Civinnovate

Discover, Learn, and Innovate in Civil Engineering

Estimating and Costing

Chapter 1. Introduction

It is required to know beforehand the probable cost of construction known as estimated cost for all engineering works. If the estimated cost is greater than the money available, then attempts are made to reduce the cost by reducing the work or by changing the specifications. From this the importance of estimate to engineers may be understood.

In simple words estimating is the process which guides us to determine the cost, quantity, tools, plants and labors which are needed to complete the project with in time of completion.

Before taking up any work contractor should have a thorough idea of works and cost. Without this knowledge it will too risky to take up any work. Estimating and costing deals with this problem and gives us a detailed idea of work and cost.

Thus, **an estimate for any construction work may be defined as the process of calculating the quantities and costs of the various items required in connection with the work.** It is prepared by calculating the quantities, from the dimensions on the drawings for the various items required to complete the project and multiplied by unit cost of the item. Estimate is the anticipated or probable cost of work and is usually prepared before the construction is taken

In preparing the estimate one has to go into details of each items, big or small, nothing can be left or missed. Accuracy in estimate is very important. If estimate is exceeded, it becomes very difficult for engineers to explain, to account for and arrange the additional money. Inaccuracy in preparing estimate, omission of items, changes in designs, improper rates etc. are the reasons for exceeding the estimate, though increase in rates may be one of the reason.

Importance of Estimating

To give a reasonably accurate idea of the cost

An estimate is necessary to give the owner a reasonably accurate idea of the cost to help him decide whether the works can be undertaken as proposed or needs to be curtailed or abandoned, depending upon the availability of funds and prospective direct and indirect benefits. For government works proper sanction has to be obtained for allocating the required amount. Works are often let on a lump sum basis, in which case the Estimator must be in a position to know exactly how much expenditure he is going to incur on them

1. Estimating Materials

From the estimate of a work it is possible to determine what materials and in what quantities will be required for the works so that the arrangements to procure them can be made.

2. Estimating Labor

The number and kind of workers of different categories who will have to be employed to complete the work in the specified time can be found from the estimate.

3. Estimating Plant

An estimate will help in determining amount and kind of equipment needed to complete the work.

4. Estimating Time

The estimate of a work and the past experience enable one to estimate quite closely the length of time required to complete an item of work or the work as a whole.

Whereas the importance of knowing the probable cost needs no emphasis, estimating materials, labor, plant and time is immensely useful in planning and execution of any work.

- It is also helpful to check the works done by the contractors during and after the execution.
- It is required for preparing tender for the project.

Estimated cost and Actual cost

Estimated cost is the probable cost or anticipated cost of the work and is usually prepared before the construction is started.

Actual cost is the cost which is known only after the completion of the work from the account of the completed work.

The actual cost should not differ much from the estimated cost worked out at the beginning.

Purpose of Estimating

1. **MONEY**-to determine necessary amount of money required by the owner to complete the proposed work.
2. **QUANTITY**– to determine the quantities of materials required in order to program their timely procurement.
3. **WORKER**– to determine the number of various types of workers required in each work.
4. **TOOLS AND PLANTS**-to arrange necessary tools and plants as per schedule of work in correct numbers.
5. **SCHEDULE**– to create a schedule of work.
6. **TIME**-to calculate the completion time of project
7. **COST BENEFIT RATIO**-to justify cost benefit ratio.
8. An estimate for an existing property is required for valuation.
9. To invite tenders and prepare bills for payment.

Data required for estimating

In order to prepare a detailed estimate the estimator must have with him the following data:

1. Plans, sections, elevations and other relevant details of the work.

2. Specifications indicating the exact nature and class of materials to be used.

   - General Specification
   - Detailed Specification

3. The rates at which the different items of work are carried out.

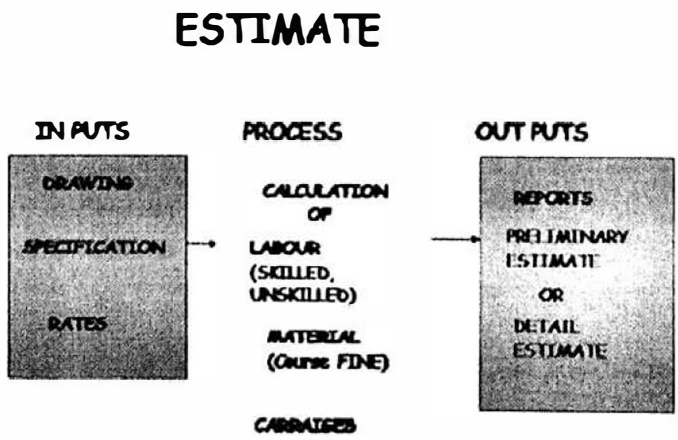
For preparing the estimate the unit rate of each item of work are required. Unit rates of each item is derived from:

- The rates of various materials to be used in the construction.
- The cost of transport materials.
- The cost of labor.

4. Updated mode of measurement (deductions, additions, etc.)

5. Standing circulars (insurance, taxes, etc.)

To enable an estimator to take out the quantities accurately, the drawings must themselves be clear, true to the fact and scale, complete, and fully dimensioned. The estimator has also to bear in mind certain principles of taking out quantities.



Units of Measurements

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

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

b) Long and thin works like cornice, fencing, hand rail, bands of specified width etc., are expressed in running metres (RM) and linear measurement shall be taken.

c) Shallow, thin and surface works like plastering, white washing, partitions of specified thickness etc., and are expressed in square meters (m^2). The measurement of length, breadth or height can be taken to compute surface area.

d) Mass, Voluminous and thick works like earth work, cement concrete, Masonry etc are expressed in Cubic metres. The measurement of length, breadth and height or depth can be taken to compute cubic content or volume.

