

B.Tech II yr II SEM
Subject- Building Construction
and Cost Estimation
Topic- Rate Analysis
Er. Y.N.Shrivastava

Rate Analysis

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

Necessity of Rate Analysis

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

Factors Deciding Rate of Items

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

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

Procedure of Rate Analysis

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

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

Material cost

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

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

a) Lead statement

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

A typical lead statement is provided as follows:

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

Labour cost

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

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

a) Task or out-turn work

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

OUT-TURN OR TASK

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

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

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

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

LABOUR REQUIREMENTS

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

Miscellaneous cost

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

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

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

b) Water charges

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

c) Over head charges

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

General overhead:

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

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

Job overhead:

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

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

c) Contractor's profit

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

Rate Analysis of Important Items

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

Assume volume of excavation = 100 cu m

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

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

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

a) Estimation of Materials

Assume volume of brickwork = 10 cu m

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

Hence, the number of bricks required = _____

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

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

$$= 10 - (5000 \times 0.09 \times 0.09 \times 0.19) = 2.3 \text{ cu m.}$$

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

Thus volume of set mortar = $2.3 + 2.3 \times \frac{15}{100} = 2.64 \text{ cum.}$

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

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

$$= 1.25 \times 2.64 \text{ cu m} = 3.30 \text{ cu m.}$$

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

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

Hence, volume of cement = $3.3/7 = 0.47 \text{ cu m.}$

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

$$[Mass = 50 \text{ kg}; Density = 1440 \text{ kg/m}^3; Thus, Volume = 50/1440 = 0.0347 \text{ cu m}]$$

$$[Thumb rule: 1 \text{ cu m of cement} = 30 \text{ bags of cement.}]$$

Therefore, number of bags required = $0.47 / 0.0347 = 13.5 \text{ bags.}$

Volume of sand required = $0.47 \times 6 = 2.82 \text{ cu m.}$

b) Rate Analysis

Assume, the volume of brickwork = 10 cu m.

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

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

a) Estimation of Materials

Assume plastering area = 100 sq m

Hence volume of mortar for 12 mm plaster = $100 \text{ m} \times 0.012 \text{ m} = 1.2 \text{ cum}$

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

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

$$= 1.2 + 1.2 \times \frac{30}{100} = 1.56 \text{ cu m.}$$

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

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

$$= 1.25 \times 1.56 \text{ cu m} = 1.95 \text{ cu m},$$

Hence, volume of cement = $1.95/7 = 0.28 \text{ cu m}$.

Number of bags required = $0.28 / 0.0347 = 8 \text{ bags}$.

Volume of sand required = $0.28 \times 6 = 1.68 \text{ cu m}$.

b) Rate Analysis

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

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

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

a) Estimation of Materials

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

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

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

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

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

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

Volume of sand required = $2.2 \times 2 = 4.4$ cu m.

Volume of coarse aggregate required = $2.2 \times 4 = 8.8$ cu m.

b) Rate Analysis

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

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

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

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

a) Estimation of Materials

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

1.54 cu m dry volume produces 1.0 cu m set concrete

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

Sum of proportion of cement, sand and coarse aggregate = $1+2+5\frac{1}{2} = 8\frac{1}{2}$

Hence, volume of slaked lime = $15.4/8\frac{1}{2} = 1.8$ cu m.

Volume of surki required = $1.8 \times 2 = 3.6$ cu m.

Volume of jhama brick chips required = $1.8 \times 5\frac{1}{2} = 10$ cu m.

b) Rate Analysis

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

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

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

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

a) Estimation of Materials

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

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

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

Reinforcement required by volume = $10 \times 1/100 = 0.1$ cu m

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

Increase this amount by 5% for wastages.

Thus the volume of reinforcement required = $7.85 \times 5/100 = 8.25$ qu.

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

b) Rate Analysis

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

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

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

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

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

a) Estimation of Materials

Assume area of DPC is = 100 sq m

The volume of concrete will be = $0.025 \times 100 = 2.5$ cum.

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

Number of cement bags required = $16\frac{1}{2}$ bags.

Volume of sand required = 1.10 cu m.

Volume of coarse aggregate required = 2.20 cu m.

Quantity of water proofing compound required = 3% by weight of cement =
= 3% of $16\frac{1}{2} \times 50$ kg = 25 kg.

b) Rate Analysis

Assume, area of DPC = 100 sq m.

Particulars	Qty/Nos.	Rate (Rs.)	Cost (Rs.)
Material Charges			
1. Cement	$16\frac{1}{2}$ bags	320.00 per bag	5280.00
2. Sand	1.1 cu m	350.00 per cu m	385.00
3. C. aggregate	2.2 cu m	800.00 per cu m	1760.00
4. Water proof compound	25 kg	25.00 per kg	625.00
Labour Charges			
1. Head Mason	/ Nos.	450.00 per day	225.00
2. Mason	08 Nos.	350.00 per day	2800.00
3. Mazdoor	08 Nos.	220.00 per day	1760.00

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

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

a) Estimation of Materials

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

b) Rate Analysis

Assume, volume of RR masonry = 10 cu m.

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

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

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

a) Estimation of Materials

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

b) Rate Analysis

Assume, area of Rule pointing = 100 sq m.

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

