Estimate of culvert and bridges (Module 1)

1. Simple hume pipe culvert with right angled wing walls:

Lowering in trenches upto a depth of 1.5m including transport of pipes upto 8km, jointing with 1:2 cement and sand mortar and testing but excluding excavation of trenches and refilling (pipes applied at the godowns by the department) as unit 1m. Always a 32m length of sewer, no. of pipes as 16 each of 2m. length and no. of joints 16 is taken.

Problem:

Q. Supplying and laying of RCC hume pipe and specials for sewers 100mm diameter.

a) Cost of 100mm diameter hume pipe 32m
@ Rs 200/m = 32 × 200 = Rs 6400

b) Cartage upto 8km distance ⟶
Cartage of 32m length of pipes
@ 24kg/m = 768kg. = 7.68quintal @ Rs 70/q
= 7.68 × 70 = Rs 537.6.

Cartage of 16no. collars @5.6kg each

= 16 × 5.6 = 89.6kg = 0.9 @ Rs 70/q

= 0.9 × 70 = Rs 63

c) Materials for 16 joints ⟶

Cement @ 0.043bag/joint

= 0.043 × 16 = 0.688 = 0.69 bags @ Rs 330/bag

= 330 × 0.69 = Rs 227.2

Sand @ 0.003m^3/joint

= 0.003 × 16 = 0.048m^3 = 0.05m^3 @ Rs 1500/m^3

= 1500 × 0.05 = Rs 75

Hemp or spun yarn @ 0.073kg/joint

= 0.073 × 16 = 1.17kg @ Rs 60/kg

= 60 × 1.17 = Rs 70.2

Bitumen @ lumpsum Rs 50 = Rs 50

d) Labour ⟶

Mistri (head mason) 1no. @ Rs 425/day

= Rs 425 × 1 = Rs 425

Mason 2no. @ Rs 400/day

= 400 × 2 = Rs 800

Mazdoor (beldar) 4no. @ Rs 250/day

= Rs 250 × 4 = Rs 1000

Bhisti 1no. @ Rs 230/day

= Rs 230 × 1 = Rs 230

Watchman (8hrs working) 3no. @ Rs 250/day

= 250 × 3 = Rs 750

e) Miscellaneous work

Excavation below invert level of each joint

@ lumpsum = Rs 250

Testing of laid pipe @ lumpsum
: Rs 150
Sundries, hiring charges, handling, etc
@ lumpsum : Rs 300

Total : Rs 11328.5

Additional 10% contractor's profit : Rs 1132.85

Total for 32m length = Rs 12461.35

Rate per m = Rs $\frac{12461.35}{32}$

= Rs 390

9. RCC deck slab culvert with right angled wing wall.

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 and mortar. Slab shall be of RCC 1:2:4 with reinforcement as per drawing. Exposed surface of brick masonry shall be cement painted 1:2. Road shall be provided with 10cm thick wearing coat of 1:2:4 cement concrete

Problem:

Q. Prepare a detailed estimate of a slab culvert of 1.5m span and 4m roadway.

Item no.	Particulars of items of work	No.	L (m)	B (m)	H (m)	Quantity (m^3)	Explanatory notes
1.	Earthwork in excavation →						
•	Abutments	2	5.1	0.7	0.6	4.28	
•	Wing walls	4	1.2	0.7	0.6	2.02	
				Total		6.30	
2.	Cement concrete 1:3:6 →						
•	Abutments	2	5.1	0.7	0.3	2.14	{1/2 of earthwork in excavation in item 1}
•	Wing walls	4	1.20	0.7	0.3	1.01	
				Total		3.15	
3.	1st class brick work in 1:4 cement mortar →						
•	Abutment	2	4.8	0.4	1.5	5.76	{upto top of RCC slab}
•	Wing walls	4	1.2	0.4	1.5	2.88	
•	Parapet upto kerb	2	4.7	0.4	0.3	1.13	{above RCC slab upto kerb}
•	Parapet above kerb	2	4.7	0.3	0.5	1.41	{above kerb excluding coping}
•	Parapet coping	2	4.9	0.4	0.1	0.39	
				Total		11.57	
	Deduction →						
	Bearing of RCC slab in abutment	2	4.8	0.3	0.2	0.57	
				Net Total		11	
4.	RCC work 1:2:4 →						
	slab excluding steel and its bending but including centering, shuttering and binding steel	1	4.8	2.1	0.2	2.016	{No deduction for volume of steel}