Table below shows units of measurement of various items of civil engineering works based on IS 1200.

Sl. No.	Particulars of item	Units of measurement	Units of payment
1	**Earthwork**		
	1. Earthwork 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
	4. surface dressing	SQM	Per SQM
2	**Concrete**		
	1. Lime concrete in foundation	CUM	Per CUM
	2. Cement concrete in lintels	CUM	Per CUM
	3. RCC in slab	CUM	Per CUM
	4. Cement concrete or RCC in chajja, sunshade	CUM	Per CUM
	5. Lean concrete in roof terracing (thickness specified)	SQM	Per SQM
	6. Cement concrete bed	CUM	Per CUM
	7. Reinforced concrete sunshade (specified width and height)	CUM	Per CUM
	8. Plain Cement Concrete in foundation	CUM	Per CUM
3	**Damp proof course (DPC) – thickness mentioned**	SQM	Per SQM

4	**Brick work**		
	1. Brickwork in foundation	CUM	Per CUM
	2. Brickwork in plinth	CUM	Per CUM
	3. Brickwork in super structure	CUM	Per CUM
	4. Thin partition walls	SQM	Per SQM
	5. Brickwork in arches	CUM	Per SQM
	6. Reinforced brickwork	CUM	Per CUM
	7. Brickwork in flat soling	SQM	Per SQM
5	**Stone work**		
	1. Stone masonry	CUM	Per CUM
6	**Wood work**		
	1. Doors and windows frames or chaukhats, rafters, beams	CUM	Per CUM
	2. Shutters of doors and windows (thickness specified)	SQM	Per SQM
	3. Doors and windows fittings (like hinges, tower bolts, sliding bolts, handles)	Each	Per Each
	4. wooden formwork	SQM	Per SQM
	5. Wooden false ceilings	SQM	Per SQM
7	**Steel work**		
	1. Steel reinforcement bars etc. in RCC and reinforced brick work	Quintal	Per Quint
	2. Bending, binding of steel reinforcement	Quintal	Per quint

	4. Rivets, bolts and nuts, anchor bolts, Lewis bolts, holding down bolts	Quintal	Per quinta
	5. Iron grills	kg	Per kg
8	**Roofing**		
	1. RCC and RB slab roof (excluding steel)	CUM	Per CUM
	2. Lean concrete roof over and inclusive of tiles or brick or stone slab etc. (thickness specified)	SQM	Per SQM
	3. Centering and shuttering formwork	SQM	Per SQM
	4. AC sheet roofing	SQM	Per SQM
	5. C.G.I sheet on ridge, valley, gutter	RM	Per RM
	6. Water proof treatment on roof, water tank	SQM	Per SQM
9	**Plastering, pointing and finishing**		
	1. Plastering – cement or lime mortar (thickness and proportion specified) in wall and ceiling	SQM	Per SQM
	2. Pointing	SQM	Per SQM
	3. White washing, color washing, cement washing, (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
10	**Flooring**		
	1. 25mm cement concrete over 75mm lime concrete floor (including lean concrete)	SQM	Per SQM
	2. 25mm or 40mm cement concrete floor	SQM	Per SQM

	3. Doors and window sills (CC or cement mortar plain)	SQM	Per SQM
	4. Sand filling	CUM	Per CUM
	5. Marble flooring	SQM	Per SQM
	6. Tile flooring	SQM	Per SQM
11	Rain water pipe / plain pipe	RM	Per RM
12	Steel wooden truss	Each	Per each
13	Glass panels (supply)	SQM	Per SQM
14	Fixing of glass panels or cleaning	Each	Per Each
15	Cement Skirting	M	Per M
16	Plaster of Paris (P.O.P)	SQM	Per SQM

Note:

- SQM = Square meter
- CUM = Cubic meter
- RM = Running meter

Principles of deciding Unit of Measurement

A beginner may find it difficult to remember the units of measurement of different items. Memorizing of units of measurement would be greatly simplified if he knows the principles kept in view while selecting the units of measurements. Following are the most important principles of selection of unit of measurement:

1. The unit of measurement should be simple and convenient to measure, record and understand.

2. It should be one, which provides for fair payment for the work involved.

3. In the result it should yield quantities, which are neither too minute nor too large.

4. The price per unit should not be a very small figure or a very large one, that is, generally costlier items will be measured in smaller units, cheaper ones in larger units.

5. The unit of measurement may sometimes depend upon the unit for the raw material and/or labor and/or important dimensions.

Estimating and Costing

Chapter 2

Methods of Measurements of Building and Civil Engineering Works

Measurement of works plays a very important role in planning and execution of any work or project, from the time of preparation of first estimate until the completion of work and final settlement of payments. The methods followed may vary from one place to another, so for convenience uniform method should be followed.

General rules

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

2. The order of dimensions while booking shall be in sequence of length, breadth and height or thickness.

3. All works shall be measured subject to the following tolerances.

- Linear measurement shall be measured to the nearest 0.01m.
  Exceptions: Wood work- nearest 0.002 m
  Steel reinforcement- nearest 0.005 m
  Thickness of RCC slab- nearest 0.005 m
  <20 cm thick road pavement- nearest 0.005 m
- Areas shall be measured to the nearest 0.01 SQM
  Exceptions: Steel plate: nearest 0.001 SQM
- Cubic contents shall be worked out to the nearest 0.01 cum.
  Exceptions: Wood work- nearest 0.001 cum
  Steel reinforcement- nearest 0.001 MT (1kg)

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 as:

- From foundation to plinth level
- From plinth to first floor level
- From first floor to second floor level and so on.

Earth Work

Earthwork shall be taken in cum (cu ft) and the dimensions shall be measured to get the cubic content. Earthwork of different nature (Excavation in foundation, in trenches etc. and in filling in plinth, in banking etc.) shall be measured under separate items.

