

SWAMIVIVEKANANDA SCHOOL OF **ENGINEERING & TECHNOLOGY**

MADANPUR,BHUBANESHWAR



DEPARTMENT OF CIVIL ENGINEERING

LECTURE NOTES ON

ESTIMATION & COST EVALUATION-II

SEMESTER=5TH

PREPARED BY:-

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LECT. IN CIVIL

CULVERT:-

- Culvert is defined as a tunnel structure constructed under roadways or railways to provide cross drainage or to take electrical or other cables from one side to other.
- It is totally enclosed by soil or ground. Pipe culvert, box culvert and arch culvert are the common types used under roadways and railways.
- Generally the length between the faces of a abutment is 6m or less than 6m .
- It contains 4 wing wall and 2 abutment.

TYPES OF CULVERTS:-

- PIPE CULVERT
- PIPE ARCH CULVERT
- ARCH CULVERT
- BOX CULVERT
- BRIDGE CULVERT

BRIDGE:-

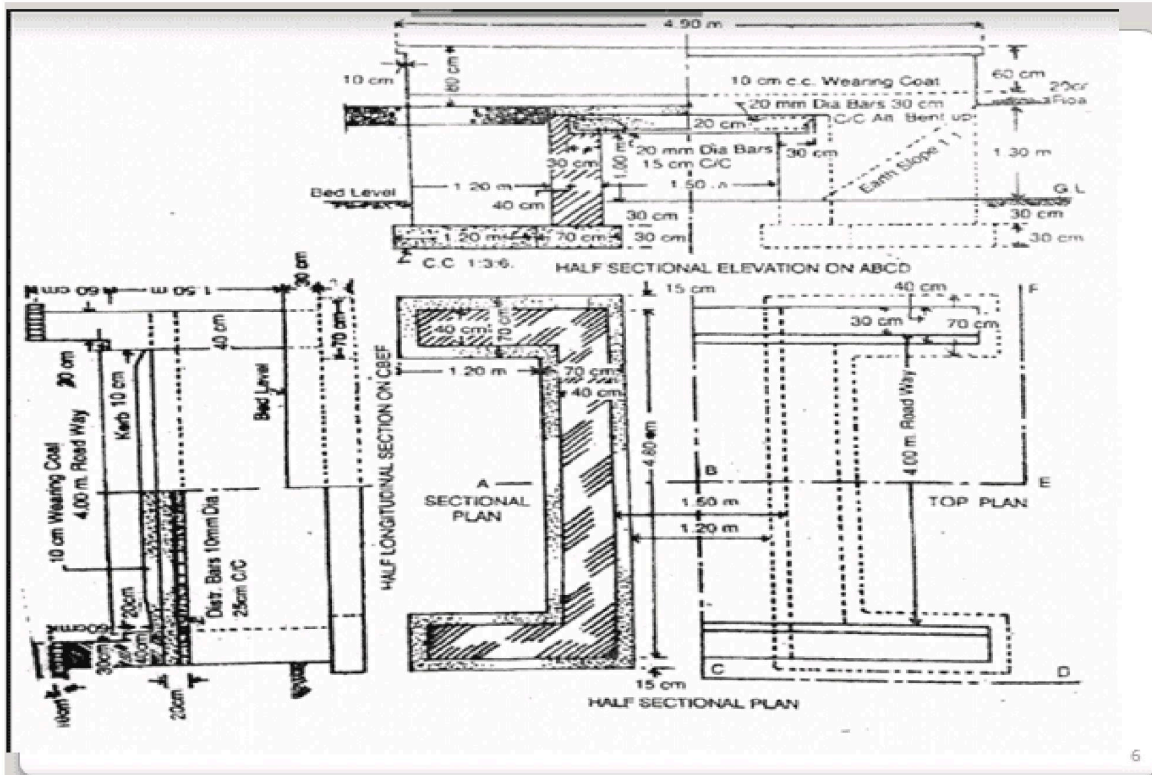
- A bridge is a passage of transportation (for people or vehicles) over a large body of water or physical obstruction.
- It is built to be strong enough to safely support its own weight as well as the weight of anything that should pass over it.

TYPES OF BRIDGE:-

- CULVERT BRIDGE
- MINOR BRIDGE
- MAJOR BRIDGE
- LONG SPAN BRIDGE

DIFFERENCE BETWEEN BRIDGE AND CULVERT:-

BRIDGE	CULVERT
<ul style="list-style-type: none">➤ Bridges are linear structures built over large bodies of water or physical obstruction and allow the passage of heavy and speeding vehicles.➤ A bridge spans from 6 meters (minor bridges) to more than 120 meters.➤ A bridge is usually a linear and straight passage.➤ Bridges provide an easier route of transportation that saves time and reduces distance.	<ul style="list-style-type: none">➤ Culvert is defined as a tunnel-like structure that facilitates the movement of water from one side to another and supports vehicular, human, and animal loads.➤ The length of culverts is typically not more than 6 meters.➤ Culverts are totally enclosed structures that can be semi-circular, rectangular, elliptical or pear-shaped.➤ Culverts prevent water logging, flood, and erosion, and allows water to flow its natural course under a roadway or railway.



RCC SLAB CULVERT

Details of Measurement and Calculation of Quantities (Ex. 1, Page No-376-377 B.N. DUTTA)

Item No.	Particulars of items of works	No.	Length M	Breadth M	Height Or Depth m	Quantity	Explanatory notes
1.	Earthwork in excavation in foundation – Abutments ... Wings Walls ...	2	5.10	0.70	0.60	4.28	cu m
		4	1.20	0.70	0.60	2.02	
					Total	6.30	
2.	Cement Concrete 1:3:6 In foundation with stone ballast – Abutments ... Wings walls ...	2	5.10	0.70	0.30	2.14	(1/2 of earthwork in excavation in item 1.)
		4	1.20	0.70	0.30	1.01	
					Total	3.15		cu m

3.	I-class brick work in I : 4 cement mortar- Abutments ...	2	4.80	0.40	1.50	5.76	(Up to top of R.C.C slabs.)
	Wing walls ...	4	1.20	0.40	1.50	2.88	
	Parapets up to kerb ...	2	4.70	0.40	0.30	1.13	(Above R.C.C. 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	
4.	Deduct- Bearing of R.C.C slab in abutment	2	4.80	0.30	0.20	0.57	
	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 Cu m	Cu m 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.= $\frac{4.80}{.30} + 1 = 17$)	17	2.38	-	-	40.46 Cu m	L = 2.10 – 2 side covers + 2 hooks = 2.10-(2X4 cm) +(18X20 mm) = 2.38 m
Item No.	Particulars of items of works	No.	Length m	Breadth M	Height Or Depth m	Quantity	Explanatory notes

	Main bent up bars 30 cm c/c (No.= $4.80/0.30=16$)	...	16	2.54	-	-	40.64 m	Adding one depth, 16 cm for two bent ups $L=2.38+.16=2.54$ m
	10 mm Dia. Bars – Distributing bottom Bars 25 cm c/c	...	9	4.90	-	-	44.10 m	
	Distributing top bars		4	4.90	-	-	19.60	
		Total		63.70 m	@.62 kg	=	39.49 kg	
				Total	Of	Steel	239.81 kg	2.398 quintal
6.	Cement concrete 1:2:4 Wearing coat	...	1	4.00	2.30	0.10	0.92cum	In between parapets
7.	Cement Pointing 1:2 in walls- Face wall from 10 cm below G.L up to bottom of coping Inner side of parapet excluding coping		2	4.70	-	2.10	19.74	
			2	4.70	-	0.80	7.52	Ht. = (20+10+50) =0.80 mm
	Coping (inner edge, top, outer edge and outer and 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 and under side
						Total	35.36	Including 10 cm below G.L and edge of R.C.C slab.
	Deduct- Rectangular opening		2	1.50		1.30	3.90	
	Triangular portion below earth slope		2	(1/2 X	1.3 X		1.69	Sq. mm
					1.3			
				Total of		Deduct ion	5.59	
				Net		Total	29.77	

