

ESTIMATION AND COSTING

DEFINITION OF ESTIMATION AND COSTING

Estimating is the technique of calculating or Computing the various quantities and the expected Expenditure to be incurred on a particular work or project.

Particularly if 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.

REQUIREMENT FOR ESTIMATION AND COSTING

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 arange 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.

METHOD 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

1. Drawings i.e., plans, elevations, sections etc.
2. Specifications.
3. Rates.

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.

Specifications

- (a) General Specifications: This gives the nature, quality, class and work and materials in general terms to be used in various parts of woks. It helps to form a general idea of building.
- (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 method of preparation workmanship and execution of work.

Rates

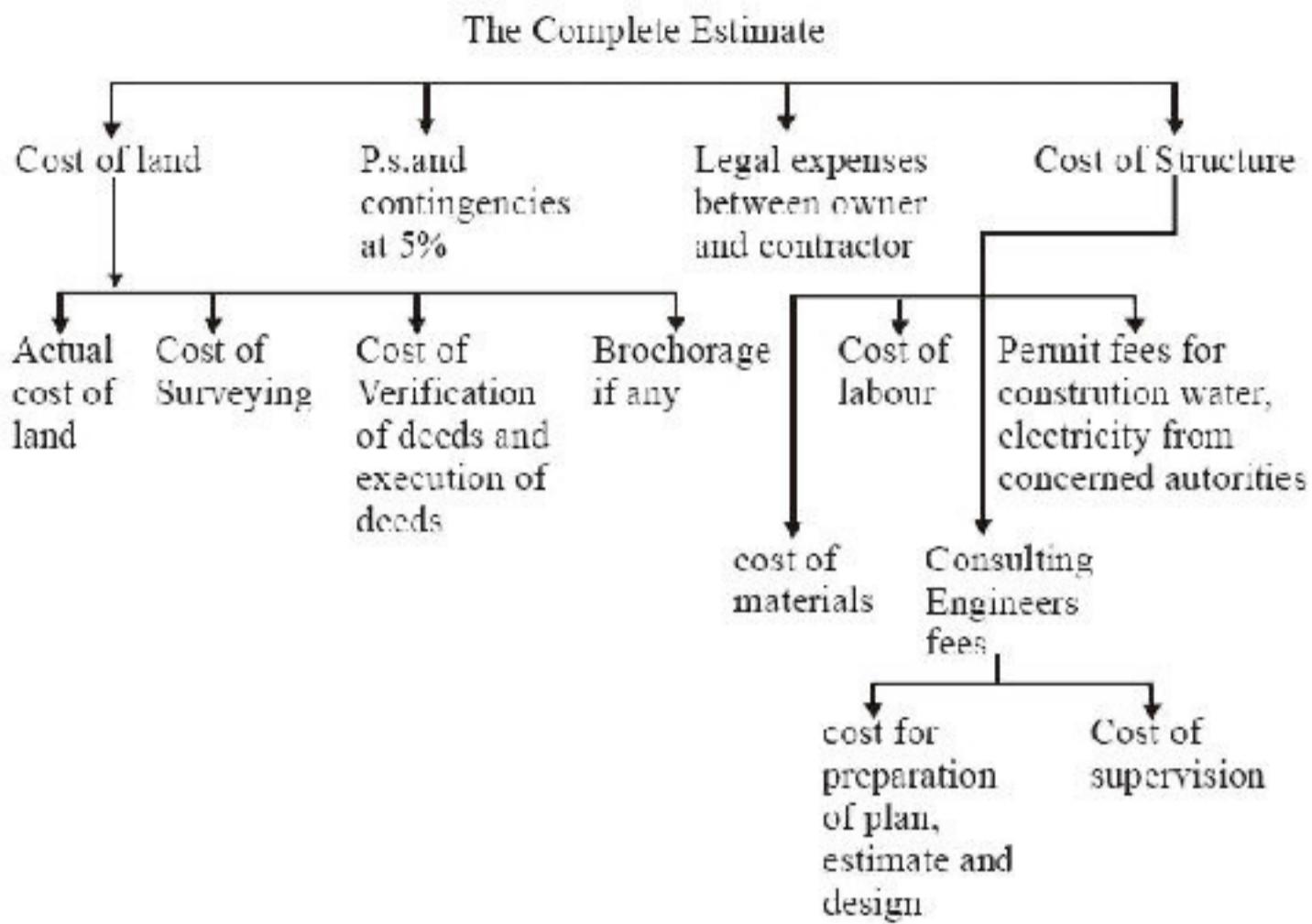
For preparing the estimate the unit rates of each item of work are required.

