Civinnovate

Discover, Learn, and Innovate in Civil Engineering

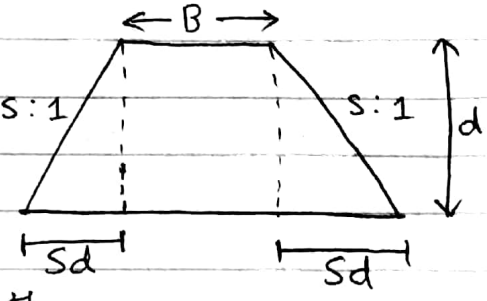
Estimating & Costing

1. Preparation of estimation of earthwork in road construction in plain area

Method I : Mid section area method

Area of mid section

$= Bd + Sd^2$



Method II : Mean sectional area method

Quantity = Mean sectional area × length

Mean area = $\frac{1}{2}$ (Sectional area at one end (A_1) + Sectional area at other end (A_2))

Method III : Prismoidal formula method

Quantity of volume = $\frac{L}{6}(A_1 + A_2 + 4A_m)$

A_1 = cross-sectional area at one end

A_2 = " " " at other end

A_m = mean sectional area

$d_m = \frac{d_1 + d_2}{2}$, $A_m = Bd_m + Sd_m^2$

Q. Prepare an estimate of a road from chainage 14 to 22 from data below. Draw typical cross-section for cutting & embanking. The formation width of the proposed road is 12m. Side slopes are 1 ½ : 1 in cutting and 2 : 1 in banking.

Chainage	14	15	16	17	18	19	20	21	22
RL of ground	108.6	109.25	109.4	108.85	108.15	107.25	106.8	107.15	107.2

The road formation level is proposed as uniformly falling gradient of 1 in 200 passing through the ground level at CH 14, length of one chain = 30m

Soln. Change of level per chain of 30m $= \frac{3\cancel{0}}{20\cancel{0}} = 0.15$

Table same as in ques

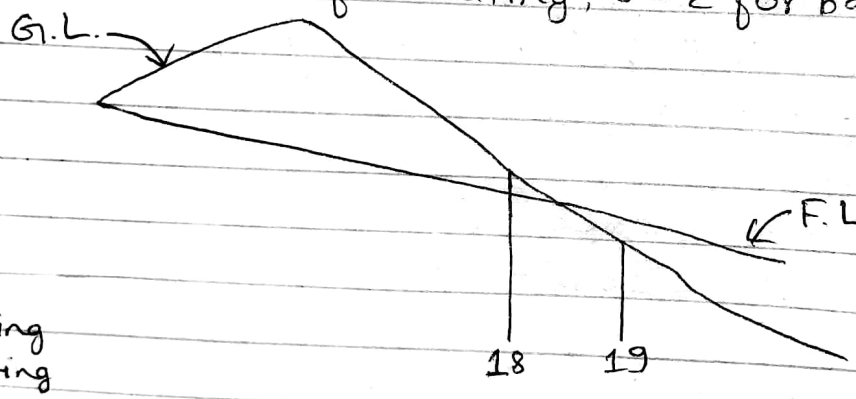
RL of formation	108.6	108.45	108.30	108.15	108.00	107.85	107.7	107
								107
Depth of earthwork	0	-0.8	-1.10	-0.7	-0.5	0.6	0.9	0.4
								0.2

$\frac{0.5}{x} = \frac{0.6}{30-x}$

$\Rightarrow x = 13.63 \simeq 14$ m

From mid sectional method:

B = 12, S = 1.5 for cutting, S = 2 for banking

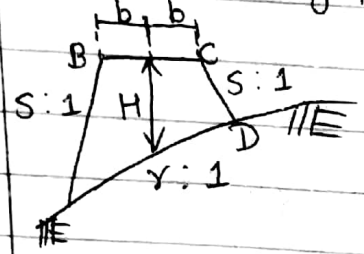


Ht. of cutting
Ht. of banking
RL of F.L.
RL of G.L.

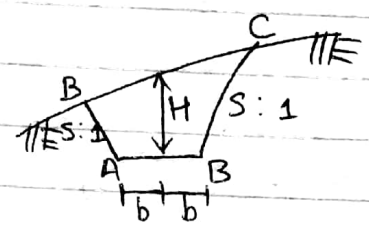
Chainage	Depth (m)	Mean depth	Area of central portion 'Bd' (m^2)	Area of sides 'Sd²' (m^2)	Total area (m^2)	Length bet'ch. 'L' (m)	Quantity Cutting (m^3)	Quantity Filling (m^3)
14	0	–	–	–	–	–	–	–
15	-0.8	-0.4	4.8	$1.5 \times (0.4)^2 = 0.24$	5.04	30	151.2	
⋮								
18	-0.5	-0.6	7.2	0.54	7.74	30	232.2	
Passes	0	-0.25	3	0.09	3.09	14	43.3	
19	0.6	0.3	3.6	0.18	3.78	16		60.4
						Total	1169.77	730

Estimate of earthwork in road construction in hilly area

Case I : Fully in banking or fully in cutting



fully banking



fully cutting

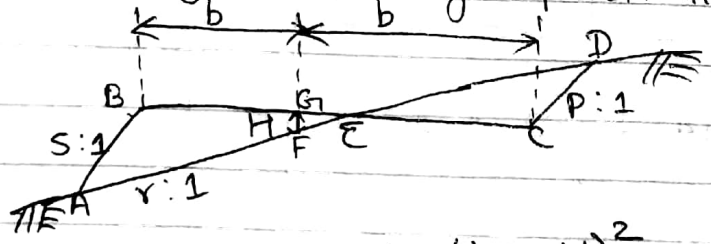
From the geometry of figure,

Area of fully cutting or banking $= \frac{Sb^2 + r^2(2bH + SH^2)}{r^2 - S^2}$

$S:1 \rightarrow$ side slope, $r:1 \rightarrow$ transverse slope

$H \rightarrow$ ht. of banking or cutting, $b \rightarrow$ half of formation width

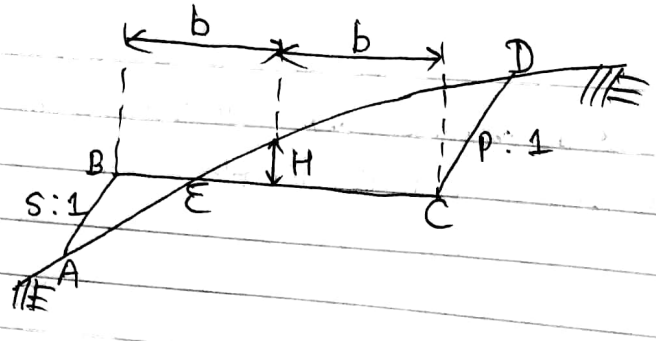
Case II : When the centre line is in banking portion Partially in banking & partially in cutting



Area of $ABE = \frac{1}{2} \frac{(b + rH)^2}{r - S}$

Area of EDC = Area of cutting $= \frac{1}{2} \frac{(b - rH)^2}{r - p}$

Case III : When the centre line is in cutting portion



Area of ABE = Area of banking = $\frac{1}{2} \frac{(b - rH)^2}{r - S}$

Area of EDC = Area of cutting = $\frac{1}{2} \frac{(b + rH)^2}{r - P}$

Q. Prepare an estimate of earthwork for a road portion from the following data:
Formation width in filling = 10m, Side slope = 2 : 1
Formation width in cutting = 8 m, Side slope = 1 : 1

Chainage	0	30	60	90	120	150
Depth of cut (m)	0.5	0.3	0.2	–	–	–
Depth of bank (m)	–	–	–	0.5	0.5	0.7
Cross slope of ground	10 : 1	12 : 1	14 : 1	12 : 1	10 : 1	8 : 1

At chainage 0,
Check for partial cutting or filling
Depth = Given depth at 0m − $\frac{\text{Half of formation width}}{\text{Cross slope @ 0m}}$

$= 0.5 - \frac{8/2}{10}$

$= 0.1 \geq 0$

∴ There is only presence of cutting.

