UNIT - III

ESTIMATION OF BUILDINGS & ROADS

The estimation of building quantities like Earthwork, foundation concrete, brickwork in plinth and superstructure can be worked out by following methods.

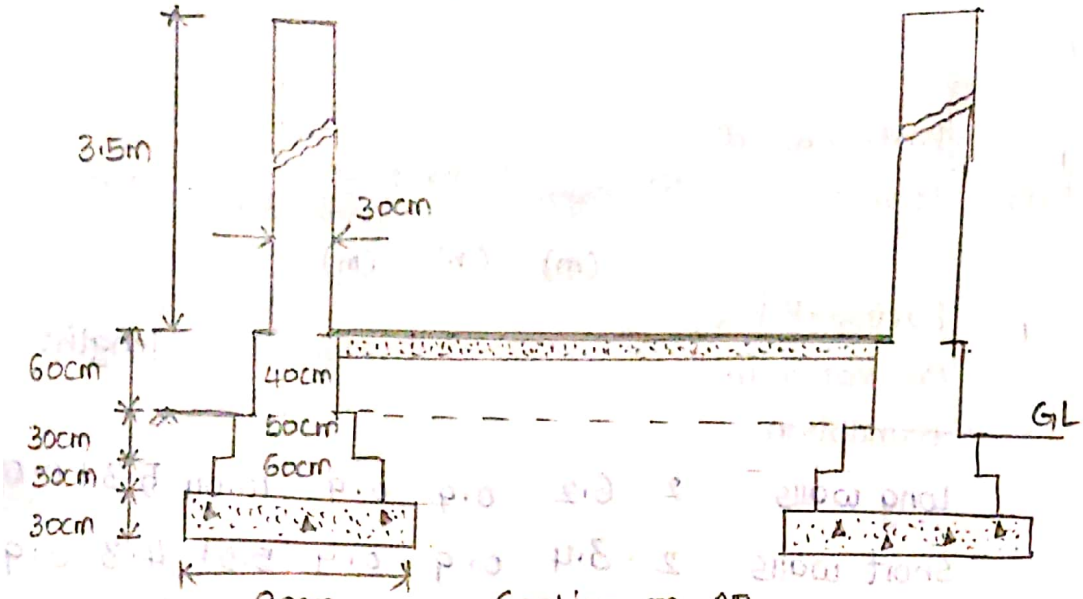
1. Long wall - Short wall method or Seperate or Induvidual wall method
2. Centre line method
3. Partly centre line and short wall method.

Long wall - Short wall method:

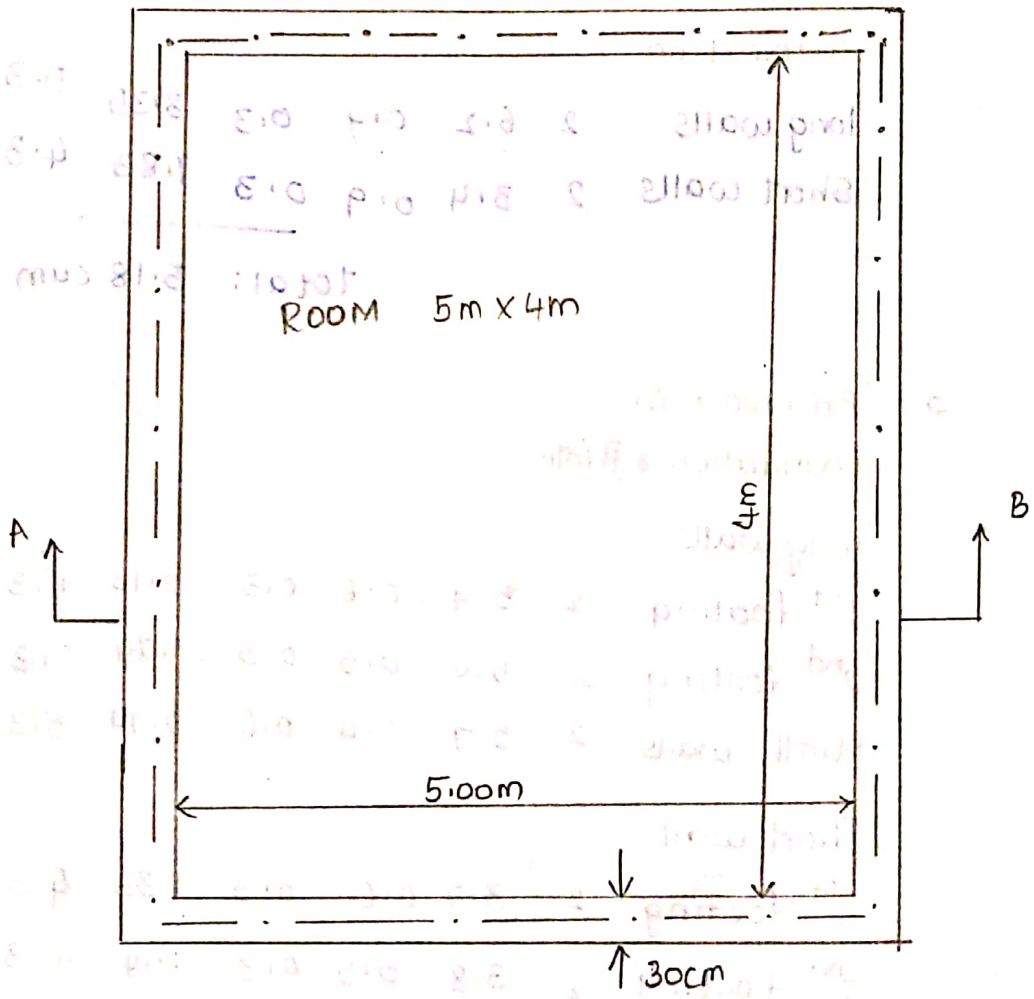
In this method, length of long walls and short walls are found out. Generally long walls are calculated out-to-out and short walls are calculated in-to-in.

Problem 1: The plan represents superstructure wall of a single room building of 5m X 4m, and sections represent cross section of walls with foundation. Estimate the quantities of -

1) Earthwork in excavation in foundation
2) Concrete in foundation
3) Brickwork in foundation and plinth
4) Brickwork in Superstructure



Section on AB



PLAN of single room

length of longwall = $5 + \frac{0.3}{2} + \frac{0.3}{2} = 5.3\,m$

length of Short wall = $4 + \frac{0.3}{2} + \frac{0.3}{2} = 4.3\,m$

Item No	Particulars of items	No.	length (m)	Breadth (m)	Height or Depth (m)	Quantity	Explanatory note
1	Earthwork in excavation in foundation						length:
	Long walls	2	6.2	0.9	0.9	10.04	5.3+0.9 =6.2m
	Short walls	2	3.4	0.9	0.9	5.51	4.3-0.9=3.4m
				Total:		15.55 cum	
2	concrete in foundation						
	long walls	2	6.2	0.9	0.3	3.35	5.3+0.9=6.2m
	Short walls	2	3.4	0.9	0.3	1.83	4.3-0.9=3.4m
				Total:		5.18 cum	
3	Brickwork in Foundation & Plinth-						
	long walls						
	1st footing	2	5.9	0.6	0.3	2.13	5.3+0.6=5.9 m
	2nd footing	2	5.8	0.5	0.3	1.74	5.3+0.5=5.8 m
	plinth walls	2	5.7	0.4	0.6	2.74	5.3+0.4=5.7 m
	Short wall						
	1st footing	2	3.7	0.6	0.3	1.33	4.3-0.6=3.7m
	2nd footing	2	3.8	0.5	0.3	1.14	4.3-0.5=3.8m
	plinth walls	2	3.9	0.4	0.6	1.87	4.3-0.4=3.9m
				Total:		10.95 m³	
4	Brickwork in Super Structure-						
	long walls	2	5.6	0.3	3.5	11.76	5.3+0.3=5.6m
	Short walls	2	4	0.3	3.5	8.4	4.3-0.3=4m
				Total:		20.16 m³	

Estimate the quantities for following items:-

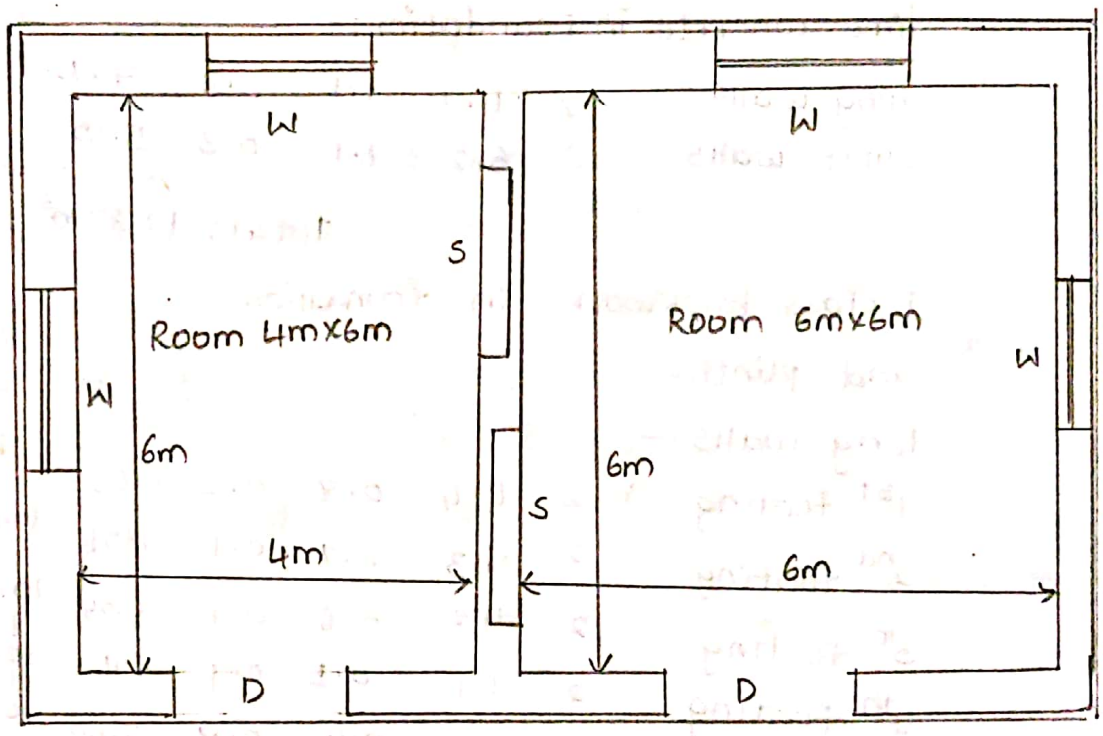
a) Earthwork in excavation in foundation

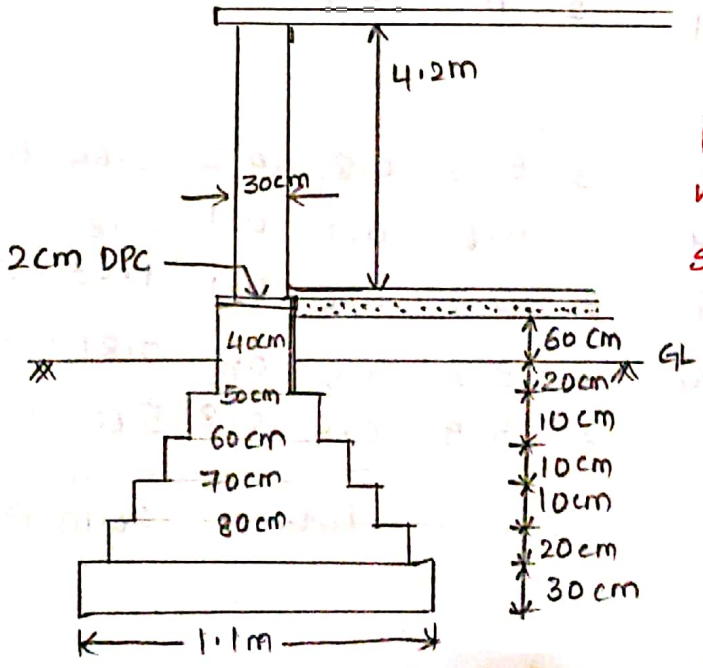
b) lime concrete in foundation

c) I class brickwork in cement mortar 1:6 in foundation and plinth

d) 2.5cm cc damp proof course

e) I class brickwork in lime mortar in superstructure.