HUME PIPE CULVERT

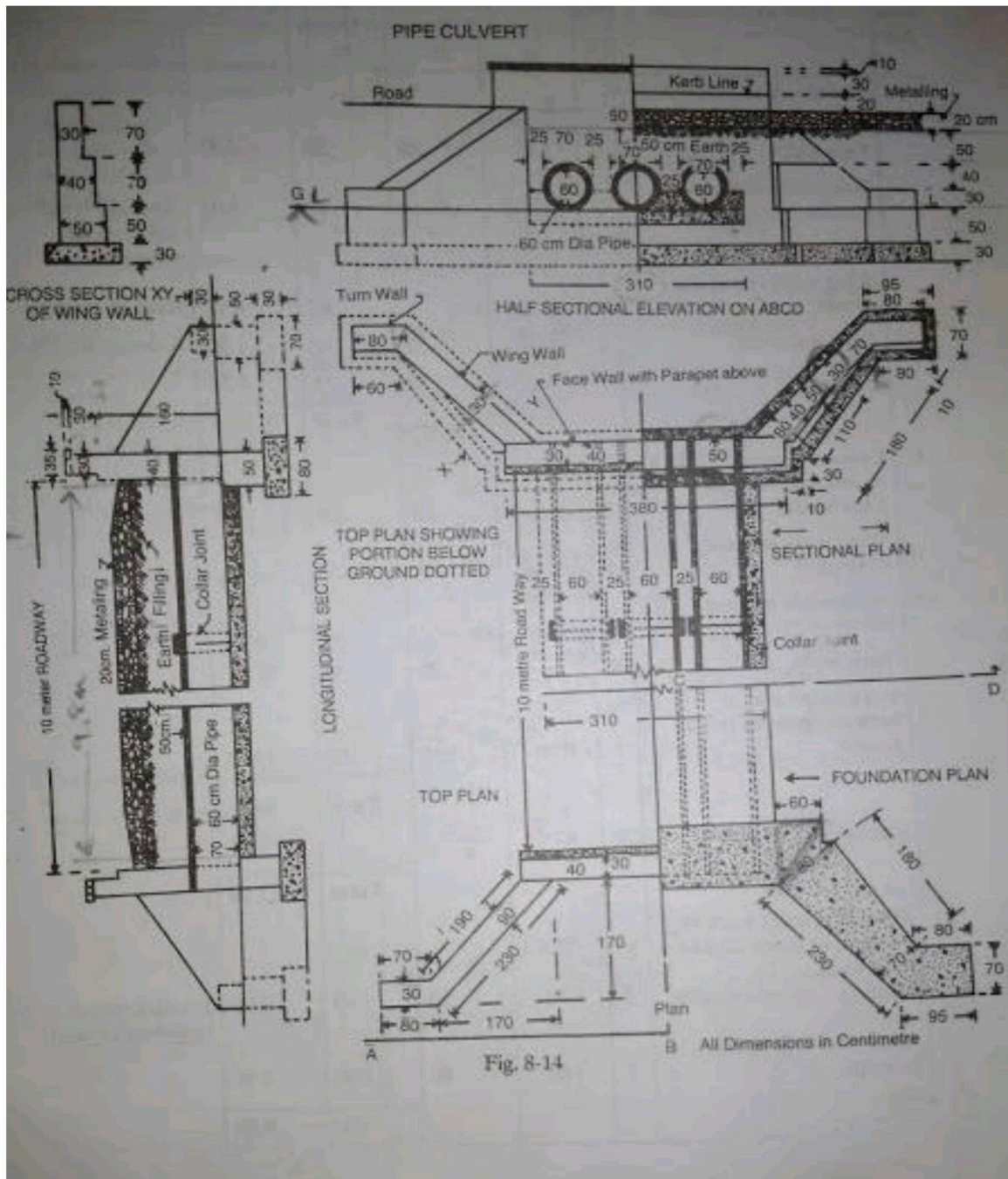


Fig. 8-14

ESTIMATING AND COSTING

Details of Measurement and calculation of Quantities

Item No.	Particular of items	No	Length m	Breadth m	Height Or Depth m	Quantity	Explanatory notes
1.	Earthwork in excavation In foundation —						
	Face walls	2	3.10	0.80	0.80	3.97	
	Wing walls inclined Portion	4	$\frac{2.3 + 1.8}{2}$	$\frac{0.8 + 0.7}{2}$	0.80	4.92	Average length and average breadth.
	Wing walls triangular corner	4	(1/2 X 0.6	X 0.8)	0.80	0.77	Area of triangle.
	Turn walls	4	$\frac{0.95 + 0.80}{2}$	0.70	0.80	1.96	Average length.
	Under pipe	1	9.80	3.10	0.15	4.56	
					Total	16.18 Cu.m	
2.	Cement concrete 1:4:8 In foundation —						
	Face walls	2	3.10	0.80			
	Wing walls inclined Portion	4	$\frac{2.3 + 1.8}{2}$	$\frac{0.80 + 0.70}{2}$	0.30	1.49	
	Wing walls inclined Portion	4	(1/2 X 0.6	X 0.8)	0.30	1.85	
	Turn walls	4	$\frac{0.95 + 0.80}{2}$	0.70	0.30	0.29	
	Upper pipe and in Between pipe up to half Height	1	9.80	3.10	0.50	0.74	
					Total	15.19	
	Deduct half of pipes ...	3	9.80 X 1/2	$\frac{\pi \times 0.7^2}{4}$	Total	19.56 5.66	Thickness = $\frac{15 + 70}{2}$ = 50 cm = 0.50 m
3.	First class brick work in 1:6 cement sand mortar —						
	Face wall — Footing — 50cm breadth	2	4.00	0.50	0.50	2.00	cu m Breadth means thickness of wall.
Item No.	Particular of items	No	Length m	Breadth m	Height Or	Quantity	Explanatory notes

					Depth m		
	Above footing 40 cm Breadth	2	3.80	0.40	1.60	4.86cum	
	Parapet 30 cm breadth Coping — 35 cm breadth	2	3.80	0.30	0.30	0.68	
	Wing wall — 1st step — 50 cm breadth	4	1.10	0.5	$\frac{0.5+0}{2}$	0.55	
	2nd step — 40 cm breadth — (i) straight portion (ii) Sloping portion	4	1.80	0.40	0.30	0.86	Average height
	3rd step — 30 cm breadth	4	1.90	0.30	$\frac{0.70+0}{2}$	0.80	
	Turn wall — 40 cm breadth	4	$\frac{0.8+0.75}{2}$	0.40	0.50	0.62	
	Turn wall — 30 cm Breadth	4	$\frac{0.8+0.7}{2}$	0.30	0.30	0.27	
					Total	11.49	cu m
4.	Cement pointing 1:2 in Exposec surfaces above G.L— Face walls outer sides	2	3.10	—	1.4	8.68sqm	Up to road level Above road level Including coping. Ht = 20+30+10+5 = 65 cm = 0.65m Including kerb Offset of 10 cm Average height.
	Face wall parapet outer side	2	3.80	—	0.65	4.94	
	Parapet inner faces	2	3.80	—	0.70	5.32	
	Wing walls vertical face	4	2.30	0.30	$\frac{1.40+0.50}{2}$	8.74	
	Wing wall top	4	2.30	—	0.30	2.76	
	Turn walls vertical face three sides	4	1.80	0.3		2.16	L = Perimeter = 80+30+70 = 180 cm = 1.80 m

Item No.	Particular of items	No	Length m	Breadth m	Height Or Depth m	Quantity	Explanatory notes
	Turn walls top	4	$\frac{0.8+0.7}{2}$		—	0.90	
					Total	33.50	Sq m
5.	Hume pipe heavy type 60 cm dia. Including collar joint	3	10.80			32.40	L= 10+0.4+0.4 = 10.8 m

Item No.	Particulars of item and details of work	No.	Length m	Breadth m	Height or Depth m	Quantity m	Explanatory notes
1.	E/W in excavation						
	.Crest wall —	1	2.65	6.00	1.15	18.29	$B=4.5+2X0.6+2X0.15$ $= 6 \text{ m}$
	.Side wall —	1	2.10	5.80	1.05	12.79	$B=4.5+2X0.5+2X0.15$ $= 5.80 \text{ m}$
	.Floor —	1	1.50	5.60	0.95	7.98	$B=4.5+2X0.4+2X0.15$ $= 5.60 \text{ m}$
	Wing wall beyond side wall---	2	1.80	0.70	1.00	2.52	
	.Curtain walls upstream side pitching 20 cm depth Bed ----	1	4.50	0.60	1.20	3.24	
	.Side slope (up to F.S.L) ---	2	1.80	1.62	0.20	1.17	
	.Down stream channel beyond curtain wall. Trapezium section($bd+sd^2$)L.	(4.0	$5X0.8+1\frac{1}{2}$	$X0.8^2$	$X3.90$	16.38	Sloping breadth $= \frac{h}{S} \sqrt{S^2+1}$ $= \frac{0.9}{1} \sqrt{1^2+1}$ $= 1.27 \text{ m}$
	.Down stream pitching 20 cm depth, excluding toe wall --- Bed -	1	$3.90X$	$\frac{4.1+3.2}{2}$	$X0.20$	2.85	Average breadth $= \frac{4.5+3.6}{2} = 4.05 \text{ m}$
	Side slope up to FSL(Upper length=2.0m)	2	$\frac{4.2+2.0}{2}$	$X1.44$	$X0.20$	1.79	Average depth $= \frac{0.60+1.0}{2} = 0.80 \text{ m}$
	Curve portion ---	2		(area)	$X0.20$	0.45	Sloping breadth at middle $= \frac{d}{S} \sqrt{S^2+1}$ $= \frac{0.8}{1} \sqrt{1^2+1}$ $= 1.13 \text{ m}$
	toe wall ---	2	$\pi X0.6^2$	0.20	0.30	0.47	
			3.90		Total	69.23	Taken as Quadrant of sphere

Item No.	Particulars of item and details of work	No.	Length m	Breath m	Ht or Depth m	Quantity m	Explanatory notes	
2.	Deduct for set back of wing wall	2	0.60	0.10	1.15	0.14		
	....			Net	Total	69.09 cu m		
	Cement concrete 1:3:6 in foundation and —							
	(i) Crest wall	1	2.65	6.00	0.45	7.16		
							
	(ii) side walls	1	2.10	5.80	0.35	4.26		
							
(iii) floor	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	4.50	0.60	0.20	0.54			
....								
					Total	14.82		
3.	Deduct for set back of wing wall	2	0.60	0.10	1.15	0.14		
	....			Net	Total	14.68 cu m		
	1-class brick work in 1:4 cement mortar crest wall —							
	1st step	1	4.50	0.70	0.40	1.26		} As per cross sec.BC
	....	1	4.50	0.60	0.90	2.43		
	2nd step							
							
	Side wall —							
	(i) 1st step	2	2.35	0.60	0.40	1.13		} As per cross sec.EF
	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		} As per cross sec.GH
	(ii) 1st step	2	2.10	0.50	0.40	0.84		
	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.
	2nd step	2	1.50	0.30	0.60	0.54		
Wing wall beyond						12.36	} As per cross sec. XY	

Item No	Particulars of item and details of work	No.	Length m	Breath m	Height or Depth m	Quantity m	Explanatory notes
.	side wall	2	1.80	0.40	0.40	0.58	
	....	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	
4.	Curtain wall	1	4.50	0.30	0.40	0.54	Down stream in between walls
	Toe wall	2	3.90	0.20	0.30	0.47	
					Total	16.39 cu m	
	Brick edge Floor in 1:8 cement mortar Including pointing ...	1	5.40	4.50	—	24.30 sq m	
5.	Cement pointing in 1:3 cement mortar – Crest wall (upstream face top and down stream (face)	1	4.50	—	2.40	10.80	Ht = 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 portin Above crest wall	2	0.60	—	0.80	0.96	Full length of 30 cm wall
	Vertical faces of stepping vertical face of end	2X2	—	0.30	0.30	0.36	
	Top of side walls	2	—	0.40	0.90	0.72	Triangular portions of slope
	Top of curtain wall	2	—	0.30	0.60	0.36	
	Top of toe walls	2	6.00	0.30	—	3.60	
	Wing wall top face	1	4.50	0.30	—	1.35	
	Wing wall up-stream	2	3.90	0.20	—	1.56	
	Side Triangular portion above slope	2	½(2.10	X 1.40)	—	2.94	
					Total	42.45 sq m	
6.	Brick –pitching — Up-stream bed	1	1.80	3.60	0.20		Dimension same as in item 1)
	Up-stream side slop	2	1.80	1.62	0.20	1.30	
	Down- stream bed	1	3.90X	$\frac{4.1+3.2}{2}$	X0.20	1.17	
	Down - stream Side Slopes	2	$\frac{4.2+2.0}{2}$	X1.44	X0.20	2.85	
						1.79	

	Side curved portions	2	3.14×0.6^2	(area)	X0.20	0.45	
					Total	7.56 cu m	

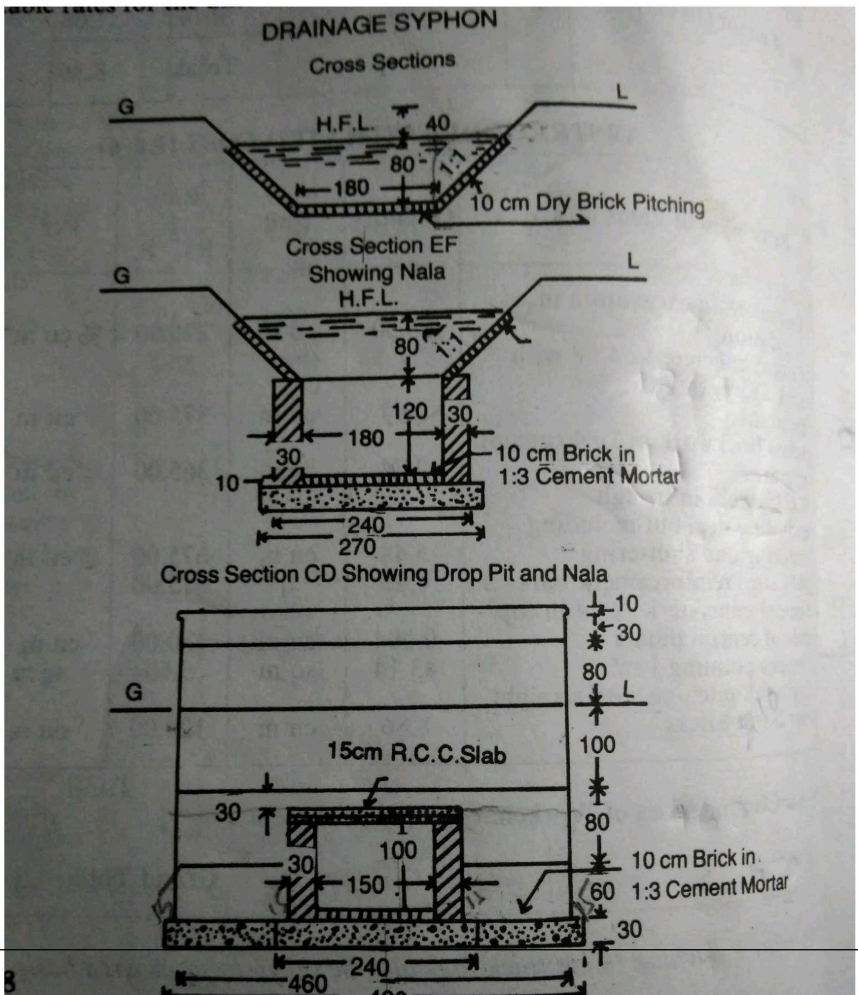
DRAINAGE SYPHON

Due to relative levels sometime it is required to lower the bed of the irrigation channel or the drainage channel at their crossing. When the bed of the irrigation channel is depressed and taken under nala or stream it is known as irrigation siphon. When the bed of the nala or stream is depressed and taken under the irrigation channel it is known as drainage syphon. The syphon crossing may be of rectangular closed masonry channel or of circular brickwork of R.C.C OR Hume pipe of the required diameter and number. Approach and exit may be through masonry drop pit or of masonry sloped channel. The down stream end is kept lower than the up stream end by at least 15cm for better flow. An estimate of a small drainage syphon has been given in Example-7 of BN Dutta.

