Lecture note on

Estimation & Costing-II

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Detailed Estimate of Culverts and Bridges

Detailed Estimate of a simple Humepipe culvert with right angled wing walls

Q. Estimate of a 90 cm dia. double barrel Hume Pipe Culvert.

Prepared a quantity estimate for a barrel of 30cm 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 given drawing. Extra earth work in excavation shall be considered in the estimate to provide a side slope of 1:2 in order to prevent collapsing of earth work at water level.

Figure is given in page No - 5.

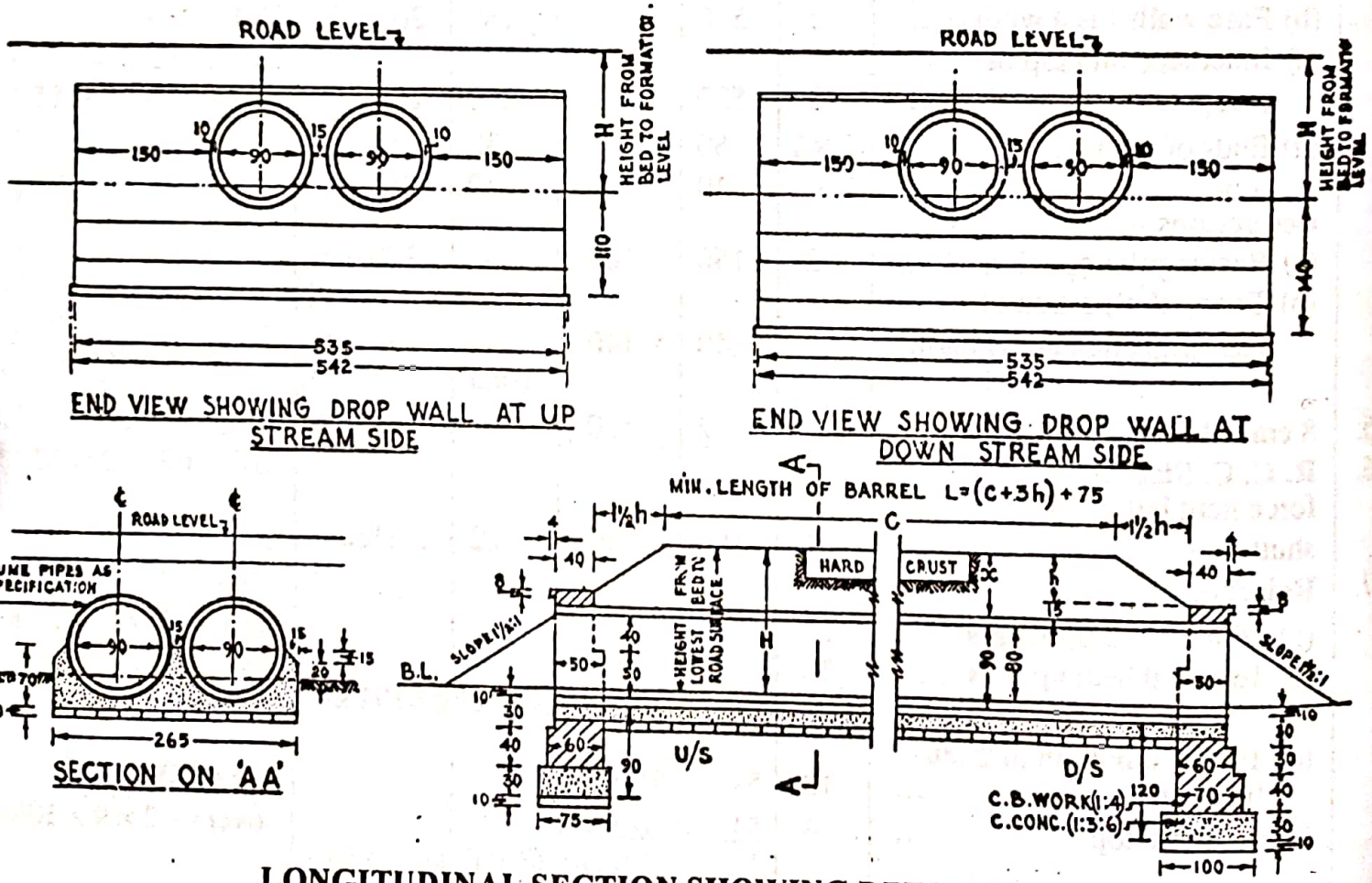
Item No.	Description of Item	Nos	L. in cm	B. in cm	H. in cm	Qty.	Total	Explanatory note
	(A) For 30cm length of Barrel :-							
1.	Earth work in Excavation	1	30	310	45	0.418	0.418 cum.	B= 310 = 265 + 2x 45/2. Extra work for a side slope of 1:2 to prevent collapsing of earth at water level.
2.	Earth work in filling and ramming complete.	2	30	45/2	45	0.061	0.061 cum.	
3.	Single Brick flat soling	1	30	265	-	0.795	0.795 sqm.	
4.	cement concrete (1:3:6) with brick ballast (considering whole first)	1	30	265	55	0.437		H = 55 = 70-15
	Chamfering portion	1	30	250	15	0.113		B = 1/2 (265 + 265 - 30) = 250
	Deduction for pipes	2	30 x 1/2 x π x 1/2		$(110)^2$	0.133	(-ve 0.417 cum	
5.	90 cm dia. 10 cm thick Hume Pipe	2	30	-	-	0.60	0.60cum	
6.	Shuttering for concrete	2	30	-	70	0.42	0.42 sqm	

SL NO.	Description of Items	Nos	L in cm	B in cm	H in cm	Qty	Total	(E.N.
(B)	Quantities for drop walls							Extra excavation to provide a side slope of 1:2 all round.
1.	Earth work in Excavation.							
	UP stream side	1	662	195	120	15.49		195 = 75 + 2 × ½ (10+90)
	Down-stream side	1	692	250	150	25.95		
						Total =	41.44 cum	
2.	Earth work in filling	= Item(1) – items (3), (4) and portion of work upto G.L from (5)						
		= 41.44 – 0.94 – 2.81 – 5.88 –					31.81 cum	All the items are from subhead (B)
3.	Single brick flat soling.							
	U/S side	1	535	75	–	4.01		0.94 = 9.36 × 0.1
	D/S side	1	535	100	–	5.35		
							9.36 Sqm	
4.	Cement concrete (1:3:6) with brick ballast.							
	U/S side	1	535	75	30	1.20		
	D/S side	1	585	100	30	1.60		
						Total	2.81 cum	
5.	First class Brick work in cement mortar (1:4) U/S side for 60 cm layer	1	535	60	40	1.28		

Item No	Description of Item	Nos	L in cm	B in cm	H in cm	Qty	Total	B.N
	50 cm layer	1	535	50	80	2.14		80 = 30 + 50
	40 cm layer	1	535	40	65	1.39		65 = 40 + 10 + 15
	D/s side for							
	70 cm layer	1	535	70	40	1.50		
	60 cm layer	1	535	60	30	0.96		
	50 cm layer	1	535	50	80	2.14		
	40 cm layer	1	535	40	65	1.39		
	Deduction for:							
	Pipe opening both U/s & D/s sides	2x5	$\frac{\pi \times 110^2}{4}$	x45	(av.)	1.71	(-ve)	$45 = \frac{50+40}{2}$
	Concreting under pipes	2	50	x 0.417	cum/rm	0.42	0.42	
						Total =	8.67 cum	
6.	12mm cement plaster (1:2) U/s & D/s faces							
	Cup to 15 cm below G.L	2	535	-		120	12.84	120 = 80 + 10 + 15 + 15 (below G.L)
	Tops	2	525	40	-		4.20	
	Deductions for pipe opening	2x2	$\frac{\pi \times 110^2}{4}$	-	-		3.80 (-ve)	
						Total =	13.24 Sqm	
7.	Shuttering for concrete work in foundation	2x2	535	-		30	6.42	6.42 Sqm
8.	String course at top	2	535	-	-		10.7	10.7 rm

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

RCC deck slab culvert with right angled wing wall

Q Prepare a detailed estimate of a slab culvert of 1·50 meter span and 4·00 meter road way from the given drawing.

Drawing is given in page No – 9

SL NO.	Description of Items	Nos	L	B	H/D	Quantity	E·N.
1.	Earth work in excavation in foundation.						
	Abutments	2	5·10	0·70	0·60	4·28	
	Wing walls	4	1·20	0·70	0·60	2·02	
					Total =	6·30 cum	
2.	Cement concrete 1:3:6 in foundation with stone ballast						
	Abutments	2	5·10	0·70	0·30	2·14	
	Wing walls	4	1·20	0·70	0·30	1·01	
					Total =	3·15 cum	
3.	1st class Brick work in 1:4 cement mortar.						
	Abutments	2	4·80	0·40	1·50	5·76	up to top of RCC slab
	Wing walls	4	1·20	0·40	1·50	2·88	
	Parapets upto kerb	2	4·70	0·40	0·30	1·13	Above RCC slab up to kerb
	parapets above kerb	2	4·70	0·30	0·50	1·41	Above kerb excluding coping.
	parapet coping	2	4·90	0·40	0·10	0·39	
					Total =	11·57 cum.	

Sl No	Description of Items	Nos	L	B	H/D	Quantity	C.N.
	Deduction						
	Bearing of RCC Slab in abutment	2	4.80	0.30	0.20	0.57	
				Net Total =		11.00 cum	
4.	R.C.C. Work 1:2:4 in slab excluding steel and its bending but including centering shuttering and binding steel.	1	4.80	2.10	0.20	2.016 cum	No deduction for volume of steel.
5.	Steel bars including bending in R.C.C. Work:						
	20 mm dia. bars. Main straight bars 30 cm c/c. ($No = \frac{4.80}{0.30} + 1 = 17$)	17	2.38	-	-	40.46 cum	L = 2.10 - 2x side covers + 2 hooks = 2.10 - (2x4 cm) + (18 x 20 mm) = 2.38 m
	Main bent up bars 30 cm c/c. ($No = \frac{4.80}{0.30} = 16$)	16	2.54	-	-	40.64 m	Adding one depth, 16 cm for two bent ups. L = 2.38 + 0.16 = 2.54 m
		Total	81.10 m	@ 2.47 kg/m =		200.32 kg	
	10 mm Dia. bars						
	Distributing bottom bars 25 cm c/c	9	4.90	-	-	44.10 m	L = 4.80 - 2 end covers + 2 hooks. = 4.80 - (2x4 cm) + (18 x 10 mm) = 4.90 m.
	Distributing top bars.	4	4.90	-	-	19.60 m	
		Total	63.70 m	@ 0.62 kg =		39.49 kg	
		Total of steel				= 239.81 kg = 2.398 quintal	