Doors D: 1.2m×2.1m

windows W: 1m×1.5m

shelves S: m×1.5m

long wall: $4+0.3+6+\frac{0.3}{2}+\frac{0.3}{2} = 10.6\,m$

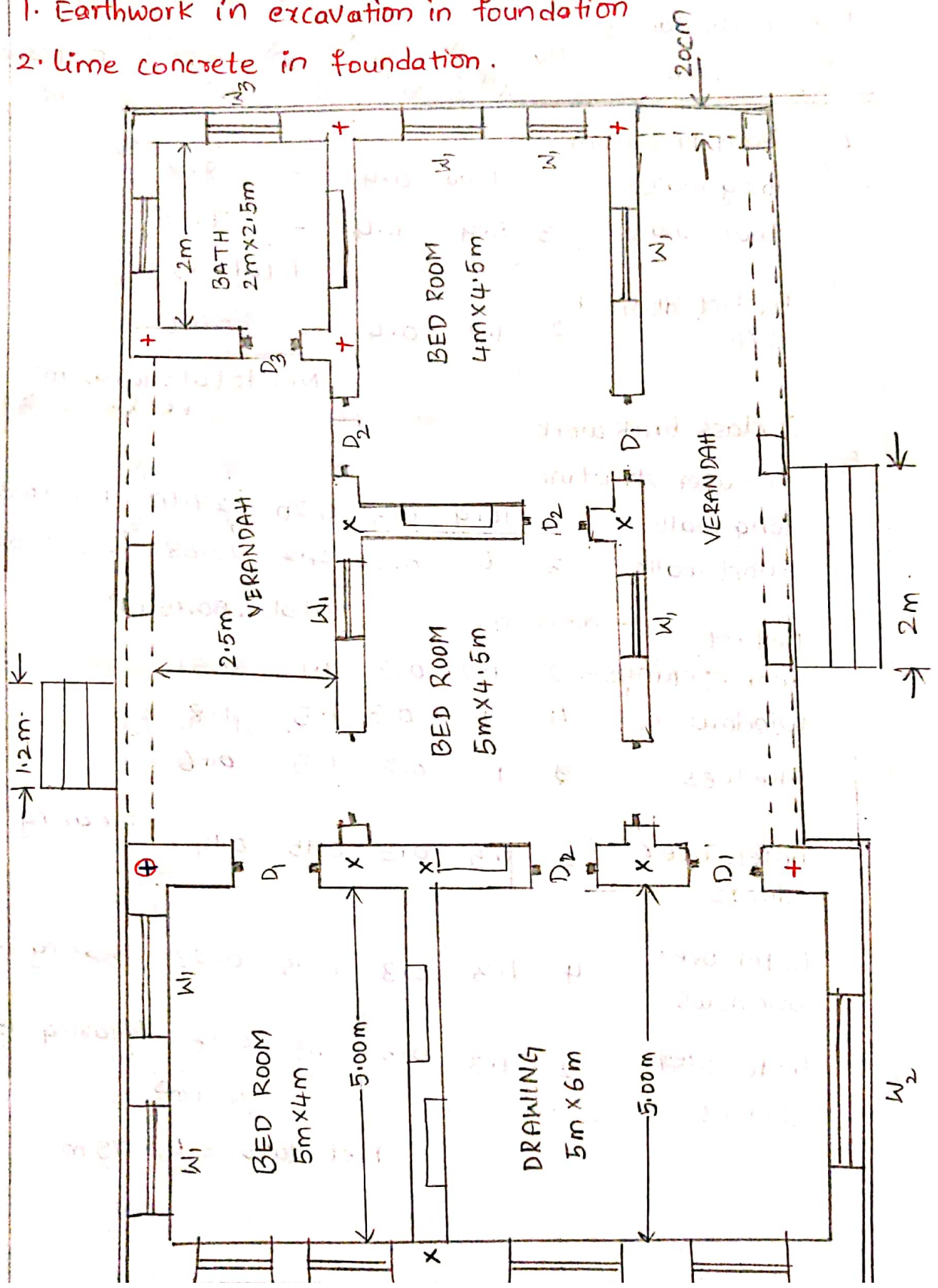
Short wall: $6+\frac{0.3}{2}+\frac{0.3}{2} = 6.3\,m$

Item No.	Particulars of Items	No.	length (m)	Breadth (m)	Height (m)	quantity	Explanatory note
1	Earthwork in excavation in Foundation						
	long walls	2	11.7	1.1	1	25.74	10.6+1.1=11.7
	Short walls	3	5.2	1.1	1	17.16	6.3−1.1=5.2
					Total:	42.9 m^3	
2	lime concrete in Foundation:-						
	long walls	2	11.7	1.1	0.3	7.72	
	Short walls	3	5.2	1.1	0.3	5.15	
					Total:	12.87 m^3	
3	I class brickwork in foundation and plinth-						
	long walls —						10.6+0.8=11.4m
	1st footing	2	11.4	0.8	0.2	3.65	10.6+0.7=11.3m
	2nd footing	2	11.3	0.7	0.1	1.58	10.6+0.6=11.2m
	3rd footing	2	11.2	0.6	0.1	1.34	10.6+0.5=11.1m
	4th footing	2	11.1	0.5	0.1	1.11	10.6+0.4=11m
	Plinth wall	2	11	0.4	0.8	7.04	
	Short walls —						
	1st footing	3	5.5	0.8	0.2	2.64	6.3−0.8=5.5
	2nd footing	3	5.6	0.7	0.1	1.18	6.3−0.7=5.6
	3rd footing	3	5.7	0.6	0.1	1.03	6.3−0.6=5.7
	4th footing	3	5.8	0.5	0.1	0.87	6.3−0.5=5.8
	Plinth wall	3	5.9	0.4	0.8	5.66	6.3−0.4=5.9
					Total:	26.10 m^3	

Item No.	Particulars of Item	No	length	Breadth	Height	quantity	Explanatory note
4	Damp proof course-						
	long walls	2	11.00	0.4	-	8.8	
	Short walls	3	5.9	0.4	-	7.08	
					Total :	15.88	
	Deduct door Sills -	2	1.2	0.4	-	0.96	
					Net total :	14.92 m^2	
5	I class brick work in super structure-						
	long walls	2	10.9	0.3	4.20	27.47	10.6+0.3=10.9
	Short walls	3	6	0.3	4.2	22.68	6.3-0.3=6m
					Total	50.15 m^3	
	Deduct door openings-	2	1.2	0.3	2.1	1.51	
	window	4	1	0.3	1.5	1.8	
	Shelves	2	1	0.2	1.5	0.6	
	lintels over doors	2	1.5	0.3	0.15	0.14	Bearing 15cm
	Lintel over windows	4	1.3	0.3	0.15	0.23	Bearing 15cm
	Lintel over Shelves	2	1.3	0.3	0.15	0.12	Bearing 15cm
						4.4 m^3	
					Net total =	45.75 m^3	

3) Estimate the following quantities:

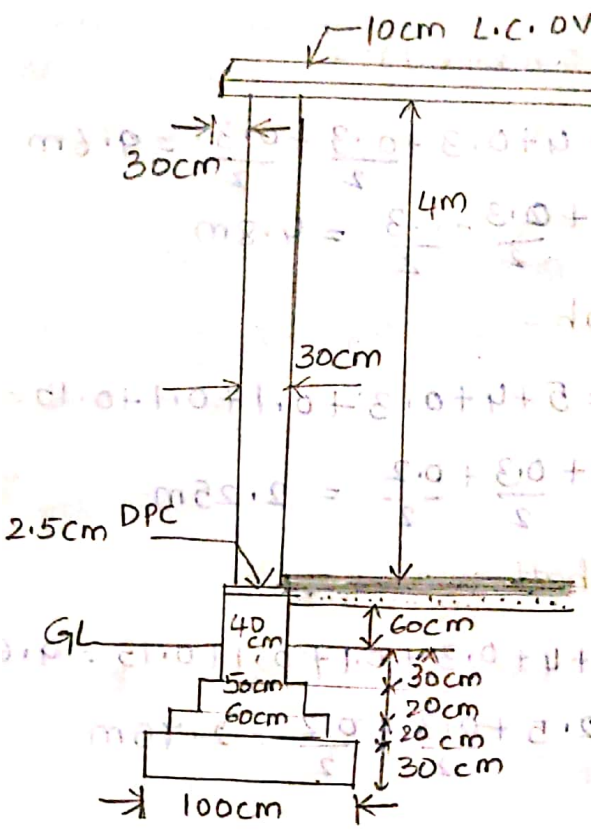
1. Earthwork in excavation in foundation
2. Lime concrete in foundation.



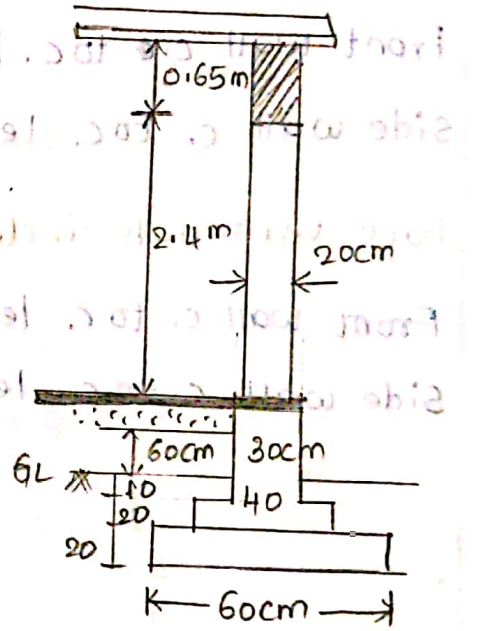
3) First class brickwork in 1:6 cement Sand mortar in foundation and plinth

4) 2.5cm Damp proof course

5) First class brickwork in lime mortar in Superstructure



CROSS SECTION OF MAIN WALLS



CROSS SECTION OF VERTICAL WALLS

Doors: D_1 – 120cm x 210cm

D_2 – 100cm x 200cm

D_3 – 75cm x 180cm

Windows: 1m x 1.5m – W_1

W_2 – 2m x 1.5m

W_3 – 0.75 x 1.2m

CW = 0.75m x 0.6m

Shelves S: 1m x 1.5m

lintel over Doors, windows are 15cm RB

Drawing and left hand side bed room combined -

C. to C. long walls = $6+4+0.3+\frac{0.3}{2}+\frac{0.3}{2} = 10.6$m

C. to C. short walls = $5+\frac{0.3}{2}+\frac{0.3}{2} = 5.3$m

Bed rooms right side (both combined):-

C. to C. long walls = $5+4+0.3+\frac{0.3}{2}+\frac{0.3}{2} = 9.6$m

C. to C. Short walls = $4.5+\frac{0.3}{2}+\frac{0.3}{2} = 4.8$m

Bed rooms Front Verandah-

Front wall C. to C. length = $5+4+0.3+0.1+0.1+0.15 = 9.65$

side wall C. to C. length = $2+\frac{0.3}{2}+\frac{0.2}{2} = 2.25$m

Back Verandah including bath room-

Front wall C. to C. length = $5+4+0.3+0.1+0.1+0.15 = 9.65$m

Side wall C. to C. length = $2.5+\frac{0.3}{2}+\frac{0.2}{2} = 2.75$m

Item No.	Particula
1	Earthwor
	Drawing ro
	Long wa
	Short wa
	Bed rooms
	long wal
	Short wa
	Front ver
	Front long
	Side Shor
	Back verar
	Long wal
	Short wa
	lime concr
2	Drawing r
	long wa
	Short w
	Bed room
	long wa
	Short w
	Front ver
	Front long
	Side Shor
	Back Vera
	long wall
	Short wa
	I class br
3	Drawing r
	long wal
	1st Foo
	2 Foot
	plinth

Item No.	Particulars	No.	length	Breadth	Height	Quantity	Explanatory note
1	Earthwork in excavation –						
	Drawing room & left bed room –						
	Long walls	2	11.5	0.9	1	20.70	10.6 + 0.9 = 11.5
	Short walls	3	4.4	0.9	1	11.88	5.3 − 0.9 = 4.4
	Bed rooms right side –						
	long walls	2	9.6	0.9	1	17.28	$9.6 - \frac{0.9}{2} + \frac{0.9}{2} = 9.6$
	Short walls	2	3.9	0.9	1	7.02	4.8 − 0.9 = 3.9
	Front verandah –						
	Front long wall	1	9.5	0.6	0.5	2.85	$9.65 - \frac{0.9}{2} + \frac{0.6}{2}$ = 9.5m
	Side short wall	1	1.5	0.6	0.5	0.45	$2.25 - \frac{0.9}{2} - \frac{0.6}{2} = 1.5$
	Back verandah –						
	Long wall	1	9.5	0.6	0.5	2.85	$9.65 - \frac{0.9}{2} + \frac{0.6}{2} = 9.5m$
	Short wall	2	2	0.6	0.5	1.2	$2.75 - \frac{0.9}{2} - \frac{0.6}{2} = 2m$
					Total:	64.23 m^3	
	lime concrete in foundation –						
2	Drawing room & left bed room –						
	long walls	2	11.5	0.9	0.3	6.21	
	short walls	3	4.4	0.9	0.3	3.56	
	Bed rooms right side –						
	long walls	2	9.6	0.9	0.3	5.18	
	short walls	2	3.9	0.9	0.3	2.11	
	Front verandah –						
	Front long wall	1	9.7	0.6	0.2	1.16	$9.65 - \frac{0.5}{2} + \frac{0.6}{2} = 9.7$
	Side short wall	1	1.7	0.6	0.2	0.2	$2.25 - \frac{0.5}{2} - \frac{0.6}{2} = 1.7$
	Back verandah –						
	long wall	1	9.7	0.6	0.2	1.16	$9.65 - \frac{0.5}{2} + \frac{0.6}{2} = 9.7$
	Short wall	2	2.2	0.6	0.2	0.53	$2.75 - \frac{0.5}{2} + \frac{0.6}{2} = 2.2$
					Total:	20.11 m^3	
	I class brick work in foundation –						
3	Drawing room & left bed room –						
	long walls –						
	1st Footing	2	11.2	0.6	0.2	2.69	10.6 + 0.6 = 11.2
	2 Footing	2	11.1	0.5	0.2	2.22	11.2 − 2×0.5 = 11.1
	plinth	2	11	0.4	0.9	7.92	11.1 − 0.10 = 11m

Particular	No.	length	Breadth	height	Quantity	Explanatory note
Short walls—						
1st footing	3	4.7	0.6	0.2	1.69	5.3 − 0.6 = 4.7
2nd footing	3	4.8	0.5	0.2	1.44	4.7 + 2×0.5 = 4.8
Plinth wall	3	4.9	0.4	0.9	5.29	4.8 + 0.1 = 4.9
Bed rooms right side—						
Long walls—						
1st footing	2	9.6	0.6	0.2	2.31	$9.6 - \frac{0.6}{2} + \frac{0.6}{2} = 9.6$
2nd footing	2	9.6	0.5	0.2	1.92	$9.6 - \frac{0.5}{2} + \frac{0.5}{2} = 9.6$
Plinth wall	2	9.6	0.4	0.9	6.91	$9.6 - \frac{0.4}{2} + \frac{0.4}{2} = 9.6$
Short walls—						
1st footing	2	4.2	0.6	0.2	1.01	4.8 − 0.6 = 4.2
2nd footing	2	4.3	0.5	0.2	0.86	4.2 + 2×0.5 = 4.3
Plinth wall	2	4.4	0.4	0.9	3.17	4.3 + 0.1 = 4.4m
Front verandah—						
Front wall footing	1	9.65	0.4	0.2	0.77	$9.65 - \frac{0.4}{2} + \frac{0.4}{2}$
Plinth wall above footing	1	9.6	0.3	0.7	2.02	$9.65 - \frac{0.4}{2} + \frac{0.3}{2}$
Side short wall footing	1	1.85	0.4	0.2	0.15	$2.25 - \frac{0.4}{2} - \frac{0.4}{2}$
Plinth wall above footing	1	1.9	0.3	0.7	0.4	$2.25 - \frac{0.4}{2} - \frac{0.3}{2}$
Back verandah—						
long wall footing	1	9.65	0.4	0.2	0.77	
Plinth wall footing	1	9.6	0.3	0.7	2.02	
Short wall footing	2	2.35	0.4	0.2	0.38	$2.75 - \frac{0.4}{2} - \frac{0.4}{2}$
Plinth wall footing	2	2.4	0.3	0.7	1.01	$2.75 - \frac{0.4}{2} - \frac{0.3}{2}$
				Total:	44.95 m^3	
2.5cm Damp Proof course—						
Drawing and left bed rooms—						
Long walls	2	11	0.4	=	8.8	
Short walls	3	4.9	0.4	−	5.88	
Bedroom inner side—						
long walls	2	9.6	0.4	=	7.68	
Short walls	2	4.4	0.4	−	3.52	
Verandah Pillars	4	0.5	0.3	−	0.6	
Bath room—						
Rear wall	1	2.5	0.3	−	0.75	
Side and inter walls	2	2.4	0.3	−	1.44	
				Total:	28.67 m	

Centre line method:

Sum of total length of centre lines of walls is found out. The quantities are found by multiplying the total centre length by respective breadth and height.