Passes			
19	0.6	0.3	

$$\text{Area of cutting} = \frac{Sb^2 + r^2(2bH + sH^2)}{r^2 - s^2}$$

$$= \frac{1 \times 4^2 + (10)^2(2 \times 4 \times 0.5 + 1 \times 0.5^2)}{10^2 - 1^2}$$

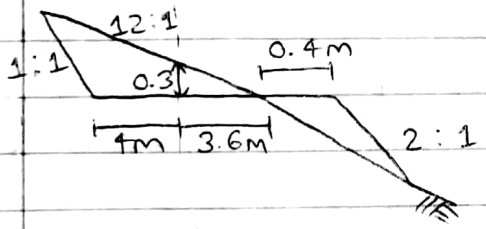
At 30m chainage,

$$\text{Depth} = 0.3 - \frac{8/2}{12} = -0.033$$

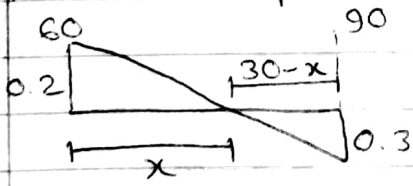
∴ There is presence of both partial cutting & filling.

$$\text{Area of partial cutting} = \frac{1}{2}\frac{(b + rH)^2}{r - s} = \frac{1}{2}\frac{(4 + 12 \times 0.3)^2}{12 - 1}$$

$$\text{Area of partial filling} = \frac{1}{2}\frac{(b - rH)^2}{r - p} = \frac{1}{2}\frac{(4 - 12 \times 0.3)^2}{12 - 2}$$



At balance point



$$\frac{x}{0.2} = \frac{30 - x}{0.3} \Rightarrow x = 12$$

At 60+12 m chainage,

$$r = \frac{2r_1r_2}{r_1 + r_2} = \frac{2 \times 12 \times 14}{12 + 14} = 13$$

$H = 0$

$$b = \frac{1}{2}\left(\frac{B_1}{2} + \frac{B_2}{2}\right) = \frac{1}{2}\left(\frac{8}{2} + \frac{10}{2}\right) = 4.5\text{m}$$

$$\text{Area of cutting} = \frac{1}{2}\frac{(b + rH)^2}{r - s} = \frac{1}{2}\frac{(4.5 + 13 \times 0)^2}{13 - 1} = 0.84\text{m}^2$$

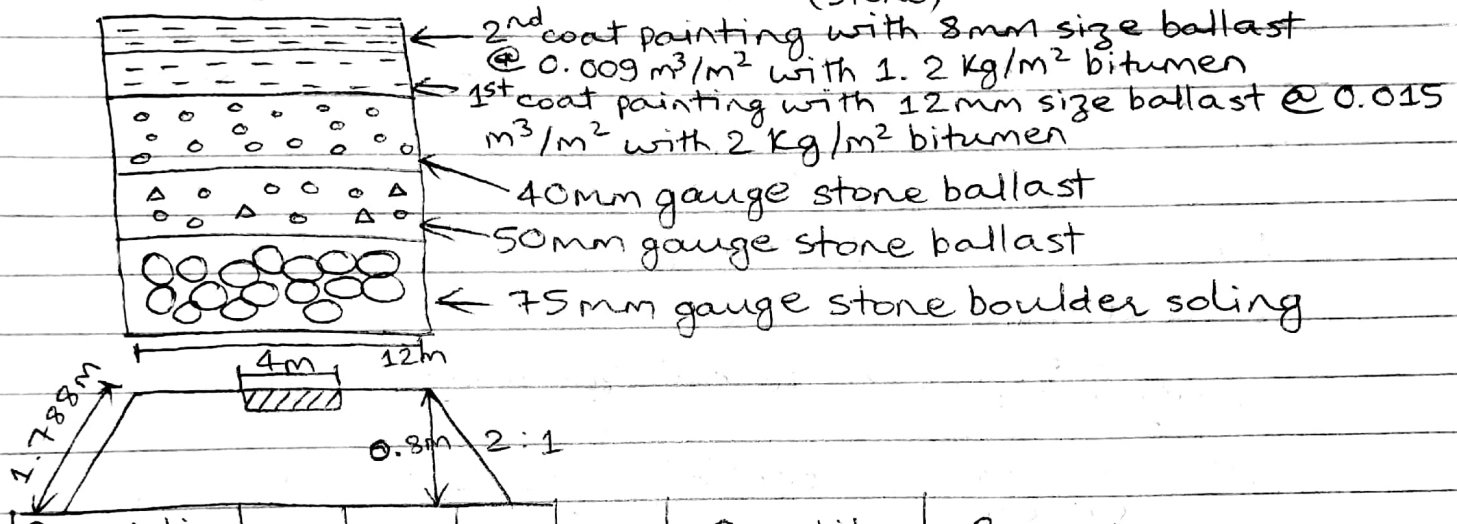
Area of filling $= \frac{1}{2} \frac{(b - rH)^2}{r - P} = \frac{1}{2} \frac{(4.5 - 13 \times 0)^2}{13 - 2} = 0.92$

At 72m chainage,

Chainage	Area Cut (m^2)	Area Fill (m^2)	Mean area (A_m) Cut	Mean area (A_m) Fill	Length 'L' (m)	Quantity Cut (m^3)	Quantity Fill (m^3)
0	4.45	0	–	–	–	–	–
30	2.63	0.008	3.54	0.004	30	106.2	0.12
60	1.77	0.072			30		
72					12	15.66	5.95
90	0.84	0.92	1.305	0.496			
120					Total	197.53	424.57
150							

Estimate for the construction of highway for one Km length

Q. Prepare a detail estimate for the construction of new highway for 1 Km length with the following data:
Formation width = 12m, Avg. Ht. of embankment = 0.8m
Side slope of embankment = 2:1
Depth of borrow pits = 0.3m, metal (stone) width = 4m



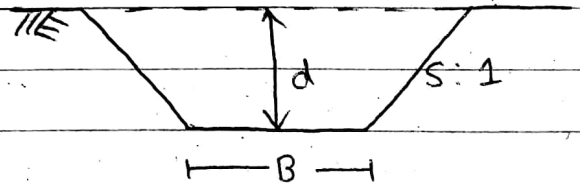
Item no.	Description of work	No	L	B	H	Quantity	Remarks
1.	Surveying of centerline marking	1	1 Km	–	–	1 Km	
2.	Permanent land required	1	1000m	30m	–	30,000 m^2	
3.	E/w in embankment	$= (Bd + Sd^2) \times L$ $= (12 \times 0.8 + 2 \times 0.8^2) \times \frac{1000}{1000}$				10,880 m^3	
4.	Temporary land req^d	$= \frac{\text{Quantity of e/w}}{\text{depth of borrow pit}}$ $= 10880/0.3$				86266.7 m^2	
5.	Turfing on side slopes of embankment	2	1000m	1.788	–	3577.7 m^2	
6.	Preparation of subgrade	1	1000m	4.6m	–	4600 m^2	30cm width

