ESTIMATION AND SPECIFICATION (TH-II)

Lectures Notes & Question Bank

Government Polytechnic, Bhubaneswar

Diploma in Architecture Assistantship | IV Semester

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Lect. In AA

Contents

1 Introduction

1.1 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.

In case the funds available are less than the estimated cost the work is done in part or by reducing it or specifications 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.

1.2 Objective of Estimation

1. Estimate give 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.

1.3 Types of Estimates

An estimate prepared from the plans and specifications and evaluating the present market prices of materials is never the actual cost of work. Because the cost of materials and labour may vary during the period of its actual or due to variations and modifications of actual dimensions shown in the drawing or due to some unforeseen contingencies. The difference between the estimated and the actual cost will depend upon the skill and accuracy of the estimator. There are different kinds of estimates and they are –

1.3.1 Detailed Estimate

This includes the quantities and cost of everything required for satisfactory completion of work and this is the best and most reliable estimate that can be made. A detailed estimate is accompanied with (a) Re pork, (b) Specifications, (c) Detailed drawings showing plans, different sections, key or Index plan etc., (d) Design data and calculations, (e) Basic of rates adopted in the estimate. Such a detailed estimate is prepared for technical sanction, administrative approval and also to execute a contract with the eon tractor.

1.3.2 A preliminary or approximate or Rough Estimate

This IS an approximate estimate made to find out an approximate cost in a short time and thus enable the responsible authority concern to consider the financial aspect of the scheme for

according sanction to the same. Such an estimate is framed after knowing the rate of similar works and by the use of any one of the following methods of estimates -

1.3.2.1 Unit rate Estimate

In this method all costs of a unit quantity such as per k.m. for a highway, per meter of span fora bridge, per classroom for school building, per bed for hospital, per litre (or gallon) for water tank etc. are considered first and the estimate is prepared by multiplying the cost per corresponding unit by the number of units in the structure.

1.3.2.2 Plinth area Estimate

In this method the plinth area should be calculated by taking the external dimensions of the building at the plinth, Court yard and other open areas should not be included in the plinth area, At the beginning, when plan of a building has not yet been prepared or available determine the total floor area of all the rooms corridor, verandah, kitchen, W. C. and bath according to the requirement of the owner, and of the total areas thus found, may be added for walls and waste to get the approximate total plinth area. The plinth area thus found shall be multiplied by the plinth area rate for similar type design and specification of building at the locality.

1.3.2.3 Cubic rate estimate

The method of estimating building cost by the cubic meter (or cubic foot) of volume is more accurate in general, than the method of estimating cost by plinth area, because cost of building depends not only on their plinth area but also on their respective height. The best of estimating costs by the cubic rate is to find the volume of the building (length x breadth x height) and then multiply the volume by the local cubic rate for similar type of building, Length and breadth should be measured external to external excluding plinth offset, corbelling, string course etc. The height should be measured from the top of the flat roof (or half way of the sloped roof) to half the depth of the foundation below the plinth. Parapet is not to be included.

1.3.3 A quantity estimate or quantity survey

This is a complete estimate of the quantities of materials that may be required to complete the work concerned.

1.3.4 Revised Estimate

When a sanctioned estimate is likely to be exceeded by more than 5 percent either from the rates being found insufficient due to change to price level or from any cause whatever, except important structural alterations an estimate is prepared which is called a revised estimate, In case where important structural alterations are contemplated though not necessarily involving an increased outlay revised estimate should also be submitted for technical sanction. The method of preparation a revised estimate is same as that a detailed estimate. A comparative statement showing in an abstract form the probable variations of each item of works, its quantity, rate as compared with the original estimate stating the reasons of variations should be attached with it.

1.3.5   A Supplementary Estimate

While a work is in progress some additional works may be thought necessary for development of a project which was not foreseen when the original estimate framed and the expenditure for such supplementary work cannot be meet up from savings elsewhere within the Grant, an estimate is then prepared to cover up all such works which is known as supplementary estimate. The method of preparation of a supplementary estimate is same as that a detailed estimate and it should be accompanied by a full report of the circumstances which render it necessary. The abstract must show the amount of the original estimate and the total of the sanction required including the supplementary amount.

1.3.6   A complete Estimate

This is an estimated cost of all items which are related to the work in addition to the main contract or to the detailed estimate.

One may think that an estimate of a structure includes only the cost of land and the cost of the main contracts or labour, materials and supervision. But there are many other cost items to be included. A picture of a complete estimate is diagrammatically shown as below.

Complete Estimation
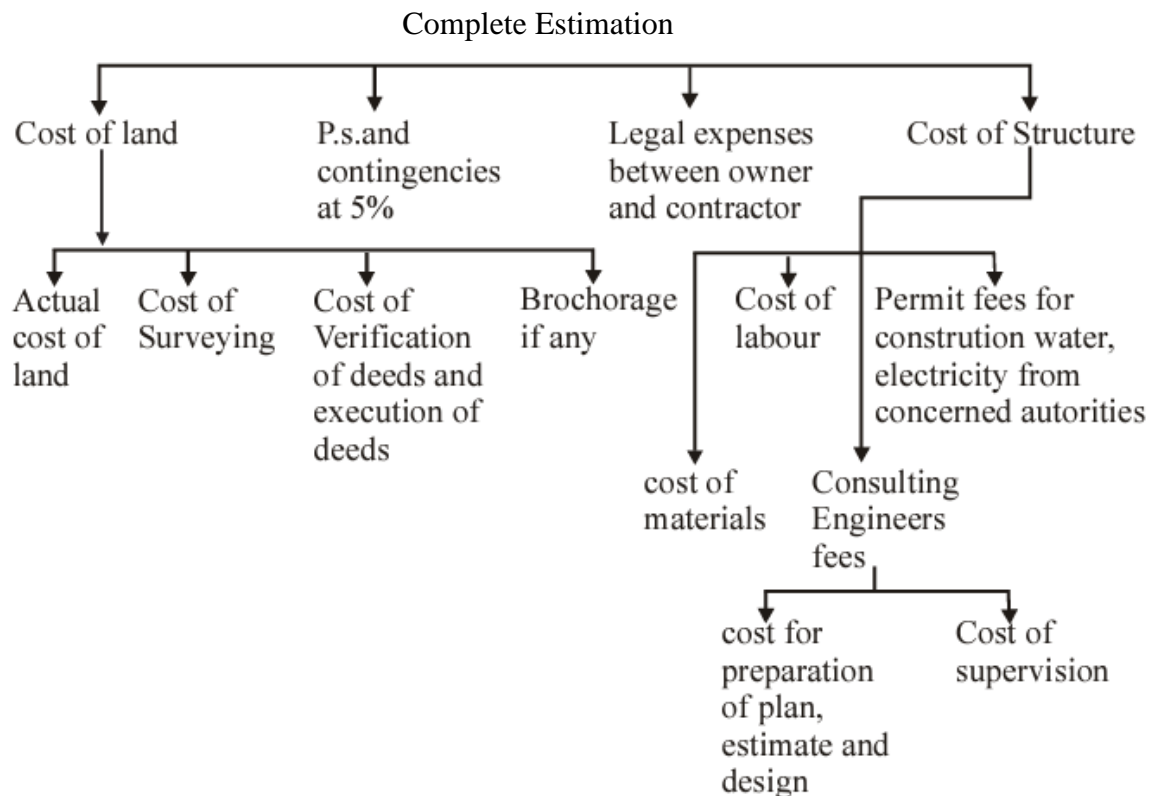
1.4   Method for preparing Plinth area estimate