1. For arriving at 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 labour, skilled or unskilled of masons, carpenters, Mazdoor, etc.,

COMPLETE ESTIMATE:

Most of people think that the estimate of a structure includes cost of land, cost of materials and labour, But many other direct and indirect costs included and is shown below.

2.2 Estimation, Costing & Valuation



LUMPSUM

While preparing an estimate, it is not possible to workout in detail in case of petty items. Items other 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.

1. Water supply and sanitary arrangements.
2. Electrical installations like meter, motor, etc.,
3. Architectural features.
4. Contingencies and unforeseen items.

In general, certain percentage on the cost of estimation is allotted for the above L.S.Items

Even if sub-estimates prepared or at the end of execution of work, the actual cost should not exceed the L.S.amounts provided in the main estimate.

WORK CHARGED ESTABLISHMENT:

During the construction of a project considerable number of skilled supervisors, work assistance, watch men etc., are employed on temporary basis. The salaries of these persons are drawn from the L.S. amount allotted towards the work charged establishment. that is, establishment which is charged directly to work. an L.S.amount of 1½ to 2% of the estimated cost is provided towards the work charged establishment.

MEASUREMENT OF MATERIALS AND WORKS

UNITS OF MEASUREMENTS

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 consists linear measurements involve length like cornice, fencing, hand rail, bands of specified width etc., are expressed in running metres (RM)
- (c) Works consists areal surface measurements involve area 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 metres.

[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.	Earthwork 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.	C.C. or R.C.C. Chujja, Sunshade	cum	per cum
5.	L.C. in roof terracing (thickness specified)	cum	per cum
6.	Cement concrete bed	cum	per cum
7.	R.C. Sunshade (Specified Width & Height)	cum	Lrm

Sl. No.	Particulars of item	Units of Measurement	Units of payment
III. Damp Proof Course (D.P.C)			
	(Thickness should be mentioned)	sqm	persqm
IV. Brick work:			
1.	Brickwork in foundation	cum	per cum
2.	Brick work in plinth	cum	per cum
3.	Brick work in super structure	cum	per cum
4.	Thin partition walls	cum	per cum
5.	Brick work in arches	cum	per cum
6.	Reinforced brick work (R.B.Work)	cum	per cum
V. Stone Work:			
	Stone masonry	cum	per cum
VI. Wood work:			
1.	Door sand windows frames or chowkhats, rafters beams	cum	per cum
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 proportion 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

Sl. No.	Particulars of item	Units of Measurement	Units of payment
X. Flooring			
	1. 25mm cement concrete over 75mm lime concrete floor (including L.C.)	sqm	persqm
	2. 25mm or 40mm C.C. floor	sqm	persqm
	3. Doors and window sills (C.C. or cement mortar plain)	sqm	persqm
XI.	Rain water pipe /Plain pipe	1RM	per RM
XII.	Steel wooden trusses	1No	per 1 No
XIII.	Glass pannels(supply)	sqm	per sqm
XIV.	Fixing of glass panels or cleaning	No	per no.

RULES FOR MEASUREMENT :

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

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.
 - (i) Linear measurement shall be measured to the nearest 0.01m.
 - (ii) Areas shall be measured to the nearest 0.01 sq.m
 - (iii) 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.

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 centre line and short wall method.

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(a) 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 centre 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 centre line length. Thus the length of short wall measured into in and may be found by deducting half breadth from its centre 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.

(b) Centre line method:

This method is suitable for walls of similar cross sections. Here the total centre 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 mainhall, the centre line length gets reduced by half of breadth for each junction. such junction or joints are studied caefully while calculating total centre line length. The estimates prepared by this method are most accurate and quick.

(c) Partly centre line and partly cross wall method:

This method is adopted when external (i.e., alround the building) wall is of one thickness and the internal walls having different thicknesses. In such cases, centre 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.

TYPES OF ESTIMATES

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 is 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 measurements are taken from drawings and entered in respective columns of prescribed proforma. the quantities are calculated by multiplying the values that are in numbers column to Depth column as shown below:

Details of measurements 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 ESTIMATE FORM

Item No.	Description/ Particulars	Quantity	Unit	Rate	Per (Unit)	Amount

The detailed estimate should accompanied with

- (i) Report
- (ii) Specification
- (iii) Drawings (plans, elevation, sections)
- (iv) Design charts and calculations
- (v) Standard schedule of rates.