Excavation shall include throwing of the excavated earth at least one metre clear of the edge of excavation.

Dressing or trimming and levelling or grading, ramming and consolidation thickness of each layer etc. shall be described and included in the item of earthwork.

No separate measurements shall be taken for setting out works, profiles, site clearance, removal of slips or falls etc.; these are included in the rates.

Concrete Work

Concrete work shall be measured in cum (cu ft) and measurement of dimensions (L, B and H) shall be taken to the nearest 1 cm. No deductions shall be made for openings upto 0.1 sqm (1 sq. ft).

Unless otherwise provided, formwork (centering and shuttering) shall be taken under separate item in sq. m (sq ft). Formwork shall be measured ass the actual surface in contact with the concrete whereas for slabs, vertical sides shall not be measured.

R.C.C Work

RCC work shall be measured in cum (cu ft) excluding steel. Steel reinforcements shall be measured under separate items in Quintal. Normally, formwork (centering and shuttering) shall not be measured separately but included in the rate of RCC work. Binding wire is not measured separately.

RCC work shall include RCC slabs, beams, columns, lintels, chajjas, staircases, foundation, rafts and footing etc.

Brickwork

Brickwork shall be measured in cu m (cu ft) and measurements of dimensions shall be taken to compute the quantity. The length and height shall be measured to nearest 1 cm.

Brick walls upto and including three bricks in thickness shall be measured in multiples is half brick which shall be deemed to be inclusive of the mortar joint.

For brick size 22.9*11.4*7.6 cms, half brick size is 11.5 cm.

For brick size 25.5*12.7*7.6 cms, half brick size is 12.7 cm.

For walls which are more than three brick in thickness, the actual thickness shall be measured to nearest 1 cm.

No deductions or additions shall be made up to 0.1 sq m (1 sq ft) opening in section. No deductions or additions for end of joints, beams, lintels, posts, rafter, steps etc.

Painting

Painting shall be measured in sq m (Sq ft) stating the number of coats and measurement shall be taken flat. Prepatory works such as cleaning, rubbing down, removing etc. shall be described.

Different types of surfaces such as steel, wood, fibre board, concrete surface etc. shall be measured under separate items.

Painting of doors and windows shall be measured closed and flat not girthed in sqm (sq ft) and shall include chaukhat, edges cleats etc.

Different types of door and windows shall be grouped under one item and the areas of uneven surfaces shall be converted into equivalent plain area by multiplying the flat area measured by a multiplying factor.

Particular	Multiplying Factor
Panelled shutter	1.30
Flush shutter	1.20
Glazed window	0.8 (0.5 for big glass panels)
Louver	1.80
Collapsible gate	1.50
Rolling Shutter	1.10
M.S grill, railing	1
C.G.I sheet	1.14

Ceiling

Ceiling shall be measured in sqm (sq ft) and the materials, thickness and the method of fixing shall be described. No deductions shall be made for opening upto 0.4 sqm (4 sq ft)

Plastering

Plastering shall be taken in sqm (sq ft) stating thickness, mortar and its mix. Plastering of the roofs, ceiling walls etc. shall be measured under separate items. The measurement of all plastering shall be taken for the dimensions before plastering for length and from top to floor or skiting to the ceiling for height.

Pointing

Pointing in walls is calculated is sq m for whole surface and deductions similar to plastering is made.

Woodwork

Wooden beams, posts, wooden roof trusses, chowkhats etc. come under this item and the quantities are taken in cu m. The dimensions of finished work shall be taken.

Subheads of various items of work

The term sub head is used to describe the sub divisions into which the total cost of a work is divided for financial control and statistical convenience. The whole work is divided into different classes of items and items of similar nature are grouped under sub-heads of work.

1. Earthwork
2. Concrete work
3. Brick work
4. Stone work
5. Steel work
6. Wood work
7. Roofing
8. Flooring
9. Plastering and pointing work
10. Painting and polishing
11. Miscellaneous work

Under each sub head there are different items of work. For example, under earthwork, the cost of all items of earthwork in excavation, in filling, dressing of earthwork etc. is taken.

Various Methods of Taking Out Quantities

The procedure by which quantities of the various items in a particular structure are worked out is known as taking out quantities. The quantities are obtained by studying in detail the drawings of the structure.

Methods of taking out
English method
PWD method

English method of taking out quantities

(1) Taking off;
(2) Grouping
(3) Billing

Thus, the quantities of the various items are worked out on a measurement or dimension form and then quantities of identical items are grouped together and written on an abstract form.
In the dimension column, the length, the breadth or width and the height or depth are written in sequence in vertical direction. The multiplication giving the final quantity is then entered in the squaring column.
Timesing columns: These columns are used to enter multipliers when there is more than one of the particular items being measured.
Dimension columns: Where the dimensions of the item being measured are recorded.

Squaring columns: These columns are used to calculate the quantities which are produced by multiplying the timesing factor by the dimensions. The results are then totaled to derive the final quantity of work.

Description columns: These wider columns are used for descriptive content such as location references and explanatory notes called annotations. Preliminary calculations, called waste calculations may also be carried out in these columns.

Timesing	Dimension	Squaring	Description
	4.0 3.0 2.0	24.0	This indicates 24 cubical content
	4.0 3.0	12.0	This indicates 12 superficial contents
	4.0 5.0	4.0	This indicates linear measurements
	No.5 5		This indicates no.

The following column is used to indicate the number by which the measurements are to be multiplied. It should be remembered that an item timesed can be timesed again as shown below.

3/	4.0 3.0 2.0	72.00	This indicates the cubical contents are to be multiplied by 3.
2/5/3	4.0 3.0 2.0	720.00	This indicates the cubical contents are to be multiplied by 3x5x2= 30

When the measurement is to be added and not to be multiplied, the process known as dotting on is adopted. A dot below a figure in the timesing column indicates an addition.