7. Providing laying & consolidation of 75mm gauge stone	1	1000m	4m	0.15m	$600m^3$
8. Laying consolidation of 50mm gauge stone of intermediate layer	1	1000m	4m	0.12m	$480m^3$
9. Laying consolidation of 40mm gauge stone of top layer	1	1000m	4m	0.12m	$480m^3$
10. i) 1st coat paint 12mm gauge stone ballast @ $0.015m^3/m^2$	1	1000m	4 x 0.015		$60m^3$
ii) Bitumen @ $2kg/m^2$ surface area	1	1000m	4 x 2		8000kg
iii) 1st coat laying	1	1000m	4		$4000m^2$
11. 2nd coat paint					
i) 8mm gauge stone ballast @ $0.009m^3/m^2$ surface area	1	1000m	4 x 0.009		$36m^3$
ii) Asphalt @ $1.2kg/m^2$ surface area	1	1000m	4 x 1.2		4800kg
iii) 2nd coat laying	1	1000m	4	—	$4000m^2$
12. Dressing of shoulder	1	1km			1km
13. Brick edging on both sides	1	1km			1km
14. Provision of minor bridge culvert	1	1km			1km
15. Formation of pillars at every 100m	1	1km			1km
16. Traffic diversion construction of service roads	1	1km			1km
17. Road direction posts	1	1km			1km

* Estimate of earthwork in canals:

3 types of canal sections:

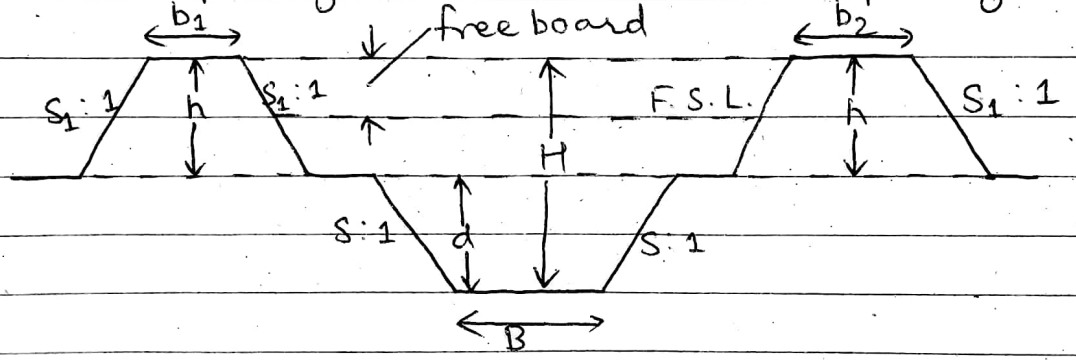
1. Canal fully in excavation



Sectional area = $Bd + Sd^2$

Quantity = Sectional area × length

2. Canal partly in embankment and partly in excavation



B → bed width, d → depth of excavation, h → ht. of embankme

H → ht. of banking from the bed of canal

$h = H - d$

Sectional area in digging = $Bd + Sd^2$

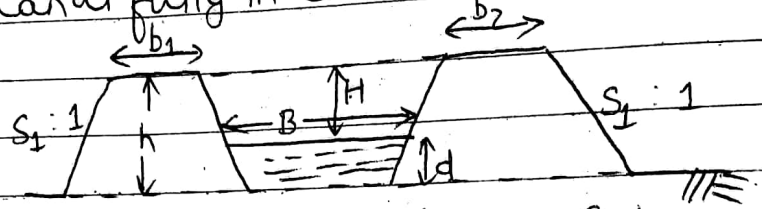
" " in embankment = $2S_1h^2 + b_1h + b_2h$

For economic digging or balancing depth,

Quantity of digging = Quantity of embankment

$Bd + Sd^2 = 2S_1h^2 + b_1h + b_2h$

3. Canal fully in embankment



d - depth of filling between G.L. and canal bed

$h = H + d$

Sectional area $= 2S_1h^2 + b_1h + b_2h$

No earthwork is to be done between G.L. and canal bed as this portion is filled up by silting.

Q. Calculate the quantity of earthwork of a portion of a canal with the following data:

Bed width = 3m, free board = 44cm, slope of digging = 1 : 1, slope of banking = 1.5 : 1, FSD = 1m, top width of both banks = 1.5m

R_d	0	30	60	90	120	150
G.L.(m)	225.24	224.80	224.43	224.12	224.50	224.98
Proposed bed level(m)	224	223.94	223.88	223.82	223.76	223.70

Sol^n in next page.

Q.

Digging B = 3m, S = 1

R.d	Depth of digging 'd' (m)	Area of central portion 'Bd' (m^2)	Area of sides 'Sd^2' (m^2)	Total area (m^2)	Mean sectional area (m^2)	Distance	Quantity $Q = \frac{\text{Mean area}}{I} \times D$ (m^3)
0	1.24	3.72	1.538	5.258	—	—	
30	0.86	2.58	0.74	3.32	4.289	30	128.67
60	0.55						79.08

Total = 431.97 m^3

Embankment Ht. above G.L. = 1 + 0.44 = 1.44m
$b_1 = b_2 = 1.5m$, $S_1 = 1.5$

Ht. above the bed 'H' (m)	Ht. of bank above G.L. h = H − d (m)	Area of central portion ($b_1 h + b_2 h$) (m^2)	Area of sides '$2S_1 h^2$' (m^2)	Total sectional area (m^2)	Mean sectional area (m^2)	Quantity (Q_2) (m^3)	Balance $Q_2 - Q_1$ for borrow pit
1.44	0.20	0.6	1.2	0.72	—	—	
1.44	0.58	1.74	1.009	2.749	1.235	37.05	—
						101.94	22.86
						Total	271.11 m^3

Qty. of earthwork in excavation = 431.97 m^3
" " in embankment = 271.11 m^3
to be taken from borrow pit
Grand total = 703.08 m^3

Design of Slab Culvert
Estimation

Item no.	Description of item	No.	L (cm)	B (cm)	H (cm)	Quantity	Remarks
1.	E/w in excavation for						
	a) Abutment wall	2	530	80	75		
	b) Wing wall	4	140	80	75		
					total =		
2.	Cement concrete in foundation (1:2:4) for						
	a) Abutment wall	2	530	80	30		
	b) Wing wall	4	140	80	30		
					total =	3.88 m³	
3.	First class brickwork in cement mortar (1:4) for						
	a) Abutment walls	2	500	50	157		
	b) Wing walls	4	140	50	157		
	c) Parapets 50cm layer	2	530	50	30		=90+45+22
	d) Parapet 40cm layer	2	530	40	40		
	Deduction for bearing of RCC slab in abutments	2	500	30	22		
					total =	14.87 m³	
4.	Cement pointing (1:3) to exposed surfaces of brickwork						
	a) Inner faces of abutment	2	500		105		15cm below G.L. =90+15
	b) Face walls	2	530		189		15+120+22+(40-8)

Slab Culvert	No.	L(m)	B(m)	H(m)	Qty.	Remarks
4.c) Inner side & top of parapets	2	530	–		112	
d) Ends of parapet	2×2	50	–		30	
	2×2	40	–		40	
Deduction						
a) Rect. opening	2	150			105	
b) Triangular portion of face wall hidden by earth	4	$\frac{1}{2}\times 140\times 140$				
					Total	
5. 8cm x 12cm string course	2	530			~~10.6m~~	10.6m
6. RCC slab excluding reinforcement but including shuttering	1	500	(150+2×30) 210		22	