Factors to be consisdered While Preparing Detailed Estimate:

(i) Quantity and transportation of materials:

For bigger project, the requirement of materials is more. such bulk volume of mateials will be purchased and transported definitely at 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 labourers are consideed 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 scheduled 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 (T&P):** Some works need special type of equipment, tools and plant. In such case, an amount of 1 to 2% of estimated cost is provided.
- (iv) **Overhead charges:** To meet expenses of office rent, depreciation of equipment salaries of staff postage, lighting an amount of 4% of estimate cost is allocated.

METHODS OF PREPARATION OF APPROXIMATE ESTIMATE:

Preliminary or approximate estimate is required for studies of various aspects of work of project and for its administrative approval. It can decide, in case of commercial projects, whether the net 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 accompanied by a report duly explaining necessity and utility of the project and with a site or layout plan. A percentage 5 to 10% is allowed for contingencies. The following are the methods used for preparation of approximate estimates.

- (a) Plinth area method
- (b) Cubical contents methods
- (c) Unit base method.

(a) Plinth area method: 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, careful 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 2.0m^2 , lifts, airconditioning 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 sunbreakers.

(b) Cubical Contents Method: This method is generally used for multistoreyed buildings. It is more accurate than the other two methods viz., plinth area method and unit base 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 off set.

The cost of string course, cornice, carbelling etc., is neglected.

The cost of building = volume of buildings x rate/ unit volume.

(c) Unit Base 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 calculated by dividing the actual expenditure incurred or cost of similar building in the nearby locality by the number of units.

Problems on Plinth Area Method :

Example : 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 @ $7\frac{1}{2}\%$ of cost of building.
- (iii) Cost of Sanitary and Electrical installations each @ $7\frac{1}{2}\%$ 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.

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Solution :

Data given:

$$\text{Plinth area} = 800 \text{m}^2.$$

$$\text{Plinth area rate} = \text{Rs. } 4500 \text{ per Sqm.}$$

$$\therefore \text{Cost of building} = 800 \times 4500 \\ = \text{Rs. } 36,00,000 = 00$$

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 architectural features @ 1%

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

Add the cost of Roads Lawns @ 5%

$$= \frac{36,00,000 \times 5}{100} = 1,80,000 = 00$$

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 : Prepare the rough estimate for a proposed commercial complex for a municipal corporation for the following data.

$$\text{Plinth Area} = 500 \text{m}^2/\text{floor}$$

$$\text{Ht of each storey} = 3.5 \text{m}$$

$$\text{No.of storeys} = G + 2$$

$$\text{Cubical content rate} = \text{Rs. } 1000/\text{m}^3$$

Provided for a following as a percentage of structured cost

- | | |
|---|-------|
| (a) water supply & Sanitary arrangement | - 8% |
| (b) Electrification | - 6% |
| (c) Fluctuation of rates | - 5% |
| (d) Contractors profit | - 10% |
| (e) Petty supervision & contingencies | - 3% |

Solution :

$$\begin{aligned} \text{Cubical content} &= \text{No.of storeys} (\text{Plinth Area} \times \text{height} \\ &\quad \text{of each storey}) \\ &= 3(500 \times 3.5) = 5250 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Structural cost} &= \text{Cubical content} \times \text{cubical content rate} \\ &= 5250 \times 1000 = 52.5 \text{ Lakhs} \end{aligned}$$

other provisons:-

- | | |
|---------------------------------|--------------------------------|
| (a) Water supply and sanitation | = 52.5 × 8/100 = Rs.4.2 Lakhs |
| (b) Electrification | = 52.5 × 6/100 = Rs.3.15 lakhs |
| (c) fluctuation of rates | = 52.5 × 5/100 = Rs.2.625 |

$$\begin{array}{l} \text{Total} = \text{Rs. } 9.975 \text{ Lakhs} \\ \text{Structural cost} = \text{Rs. } 52.500 \text{ Lakhs} \end{array}$$

$$\text{Total} = \text{Rs. } 62.475 \text{ Lakhs}$$

- | | |
|--------------------------|------------------------------------|
| (d) P.S./& contingencies | = 62.475 × 3/100 = Rs.1.874 Lakhs |
| (e) Contractors Profit | = 62.475 × 10/100 = Rs.6.247 Lakhs |

$$\text{Total Cost} = \text{Rs. } 70.596 \text{ Lakhs}$$

ANALYSIS OF RATES

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 IIInd 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" 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 metalled road and include loading and staking charges. The environment lead on the metalled roads are arrived by multiplying by a factor

- (a) for metal tracks - lead × 1.0
- (b) For cartze tracks - Lead × 1.1
- (c) For Sandy tracks - lead × 1.4

Note: For 1 m³ wet concrete

$$= 1.52 \text{ m}^3 \text{ dry concrete approximately}$$

$$\text{SP.Wt of concrete} = 1440 \text{ kg/m}^3 \text{ (or)} 1.44 \text{ t/m}^3$$

$$1 \text{ bag of cement} = 50 \text{ Kg}$$

Example : Calculate the Quantity of material for the following items.

