1532.18

Grand Total = 32175.68

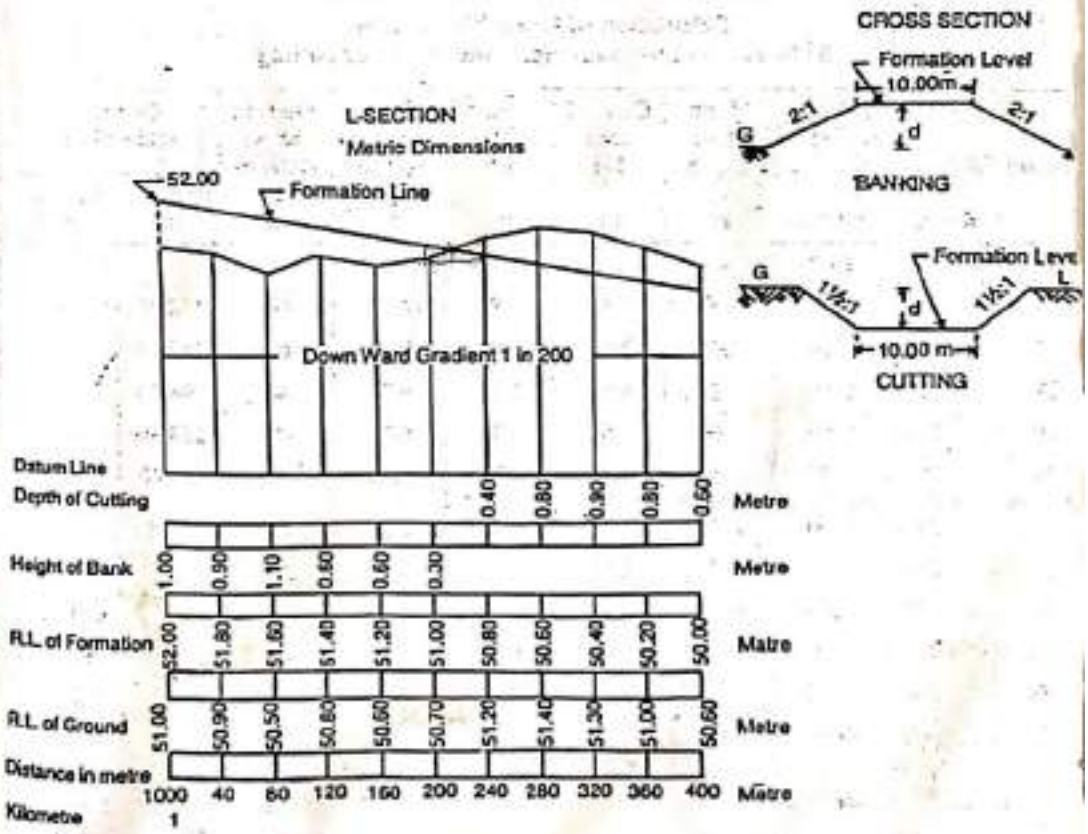


Example 4.—Estimate the cost of earthwork for a portion of road for 400 metre len the following data :—

Formation width of the road is 10 metre. Side slopes are 2 : 1 in banking 1½ : 1 in c

Station	Distance in metre	R.L. of Ground	R.L. of formatio
25	1000	51.00	52.00
26	1040	50.90	
27	1080	50.50	
28	1120	50.80	
29	1160	50.60	Downward gradier
30	1200	50.70	of 1 in 200
31	1240	51.20	
32	1280	51.40	
33	1320	51.30	
34	1360	51.00	
35	1400	50.60	

Lengitudinal section of the road and type cross-section are as given in Fig. 7-9. The exan can, however, be solved without the help of L-section and cross-section.



B = 10m S = 2 for banking and 1½ for cutting

Station	Distance Km m	Height of Depth diff of G.L & F.L	mean height or depth (d) m	central area Bd (m²)	Area of Sides (Sd²) m²	Total sec. area Bd+Sd²	Distance B/W station (m)	Quantity (Bd+Sd²)/2 Banking m³	cutting m³
25	1-00	1.00	–	–	–	–	–	–	
26	1-40	0.90	0.95	9.50	1.80	11.30	40	452.40	
27	1-80	1.10	1.00	10.00	2.00	12.00	40	480.00	
28	1-120	0.60	0.85	8.50	1.45	9.95	40	398.00	
29	1-160	0.60	0.60	6.00	0.72	6.72	40	268.80	
30	1-200	0.30	0.45	4.50	0.40	4.90	40	196.00	
Passes	from	banking	to cutting						
–	1-217	0.00	0.15				17		
31	1-240	0.40	0.20	2.00	0.06	2.06	23	–	47.38
32	1-280	0.80	0.60	6.00	0.54	6.54	40	–	261.60
33	1-320	0.90	0.85	8.50	1.08	9.58	40	–	383.20
34	1-360	0.80	0.85	8.50	1.08	9.58	40	–	383.20
35	1-400	0.60	0.70	7.00	0.73	7.73	40	–	309.60
						Total	1821.95 m³		1384.98 m³

Item No	Particulars of Items	Quantity	Unit	Rate Rs.P	per	cost Rs	P
1.	Earthwork in banking	1821.95	m³	275-00	% Cum	5010	36
2.	Earthwork in cutting	1384.98	m³	350-00	% Cum	4847	43
	Total					9857	79
	Add 3% for Contingencies					295	73
	Add 2% for work charged establishment					197	15
					Grand total	10350	68

4) Estimate the quantity of Earthwork for an Embankment 120m long 8m wide at crest and side slopes is 2:1 one vertical height from (0 to 30)m Intervals are 0.6m, 1.2m, 1.6, 2m, 1.3m use the mean sectional area method.

Sol:- Given data

120m long

$B = 8m$

$S = 2$

$h = 0$ to 30 m

Station	Depth or height (d)	Central area (b×d)	Side area ($S \times d^2$)	Total area C.A + S.A	mean Total area	Intervals	Quantity f	Quantity c
0	0.6	4.8	0.72	5.52	–	30	–	
30	1.2	9.6	2.88	12.48	9	30	270	
60	1.6	12.8	5.12	17.92	15.2	30	456	
90	2	16	8	24	20.96	30	628.8	
120	1.3	10.4	3.38	13.78	18.89	30	566.7	
						Total	1921.5	

Abstract of Estimation :-

Item No	Particulars of item	Quantity	unit	Rate Rs. P	per	Cost
1	Earthwork banking	1921.5	Cu.m	275.00	1 Cum	528412
2	Earthwork filling	–	–			

5). Calculate the volume of Earth work using mid ordinate method having formation width 10m and slope 2:1.

Depth = FL - GL

Chainage(m)	400	420	440	460	480	500
GL(m)	11.5	11.6	11.4	11.2	11.5	11
FL(m)	12.5	12.4	12.3	12.2	12.1	12
Depth (m)	1	0.8	0.9	1	0.6	1

Sol:- Given data

B = 10m

S = 2

Mid sectional area method:-

Station Chainage	Depth or height	mean depth (m)	Central area (b×d m)	Side area (S×d m²)	Total area C.A+S.A	Interval (m)	Quantity	
							Fill	cutting
400	1							
		0.9	9.00	1.62	10.62	20	212.4	-
420	0.8							
		0.85	8.50	1.445	9.945	20	198.9	-
440	0.9							
		0.95	9.50	1.805	11.305	20	226.1	-
460	1							-
		0.8	8.00	1.28	9.28	20	185.6	
480	0.6							✓
		0.8	8.00	1.28	9.28	20	185.6	
500	1							
						Total	1008.6	

Mean Sectional area Method:

Station of chainage	Depth or height	Central area (b×d)	Sides area ($s \times d^2$)	Total area (C.A+S.A)	mean total area	Intervals	Quantity	
							Filling	cutting
400	1.0	10	2.0	12	10.64	20	212.8	—
420	0.8	8.0	1.28	9.28	9.95	20	199.0	—
440	0.9	9.0	1.62	10.62	11.3	20	226.2	—
460	1.0	10.0	2	12.0	9.36	20	187.2	—
480	0.6	6.0	0.72	6.72	9.36	20	187.2	—
500	1.0	10.0	2	12.0		Total	1012.4	

6) Calculate the volume of Earthwork using Prismoidal formula for a proposed road having following data details:

(1) Formation width of road is 10m

(2) side slope in filling is 2:1.

(3) " " in cutting is 1.5:1.

(4) Formation level is 108.00 m at 0 chainage.

(5) Road has no slope in longitudinal direction.

Chainage(m)	0.00	20.0	40.0	60.0	80.0	100.0	120.0
G.L (m)	107.20	107.90	108.00	108.80	109.00	108.80	109.10

Sol:- Given data

$B = 10\,m$

$S = 2$ for filling

$S = 1.5$ for cutting

$F.L = 108.00\,m$ at 0 chainage

At 0 chainage F.L = 108.00 m and there is no slope in longitudinal direction.

∴ formation level will be same at all chainages

from table given below, it is clear that from chainage 0 to 40, road is in filling and from the chainage 40 to 120, road is in cutting.

Depth of cutting = G.L − F.L

Depth of filling = F.L − G.L

Area at different cross-sections:-

$$A = bh + sh^2$$

$B = 10\,m$, $S = 2$ for filling

" " $S = 1.5$ for cutting

$A_0 = (10 \times 0.8) + (2.0 \times 0.8^2) = 9.28\,m^2$ filling

$A_{20} = (10 \times 0.1) + (2.0 \times 0.1^2) = 1.02\,m^2$ "

$A_{40} = 0$

$A_{60} = (10 \times 0.8) + (1.5 \times 0.8^2) = 8.96\,m^2$ cutting

$A_{80} = (10 \times 10) + (1.5 \times 10^2) = 11.5\,m^2$ "

$A_{10} = (10 \times 2.8) + (1.5 \times 2.8)^2 = 39.76\,m^2$

$A_{120} = (10 \times 1.1) + (1.5 + 1.1^2) = 12.815\ m^2$ (cutting)

Using prismoidal formula :-

Quantity of filling $= \frac{d}{3} \times (A_0 + 4A_{20} + 4A_{40})$

$$V = \frac{20}{3} \times (9.28 + 4 \times 1.02 + 4 \times 0)$$

$$= 89.07\ m^3$$

Quantity of cutting $= \frac{d}{3} \times (A_{40} + 4A_{60} + 2A_{80} + 4A_{100} + A_{120})$

$$V = \frac{20}{3} \times (0 + 4 \times 8.96 + 2 \times 11.5 + 4 \times 39.76 + 12.815)$$

$$= 1537.97\ m^3$$

Station (m)	G.L (m)	F.L (m)	Depth (h)	Area ($6h + 5h^2$) (m^2)	Quantity
0.0	107.20	108.0	0.80	9.28	filling
20.0	107.90	108.00	0.10	1.02	
40.0	108.0	108.00	0.00	0	
60.0	108.80	108.00	0.80	8.96	cutting
80.0	109.0	108.00	1.00	11.5	
100.0	110.80	108.00	2.80	39.76	
120.0	109.10	108.00	1.10	12.815	

7). Calculate the volume of Earthwork by using trapezoidal formula for a proposed road having following details.

(1) Formation width of road is 8 m

(2) side slope in filling is 2:1

(3) side slope in cutting is 1.5:1

(4) Cutting is zero at 0 m chainage

(5) Road has longitudinal slope of 100:1 falling gradient

Chainage (m)	0.00	20.00	40.00	60.00	80.00	100.00
G.L (m)	51.00	51.50	51.65	52.05	52.15	52.30

Also draw following sections with required details.

(1) Longitudinal section and give necessary details.

(2) C/s at Chainage 20 m and 60 m.

Sol:- Given data

$B = 8$ m ; $S = 2$ for filling ; $S = 1.5$ for cutting

The longitudinal slope is 100:1 falling. So, for each 20m distance, fall in level will be $0.2\text{ m} = \frac{1}{100} \times 20 = 0.2$m

Chainage (m)	0.00	20.00	40.00	60.00	80.00	100.00
G.L	51.00	51.50	51.65	52.05	52.15	52.30
F.L	51.00	50.80	50.60	50.40	50.20	50.00
Depth	0.00	0.70	1.05	1.65	1.95	2.30

From the above table we can see that ground level is higher than formation level.

So, whole road in cutting

Depth of cutting = G.L − F.L

⇒ Area at different C/s:-

$A = bh + sh^2$

Taking B = 8 m and S = 1.5 for cutting

S = 2 for filling

$A_0 = 0$

$A_{20} = (8 \times 0.7) + (1.5 \times 0.7^2) = 6.34\ m^2$ -- Cutting

$A_{40} = (8 \times 1.05) + (1.5 \times 1.05^2) = 10.05\ m^2$ -- Cutting

$A_{60} = (8 \times 1.65) + (1.5 \times 1.65^2) = 17.28\ m^2$ -- Cutting

$A_{80} = (8 \times 1.95) + (1.5 \times 1.95^2) = 21.30\ m^2$ -- Cutting

$A_{100} = (8 \times 2.30) + (1.5 \times 2.30^2) = 26.34\ m^2$ -- Cutting

⇒ Using Trapezoidal formula:-

$$V = \frac{d}{2} \times [A_0 + 2(A_{20} + A_{40} + A_{60} + A_{80}) + A_{100}]$$

$$= \frac{20}{2} \times [0 + 2(6.34 + 10.05 + 17.28 + 21.30 + 26.34)]$$

$$= 10 \times [0 + 109.94 + 26.34]$$

$$= 1362.80\ m^3.$$

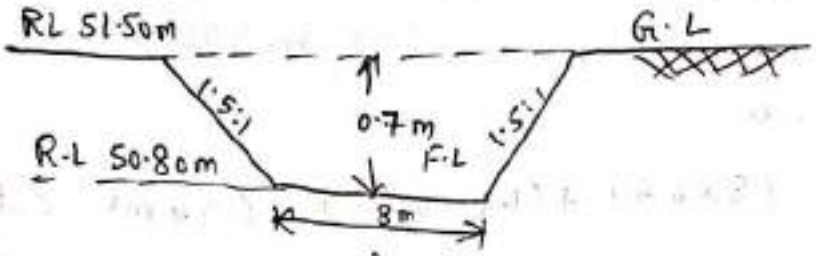
(i) Fig Show longitudinal section of a road:-

H-scale : 1.5cm = 20m

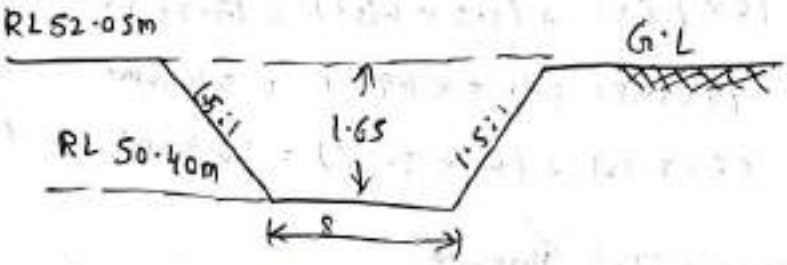
V-scale : 1cm = 1m

Chainage	0.0	20.0	40.0	60.0	80.0	100.0
Depth	0.0	0.70	1.05	1.65	1.95	2.30
FL	51.00	50.80	50.60	50.40	50.20	50.00
GL	51.00	51.50	51.65	52.05	52.15	52.30

(2) Fig shows C/S at 20m and 60m chainage



(a) C/S at chainage 20m



(b) C/S at chainage 60m

UNIT - II

REINFORCEMENT ESTIMATION:

Introduction:-

→ R.C.C work is usually estimated under two items. The concrete work including centering and shuttering and binding of steel bars in position is taken under one item in cu.m (cu.ft) and the steel Reinforcement and its bending is taken under a separate item in quintal (cwt).

→ The quantity of steel being small no deduction is made for steel from the volume of concrete. Binding wire is not taken separately but included in item of R.C.C works.

→ Centering and Shuttering may also be taken under a separate item in sq.m (sq.ft) Bending and binding of steel may also be taken separately in quintal (cwt).

→ Steel reinforcement is calculated as per actual requirement as laid in position including over-laps, hooks, cranks, etc and is determined from the detailed drawings. If the detailed drawing. If the detailed drawings are not available. The steel reinforcement may be calculated approximately on the percentage basis of concrete.

→ The density of steel may be taken as 78.5 quintal per cum or 7.85 grams per cum (490 lbs per cu.ft)

→ The percentage of steel reinforcement depends on the design of the structure. In absence of detailed design the % of steel concrete may be taken approximately as given below-

(i) Lintel, slabs, etc — 0.7 to 1.0 %

(ii) Beams — 1.0 to 2.0 %

(iii) Column — 1.0 to 5.0 %.

(iv) Foundation raft, footings, etc — 0.5 to 0.8%

for small span and light load less steel is required and for bigger span and heavier load greater amount of steel is required.

→ R.C.C work may also be taken as complete work inclusive of reinforcement and centering and shuttering, including steel reinforcement and centering and shuttering, bending of steel to the required shape, placing and binding of steel with G.I wire in position.

→ Same principle is adopted for reinforced brick (R.B) work but the exposed surface of R.B work is finished with 12 mm ($\frac{1}{2}$") thickness plastering in 1:2 to 1:3 cement mortar and the item of plastering is measured with the can taken separately under separate item.

→ In RCC work the end or side covers for steel bars may be taken as 4cm to 5cm ($1\frac{1}{2}$" to 2") and the bottom and top covers may be taken as 1.2 cm to 2cm ($\frac{1}{2}$" to $\frac{3}{4}$") for slab and 2.5cm to 5cm (1" to 2") for beams.

→ The standard of one hook and cranked bent up bars have been illustrated. The length of one hook may be taken as 9 dia. of bar and the total length of straight bar hooked at both ends may be taken as L + 18 d

for 45° cranked or bent up bar :-

The length for one bent up is = Difference in length of hypotenuse and bar.

$$= \frac{d}{\sin 45^\circ} - d = d\left[\frac{1}{0.707} - 1\right] = d(1.42 - 1) = 0.42d$$

$= 0.45d$ (approximate).

for two bent-ups additional length is equal to $2 \times 0.45d$ $= 9d$, where 'd' is the vertical distance b/w the centre of

upper and lower arms of the bent-up bar, which is equal to total depth of beam or slab minus bottom and top covers.

For 30° cranked or bent up bar Inclined length of crank.

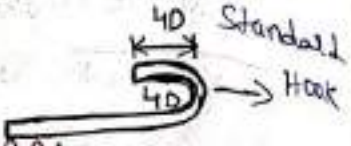
$= \frac{d}{\sin 30°} = 2d$. Horizontal length of crank $= \frac{d}{\tan 30°} = 1.732d$

$= 1.732d$

Two extra length required for one crank $= 2d - 1.732d$

$= 0.268d = 0.3d$ says. for a bar cranked at 60 the ends at 30° the additional length is equal to

$2 \times 0.3d = 0.6d$.



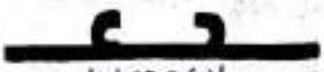
STEEL REINFORCEMENT BARS

Straight Bar

Length of 1 Hook = 9D

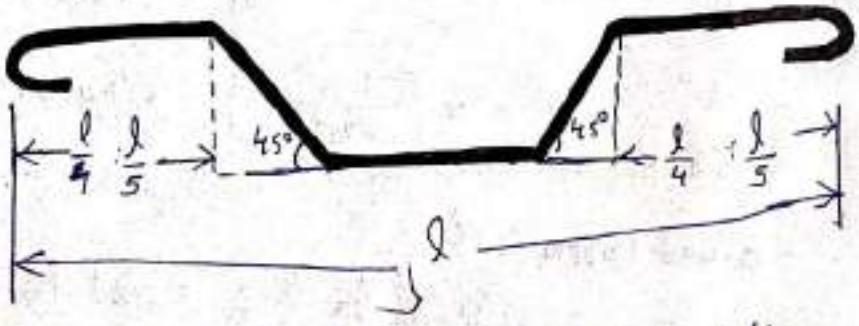
Total length of bar = L + 18D

L = length of Beams or slab minus Two end cover

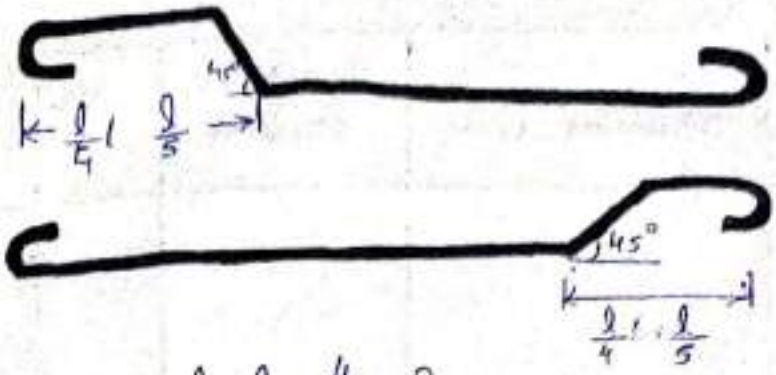


Overlap at joint

CRANKED or BENT UP BARS



Alternate Bars Bent up Both Ends, Alternate Bars Straight as above (Top) or Every Bar Bent up on Each

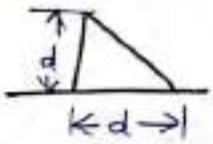


Additional length for Bent up for one bent up additional length

$$\frac{d}{\sin 45^\circ} - d = d\left(\frac{1}{.707} - 1\right) = d\,[1.42 - 1) = 0.42d$$

For Two Bent up Additional length $= 2 \times 0.42d = 0.84d$

d = vertical distance C/C = Total 'D' Depth of Beam or slab Minus Top Cover & Bottom Cover.



* Schedule of bars :-

The schedule of bars is a list of reinforcement bars in a tabular form giving the particulars of bars, shape of bending with sketches, length of each, total length and total weight. For each type of RCC work a schedule of bars is usually prepared. From the schedule of bars the requirement of different size and lengths of bars may be known, and may be arranged and bent-up during the time of construction.

Schedules of bars of a R.C.C slab and a beam are given under Examples 21 and 22

Schedule of Bars – R.C.C Work Table :-

Description of Bars	Shape of Bending Dimension in cm	Length of Each m	NO	Total Length m	Weight Kg

Steel reinforcement is calculated as per actual requirements as laid in position including over-laps, hooks, etc. from detailed drawing. No deduction for steel is made from the volume of concrete. The cost of binding wire and wastage of steel is considered in the item of steel reinforcement. When detailed drawings of steel reinforcement are not available, it is worked out using following thumb rule, taking density of steel 7850 kg/cu m.

TABLE 9-1

APPROXIMATE MAXIMUM QUANTITY OF STEEL REQUIRED PER cu m OF CONCRETE FOR DIFFERENT R.C.C. ITEMS

No.	Item	% of steel per cu m of concrete	Steel in kg
1.	R.C.C. slab	1 % to 1.5 %	8 kg/sq m
2.	R.C.C. beam	2 %	130 kg/cu m
3.	R.C.C. column	2 % to 2.5 %	175 kg/cu m
4.	R.C.C. lintel	0.9 % to 1 %	70 kg/cu m
5.	R.C.C. footing	0.5 to 0.6 %	40 kg/cu m
6.	R.C.C. coping	0.7 %	60 kg/cu m
7.	R.C.C. plinth beam	1.8 %	160 kg/cu m
8.	R.C.C. cantilever slab	1.7 %	10 kg/sq m
9.	R.C.C. weather shed	0.8 % to 1.2 %	6.5 kg/sq m
10.	R.C.C. stair step (1 m wide)	0.7 %	4 to 5 kg/step
11.	R.C.C. paradi	1 %	7 kg/sq m
12.	R.C.C. canopy slab	1.7 %	10 to 12 kg/sq m
13.	R.C.C. retaining wall	1 %	12 to 15 kg/sq m

Total steel required in a high rise building = 110 kg/cu m of concrete volume or 48 kg per sq m of built-up area

The steel reinforcements used in R.C.C. construction are of *two* types:

(1) Mild steel and

(2) *High Yield Strength Deformed* (HYSD) steel i.e., torsteel.