The cost of construction is determined by multiplying plinth area with plinth area rate. The area is obtained by multiplying length and breadth (outer dimensions of building). In fixing the

plinth area rate, carefully 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 installations not exceeding 2.0m2, lifts, air-conditioning ducts etc.,
c) Area of barsati at terrace level: (Barsati 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 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 sun breakers.

Problems on Plinth Area Method

Example 3.1: Prepare an approximate estimate of building project with total plinth area of all building is 800 sqm. and from following data.

    i)   Plinth area rate Rs. 4500 per sqm

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

    iii)   Cost of Sanitary andElectrical installations each @ 7½% of cost of building.

    iv)   Cost of architectural features @1% of building cost.

    v)   Cost of roads and lawns @5% of building cost.

    vi)   Cost of P.S. and contingencies @4% of building cost.

Determine the total cost of building project.

Solution :

Data given:

Plinth area $= 800 m^2$.

Plinth area rate $=$ Rs. 4500 per Sqm.

∴   Cost of building $= 800 \times 4500 =$ Rs. 36,00,000=00

Add the cost of the water supply charges @7½%

$$= \frac{36,00,000 \times 7.5}{100} = 2,70,000 = 00$$

Add the Cost of Sanitary and electrical installation @ 15%

$$= \frac{36,00,000 \times 15}{100} = 5,40,000 = 00$$

Add the cost of archetectural features @1%

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

Add the cost of Roads Lawns @ 5% $= \dfrac{36,00,000 \times 5}{100} = 1,80,000 = 00$

Add the Cost of P.S. and contingencies @ 4%

$$= \frac{36,00,000 \times 4}{100} = 1,44,000 = 00$$

Total   **Rs.**   47,70,000=00

Assume Add supervision charges 8% on overall cost

$$= 47,70,000 \times \frac{8}{100} = 3,81,600 = 00$$

Grand Total Rs.   51,51,600=00

Example 3.2 : The plinth area of an appartment is 500 sqm. Detemine the total cost of building from the following data:

    a)   Rate of construction = Rs. 1230/--per m³.

    b)   The height of appartment = 16.25 m

    c)   Water Supply, Sanitary and Electrical installations each at 6% of building cost.

    d)   Architectural appearance @ 1% of building cost.

    e)   Unforeseen item @2% of Building cost.

    f)   P.S. and contingencies @4% of building.

Solution :

    a) The Cost of building = cubic content x cubic rate

$$= 500 \times 16.25 \times 1230 = \text{Rs. } 99,93,750/-$$

    b) Provision for water supply, sanitary and

Electrical installations water supply and sanitation each @ 6%

$$= \frac{99,93,750 \times 18}{100} = \text{Rs.} 17,98,875/-$$

    i.e total percent = 3×6 = 18% building cost

    c) Architectural appearance @1% $= \dfrac{99,93,750 \times 1}{100} = \text{Rs. } 99,937/-$

    d) Unforeseen items @2%   = Rs. 1,99,875/-

    e) P.S. and contingenies @4%   = Rs. 3,99,750/-

                              Total   **= Rs.1,24,92,187/-**

                              Sundries   7,813/-

Total cost of the building project = Grand Total = Rs.1,25,00,000/-

Example 3.3: The plinth area and plinth area rate of a residential building are 100 sqm and Rs. 5000/- respectively. Determine the total cost of building assuming suitable provisions.

Solution :

Cost of building = 100 x 5000 = Rs.5,00,000

Cost of water supply and

sanitary fittings @15% $= \dfrac{5,00,000 \times 15}{100}$ = Rs. 75,000

Cost of Electrification @7½% $= \dfrac{5,00,000 \times 7.5}{100}$ = Rs. 37,500

Cost of Roads & Lawns @5% $= \dfrac{5,00,000 \times 5}{100}$ = Rs. 25,000

Cost of P.S.& contingencies@4% $= \dfrac{5,00,000 \times 4}{100}$ = Rs. 20,000

Total Cost Rs. 6,57,500/-

Example 3.4 : Prepare an approximate Extimate of a proposed building from the follwoing?

Plinth area of the building = 226 sqm.

Cost of the structure = 2500 per sqm.

Water supply and sanitary arangements = 12½%

Electrification =7%

Fluctuation of rates = 5%

petty supervision charges = 3%

sol: Cost of Building = 226x 2500 = Rs.5,65,000

Water supply & Sanitory arrangements @ 12½ %

$= \dfrac{5,65,000 \times 12.5}{100}$ = Rs. 70,000

Electrification @7% $= \dfrac{5,65,000 \times 7}{100}$ = Rs. 39,550

Fluctuation of rates 5% $= \dfrac{5,65,000 \times 5}{100}$ = Rs. 28,250

Pettysupervision charges 3% $= \dfrac{5,65,000 \times 3}{100}$ = Rs.16,950

Total Cost Rs. = 7,19,750.00

QUESTIONS FOR PRACTICE:

A. Two Marks Questions:
1. Define Estimation.
2. Define different types of estimation.
3. Explain detailed estimation.
4. Define rough estimation.
5. Explain quantity estimation.
6. Define plinth area estimation.

B. Six Marks Questions:
1. Define estimation and explain the purpose of estimation.
2. Explain different types of estimations.

C. Ten Marks Questions:
1. Prepare an approximate estimate of building project with total plinth area of all building is 900 sqm and from following data.
    i. Plinth area rate Rs. 4400 per sqm
    ii. Cost of water supply @7.5% of building.
    iii. Cost of Sanitary and Electrical installations each @7.5% of cost of building
    iv. Cost of architectural features @1% of building cost
    v. Cost of roads and lawns @5% of building cost.
    vi. Cost of P.S. and contingencies @4% of building cost.