- (a) R.C.C. (1:2:4) for 20m³ of work
- (b) R.C.C. (1:3:6) for 15m³ of work

Solution :

(a) Quantity of cement required

$$\begin{aligned} &= \frac{1}{(1+2+4)} \times 1.52 \times 20 \\ &= 4.14 \text{ m}^3 \times 50 = 119.26 \text{ bags} \end{aligned}$$

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

$$\begin{aligned} \text{Quantity of course aggregate} &= \frac{4}{7} \times 1.52 \times 20 \\ &= 16.56 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} (b) \text{Quantity of cement required} &= \frac{1}{10} \times 1.52 \times 1.5 \\ &= 2.28 \text{ m}^3 \times \frac{1440}{50} \\ &= 65.66 \end{aligned}$$

$$\begin{aligned} \text{Quantity of sand required} &= \frac{3}{10} \times 1.52 \times 15 \\ &= 6.84 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Quantity of CA required} &= \frac{6}{10} \times 1.52 \times 15 \\ &= 13.68 \text{ m}^3 \end{aligned}$$

GENERAL SPECIFICATIONS OF FIRST CLASS BUILDINGS

Foundation and Plinth: Shall be of first class burnt bricks in lime or cement mortar (1:6) over a bed of cement concrete. (1:6:12 or 1:8:16)

Superstructure : Shall be of first class burnt brick work in lime or cement mortar (1:6)

Damp Proof Course : Shall be of a cm thick cement concrete (1:2:4) with on-layer of bitumen laid hot or any other specified water proof material.

Roofing : Shall be of R.C.C. slabs (1:2:4) covered with two coats of bitumen laid hot and a layer of lime or cement concrete 8 cm. thick over it with a tile flooring with cement flush with cement flush pointed on the top.

Flooring : Shall be of TERRAZO in drawing, dining, bath and W.C., 4 cm thick plain conglomerate polished floors in bed rooms and in other rooms.

Doors and Windows : Doors and windows shall be of teak wood, paneled and glazed with gauze shutters to outer doors and fixed wire gauze to windows and ventilators Fittings shall preferably of brass or good quality metal.

Finishing : The inside and outside walls shall have 1.25 cm. thick cement plaster. Drawing, dining and bed rooms inside of walls shall have 2 coats of distemper and other rooms shall have three coats of white washing. The outside of the wall shall have two coats of colour washing over one coat of white washing.

Painting : Doors and windows shall be given three coats of white lead where exposed and white zinc or cream or grey silicate paint elsewhere.

Miscellaneous : First class buildings shall be provided with first class sanitary and water supply fittings and electrical installations. A plinth protection 1.50 m. wide of bricks sloped away from the building shall be provided all round the building.

GENERAL SPECIFICATIONS OF SECOND CLASS BUILDINGS

Foundation and Plinth : All walls shall be built of first class burnt bricks laid in mud mortar over a bed of lime concrete or cement concrete. Top course of the plinth shall be laid in cement mortar (1:6)

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Superstructure : All walls shall be built of first class burnt bricks laid in mud mortar.

The Following portions to be built in cement mortar (1:6.)

- (a) Shills of windows, C. windows and almirahs.
- (b) Back of almirahs.
- (c) Top course of parapet.
- (d) Jambs of doors, windows, C. windows and almirahs.
- (e) Drip course, cornice and weather course etc.
- (f) Two courses below the R.C.C. slab and roof battens.

Damp proof Course : Damp proof course 4 cm thick shall be of Portland cement concrete (1:2:4) with one coat of bitumen laid hot.

Roofing : All main rooms shall have R.B. roof or R.C. roof and first class or second class mud roofs over other rooms.

Floors : the main rooms shall have conglomerate floors and verandahs shall have flat or brick on edge floors over cement concrete and sand.

Doors and Windows : Interior and exterior surface of wall shall be cement plastered 1.25 cm thick, covered with three coats of white washing.

Painting : Doors and windows shall be painted with three coats of chocolate paint or any other approved paint.

Miscellaneous : Roof drainage shall be carried by means of Gargoyles and khassi parnals. Plinth protection 1.50 m. wide of bricks shall be provided all round the building.

GENERAL SPECIFICATION FOR THIRD CLASS BUILDINGS

Foundations and Plinth : All walls shall be built of second class burnt laid in mud mortar over bed on lime concrete.