In conventional R.C.C. works, the mild steel bars have been replaced by HYSD bars except 6 mm diameter bars. The properties like diameter, area, weight per metre, etc. are same for both types of bars.

9-3. WEIGHTS OF STEEL BARS

The weights of bars of different diameters are as follows:

Diameter of bar in mm	Weight in kg per metre	Diameter of bar in mm	Weight in kg per metre
6	0.22	16	1.58
8	0.39	18	2.00
9	0.50	20	2.46
10	0.62	22	2.98
12	0.89	25	3.85

Note: The following rule of thumb can be applied to find out the weight of a bar of any diameter *(devised by the author of this book)*:

$$\text{Weight in kg per metre length} = \frac{(\text{diameter of bar in mm})^2}{160} \text{ approximately.}$$

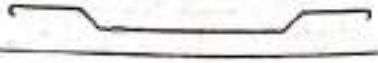
Thus, for 9 mm diameter bar, weight in kg per metre length $= \frac{81}{160} = 0.50$.

9-4. NUMBER OF BARS OR STIRRUPS

$$\text{Number of bars or stirrups} = \left[\frac{\text{Length of component} - (2 \times \text{cover})}{\text{c/c spacing of bars or stirrups}}\right] + 1.$$

9-5. TYPES OF STEEL BARS

There are *three* types of steel bars:

(i)	Main steel bars	
(ii)	Alternate bent-up bars	
(iii)	Distribution steel bars	

Straight bars and alternate bent-up bars are arranged alternatively so the distance between *two* straight bars or *two* bent-up bars are considered double than centre to centre distance given in drawing. Sometimes instead of alternate bent-up bars, each bar is bent on one side only and arranged as shown below:

In this type of arrangement, the c/c distance between bars is taken same as mentioned in the drawing, because each bar is bent-up. No matter whichever arrangement is considered, the quantity of steel remains the same.

9-6. LENGTH OF HOOK AND BENT-UP BARS

(1) Hook: Extra length for hook and bend

Let l = length of bar

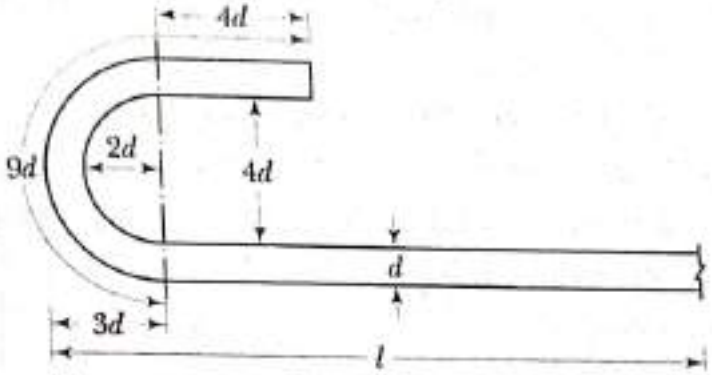
d = diameter of bar.

Then, extra length for one hook

$$= \left(l - d - 2d + \frac{\pi \times 5d}{2} + 4d\right) - l$$

$$= l + d + 2.5\pi d - l$$

$$= d(1 + 2.5\pi) = 8.85d \text{ say } 9d.$$



Hook

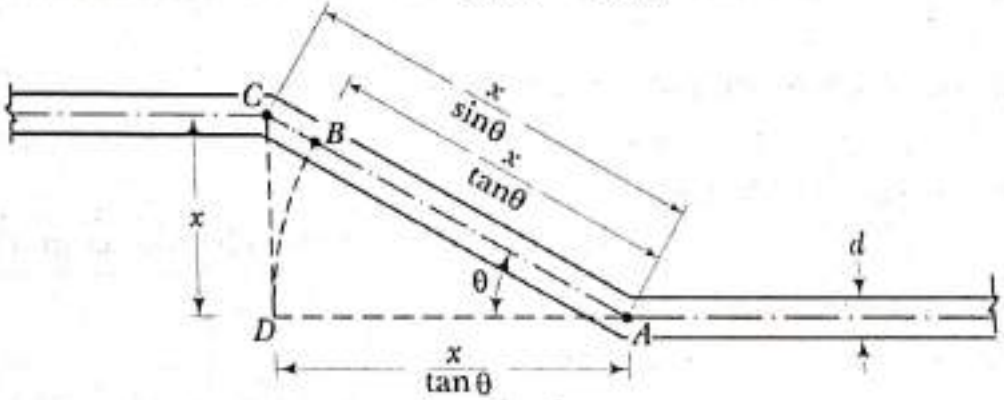
FIG. 9-1

(2) Bent-up bars: Fig. 9-2 shows single bent-up bar, bend at an angle θ°. In this fig. 9-2,

x = Effective depth

BC = Length of bend or extra length for bent-up bar.

$$= \frac{x}{\sin\theta} - \frac{x}{\tan\theta} = x\left[\frac{1}{\sin\theta} - \frac{1}{\tan\theta}\right]$$



Bent-up bar

FIG. 9-2

(i) If angle of bend $\theta = 45°$:

$$BC = \frac{x}{\sin 45°} - \frac{x}{\tan 45°} = \frac{x}{\frac{1}{\sqrt{2}}} - \frac{x}{1}$$

$$= \sqrt{2}x - x = x(\sqrt{2} - 1) = x(1.42 - 1) = 0.42\,x, \text{ say } \boxed{0.43\,x}$$

(ii) If angle of bend $\theta = 30°$:

$$BC = \frac{x}{\sin 30°} - \frac{x}{\tan 30°} = \frac{x}{\frac{1}{2}} - \frac{x}{\frac{1}{\sqrt{3}}} = x(2 - \sqrt{3})$$

$$= x(2 - 1.73) = 0.27\,x, \text{ say } \boxed{0.30\,x}$$

(iii) If angle of bend $\theta = 60°$:

$$BC = \frac{x}{\sin 60°} - \frac{x}{\tan 60°} = \frac{x}{\frac{\sqrt{3}}{2}} - \frac{x}{\sqrt{3}}$$

$$= x(1.16 - 0.58) = 0.58\,x, \text{ say } \boxed{0.60\,x}$$

(iv) If angle of bend = 90°;

length of bend = $6d$.

(3) Lateral ties or vertical stirrups:

(i) ***Two-legged stirrups:***

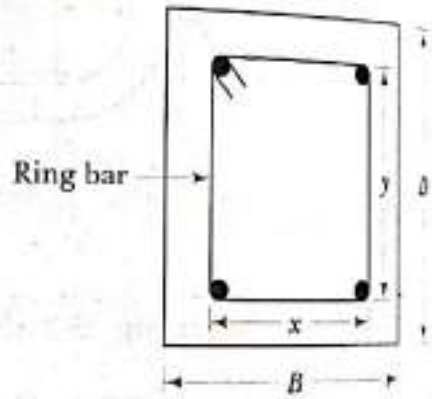
As shown in fig. 9-3,

B and D are the outer dimensions of R.C.C. beam or column.

$x = B - 2 \times \text{cover} - 2d$

$y = D - 2 \times \text{cover} - 2d$

Here, d = diameter of ring bar.



Two-legged stirrup

FIG. 9-3

As per IS, the hook allowance for the normal type of ring as shown in figure is to be taken as equal to $24d$ where d is the diameter of bar used for ring. For other shapes of rings, the IS recommends hook allowance ranging from $20d$ to $28d$.

∴ In two-legged stirrups, length of two hooks

$= 2 \times 12d$ or 0.15 m $= 24d$ or 0.15 m (which ever is more)

∴ Total length of two-legged stirrups

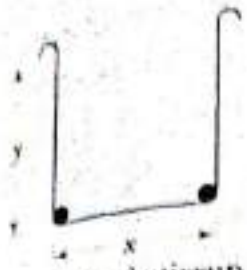
$= 2(x + y) + (24d \text{ or } 0.15 \text{ m})$ (which ever is more)

(ii) ***One-legged stirrups:***

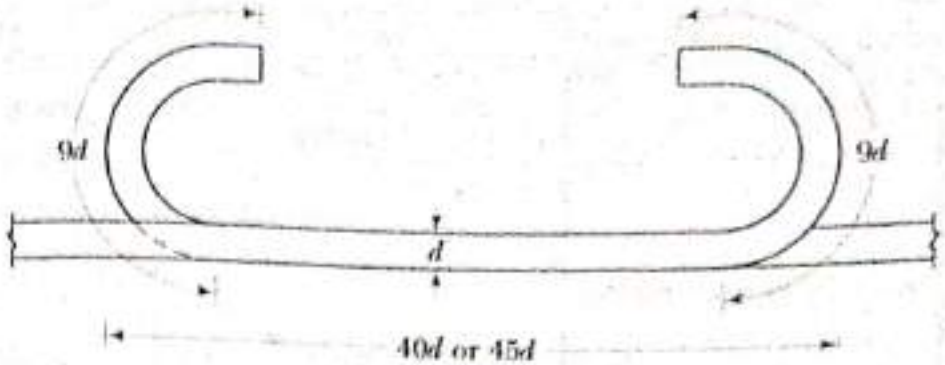
Fig. 9-4 shows one-legged stirrup.

For one-legged stirrup, length of hook $= 14d + 14d = 28d$

∴ Total length of one-legged stirrup $= x + 2y + 28d$.



One-legged stirrup
FIG. 9-4



Overlapping bars
FIG. 9-5

(4) Overlapping bars:

Fig. 9-5 shows overlapping bars having diameter d.

For bars in tension, extra length $= 40d + 9d + 9d$

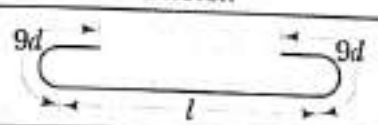
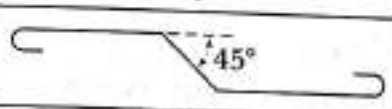
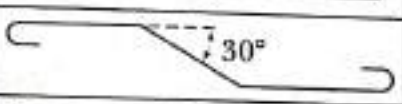
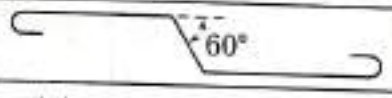
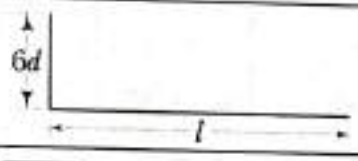
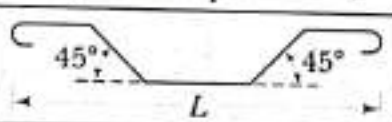
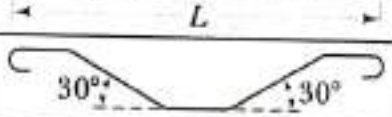
$= 58d$ (for M.S. bars)

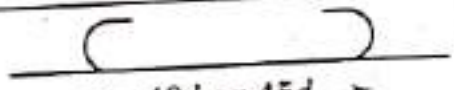
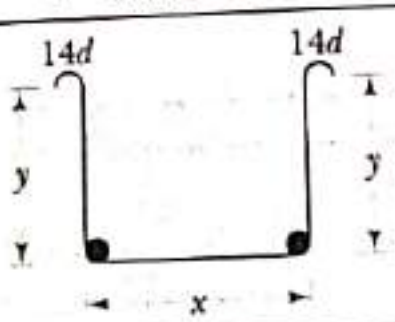
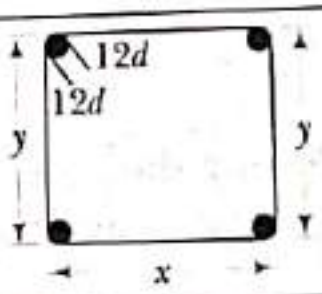
$= 68.5d$ (for HYSD bars)

For bars in compression, extra length $= 45d$.

Table 9-2 shows tabular form of all types of hooks, bent-up bars and stirrups.

TABLE 9-2

No.	Type of bar	Sketch	Hook length	Total length of bar
1.	Straight bar		$9d + 9d = 18d$	$l + 18d$
2.	One side bent-up x = Effective depth		$9d + 9d = 18d$	$l + 18d + 0.45x$
			$9d + 9d = 18d$	$l + 18d + 0.30x$
			$9d + 9d = 18d$	$l + 18d + 0.60x$
3.	90° bent-up		$6d$	$l + 6d$
4.	Both side bent-up		$9d + 9d = 18d$	$l + 18d + 2 \times 0.45x$
			$9d + 9d = 18d$	$l + 18d + 2 \times 0.30x$
			$9d + 9d = 18d$	$l + 18d + 2 \times 0.60x$

No.	Type of bar	Sketch	Hook length	Total length of bar
5.	Over lapping		$9d + 9d = 18d$	(40d or 50d) + 18d
6.	One-legged stirrup		$14d + 14d = 28d$	$x + 2y + 28d$
7.	Two-legged stirrup		$12d + 12d = 24d$	$2(x + y) + 24d$

Note: (i) Here d: diameter of bar or stirrup.

Problems:-

(1) Work out the quantities of steel of Rcc beam used over a clear span of 5.5m. The walls supporting the beam are 450mm and the beam has 300mm bearing over the wall on both sides. The size of beam 250mm x 550mm Concrete Covers at the Ends of ~~beam~~ bars and sides is 40mm & top & bottom is 30mm Each.

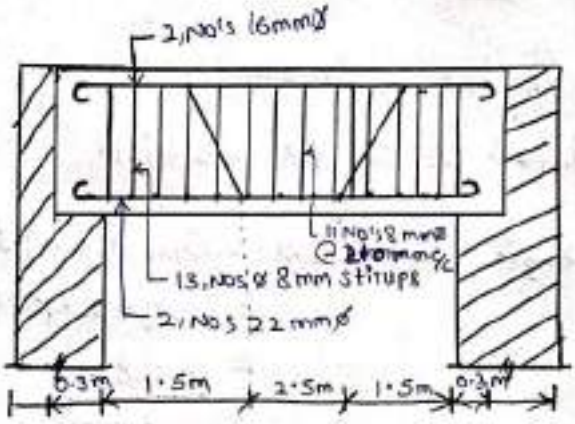
(i) main Reinforcement @ bottom - 1, 4 ; 22mm - 2 No's

(ii) main bent up bars 2, 3 ; 22mmϕ - 2 No's

(iii) Top bars 5, 6 ; 16mmϕ - 2 No's

(iv) Stirrup - 8mmϕ @ both end 1.5m, 150mm c/c - 2 No's
- 16mmϕ @ middle 2.5m, @ 10mm c/c - 2 No's

Sol:-



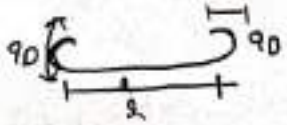
Sol:- (1) Main Straight bars:-

Length of the bar = clear span + bearing - End covers

$= 5.5 + 2 \times (0.3) - (2 \times 0.04)$

$= 6.02\ m$

$= \underline{6020\ mm}$



$\therefore$ Total length of bar = length of bars + 2 hooks

$= 6020 + 2 \times 9\phi$

$= 6020 + 2 \times (0.022) \times 9$

$= 6.416\ m$

$= \underline{6416\ mm}$

(2). Main Bent-up bars:-

Length of the bar = 6.02 m

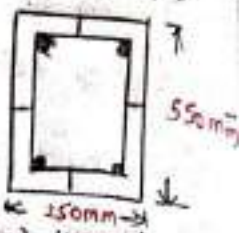
Total length of the bar = length of the bar + 2×hooks + 2×cranks

= 6.02 + (2×9×(0.022) + 2×(0.42d)

d = depth of beam - (top & bottom cover + dia of bar)

= 550 - (2×30) + 22

= 468mm = 0.468 m



Total length of bar = 6.02 + (2×9×(0.022) + 2×(0.42×0.468)

= 6.8091 m

(3). Distribution bars:-

length of bar = 6.02 m

Main bar Total length of the bar = 6.416 m

Distribution Total length of the bar = 6.02 + 2×9ø

= 6.02 + 2×9×(0.016)

= 6.308 m

= 6308 mm

(4) Stirrups:-

(i) length of stirrup = 2×[(B)+(D)] - (2×cover) - (2×side cover) + 2×12ø (top 2ø)

= 2×[250+550] - (2×30) - (2×40) + (2×12×8)

= 2×660 + 192

= 1.512 m

= 1512 mm

No of stirrups at one end = (1500/150) + 1

= 11 No's

No of stirrups at other end = (1500/150) + 1 = 11 No's

No of stirrups @ middle = $(2500/210) - 1$

$= 10.904 \simeq 11$ NO's

Total no's of stirrups = 11 + 11 + 11 = 33 NO's

Schedule of bars for RCC Beams :-

SNo	Description of bars	Shape of Bending Dimension in m	Dia (mm)	NO	Length (m)	Total length in (m)	Weight (Kg/m) $(\frac{D^2}{162.2})$	Total (Kgs)
1)	main straight		22	2	6.416	2×6.416 = 12.832	2.98	12.832×2.98 = 38.23
2)	main bent-up		22	2	6.809	2×6.809 = 13.618	2.98	13.618×2.98 = 40.586
3)	Distribution bars		16	2	6.308	2×6.308 = 12.616	1.58	12.616×1.58 = 19.933
4)	Stirrups		8	33	1.512	(33×1.512) = 49.896	0.39	49.896×0.39 = 19.459
								118.204

Density of steel = 7850 Kg/m3

= 7.85 quintal/m3

Density = mass/volume = $\rho = \frac{M}{V}$

Mass in Kg's = density of steel × volume of steel

$.785 \times V = m$

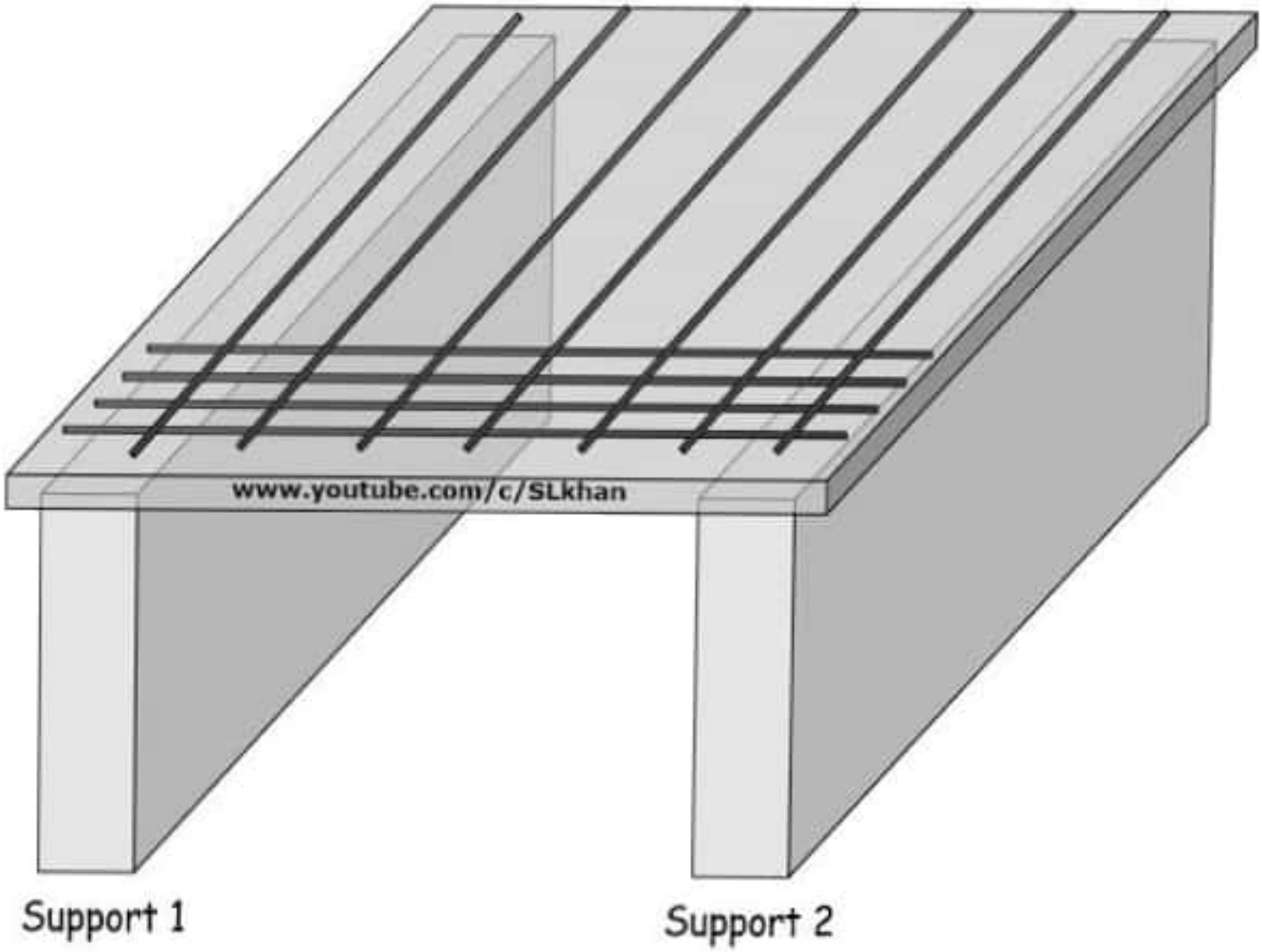
$V = \pi/4 \times d^2 \times L = \pi/4 \times (.022)^2 \times 12.832$

$0.004877 m^3$

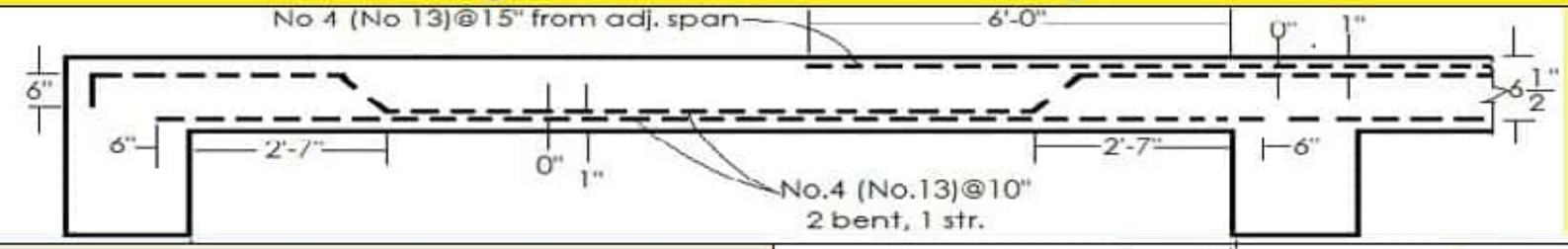
$m = 7.85 \times 0.0048 = 7.85 \times 0.0048$