5.	Steel bars including bending in RCC work →						
•	20mm diameter bars – main straight bars 30cm c/c (No. = $\frac{4.80}{0.30}$ + 1 = 17)	17	2.38	—	—	40.46m	L = 2.10 – 2(side cover) + 2 hooks = 2.1 – (2 × 4cm) + (18 × 20mm) = 2.38m
•	Main bent up bars 30cm c/c (No. = $\frac{4.80}{0.3}$ = 16)	16	2.54	—	—	40.64	Adding 1 height, 16cm for 2 bent ups L = 2.38 + 0.16 = 2.54m
			Total	81.10m	@2.47 kg/m	200.32kg	
•	10mm diameter bars – distributing bottom bars 25 cm c/c	9	4.9	—	—	44.1m	L = 4.8 – 2 end cover + 3 hooks = 4.8 – (2 × 4cm) + (18 × 10mm) = 4.90m
•	Distributing top bars	4	4.9	—	—	19.6m	
		Total	63.7m	@0.62kg	=	39.49 kg	2.398 quintal
6.	Cement concrete 1:2:4 wearing coat →	1	4	2.3	0.1	0.92 m^3	In between parapets
7.	Cement pointing 1:2 in walls →						
•	Face wall from 10cm below GL upto bottom of coping	2	4.7	—	2.1	19.74	
•	Inner side of parapet excluding coping	2	4.7	—	0.8	7.52	Ht. = (20 + 10 + 50) = 0.8mm
•	Coping (inner edge, top, outer edge, outer side)	2	4.9	0.7	—	6.86	B = (10 + 40 + 10 + 10)cm = 0.7m
•	Ends of parapet	4	—	0.4	0.2	0.32	Upto kerb
•	11	4	—	0.3	0.5	0.60	above kerb

• Ends of coping	4	—	0.4	0.2	0.32	Edge and under side.
			Total		35.36	
Deduction →						
Rectangular opening	2	1.5	—	1.3	3.9	Including 10 cm below G/L and edge of RCC slab.
• Rectangular portion below earth slope	2	$\frac{1}{2}$ × 1.3 × 1.3	—	—	1.69	
Deduction →					5.59	
	Net total				29.77 m^2	

Item no.	Particulars of items of work	Quantity	Unit	Rate (Rs)	Per	Amount (Rs)
1.	Earthwork in excavation in foundation	6.3	m^3	350	%m^3	22.05
2.	Cement concrete 1:3:6 in foundation with stone ballast	3.15	m^3	400	m^3	1260
3.	I-class brickwork in 1:4 cement mortar	11	m^3	365	m^3	4015
4.	RCC work 1:2:4 in slab excluding steel and its bending but including centering, shuttering and binding steel	2.016	m^3	775.00	m^3	1562.40
5.	Steel bar including bending in RCC work	2.398	quintal	515	quintal	1234.97
6.	Cement concrete 1:2:4 in wearing coat	0.92	m^3	450	m^3	414
7.	Cement pointing 1:2 in wall	29.77	m^2	5.6	m^2	166.71

Total →	8675.13
Add 5% – (3% for contingencies and 2% for workcharged establishment) →	433.75
Grand total →	9108.88

