Culvert

According to IRC specification a culvert is one which has linear water way upto 6m. ~~and below 30m~~.

The structure having linear water way above 6m & below 30m are called minor bridges and the structure having linear water way of 30m or more is called major bridge.

There should be atleast one culvert in every 1.5 km of highway.

- Definition —

① Abutment -

It is a masonry or RCC wall which constitute and support of bridge in the banks of water level.

② Wing wall -

It is a retaining wall which sustains embankments of the approaches where they join the bridge.

③ Return wall –

It is a retaining wall built parallel to the centreline of the road to retain the embankment.

④ Curtain wall –

Cross walls are built across the string on the upstream or downstream site to protect the structure from erosion due to strong current of water.

R.C.C. SLAB CULVERTS - 1.5 METRE SPAN

Example 1. -- Prepare a detailed estimate of a slab culvert of 1.50 metre span and 4.00 metre roadway from the given drawing (Fig. 8.5). The general specifications are as follows :—

Foundation concrete shall be of cement concrete 1 : 3 : 6 with stone ballast and coarse sand. Masonry shall be of first class brickwork in 1 : 4 cement coarse sand mortar. Slab shall be of R.C.C. 1 : 2 : 4 with reinforcement as per drawing. Exposed surface of brick masonry shall be cement pointed 1 : 2. Road shall be provided with 10 cm thick wearing coat of 1 : 2 : 4 cement concrete. Assume suitable rates.

R.C.C. SLAB CULVERT 1.50 m SPAN with standard modular bricks

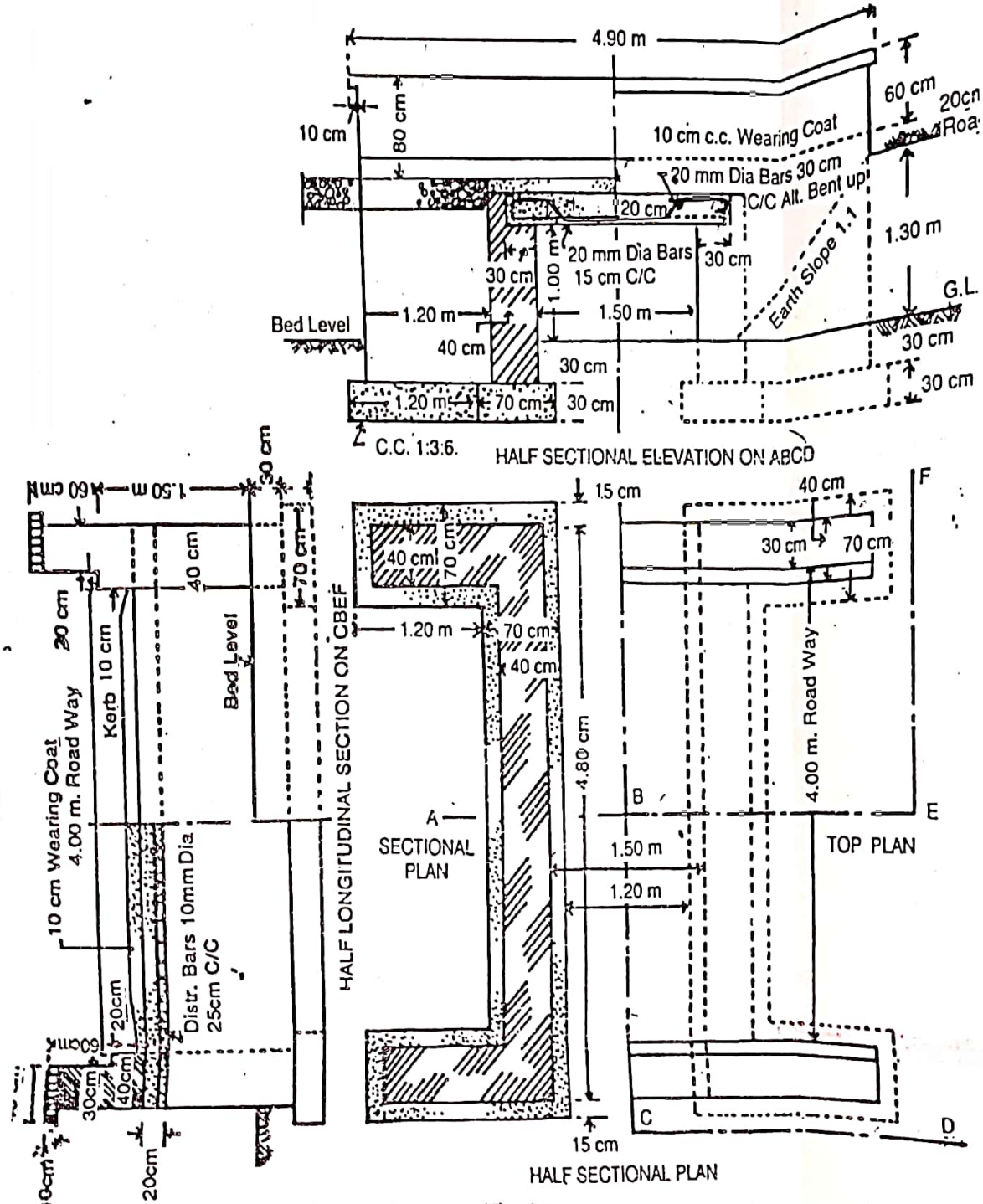


Fig. 8-5

Item No.	Description	No.	L	B	H	Quantity	Remark
1.	Earth work in excavation in foundation —						
	Abutment	2	5.1	0.7	0.60	4.28	L = 4.8 + 0.3 = 5.1
	Wing walls	4	1.2	0.7	0.60	2.02	
					total	6.30 cum.	
2	Cement concrete 1:3:6 in foundation with stone ballast -						
	Abutments	2	5.1	0.7	0.3	2.14	
	wing walls	4	1.2	0.7	0.3	1.01	
					total	= 3.15 cum.	
3	I-class brick work in 1:4 cement mortar -						
	Abutments	2	4.80	0.4	1.5	5.76	
	wing walls.	4	1.20	0.4	1.5	2.88	
	Parapet upto kerb	2	4.8	0.4	0.3	1.15	
	parapet above kerb	2	4.7	0.3	0.5	1.41	
	parapet coping	2	4.9	0.4	0.1	0.39	
					total	11.59	
	Deduct - Bearing of R.C.C slab in abutment.	2	4.8	0.3	0.2	0.58	
					total deduction	0.58	
					Net total =	11.01 cum	
4	RCC work 1:2:4 in slab excluding steel and its bending but including centring shuttering and binding steel	1	4.8	2.1	0.2	2.016 cum	B = 1.5 + 0.6 = 2.1
5.	Steel bars including bending in RCC work. 20 mm dia bars, main straight bars,						

	$\left(\frac{4.8}{0.3} = 16+1 = 17\right)$	17	2.38 41	—	—	40.46 97 cum	$L = 2.1 - (2 \times 0.04) + (18 \times 0.09) + 2.41$ (0.025 end)
	Main bent up bars 30 cm c/c $\left(\text{No. } \frac{4.8}{0.3} = 16\right)$	16	2.55	—	—	40.92 cum	Adding one depth, 0.42d for one bent up bars. (d = effective depth) $2.41 + (2 \times 0.42d)$
	wt. of 1 m bar $= \frac{D^2}{162} = \frac{400}{162} = 2.47$ kg		Total = 81.98 m @ 2.47 kg/m			= 202.37 kg	$= 2.41 + (2 \times 0.42 \times 0.175)$ $= 2.56$ m.
	10 mm dia. bars — Distribution bottom bars 25 cm c/c $\left(\frac{2.1}{0.25} = 8.4 \simeq 9\right)$	9	4.93	—	—	44.37	$L = 4.8 - (2 \times 0.025) + (18 \times 0.01) = 4.93$
	Distributing top bars	4	4.93	—	—	19.72	H = 200 − 25 = 175 mm = 0.175 m.
	wt. of 1 m bar $= \frac{D^2}{162} = \frac{100}{162} = 0.62$		Total = 64.09 @ 0.62 kg = 39.73 kg				
6	Cement concrete 1:2:4 wearing coat	1	4.00	2.30	0.10	0.92 cum	1.5 + 0.8 = 2.3
7	Cement pointing 1:2 in walls —						
	Face wall from 10 cm below GL up to bottom of the coping	2	4.7	—	2.1	19.74	
	Inner side of parapet excluding coping	2	4.7	—	0.8	7.52	$B = 0.1 + 0.6 - 0.1) + 0.2 = 0.8$
	Coping (inner edge, top, outer edge and outer and side)	2	4.9	0.7	—	6.86	$B = 0.4 + 0.1 + 0.1 + 0.1 = 0.7$
	Ends of parapet	4	—	0.4	0.2	0.32	Upto kerb
	Ends of parapet	4	—	0.3	0.5	0.6	above kerb
	Ends of coping	4	—	0.4	0.1	0.16	Edge & under-side

Deduct -

Rectangular opening	2	1.5	– 1.3	3.90
Triangular portion below earth slope	2	0.845	– –	1.69

Total Deduction = 5.59

$\frac{1}{2} \times b \times h$

$= \left(\frac{1}{2} \times 1.3 \times 1.3\right)$

$= 0.845$

ARCHED CULVERTS — TWO METRE SPAN

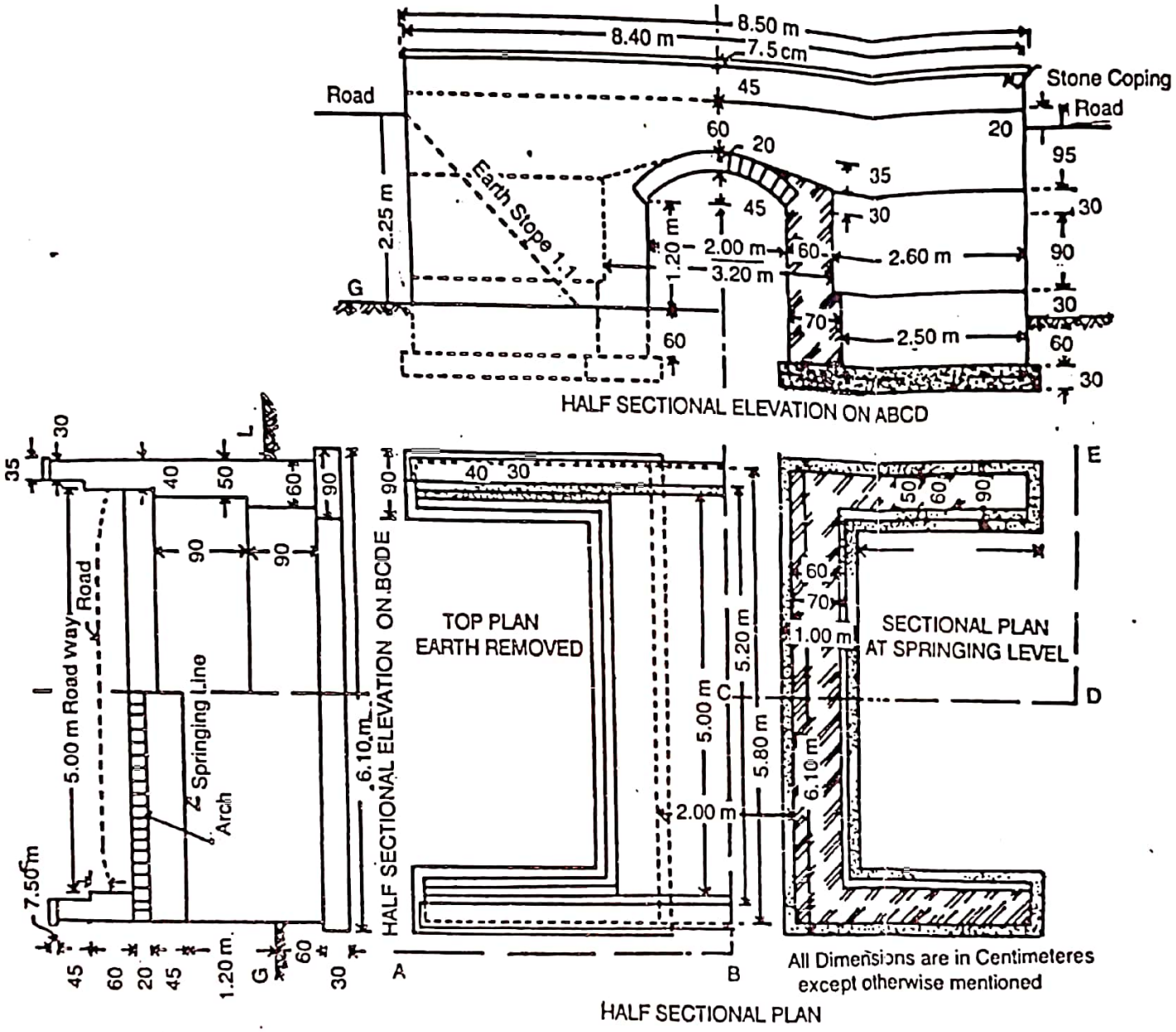


Fig. 8-6

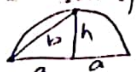
For the beginners to form clear conception isometric views of different parts of the culvert detached from one another are given in Fig. 8-7 in page383. The dimensions in the solution of this example may be compared with the dimensions in the isometric view.

Item No.	Description	No.	L	B	H	Quantity	Remark
1	Earthwork in excavation in foundation -						
	Abutments.	2	6.10	1.0	0.9	10.98	
	Wingwalls	4	2.50	0.9	0.9	8.1	
					total =	19.08 cum	
2	Cement concrete 1:4:8 with the overburnt brick ballast in foundation -						
	Abutments	2	6.10	1.0	0.3	3.66	
	wing walls	4	2.50	0.9	0.3	2.7	
					total =	6.36 cum	
3	I. class brickwork in 1:5 cement local sand mortar -						
	Abutments -						
	1st step	2	5.80	0.70	0.90	7.308	
	2nd step upto springing level	2	5.80	0.60	0.90	6.264	
	Above springing level as rectangular solid upto top of crown	1	5.80	3.20	0.65	12.064	
	Wing walls -						
	1st step -	4	2.5	0.6	0.9	5.4	
	2nd step upto spandrel level	4	2.6	0.5	1.2	6.24	
	Parapet upto kerb as solid (whole length)	2	8.4	0.4	0.95	6.384	
	Parapet above kerb	2	8.4	0.3	0.45	2.268	
					total =	45.928 cum	
	Deduct -						
	Arch opening segmental portion -	1	5.8	X 0.6	=	3.48	
	Arch masonry	1	5.8	2.42	0.20	2.81	
	Triangular portions above abutment ($\frac{1}{2}$ X 3.20 X 0.35)	2	5.8	X 0.56	=	6.50	
	Triangular portions above parapet ($\frac{1}{2}$ X 3.20 X 0.35 X 0.4) (0.4 = parapet thickness)	2	X	0.224	=	0.45	
					Total deductions =	13.24	
					Total =	32.688 cum.	

Area = $\frac{2}{3}$ span x rise
= $\frac{2}{3}$ X 2.0 X 0.45
= 0.6

$R = \frac{h}{2} + \frac{s^2}{8h} = \frac{0.45}{2} + \frac{2^2}{8 \times 0.45}$
= 1.336 m.

$R_m = R + \frac{t}{2} = 1.336 + \frac{0.2}{2}$
= 1.436 m.

4	I. class brickwork in arch in 1:3 cement, coarse sand mortar 	1	5.8	2.43	0.2	2.81 cum	$b = \sqrt{r^2+h^2}$ $= \sqrt{(1)^2+(0.45)^2}$ $= 1.096$ $L = \frac{8b-2a}{3}$ $= \frac{8\times1.096-2\times1}{3}$ $= 2.256$ m. $l_m = L\times\frac{\pi m}{\pi}$ $= 2.256\times\frac{1.436}{1.336}$ $= 2.42$m. $Q = L\times l_m\times t$ $= 5.8\times2.42\times0.20$ $= 2.81$ cum
5	Cut stone work laid with 1:3 cement coarse sand mortar in coping	2	8.5	0.35	0.075	0.45 cum	
6	cement pointing 1:2 in exposed surface ~~including~~ including 10cm below ground.						
	Face wall from 10cm below G.L up to top of parcapet. h= 2.25+0.2+0.45+0.1 = 3.0	2	8.4	—	3.0	50.4	
	Inner face of parcapets above road levels	2	8.4	—	0.75	12.6	
	Ends of parcapet	4	—	0.4	0.2	0.32	
	Ends of parcapet	4	—	0.3	0.45	0.54	
	Inner face of abutments soffit or arch	2	5.8	—	1.3	15.08	h= 1.2+0.1 = 1.3
		1	5.8	2.256	—	13.08	
					total =	92.02 cum	
	Deduct —						
	Rectangular opening	2	2.0	—	1.3	5.2	
	Arch opening segmental portion $\left(\frac{2}{3}\times2\times0.45\right) = 0.6$	2	X	0.6	=	1.2	
	Triangular portion below earth slope in face walls	4	$\left(\frac{1}{2}\times1.35\times2.35\right)$ $\times4$	2.76	=	11.04	base = 2.25+0.10 = 2.35 Area = $\frac{1}{2}\times b\times h$
				Total	deduction =	16.24	
				Net	total =	75.78	

Dt- 21/1/20

Lead -

It is horizontal straight poret distance through which earth can be carried & transported from the place of spreading or disposal & not the route actualy taken.

unit of lead is 50 m for a distance upto 500 m and measured as a separate item for

① 0 m to ≤ 250 m.
② > 250 m & ≤ 500 m.

The unit of lead is 500m. for a distance exceeding 500 m & upto 5 km.

When the lead exceeds 5 km it is measured in units of 1 km.

The loading & unloading of earth is included in the item.

Lift

It is measured from G.L.. Excavation upto 1.5 m depth below G.L. and depositing excavated material on the ground shall be included in the item of earthwork for various kinds of soil.

Extra lift shall be measured in the unit of 1.5 m or part thereof.

General methods for computation of works:

It is classified into 3 types—

(I) Cross section
(II) Spot level
(III) Contour lines

measurements from cross section is applied universely ~~adopted~~ whereas spot levels is applied for large excavation & rough estimate of volume for the determination of capacity of Reservoir is done by contour lines.

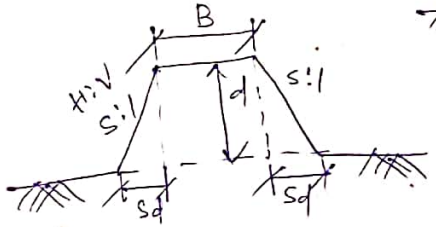
Volume of earthwork—

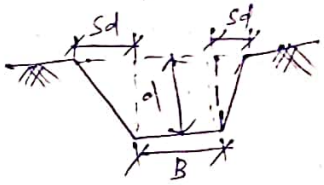
Considering two adjacent c/s with plane ends if length L equal to distance between the sections volume of earthwork = section of area × Length.

→ volume of earthwork for level ground and formation level of the road after banking or cutting has no gradient,

Volume of earthwork (V) =

$$(Bd + Sd^2) \times L$$





→ Volume of earthwork when the ground is on a longitudinal slope or formation level has a

uniform gradient for a length L then quantity of earthwork is found out by formula

① Mid section
② Trapezoidal or Avg. end area or Mean sectional area method
③ Prismoidal method according to simpson's one-third Rule.

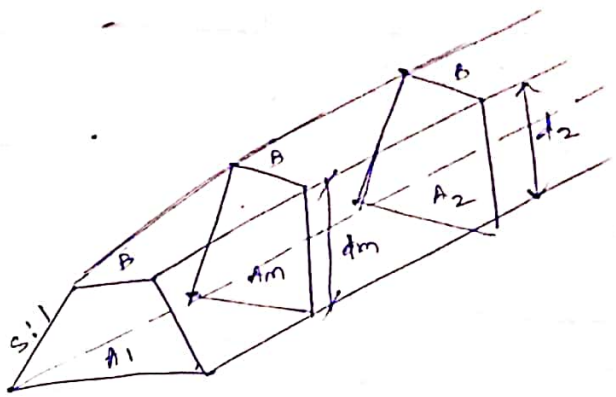
① Mid section formula -

In this method mean depth is calculated by averaging two consecutive depths of two section. Then the volume is computed by multiplying area of mid section from mid depth by distance between two original section.

$$d_m = \frac{d_1 + d_2}{2}$$

$$A_m = Bd_m + Sd_m^2$$

$$V = (Bd_m + Sd_m^2)L$$



Q. Estimate the quantity of earthwork for an embankment 120m long, 8 m wide at crest and whose side slope is 2 to 1. The central ht. from 0 to at every 30m interval 0.60 m, 1.2m, 1.6 m, 2m & 1.3m. estimate using mid section formula.

Station | Forward | Chainage

B = 8 m
L = 120 m.
S = 2

Station on Chainage	Depth on height at Station (GL−FL)	Mean depth on height (d_m) $\left(\frac{0.6+1.2}{2}\right)$	Area of central portion (Bd_m) $B = 8m$, $d_m \times 8 =$	Area of sides (Sd_m^2)	Total area ($Bd_m + Sd_m^2$) ('A_m')	Length between stations (L)	Quantity	
							Embankment	cutting
0	0.6	0.90	7.20	1.62	8.82	30	264.6	
30	1.2	1.40	11.20	3.92	15.12	30	453.6	
60	1.6	1.80	14.40	6.48	20.88	30	626.4	
90	2.0	1.65	13.20	5.45	18.65	30	559.5	
120	1.3							

Total Earthwork = 1904.1 cum

② Trapezoidal formula or avg. end area method or mean sectional area method:-

Total volume (V) =

$$= \frac{L}{2}\left[A_1 + A_n + 2(A_2 + A_3 + \dots + A_{n-1})\right]$$

$A_0 = Bd + Sd^2$

$= (8 \times 0.6) + (2 \times (0.6)^2)$

$= 4.8 + 0.72$

$= 5.52$

$A_1 = Bd + Sd^2$

$= (8 \times 1.2) + (2 \times (1.2)^2)$

$= 9.6 + 2.88$

$= 12.48$

$A_2 = Bd + Sd^2$

$= (8 \times 1.6) + (2 \times (1.6)^2)$

$= 12.8 + 5.12 = 17.92$

$A_3 = (8 \times 2) + (2 \times (2)^2)$

$= 16 + 8$

$= 24$

$A_4 = (8 \times 1.3) + (2 \times (1.3)^2)$

$= 10.4 + 3.38$

$= 13.78$

$V = \frac{30}{2}[5.52 + 13.98 + 2(12.48 + 17.92)]$

$= \frac{15}{2}[128.1]$

$= 1921.5\ m^3$

③ Prismoidal method –

$V = \frac{L}{3}[A_1 + A_n + 4(A_{even}) + 2(A_{odd})]$

N.B
The no. of section (for prismoidal formula) appln of simpson's rule 1 must be odd.
In case of even no. of sections, end strip must be treated separately and the volume of last strip is calculated by mid-section or prismoidal formula.