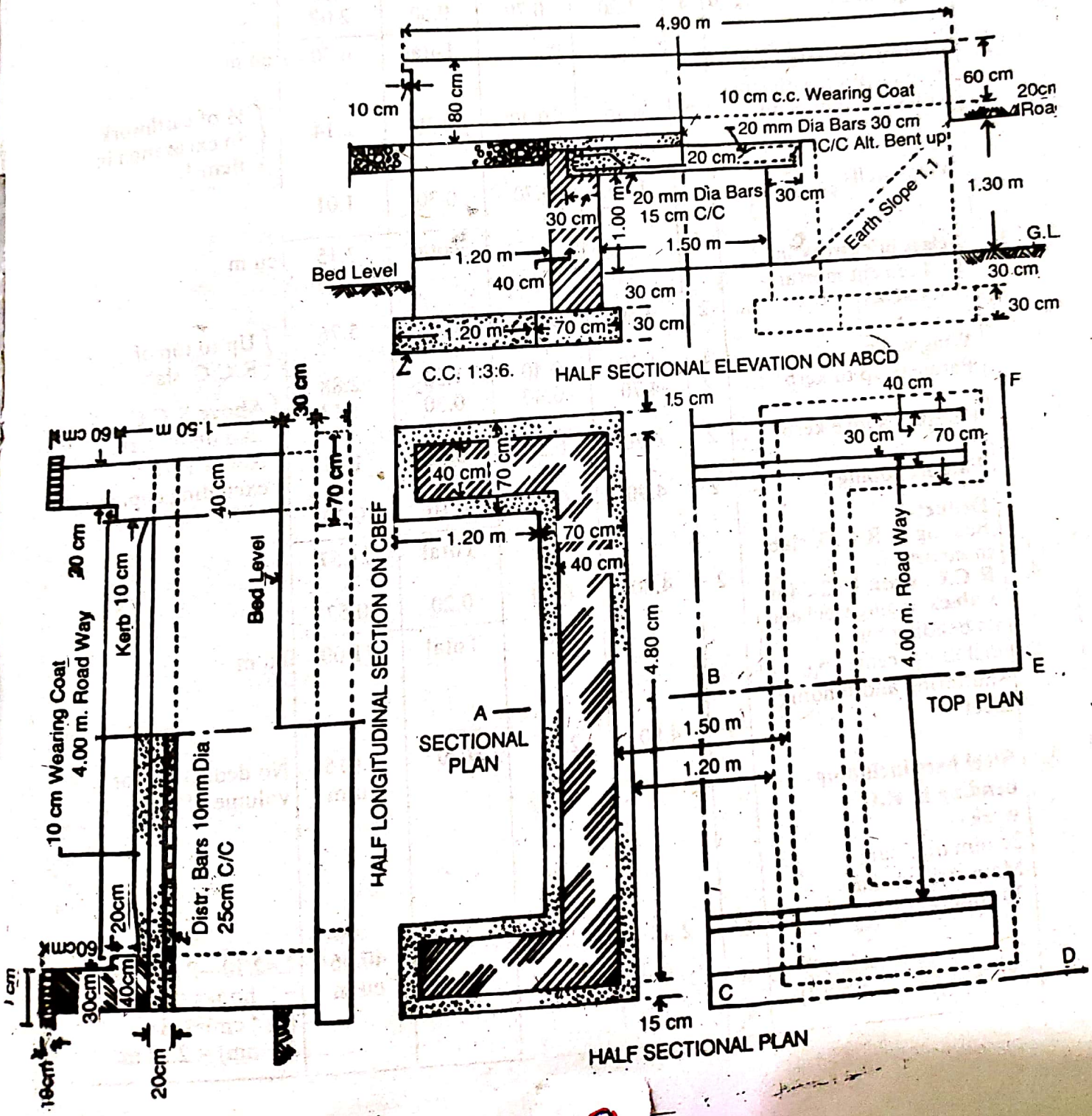
SL NO.	Description of Items	NOS	L	B	H/D	Quantity	E.N.
6.	Cement concrete 1:2:4 wearing coat	1	4.00	2.30	0.10	0.92 cum	In between parapets
7.	Cement pointing 1:2 in walls:						
	Face wall from. 10 cm below G.L up to bottom of coping	2	4.70	–	2.10	19.74	
	Inner side of parapet excluding coping	2	4.70	–	0.80	7.52	H = (40+10+50)cm = 0.80 m
	Coping (inner edge, top, outer edge and outer & side)	2	4.90	0.70	–	6.86	B = (10+40+10+10) cm = 0.70 m
	Ends of parapet	4	–	0.40	0.20	0.32	up to kerb
	Ends of parapet	4	–	0.30	0.50	0.60	Above kerb
	Ends of coping	4	–	0.40	0.20	0.32	Edge & under side
					Total =	35.36 cum	
	Deduction						
	Rectangular opening	2	1.50	–	1.30	3.90	Including 10 cm below G.L and edge of R.C.C slab.
	Triangular portion below earth slope	2	(1/2 x 1.30 x 1.30)			1.69	
				Total deduction =		5.59	
				Net Total =		29.77 Sqm	

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



RCC deck slab culvert with splayed wing wall

Q Estimate the quantities of the following items from the drawing of a splayed wing wall show in fig.

(1) Earth work in excavation

(2) cement concrete (1:3:6) in foundation.

(3) First class Brickwork in cement mortar (1:6)

(4) R.C.C. M-15 deck slab

(5) 10 cm thick cement concrete (1:1½:3) wearing coat.

Figure is given in page No - 14

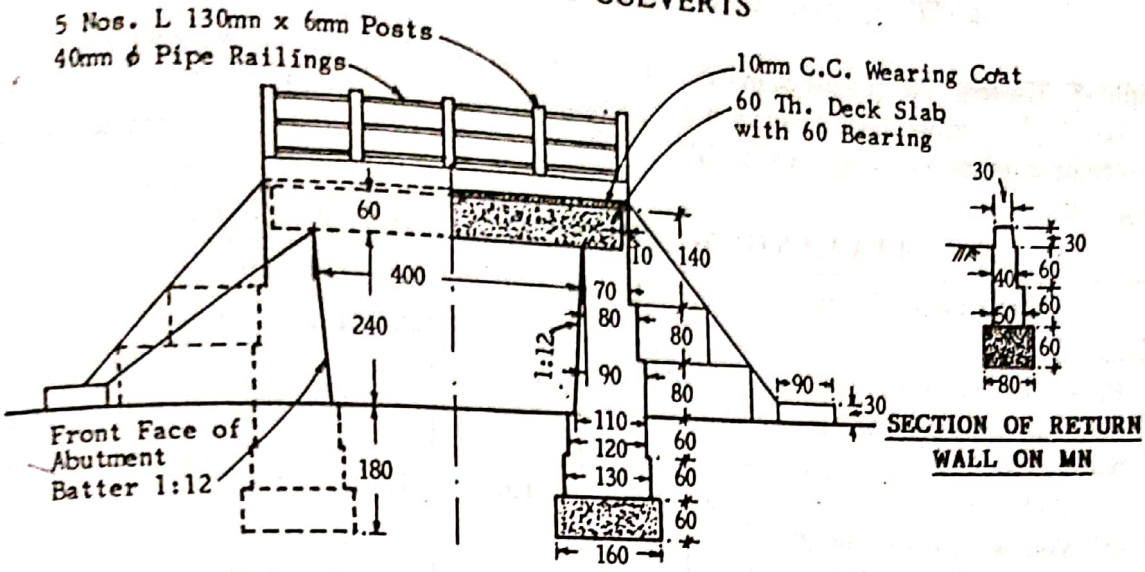
Sl No	Description of Items	Nos	Length	Breadth	Height	Quantity	C.N.
1.	Earthwork in excavation in sand depth up to 2m below G.L.						
	(a) Abutment	2	8.80	1.60	1.80	50.69	L=2(3.50+0.40+$\frac{2.40}{12}$+0.10+0.05+0.15) = 8.80M
	(b) Wing walls upto end of return walls excavation						
	L=3.00+(0.10+0.05+0.15) =3.30	4	3.30	$\frac{1.60+1.28}{2}$	1.80	34.21	0.80 is trench width inclined width up to end 1.28
	Deduct abutment end offset.						
	L=0.15+0.05+0.10+$\frac{0.40}{2}$=0.50	4	0.50	½(1.60+1.60-0.50)	1.80	4.86(-ve)	=0.80×$\sqrt{1.25^2+1^2}$ splay is 1.25:1
	(c) Return walls (remaing)	4	½(0.12+0.22)	0.80	1.80	0.97	0.12=[0.90+2(0.15+0.05)+0.10]-1.28 Inside=0.12+0.12×$\frac{2.4}{20}$ =0.22

Total = 81.01 Cum

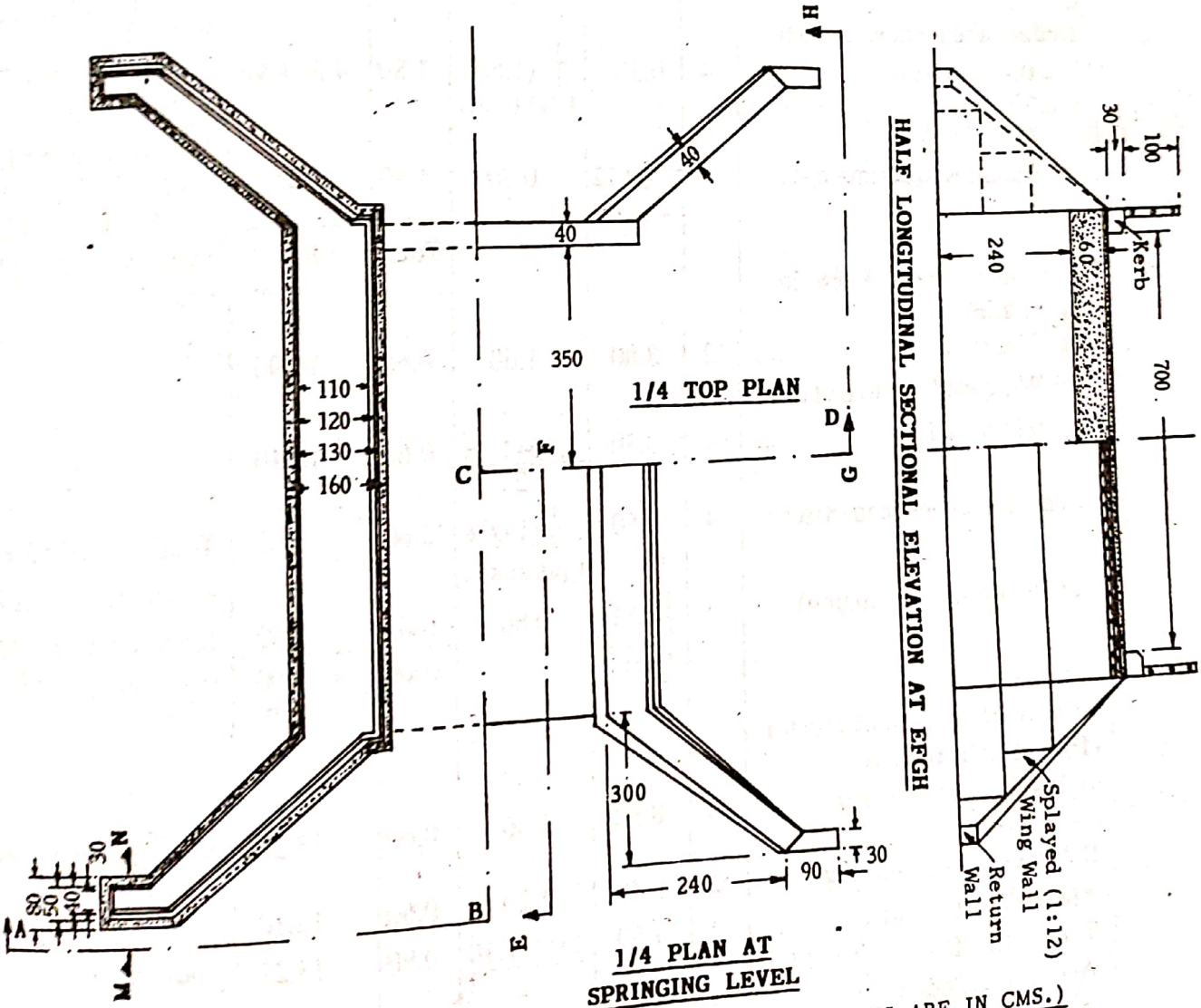
SL NO	Description of Item	Nos	Length	Breadth	Height	Quantity	E.N.
2.	Cement concrete (1:3:6) in foundation.						
	(a) Abutments	2	8.80	1.60	0.60	16.90	
	(b) Wingwalls upto end of return walls	4	3.30	$\frac{1.60+1.28}{2}$	0.60	11.40	
	Deduct abutment end offsets	4	0.50	$\frac{1}{2}(1.60+1.60-0.50)$	0.60	(-)1.62	Total offset $0.50=\frac{0.40}{2}+0.10+0.05+0.15$
	(c) Return walls (remaing)	4	$\frac{1}{2}(0.12+0.22)$	0.80	0.60	0.32	Inner length. $=0.22=0.12+0.12\times\frac{2.4}{30}$
					Total=	27.00 cum	
3.	Brick work in cement mortar (1:6)						
	(a) Abutments.						
	Below G.L 1st footing	2	8.50	1.30	0.60	13.26	$L=8.80-2\times0.15=8.5$ m.
	Below G.L 2nd footing	2	8.40	1.20	0.60	12.10	
	Above G.L 1st offset Top width $=0.9+\frac{1.60}{12}=1.03$	2	7.80	$\frac{1.03+1.10}{2}$	0.80	13.29	$7.80=2(3.50+0.40)$ Extra length for battering is accounted in wing wall.
	Above G.L 2nd offset Bottom width $=0.80+\frac{1.60}{12}=0.93$ Top width $=0.80+\frac{0.80}{12}=0.87$	2	7.80	$\frac{0.87+0.93}{2}$	0.80	11.23	
					C.O=	49.88	