2 . 3	4.0 3.0 2.0	120.00	This indicates that the cubical contents are to be multiplied by 3+2 = 5
2 3 . 2	4.0 3.0 2.0	240.00	This indicates that the cubical measurements are to be multiplied by (3+2) x 2= 10
3 3 2 . . 2 1	4.0 3.0	540.00	This indicates that the superficial measurements are to be multiplied by (2+1)x(3+2)x3 = 45

After working out the quantities of various items an abstract is prepared in which the items are classified, grouped and arranged accordingly

The abstract form is commonly known as the bill of quantities and the process of writing the bill of quantities is called the billing. Thus, a bill of quantities indicates a document which lists all the items necessary for the complete construction of the project.

Each item of the bill of quantities includes a brief description of every item together with its estimated quantity. Thus, the main function of bill of quantities is to provide a basis on which tenders can be obtained from the prospective contractors and the bill of the quantities can be used to assess the value of work as executed and they help in preparing the revised estimate, if found necessary.

Features of the English method

(1) The quantities are found out in the sequence of measurements irrespective of items of work and sequence of execution.

(2) The grouping is a separate process and it is followed along with the process of billing on the abstract form.

(3) The chances of omitting any measurements are reduced.

(4) The method is lengthy and it requires more time.

P.W.D. method of taking out quantities

The three processes namely, taking off, grouping and billing, are also involved in this method.

1) But the first and second processes of taking off and grouping are carried out on the quantity sheet.

2) The measurements are recorded item wise and the items are arranged in the sequence of execution.

3) The third process of billing is done on the abstract form as in case of the English method.

4) Thus, in this method, the grouping will appear on measurements form as well as on the abstract form.

Features of P.W.D. method are as follows

(1) The quantities are found out in the sequence of execution, irrespective of the sequence of measurements.

(2) The grouping process is eliminated in the sense that the measurements are directly grouped on the quantity sheet.
(3) There are chances of missing some measurements.
(4) The method is easy and it requires less time.

Item No.	Description of work	No.	L	B	H/D	Quantity	Remarks
1	Brick Wall	1	10.00	0.30	2.00	6.0 m^3	

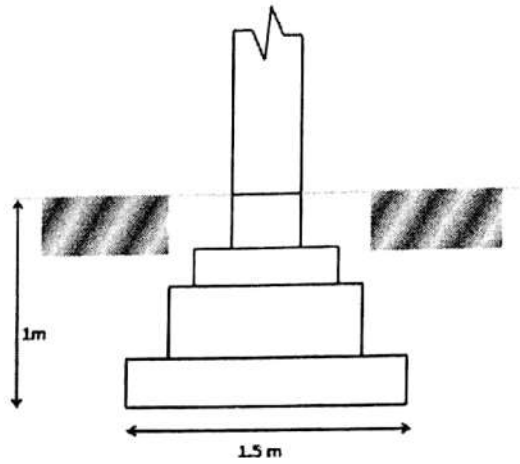
Methods of Estimation for Building Works

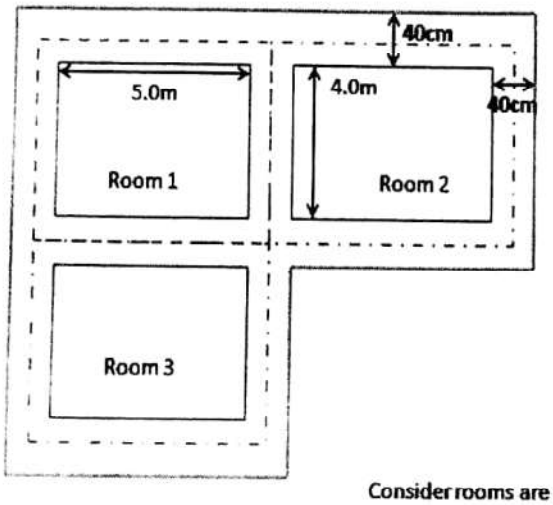
The estimation of building quantities like earth work, foundation concrete, brickwork in plinth and superstructure etc. can be worked out by long wall short wall method and centerline method.
Following are the different methods used for estimating building works:
Long wall – short wall method
Centre line method.
Partly Centre line and short wall method.
Bay Method
Crossing Method

Long Wall – Short Wall Method (Out to Out and In to In Method)

For the calculating quantity of various construction item, long wall and short wall method is used. For measuring the long wall and short wall the external out-to-out length of walls running in the longitudinal direction generally is considered as "long wall" while the in-to-in internal length of walls running in the transverse direction is called as "short wall" or "cross wall". For calculating quantity multiply the length into the breadth and height of the wall.
Length of Long Wall = Center to Center Length of wall + Half Breadth on One Side + Half Breadth on the Other Side
= Center to Center Length of wall + One Breadth
For finding out length of short wall or cross wall subtract from the centre length, the one breadth of the wall, which gives the length of the short wall (in-to-in) (instead of adding).
Length of Short Wall = Centre to Centre Length – One breadth

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.
This method is simple and accurate, so there is may be no chances of any mistake. But correctly choose long wall and short wall for finding out accurate quantity.





Consider rooms are identical with 5m length and 4m breadth. The thickness of the wall is 40cm.