Superstructure : All walls shall be built of second class burnt bricks laid in mud mortar.

Roofing : All rooms shall have second class mud roof and the verandahs shall have G.I. sheet roof.

Floors : Floors everywhere shall be of brick over mid concrete and cement pointed.

Doors and Windows : Doors and windows shall be of kail, Chir, Mango or any other soft wood, ledged, battened and braced type.

Finishing : Interior surface of walls shall be mud plastered and covered with three coats of white washing. The outside surface shall be flush lime pointed.

Painting : Doors and windows shall be give two coats of ordinary chocolate paint.

GENERAL SPECIFICATIONS OF FOURTH CLASS BUILDINGS

Foundation and Plinth : All walls shall be built of second class brick work laid in mud mortar.

Superstructure : All walls shall be built of sand molded sun dried bricks laid in mud mortar with the exception of the following which shall be built in second class brick work in mud.

1. Two courses underneath the roof battens.
2. Jambs of doors and windows.
3. Pillars under the roof beams.
4. Shills of windows, C. windows and almirahs.

Roofing : Third class mud roof.

Floors : Mud floors(2.5 cm) mud plaster over the rammed earth and gobri leeped.

Doors and Windows : Doors and windows shall be of kail, chir or any other soft wood battened doors.

Finishing : Mud and mud plaster inside and outside.

Painting : Two coats of ordinary paint.

DETAILED SPECIFICATIONS

Detailed specifications give the method of constructions and specify the nature of work.

EXCAVATION OF FOUNDATIONS

Equality of pressure should be aimed at in designing foundations. The foundation Trenches shall be taken down to the exact width of the widest part of the foundation. The trenches where possible shall always be taken down to a few cms into good hard soil. In order to ascertain the nature of the soil, it is essential to dig trial pits at each of the four corners of the proposed site of a building before starting the construction.

The bottoms of all trenches shall be well watered and rammed. The soft and defective place shall be filled with concrete or with any other hard material as directed by the Engineer-in-charge.

If, however, rocky surface is met, it shall be made as leveled as possible and any small inequalities shall be filled with concrete.

Foundation in bad soil

Where great depths of bad soil are met with, such as black cotton soil, it may be necessary to resort to piles which may be of wood, steel or reinforced concrete. Where the depth of the bad soil is not excessive, the foundations may consist of beams or concrete arches of concrete pillars.

The pillars being taken down into good soil. In some cases the structure may be built on a raft of concrete reinforced with a grillage of R.s Beams.

EARTH FILLING

Earth used for filling shall be free from saltpeter and white ants and only foamy and clayey soil free from clods shall be used. It shall be laid in 15 cm layers and each layer shall be well watered and rammed with iron rammers. In case of high embankments, the layers shall not exceed 30 cm depth and the settlement allowances shall be made @ 10% of the height of uncomapacted fills.

CONCRETE IN FOUNDATIONS

Lime concrete or cement concrete shall be used in foundations to be a base for the super structure.

Lime Concrete

Ingredients Lime, Surkhi, Sand, Brick ballast or stone ballast and water.

Lime

Lime is always used as putty lime of class 'B' [semi - hydraulic or quick lime form] and

Class 'C' [Non- hydraulic in hydrated or quick lime form], shall be used as directed by the Executive Engineer.

The hydrated lime used should be thoroughly mixed with water in suitable container. It shall then be stirred into thick consistency and left undistributed for not less than 36 hours. Extra water should be drained out and putty should be used. Similarly quick lime should be converted into putty. The volume of lime putty shall be taken as equal to the volume of dry slaked lime.

Surkhi

Surkhi shall be obtained by pounding fully bricks or bats. It shall be free from admixture of clay, dust or foreign matter. No un burnt bricks or bats shall, be used for grinding in to surkhi.

Aggregate

The brick aggregate shall be broken from first class or second class bricks or their bats, or from dense over burnt bricks. The gauge of the ballast shall be 2 cm to 4 cm.

The stone aggregate shall consist of good hard tough broken stone, gravel or shingle of the gauge specified. It shall free from dirt, leaves or any other organic, or admixture of soft or decayed stone.

Water

Water used in construction shall be clean, free earthly, vegetable or organic impurities, like alkalis, salts etc. which cause efflorescence and affect settling time of mortar.

Mixing And Laying

The aggregate previously well soaked, shall be measured and laid on a clean platform of brickscut 555 or wood. The platform shall be sufficient size to give ample room for mixing 23 to 28 cub.m. of concrete.