7. Reinforcements

a) 16 mm ϕ straight bars 25+1 234 = 58.5rm

b) 16 mm ϕ bent up bars 25 253 = 63.5rm

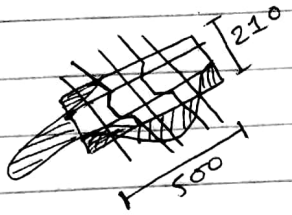
122rm @ 1.58kg = 193kg

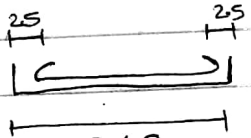
c) 10mm ϕ bottom dist^n bars 10 513 51.3rm

d) 10mm ϕ top 4 513 20.52rm

71.82rm @ 0.62kg = 45kg

Total = 238kg





Hoop – 9D

= 9×16

= 1

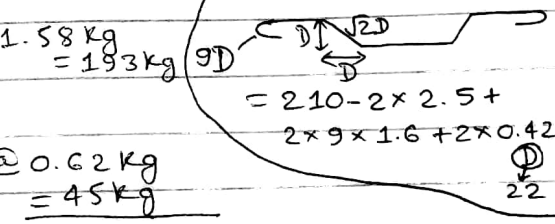
210 – 2.5×2 + ~~2×9×16~~

= 234

Bent-up

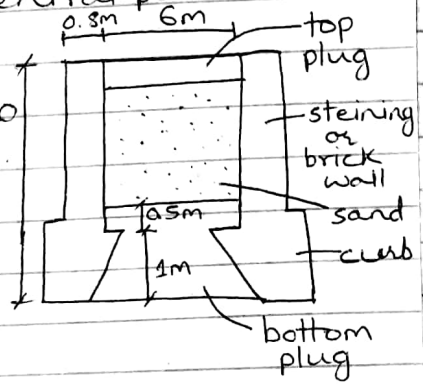
C.S. + Hook

– 4*d



= 210 – 2×2.5 + 2×9×1.6 + 2×0.42×22

Q. Estimate the cost of well foundation of a bridge, the well is to be 6m internal dia with 800mm thick brick wall in 1:6 cement sand mortar. The well is to be founded on a strata 20m below river bed. Bottom of the well is plugged with 1.5m thick cement concrete 1:3:6 & the top is to be sealed with 1m thick cement concrete (1:3:6) & the central portion is sand filled.



S.N.	Particulars of items of works	No	L(m)	B(m)	H(m)	Qty.
1.	Brick masonry in 1:6 cement mortar	1	$\pi \times 6.8$	0.8	19	
2.	Cement ~~concrete~~ 1:3:6					
	a) Bottom plugging curb portion	1	$\frac{\pi}{4} \times 6.8^2$		1	
	b) Bottom plugging above curb	1	$\frac{\pi}{4} \times 6^2$		0.5	
	c) Top plugging	1	$\frac{\pi}{4} \times 6^2$		1	
3.	Sand filling	1	$\frac{\pi}{4} \times 6^2$		17.5	
4.	R.C.C. well curb including reinforcement steel, tie, rods, bars etc.					
5.	Sinking of well					
	0 - 1.5					
	1.5 - 3.0					
	3.0 - 6					
	6 - 9					
	9 - 12					
	12 - 15					
	15 - 18					
	18 - 19					

Abstract of Cost

	Particulars of item of work	Qty	Unit	Rate	Unit	Cost
1	Brickwork ...	-	m^3	250	$/m^3$	
	RCC well					
4	Curb					
		1	Tot			

L S

Add 5% contingency

Add 25% WC (Wm. Charges)

Total =

Add 13% VAT

Grand Total

Estimate of septic tank for 25 users

Item No	Particulars of item	No	L(m)	B(m)	H(m)	Quantity	Remarks
1.	E/w in excavation						
	Septic tank	1	2.8	1.7	1.95		
	Soak pit upto 3m depth	1	$\frac{\pi \times 2^2}{4}$	–	3.0		
	Soak pit lower portion	1	$\frac{\pi \times 1.4^2}{4}$	–	0.2		
2.	Cement concrete 1:3:6						
	Floor and foundation	1	2.8	1.7	0.2		
	Sloping floor	1	2.0	0.9	0.05		
3.	First class brickwork in 1:4 cement mortar in septic tank long walls -						
	1st step	2	2.6	0.3	0.6		
	2nd step	2	2.4	0.2	1.15		
	Short walls						
	1st step	2	~~0.3~~ 0.2	0.3	0.6		
	2nd step	2	0.9	0.2	1.15		
4.	2nd class brickwork in 1:6 cement mortar in soak pit						
	Upper portion	1	$\pi \times 1.2$	0.2	0.5		
	Lower portion	1	$\pi \times 1.2$	0.2	0.2		
5.	2nd class dry brickwork in soak pit	1	$\pi \times 1.2$	0.2	2.5		
6.	Precast RCC work finished smooth including steel reinforcement complete laid in position						
	Roof cover slab of septic	1	2+0.2 +0.2	0.9+0.2 +0.2	0.075		
	Roof cover slab of soak pit	1	$\frac{\pi \times 1.4^2}{4}$	–	0.075		
	Baffle wall in septic tank	1	1.0	0.04	0.45		

Septic Tank

Contd...

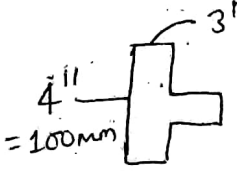
Item no.	Particulars of item	No.	L(m)	B(m)	H(m)	Qty.	Remarks
13.	S.W. Tee 100mm dia with one leg 40cm long	1	-	-	-	1nos	
14.	SW Bend 100mm dia	1	-	-	-	1nos	
15.	50mm dia C.I. ventilating pipe	1	2.0	-	-	2rm	
16.	50mm dia C.I. cowl at the top of ventilating pipe	1	-	-	-	1nos	

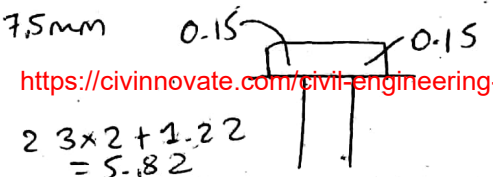
Estimate of two room load bearing building

Item no.	Particulars of item	No	L(m)	B(m)	H(m)	Qty	Remarks
1.	E/w in excavation in foundation						
	a) Long walls	2	7.6	1.0	1.0	15.2 m^3 ~~7.6m³~~	3.5+2.5+0.3+0.15x2+0.5x2
	b) Short walls	3	3.8	1.0	1.0	11.4 m^3 ~~7.4m³~~	4.5+0.15x2-0.5x2
2.	Brick on flat soling						
	a) Long wall	2	7.6	1.0	~~0.05~~	15.2 ~~7.6m²~~	
	b) Short wall	3	3.8	1.0	~~0.05~~	11.4 ~~3.8m²~~	
3.	P.C.C (1:3:6)						
	a) Long wall	2	7.6	1.0	0.15		
	b) Short wall	3	3.8	1.0	0.15		
4.	Brickwork (1:6) cement mortar in foundation						
	i) Long walls						
	a) 1st footing	2	7.2	0.6	0.2		
	b) 2nd footing	2	7.1	0.5	0.2		
	c) 3rd "	2	7.0	0.4	0.2		
	d) 4th " upto DPC	2	6.9	0.3	0.65		

...