Example-7 Prepare a detailed estimate of a drainage syphon across a minor from the given drawing.

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.



Item No.	Particulars of item and details of work	No.	Length m	Breath m	Height or Depth m	Quantity Cu m	Explanatory notes
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1	Earthwork in excavation in foundation — Syphon duct Drop pit Wing walls	1 2 4	9.50 2.10 1.25	2.40 2.70 1.10	1.60 1.60 1.60	36.48 18.14 8.80	For bed level of nala
					Total	63.42 cu m	
2	Cement Concrete 1:4:8 With brick ballast — Syphon duct Drop pit Wing walls	1 2 4	9.50 2.10 1.25	2.40 2.70 1.10	0.30 0.30 0.30	6.84 3.40 1.65	
					Total	11.89 cu m	
3	First class brick work in 1:4 cement mortar — Syphon duct side walls Drop pit walls Wing wall — 1st step 70cm walls 2nd step 60cm walls 2nd step 60 cm Walls above slab	2 2X2 2 4 4 2	9.20 2.10 1.80 1.25 1.25 4.60	0.30 0.30 0.30 0.70 0.60 0.60	1.30 1.30 1.30 0.60 0.60 0.20	7.18 3.28 1.40 2.45 1.80 1.10	Upto top of slab
Item No.	Particulars of item and details of work	No.	Length m	Breath m	Height or Depth m	Quantity Cu m	Explanatory notes
	3rd step 50 cm	2	4.60	0.50	1.00	4.60	

	wall						
	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 cu m	
4	R.C.C slab of siphon						
	Duct including steel reinforcement complete work	1	9.20	2.10	0.15	2.90 cu m	
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 sq m	
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	6.0	—	0.30	3.42	L = 2x180+240 = 600 cm
	Parapet wall inner Face top and outer Face up to G.L	2	4.60	—	2.30	21.16	Ht= 20+10+30+10+35 +10+5+110 = 230 cm
		2	1.80		1.20	4.32	

	Outer face of wing Wall above slab ... Triangular portion of Outer face of wing wall ...	2X2	(1/2X0.8	— X 0.8)	=	1.28	
					Total	61.54 sq m	
7	10 cm dry brick pitching with straight over burnt brick — Bed of nala Side slopes of nala	2 2X2	3.00 3.00	1.80 1.13	— —	10.80 13.56	Thin pitching unit in area basis
					Total	24.36 sq m	Up and down stream Sloping breadth = $0.8^2+0.8^2=1.13$ m

NUMERICAL ON ESTIMATE OF WBM ROADS

Estimate the items involved for construction of WBM road from the following data:

Length of the road 100m, metalled width = 5.5 mt

Thickness of the grade – I metal solving = 80mm

Wearing coat of grade – II metal loose consolidated to 80mm thick. Surface of the road is to be finished with a coat of bitumen as given below:

1st finishing coat: 12mm chips @ 0.018 m³ and bitumen @ 1.22 kg per square meter of road surface.

2nd finishing coat: 6mm chips @ 0.01 m³ and bitumen @ 1.22 kg per square meter of road surface.

Consumption of fuel @ 0.42 kg per kg of bitumen.

Ans – Length of the road = 100m

Metalled width = 5.5 mt

Area of the road surface = $5.5 \times 100 = 550$ sqm

Thickness of grade I metal solving

$$= 80\text{mm} = 0.08\text{mt.}$$

Quantity required = $5.5 \times 0.08 \times 100 = 44$ cum.

Thickness of grade II metal consolidated thickness

$$= 80\text{mm} = 0.08\text{mt}$$

Quantity required = $5.5 \times 0.08 \times 100 = 44$ cum

1st finishing coat: 12mm chips @ 0.018 m³ per square meter

25

For 550 sqm chips required

$$= 550 \times 0.018 = 9.9 \text{ cum}$$

Bitumen required

$$= @ 1.22 \text{ kg per m}^2 \text{ of road surface}$$

$$= 550 \times 1.22 \text{ kg} = 671 \text{ kg}$$

For 2nd finishing coat : 6 mm chips @ 0.01 m³ per square meter of road surface

quantity required

$$= 550 \times 0.01 = 5.5 \text{ cum}$$

Bitumen required

$$= @ 1.22 \text{ kg per m}^2 \text{ of road surface}$$

$$= 550 \times 1.22 \text{ kg} = 671 \text{ kg}$$

For 1st coat and 2nd coat bitumen required

$$= 671 + 671 = 1342 \text{ kg}$$

Consumption of fuel @ 0.42 kg per kg of bitumen.

$$\text{Consumption of fuel} = 1342 \times .42 = 563.64 \text{ kg.}$$

ROAD ESTIMATE

EXAMPLE 1 :-Reduced level (R.L) of ground along the center 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 up to the chainage 14 and then the gradient changes to 1 in 100 downward. Formation width of road is 10 metre and side slopes of banking are 2:1 (Horizontal : Vertical). Length of the chain is 30 metre.

Draw longitudinal section of the road and a typical cross-section and prepare an estimate of earthwork at the rate of Rs-275.00 % cu m.

R.L of Formation 107.00



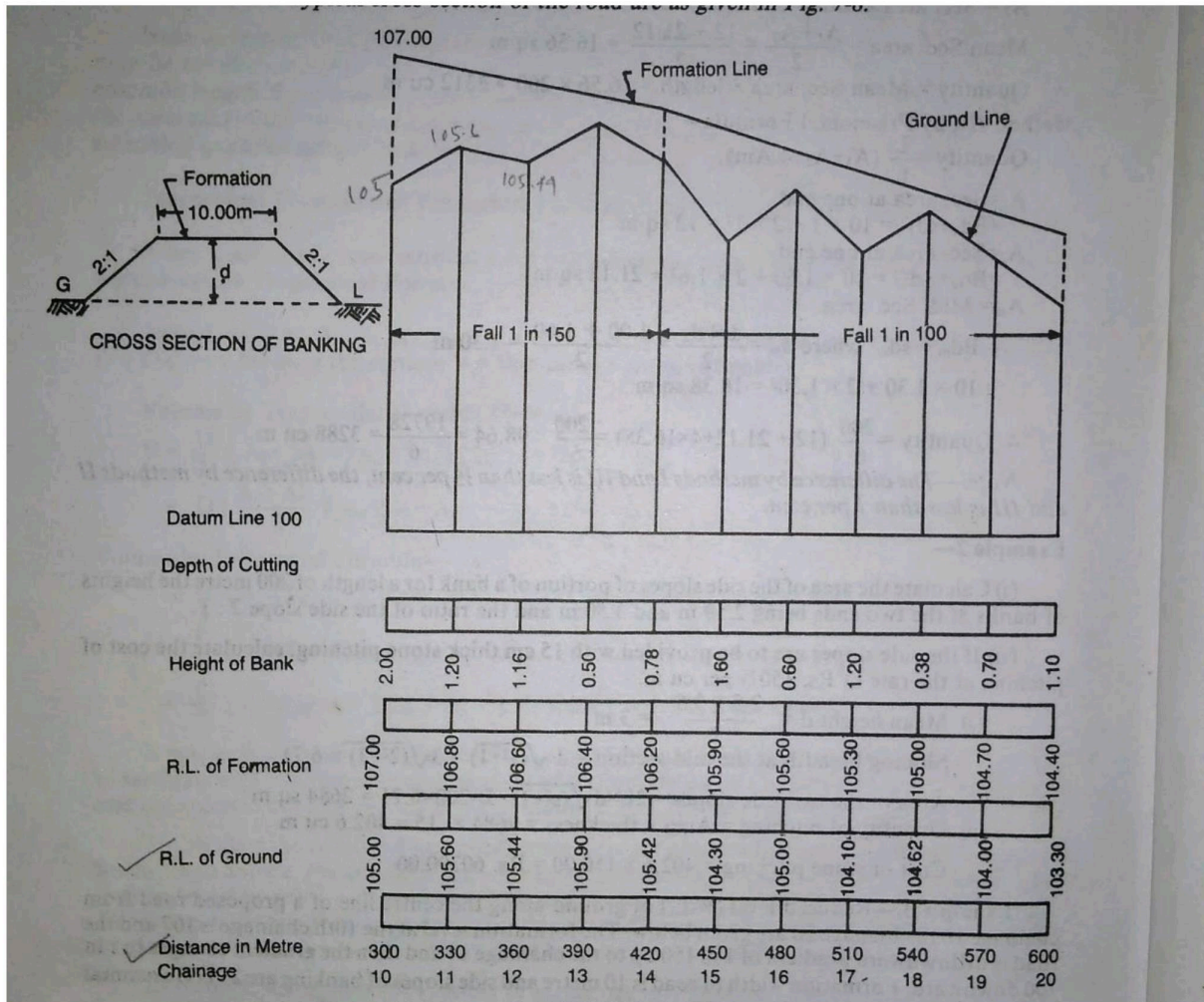
Chainage	10	11	12	13	14	15	16	17	18	19	20
R.L of ground	105.00	105.60	105.44	105.90	105.42	105.30	105.00	104.10	104.62	104.00	103.3

Gradient Down gradient 1 in 150 Down gradient 1 in 100

Calculation of Quanties of Earthwork (EX-3 OF BN DUTTA)

B = 10 m, S = 2

SOLUTION:-



Stations Or Chainage	Length	Height Or Depth Diff.Of G.L.and F.L	Mean height Or Depth d	Central Area Bd	Side Area Sd ²	Total sec.area Bd+sd ²	Length In betw. Stations L	Quantity (Bd+sd ²)XL	
								Banking	Cutting
m	m	m	m	M ²	M ²	M ²	M ²	M ³	M ³
10	300	2.00	---	---	---	---	---	---	---
11	330	1.20	1.60	16.00	5.12	21.12	30	633.6	---
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

cu m

ABSTRACT OF ESTIMATED COST (EX-3)