In case of building having different type of walls, suppose the outer (main) walls are of A type and inter cross walls are of B type, then all A type walls shall be taken jointly first and then all B type walls shall be taken together seperately. In such cases no deduction of any kind need be made for A type walls, but when B type walls are taken, for each junction deduction of half breadth of A type wall shall have to be made from the total centre length of walls.

Problem:

Estimate by centre line method the following quantities:

1) Earthwork in excavation in foundation
2) Concrete in foundation
3) Brickwork in Foundation and plinth
4) Brickwork in superstructure.

Follow the plan in Problum 4.1.

centreline length = 5.3 + 4.3 + 5.3 + 4.3 = 19.2m

Item No.	Description of Items	No.	length (m)	Breadth (m)	Height (m)	Quantity	Explanatory notes
1	Earthwork in excavation in Foundation	1	19.2	0.9	0.9	$15.55m^3$	
2	concrete in Foundation	1	19.2	0.9	0.3	$5.18m^3$	
3	Brickwork in Foundation & Plinth–						
	1st Footing	1	19.2	0.6	0.3	3.46	
	2nd Footing	1	19.2	0.5	0.3	2.88	
	Plinth wall	1	19.2	0.4	0.6	4.61	
4	Brickwork in Super structure	1	19.2	0.3	3.5	$20.16m^3$	

5 Estimate by centre line method the following quantities:

1. Earthwork in excavation in foundation
2. Lime concrete in foundation
3. I class brickwork in cement mortar 1:6 in Foundation
4. 2.5cm cc damp proof course.

:kwork in lime mortar in Superstructure.

n problem 2

= 10.6 + 6.3 + 10.6 + 6.3 + 6.3 = 40.10m

No.	length (m)	Breadth (m)	Height (m)	Quantity	Explanatory notes
1	39m	1.10	1	42.90m³	$40.10-2\times\frac{1.10}{2}$
1	39	1.10	0.3	12.87m³	
< in foundation –					
1	39.3	0.8	0.2	6.29	$40.10-2\times\frac{0.8}{2}$
1	39.4	0.7	0.1	2.76	$40.10-2\times\frac{0.7}{2}$
1	39.5	0.6	0.1	2.37	$40.10-2\times\frac{0.6}{2}$
1	39.6	0.5	0.1	1.98	$40.10-2\times\frac{0.5}{2}$
1	39.7	0.4	0.8	12.70	$40.10-2\times\frac{0.4}{2}$
			Total	26.10 m³	
1	39.7	0.4	–	15.88	
2	1.2	0.4	–	0.96	
			Net	14.92 m²	
k					
1	39.8	0.3	4.2	50.5	$40.10-2\times\frac{0.3}{2}$
2	1.2	0.3	2.1	1.51	
4	1	0.3	1.5	1.8	
2	1	0.2	1.5	0.6	
2	1.5	0.3	0.15	0.14	
4	1.3	0.3	0.15	0.23	
2	1.3	0.3	0.15	0.12	
				4.40 m³	
			Net total =	46.10m³	

6 Estimate the quantities of following items

i) Earthwork in excavation

Follow the question ③. use centre line method.

Total centre line length of 30cm thick walls.

= Total Centre length of walls of drawing and left bed room + Total centre length of walls of bedroom right side

= (2x c. to c. length of long wall + 3 x c. to c. length of short wall) + (2x c. to c. length of long wall + 2 x c to c length of short wall)

= (2x 10.6 + 3x5.3) + (2x 9.6 + 2x 4.8)

= 37.1 + 28.8 = 65.9m

No. of junctions in these walls = 6

Marked as 'x' in the plan

Total centre line length of 20cm thick walls:

C. to C. length of Front wall + C. to C. length of side wall C. to C. length of back verandah long wall including bathroom + 2x C. C length of cross walls of bathroom.

= 9.65 + 2.25 + (9.65 + 2x 2.75) = 11.9 + 15.15

= 27.05m

No. of junctions = 5

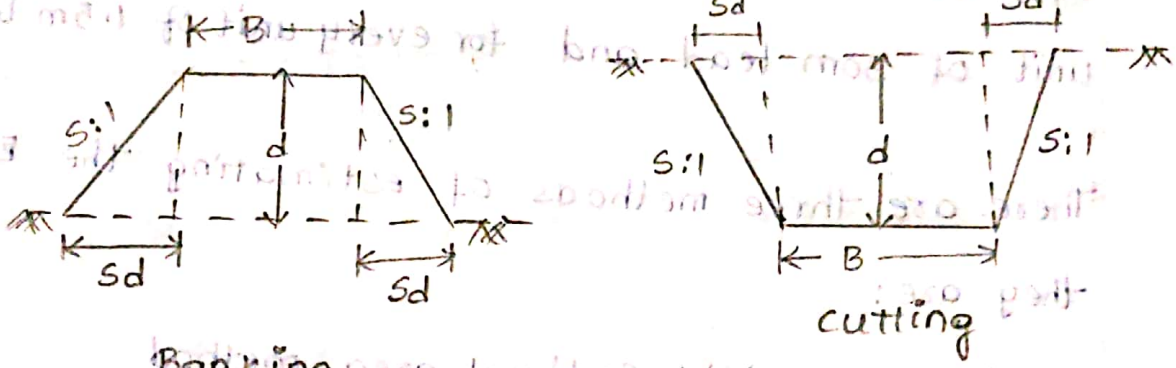
Marked as '+' in the plan. and one is marked '—'

Item No	Particulars	No.	length	Breadth	Height or Depth	Quantity	Explanatory notes
1	Earthwork in excavation—						
	Wall of main rooms	1	63.2	0.9	1	56.88	$65.9-6\times\frac{0.9}{2}$
	Wall of verandah & bath room	1	24.5	0.6	0.5	7.35	$27.05-5\times\frac{0.9}{2}-1\times\frac{0.6}{2}$
					Total:	64.23	m^3
2	Lime concrete in Foundation—						
	walls of main rooms	1	63.2	0.9	0.3	17.06	
	walls of verandah & bathroom	1	25.5	0.6	0.2	3.06	$27.05-5\times\frac{0.5}{2}-1\times\frac{0.6}{2}$
3	I class brickwork in Foundation—						
	walls of main rooms—						
	1st Footing	1	64.1	0.6	0.2	7.69	$65.9-6\times\frac{0.6}{2}$
	2nd Footing	1	64.4	0.5	0.2	6.44	$65.9-6\times\frac{0.5}{2}$
	Plinth wall	1	64.7	0.4	0.9	23.29	$65.9-6\times\frac{0.4}{2}$
	walls of verandah—						
	Footing	1	25.85	0.4	0.2	2.07	$27.05-5\times\frac{0.4}{2}-1\times\frac{0.4}{2}$
	Plinth wall	1	25.9	0.3	0.7	5.44	$27.05-5\times\frac{0.4}{2}-1\times\frac{0.3}{2}$
					Total	44.93	
4.	2.5cm Damp proof course—						
	walls of main rooms	1	64.7	0.4	—	25.88	
	Verandah pillars	4	0.5	0.3	—	0.6	
	Bathroom	1	7.3	0.3	—	2.19	
						28.67	
	Deduct door sills—						
	Door Sills D_1	6	1.2	0.4	—	2.88	
	D_2	2	1	0.4	—	0.8	
	D_3	1	0.75	0.3	—	0.23	
						3.91	
					Net total = 24.76 m^2		

Item No	Particular	No.	length	Breadth	Height	Quantity	Explanatory notes
5	I Class brickwork in Super Structure:-						
	walls of Main rooms	1	65.00	0.3	4	78.00	$65.9-6\times\frac{0.3}{2}$
	walls of verandah and bath	1	26.20	0.2	3.05	15.98	$27.05-5\times\frac{0.3}{2}-1\times\frac{0.2}{2}$
					Total	93.98	
	Deduct —						
	Door openings D_1	6	1.2	0.3	2.1	4.54	
	D_2	2	1	0.3	2	1.2	
	D_3	1	0.75	0.2	1.8	0.27	
	window openings						
	W_1	11	1	0.3	1.5	4.95	
	W_2	1	2	0.3	1.5	0.90	
	W_3	2	0.75	0.2	1.2	0.36	
	Clerestory window	18	0.75	0.3	0.6	2.43	
	Shelves openings	5	1	0.2	1.5	1.5	
	Front verandah opening in between Pillars	1	8.4	0.2	2.4	4.03	$9.6-3\times0.4=8.4$
	Front verandah — opening side	1	2	0.2	2.4	0.96	
	Back verandah Opening	1	6.8	0.2	2.4	3.26	$9.6-2.40-0.4=6.8$
						24.4	
					Net =	69.58 m^3	

Road Estimating - Earthwork:

cross-section of Earthwork of road in banking or in cutting is usually in the form of trapezium.



Sectional area = Area of central rectangular portion + Area of two side triangular portion

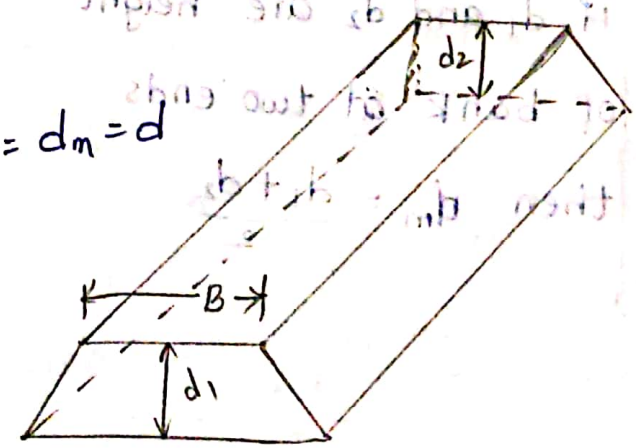
$$= Bd + 2\left(\frac{1}{2} \times Sd \times d\right) = Bd + Sd^2$$

where S:1 = side slopes as horizontal : Vertical

$$\text{Quantity} = (Bd + Sd^2)L$$

If the ground is in a longitudinal slope, the height of bank or the depth of cutting will be different at two ends.

$$\text{Mean height} = \frac{d_1 + d_2}{2} = d_m = d$$



Lead and lift:

Earthwork is estimated for 30m lead for distance and 1.5m lift for height or depth. and this distance of 30m and 1.5m height is called normal lead and lift. For greater lead or lift the rates will be different (higher) for every unit of 30m lead and for every unit of 1.5m lift.

There are three methods of estimating the Earthwork, they are:

Method I: Mid sectional area method

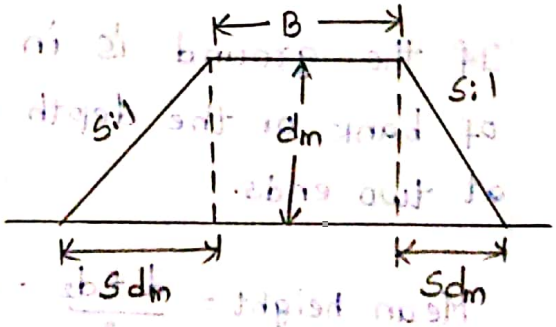
Method II: Mean sectional area method

Method III: prismoidal formula method

Method I: Mid-Sectional area method:

Quantity of Earthwork

$$Q = (Bd_m + Sd_m^2) \times L$$



If d_1 and d_2 are height of bank at two ends then $d_m = \frac{d_1 + d_2}{2}$

Area of Side Sloping Surface:

Area of both side slopes = $2Ld\sqrt{s^2+1}$

Method II: Mean sectional area method:-

mean sectional area $A = \frac{A_1+A_2}{2}$

Quantity $Q = \left[\frac{A_1+A_2}{2}\right] \times$ length

where $A_1 = Bd_1 + sd_1^2$

$A_2 = Bd_2 + sd_2^2$

Method III: Prismoidal formula method

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

$A_m = Bd_m + sd_m^2$

Trapezoidal and prismoidal formula for series of cross-sections:

Volume by Trapezoidal method:

$$V = \frac{D}{2}\left[\frac{A_0+A_n}{2} + A_1 + A_2 + A_3 + \cdots + A_{n-1}\right]$$

Volume by Prismoidal method:

$$V = \frac{D}{3}\left[A_0 + A_n + 4(A_1 + A_3 + A_5 + \cdots A_{n-1}) + 2(A_2 + A_4 \cdots A_{n-2})\right]$$

$V = \frac{D}{3}$[First area + last area + 4 Σodd areas + 2 Σeven areas)

Problem 7:

Calculate the quantity of earthwork for 200m length for a portion of road in an uniform ground, the heights of banks at two ends being 1m and 1.6m. Formation width is 10m and side slopes 2:1.