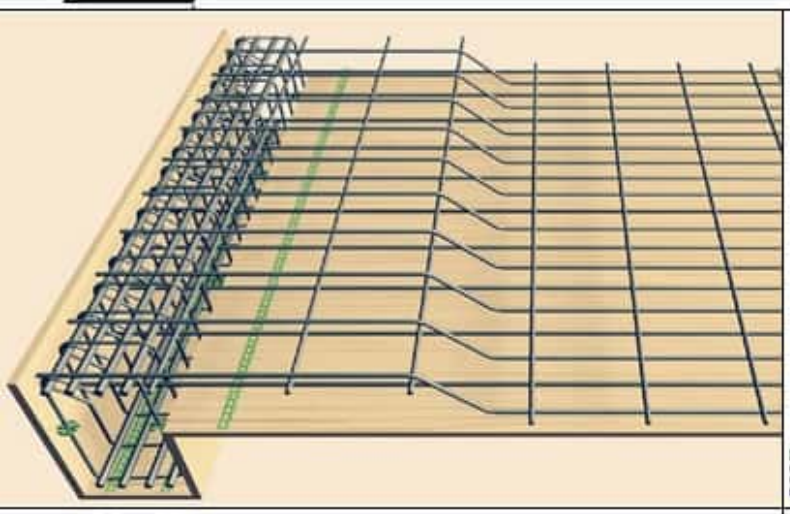
0.0382844 Kg

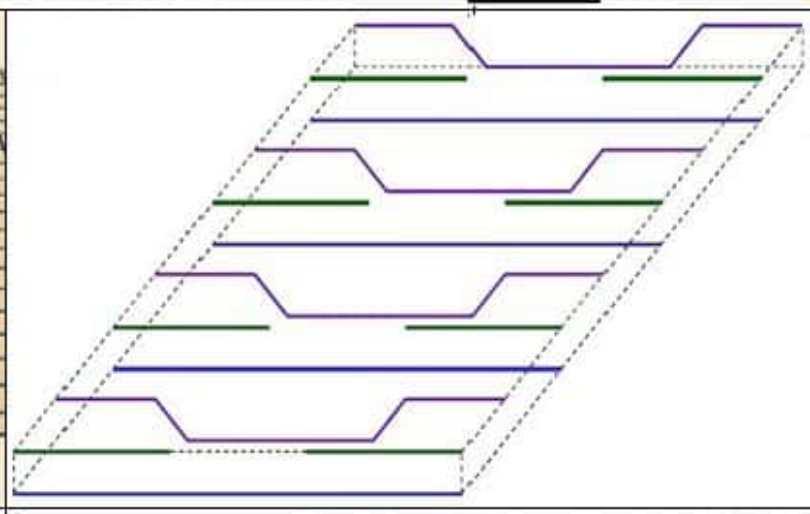
One-Way Slab

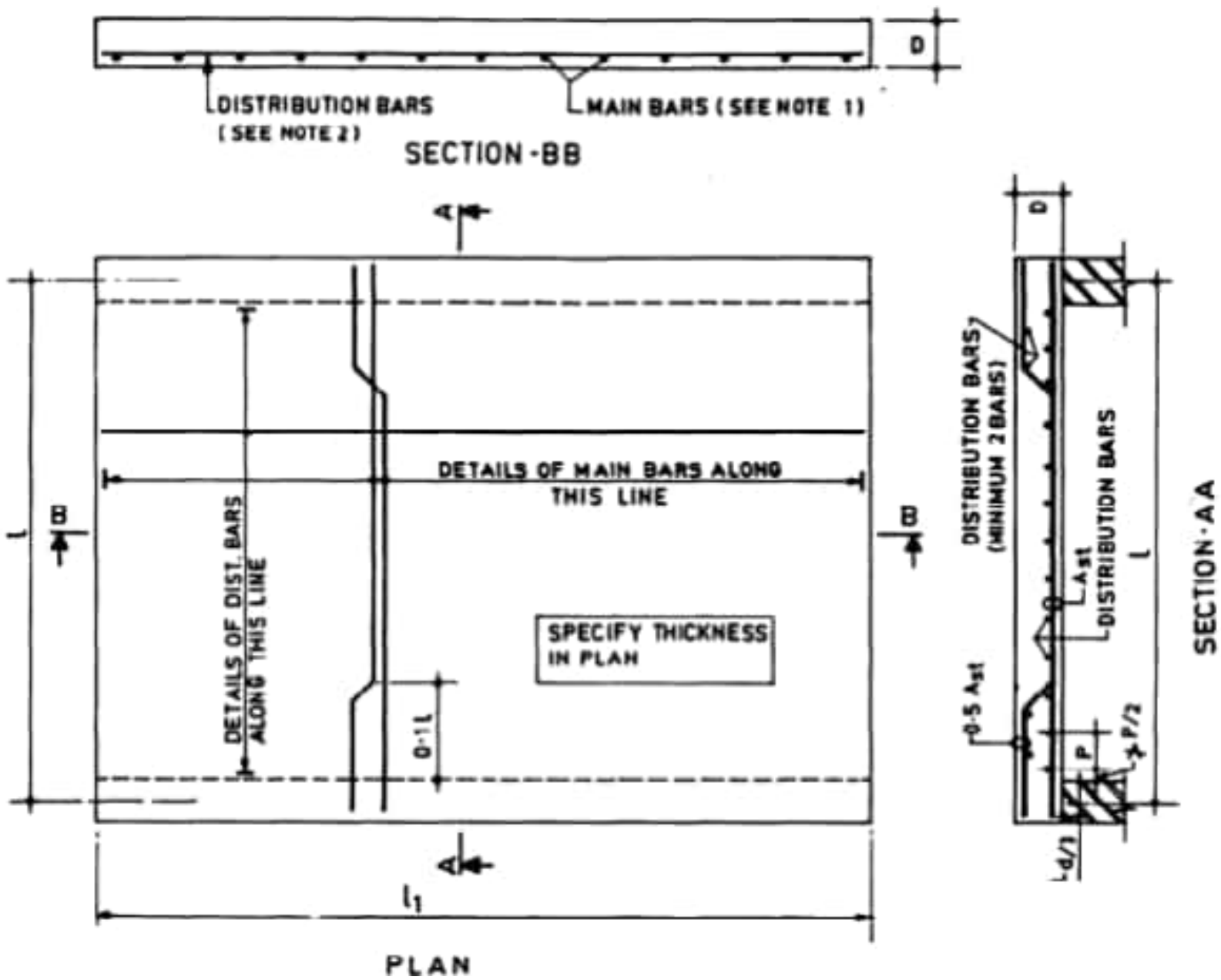


Design Of One Way Slab









Rcc slab Roof :-

2). prepare the detailed estimate of Rcc roof slab 3m clear span and 6.6m long. prepare bar bending schedule of steel.

(1). main Reinforcement 10mm ø @ 120mm c/c

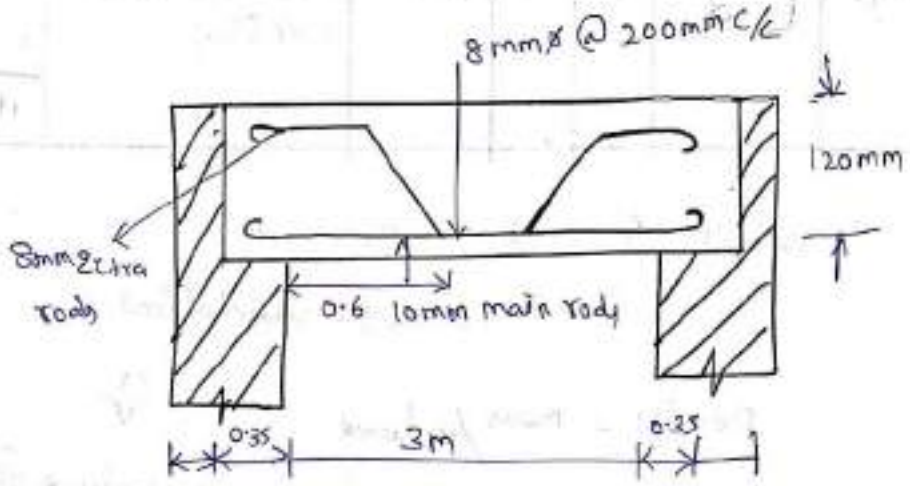
(2). Distribution steel 8 mm dia @ 200mm c/c

(3). The slab is to be rest over the Entire width of the wall on four sides.

(3). main Reinforcement 10mm ø Bars @ 120 mm c/c alternate rods bent up @ 1/5 th span at both sides.

(4). Distribution reinforcement 8mm dia Bars at 200mm c/c at Bottom.

(5). Extra reinforcement @ bent up portion 8mm ø . 4 no's on Each side.



Sol:- Given data

Short span = 3m

long span = 6.6m

main Straight = 10mm ø @ 120mm c/c

main bent-up = 10mm ø @ 120mm c/c

Distribution bars = 8 mm ø @ 200 mm c/c

(1). Main Reinforcement Straight bar?-

Assume = 40mm cover

length of the straight bar = clear span + 2 x bearing - (2 x cover)

= 3 + 2 x 0.35 - (2 x 0.04)

= 3.62 m

Total length of the straight bar = length of the straight bar + 2 x hooks

= 3.62 + 2 x 9Ø

= 3.62 + 2 x 9 x 0.01

= 3.880m

(2). main reinforcement cranked bar?-

length of bar = 3.62

Total length of the bar = length of the bar + 2 x hooks + 2 x cranks

= 3.62 + 2 x 9 x 0.01 + 2 x 0.42d

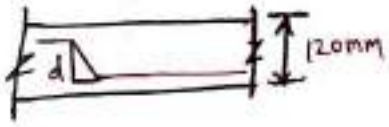
= 3.62 + 2 x 9 x 0.01 + 2 x 0.42

d = depth of beam - cover

= 120 - (2 x 20) - 10

= 70mm = 0.07m

Assume = tape bottom
Cover = 20mm



Total length of bar = 3.62 + 2 x 9 x 0.01 + 2 x 0.42 x 0.07

= 3.858m

(3). Distribution reinforcement?-

length of distributed bar = 6.6 + 2 x bearing + 2 x hook - 2 x cover

= clear span + 2 x bearing + 2 x hook - 2 x cover

= 6.6 + (2 x 0.35) + 2 x 9 x 0.008 - (2 x 0.04)

Length of distribution bar = 7.364 m

4) Tie bars :-

Length of the tie bars = 7.364 m

Calculation of numbers of bars :-

→ On longer span = $\left[\frac{\text{(clear span for long + 2x bearing - (2x cover)}}{120\text{ mm c/c}} + 1\right]$

$= \left[\frac{[6.6 + 2\times0.35 - (2\times0.04)]}{0.120}\right] + 1$

= 61 No's

Main straight bar = 31

Main cranked bar = 30

→ On shorter direction = $\left[\frac{(3 + 2\times\text{bearing} - (2\times\text{cover}))}{200\text{ c/c}} + 1\right]$

$= \left[\frac{(3+2\times0.35 - (2\times0.04))}{0.20}\right] + 1$

= 19 bars

Additional tie bars = 8 no's

Schedule of bar for RCC Roof slab:-

S.No	Description bar	Shape of Bending in mm	Dia	No	length in m	Total length in m	weight (Kg/m)	Total Kgs
1.	Main Straight Bar		10	31	3.8	(31×3.8) = 117.8	0.616	(0.616 × 117.81 = 72.564
2.	Main Bent-up Bar		10	30	3.858	(30×3.858) = 115.74	0.616	(0.616×115.7 = 71.295
3.	Distribution bar		8	19	7.364	(19×7.364) = 139.916	0.394	(0.394×139.9 = 55.1269
4.	Extra Reinforcement		8	8	7.364	(8×7.364) = 58.912	0.394	(0.394×58.9 = 23.2113
							Total	267.442

Density of steel bar = 78.5 Quintal /m³

= 7850 Kg/m³

Density = mass / volume

Volume = $\frac{\Pi}{4} \times d^2 \times L$

= $\frac{\Pi}{4} \times (0.010)^2 \times 1$

= 0.000078

mass = Density × volume

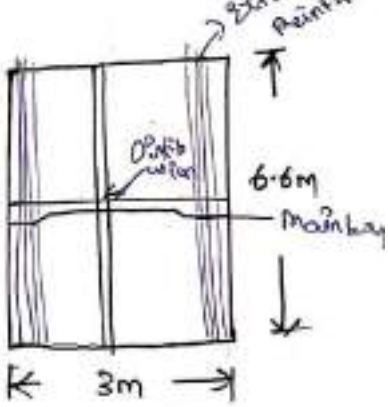
= 78.5 × 0.00098

= 0.0061 Quintal

mass = 7850 × 0.00098

= 0.612 Kg (per m)

Per 1 meter length



(1) main straight Bar = Density = mass/volume

Mass = 7850 × 0.0092

= 72.22 Kgs

(2) Similarly calculated remaining item of works same procedu

Rcc Lintel:-

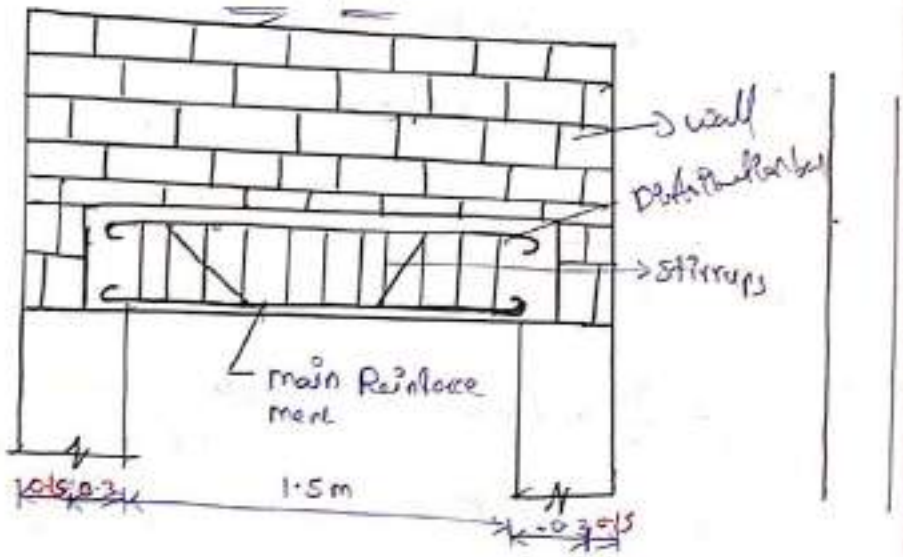
4). Work out the quantities of concrete and Reinforcement for Lintel. The lintel is used for a clear span of 1.5m and has bearing of 300mm on the walls on either side. The lintel has the following reinforcement size 450 x 150 mm.

(1) 12mm ø of 2 no's and 2 no's cranck @ 1/5 th of clear span on both sides

(2). 10mm ø Anchor bars 2 no's on top

(3). 6mm ø stirrups @ 15 no's c/c through on the lintel.

Rcc lintel



Sol:- Given data

Clear span = 1.5 m

bearing = 300 mm = 0.3 m

b = 450 mm = 0.45 m

d = 150 mm = 0.150 m

Assume all side of cover = 25 mm

(1): Main Reinforcement Bars?-

$\phi = 12mm$

main straight bar length 'L' = clear span + 2 x bearing - (2 x cover) + 2 x hook

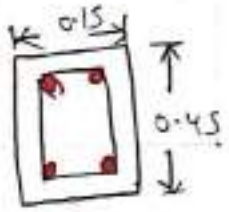
$L = 1.5 + 2 \times 0.3 - (2 \times 0.025) + 2 \times 9 \times 0.012$

$= 2.266m$

(2): Main Bent-up bars?-

$\phi = 12mm$

main cranked bar length 'L' = $1.5 + 2 \times 0.3 - (2 \times 0.025) + 2 \times 9\phi + 2 \times 0.42d$



$d = D.450 - (2 \times 0.025) - (0.012)$

$= 0.388m$

$L = 1.5 + 2 \times 0.3 - (2 \times 0.025) + 2 \times 9 \times 0.012 + 2 \times 0.42 \times 0.388$

$= 2.591m$

(3) Distribution bars?-

$\phi = 10mm = 0.01m$

Length of bar = $1.5 + 2 \times 0.3 - (2 \times 0.025) + 2 \times 9 \times \phi$

$= 1.5 + 2 \times 0.3 - (2 \times 0.025) + 2 \times 9 \times 0.010$

$= 2.230m$

(4) Stirrups?-

$\phi = 0.006m = 6mm$

length of the stirrup = $2(A+B) - (4 \times cover) + 2 \times 12\phi$

$= 2(0.450 + 0.150) - (4 \times 0.025) + 2 \times 12 \times 0.006$

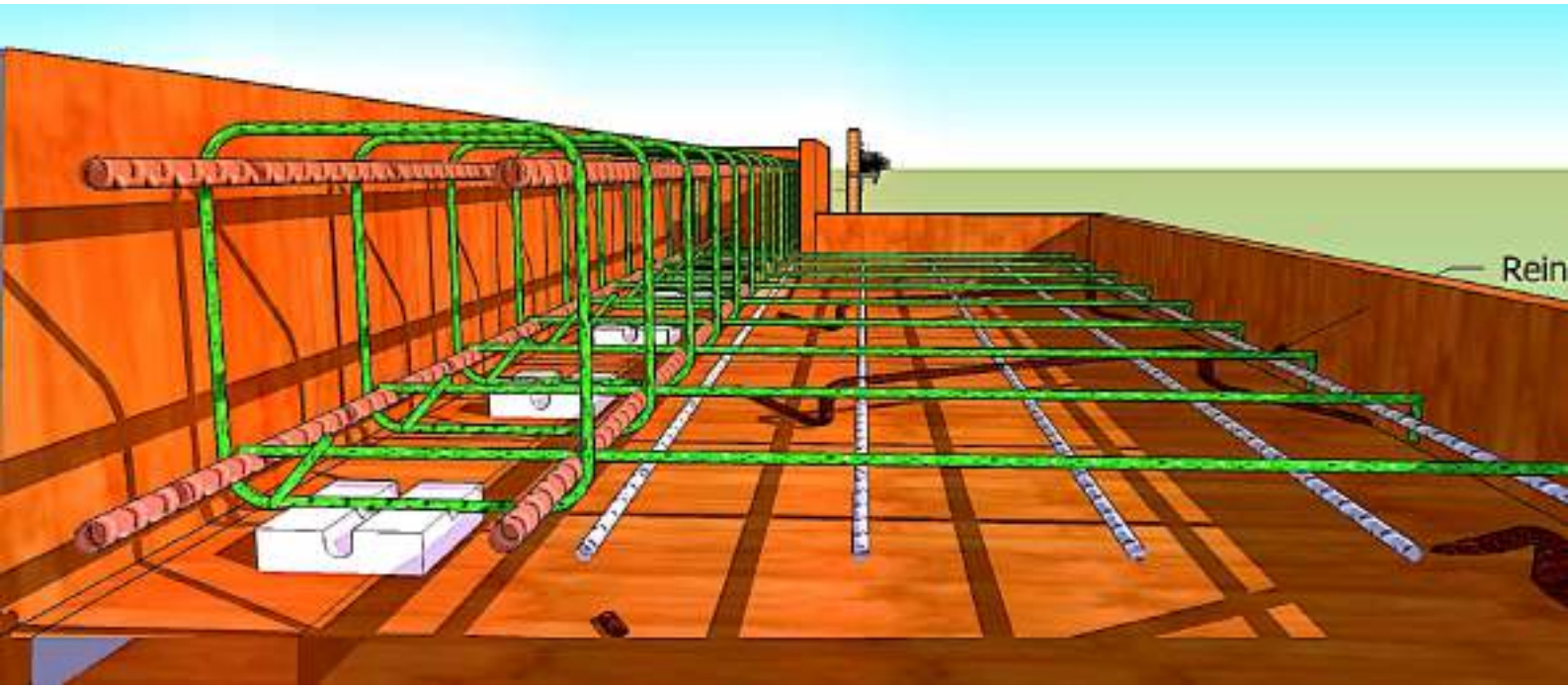
$= 1.244m$

Schedule of bar for Rcc lintel :-

S.No	Description bars	Shape of Bending in mm	Dia	NO	length in m	Total length in m	weight kg/m	Total kg
1.	main Straight bars		12	2	2.266	(2x2.266) =4.532	0.89	(0.89x4.532) = 4.033
2.	main bent-up bars		12	2	2.591	(2x2.591) =5.182	0.89	(0.89x5.182) = 4.6119
3.	Distribution bar		10	2	2.230	(2x2.230) =4.46	0.617	(0.617x4.46) = 2.751
4	Stirrups		6	15	1.244	(15x1.244) =18.66	0.22	(0.22x18.66) = 4.105
							Total	15.500

Density of steed = 7850 kg/m3 or 78.50 quintal/m3

mass = Density x volume



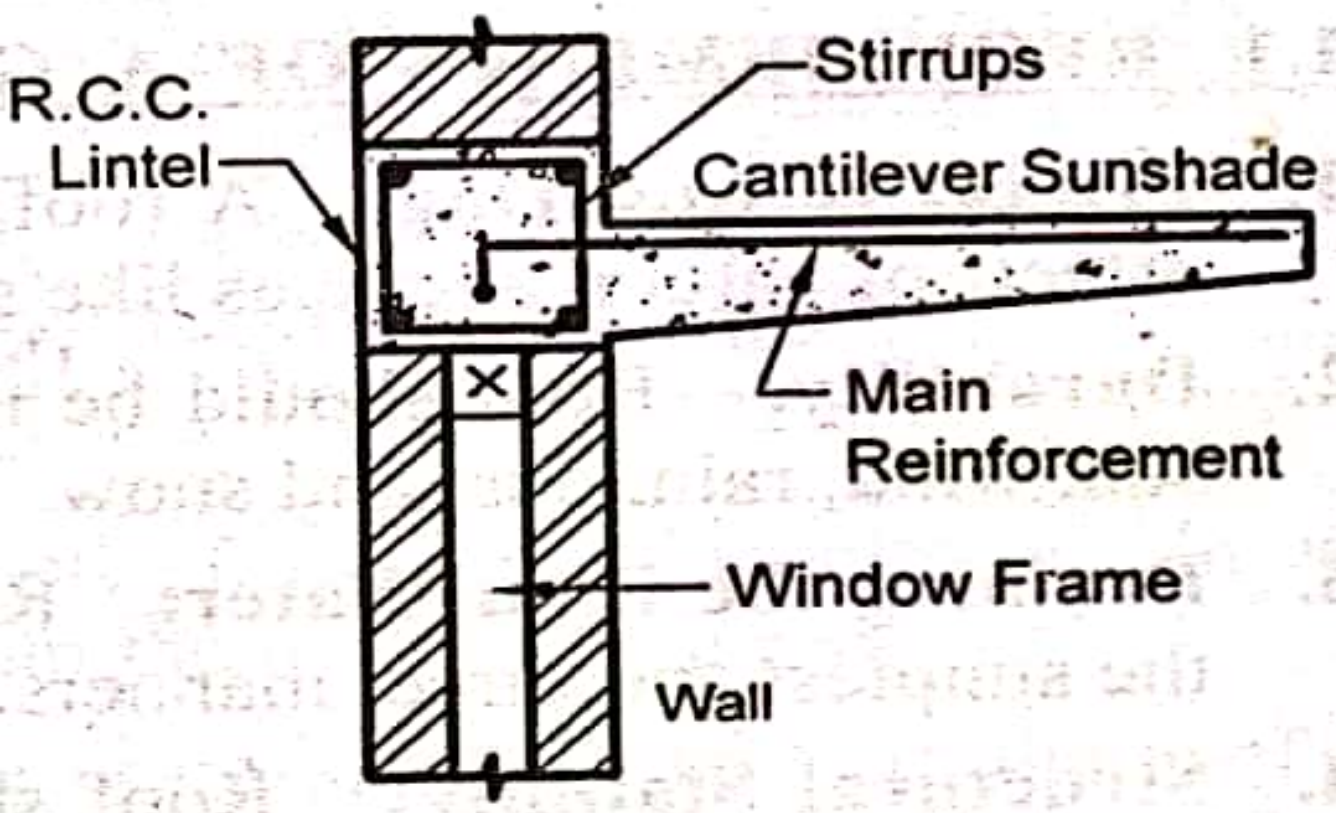
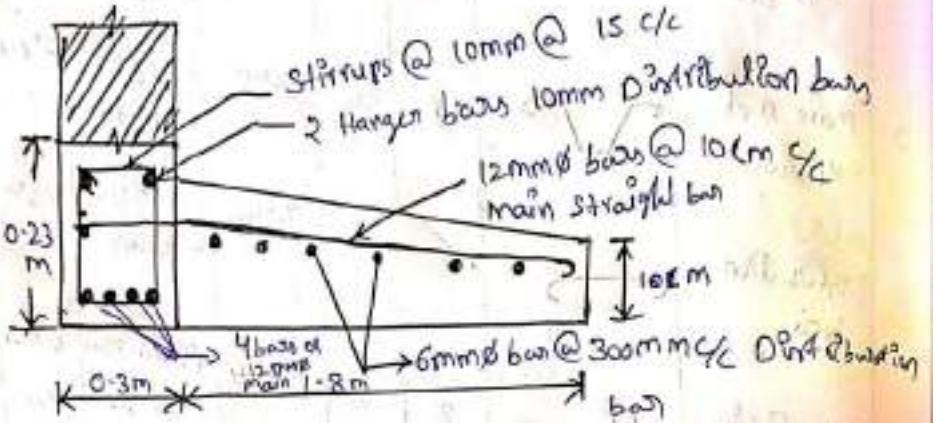


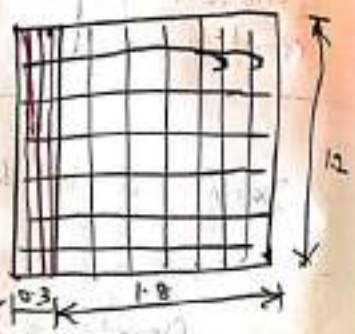
FIG. 4

LINTEL OVER
EXTERIOR WINDOW OPENING

RCC Lintel & sunshade's-

3). Calculate the quantity of steel reinforcement by preparing bar bending schedule for a RCC (1:5:3) lintel & cum sun-shade as given below. The span of lintel as 1.2m and bearing over the supports is 0.3m.