    Determine the total cost of budding project.

2   Units of Measurements

The units of measurements are mainly categorized 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 consists linear measurements involve length like cornice, fencing, hand rail, bands of specified width etc., are expressed in running meters (RM)
c) Works consists areal surface measurements involve area like plastering, white washing, partitions of specified thickness etc. are expressed in square meters (m2)
d) Works consists cubical contents which involve volume like earth work, cement concrete, Masonry etc are expressed in Cubic meters.

[BASED ON IS 1200 REVISED]

Sl. No.	Particulas of item	Units of Measurement	Units of payment
I	**Earth work:**		
	1. Earth work in Excavation	cum	Per%cum
	2. Earthwork in fillingin foundation trenches	cum	Per%cum
	3. Earth work in filling in plinth	cum	Per%cum
II	**Concrete:**		
	1. Lime concretre in foundation	cum	percum
	2. Cement concrete in Lintels	cum	percum
	3. R.C.C.in slab	cum	percum
	4. C.C. or R.C.C. Chujja, Sunshade	cum	percum
	5. L.C. in roof terracing (thickness specified)	sqm	persqm

	6. Cement concrete bed	cum	per cum
	7. R.C. Sunshade (Specified Width & Hight	cum	1rm
III	**Damp ProofCource (D.P.C)**		
	(Thickness should be mentioned)	sqm	persqm
IV	**Brick work:**		
	1. Brickwork in foundation	cum	percum
	2. Brick work in plinth	cum	percum
	3. Brick work in super structure	cum	percum
	4. Thin partition walls	sqm	percum
	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 sand windows frames or chowkhats, rafters beams	cum	percum
	2. Shutters of doors and windows (thickness specified)	sqm	persqm
	3. Doors and windows 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 Reinforcement	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

VIII	**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 pro-portion specified)	sqm	per sqm
	2. Pointing	sqm	per sqm
	3. White washing, colour washing, cement wash (number 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 40mm C.C. floor	sqm	per sqm
	3. Doors and window sills (C.C. or cement mortar plain)	sqm	per sqm
XI	**Rain water pipe /Plain pipe**	1RM	per RM
XII	**Steel wooden trusses**	1No	per 1No
XIII	**Glass pannels(supply)**	sqm	per sqm
XIV	**Fixing of glass panels or cleaning**	No	per no.

QUESTIONS FOR PRACTICE:

A. Two Marks Questions:
1. Write the units of RCC and Brickwork in foundation.
2. Write the units of excavation and stone masonry.
3. Write the units of wooden doors and reinforcement bars.
4. Write the units of Flooring and painting work.

B. Six Marks Questions:
1. Explain the principle of units of measurements.

3 Method of building estimates.

3.1 Rules for Measurement

The rules for measurement of each item are invariably described in IS1200. However some of the general rules are listed below.

1. Measurement shall be made for finished item of work and description of each item shall include materials, transport, labour, fabrication tools and plant and all types of overheads for finishing the work in required shape, size and specification.
2. In booking, the order shall be in sequence of length, breadth and height or thickness.
3. All works shall be measured subject to the following tolerances.
   a) Linear measurement shall be measured to the nearest 0.01m.
   b) Areas shall be measured to the nearest 0.01 sq.m
   c) Cubic contents shall be worked-out to the nearest 0.01 cum
4. Same type of work under different conditions and nature shall be measured separately under separate items.
5. The bill of quantities shall fully describe the materials, proportions, workmanships and accurately represent the work to be executed.
6. In case of masonry (stone or brick) or structural concrete, the categories shall be measured separately and the heights shall be described:
   a) from foundation to plinth level
   b) from plinth level to First floor level
   c) from Fist floor to Second floor level and so on.

3.2 Methods of Taking out Quantities

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

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

3.2.1 Long wall-short wall method

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

3.2.2   Centre line method

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

3.2.3   Partly center line and partly cross wall method

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

Example 1:

From the given figure below calculate the detailed and abstract estimate for the single roomed building (Load bearing type structure) by Centre Line Method.

Note: All Dimensions are in 'M'

D=1X2.1M

W=1.5X1.2M

Single Roomed Building

(Load Bearing type structure)
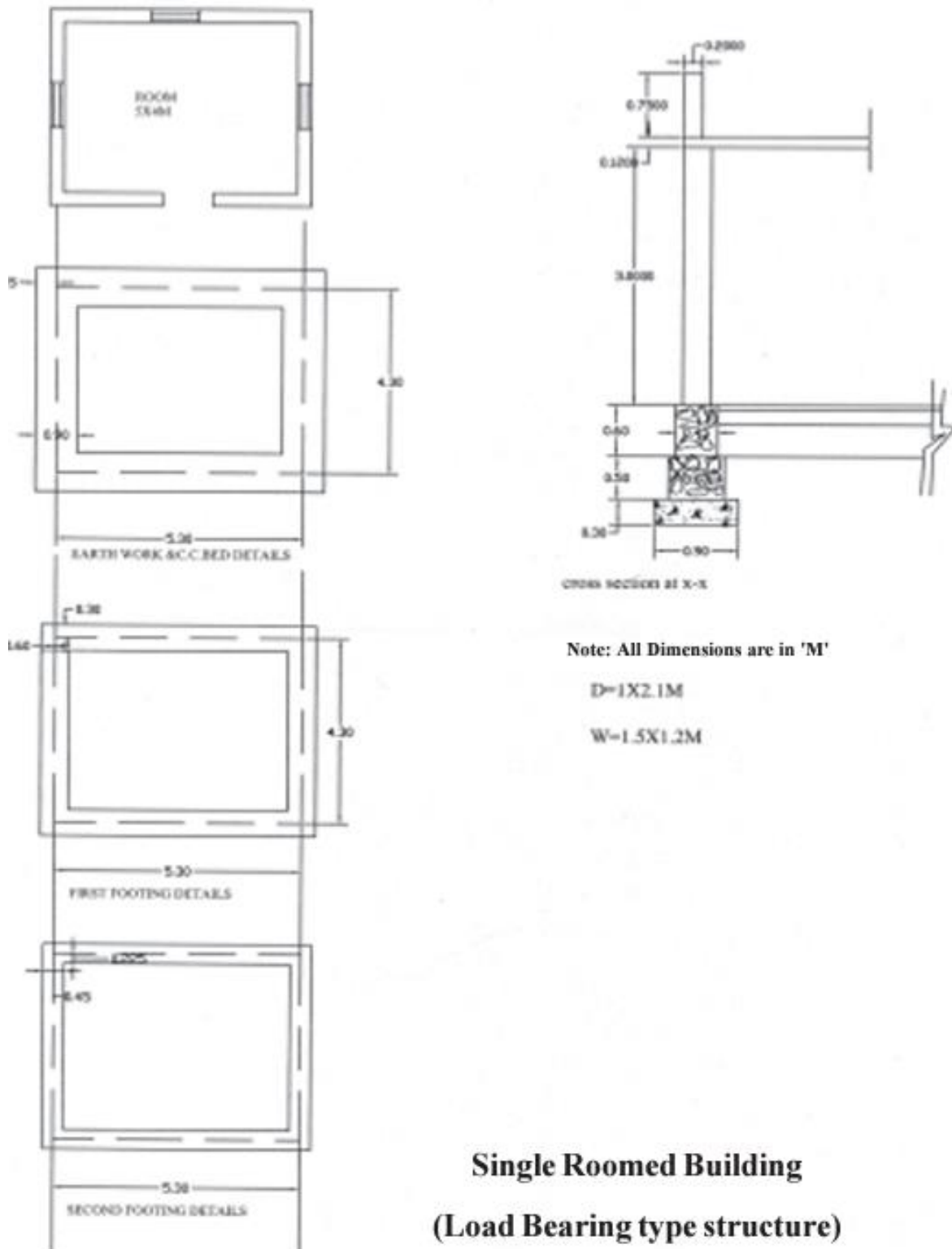
Answer: Centre Line Method