Sl No	Description of Item	Nos	L	B	H	Quantity	C.N
					B.F =	49.88	
	Above G.L topwall Bottomwidth = 0.70 + $\frac{0.80}{12}$ = 0.77	2	7.80	$\frac{0.77+0.70}{2}$	1.40	16.05	
	Deduct bearing of deck slab	2	7.80	0.60	0.60	5.62 (-ve)	
	(b) Wing walls up to end of return wall.						Incline width,
	Below G.L Ist footing	4	3.15	$\frac{1.30+0.80}{2}$	0.60	7.94	$0.80 = 0.50\sqrt{1.25^2+1^2}$
	Below G.L 2nd footing	4	3.10	$\frac{1.20+0.64}{2}$	0.60	6.84	$0.64 = 0.40\sqrt{1.25^2+1^2}$
	Deduct abutment end offsets						
	For Ist footing	4	0.35	$\frac{1}{2}$(1.30 + 1.30 - 0.28)	0.60	0.97 (-ve)	For splay 2.4 as x and 3.0 as y $0.28 = 0.35 \times \frac{2.4}{3.0}$
	For 2nd footing	4	0.30	$\frac{1}{2}$(1.20 + 1.20 - 0.24)	0.60	0.78 (-ve)	
	Above G.L The whole section with parallel inclined width considered as Frusta of pyramid Vol. = $\frac{h}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$ $A_1 = \frac{1}{2}(0.96 + 0.64) \times 2.4 = 1.92$ $A_2 = \frac{1}{2}(0.68 + 0.64) \times 0.30 = 0.20$	4	$\frac{2.70}{3}$	$(1.92 + 0.20 + \sqrt{1.92 \times 0.20})$		9.86	Top inclinded width = 0.40 x 1.6 = 0.64 Bottom width at abutment = 0.64 + $\frac{2.4}{12}$ x 1.6 = 0.96 Bottom width at the end = 0.64 + $\frac{0.30}{2}$ x 0.30 = 0.68

SL NO	Description of Item	NOS	Length	Breadth	Height	Quantity	E.N.
	(C) Return wall (remaining portion a trapezium)						
	$1.54 = 0.90 + (0.90 - 0.40\sqrt{1.2^2 + 1.25^2})$	4	$\frac{0.90+1.54}{2}$	0.30	0.30	0.44	
					Total =	83.64 cum	
4.	R.C.C. M-15 deck slab	1	7.80	5.20	0.60	24.34 cum	
5.	10 cm thick cement concrete (1:1½:3) wearing coat	1	7.00	4.40	0.10	3.08 cum	



HALF CROSS SECTIONAL ELEVATION AT ABCD



(DIMENSIONS ARE IN CMS.)

SLAB CULVERT

Quantity for steel for deck slab with bar bending schedule of the above job (BBS)

Ex-1 Estimate the

(a) Quantity of steel including 10% wastage.

(b) Quantity of binding wire

(c) Quantity of steel per m^3 of concrete.

From the following data of RCC slab 4m x 4.5m x 12 cm thick 8mm dia rods are placed in short span @ 20 cm c/c with one side 45° crank with end hooks. Rods are placed in long span @ 25 cm c/c with one side 45° crank with end hook. 8mm dia straight bars with end hooks, 6 nos along long span & 6 nos along short span have been used.

Cover = 25mm, k = 2

Sl. No.	Name of the Items	Nos	L	B	Hor D	Quantity	E.N
(a)	**Main Bars**						
	8mm dia bar @ 20 cm c/c.						
	Nos = $\frac{4.5 - 2\times0.025}{0.2} + 1$						
	$= 23.25 \simeq 24$ Nos	24	4.129	$(\frac{\pi}{4}\times0.008^2)$		0.00498	L = 4 − 2 × side cover + 2 × hooks + ½ effective depth.
							= 4 − 2×0.025 + 2×9×0.008 + $\frac{0.07}{2}$
							= 4.129 m.
	Distribution Bars						
	8mm ϕ bars @ 25 cm c/c.						
	Nos = $\frac{4 - 2\times0.025}{0.25} + 1$						L = 4.5 − 2×0.025 + 2×9×0.008 + $\frac{0.07}{2}$
	$= 16.8 \simeq 17$ Nos	17	4.629	$(\frac{\pi}{4}\times0.008^2)$		0.00395	= 4.629 m.
	8mm dia hanger bar in short span	6	4.094	$(\frac{\pi}{4}\times0.008^2)$		0.00123	L = 4 − 2×(0.025) + 2×9×0.008 = 4.094 m.
	8mm dia hanger bars in long span	6	4.594	$(\frac{\pi}{4}\times0.008^2)$		0.00138	L = 4.5 − 2×0.025 + 2×9×0.008 = 4.594 m
						Total = 0.01154 cum.	

Wt. of steel @ 78.5 quintal/cum = 0.01154 × 78.5

= 0.905849 qui.

= 90.588 kg.

(b) Add 10% wastage = 9.059 kg.

Take binding wire 2.7 kg/10 sqm.

Wt. of binding wire for (4×4.5) = 18 sqm = $\frac{2.7}{10}\times18 = 4.86$ kg.

Grand Total = 104.508 kg

(C) volume of concrete $= 4.5 \times 4 \times 0.12 = 2.16$ cum.

For 2.16 cum = 0.01154 cum steel is required.

For 1 cum $= \frac{0.01154}{2.16} = 0.00534$ cum steel is required.

Ex-2 Estimate

(i) Quantity of steel per m^3 per concrete.

(ii) Quantity of steel including 10% of wastage.

(iii) Quantity of binding wire.

From the following data from RCC slab 5.5m x 5.5m x 15 cm depth 10 mm dia rod are placed in short span @ 12 cm C/C with one side 45° crank with end hook. 8 mm dia rods are placed on long span @ 15 cm C/C with one side 45° crank with end hooks. 8mm dia straight bars with end hooks. 6nos are used in long span and 6nos used in short span.

Assume cover = 25 mm

K = 2.

Sl No	Name of the Items	Nos	L	B	H	Quantity	C.N.
(a)	Main Bars. 10mm dia bars @ 12cm c/c. Nos: $\frac{5.5-2\times0.025}{0.12}+1$ = 46.41 ≃ 47 Nos	47	5.68	$(\frac{\pi}{4}\times0.01^2)$	0.002		L = 5.5 − 2×0.025 + 2×9×0.01 + $\frac{0.1}{2}$ = 5.68 m.
	Distribution Bars. 8mm dia bars @15 cm c/c. with one side crank Nos: $\frac{5.5-2\times0.025}{0.15}+1$ = 37.33 ≃ 38	38	5.644	$(\frac{\pi}{4}\times0.008^2)$	0.010		L = 5.5 − 2×0.025 + 2×9×0.008 + $\frac{0.1}{2}$ = 5.644 m.
	8mm dia hanger bars in short span.	6	5.594	$(\frac{\pi}{4}\times0.008^2)$	0.00168		L = 5.5 − 2×0.025 + 2×9×0.008 = 5.594 m.
	8mm dia hanger bars in long span	6	5.594	$(\frac{\pi}{4}\times0.008^2)$	0.00168		
					Total =	0.0336 cum	

Wt. of steel @ 78.5 g/m³ = 78.5 × 0.0336
= 2.639 quint
= 261.87 kg.

(2) Add 10% wastage = 26.187 kg.

Add Binding wire 2.7 kg / 10 sqm.

For (5.5 × 5.5) = 30.25 sqm

Wt. of binding wire is = $30.25\times\frac{2.7}{10}$ = 8.167 kg.

Total wt. of steel = 296.224 kg.

(3) Volume of the concrete = 5.5 x 5.5 x 0.15 = 4.53 cum.

For 4.53 cum = 0.0336 cum steel is required.

∴ For 1 cum of conc. = $\frac{0.0336}{4.53}$ = 0.0073 cum steel is required.

Estimate of Irrigation Structures

Detailed estimate of simple type of vertical fall to given specification

Q Prepare a detailed estimate of a 60 cm fall for a distributory of 360 cm bed width and 90 cm depth of water, from the given drawing. Side slope of bank and channel are 1½:1.

Figure is given in page No-6

Sl No	Name of the Items	Nos	Length	Breadth	Height or Depth	Quantity	D.N.
1.	Earthwork in excavation cretwall, side walls and floor (taken together)						
	(i)	1	2.65	6.00	1.15	18.29	B=4.5+2x0.6+2x0.15 = 6.00m
	(ii)	1	2.10	5.80	1.05	12.79	B=4.5+2x0.5+2x0.15 =5.80m.
	(iii)	1	1.50	5.60	0.95	7.98	B=4.5+2x0.4+2x0.15 = 5.60m
	Wing walls beyond sidewalls	2	1.80	0.70	1.00	2.52	
	Curtain walls	1	4.50	0.60	1.20	3.24	
	up streaming pitching 20cm depth Bed	1	1.80	3.60	0.20	1.30	
	side slopes (up to F.S.L)	2	1.80	1.62	0.20	1.17	Sloping breadth = $h\sqrt{S^2+1}$ = $0.9\sqrt{(1\frac{1}{2})^2+1}$ = 1.62m

Sl No	Name of the Items	Nos	L	B	H	Quantity	E.N.
	Down stream channel beyond curtain wall trapezium section $(bd+sd^2)L$ ($L = 4.20-0.30 = 3.90m$)		$(4.05\times0.8 + 1\frac{1}{2}\times0.8^2)$		$\times 3.90$	16.38	Average breadth $= \frac{4.5+3.6}{2} = 4.05\,m$ Average depth $= \frac{0.60+1.00}{2} = 0.80\,m$
	Down stream pitching 20 cm depth, excluding toe wall. Bed	1	3.90	$\frac{4.1+3.2}{2}$	$\times 0.20$	2.85	sloping breadth at middle.
	Side slopes upto F.S.L (upper length = 2.0m)	2	$\frac{4.2+2.9}{2}$	$\times 1.44\times$	0.20	1.79	$= d\sqrt{s^2+1}$ $= 8\sqrt{(1\frac{1}{2})^2+1} = 1.44m$
	Curved portion	2	$\pi\times0.6^2$	(area)	$\times 0.20$	0.45	Taken as quadrant of sphere.
	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.	Cement concrete 1:3:6 in foundation and floor-crest wall side walls and floor						
	(i)	1	2.65	6.00	0.45	7.16	
	(ii)	1	2.10	5.80	0.35	4.26	
	(iii)	1	1.50	5.60	0.25	2.10	

Sl No	Name of the Items	Nos	L	B	H	Q	B.N.
	Wing wall beyond side wall	2	1.80	0.70	0.30	0.76	
	Curtain wall	1	4.50	0.60	0.20	0.54	
					Total=	14.82 cum	
	Deduct for set back of wing wall	2	0.60	0.10	1.15	0.14	
				Net	Total=	14.68 cum	
3.	1st class Brick work in 1:4 cement mortar.						
	Crest wall.						
	1st step	1	4.50	0.70	0.40	1.26	
	2nd step	1	4.50	0.60	1.00	2.70	
	Side wall :-						
	(i) 1st step	2	2.35	0.60	0.40	1.13	As per cross-section 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	
	(ii) 1st step	2	2.10	0.50	0.40	0.84	As per cross sec. EF.
	2nd step	2	2.10	0.40	0.50	0.84	
	3rd step	2	2.10	0.30	0.90	1.13	
	(iii) 1st step	2	1.50	0.40	0.90	1.08	As per cross sec. GH.
	2nd step	2	1.50	0.30	0.60	0.54	
	~~3rd step~~						
					C.O.	12.63	

SL No	Name of the Items	Nos	L	B	H	Q	E.N.
					B.F. =	12.63	
	Wing wall beyond side wall	2	1.80	0.40	0.40	0.58	As per cross. sec. XY.
		2	1.90	0.40	0.50	0.76	
		2	2.00	0.40	0.50	0.80	
		2	2.10	0.30	0.70	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 =	16.66 cum	
4.	Brick on edge floor in 1:8 cement mortar including pointing	1	5.40	4.50	-	24.30 sqm	Down stream in between walls.
5.	Cement pointing in 1:3 cement mortar						
	Crest wall (up stream face top & down stream (face)	1	4.50	-	2.40	10.80	H = 0.6 + 0.6 + 1.2 = 2.40 m.
	Side wall 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	