Sol:- Given Data

b = 300mm d = 230mm

Clear span = 1800 = 1.8m

Bearing = 300mm = 0.3m

Assume cover sides on both = 25mm

Stirrups 10mm ISEC/c

main 12mmØ bars @ 10mm c/c

Span of lintel = 1.2m

(1) Main Reinforcement bars in Sunshade:-

length of straight bar = Clear span + bearing + (hook length) - (cover on both sides)

= 1.8 + 0.30 + 9Ø - (2×0.025)

= 1.8 + 0.30 - (2×0.025) + 9×(0.012)

= 2.158m

No of straight main bars = $\frac{\text{length of lintel} - (2 \times \text{cover})}{\text{spacing}} + 1$

$= \frac{1.2 - (2 \times 0.025)}{0.1} + 1$

$= 11.5 + 1 = 12.5$

= 13 Nos of bars

(2) Distribution bars in sunshade:-

$\phi = 6\text{mm}$

Length of bar = $1.2 + 2 \times 9\phi - (2 \times \text{cover})$

= Length of lintel + 2 x hooks $- (2 \times \text{cover})$

$= 1.2 + 2 \times 9 \times 0.006 - (2 \times 0.025)$

$= 1.2 + 2 \times 9 \times 0.006 - (2 \times 0.025)$

= 1.258 m

No of distribution bars = $\frac{\text{span} + \text{bx bearings} - (2 \times \text{cover})}{\text{spacing}} + 1$

$= \frac{18 + 0.3 - (2 \times 0.025)}{0.3} + 1$

$= 6.83 + 1 = 7.83$

= 8 Nos of bars

(3) Lintel:-

Length of main bar = $1.2 + (2 \times 9\phi) - (2 \times \text{cover})$

$= 1.2 + (2 \times 9 \times 0.012) - (2 \times 0.025)$

= 1.366 m

Length of distribution bars = $1.2 + (2 \times 9 \times 0.01) - (2 \times 0.025)$

= 1.33 m

$= 1.33m$ $\phi = 10mm$

length of stirrup $= 2(230+1300) - (4\times25) + (2\times12\phi)$

$= 2(230+1300) - (4\times25) + (2\times12\times8)$

$= 1200mm$

$= 1.2m$

No of stirrups $= \frac{(1.2 - (2\times0.025)}{0.150} + 1$

$= 8.667$

$= 9$ No's of bars

Schedule of Bar for Rcc lintel cum sunshade:

S.No	Description of bar	Shape of Bending in mm	Dia	NO	length in m	Total length in m	weight kg/m	Total Kgs
1	Main Straight bar in sunshade		12	13	2.158	(13×2.158) = 28.054	0.89	(28.054×0.89) = 24.96kgs
2	Distribution in sunshade		6	8	1.258	(8×1.258) = 10.064	0.22	(10.064×0.22) = 2.214 kgs
3	main bar in lintel		12	4	1.366	(1.366×4) = 5.464	0.89	(0.89×5.464) = 4.86kgs
4	Distribution bar in lintel		10	2	1.33	(1.33×2) 2.66	0.617	(0.617×2.61) = 1.641kgs
5	Stirrups in lintel		10	9	1.2	(1.2×9) 10.8	0.617	(0.617×10.8) = 6.663kgs
							Total	40.337kgs

Density of steel = mass / Volume

Mass = Density × volume

$V_1 = \frac{\pi}{4} \times d^2 \times L$

$= \frac{\pi}{4} \times (0.012)^2 \times 28.054$

$= 0.00031 = 0.00317\ m^3$

$M_1 = \text{Density} \times V_1$

$= 7850 \times 0.00317$

$= 24.884\ \text{kgs}$

$M_2 = D \times V_2$

$V_2 = \frac{\pi}{4} \times (0.006)^2 \times 10.064$

$= 0.00028\ m^3$

$M_2 = 7850 \times 0.00028$

$= 2.198\ \text{kgs}$

$M_3 = D \times V_3$

$= \frac{\pi}{4} \times (0.012)^2 \times 5.464$

$= 0.00061\ m^3$

$M_3 = 7850 \times 0.00061$

$= 4.788\ \text{kgs}$

$M_4 = D \times V_4$

$V_4 = \frac{\pi}{4} \times (0.010)^2 \times 2.66$

$= 0.000208\ m^3$

$M_4 = 7850 \times 0.000208$

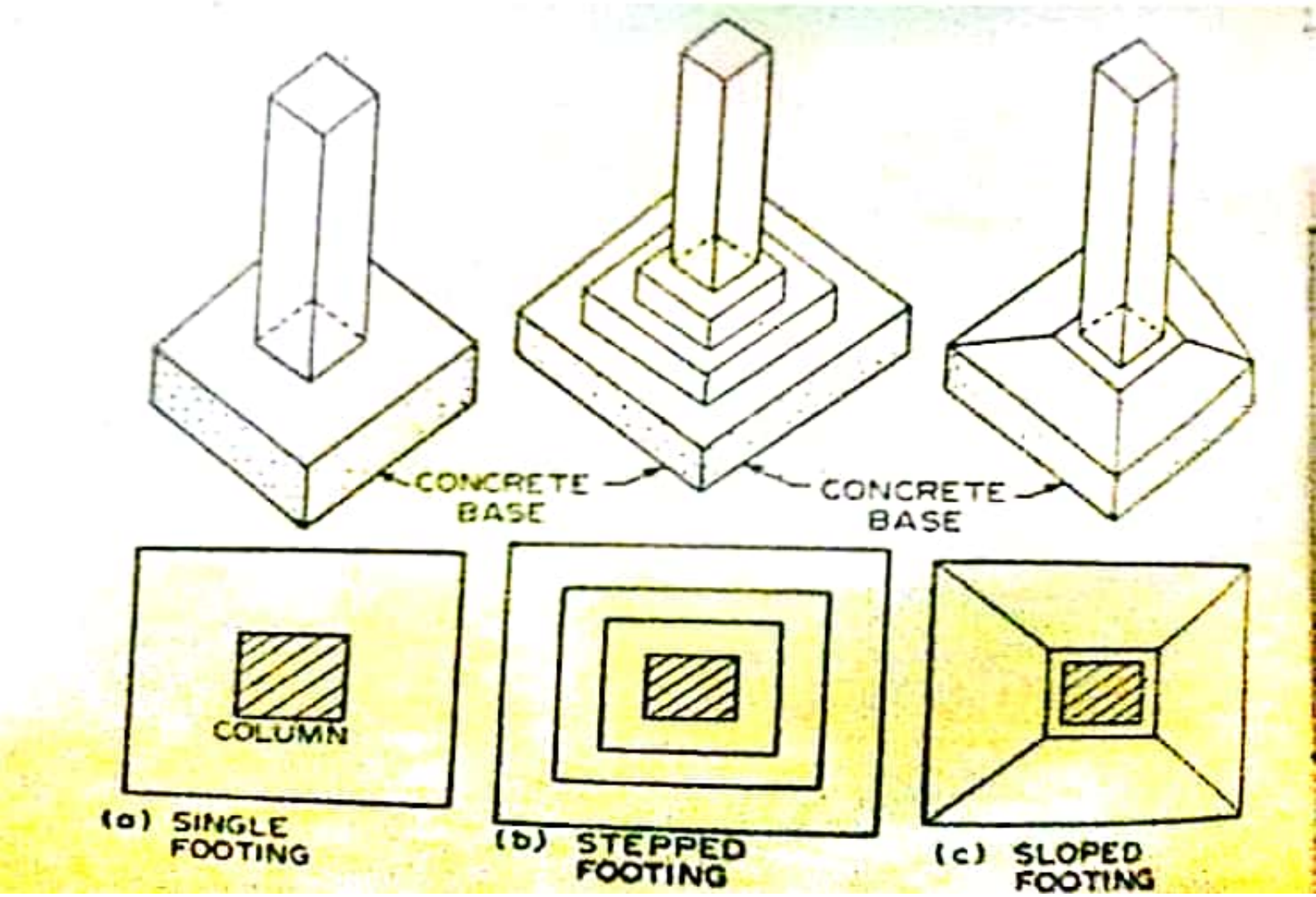
$= 1.57\ \text{kgs}$

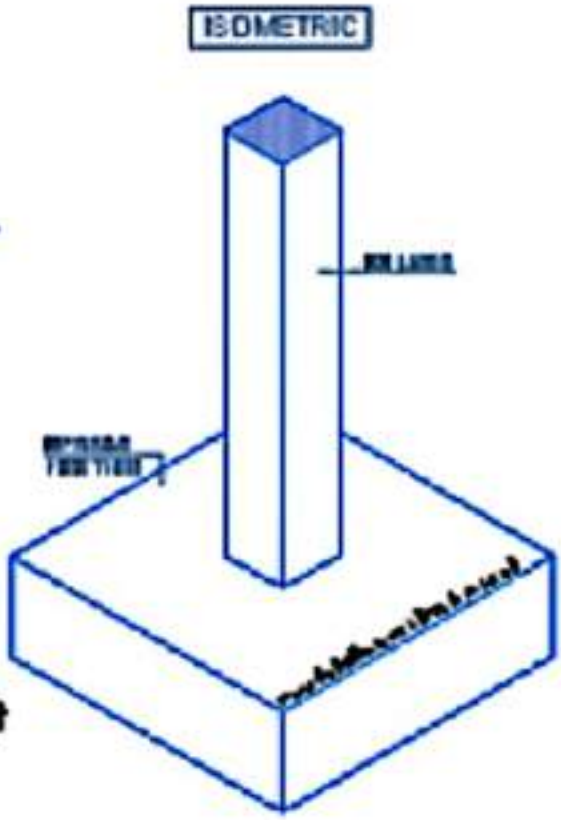
$M_5 = D \times V_5$

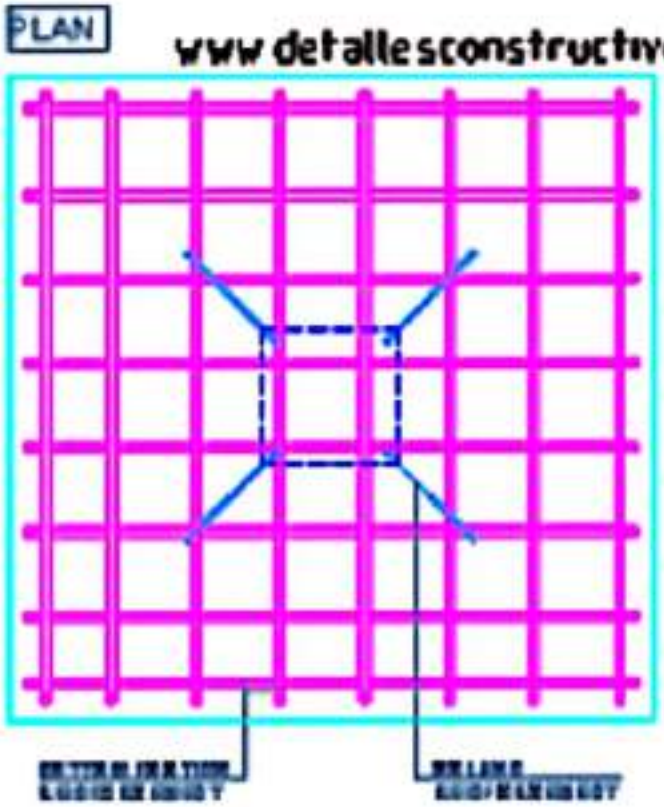
$V_5 = \pi/4 \times (0.010)^2 \times 10.8$

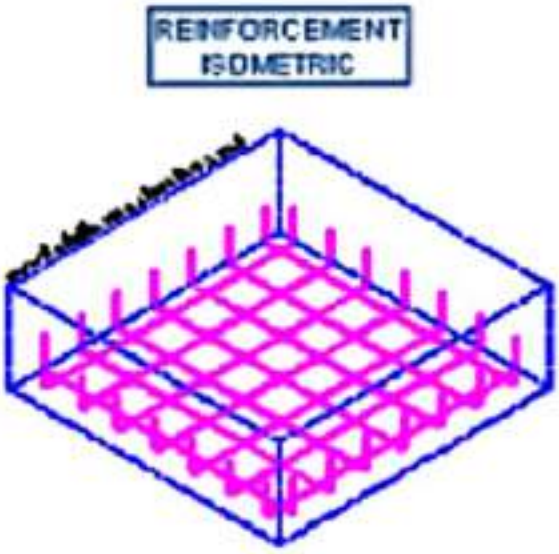
$= 0.00084 \Rightarrow M = 7850 \times 0.0084 = 6.594\ \text{kgs}$

Spread footings for columns









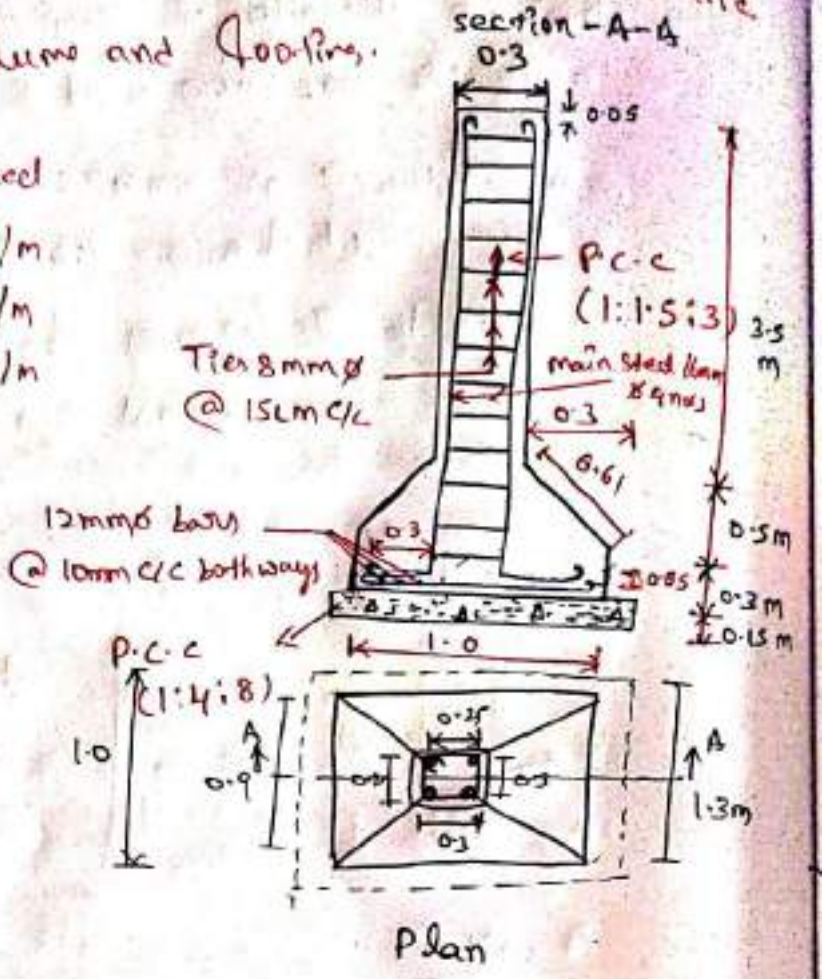
6). Work out the quantities of Concrete and Reinforcement for RCC footing. Show the figure of plan and section of column and footing.

Weight of steel

8mmø = 0.39 kg/m

12mmø = 0.89 kg/m

16mmø = 1.58 kg/m



Sol:- (1): Column:-

Main longitudinal bar = length of straight bar + development length + hook length − cover on both edges

= (3.5+0.5+0.3) + (0.3) + (2×9×0.016) − (8×0.05+0.05+0.05)

= 4.738 m

(2). Footing mat:-

= length of bar + hook length − cover on both sides

Straight bar = 1.0 + 2×9×ø − (2×cover)

= 1.00 + 2×9×0.012 − (2×0.05)

= 1.116 m

No of bars = (Effective length) / Spacing + 1

$$= \frac{(1.0 - 2\times0.05)}{0.1} + 1$$

$$= 10 \text{ No's}$$

(3). Stirrups:-

Length of stirrups = length of 4 sides − (cover on 4 sides) + (hook length).

$$= (0.3\times4) - (4\times0.05) + (2\times12\times0.008)$$

$$= 1.192\text{m}$$

$$\text{No of stirrups} = \frac{(3.5+0.5+0.3) - (0.05\times0.05\times0.005)}{0.150} + 1$$

$$= 27.66 + 1 = 28.66 \simeq 29$$

$$= 29 \text{ bars No's}$$

Sno	Description	Shape of Bending in mm	Dia	No	length	Total length	Weight (Kg/m)	Total (Kgs)
1	Main longitudinal bars		16	4	4.738	4×4.738 = 18.952	1.58	(18.952×1.58) = 29.944
2	Bottom Straight bar		12	10	1.116	10×1.116 = 11.16	0.89	(11.16×0.89) = 9.932
3	Stirrups		8	29	1.192	29×1.192 = 34.568	0.39	(34.568×0.39) = 13.48152

Density = 7850 kg/m or 78.50 Quintal/m3

Mass = Density × volume

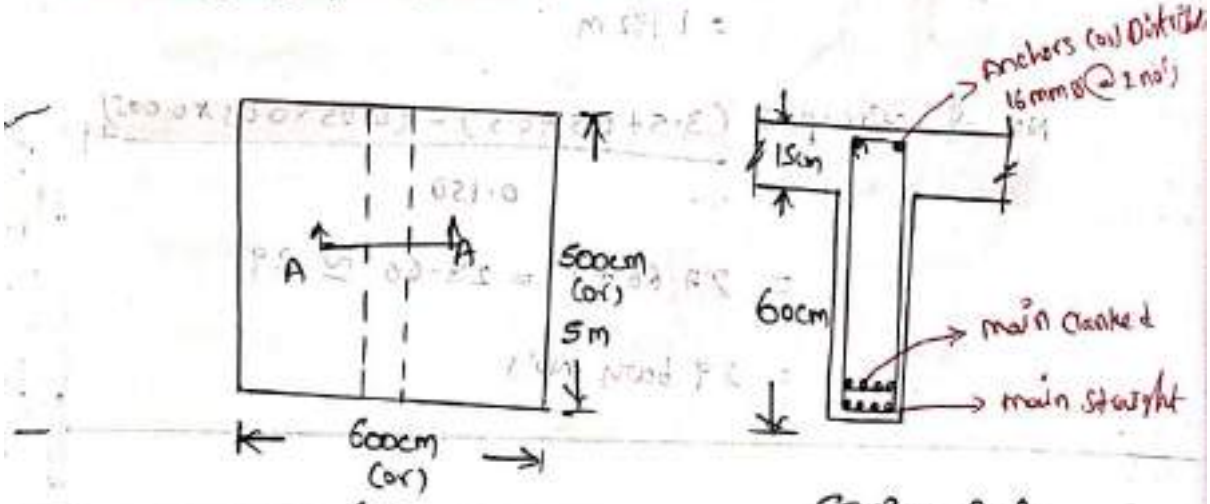
$M_1 = 7850\times0.0038 = 29.912$ Kgs, $M_2 = 7850\times0.0012 = 9.908$ Kgs, $M_3 = 7850\times0.0017 = 13.345$ Kgs

7). A Room 600cm long and 500cm wide has a flat roof. There T-Beam. In the centre (c/s below the Slab 30cm×50cm) and the slab thick. Estimate the quantity of Iron bars reqiure for reinforcement T-beam only) from the given data.

→ Main bars - 8 no's, 25mmø in 2 rows of 4 Each [all 4 in the being straight and other bent).

→ Stirrups - 10mmø and 15cm c/c through out.

→ Anchor bars - 2 No's 16mmø



Sol:- (1) main straight bars:-

Length of straight bar = Span + [2 × hook] - [2 × cover]

= 5 + [2 × 9ø] - [2 × 0.025]

Assume clear cover = 25 mm = 0.025 m

bar are bent @ 45°

= 5 + [2 × 9 × 0.025] - [2 × 0.025]

= 5.45 m

(2): main bent up bars:-

length of bent up bar = span + (hook length) + (anchor

length) + (2×cover)

$= 5000 + (2\times9\times25) + (2\times0.42d) - (2\times25)$

$d = (0.15+0.6) - (2\times0.025) - (0.025) - (0.025)$

$= 0.650\,m$

$= 5 + (2\times9\times0.025) + (2\times0.42\times0.650) - (0.025) - (0.025)$

$= 5.94\,m$

(3) Anchor bar or top bar or hanger bar :-

"length of the top bar = Span + (hook length) − (covers)

$= 5 + (2\times9\times\phi) - (2\times\text{cover})$

$= 5 + (2\times9\times0.016) - (2\times0.025)$

$= 5.238\,m$

(4) Stirrups :-

length of the stirrup bar $= 2\times[A+B] - [4\times\text{cover}) + (2\times12\phi)$

$= 2\times[0.750+0.30] - [4\times0.025) + (2\times12\times0.010)$

$= 2.24\,m$

No of stirrups $= \frac{(5-(2\times0.025)}{0.15} + 1 = 34$ Nos

Schedule of Bar for RCC Beam-T :-

Sno	Description	Dia	NO	length	Total length	weight	Total weight	Shape of Bends in mm
1	main straight bar	25	4	5.4	(4×5.4) = 21.6	3.85	21.6×3.85 = 83.16	
2	main cranked bar	25	4	5.94	(4×5.94) = 23.76	3.85	23.76×3.85 = 91.47	
3	Hanger or top bar	16	2	5.238	(2×5.238) = 10.476	1.58	10.476×1.58 = 16.55	
4	Stirrups	10	34	2.24	(34×2.24) = 76.16	0.617	76.16×0.617 = 46.972	

Density of steel = 7850 kg/m3 or = 78.50 quintal/m3

Mass = density × volume

$V_1 = 0.010\,m^3$, $V_2 = 0.011\,m^3$

$V_3 = 0.0021\,m^3$, $V_4 = 0.0059\,m^3$

$M_1 = 7850\times0.010 = 78.5\,m3$

$M_2 = 7850\times0.011 = 86.35\,m3$

$M_3 = 7850\times0.0021 = 16.485\,m3$

$M_4 = 7850\times0.0059 = 46.315\,m3$

UNIT - 4
CONTRACTS AND TENDERS

INTRODUCTION:

- A contract is a legally binding document that recognizes and governs the rights and duties of the parties to the agreement.
- A contract is legally enforceable because it meets the requirements and approval of the law.
- A contract typically involves the exchange of goods, service, money, or promise of any of those.
- An agreement between two private parties that creates mutual legal obligations.
- A contract can be either oral or written.
- Contract, in the simplest definition, a promise enforceable by law.
- A voluntary, deliberate, and legally binding agreement between two or more competent parties.