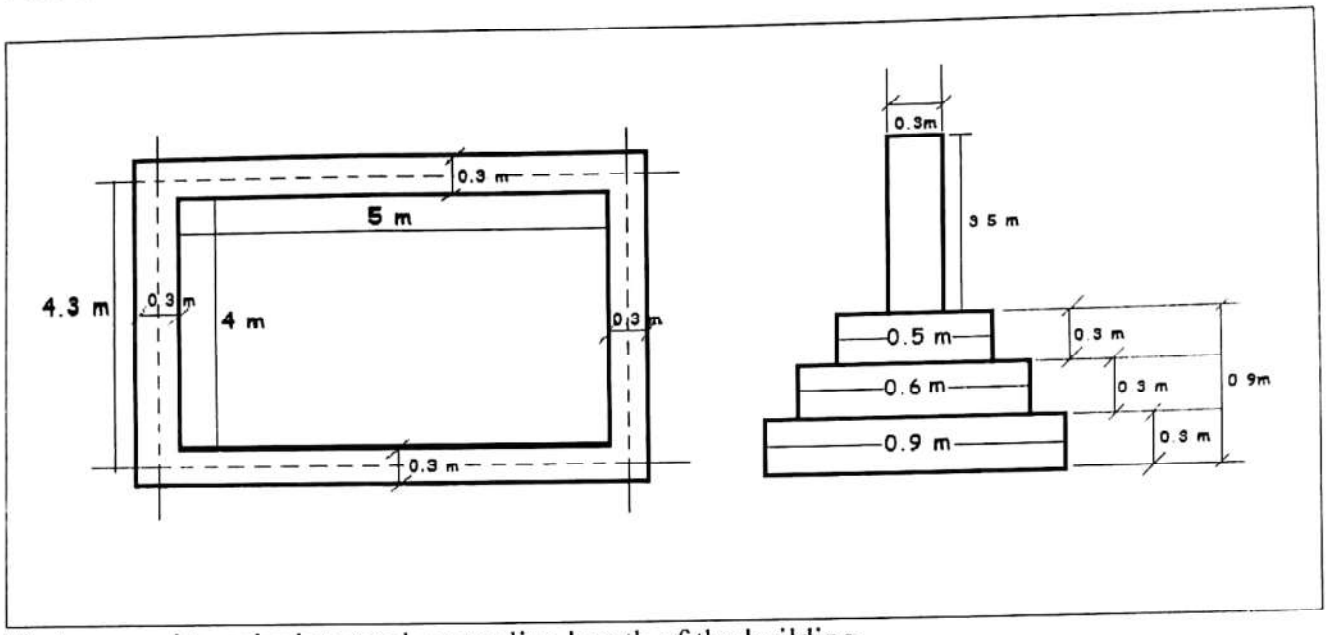
Calculate the quantity of excavation for the given plan using long wall – short wall method and centre line method?

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 main wall, the centre line length gets reduced by half of breadth for each junction.
Such junction or joints are studied carefully while calculating total centre line length. The estimates prepared by this method are most accurate and quick.

Corrected Centre Line Length= C.L – Number of T joints *width/2

FOR ONE ROOM BUILDING:



First we need to calculate total center line length of the building.

Total center line length = 2 x 5.3 + 2 x 4.3 = 19.2 m.

1. Earthwork in excavation = Total center line length x breadth x depth

= 19.2 x 0.9 x (0.3+0.3+0.3)

= 19.2 x 0.9 x 0.9

= 15.52 cu.m

2. Concrete in foundation = 19.2 x 0.9 x 0.3 = 5.18 cu.m

3. a) Brickwork in foundation for 1st footing = 19.2 x 0.6 x 0.3 cu.m

b) Brickwork in foundation for 2nd footing = 19.2 x 0.5 x 0.3 = 2.88 cu.m

4. Brickwork in superstructure = 19.2 x 3.5 x 0.3 = 20.16 cu.m

Partly Centre 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, 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.

Bay Method

This method is useful and is generally followed in case of buildings having several bays. The cost of the typical bay is worked out and is then multiplied by the number of bays in that building. The extra cost for the end walls and difference in framing, if there is any, should be made, so as to arrive at the correct cost.

Crossing Method

In this method, lengths and breadths of the masonry walls at plinth level are taken (internal dimension of the room + thickness of the walls) for calculating quantities. The symmetrical offsets are a must as in the case of centerline method.

Bill of Quantities (BoQ)

It is the statement of various items of work giving the description, quantities and unit of rates. A bill of quantities (BoQ) is a document used in tendering in the construction industry / supplies in which materials, parts, and labor (and their costs) are itemized. It also (ideally) details the terms and conditions of the construction or repair contract and itemizes all work to enable a contractor to price the work for which he or she is bidding. It is same as abstract of estimated cost but the rates and amount columns are left blank. BoQ is prepared after approval of detailed estimate used in tendering process.

Sample of BoQ

Item No	Description of Work	Quantity	Unit	Rate	Amount	Remarks
1	E/W in excavation in foundation lift upto 1.5 m, lead 30 m in ordinary soil	29.50	CUM			It is filled up by bidders.
2	Providing and soling brick on flat foundation with handmade brick	29.5	SQM			
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....

Preparing a bill of quantities requires that the design is complete and a specification has been prepared. The bill of quantities is issued to tenderers for them to prepare a price for carrying out the works. The bill of quantities assists tenderers in the calculation of construction costs for their tender, and, as it means all tendering contractors will be pricing the same quantities (rather than taking off quantities from the drawings and specifications themselves).

The contractor tenders against the bill of quantities, stating their price for each item. This priced bill of quantities constitutes the tenderer's offer. As the offer is built up of prescribed items, it is possible to compare both the overall price and individual items directly with other tenderers' offers, allowing a detailed assessment of which aspects of a tender may offer good or poor value.

Advantages of BoQ

A BoQ can provide a clear and extensive statement of the work that is to be completed, as well as a reliable base for budget control and accurate cost reporting. It enables the preparation of cash flow forecasts and provides a basis for the valuation of variations, the preparation of interim payments, and the final account.

For tenderers, it helps create a low-risk and low-cost tendering environment, which encourages the submission of competitive bids since the risk is better understood and defined.

Preparation of Detailed Estimate

The preparations of detailed estimate consist of working out quantities of various items of work and then determine the cost of each item.