SL NO.	Name of the Items	NOS	L	B	H	Quantity	R.N.
	vertical faces of steppings	2x2	–	0.30	0.30	0.36	
	Vertical face of end	2	–	0.40	0.90	0.72	
		2	–	0.30	0.60	0.36	
	Top of side walls	2	6.00	0.30	–	3.60	Full length of 80cm wall.
	Top of curtain wall	1	4.50	0.30	–	1.35	
	Top of toe walls	2	3.90	0.20	–	1.56	
	wing wall top face	2	2.10	0.30	–	1.26	
	Wing wall up-stream side triangular portion above slope	2	(½x2.10x1.40)		–	2.94	Triangular portion of slope.
					Total-	42.45 Sqm	
6.	Brick-pitching						
	up-stream bed	1	1.80	3.60	0.20	1.30	
	up-stream side slopes	2	1.80	1.62	0.20	1.17	
	Down stream bed	1	3.90x	$\frac{4.1+3.2}{2}$	x0.20	2.85	
	Down stream side slopes	2	$\frac{4.2+2.0}{2}$	x1.44	x0.20	1.79	
	side curved portions	2	$\pi \times 0.6^2$	(area)	x0.20	0.45	
					Total-	7.56 cum	

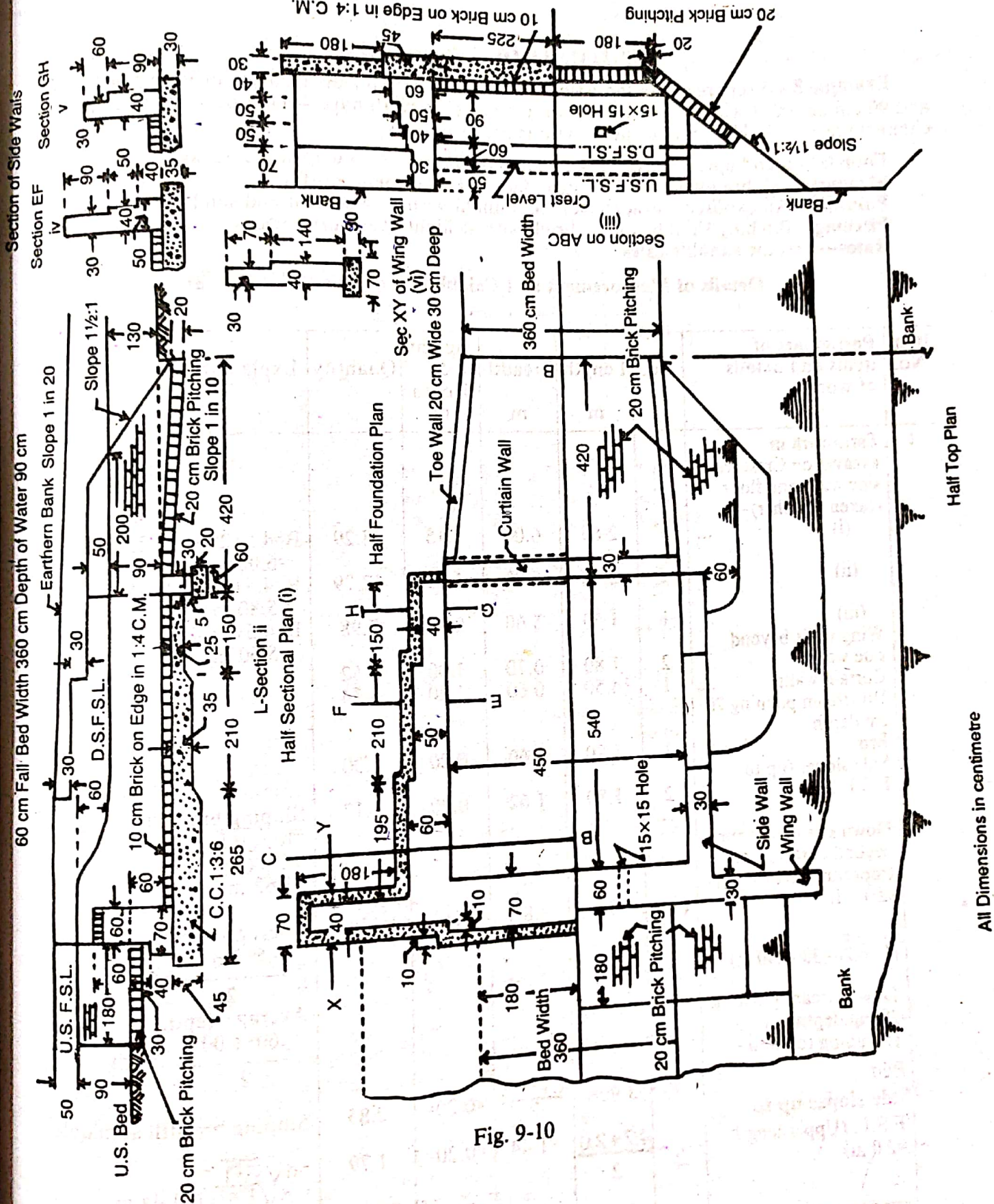


Fig. 9-10

Detailed estimate of a siphon well drop to given specification

Q Prepare a detailed estimate of a Drainage syphon across a minor from the given drawing.
Foundation concrete shall be 1:4:8 cement concrete with brick ballast. All brick work 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.

Figure is given in page NO-10 & 11

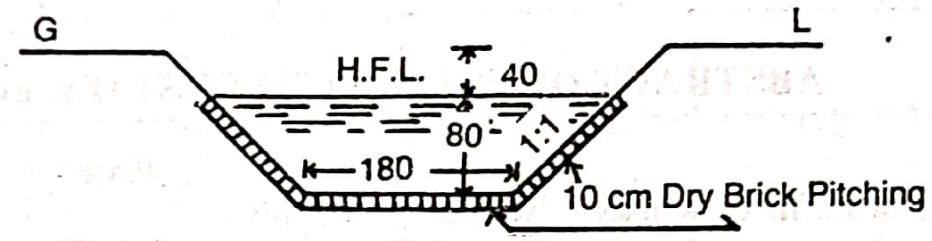
SL NO	Name of the Items	Nos	Length	Breadth	Height	Quantity	E.N.
1.	Earthwork in excavation in foundation.						
	syphon duct	1	9.50	2.40	1.60	36.48	For bed level of nala
	Drop Pit	2	2.10	2.70	1.60	18.14	
	Wing walls	4	1.25	1.10	1.60	8.80	
					Total =	63.42 cum	
2.	Cement concrete 1:4:8 with brick ballast.						
	syphonduct	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	

SL NO	Name of the Items	NOS	L	B	H	Quantity	E.N.
3.	First class brick work 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 :-						
	1st step 70 cm walls	4	1.25	0.70	0.70	2.45	top of slab upto
	2nd step 60 cm walls	4	1.25	0.60	0.60	1.80	
	2nd step 60 cm wall above 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.	1	9.20	2.10	0.15	2.90 cum	
5.	10cm thick 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	

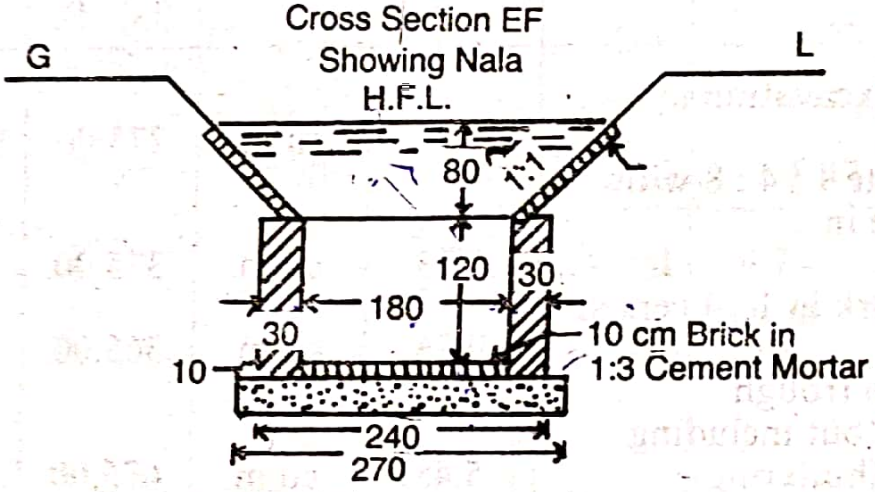
Sl No	Name of the Items	Nos	L	B	H	Quantity	E.N.
6.	Cement stuck Pointing 1:2:						
	syphon duct inner faces	2	9.20	–	1.00	18.40	
	Drop pit 3 vertical faces	2x3	1.80	–	1.20	12.96	
	Drop pit 3 top faces	2	5.70	–	0.30	3.42	L = 2x180 + 210 = 570 cm
	Parapet wall inner face top and outer face up to G.L	2	4.60	–	2.30	21.16	H = 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	(½x0.8x0.8)	–		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 stream
	side slopes of nala	2x2	3.00	1.13	–	13.56	sloping breadth = $\sqrt{(0.8)^2+(0.8)^2}$ = 1.13m
					Total =	24.36 sqm	