Lime and surkhi shall be measured and laid on the aggregate. The whole dry and wet mix is then turned over three or four times so that it shall be thoroughly mixed concrete shall be laid slowly and gently in layer of 15 cm (not thrown from a height) and thoroughly consolidated with 5.5 kg. Rammers shall be used for consolidating the edges.

Tests

The consolidation of a concrete is said to be complete if (a) a stick end ways from a height of 1 m rebounds with ringing sound. (b) The second test is by digging a hole in the concrete and pouring water in the hole. If the consolidation in complete, the water shall not be absorbed in the.

Curing

The concrete shall be kept wet for a period of at least ten days no brick work masonry shall be laid on the concrete for at least seven days after laying.

PERMISSIBLE SAFE LOADS OF FOUNDATIONS.

SOIL	Lottes per sq.m.
Ordinary earth	5.46
.....	5.46
Make up ground, well consolidated	5.46 to 10.93
.....	8.20 to 16.40
Soft clay	16.40 to 21.86
.....	21.86
Loamy soils and sand mixed clay	32.80 to 43.70
.....	
Ordinary clay	
Solid clay	
Very hard clay	

USE OF COARSE AGGREGATE FOR DIFFERENT TYPES OF CONCRETE

(i) 65mm, Nominal size:

For unreinforced mass concrete word on ordinary work.

(ii) 40mm, Nominal size:

For unreinforced mass work of cement concrete on small jobs over 15 cm minimum dimensions. For reinforced works, it shall be used where the dimension of members exceed 45cm.

(iii) 20mm Nominal size:

Unless otherwise mentioned, if will be used as under-

(a) Unreinforced cement concrete work between 5cm minimum size.

(b) Conglomerate floor.

(c) R.C.C. works exceeding 12cm but not exceeding 45cm in minimum dimension.

2.10 Estimation, Costing & Valuation

(iv) 15mm Nominal size.

Unless otherwise mentioned and specified, this aggregate shall be used in cement concrete works of the following description.

- (a) R.C.C. lintels and slabs under 12cm and more than 5cm.
- (b) R.C.C. posts and battens less than 40cm sectional area.

CEMENT CONCRETE

Ingredients

Cement, sand, brick or stone aggregate, gravel or shingle and water

Cement

Cement shall be Portland cement of the Indian standard Specifications as per IS: 269. All cement shall be brought to the site of work in bags with the seals intact. Fresh and from moisture. All cement shall be gauged by weight and shall be added at the mixture in whole 50kg.bags.

Fine Aggregate (Sand)

It shall consist of clean, hard, uncoated grains of natural sand or crushed stone sand rashed gravel sand or combination of any of these free clay, loam, silt, organic or other deleterious substances.

Course Aggregate

Coarse aggregate (bajri or grit) shall consist of good hard tough and clear water worn bajri obtained from natural streams. The girl shall be free from dirt, clay, leaves or other organic matter and soft or decayed stone and shall be of the gauge specified according to the nature of the work.

Water

Water used in construction shall be clean, free from earthly, vegetable or organic impurities: like alkalis, salts etc. which cause efflorescence and affect settling time of mortar.

MIXING (CEMENT CONCRETE 1:6:12 ETC)

In all proportions of cement concrete except 1:1 $\frac{1}{2}$:3, 1:2:4 and 1:3:6, the measured quantity of cement is to be placed on top of the measured quantity of the aggregate (fine and coarse) and the whole mass mixed three or four times so that it shall be thoroughly incorporated. The required quantity of water (clean, rather drinking water) shall then be added and the entire wet mass shall be turned over unto the homogeneous mixture of the required consistency is obtained.

LAYING AND CONSOLIDATION OF CEMENT CONCRETE IN FOUNDATIONS

Concrete shall be handed from the mixing platform to the place of final deposit as rapidly as possible. It shall be laid slowly and gently in layers of 15cm (not thrown from a height) and thoroughly consolidated with 5.5 kg. Rammers.

FARMA OR BATCH BOX

The design of the farma is given below

$$15'' \times 15'' \times 9 \times 5''/8 = 1.25 \text{ cft.}$$

$$\text{Or } 38\text{cm} \times 38 \text{ cm} \times 25\text{cm} = .036\text{m}^3$$

REINFORCED CEMENT CONCRETE

The standard mix for reinforced cement concrete is (1:2:4).

In addition to this, round steel bars are embedded to make the structure strong to take up all the tensile stresses.

MIXING

The two ingredients i.e. cement and sand shall be hand mixed dry, three or more times until the mix comes to a uniform colour. The measured quantity of coarse aggregate shall then be added to the mixture and whole mixed dry thoroughly.