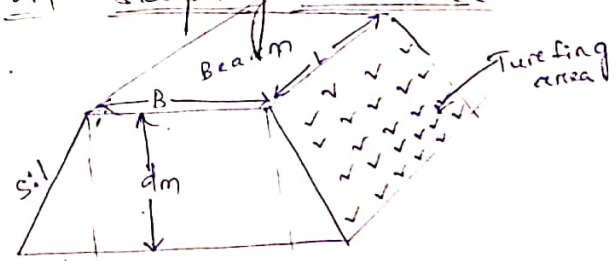
$V = \frac{30}{3}[5.52 + 13.98 + 4(12.48 + 24) + 2(17.92)]$

$= \frac{1}{10}[201.06]$

$= 2010.6\ m^3$

N.B - Quantity obtained by prismoidal formula is more accurate and this is more by 5% and 0.7 % as compared to 1st method & 2nd method resp.. Considering low rate of earth work method 1 & method 2 are normally used but method 2 should be preferred as the result is more closer to method 3.

Area of turfing or pitching on sloping surface —



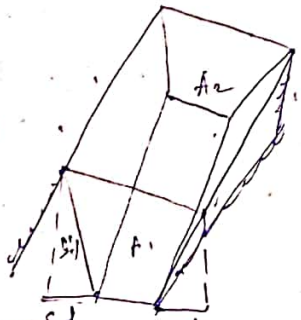
Width of turfing area $= \sqrt{(dm)^2 + (Sdm)^2}$

$= \sqrt{dm^2(1+S^2)} = dm\sqrt{1+S^2}$

So total area $= 2 \times L \times dm\sqrt{1+S^2}$

Q. Find the volume of earthwork of a tank which is excavated in level ground to a depth of 4m. the top of the tank is rectangular in shape has an area of 50m × 40m & side slope of the tank is 2:1.

① Prismoidal formula
② Trapezoidal formula



Length at top = 50 m.

Length at bottom = L − 2sd. = 50 − 2×2×4

= 34 m.

width at middle = $\frac{40+24}{2}$

= 32 m.

width at bottom = 40 − 2×2×4

= 24 m

width at top = 40 m.

40 − 2×2×4 = 24

$A_m = \left(\frac{50+34}{2}\right) \times \left(\frac{40+24}{2}\right) = 1344$ sqm.

$A_1 = 50 \times 40 = 2000$ sqm

$A_2 = 34 \times 24 = 816$ sqm.

Prismoidal formula

$V = \frac{L}{6}(A_1 + A_2 + 4A_m)$.

$= \frac{4}{6}(2000 + 816 + 4 \times 1344)$

$= 5461.33$ cum.

Trapezoidal formula.

$V = A_m \times L$

$= 1344 \times 4$

$= 5376$ cum.

Q. Prepare an estimate for the portion of a road from chainage 14 to 22 from the data given below. Draw also the longitudinal & typical cross section on cutting and banking. fencing with grass soils shall be provided on the sides of embankment @ rupees 2 per sqm. The rate of earthwork in cutting is 8.5 for cum

& embankment is rupees 7.5 per cum. The formation width of the proposed road is 12m side slopes are 1½:1 in cutting and 2:1 in banking. The road formation is proposed at uniform fall in gradient at 1 in 200 passing through G.L. at chainage 14.

Length of 1 chain = 30 m.

Chainage (30m)	14	15	16	17	18
RL of ground	108.60	109.25	109.40	108.85	108.50
RL of F.L	~~108.60~~	~~108.45~~	~~108.25~~	108.7	108.35

19	20	21	22
107.25	106.80	107.15	107.20

cutting = -ve

filling = +ve

Depth of cutting or banking = difference between G.L & formation level (F.L).

Falling gradient 1 in 200.

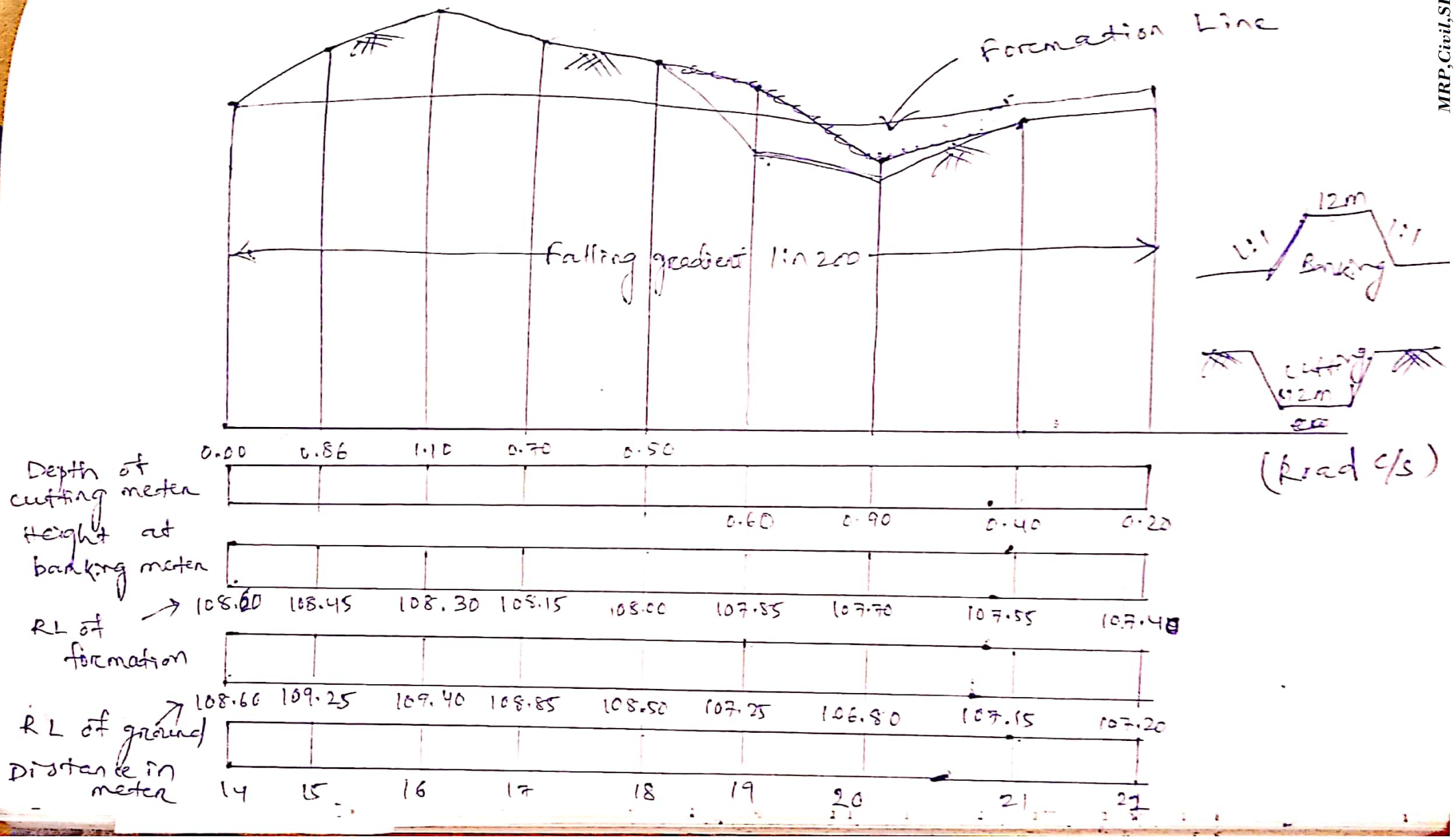
So per m. falling = $\frac{30}{200}$ = 0.15 m.

RL of F.L	108.60	108.45	108.25	108.15	108	107.85	107.7	107.55	107.4
Depth of Earthwork (Diff. btw GL & FL)	0	cutting −0.8	−1.1	−0.7	+0.50	+0.6	0.9	0.4	0.2

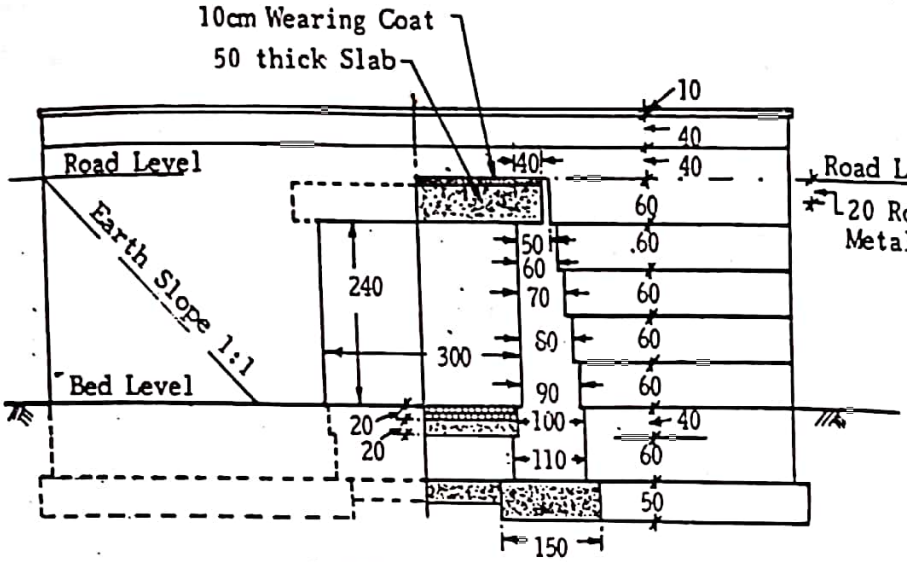
Chainage	Depth of station (GL − FL) (m)	Mean depth or height (dm) in m	Area of central portion (Bdm) in m² B = 12	Area of sides (Sdm²) in m²	Total area (Bdm + Sdm²) in m²	Qty L (Bdm + Sdm²): Length b/w chainage L (m)	Qty L (Bdm + Sdm²): Banking / Cutting	Area of both side turfing (2L × dm √(1+S²)) in m²
14	0							Cutting
		−0.4	+4.8	0.24	5.04	30	151.20	
15	−0.8							
		−0.95	+11.4	1.35	12.75	30	382.50	
16	−1.1							
		−0.9	+10.8	1.22	12.02	30	360.60	
17	−0.7							
		−0.6	+7.2	0.54	7.74	30	232.20	
18	−0.5							
		−0.25	+3	0.09	3.09	14	43.26	
passes	0							
		0.3	3.6	0.18	3.78	16	60.48	Filling 21.47
19	0.6							
		0.75	9	1.23	10.23	30	306.9	100.62
20	0.9							
		0.65	7.8	0.85	8.65	30	259.5	87.20
21	0.4							
		0.3	3.6	0.18	3.78	30	113.40	40.25
22	0.2							
								249.54 sqm

Σ cutting = 1169.70 cum

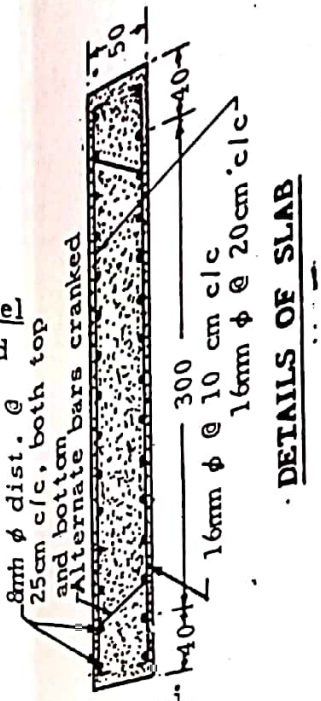
Σ filling = 740.28 cum



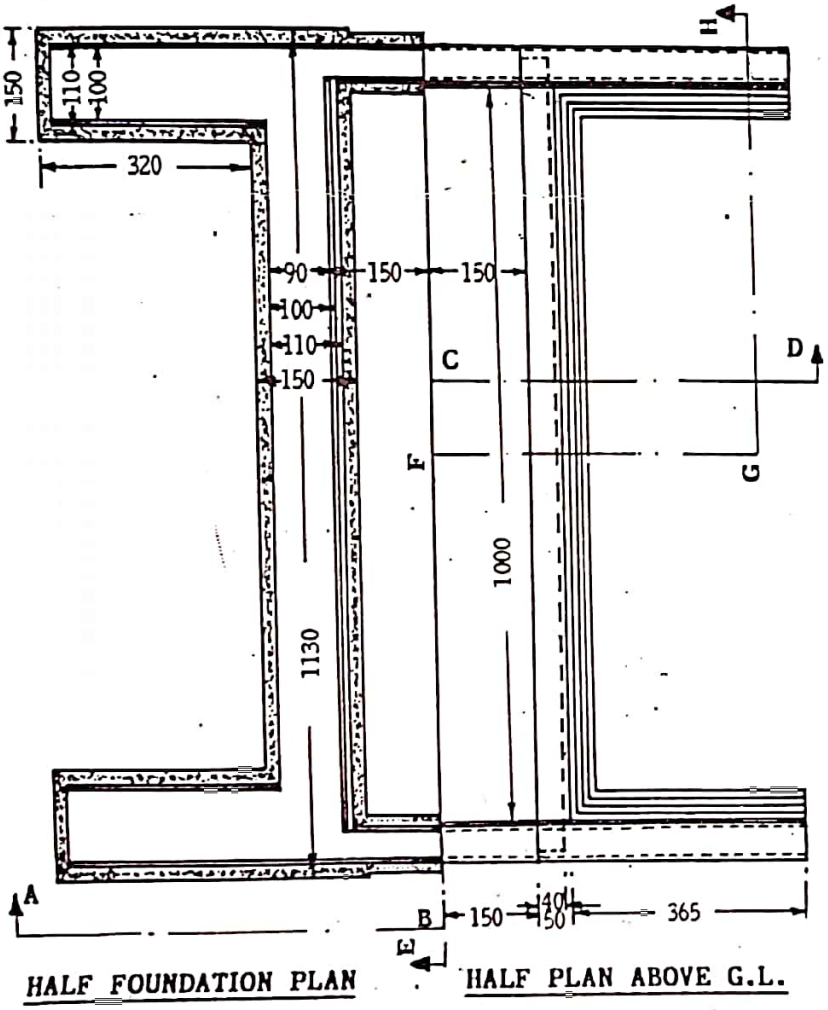
BRIDGES AND CULVERTS



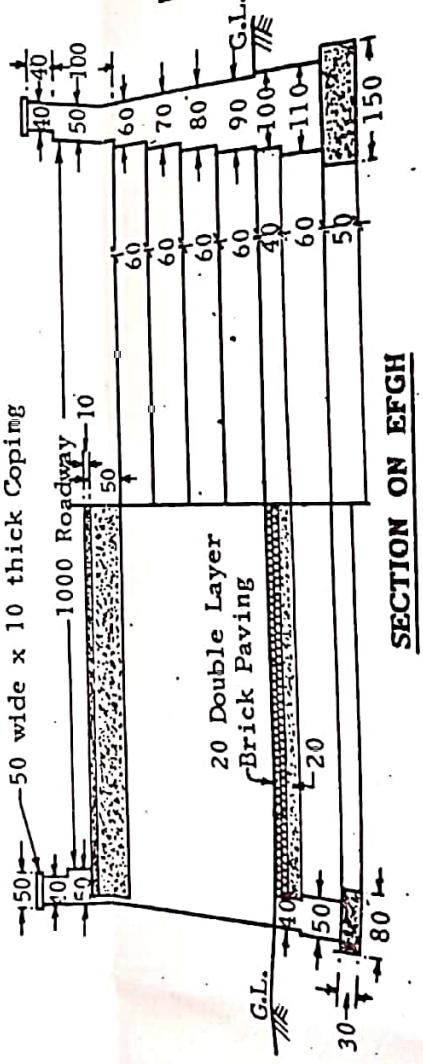
SECTION ON ABCD



DETAILS OF SLAB



HALF FOUNDATION PLAN



HALF PLAN ABOVE G.L.

SECTION ON EFGH

ALL DIMENSIONS IN CENTIMETRE

Q) Prepare a detailed estimate for a 3m. culvert from the drawing shown in fig. The general specifications are as follows:

(a) Foundation concrete shall be of cement concrete 1:3:6 with stone chips.

(b) All brickwork shall be of 1st class in cement mortar 1:4.

(c) Coping shall be of cement concrete 1:2:4 with 12mm down stone chips and 12mm cement plastered with a proportion 1:4

(d) The flooring shall be of double layer 1st class brickwith breake joint in cement mortar (1:6)

(e) All exposed surfaces shall be Rule pointing in cement mortar (1:3).

Sl. No.	Description	No	L	B	H	Quantity	Remark
1	Earthwork in excavation						
	Abutments	2	11.30	1.50	1.50	50.85	L = 10.00 + 2(0.4 + 0.05 + 0.2) = 11.30
	wing walls -	4	3.20	1.50	1.50	28.8	
	curtain walls -	2	2.30	0.80	1.30	4.78	L = 3.00 − 2(0.3 + 0.05) = 2.3
	floor between abutment-	1	9.6	2.3	0.4	8.83	L = 10.00 − 2(0.2) = 9.6
					total	93.262	
2	Cement concrete in foundation (1:3:6)						
	Abutments	2	11.30	1.5	0.5	16.95	
	Wing walls	2	3.20	1.5	0.5	4.8	
	Curtain walls	1	2.30	0.8	0.3	0.552	
	flooring	1	10.00	3.0	0.2	6	
					total	28.302	
3	1st class brickwork in cement mortar (1:4)						
	Abutments.						
	1st footing	2	10.9	1.10	0.6	14.388	L = 11.30 − 2 × (0.20) = 10.9
	2nd footing	2	10.9	1.00	0.4	8.72	
	3rd footing	2	10.9	0.9	0.6	11.772	
	4th footing	2	10.9	0.8	0.6	10.464	
	5th footing	2	10.9	0.7	0.6	9.156	
	6th footing	2	10.9	0.6	0.6	7.848	
	Top wall	2	10.9	0.5	0.6	6.54	
	Deduct the bearing of slab	2	10.9	0.4	0.5	-4.36	
	Wing walls -						
	1st footing	4	3.20	1.10	0.6	8.448	
	2nd footing	4	3.20	1.00	0.4	5.12	
	3rd footing	4	3.25	0.9	0.6	7.02	L = 3.20 + 0.05 = 3.25
	4th footing	4	3.35	0.8	0.6	6.432	L = 3.25 + 0.1 = 3.35
	5th footing	4	3.45	0.7	0.6	5.796	L = 3.35 + 0.1 = 3.45
	6th footing	4	3.55	0.6	0.6	5.112	L = 3.45 + 0.1 = 3.55
	Top wall	4	3.65	0.5	0.6	4.38	L = 3.55 + 0.1 = 3.65
	Parapet wall bottom	2	11.30	0.5	0.4	4.52	L = 2(3.65 + 0.5 + 1.50) = 11.30

	parapet wall top curtain wall: Sol footing Top	2	11.30	0.4	0.4	3.616	
		1	2.7	0.5	0.6	0.81	L = 2.3 + 2×0.2 = 2.7
		1	2.8	0.4	0.4	0.4118	L = 2.7 + (0.05)2 = 2.8
					Total	= 116.23	
4	Cement concrete M15 for R.C.C work	1	11.00	3.8	0.5	20.9	L = 10 + (0.5)×2 = 11.0 B = 3 + (0.4)×2 = 3.8
5	Shuttering and staging	1	11.00	3.00	—	33	
6	Tor steel bars including supplying bending & and placing in position.						
	16mm ϕ straigh top & bottom bars 20cm c/c	112	3.95	—	—	—	L = 3.8 − 2×0.02 + 2×6×0.016 = 3.95
	No = 2(11 − 2×0.04 / 0.25 + 1) = 112 No.						
	16mm cranked bars No: 112/2 = 56	56	4.25				
			680.4	@1.58	kg/m =	1075.032	
	8mm ϕ distribution bar @ 25 cm c/c top & bottom						
	Nos = 2(3.80 − 2×0.04 / 0.25 + 1) = 32	32	10.90				
			348.8m	@0.39	kg/m =	136.032	kg
						1211.064	kg.
7	10cm thick cement concrete (1:2:4) coping finished with cement-plaster (1:4)	2	11.5	0.5	—	11.5	L = 11 + 0.25 + 0.25 = 11.5
						sqm	
8	Rule pointing with cement mortar (1:3)						
	Abutments inner sides	2	11.00	—	3.00	66	h = 5×0.6 = 3.00
	Face walls including outside of parapet	2	11.3	—	3.80	85.88	h = 3 + 0.4 + 0.4 = 3.8

	Inner sides of parapet	2	11.3	—	0.9	20.34	h = 0.4+0.4+0.1 = 0.9
	Edges of parapet	4	0.5	—	0.4	0.8	
	Edges of parapet	4	0.4	—	0.4	0.64	
					total	173.66	
	Deduct area of Culvert opening	1	3.00	—	2.40	- 7.2	h = 4 × 0.6 = 2.40
					Net total	= 166.46	
9	Double layer brick flooring with brake joint in cement mortar 1:6	1	10.00	3.00	—	30.00 sqm	

Estimate the quantity of a road. From the following data,

Distance	0	60	120	180	240
RL of GL	73.12	72.44	71.86	72.08	71.30
RL of FL	← Downward gradient 0.8 % →				

300	360	420	480	540
70.80	70.54	70.82	70.96	71.50
←		upward grad. 0.5%		

formation width = 10m

side slope 1½ : 1 in cutting and 2:1 in banking (V:H)

Assume there is no transverse slope of the ground.

In 100 = 0.8

~~In 1 = $\frac{0.8}{100}$ = 0.008~~

1 in $\frac{100}{0.8}$ = 125

for 125 m slope = 1 m

60 m slope = $\frac{1}{125} \times 60$ = 0.48 m.