Rate per running m of span

$$= \frac{\text{total cost}}{\text{span}} = \frac{9108.88}{1.5}$$

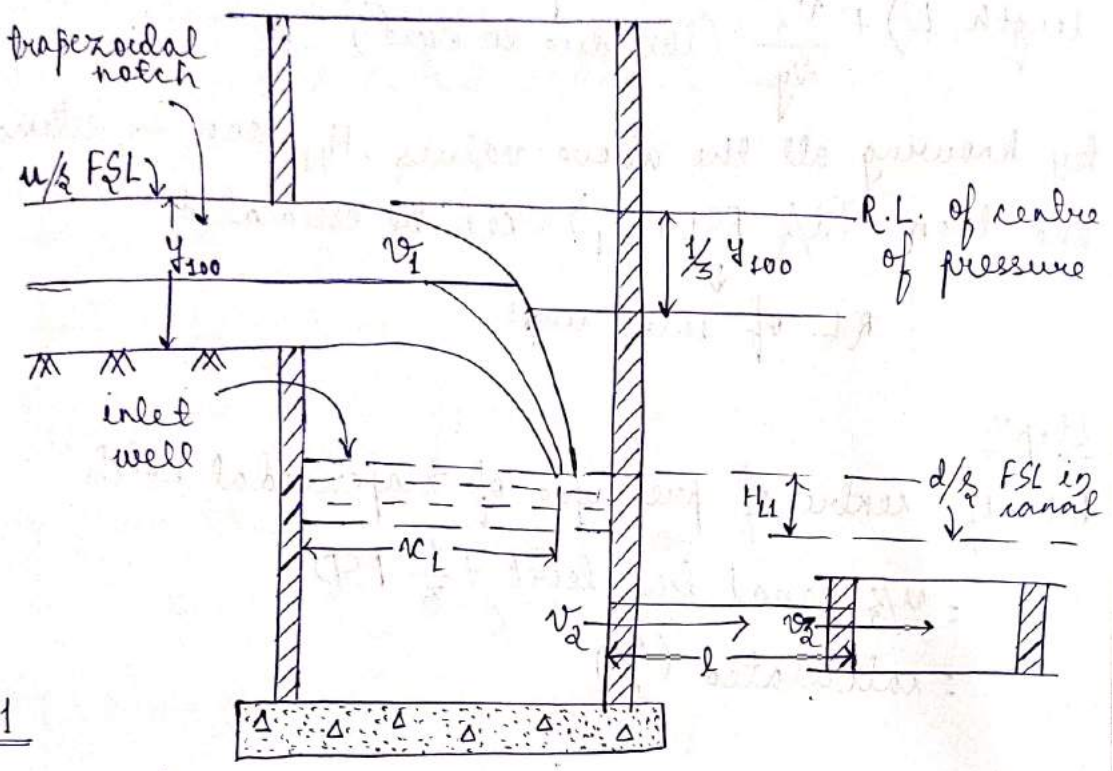
$$= \text{Rs } 6072.58 \text{ per m}$$

Estimate of Irrigation Structure (Module -2)

1. Siphon well drop:

→ It is generally adopted for smaller discharge and larger drops.

→ The main feature of the estimation involves the determination of size of the inlet well and the pipe.



Step 1

The size of the trapezoidal notch is estimated so as to pass the design distance.

Let v_1 be the velocity over the notch.

v_2 be the velocity of entry in the pipe.

v_3 be the velocity through pipe.

$v_1 = \frac{\text{full supply discharge}}{\text{area of flow over the notch}}$

$v_2 = \frac{\text{full supply discharge}}{\text{area of opening at entry}}$

v_3 = full supply discharge / area of pipe

Step 2

Head loss between inlet well and d/s FSL is H_{L1} as

$H_{L1} = 0.5\frac{v_2^2}{2g}$ (loss due to entry) + $\frac{(v_2 - v_3)^2}{2g}$ (loss due to sudden enlargement) + $\frac{f'Lv_3^2}{2gd}$ (loss in assumed pipe length L) + $\frac{v_3^2}{2g}$ (loss due to exit)

By knowing all the above values, H_{L1} can be estimated and then (d/s FSL + H_{L1}) can be estimated.

↓

R.L. of inlet well

Step 3

R.L. of centre of pressure of trapezoidal notch

: u/s canal bed level + $\frac{1}{3}$ FSD

: calculated (?)