CONTRACTOR:

- A person or a firm who undertakes any type of contract.
- Contractor means private individuals partnership firm, public or private limited concerns who have made such an undertaking for concerned therewith with the respective govt. the execution of works or supply of materials or for services.
- A general contractor is responsible for providing all of the material, labor, equipment (such as engineering vehicles and tools) and services necessary for the construction of the project.
- A general contractor often hires specialized subcontractors to perform all or portions of the construction work.

ARRANGING CONTRACTOR:

- ✓ Contract for a work is arranged by inviting sealed tenders, by issuing tender notices.
- An agreement
- Between two or more parties
- Recognized by law
- Enforceable through the courts.

TYPES OF CONTRACTS:

- Lump sum contract
- Lump sum and schedule contract
- Schedule contracts or Item Rate contract
- Labour contract
- Target contract
- Materials supply contract
- Piece-Work agreement
- Cost Reimbursement Contracts
    - Cost plus fixed fee contract
    - Cost plus percentage contract
    - Cost plus fluctuating fee contract
    - Percentage rate contract

LUMP SUM CONTRACT:

- ✓ A lump-sum contract is normally used in the construction industry to reduce design and contract administration costs.
- ✓ It is called a lump-sum because the contractor is required to submit a total and global price instead of bidding on individual items.
- ✓ A lump-sum contract is the most recognized agreement form on simple and small projects and projects with a well-defined scope or construction projects where the risk of different site conditions is minimal.
- ✓ Also known as a fixed-price contract.
- ✓ This type of contract is often used in the construction field to decrease the costs of contract administration.
- ✓ It's the most common agreement form for both small and simple projects.
- ✓ It tends to be used where a project is already well-defined in responsibilities and scopes for the parties.
- ✓ There also is little chance for a change, so the owner needs to have specifications and drawings that are complete.

Advantages:

- ✓ Low risk to the owner.
- ✓ 'Fixed' construction cost and Minimize change orders
- ✓ Owner supervision is reduced when compared to Time and Material Contract.

- ✓ The contractor will try to complete the project faster.
- ✓ Accepted widely as a contracting method.
- ✓ Bidding analysis and selection process is relatively easy.
- ✓ The contractor will maximize its production and performance.

Disadvantages:

- ✓ It presents the highest risk to the contractor.
- ✓ Changes are difficult to quantify.
- ✓ The Owner might reject change order requests.
- ✓ The project needs to be designed completely before the commencement of activities.
- ✓ The construction progress could take longer than other contracting alternatives.
- ✓ The contractor will select its own means and methods.
- ✓ Higher contract prices that could cover unforeseen conditions.

LUMPSUM AND SCHEDULE CONTRACT:

- ✓ In this type of contract, the schedule of rates is also provided in the contract agreement.
- ✓ Measurement of extra items only shall have to be taken.
- ✓ The original work is however be checked and compared.
- ✓ The contract however includes a fixed sum within a fixed time along with the detailed specifications and conditions, and the scheduled rates.
- ✓ This contract is suitable when the number of items are limited or when it is possible to work out exact quantities of work to be executed.
- ✓ Under a lump sum contract, a “fixed price” for the work to be done is agreed upon by the client and contractor before the work begins.

Advantages:

- ✓ Low risk to the owner.
- ✓ 'Fixed' construction cost.
- ✓ Minimize change orders.
- ✓ Owner supervision is reduced when compared to Time and Material Contract.
- ✓ The contractor will try to complete the project faster.
- ✓ Accepted widely as a contracting method.

Disadvantages:

- ✓ It presents higher risk to contractor.

- ✓ The project needs to be designed completely before the commencement of activities.Changes are difficult to quantify.
- ✓ The Owner might reject change order requests.
- ✓ The construction progress could take longer than other contracting alternatives.

SCHEDULE CONTRACTS OR ITEM RATE CONTRACT:

- ✓ An item-rate contract is one in which the contractor agrees to carry out the work as per the drawings, bills of quantities, and specifications in consideration of a payment to be made entirely on measurements taken as the work proceeds, and at the unit- prices tendered by the contractor in the bill.
- ✓ An item rate contract, or unit price or schedule contract is a type of contract which is undertaken on per piece or item basis.

Advantages:

- ✓ There are no rates for individual items the benefit due to increase in quantities will not be availed by the contractor.
- ✓ Comparative statement can be prepared quickly.
- ✓ Overwriting & erasing of rates etc. can be avoided.
- ✓ profit of contractor is linked with actual cost so economic completion of work.
- ✓ Early completion.

Disadvantages:

- ✓ No extra work is allowed.
- ✓ The quantities of works are not guaranteed therefore there is risk to the contractor.
- ✓ The contractor may submit high tender.
- ✓ profit is not assured & depends on economy achieved in construction.

LABOUR CONTRACT:

- ✓ Contract labour refers to an employed person, hired to work in a company through a contractor for a specific work and a finite period.
- ✓ Contract labour, the labour of workers whose freedom is restricted by the terms of a contractual relation and by laws that make such arrangements permissible and enforceable.
- ✓ Other stipulations cover such matters as repayment of the costs of transportation, housing, training, and other expenses.
- ✓ The essence of the contract labourer's obligation is his surrender for a specified period of the freedom to quit his work and his employer.

Advantages:

- ✓ There is a wide disparity of views among the employers whether contract labour is engaged for flexibility or as cost saving mechanism.
- ✓ One of the main benefits, next to cost savings, for hiring contract labor involves the ease of separation.

Disadvantages:

- ✓ Job security: Even though there is no dearth of opportunities available for contract employment.
- ✓ Tax information: This is the part of legal obligation fulfilling which sometimesbecomes difficult for employees.
- ✓ Creating a brand
- ✓ Burden
- ✓ Time management issue

TARGET CONTRACT:

- ✓ Target cost contracts base their pricing on a figure that's aptly known as the target cost.
- ✓ This number is negotiated by both the contractor and the client before signing the contract, and represents the expected cost to the contractor of providing the agreed goods or services.
- ✓ If the final cost of the project is below the target cost, both the contractor and the client split the savings (the "gainshare").
- ✓ Similarly, if the final cost exceeds the target cost, both parties are responsible for paying this extra money.

TIME & MATERIALS SUPPLY CONTRACT:

- ✓ A Raw Material Supply Agreement is essentially an agreement to Sell as defined under the Sale of Goods Act, 1930.
- ✓ In other words, it is a sale agreement where one party agrees to sell and the other agrees to buy definite goods of economic value.
- ✓ The vesting of rights may be immediate or in future.

Advantages:

- ✓ Risk is less – the contractor will receive a fixed amount of overhead and profit, usually based on the total costs in a billing period.
- ✓ If additional costs are spent in a period, the contractor shall receive a larger payment for overhead and profit on top of those costs.
- ✓ Transparency for the client.

Disadvantages:

- ✓ Contractors may not understand the details of accounting in a construction context.
- ✓ They may bill haphazardly and infrequently.
- ✓ They may not have a good grasp of important concepts such as markup and margin.
- ✓ Contractors who agree to T&M contracts may be under cash flow stress and need to get the job started quickly.
- ✓ Contractors who use T&M contracts are often newer or inexperienced businesspeople who may not have substantial amounts of time in the industry.
- ✓ Contractors may find themselves with huge expenses at the end of a project that cannot be collected because of the terms of a T&M contract.

PIECE-WORK AGREEMENT:

- ✓ The piecework agreement between the employer and the individual employee must be in writing and signed by the employer and the employee.
- ✓ The employer must give the individual employee a copy of the piecework agreement and keep it as a time and wages record.

Advantages:

- ✓ When paid per piece, workers tend to develop and adhere to the most efficient means of production.
- ✓ Workers have a vested interest in achieving the company's goals in the most efficient way possible, because they're achieving more both for the company and for themselves.
- ✓ Increases the efficiency of all the employees.
- ✓ It is very easy to calculate the dues of the worker.
- ✓ Workers do not end up wasting any time.
- ✓ They are encouraged to think of better working methods.
- ✓ The number of products produced is much higher.
- ✓ The workers set deadlines for themselves.

Disadvantages:

- ✓ Workers pay much more attention to quantity and not quality.
- ✓ Planning for the future becomes rather tough.
- ✓ Finding and fixing on a reasonable piece cost is a rather tough task.
- ✓ It puts immense pressure on all the employees.
- ✓ Sometimes even more supervision is required.

COST REIMBURSEMENT CONTRACTS:

- ✓ Cost reimbursement items are not fixed prices. Those items are paid for based on what the Contractor spends in executing the work.
- ✓ Therefore, the payment of the Contractor is based on his actual expenditure.
- ✓ It includes labour, material, plants, sub-contracting cost, and other direct costs.
- ✓ Then the Contractor has to submit a load of invoices to demonstrate his actual cost.
- ✓ And also, he will be paid an agreed fee for his overhead and profit.
- ✓ The Contractor's cost accounts are open to audit by the Client (Open-Book Accounting).
- ✓ It is a little contractual incentive for the Contractor to perform, and the final price will depend both on the extent to which risks materialize and on the efficiency of the Contractor.

Advantages:

- ✓ Provide extreme flexibility.
- ✓ Allow and require a high level of client involvement.
- ✓ They facilitate joint planning.

Disadvantages:

- ✓ There is little incentive for the Contractor to perform efficiently.
- ✓ There is no estimate of the final price at the tender.
- ✓ Administrative procedures may be unfamiliar to all parties.
- ✓ In particular, the Client must provide cost accountants or cost engineers, who must understand the nature of a contractor's business.

FORMATION OF CONTRACT

Goals:

The goals of this section will be for you:

- ✓ To understand how a contract is formed.
- ✓ To understand each core concept of a contract.
- ✓ To understand the relationship between each core concept of a contract.

Objectives:

- ✓ To be able to understand the key terminology that relates to the formation of the contract.
- ✓ To be able to identify when a contract has been formed.

- ✓ To be able to identify whether the issue with a contract's formation is with the offer, acceptance, certainty/intention or consideration.

An agreement must have four essential elements to give rise to a contract and its respective obligations:

- ✓ Offer
- ✓ Acceptance
- ✓ consideration
- ✓ intention to create legal relations.

Offer:

- ✓ It is a promise to enter into a contract on certain terms.
- ✓ It must be specific, complete, capable of acceptance, and intended to be bound by acceptance.
- ✓ It can be express or implied by conduct.
- ✓ It can be made to an individual or a group or persons.

Acceptance:

- ✓ An offer must be accepted to create a contract.
- ✓ It must be final and unqualified with no variation to the proposed terms.
- ✓ It must be communicated by the accepting party to the offeror or, in some cases, conduct will constitute acceptance.

Consideration:

- ✓ Consideration essentially means that a person cannot enforce a promise unless he has given or promised something in return.
- ✓ A contract without consideration will only be enforceable if made by deed.

Intention to Create Legal Relations:

- ✓ The parties must intend to create a legally binding agreement, else there is no contract.

CONDITIONS OF CONTRACTS

- ➢ Rates inclusive of materials, labour,etc.
- ➢ Amount of security money
- ➢ Time for completion of work
- ➢ Progress to be maintained
- ➢ Penalty for bad work

- Mode of payment
- Extension of time limit for delay
- Termination of contract
- Compensation to labour, minimum wages, etc.

ELEMENTS OF A CONTRACT

- The contract itself must include the following:

- ✓ Offer.
- ✓ Acceptance.
- ✓ Consideration.
- ✓ Parties who have legal capacity.
- ✓ Lawful subject matter.
- ✓ Mutual agreement among both parties.
- ✓ Mutual understanding of the obligation.

CONTRACTS DOCUMENTS

- ✓ Contract Document is the written documents.
- ✓ It describes clearly about the work and defines the right and obligations of parties. (i.e., Owner and contractor).
- ✓ Its define the basis of the contract including both parties' roles, responsibilities, and detailed description of the work or service such as drawings, specifications, procedures, any other conditions, etc.
- ✓ It should include sufficient information to be able to complete the work or service.
- ✓ Construction contract documents include the Agreement, the Conditions of Contract, the Drawings, and the Specifications.
- ✓ Because of the legal implications, owners produce the Agreement and the Conditions.
- ✓ Architects are responsible for producing the Drawings and the Specifications.

CONTRACT AGREEMENTS AND CONTRACTS:

- ✓ This is an agreement used by the prospective building's owner and the contractor.
- ✓ It is the main contractual document, and other contractual documents attach a reference to it.

Statement of Work (Som):

- ✓ A solid scope of work is crucial in the bidding process and the constructions sequence.

- ✓ This document defines the scope of work to be applied in determining the work amount required for project completion.

General Conditions:

- ✓ This is a contract document defining obligations in regards to project execution and the rights of each party.
- ✓ It includes all overhead costs, what someone can claim, and entitlements.

Special Conditions:

- ✓ This is an amend and an extension of the general conditions.
- ✓ It needs to specify general conditions and clauses pertaining to every project or job.
- ✓ It has special instructions and requirements on how each job should be performed.

Bill of Quantities:

- ✓ This is a document made up by the list of different materials and trades that the construction project will require.
- ✓ This document might not be required by the contracting officer at all times.

Drawings:

- ✓ Each contract can have a set of drawings forming part of the job that ought to be performed.
- ✓ The drawings need to be issued to a contractor before commencing the building.
- ✓ This should include all drawings from consultants and experts constituting the entire project.

Master Format Outline:

- ✓ This is a technical requirement to complete, execute and perform tasks or get matters incorporated in a building project.
- ✓ It adds intelligence to the drawings of a construction.
- ✓ The role of this document is specifying common standards explaining accepted deviations, and providing information on accepted material details.
- ✓ It also cites all required materials for testing.
- ✓ Specifications could be made through referencing construction codes and standards.

Creating Construction Schedule:

- ✓ A construction schedule is a crucial component of this document.
- ✓ A contracting officer knows how and when a project will be completed through the review of this part.

- ✓ At times, a construction contract might need an updated schedule throughout the construction progress.
- ✓ The schedule can be monthly or agreed on payment application terms.

Costs in The Construction Industry:

- ✓ This breaks down all the construction project's incorporated items.
- ✓ It is normally the base for payment application.
- ✓ It could be detailed per item or in the form of lump sum without specifying individual items.

List of Common Types of Construction Insurance:

- ✓ This forms an important part of the contract by providing the owner a guarantee that the contractor has economic backup and means to perform under the construction contract's terms.
- ✓ It includes specific coverage types, insurance protections available to the prospective property owner, and required bonding.

EARNEST MONEY DEPOSIT:

- ➢ Earnest money refers to the deposit paid by a buyer to a seller, reflecting the good faith of a buyer in purchasing a home.
- ➢ The money buys more time to the buyer before closing the deal to arrange for funding and perform the hunt for names, property valuation, and inspections.
- ➢ Earnest money can be called, in many respects, a deposit on a property, an escrow deposit, or money of goodwill.
- ➢ Make sure the contract provides contingencies for funding and inspections.
- ➢ Without these, the deposit will be forfeited if, during the inspection, the buyer can't get funding or a significant defect is found.
- ➢ Read, comprehend, and comply with the terms and conditions of the contract.
- ➢ For instance, if the contract specifies that home inspection needs to be done by a certain date, the buyer must meet the deadline, or they risk losing the deposit and the property.
- ➢ Ensure that the deposit is handled properly.
- ➢ The deposit needs to be payable to a reputed third party, such as a well-known real estate brokerage, title company, escrow, or a law firm (never send the deposit directly to the seller).
- ➢ Buyers can keep the funds in an escrow account and also get a receipt.

SECURITY DEPOSIT:

- A security deposit is money that is given to a landlord, lender, or seller of a home or apartment as proof of intent to move-in and care for the domicile.
- Security deposits can be either be refundable or nonrefundable, depending on the terms of the transaction.
- A security deposit is intended as a measure of security for the recipient, and can also be used to pay for damages or lost property.
- Security deposits serve as an intangible measure of security, or as a means of tangible security in the event of damages or lost property.
- A security deposit might be used toward any repairs or replacement of appliances in a rental unit if the damages resulted from the actions of the renter.

MEASUREMENT BOOK:

- It is a complete measurement of some physical intervention, which can be recorded in the time of completion of any physical intervention.
- The most important objective of maintaining the final measurement would be to keep all the measurements in one place.

- Measurement Book" is an important document in which measurements are recorded for the work done by the contractor, or for the materials received at the site or services rendered.
- MB belongs to the Division and is serially numbered recording to whom issued, date of issue, etc
- Contractor payments are made based on the measurements recorded in the MB.
- It is considered very important accounts record and maintained very carefully and accurately and form substantial evidence in the court of law - should need arises
- Measurements are written legibly so that transactions are readily traceable.

- **Recording of measurements**

  Each set of measurements should commence with entries

  - ✓ Work Name as given in the estimate / agreement
  - ✓ Work location
  - ✓ Contractors Name
  - ✓ Agreement Number and date
  - ✓ Work commencement date
  - ✓ Work completion date
  - ✓ Measurement recording date

NOMINAL MUSTER ROLL:

- ✓ Nominal Muster Roll where daily attendance are recorded.
- ✓ In this part there are column and spaces for the names of the labourer, designation, father's name, dates of attendees, rates, total amount due for each, total amount for whole, signature of the person taking attendance, signature of the officer making payment etc.
- ✓ Nominal Muster Roll never be made in duplicate and entries should be made in such manner that it may not be possible to interpolate or to alter them.
- ✓ The names of the labourer are grouped according to classes as masons, mazdoors, carpenters etc.

ARBITRATION AND LEGISLATION:

Definition:

- ✓ It is a process by which parties by way of an agreement in writing submit their disputes or differences to a neutral person or group of persons for binding adjudication.

Arbitrator:

- ✓ An arbitrator is more or less like a private judge chosen by parties and endowed by them with power and privilege to decide the matter of dispute between them.

Advantages of Arbitration:

- ✓ It is possible to avoid legal formalities, delays and expenses.
- ✓ Simple process to solve the dispute
- ✓ It is conducted in private and not in open as in court.

TENDERS

TENDER:

- Tendering is the process of making an offer, bid or proposal, or expressing interest in response to an invitation or request for tender
- Tendering usually refers to the process where by governments and financial institutions invite bids for large projects that must be submitted within a finite deadline.

Tender Form:

- ✓ It is a printed standard form of contract giving standard condition of the contract, general rules and directions for guidance of contractors.

Tender Calling:

- ✓ Call for Tender" is the process by which a company (Private or government) invites potential suppliers to submit offers for the execution of a contract.
- ✓ In simple words, Tendering calling procedure (or call for tenders) means that a public- sector organization announces publicly that it wishes to have a contract executed.

Procedure for Inviting Tenders:

- ✓ Preparation of tender documents
- ✓ Issue of tender notice
- ✓ Submission and opening of tenders
- ✓ Acceptance of tender and award of contract.

TENDERING:

- **Invitation to Pre-qualification:**
- ✓ In this stage the client publishes the requirement using the bidding method (competitive or negotiate) with the intention to select a suitable contractor.
- ✓ The invitation normally calls through the newspaper advertisement.
- **Tender selection stage:**

In this stage the process will take to select the correct tender specially consider the,

- ✓ Way of the application fills
- ✓ Completeness of applications
- ✓ Legal consideration –Whether the organization have any legal problems or acceptance
- ✓ Whether have the eligible to apply.

- **Evaluate the criteria:**

  After select the qualified tender documents from the applications the suitable contractor will select for the project according to the requirement criteria such as

- ✓ General experience
- ✓ Personnel capabilities
- ✓ Equipment capabilities
- ✓ Financial position
- ✓ Litigation history

  Normally this will consider according to the requirement criteria which mention in the paper advertisement.

- **Select the suitable applicant:**

- ✓ After analyze the applicants who pass in the preliminary examination the evaluate criteria will check and the applicant who satisfy the client requirement will select and inform through the "letter of acceptance" to the selected particular and also the submission of evaluation reports to Procuring Entity also will happen in the stage.

- **Contract Form:**

- ✓ This stage identifies as the last stage in the pre- qualification activities after the response from the selected applicant the agreement will sign between the two parties and the construction process will start.

TYPES OF TENDERS:

- **OPEN TENDER**

The client advertises the tender offer in the local news paper along with the key information of the proposed works and inviting interested contracts

- **SEALED TENDER**

Invited for important and huge products

Wide publicity made and always written documents are made

- **LIMITED TENDER**

Only selected number of contracts are invited to quote their rates

- **SINGLE TENDER**

Invitation is given to only one firm to render a service by quoting their rates.

- **RATE CONTRACT**

Supply of items at a fixed rate during the time of contract.

TENDER DOCUMENTS

TENDER DOCUMENTS CONSIST OF THE FOLLOWING:

1. TENDER DRAWINGS

2. THE SPECIFICATION

General requirements

Specification of workmanship and materials

3. BILL OF QUANTITIES

4. CONDITIONS OF CONTRACT

5. FORM OF TENDER

6. FORM OF AGREEMENT

7. FORM OF BOND

1. TENDER DRAWINGS

The purpose of tender drawings is to describe the project in sufficient detail so that the Price submitted by the contractor can be expected to be realistic.

Drawings must show sufficient detail so that there is not significant change and Subsequently no significant change of the cost.

2. THE SPECIFICATION

General requirements- it includes relevant details of the site and information on items Which do not form part of the permanent works.

Specification of workmanship and materials- it deals with the detailed requirements of Every trade.the type, the quality and method of fixing (or fabrication) and testing of Every item for incorporation in permanent works is described.

3.BILL OF QUANTITIES

It is like a 'shopping'list

It lists every work activity or component part necessary for the execution of the (permanent)works.

Bill of Quantities is essential to cost control.

Bills of quantities are prepared from tender drawings.

4. CONDITIONS OF CONTRACT

The purpose of the Conditions of Contract is:

- To define the responsibilities and liabilities of the parties to the contract.
- To describe the method of administration (by Engineer)

The Conditions of Contract define the terms under which the work is to be carried out the relationship between the Employer and the Contractor, the powers of the Engineer and the terms of payment.

The imposition of conditions of contract which are biased (unfair) in favour of the Employer can be uneconomical.

5. FORM OF TENDER

It is a standard letter of offer by the Contractor to execute the works.

It is prepared by the Engineer and signed by the contractor.

It contains the main points of the offer:

Starting date

Duration

Tender sum

6. FORM OF AGREEMENT

To set up names of parties, list of contract documents, signatures of parties,sealed contact documents, sealed contact.

A standard form of agreement is the legal contract between the promoter and the contractor. It evidences the agreement of the Employer to pay the price indicated in the contractor’s tender and the contractor's agreement to undertake the works in accordance with the tender documents.

7. FORM OF BOND

It is signed by both the contractor and a third party evidencing their agreement to pay a sum of money to the Employer in the event of the contractor's default.

Often,the Employer worries whether the work will be good. Guarantee is provided by a third party(often a bank or an insurance company)to the contractor.