Given,

$B = 10m$

$S:1 = 2:1 \Rightarrow S = 2$

$d_1 = 1m, \; d_2 = 1.6m \qquad dm = \frac{d_1 + d_2}{2} = \frac{1+1.6}{2} = 1.3m$

length = 200m

Method 1: mid Sectional area method

$$Q = (B d_m + S d_m^2) L$$

$$= (10 \times 1.3 + 2 \times 1.3^2) \times 200 = 3276 m^3$$

Method 2: Mean Sectional area method

$$Q = \left[\frac{A_1 + A_2}{2}\right] \times L$$

$A_1 = 10 \times 1 + 2 \times 1^2 = 12 m^2 \qquad A_2 = 10 \times 1.6 + 2 \times 1.6^2 = 21.12 m^2$

$$Q = \left[\frac{12 + 21.12}{2}\right] \times 200 = 3312 m^3$$

Method 3: Prismoidal Formula method

$$Q = \frac{1}{6}[A_1 + A_2 + 4A_m] \times L = \frac{200}{6}[12 + 21.12 + 4 \times 16.38]$$

$$= 3288 m^3$$

Problem 8:

i) Calculate the area of side slopes of portion of a bank for length of 200m the heights of banks at the ends being 2.5m and 3.5m and side slope 2:1

ii) If the side slopes are to be provided with 15cm thick stone pitching, calculate the cost of pitching at RS 150 per cu.m

Mean height $d = \frac{d_1 + d_2}{2} = \frac{2.5 + 3.5}{2} = 3m$

Sloping breadth at mid section $= d\sqrt{s^2+1} = 3\sqrt{4+1}$

$= 6.71\ m$

Area of side slopes $= 2L \times d \times \sqrt{s^2+1}$

$= 2 \times 200 \times 6.71 = 2684\ m^2$

ii) Quantity of pitching = A x thickness $= 2684 \times 0.15 = 402.6 m^3$

Cost of stone pitching $= 402.6 \times 150 =$ RS 60390.00

Problem 9:

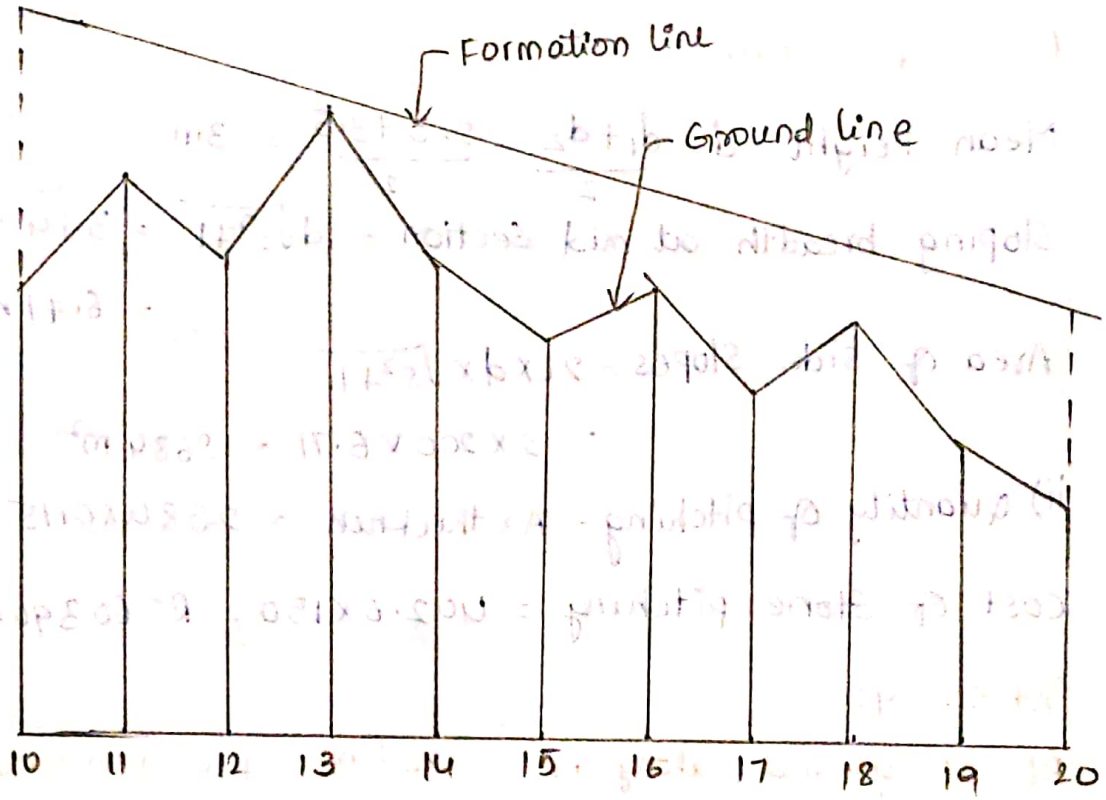
RL of ground along the centre line of a proposed road from chainage 10 to chainage 20 are given below. Formation level at 10th chainage is 107. The road is downward gradient of 1in 150 upto chainage 14 and 1 in 100 remaining. Formation width is 10m and side slopes of banking 2:1. Length of chain is 30m.

Draw longitudinal section of road and typical cross-section and prepare an estimate of earthwork

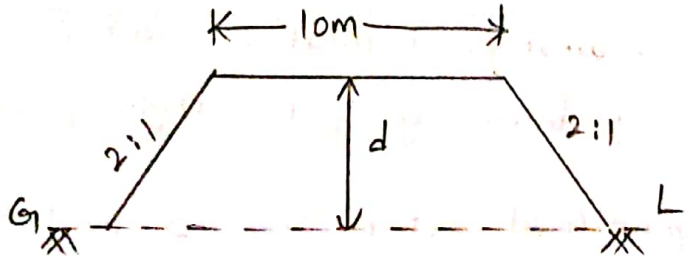
at the rate of RS 275.00% cum.

ii) Find the area of side slopes and the cost of turfing the side slopes at rate of RS 60.00% per Sq.m.

Chainge	10	11	12	13	14	15	16	17	18	19	20
RL of ground	105	105.6	105.44	105.9	105.42	104.3	105	104.11	104.64	104	103.3



longitudinal section



CROSS SECTION

Chainage	RL of ground (m)	RL of formation (m)	Height diff of GL & FL (m)	Mean height d	Central Area Bd (m^2)	Side area sd^2 (m^2)	Total area $Bd+sd^2$	length in b/w stations (m)	Quantity $(Bd+sd^2)L$ Banking m^3	Quantity $(Bd+sd^2)L$ cutting (m^3)
10	105.00	107	2	–	–	–	–	–	–	–
11	105.6	106.8	1.2	1.6	16	5.12	21.12	30	633.6	–
12	105.44	106.6	1.16	1.18	11.8	2.78	14.58	30	437.4	–
13	105.9	106.4	0.5	0.83	8.3	1.38	9.68	30	290.4	–
14	105.42	106.2	0.78	0.64	6.4	0.82	7.22	30	216.6	–
15	104.3	105.9	1.6	1.19	11.9	2.83	14.73	30	441.9	–
16	105	105.6	0.6	1.1	11	2.42	13.42	30	402.6	–
17	104.10	105.3	1.2	0.9	9	1.62	10.62	30	318.6	–
18	104.62	105	0.38	0.79	7.9	1.25	9.15	30	274.5	–
19	104	104.70	0.7	0.54	5.4	0.58	5.98	30	179.4	–
20	103.3	104.40	1.10	0.9	9	1.62	10.62	30	318.6	–

Total: 3513.6 m^3

Abstract of estimated cost

Item No.	Particulars	Quantity	unit	Rate	per	cost
1	Earthwork in banking	3513.6	m^3	275	%, m^3	9662.40

Total : 9662.40

Add 5% (3% for contingencies and 2% for workcharged establishmunt) 483.12

Grand Total : Rs 10145.52

ii) Calculation of Area of side Slopes

Chainage	Depth	Mean Depth d, (m)	sloping breadth of side slope $d\sqrt{s^2+1}$, (m)	length L (m)	Area of both side slopes : $2Ld\sqrt{s^2+1}$
10	2	–	–	–	–
11	1.2	1.6	3.58	30	214.8
12	1.16	1.18	2.64	30	158.4
13	0.5	0.83	1.86	30	111.6
14	0.78	0.64	1.43	30	85.8
15	1.6	1.19	2.66	30	159.6
16	0.6	1.10	2.46	30	147.6
17	1.2	0.9	2.01	30	120.6
18	0.38	0.79	1.77	30	106.2
19	0.7	0.54	1.21	30	72.6
20	1.10	0.9	2.01	30	120.6

Total : 1297.80 m^2

Abstract of estimated cost

Turfing side slopes 1297.80 @ Rs 60 per $\%. m^2$ = 778.68

Add 5% for Contingencies = Rs 38.93

Grand total : Rs 817.61

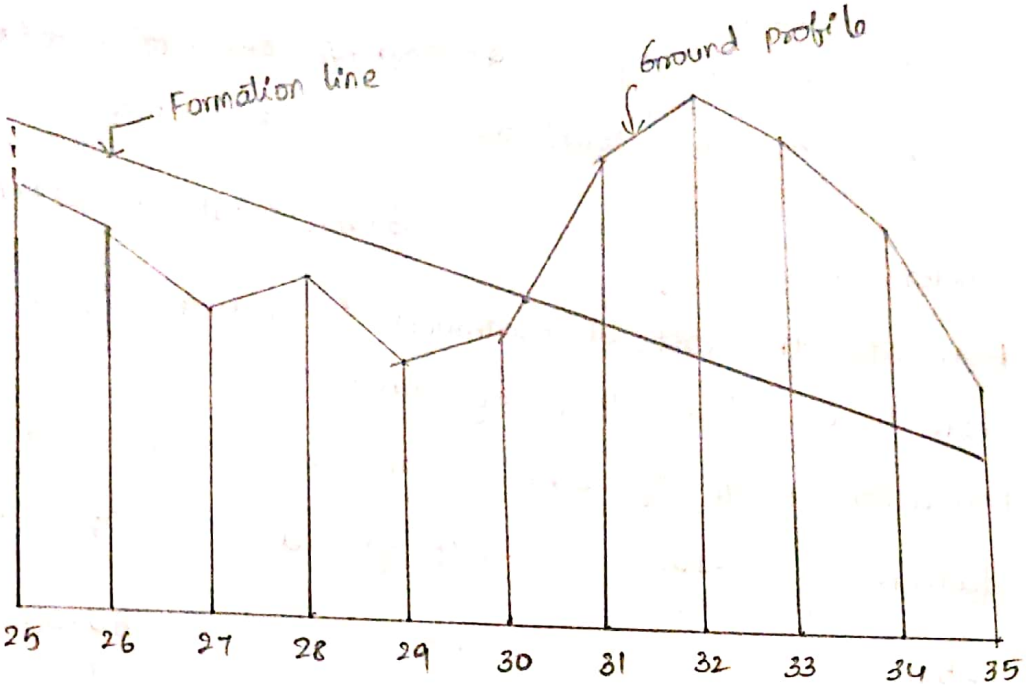
Problem 10:

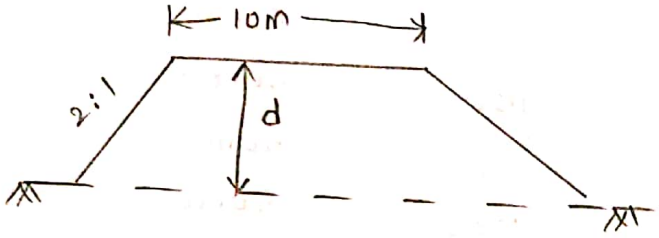
Estimate the cost of Earthwork for a portion of road for 400m length from following data:

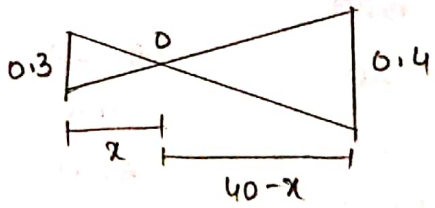
Formation width of road is 10m. Side slopes are 2:1

Station	Distance (m)	RL of ground	RL of formation
25	1000	51	52.00
26	1040	50.90	|
27	1080	50.50	|
28	1120	50.80	|
29	1160	50.60	Downward gradient
30	1200	50.70	of 1 in 200
31	1240	51.20	|
32	1280	51.40	|
33	1320	51.30	|
34	1360	51.00	|
35	1400	50.60	|

Draw the longitudinal & L-section and cross section of road.







$$\frac{x}{0.3} = \frac{40-x}{0.4}$$

$$0.4x = 0.3(40-x)$$

$$x = 17.14 \simeq 17\text{m}$$

Station	RL of Ground	Distance in (m)	RL of formation (m)	Difference of GL & FL (m)	Mean height d (m)	Central area Bd (m^2)	Area of sides sd^2 (m^2)	Total area $Bd+sd^2$ (m^2)	Distance b/w stations (m)	Quantity $(Bd+sd^2)L$ Banking (m^3)	Quantity $(Bd+sd^2)L$ cutting (m^3)
25	51	-	52	1	-	-	-	-	-	-	-
26	50.9	40	51.8	0.9	0.95	9.5	1.81	11.31	40	452.40	-
27	50.5	40	51.6	1.10	1.00	10	2	12	40	480	-
28	50.8	40	51.4	0.6	0.85	8.5	1.45	9.95	40	398	-
29	50.6	40	51.2	0.6	0.6	6	0.72	6.72	40	268.8	-
30	50.70	40	51	0.3	0.45	4.5	0.41	4.91	40	196.4	-
Passes from banking to cutting				0.00	0.15	1.5	0.05	1.55	17	26.35	-
-	-	17	-								
31	51.2	23	50.8	0.40	0.2	2	0.06	2.06	23	-	47.38
32	51.4	40	50.6	0.8	0.6	6	0.54	6.54	40	-	261.6
33	51.3	40	50.4	0.9	0.85	8.5	1.08	9.58	40	-	383.2
34	51	40	50.2	0.8	0.85	8.5	1.08	9.58	40	-	383.2
35	50.6	40	50	0.6	0.70	7.00	0.74	7.74	40	-	309.6
									Total	1821.95 m^3	1384.98 m^3

Item No.	Particulars	Quantity	unit	Rate	Per	Cost
1	Earthwork in banking	1821.95	m^3	275	% Cum	5010.36
2	Earthwork in cutting	13884.98	m^3	350	% Cum	4847.43

Total: 9857.79

Add 3% for contingencies: 295.73

Add 2% for workcharged establishment: 197.16

Grand total: 10350.68

Problem 11:

Estimate the quantity of Earthwork required for 180m length of road in a tabular form using standard Prismoidal formula from following data.