...ashing





ii) Short walls

a) 1st footing	2+1	4.2	0.6	0.2
b) 2nd "	2+1	4.3	0.5	0.2
c) 3rd "	2+1	4.4	0.4	0.2
d) 4th " upto DPC	2+1	4.5	0.3	0.65
			Total	m^3

8 5. 50mm thick P.C.C. (1 : 1½ : 3) for DPC

9

i) Long wall	2	6.9	0.3	-
ii) Short wall	3	4.5	0.3	-

6. Brickwork (1 : 4) cement mortar in superstructure

10

i) Long walls	2	6.9	0.3	3.0
ii) Short walls	3	4.5	0.3	3.0

11 Deduction

12 Door & window & lintel

i) Door (D)	2	1.22	0.3	2.3
ii) Window (W_1)	2	1.5	0.3	1.5
iii) Window (W_2)	2	2.0	0.3	1.5
Lintel over door (D)	2	1.52	0.3	0.15

13 Lintel over window

W_1	2	1.8	0.3	0.15
W_2	2	2.3	0.3	0.15

Total m^3

7. Saalwood work for door and window frame

Door (D)	2	5.82	0.075	0.1
W_1	2	6.0	0.075	0.1
W_2	2	7.0		

Total m^3

2.23 = 2.3 − 0.075 + 0.015 − 0.01

8. Panelled door shutter (D)	2	1.10		2.23	1.1 = 1.22 − 2×0.075 + 2×0.015
9. Glazed window shutter					
W_1	2	1.38		1.38	1.5 − 0.075×2 + 0.015×2 = 1.38
W_2	2	1.88		1.38	

Total m^2

10. PCC M20 for RCC work excluding steel				
i) RCC Slab	1	7.9	6.1	
ii) Lintel over door	2	1.52	0.3	0.15
iii) Lintel over window				
W_1	2	1.8	0.3	0.15
W_2	2	2.3	0.3	0.15

Total m^3

11. Formwork for RCC works				
a) Slab Bottom				
Room (1)	1	4.5	3.5	
Room (2)	1	4.5	2.5	
b) Sunshades (projection of slab from wall)				
i) Long side	2	7.9	0.5	
ii) Short side	2	5.1	0.5	
c) Edges				
i) Long side	2	7.9		0.125
ii) Short side	2	6.1		0.125
d) Lintel over door				
Bottom	2	1.22	0.3	
Sides	2×2	1.52		0.150

0.16

Washing

e) Lintel over windows					
Bottom sides (W_1)	2	1.5	0.3		0.15
Bottom sides (W_2)	2×2 H/W	1.8	—		
	H/W				
12. Steel reinforcement for RCC work of slab, lintel					

13. 12mm plaster (1:6) cement sand mortar in					
inside walls					
Room 1					
i) Long wall	2	4.5	—	3.0	
ii) Short wall	2	3.5	—	3.0	
Room 2					
i) Long wall	2	4.5	—	3.0	
ii) Short wall	2	2.5	—	3.0	
Outside walls					
i) Long walls	2	6.9	—	3.6	10cm below G.L.
ii) Short walls	2	5.1	—	3.6	= 3.0 + 0.5 + 0.1 = 3.6m
Deduct					
a) Door opening (both sides)	2×2		1.22	2.3	(-ve)
b) Window opening (11)					
W_1	2×2		1.5	1.5	(-ve)
W_2	2×2		2.0	1.5	(-ve)
					Total =

14. 6mm plaster (1 : 3) cement coarse sand mortar

i) Ceiling

Room 1	1	4.5	3.5
Room 2	1	4.5	2.5

ii) Sunshades

Long side bottom

Short side bottom

iii) Edges

Long side

Short side

15. Flooring work 2.5cm cement concrete 1 : 2 : 4 over floor

Room 1	1	4.5	3.5
Room 2	1	4.5	2.5
Sill of doors	2	1.22	0.3

Total =

16. Mild steel work for iron holdfast

i) Door

ii) Window

2 × 6 = 12

4 × 4 = 16

28 no. @ 0.5 kg

14 kg

17. White washing 3 coats inside and outside

a) Walls → Same as 13

b) Ceiling and sunshade → Same as 14

Total m²

Enamel paint 2 coats over a coat of priming

a) Doors (both sides)	2×2×1.3	1.22		2.3
b) Windows (" ")				
W_1	2×2×1.3	1.5		1.5
W_2	2×2×1.3	2.0		1.5
			Total	m^2

Remarks: As per IS 1984, multiplying factor for each side is taken as 1.3 times the area of the opening including the frame.

Abstract of Cost

Item no.	Description of work	Qty.	Unit	Rate	per	Amount

Estimate of a Pier

Description of works	No.	Length (m)	Breadth (m)	Ht. (m)	Quantity	Remarks
1. Earthwork in excavation in foundation						
i) Pier	1	10.4	2.2	1.35		
ii) Cut water end	1	0.55	1.6	1.35		
2. Cement concrete 1:4:8 P.C. in foundation	1	10.4	2.2	0.45		
Cut water	1	0.55	1.6	0.45		
3. I-class brickwork 1:5 in cement mortar						
Pier						
1st footing	1	8.3	1.8	0.3		
2nd "	1	8.3	1.7	0.3		
3rd "	1	8.3	1.6	0.3		
Above footing & upto springing level	1	8.3	$\frac{1.5+0.9}{2}$	3.6		
Trapezium portion above springing level	1	8.3	$\frac{0.9+0.5}{2}$	0.4		
Ease water end						
1st footing	1	$\frac{1}{2}\left(\pi \times \frac{1.8^2}{4}\right)$		0.3		
2nd "	1	$\frac{1}{2}\left(\pi \times \frac{1.7^2}{4}\right)$		0.3		
3rd "	1	$\pi \times \frac{1.6^2}{8}$		0.3		
Above footing upto springing level	1	$\left(\pi \times \frac{1.2^2}{4}\right) \times \frac{1}{2}$		3.6		
Cut water end						
1st footing	1	$\frac{\sqrt{3}}{4} \times 1.8^2$		0.3		
2nd "	1	$\frac{\sqrt{3}}{4} \times 1.7^2$		0.3		
3rd "	1	$\sqrt{3}/4 \times 1.6^2$		0.3		
Above footing upto springing level	1	$\sqrt{3}/4 \times 1.2^2$		3.6		
				Total	m^3	

plastering, white washing

4.	Cement concrete 1:2:4 at the upper ends of the pier			
	i) Ease water end	1	$\frac{1}{4}\left(\frac{4}{3}\times\pi\times\left(\frac{0.9}{2}\right)^3\right)$	
	ii) Cut water end	1	$\left(\frac{\sqrt{3}}{4}\times 0.9^2\right)\times\frac{1}{3}\times\left(\frac{0.9}{2}\right)$	
5.	Cement pointing 1:2 in exposed surface			
	Pier	2	8.3	3.6
	Ease water end	1	$\pi\times\frac{1.2}{2}$	3.6
	Cut water end	2	1.2	3.6
				Total m^2

Estimate the various quantities for an aqueduct

Item no	Description of works	No	L	B	H	Q	Remarks
1.	E/w in excavation in foundation						
	i) Central pillar straight portion	1	1.8	0.5	0.5		
	ii) Central pillar triangular portion	2	$\frac{\sqrt{3}}{4} * 0.5^2$		0.5		
	iii) End pillars at ~~bed~~ end	2	2.1	0.5	0.5		180+15+15
	iv) End pillars at bank including wing walls	2	6.3	0.5	0.3		
	v) Slopes of stream pitching	2	$\frac{6.0+8.8}{2}$	1.84	0.2		$\sqrt{1.2^2+1.4^2}$ = 1.84
	vi) Slopes of minor pitching	2x2	3.0	1.80	0.1		
	vii) Pitching at bed of minor	2	3.0	1.80	0.1		
	viii) Toe wall	2	8.8	0.2	0.3		
						Total	m^3
2.	Cement concrete 1:4:8 in foundation						
	i)				0.2		
	ii)				0.2		
	iii)				0.2		
	iv)				0.2		
3.	I class brickwork in 1:4 cement mortar						
	i)	1	1.8	0.3	2.10		
	ii)	2	$\frac{\sqrt{3}}{4} * 0.3^2$		2.10		
	iii)	2	1.80	0.3	2.10		
	iv) End pillars at bank	2	1.80	0.3	0.70		
	v) Wing walls	2x2	2.10	0.3	2.15		
						Total	m^3