If the contractor does not complete the work according to the specification (contract documents), he pays sum of money (bond)to the Employer.

UNIT-5

ANALYSIS OF RATES

* Analysis of Rates:-

The determination of rates per unit of a particular item of work, from the cost of quantities of materials, cost of labourers, & then miscellaneous expenses required for its completion is known as the "Analysis of rates".

→ Rates of materials is rates delivered at site of work, which include first cost (i.e cost at origin), cost of transportation etc.

→ If materials carried from distant places i.e, more than 8 Km, cost of transport is added.

→ Rates of different items various from place to places.

* Requirement for Analysis of Rates:-

→ Operations involved in carrying out work should be available.

→ quantities of material is required & their costs should be known.

→ No of different categories of labours & capacity of doing work per day and their wages per day.

* Rates of particular item depends on:-

→ Specifications of works & materials, quality of materials, proportion of mortar, method of construction, location etc.

→ Quantities of materials & their rates, no of diff. types of labours & their rates.

→ Location of site of work & its distance from sources of materials & rates of transport, availability of water.

→ Profits & miscellanous & overhead Expenses of Contractor.

⇒ Overhead Costs:-

This include general office Expenses, rents, taxes, Supervision and other costs which are indirect Expenses and not productive Expenses on Job.

(or)

This Charges are in Construction is the Expenditure incurred other than cost of Construction, material labours & the related works.

(a) General overheads:-

(i) Establishment (office staff)
(ii) stationary, printing, postage etc,
(iii) Travelling Expenses,
(iv) Telephone.
(v) Rent & Taxes.

(b) Job overheads:-

(a) supervisions (b) Handling of materials & Repairs
(c) [illegible] carriage, depreciation of Tools & Plants
(d) Amenities of labour (e) workmen's compensation insurance etc.

advantages.

⇒ Task (or) out-turn work :-

The capacity of doing work by an artisan or skilled labour in form of quantity of work per day is known as the task work or out-turn of the labour.

* Rate Analysis of cement / Lime Concrete :-

M5 = 1:5:10	Labour :
M7.5 = 1:4:8	Head mason = 1/2 NO's
M10 = 1:3:6	mason = 1 (or) 2
M15 = 1:2:4	Mazdoor (Beldar) - 10 (or) 12 NO's
M20 = 1:1½:3	Boy (or) women coolie - 15 (or) 20 NO's
M25 = 1:1:2	Bhishti (water man) - 2 (or) 4 NO's

Materials :-

Lime / cement, sand / surkhi, stone & brick aggregate etc. have voids varying 40 to 50% & fine ingredients to fill up voids in coarse.

∴ Sum of total quantity of determining the quantity of material for 10 cu.m concrete is to divide '15.4' (10 + 54% (10)) by the sum of

⇒ Factors Affecting Analysis & Rate :-

(1) Specifications of works & materials :-

Specification like quality of material, proportion of mortar or concrete thickness of plastering, no of

(2) Location of site:-

Distance of construction site from source of materials, availability of labours, availability of water machinery etc, influence the rate analysis.

(3) materials & labours:-

Quantity of materials, no of different type of labours & rates of material labours influence rate analysis.

(4) Profit Expenses:-

Profit of contractor, miscellaneous expenses & other over heads.

* Elements of Rate analysis:-

1). material cost inclusive of wastages
2). Labour cost
3). Plan & machinery owning & operation charges
4). water charges
5). Taxes
6). Insurance / risk coverage charges
7). Contractors overheads & profit.

1). For the purpose of tendering:-

In case of tendering, contractor may calculate

cost of involved in each construction activity for justified quality of rates.

The client may also required rate analysis to calculated cost of construction project.

2). materials cost) labours:-

To assess the requirements of quantities of labours, materials machineries & capital to complete the project.

3). To optimise the use of labour, materials, machineries & to known the alternatives to optimize the resources.

4). To assess the rate of unit work from time to time for payment increase in materials or labours costs or any deviations in work specification, extra items of work to contractor.

Problems:- (lime concrete Rate Analysis)

1). lime concrete in foundation with 40mm gauge brick ballast - unit 1 cu.m. (white lime & surkhi = 1:2:6 proportion)

Sol:- Given data

Take $10m^3$

Dry weight = wet wt + 54% (wet weight)

$= 10 + \frac{54}{100} \times 10 = 15.4\ m^3$

Quantity of lime = $\frac{1}{1+2+6} \times 15.4 = 1.71\ m^3$

Quantity of surkhi = $1.71 \times 2 = 3.42 m^3$

Quantity of brick ballast 40mm guage = 1.71×6

$= 10.26 m^3$

Item No	Particular of Item	Quantity (or) No's	Rate Rs Ps	Cost Rs Ps
1	materials:-			
	Brick ballast 40mm Gauge I-class	$10.26\ m^3$	1000/- Per cum	10260/-
	White lime slaked	$1.71\ m^3$	1000/- Per cum	1710/-
	Surkhi	$3.42\ m^3$	800/- Per cum	2736/-
			Total	14706/-
2)	labours:-			
	Head mason	1/2 No's	425/- Pady	212.5/-
	mason	1 No	400/- "	400/-
	Mazdoor	12 No's	250/- "	3000/-
	Coolies	12 No's	230/- "	2760/-

Bhishti (water man)	2 no's	230/-	460/-
Sundries	lumpsum	100/-	100/-
		Total	6833.0/-

Total materials & labours = 21539/-

Add 1.5% water charges = $21539 \times \frac{1.5}{100}$ = 323.09/-

Add 10% Contractor profit = $21539 \times \frac{10}{100}$ = 2153.9/-

Total cost for 10m³ = 24016/-, Total Cost for 1 m³ = 2401.6/-

2) lime concrete in Terraced roof with 25mm gauge brick ballast unit 1 cu.m.

Sol:- Given data

As the proportion is not given assume as 1:2:6 approximately.

Proportion 1:2:6

Dry Volume = 15.4%.

Quantity of cement = $\frac{1}{1+2+6} \times 15.4$ = 1.71 m³

" " sand = 1.71 m³ × 2 = 3.42 m³

Quantity of Brick Ballast 25mm gauge = 1.71 × 4.

= 10.26 m³

Item no	Particulars of item	Quantity (or) No's	Rate Rs Ps	Cost Rs Ps
1	materials:-			
	Brick Ballast 1-class 25mm gauge	10.26 m³	1100.00 m³	11286.00/-
	lime	1.71 m³	1000.00 m³	1710.00/-
	Sand	3.42 m³	1800.00 m³	6156.00/-
			Total	19152.00

Labours :-			
→ Head mason	½ Nos	425.00/- Per day	212.50
→ Mason	2 Nos	400.00/- "	800.00
→ Mazdoor	10 Nos	250.00/- "	2500.00
→ Boy (or) women	25 Nos	280.00/- "	5750.00
→ Coolies		230.00/- "	690.00
→ Bhishti	3 Nos		150.00
→ Sundries	lumpsum	150.00 L.S	
		Total	10102.50

Total cost of material & labours = 29255.00

Add 1.5% of water charges = 438.82/-

Add 10% " Contractor profit = 2925.5/-

Cost for 10 m³ = 32620/-

Cost for 1 m³ = 3262.0/-

Assume 7.5cm thick

1.0 cum = x sq.m. × 7.5 cum

$$x \text{ sq.m} = \frac{1}{7.5\text{cm}}$$

$$= \frac{1}{0.075\text{ m}}$$

$$x = 13.34 \text{ sq.m}$$

Rate for 13.34 sq.m = 3262 $\Rightarrow \frac{3262}{13.34} = 244.6$

Rate for 1.0 sq.m = 244.625

Cost for 1.0 sq.m = 245.00/-

Rate Analysis for cement Concrete

3). Cement Concrete 1:5:10 in foundation or floors with Brick Ballast 40mm gauge and sand – 1 cum unit

Sol:- Given data

Proportion = 1:5:10 ; Take = $10m^3$

1. cu.m of cement content = 1440 Kgs

Each bag cement carries 50 Kgs

$$1 \cdot cum\ bags = \frac{1440}{50} = 29\ bags$$

1 - cum carries 29 bags of cement

$$\text{Dry volume} = 10 + \frac{54}{100} \times 10 = 15.4\ m^3$$

→ Quantity of cement $= \frac{1}{1+5+10} \times 15.4 = 0.96\ m^3$

$$\text{No of cement bags} = \frac{0.96 \times 29}{1} = (28\ bags)$$

→ Quantity of sand $= 0.96 \times 5 = 4.8\ m^3$

→ Quantity of Brick ballast 40mm gauge $= 0.96 \times 10$

$= 9.6\ m^3$

Item No	Particular of item	Quantity (or) Nos	Rate Rs	Rs	Cost Rs	Rs
1).	Materials :-					
	Cement	0.96 m3(28 bags)	330/-		9240.0/-	
	Sand (fine)	4.8 m3	1500.0/-		7200.00/-	
	Brick Ballast 40mm gauge	9.6 m3	1000.0/-		9600/-	
			Total		26040.00	

2.

Labours:-			
Head mason	1/3 Nos	425.00/-	212.50/-
Mason	2 Nos	400.00/-	800.00/-
Mazdoor	12 Nos	250.00/-	3000.0/-
Boy or women	18 Nos	230.0/-	4140.00
Coolies	4 Nos	230.0/-	920.00
Bhishti (water man)			
sundries	lumpsum	150.0/-	150.00
		Total	9222.50/-
Total Material & labour =		35262.50/-	
Add 1.5% of water charges =		528.9 ≈ 529.00/-	
Add 10% of Contractor profit =		3526.25/-	
Cost for 10m3 =	39317.75/-		
Cost for 1 m3 =	3931.77/-		

* Cement Concrete of M15 grade - Unit 1 cum (M15) = 1:2:4)

Sol:- Given data

Take 10 m3

Quantity of cement = $\frac{1}{1+2+4} \times 15.4 = 2.2$ m3

" of sand = $2.2 \times 2 = 4.4$ m3

" of stone ballast (40 mm gauge) = $2.2 \times 4 = 8.8$

Same as calculation for previous problems. prepare Schedule of Rate analysis Calculate the materials and labours.

Rate Analysis for RCC works

Important note points:-

1) lintel, slab = 0.7 to 1.0%
2) Beams = 1.0 to 2.0%.
3) Column = 1.0 to 5.0% (usually 2.5%.)
4) Foundation, footing = 0.5 to 0.8% (usually 0.6%.)

→ Density of steel = 7850 kg/m³

→ Density of steel in 1m³ = 78.50 quintal/m³

→ For every quintal of steel → 0.4 to 1.6 kgs of binding wires is Consider.

4) RCC works in Beams, slabs, etc 1:2:4 – unit 1.cu.m

Sol:- Given data

Take 10m³

Proportion = 1:2:4

Quantity of cement = $\frac{1}{1+2+4} \times 15.4 = 2.20 m^3$

" of Sand (coarse) = $2.20 \times 2 = 4.40 m^3$

" of stone ballast 20mm gauge = 2.20×4
$= 8.80 m^3$

Quantity of steel (mild steel) bars @ 1% = 1.cu.m

10m³ = 785 kg and multiplying 1% of steel

$\Rightarrow \frac{785 \times 10}{100} = 7.85$ quintal

No of bags of cement = $\frac{2.20 \times 29}{1} = 63.8$ (or 64 bags)

Item No	Particular of Item	Quantity (or) No's	Rate Rs Ps	Cost Rs Ps
1,	**materials:-**			
	-> cement	9.20 m3	330/- Per bag	21120.00
	-> sand (Coarse)	4.40 m3	1800/- Per Cu.m	7920.00
	-> Stone ballast 20mm gauge	8.80 m3	2400/- "	21120.00
	-> steel, mild steel bars @ 1% = 1:64 m	7.85 Quintals	4200/- "	32970.00
	-> Binding wires	1.5 Kgs	65/- Per Kgs	97.50
			Total	83227.50
2)	**labours:-**			
	Head mason	1/2 No's	425.0/-Per day	212.50/-
	Mason	3 No's	400.0/-	1200.00/-
	Mazdoor	12 No's	250.0/-	3000.00/-
	Boy or woman Coolie	20 No's	230.0/-	4600.00/-
	Bhishti (water man)	6 No's	230.0/-	1380.00/-
	Sundries	lumpsum	250.00/-	250.0/-
			Total	10642.50
	* Bendings, cranckings and bindings steel bars in position:			
	-> Black smith (II class)	8 No's	300.00 Per day	2400.00/-
	-> Mazdoor (Helpers)	8 No's	250.00/- "	2000.00/-
	Sundries	lumpsum	100.00/-	100.00/-
			Total	4500

* Centering and shuttering (both Erection & dismantling) :-			
-> Timber Planks and Battens	lumpsum	1500.00 L.S	1500.00 L.S/-
-> Carpenter (II class)	10 Nos	2800.00 L.S/-	3000.0/-
-> Mazdoor (Beldar)	10 Nos	220.00/- Per day	2500.00/-
-> Nails	lumpsum	200.00 L.S	250.00/-
Sundries	lumpsum	70.00 L.S	100.00/-
		Total	7850.0/-

Total material & labour = 106440.00/-

Add 1.5% contr charges = 1596.00/-

Add 10% Contractor profit = 10644.00/-

Cost per 10 cu.m = 118680.00/-

Cost per 1 cu.m = 11868.0/-

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5). R.C.C work in column 1:1½:3 — unit 1 cu.m

Sol:- Given data

Take = 10 m³

Dry volume = 15.4 m³

Quantity of cement = $\frac{15.4}{1+1\frac{1}{2}+3}$ = 2.8 m³

" sand = 2.8 × 1.5 = 2.8 × 1.5

= 4.2 m³

" Stone ballast 20mm gauge = 2.8 × 3 = 8.4 m³

Quantity of steel (mild steel) bars @ 2% =

= $\frac{785 \times 2}{100}$ = 15.7 quintal

No of bags of cement = $\frac{2.8 \times 29}{1}$ = 82 bags

= 82 bags

Item No	Particulars of Item	Quantity (or) No's	Rate	Cost
1	Material :-			
	→ cement	2.8 m³ (82 bag)	330/- Per bag	26401.-
	→ sand (coarse)	4.2 m³	1800/- Per cum	7560.0/-
	→ stone ballast 20mm gauge	8.4 m³	2400/- "	20160.0/-
	→ steel (mild steel) bars @ 1%	15.7 QJ	4200.00/- Per quintal	65940.0/-
	→ Binding wires	2 Kg	65.00/- Per kg	130.0/-
			Total	120192.0/-
2)	labours :-			
	→ Head mason	½ No's	425/- Per day	212.5/-
	→ Mason	3 No's	400/- "	1200.0/-
	→ Mazdoor	12 No's	250/- "	3000/-
	→ Bag or coarse (coolies)	20 No's	330/- "	16800.0/-
	→ steel (mild steel) bars @	6 No's	230/- "	1380.00/-
			Total	10642.5/-
•	Bending, Cranking and binding steel bars in position :-			
	→ Black smith	12 No's	400/-	4800/-
	→ mazdoor	12 No's	250/-	3000/-
	Sundries	lumpsum	100.00 L.S	100
			Total	7900.0/-
•	Centring & shuttering			
	: Same as previous problems data			7850.0/-
	Total materials & labours =			1,46584.5/-

Add 1.5 % of water charges = 2198.76/-

Add 10% of Contractor Profit = 1,46584.5/-

Cost for 10 m³ = 1,63484.71/-

Cost for 1 m³ = 1,6344.171/-

Rate Analysis for R.B works:-

6) Reinforced Brick work in slabs with 1:3 mortar - Unit - 1 Cu.m.

Sol:- Given data

Proportion = 1:3

Take = 10m³

Size of brick = 19x9x9 cm = 0.19 x 0.09 x 0.09 m

Size of brick with mortar = 20 x 10 x 10 cm

= 0.2 x 0.1 x 0.1 m

No of bricks for 10m³ = $\frac{\text{Volume of wall}}{\text{Volume of 1 brick with mortar.}}$

= $\frac{10}{0.2 \times 0.1 \times 0.1}$ = 5000 Nos

10 m³ = 5000 Nos of bricks

1 m³ = 500 Nos of "

Volume of mortar = 10 - (0.19 x 0.09 x 0.09 x 5000)

= 2.305 m³

for wastage add 15% for Extra mortar due to wastage

Reinforced Brick work we should take 4500 Nos Brick only because their are Reinforced B.W that's why 500 Nos

$= 2.305 \times \frac{15}{100} + 2.305$

$= 2.65 \text{ m}^3$

total dry weight add 45% of wet volum

$= 2.65 + \frac{45}{100} \times 2.65$

$= 3.84 \text{ m}^3$

Add 1 m3 for Reinforced Brick work because Reinforced there in that B.W that's why 1 m3 of Reinforcement we add.

$= 3.84 + 1 = 4.84 \text{ m}^3$

→ Quantity of cement $= \frac{1}{1+3} \times 4.84 = 1.21 \text{ m}^3$

Quantity of sand $= 1.21 \times 3 = 3.60 \text{ m}^3$

No of bags of cement $= \frac{1.21 \times 29}{1} = 35.09 \simeq 36$ bags

Item No	Particular of Item	Quantity (or) Nos	Rate Rs Ps	Cost Rs Ps
1	material:-			
	→ Brick I class @ 450 nos percum	4500 nos	8000/- Per 1000 Brick	36000-00/-
	→ cement	1.21 (36 bags)	330/- Per bag	11880-00/-
	→ sand	3.60	1800/- "	6480-00/-
	→ Steel (mild steel @ 0.8% = $\frac{785 \times 08}{100}$	6.28 @	4200 - per quintal	26376-00/-
			Total	80736-00/-
2)	labours:-			

Head mason	1/2 Nos	425.00/-	212.5/-
Mason	10 Nos	400.00/-	4000.00/-
Mazdoor	10 Nos	250.00/-	2500.00/-
Coolies	10 Nos	230.00/-	2300.00/-
Bhisthi (Water Man)	4 Nos	230.00/-	920/-
Sundries	lumpsum	150.00/-	150.00/-
		Total	10082.5/-
→ Bending and cranching steel bars :-			
Black smith (II class)	6 Nos	375/- Per day	2250.00/-
Mazdoor	6 Nos	250/- Per day	1500.00/-
Sundries	lumpsum	100.00/-	100.00/-
		Total	3850.0/-
→ Centering and Shuttering both Erection and dismantling :-			
→ Timber planks and battins	lumpsum	2000/- Per day	2000/-
→ Carpenter (II class)	8 Nos	400/- "	3200.00/-
→ Mazdoor	8 Nos	250/- "	2000.00/-
→ Sundries	lumpsum	200/- "	200.00/-
→ Nails	lumpsum	100/- "	100.00/-
		Total	7500/-
Total labours & materials =			102168.5/-

Add 1.5 % water charges = $102168.5 \times \frac{1.5}{100} = 1532.52/-$

Add 10 % Contractor profit = $102168.5 \times \frac{10}{100} = 10216.85$

Cost for 10 m^3 = 113917.87/-

1 m^3 = 11391.78/-

Rate Analysis for Brick masonary

→ Consider a wall of 30cm nominal thickness of 20m length & 5m height.

Nominal volume = $20 \times 5 \times 0.3 = 30 m^3$

→ Mortar joint will be less than 1cm, Assume 1cm mortar joint actual thickness of wall be 29cm

$\therefore$ No of bricks = $\frac{29}{0.2 \times 0.1 \times 0.1}$ = 14500 No's

$30 m^3 \longrightarrow 14500$ No's

$1 m^3 \longrightarrow ?$ $\Rightarrow \frac{14500}{30} = 483$ No's

5% Breakage, wastages = 500 per m^3

$\therefore$ for $10 m^3$ = 5000 bricks

Mortar volume = Total net volume − volume of bricks

$= 29 - (0.19 \times 0.09 \times 0.09 \times 5000)$

$= 6.685 m^3$

for dry filling = $6.685 + \frac{15}{100} \times 6.685$

$= 7.688 m^3$

dry volume 25% addition of unit volume

$\therefore$ Volume of mortar for $30 m^3$ = $7.68 \times \frac{25}{100} + 7.68$

$= 9.61 m^3$

$\therefore$ for $10 m^3$ = $\frac{9.61 \times 10}{30} = 3.2 m^3$

$\therefore$ In practice $3 m^3$ for cement dry mortar & $3.5 m^3$ for lime mortar is taken for 10cm.

→ If traditional bricks ($22.9 \times 11.4 \times 7.6 cm^3$) are used then it is taken as standard bricks only as the volume is almost Equal.

7. I class Brick work in foundation and plinth with 20x10x10cm (nominal size) Bricks with coarse sand mortar 1:6 unit 1 cu.m.

Sol: Given data

Take = $10m^3$

No of bricks for $10m^3$ = 5000

Quantity of cement = $\frac{1}{1+6} \times (3.2) = 0.45 m^3$

$\Rightarrow \frac{0.45 \times 29}{1}$ = 14 bags or 13.5 bags

No of bags of cement = 13.5 bags

Quantity of sand = $0.45 \times 6 = 2.7 m^3$

Item no	Particulars of item	Quantity	Rate Rs Ps	cost Rs Ps
1	materials:-			
	Cement	[0.45 m3 / 13.5 bags]	330/- Per bag	4455.0/-
	Sand (local)	2.7 m3	1500/- Per m3	4050.0/-
	Brick I-class (500 nos bricks Per cu.m)	5000 Nos	8000/- Per 1000 bricks	40,000
			Total	48505.0/-
2)	labours:-			
	Head mason	1/2 Nos	425.0/- Per day	212.5/-
	mason	7 Nos	400.0/- per day	2800/-
	Maidoor	7 Nos	250.0/- "	1750.0/-
	Boy or women coolies	7 Nos	230.0/- "	1610.0/-
	Bhishti (water man)	2 Nos	230.0/- "	460.0/-
	Sundries T. and P etc	lumpsum	120.00 L.S	120.00/-
			Total	6952.5/-
	Total material and labour		= 55457.5/-	
	Add 1.5% of water charges		= 831.86/-	
	Add 10% of contractor profit		= 5545.75/-	
	Cost for 10m3		= 61835.11/-	
	Cost for 1m3		= 6183.511/-	

8). I - class B.W in superstructure with 20 × 10 × 10 cm B. with 1:6 cement sand mortar — unit 1 cu.m.