REINFORCEMENT

Round steel bars as far as possible shall be used in preference to square bars. The bars shall be thoroughly cleaned of rust, scale and of coatings that might destroy or reduce bond. The ends of all bars shall be properly hooked and bends shall be made as per drawing and design supplied. In case of joints in reinforcement an overlay of not less than 40 diameters shall be given for tension member.

MIXING CEMENT CONCRETE (1:2:4 OR 1:3:6)

The two ingredients i.e. cement and sand shall be mixed dry, three or more times until the mix comes to a uniform colour. The measured quantity of coarse aggregate shall then be added to the mixture and whole mixed dry thoroughly. The required quantity of water shall then be added with a rose.

PLACING AND HANDLING THE CONCRETE

Concrete shall be handled from the mixing platform to the final deposit as rapidly as possible. After depositing, the concrete is to be ridded, vibrated, tamped or worked to ensure that no hollow places are left.

FORMS AND CENTERING

Forms wherever required shall be sufficiently rigid and strong to withstand the weight placing and putting of concrete and the movement of labor, material and

plant. Forms shall be sufficiently water tight to prevent leakage of mortar. Forms shall be supported or fixed by wedges of the load being eased and the forms removed without shock to the work and without hammering.

LAYING

Before depositing the concrete, the reinforcement shall be correctly laid in position and secured against displacement by tying with soft iron wire. The bars shall remain in position 20 mm. above the surface of centering.

CURING

The concrete when laid shall be carefully protected from the extremes of weather and temperature and from unequal or too rapid drying. It shall be thoroughly kept wet for at least 15 days.

EXPANSION JOINTS

In every long lengths of slab work, expansion joints shall be provided at intervals of about 9 m. to 12m.

BEARING

The bearing of slabs not be less than the thickness of the slab with a minimum of 12cm.

BRICK WORK

Brick work consists of first class bricks laid in the mortar specified.

BRICK WORK IN MUD MORTAR.

Bricks

Shall be first class made from good brick free from saline deposits and shall be sand molded thoroughly burnt without being vitrified, of good colour, shall be regular and uniform in shape & size with sharp and square arises and parallel faces. Emits a clear ringing sound when struck, shall be free from flaws, cracks etc. should not absorb more than 20% of water by weight after being soaked in water for 24 hours.

Mud mortar

Mud mortar shall be prepared from stiff clay, broken up into powder and free grass, stones, kankar, roots and other matter. The clay shall then be worked up with water by mens. feet and PHOWRATHS on a clean platform.

Joints

The thickness of the joints shall be 6mm and in no case exceeds 10 mm. All brick work shall be taken truly plumb, laid in English bond.

BRICK WORK IN LIME MORTAR

Lime mortar

Ingredients-Lime, Surkhi sand or cinder and water.

The proportions upon the ingredients available at site. General one part of lime and 2 parts of surkhi are suitable.

Mixing : the mortar shall be mixed by measure on a clean platform close to the mill. The measuring wooden boxes may be used. The ingredients shall be mixed twice dry and then ground with sufficiency of water in a mill continuously for three hours.

For big works a bullock mortar mill (see Fig.2.6) is used and shall be constructed of first class bricks in lime mortar. Class shall be taken that fresh mortar shall be made daily and used as fresh as

Lying : Bricks should be laid in proper bond.

Soaking : All bricks shall be soaked in clean water before use for at least one hour.

Joints: Joints shall be of uniform thickness, not exceeding 6mm. 10mm and 13mm for 1st class brick work respectively. The vertical joints must be quite symmetrical and truly plumb in case of 1st class brick work.

The joints in faces which are to be plastered or pointed shall be raked out while the mortar is green.

The brick work shall be kept moist for a period of ten days.

BRICK WORK IN CEMENT MORTAR

Cement mortar : cement mortar shall consist of mixture of 1:3, 1:5,or1:6 according to the nature of work.

Mixing : cement and sand shall be thoroughly mixed dry and then water is added with a fine rose to make the mortar workable. Mortar to which the water has been added shall be used within 30 minutes of the addition of water.

The thickness of joints shall be regulated so that height of 10 courses when laid with Horizontal joints shall measure one meter in height.

The joints in faces which are to be plastered or pointed should be raked out while the mortar is green i.e not later than 24 hours after the work is done.

Watering : Walls as they progress shall be kept thoroughly well watered on their faces and tops.

BRICK OR TILE FLOORING

Consists of first class burnt bricks or tiles laid flat or on edge over a bed of 10cm, thick lime concrete or cement (1:6:18) and 10cm. thick sand.