DRAINAGE SYPHON

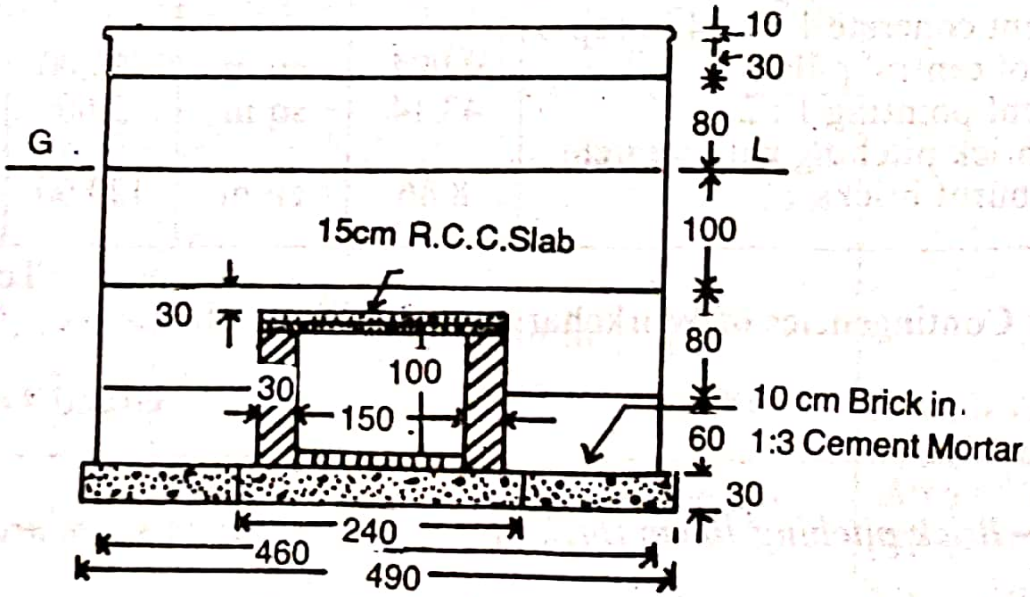
Cross Sections



Cross Section EF
Showing Nala



Cross Section CD Showing Drop Pit and Nala



Cross Section AB
Showing Duct and Wing Walls

Fig. 9-8

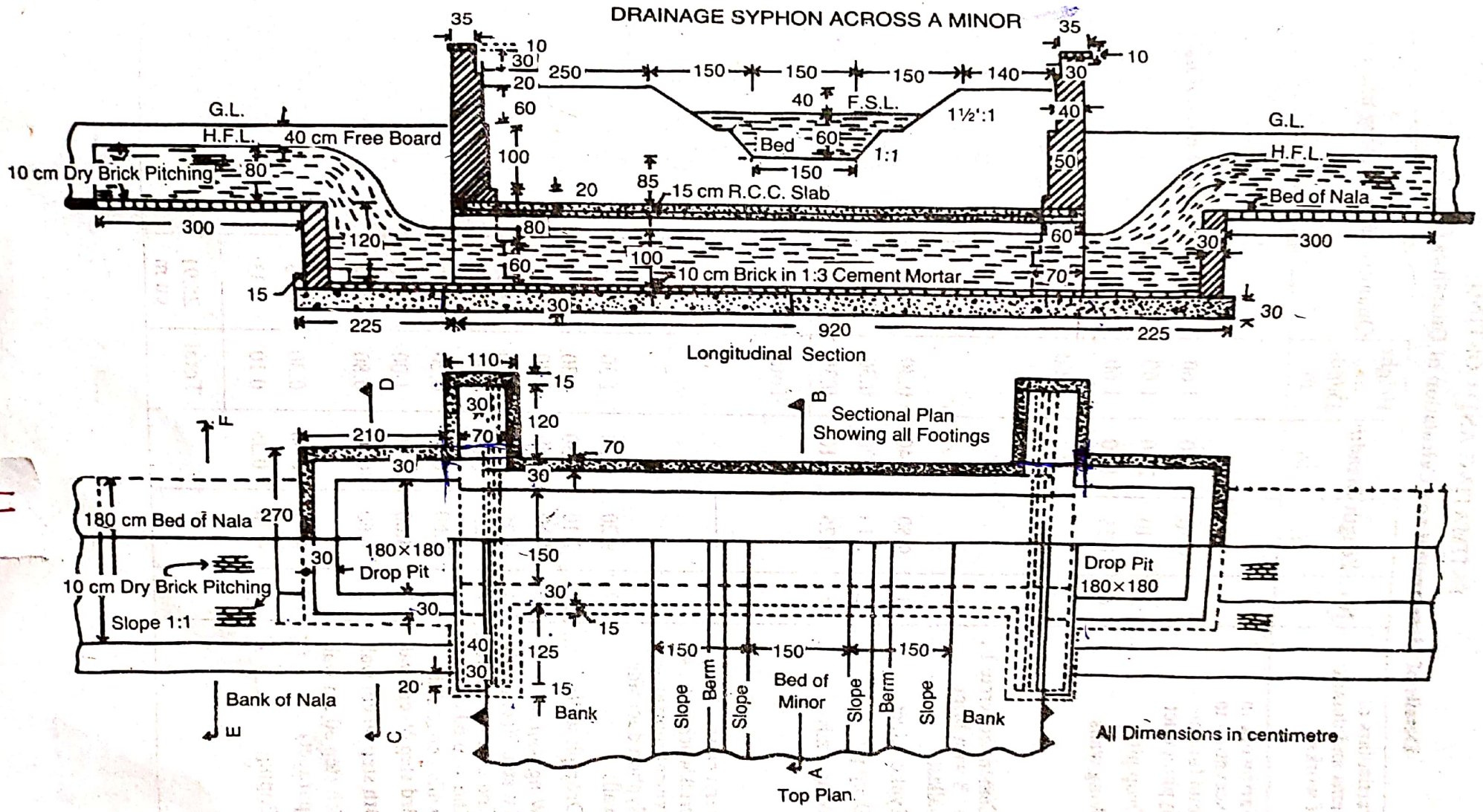


Fig. 9 9

Detailed Estimate of Roads

Detailed estimate of a National Highway in cutting / Filling

Ex-1

Calculate the quantity of earth work for 200 meter length for a portion of a road in an uniform ground the heights of banks at the two ends being 1.00 m and 1.60 m. The formation width is 10 meter and side slopes 2:1 (H:V). Assume that there is no transverse slope.

Sol^n Given data

Length (L) = 200 m.

Formation width, (B) = 10 m

$d_1 = 1m$, $d_2 = 1.6m$

* Mid sectional Area Method (Method - 1) -:

Mean height (dm) = $\frac{d_1+d_2}{2} = \frac{1+1.6}{2} = 1.3m$

sectional Area ($Bdm + Sdm^2$) = $(10 \times 1.3 + 2 \times 1.3^2)$

= 16.38 m^2

Quantity of Earth work = Area x Length

= 16.38 x 200

= 3276 cum.

* Mean sectional Area method (Method-2) -:

$A_1 = Bd_1 + Sd_1^2 = (10 \times 1) + (2 \times 1^2) = 12$ sqm

$A_2 = Bd_2 + Sd_2^2 = (10 \times 1.6) + (2 \times 1.6^2) = 21.12$ sqm.

Mean sectional Area (Am) $= \frac{A_1 + A_2}{2} = \frac{12 + 21.12}{2} = 16.56 \text{ Sqm}$

Quantity of Earth work = Am x L

= 16.56 x 200

= 3312 cum.

* Prismoidal method (Method-3)

$A_1 = Bd_1 + Sd_1^2 = (10 \times 1) + (2 \times 1^2) = 12 \text{ sqm}$

$A_2 = Bd_2 + Sd_2^2 = (10 \times 1.6) + (2 \times 1.6^2) = 21.12 \text{ Sqm.}$

$d_m = \frac{d_1 + d_2}{2} = \frac{1 + 1.6}{2} = 1.3 \text{ m}$

$A_m = Bd_m + Sd_m^2 = (10 \times 1.3) + (2 \times 1.3^2) = 16.38 \text{ sqm.}$

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

$= \frac{200}{6}\{12 + 21.12 + (4 \times 16.38)\}$

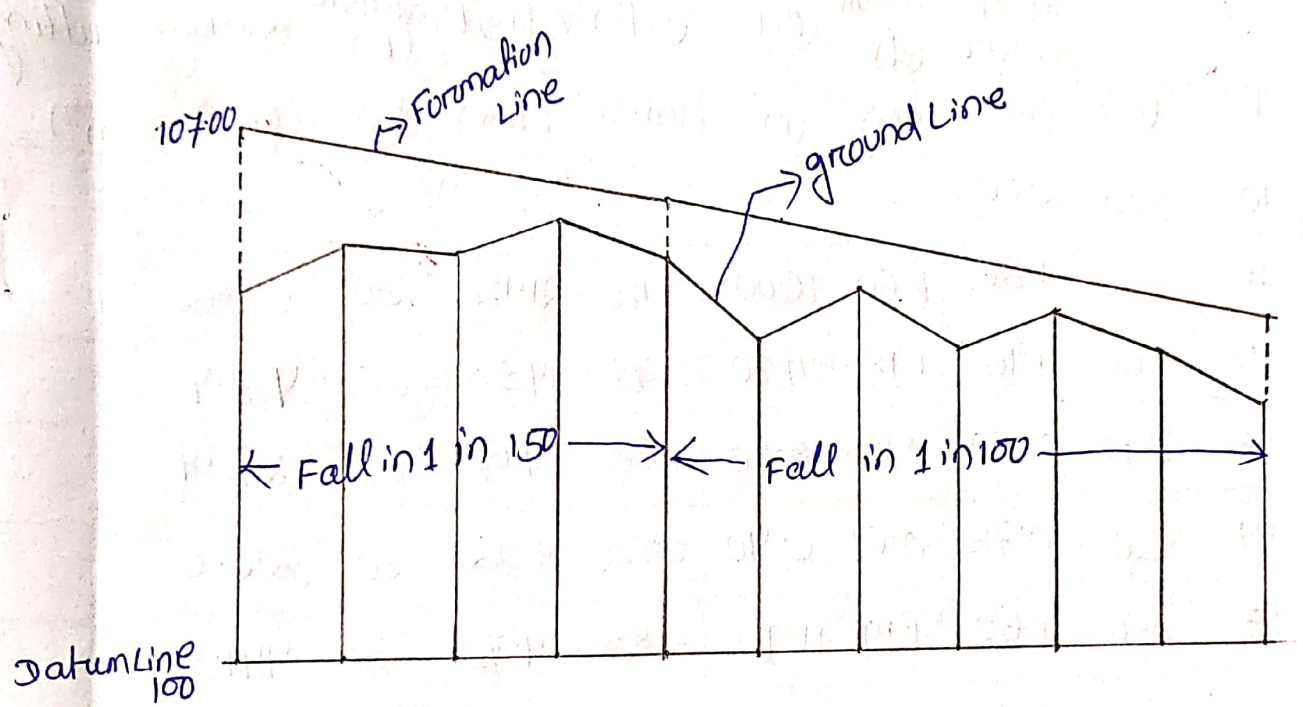
= 3288 Cum

Ex-2 Reduced level of ground along the centre line of a proposed road from chainage 10 to chainage 20 are given below. The formation level at the 10th chainage is 107 and the road is in downward gradient of 1 in 150 upto the chainage 14 and then the gradient changes to 1 in 100 downward. Formation width of road is 10 meter and side slopes of banking are 2:1 (H:V) Length of chain is 30 m.

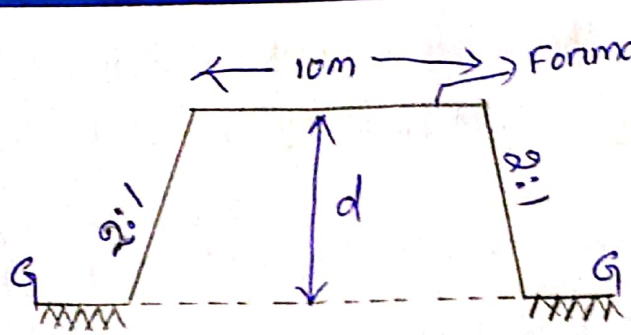
Draw longitudinal section of the road and a typical cross-section and prepare an estimate of earth work at the rate of Rs 875.00 /. cum.

Find also the area of the side slopes and the cost of the turfing the side slopes at the rate of Rs 60.00 / sq.m.

Chainage	10	11	12	13	14	15	16	17	18	19	20
R.L of Ground	105.00	105.60	105.44	105.90	105.42	104.30	105.00	104.10	104.62	104.00	103.3
R.L of Formation	107.00										
Gradient	Down Gradient 1 in 150 →					← Down Gradient 1 in 100 →					



(L-Section)



(Cross section of Banking)

Calculation of Quantities of Earth Work

B = 10m, S = 2

Stations or chainage (m)	Length (m)	Height or Depth diff. of G.L & F.L (m)	Mean height or depth (d) (m)	Central Area (Bd) (m^2)	Side Area (Sd^2) (m^2)	Total sec. Area ($Bd+Sd^2$) (m^2)	Length in between stations (L) (m)	Quantity $\frac{(Bd+Sd^2)}{2}+L$ Banking (m^3)	Cutting (m^3)
10	300	2.00	–	–	–	–	–	–	–
11	330	1.20	1.60	16.00	5.12	21.12	30	633.60	
12	360	1.16	1.18	11.80	2.78	14.58	30	437.4	
13	390	0.50	0.83	8.30	1.38	9.68	30	290.4	
14	420	0.78	0.64	6.40	0.82	7.22	30	216.6	
15	450	1.60	1.19	11.90	2.83	14.73	30	441.9	
16	480	0.60	1.10	11.00	2.42	13.42	30	402.6	
17	510	1.20	0.90	9.00	1.62	10.62	30	318.6	
18	540	0.38	0.79	7.90	1.25	9.15	30	274.5	
19	570	0.70	0.54	5.40	0.58	5.98	30	179.4	
20	600	1.10	0.90	9.00	1.62	10.62	30	318.6	
								Total = 3513.6 cum	

Abstract of Estimated cost.

Item No.	Particulars of Items	Quantity	Unit	Rate Rs. P.	per	cost Rs. P.
1.	Earthwork in banking	3513.6	cum	275.00	% cum	9662.40
				Total		9662.40
	Add 5% (3% for contingencies and 2% for Workcharged Establishment)					483.12
				Grand Total		Rs 10145.52

Calculation of Areas of side slopes

$S = 2$, $\sqrt{S^2+1} = 2.236$

Station or chainage	Height or Depth	Mean Ht. or depth (d) (m)	Sloping breadth of side slope $d\sqrt{S^2+1}$ (m)	Length L (m)	Area of both side slopes $2Ld\sqrt{S^2+1}$ (m^2)
10	2.00	–	–	–	–
11	1.20	1.60	3.58	30	214.80
12	1.16	1.18	2.64	30	158.40
13	0.50	0.83	1.86	30	111.60
14	0.78	0.64	1.43	30	85.80
15	1.60	1.19	2.66	30	159.60
16	0.60	1.10	2.46	30	147.60
17	1.20	0.90	2.01	30	120.60
18	0.38	0.79	1.77	30	106.20
19	0.70	0.54	1.21	30	72.60
20	1.10	0.90	2.01	30	120.60
				Total	1297.80 Sq m.

Abstract of cost of Turfing.