Sol:- Given data

Proportion = 1:6

Take = 10 m³

No of bricks = 5000 No's

Quantity of cement = 0.45 m³

" of sand = 2.7 m³

No of bag of cement = 13.5 bags

Item No	Particular of item	Quantity	Rate Rs - Ps	Cost Rs Ps
1	Material:-			
	Same material for ~~above~~ Previous Problem			48505.0/-
2)	labours:-			
	Head Mason	½ No's	425.0/-	212.5/-
	Meison	10 No's	400.0/-	4000/-
	Mazdoor	7 No's	250.0/-	1750.0/-
	Boy or women Coolies	10 No's	230.0/-	2300.0/-
	Bhishti	2 No's	230.0/-	460.0/-
	Scaffolding	lumpsum	350.0/-	350.0/-
	Sundries	lumpsum	120.00/-	120.0/-
				9192.5
		Total	Material & labour	= 57697.5/-

Add 1.5 % of water charges = 865.46/-

Add 10 % of contractor profit = 5769.75/-

Cost for 10 m³ = 64332.71/-

Cost for 1 m³ = 6433.271/-

4 Q. I-class B.W in superstructure with 1:3 lime surkhi mortar - unit 1 cum.

Sol:- Given data

Proportion = 1:3

Take = 10 m3

Add 30 % of total dry volume

Volume of mortar = 2.63 m3

Dry volume = $2.63 + \frac{30}{100} \times 2.63 = 3.41 \simeq 3.5\ m^3$

Quantity of lime = $\frac{1}{1+3} \times 3.5 = 0.9\ m^3$

" of surkhi = $0.9 \times 3 = 2.70\ m^3$

Item no	particular of item	Quantity	Rate	Cost
1	material:-			
	Brick 1 st class	5000 Nos	8000/-	40,000/-
	lime	0.90 m3	1000/-	900.0/-
	surkhi	2.7 m3	800/-	2160.00/-
			Total	43060.00
2)	labour:-			
	same as labour	pervious problem		9192.5/-

Total materials & labour = 52252.5/-

Add 1.5 % water charges = 783.78/-

Add 10 % Contractor profit = 5225.25/-

Cost for 10 m3 = 58261.56/-

Cost for 1 m3 = 5826.15/-

Item No	Particular of item	Quantity (or) Nos	Rate Rs	Ps	Cost Rs	Ps
1.	materials:-					
	Brick 2nd class	5000 Nos	7000/- per 1000 /- Brick		35000.00	/-
	Earth (loamy soil) including wastage	5.00 m^3	3000 per m^3		150.00	/-
					35150.00	/-
2)	labour:-					
	Head mason	1/4 Nos	425.00	/-	106.25	
	mason	8 Nos	400.00	/-	3200.00	/-
	Mazdoor	6 Nos	250.00	/-	1500.00	/-
	Boy or women coolie	6 Nos	230.00	/-	1380.00	/-
	Bhishti	1 Nos	230.00	/-	230.00	/-
	Scaffolding	lumpsum	400.00	L.S	400.00	/-
	sundries T and P etc	lumpsum	120.00	LS	120.00	/-
				Total	6936.25	

Total material & labour = 42086.25 /-

Add 1.5 % water charges = 631.29 /-

Add 10% Contractor profit = 4208.62 /-

Cost for 10 m^3 = 46926.16 /-

Cost for 1 m^3 = 4692.616 /-

10). I - class B.W in Arches with 1:3 cement Coarse Sand mortar — unit 1 cu.m.

Cal:- Given data

Proportion = 1:3

Take = 10 m^3

Dry Volume = 3.2 m^3 (In practical purpose should take 3)

Quantity of cement = $3 \times \frac{1}{1+3} = 0.75\ m^3$

" of sand = $0.75 \times 3 = 2.25\ m^3$

No of bags of cement = $\frac{0.75 \times 29}{1} = 22$ bags

Item no	Particular of item	Quantity	Rate	cost
	Materials:-			
1	Brick I-class	5000 Nos	8000/- Per one Brick	40,000/-
	Cement	0.75 m³ (22 bags)	330/-	7260/-
	Sand	2.25 m³	1800/-	4050/-
			Total	51310.01/-
2	labours:			
	Head mason	½ Nos	425/-	212.50
	mason	16 Nos	400/-	6400.00/-
	Mazdoor	10 Nos	250/-	2500.00/-
	Boy or women coolies	10 Nos	230/-	2300.00/-
	Bisti	2 Nos	230/-	460.00/-
	centering and Shuttering (formwork)	lumpsum	1000/-	1000.00/-
	scaffolding	lumpsum	450.00/-	450.00/-
	sundries T and P Etc.	lumpsum	120.00/-	120.0/-
			Total	13442.50/-

Total materials and labours = 72215.75/-

Add 1.5% water charges = 1083.23/-

Add 10% Contractor profit = 7221.575/-

Grand total = 80520.55/-

Cost for 10 m³ = 80520.55/-

Cost for 1 m³ = 8052.055/-

Rate analysis for plastering

Calculation of Quantity of mortar and materials:

Area x thickness gives the quantity of mortar for brick uniform thickness for filling up the joints and to make up un-uniform surface of wall. This may be increased by 30%. which will give wet mixed mortar. To get the total dry volume of ingredient materials mortar the wet volume may be further increased by 25%. The quantities of each mortar of the materials may be found by usual method, dividing the dry volume of mortar by the sum of materials of proportions and multiplying by the individual methods.

⇒ **Materials for 12mm thick plastering in wall for 100 sq.m :-**

Volume of plastering = Area x thickness

$= 100 \times 0.012$

$= 1.2 \text{ m}^3$

Add 30% to fill up joints, uneven surface etc.

The Quantity of mortar $= 1.2 + \frac{30}{100} \times 1.2$

$= 1.56 \text{ m}^3$

Add 25%. The total dry volume

dry volume $= 1.56 + \frac{25}{100} \times 1.56 = 1.95 \simeq 2.0$

$= 2.0 \text{ m}^3$

⇒ materials for 20mm thick plastering in wall for 100 sq.m:-

Volume of plastering = $100 \times 0.02 = 2.0\ m^3$

Add 20% of mortar may be taken to fill up joints, unevenness etc.

Quantity of mortar = $2.0 + \frac{20}{100} \times 2.0$

$= 2.4\ m^3$

Add 25% The total dry volume

dry volume = $2.4 + \frac{25}{100} \times 2.4 \Rightarrow 2.4 + \frac{25}{100} \times 2.4$

$= 3\ m^3$

Rich mortar:-

for rich mortar, quantities of materials is less as the cement will be in excess then the voids in sand & reduction in volume of dry mortar less.

⇒ Ceiling plastering 12mm thick for 100 m²:-

In plastering in ceiling, unevenness will be less 20% extra mortar may be taken to get even surface.

Volume of plastering = $100 \times 0.012 = 1.2\ m^3$

Add 20% Extra to joints, unevenness

The Quantity of mortar = $1.2 \times \frac{20}{100} + 1.2 = 1.44\ m^3$

Add 25% the dry volume

dry volume = $1.44 + \frac{25}{100} \times 1.44 = 1.8\ m^3$

⇒ for 6mm thick plastering R.C.C ceiling the quantity of dry volume of dry mortar may be takes as 1 cum

⇒ 6mm thick take as dry volume = 1.0 cum

Neat cement flooring:-

for Neat cement finishing in floor, the thickness neat cement layer may be taken as 1.5 mm to

The cement paste required for 100 sq.m

Volume of flooring = $100 \times 0.0015 = 0.15\ m^3$

Add 25% of total dry volume

Dry volume = $0.15 + \frac{25}{100} \times 0.15$

$= 0.187\ m^3 \simeq 2.0\ m^3$

$= 2.0\ m^3$

6 bags of cement per 100 sq.m

Problem:-

1) 12 mm plastering 1:6 - unit 1 sq.m.

Sol:- Given data

Proportion = 1:6

Take = 100 sq.m

Quantity of Mortar = $1.51\ m^3$

Dry volum = $2.0\ m^3$

Volume of plastering = $100 \times 0.012 = 1.2\ m^3$

-> Quantity of cement = $\frac{1}{1+6} \times 2 = 0.30\ m^3$

-> Quantity of Sand = $0.3 \times 6 = 1.8\ m^3$

No of bags of cement = $\frac{0.30 \times 29}{1} = 9$ bags

Item No	Particulars of item	Quantity	Rate	Cost
1	Materials:-			
	Cement	0.30 m³ (9 bags)	330/- Per bag	2970.0/-
	Sand (local)	1.8 m³	1500/- Per m³	2700.0/-
			Total	5670.0/-
2)	labours:-			
	Head mason	1/3 No's	425.0/-	141.70/-
	mason	10 No's	400.0/-	4000.00/-
	Mazdoor	15 No's	250.0/-	3750.00/-
	Brick (Water mark)	3/4 No's	230.0/-	172.50/-
	Sundries	Lumpsum	300.0 L.S	300.0/-
			Total	8364.2/-
	Total	material & labour	=	14034.2

Add 1.5% of water charge = 210.393

Add 10% Contractor profit = 1403.42

Cost for 100m² = 15648.193/-

Cost for 1 m² = 1564.81/-

2) 12mm cement plastering in ceiling 1:3 with Coarse sand

Unit – 1 Sq.m

Sol:- Given data

Take = 1m³

Proportion = 1:3, Dry volume = 1.8 m³

Quantity of cement = $\frac{1}{1+3} \times 1.80 = 0.45\ m^3$

No of bags of cement = $\frac{0.45 \times 29}{1}$ = (13.5 bags)

Quantity of sand = 0.45 × 3 = 1.35 m³

Item No	Particular of Item	Quantity	Rate	Cost
1	materials:-			
	Cement	0.45 m³ (13.5 bag)	330/- Per bag	4455/-
	Sand (Coarse)	1.35 m³	1800/- Per m³	2430/-
			Total	6885/-
2	labours:-			
	Head mason	1/3 No's	425/-	141.7/-
	Mason	12 No's	400.0/-	4800.0/-
	Mazdoor	15 No's	250.0/-	3750.0/-
	Bishti	1 No's	230.0/-	230.0/-
	Scaffolding & sundries Etc.	lumpsum	250.0 L.S	250.0/-
			Total	9171.7/-
	Total material & labours = 16056.7/-			
	Add 1.5% of water charge = 240.85/-			
	Add 10% of contractor profit = 1605.67/-			
	Cost for 100m² = 17903.22/-		Cost for 1m² = 179.03/-	

3). 6mm thick cement 1:3 in R.c.c ceiling — unit 1 sqm

Sol:- Given data

Proportion = 1:3

Dry volume = 1.0 m³

Quantity of cement = $\frac{1}{1+3} \times 1 = 0.25\ m^3$

" sand = $0.25 \times 3 = 0.75\ m^3$

No of bags of cement = $\frac{0.25 \times 29}{1} = 7.5$ bags

Item no	Particulars of item	Quantity	Rate	Cost
1	materials :-			
	Cement	0.25 m³ (7.5 bags)	330/-	2475/-
	Sand (coarse)	0.75 m³	1800/-	1350/-
			Total	3825/-
2)	labours :-			
	Head mason	1/4 Nos	425.0/-	106.25/-
	Mason	12 Nos	400.0/-	4800.0/-
	Mazdoor	10 Nos	250.0/-	2500.0/-
	Bhishti	3/4 Nos	230.0/-	172.5/-
	Sundries, scaffolding T and P etc.	lumpsum	125.00/-	125.0/-
			Total	7703.75

Total material & labour = 11528.75 /-
Add 1.5% of water charges = 172.93/-
Add 10% of contractor profit = 1152.875/-
Cost for 100 sq.m = 12854.55 /-
cost for 1 sq.m = 128.54/-

Rate Analysis for Pointing :-

For pointing in brickwork the total dry volume of materials is taken as 0.60 m³ for 100 sq.m

1). Cement mortar 1:2 — 0.20 m³ cement (6 bags) and 0.4 m³ sand.
2) Cement mortar 1:3 — 0.16 m³ " (4.8 bags) and 0.48 m³ sand.
3). White lime and surkhi — 0.32 m³ lime (slaked) and 0.32 m³ surkhi.
4). Kankar lime mortar above — 0.50 m³ kankar lime

For all types of pointing the quantity of materials may be taken same as above, except raised pointing where the quantity may be increased by 10%.

1). Cement Pointing 1:2 - Unit 1 sqr.m

Sol:- Given data

Take = 100 sqr.m

Proportion = 1:2

Item No	Particular of item	Quantity	Rate	Cost
1	Materials:-			
	Cement	0.20 m³ (6 bags)	330/-	1980.0/-
	Sand (local)	0.40 m³	1500/-	600.0/-
2)	labours:-		Total	2580.0/-
	Head Mason	1/3 Nos	425.0/-	141.70/-
	Mason	10 Nos	400.0/-	4000.0/-
	Mazdoor	10 Nos	250.0/-	2500.0/-
	Bhisti	1/2 Nos	230.0/-	115.0/-
	Scaffoldins, Sundries T. and P etc. - -	lumpsum	150.Ls	150.0/-
			Total	6906.7/-

Total material & labours = 9486.7/-

Add 1.5%. water Charges = 142.305/-

Add 10%. Contractor Profit = 948.67/-

Cost for 100m2 = 10577.67/-

Cost for 1 m² = 105.776/-

Rate Analysis for flooring :-

* 2.5cm thick floor for 100 sq.m :-

Volume of flooring = $100 \times 0.025 = 2.5\ m^3$

10% for unevenness = $2.5 + \frac{10}{100} \times 2.5 = 2.75\ m^3$

50% more for dry volume = $2.75 + \frac{50}{100} \times 2.75$

Dry volume = $4.125\ m^3$

* 2 cm thick floor for 100 sq.m :-

volume of flooring = $100 \times 0.02 = 2\ m^3$

10% for unevenness = $2 + \frac{10}{100} \times 2 = 2.2\ m^3$

50% more for dry volume = $2.2 + \frac{50}{100} \times 2.2$

Dry volum = $3.3\ m^3$

* 4cm thick floor for 100 sq.m :-

Volume of flooring = $100 \times 0.04 = 4\ m^3$

10% for unevenness = $4 + \frac{10}{100} \times 4 = 4.4\ m^3$

50% more for dry volume = $4.4 + \frac{50}{100} \times 4.4$

Dry volume = $4.84\ m^3$

Problem :-

1. 2.5cm cement concrete floor 1:2:4 unit - 1 sq.m

Sol :- Given data

Proportion = 1:2:4

Take = $10\ m^3$

Quantity of cement = $\frac{1}{1+2+4} \times 4.125$

$= 0.58 \approx 0.6\ m^3$

Quantity of sand = $0.6 \times 2 = 1.2\ m^3$

Quantity of stone ballast 20mm = 0.6×4

$= 2.4\ m^3$

No of bags of cement = 18 bags

Item No	Particular of item	Quantity	Rate Rs Rs	Cost Rs P
1)	materials:-			
	cement	0.60 m³ (18 bags)	330/-	5940.0/-
	sand (coarse)	1.20 m³	1800.0/-	2160.0/-
	stone ballast (20mm)	2.40 m³	2400.0/-	5760.0/-
	for coneal finishing	0.2 m² (6 bags)	330/-	1980.0/-
			Total	15840
2)	labours:-			
	head mason	3/4 NO'	425/-	318.75/-
	mason	10 NO'S	400.0/-	4000.0/-
	mazdoor	5 NO'S	250.0/-	1250/-
	Boy or women coolies	5 NO'S	230.0/-	1150.0/-
	Bhishti (including curing)	2 NO'S	230.0/-	460.0/-
	Side forms	lumpsum	300.0 L.S	300.0L.S
	Sundries T and P etc	lumpsum	120.0 L.S	120.L.S
			Total	7598.75

Total materials & labours = 23438.75/-

Add 1.5% water charge = 351.58/-

Add 10% Contractor profit = 2343.87/-

Cost for 100 m² = 26134.2/-

Cost for 1 m² = 261.34/-

2). 2cm cement concrete floor 1:3 proportion 100 sq.m:-

Sol:- Given data

Proportion = 1:3

Take = 100 m² ; Dry Volume = 3.3 m³

Quantity of cement = $\frac{1}{4}$ x 3.3 = 0.825 m³ ≈ 0.9 m³

Quantity of sand = 0.9 x 3 = 2.7 m³

No of bags of cement = $\frac{0.9 \times 29}{1}$ = (26

same procedure to Prepare the schedules of materials and labours.

3). 2cm Thick damp proof course (D.P.C) with cement mortar 1:2 - unit 1 sq.m.

Sol:- Given data

Proportion = 1:2

Take = 100 sq.m

Volume of DPC = $100 \times 0.02 = 2\ m^3$

Add 15% of joints and unevenness,

The volume of mortar = $2 \times \frac{15}{100} + 2 = 2.3\ m^3$

Add 20% the total dry volume

dry volume = $2.3 + \frac{20}{100} \times 2.3 = 2.76\ m^3$

Quantity of cement = $\frac{1}{1+2} \times 2.76 = 0.92\ m^3$

" of sand = $0.92 \times 2 = 1.84\ m^3$

No of bags of cement = 26.68 ≈ 27 bags

Item No	Particular of item	Quantity	Rate	Cost
1)	Materials:-			
	cement	0.92 m³ (27 bags)	330/-	8910.0/-
	Sand (Coarse)	1.84 m³	1800.0/-	3312.0/-
	(Cem-seal or Impermo (1Kg per bag of cement)	27.00 Kgs	75.00/-	2025.0/-
			Total	14247.0/-
2)	Labours:-			
	Head mason	½ No's	425.0/-	212.5/-
	mason	5 No's	400.0/-	2000.0/-
	Mazdoor	5 No's	250.0/-	1250.0/-
	Bhishti (including cur	1 No's	230.0/-	230.0/-

form finishes	lumpsum	250.00	250.0/-
sundries	lumpsum	100.00	100.0/-
		Total	4401.2

Total materials and labours = 18289.5/-

Add 15% water charges = 2743.4/-

Add 10% Contractor profit = 1828.95/-

Rate Per two Sq.m = 20392.79/100 /-

Rate Per 1 Sq.m = 203.92/-

4). 2.5 cm thick cement concrete 1:1½:3 DPC - unit 1 Sq.

Sol:- Given data

Proportion = 1:1½:3

Take = 100 Sq.m

Volume of plastering = 100 x 0.025 = 2.5 m³

Add 25% of fill up joints & unevenness.

The volume of Mortar = 2.5 + 25/100 x 2.5

= 3.125 m³

Add 35% the total dry volume

dry volume = 3.125 + 30/100 x 3.125

= 4.062 m³

Quantity of cement = 1/(1+1.5+3) x 4.062

= 0.765

of sand = 1.14 m³

Quantity of stone ballast 12 mm gauge (stone chips)

$= 0.76 \times 3 = 2.28\ m^3$

No of bags of cement $= \frac{0.76 \times 29}{1} = 22.5$ bags

Item No	Particular of item	Quantity	Rate	Cost
1	materials :-			
	→ Cement	0.76 m³ (22.5)	330/-	7425.0/-
	→ sand (coarse)	1.14 m³	1800/-	2052.0/-
	→ Stone ballast 12mm gauge (stone chips)	2.28 m³	1900/-	4332.0/-
	→ Cem-seal or Impermo (1 Kg per bag	22.50 Kgs	75/-	1687.5/-
			Total	15496.5/-
2	labours :-			
	Head mason	1/3 No	425/-	141.67/-
	mason	8 No's	400/-	3200.0/-
	Mazdoor	8 No's	250/-	2000.0/-
	Bhishti (including Coolies)	1 No's	230/-	230.0/-
	Form Invides	lumpsum	250.0/-	250.0/-
	Sundries and Petc	lumpsum	100.0/-	100.0/-
			Total	5921.67/-

Total material & labours = 21418.17/-

Add 1.5 % of water charges = 321.27/-

Add 10 % of contractor profits = 2141.817/-

Rate Per 100 Sq.m = 23881.25/-

Rate Per 1 Sq.m = 238.81/-

* Importants formulas and percentages :-

⇒ Lime concrete = 54% of Dry volume total

Dry volume = 15.4 m³

⇒ Cement concrete - 54% of total Dry volume

Dry volume = 15.4 m³

⇒ Rcc works = 54% of total Dry volume

Dry volume = 15.4 m³

Steel taken in quintals = 785 Qu/10m³

⇒ R.B works :- No of bricks in 1 m³ = 500 Nos

No of bricks in 10 m³ = 5000 No's but (As per Standards) No of R.B Bricks = 4500 No's per

Volume of mortar - 2.305 m³

Add 15% wastages for Extra mortar = 2.65 m³

Dry volume = 3.84 m³ (Add 45% of total dry vol

Add 1% extra = 4.84 m³)

⇒ Rate Analysis for Brick masonary :-

Volume of mortar for 10m³ = 2.305 m³

Add 15% for Extra wastages = 2.65 m³ (Volume of mo

Add 25% for total dry volume = 3.20 m³ (dry volum)

⇒ Rate Analysis for plastering :-

Volume of plastering for 12mm = 1.2 m³

Add 30% of fill up joints and unevenness Surface etc

The Quantity of mortar = 1.56 m³

Add 25% of dry volume = 2.0 m³ (dry volume)

Volume of Plastering for 20mm = 2.0 m³

Add 20% of mortar fill up joints and uneven surface

The Quantity of mortar = 2.4 m³

Add 25% of total dry volume = 3 m³ (dry volume)

⇒ Rate Analysis for ceiling plastering :-

→ Volume of Plastering for 12mm = 1.2 m³

Add 20% of mortar fill up joints and uneven surface

The Quantity of mortar = 1.44 m³

Add 25% of total dry volume = 1.8 m³ (dry volume)

→ Volume of plastering for 6mm = 0.6 m³

The dry volume taken as standards value for 100sq.m

The dry volume for 100 Sq.m = 1 cu.m

→ Volume of flooring = 0.15 m³

Add 25% of total dry volume = 2.0 m³

⇒ Rate Analysis for flooring :-

⇒ The volume of flooring for 2.5cm = 2.5 m³

Add 10% for uneveness = 2.75 m³

Add 50% total dry volume = 4.125 m³

⇒ The volume of flooring for 2.0 cm = 2 m³

Add 10% for uneveness = 2.2 m³

Add 50% for total dry volume = 3.3 m³

⇒ The volume of flooring for 4.0 cm = 4 m³

Add 10% for uneveness = 4.4 m³

Add 50% for total dry volume = 4.84 m³

UNIT - 5
VALUATION

- Valuation is the analytical process of determining the current worth of an asset or a company.
- Valuation is the technique of estimation or determining the fair price or value of property such as building, a factory, other engineering structures of various types, land etc.
- By valuation the present value of a property is determined.
- The present value of property may be decided by its selling price, or income or rent it may fetch.
- The value of a property depends on its structure, life, maintenance, location, bank interest, legal control etc.
- The value also depends on supply on demand and the purpose for which valuation is required.

PURPOSE OF VALUATION:

- **Buying or Selling Property:**

✓ When it is required to buy or sell a property, its valuation is required.

- **Taxation:**

✓ To assess the tax of a property, its valuation is required.

✓ Taxes may be municipal tax, wealth tax, Property tax etc, and all the taxes are fixed on the valuation of the property.

- **Rent Fixation:**

✓ In order to determine the rent of a property, valuation is required. Rent is usually fixed on the certain percentage of the amount of valuation which is 6% to 10% of valuation.

- **Security of Loans or Mortgage:**

✓ When loans are taken against the security of the property, its valuation is required.

- **Compulsory Acquisition:**

✓ Whenever a property is acquired by law; compensation is paid to the owner. To determine the amount of compensation, valuation of the property is required.

- Valuation of a property is also required for Insurance, Betterment charges, speculations etc.

- **Role of An Engineer:**

✓ The roll of an Engineer in valuation is felt when an Engineering structure is to be valued, if and when it is: -

To be acquired

To be divide

To be allotted to a claim holder.

FACTORS CONSIDERATION FOR VALUATION:

- **Locality: -**

✓ In case a building is located in such an area, where there is easy access to market, schools and is located on road side.

✓ The Orientation of the building is according to Engineering rules.

✓ It will fetch more cost than a building which is in a neglected condition and is locate at unhealthy site.

- **Structure:**

✓ The structure of a building is also an important consideration while evaluating a building.

✓ Workmanship I attractive and the building is properly maintained, it will fetch more cost than the building in a neglected form with poor quality of material used.

- According to specifications a building is divided in four classes:-
  - ✓ First Class
  - ✓ Second Class
  - ✓ Third Class
  - ✓ Fourth Class

- **Value:**

✓ Present day cost of a Engineering structure (Saleable value)

- **Cost:**

✓ Original cost of construction.

✓ It is used to find out the loss of value of property due to various reasons.

IMPORTANT TERMS

- **Municipal Taxes:**

✓ Municipality needs money in order to undertake and maintain public utility services and the same is collected by imposing taxes on the property.

- ✓ The main utility works areroads, drainages, water supply tec. and the construction and maintenance.
- ✓ The taxes are assessed on some percentage basis on the net income from the property and varies from 10 % to 25 % of the net income.
- ✓ Usually for small houses the taxes are less and for big houses the taxes arehigh.