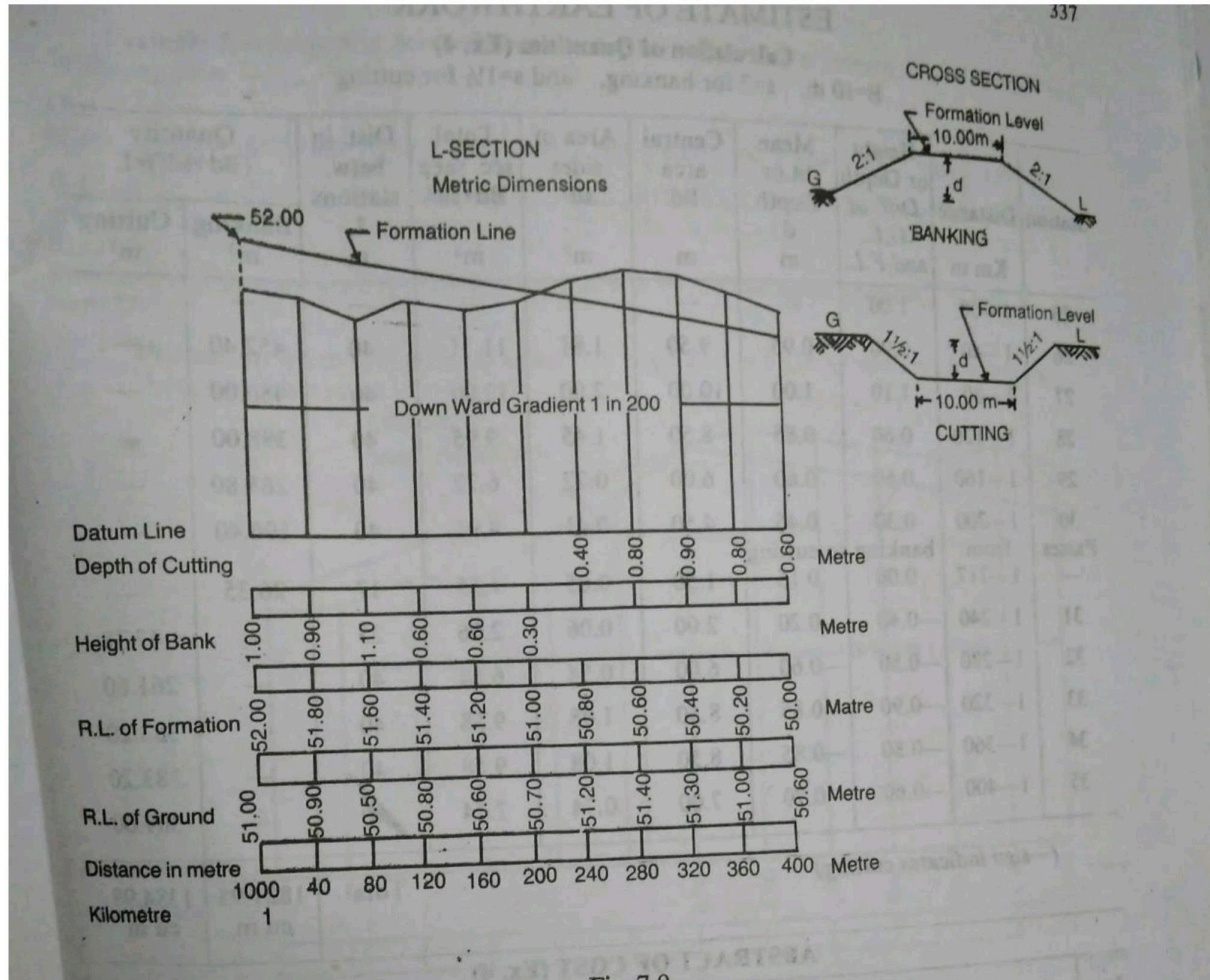
Item No.	Particulars of items	Quantity	Unit	Rate Rs. P.	per	Cost
						Rs. P.
1	Earthwork in banking ...	3513.6	Cu m	275.00	% cu m	9662.40
Total ...						9662.40
...						483.12
Total ...					Grand	Rs. 10145.52

EXAMPLE 2:- Estimate the cost of earthwork for a portion of road for 400 meter length from the following data:-

Formation width of the road is 10 meter. Sides slopes are 2:1 in banking $1\frac{1}{2}$: 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	I
27	1080	50.50	I
28	1120	50.80	I
29	1160	50.60	Downward gradient Of 1 in 200
30	1200	50.70	
31	1240	51.20	I
32	1280	51.40	I
33	1320	51.30	I
34	1360	51.00	I
35	1400	50.60	I

Longitudinal section of the road and type cross-section are as given in fig. 7-9. The example can, however, be solved without the help of L-section and cross-section.



The road passes from banking to cutting in between the station 30 (1200 m) and 31 (1240 m). The distance where it passes through zero, i.e., ground level, may be determined as follows:-

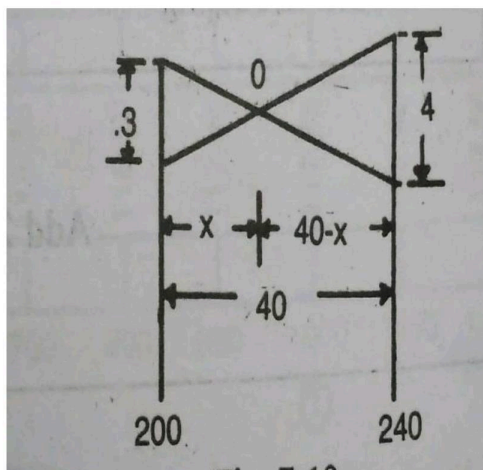
The two triangles on either side of zero point are symmetrical (fig.7-10) .

$$\frac{x}{.3} = \frac{40-x}{.4} ; \text{ or } .4x = .3(40-x) \qquad \text{or } .4x = 12 - .3x$$

$$.3x + .4x = 12$$

$$.7x = 12$$

$$\therefore x = \frac{12}{.7} = 17.14 \text{ m} = 17 \text{ m say}$$



Therefore length of banking portion is 17m, and the length of cutting portion is $40 - 17 = 23\text{m}$

ESTIMATE OF EARTHWORK

Calculation of Quantities (Ex.4)

B=10m, s=2 for banking, and $s=1\frac{1}{2}$ for cutting

Stations	Distance Km m	Height Or Depth Diff.Of G.L.and F.L	Mean height Or Depth d m	Central Area Bd m	Area of Sides Sd ² m ²	Total sec.area Bd+sd2 m ²	Distance In betw. Stations L m	Quantity (Bd+sd2)XL	
								Bankin g m ³	Cutting m ³
25	1 --- 00	1.00	---	---	---	---	---	---	---
26	1 --- 40	0.90	0.95	9.50	1.81	11.31	40	452.40	---
27	1 --- 80	1.10	1.00	10.00	2.00	12.00	40	480.00	---
28	1 --- 120	0.60	0.85	8.50	1.45	9.95	40	398.00	---
29	1 --- 160	0.60	0.60	6.00	0.72	6.72	40	268.80	---
30	1 --- 200	0.30	0.45	4.50	0.41	4.91	40	196.40	---
Passes	From	banking	To cutting						

---	1 --- 217	0.00	0.15	1.50	0.05	1.55	17	26.35	---
31	1 --- 240	--- 0.40	--- 0.20	2.00	0.06	2.06	23	---	47.38
32	1 --- 280	--- 0.80	--- 0.60	6.00	0.54	6.54	40	---	261.60
33	1 --- 320	--- 0.90	--- 0.85	8.50	1.08	9.58	40	---	383.20
34	1 --- 360	--- 0.80	--- 0.85	8.50	1.08	9.58	40	---	383.20
35	1 --- 400	--- 0.60	--- 0.70	7.00	0.74	7.74	40	---	309.60
(-- Sign indicates cutting)							Total	1821.95 cu m	1384.98 cu m

ABSTRACT OF ESTIMATED COST (EX-3)

Item No	Particulars of items	Quantity	Unit	Rate Rs. P	per	Cost
						Rs. P.
1	Earthwork in banking	1821.95	cu m	275.00	% cu m	5010.36
2	... Earthwork in cutting	1384.98	cu m	350.00	% cu m	4847.43
	...					
Total	...					9857.79
					Add (3% for Contingencies	295.73
...						197.16
					Add 2% for workcharged Establishment)	10350.68
...						
					Grand Total	
...						

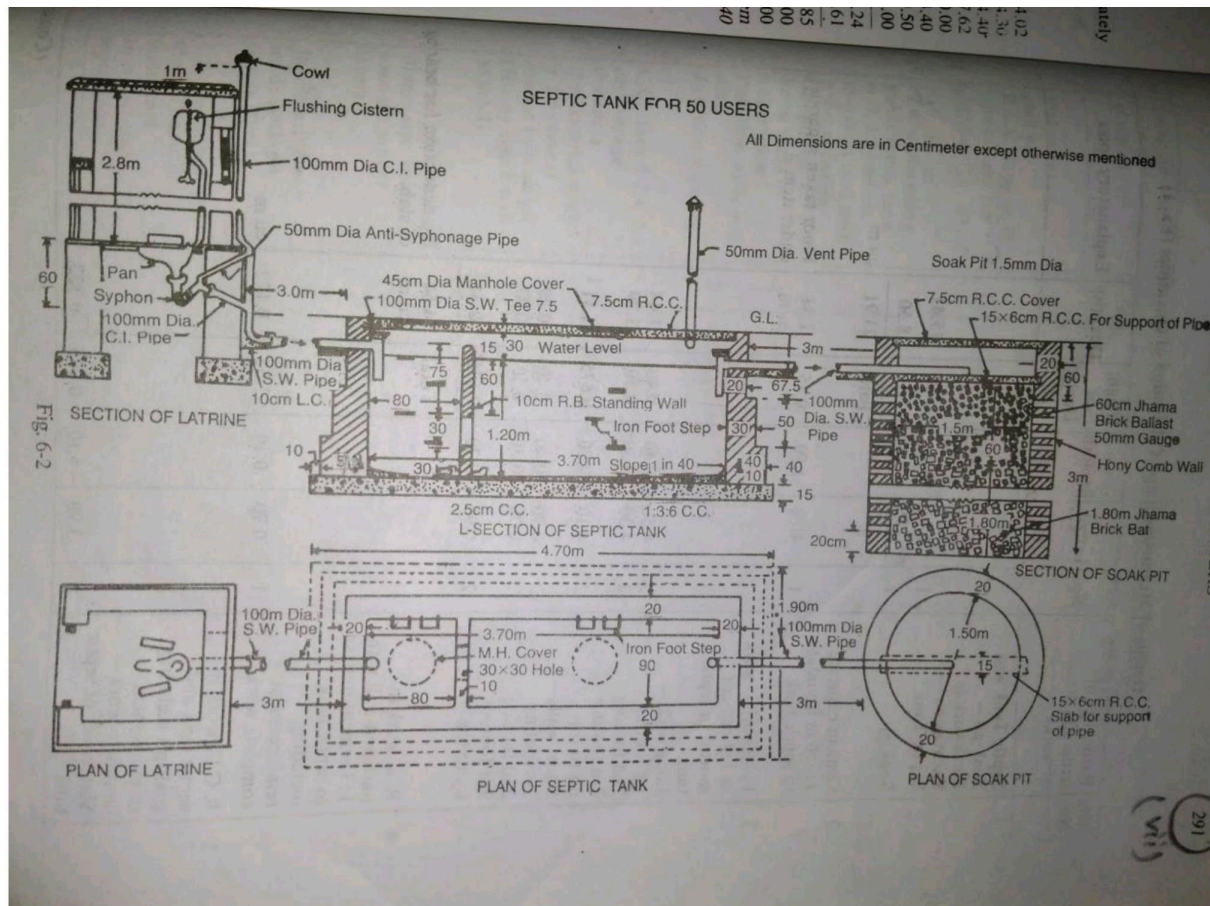
ESTIMATE OF SEPTIC TANK FOR 50 USERS

Example-2 Prepare a detailed estimate of a Septic tank with Soak-pit for 50 users together with sanitary fittings of one seat of Latrine from the given drawings (fig-6.2)

Septic tank shall be of 1 class brick masonry 1:4 cement mortar over cement concrete 1:3:6 foundation and base, with R.B . Partition wall and R.C.C slab cover. inside of tank including floor shall be of II class brick masonry with 1:6 cement mortar.