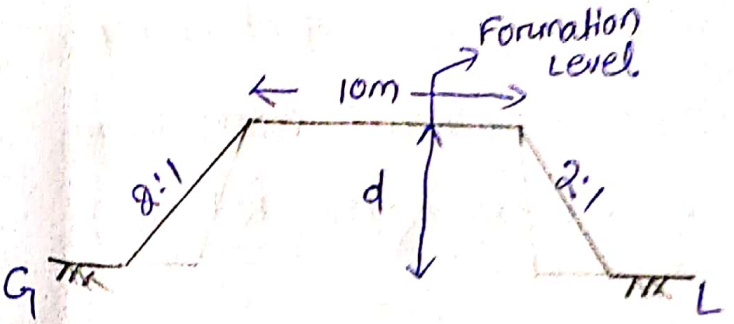
Item No.	Particulars of Items	Quantity	Unit	Rate Rs. P.	Per	Cost Rs.	Cost P.
1.	Turfing in both sides	1297.80	sqm	60.00	Y.sqm	778.	68
				Total		778.	68
Add 5%. (3% for contingencies and 2% for workcharged Establishment)						38.	93
				Grand Total		=Rs 817.	61

Ex-3 Estimate the cost of earth work for a portion of road for 400 meter length from the following data:-

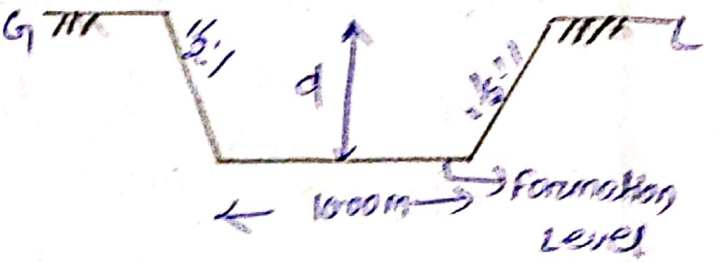
Formation width of the road is 10 meter. side slopes are 2:1 in banking 1½:1 in cutting.

Station	Distance in meter	R.L. of Ground	R.L of Formation
25	1000	51.00	52.00
26	1040	50.90	
27	1080	50.50	
28	1120	50.80	
29	1160	50.60	
30	1200	50.70	
31	1240	51.20	
32	1280	51.40	
33	1320	51.30	
34	1360	51.00	
35	1400	50.60	

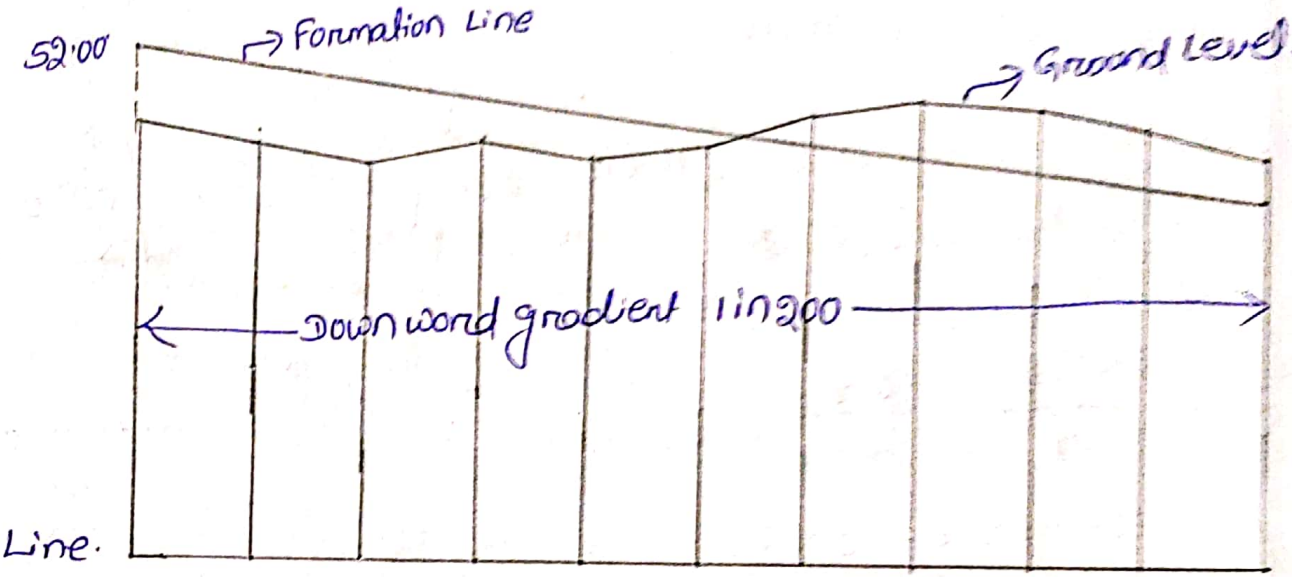
Downward gradient of 1 in 200



(Cross section in Banking)



Cross section in cutting.

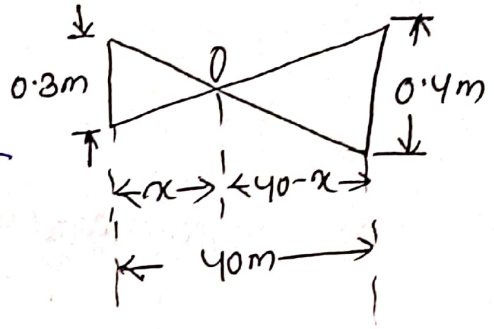


Depth of cutting.						0.40	0.80	0.90	0.80	0.60 meter
Height of Bank	1.00	0.90	1.10	0.60	0.60	0.30				meter
R.L of Formation.	52.00	51.80	51.60	51.40	51.20	51.00	50.80	50.60	50.40	50.20 50.00 meter
R.L. of Ground	51.00	50.90	50.50	50.80	50.60	50.70	51.20	51.40	51.30	51.00 50.60 meter
Dist. in meter	1000	1040	1080	1120	1160	1200	1240	1280	1320	1360 1400 meter
Station	25	26	27	28	29	30	31	32	33	34 35

(L-Section)

The road passes from banking to cutting in between the stations 30 (1200m) and 31 (1240m). When it passes from banking to cutting the R.L of Ground & the R.L of formation is same.

The distance of the point where it changes from banking to cutting from station no. 30 (1200) is determined by the following method.



The two triangles on either side of the zero (0) point are symmetrical.

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

$$\Rightarrow 12 - 0.3x = 0.4x$$

$$\Rightarrow 12 = 0.7x$$

$$\Rightarrow x = \frac{12}{0.7} = 17.14\,m. \simeq 17m.$$

$$\therefore 40 - x = 40 - 17 = 23m.$$

Calculation of Quantities of Earth work.

B = 10m, S = 2 for banking, S = 1½ = 1.5 for cutting.

station	Distance in (m)	Height or depth diff. of GL & FL (m)	Mean height or depth (d) (m)	central Area (BD) (m^2)	Area of ends (sd^2) (m^2)	Total cross Area $(B+sd)d^2$ (m^2)	Dist. in between stations (L) (m)	Quantity $(B+sd)d^2 \times L$	
								Banking (m^3)	cutting (m^3)
25	1000	1.00	–	–	–	–	–	–	–
26	1040	0.90	0.95	9.50	1.81	11.31	40	452.40	
27	1080	1.10	1.00	10.00	2.00	12.00	40	480.00	
28	1120	0.60	0.85	8.50	1.45	9.95	40	398.00	
29	1160	0.60	0.60	6.00	0.72	6.72	40	268.80	
30	1200	0.30	0.45	4.50	0.41	4.91	40	196.40	
Passes from banking to cutting.									
–	1217	0.00	0.15	1.50	0.05	1.55	17	26.35	
31	1240	-0.40	-0.20	2.00	0.06	2.06	23		47.38
32	1280	-0.80	-0.60	6.00	0.54	6.54	40		261.60
33	1320	-0.90	-0.85	8.50	1.08	9.58	40		383.20
34	1360	-0.80	-0.85	8.50	1.08	9.58	40		383.20
35	1400	-0.60	-0.70	7.00	0.74	7.74	40		309.60
(-ve sign indicates cutting)						Total		1821.95 cum	1384.98 cum

Abstract of cost.

Item NO	Name of Items	Quantity	Unit	Rate Rs. P.	per	Cost Rs.	P.
1.	Earth work in banking	1821.95	cum	275.00	y. cum	5010	.36
2.	Earth work in cutting	1384.98	cum	350.00	y. cum	4847	.43
					Total	9857	.79
Add 3% for contingencies						295	.73
Add 2% for workcharged establishment						197	.16
					Grand Total	10350	.68

Detailed Estimate of a Water bound macadam Road.

(Road Material Calculation)

Ex-1 Estimates the item involved for construction of a road from the following data.

length of the road = 150m

Formation width = 10m

metal width = 8m

Thickness of grade-1 metal soaling = 90mm, wearing coat of grade-2 metal = 12cm thick loose and 8cm thick compacted surface to be finish with two coats of bitumen as given below.

First finishing coat = 12mm chips @ 0.020 m^3 and bitumen @ 1.24 kg/m^2 of road surface.

second finishing coat = 6mm chips @ 0.020 m^3 and bitumen @ 1.24 kg/m^2 of road surface.

consumption of fuel @ 0.45 kg / kg of bitumen.

SL NO	Name of the Items	Nos	Length	Breadth	Height or Depth	Quantity	B.N.
01.	cleaning of site	1	150	10	-	1500 sqm	
02.	Grade-I metal soaling	1	150	8	0.09	108.0 cum	
03.	Grade-II metal soaling	1	150	8	0.12	144.0 cum	
04.	12mm size chips at 1st wearing coat @ 0.020 m^3/m^2 at road	1	150	8	@0.020 m^3/m^2	24 cum	

SL NO	Name of the Items	NOS	Length	Breadth	Height or Depth.	Quantity	E.N.
5.	Quantity of bitumen in first finishing coat @1.24 kg/m2 at road surface	1	150	8	@1.24 kg/m2	1488 kg	
6.	6mm size chips in second finishing coat @0.02 m3/m2 of road	1	150	8	@0.020 m3/m2	24 kg.	
7.	Quantity of bitumen in 2nd finishing coat @1.24 kg/m2. at road surface	1	150	8	@1.24 kg/m2	1488 kg	
8.	Quantity of fuel @0.45 kg/kg of bitumen.	(1488+1488. = 2976 kg)			@0.45 kg/kg. of bitumen	1339.2 kg.	

Ex-2 Estimate the required quantity of dry materials required for the construction of road length 2km metal width 3.8m, thickness of metal soaling is 100mm. Thickness of wearing coat consolidated is 80 mm. The surface of the road is to be finished with 2 coats of bitumen. First coat finish is 12 mm size chips @ 0.018 m3 and bitumen @1.2 kg/m2 of road surface. second coat finishing is 6mm size chips @ 0.009 m3 and bitumen @1.2 kg/m2 of road surface fuel is 0.3 kg/kg of bitumen.

Sl No.	Name of the Items	NOS	Length	Breadth	Height or Depth.	Quantity	B.N.
01.	Cleaning of site	1	2000	5.3	—	10600 Sqm.	B=3.8+2x0.7 = 5.3m
02.	metal soaling	1	2000	3.8	0.1	760cum	
03.	Wearing coat	1	2000	3.8	0.12	912cum	80mm consolidated of the loose it is 120 mm.
04.	12mm size chips in 1st finishing coat @ 0.018 m^3/m^2 of road surface	1	2000	3.8	@0.018 m^3/m^2 of road surface	136.8 cum	
05.	Quantity of bitumen in 1st finishing coat @1.2kg/m^2 of road	1	2000	3.8	@1.2kg/ m^2 of road	9120kg	
6.	6mm size chips in 2nd finishing coat @ 0.009 m^3/m^2 of road surface	1	2000	3.8	@0.009 m^3/m^2 of road	68.4 cum	
7.	Quantity of bitumen in 2nd finishing coat @ 1.2kg/m^2 of road surface	1	2000	3.8	@ 1.2kg /m^2 of road surface	9120kg	
8.	Quantity of fuel @ 0.3kg/kg of bitumen.	(2X9120 = 18240kg)			@ 0.3kg per kg of bitumen.	5472kg.	

Ex-2 Estimate the item involved for construction of a 3.0 m road for the following data.

Length of Road = 120 m.

Metal soaling = 5 m.

Thickness of grade-I metal soaling = 80 mm wearing coat of grade-II metal - 120 mm loose consolidated to 80 mm thick. Surface of road is to be finish with two coat of bitumen as given below.

1st finishing coat = 12 mm chips @ 0.015 m^3 and bitumen @ 1.32 kg/m^2 of road surface.

2nd finishing coat is 6 mm chips @ 0.01 m^3 and bitumen @ 1.32 kg/m^2 of road surface.

consumption of fuel @ 0.45 kg/kg of bitumen.