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. 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 is already computed in the detail's measurement form. But the total cost is worked out in the prescribed form known as abstract of estimated form.

Abstract of Estimate Form

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

The detailed estimate should be accompanied with:

i) Report

ii) Specification

iii) Drawings (plans, elevation, sections)

iv) Design charts and calculations

v) Standard schedule of rates

Factors to be considered while Preparing Detailed Estimate:

i) Quantity and transportation of materials: For bigger project, the requirement of materials is more. Such bulk volume of materials 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 laboures are considered while preparing the detailed estimate.

iv) Availability of materials: Estimated cost of work will be higher if the materials required are not available when required; the workers and the technical staff.

Work Charged Establishment or Overhead

Work charged establishment is the establishment which is charged to works directly. During construction work, a certain number of work supervisors, chaukidars and other staffs are needed and their salaries are paid from amount of work charged establishment. An amount of 1.5 to 2.5% of estimated cost is included in the estimate as work charged establishment.

Contingency

The term contingencies indicates incidental expenses of miscellaneous character. Contingency is provided in construction contracts to allow for miscellaneous unforeseen costs which can not be classified under any heading but is necessary for successful completion of project. Usually 3 to 5 % of contract value is provided as contingency allowance.

Estimating and Costing

Chapter 3: Types of Estimate

Definitions:

Plinth area: It is the built up covered area measured at floor level of the basement or of any story of building.

Floor area: It is the plinth area less area of walls.

Carpet area: It is the floor area less corridor, passage, veranda, entrance hall, porch, staircase, bathroom, kitchen, pantry, store canteen, machine room.

Circulation area: A certain amount of free area is required for movement and access to different room, sitting room, kitchen, bath, for those who use the building is known as circulation area. It is mainly of two types.

Horizontal circulation area (veranda, balconies, passages, corridors, porch).

Vertical circulation area (Staircase, lift).

FAR (floor area ratio):

FAR is used as a measure of the intensity of the site being developed. The ratio is generated by dividing building area by plot area in same units.

Thus a FAR of 3.0 would indicate that the total floor area of a building is three times the gross area of the plot on which it is constructed as would be found in multiple storey building.

If the ratio is 0.10 that means that only one tenth of the plot will be building constructed on it.

1. Approximate Estimate

The approximate estimate is done in order to find out an approximate cost in very short time before starting the project. The estimation is made before selecting the final specification and design of the project. Depending on this estimate, the material approving authority grants administrative approval once the proper scrutiny is done. This method is also known as preliminary or rough estimate.

It is prepared in
a) feasibility study of the project
b) Administrative approval (budget estimate)

Purpose of Approximate Estimate:

1. To evaluate the cost of a project in short time.

2. To evaluate the difference between several options.

3. To check the final cost of the project that is calculated by detailed estimation.

4. To give the owner a reasonably accurate idea of the cost to help him decide whether the work can be undertaken as proposed or needs to be curtailed or abandoned, depending upon the availability of funds and prospective direct and indirect benefits.

5. To determine what materials and in what quantities will be required for the work so that the arrangements to procure them can be made.

6. To determine the number and kind of workers of different categories who will have to be employed to complete the work in the specified time.

7. To determine amount and kind of equipment needed to complete the work.

Methods of Approximate Estimate:

A. Square Meter or Plinth Area Method:

The estimate prepared on the plinth area basis of the building by using suitable plinth area rates is called the plinth area estimate. The area of the building at the plinth level, by taking the external dimensions is worked out and is multiplied by suitable rate per sq m. The cost thus arrived at is the cost of building based on plinth area. The plinth area rates for different types of buildings are different i.e., the rates for residential buildings are less than the rates for the hospital buildings etc. Plinth area estimate is also a rough cost estimate. This estimation is done by selecting the price of 1 square meter area of a building. It is mainly adopted for calculating the cost of following buildings:

Office Buildings, Residential Buildings, School Buildings, Apartment/Flat Buildings, Hospitals.

This method is considered as the best method for calculating the cost of new buildings.

The plinth area is the built up area or external dimensions of a building. The area of the court yard etc. should be excluded from it.

Plinth area= carpet area+ circulation area+ wall and column area

Cost of building= total plinth area prevailing plinth area rate per sqm.*

The plinth area estimate is supported with the following: - Report, Line Plan of building, Detailed Specifications, Line Plan of the building for which the plinth area rate is determined.

B. **Cubic Rate or Cubic Meter Method:**

The cube method is based on the cubic content of a building. Cost per cubic meter is specific for building project. This method aims to overcome the criticism of floor area method that does not take into account possible variations of the storey height. The total cost of the project will be given by:

*Estimate= volume * Unit cost (cost /m^3)*

The volume of the floor is determined as

Volume = Area × Height of one floor

The height of one floor is found out by the following guidelines:

1. Ground Floor: The height of ground floor is calculated from the top of the footing to the middle of the parapet.

2. First Floor: The height of the first floor is calculated from the ground rooftop to the middle of the parapet.

3. Other Floors: The height of other floors are calculated from floor to floor.

Advantages of Cube Method Estimating

- Quick method
- Simple math process
- Easy to understand
- Satisfactory on works of a recurring nature.
- Suitable where cubic content of a space or a building directly influences the cost of an element.

Disadvantages of Cube Method Estimating

- Need higher levels of skill to assess unit rate
- Do not express the actual cost of different parts of the building
- Due to large number of variables, difficult to adjust unit cost
- Doesn't provide any indication about amount of usable space
- Fails to take account of variations in plan, shape, storey height/ total number of storeys etc.

C. Unit rate Estimate

In this method, all costs of a unit quantity such as per km for a highway, per meter of span for a bridge, per classroom for school building etc. are considered first and the estimate is prepared by multiplying the cost per corresponding unit by the number of unit in the structure.