Step 4

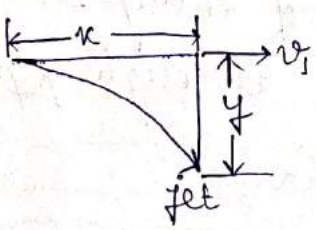
The height (y) of the centre of pressure above water level in inlet well = RL of CP − RL of water level in inlet well

= ? (known)

Step 5

$v_1 = \sqrt{\frac{gx^2}{2 \cdot Y}}$

where x and y are the coordinates of the jet w.r.t. the water surface level in inlet well



$x = v_1 t$, $y = \frac{1}{2} g t^2$

$\Rightarrow y = \frac{1}{2} g \left(\frac{x}{v_1}\right)^2$

$\Rightarrow v_1 = \sqrt{\frac{gx^2}{2y}}$

From above eqⁿ, value of x can be determined. Then diameter of inlet well is kept 1.5 times the value of x.

Problem:

Given,

G.L. = 163.36 m
Full supply depth = 75 cm
u/s bed level = 162.83
Discharge = 1 cumec
u/s and d/s bed width = 2.4 m
Fall = 3.8 m

we know that, $Q = 2.22 H^{3/2} [l + 0.4\eta H]$

at full supply level,

$$Q_{100} = 2.22 (y_{100})^{3/2} [l + 0.4\eta y_{100}]$$

It is given that $y_{100} = FSD = 0.75 m$

$Q_{100} = FSQ = 1$ cumec

$$\Rightarrow 1 = 2.22 \times (0.75)^{3/2} [l + 0.4\eta (0.75)]$$

$$\Rightarrow 0.71 = l + 0.3\eta \longrightarrow (1)$$

at 50% full supply discharge,

$$Q_{50} = 2.22 (y_{50})^{3/2} [l + 0.4\eta y_{50}]$$

From discharge formula of trapezoidal notch fall, we know that

$$y_{50} = 0.66 \times y_{100}$$
$$= 0.66 \times 0.75$$
$$= 0.5 m$$

also, $\frac{Q_{50}}{Q_{100}} = \left(\frac{y_{50}}{y_{100}}\right)^{1.64} \Rightarrow \frac{Q_{50}}{1} = \left(\frac{0.5}{0.75}\right)^{1.64}$

$\Rightarrow Q_{50} = 0.5 \text{ cumec}$

Now, $0.5 = 2.22 \times (0.5)^{3/2} \left[l + 0.4n(0.5) \right]$

$\Rightarrow 0.64 = l + 0.2n \longrightarrow (2)$

From eqn (1) and (2)

$0.71 = l + 0.3n$

$0.64 = l + 0.2n$

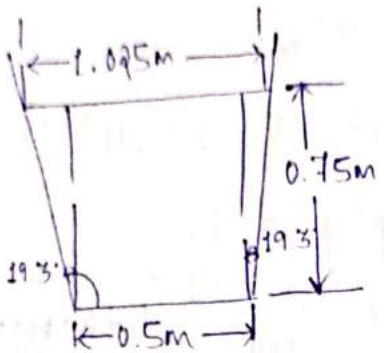
$\Rightarrow 0.1n = 0.07$

$\Rightarrow n = 0.7$

$\Rightarrow l = 0.64 - 0.2 \times (0.7) = 0.50$

$\tan \frac{\alpha}{2} = 0.7$

$\Rightarrow \frac{\alpha}{2} = 19.3°$



Hence provide a trapezoidal notch in the inlet well with 0.5m bottom width and each side inclined at an angle of 19.3° with vertical.

So, width of water at FSL flowing over notch

$= 0.5 + 0.7 \times (0.75) = 1.025\text{m}$

Velocity, v_1 over notch

$= \frac{FSQ}{\text{area of flow over notch}}$

$= \frac{1}{\frac{0.5 + 1.025}{2} \times 0.75} = 1.75 \text{ m/sec}$

Let the diameter of pipe = 1m

$\Rightarrow$ velocity, $v_3 = \frac{1}{\frac{\pi}{4}(1)^2} = 1.27 m/sec$

Let the diameter of the opening at inlet of pipe
$= 0.5m$

$\Rightarrow$ velocity, v_2 at entry to pipe

$= \frac{1}{\frac{\pi}{4}(0.5)^2} = 5.1 m/sec$

Let length of pipe $= 12m = l$

f' = Darcey's coefficient of friction $= 0.012$

$\therefore$ head loss between inlet wall and d/s FSL,

$$H_{L1} = 0.5\frac{v_2^2}{2g} + \frac{(v_2 - v_3)^2}{2g} + \frac{f' l v_3^2}{2g d} + \frac{v_3^2}{2g}$$