S.No	Particulars of Items	No.	L	B	H	Q	Explanation
1.	**Earth Work exevation** for foundation	1	19.2	0.9	1.4	24.192	m³ L=2(5.3+4.3)=19.2
2.	**C.C.(1:4:8) bed for** foundation	1	19.2	0.9	0.3	5.184	m³
3.	**R.R.Masonry in CM (1:6) for**						
	a)Footings	1	19.2	0.6	0.5	5.76	
	b)Basement	1	19.2	0.45	0.6	5.184	
					Total	10.944	
4.	**Brick masonry** with CM(1:6)for super structure	1	19.2	0.3	3.0	17.28	m³
	For parapet wall	1	20.0	0.2	0.75	3.00	
	Deductions for openings						
	a)Doors	1	1.0	0.3	2.1	0.63	
	b)Windows	3	1.5	0.3	1.2	1.62	
					Total	(-)2.25	m³
	Net Brick Masony =		17.28	+3.0	-2.25 =	18.03	m³
5.	**R.C.C. (1:2:4) for**						
	a)roof slab	1	5.6	4.6	0.12	3.090	
	b) Lintels over						
	i) Doors	1	1.2	0.3	0.15	0.054	
	ii)Windows	3	1.5	0.3	0.15	0.202	
	c)beams	1	19.2	1.3	0.3	1.728	
					Total	5.074	m³
6.	**Sandfilling for** basement	1	4.85	3.85	0.48	8.96	L=5.0-0.075-0.075=4.85
7	**C.C.(1:4:8) for** flooring	1	4.85	3.85	0.1	1.86	B=4.0-0.075-0.075=3.85

8.	flooring with Mosaic tiles	1	5.0	4.0	--	20.0	
9	**Plastering with CM (1:6)for super structure** **Inside**						
	For walls	1	18.0	--	3.0	54.0	
	Out side						
	For walls	1	20.4	--	3.87	61.2	
	Basement outside	1	21.6	--	0.6	12.96	
	Parapet wall						
	a) Inside	1	18.8	--	0.75	14.1	
	b) top	1	19.6	0.2	---	3.92	
	Deductions for opeinings				Total	**146.18**	m²
	Doors	1x2	1.0	--	2.1	4.2	L=5.0-0.075-0.075=4.85
	Windows	3x2	1.5	--	1.2	10.8	B=4.0-0.075-0.075=3.85
						15.0	m²
	Net Plastering =		146.18-15	=		131.18	m²
10	Plastering for Ceiling with CM(1:5)	1	5.0	4.0	--	20.0	m²
11	White Washing with two coats with Janatha cement						
	Same as quantity of plastering for walls and ceiling					151.18	m² (131.18+20=151.18)
12.	Colour washing with two coats						
	Same as quantity of plastering for walls and ceiling					151.18	m²
13	Supply & Fixing of best country wood for						
	a) Doors	1				1 No.	
	b) Windows	3				3No.	

S.No.	Particulars of Items	No.	L	B	H	Q	Explanation
14	Painting with ready mixed synthetic enamil paints with two coats over primary coat for new wood for						
	a) Doors	2¼x1	1.0	---	2.1	4.725	
	b) Windows	2¼x3	1.5	---	1.2	12.15	
					Total	**16.875**	m²
15	Petty supervision and contingencies at 4% and rounding off.						

Abstract estimate of single roomed building (load bearing structure)

S.No.	Description of item	Quantity	Unit	Rate	Per	Amount
1.	Earth work excaation	24.192	m³	465	10m³	1125.00
2.	Cement concrete(1:4:8)	5.184	m³	4545	1m³	8009.30
3.	RR.masonry in C.M.(1:5)	10.94	m³	1391	m³	15217.50
4.	Sand filling in basement	8.96	m³	195.20	10m³	175.00
5.	Brick masonry in country bricks of standard size in CM(1:8)	18.03	m³	2291	m³	41306.73
6.	R.C.C. (1:2:4) for lintels, beams etc.	1.984	m³	6030	m³	11963.52
7.	R.C.C.(1:2:4) for slabs,	3.09	m³	6030	m³	18633.00
8.	Cement concrete (1:5:10) for flooring	1.86	m³	1452	m³	2700.72
9.	Supplying and fixing of country wood for doors.	2.1	m²	1650	m²	3465.00
10.	Supplying and fixing of country wood for windows and ventilators.	5.4	m²	2300	m²	12420.00
11	Plastering to all exposed surfaces of brick work and basement with C.M (1:5)	151.18	m²	582	10m²	8798.70
12	White washing with best shell lime	151.18	m²	116	10m²	1753.68
13	Flooring with spartek tiles set in C.M (1:3)	20	m²	4230	10m²	8460.00
14	Painting with ready mixed enamel paint	16.875	m²	335	10m²	565.31
					Total	134593.46
15	Povision for water supply and sanitary arangements @12.5%					16824.18
16	Provision for electrification @7.5%					10094.50
17	Povision for architectural appearance @2%					2691.86
18	Provision for unforeseen items 2%					2691.86
19	Provision for P.s.and contingencies @4%					5383.73
					Grand Total Rs.	172279.65

QUESTIONS FOR PRACTICE:

A. Two Marks Questions:
1. Define long wall - short wall method of estimation.
2. Define center line method of estimation.