Finishing works like plastering, white washing

4. RCC work in trough excluding steel and its bending but including centering & shuttering and binding steel
   i) Bottom slab
   ii) Vertical sides

1	8.3	1.8	0.15
2	8.3	0.15	1.30

Total m^3

5. Mild steel reinforcement @ 1% of the volume of RCC work

$5.48 \times \frac{1}{100} \times 785$ | 4.39

6. Cement pointing 1:2 cement mortar
   i) Central pillar
   ~~ii) Central pillar Arc portion~~
   iii) End pillars at bed
   iv) " bank
   v) Wing walls

$[2 \times (1.8 + 0.3 \times 2)]$ — from bed level

1	4.8	–	1.8
~~2~~	~~4.2~~	~~–~~	~~1.8~~
2	4.2	–	1.8
2	1.8	–	0.6
2×2	2.1	–	2.05

Total m^2

7. Dry brick pitching with straight over burnt bricks
   i) Slopes of stream (20cm)
   ii) " minor (10cm)
   iii) Bed " " "

2	$\frac{6.0+8.8}{2}$	1.9	0.2
2×2	3	1.8	0.1
2	3	1.8	0.1

Total m^3

* T-beam decking

Item no	Description of works	No	L	B	H	Q	Remarks
1.	Earthwork in excavation in foundation footing						
	F_1	4	2.0	2.0	2.25		
	F_2	2	2.5	2.5	2.25		
	In-between columns						
	Ⓐ-Ⓐ & Ⓑ-Ⓑ	2	3.5	0.5	1.525		8+2 [redacted] - 6.5 = 3.5
	①-① & ③-③	2	3.0	0.5	1.525		
	②-②	1	2.5	0.5	1.425		
2.	Flat brick soling					m^2	
	F_1	4	2.0	2.0	-		
	F_2	2	2.5	2.5	-		
	In between column				-		
	A-A & B-B	2	3.5	0.5	-		
	1-1 & 3-3	2	3.0	0.5	-		
	2-2	1	2.5	0.5	-		
3.	75mm thick PCC (1:3:6)	Same as item 2					
4.	PCC (1:1½:3) for RCC works						
	F_1						
	Base rectangular cuboid	4	2.0	2.0	0.2		
	Truncated pyramid	4.	$H/3\,(A_1 + A_2 + \sqrt{A_1 A_2})$ → H = 0.4, A_1 = 4, A_2 = 0.16				
	F_2						
	Same as F_1	2	2.5	2.5	0.2		
		2	$\frac{0.5}{3}$	$(6.25 + 0.16 + \sqrt{6.25 * 0.16})$			
						Total m^3	

... are plastering, white washing

Estimating and Costing
Chapter 4 – Nepali writer
Chapter 1 : Introduction
Importance of estimating

1. Estimating of materials
2. " Labour
3. " plant
4. " time
5. Required for preparing tender
6. Helpful to check works done by the contractor during & after execution

- Estimated and actual cost

Purpose of estimating

1. Money 2. Quantity 3. Worker 4. Tools & plants
5. Schedule 6. Time 7. Cost benefit ratio

Data required for estimating

1. Drawings 2. Rates 3. Specifications

Units of measurement

The principle of units of measurement normally consists of the following :

1. Piece works or single units like door, windows, trusses etc. are expressed in numbers
2. Long and thin works like cornice, fencing, hand rail etc. are expressed in running metres (RM) & linear measurements shall be taken.
3. Shallow, thin & surface works like plastering, white washing

partitions of specified thickness etc are expressed i square metre. The measurement of length, breadth or shall be taken to compute area.

4. Mass, voluminous and thick works like earthwork, concr work, masonry etc. are expressed in cubic metres. The measurement of length, breadth and height or depth can be taken to compute volume.

Chapter 2 : Methods of Measurement

* Methods of measurement of building and civil engg. works

General rules

1. Measurement shall be measured for finished item of work.
2. Order of dimensions shall be length, breadth & height.
3. Tolerances
   - Linear measurement - nearest 0.01 m
     Exceptions : Woodwork - nearest 0.02 m
     Steel reinforcement - nearest 0.005 m
     Thickness of RCC slab - nearest 0.005 m
     < 20 cm thick road pavement - " 0.005 m
   - Areas - nearest 0.01 m^2
     Exceptions : Steel plate - nearest 0.001 m^2
   - Cubic contents - nearest 0.01 m^3
     Exceptions - Woodwork - nearest 0.001 m^3
     Steel reinforcement - 0.001 MT (1 Kg)
4. Same type of work under diff. conditions shall be measured as separate items.
5. Bill of quantity shall fully describe the materials, proportions, workmanships and accurately represent the work to be executed.
6. In case of masonry, heights shall be described as
   - From foundation to plinth level
   - From plinth level to first floor level
   - From first floor to second floor level & so on.

~~* Subheads of various items~~

m^3 - Earthwork — Brickwork — m^2 — Plastering — m^2 — ratio included

m^3 - Concrete work — ignore upto 0.01 m^2 opening — Painting — m^2 — no. of coat — Pointing

m^3 - R.C.C. work — Ceiling — m^2 — 0.4 m^2 opening neglected — Woodwork — m^3

steel → MT

formwork included

Sub heads of various items of work

1. Earthwork 2. Concrete work 3. R.C.C. work
4. Brickwork 5. Painting & polishing 6. Roofing
7. Plastering & pointing work 8. Flooring 9. Woodwork
10. Steel work 11. Miscellaneous work

Various methods of taking out quantities

- English method
  - taking off
  - grouping
  - billing
- PWD method
  - same as English but taking off & grouping at once

Timesing (multiplication factor)	Dimension	Squaring	Description
2/3 = 6 2/3 = 5 2/3 1	4.0 3.0 } vertical 2.0 } order	24.0	

$= (3+1)*2$

PWD format

Item No.	Description of work	No	L	B	H	Quantity	Remarks
1.	Brick wall	1	10	0.3	2	$6 m^3$	

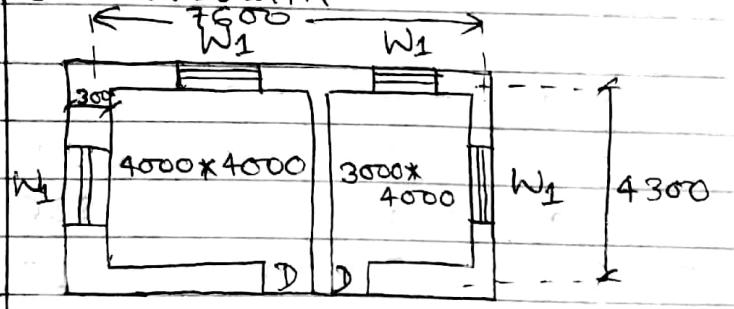
* Methods of estimation of building works
- Long wall - short wall method
- Centre line method
- Partly centre line & short wall method
- Bay method
- Crossing method

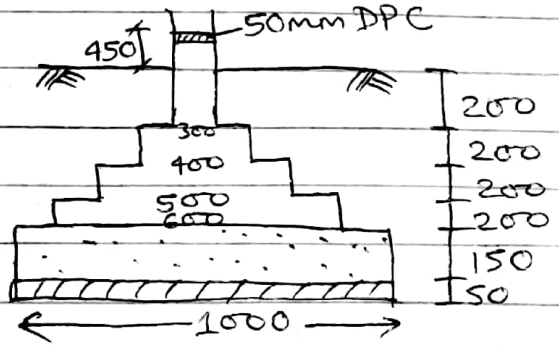
* Long wall - short wall method

Length of long wall = Centre to centre length of wall + half breadth of one side + half breadth of other side