Chainage	0	30	60	90	120	150	180 (m)
RL of ground	112	111.8	111.7	111.6	111.5	111.3	111.4
RL of Formation	←			112.60			→ level

Formation width of road is 10m and side slopes 2:1

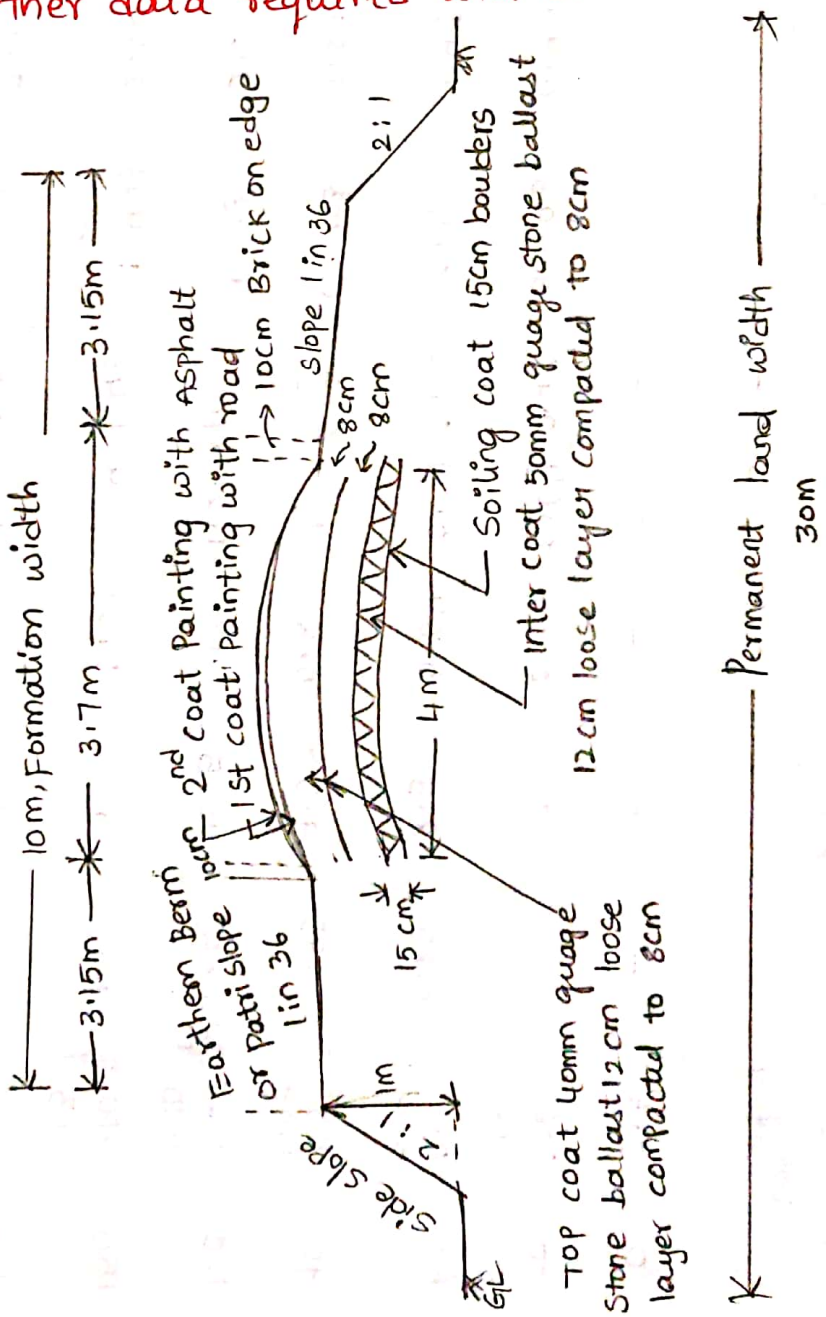
$$\text{Quantity} = \left[B\left(\frac{d_1+d_2}{2}\right) + s\left(\frac{d_1^2+d_2^2+2d_1d_2}{3}\right) \right] \times L$$

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
Chainage	Ht of bank or depth of cutting	$\frac{d_1+d_2}{2}$	$B\times\left(\frac{d_1+d_2}{2}\right)$	d_1^2	d_2^2	d_1d_2	$\frac{d_1^2+d_2^2+d_1d_2}{3}$	$s\times\frac{[d_1^2+d_2^2+d_1d_2]}{3}$	Total area sum of ④ & ⑨	Dist. blw Stations	Quantity (m^3) Banking	Cutting
0	0.6	–	–	–	–	–	–	–	–	–	–	–
30	0.6 0.8	0.7	7	0.36	0.64	0.48	0.493	0.99	7.99	30	239.7	
60	0.8 0.9	0.85	8.5	0.64	0.81	0.72	0.723	1.45	9.95	30	298.5	
90	0.9 1.00	0.95	9.5	0.81	1	0.9	0.903	1.81	11.13	30	333.9	
120	1.00 1.10	1.05	10.5	1	1.21	1.1	1.103	2.21	12.71	30	381.3	
150	1.10 1.3	1.2	12	1.21	1.69	1.43	1.443	2.89	14.89	30	446.7	
180	1.3 1.2	1.25	12.5	1.69	1.44	1.56	1.563	3.13	15.63	30	468.9	
										Total:	2169 m^3	

Problem 12:

Prepare a detailed estimate for the construction of new state highway for one kilometre length. Formation width of road is 10m. Avg height of bank is 1m and side slope 2:1. Metalled road width is 3.7m and three coats of metalling are to be provided as per cross section. Surface shall be finished with two coats of painting.

Assume other data required and suitable rates



S.NO	Particulars	No.	length (m)	Breadth (m)	height (m)	Quantity	Remarks
1	Surveying, dagbelling	1	1km			1km	
2	Permanent land acquisition	1	1000	30		$30000m^2$ = 3 hectare	
3	land acquistion temporary	1			$\frac{12000}{0.3}$	$40000m^2$	$\frac{\text{Quantity}}{\text{Depth of borrow pit}}$
4	Earthwork in Embankment:	$(Bd+Sd^2)L$ = 1		$(10\times1+2\times1^2)\times1000$ =		$12000m^3$	B = 10m, d = 1m
5	Plantation of grasseson side Slopes	1	1000	$\times 2\times$	$\sqrt{2^2\times1}$ =	$4500m^2$	
	Metalling:						
6	Preparation of Subgrade	1	1000	4		$4000m^2$	30cm wider
7	Soiling coat – i) Stone boulders 15cm size	1	1000	4	0.15	$600m^3$	
	ii) Laying and consolidation of boulders	1	1000	4	0.15	$600m^3$	
8	Inter coat – i) Stone ballast 50mm gauge	1	1000	3.7	0.12	$444m^3$	12cm thick layer Compacted to 8cm.

S.NO	Particular	NO	length (m)	breadth (m)	height (m)	Quantity	Remarks
	ii) Laying and consolid -ation	1	1000	3.7	0.12	$444m^3$	
9	Top coat -						
	i) stone ballast 40mm gauge	1	1000	3.7	0.12	$444m^3$	
	ii) Laying and consolida -tion	1	1000	3.7	0.12	$444m^3$	
10	Beam or patri dressing	1	1Km			1km	
	PAINTING OR BLACK TOP SURFACING						
11	Painting 1st coat with Road tar -						
	i) Stone grit 20mm gauge @ 1.35cum % sq m	1	1000	3.7m	$\frac{1.35}{100}$	50	
	ii) Paint or binding Asphalt@ 220 kg % Sqm	1	1000	3.7	$\frac{220}{100}$	8140 kg = 8.14 tonne	
	iii) Laying	1	1000	3.7		3700 Sq.m	
12	Painting 2nd coat with Asphalt						
	i) Stone grit 12mm gauge @ $.75m^3$ % sq m	1	1000	3.7	$\frac{.75}{100}$	27.75 m^3	
	ii) Paint or binder Asphalt @ 120kg % Sqm	1	1000	3.7	$\frac{120}{100}$	4440 kg 4.4 tonn	

Particulars	No.	length	Breadth	height	quantity	Remarks
Brick edging on both sides	1	1km			1km	
Bridges (minor) and Culverts	1	1km			1km	
Boundary stones	1	1km			1km	
Formation level pillars	1	1km			1km	
Road direction posts, caution signs etc	1	1km			1km	
Traffic diversion, service road etc.,	1	1 km			1 km	
Arboriculture	1	1km			1km	

Estimation of RCC work and Bar bending Schedule

Reinforced cement concrete work is estimated under two items.

i) concrete work, including centering and shuttering and binding of steel wires in position is taken under one item in m^3 or ft^3.

ii) steel reinforcement and its bending is taken under another item.

→ If the detailed drawings are not available, Steel Rft may be calculated as percentage of concrete.

→ Density of Steel is 78.5 quintal/m^3 or 7.85 g/m^3

→ Percentage of steel can be taken as follows

i) Lintel, slabs etc., – 0.7 to 1%.

ii) Beams – 1 to 2%

iii) Columns – 1 to 5%.

iv) Foundation raft, footing etc., – 0.5 to 0.8%.

→ In R.C.C work, the end or side covers for steel bar may be taken as 4cm to 5cm and bottom and top covers may be taken as 1.2 cm to 2cm.

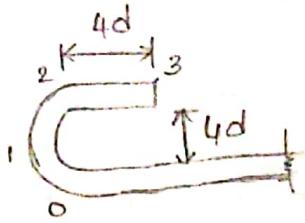
BAR BENDING SCHEDULE:

It is a list of reinforcement bars in a particular tabular column giving the particulars of bars, Shape of bending with sketches, length of each bar, total length and total weight.

From the schedule of bars, the requirement of different sizes and lengths of bars may be known and can be arranged and bent up during the construction.

Calculation of Reinforcement Shape, Cutting and Bending lengths:

Length of one hook = 9d

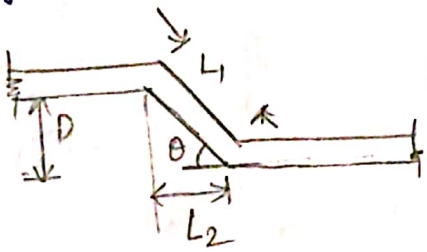


Standard hook

Additional length of bar due to bent up at θ say 30° to 60° is 'La'

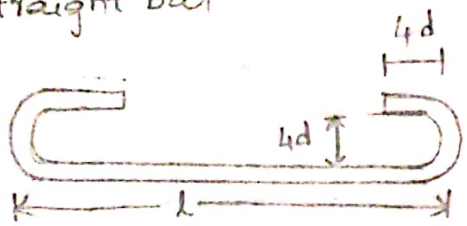
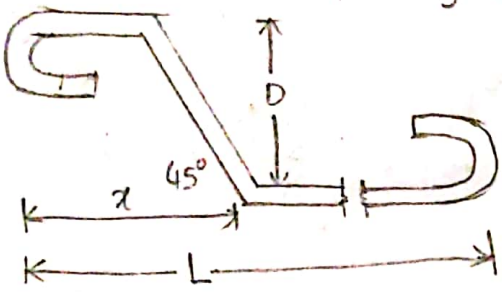
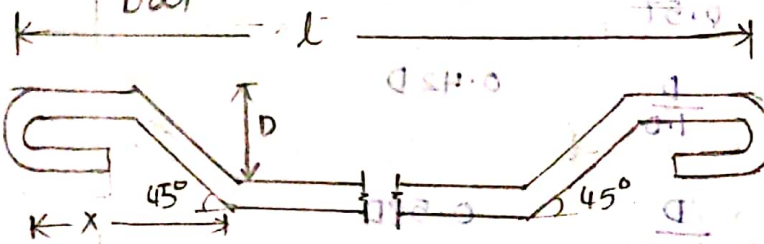
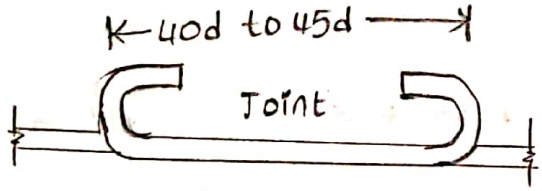
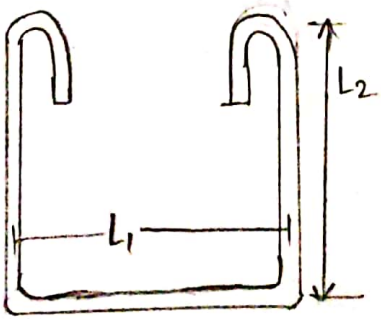
$$L_a = L_1 - L_2$$