B. Six Marks Questions:
1. Write the rules for measurement of each items.
2. Explain different types of methods for preparing estimation.

C. Ten Marks Questions:

In this section different problematic question will come to calculate cost and quantity of a small single storied building or a portion of it. (Examples are given above)

4 Analysis or Rates

4.1 Definition

In order to determine the rate of a particular item, the factors affecting the rate of that item are studied carefully and then finally a rate is decided for that item. This process of determining the rates of an item is termed as analysis of rates or rate analysis.

The rates of particular item of work depends on the following.

1. Specifications of works and material about their quality, proportion and constructional operation method.
2. Quantity of materials and their costs.
3. Cost of labours and their wages.
4. Location of site of work and the distances from source and conveyance charges.
5. Overhead and establishment charges
6. Profit

Cost of materials at source and at site of construction

The costs of materials are taken as delivered at site inclusive of the transport local taxes and other charges.

Purpose of Analysis of rates:

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

Cost of labour - types of labour , standard schedule of rates

The labour can be classified in to

1) Skilled 1st class
2) Skilled IInd Class
3) un skilled

The labour charges can be obtained from the standard schedule of rates 30% of the skilled labour provided in the data may be taken as Ist class, remaining 70% as II class. The rates of materials for Government works are fixed by the superintendent Engineer for his circle every year and approved by the Board of Chief Engineers. These rates are incorporated in the standard schedule of rates.

Lead statement:

The distance between the source of availability of material and construction site is known as "Lead Statement" and is expected in Km. The cost of conveyance of material depends on lead.

This statement will give the total cost of materials per unit item. It includes first cost, conveyance loading, unloading stacking, charges etc.

The rate shown in the lead statement are for metaled road and include loading and staking charges. The environment lead on the metaled roads are arrived by multiplying by a factor

    a) For metal tracks - lead x 1.0
    b) For cartze tracks - Lead x 1.1
    c) For Sandy tracks - lead x 1.4

Note: For 1m3 wet concrete = $1.52m^3$ dry concrete approximately

SP.Wt of concrete= 1440 kg/ m^3 (or) 1.44 t/ m^3

1 bag of cement = 50 Kg

Example 1:- Calculate the Quantity of material for R.C.C. (1:2:4) for 20 m^3 of work

Answer

$$\text{Quantity of cement required} = \frac{1}{(1+2+4)} \times 1.52 \times 20 = 4.14m^3 \times \frac{1440}{50}$$
$$= 119.26 \text{ bags}$$

$$\text{Quantity of Sand required} = \frac{2}{(1+2+4)} \times 1.52 \times 20 = 8.28m^3$$

$$\text{Quantity of cource aggreate} = \frac{4}{7} \times 1.52 \times 20 = 16.56m^3$$

CEMENT CONCRETE

Sum total quantity of determining the quantity of materials for 10 cu m concrete is to divide 15.2 by the sum of the numerals of the proportion of the materials which gives the quantity of cement in cu m.

Illustration. — To find the materials for 10 cu m of cement of 1 : 4 : 8 proportion.

$$\text{Cement} = \frac{15.2}{1 + 4 + 8} = \frac{15.2}{13} = 1.17 \text{ cu m} = \text{Say } 1.15 \text{ cu m.}$$

Therefore, sand = 1.15 x 4 = 4.60 cu m and ballast = 1.15 x 8 = 9.20 cu m.

Materials required for different Proportion of Cement Concrete — 10 cu m.

Quantity of materials may be calculated by 15.2 as sum total and dividing by sum of the propotions.

Proportion	Ballast	Sand	Cement
1 : 1½ : 3	8.40 cu m	4.20 cu m	2.80 cu m (84 bags)
1 : 2 : 4	8.80 cu m	4.40 cu m	2.20 cu m (66 bags)
1 : 3 : 6	9.00 cu m	4.50 cu m	1.50 cu m (45 bags)
1 : 4 : 8	9.20 cu m	4.60 cu m	1.15 cu m (34½ bags)
1 : 5 : 10	9.50 cu m	4.75 cu m	0.95 cu m (28½ bags)
1 : 6 : 12	9.60 cu m	4.80 cu m	0.80 cu m (24 bags)

4.2 Analysis the rates of cement concrete work (1:2:4)

6. Cement concrete 1 : 2 : 4 — unit 1 cu m. *Take — 10 cu m.*

Materials—				
Stone ballast 40 mm gauge	...	8.80 cu m	900.00 per cu m	7920.00
Sand (coarse)	...	4.40 cu m	700.00 per cu m	3080.00
Cement (66 bags)	...	2.20 cu m	6325.00 per cu m	13915.00
			Total	24915.00
Labour—				
Mistri (Head mason)	...	⅓ no.	160.00 per day	53.30
Mason	...	2 nos.	150.00 per day	300.00
Mazdoor (Beldar)	...	12 nos.	80.00 per day	960.00
Boy or woman coolie	...	20 nos.	70.00 per day	1400.00
Bhishti (including curing)	...	6 nos.	70.00 per day	420.00
Forms etc. (according to requirement)	...	Lump sum	600.00 L.S.	600.00
Sundries T. and P. etc.	...	Lump sum	70.00 L.S.	70.00
			Total	3803.30
		Total of materials and labour	...	28718.30
Add 1½% Water charges	...	...	...	430.70
Add 10% Contractor's profit	...	...	...	2871.80
			Grand Total ...	32020.80
Rate per cu m — Rs.32020.00 / 10 = Rs.3202.00				for 10 cu m

4.3 Analysis the rates of Brick work with (1:6) cement mortar.

14. I-class Brickwork in Foundation and Plinth with 20 x 10 x 10 cm (nominal size) Bricks with Cement Sand Mortar 1 : 6 — unit 1 cu m. *Take — 10 cu m.*

Particulars	Qntty or Nos.	Rate Rs.	P.	Cost Rs.	P.
Materials —					
Brick I-class (500 bricks per cu m)...	5000 nos.	2000.00 per ‰ nos		10000.00	
Cement (13.5 bags) ...	0.45 cu m	6325.00 per cu m		2846.25	
Sand (local) ...	2.7 cu m	400.00 per cu m		1080.00	
		Total		13926.25	
Labour —					
Mistri (Head mason) ...	½ no.	160.00 per day		80.00	
Mason ...	7 nos.	150.00 per day		1050.00	
Mazdoor (Beldar) ...	7 nos.	80.00 per day		560.00	
Boy or woman coolie ...	7 nos.	70.00 per day		490.00	
Bhishti (water man) ...	2 nos.	70.00 per day		140.00	
Sundries, T. and P., etc. (Misc. Petty things)	Lump sum	35.00 L.S.		35.00	
		Total		2355.00	
Total of materials and labour ...				16281.25	
Add 1½% Water charges				244.25	
Add 10% Contractor's profit				1628.00	
		Grand Total		18153.50	