0.5 % in 100

1 in $\frac{100}{0.5}$ = 200

for 200 m slope = 1 m

∴ for 60 m slope = $\frac{1}{200} \times 60$ = 0.3 (upward)

Chainage	RL of ground GL	RL of formation width FL	Depth FL-GL	dm	Area Bdm	Side area Sd_m^2	Whole section area $Bd_m + Sd_m^2$	Mean section area	Length	Quantity $(Bd + Sd^2) \times L$ Cutting	Quantity $(Bd + Sd^2) \times L$ Filling
0	73.12	72.42	-0.7	-0.6	6.00	0.54	6.54		60		392.40
60	72.44	71.94	-0.5	-0.45	5.00	0.375	5.375		60		322.5
120	71.86	71.46	-0.4	-0.8	8.00	0.96	8.96		60		537.6
180	72.08	70.98	-1.1	-0.95	9.5	1.35	10.85		60		651
240	71.30	70.5	-0.8	-0.4	4.00	0.24	4.24		60		254.4
300	70.80	70.8	0	0.28	2.8	0.16	2.96		60	177.60	
360	70.54	71.1	0.56	0.57	5.7	0.65	6.35		60	381	
420	70.82	71.4	0.58	0.66	6.6	0.87	7.47		60	448.2	
480	70.96	71.7	0.74	0.62	6.2	0.77	6.97		60	418.2	
540	71.50	72.00	0.5								
									Total	1425	2157.9

Example 5.—Prepare a detailed estimate for earthwork for a portion of a road from the following data :—

Dist. in m	0	100	200	300	400	500	600	700	800	900	1000	1100	1200
R.L. of ground	114.50	114.75	115.25	115.20	116.10	116.85	118.00	118.25	118.10	117.80	117.75	117.90	119.50
R.L. of Formation	115 Upward gradient 1 in 200 up to 600 m →						←Downward gradient 1 in 400						

Formation width of road is 10 metre side slope 2 : 1 in banking and 1½ : 1 in cutting. Adopt suitable rates.

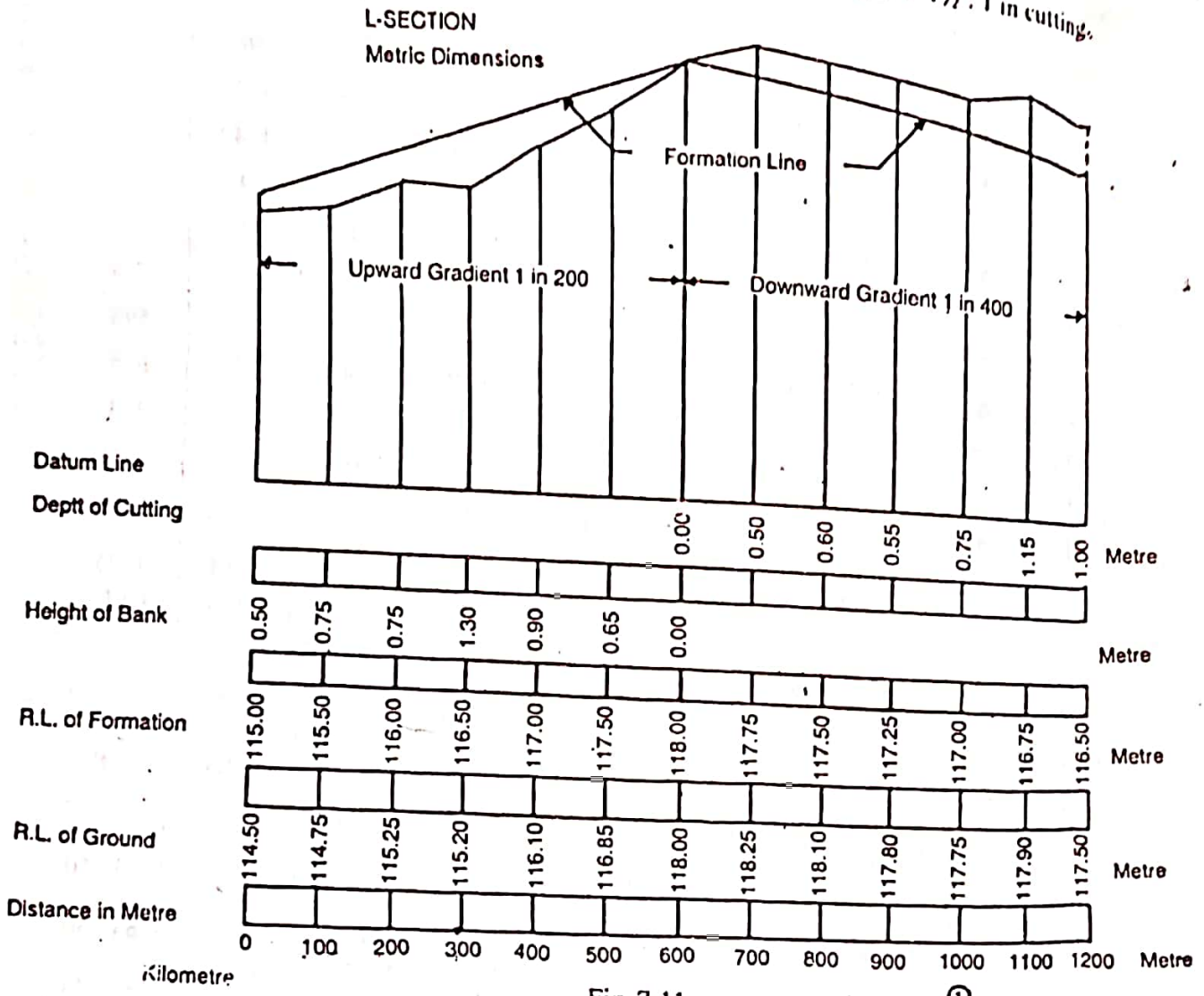


Fig. 7-11

From the data given, L-section can be plotted and heights of bank and depths of cutting of different stations can be calculated. The heights of bank, and depths of cutting are the difference of R.L. of ground, R.L. of formation, and even without plotting L-section the height and depth can be calculated.

Dt - 29/1/20

Prepare a detailed estimate for earthwork for a portion of road on the following data:

Dist in m	0	100	200	300	400	500	600
RL of GL	114.50	114.75	115.25	115.20	116.10	116.85	118.00

RL of FL: 115 ← Up gradient 1 in 200 up to 600m →

700	800	900	1000	1100	1200
118.25	118.10	117.80	117.75	117.90	119.50

← Down ward gradient 1 in 400 →

B = 10 m. 2:1 in banking &
1½:1 in cutting.

In 200 = 1 m.
1 m in $\frac{200}{1}$ $\frac{200}{1}$ = 200

for 200 m slope = 1 m.

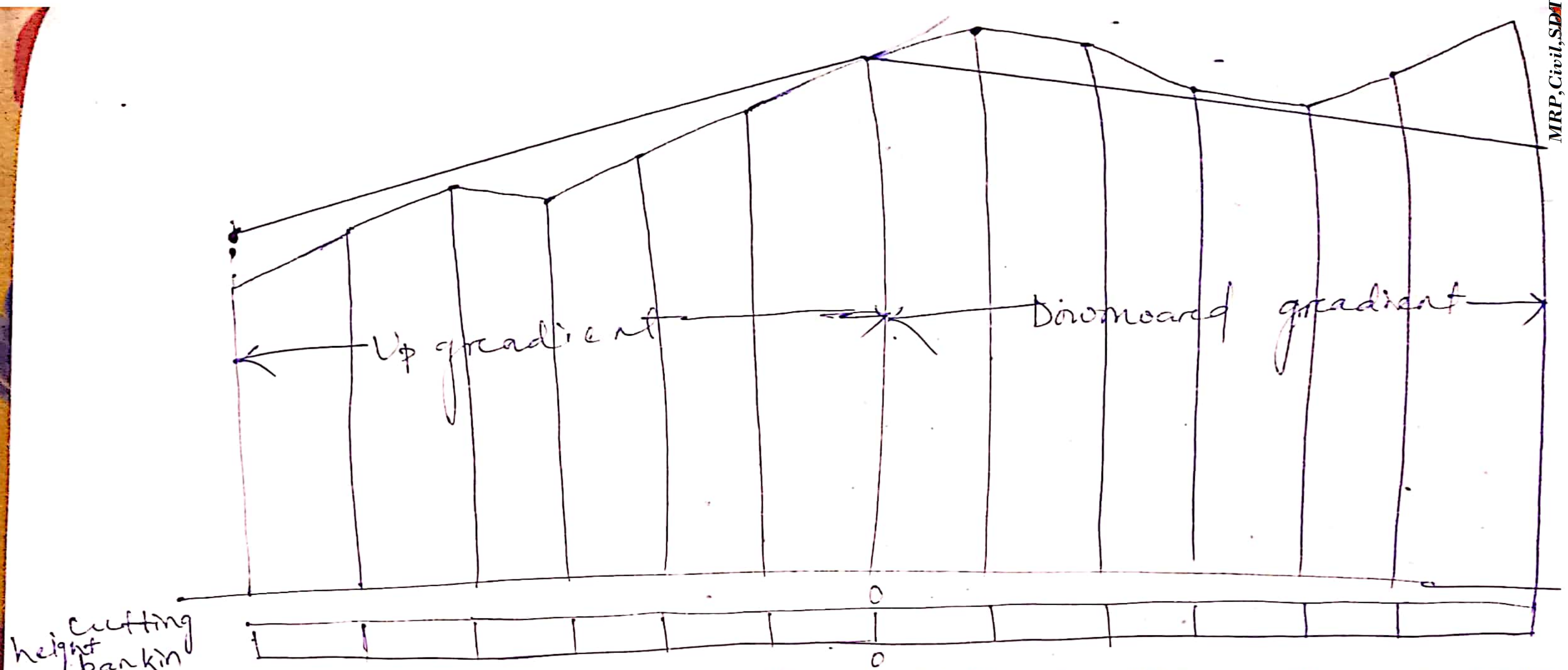
for 100 m slope = $\frac{1}{200} \times 100$
= 0.5 m.

1 m in $\frac{400}{1}$ = 400

for 400 m slope = 1 m.

for 100 m slope = $\frac{1}{400} \times 100$
= 0.25 m.

Chainage	RL of GL	RL of FL	Depth FL-GL	dm	Area Bdm	Side area Sdm²	Whole section area Bdm+Sdm²	Length	Quantity (Bd+Sd²)×L Cutting	Filling
0	114.50	115	0.5	0.625	6.25	0.78	7.03	100	703	
100	114.75	115.5	0.75	0.75	7.5	1.125	7.995	100	799.5	
200	115.25	116	0.75	1.025	10.25	2.10	12.35	100	1235	
300	115.20	116.5	1.3	1.1	11	2.42	13.42	100	1342	
400	116.10	117	0.9	0.775	7.75	1.20	8.95	100	895	
500	116.85	117.5	0.65	0.32	3.2	0.20	3.4	100	340	~~340~~
600	118.00	118	0	-0.25	-2.5	0.125	2.625	100		262.5
700	118.25	117.75	-0.5	-0.42	-4.2	0.35	4.55	100		455
800	118.10	117.5	-0.6	-0.57	-5.7	0.65	6.35	100		635
900	117.80	117.25	-0.55	-0.65	-6.5	0.845	7.345	100		734.5
1000	117.75	117	-0.75	-0.95	-9.5	1.805	11.305	100		1130.5
1100	117.90	116.75	-1.15	-2.07	-20.7	8.57	29.27	100		2927
1200	119.50	116.50	-3							



RL of GL	114.50	114.75	115.25	115.20	116.10	116.85	118	118.25	118.10	117.80	117.75	117.90	119.50
Distance	0	100	200	300	400	500	600	700	800	900	1000	1100	1200
RL of FL	115	115.5	116	116.5	117	117.5	118	117.75	117.5	117.25	117	116.75	116.5

Dt-15/2/20

Bar binding schedule

It is the list of reinforcement bar in a tabular form and the following essential details are generally given for a bar bending schedule (BBS) in RCC work.

(I) Bar mark or position of bars in the structure.
(II) Diameter of bar.
(III) Shape and bending dimension of the bar.
(IV) Length of each bar.
(V) No. of same types of bar
(VI) Total length, weight of bar, Total weight of different diameter of bar.

Unit weight of bar

$\frac{d^2}{162}$ d = in mm

8mm = 0.39
10mm = 0.617
12mm = 0.888
16mm = 1.580
20mm = 2.469
25mm = 3.858
6mm = 0.222

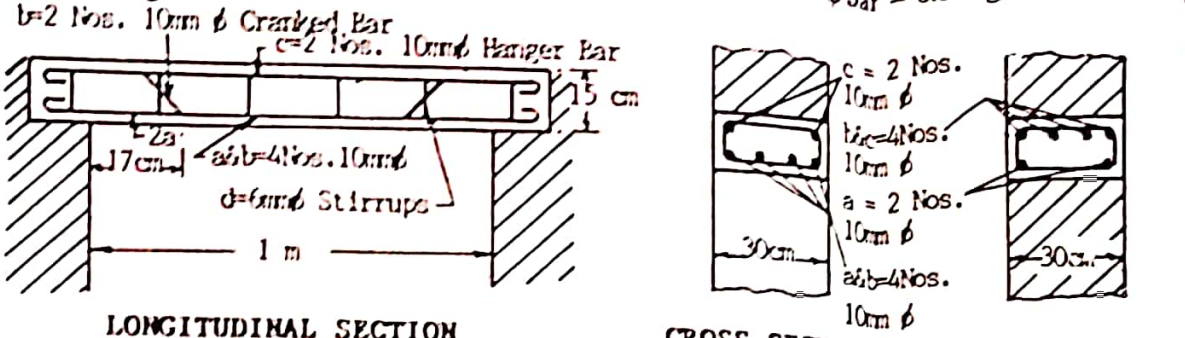
6-19. Estimating steel for reinforcement :- For reinforced concrete works estimate of steel may be necessary mainly for the following purposes :- (a) For procurement of the material, (b) To submit or to check at site the consumption of the material, (c) For preparation of bill for payment. For (a) and (b) quantity of steel may be calculated from the bar-bending schedule which is normally provided in the detailed drawings for R.C.C. works.

In absence of bar bending schedule the quantity of steel may be estimated providing a take off sheet having the following columns as shown in the table as below.

(1) Size of bar and Position	(2) Overall length with cover	(3) Extra length for			(4) Less cover	(5) Actual length 2+3-4	(6) No. of bars	(7) Total length	(8) Weight
		laps	cranks	hooks					

For (c) to prepare bill of quantity of steel for payment, measurement are entered in the Measurement book as shown in example-3.

Example 1. Prepare a schedule of bars for the R.C.C. Lintel shown in the fig. 6-13 assuming bearing of the lintel be 15 cm on walls at each side. Weight of 10 mm ϕ bar = 0.62 kg/rm and 6 mm ϕ bar = 0.22 kg/rm.



LONGITUDINAL SECTION CROSS SECTION CROSS SECTION AT SUPPORT

FIG. 6-13 AT MID SPAN

Discussion. Cover of concrete has not been shown in the figure. In such cases standard minimum cover (in this case 25 mm) may be considered. Bar mark should be carefully studied from the figure. In absence of bar mark in a figure, name of the bar may be written in the bar mark column. The degree of bend if not mentioned may be taken as 45°.

Details of bar for bar bending schedule :

Bars a-a or c-c = 1 m (clear span) + 2 x 15 cm (bearings)–2 x 2.5 cm (covers) + 2 x 9 x 10 mm = 1.43 m
Bars b-b = 1.25 m + extra for cranks + 2 bends = 1.25 m + 2 x 0.42 x 10 cm + 2 x 9 x 10 mm = 1.52 m
Bars d-d = 2(23.8 cm + 8.8 cm) + 24 d = 80 cm 23.8 cm and 8.8 cm are inner, 24 d extra length.

Bar bending schedule

Bar mark	Dia. mm	Shape of bending Dimensions in cm	Length m	Nos.	Total length m	Weight	Total weight
a-a & c-c	10 mm		1.43	4	5.72		
b-b	10 mm		1.52	2	3.04		
					8.76	5.43 kg.	
d-d	6 mm		0.80	6	4.80	1.06 kg	
							6.5 kg..

Example 9. Details of a simply supported R.C.C. Slab of the mix proportion 1:2:4 are as below :-

(i) Size. 4.05 x 5.0 metres x 12 cms deep. *(ii) Reinforcement.* 12 mm dia. rods are placed in the direction of 4.05 metres at the rate of 15 cms centre to centre. Of the total number of rods, 16 Nos. have been cranked at 45° at appropriate places and hooked at ends. Other rods are straight and hooked at ends. The 12 mm dia. rod weighs 0.89 kg/m. To hold the cranked portions 4 Nos. 10 mm dia. straight and hooked rods have been used. 10 mm dia. rods are placed in the direction of 5 metres at the rate of 20cms centre to centre and all are straight and hooked at ends. The 10 mm dia. rod weighs 0.62 kg/m. *(iii) Cover.* 1.5 cm at the bottom and 2.5 cm on all sides. (iv) Assume any other dimensions not given.

(a) Draw sketches (plan and section) showing details of reinforcements of the slab. (b) Estimate quantities of cement, sand and stone aggregates for the slab. (c) Make out appropriate columns and estimate the total weight of steel required in reinforcements for the slab.

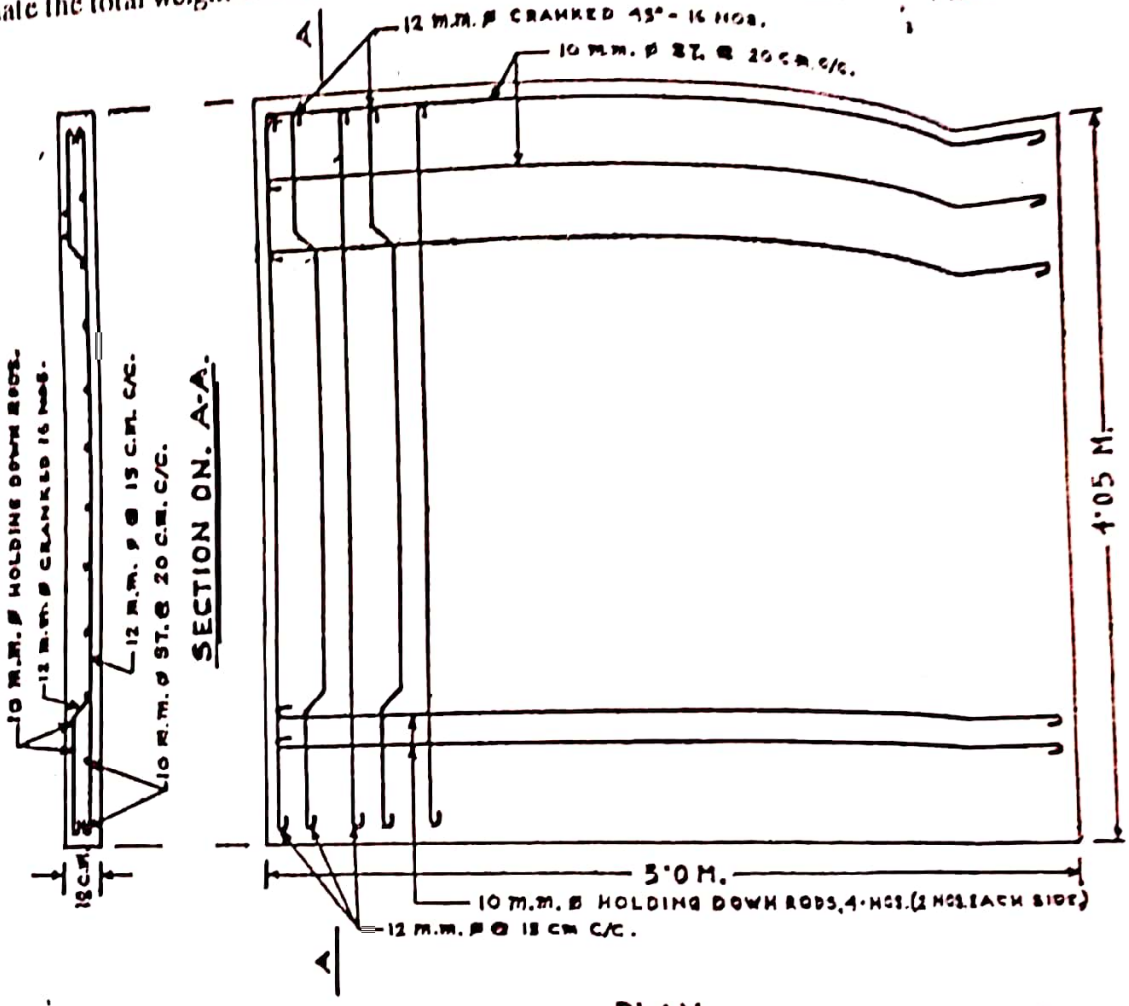


FIG. 6-22

(a) Fig. 6-22 shows the details of reinforcements of the slab.

(b) Volume of concrete = 5 m x 4.05 m x 12 cm = 2.43 cu m

Considering 1 cu m wet vol. = 1.54 cu m dry vol.

Quantity of cement for (1:2:4 prop) = $\frac{1.54}{7}$ x 2.43 = 0.5346 cu m = 0.5346÷0.0347=15.4 bags. (1 bag cement = 0.0347 cu m).

Quantity of sand = 0.5346 x 2 = 1.0692 = 1.1 cum(say); Quantity of stone aggregate = 1.1 x 2 = 2.2 cum

Indent :– Cement = 15.4 bags, Sand = 1.1 cu m, Stone aggregate = 2.2 cu m

Dry material calculation.

(1) Volume of concrete

$= 5m \times 4.05m \times 0.12m = 2.43 cum$

considering 1 cum wet vol. = 1.54 cum dry vol.