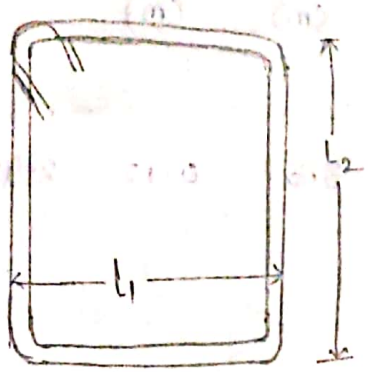
$$\tan\theta = \frac{D}{L_2} \; ; \; \sin\theta = \frac{D}{L_1}$$



Bent-up bar

Sl.No	θ	$\frac{D}{\sin\theta}$	$\frac{D}{\tan\theta}$	Additional length of Bent-up bar, l_a
1	30°	$\frac{D}{0.5}$	$\frac{D}{0.57}$	0.27D
2	45°	$\frac{D}{0.707}$	$\frac{D}{1.0}$	0.42D
3	60°	$\frac{D}{0.866}$	$\frac{D}{1.732}$	0.58D

1.	Straight bar 	$2[9d] = 18d$ both hooks together	$L + 18d$
2.	Bent up at one end $x = \frac{L}{4}$ to $\frac{L}{5}$ 	$2[9d] = 18d$ both hooks together	$L + 18d + 0.42D$
3.	Double bend up bar $x = \frac{L}{4}$ to $\frac{L}{6}$ 	$2[9d] = 18d$	$L + 18d + [2 \times 0.42D]$
4.	overlap of bars 	$2[9d] = 18d$	$[40d \text{ to } 45d] + 18d$
5.		one hook height $= 14d$ $2 \times 14d = 28d$	$L_1 + 2L_2 + 28d$



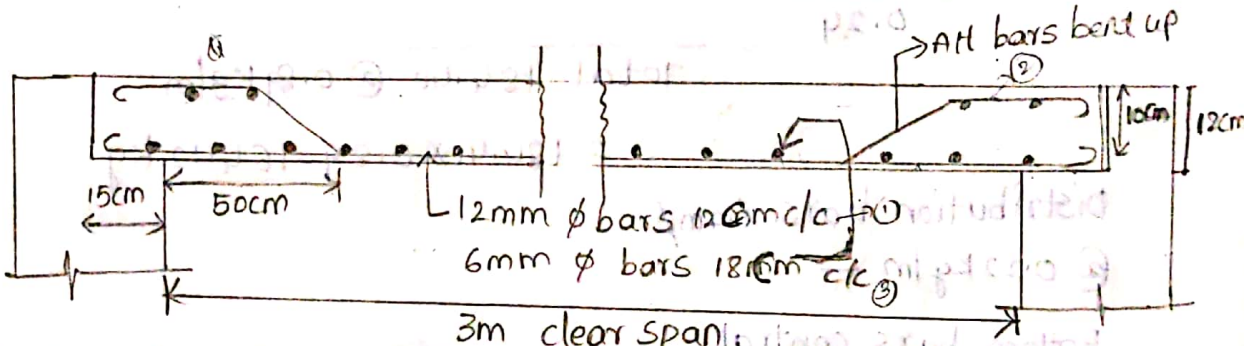
$2(12d) = 24d$

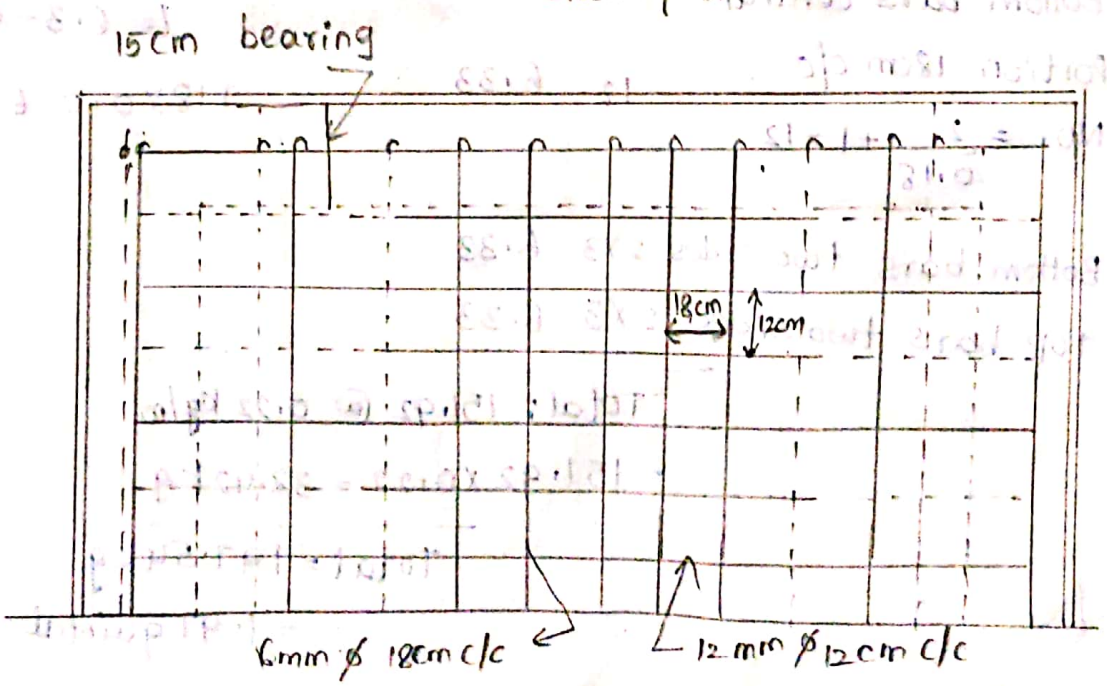
$2(L_1 + L_2) + 24d$

Problem:

Estimate a RCC roof slab of 3m clear span and 6m long from the given drawings. RCC work including centering and shuttering and steel Rft in detail shall be taken separately

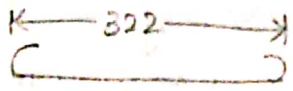
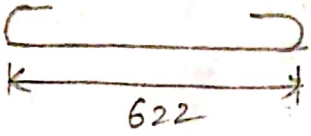
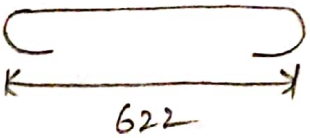
Also prepare schedule of bars.





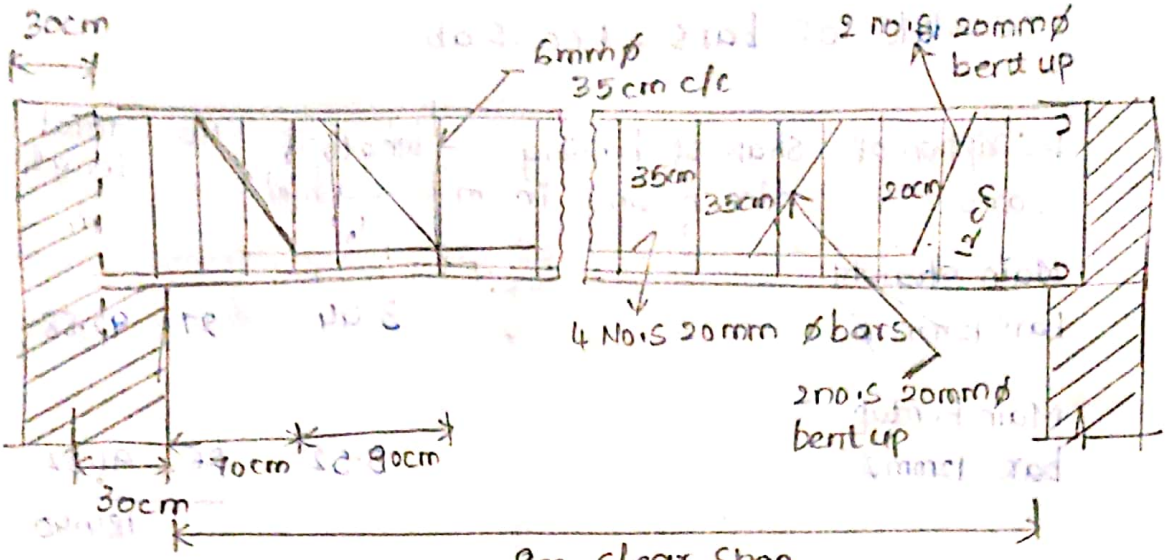
Item No.	Particulars	No.	length (cm)	Breadth (cm)	Height (cm)	Quantity	notes
1	Rcc work 1:2:3 excluding Steel and its bending including shuttering, centering and binding	1	6.3	3.3	0.12	2.495m^3	
2	Steel bars :—						
	Main bars 12mm ø @ 0.89 kg/m						Side cover 4cm
	Straight bars 24cm c/c	27	3.44				L = 3.3 − 2 side covers + 2 hooks
	No. = $\frac{6.3-0.08}{0.24}+1=27$						= 3.3 − 0.08 + (18 × 0.12) = 3.44m
	Bent up bars 24cm c/c	26	3.52				Adding one depth 8cm
	No. = $\frac{6.3-0.08}{0.24}=26$						
	Total 184.40 @ 0.89 kg/m						
	= 184.40 × 0.89 = 164.12 kg						
	Distribution bars 6mm ø @ 0.22 kg/m —						
	Bottom bars central portion 18cm c/c	12	6.33				L = 6.3 − 0.08
	No. = $\frac{2}{0.18}+1=12$						+ 18 × 0.006 = 6.33m
	Bottom bars two sides	2×3	6.33				
	top bars two sides	2×3	6.33				
	Total: 151.92 @ 0.22 kg/m						
	= 151.92 × 0.22 = 33.42 kg						
	Total = 197.54 kg						
	= 1.97 quintal						

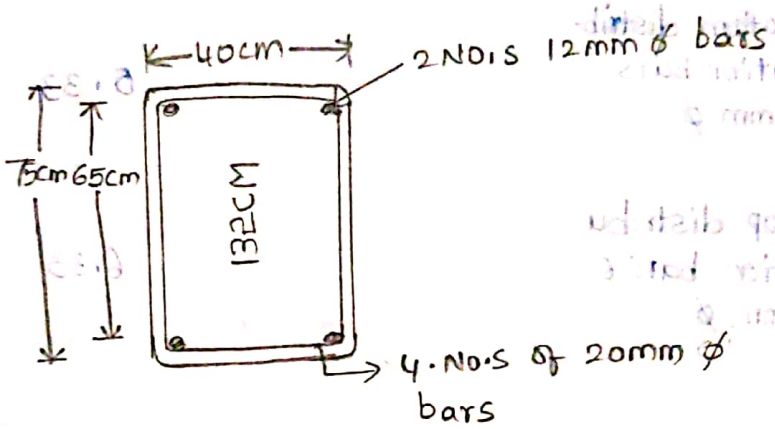
Schedule of bars - RCC slab

Description of bars	Shape of bending dimensions in cm	length of each 'm' 'm'	No.	Total length m	Weight kg
Main straight bars 12mm ø		3.44	27	92.88	
Main bentup bars 12mm ø		3.52	26	91.52	
				184.40	164.12
Bottom distribution bars 6mm ø		6.33	18	113.94	
Top distribution bars 6mm ø		6.33	6	37.96	
				151.92	33.42

Problem:

Prepare a detailed estimate of RCC beam of 8m clear span and 75cm x 40cm from the drawing. Steel in detail and RCC work shall be calculated seperately. Also prepare a schedule of bars.





1	RCC work 1:2:4 Excluding steel but including centering, Shuttering and binding of steel	1	8m	0.4	0.175	2.58 ~~2.58~~ m^3	
2	Steel bars including bending—						
	Main bars— 22mm straight bars @ 2.98 kg/m	4	8.92	= 35.68 × 2.98		= 106.33 kg	

8.6 - 2co + 2 hook
= 8.6 - 2x4 + 18x22

20mm dia bentup bars @ 2.4kg/m

4 | 9.48 = 37.92 x 2.47 = 93.66kg

$L = 8.6 - 2c + 2h + d$ mm

$= 8.6 - 8 + (18 \times 20)$ mm $+ 60cm$

$= 9.48m$

12mm dia top bars @ 0.89 kg/m

2 | 8.74 = 17.48 x 0.89 = 15.56kg

$L = 8.6 - 2c + 2h$

$= 8.6 - 8cm + (18 \times 12mm)$

$= 8.74\ m$

Stirrups 10mm ϕ bars @ 0.62 kg/m

At end 12 cm c to c.

Next at 20 cm c.t.c.

5x2 | 2.42

4x2 | 2.42

L = 65x2 + 32x2 + 2h + extra 30cm = 194cm

18 | 2.42 = 40.32 x 0.62 = 27.01kg

Stirrups 6mm ϕ @ 0.22kg/m

At central remaining length of 5.2m at 35 cm c. to c.