Rate per cu m — Rs.18153.50 / 10 = Rs.1815.00   for 10 cu m

15. I-class Brickwork in Superstructure with 20 x 10 x 10 cm Brick with 1 : 6 Cement Sand Mortar — unit 1 cu m. *Take — 10 cu m.*

Particulars	Qntty or Nos.	Rate Rs.	P.	Cost Rs.	P.
Materials —					
Brick I-class (500 bricks per cu m)...	5000 nos.	2000.00 per ‰ nos		10000.00	
Cement (13.5 bags) ...	0.45 cu m	6325.00 per cu m		2846.25	
Sand (local) ...	2.7 cu m	400.00 per cu m		1080.00	
		Total		13926.25	
Labour —					
Mistri (Head mason) ...	½ no.	160.00 per day		80.00	
Mason ...	10 nos.	150.00 per day		1500.00	
Mazdoor (Beldar) ...	7 nos.	80.00 per day		560.00	
Boy or woman coolie ...	10 nos.	70.00 per day		700.00	
Bhishti ...	2 nos.	70.00 per day		140.00	
Scaffolding	Lump sum	130.00 L.S.		130.00	
Sundries, T. and P., etc. ...	Lump sum	35.00 L.S.		35.00	
		Total		3145.00	
Total of materials and labour ...				17071.25	
Add 1½% Water charges				256.00	
Add 10% Contractor's profit				1707.00	
		Grand Total		19034.25	

Rate per cu m — Rs.19034.25 / 10 = Rs.1903.00   for 10 cu m

QUESTIONS FOR PRACTICE:

A. Two Marks Questions:
1. Define Analysis of Rates.
2. Write different type of labours.
3. Define lead statement.

B. Six Marks Questions:
1. Write the factors on which the rate of the materials depend on.
2. Define Analysis of rates and its purpose.
3. Calculate the Quantity of material for R.C.C. (1:4:8) for 20 m^3 of work

C. Ten Marks Questions:
1. Analysis the rates of cement concrete work (1:2:4).
2. Analysis the rates of cement concrete work (1:4:8).
3. Analysis the rates of Brick work with (1:6) cement mortar.

5   Specification

5.1   What is Specification?

A specification is a specific description of a particular subject. An engineering specification contains detailed description of all workmanship and materials which are required to complete an engineering project in accordance with its drawings and details. The technical drawings of a structure will show the proportions and relative positions of the various components of the structure. Many a time it is not possible to furnish the information on the drawings, regarding the quality of materials to be used and the quality of workmanship to be achieved during construction, due to shortage of space. This data regarding the materials and workmanship is conveyed in a separate contract document which is known as the "specifications" for the work. Thus the drawings with the specifications "will completely define the structure". This "specification" is furnished separately along with drawings and is an essential part of all engineering contracts.

5.2   Necessity of Specifications

The necessity of specifications are the following

(i)   The cost of a unit quantity of work is governed by its specification.

(ii)   Specification of a work is required to specify the quality and quantity of different materials required for a construction work and is one of the essential contract documents. Thus a contractor can make a program to procure the materials required for a project as well as (be owner can check the quality of materials confirming the specification avoiding dispute with the contractor.

(iii)   This also specifies the workmanship and the method of doing the work. Thus specification of a work serves as a guide to the supervising star of the contractor as well as the owner to execute the work with their satisfactions.

(iv)   A work is carried out according to its specification and the contractor is paid for the same. Any change in specification changes the tendered rate.

(v)   As the rate of a work is based on specification a contractor can calculate the rates of various items of works in a tender with his procurement rates of materials and labour. Thus tender paper without specifications of works is baseless.

(vi)   Specification is necessary to specify the equipments, tools and plants to be engaged for a work and thus enables to procure them beforehand.

(vii)   The necessity of specification is to verify and check the strength of materials for a work involved in a project.

(viii)   Specification is an essential contract document and is required for Arbitration or court cases.

5.3   How to write specification?

While writing a specification endeavors should be made to express the requirements of the specifications clearly and in concise form, avoiding repetition and unusual words. Ambiguous terms such as 'suitable', 'proper' etc. should be avoided. As far as possible, the clauses should

be arranged in the order in which work will be carried out. This does not mean to follow the works according to the order of arranging but it facilitates reference.

Specifications depend upon the site conditions, the nature of work and the purpose for which the work is carried out.

Students should practice drawing up clauses for imaginary work, introducing as many new clauses as possible in the specification. It is only practice by which they will acquire the necessary skill to write well phrased clauses.

5.4 Types of Specifications

The specifications are broadly divided as two types

5.4.1 General specifications

In general specifications, nature and class of works and names of materials that should be used are described. Only a brief description of that every item is given. It is useful for estimating the project. The general specifications do not form part of the contract document.

5.4.2 Detailed specifications

The detailed specifications form a part of the contract document. They specify the qualities, quantities and proportions of materials, and the method of preparation and execution for a particular item of works in a project. The de- tailed specifications of the different items of the work are prepared separately and they describe what the work should be and how they shall be executed and constructed. While writing the detailed specifications the same order of sequence as the work is to be carried out is maintained.

5.5 Cement concrete in foundation or used as sub-grade for flooring

(a) Materials: (1) Coarse aggregate: The aggregate used shall be the hardest available, such as granite, gravel or broken stone as specially mentioned and free from dust, dirt, soft material, vegetable matter etc. It shall be well graded from 2•5cm down to 10mm. 12% upto 4cm size aggregate is permitted as oversize materials. (2) Fine aggregate shall be of coarse sand, consisting of sharp and angular grains and it shall pass through a size of 5•5mm mesh sieve. It shall be clean and free from dust, dirt and organic matters. Sea sand shall not be used. These shall also follow their standard specifications. (3) Water shall be clean, free from alkali, acid and suitable for drinking purposes. Cement shall be fresh Portland cement and conform to the standard specifications.