Quantity of cement 1:2:4 $= \frac{1.54}{1+2+4}$

$= 0.22 cum$

Quantity of sand $= 0.22 \times 2 = 0.44 cum$

Quantity of aggregate $= 0.22 \times 4 = 0.88 cum$

Coarse agg

for 1 cum cement required = 0.22 cum

for 2.43 cum cement required = 0.22 × 2.43
= 0.53 cum

1 bag = 0.0347 cum

$= \frac{0.53}{0.0347}$

= 15.3 bags

≃ 16 bags cement

Sand = 0.53 × 2 = 1.06 cum

coarse agg. = 0.53 × 4 = 2.12 cum

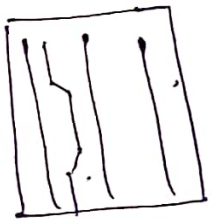
Steel bar Calculation

(1) Main bar (12 mm ϕ)

(a) Main straight bar

$= \frac{4.95}{0.15} + 1$

= 33 + 1 = 34 nos.



3 - 2 × 0.25
= 4.95

25 cm cover at sides
25 mm = 0.025 m
0.15 mm c/c spacing.

Deducting cranked bar nos.

34 - 16 = 18 nos.

Length of no. of. straight bar.

= 4.05 - (2 × 0.025) + (2 × 9 × 0.012)

= 4.22 m -

(6) Main cranked bars (12 mm ϕ)

nos. : 16 nos.

Length = 4.22 + 2 × 0.42 × 0.096

= 4.29 m.

12 - 3 = 9 cm

(Thickness - Clear cover)

(3) Holding bars (10 mm ϕ)

nos. = 4 nos.

Length = 5 - (2 × 0.025)

+ 2 × 9 × 0.10

= 5.13 m.

(4) Distribution bars 10 mm ϕ 2 mm ϕ

$$\text{nos.} = \frac{4.05 - 0.025}{0.20} + 1$$

= 21 nos.

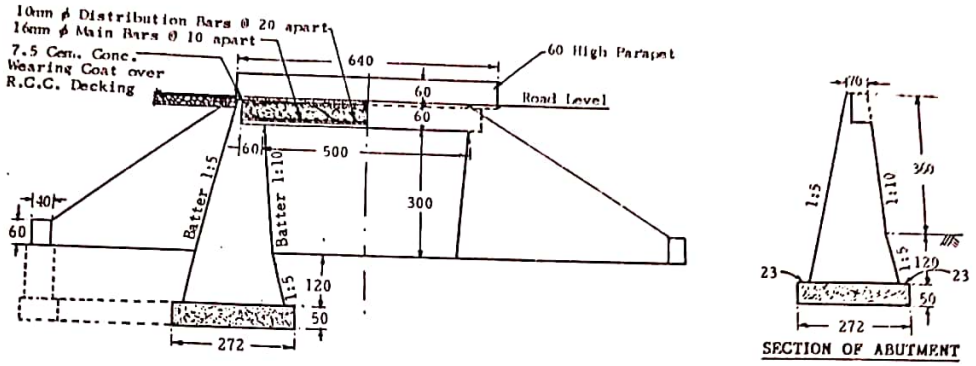
Length = 5 - (2 × 0.025) + 2 × 9 × 0.10

= 5.13 m.

L = 4.05 - 2 × 0.025 = 4

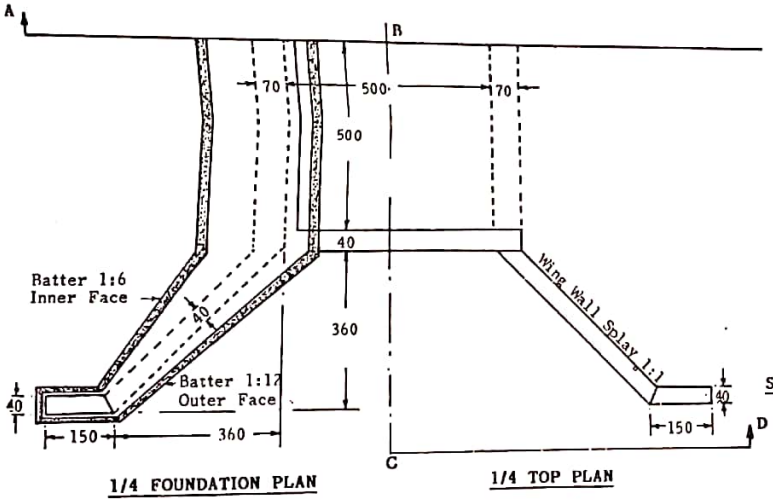
9d = 9 × 0.12' = 0.108 mm

Description of bar / bar type	Dia in mm	Shape of bending dimension in m	Length in m	Nos	Total length	weight (kg)	Total weight (kg)
12mm straight rod	12 mm	0.108 4 0.108	4.22	18	75.96	(x 0.89) 67.60	
12mm cranked bar	12 mm	4	4.29	16	68.64	+ 61.08 128.68	
10mm holding bar	10 mm		5.13	4	20.52	(x 0.62) 12.72	
10mm distribution bar	10 mm		5.13	21	107.73	+ 66.79 79.51	208.19



HALF SECTIONAL ELEVATION ON - ABCD

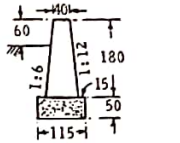
SECTION OF ABUTMENT



1/4 FOUNDATION PLAN

(Portion above bed level are shown in dotted lines)

1/4 TOP PLAN



SECTION OF RETURN WALL

All dimensions are in cms.

SINGLE SPAN SLAB CULVERT

FIG. 10-32

Item No.	Description	No	L	B	H
1	Earthwork in excavation in foundation				
(a)	Depth upto 1.5m below G.L. Abutments	2	12.46	2.72	1.50
	wing walls	4	3.9	$\frac{1}{2}(2.72+\sqrt{2}\times1.15)$ $= 2.17$	1.50
	Deduct offsets of abutments	4	2.305	0.83	1.50
	Return walls (remaining trapezoidal portion)	4	$\frac{1}{2}(0.47+1.62)$ $= 1.045$	1.15	1.50

$L = 25.00 + 0.40 + \frac{3.60}{10} + \frac{1.20}{5} + 0.23$

$= 12.46$

$L = 3.60 + \frac{1.80}{12} + 0.15$

$= 3.9$

$B = \frac{1.20}{5} + \frac{3.60}{10} + 0.23$

$= 0.83$

$L = \frac{1}{2} \times (2.72 + 2.72 + 0.83)$

$= 2.305$

total length

$= 1.50 + 2\left(\frac{1.80}{12} + 0.15\right)$

$= 2.10$

remaining outer length

$= 2.10 - 1.15\sqrt{2} = 0.47$

$0.47 + 1.15 = 1.62$

2.17

(b) Depth from I.s m upto 2 m below G.L

Abutments	2	12.846	2.72	0.2
Wingwalls	4	3.90	2.42	0.2
Deduct offsets of abutments	4	2.305	0.83	0.2
Return wall	4	1.045	1.15	0.2

2 Cement concrete (1:3:6) in foundation

Abutments	2	12.846	2.72	0.5
wing walls	4	3.9	2.17	0.5
Deduct offset of abutments	4	2.305	0.83	0.5
Return walls	4	1.045	1.15	0.5

3 Rubble dressed stone masonry

Abutments below G.L (trapezoidal volume)

2 $\frac{1}{2}(12 + 11.40) \quad \frac{1.78 + 2.26}{2} \quad 1.20$

Top part above G.L. (batthered length is included in wing walls)

2 10.8 $\frac{1.78 + 0.7}{2}$ 3.60

Deduct bearing of R.C. slab

2 10.8 0.60 0.60

Wingwalls (forming frusta of pyramids)

$A_1 = \frac{1}{2}(2.62 + 0.57) \times 4.80$

$= 7.66$

Base length $= 12.846 - 2 \times 0.23 = 12$

Length at trapezoidal level $= 11.88 - 2 \times \frac{1.20}{5}$

$= 11.4$

$2.72 - 2 \times 0.23 = 2.26$

$2.72 - 2(0.23 + \frac{1.20}{5})$

$= 1.78$

For A_1 at abutment bottom inclined width $= 2.72 - 2 \times 0.23$

$= 2.62$

Top inclined width $0.40 \times \sqrt{2} \times 0.57$

Height $= 3.60 + 1.20$

$= 4.80$

$A_2 = \frac{1}{2}(1.20+0.57)\times 1.80$

$= 1.59$ sq.m.

4 × 15.287 = 61.16

Volume

$= \frac{h}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$

$= \frac{3.6}{3}(7.66 + 1.59 + \sqrt{7.66 \times 1.59})$

$= 15.29$

For the bottom rectangular width $= (1.15 - 2/0.15) \times \sqrt{2}$

$= 1.20$.

top $= 0.40\sqrt{2} = 0.57$

Height $= 1.80$

Top portion over the trapezium is included in the wing wall.

Deduct abutment offsets of abutments (below G.L)

4 $\frac{1}{2}(2.26 + 2.16)$ $\frac{0.6+0.36}{2}$ 1.2

$= 0.48$

Bottom trapezoidal part

Bottom offset $= \frac{3.60}{10} + \frac{1.25}{5} = 0.6$

Top offset $= \frac{3.60}{10} = 0.36$

Remaining top length $1.5 - 0.4\times\sqrt{2} = 0.93$

Remaining bottom face length $= (1.5 + \frac{1.8}{12}) - (0.4 + \frac{1.8}{12})\sqrt{2}$

$= 0.87$

Inner top length $0.93 + 0.40 = 1.33$

Inner bottom length $= 0.87 + (0.4 + \frac{1.8}{6} + \frac{1.8}{12})$

$= 1.72$

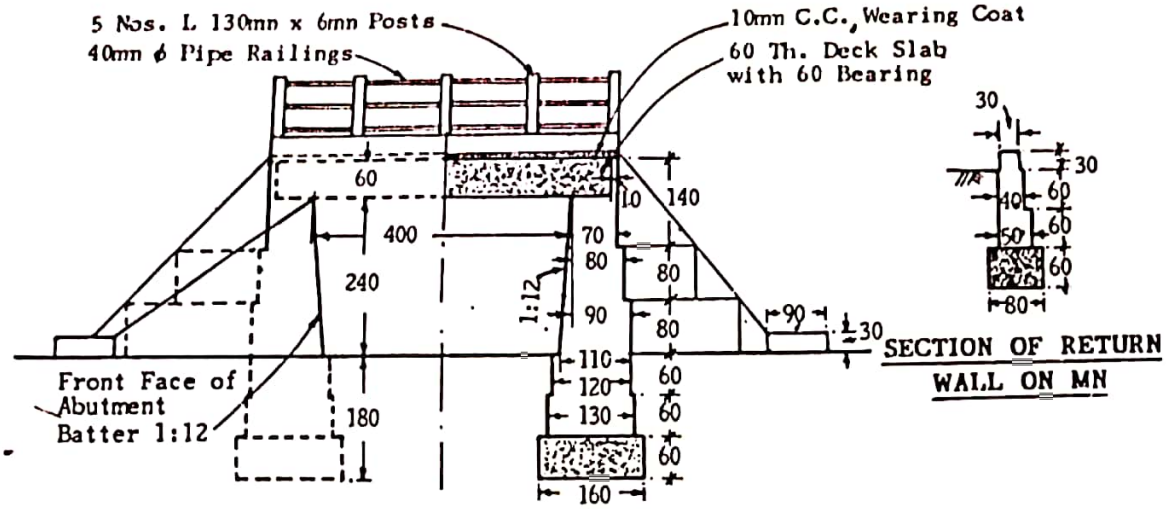
Return walls (remaining trapezoidal portion)	4	$\frac{0.93+1.33}{2}$	$\frac{0.87+1.72}{2}$	1.8	
parapet walls	2	6.40	0.40	0.60	
4) Shuttering with staging, propping for slab of culvert	1	10.80	5.00	—	
5) Tor steel reinforcement 16 mm dia main bar @ 10 cm c/c. No.s $= \frac{1000}{10} + 1 = 101$					
(i) 50% cranked bars	50	6.79	—	—	339.5
(ii) 50% straight bars	51	6.29	—	—	320.79

$L = 6.20 - 2\times 0.05 + 2\times 0.25 + 2\times 6\times\frac{16}{}$

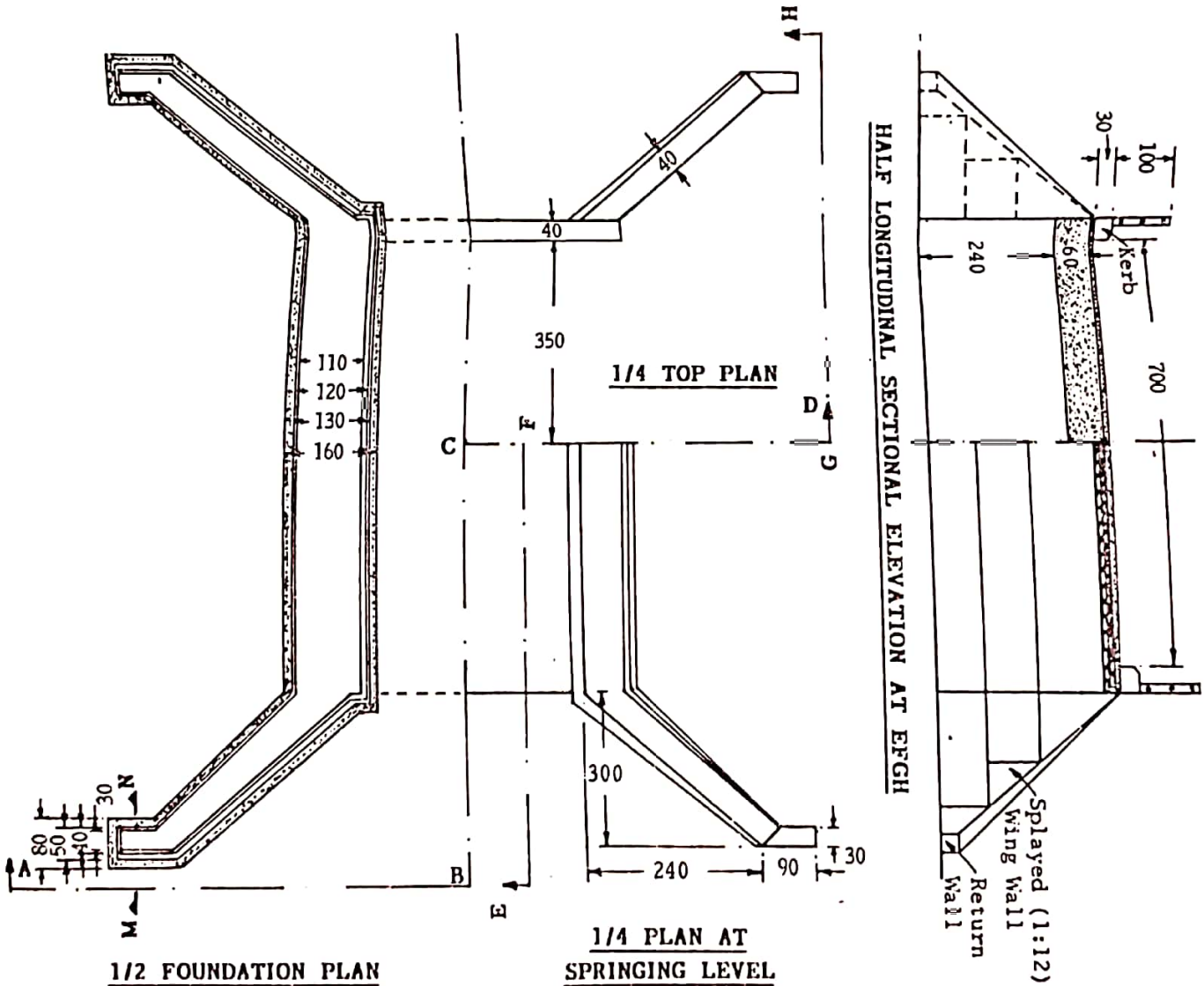
$= 6.79$

660.29 m @ 1.58 kg/m = 1043.26 kg

	10mm dia distribution bars @ 20cm c/c (straight without L-hook) Nos. $\frac{5.3-2\times0.05}{0.20}+1=27$	27	$\frac{10.70}{288.90}$ @ 0.62	—	—	288.90 179.12 kg
					Total =	1222.38 kg
6	M-15 controlled concrete excluding shuttering & reinforcement with stone chips deck slab	1	10.80	6.20	0.60	
7	Cement Concrete (1:1½:3) for wearing course	1	10.80	6.20	0.075	
8	Rule pointing to stone masonry to exposed surfaces.					
	Abutments (above G.L) inner	2	10.80	—	3.01	$\sqrt{3^2+(\frac{3}{10})^2}$ = 3.01
	wing walls inner faces	4	5.09	—	$\frac{1}{2}(3.01+0.60)$	3.60×2 = 5.09
	wing walls top surfaces	4	5.09	0.4	—	
	Return walls, front	4	1.5	—	0.6	
	Return walls, back	4	1.1	—	0.6	1.5−0.4=1.1
	Return walls, top	4	$\frac{1.5+1.1}{2}$	—	0.4	
	Parapet wall, sides	4	6.4	—	0.6	
	ends	4	0.4	—	0.6	
	tops	2	0.4	0.4	—	
					Total =	



HALF CROSS SECTIONAL ELEVATION AT ABCD



1/2 FOUNDATION PLAN

(DIMENSIONS ARE IN CMS.)

SLAB CULVERT

FIG. 10-31

Item No.	Description	No	L	B	H	Qty	Remark
1	Earthwork in excavation in foundation depth upto 2m below GL						
	(a) Abutment	2	8.80	1.60	1.80		L = 2(3.5 + 0.4 + 2.4/12 + 0.1 + 0.05 + 0.15) = 8.80
	(b) Wingwall upto end of return walls excavation	4	3.30	(1.60+1.28)/2	1.80		L = 3.0 + (0.1 + 0.05 + 0.15) = 3.30
	Deduct abutment end offset L = 0.15 + 0.05 + 0.1 + 0.4/2 = 0.50	4	0.50	1/2 (1.6 + 1.6 − 0.5)	1.80	−4.86	0.80 is trench width. ∴ Inclined width upto end 1.28 = 0.80 × √(1.25² + 1²) = 1.28 Splay is 1.25 : 1
	(c) Return walls (remaining)	4	1/2 (0.12 + 0.22)	0.80	1.80		outside remaining length = [0.9 + 2(0.15 + 0.05) + 0.10] − 1.28 = 0.12 Inside = 0.12 + 0.12 × 2.4/3.0 = 0.216 ≈ 0.22
					total =		

2 Cement concrete (1:3:6) in foundation

(a) Abutments	2	8.80	1.60	0.60
(b) Wing walls upto end of return walls	4	3.30	$\frac{1.60+1.28}{2}$	0.60
Deduct abutment end offsets	4	0.5	$\frac{1}{2}(1.60+1.60-0.50)$	0.60
(c) Return walls (remaining)	4	$\frac{1}{2}(0.12+0.22)$	0.8	0.60
				total =

Total offset $= \frac{0.4+0.10+0.05}{2} + 0.15 = 0.5$

Inner length: $0.22 = 0.12 + 0.12 \times \frac{2.4}{3.0}$

3 Brickwork in cement mortar (1:6)

(a) Abutments				
Below G.L. 1st footing	2	8.5	1.3	0.6
Below G.L 2nd footing	2	8.4	1.2	0.6
Above G.L 1st. offset	2	7.8	$\frac{1.03+1.10}{2}$	6.8
Above G.L 2nd offset	2	7.8	$\frac{0.84+0.92}{2}$	0.8
Above G.L. top wall	2	7.8	$\frac{0.77+0.70}{2}$	1.40
Deduct bearing of deckslab	2	7.8	0.6	0.16
(b) Wing walls upto end of return wall				
Below G.L. 1st footing	4	3.15	$\frac{1.30+0.80}{2}$	0.6
Below G.L. 2nd footing	4	3.10	$\frac{1.20+0.64}{2}$	0.6
Deduct abutment end offsets for 1st footing	4	0.35	$\frac{1}{2}(1.30+1.30-0.28)$	0.6
For 2nd footing	4	0.30	$\frac{1}{2}(1.20+1.20-0.24)$	0.6

Top width $= 0.8 + \frac{0.8}{12} = 0.87$

Bottom width $= 0.8 + \frac{1.6}{2} = 0.13$

Top width $= 0.8 + \frac{0.8}{12} = 0.87$

Bottom width $= 0.7 + \frac{0.8}{12} = 0.77$

$L = 8.8 - 2 \times 0.15 = 8.5$

$L = 2(3.5 + 0.4) = 7.8$

$0.5\sqrt{1.25^2+1^2} = 0.80$

$0.4\sqrt{1.25^2+1^2} = 0.64$

For splay 2.4×3.0

$0.35 \times \frac{2.4}{3.0} = 0.28$

Above G.L. The whole section with parallel inclined width considered as frusta of pyramid

$$\text{vol.} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$

$$A_1 = \frac{1}{2}(0.96 + 0.64) \times 2.4 = 1.92$$

$$A_2 = \frac{1}{2}(0.68 + 0.64) \times 0.3 = 0.20$$

Top inclined width $= 0.40 \times 1.6 = 0.64$

Bottom width at abutment $= 0.64 + \frac{2.4}{12} \times 1.6 = 0.96$

Bottom width at the end $= 0.64 + \frac{0.3}{2} \times 0.3 = 0.68$

4		$\frac{2.70}{3}$	$(1.92 + 0.20 + \sqrt{1.92 \times 0.20})$				

(C). Return wall (remaining portion of trapezium)

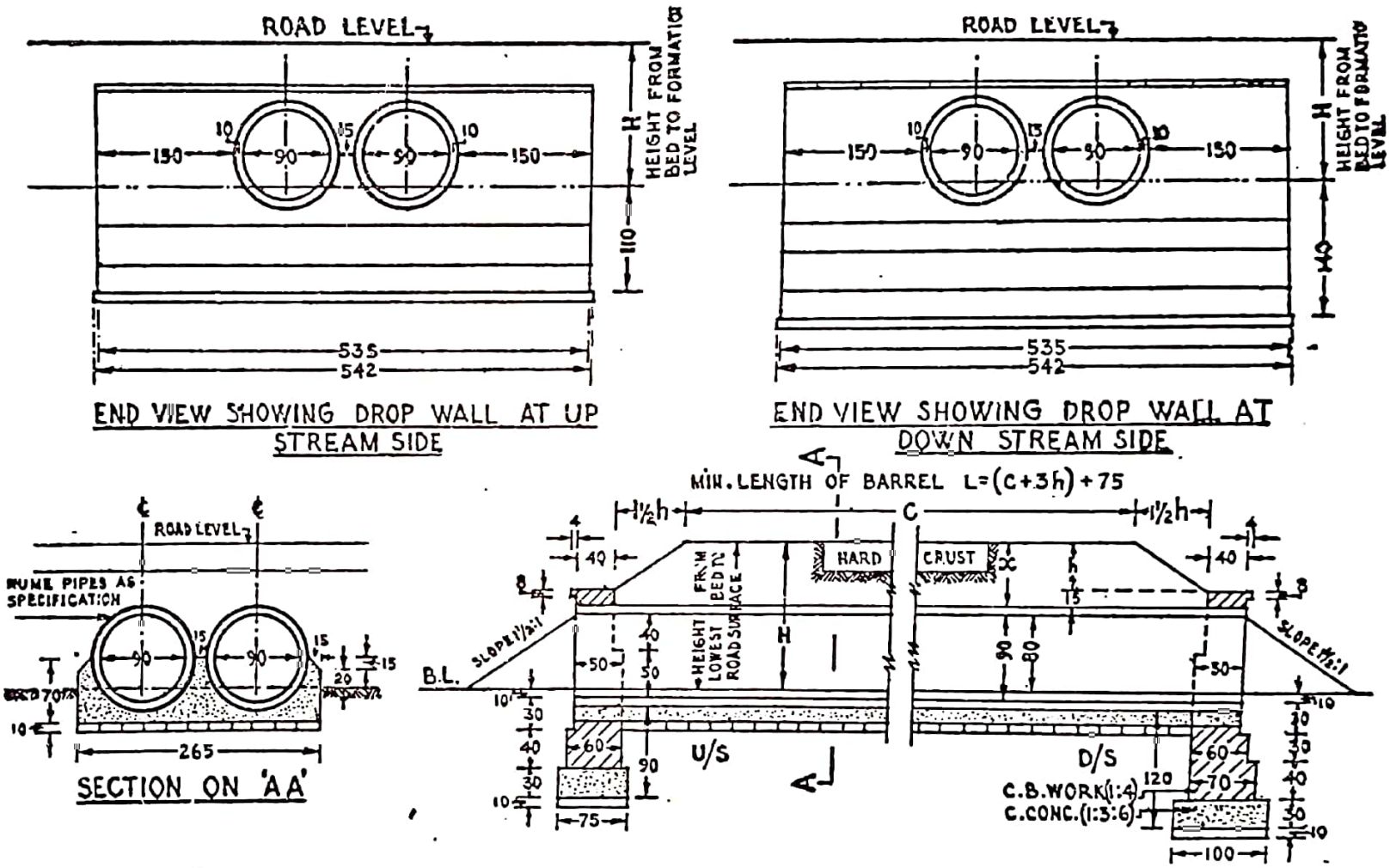
$0.9 + (0.9 - 0.4\sqrt{1^2 + 1.25^2}) = 1.54$

4		$\frac{0.9 + 1.54}{2}$		0.3	0.3		

					total =		cum
4	R.C.C M15 in deck slab	1	7.80	5.20	0.6		Cum
5	10 cm thick cement concrete (1:1½:3) wearing coat	1	7.00	4.40	0.1		Cum

Example – 3. Estimate of a 90 cm dia. double barrel Hume pipe culvert (as used in National High-way).