D. Item Rate Estimate

This is more accurate method and most used as well. In this method, the quantities of each item are calculated at first and the cost of these items is abstracted in the second stage.

2. **Detailed Estimate**

After obtaining the administrative approval of the concerned department against the rough cost estimate, the detailed estimate is prepared by P.W.D. department. As this estimate is based on the plans and sections of the building so it is the most accurate estimate. The quantities of items under various sub heads of work are calculated from the drawings and cost of each item is worked out separately according to the prevalent market rates and is totaled. After doing the total of all items a percentage of 5 to 10 is added for unforeseen items, change of design and provision of petty-establishment and a percentage of about 2 is provided for work charged establishment. Grand total so obtained gives the estimated cost of building. This estimate is then submitted to the competent authority for according technical sanction. The competent authority may be Chief Engineer or Superintending Engineer of the P.W.D. department. The detailed estimate is accompanied by report, design and scope, detailed drawings, detailed specifications, justification of the rates

provided and the limit for execution of the work. The work is executed according to the detailed estimate.

3. **Revised Estimate**

When the cost of the estimate exceeds or likely to increase by 5% or more, a revised estimate is required to be prepared. It is accompanied by the comparative statement showing the variations of each item of work and giving the reasons of excess. The excess may be due to change of design and scope of variation in rates etc.

Sample of comparative statement of estimate

		Original Estimate				Revised Estimate				Remarks
Item No	Description of work	Qty.	Unit	Rate	Amount	Qty.	Unit	Rate	Amount	
1	E/W in excavation in foundation	29.5	m^3	410.0		27.1	m^3	520.0		
2	Brick on flat soling	29.5	m^2	650.0		29.5	m^2	780.0		

4. **Supplementary Estimate**

When some addition to the original work is made, a fresh detailed estimate for the additional work is prepared to supplement the original estimate and thus called supplementary estimate. This estimate is in addition to the original estimate. This estimate is prepared during construction due to additional work to be carried out at site.

Example: Additional partition can be planned in the building. The estimate is prepared for partitioning as supplementary estimate. Structural / architectural changes are prerequisite for supplementary estimate.

5. **Annual Repair of Annual Maintenance Estimate**

This estimate is prepared to carry out annual repairs or maintenance. The amount of annual repair estimate should not exceed more than 1.5% of the capital cost of the work. Annual repair are much common in road work for which annual repair estimates are prepared to carry out the work.

Example: White washing, Color washing, Painting of doors and windows etc.

6. **Extension and Improvement Estimate**

When some changes and extensions are required to be made in the old work, the cost of which cannot be met by the annual repair/maintenance estimate, a detailed estimate is prepared for such work which is called as Extension and Improvement estimate.

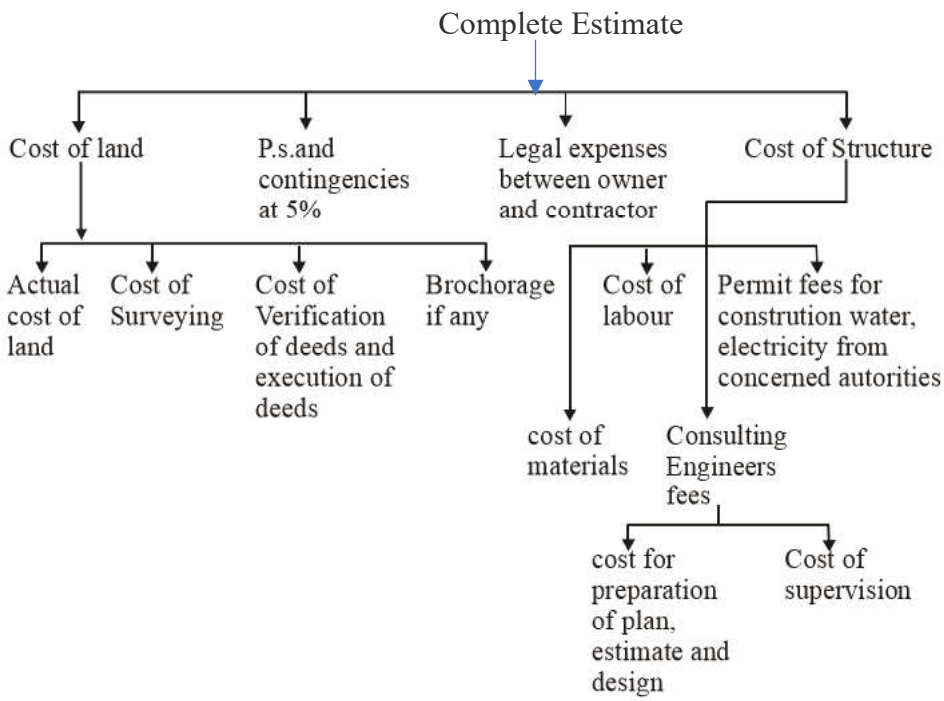
7. Complete Estimate

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.

Complete estimate:

a) Total cost of land

b) Total cost of building or any other infrastructure : This includes cost of preliminary works, feasibility study, preliminary design, drawings, cost of preparing detailed design, drawings, estimate, specification, contract documents, cost of electrical installation, water supply, sanitation works, supervision costs, cost of temporary accommodation during construction, cost of external services, cost of maintenance and repairs during construction and all the other cost incurred during design as well as construction of related work.