➢ **Capital Cost:**

- ✓ Capital cost is the total cost of a construction including land or the original amount required to possess a property.
- ✓ It is the original cost and does not change, while value of a property is the present cost which may be calculated by methods of valuation.

➢ **Capitalized Value:**

- ✓ The capitalized value of a property is the amount of a money whose annual interest at the highest prevailing rate of interest will be equal to the net income from the property.
- ✓ To determine the capitalized value of a property it is required to know the net income from the property and the highest prevailing rate of interest.

➢ **Year's Purchase (Y.P):**

- ✓ Year's purchase is defined as the capital sum required to be invested in order to receive an annuity of Rs. 1 at certain rate of interest.
- ✓ For 4 % interest per annum to get Rs.4 it requires Rs.100 to be deposited in a bank.
- ✓ To get Rs.1 per year it will be required to deposit ¼ of Rs.100 i.e 100/4 = Rs.25.
- ✓ Year's Purchase = 100/Rate of interest

➢ **Gross Income:**

- ✓ Gross income is the total income and includes all receipts from various sources of outgoings and the operational and collection charges are not deducted.

➢ **Net Income or Net Return:**

- ✓ This is the saving or the amounts left after deducting all outgoings, operational and collection expenses from the gross income or total receipt.

➢ **Outgoings:**

- ✓ Outgoings or expenses which are required to be incurred to maintain the revenue of the building.
- ✓ The various types of outgoings are as follows:

- Taxes
- Repairs

- Management and Collection charges
- Sinking Fund
- Loss of Rent
- Miscellaneous

Taxes:

These are annual taxes paid by the owner, such as wealth tax, property tax and municipal taxes (varies from 10% to 25% of net income).

Repairs:

For this 1 ½ % of the total construction is set aside for annual repairs of the building.

These repairs are must to maintain the building. It is also calculated as 10% of the gross income.

Management:

Upto 10% of the gross revenue is kept aside for this expense.

This includes, chowkidar sweeper etc. this is applicable only for big buildings or apartments

Miscellaneous:

This is again suitable for big buildings.

Lighting of common place, expenditure of liftman etc. are to be paid by the owner.

Loss of Rent:

This is also an outgoing in case a building in not fully occupied by the tenants.

This has to be deducted from gross income.

Insurance:

Premium given against fire or for theft policy.

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 reasons of this is fast changing techniques of construction, design, ideas leading to more comfort etc.

Free Hold Property:

- ✓ Any property which is in complete possession f the owner is known as free hold property.
- ✓ The owner can use the property in an way he likes.

- ✓ But he will have to follow constraints fixed by town planners or Municipality before doing any construction.

Lease Hold:

- ✓ If a property is given to some person on yearly payment basis by the free holder, then the property is called „lease hold property" and the person who take s the property is called Lease-holder.
- ✓ In case of building, the lease is for 99 years to 9 years.
- ✓ Types of Lease
    - Building Lease
    - Occupation Lease

Easement:

- ✓ An owner getting over the property of another person, the following faculties is known as easements.
- ✓ Facility of running water and sewer pipes through other's land.
- ✓ Facility of air and light.
- ✓ Facility of drainage of rain water.
- ✓ Facility of access.

Scrap Value:

- ✓ If a building is to be dismantled after the period of 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.
- ✓ If varies from 8% to 10% of the cost of construction according to the availability of the material.
- ✓ In case where Wood & Steel are available, the scrap value is more than as R.C.C structure, as in the latter case, the material has less reuse value.

Salvage Value:

- ✓ If property after being discarded at the end of the utility period is sold without being broken into pieces, the amount thus realized by sale is known as its Salvage Value.
- ✓ For example, railway sleepers can be re-used as posts and even old iron rails taken out can be used as beams in a roof or sheds of a building.

Annuity:

- ✓ The return of capital investment in the shape of annual instalments (monthly, quarterly, half yearly & yearly) for a fixed number of years is known as annuity.

Market Value:

- ✓ It is defined as the value which a property can fetch when sold out in open market.
- ✓ This value is variable, depending upon the will to buy or sell.

Book Value:

- ✓ It is the amount of a property shown in the books, after allowing necessary depreciations year-wise.
- ✓ The book value is independent of market-value.

Sinking Fund:

The fund which is gradually accumulated by way of periodic on annual deposit for the replacement of the building or structure at the end of its useful life is termed as sinking fund.

The calculation of sinking fund depends on the life of the building and scrap value of the building for the cost of old materials.

The cost of land is not taken into account in calculating sinking fund as land remains intact.

This is also taken as outgoings.

A fund which is gradually accumulated and aside to reconstruct the property after the expiry of the period of utility is known as sinking Fund.

The sinking funds may be found out by taking a sinking fund policy with any insurance company or depositing some amount in the bank.

Generally, while calculating the sinking fund, life of the building is considered.

90% of cost of construction is used for calculations & 10% is left out as scrap value.

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

Where, S = total amount of Sinking fund to be accumulated

n = number of years required to be accumulated the Sinking fund

i = rate of interest in decimal

I = annual instalment required.

PROBLEMS ON DETERMINATION OF SINKING FUND:

1. A pumping set with a mortar has been installed in a building at a cost of Rs.2,500.00. Assuming the life of the pump as 15 years, work out the amount of annual instalment of Sinking fund required to be deposited to accumulate the whole amount of 4 % compound interest.

Solution:

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

$$= \frac{2500 \text{ X } 0.04}{(1 + 0.04)^{15} - 1}$$

= Rs.125

2. The cost of newly constructed building is Rs.1,00,000. Assuming the future life of the building is 20 years. Calculate the amount of annual sinking fund @5 % compound interest.

Solution:

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

$$= \frac{100000 \text{ X } 0.05}{(1 + 0.05)^{20} - 1}$$

= Rs.3024

3. An old building has been purchased by a person at a cost of Rs.30,000/- excluding the cost of the land. Calculate the amount of annual sinking fund at 4 % interest assuming the future life of the building as 20 years and the scrap value of the building as 10 % of the cost of purchase.

Solution:

The total amount of Sinking fund to be accumulated at the end of 20 years,

S = 30000 X 90/100 = Rs. 27,000.00

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

$$= \frac{27000 \text{ X } 0.04}{(1 + 0.04)^{20} - 1}$$

= Rs.907.20

4. An old building was purchased by a person for Rs.2,00,000. Calculate the co-efficient of sinking fund, amount of sinking fund and yearly instalment of sinking fund, if the future life of the building is 15 years, rate of interest is 5 % and scrap value is taken as 10 % of the cost of the purchase.

Solution:

Cost of purchase = Rs.2,00,000

Scrap value = 200000 X 10/100 = Rs.20,000

1. Co-efficient of sinking fund:

$$I_C = \frac{I}{(1+i)^n - 1} = \frac{0.05}{(1 + 0.05)^{15} - 1} = 0.0463$$

2. Annual Instalment of sinking fund:

$$I = \frac{Si}{(1+i)^n - 1} = S \text{ X } I_C = 180000 \text{ X } 0.0463 = \text{Rs.}8334$$

3. Total amount of sinking fund:

Total amount of sinking fund, S = 200000 – 20000 = 1,80,000

5. A person has purchased an old building at a cost Rs.100000 on the basis that cost of land is Rs.40000 and cost of building is Rs.60000. Considering the future life of the building structure be 20 years. Work out the amount of annual sinking fund at 4 % interest when scrapvalue is 10 % of the cost of building structure.

Solution:

Scrap Value = 10 % cost of building structure

= 10/100 X 60000 = Rs.6000

Total amount of sinking fund = 60000 – 6000 = Rs. 54000

1. Annual sinking fund:

$$I = \frac{Si}{(1+i)^n - 1} = \frac{54000 \text{ X } 0.04}{(1 + 0.04)^{20} - 1} = \text{Rs.}1813$$

6. A property fetches a net annual income of Rs.900.00 deducting all outgoings. Workout the capitalized value of the property if the rate of interest is 6 % per annum.

Solution:

Year's purchase (Y.P) = 100 / 6 = 16.67

Capitalized value of the property = Net income X Y.P = 900 X 16.67

= Rs.15003.00

VALUATION OF BUILDING:

- **Cost Determination Methods:**
  - ✓ Cost from record
  - ✓ Cost from detailed measurement
  - ✓ Cost by plinth area basis

METHODS OF VALUATION:

- The following are the various methods of valuation:
  - ✓ Depreciation method of valuation
  - ✓ Valuation based on cost
  - ✓ Valuation based on profit
  - ✓ Valuation by Development method
  - ✓ Rental method of valuation

Depreciation Method of Valuation:

In this method, the structure is divided into four parts for calculating depreciation:

Walls

Roofs

Floors

Doors and Windows

The measurement is done accurately and the cost is found out using current rates.

Depreciated value, $D = P \left(100 - rd \right)^n$

100

Where, D – Depreciated Value

P – Cost at present market rate

rd – Fixed percentage of depreciation

r – Rate

d – Depreciation

n – Number of years the building had been constructed.

- ✓ Structures with 100 years life, rd = 1.0
- ✓ Structures with 75 years life, rd = 1.3
- ✓ Structures with 50 years life, rd = 2.0

- ✓ Structures with 25 years life, rd = 4.0
- ✓ Structures with 20 years life, rd = 5.0

METHODS TO CALCULATING DEPRECIATION:

- Straight line method
- Constant percentage method or Declining balance method
- Sinking fund method

Straight Line Method:

$$\text{Annual Depreciation, } D = \frac{C - S}{n}$$

Where, C – Original capital cost

n – Age of the property in years.

S – Scrap Value or Salvage value.

Constant Percentage Method:

Annual Depreciation, $D_m = C\,[\,(1 - r)^{m-1} - (1 - r)^m\,]$, $\quad r = 1 - (S/C)^{1/n}$

Sinking Fund Method:

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

VALUATION BASED ON COST:

- ✓ In this method, the actual cost of the construction is found out and valuation is done after considering depreciations and the points of obsolescence should also be considered.

VALUATION BASED ON PROFIT:

- ✓ This method of valuation is suitable for buildings like cinema theatres, hotels, banks, big shop etc. for which the capitalized value depends on the profit.
- ✓ The capitalized value is calculated by multiplying year's purchase with net profit.
- ✓ In such cases, valuation may work out to be too high in comparison with the cost of construction.
- ✓ The net profit is worked out after deducting all possible outgoings and expenditures from the gross income.
- ✓ In such cases the cost will be too high as compared with the cost of construction actually incurred.

VALUATION BY DEVELOPMENT METHOD:

- ✓ This method of valuation is used for the properties which are in the undeveloped stage or partly developed and partly undeveloped stage.
- ✓ If a large place of land is required to be divided into plots after providing for roads, parks etc., this method of valuation is to be adopted.
- ✓ This method is also used for working out the value of a building.
- ✓ If a building is required to be renovated by making additions, alterations or improvements, development method of valuation may be used.
- ✓ In cases, when the building is still under development.
- ✓ In this case the future development of the building and profits from it should be anticipated while evaluating.

RENTAL METHOD OF VALUATION:

- ✓ Rent of a building is used as a base for calculating value of a building.
- ✓ In this method the net income by way of rent is found out after deducting all out goings from the gross rent.
- ✓ A suitable rate of interest prevailing in the market is assumed and year's purchase (Y.P) is calculated.
- ✓ Based on the above rate of interest, the net income multiplied by Y.P gives the capitalized value or valuation of the property.
- ✓ This method is applicable only when the rent is known or probable rent is determined by enquiries.

FIXATION OF RENT:

- ✓ The rent of building is fixed on the basis of certain percentage of annual interest on the capital cost and all possible annual expenditures on outgoings.
- ✓ The capital cost includes the cost of construction of the building, the cost of sanitary and water supply work, cost of electric installations and cost of subsequent additions and alterations if any.
- ✓ The cost of construction also includes the expenditures on the following:

- Raising, levelling and dressing sites
- Construction of compound walls, fences and gates, Storm water drains
- Approach road and other roads within the compound.
- Gross rent = Net rent + outgoings and Gross rent per month = Gross rent/12
- The rent worked out by this procedure is known as standard rent, while the actual rent of the property, may be higher or lower than this rent depending upon the situation of the property, type of construction, demand and supply etc.

PROBLEMS IN CALCULATING DEPRECIATION VALUE:

7. A building has been constructed for Rs.1200000. Assuming its salvage value at the end of 6 years as Rs.300000, determine the amount of depreciation and book value for the 6 years by Straight line method, Constant percentage method and Sinking fund method 4 % rate of interest.

Solution:

1. Amount of depreciation by Straight line method,

$$D = \frac{C - S}{n} = \frac{1200000 - 300000}{6} = \text{Rs.1,50,000}$$

Total Depreciation at 5^{th} year, DT = 150000 X 5 = Rs.7,50,000

Book value at the end of 5^{th} year (B) = C – DT = 1200000 – 750000 = Rs.4,50,000

2. Amount of depreciation by Constant percentage method,

Rate of depreciation, $r = [\ 1 - (S/C)^{1/n}] = [\ 1 - 300000/1200000)^{1/6}\ ]$

$= 1 - 0.7936 = 0.2064$

Annual Depreciation for the 5^{th} year,

$D = C [\ (1 - r)^{m-1} - (1 - r)^{m}\ ]$

$= 1200000 [\ (1 - 0.2064)^{5-1} - (1 - 0.2604)^{5}\ ]$

$= 1200000 [\ 0.39666 - 0.3147]$

$= 98352$

Total Depreciation at the end of 5 year,

$D_T = C [1 - (1 - r)^5\ ] = 1200000 [\ 1 - 0.3147] = 822360$

Book Value at the end of 5-year, B = C – DT = 1200000 – 822360

$= 377640$

2. Amount of depreciation by Sinking fund method,

S = C – Salvage value

$= 1200000 - 300000 = 900000$

$$I = \frac{Si}{(1+i)^n - 1} = \frac{900000 \text{ X } 0.04}{(1 + 0.04)^6 - 1} = 135685.71$$

Annual Depreciation for the 6 year, $D = I (1 + i)^{6-1} = 135695.43 (1 + 0.04)^{6-1}$

$= 165082.41$

Total Depreciation at the end of 6 year,

$$D_T = \frac{I [(1 + i)^6 - 1]}{i}$$

$$= \frac{135685.71\ [\ (1 + 0.04)^{6} - 1\ ]}{0.04}$$

$$= 899999.985$$

Book Value at the end of 6 year,

$$B = C - D_T = 1200000 - 899999.985$$

$$= 300000.015$$

8.The estimated cost of a building is Rs. 20,000. It is 20 years old & well maintained. The life of the structure is assumed to be 80 years. Work out the cost of building for acquisition solution.

Solution:

Life of the building is given as 80 years, rd = 1.

Depreciated value, $D = \frac{P\ (100 - rd\ )^{n}}{100}$

$$= \frac{20000\ (100 - 1)^{20}}{100}$$

$$D = \text{Rs.16,400.}$$

9.A plot measures 500 sq.m. The built-up area is 300 sq.m. The plinth area rate of this 1st class building is Rs.600/- per sq/metre. This rate includes cost of water supply, sanitary and electric installation. The age of the building is 40 years. The cost of the land is Rs.80/- per sq.m.

Solution:

Cost of land = 500 x 80 = Rs.40,000/-

Cost of building = 300 x 600 = Rs. 1,80,000/-

Life of a building is given 40 years. So rd = 2.

The depreciated value, $D = \frac{P\ (100 - rd\ )^{n}}{100}$

$$= \frac{180000\ (100 - 2)^{40}}{100}$$

$$= 180000 \text{ x } 0.466$$

$$D = \text{Rs. } 80280/-$$

Total value of property = 80280 + 40000 = Rs. 120,280/-

10.A building is situated on Ambala-Kalka road and costs Rs.38,000/-, considering its scrap value as 10% of the cost and life as 80 years. Find out depreciated value if the life of the building is 20 years.

Solution:

$$D = \frac{C - S}{n}$$

C =Rs.38,000, S =10% or Rs.3,800, n = 80 years.

$$D = \frac{38000 - 3800}{80} = \text{Rs.428 per year}$$

In 20 years = 428 x 20 = Rs. 8560

Value of property = 38000 – 8560

Value of property = Rs.29,440

11.A building is situated by the side of a main road of Lucknow city on a land of 500 sq.m. The built-up portion is 20 m X 15 m. The building is first class type and provided with water supply, sanitary and electric fittings and the age of the building is 30 years. Workout the valuation of the property.

Solution:

Plinth area of the building = 20 m X 15 m = 300 sq.m

Assuming the plinth area rate as Rs.200 per sq.m including water supply, sanitary and electric fittings, the cost of the building = 300 X 200 = Rs.60,000

Considering the life of the building as 100 years, the depreciated value of the building:

$$D = \frac{P\,(100 - rd)^n}{100}$$

$$= \frac{60000\,(100 - 1)^{30}}{100}$$

D = Rs. 44,280/-

The cost of land assuming Rs.60 sq.m = 500 X 60 = Rs.30,000

Total valuation of property = 44280 + 30000

Total valuation of property= Rs.74,280

12.A Building costing Rs.7,00,000 has been constructed on a freehold land measuring 1000 sq.m recently in a big city. Prevailing rate of land in the neighbourhood is Rs.150 per sq.m. Determine the net rent of the property, if the expenditure on an outgoing including sinking fund is Rs.24,000 per annum. Work out also the gross rent of the property per month.

Solution:

Cost of construction = Rs.7,00,000

Cost of land @ Rs.150 per sq.m = 1000 X 150 = Rs.1,50,000

Net Return:

On building@ 6 % on the cost of construction = 7,00,000 X 6/100

= Rs.42,000

On the land @ 4 % on the cost of land = 1,50,000 X 4/100

= Rs.6,000

Total net rent per year = 42,000 + 6,000

= Rs.48,000

Gross rent = Net rent + outgoings = 48,000 + 24,000 = Rs.72,000 per annum.

Gross rent per month = 72000 / 12 = RS.6,000

Problem:

In a plot of land costing Rs.20,000 a building has been newly constructed at a total cost of Rs.80,000 including sanitary and water supply works, electrical installation, etc. The building consists of four flats for four tenants. The owner expects 8 percent return on the cost of construction and 5 percent return on the cost of land. Calculate the standard rent for each flat of the building consisting:

i) The life of the building as 60 years, and sinking fund will be created on 4 % interest basis.

ii) Annual repairs cost at 1 % of the cost of construction.

iii) Other outgoings including taxes at 30 % of the net return of the building.

Solution:

Net return required on land per annum = 20,000 X 5/100 = Rs.1,000

Net return required on building per annum = 80,000 X 8/100 = Rs.6,400

Total net return per annum = Rs.7400

Expenditure on outgoings per annum:

1) Annual repair @ 1 % on cost of building = 80,000 x 1/100 = Rs.800
2) Sinking fund @ 4 % for 60 years on 90 % of building cost,

= 80,000 X 90/100 X 0.42/100

= Rs.302.40

0.42 % being the amount of sinking fund per annum of Rs.100

3) Other outgoings at 30 % of net return on building = 6,400 X 30/100 = Rs.1920

Total expenditure on outgoing per annum = Rs.3022.40

Gross rent = Net return + outgoings = 7400 + 3022.40 = Rs.10,422.40

per annum

Standard rent per month = 10,422.40 / 12 = Rs.868.53

Standard rent per flat per month = 868.53/4 = Rs.217.13

Problem:
A three-storied building is standing on a plot of land measuring 800 sq.m. The plinth area of each storey is 400 sq.m. The building is of R.C.C framed structure and the future life may be taken as 70 years. The building fetches a gross rent of Rs.1500 per month. Work out the capitalized value of the property on the basis of 6 % net yield. For sinking fund 3 % compound interest may be assumed. Cost of land may be taken as Rs.40 per sq.m. Other data required may be assumed suitably.

Solution:

Gross income per year = 1500 X 12 = Rs.18,000

Outgoings per annum by assuming suitable data:

1) Repairs @ 1/12 gross income = Rs.1500

2) Municipal tax 20 % of gross rent = 18000 X 20/100 = Rs.3600

3) Property tax 5 % of gross rent = 18000 X 5/100 = Rs.900

4) Insurance premium @ ½ % of gross rent = 18000 X 0.5/100 = Rs.90

5) Management charges @ 6 % of gross rent = 18000 X 6/100 = Rs.1080

6) Other miscellaneous charges @ 2 % of gross rent = 18000 X 2/100 = Rs.360

7) Sinking fund required to accumulate the cost of the building (which is at the rate of rs150 per sq.m of plinth area = 400 X 3 X 150 = Rs.180000) in 72 years @ 3 % interest.
= 180000 X 0.0043 = Rs.774

Total outgoings per annum = Rs.8304

Net annual return = 18000 – 8304 = Rs.9696

Capitalized value of the property = Net income X Y.P = 9696 X 100/6

= Rs.161600

Cost of land @ Rs.40 per sq.m = 800 X 40 = Rs.32000

Total = Rs.193600

Total value of the whole property is Rs. 193600

Problem:
coloniser intends to purchase a land of 100000 sq.m area located in the suburb of a big city to develop it into plots of 700 sq.m each after providing necessary roads and parks and other amenities. The current sale price of small plots in the neighbourhood is Rs.30 per sq.m. The coloniser wants a net profit of 20 %. Workout the maximum price of the land at which the coloniser may purchase the land.

Solution:

Total area of land = 100000 sq.m

Deduct 30 % for roads, parks etc. = 30000 sq.m

Net area of plots = 70000 sq.m

Number of plots @ 700 sq.m per plot = 70000 / 700 = 100

Selling price per plot @ Rs.30 per sq.m = 700 X 30 = Rs.21000

Total price from sale of all plots = 21000 X 100 = Rs.2100000

Deduct expenses:

1) Cost of improving of land levelling and dressing @ Rs.0.25 per sq.m

= 100000 X 0.25 = Rs.25000

2) Cost of providing metallic roads drainage, water supply and electrification @ Rs.3 per sq.m of whole land = 100000 X 3 = 300000

3) Engineer's and Architect's fees for surveying, planning, sub-dividing and supervising @ 3 % on the sale price = 2100000 X 3/100 = Rs.63000

4) Other miscellaneous expenses @ 1 % on the price = 2100000 X 1/100 = Rs.21000

5) Coloniser's profit @ 20 % on the sale price = 2100000 X 20/100 = Rs.420000

Total expenditure = Rs.8,29,000

Maximum price of land in the undeveloped stage =

2100000-829000 = Rs.12,71,000

Maximum rate of purchase = 1271000 / 100000 = Rs.12.71 per sq.m

The coloniser may purchase the whole land @ Rs.12.71 per sq.m for a total amount of Rs.12.71 Lakhs.

PROBLEMS BASED ON RENT FIXATION:

16. Find the plinth area required for the residential accommodation for an Assistant Engineer in the pay scale of Rs.400 to Rs.1000 per month.

Solution:

Average Pay = 400 + 1000 /2 = Rs.700 per month.

Average Monthly Rent @ 10 % of salary = 700 X

10/100 = Rs.70 Average Annual Rent 70 X 12 =

Rs. 840

Capital cost of the building @ 6 % interest = 840 X

100/6 = Rs.14000 Plinth area required @ Rs.150 per

sq.m of plinth area = 14000 / 150

= 93.33 sq.m

Normally the quarters for the Assistant Engineer should be constructed at the cost of Rs.14000 having plinth area of 93.33 sq.m.

MORTGAGE:

✓ An owner can borrow money against the security of his property, and for that purpose he is required to grant an interest to the party advancing the loan.

✓ The loan is required to be returned in specified.

✓ The person who takes the loans is known as Mortgagor, and the person who advances the loan is known as Mortgagee, and the relevant document for the mortgage transaction is known as mortgage deed.