Estimate for water arrangements, Should also be made with a 250 litre G.l overhead tank connecting flushing Cistern of W.C. and a water tap, assuming that there is a pipe water supply within 10 m of the latrine.

Details of Measurement and Calculation of quantities (Ex-1)



Item No.	Particulars of item and details of work	No.	Length m	Breath m	Height or Depth M	Quantity	Explanatory notes
1	Septic tank and Soak-Pit — Earthwork in excavation — Septic Tank Soak pit	1	4.70	1.90	1.725	15.41	Floor taken separately under item 7.
		1	$\pi \times (1.9)^2$	X3.00	—	8.50	
2	Cement Concrete 1:3:6 in Foundation of Septic tank	1	4	1.90	Total 0.15	23.91 cu m 1.34 Cu m	
3	1 - class brick work in 1:4 cement mortar in septic tank Long walls						
	1st footing	2	4.50	0.40	0.40	1.44	
	... 2nd footing	2	4.30	0.30	0.50	1.29	
	... 3rd footing	2	4.10	0.20	0.675	1.11	
	Up to top Short walls —						
	1st footing	2	0.90	0.40	0.40	0.29	
	2nd footing ...	2	0.90	0.30	0.50	0.27	
	3rd footing						
	Up to top	2	0.90	0.20	0.675	0.24	
	...						
					Total	4.64 Cu m	No deduction for bearing of slab
4	R.B work in partition wall with 1:3 cement mortar in septic tank including Reinforcement						
Item No.	Particulars of item and details of work	No.	Length m	Breadth m	Height or Depth m	Quantity	Explanatory notes
5	complete work ... R.C.C work in septic tank and	1	0.90	0.10	1.35	0.122 Cu m	

	soak pit including reinforcement complete work — slab cover of septic tank	1	3.90	1.10	0.075	0.322	
	slab cover of soak pit R.C.C ...	1	$\pi \times (1.7)^2$	X	0.075	0.170	
	support of pipe in soak pit ...	1	$\frac{4}{1.70}$	0.15	0.06	0.015	
					Total	0.507 cu m	
6	12 mm plastering inside septic tank with 1:2 cement mortar mixed with Water proofing Compound						
	Long walls	2	3.70	—	1.50	11.10	
	Short walls	2	0.90	—	1.50	2.70	
	Partition walls						
	Both Sides	2	0.90	—	1.35	2.43	
	Partition Walls top	1	0.90	0.10	---	0.09	
					Total	16.32 sq m	
7	C.C floor 1:2:4, 5 cm average thickness	1	3.70	0.90	—	3.33 sq m	
8	II class brickwork in 1:6 cement mortar in soak-pit (Honey comb wall as solid) ...	1	$\pi \times 1.70$	X0.20x	3.00	3.20 cu m	Mean circumference.
9	Jhama brick ballast 10 mm size inside Soak-pit (upper layer)	1	$\frac{\pi \times 1.5^2}{4}$	X0.60	—	1.06 cu m	
10	Jhama brick bats Inside soak-pit (lower layer) ...	1	$\frac{\pi \times 1.5^2}{4}$	X 1.80	—	3.18 cu m	
11	C.I. Manhole cover 45 cm Dia. over Septic tank ...	2	—	—	—	2 Nos.	
12	Iron foot steps septic tank	8	—	—	—	8 Nos	Flushing cistern telescopic pipe foot rests. etc., each may also be taken as separate items.
13	Sanitary works — W.C Indian pattern 50 cm white glazed Pan with siphon and						

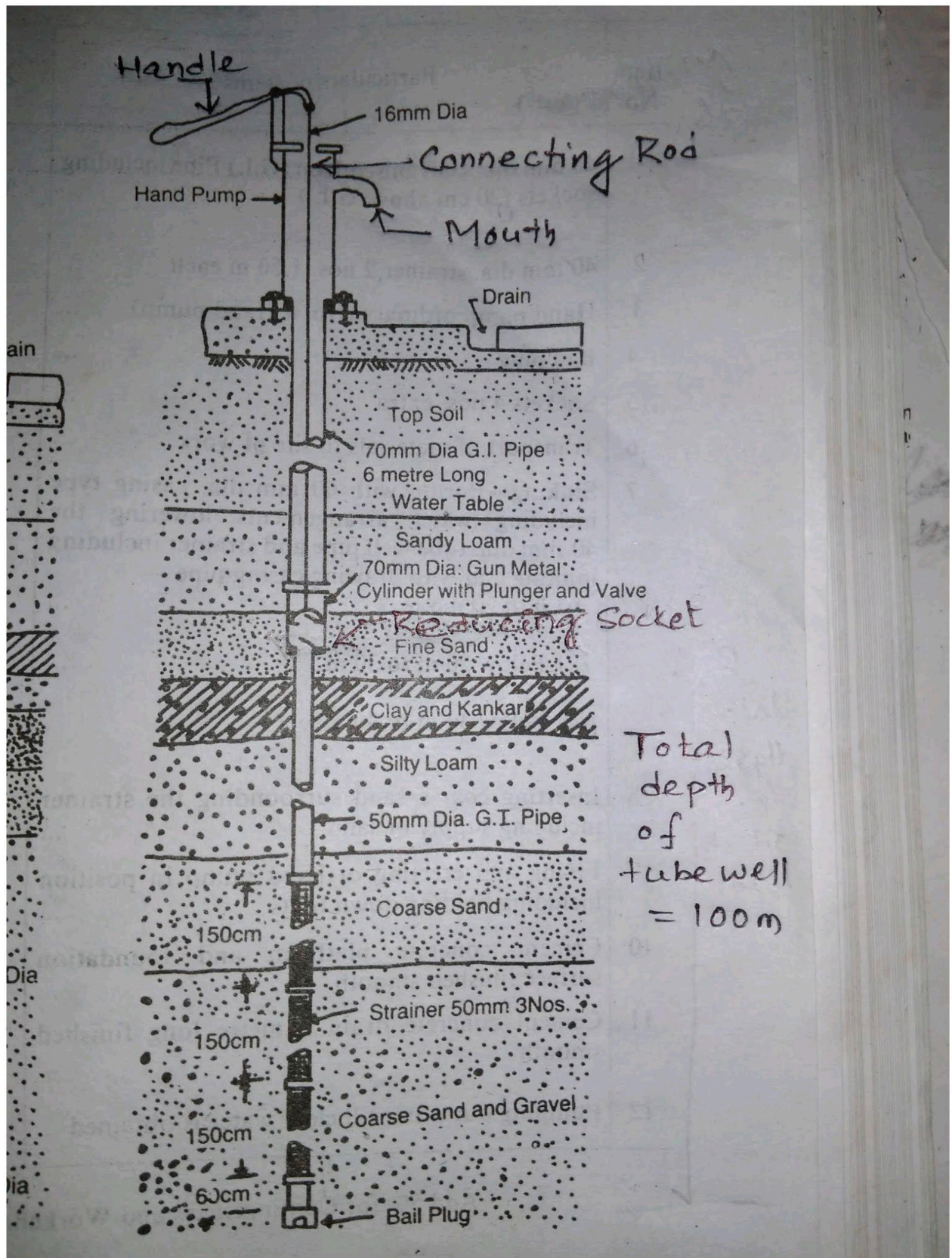
	with 13.5 – litre C.I Flushing cistern (E.L.C) with brackets and 32 mm Dia G.I telescopic flush pipe painted two coats and with chain foot rests complete supply and fixing ...	1	—	—	—	1 set
14	S.W (stone –ware) Pipe 100 mm dia. Laid over 10 cm L.C including digging, layer, jointing, testing, etc., complete —					
	Connecting latrine with septic tank ...	1	3.00	—	—	3.00
	Connecting septic tank with soak-pit ...	1	3.00	—	—	3.00
15	S.W Tee 100 mm dia. at the inlet and outlet of septic tank	2	—	—	Total	6.00 m 2 Nos.
16	C.I Heavy soil Pipe 100 mm dia. connecting latrine Seat, vent pipe including fixing with lead jointing ...	1	5.00	—	—	5.00 m
17	C.I Heavy soil Pipe 50 mm dia complete With lead jointing connecting latrine pan with vent pipe... Vent pipe for septic tank ...	1	0.60	—	—	0.60
		1	3.00	—	—	3.00
					Total	3.60 m
18	C.I Cowl 100 mm dia in latrine ...	1	—	—	—	1 No
19	C.I Cowl 50 mm dia for septic tank vent pipe ...	1	—	—	—	1 No
20	250- litre G.I. Tank of 20 B.W.G. Sheets with 45 cm dia.	1	—	—	—	1 No

	raised hinged cover with locking arrangement and fitted with 15 mm dia. brass ballcock supplying and fixing in position complete ...						
21	15 mm dia G.I pipe with fittings including digging, laying, clamping complete. Connecting G.I tank with water main	1	15.00	—	—	15.00	L= 10.00+0.60+2.80 +1.00+0.60 extra = 15.00 m Top on outside wall.
	Connecting flushing Cistern from G.I tank	1	2.00	—	—	2.00	
	Connecting water tap from G.I. tank ...	1	4.50	—	—	4.50	
					Total	21.50 m	
22	15 mm dia brass stop-cock (one for G.I. tank and one for flushing cistern) supplying and fixing	2	—	—	—	2 Nos.	
23	15 mm dia brass bib cock supplying and fixing	1	—	—	—	1 No.	
24	Brass Ferrule 6 mm dia. supplying and fixing ...	1	—	—	—	1 No.	

ESTIMATE OF 50 MM Dia. TUBE WELL WITH DEEF HAND PUMP

Example:-10 – Prepare an estimate of 50 mm dia. Tube well 100 meter deep with deep well pump from the given drawing (Fig-6.19). The strainer will consist of 3 pieces of 1.50 meter each. The housing pipe consist of 70 mm dia. G.I pipe 6 meter in length.

Assume suitable rates.



Bill of Quantities and cost (Ex-10)

Item No	Particulars of Items	Quantity	Rate Rs.	Amount Rs.
---------	----------------------	----------	-------------	---------------

			P.	P.
1	50 mm dia. Galvanised iron (G.I) pipe	94.00 m	11.50 per r m	1081.00
2	70 mm dia. G.I housing pipe	6.00 m	23.00 per r m	138.00
3	50 mm dia. Strainer 3 nos. 1.50 m each	3 nos.	55.00 each	165.00
4	70 mm dia. Gun metal cylinder with valve and plunger	1 no.	100.00 each	100.00
5	Hand pump with extra length of 16 mm dia. Connecting rod	1 no.	45.00 each	45.00
6	Bail plug	1 no.	7.50 each	7.50
7	Sockets 4 nos. extra	4 no.	2.50 each	10.00
8	Transport of materials to site of work	1 job	20.00 L.S	20.00
9	Sinking – Boring with 70 mm dia. casing pipe including water arrangements, lowering the 50 mm dia. tube well pipe and strainer including jointing and withdrawing of casing pipe-			
	(i) 0 to 20 meter	20 m	7.50 per r m	150.00
	(ii) Below 20 m to 35 m	15 m	11.00 per r m	165.00
	(iii) Below 35 m to 50 m	15 m	15.50 per r m	232.50
	(iv) Below 50 m to 65 m	15 m	20.00 per r m	300.00
	(v) Below 65 m to 80 m	15 m	24.00 per r m	360.00
	(vi) Below 80 m to 95 m	15 m	28.50 per r m	427.50
	(vii) Below 95 m to 100 m	5 m	33.00 per r m	165.00
10	Inserting coarse sand surrounding the strainer including supply of sand	1 job	20.00 L.S	20.00
11	Fixing and erecting hand pump in position including holding down bolts	1 job	10.00 L.S	10.00
12	Cement concrete platform and foundation, Surface finished smooth	1 job	30.00 L.S	30.00
13	Cement concrete drain 3 meter long finished smooth ...	1 job	9.00 per r m	27.00
14	Plumbing out water till clear water is obtained ...	1 job	15.00 L.S	15.00
Total				3468
...				173.42
Add 5% for contingencies and workcharged Establishment				3641.92
...				
Grand				

Total ...	
-----------	--

PWD ACCOUNTS WORK

WORKS

Classification of work:

Works are primarily divided into two classes— "Original works" and "Repairs or maintenance."