= Centre to centre length of wall + One breadth

Length of short wall = centre to centre length of wall - one breadth





Item No	Description of work	No	L	B	H	Quantity	Remarks
1	E/w in excavation in foundation						
	a) Long wall	2	8.6	1.00	1.00	17.20	7600+1000 = 8600
	b) Short wall	3	3.3	1.00	1.00	9.9	4300-1000 = 3300
						27.10 m^3	
2.	Brick flat soling						
	a) Long wall	2	8.6	1.00	—	17.2	
	b) Short wall	3	3.3	1.00	—	9.9	
						27.10 m^2	
3.	PCC (1:3:6) in foundation						
	a) Long wall	2	8.6	1.00	0.15	2.58	
	b) Short wall	3	3.3	1.00	0.15	1.485	
						4.065 m^3	

4. B/w in (1:6) cement mortar in foundation

a) Long wall

-1st footing	2	8.2	0.6	0.2	1.968
-2nd	2	8.1	0.5	0.2	1.62
-3rd	2	8.0	0.4	0.2	1.28
-4th footing upto DPC	2	7.9	0.3	0.6	2.628
					7.496 m³

b) Short wall

-1st footing	3	3.7	0.6	0.2	1.332
-2nd	3	3.8	0.5	0.2	1.14
-3rd	3	3.9	0.4	0.2	0.936
-4th footing upto DPC	3	4.0	0.3	0.6	2.16
					5.568 m³

5. 50mm thick DPC (1:1½:3)

a) Long wall	2	7.9	0.3	–	4.74
b) Short wall	3	4.0	0.3	–	3.6
					8.34 m²

* Centre line method

Corrected centre line length = Centre line length − No. of T joints * Width/2

C/c length = 2*7600 + 3*4300 − 2*½*1000 = 27100

1. E/w in excavation in foundation

	1	27.10	1.00	1.00	27.10 m³

2. Brick flat soling

	1	27.1	1.00	–	27.1 m²

3. PCC

	1	27.1	1.00	0.15	4.065 m³

4. B/w

-1st	1	27.5	0.6	0.2	3.3
-2nd	1	27.6	0.5	0.2	2.76
-3rd	1	27.7	0.4	0.2	2.216
-4th	1	27.8	0.3	0.6	5.004
					13.28 m³

Bill of Quantities (BOQ)

Sample of BOQ

Item no.	Description of work	Quantity	Unit	Rate	Amount	Remarks
1.	E/w in excavation in foundation lift upto 1.5m, lead 30m in ordinary soil	29.5	m^3			It is filled up by bidders.

Preparation of detailed estimate

i) Details of measurement and calculation of quantities

Item no.	Description of item	No	L(m)	B(m)	H(m)	Quantity	Remarks

ii) Abstract of estimated cost

Item no.	Description	Quantity	Unit	Rate	Amount

Factors to be considered while preparing detailed estimate

1. Quantity and transportation of materials
2. Location of site
3. Local labour charges
4. Availability of materials

- Work charged establishment (1.5-2.5%)
- Contingency (3-5%)

Chapter 3: Types of estimate

Definitions

1. Plinth Area
2. Floor Area
3. Carpet Area
4. Circulation Area
   - Horizontal circular area
   - Vertical circular area
5. FAR (Floor Area Ratio)

1. Approximate estimate (Rough/Preliminary)
   a) Square meter or plinth area method
   b) Cubic rate or cubic meter method
   c) Unit rate estimate
   d) Item rate estimate
2. Detailed estimate 3. Revised estimate (Cost change > 5%) (original also shown)
4. Supplementary estimate 5. Annual repair ~~of a~~ or annual maintenance estimate (≯1.5%)
6. Extension & improvement estimate
7. Complete estimate

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

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

- Estimate for small sewerage projects (Dec. 27)

Q. Prepare a preliminary estimate for a framed 4-storied office building having a carpet area of 300 m^2 for each floor. Assume area occupied by corridor, staircase, verandah etc. as 25% of built up area & that occupied by walls & columns as 8.5% of the same. Given,

i) Built up area rate for ground floor = Rs 1500/m²
ii) " " 1st & 2nd " = Rs 1650/m²
iii) " " 3rd floor = Rs 1800/m²
iv) Extra cost for foundation = 20% of superstructure cost
v) " special architectural treatment = 1% of building cost
vi) " for water supply & sanitary = 7% of building cost
vii) Work charged establishment & supervision charges = 10%
viii) Extra for other sources = 5% of building cost
ix) " electrical installation = 8% " "
x) Assume contingency as 4%

Soln. Built up area or plinth area = carpet area + circulation area + area occupied by wall & columns

Let, P be plinth area.

$P = 300 + 25\% \text{ of } P + 8.5\% \text{ of } P$

$\Rightarrow P = 451.13 \text{ m}^2$

~~Cost for ground floor =~~

Item no	Description	Rate(Rs)	Cost (Rs)
1.	Ground floor	1500	676695
2.	1st floor	1650	744364.5
3.	2nd floor	1650	744364.5
4.	3rd floor	1800	812034
		Total =	2977458
5.	Foundation		595491.6
		Total =	3572949.6
6.	Architectural		35729.50
7.	Water supply & sanitary		250106.470
8.	Other sources		178647.48
9	Electrical installation		285835.97
			4323269.02

WC = 4323269
Cont. = 172930.76
Grand Total = ~~4539432.5~~ 4,28,526.7

Q. Prepare a preliminary estimate for building project from following data collected:

Residential building of 4 stories having total carpet area of 500 m^2 & wall is 8% of plinth area, the circulation area occupied by passages, staircase, verandah etc. is 10% of plinth area. Provision for architectural design is 10% of civil cost, provision for w/s & sanitary = 6% of civil cost & for electrification is 8% of civil cost. Floor height of 1 flat is 3M and ht. of parapet wall on top is 1.2M. Rate per cubic content is Rs 5000/m^3. Assume suitable % contingencies & work charge establishment.

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.

Purpose of rate analysis

- To determine the actual cost per unit items at the locality
- To revise the schedule of rates
- To workout the cost of extra items of work
- To workout the economical use of materials
- To examine the viability of tender rates.

Factors affecting rate analysis

- Quality of materials
- Proportion of mortar or concrete
- Thickness of plastering
- No. of coats of painting
- Depth of excavation
- Distance of construction site from source of materials
- Availability of labours, water, machinery etc.
- Transportation charges & condition of road to the site
- No. of different types of labours & rate of materials & labour
- Profit of contractor
- Overhead cost
- Experience of workers and amneties provided to them

Importance of rate analysis

- Gives clear picture of various materials, labours, tools & plants etc. required for completing a particular work

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 = Rs Z
Total = Rs (X + Y + Z) = Rs K (say)
D) Contractor's overhead 15% of Rs K = Rs 0.15K
E) Unit rate of an item = Rs 1.15K

Material Estimate

1. In concrete mix
To get dry mix (cement + sand + aggregates), increase 50 to 55% of wet mix
2. In mortar mix, To get dry mix (cement + sand), increase 30 to 35% of wet mix
3. In plastering works, First, increase 25% for filling in between joints & irregular surface. In case of concrete surface, inc. 10 to 15% of wet mix to get total wet mix.
Then, to get dry mix (cement + sand), increase 30 to 35% of wet mix.
4. In case of stone works, increase 15 to 20% of total work due to wastage and dressing required to stone.
5. In RCC works,
- To get reinforcement = 1% of volume of RCC
- Binding wire = 1 kg per quintal