Sl No	Name of the Items	NOS	Length	Breadth	Height or Depth	Quantity	R.M.
01	cleaning of site	1	120	8	-	960 Sqm	B = 5 + 2x1.5 = 8m
02	Grade-I metal soaling	1	120	5	0.08	48 cum	
03	Grade-II metal soaling	1	120	5	0.12	72 cum	
4	12 mm size chips @ 0.08 m^3/m^2 of road surface	1	120	5	0.08	108 cum	

Sl No.	Name of the Items	Nos	Length	Breadth	Height or Depth	Quantity	B.N.
5.	Quantity of bitumen in 1st finishing coat @ 1.22 kg/m² of road surface	1	120	5	1.22 kg/m² of road surface	732 kg	
6.	6mm size chips @ 0.01 m³/m² of road surface	1	120	5	0.01 m³/m² of road surface	6 cum.	
7.	Quantity of bitumen in 2nd finishing coat @ 1.22 kg/m² of road surface	1	120	5	1.22 kg/m² of road surface	732 kg	
8.	Quantity of fuel @ 0.45 kg/kg of bitumen	1	(732+732) = 1464 kg		@ 0.45 kg/kg of bitumen	658.8 kg.	

Ex-4 Estimate the following quantity for construction of a WBM road for 1 km length having following specifications.

Formation width of the road = 10 m.

Avg. height of bank = 1 m.

Side slope of bank = 2:1

Metal width of road = 3.8 m.

Soaling coat of overburnt brick laid flats i.e. 10 cm thick. Inner coat of metalling shall be

of stone ballast of 12 cm thick loose layer compacted 8 cm. Top coat of metaling shall be of stone ballast of 9 cm thick loose layer compacted to 6 cm (4 cm to 5 cm gauge)

(1) Earth work in Excavation

(2) Numbers of brick for soaling

(3) Quantity of bitumen.

Soln

Given Data

Road length (L) = 1 km = 1000 m

Formation width (B) = 10 m

Avg. height of bank (d) = 1 m.

side slope = 2:1, s = 2

metal width of road = 3.8 m

Thickness of brick = 10 cm.

Inner coat = 12 cm loose compacted to 8 cm.

Top coat = 9 cm loose compacted to 6 cm.

(1) Earth work in Excavation. :-

$$Q = V = (Bd + sd^2) \times L$$

$$= (10 \times 1 + 2 \times 1^2) \times 1000$$

$$= (10 + 2) \times 1000$$

$$= 12000 \text{ cum.}$$

(2) Number of Brick

Quantity of brick soaling.

$= 1 \times 1000 \times 3.8 \times 0.10$

$= 380$ cum.

1 cum = 500 Nos of brick

For 380 cum = 380×500 = 1,90,000 nos of brick.

Inner coat stone ballast 12 cm compacted to 8 cm.

$= 1 \times 1000 \times 3.8 \times 0.2 = 456$ cum.

Top coat of stone ballast 9 cm compaced to 6 cm.

$= 1 \times 1000 \times 3.8 \times 0.09 = 342$ cum.

(3) Quantity of Bitumen

Quantity of bitumen @ 220 kg / 100 sqm of road surface.

Area of road surface = $1000 \times 3.8 = 3800$ Sqm.

Quantity of bitumen = $3800 \times \frac{220}{100} = 8360$ kg.

PWD ACCOUNTS WORKS

WORKS

For any original work, the Engineering Dept. prepares a proposal on the basis of preliminary estimate, from the requirements and informations supplied by the department concerned. The Department after due consideration approves the proposal with respect to the work and fund, and convey their approval or administrative sanction to the Engineering Dept.

Ex For a hospital building the medical dept. will first initiate the proposal and will ask P.W.D for preparing a preliminary estimate. The P.W.D will prepare the preliminary estimate which shall be formally approved by the Medical Dept.

The Engineering Dept. then prepares the detailed estimate after necessary surveying, preparing plan and designing. The detailed estimate is then technically sanctioned by the competent authority of the Engineering Dept. The detailed estimate is prepared by the Asst. Engineer with the help of the J.E and with the guidance of the Executive Engineer. The estimate is then checked by the computer and technically sanctioned by the Executive Engineer, if within his competence, or otherwise sent

to the higher authorities for technical sanction

Classification of works according to their nature

The works according to their nature are classified under the two main categories.

1. Original work -: The original work may be of different types.

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

(ii) Additions and alterations to the existing work will increase the value of the property as - Addition of room or rooms, conversion of verandah into room, dividing a big room into 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 and windows etc.

2. Repair work -: The repair works may be of the 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 as - opening a door, providing sunshades, providing shelves etc.

(iii) special repair, Monsoon damage repair, etc.

classification of works according to their cost

With respect to the cost, the original work is classified as Major work, Minor work and petty work.

Major Work -:

The work costing more than Rs. 2 lakhs is termed as Major work, and the estimate for such work is known as Major Estimate.

Minor Work -:

The work costing more than Rs. 50,000.00/- but not exceeding Rs. 2 lakhs is known as Minor work and the estimate for such work is known as minor estimate.

Petty Work -:

The work whose cost does not exceed Rs. 50,000.00/- is known as petty work and the estimate is known as petty Estimate.

According to the C.P.W.D. Account code, the work costing more than Rs. 75,000.00/- is termed as Major work and major estimate, and the work costing up to Rs. 75,000.00/- is termed as minor work or minor estimate.

different types of Repairs work:

(1) Annual repair or Maintenance work (A.R. work) -:

All works and structures are repaired and maintained in proper condition. The normal repair works done annually, come under A.R. work.

All buildings are white washed, colour washed and repaired for minor repairs once in every year. For annual repair of building 1 to $1\frac{1}{2}$ percent of the original constructional cost of the whole building is provided. A.R. work is usually done by contract. by inviting tenders or quotations. For maintenance and repair, money is alloted in the budget under Annual Repair and maintenance Head. Annual repair works are ~~executed~~ executed by the dept. concerned as - Medical dept. buildings are maintained by the medical dept, police dept. buildings are maintained by police dept.

(2) Quadrantal / Quadrennial Repair -:

Besides annual repair work of white washing and colour washing, every fourth year special repair works are done for thorough repair as repainting of doors and windows, patch repair of plastering, etc. special repair work every fourth year is known as Quadrennial Repair.

(3) Special Repair (S.R) :-

Special repair work consist of renovations or renewals of structures or damaged works. It generally consists of renewal of floor, roofs and other items of working involving replacements occuring at long intervals. Special repairs also comprise minor improvements in the building, etc.

Repair of monsoon or flood damage works also come under special repair work.

Contract

An aggrement enforceable by law is contract. The contract invariably follows a proposal from one party and its acceptance by the other. In absence of any of the above elements of a contract it becomes void, i.e. without a legal effect or voidable i.e. which can be avoided by any of the parties to it.

"Or"

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 and repairs, for the supply of materials, for the supply of labour, for the transport of materials, etc.

Contractor

The term contractor means a person or

firm who undertakes any type of contract. Usually, this term is confined to the contractors engaged for the construction or execution of works of repairs.

Contract system

In contract system the work is got done through contractors who arrange all material required and employ the workers required for the completion of the work in time. A contract aggrement is a bond, the contractor and the dept. are bound by the terms and conditions of the contract.

The contract aggrement stipulates the quantities of works and rates, the detailed specifications of various items of work to be done, the time limit within which the whole work shall have to be completed and various other conditions. Contracts are usually arranged by inviting sealed tenders and entrusting the work to the lowest tender usually.

Work order

Small work up to ₹2,000.00/- 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 the whole work, penalty that will be imposed for not fulfilling terms & conditions, etc. payment is made on the measurement of the workdone and 10% of the bill amount

is deducted from the running account bill of the contractor as security money which amount is refunded in the final payment on the satisfactory completion of the work.

~~Piece work Agreement~~

Piece work Agreement (P.W.A)

P.W. Agreement is that where only rates are agreed upon without reference to the total quantity of work or time, and that involves payment of work done at the stipulated rate. Small works or piece-work up to Rs. 2,000.00/- may be carried out through contractors by piece-work Agreements. The P.W. Agreement contains only the descriptions of different items of works to be done and the rate to be paid for but does not provide the quantities of different items to be executed nor the time within which the work is to be completed. Detailed specifications of the different items of work to be done are however included in the P.W. Agreements and the total cost of the whole work to be done is also mentioned. Contractors have to arrange all materials, labours etc., required for the execution of the work, P.W. Agreements, are not contracts in the true sense, there is no penalty clause and no security money, and the dept. may terminate the work at any time

they like but a notice specifying the date of termination should be served to the piece worka. payment is made on the measurement of the work actually done.

Under special circumstances work up to Rs. 7,500.00/- can also be executed by P.W.A.

Different types of Contracts.

(1) Item rate contract:-

It is also known as Unit-price contract or schedule contract. For Item rate contracts, contractors are required to quote rates for individual items of work on the basis of schedule of quantities furnished by the dept. This schedule indicates full nomenclature of the items as per sanctioned estimate, estimated quantities and unit therein. While filling up the rates, the contractors are required to express the amount in figures and words and also to work out the cost against each item. The final total of the amount tendered for the work is also drawn up by them. This type of contract is followed by Railway Dept.

(2) Lumpsum Contract:-

In this contract the contractors undertakes the execution or construction of a specific work with all its contingencies, to complete it in all respect within a specified time for fixed amount.

The detailed specification of all items of works pertaining to the whole work, plans and detailed drawings, and deposit of 10% security money, penalty, progress and other conditions of contract are included in the contract agreement. The general specification and description of different part of the building with dimensions where required are included. The quantities or schedule of different items of work are not provided, the contractor shall have to complete the work as per plan and specification, within the contract fixed sum, within a fixed time irrespective of qualities of different items. On completion of the work no detailed measurement of different items of work is required but the whole work is compared and checked with plans and drawings.

(3) Labour Contract :-

On this type of contract the contractor under takes contract for the labour portion. All materials for the construction are arranged and supplied at the site of work by the department or owner, the labour contractor engages labour and gets the work done according to the specification. The contract is on item rate basis for labour portion only and contractor is paid for the quantities of work done on measurement of the different items of work at the stipulated rate in the contract agreement.

Materials for scaffolding, centering and shuttering and other similar materials are supplied by the dept or owner; contractor may also use his own materials for scaffolding, centering and shuttering etc, if provided in the agreement. Contractor uses his own tools for working, but plants and machineries are arranged by the dept. or owner.

This system of contract is not generally adopted in the Govt. dept.

(4) Schedule Contract -:

This is similar to lumpsum 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 specification and conditions, and the schedule of rates for various items of work are also provided which regulates the extra amount to be paid or deducted for any additions and alteration. In this case also no measurement of various items of work involved in the original coork is required, but measurement of extra items only shall have to be taken.

(5) 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 and keeps proper account and he is paid by the department or owner the whole cost together with certain percentage, say 10% as his profit as agreed upon before hand. An aggrement is prepared with all conditions of contract in advance. In this case proper control in the purchase of the materials and in labour shall have to be exercised by the department or owner.

Accounts of Works

Administrative approval -:

For any work or project required by the department, an approval or sanction of the competent authority of the department, with respect to the cost and work is necessary at the first instance. The approval authorities the engineering department to take up the work.

Administrative approval denotes the formal acceptance by the department concerned of the proposal, and after the administrative approval is given the engineering department (P.W.D) take up the work and prepares detailed design, plans and estimates and then executes the work. The engineering department prepares approximate estimate and preliminary plans and submits to the department concerned for administrative approval.

Technical Sanction :-

Technical sanction means the sanction of the detailed estimate, design calculations, quantities of works, rates and cost of the work by the competent authority of the engineering department. After the technical sanction of the estimate is given, then only the work is taken up for construction. In case of original work the counter signature of the local head of the department should be obtained in the plan and estimate before technical sanction is accorded by the engineering department. The power for Technical sanction differs from state to state.

Contingencies :-

The term "contingencies" indicates incidental expenses of miscellaneous character which cannot be classified under any distinct item sub-head, yet pertain to the work as a whole.

In an estimate a certain amount in the form of contigencies of 3% to 5% of estimated cost, is provided to allow for the expenses for miscellaneous petty items which donot fall under any sub-head of items of work.

Tender :-

Tender is an offer in writting to execute some specified work or to supply some specified articles at certain rates, within a fixed time under certain conditions of contract and agreement

between the contractor and the department or owner or party. The construction of work is usually done by contract. Sealed tenders are invited and the work is usually entrusted to the lowest tender. While inviting tenders the bill of quantities, detailed specifications, conditions of contract and plans and drawings are supplied on payment of the requisite cost to the contractors who tender or quote their rates.