Original Work: Original works include all new constructions whether of entirely new works or of additions and alterations to existing works which increase the capital cost of a building or work. Repairs to newly purchased or previously abandoned buildings required to render them useable are also original works.

Repairs Work: Repairs or maintenance includes all operations required to maintain in proper condition buildings and works in ordinary use.

Petty Work, Minor Work and Major Work: A petty work is one the cost of which does not exceed Rs. 20,000, a minor work is one the cost of which exceeds Rs. 20,000, but does not exceed Rs. 1,00,000 and a major works is one the cost of which exceeds Rs. 1,00,000.

NOTES—(1) In the case of mixed estimates, if the amount debitable to the "Original Works" portion of the estimate is Rs. 20,000 or less then it should be treated as a petty work and not minor work although the total cost of such mixed work (including repairs) might exceed Rs. 20,000 and the departmental head should be responsible for the execution of such mixed work and for finding funds for the purpose from their own budgets. When the original works portion of a mixed estimate exceeds Rs. 20,000 then it should be treated as a minor work and the whole work including repairs should be entrusted to the Public Works Department for execution. Provision for such works should be made in the Public Works Department budget both under "Original Works" and "Repairs."

(2) When an existing building is to be re-modelled or a portion thereof is to be replaced, then, if a type of construction or material of a more costly nature than that which previously existed is to be adopted or if the proposed reconstruction will result in an increase of accommodation, only one estimate will be prepared but the estimate will be a mixed estimate part of which is chargeable to "Original Works" and part to "repairs." The amount to be charged to "Original Works" will be the total estimated cost of the work minus the original cost (estimated, if necessary) of that portion of the building which has been replaced.

Exception—When in any one estimate, the amount chargeable to "Original Works" is less than Rs. 2,000 the whole of the expenditure may be charged to repairs ; provided that if the work relates to a residential building the amount which is correctly chargeable to "Original Works" is added to capital value and taken into account in calculating the rent.

Repair work

The repair works are classified in under mentioned categories:

- Day to day repairs/service facilities
- Annual repairs

- Special repairs

Day to day repairs

Day to day repairs are carried out by CPWD in all the buildings under its maintenance. The works which are to be attended on day to day basis such as removing chokage of drainage pipes, man holes, restoration of water supply, replacement of blown fuses, repairs to faulty switches, watering of plants, lawn mowing, hedge cutting, sweeping of leaf falls etc. are attended under day to day service facilities. The purpose of this facility is to ensure satisfactory continuous functioning of various services in the buildings. These services are provided after receipt of complaint from the users at the respective Service Centres. Complaints of periodical nature like white washing, painting etc.. which are usually got attended through contractors and cannot be attended on daily basis is transferred to register of periodical repairs.

Annual Repairs

The works of periodical nature like White washing, colour washing, distempering, painting etc. are called Annual Repair works and these are generally undertaken; through system of contracts.

The periodicity of applying white washing and colour washing for a building has been laid down by the Government. The periodicity is two years for white washing and colour washing and three years for painting. In addition, works such as patch repair to plaster, minor repairs to various items of work, replacement of glass panes, replacement of wiring damaged due to accident, replacement of switches, sockets tiles, Gap filling of hedges/perennial beds, Replacement/Replanting of trees, shrubs, painting of tree guards, planting of annual beds and trimming /pruning of plants etc., which are not emergent works and are considered to be of routine type, can be collected and attended to for a group of houses at a time and particular period of financial year, depending upon the exigency. Such works can be done under day to day repair also. The yard stick for annual repairs cover both the above facilities.

SPECIAL REPAIRS

As the building ages, there is deterioration to the various parts of the building and services. Major repairs and replacement of elements become inevitable. It becomes necessary to prevent the structure from deterioration and undue wear and tear as well as to restore it back to its original conditions to the extent possible. The following types of works in general are undertaken under special repairs: -

- I. White Washing, Colour washing, distempering etc., after completely scrapping the existing finish and preparing the surface afresh.
- II. Painting after removing the existing old paint from various members.
- III. Provision of water proofing treatment to the roof. All the existing treatments known are supposed to last satisfactorily only for a period of about ten years.
- IV. Repairs of internal roads and pavements.
- V. Repairs/replacement of flooring, skirting, dado and plaster.
- VI. Replacement of doors, window frames and shutters. Replacement of door and window fittings.
- VII. Replacement of water supply and sanitary installation like water tanks, WC cistern, Wash basins, kitchen sinks, pipes etc..

- VIII. Re-grassing of lawns/grass plots within 5-10 years.
- IX. Renovation of lawn in 5-6 years.
- X. Replanting of hedges in 8- 10 years.
- XI. Completely uprooting and removing hedges & shrubbery.
- XII. Replanting of
 - a) Rose beds in 5-6 years.
 - b) Perennial beds in 5-6 years.
 - c) Cannal beds in 1-2 years.
- XIII. Shifting of any garden feature from one site to another within building.

Quadrennial repair work

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

Method of execution of works through the contractors

Contract and agreement

When two or more persons have common intention communicated to each other to create some obligation between them there is said to be an agreement. An agreement which is enforceable by law is a "**Contract.**"

According to Section 10 of the Indian Contract Act, 1872 only those agreements are enforceable by law which are made by the free consent of parties competent to contract, for a lawful consideration and with a lawful object and, are not expressly declared to be void. This is subject to any special law according to which a contract should be in writing and attested by witnesses.

The following are the essential ingredients of a contract:-

- a) Offer made by one person called the "Promisor".
- b) Acceptance of an offer made by the other person called the "Promisee".
- c) Doing of an act or abstinence from doing a particular act by promisor for promisee called consideration.
- d) The offer and acceptance should relate to something which is not prohibited by law.
- e) Offer and acceptance constitute an agreement, which when enforceable by law, become a contract.
- f) In order to make a valid and binding agreement, the party entering into such an agreement should be competent to make such agreement.

For the purpose of an agreement, there must be a communication of intention between the parties thereto. Hence in the forms of a Contract there is:

- (a) A proposal.
- (b) Communication of the proposal.
- (c) A communication of the acceptance of the proposal.

The communication of acceptance of the proposal completes the agreement. An offer may lapse for want of acceptance or be revoked before acceptance. Acceptance produces something which cannot be recalled or undone. A contract springs up as soon as the offer is accepted and imposes an obligation upon the person making the offer. It has been opined by the Ministry of Law that before communication of acceptance of an offer the tenderer would

be within his right to withdraw, alter and modify his tender before its acceptance, unless there is a specific promise to keep the offer open for a specific period backed by a valid consideration.

Work order

Small work up to Rs. 2000.00 may be carried out by work order. This is a contract and specifies the approximate quantities of different items of work, details specification of each item of work, time for completion of the whole work, penalty that will be imposed for not fulfilling the terms and conditions etc. Payment is made on the measurement of work done and 10% of the bill amount is deducted from the running bill of the contractor as security money which amount is refunded in the final payment on the satisfactory completion of the work. Debitable agency can be engaged for bad work or for unsatisfactory progress. Contractors are usually selected by taking quotations. (P.W.Agreement is used in P.W.D and Work Order is used in Irrigation Department)

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 item of work on the basis of schedule of quantities furnished by the department. This schedule indicates full nomenclature of the item as per sanctioned estimate, estimated quantities and therein. While filling up the rates, the contractors are required to express the amount in figures 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 Department.

Lump sum contract

As its name indicates, is used for work in which contractors are required to quote a lump-sum figure for completing the works in accordance with the given designs, drawings, specification and functional requirements as the case may be. Lump-sum tender can be either for only executing the work as per given design, drawing and specification or it may include element of doing design work and preparation of structural drawings as well which shall be in keeping with the given functional, structural and architectural parameters and subject to approval by the competent authority beforehand.

In cases where work is to be executed as per design and drawing of the department, all the detailed working drawings, both architectural and structural must be prepared before hand and should form part of the tender documents which should also contain complete and detailed specifications of the work. The tender documents must set out complete scope of the work. Only the drawings and the detailed specifications as contained and/or referred to in the tender documents shall form the basis of execution and payment. The extra payment or recovery over and above the accepted rate shall therefore be called for only in the event of authorized deviations from the drawings and specifications (as given and/or referred to in the tender documents) in course of execution and not otherwise.

In cases where the detailed architectural and structural drawings are to be provided by the Contractor, all the architectural and structural data/parameters necessary to work out the cost of the work, details of the functional requirement and complete/detailed specification thereof including preliminary drawings if any, must be finalised before call of tender and the tender documents must

contain all these details so that there is little scope of guess work on the part of the contractor while tendering and chances of dispute at later stage are minimised.

A condition should be stipulated in the tender documents that the work shall be executed as per detailed design and architectural/structural drawings to be prepared by the successful contractor conforming to the given parameters and functional/design requirements as enunciated in the tender documents and submitted to the department within specified time after the award of work. The contractor shall accordingly get the design/drawings approved by the department before taking up execution of the work. In case any modification for any reason is ordered in course of execution, suitable adjustment for extra payment or recovery shall be effected only if such modification in the tender documents or any change from the specified parameters.

Labour contract

In Labour contract the contractors undertakes contract for the labour portion. All material for the construction are arranged and supplied at the site of work by the department or owner, the labour contract engages labour and gets the work done according to specifications. 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 item of work at the stipulated rate in the contract agreement. Materials for scaffolding, centering and shuttering and other similar materials are supplied by the department 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. An agreement with all conditions of contract, rates bill of quantities (BOQ) etc. is prepared before the work is given out to the contractor. This system of contract is not generally adopted in the Govt. Deptt. . Private buildings are however by labour contract system which is less troublesome.

Daily labour

Work may be executed by departmentally by employing daily labour as masons, coolies , bhisties, carpenters, etc. The materials required for the construction as bricks, cement, sand lime, timber, steel etc. and tools and plants required for the operation are, got issued from the store by indent or purchased directly chargeable to the authorised agent as work-supervisor , misty, mate, etc. The attendance of labour is checked and initialled by Assistant Engineer or Sub- Divisional Engineer frequently during their inspections. The labour are paid weekly, fortnightly, monthly or at the completion of work according to the requirement.