Prepare a quantity estimate for a barrel of 30 cm length (total length depends on the bank height) and the drop walls. In the estimate, the earth cushion whose depth has been indicated by X = 60 cm minimum and the Hard Crust are not to be included. General specification of works are same as mentioned in the drawing. Extra earthwork in excavation shall be considered in the estimate to provide a side slope of 1 : 2 in order to prevent collapsing of earthwork at water level.



LONGITUDINAL SECTION SHOWING DETAILS OF DROP WALLS

ALL DIMENSIONS ARE IN CENTIMETRE

FIG. 10-26 Scale 1:75

Sl. No.	Description	No	L	B	H	Quantity	Remark
	for 30cm length of barrel						
1	Earthwork in excavation	1	0.3	2.873	0.45	0.388	
2	Earthwork in filling and ramming complete.	1	0.3	$\frac{1}{2}$ X 0.45	0.45	0.03	
3	single brick flat soiling	1	0.3	2.65	—	0.795	
4	Cement concrete (1:3:6) with brick ballast ~~shaped~~ portion	1	0.3	2.65	0.55	0.4371	
	Chamfering portion	1	0.3	$\frac{1}{2}$(2.65+2.35)	0.15	0.1125	
						0.549	
	Deduction for pipe	1	0.3	$\frac{\pi}{4}$(1.10)	1.10	-0.285	
					Net total	0.264	
5	90cm dia 10cm thick hume pipe	2	0.3	—	—	0.6	
6	Shuttering for concrete	2	0.3	—	0.55	0.33	
B	Quantity of Dredge wall						
①	Earthwork in excavation						
	upstream side	1	6.02	1.35	1.20	9.775	
	Downstream side	1	$\frac{1}{2}$(6.92+5.42) = 6.17	$\frac{1}{2}$(1+2.15) = 1.575	1.50	14.577	
						24.327	
②	~~Dordered~~ Single brick flat soling						
	U/S	1	5.42	0.75	—	4.065	
	D/S	1	5.42	1.00	—	5.42	
						9.485 X 0.1 = 0.95	
③	Cement concrete (1:3:6) with brick ballast						
	U/S	1	5.35	0.75	0.30	1.204	
	D/S	1	5.35	1.00	0.30	1.605	
						12.294	
④	Earth filling (Total excavation — (Brick soling in cum + Brickwork upto B.L)	1	24.327	-(0.95+2.81+5.88)		= 14.687 cum	

Up to BL Brickwork Qty

U/S (0.6X0.4) + (0.5X0.4X5.35) X5.35 = 2.35

D/S (0.7X0.4X5.35) + (0.6X0.3X5.35) + (0.5X0.4X5.35) = 3.53

total 5.88

3	First class brickwork in cement mortar (1:4)					
	U/s side for -					
	60 cm layer	1	5.35	0.6	0.4	1.284
	50 cm layer	1	5.35	0.5	0.8	2.14
	40 cm layer	1	5.35	0.4	0.65	1.391
	D/s side for -					
	70 cm layer	1	5.35	0.7	0.4	1.498
	60 cm layer	1	5.35	0.6	0.3	0.963
	50 cm layer	1	5.35	0.5	0.8	2.14
	40 cm layer	1	5.35	0.4	0.65	1.391
					total =	10.807
	Deduction for pipe openings both U/s and D/s sides	2	$\times 2 \times \frac{\pi}{4} \times (1.10)^2$		$\times 0.45$	1.71
	concreting under pipes	2	0.5	$\times \frac{0.264}{0.30}$	=	0.88
					Net total =	8.22 cum
6	12 mm cement plaster (1:2) U/s & D/s faces (up to 15 cm below B.L.)	2	5.35	—	1.20	12.84
	tops	2	5.35	0.40	—	4.28
					total =	17.12 sqm
	Deduction for pipe openings	2	$\times 2 \times \frac{\pi}{4} \times (1.10)^2$		— =	3.80
						13.32 sqm
7	Shuttering for concrete work in foundation for U/s	2	$\times 5.35$	$\times 0.3$	=	3.21
		2	$\times 0.3$	$\times 0.75$	=	0.45
	for D/s	2	$\times 5.35$	$\times 0.3$	=	3.21
		2	$\times 1.00$	$\times 0.3$	=	0.6
					total =	7.47 sqm
8	~~Shut~~ String course at top	2	5.35	—	—	10.7 rm

Q) Calculate the quantity of metal required for a 3.7m wide WBM road for 1 km length for 1 layer of 8cm compacted thickness.

8 + 50% of 8 = 8 + 4 = 12cm

1000 × 3.7 × 0.12 = 444 m^3

Q) calculate the quantity of material, stone brick & binder of paint required for 1st coat of painting for 1km length of a 3.7m wide bitumenous road.

per 100 sqm Bitumen = 180kg
stonechips = 1.50 cum
Sand = 0.60 cum.

for 1st coat painting
1km × 3.7m = 1000 × 3.7 = 3700 sqm.

for 3700 sqm Bitumen required = $3700 \times \frac{180}{100}$
= 6660 kg
= 6.66 tons.

for 3700 sqm stonechips required = $3700 \times \frac{1.50}{100}$ = 55.5 cum

for 3700 sqm sand required = $3700 \times \frac{0.60}{100}$

= 22.2 cum.

For 2nd coat :-

Bitumen = 110 kg for 100 sqm.

Stone chips = 1.0 cum for 100 sqm.

for 3700 sq Bitumen required = $3700 \times \frac{110}{100}$

= 4.07 tons

for 3700 sqm stone chips required = $3700 \times \frac{1.0}{100}$

= 37 cum

Q) Calculate the quantity of cement concrete for C.C. road of 1km length ~~of Calculate the~~ 3.7 m wide for 8cm thick layer. also calculate the cost at the rate 375/- per cum.

Quantity of cement concrete =

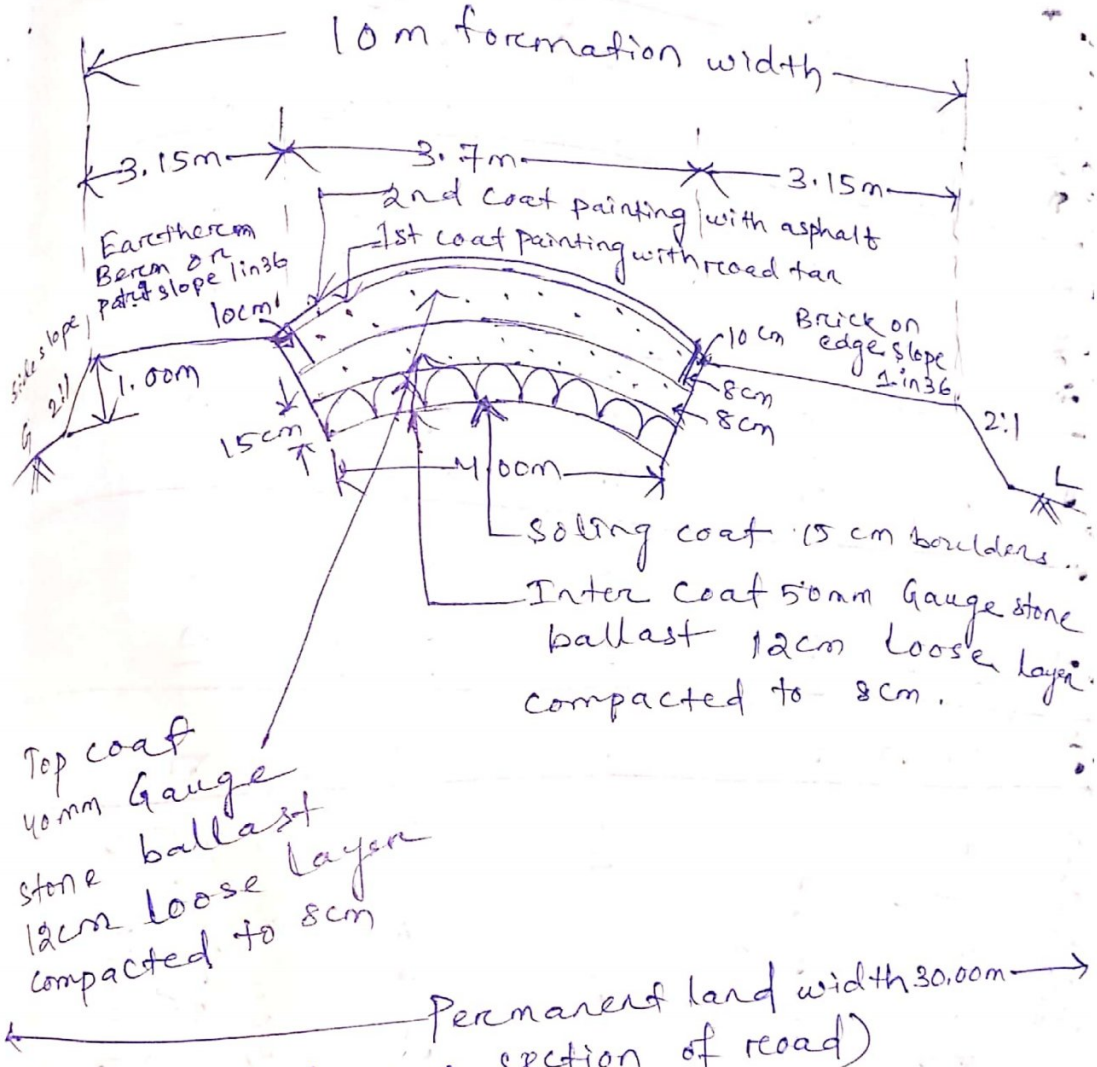
$1000 \times 3.7 \times 0.08 = 296$ cum.

per cum = 375 /-

total cost = $375 \times 296 = 111000.00$ rupee

Q) Prepare a detailed estimate for the construction of a new state highway for 1km length. the foundation width of road is 10m. avg. ht of road is 1m. & side slope, 2:1. The metal width is 3.7 m. and 3 coats

of metalling are to be provided as per the cross section given in the fig. the surface shall be finished with 2 coats of painting.



Item No.	Descriptions	No	L	B	H or D	Qty	Remark
1	Surveying (marking alignments) ~~det~~ dafbelling etc.	1	1000	–	–	1000 sqm	
2	Land acquisition.	1	1000	30	–	30000 sqm = 3hectar	
3	Earthwork in embankment	1	X	12000	0 =	12000 cum	$A=(Bd+sd^2)L$ $=(10\times1+2\times1^2)\times1000$ $=12000$ cum
4	plantation of grasses on the side slope.	1	1000	2.24	–	2240 sqm	$B=d\sqrt{s^2+1}$ $=1\sqrt{(2)^2+1}=2.24$ m
5	Metalling:-						
	① ~~See~~ Preparation of soil subgrade	1	1000	4.00	–	4000 sqm	
	② Soling coat						
	① Stone boulder of 15cm size	1	1000	4.00	0.15	600 cum	
	② Laying & consolidation of boulders including binding with local sandy soil	1	1000	4.00	0.15	600 cum	
	③ Inter coat						
	① Stone ballast 50mm gauge (size)	1	1000	~~4200~~ 3.7	0.12	~~444~~ 444 cum	12cm Loose Layer compacted to 8cm.
	② Laying & consolidation of stone ballast including binding with local sandy soil	1	1000	3.7 ~~4200~~	0.12	~~444~~ 444 cum	
	④ top coat						
	① stone ballast 40mm gauge	1	1000	3.7	0.12	444 cum	
	② Laying & consolidating of stone ballast including binding with local sandy soil.	1	1000	3.7	0.12	444 cum	
	⑤ Earthen berm ~~of~~ at patri dressing	1	1000	–	–	1000 m = 1 km	
6	* painting or surface dressing						
	③ 1st coat painting with road tar	1	1000	3.7 @ per	180 kg 100sqm	6660 kg = 6.66 tons	
	~~2nd coat painting with Asphalt~~	1	1000	~~3.7~~ @			
	① Stone brick 20mm gauge @ 1.5 cum per 100 sqm	1	1000	3.7 @ per	1.5 cum 100sqm	55.5 cum.	

	② Sand	1	1000	3.7 per	@ 0.6 cum 100 sqm	22.2 cum
④	Laying of ③ road tar mix	1	1000	3.7	—	3700 sqm
	2nd coat painting with asphalt					
	① Stone brick 12mm gauge	1	1000	3.7 per	@ 1.0 cum 100 sqm	37 cum
	② Asphalt	1	1000	3.7 per	@ 110 kg 100 sqm	4070 kg = 4.07 tons.
	③ Laying of Asphalt mix	1	1000	3.7	—	3700 sqm.
7)	Brick edging on both sides including bricks & Labour.	1	1000	—	—	1000 m 1 km.
8	Miscellaneous item 1km, ½ km & boundary stone	1	1000	—	—	1 km
9	Formation level pillars	1	1000	—	—	1 km
10	Road direction post sign etc.	1	1000	—	—	1 km.
11	Traffic, diversion, service road etc	1	1000	—	—	1 km
12	Arboriculture	1	1000	—	—	1 km

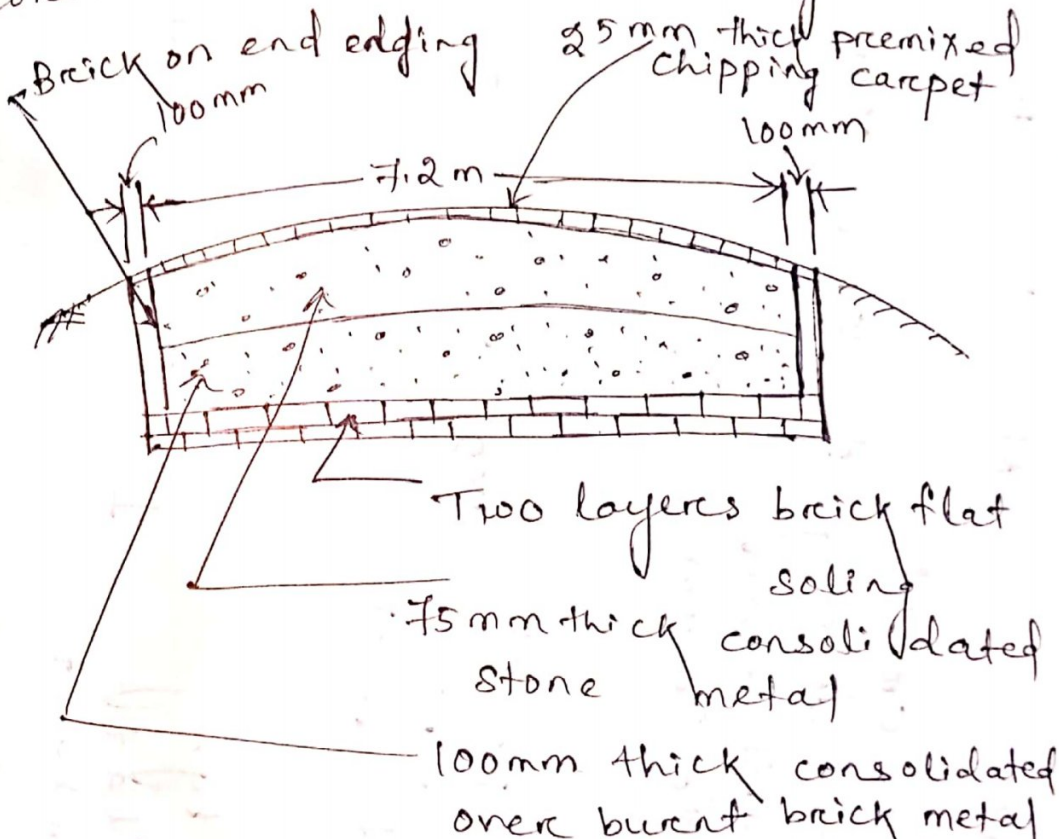
Q) The thickness of an existing macadam road is 15 cm and surface as become patchy & rock. It is proposed to modelise the road by providing 1 layer of stone macadam & two coarse of surface painting. The metalled width of road is 3.7 m. Prepare a detailed estimate for modelising 1 Km length of road. Assume suitable rate.

Item No.	Description	No	L	B	H	Qty	Remarks
1	Preparing surface to camber after patching repair.	1	1000	3.7	—	3700 sqm	
2	Stone ballast or metal 40mm gauge for 8cm thick layer (12cm loose)	1	1000	3.7	0.12	444 cum	12cm loose layer compacted 8+4=12cm
	Laying & consolidation of stone metal	1	1000	3.7	0.12	444 cum	
3	Painting 1st coat with road tar	1	1000	3.7 @ per	180kg 100sqm	6660 kg 6.66 tons	
	(1) Laying of road tar mix	1	1000	3.7	—	3700 sqm	Laying of asphalt mix = 1×1000×3.7 = 3700 sqm
	(3) Stone brick 20mm gauge @ 1.5 cum per 100 sqm	1	1000	3.7 @ per	1.5 cum 100 sqm	55.5 cum	
	(4) Sand	1	1000	3.7 @ per	0.6 cum 100 sqm	22.2 cum	
	2nd coat painting with asphalt- (1) stone brick 12mm gauge	1	1000	3.7 @ per	1.0 cum 100 sqm	37 cum	(2)
	Asphalt	1	1000	3.7 @ per	110 kg 100 sqm	4070kg 4.07 tons	

Pg-423
Ch-6
Ex-3

Roads Pavement

A dimensioned sketch of a road crust 7.2 m wide between the edgings is shown below. Prepare a detailed estimate for constructing 2.5 km long road and calculate quantities of materials required for the road. The crust is constructed with the following:—



1. Two layers of brick flat soling with overburnt bricks.
2. 100 mm thick consolidated overburnt brick metal with 75mm thick consolidated stone.
3. 25 mm thick premixed chipping carpet with bitumen.
4. Brick on end edging with overburnt bricks.

Item No	Descriptions	No	L	B	H or Depth	Qty	Remark
1	Box cutting in road crust, & consolidating and dressing the subgrade depth above 150mm and upto 300mm	1	2500	7.4	—	18,500 sqm	
2	Edging: Brick on end edging with overburnt brick laid true to line and level	1X2	2500	—	—	5000 rm	
3	Base course: (a) Supplying and lying double brick flat soling with overburnt bricks	1	2500	7.4	—	18500 sqm	
	(b) Bottom Layer – (1) Supplying overburnt brick metal 50 to 65mm size stacked at road side at regular intervals	1	2500	7.2	0.15		150mm loose compacted to 100mm
	(11) Labour for spreading & Consolidating of brick metal	1	2500	7.2	0.15		
	(C) Top Layer – (1) Supplying 40 to 25mm size trap stone metal and stacked at road side at regular intervals	1	2500	7.200	0.112		75 compacted when loose 75 + $\frac{1}{2}$ x 75 = 112 mm sqm
	(2) Labour for spreading and consolidation of stone metal	1	2500	7.2	0.112		

4 Wearing Coat–

(I) Supplying bitumen (asphalt 80/100) delivered and stacked at site	1	2500	7.2 @ 280kg per 100 sqm	= 50,400 = 50.4 tons
(II) Supplying trap stone chips 12 to 6.3mm size delivered at site	1	2500	7.2 @ 3.38 cum per 100 sqm	= 608.40 cum
(III) Premixing, laying the premix uniformly on W.B.M. surface applying tack coat and consolidating 25 mm thick Carpet	1	2500	7.2	— 18000 sqm

Quantity of Materials –

1(a) Over burnt bricks for single soling @ $\frac{10}{0.2 \times 0.1}$ = 50 nos per sqm.