Q. Calculate the quantities of materials required for following items of work:
1) 48.5 m^3 of brickwork in 1:3 cement mortar

Sol^n. Let size of brick = 230 × 110 × 55 mm

Thickness of mortar joint = 10 mm (3-12mm)

Size of brick with mortar = 240 × 120 × 65 mm

No. of bricks = $\frac{48.5}{0.24 \times 0.12 \times 0.065}$ = 25909

Add 5 % wastage, then

* No. of bricks = 1.05 * 25909 = 27205

Vol. of mortar = Total volume - Vol. of bricks

= 48.5 - 25909 (0.23 × 0.11 × 0.055) = 12.45 m^3

Add 30 % to get dry volume of mortar = 1.3 * 12.45 = 16.19 m^3

Vol. of cement = $\frac{1}{4}$ * 16.19 = 4.05 m^3

* No. of bags of cement = 4.05 * 28.8

= 116.57

$1 m^3$ of cement = 28.8 bags

1 bag of cement = 50 Kg

* Sand = $\frac{3}{4}$ × 16.19 = 12.14 m^3

W/C ratio = 0.5 (by weight)

* Water required = 0.5 × 116.57 × 50 = 2914.25 lit

b) A PCC 1 : 1.5 : 3 for RCC roof 0.1m thick, 20m wide & 25m long

Assume steel reinforcement as 0.8 % of volume of PCC.

Sol^n. Total volume = 50 m^3

Vol. of PCC = 49.6 m^3 Vol. of dry mix = 74.4 m^3

~~Cement = $\frac{1}{5.5}$~~

Cement = $\frac{1}{5.5}$ × 74.4 = 13.53 m^3

$1 m^3$ = 7850 Kg steel

1 quintal = 100 Kg

No. of bags = 389.59

Fine agg. = $\frac{1.5}{5.5}$ × 74.4 = 20.29 m^3

Coarse = 40.58 m^3

Reinforcement = 0.8 % of 50 = 0.4 m^3 = 3140 Kg = 31.4 qui

Binding wire = 31.4 Kg

Water = 0.5 * 389.59 * 50 = 9739.75 lit

Sand - Rs 3105 per m^3 Binding wire = Rs 101.77/kg
Brick (Chimney made) = Rs 14540/per 1000 Steel reinforcement = Rs 85.84/k
Cement = Rs 841 per bag Unskilled = Rs
Aggregate = Rs 3317/m^3 Water = Rs 0.3 per lit
Skilled labour = Rs 960/day/head

Q. Prepare an analysis of rate for PCC 1:2:4 per m^3.

Sol^n: Cement = $\frac{1}{7} * 1.5 = 0.21 m^3$, Sand = $\frac{2}{7} \times 1.5 = 0.48 m^3$

Coarse = $\frac{4}{7} \times 1.5 = 0.86 m^3$

No. of bags = 6.05 bags @ Rs 841 per bag =

A. Total of materials = Rs 9543

B. Labour

i) Skilled = 1.00 no @ Rs 960/head/day

ii) Unskilled = 4.00 no @ Rs 700/head/day

Total of labour =

C. Hire of tools & plants = 3% of unskilled labour

D. Contractor's overhead = 15% of (A+B+C)

Grand total = A+B+C+D

Hence, Rate per cubic metre = Rs (A+B+C+D) excluding VAT

Prepare rate analysis for steel reinforcement for RCC work per metric tonne.

A. Materials

Mild steel of different size = 1 MT

Add 5% wastage.

Total = 1.05 MT @ 85840 per MT =

Binding wire = 10 Kg @ 101.77/Kg =

B. Labour

i) Skilled = 12 nos @ Rs 960/day/head =

ii) Unskilled = 12 nos @ Rs 700/day/head =

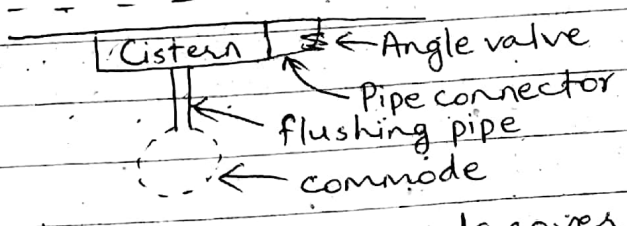
C. Hire of tools & plants = 3% of unskilled

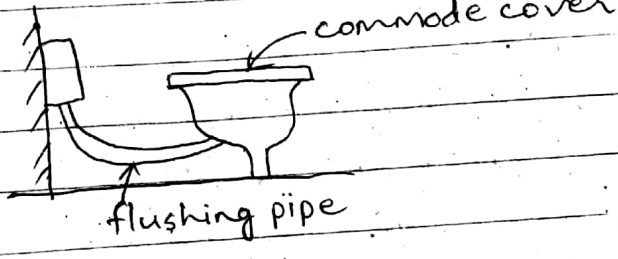
D. Contractor's overhead cost & profit = 15% of (A+B+C)

Rate per MT = Rs (A+B+C+D)

Rate per Kg = Rs $\frac{(A+B+C+D)}{1000}$

Prepare rate analysis for W.C. commode with low level cistern.





A. Materials

i) White glazed ceramic day WC commode with pan strap = 1 no * Rs 4000 = Rs 4000

ii) White glazed ceramic clay 10 litre capacity low ~~bea~~ level cistern with complete accessories = 1 no * Rs 3500 = Rs 3500

... slab culvert, pier

iii) Chromium plated (CP) angle valve = 1 no * Rs 1500
= Rs 1500

iv) 15 * 450mm PVC pipe connector with coupling
= 1 no * Rs 300 = Rs 300

v) 32mm dia PVC flushing pipe with coupling = 1 no * Rs 400
= Rs 400

Q

Sol vi) Heavy duty bakelite commode cover = 1 no * Rs 500 = Rs 500

vii) Clamp, pipe, tape, screws etc. (lump sum) = Rs 500

Total of A = Rs 10700

B. Labour

i) Skilled = 3 nos @

ii) Unskilled = 3 nos @

C. Hire of tools and plants = 3 % of unskilled

D. Contractor's overhead = 15 % of (A+B+C)
=

Rate per no = Rs (A+B+C+D)

Prepare rate analysis for 40mm thick premix asphalt concrete including compaction for $10m^2$

Sol^n: Volume of 40mm thick asphalt premix $= \frac{4\cancel{0}}{10\cancel{0}\cancel{0}} \times 1\cancel{0}$

$= 0.4\ m^3$

Add 40% to 50% for loose volume,

Volume $= 1.4 * 0.4 = 0.56\ m^3$

A. Materials

i) Bitumen 9.6 kg @ Rs. 85 =

ii) Kerosene (LS) = Rs 150

iii) Wood (4 kg @ Rs 25) =

iv) Coarse sand $0.07\ m^3$ @ 2100 =

Sub total (A) =

B. Labours

Unskilled = 0.45 @ 960 =

Sub total (B) =

C. Equipments

Roller = 0.04 hr @ Rs 1000 =

Boiler and sprayer = 0.04 hr @ Rs 475 =

Sub total (C) =

D. Hire of tools and plants = 3% of unskilled labour

=

E. Contractor's overhead and profit @ 15% of (A+B+C+D)

=

Total = A+B+C+D+E

Rate per $10m^2$ = Rs (A+B+C+D+E) excluding VAT

*. Mag MQ (~~Wed~~ Thu), 12 pm Chapters - 1 to 5 (2, 3, 4)

Chapter 6 - E/w in plain area, hilly area, canal, estimate for slab culvert, pier

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