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 work or piece-work up to Rs. 2000.00 may be carried out through contractors by Piece work agreement. 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 specification of the different items of work to be done are however included in the P.W.Agreement

and the total cost of the whole work to be done is also mentioned. Contractors have to arranged all materials, labours, etc., required for the execution of work., P.W.Agreement are not contracts in the true sense , there is no penalty clause and no security money and the department may terminate the work at any time they like but a notice specifying the date of termination should be served to the piece worker. Separate agency may also be engaged chargeable to the contractor to complete the work if the contractor does not carry out the work satisfactorily to the specification or delays the work or leaves the work incomplete or used bad materials. Urgent small work are selected by taking quotations. Rates of different item should be within schedule of rates or within sanctioned estimated rates . Payment is made on the measurement of the work actually done.

Scheduled contract or Item Rate contract:

In Schedule contract , 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 for various item of work and the total amount of contract (BOQ with rate , amount and total amount), plans and detailed drawings, detailed specifications and deposit of 10% security money; penalty, progress, date of completion and other conditions of contract. The payment to the contractor is made by detailed measurement of different items of works actually done by the contractor. The system is used for all works.

Item Rate Contract may also be a percentage above or below the printed schedule of rates of the department

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 labours 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 beforehand. An agreement 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 Explanation of various terms Administrative approval

For any work or project required by a department , an approval or sanction of the competent authority of the department, w.r.t the cost and work is necessary at the first instance. The approval authorise the engineering department to take up the work . Administrative approval denotes the formal acceptance by the department concern of the proposal , and after the administrative is given the engineer department (P.W.D) take up the work and prepare detailed designs, 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

After receipt of administrative approval and expenditure sanction, detailed estimates are required to be prepared for technical sanction. As its name indicates, it amounts to no more than a guarantee that the proposals are

structurally sound and that the estimates are accurately calculated and based on adequate data.

Before an estimate is technically sanctioned, the following shall be available.

- (i) Detailed architectural drawings and specifications
- (ii) Structural drawings for foundations
- (iii) Structural drawings of superstructure at least upto slab at level 2
- (iv) Detailed drawings of internal and external services.

Before according technical sanction to detailed estimates, the authority competent to accord such sanction shall ensure that the design and specification etc., of the building are rich enough to provide the desired life to it. In the 'Design and Scope' column of the estimate, it shall be specifically mentioned that, 'Under normal use and maintenance, the building is expected to have an economic life of years.'

For various types of buildings, the economic life shall be taken as below:

- (a) Monumental structures 100 years
- (b) RCC framed structures 75 years
- (c) Load bearing structures 55 years
- (d) Semi permanent structures 30 years

The technical sanction should be given by the competent authority before a work is taken in hand. In case of revised estimates, it is not necessary to wait for the revised administrative approval or the revised expenditure sanction to accord revised technical sanction.

Contingency budget

A contingency budget is money set aside to cover unexpected costs during the construction process. This money is on reserve and not allocated to one area of the work, and simply "insurance" against other costs.

In deterministic methods, contingency is estimated as a predetermined percentage of base cost depending on the project phase. In this technique, you take a percentage of the cost of the project

and calculate the contingency amount.

The estimated costs of the known-unknowns is referred to by cost estimators as cost contingency. Contingency "refers to costs that will probably occur based on past experience, but with some uncertainty regarding the amount. The term is not used as a catchall to cover ignorance.

Tender

To tender is to invite bids for a project or accept a formal offer such as a takeover bid. Tendering usually refers to the process whereby governments and financial institutions invite bids for large projects that must be submitted within a finite deadline.

Before tenders for a work are invited a detailed estimate showing the quantities, rates and amounts of the various items of work and also the specifications to be adopted should be prepared. Before sanctioning, the draft of the detailed estimate, for works having involvement of Architect, should be sent to the Senior Architect to examine it vis-a-vis the specifications of various items provided by him.

In case of works for which tenders are to be invited, tender documents comprising of the following should be prepared and approved by an authority

who is empowered to approve the Notice Inviting Tenders (NIT) before notice inviting tender is issued.

- I. The notice inviting tender in Form PWD 6.
- II. The form of tender to be used along with a set of conditions. Particular specifications and special conditions should not be repetitive and in contradiction with each other. Additional condition to be decided by NIT approving authority and he should be responsible for the same.
- III. The schedule of quantities of work.
- IV. A set of drawings referred to in the schedule of quantities of work.
- V. Specification of the work to be done.

Executive Engineer/Assistant Executive Engineer/Assistant Engineer issuing the tenders should invariably date and initial corrections, conditions and additions in the Schedule of Quantities, Schedule of Material to be issued and specifications and other essential parts of contract documents, and also date and initial on pages of the tender documents irrespective of fact whether they contain or do not contain any corrections or over writings etc. The officer concerned should record the fact in writing at the end of those pages individually.

Preparation of notice inviting tender

All notice calling for tenders should be in the standard form and be serially numbered, a proper register being maintained for the purpose. They should only be issued after the authority competent to accept the tender has approved the NIT papers. The notice inviting tenders should be carefully prepared, the use of symbols % and per thousand in the schedule of quantities accompanying the Notice Inviting Tenders is prohibited and the words hundred and thousand must be written e.g. "Per hundred sq. metre" must be written and not "% sq. metre". The units should thus be more specific.

In case of lump-sum tenders the Divisional Officer should see that detailed drawings and specifications duly authenticated by the competent authority form part of the notice inviting tenders and that the cost of various items forming part of the sanctioned estimate of the work is correctly assessed with reference to the relevant schedule of rates or in the case of non schedule items on the basis of rates supported by detailed analysis therefore, sanctioned by the competent authority.

The NIT papers are very important documents on which call of tenders and subsequent agreements with the contractors are based. It is, therefore, very necessary that each page and the correction slips as also other corrections and modifications made in the NIT papers are numbered and signed by the competent authority in token of approval so that all chances of tampering with such documents are avoided. Mere approval on forwarding letters would not serve the purpose. All corrections in the NITs and pages of the NITs approved by the Superintending Engineer and Chief Engineer should be attested by the Surveyor of Works. Thereafter the documents must be properly sealed to prevent any tampering.

It will be the responsibility of the Divisional Accountant to see that all forms issued to tenderers whether printed or otherwise, are clear, legible and unambiguous. The schedule of quantities attached to tender document other than Form PWD 7 must also contain a column for the "Amount" after the column

"Rate" and the contractor must calculate the amount of each item and enter it in the column. The Contractor must also total these amounts both by sub-head and give a grand total in words and figures both.

It will also be the duty of the Divisional Accountant to ensure that the tenders are issued to only those contractors who satisfy the eligibility criteria for issue of tenders as inserted in the Press Notice. He should properly scrutinise the applications received for issue of tenders keeping in view the eligibility criteria and then put up to the Executive Engineer for a decision.

The NIT for all works for which tenders are invited on PWD form 7 should provide that the Contractor should quote the percentage above or below to two places of decimal only.

The Notice inviting tender should stipulate reasonable time for completion of work. For building works, the Schedule of Contract period should be decided in accordance with Appendix 16 of this Manual by the NIT approving authority.

It should be ensured that a specific reference to the number of correction slips is made while mentioning the schedule of the rates or the CPWD specifications for works at Delhi, e.g. "Schedule of Rates for Delhi with correction Slips to" and "CPWD Specifications for works at Delhi with correction Slips to". The name should include the year also.

Receiving of quotations

A quotation, or quote, is a document that a supplier submits to a potential client with a proposed price for the supplier's goods or services based on certain conditions. Therefore, a quotation is often required for services but is also commonly used by businesses that sell goods.

Earnest money

According to the practice in Central PWD, earnest money is paid by each tenderer to enable Government to ensure that a tenderer does not refuse to execute the work after it has been awarded to him. In case where a tenderer fails to commence the work awarded to him, the earnest money is absolutely forfeited to the President.

If only a part of the work as shown in the tender is awarded and the contractor does not commence the work, the amount of the earnest money to be forfeited to the Government should be worked out with reference to the estimated cost of the work so awarded.

Rates of Earnest Money

The amount of the earnest money which a contractor should deposit with the tender is regulated by the following scales. In case of petty works costing Rs. 5,000/- or less the Executive Engineer may, at his discretion, dispense with the conditions for calling for earnest money.

(i) For works estimated to cost upto 2% of the estimated cost .

Rs. Twenty five crores

(ii) For works estimated to cost more Rs. fifty lakhs plus 1% of the excess of than Rs. twenty five crores estimated cost over Rs. twenty five crores.

Rules For Enlistment of Contractors in CPWD, 2001, do not provide for exemption of depositing earnest money with individual tenders by the contractors. Therefore, no exemption of earnest money against lump sum deposit is to be mentioned in the enlistment/revalidation orders.

Security deposit

The security deposit will be collected by deductions from the running bills of the contractors at the rate mentioned below and the earnest money, if deposited in cash at the time of tender, will be treated as part of security deposit. The security deposit will also be accepted in cash or in the form of Government Securities, Fixed Deposit Receipts. Performance security may be accepted as Bank Guarantee of Scheduled Banks and State Bank of India .

A sum @ 10% of the gross amount of the bill shall be deducted from each running bill of the contractor till the sum along with the sum already deposited as earnest money, will amount to Security Deposit of 5% of the tendered value of the work. In addition, the contractor shall be required to deposit an amount equal to 5% of the tendered value of the contract as Performance Security within the period prescribed for commencement of work in the letter of award issued to him.

Advance payment

This means payment made on a running account 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 case when the work is sufficiently progressed but measurement cannot be taken for certain valid reasons, on the certificates of Assistant Engineer in-charge of work that the value of work done is 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 payment

Means a payment made on a running account, to a contractor in respect of work done or supplied made by him and duly measured. Such a payment may or may not be for the full value of work or supplied; if it is subject to the final settlement of running account on the completion of the contract for the work or supplies.

Intermediate payment

The term applied to a disbursement of any kind on 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/ Final Bill

This means 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**"

Running bill

Denotes the account with a contractor when payment for work or supplies is made to him at convenient intervals subject to final settlement of the accounts on the completion or determination of his contract.

Regular and temporary establishment 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 cash balance.

Major & subhead of account

- The main unit of classification in accounts shall be the major head which shall be divided into minor heads, each of which shall have a number of subordinate heads, generally shown as sub-heads. The subheads are further divided into detailed heads. Sometimes major heads may be divided into 'sub-major heads' before their further division into minor heads.
 - The Sectors, Major heads, Minor heads, Sub-heads and Detailed heads together constitute a five tier arrangement of the classification structure of Government Accounts.
 - The Major Heads corresponds to 'Functions' of the Government.
 - Minor Heads subordinate to the Major Head shall identify the 'Programme' undertaken to achieve the objectives of the function.
 - The sub head below the Minor Head represents various schemes or activities under the programme. Detailed Head is termed as object classification.
 - The detailed classification of account heads in Government Accounts and the order in which the Major and Minor Head shall appear in all the account records shall be such as prescribed by the Central Government from time to time on the advice of C&AG of India.
 - The 'List of Major and Minor Heads of Account of Union and States contains the classification prescribed in this regard.
 - The classification prescribed should be strictly followed.

Temporary advance

An accountable advance that substitutes for credit or other payment arrangements that would ordinarily be used under similar circumstances (e.g., advancing cash to a construction contractor for materials received on site instead of only paying for work that has already been erected, inspected, accepted, and invoiced).

Issue rate

Issue rate denotes cost per unit fixed on the article of stock for the purpose of calculating the amount creditable to the subhead 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.

Storage charges

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

Supervision charges

This term is ordinarily applied to the charges which are levied, in addition to book value and storage charge(issue rate) , in respect to stock material sold or transferred and are intended to cover such item of expenditure incurred on the stores as do not enter in their book value and are not included in storages. When the stock materials 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 a general ledger account in which amounts are temporarily recorded. The suspense account is used because the appropriate general ledger account could not be determined at the time that the transaction was recorded.