∴ For double soling @ 50 nos. × 2 = 100 nos. per sqm ∴ For 18,500 sqm = 1850000 nos.

(b) Brick edging = 5000 rm = $\frac{5000}{0}$ = 50000 nos.

Total nos. of overburnt bricks = 1850000 nos. + 50000 = 1900000 nos.

2. Over burnt brick metal 50 to 65 mm size = 2700 cum

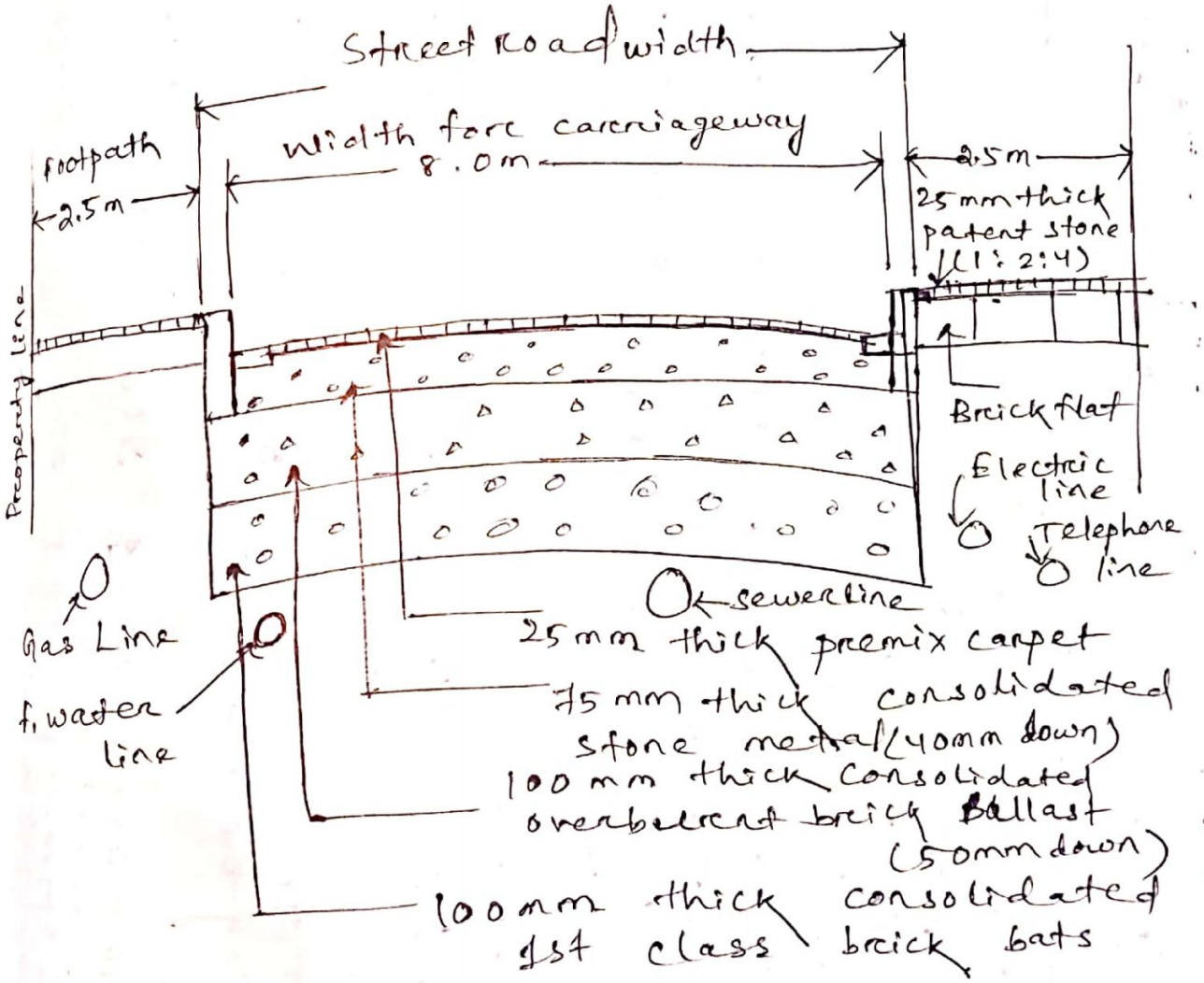
3. Trap stone metal = 2016 cum

4. (I) Bitumen (asphalt 80/100) = 50.4 tons

(II) Trap stone chips 12 mm down = 608.4 cum

Ex 4

Detailed dimensioned sketch cross section of a city street having metalled portion of 8m for the carriageway is shown in fig. Prepare a detailed estimate for constructing 500m length of this street, Indicated also quantities of materials.



Item No.	Description	No	L	B	H or D	Qty	Remark
1	Box cutting in road crust & consolidating and dressing the sub-greable depth above 150mm & upto 300mm	1	500	8.20	—	4100 sqm	L = 8.00 + 0.2 (2x0.1) for kerbs = 8.20.
2	Base course (a) soling :-						
	(i) supplying 1st class brick bats	1	500	8.20	0.15	615 cum	0.15 m Loose consolidated to 0.1 m (i.e. 50% less).
	(ii) Labour for laying, spreading and consolidating with departmental brick bats.	1	500	8.20	0.15	615 cum	
	(b) bottom layer :-						
	(1) supplying overburent brick metal 50 to 65mm size	1	500	8.20	0.15	615 cum	0.15 m loose consolidated to 0.10 m
	(2) Labour for spreading & consolidating the brick metal	1	500	8.20	0.15	615 cum	
	(c) Top layer.						
	(i) supplying 40 to 25mm size treap stone metal	1	500	8.00	0.100	400 cum.	0.075 m. Consolidated loose vol. = 0.10m
	(ii) Labour for spreading and consolidation of stone metal	1	500	8.00	0.100	400 cum	
3	Wearing coats :-						
	(i) supplying bitumen (asphalt 50/100) delivered land stacked at site	1	500	7.40	@ 280	kg/100 sqm = 10360 kg = 10.36 tons	B = 8.00 − 2x0.3 = 7.4 for channels width
	(ii) Supplying treap stone chips 12 to 6.3 mm size	1	500	7.40	@ 3.38 cum/100 sqm	= 125.1 cum	
	(iii) Premixing, laying the premix chips applying tack coat & consolidating 25 mm thick carpet	1	500	7.40	—	3700 sqm	
4	Edging —						
	(i) supplying 900x300x100 mm stone blocks for kerb and channel.	2x2	500	—	—	2000 rm	
	(ii) Laying, levelling kerb and channel on 75 mm thick cement concrete (1:3:6) bed with brick ballast and pointing the joints with cement mortar (1:6)	2x2	500	—	—	2000 rm	

Quantity of materials.

(1) 1st class brick bats = 615 cum
(2) Overburnt brick metal = 615 cum
50 to 65mm size
(3) stone metal 40mm down = 400 cum
(4) stone chips 12mm down = 125.1 cum
(5) Bitumen = 10.36 tons
(6) stone blocks 900 X 300 X 100 mm = 2000 cm

Example-5

The details of cross-section of a road crust 4m wide are -

(a) 15cm boulder soling,
(b) 100mm wide & 125mm deep boulder edging.
(c) 10 cm consolidated stone metalling.
(d) Wearing course is 75mm thick bituminous Macadam (miller mixer).

Prepare a detailed estimate for 6km length of the crust adopting current rates.

Item No	Description	No	L	B	H or D	Qty	Remark
1	Box cutting in road crust and consolidating and dressing the sub grade depth above 150mm & upto 300mm.	1	6000	4.20	—	25200 sqm	
2.	Supplying boulders at road side at regular intervals for soling	1	6000	4.20	0.15	3780 cum	15 cm loose compacted to 10cm
3	Labour for laying 15cm average thick boulder soling including rough dressing	1	6000	4.20	-	25200 sqm	
4	Supplying boulders at road side for edging	2	6000	0.10	0.125	150 cum	
5	Labour for laying stone edging laid to correct line and level 100mm wide & 125 mm deep	2	6000	—	—	12000 rm	

6 Supplying 40 to 25mm trap Stone metal & stacked at road side at regular intervals	1	6000	4.00	0.15	3600 cum	
7 Labour for spreading and consolidating the stone metal	1	6000	4.00	0.15	3600 cum	Labour for spreading & consolidation may also be made in sqm stating the thickness.

8 For bituminous Macadam:-

(i) Supplying stone chips for 75mm thick bituminous macadam from 25mm to 6mm size	1	6000 per	4.00 @ 8.5 cum per 100 sq m = 2040		for 75mm thick cum
(ii) Sand	1	6000 per	4.00 @ 1.5 cum per 100 sqm = 360		25mm = 3.50 cu 12mm = 2.50 cu 6mm = 2.50 cu
(iii) Matrix	1	6000 per	4.00 @ .665 kg per 100 sqm = 159600 kg = 159.6 tons		per 100 sq m.

9 Labour for bituminous Macadam including thorough cleaning of the surface dressing etc with 40mm thick	1	6000	4.00	—	24000 sqm

DRAINAGE SYPHON ACROSS A MINOR

Example 7. —Prepare a detailed estimate of a Drainage Syphon across a minor from the given drawing, Figs. 9-8 and 9-9.

Foundation concrete shall be of 1 : 4 : 8 cement concrete with brick ballast. All brickwork shall be of 1 : 4 cement mortar. Exposed surfaces of brickwork shall be struck pointed with 1 : 2 cement mortar. Brick pitching shall be of dry brick with straight over burnt bricks.

Assume suitable rates for the different items of work.

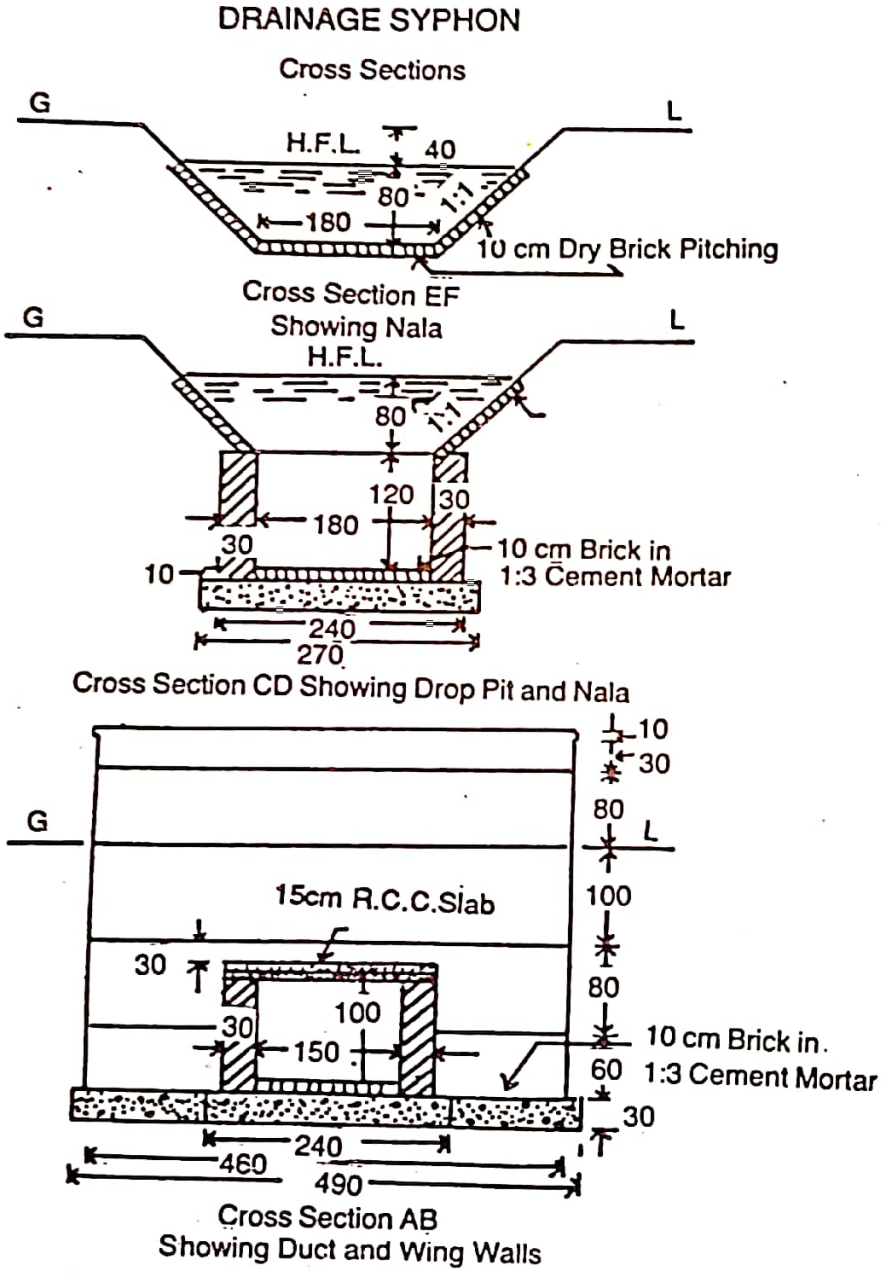


Fig. 9-8

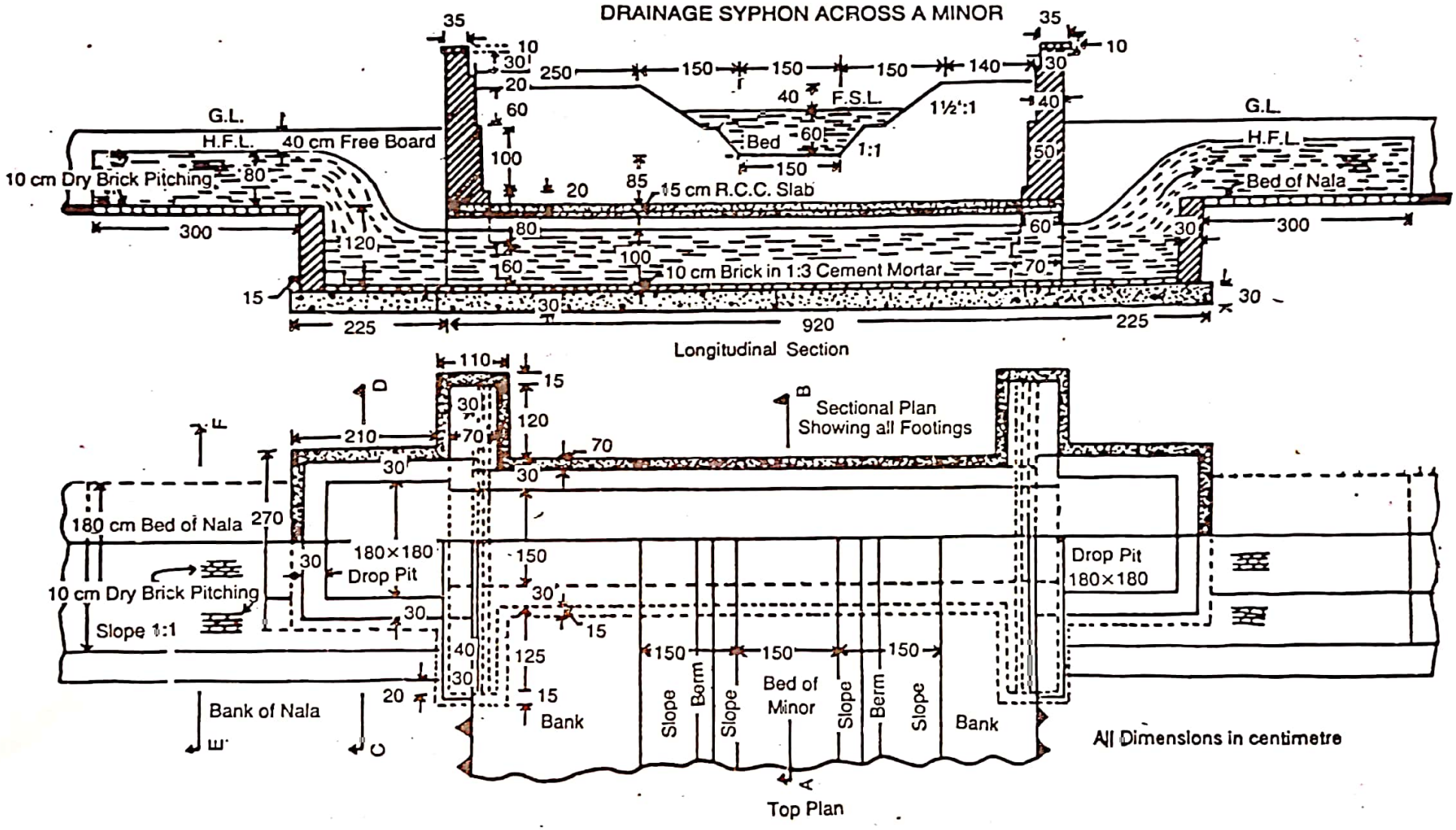


Fig. 9.9

Item No.	Descriptions	No	L	B	H	Quantity	Remarck
1	Earthwork in excavation in foundation –						
	Syphon duct	1	9.50	2.40	1.60	36.48	For bed level of nala.
	Drop pit	2	2.10	2.70	1.60	18.14	
	wing walls	4	1.25	1.10	1.60	8.80	
					total	63.42 cum	
2	Cement concrete 1:4:8 with brick ballast –						
	Syphon duct	1	9.50	2.40	0.30	6.84	
	Drop pit	2	2.10	2.70	0.30	3.40	
	Wing walls	4	1.25	1.10	0.30	1.65	
					total	11.89 cum	
3	First class brickwork in 1:4 cement mortar –						
	Syphon duct side walls	2	9.20	0.30	1.30	7.18	
	Drop pit walls	2X2	2.10	0.30	1.30	3.28	
		2	1.80	0.30	1.30	1.40	
	Wing walls –						
	1 step 70 cm walls	4	1.25	0.70	0.70	2.45	

	2nd step 60 cm walls	—	1	1.25	0.60	0.60 1.20 sqm. slab
	2nd step above 60 cm walls slab.	—	2	4.60	0.60	0.20 1.10
	3rd step 50 cm wall		2	4.60	0.50	1.00 4.60
	4th step 40 cm wall		2	4.60	0.40	0.80 2.94
	5th step 30 cm wall (parapet)		2	4.60	0.30	0.30 0.83
	Coping		2	4.70	0.35	0.10 0.33
						total 25.91 cum
4	R.C.C slab of syphon duct including steel reinforcement complete work		1	9.20	2.10	0.15 2.90 cum
5	10 cm thick brick floor in 1:3 cement mortar including 1:2 cement pointing -					
	Floor of syphon duct		1	9.20	1.50	— 13.80
	floor of drop pit		2	1.80	1.80	— 6.48
						total 20.28 sqm.
6	Cement struck pointing 1:2- syphon duct inner faces		2	9.20	—	1.00 18.40

Drop pit 3 vertical faces	2X3	1.80	—	1.20	12.96	
Drop pit 3 top faces	2	5.70	—	0.30	3.42	L = 2X180+210 = 570 cm
Parapet wall inner face top and outer face upto G.L.	2	4.60	—	2.30	21.16	Ht = 20+10 +30+10+35 +10+5+110 = 230 cm
Outer face of wing wall above slab	2	1.80	—	1.20	4.32	
Triangular portion of outer face of wing wall	2X2	$(\frac{1}{2} \times 0.8 \times 0.8)$		=	1.28	
				total	61.54 sqm	

7. 10 cm dry brick pitching with straight over burnt bricks.-

Bed of nala	2	3.00	1.80	—	10.80	Up & down streams
side slopes of nala	2X2	3.00	1.13	—	13.56	sloping depth $= \sqrt{0.8^2+0.8^2}$ $= 1.13$ m.
				total	24.36 sqm	

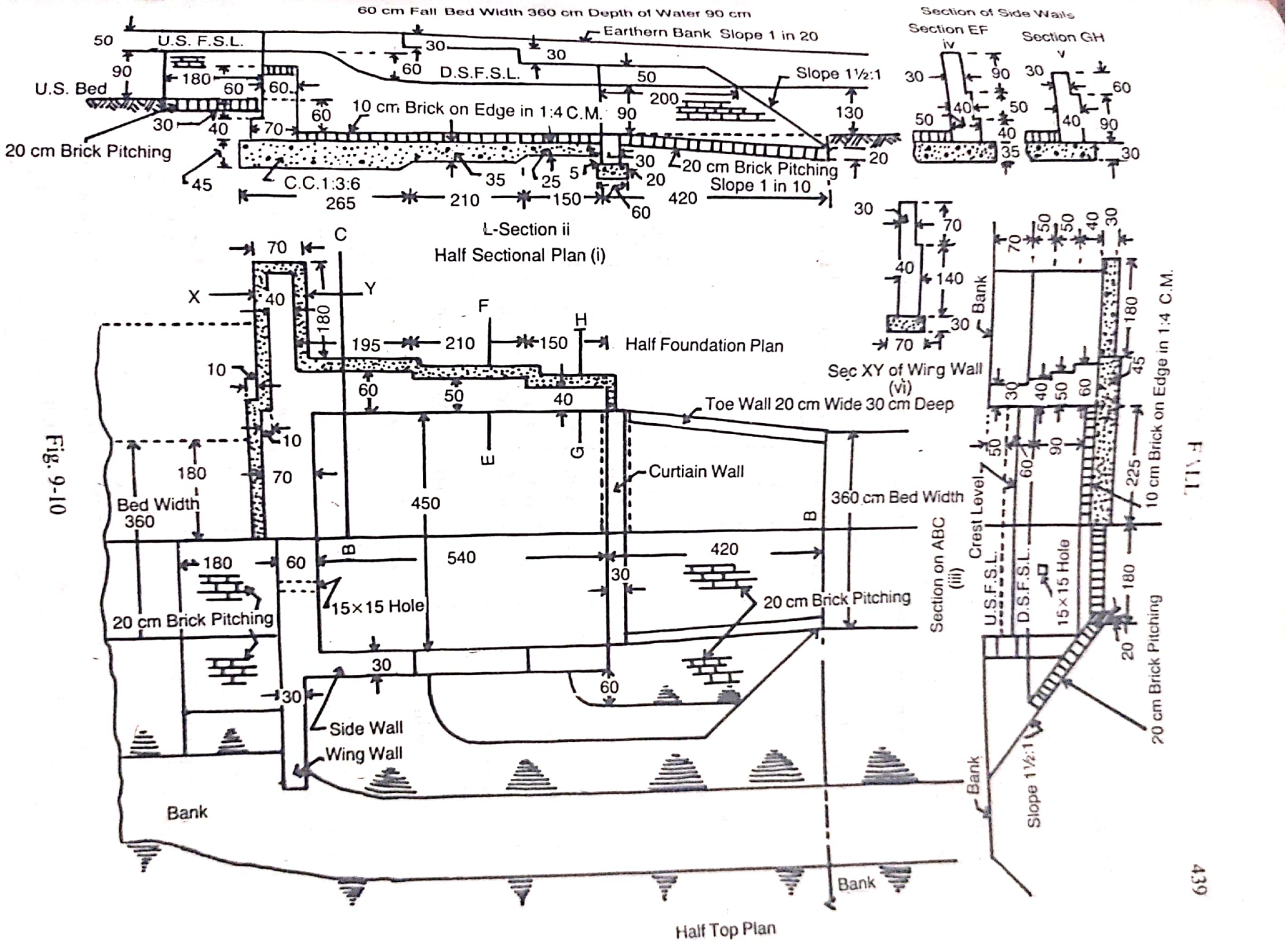


Fig. 9-10

(2.0) Estimate of Irrigation structures

(2.1) Detailed estimate of simple type of vertical fall :-

Steeper longitudinal slope in irrigation channel develops higher velocities causing scour in the bed of the channel. If the general ground has a steep slope and the channel is given a flatter slope, the channel may meet the G.L. & move the G.L necessitating high bank. So to overcome this difficulty, falls or drops are given in channel at suitable points

→ **Example :-** Prepare a detailed estimate of a 60cm fall for a distributory of 360 cm bed width and 90cm depth of water, from the given drawing. Side slope of bank and channel are $1\frac{1}{2}:1$. General specification are :- Foundation and apron concrete is of cement concrete 1:3:6 with stone ballast.