(b) Proportioning of concrete: Proportion of cement, sand, and coarse aggregate shall be 1:2:4 or 1:3:6 or as specified. Coarse aggregate and sand shall be measured by gauge boxes of suitable size 35x2S x 40cm while cement shall be taken by bag weighing 50kg or a volume of 0.035cum. If the sand contains moisture, then bulkage shall be deter- mined at site and the extra quantity of sand so determined shall be added. No extra quantity shall be permitted unless-bulkage is determined. As the bulking of sand may vary from day to day and at different parts

of the day on account of varying moisture content, frequent tests for bulking shall be carried out with the sand to be used while measuring the aggregate, shaking, ramming or hammering shall not be done.

(c) Mixing of concrete: (1) 'Hand mixing' by batches shall be permitted on small works. Normally Ml structural concrete of proportion 1:2:4 or 1:3:6 shall be mixed in mixture machine. For small quantity when hand mixing be permitted by the Engineer in-charge extra cement upto 100% over the standard requirement of cement for machine mix shall have to be provided by the contractor at his own cost. The mixing shall be done on a clean water tight masonry, or concrete slab or steel plate platform. Dry coarse aggregate shall be stacked evenly on the platform. Sand and cement in the specified quantities at first be mixed dry till of uniform colour and spread over the stacked course aggregate. The materials shall then be turned over once without adding water and then at least further three times gradually and slowly water according to the water cement ratio to give a uniform concrete. (2) Machine mixing: The coarse aggregate shall be placed at first which shall be followed by sand and cement and be thoroughly mixed together dry in the specified proportion in a batch type mechanical mixer unless otherwise approved. Water will be added gradually to the required quantity to have the desired water cement Ratio. Missing shall be continued until there is a uniform distribution of the materials and the concrete is uniform in colour and consistency, but in no case shall the mixing be done for less than two minutes after all the materials including water are kept in the drum. The mixed concrete shall be unloaded on a water tight masonry platform or on steel plates. Only such quantity as are required for immediate use are to be mixed at any one time and the entire quantity shall be removed and placed at its position before the initial setting time of cement.

(d) Workability: Workability of concrete shall be checked at frequent intervals. The slump test or where facilities exist the compaction factor test in accordance with ICS. 1919-1957 shall be adopted for this purposes,

(e) Placing of concrete: Before proceeding to place the concrete, the brick flat soling shall be well wetted and cleaned. Concrete shall not be dropped from a height or hand, led in a manner which will cause separation. It shall be laid gently in its permanent position and shall be levelled both transversely and longitudinally. Each layer of concrete while being placed, shall be consolidated by mechanical vibration or by punning with 16mm dia. steel rod and tamping with wooden tampers to form a dense material. All surfaces after consolidation shall be free from air holes, honey combing or any other blemishes, Any water accumulation on the surface of newly placed concrete shall be removed by approved means, Concrete shall be placed continuously till the completion of the part of work between construction joints. For thick foundations the successive layers shell be laid before the immediate lower layer has set, Before placing new concrete against the concrete that has already set, the face of the old concrete shall be cleaned, wetted, roughened and a coating of neat cement grout (1:1) applied thereto. The interval between adding the water to the dry materials and the completion of the placing of concrete shall not exceed 25 minutes.

(f) Construction Joints: For construction joints in the same layer, the concrete shall be left in a long slope at an angle of 30' and the joints of two successive layer shall be of break joints.

(g) Protection and curing of concrete: Freshly laid concrete shall be adequately protected, about 1 to 2 hours after its laying, from too rapid drying due to sunshine etc. and also from running of surface water and shocks. After about 24 hours of laying of concrete the surface shall be cured by flooding with water of minimum 25mm depth or by covering with wet absorbent materials. The curing shall be done for a minimum period of 10 days. Over the foundation concrete, the masonry work may be started after 48 hours of its laying, but the curing of cement concrete shall be continued b along with the masonry work for a minimum period of 10 days.

5.6 First Class brickwork:

(a) Materials: (1) Brick shall be first class of standard specifications, regular in shape and size with sharp edges, They shall be of uniform deep red cherry or copper colour, free from cracks, chips, flows and lumps of any kind. Dry bricks shall not absorb more than one-sixth of their weight when immerged in water for one hour, Brick shall have a minimum crushing strength of 105 kg per sq cm, (2) For cement mortar, cement shall be fresh portland cement of standard quality, Sand shall be medium coarse, clean, sharp and free from clay, mica or other organic matter. (3) For lime mortar, lime shall be slaked end fresh stone lime screened at work site conforming its standard specification. Surkhi shall be made from first class brick having uniform colour and free from admixture of foreign matter.

(b) Mortar: The brickwork shall be done with the specified mortar (cement or lime) mixing the ingredients in the specified proportion, Sand shall be measured on the basis Of its dry volume, In case of damp sand, its quantity shall be increased suitable to allow for bulkage. Materials of mortar shall be first mixed dry till of uniform colour on a solid clean water tight platform and then mixed wet at least three limes by adding water gradually and evenly.

(c) Bricks before laying: All bricks shall be thoroughly soaked in water by submerging them in clean water for at least four hours just before use. The wetted bricks shall be staked on a clean platform of wooden planks to avoid any contact with mud.

(d) Laying: The brick shall be of English bond unless specially mentioned. The brickwork shall be true to line, plumb and solid through with joints not exceeding 6mm in thickness for cement mortar and 10 mm for lime mortar. Each course of brick shall be laid quite levelled and perfect in bond well bedded with frogs upward and flushed in sound mortar. No bats shall be permitted except where absolutely required for obtaining the specified bond or dimensions of different courses. Brickwork shall be carried out together so as to maintain, as far as possible, uniform height of not more than 1 m at a time. All mortar joints on the surfaces of walls shall be raked to a depth of 12mm in case where the walls are to be plastered while the mortar is green and left clean and free from all loose or adherent mortar by brushing. Mortar of the proper consistency only shall be delivered on the work and subsequent shinning with water if required shall be provided. Very thick or thin mortar shill be remixed. Only fresh mortar within hour

for cement and 24 hours for lime mortar from the time of adding water shall be used and no old or stale mortar be allowed in brick joins even remixed. During rains no brickwork shall be carried out unless special arrangements are made to protect the brickwork from rains for 24 hours to the direction of the Engineer-in charge.

(e) Curing: The brickwork shall be protected from rain or sun while it is green. The brickwork shall be kept wet on all the faces for at least 10 days during construction. At the end of day's work droughts shall be formed on the top of, walls by weak cement mortar or by mud edging to a depth of 25 cm minimum and be kept flooded with water.

(f) Scaffolding: ln all first class building work, double scaffolding having two sets of vertical supports shall be provided, The supports shall be sound and strong, tied together by horizontal pieces, over which scaffolding planks shall be fixed, For other classes of work single scaffolding may be allowed.