General Split up of cost of building works

1. Cost of materials = 65 to 70% of whole cost
2. Cost of labour = 30 to 35% of whole cost
3. Cost of foundation and plinth = 10 to 15% of whole cost

Break down of cost of building work

1. E/W in excavation and filling = 1 to 1.5 % of whole cost
2. Cost of concrete in foundation = 5 to 6 % of whole cost
3. Cost of DPC = 1 to 1.5 % of whole cost
4. Cost of Brick work = 30 to 34 % of whole cost
5. Cost of Roofing = 18 to 20 % of whole cost
6. Cost of Flooring = 5 to 6 % of whole cost
7. Cost of Wood work = 16 to 20 % of whole cost
8. Cost of Plaster and Pointing = 10 to 12 % of whole cost
9. Cost of Painting = 3 to 5 % of whole cost
10. Cost of Miscellaneous works = 4 to 6 % of whole cost

Break down of cost of Road work

1. E/W in embankment/cutting = 14 % of whole cost
2. Soling coat with stone including consolidation = 44 % of whole cost
3. Wearing coat with bitumen including consolidation = 22 % of whole cost
4. Other items = 20 % of whole cost

Estimating and Costing

Chapter 4: Rate Analysis

"*The method of determining the rate of an item of work considering the cost of materials, cost of labour, hire charges of tools and plants, overhead cost, profit etc. is known as rate analysis.*"

At various stages in the project management, we need to know

- how much is cost of executing unit amount of the work
- how many equipment or labour are required to execute unit amount of an item of work.

Obtaining the cost of unit amount of an item is called rate analysis. To obtain the rate of an item, generally following cost are considered.

- cost of material
- cost of labour
- cost of equipment's, plant tools etc.
- overhead cost
- profit

The costs of these components are determined from the area survey, schedule of rates published by central and state government; transportation charges based on the location of the area. Also, we need to know how much is required for execution of the work. Similarly, number of labour and equipment. Not only specification is important for obtaining the cost of the work, but one has also to include quality mentioned during construction we shall discuss this pointing detail through case study.

a. *Cost of material* – To obtain the cost of material in the unit amount of an item, first specification is studied carefully. Quantity of material required is calculated and multiplied by the cost to obtain the unit cost. Cost includes freight, transportation, sales tax, insurance, as well as profit. An estimator has to do his market survey and the area survey before calculating the unit cost of the material.
b. *Cost of labour* – Productivity of the labour is very important aspect in calculation of labour cost. Productivity of the labour depends upon the type of work, training imparted to the laborer, nature of work, time schedule of the work, etc. For example, a mason can do more plastering standing on the floor than working at a height on the scaffolding. Initially, it takes time to learn the work and gradually productivity increases.

For specific works, different types of laborer's, such as skilled and unskilled labour, mason, carpenter, mazdoor, etc. are required to execute the work. Unit amount of work is obtained based on experience; and their cost is obtained from the local survey or government wage rules.

c. *Cost of equipment* - Calculation of work-hour used for equipment is dependent upon the type of equipment utility. Some equipment's are used for specific purpose where as some of it are used for different work simultaneously. Generally, equipment used individually is

calculated for each item of work. For these equipment's, it is not possible to calculate the cost; the equipment charge can be added as overhead. For example, installation of a batching plant requires special effort and it is not easy to distribute its initial cost on the concreting. We can incorporate such kind of work as establishment charges or overhead.

d. *Overhead cost* – During the period of construction, a company has to maintain an office or depreciation of its equipment's may take place. This is usually taken as 2-5% of unit rate.

Part of the overhead is directly related to the construction of an item of work. Such expenses include:

i. Repair and depreciation of tool and plants
ii. Salaries of supervisors, etc.; who are indirectly involved in the work
iii. Temporary go down and sheds to store the material at the site
iv. Lighting arrangements
v. Labour welfare
vi. Safety scheme
vii. Small tools used for work

Such expenses are incurred only when work is under execution. If there is no work, no expense is required.

Other parts of overhead are permanent in nature. These expenses are throughout the year. These expenses include

i. Salaries of office staff,
ii. Printing and stationary charges,
iii. Electricity and rental charges,
iv. Communication expenses such as telephone, e-mail, etc.,
v. Traveling, etc.

In bigger companies, these expenses are higher compared to smaller contractors.

Purposes of Rate Analysis

1. To determine the actual cost of per unit of the items at the locality.
2. To revise the schedule of rates.
3. To workout the cost of extra items of work.
4. To workout the economical use of materials.
5. to examine the viability of tender rates.
6. To fix up labour contract rates.

Importance of Rate Analysis

Rate analysis gives the clear picture of various materials, laboureres, tools and plants etc. required for completing a particular work.

Requirements of Rate Analysis:

Following are the main requirements for performing rate analysis.

1. Correct information of the market rates of materials.
2. Correct information of the different categories of labors.
3. Up to date knowledge of construction work.
4. Output of labors. i.e. task or out turn per day for various types of labors.
5. Knowledge, rate of out turn of various types of plants to be used in in the construction work.

Factors affecting the rate analysis:

1.Specification of the civil work and materials such as **quality of materials, proportion of mortar** or concrete, thickness of plastering, number of coats of painting, depth of excavation, type of soil etc.

2.Location of the construction site – Distance of construction site from source of materials**, availability of labors, availability of water, machinery etc.** influence the rate analysis of construction work. **Transportation facilities available as well as transportation charges and condition of road to the site** of work also influences the rate analysis.

3.**Quantity of materials**, number of different types of labors and rates of materials and labors influence the rate analysis.

4.**Profit of the contractor, miscellaneous expenses and other overheads** also influence the rate analysis.

5.Proper management and guidance.

6.Experience of workers and amenities provided to them.

Government Procedure of Preparing Rate Analysis

A) Total cost of materials = Rs. X
B) Total cost of Labour= Rs. Y
C) Hire charges of tools and plants (including cost of fuel) = Rs. Z

Total = Rs. (X+Y+Z) = say Rs. k

D) Contractor's overhead 15% of Rs. k= Rs. 0.15 k
E) Unit rate of an item= Rs. 1.15 k.

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