Masonry → All brickwork shall be I st class in 1:4 cement mortar.

pointing → All exposed surfaces shall be pointed with 1:4 cement and sand mortar.

pitching → pitching shall be of dry brick with straight over burnt bricks.

Details of measurement and calculation of Quantities

Item No.	Description of Items	No	L in m	Breadth in m	H or depth in m	Qty	Remarks
1	Earthwork in excavation Crest wall, side walls and floor (taken together)						
	(i)	1	2.65	6.00	1.15	18.29	B=4.5+2×.6 +2×.15 = 6.00m
	(ii)	1	2.10	5.80	1.05	12.79	B=4.5+2×.5 +2×.15 = 5.80m
	(iii)	1	1.50	5.60	0.95	7.98	B=4.5+2×.4 +2×.15=5.6
	wing wall beyond side walls	2	1.80	0.70	1.00	2.52	
	Curtain walls	1	4.50	0.60	1.20	3.24	
	U/s pitching 20cm depth — Bed	1	1.80	3.60	0.20	1.30	
	Side slopes (upto FSL)	2	1.80	1.62	0.28	1.17	sloping breadth $= h\sqrt{s^2+1}$ $= 9\sqrt{(\frac{1}{2})^2+1}$ $= 1.62m$
	Downstream channel beyond curtain wall trapezium section $(B_d+S_d^{2.5})$ XL (L = 4.20 − .3 = 3.90m)		$(4.05\times.8+1\frac{1}{2}\times.8^2)\times3.90$			16.38	Avg. breadth $=\frac{4.5+3.6}{2}$ $=4.05m$ Avg. depth $=\frac{.6+1}{2}=.8m$
	D/s pitching 20cm depth excluding toe wall — Bed	1	3.90	$\frac{4.1+3.2}{2}$	0.20	2.85	sloping breadth at middle

Item no.	Desc. of Items	No.	L	B	H	Qty	Remarks
	Side slopes upto FSL (upper length = 2m)	2	$\frac{4.2+2}{2}$	× 1.44	0.20	1.79	$d\sqrt{S^2+1}$ $= 8\sqrt{1\frac{1}{2}^2+1} = 1.44$m
	Curved portion	2	$\pi \times .6^2$ (area)		0.20	0.45	
	Top wall	2	3.90	0.20	0.30	0.47	
				Total		69.23	
	Deduct for set back of wing wall	2	0.60	0.10	1.15	0.14	
				Net Total		69.09 cum	
2	C.C 1:3:6 in found^{n} & floor - Crest wall, side wall & floor -						
	(i) —	1	2.65	6	0.45	7.16	
	(ii) —	1	2.10	5.80	0.35	4.26	
	(iii) —	1	1.50	5.60	0.25	2.10	
	wing wall beyond side wall	2	1.80	0.70	0.30	0.76	
	curtain wall	1	4.5	0.6	0.2	0.54	
				Total		14.82	
	Deduct for set back of wing wall	2	0.60	0.10	1.15	0.14	
				Net Total		14.68 cum	
	I-class brick work in 1:4 cement mortar —						
	Crest wall -						
	1st step	1	4.5	0.7	0.4	1.26	
	2nd step	1	4.5	0.6	1.00	2.70	
	Side wall -						
	(i) 1st step	2	2.35	0.60	0.40	1.13	As per cross sec^{n} BC
	2nd step	2	2.35	0.50	0.50	1.18	
	3rd step	2	2.35	0.40	0.50	0.94	
	4th step	2	2.35	0.30	0.70	0.99	

Item No.	Desc. of items	No.	L	B	H	Qty	Remarks
	(ii) 1st step	2	2.1	0.5	0.4	0.84	As per cross sec^{n} EF
	2nd step	2	2.1	0.4	0.5	0.84	
	3rd step	2	2.1	0.3	0.9	1.13	
	(iii) 1st step	2	1.5	0.4	0.9	1.08	As per cross sec^{n} GH
	2nd step	2	1.5	0.3	0.6	0.54	
	~~3rd step~~						
	wing wall beyond side wall	2	1.8	0.4	0.4	0.58	As per cross sec^{n} xy
		2	1.9	0.4	0.5	0.76	
		2	2.0	0.4	0.5	0.80	
		2	2.10	0.3	0.7	0.88	
	Curtain wall	1	4.50	0.30	0.40	0.54	
	Toe wall	2	3.90	0.20	0.30	0.47	
				Total		16.64 cum	
4	Brick-on-edge floor in 1:8 cement mortar including pointing	1	5.4	4.5	-	24.30 sqm	D/S in b/w walls
5	cement pointing in 1:3 cement mortar -						
	Crest wall (U/S face top and down stream face)	1	4.5	~~5.4~~	2.4	10.8	Ht = .6+.6 +1.2 = 2.4 m
	Sidewall inner face						
	(i)	2	1.80	-	2.00	7.20	
	(ii)	2	2.10	-	1.70	7.14	
	(iii)	2	1.50	-	1.40	4.20	
	Side wall portion above crest wall	2	0.60	-	0.80	0.96	
	vertical faces of steppings	2×2	-		0.3	0.36	
	vertical face of end	2	-		0.4	0.72	
		2	-		0.3	0.36	
	Top of side walls	2	6.00	0.3	-	3.60	Full length of 30cm wall
	Top of curtain wall	1	4.50	0.3	-	1.35	
	Top of toe walls	2	3.9	0.20	-	1.56	

Item no.	Desc. of items	No.	L	B	H	Qty	Remark
	wing wall top face	2	2.10	0.30	–	1.26	
	wing wall up-stream side triangular portion above slope	2	$\frac{1}{2}(2.10 \times 1.4)$			2.94	Δ portion of slope
			Total =			42.45 sqm	
6	Brick-pitching						
	U/s bed	1	1.80	3.60	0.20	1.30	
	U/s side slopes	2	1.80	1.62	0.20	1.17	
	D/s bed	1	$3.9 \times \frac{(4.1+3.2)}{2} \times 0.2$			2.85	(Dimensions same as in item-1)
	D/s side slopes	2	$\frac{4.2+2}{2} \times 1.44 \times 0.2$			1.79	
	side curved portions	2	$\frac{\pi(.6)^2}{2}$ (area) $\times 0.2$			0.45	
			Total =			7.56 cmm	

(4.0) PWD accounts works :-

(4.1) Works

Classification of works according to their nature :-

(a) original work :-

It may be of different types

(i) Entirely new construction as construction of new building, bridge, road, dam, etc.

(ii) Additions and alteration to the existing work like addition of room, Conversion of verandah to room, dividing big room to two rooms, etc.

(iii) Special repairs for renovation or for thorough repairs of the damaged work as changing of roof, changing of floor, changing of doors & windows, etc.

(b) Repair work :-

It is of following types :-

(i) The repairs required to maintain the work in proper condition as annual repairs to buildings, roads, etc. as annual repairs, white washing, colour washing, etc.

(ii) Minor additions and alterations within certain monetary limit, which will not increase the value of the property eg – providing shelves, etc

(iii) Special repair; monsoon damage repair.

→ Classification of work according to their cost:

(a) Major work → The work costing more than ₹ 2 lakhs is termed as major work & estimate for such work is Major estimate.

(b) Minor work :- work costing more than ₹ 50000 but not exceeding ₹ 2 lakhs is minor work.

(c) Petty work :- work whose cost not exceed ₹ 50,000 & petty work.

Different types of repair work

→ Annual repair or maintenance work:- (A.R. work)

The noormal repair works done annually. All buildings are white washed, colour washed and repaired for minor repairs once in a year. For annual repair 1 to $1\frac{1}{2}$% of original cost of whole building is provided. A.R. work is done by Contract by N.I.T. or quotations. For maintenance, money is allotted in budget under Annual repair & maintenance head.

Quadrantal repair :-

Besides annual repair work of white washing and colour washing, every fourth year special repair works are done for thorough repair as repairing of doors & windows, patch repairs of plastering, etc.

Special repair (S.R) :-

It consists of renovations or renewals of structures or damaged works. It generally consists of renewal of floor, roofs, and other items of work involving replacement occuring at long intervals. eg., minor improvements of buildings, repair of monsoon or flood discharge.

→ contract → contract is an undertaking by a person or firm to do any work under certain terms and conditions. The work may be for the construction or maintenance, for supply of labour, material, etc.

→ Contractor :- A person or farm who undertakes any type of contract.

→ Tender :- Tender is an offer in writing to execute some specified task or to supply some specified articles at certain rates, within a fixed time, under certain conditions of contract and agreement, between contractor & dept. or owner or party. while inviting tenders the BOQ, detailed specifications, conditions of contracts & plans & drawings are supplied on payment of the requisite cost to the contractors who tender or quote their rates.

→ Earnest money :- while submitting a tender the contractor is to deposit a certain amount, about 2% of the estimated cost, with the dept, as earnest money as guarantee of the tender. It is refundable for the tenderer whose tender is not accepted. In case, contractor rebeise then this money is forfeited.

→ Security money :- on acceptance of the tender, the contractor has to deposit 10% of the tendered amount as security money with the dept. which is inclusive of the earnest money already deposited. This amount is kept as a check so that the contractor fulfils all terms and conditions & carries out the work satisfactorily according to specifications and maintain progress & completes the work in time. If contractor fails to fulfill these cond's then part or whole security money is forfeited. It is refunded after satisfactory completion of whole work.

after one rainy season or 6 months.

Different methods of carrying out work :- (4.2.3)

→ Daily labour - Muster roll system :-

Work may be executed departmentally by employing daily labour as masons, coolies, bhisties, carpenters etc. The materials required for the construction as bricks, cement, steel, etc. & tools & plants required are issued from store by indent or purchased. The attendance of labourers is kept in Muster roll (Form 21) by overseer or by work-supervisor, mistry, mate, etc. The attendance of labour is checked & initialled by A.E or SDO frequently. Labourers are paid weekly, fortnightly, monthly or at completion of work. When muster roll is closed for payment the works done during the period are measured & entered in MB & muster roll is completed by overseer showing amount payable to each labourer & total amount payable & qty. of work done. The muster roll then submitted to AE or SDO or EE who check it by clerk & passed or pay order. A temporary advance or temporary imprest by cheque or cash for the total amount is then issued to overseer or AE who then disburses the wages to labourers & signs against each payment. The account of the payment is maintained in cash imprest account (Form 2) in duplicate & one part together with muster roll is submitted to DO or SDO where it is incorporated in the monthly account. other part of the imprest account is kept with the disburser as his office copy. The unpaid wages are recorded in register of Upaid wages & the amount deposited in the cash of the SDO or DO office, kept in deposit account.

→ Muster roll (M.R.)

It is of 2 parts

part-I :- Nominal Roll where daily attendance are recorded. There are columns & spaces for the names of labourer, designation, father's name, dates of attendances, rates, total amount due for each, total amount due for whole, signature of the person taking attendance, sign. of officer making payment etc. Fines if inflicted on labourers are recorded in Part-I. M.R. should never be made in duplicate & entries could not be altered. The names of labourer are grouped according to classes as masons, mazdoors, carpenters, etc.

Part-II :- Details of quantity of work done by the labourer and the progress of work are recorded in this part. Details of measurement are taken and entered in M.B. and an abstract of Quantities is prepared sub-head wise and this is recorded in part-II of the muster roll giving reference of MB. If the work is not susceptible to measurement, a remark to this effect should be recorded in this part. Unpaid wages are recorded in a Register of Unpaid wages which is maintained in the DO or SDO office. The subsequent payment of unpaid wages is made on Hand receipt form 28, and a note of payment is kept in the Register of Unpaid wages against the original entry as well as in the relevant M.R.

→ Rules for M.R :-

One or more M.R may be kept for each work, but MR should not be prepared in duplicate. If Labourers are paid more than once in a month, then separate MR is prepared for each period of payment. Daily attendance, absence & fines are

recorded correctly. After M.R has been passed, payment should be made quickly & each payment is initialled and dated by paying officer. The unpaid items are recorded in Register of unpaid wages. Amount of unpaid wages is deposited in cash and the amount is kept as deposit.

→ Labour Report :- (4.2.5)

For large work or a group of works which is done through daily labour, a consolidated labour report showing the labourers employed day to day is prepared by the overseer from the M.R. in prescribed form and submitted daily to SDO or EE for checking. It is compared with MR as soon as it is received in SDO or DO office.

The labour report shows the name of work, no. of each class of labourer employed in each work, rate of wages & approx. qty of work done. Labour report is in duplicate book form, one copy submitted & counterpart is retained by overseer.

→ Piece work agreement (P.W.A.) :-

It is that where only rates are agreed upon without reference to the total qty of work or time, and that involves payment of works done at a stipulated rate. Small works upto ₹2000 may be done through contractors by PWA. PWA agreement contains only the descriptions of different items of works to be done and rate to be paid for but does not provide the quantities of diff. items to be executed nor the time within which the work to be completed. Detailed spec^{n} & total cost of work also mentioned.

Contractors have to arrange all materials, labours, etc. for execution of the work.

If the agreement is terminated before the work is completed, a notice specifying the date of its termination is served on the piece worker and a receipt obtained.

→ **Work order** :- Small work upto ₹2000 may be carried out by work order. This is a contract and specifies the approximate quantities of different items of work, detailed specifications of each item of work, time for completion of whole work, penalty for not fulfilling terms & conditions. Payment is made on the measurement of the work done and 10% of bill amount is deducted from the running account bill of the contractor as security money which is refunded in final payment on satisfactory completion of work. Contractors are usually selected by taking quotations.

Contract system

In contract system work is done through contractors who arrange all materials required and employ the workers required for the completion of the work in time. Contract agreement is a bond b/w contractor & dept. Contracts are usually arranged by inviting sealed tenders and entrusting the work to the lowest tender usually.

→ **Lump sum contract** :-

Here the contractor undertakes the execution or construction of a specific work will all its contingencies, to complete it in all respects within a specific time for a fixed amount.

The detailed specification of all items of works, plans, drawings and deposit of 10% security money, penalty, progress & other conditions of contract are included in contract agreement. The contractor completes the whole work within contract fixed sum within time fixed. On completion no detailed measurement but the whole work is compared & checked with plans & drawings.

→ Lump sum and schedule contract

This is similar to lump sum contract but the schedule of rates is also provided in the contract agreement. In this system the contractor undertakes the execution or construction of a particular work at a fixed sum within a specified time as per plans and the detailed specifications and conditions, and the schedule of rates for various items of works are also provided which regulates the extra amount to be paid or deducted for any additions and alterations. Here only measurement of extra items shall be taken.

→ Schedule contract or Item rate contract

Here the contractor undertakes the execution or construction of a work on the item rate basis. The amount the contractor is to receive depends upon the quantities of various items of work actually done. The contract agreement includes quantities, rates and amounts of various items of work and the total amount of contract, plans and detailed drawings, detailed specifications and deposit of 10% security money, penalty, progress, date of completion and other conditions of contract.

→ Labour contract :

Here the contractor undertakes contract for the labour portion. All materials for the constr

are arranged and supplied at site by department or owner, the labour contractor engages labour and gets the work done according to spec^{n}s. The contract is on item rate basis for labour portion only & contractor is paid for the quantities of work done on measurement of different items of work. only private buildings are constructed by labour contract system.

→ cost plus percentage contract:-

In this system contractor is given certain percentage over the actual cost of the construction as his profit. Contractor arranges materials and labour at his cost & keep proper account & paid by dept. or owner the whole cost plus 10%. as his profit. So proper control in purchase of material and in labour shall be have to be done by dept. or owner

→ Labour engaged through contractors

only in case emergency, when labourers are not available & work is to be done urgently, labourers are engaged through contractor. Either payment by measured quantity or on the basis of number of labourers employed day to day at current rates a profit or commission is included in payment or lumpsm or percentage basis.

→ penalty :- It is a sort of fine for non-fulfilment of terms of contract. or breach of terms and conditions as for not maintaining progress, for delay in completion, bad work, etc. It may be fixed per day or a certain %-ge of estimated cost upto 10%., etc.

→ compensation for delay in completion :-

contractor is liable to pay as compensation or penalty an amount equal to 1% of estimated cost of the work or such smaller amount decided by E.E. or ~~comple~~ competent authority. max^m limit is 10% of total contract amount.

→ Liquidated damage :-

It is a fixed stipulated sum of penalty by the contractor & fixed per day varying from ₹ 50.00 to ₹ 10200 per day for excess period taken for the completion of work.

→ Unliquidated damage :-

This is ordinary damage having relation with actual damage done for non-completion of work with in time.

→ Extension of time :-

The E.E. or competent authority may grant necessary extension of time for valid reasons like material, labour, etc. unavailability, bad weather cond^n, land not available in due time, etc.

→ Termination of contract :-

The contract can be terminated by E.E. or competent authority in default or bankruptcy & penalty may be imposed as per term of contract agreement. If contractor leaves the work, if he does not maintain progress not obey rules, instructions, etc. ~~the~~ His security money may be seized or penalty upto 10% of estimated cost is imposed on the contractor.

→ Debitable agency :-

This is an agency which is employed to execute a work or part of work at the cost of contractor who fails to complete or to show unsatisfactory progress of the work. The debitable agency may be in the form of daily labour or another contractor and the whole

cost which is usually higher, is debited or charged to the original contractor.

(4.2) Accounts of works

(4.2.1) - Explanation of various terms

→ **Administrative approval (or sanction) :-**

For any work or project required by a deptt., an approval or sanction of the competent authority of the dept., wrt. the cost and work is necessary at first instance. It is the formal acceptance by the dept. concerned, of the proposal and after the administrative approval is given the Engg. dept. take up the work and prepares detailed design, plans and estimates and executes the work. Engg. dept. prepares approximate estimate and preliminary plans & submit to dept. concerned for administrative approval.

→ **Technical sanction :-**

It means the sanction of the detailed estimate, design calculation, quantities of works, rates, and cost of the work by competent authority of the engg. deptt. After technical sanction, work is taken up for construction.

→ **contingencies budget**

It indicates incidental expenses of misc. character which can't be classified under any distinct item sub-head, yet pertain to the work as a whole.

In an estimate 3 to 5% of estimated cost is provided to allow for expenses for misc. petty items which don't fall under any sub-head of items of work.

→ Preparation of N.I.T. :-

Tender for work or supply are invited by issuing tender notice in a prescribed form. In the tender notice the following particulars are given-

(i) Name of the authorities inviting tender
(ii) Name of work, and its location
(iii) Estimated cost
(iv) Time of completion.
(v) Cost of complete set of tender forms and conditions
(vi) Date, time and place of tender
(vii) Amount of earnest money and security money.
(viii) Validity of tenders, etc.

Tender notice is posted in the ~~Sb~~ notice board of the dept. and for major work the ~~tb~~ tender notice ~~is~~ in brief is given in the newspaper.

→ Quotation of Rates :-

(i) For priced item of works:-

A tenderer shall quote in figures as well as in words his rates at par or percentage above or below the rates shown in schedule of items with rates and probable quantities. The quantities of the schedule may vary to any extent during execution of works, for which no claim will be entertained.

(ii) For unpriced item of works :-

The tenderer is to quote under the colum of 'Rate' in figures as well as in words his rates against each item of work as detailed with the schedule of quantities of works.

Mode of payment :-

From the abstract of the MB, bill is prepared in one of the prescribed bill form no.s 24, 25, 26, 27, 28 as applicable. The bill together with MB is submitted by overseer to the SDO's or AE's office

where calculations are checked by the clerk and a duplicate bill is prepared and passed by the SDO or AE and then final pay order is given by the SDO or EE. and the payment is made to the contractor by cheque.
If contractor has not deposited security money before then from each payment 10% is deducted as security money.
Contractor payment may be made finally by one payment when work or the supply completed or by number of payments by R.A bills during the progress of the work.

Bill :- Bill is the account of work done or of supply of materials made, and includes the particulars and quantities of work done or materials supplied, their rates and amount due.

Voucher :- It is a written document with details which is kept in record as a proof of payment. After payment is made, bill becomes voucher document which is kept in record.

First and Final payment :-
The term indicates a single payment, made for a job or contract on its completion applicable for small job.

On account or running or interim payment :-
This means payment is made on a running account to a contractor for works done or supplies made by him duly measured and entered in MB when only a part of the whole work or supply has been done and the work or supply is in progress.