14 | 2.42

14 x 2.42 = 33.88 x 0.22 = 7.45kg

Total = 250.01kg

= 2.5 quintal

Abstract of estimatid cost

	Item of work	Quantity	Unit	Rate	Per	Amount
1	RCC work 1:2:4 excluding Steel and Including Centering and shuttering and binding of steel	2.58	cum	675	cum	1714.5
		2.5	quintal	515	quintal	1287.50
					Total =	3002.00
	Add 3% for contingencies and 2% for work charged establishment				=	150.00
					Grand total =	3152.00

Schedule of bars

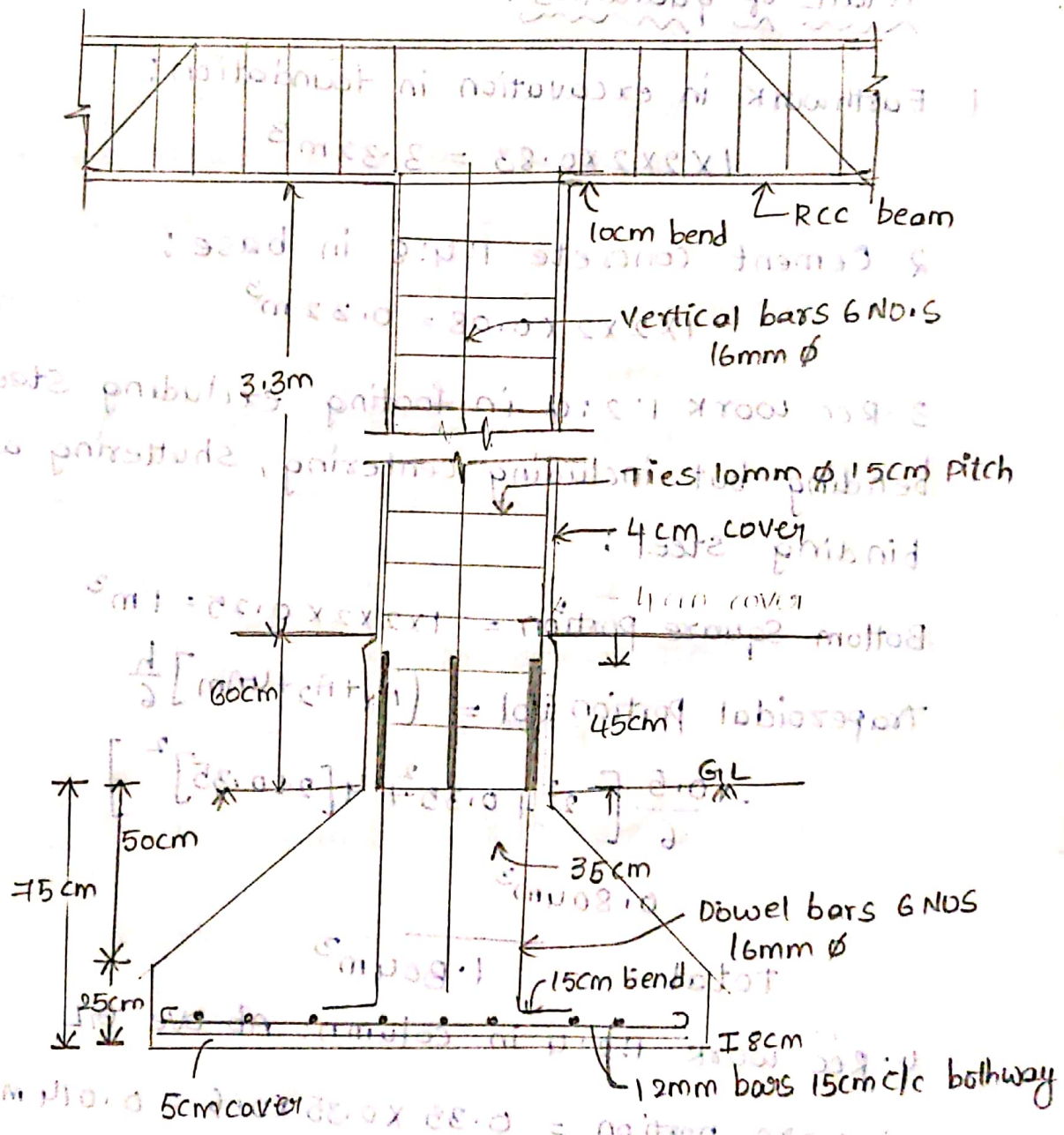
S.No	Description of bars	Shape of bending	length m	No	total length	Weight
1	Main straight bars 22mm dia	852	8.92	4	35.68	106.33
2	Main bentup bars 20mm dia	60, 96, 660, 96	9.48	2	18.96	46.83
3	Main bars bent up 20mm dia	60, 186, 480, 186	9.48	2	18.96	46.83
4	Top straight 20mm ø	852	8.74	2	17.48	15.56
5	Stirrups 10mm ø	10mm ø, 65, 32	2.24	18	40.32	25.00
6	Stirrups 6mm ø	32, 6mm ø, 65, 32	31.36	14		

Area of centering and shuttering = Bottom and two Vertical sides x length + two ends.

$= (40cm + 2 \times 75cm) \times 8.6m + [2 \times 0.4m \times 0.75m]$

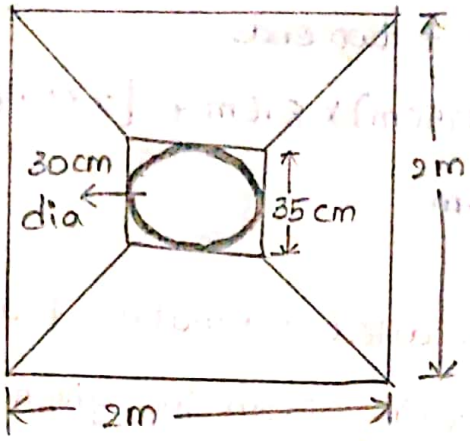
$= 16.945 sq.m$

Prepare a detailed estimate of a RCC column with foundation footing from the given drawings.



Section

Plan



Details of quantities:

1. Earthwork in excavation in foundation:

$$1 \times 2 \times 2 \times 0.83 = 3.32 m^3$$

2. Cement concrete 1:4:8 in base:

$$1 \times 2 \times 2 \times 0.08 = 0.32 m^3$$

3. RCC work 1:2:4 in footing excluding steel & its bending but including centering, shuttering and binding steel:

Bottom square portion = $1 \times 2 \times 2 \times 0.25 = 1 m^3$

Trapezoidal portion vol = $[A_1 + A_2 + 4Am] \frac{h}{6}$

$$= \frac{0.5}{6} [2^2 + 0.35^2 + 4[2+0.35]^2]$$

$$= 0.804 m^3$$

Total = $1.804 m^3$

4. RCC work 1:2:4 in column: Above GL

Square portion = $0.35 \times 0.35 \times 0.6 = 0.074 m^2$

circular portion abave the plinth level

$= 1 \times \frac{\pi}{4} \times (0.3)^2 \times 3.3 = 0.233 m^3$

Total = $0.307 m^3$.

5. steel reinforcing bars including bending

i) 12mm ø bars @ 0.89 kg in base footing

No. of bars = $\frac{200-8}{15} + 1 = 14$ no.s one way

12mm ø bars = $2 \times 14 \times 2.14 \times 0.89 = 53.33 Kg$

(L = 200 − 2 × cover + 2 hooks = 200 − 2 × 4 + 18 × 1.2

= 214 cm = 2.14m

ii) 16mm dia dowel bars @ 1.58 kg

= $6 \times 1.27 \times 1.58 = 12.04 Kg$

L = 0.45 + 0.75 − cov + bend = 0.45 + 0.75 − 0.8 + 0.15

= 1.27m

iii) 16mm dia bars @ 1.5 kg in column

L = 3.3 + 0.6 + 0.1 + 0.1 = 4.1m

16mm ø bars = $6 \times 4.1 \times 1.58 = 38.37 Kg$

iv) 10mm ø bars @ 0.62 kg in lateral ties

= $27 \times 7 \times 0.62 = 11.72 Kg$

No = $\frac{3.9}{0.15} + 1 = 27$ no.s [3.3m + 0.6m = 3.9m]

L = $\pi \times 0.22 = 0.7m$

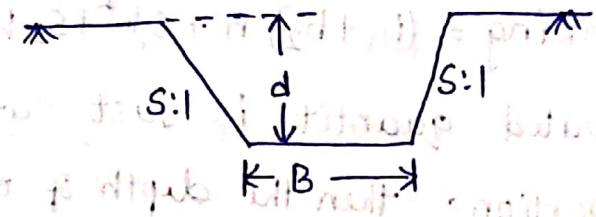
UNIT - IV

Estimation of Irrigation structures

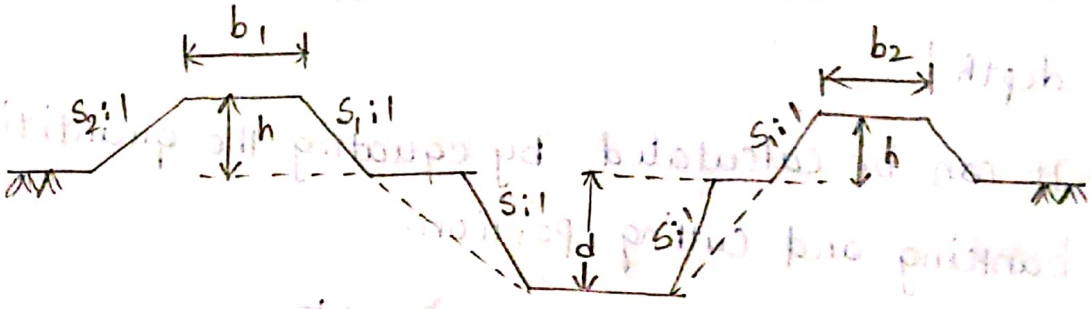
Earthwork in canals:

There may be three cases of canal sections which may be generally:

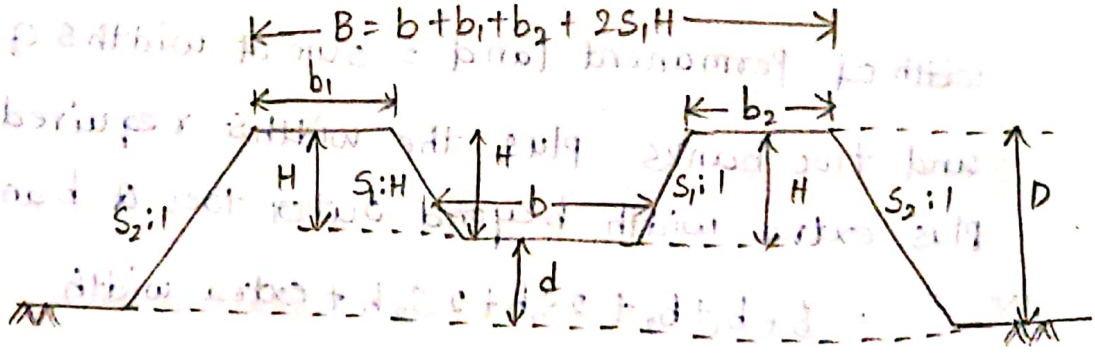
1. Fully in excavation



2. partly in excavation & partly in Embankment.



3. Fully in Embankment



Case 1: Fully in excavation:

Quantity of earthwork is calculated on the same principle of road estimate = $(Bd + Sd^2) \times$ length.

width of permanent land = B + 2sd + road widths on sides + extra land widths beyond the roads.

Area of permanent land = width of permanent land × Length

<u>case-II</u>: partly in excavatly and partly in embankment

Quantity of excavation = $(Bd + Sd^2)L$

Area of excavation = $Bd + Sd^2$

Area of banking = $(b_1 + b_2)h + S_1h^2 + S_2h^2$

If the excavated quantity is just sufficient for the banking portions, then the depth of excavation is called 'Economical depth of digging or Balancing depth.'

It can be calculated by equating the quantities of banking and cutting portion.

$$Bd + Sd^2 = (b_1 + b_2)h + S_1h^2 + S_2h^2$$

width of permanent land = sum of widths of bed and two banks plus the widths required for slopes plus extra width beyond outer toes of bank

$$= B + b_1 + b_2 + 2S_1h + 2S_2h + \text{extra width}$$

Area of permanent land = width of Permanent land × Length.

Case -III : Fully in banking:

Bed of canal is above ground level. Quantities of Earthwork may be calculated considering the whole as solid and then deducting the channel portion.

$$\text{Quantity} = \left[(Bd + S_1D^2) - (bH + S_1H^2)\right] \times \text{length}$$

$$B = b + b_1 + b_2 + 2S_1H^2 \qquad D = d + H$$

Area of Permanent land = width of permanent land × length

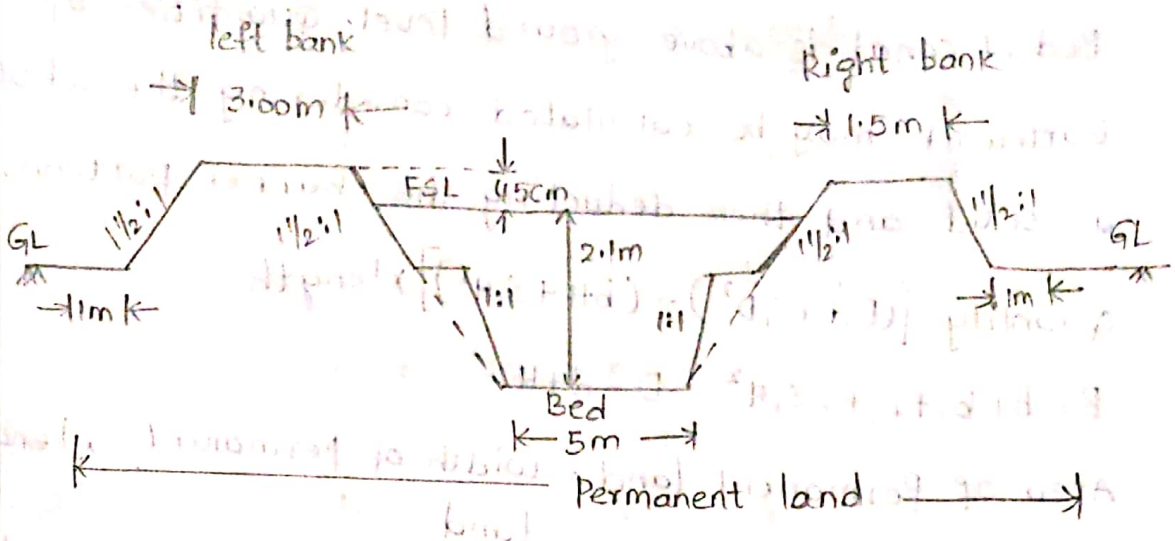
width of permanent land = $b + b_1 + b_2 + 2S_1H + 2S_2D$ + extra width beyond the outer toes of bank.