5.7 Reinforced cement concrete (R.C.C.):

(a) Shuttering and Staging: Shuttering shall be of approved dressed timber preferably of seasoned Jarool wooden boards not less than 3 cm thick, Faces in contact with concrete shall be free from adhering grout, projecting nails, spilt8 or such other defects. As an alternative, sufficiently rigid steel shuttering may be used. All joints of the shuttering shall be both tonged and grooved or the joints be perfectly closed and lined with craft paper or other type of approved materials so as to prevent the loss of liquid from the concrete. In case of steel shuttering the joints shall be similarly lined. Any timber that shows any tendency to wrap, shrink or twist shall be readjusted. All shuttering and framing shall be rigid, well braced and sufficiently strong to stand the pressure of wet concrete and stresses of ramming etc. up to the satisfaction of the Engineer-in-charge. If mechanical vibrators are to be used then bolts shall be applied in place of wire ties or nails to strengthen the frame work and to resist additional stress. All props of approved size shall be supported on double wedges and when (he props shall be taken out, these wedges shall be gently eased and not knocked out, All frame work shall be removed without shock or vibration after a period of 21 days for bottom shuttering of horizontal members and 3 days for side shuttering, Faces of shuttering in contact with concrete and interior of all moulds and boxes must be thoroughly washed and an approved mould oil or other material insoluble in water shall be applied to prevent adherence of the concrete.

(b) Reinforcements: Mild steel bars shall conform to the I.S. specification, free from rust, paint and grease or oil etc. All reinforcement bars shall be accurately placed with necessary hooks and bends etc. as described on the drawing or elsewhere, Bars at their points of intersection shall be securely wired together with 18 S, W. G. annealed black iron wire, The cover of concrete to the reinforcement shall be as described on the drawings and shall be provided by means of distance pieces of concrete block or other approved material, Bars under 25mm in size shall be bent cold by approved means producing a gradual and even motion, Bars of 25mm in size or more shall be bent hot, but shall not be heated beyond cherry-red colour and after bending it shall be allowed to cool slowly without quenching. Bends shall comply with the dimensions shown in the bending schedule.

(c) Materials for concrete: Same as cement concrete in foundation except that the size of course aggregate shall be 20mm unless specially mentioned in the type of work.

(d) Proportioning of concrete: Proportion of cement, sand, and coarse aggregate shall be 1:2:4 or 1:3:6 or as specified. Coarse aggregate and sand shall be measured by gauge boxes of suitable size 35x2S x 40cm while cement shall be taken by bag weighing 50kg or a volume of 0.035cum. If the sand contains moisture, then bulkage shall be deter- mined at site and the extra quantity of sand so determined shall be added. No extra quantity shall be permitted unless-bulkage is determined. As the bulking of sand may vary from day to day and at different parts of the day on account of varying moisture content, frequent tests for bulking shall be carried out with the sand to be used while measuring the aggregate, shaking, ramming or hammering shall not be done.

(e) Mixing of concrete: (1) 'Hand mixing' by batches shall be permitted on small works. Normally Ml structural concrete of proportion 1:2:4 or 1:3:6 shall be mixed in mixture machine. For small quantity when hand mixing be permitted by the Engineer in-charge extra cement upto 100% over the standard requirement of cement for machine mix shall have to be provided by the contractor at his own cost. The mixing shall be done on a clean water tight masonry, or concrete slab or steel plate platform. Dry coarse aggregate shall be stacked evenly on the platform. Sand and cement in the specified quantities at first be mixed dry till of uniform colour and spread over the stacked course aggregate. The materials shall then be turned over once without adding water and then at least further three times gradually and slowly water according to the water cement ratio to give a uniform concrete. (2) Machine mixing: The coarse aggregate shall be placed at first which shall be followed by sand and cement and be thoroughly mixed together dry in the specified proportion in a batch type mechanical mixer unless otherwise approved. Water will be added gradually to the required quantity to have the desired water cement Ratio. Missing shall be continued until there is a uniform distribution of the materials and the concrete is uniform in colour and consistency, but in no case shall the mixing be done for less than two minutes after all the materials including water are kept in the drum. The mixed concrete shall be unloaded on a water tight masonry platform or on steel plates. Only such quantity as are required for immediate use are to be mixed at any one time and the entire quantity shall be removed and placed at its position before the initial setting time of cement.

(f) Workability: Workability of concrete shall be checked at frequent intervals. The slump test or where facilities exist the compaction factor test in accordance with ICS. 1919-1957 shall be adopted for this purposes,

(g) Placing of concrete: Before proceeding to place the concrete, the brick flat soling shall be well wetted and cleaned. Concrete shall not be dropped from a height or hand, led in a manner which will cause separation. It shall be laid gently in its permanent position and shall be levelled both transversely and longitudinally. Each layer of concrete while being placed, shall be consolidated by mechanical vibration or by punning with 16mm dia. steel rod and tamping with wooden tampers to form a dense material. All surfaces after consolidation shall be free

from air holes, honey combing or any other blemishes, Any water accumulation on the surface of newly placed concrete shall be removed by approved means, Concrete shall be placed continuously till the completion of the part of work between construction joints. For thick foundations the successive layers shell be laid before the immediate lower layer has set, Before placing new concrete against the concrete that has already set, the face of the old concrete shall be cleaned, wetted, roughened and a coating of neat cement grout (1:1) applied thereto. The interval between adding the water to the dry materials and the completion of the placing of concrete shall not exceed 25 minutes.

(h) Construction Joints: For construction joints in the same layer, the concrete shall be left in a long slope at an angle of 30 and the joints of two successive layer shall be of break joints.

(i) Protection and curing of concrete: Freshly laid concrete shall be adequately protected, about 1 to 2 hours after its laying, from too rapid drying due to sunshine etc. and also from running of surface water and shocks. After about 24 hours of laying of concrete the surface shall be cured by flooding with water of minimum 25mm depth or by covering with wet absorbent materials. The curing shall be done for a minimum period of 10 days. Over the foundation concrete, the masonry work may be started after 48 hours of its laying, but the curing of cement concrete shall be continued b along with the masonry work for a minimum period of 10 days.

QUESTIONS FOR PRACTICE:

A. Two Marks Questions:
1. Define Specification.
2. Write the different type of specifications.
3. Explain detailed specification.

B. Six Marks Questions:
1. Explain the necessity of the specifications.
2. Write the method of preparing specifications.

C. Ten Marks Questions:
1. Write the specification of plain cement concrete in foundation.
2. Write the specification of Brick work in foundation.
3. Write the specification of Brick work in super structure.
4. Write the specification of R.C.C work in foundation.
5. Write the specification of R.C.C work in super structure.

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