Final payment :-
This means the payment made on running account, made to a contractor on the

completion of this contract and in full settlement of the account. The bill on which final payment is made is known as 'Final bill'

→ Advance payment :-

This means payment made on a RA bill to a contractor for work done but not measured under special case when work is sufficiently progressed but measurement can't be taken for valid reasons on the certificate of AE in charge and the value of work is in no case less than advance payment made

→ Secured advance payment :-

It means an advance payment made on the security of materials brought by contractor to the site of work, when the contract is for the completed items of work secured amount doesn't exceed 75% of value of material brought to the site & they are of imperishable nature

→ Regular and temporary establishment :-

Both permanent and temporary employees of the deptt. are included in the regular establishment. Their salaries and allowances are drawn monthly on regular pay bills from the treasury in prescribed form - 'Detailed pay Bill of permanent Establishment'. The payment to each is made after taking receipt on the pay bill. The salary is met from the budget grant under the head establishment. Their services are governed by civil service rules of the state or the Union Govt. The permanent establishments are not liable for retrenchment and they are entitled for leave, pensions and other amenities as per service rules. The temporary establishments are employed when the work is increased and their services can

be terminated at any time with proper notice as per rules.

→ PWD Accounting system :-

PWD account is comprehensive and maintained in D.O. in prescribed forms. The Divisional officer (DO) is the primary disbursing officer of the division. He makes payment to contractors against proper bills by issuing cheques and keeps his cash for making petty cash payments as and when required.

At the end of each month accounts are compiled and submitted direct to A.G.

The budget estimates show all the anticipated income of the govt. under the head 'revenue' and the expenditure on works of different categories as 'Grants'. The entire revenue, which realised, has to be credited under the head 'Revenue'.

The transaction of PWD offices are grouped under following four heads :-

1) Expenditure heads :-

These are for charges adjustable finally in the account of D.O. offices.

2) Revenue heads :-

These are for revenue receipts creditable finally to the government in the account of D.O. offices.

3) Remittance heads :-

These are for receipts as well as for payments for cash, stores of other values received from, or paid to, or on behalf of other dept. or govts.

4) Debit or deposit heads :-
These are for certain receipts and payments held in suspense till such time as they are cleared by payment or recovery, as the case may be, in cash or otherwise.

The transaction under each of these groups of heads are further sub-divided for the purpose of accounts. In the case of Expenditure and Revenue heads, the main unit of classification is known as the Major head. A major head is divided into Minor heads, and each of minor head is further sub-divided into Detailed heads. In some cases the minor heads are divided into sub-heads which is again divided into detailed head.

Cash :- The term cash includes legal tender coins notes, cheques payable on demand, remittance transfer receipts and DDs.

Govt. securities, deposit receipts of banks, debentures and bonds are accepted as security deposits but not treated as cash.

Debit and credit :-

Debit means expenditure and credit means receipts ~~and DDs~~.

Cash book :-

The transactions relating to the actual receipt and payment of cash are recorded in a register, made of P.W.A. Form no. 1 known as cash book. It is posted and maintained day-to-day in the DO's & SDO's office. The pages of the cash books are machine numbered and each page is divided into to receipt side (left hand) and

Payment side (right hand)

Subsidiary cash book :-

The pay and allowances of the regular establishment of the ~~Civil~~ division are drawn by D.O. from the treasury by presentation of bills. The cash balance of this account is kept separate from the cash of the main cash account.

Imprest :- An Imprest also known as Permanent Imprest is a standing advance of a fixed sum of money to an individual to enable him to make certain classes of disbursements which may be entrusted to his charge by DO or SDO. It must not exceed ₹ 1000.00. It is fixed as low as possible to meet current expenses within the month.

→ Temporary advance or Temporary Imprest :-

It is the amount which is advanced by ~~as~~ a disbursing officer to a Sub-ordinate officer to enable him to make a no. of specific payment out of a muster-roll or any other voucher which has already been passed for payment. The amount of temporary advance should be closed as soon as possible.

The temporary advanced amount is advanced for payment of passed bills, while the permanent Imprest amount is advanced for payment of unpassed bills as and when required. The accounts of both temporary and permanent Imprests are kept in Imprests Cash account - Form 2.

→ Issue Rates :-

The term denotes the cost per unit quantity as fixed on the article of stock to be issued on credit for works in order to calculate the amount of recovery from the bill for such issue. It is fixed on the principle that there will be no ultimate loss or profit in the stock accounts but the standards of articles used for works are assured. Issue rate includes the cost of procurement, transport charges, expenditure for guarding, handling, maintenance of stores godown and store yard, work charged establishment in connection with store, depreciation of article during storing, etc.

Storage charges :-

These charges form part of the issue rate and are added to it on %age basis. Such a %age is fixed annually on the principle that the total annual cost of establishment employed on handling (after acquisition) and keeping initial accounts, on the custody of stores and maintenance of store godown or yards is recovered from anticipated issues from stock during the year.

Handling charge :- similarly, a suitable %age to cover carriage and other incidental charges is fixed annually to be added to issue rates towards handling charge on the same principle fixed for storage charge.

→ Supervision charges :-

When stock materials are sold to public or to other dept., additional charges on account of supervision and contingencies at 10% are realised on the value of stock including storage charges.

→ Suspense account :-

These accounts are meant for the temporary transition of all such transactions and must at once be taken into the account of the works of grant concerned but can't be cleared finally because the relevant payment recovery or adjustment is awaited. These are subdivided into four heads viz. (i) Purchase (ii) Stock, (iii) Misc. P.W. Advance, (iv) Workshop suspense

→ Book transfer :-

It is the transfer of the legal right of ownership of an asset without physically shifting the assets to the new owner. The most common use of concept is when a bank transfers funds from accounts of payers to the account of payees when both accounts are with the same bank.

(9.2.2) Measurement Book (M.B.)

The measurements of all works and supplies are recorded in the Measurement Book Form no. 23 and payment of all works and supplies are made on the basis of measurement recorded. MBs are very important account records.

Form 23 - Measurement Book

Particulars	Details of actual measurement				Contents of area
	No.	L	B	D	

All M.B.s are numbered serially and a register is maintained

in the divisional office showing the serial number of each book, the names of the sub-division or officer to whom issued, the date of issue, the date of return and remark.
A similar register is maintained in SDO's office showing names of the officers, to whom issued, date of issue, date of return, etc.

Points to be observed while recording measurement ⇒

Measurements are recorded by the executive or Asst. Engineers or section officers or overseers to whom MB.s are issued. Measurement of works are taken accurately and recorded neatly for different items of works for the respective units.

For the supplies of materials, the quantities received are measured, weighed or counted as applicable and recorded in M.B. Description of items of work or supplies should be clear so that there may not be any ambiguity.
Measurements should be taken with correct metallic tape like steel tape. All measurements are recorded in ink directly in MB and nowhere else. If any pencil entries are there then they should be inked later on. No entry should be erased if a mistake is made it should be corrected by crossing out and inserting the corrections and with initials and dated. When any measurements are cancelled, the cancellations must be supported by the initial of the officer ordering cancellation or by a reference to his orders

initialled by the officer who made the measurements, reason for cancellation also recorded. A reliable record should be present because it may have to be produced as evidence in the court of law. All measurements should be taken in presence of contractor and his sign. should be taken in bottom of measurement.

The pages of the MB are machine numbered. Entries should be recorded continuously and no blank pages left or pages torn out. Any pages left blank through mistake should be cancelled by diagonal lines and cancellation being ~~initiated~~ initialled and attested and dated. Separate MB should be used for the works done by the contractor and by the departmental labour.

Each MB should be provided with an index of the contents of different entries at the space provided at the beginning, which should be kept upto date. If a MB is used by a number of officers the name of different officers should be recorded at the beginning of MB. The checking of measurement by officers should also be recorded at the beginning at the space provided for this.

Loss of MB is a serious matter; if it can't be traced for 1 month it is reported to SE. The cause of loss is fully investigated and suitable action is taken if anybody is found responsible. If it can't be traced within 6 months

an application for sanction to write off together with full report and explanation should be submitted to CE and matter reported to the Govt.

Each set of measurement should commence with the following entries so that each entry can be identified.

1) In case of bills for work done the measurement should commence with following entries :-

(a) Full name of work as given in the estimate

(b) Situation of the work

(c) Agency by which executed i.e., Contract, piece work, or daily labour, with number and date of contract, piece work agreement (PWA), etc.,

(d) Name of contractor.

(e) Date of written order to commence work.

(f) Date of actual completion of work if complete

(g) Date of measurement

(h) Number of measurements, i.e., 1st, 2nd, 3rd, etc., or first and final or final. In case of R.A bill, the ref. to the last set of measurement with MB number and page no. should be recorded.

2) In case of bills for the supply of materials the measurement should commence with following

(a) Name of supplier or contractor.

(b) Number and date of agreement or order

(c) Purpose of supply as -

(i) Purpose for stock.

(ii) Purchases for direct issue to work with the name of work as given in estimate.

(iii) Purchases for issue to contractor with the name of work as given in estimate.

(d) Date of written order to commence supplies.
(e) Date of actual completion of work, if completed.
(f) Date of measurement.
(g) Reference to the previous measurement in case of RA bill, no. of measurements as 1st, 2nd, 3rd or final or first and final.

At the end of each set of measurement, dated initial of the person making measurement should be made. A suitable abstract is then prepared which collects the total quantities of each items of work relating to each subhead. If it is a contractor job then sign. of contractor also taken at end as a token of his acceptance.

Preparation of bill:-

The bill for payment to the contractor is prepared from the abstract in the MB. Before the bill is prepared, the entries in MB are scrutinized by SDO or AE with the description of items and quantities of work and calculation of quantities are checked by the clerk. A certain % age of measurement are checked by SDO or AE. Bill is prepared in prescribed form. Rate entered in bill or in Abstract in MB by SDO or AE. After thorough checking and scruting the SDO or AE give pay order in bill and in MB & payment is made by cheque by disbursing officer.

After payment made, bill is given voucher number and date and entered in the account. Then every page of MB pertaining to measurement is crossed by diagonal lines in red ink and on every abstract voucher no & date recorded.

Checking of measurement :-

Certain %ge of measurement taken by subordinate officers are required to be checked by SDO or AE & EE to have proper control and check.

Checking is made within a period of $1\frac{1}{2}$ months of completion of work. During checking the person who recorded measurement should be present. On checking if difference doesnot exceed 1%, in case of original work, 5%. in case of repair work and 10% in case of earthwork, entries should be corrected and initialled. If difference exceeds the above limit, measurement should be taken by SDO or AE & matter to be reported to higher authority.

Standard Measurement Books (SMB) :-

A MB where the detailed measurements of certain items of works of a building is recorded correctly in ink on the completion of the constn and the accuracy of which is certified by an AE, is known as the SMB. This book is maintained as record, to facilitate the preparation of estimate for periodical repairs and their execution. In case of annual white washing, Colour washing, etc. no detailed measurements need be taken the contractor's bills are prepared and the payments to the contractor are made on the basis of measurements in SMB. SMB is checked ~~eve~~ every 5 yrs. and alteration if any are entered in SMB which is known as quinquennial checking. The SMB is mainly used for annual repair and maintenance works. SMB is used and maintained in the same manner as ordinary measurement book.

(4.2.4) Acquittance Roll :-

The payment of salary to persons of regular establishment working outstation is drawn on the regular pay-bill but the payment is made on a separate receipt form known as Acquittance Roll, after taking duly stamped signature of the person. The Acquittance Roll is a receipt in evidence of payment in a prescribed form having five columns as Item No., Name, Designation, Net amount payable, and Dated signature. The Acquittance Roll is prepared for the total amount as per Establishment Bill are passed by the Drawing officer. After the payment has been made the paying officer returns it after certifying that proper receipt (signature) has been taken from the person entitled to receive payment, which is then attached to the original Establishment Bill as a record of payment.

→ Labour Report format

Daily report of the day ___ of 20--

Labour work on which employed	Class of Labour	No. of each	Rate	Approx quantity of work done

Signature ___ Date ___

(4.2.6) :- Stores

The stores are produced by inviting tenders for the supply of the stores or materials on the same principle as for works. The contract agreement should contain the descriptions and spec.'s of the materials to be supplied.

total qtys of each article to be supplied, places where to be supplied, and the quantities to be delivered at each place, progress to be maintained and date and time by which the delivery should be completed. and rates of the various materials inclusive of every demand as transport, loading, unloading, stacking, taxes, etc. Penalty upto the extent of 10% of the work may be imposed on the contractor if he fails to observe the condition of contract to complete the work of supply in time or to maintain the specified progress. If materials don't comply with IS specn, they shall be rejected and contractor have to remove the rejected materials at his own cost.

Classification of stores:-

Stores are divided into the following classes: (i) stock or general stores,
(ii) Tools and plants
(iii) Road Metal
(iv) Materials charged direct to works.

The four classes of stores are distinctly grouped in two categories:
I. Stores debited to suspense (i) stock
II. Stores debited to final heads -
(ii) Tools and plant
(iii) Road Metal
(iv) Materials charged directly to works.

Tools and plant division are further sub-divided into
(a) General or ordinary tools & Plants which are required for the general use of a division.
(b) Special tools and plant which are required for a specific work.

→ Unstamped Receipt :-

This term would ordinarily mean any receipt that is unstamped but in the public work account it is used for the receipts of stores and materials issued to the contractors or other persons. At the time of issue of materials these receipts are taken from contractor duly signed but not stamped. These receipts are printed in triplicate in a book form. Contractor's sign is taken in all 3 copies & two of them are submitted to D.O. along with monthly abstract of stock Issues (Form 10).

Procedure to be followed for purchasing the stores :-

Purchase items are classified separately under two headings

(a) Purchases for stock
(b) Purchases for specific works.

Schedule and specification of listed materials are prepared with approximate estimated cost and get approval of competent authority for each purchase. Quotations or item rate tenders may be invited from manufacturers and recognised dealers so as to get the materials at competitive rates and the quality is restricted to the best minimum within time limit of full supply. All the materials received are verified or tested. Measurements and details thereof are then recorded in the M.B. payments are made by E.E. on the basis of the entries recorded in the MB.

→ Credit note :-

Instead of paying the freight in cash, payment for freight, etc. to railway is made by credit notes on the bases of which the book adjustment is made b/w railway & PWD through A. G concerned. D.O.s are authorised to sign credit notes.

→ Accounting procedure of stores :-

The accounts of stores are based on the fundamental principle that the cost of every article is ultimately debited to the final head of the account concerned or the particular work for which it is required. In case of materials, tools and plants, road metals and other such materials, which are required for a specific work, such a booking is possible immediately at the time of acquisition. when it is not possible to debit the cost to the proper head of account, the cost is debited temporarily to suspense head of account. & cost is debited to the suspense head 'stock'. when the materials are issued, their cost is charged to the specific head of account of work and suspense head cleared.

→ Distribution statement :-

Stock and tools and plants under the charge of an AE or sectional officer are sometimes scattered at various places in the section. In such cases the distribution of materials

and article is required to be shown separately for each place. This statement is known as distribution statement of stock or tools and plants as the case may be and is prepared at the end of the Register of Receipts / Issues - Form 8 in case of stock, and at the end of the yearly Register of Tools and Plants - Form 15 of the sub-division, when it is closed for the year in the end of septemper, in case of T&P.

→ Suspense Heads :-

These are such heads which are reserved for the temporary booking of the transactions of the following nature :-

(1) When the final head of account, to which the cost is ultimately debitable cannot be determined at once, eg., in case of cost of stock procured for use for several works in progress.

(2) when materials have been received from a supplier or some other division and bills of the same have not been received. In such cases the approximate cost of material is debited to work or stock as the case may be and credited to 'Purchases', the last two being suspense heads. when the bill is received, the cost is debited 'Purchases' and payment made to the party concerned.

(3) To watch recovery of cost of materials on this sale and of other shortages, pending adjustment by recovery or otherwise. In

such cases suspense head 'Miscellaneous P.W. Advances' is operated upon.

Reserve limit of stock

The financial limit upto which the stock material can be kept in a division is known as the 'Reserve Limit of Stock' which is usually ₹ 50000.000 and fixed by the govt. Reserve limit can, however, be increased temporarily if required by a separate sanction of the govt.

Issue Rate :-

This term denotes the cost per unit fixed on the articles of stock for the purpose as calculating the amount creditable to the sub-head concerned of stock account when issued from stock.

Issue rate should include the actual cost, cost of transport, expenditure on workcharged establishment for handling and keeping initial record expenditure on the custody of stock, watch and ward, expenditure on the maintenance of stores godown or yard, losses for depreciation or wastage, etc.

Sub heads of Stock :-

(1) Small stores - Nail, Screw, nut, bolt, etc.
(2) Building materials - Cement, Lime bricks, A.C sheets, etc.
(3) Timber - Teak, sal, deodar, etc.
(4) Metal - M.S bars, barbed wires, etc,
(5) Fuel - Steam coal, Charcoal, fire-wood, etc.
(6) Painter's stores - Redoxide, alumininm paint, lead paint, etc.
(7) House fittings - Hinges, handles, tower bolts, steel, window, etc.

(8) Misc. Stores - S.W. pipes, hume pipes, bitumen, bleaching powder etc.

(9) Land kilns - cost or hire of land and other expenditure connecting departmental kilns for brick and lime and the like are booked under this subhead.

(10) Manufacture - articles manufactured in the dept. workshops.

(11) Storage - Rent of store godown, maintenance cost, salary of ~~cook~~ chowkidar, etc.

Storage charges :-

This means expenditure incurred on store materials after the acquisition of stores, on workcharged establishment employed on handling and keeping initial accounts, and added on a % age basis of the cost, so as to form part of issue rate.

→ Indent + Issue of materials

Materials from stock are issued on demand in proper form (Indent forms) prepared by SDO or DE incharge of different works as and when required. Indent form is in triplicate consisting of counter foil, indent and invoice and kept in book form serially numbered. The counter foil & indent parts are filled in indenting officer and then the indent and blank invoice parts are send to issuing officer incharge of stock, who will issue the stores as available in stock and shall correct the indent as per actual issue, and entries will be made in invoice and send them to the recovering officer who will sign the invoice and return it to the issuing officer as acknowledgement of receip

which is considered as voucher for the issue. In case of issue to the contractor, the cost of materials issued is recovered from the contractor from his bill for works at the issue rate, and at the time of issue the sign. of contractor should be taken in invoice

Stock Account :-

(i) All transactions of receipt and issue of materials are recorded day-to-days in the "Register of Stock Receipts and Issues" in form 8 in the order of their occurrence as soon as they take place.

(ii) On closing of the monthly account 'Abstract of Stock Receipts' is prepared in form 9 and a single 'Abstract of Stock Issues' is prepared in Form 10 and submitted by SDO or AE in charge of store to the DO for inclusion in the monthly Divisional account, the monthly returns (Abstract) of stock receipt and issues are then posted in the division in 'Half yearly Register of stock' in form 12.

(iii) Half yearly balance returns of stock for every six months for the periods ending 30th september and 31st march are also prepared in form 11 by SDO or AE incharge of store from the monthly accounts, Forms 9 & 10 showing total receipt and issues monthwise and the grand total for 6 months and the closing balances at the end of 6 months. Half yearly returns are submitted to D.O where they are checked and Compared with Half yearly Register of Stock, form-12.

Bin Card

A record of receipts, issues and running balance of certain articles of stock kept in bin card which is kept where the materials are stored. The entries of receipt are posted in Bin card from the register of 'Stock Receipts and Issues' form 8, immediately after transactions. The entries of issues are made immediately after issues on indent, and balances are worked out and entered in Bin Card. Bincards is usually maintained for fittings.

Stock Taking and Shortage and Surpluses :-

Stock is checked, verified, physically by counting, measuring or weighing once in a year, for the period ending 31st March by the SDO or AE incharge of store. For discrepancies first check the account for any mistake. If there is no mistake, surplus, if any should be taken as receipt in form 8 and cost credited to revenue to govt and shortages, if any, should be taken in suspense head as misc. PW Advance and finally accounted as per decision of the competent ~~authority~~ authority. If shortages are minor or nobody is found responsible then the stores are written off on 'Survey Report' Form 18, on sanction of competent authority. Similarly unserviceable stores are written off on survey report and sold by public auction. For sold stores 'sale account' in Form 19 is prepared and submitted to D.O.

Tools and Plants (T. & P.)

Classification :- 2 kinds :-

1) General or ordinary T & P, i.e., those required for the general use of the Division.

2) Special tools and plants, i.e., those required not for general purposes, but for a specific work.

The cost of supply, repairs and carriage of tools and plants of class (1) General or ordinary tool and plant is charged on the main head of account 'Tools and plants' whereas the cost of class (2) spl. tools & plants charge direct to the work concerned.

Subheads & T & P :-

(1) Scientific & Drawing Instruments 's' – Theodolite, Prismatic compass, levels, Drawing instrument box, Current meter, etc.

(2) plant & machinery 'p' – Road roller, Conc. mixer, Pump, Vibrator, etc.

(3) Tools 't' – pick axes, phowrahs, Rammers, Wrenches, etc.

(4) Navigation plant 'N' – Country boat, Motor boat, Pontoons, etc.

(5) Camp equipage 'c' – Tents, Shouldaries, Duories, Carpets, etc.

(6) Live stock 'l' – Bullock, Buffaloes, pigs, etc.

(7) Offic furniture 'c' – chair, table, Almirahs, Tray, etc.

→ The Register of tools & plants Form 15 is maintained as follows

(i) The closing balance of previous year are brought forward and entered in Form 15.

(ii) The accounts of receipts and issues in Form 13 & 14 are totalled up monthly when

closing the accounts of the month

(iii) The total receipts and issues of each article, thus arrived, are posted in Para 1 of the register (form 15) in the colms for receipts & issues.

(iv) Each separate transaction connected with articles lent or sent out is posted in Part-II in section reserved for contractor or person concerned. Articles sent out shown under Debits & received back under Credits.

(v) As soon as the transactions for the month of september have been posted, the accounts are closed and balanced, and closing balance are carried forward to next yr's return.

(vi) It is not necessary to maintain separate T & P registers in D.O. The register (Form 15) received from Sub-Divisions are checked from the monthly return Form (13 & 14) already received and closing balance of previous yr's register.

Chinmaya Maharana
PTGF (Civil)
UGMIT, Rayagada

Manas Ranjan Pradhan

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