Calculate the quantity of Earthwork in an irrigation channel whose L-section and type cross section are given, Bed width of channel is 5m. Top width of banks are 3m for the left and 1:50 m for right bank. side Slopes of excavation 1:1 and of bank 1½:1. Height of bank from bed is 2.55m throught. Longitudinal slope of bed of channel is 1 in 5000.

ii) Calculate area of land required Permanently in a tabular form and cost of Permananut land @ RS 7000 per hectare

iii) Calculate economical dupth of digging.

Estimate the cost of Earthwork @ RS 275 per $\frac{1}{4}m^3$



Station	Distance in 'm'	RL of ground	RL of Bed	Depth of excavation
10	500	100.80	98.5	1.5
11	550	100.31	98.49	1.82
12	600	100.52	98.48	2.04
13	650	100.57	98.47	2.10
14	700	99.68	98.46	1.22
15	750	99.21	98.45	0.76
16	800	99.34	98.44	0.9
17	850	99.67	98.43	1.24
18	900	99.38	98.42	0.96
19	950	100.55	98.41	2.14
20	1000	100.24	98.40	1.84

$B = 5m$ $S = 1$ $b_1 = 3m$ $b_2 = 1.5m$ $S_1 = 1\frac{1}{2}$

Calculation of Quantities

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
10	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11	1.82	1.66	8.3	2.756	11.056	50	552.8	2.55	0.89	4.005	2.376	6.381	50	319.05	-	col. 2
12	2.04	1.93	9.65	3.725	13.375	50	668.75	2.55	0.62	2.790	1.153	3.943	50	197.15	-	= Diff
13	2.10	2.07	10.35	4.285	14.635	50	731.75	2.55	0.48	2.160	0.691	2.851	50	142.55	-	of R.L
14	1.22	1.66	8.3	2.756	11.056	50	552.80	2.55	0.89	4.005	2.376	6.381	50	319.05	-	of ground
15	0.76	0.99	4.95	0.980	5.930	50	296.5	2.55	1.56	7.020	7.301	14.321	50	716.05	419.55	and R.L.
16	0.9	0.83	4.15	0.689	4.839	50	241.95	2.55	1.72	7.740	8.875	16.615	50	830.75	588.80	of bed
17	1.24	1.07	5.35	1.145	6.495	50	324.75	2.55	1.48	6.660	6.571	13.231	50	661.55	336.8	
18	0.96	1.10	5.5	1.210	6.710	50	335.5	2.55	1.45	6.525	6.308	12.833	50	641.65	306.15	
19	2.14	1.55	7.75	2.403	10.153	50	507.65	2.55	1.00	4.5	3	7.5	50	375	-	
20	1.84	1.99	9.95	3.960	13.910	50	695.50	2.55	0.56	2.520	0.941	3.461	50	173.05	-	
						Total:	4907.95				Total-	87.517		4375.85		
															1651.30	

Quantity of Earthwork in Channel = $4907.95 m^3$

Quantity of Earthwork in banks, balance quantity required to be taken from borrow pit } = $1651.30 m^3$

Grand total = $6559.25 m^3$

Abstract of cost

Item No.		Q	unit	Rate per	Amount
1	Earthwork in Channel & banks	6559.25	m^3	Rs P. 275 / cum	18037.94
	Add 5% for contingencies and workcharged establishment				901.90
				Grand total =	18939.84

ii) Permanent land: width of permanent land x length

= (B + b_1 + b_2 + 2S_1H + 2S_2h + extra width) x length

B = 5m b_1 = 3m b_2 = 1.5 S_1 = 1½

Abstract of cost of permanent land:-

1. Area of permanent land 1.11725 hec @ 7000 /- per hec	=	Rs 7820.75
Add 5% for contingencies and work charged establishment	=	391.04
Total		Rs 8211.79

10	–	–	–	–	–	–	–	–	–
11	0.89	2.55	6.5	7.65	2.67	21.82	50	1091.0	
12	0.62	2.55	6.5	7.65	1.86	21.01	50	1050.5	
13	0.48	2.55	6.5	7.65	1.44	20.59	50	1029.5	
14	0.89	2.55	6.5	7.65	2.67	21.82	50	1091.0	
15	1.56	2.55	6.5	7.65	4.68	23.83	50	1191.5	
16	1.72	2.55	6.5	7.65	5.16	24.31	50	1215.5	
17	1.48	2.55	6.5	7.65	4.44	23.59	50	1179.5	
18	1.45	2.55	6.5	7.65	4.35	23.5	50	1175	
19	1	2.55	6.5	7.65	3.00	22.15	50	1107.5	
20	0.56	2.55	6.5	7.65	1.68	20.83	50	1041.5	
							Total:	11172.5m²	

iii) Economical depth of digging—

Quantity of digging = quantity in banking

Sectional area of digging = sectional area of two banks

$Bd + sd^2 = (b_1 + b_2)h + 2s_1h^2$

$B = 5m$, $b_1 = 3m$, $b_2 = 1.5m$, $s = 1$, $s_1 = 1\frac{1}{2}$ $d + h = 2.55$

$h = 2.55 - d$

$5d + d^2 = (3 + 1.5)(2.55 - d) + 2 \times 1.5 \times (2.55 - d)^2$

$d = 10.99$ or 1.41

d cannot be 10.99 hence $d = 1.41m$

∴ Economical depth of digging = 1.41 m.

Problem:

Find the area of permanent land required for two km length, in between 1km and 3km of distributary of before example. The area should be found for every 200m length taking width as maximum width in that portion.

width of Permanent land = $B + b_1 + b_2 + 2s_1H + 2s_2h$

+ extra width beyond outer toes of bank.

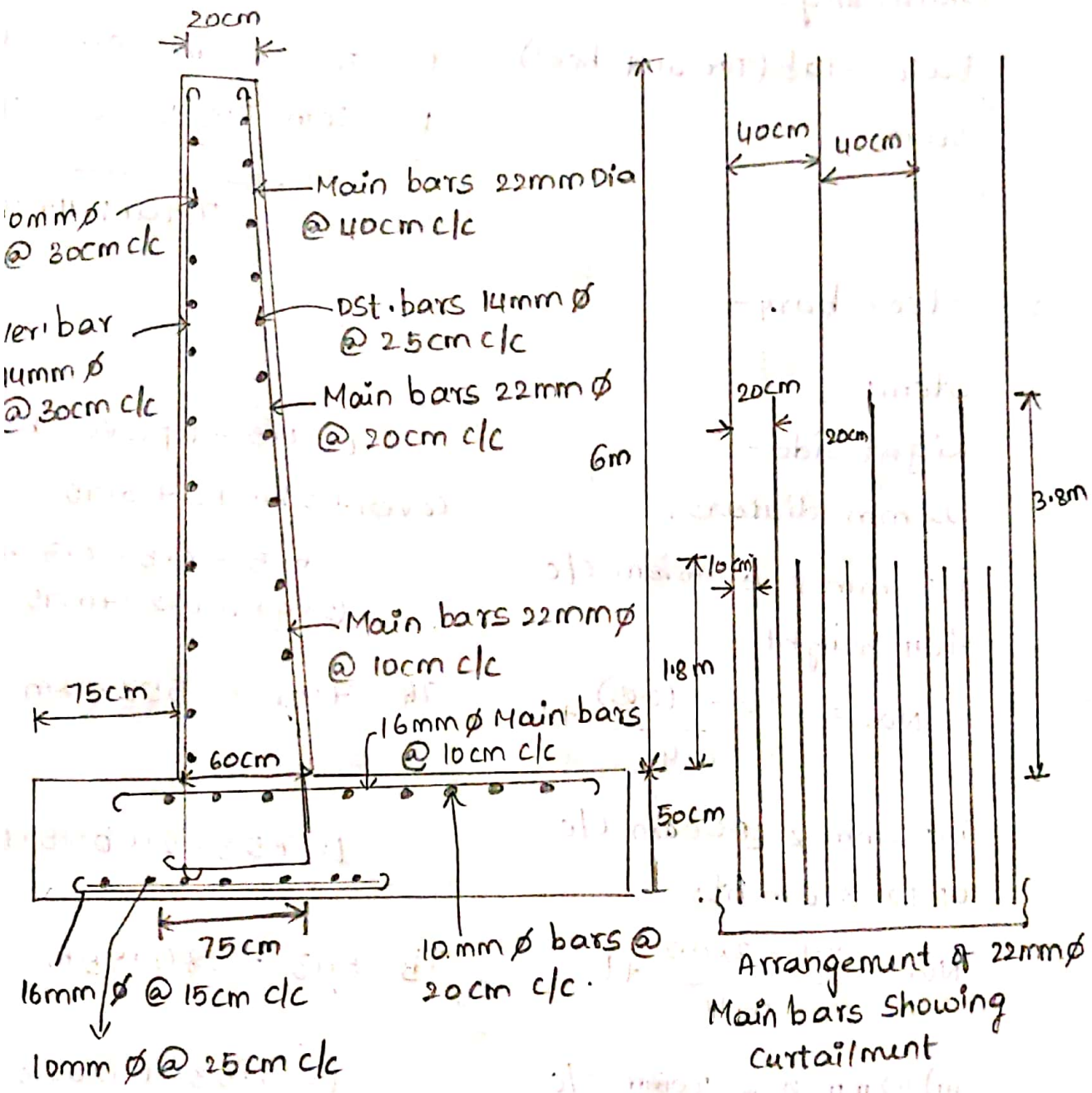
Extra width beyond toe = 60cm + 60cm = 120cm

= 1.2m

Area of permanent land = width x length.

RCC Retaining wall

Problem: Prepare a detailed estimate of RCC Retaining wall of 30m in length whose cross section is given in fig. Assume suitable rates



1	Rcc work 1:2:4 excluding Steel and its bending but including centering and Shuttering —				
	Base slab (Toe and heel)	1	30 m	3 m	
	Stem	1	30 m	$\frac{0.6+0.2}{2}$	
					Total
2	Steel bars-				
	Stem:				
	Right side -				L = 6.5 - top cover + 2 hooks +
	22 mm diatars:				= 6.5 - 0.5
	i) 22 mm ø @ 40 cm c/c full height				(2x9x0.022
	$No. = \frac{30 - 2(0.05)}{0.4} + 1$	76	7.53	=	5
	ii) 22mm ø @ 40cm c/c up to 3.6 m ht.				L = 7.53 - 2
	$No. = \frac{29 - 2x0.2}{0.4} + 1$	75	5.13	=	38.4
	iii) 22 mm ø @ 20 cm c/c up to 1.8 m ht				L = 7.53 -
	$No. = \frac{29 - 2(0.1)}{0.2} + 1$	150	3.33	=	49
					Total of 22mm ø =
					@ 2.98 Kg = 4340 434

Particulars of Item	No.	length	Quantity
14mm ø bars:-			
14mm ø distributing bars right side @ 25cm c/c No. = $\frac{6.5-0.05-0.07}{0.25}$ +1		L = 30 - 2 covers + 2 overlaps + 6 hooks = 30 - 0.1 + (2x40 x0.014) + (6x9 x0.014) = 31.52m	
	27	31.52m = 851.04m	
14mm ø vertical bars left side of stem @ 30cm c/c No. = $\frac{30-0.1}{0.3}$ = 100.6		L = 6.5 - both covers + 2 hooks = 6.5 - (0.5+0.7 + (18 x 0.014)	
	101	6.63 = 669.63m	
10mm ø bars:- 10mm ø bars left side stem @ 30cm c/c No. = $\frac{6.5-0.05-0.07}{0.3}$ +1		L = 30 - 2 covt + 2 overlaps + 6 hooks = 30 - 0.10 + (2x40x0.01) + (6x9x0.1)	
	22	31.06 = 687.28m	
Base slab: 10mm ø distributing bars at bottom (TOE) @ 25 cm c/c No. = $\frac{(0.75+0.6+0.3)-0.05}{0.125}$ +1 = 7	7	31.06 = 217.42m	
10mm ø distributing bars at top @ 20 mm c/c No. = $\frac{1.56+0.6+0.25-0.05}{0.2}$ +1	13	31.06 = 403.78m	
	Total of 10 mm ø bars = 1304.52m		
	@ 0.62 kg = 808.80 kg		

Item No	Particulars of Item	No.	length	Explanatory notes
	16mm ø bars:-			
	16mm dia main bars at bottom (Toe) @ 15cm c/c	200	1.89 = 378.00m	
	No. = $\frac{30-0.1}{0.15}+1$		L = 0.75+0.6+0.3 −0.05+(18×0.016) = 1.89m	
	16mm dia main bars at top (@ 10 cm c/c	300	2.74 = 822.00m	
	No. = $\frac{30-0.1}{0.1}+1$ = 300		L = 1.05+0.6+0.25− 0.05+18×0.16 = 2.74m.	
	Total of 16mm ø bars = 1200m @ 1.58 kg = 1896kg			
	Grand Total of all bars = 8884.46 kg = 88.845q			

Abstract of cost

1	RCC work of 1:2:4 excluding steel	117.00m³ @ 675 per m³ = Rs 78975.00	
2	Steel bars including reinforcement	88.845q @ 515 per q = Rs 45755.18.	
		Rs. 124730.18	
	Add 5% for contingencies	= 6236.51	
		Rs 130966.69	