Tender Notice :-

Tenders for work or supply are invited by issuing tender notice in 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 & conditions
(vi) Date, time and place of tender,
(vii) Amount of earnest money and security money
(viii) validity of tender, etc.

Tender notice is posted in the notice board of the department and for major work the tender notice in brief is also given in the newspaper.

Earnest money :-

While submitting a tender the contractor is to deposit a certain amount, about 2% of the estimated cost, with the department, as earnest money as guarantee of the tender. This amount is for a check so that the contractor may not refuse to accept the work or runaway when his tender is accepted. In case the contractor refuses to takeup the work his earnest money is forfeited. Earnest money of the tenderer whose tender has not been accepted is refundable. The amount of earnest money depends on the estimated cost. Earnest money should be in cash or encashable at any time. It may be in the form of deposit in Treasury or state bank or other approved Bank or Government security, or saving certificate or post office, saving pass-Book or cash certificate, pledged to the Executive Engineer.

Security money/Deposit :-

On acceptance of the tender, the contractor has to deposit 10% of the tendered amount as security money with the department which is inclusive of the earnest money already deposited. This amount is kept as a check so that the contractor fulfils all the terms and conditions of the contract and carries out the work

satisfactorily according to the specifications and maintain progress and completes the work in time. If the contractor fails to fulfil the terms of contract his whole or part of the security money is forfeited by the department. The security money is refunded to the contractor after the satisfactory completion of the whole work after a specified time, usually after one rainy season or six months of the completion of the work.

Payment

The payment to the contractor may be made finally by one payment when the work or the supply completed or by number of payments by running accounts bills during the progress of the work. Usually, Payment are made on running account bills and the final payment is made on the completion of the work. For small work payment is made by one payment.

Advance payment :-

This means payment made on a running account, made to a contractor for work done by him but not measured. Advance payment is not generally made to the contractor, but may be made under special cases when the work is

sufficiently progressed but measurement cannot be taken for certain valid reason, on the certificate of the Asst. Engineer in charge of work that the value of work done is in no case less than the advance payment made or proposed to be made and detailed measurement will be taken as soon as possible.

On account / Running / Interim Payment :-

This means payment made on a running account to a contractor for works done or supplies made by him duly measured and entered in M.B. When only a part of the whole work or supply has been done and the work or supply is in progress. During the progress of work the contractor is paid time to time and when the contractor has done some progress he is paid upto the extent of work done by him.

Intermediate payment :-

The term applied to a disbursement of any kind of a running account not being the final payment. It includes an "Advance payment", a "secured Advance" and an "On account payment", (other than the final payment on a running account) or a combination of these.

Final payment –:

This means the payment made on running account, made to a contractor on the completion or determination of his contract and in full settlement of the account. The bill on which final payment is made is known as "Final Bill".

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. It contains full and clear particulars of the claim or amount due. Reference to the agreement No. is also given in the bill.

Running Bill –:

Running account Bill means a Bill for the payment of "on account" moneys to the contractor as per the terms and conditions of agreement made between the Ministry and the tenderer.

First & Final Bill –:

This form is used for making payment to the contractor both for works and suppliers, when a single payment is to be made on the completion of the whole work or supply as final payment.

This type of bill is generally adopted for petty works or split up works in projects.

Regular establishment -:

More than five years of service in the work-charged establishment or to any work-charged employee, who has completed different natures, such as permanent establishment, commonly known as regular establishment.

Temporary establishment -:

It means an establishment the operates for a period of no more than fourteen(14) consecutive days in conjunction with a single event.

Cash -:

The term cash includes legal tender coins notes, cheques payable on demand, remittance transfer receipts and demand drafts. A small supply of revenue stamps (required for a acknowledgement of receipts) may be kept as part of the cash balance.

Major & sub-head accounts

The main unit of classification in accounts shall be the "major head" which shall be divided

in to minor heads, each of which shall have a number of subordinate heads, generally shown as sub-heads. The sub heads are further divided in to detailed heads.

Major head account -: Establishment charges, cost of purchases.

Sub-head account -: Rent, Rates and Taxes, Electricity charges, Telephone,

Temporary advance

It is also known as "Temporary Imprest" is the amount which is advanced by a Disbursing officer to a sub-ordinate officer to enable him to make a number 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.

Issue Rate.

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

An issue rate is fixed for each article of stock on the basis of actual cost plus other expenses including storage charges. The issue rate is fixed on the principle that there may not be ultimate profit or loss in the stock account and the rate should include the actual cost of materials in procuring, handling them and storage charges.

The 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. Issue rate is the rate of supply at stock godown plus the storage charge

Storage charges

This means expenditure incurred on stone materials after the acquisition of stores, on workcharged establishment employed on handling and keeping initial accounts, the custody of stock and the maintenance of stone godown or yards, etc. and added on a percentage basis of the cost, so as to form part of the issue rate.

Supervision charges:

This term is ordinarily applied to the charges which are levied, in addition to book value and storage charge (issue rates) in respect of stock materials sold or transferred and are intended to cover such items of expenditure incurred on the stores as do not enter in their book value and are not included in storage charges. When the stock material are sold or transferred a certain percentage about 10% is charged over issue rate as supervision charges which is meant for expenditure on regular establishment.

Suspense Account

A suspense account is an account used to temporarily store transactions for which there is uncertainty about where they should be recorded. Once the accounting staff investigates and clarifies the purpose of this type of transactions, it shifts the transaction out of the suspense account and in to the correct account.

Debit and Credit

Debit means expenditure and credit means receipts. When an amount is to be debited to a work means that the amount is to be shown

as expenditure on the work. Similarly when an amount is to be credited to a work it means that the amount is to be shown as receipt under the work.

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. The cash book is one of the most important record and posted and maintained correctly day to day in the Divisional office and sub-Divisional office.

Book transfer

A book transfer is the transfer of the legal right of ownership of an asset, without physically shifting the asset to the new owner. The most common use of the concept is when a bank transfers funds from the account of the payer to the account of the payee when both accounts are with the same bank.

Voucher

Voucher is a written document with details which is kept in record as a proof of payment. For any payment first, a bill is prepared and payment is made on the bill duly checked and acknowledged by the

payee, by signature on revenue stamp as required, and after the payment is made bill becomes voucher document which is kept in record.

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. The measurement books are very important account records.

Form 23- Measurement Book

Particulars	Detail of Actual measurement				contents of area
	No.	L	B	D	

All measurement book 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 the sub-divisional office showing the names of the officers, to whom issued, date of issue, date of return, etc.

points to be observed in recording measurement.

→ The measurements are recorded by the executive or Asst. Engineer; or sectional officers (Overseers) to whom measurement books have been issued for the purpose. The measurement of the works are taken accurately and recorded neatly for the 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 the measurement book. The description of items of works or supplies should be clear so that there may not be any ambiguity.

→ All measurements should be recorded in ink directly in the measurement book and nowhere else. Entries with indelible pencil is admissible but the pencil entries should not be inked over. The entries in the content or area column should be made in ink after necessary calculations. No entry should be erased if a mistake is made it should be corrected by crossing out and inserting the corrections, and the correction thus made being initialled and dated.

→ The pages of the M.B. 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 initialled and attested and dated.

→ Separate M.B should be used for the works done by the contractor and by the departmental labour.

→ Each M.B. should be provided with an Index of the contents of different ~~entries~~ entries at the space provided at the beginning, which should be kept up-to-date.

→ Loss of M.B. is a serious matter and is to be reported to the higher authorities. When a M.B cannot be traced for a month the fact should be reported to the S.E. who has to take suitable action in the matter.

Standard Measurement Book (S.M.B)

A Measurement Book where the detailed measurements of certain items of works of a building is recorded correctly in ink on the completion of the construction, and the accuracy of which is certified by an Asst. Engineer, is known as the "Standard Measurement Book". The 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 contractors are made on the basis of measurements in the Standard Measurement Book. S.M.B is checked every five years and alteration if any are entered in the S.M.B which is known as quinquennial checking. The S.M.B is mainly used for annual repair and maintenance works. S.M.B is used and maintained in the same manner as ordinary measurement Book.

Muster Roll

Work may be executed departmentally by employing daily labour, as masons coolies, bhisties, carpenters etc. The attendance of the labourers is kept in muster roll. The wages of other day labourers are drawn on Muster Rolls.

M.R. Form provides columns for recording attendance for a month but the roll may be closed for payment earlier or on completion of the job. Payment is made by the official of highest standing available

at spot and proper acknowledgement obtained on the Roll.

→ The categories of skilled and unskilled workers employed on works are daily rated muster Roll labour whose daily attendance and outturn are recorded for the purpose of payment. The work is executed under direct supervision of the sectional officer or sub-Divisional officer concerned and may be inspected by higher officers.

→ The muster Roll being the initial record of employment and payment is deal with and preserved carefully at all levels. On receipt of a requisition from the sub-Divisional officer, the Divisional officer after considering the necessity and urgency of the work and strength of labour required issues a blank form duly registered and numbered in his office indicating the period, the maximum number of labourers to be employed and their corresponding daily wages on it.

Rules for Preparation of muster Roll

The muster Rolls are prepared and dealt in accordance with the following rules -:

(i) One or more muster rolls may be kept for each work, but M.R should not be prepared in duplicate. It is permissible to keep one M.R for labourers employed on several small work in near about places.

(ii) Labourers may be paid more than once in a month, but separate M.R must be prepared for each period of payment.

(iii) The daily attendance and absence of labourers and fines, if any, imposed on them should be recorded in ink daily in the M.R so that the calculations may be done correctly and it may not be possible to temper with the attendance and entries and classification of cost on works and sub-heads of works may be kept separately.

(iv) After a M.R has been passed, payment should be made as quickly as possible, and each payment is initialled and dated by the paying officer. If any item remains unpaid the details of such items should be recorded in the Register of unpaid wages.

(v) The amount of unpaid wages is deposited in the cash and the amount is kept as deposit. The amount may be paid later on Hand Receipt.

Aequittance 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 "Aequittance Roll", after taking duly stamped signature of the person. The Aequittance 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 Aequittance 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

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 muster Roll in a prescribed form and is submitted daily

to the S.D.O or Executive Engineer for control and check. The report shows the name for the work, the number of each class of labourer employed on each work, the rate of wages, and the approximate quantity of work done. The labour report is compared with the M.R. as soon as it is received in the S.D.O or Divisional office and discrepancies, if any are investigated and necessary action taken. Labour report ~~is compared with the~~ form in duplicate in a book form, one copy is submitted and the counterpart is retained by the overseen.

Labour Report

Daily report of the day

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

Signature _____ Date _____.

classification of stores

The stores are divided into the following cases -:

(i) Stock of General store,
(ii) materials charged direct to the works.
(iii) Road metal &.
(iv) Tools and plants.

The four classes of stores fall in to two categories with respect to accounts, as given below :

I. Store charged to suspense – (i) Stock.

II. Store finally charged of { (ii) Materials charged direct to works. (iii) Road metal (iv) Tools and plants.

For convenience and quick execution of works each Division maintains stock of materials as cement, steel, timber, fittings etc. required for works from time to time. materials from the stock are issued to the works or to the contractors, cost recoverable, as and when required on an indent on the stock. One Asst. Engineer or S.D.O and one overseer remain in-charge of stock. A store keeper is also employed for all time work issue, receipt and recording. Stock account is maintained in the Sub-Divisional office and a separate account is also maintained in the Divisional office.

Stock Account

→ All transactions of receipt and issues of materials are recorded day-to-day in the "Register of stock Receipts and Issues" in Form 8 in the order of their occurrence as soon as they take place.

The account is maintained separately for every month and closed once in a month usually 25th of every month, except in the month of March when it closed on the 31st March. For a big stock when there are large number of transactions of receipt and issues, separate Register of stock Receipts Issues may be maintained, one for receipts and one for issues, instead of making entries in the same register in continuation.

→ 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 S.D.O or A.E, incharge of store to the Divisional officer for inclusion in the monthly Divisional account. The monthly returns (Abstract) of stock receipts and issues are then posted in the division in the "Half-yearly Register of stock" in Form 12.

→ Half-yearly balance returns of stock for every six months for the periods ending 30th sept. and 31st March are also prepared in Form 11 by the S.D.O or A.E. incharge of store from the monthly accounts.