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.

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 and related accounts

A voucher is an accounting document representing an internal intent to make a payment to an external entity, such as a vendor or service provider. A voucher is produced usually after receiving a vendor invoice, after the invoice is successfully matched to a purchase order.

They are:

- Debit or Payment voucher.
- Credit or Receipt voucher.
- Non-cash or Transfer Voucher.
- Supporting Voucher.

Measurement book use & maintenance, procedure of marking entries of measurement of work and supply of materials, labour employed, standard measurement books and common irregularity

The measurement book is the basis of all accounts of quantities whether of works done by Contractors or by Labourers employed departmentally or materials received. It should be so written that the transactions are readily traceable.

These books should be considered as very important accounts records and maintained very carefully and accurately as these may have to be produced as evidence in a court of law, if and when required.

All the Measurement Books belonging to a Division, should be numbered serially. A register should be maintained in form CPWA 92 showing the serial number of each book, on receipt, Sub-Division to which it is issued, the date of

issue, date of its return to the Divisional Office and date of its record after the required review in the Divisional Office has been completed.

A similar register should be maintained in the Sub-Divisional Office showing the names of person i.e. Assistant Engineer/Assistant Executive Engineer and Junior Engineer whom the measurement books are issued.

The Books, no longer to be used in the Sub-Division or with the Junior Engineer should be with drawn promptly even though not completely written up and re-issued.

The Measurement Books are required to be reviewed by Divisional Accountant under the supervision of Executive Engineer. The Assistant Engineers are required to submit the Measurement Books in use in the Sub- Divisions to the Divisional Office, from time to time, so that at least once a year the entries recorded in each of the Books are subjected to a percentage check. The Divisional Officer should ensure that this annual review is conducted regularly and positively every year.

When an Assistant Engineer or Junior Engineer in charge of the work or stores is transferred he should hand over the Measurement Books issued to him to his successor and these should be shown as received back from him and reissued to the relieving Officer. The transfer should also be recorded in the Measurement Book after the last entry in each book under dated signature of the relieving Officer and relieved Officer. Recording of Measurement

Each set of measurements to be recorded should commence with entries stating:-

- (i) In the case of bills for works done:
 - a) Full name of work as given in the agreement/Estimate.
 - b) Situation of work.
 - c) Name of contractor.
 - d) Number and date of agreement.
 - e) Date of written order to commence work.
 - f) Date of actual completion of work.
 - g) Date of recording measurements.
 - h) Reference to previous measurements.
- (ii) In the case of bills for supply of materials:
 - a) Name of supplier.
 - b) Number and date of supply order/agreement.
 - c) Purpose of supply in one of the following forms as applicable to the
 - d) case.
 - (i) Stock (for all supplies for stock purpose).
 - (ii) "Purchase" for direct issue to the work (full name of the work as given in the estimate may be mentioned).
 - (iii) "Purchase" for (full name of work as given in estimate) for issue to contractor on
 - (d) Date of written order to commence the supply.
 - (e) Date of actual supply; and
 - (f) Date of recording measurements.

A suitable abstract should then be prepared which should collect in the case of measurement for works done, the total quantities of each distinct item of work relating to each sanctioned sub-head. The measurement books meant for this

purpose contain pages in singleton. Details of quantities, rate and amount of each item for every bill are entered in this Measurement Book in a tabular form.

For recording measurements and also for preparing abstract, the agreement item No. both in words as well as in figure should be given neatly, instead of writing the description of the item in full or in abbreviated form which would not be necessary.

In case of extra/substituted item of work that is not covered in the agreement, the full nomenclature shall be reproduced in the M.B. and the bill form.

The full nomenclature of the items shall be adopted in preparing abstract of final bill in the measurement book and also in the bill form for final bills.

If the measurements are taken in connection with a running contract, a reference to the last set of measurements, if any, should be recorded. If the entire job or contract has been completed, the date of completion should be duly noted in the prescribed place. If the measurements taken are the first set of measurements on a running account, or the first and final measurements, this fact should be suitably noted against the entries in the Measurement Book and in the latter case, the actual date of completion should be noted in the prescribed place.

All measurements should be recorded neatly in the Measurement Book. The signature of the contractor or his authorised representative should be obtained in the measurement book for each set of measurements.

Muster roll : Its preparation & use for making payment of pay & wages

Muster Roll is used for keeping a complete record of attendance, payment made, un-paid wages and work done by daily labour engaged on the execution of works. It is the basic records of payment made to daily labour. After the payment is made, the Muster Roll is kept as a Voucher.

Muster rolls should be prepared and dealt with in accordance with the following rules :

1. One or more muster rolls should be kept for each work, but muster rolls should never be prepared in duplicate. It is permissible, however, to keep one muster roll for labourers employed upon several small works, in cases in which no harm can result if the total unpaid wages are regarded as relating only to the largest work in the group.
2. Labourers may be paid more than once a month and the period covered by each payment may be determined locally; but separate rolls must be prepared for each period of payment.
3. The daily attendances and absences of labourers and the fines inflicted on them should be recorded daily in part I of the muster roll in such a way as

- (i) to facilitate the correct calculation of the net wages of each person for the period of payment;
- (ii) to render it difficult to tamper with or to make unauthorized additions to or alterations, in entries once made, and
- (iii) to facilitate the correct classification of the cost of labour by works and sub-heads of works where necessary.

4. After a muster roll has been passed by the local officer, payment thereon should be made as expeditiously as possible. Each payment should be made or witnessed by the official of highest standing available, who should certify to the payments individually or by groups, at the same time specifying both in words and in figures, at the foot of the muster roll, the total amount paid on each date. If any items remain unpaid, the details thereof should be recorded in part II of the register of arrears, before the memorandum at the foot of the muster roll is completed by the person who made the payment.
5. Unpaid items should subsequently be carried forward from muster roll to muster roll until they are paid, the payments being recorded and certified in part II in the same way as payments of current items. It is optional, however, with the local officer to adopt any other alternative method of making payments of unpaid wages, provided that a systematic record of items remaining unpaid is maintained on the basis of the original entries made in part II of the muster roll and that suitable precautions are taken to prevent double payments.
6. Wages remaining unpaid for three months should be refunded into Treasury.
7. The payment of daily labour through a contractor instead of by muster roll in the usual way, is objectionable in principle. In a case of great emergency it may sometimes be found impossible to employ labour otherwise than through a contractor. Should it be possible in such a case, to determine the quantities of work done after its completion or at intervals during its progress, it is expedient to pay the contractor, at suitable rates, on the basis of work actually executed. To avoid disputes with the contractors, they should be encouraged to sign the daily reports in token of their acceptance as correct.

N.B.—The use of the muster roll is not permissible in such cases.

8. When it is necessary to bring labourers and artificers from a distance they may be allowed wages for the number of days occupied in the journey to and from the site of the work, if they join the work with proper despatch. At the discretion of the local officer, bona fide travelling expenses may also be allowed to them. The above charges must be borne by the estimate of the work.

**Acquittance Roll : Its preparation & use for making payment of pay & wages
Labour & labour report, method of labour payment, use of forms and necessity of
submission**

The payment of salary to persons of regular establishment working outstation is drawn on the regular pay-bill, but 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 Date signature. The Acquittance Roll

is prepared for the total amount as per Establishment Bill are passed 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.

Classification of stores, receipt / issue statement on standard form, method of preparation of stock account, preparation and submission of returns, verification of stocks, shortage and excess

The stores of the W.D. are divided into the following classes:-

- (i) **Stock** – Consumable materials like cement, steel, pipes, paints, spare parts of machinery, P.O.L (Petroleum, Oil, & Lubricants)., tyres, tubes etc. fall in this category.
- (ii) **Tools and Plants.**- Such equipments which can be shifted from one work site to another work site as and when required for the construction activities fall under this category e.g., spades, pickaxes, vehicles, road rollers, drilling rigs, concrete mixer /vibrator, compressor, jack hammer etc.
- (iii) **Road materials.** – Metal, moorum, gravel etc. fall in this category.
- (iv) **Material charged direct to work.** – Materials, which are accounted for in “Materials at Site Account” fall in this category. Also the machinery which shall be fixed or embedded at one place permanently shall fall in this category e.g. electric motor or pump to be fixed in pump house, electric switches etc.
- (v) **Materials charged to office contingencies.**– Stationery, furniture, typewriters, calculators, duplicating machines, copying machines, air conditioners, air coolers, water coolers, office cycle, three wheelers, blankets, warm clothing etc. fall in this category.

Receipt / issue statement on standard form

- (i) The indent books should be machine-numbered and kept in stock by the Executive Engineer, In-charge of Central Stores. He issues these indent books stamped with the stamp of his office to the various indenting Divisions and only the indents issued from such books are accepted by the Central Stores Divisions.
- (ii) The Executive Engineer in charge of the work is required to send three sets of the specimen signatures of the Junior Engineer and Assistant Engineer in charge of the work at the work site and that of the work Assistant, if any, authorised by the Executive Engineer for receiving stores in the Junior Engineer’s absence, duly attested by him to the Central Stores. One set there of will be kept by the Junior Engineer security and the other two sets will be in the Office under the personal custody of the Assistant Engineer (Indents) and Executive Engineer, Central Stores Division. The specimen signature of the EE shall be attested by the outgoing EE. For new Division, it is to be done by the SE.
- (iii) The signatures of the contractors or their authorised Agents to whom the materials are required to be issued are attested by the Asstt. Engineer and

the indent is countersigned by the Executive Engineer of the indenting Division.

- (iv) The Contractors are required to obtain identity photopasses for themselves or their authorised agents, duly attested by the Executive Engineer of the Indenting Divisions and of the Central Stores Division. On the photopass or identity card, the name of the work, for which the contractor or his agent is authorised to draw the materials is mentioned and the contractor or his agent is allowed to draw materials only for that work.
- (v) While sending the photographs of the Contractors or their authorised agents for drawal of the materials from the Central Stores, the following certificate should be recorded by the Executive Engineer of the Indenting Division:—
- Shri whose signature and photograph are attested by me is an authorised agent of Messers The indent placed on the Central Stores in the name of the above mentioned contractors for the works being carried out by them under this Division may please be honoured and the materials handed over to the authorised representative, i.e. Shri His photograph duly attested and his specimen signatures are given underneath.
- (vi) The authorisation letter with identity cards duly signed and attested should be sent through the authorised Junior Engineer of the Division in a closed cover in the name of the Executive Engineer, Central Stores Division so that there may be no change or tampering with the original identity card etc.
- (vii) The indent shall be presented at the Central Stores within 15 days of EE signing the same.
- (viii) The EE shall have the option to send advance payment for every indent or a lump sum advance for 2-3 months.

Verification of stocks

E.E. should have store verified throughout his Division at least once a year. It is not necessary that all the stores of a Division or of a Sub-Division should be checked and counted at the same time, but the dates on which articles are checked should be entered in the store returns. Stores should be counted by an officer not below the rank of an S.D.O. E.E. should ensure confidential check of store by selecting articles for check by S.D.O. monthly and obtain the result. In addition A.E. attached in Circle Office shall also carry out checking of stores atleast once in a year or as and when directed by the S.E. The Office Superintendent of E.-in-C./C.E./S.E, Head Clerk/establishment clerk in E.E.'s office and Sub-Divisional Clerk in S.D.O's office shall maintain the numerical account of furniture of his office. The physical verification will also be conducted by him and results intimated to Head of the Office.