Laying : All bricks or tiles or tiles shall be laid in lime or cement mortar with bed and vertical joints full of mortaara1:4 simple "lipping" at the edge shall not be permitted. The laying shall be in plain, diagonal, herring bone or other pattern as desired by the Engineer-in-charge. The work shall be protected from the effect of sun, frost and rain during construction.

2.12 Estimation, Costing & Valuation

Soaking: Before use, all bricks or tiles shall be soaked in clean water in tanks for at least one hour.

Joints: The joints shall not exceed 6mm in thickness. The mortar in the joints shall be struck off flush with a trowel. Care shall be taken that no mortar shall spread over the edge of the bricks or tiles.

Curing: The floor must be kept wet for seven days after laying. If cement pointing is done, it shall be kept moist for at least 15 days after the pointing has been done.

MARBLE FLOORS

The marble flooring shall consist of marble tiles laid on 12 mm thick mortar bed over the usual base courses of 10 cm base concrete 1:8:16 and 10cm sand or stone filling in case of ground floor or over R.C.C slabs. In case of upper floors the mortar bed shall be of 1:3 cement sand mortar.

The marble slabs should be of approved quality and thickness 20mm to 25mm with truly plane surface. The size of marble slab shall be slightly oversize to permit cutting to actual size of tiles at the site of work.

Curing : During the progress of work and for 10 days after laying, each section of floor shall be kept flooded. Three clear days shall be allowed for setting before the pavement is walked over and no weight should be rested upon the surface, until 7 days after laying is completed. Polishing is done, as in case of Terrazzo flooring and no first cutting is usually needed.

ROOFING

First class mud roofing consists of two layers of tiles $30 \times 15 \times 4$ cms. Resting on wooden or reinforced cement concrete battens spaced 30 cm centre to centre. The top of tiles shall have 13mm thick cement plaster (1:4) covered with two coats of bitumen laid hot and 10 cm. thick earth, another 2.5 cm. layer of mud plaster to be given and finished with gobri leaping. (45 tiles are required for one sq.m. of roof area).

DOORS & WINDOWS

Doors and windows may range from the humble ledged and braced doors and windows which are usually, fitted to out houses, to the multiple, paneled and paneled and fitted fitted with ornate molding and paneled, and which are usually associated with the entrances to important buildings. In all cases the construction shall be such as to ensure that the door shall be satisfactory in service.

Timber

All doors, windows, clerestory windows and all almirahs with their chowkats shall be made of well seasoned deodar wood or any other good timber free from sapwood, large knots, shakes cracks and other serious defects.

Panels

In case of paneled doors, the panels shall not be less than 13 mm thick.

Sash Bars

In case of glazed doors, Sash Bars shall be of the full thickness of the leaf and 38 mm. in width and shall be molded and metered on the outside and rebated from inside. The width of the rebate shall be 13 mm.

WHITE WASHING

The surface to be white washed must be clean and smooth and perfectly dry before applying white wash. Each coat be allowed to dry before next is applied. New plastered surface tone white washed, shall not be trowel led to a glazed surface otherwise white wash will not adhere.

The white wash shall be made from pure fat lime, brought to the work in an unslaked condition and termed as class „C. lime. Water shall be added to this lime in a tub, until the mixture is of a consistency of cream and allowed to rest for 24 to 48 hours. The mixture shall then be strained through coarse cloth, suitable quantity of gum shall be added, dissolved in hot water. This hot water shall be added at the rate of about 5 liters per kg. to produce kilky solution.

Colour washing

The colour wash shall be made from pure slaked fat lime and mixed with the necessary pigment to give the required shade. The pigment shall be such as to be unaffected by lime.

The surface to be colour washed shall be given one coat of white wash and then one or two coats of colour washing. Each coat of site or colour wash is to be allowed to dry and passed by the Engineer-in-Charge before the next is applied.

PAINTING

Wood work (New)

Before commencing any painting, the surface should be rubbed down with sand paper and make it smooth with grade 2 1/2 paper and then with 1 1/2 grade. The sand papering must be finished with the grain.

Before applying paint, all knots must be killed or covered with two coats of patents knotting or with a preparation of red lead glued size, laid on hot. When the wood work is thoroughly dry, the priming coat shall be applied.

DETAILED SPECIFICATIONS OF ROADS

EARTH FILLING (EMBANKMENT)

Before any earth work is commenced, the ground be cleaned of all trees jungle and roots of every description. The embankment shall be made from borrow pits on either side of the road.

The earth work should be laid in layers of 15 cm. to 23 cm. and consolidated by rollers, preferably sheep's foot rollers. The final compaction may be ordinary power roller.