$$= 0.5 \times \frac{(5.1)^2}{2\times 9.81} + \frac{(5.1 - 1.27)^2}{2\times 9.81} + \frac{0.012 \times 12 \times (1.27)^2}{2\times 9.81 \times 1} + \frac{(1.27)^2}{2\times 9.81}$$

$= 1.52m$

R.L. of water surface in inlet wall

$=$ d/s FSL $+ 1.52$

$=$ (u/s FSL $-$ fall) $+ 1.52$

$= \{(162.83 + 0.75) - 3.8\} + 1.52$

$= 161.30$

$\simeq$ R.L. of centre of pressure of the trapezoidal waterway through notch

$=$ u/s canal bed level $+ \frac{1}{3}$ FSD

$= 162.83 + \frac{1}{3} \times (0.75)$

$= 163.08$

∴ height 'y' of centre of pressure above water level in the inlet wall

$= 163.08 - 161.30 = 1.78m$

We know that,

$$v_1 = \sqrt{\frac{g \times x^2}{2y}}$$

$$\Rightarrow x = \sqrt{\frac{v_1^2 \times 2y}{g}}$$

$$\Rightarrow x = \sqrt{\frac{(1.75)^2 \times 2 \times 1.78}{9.81}}$$

$$\Rightarrow x = 1.05m$$

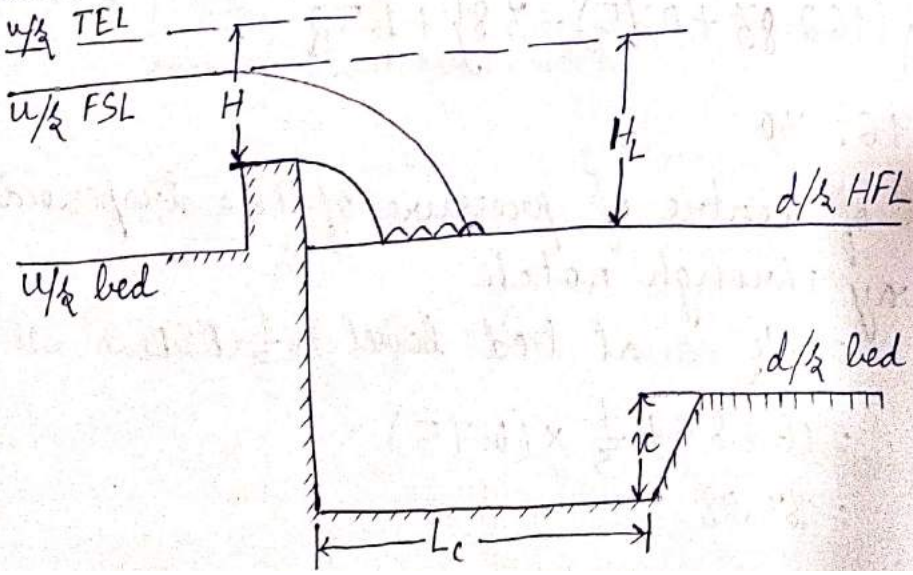
So, diameter of the inlet wall may be kept as $1.5x$, $\Rightarrow 1.5 \times 1.05$

$= 1.575m \simeq 1.6m$

Also, keep the d/s outlet wall as 1.2m.

2. Simple vertical drop fall:

→ In this the energy of the flowing water is dissipated by means of impact and by sudden deflection of velocity from vertical to horizontal direction.



$$L_c = 5 \cdot \sqrt{H \times H_L}$$

$$x = \frac{1}{4} (H \times H_L)^{2/3}$$

L_c = length of cistern in 'm'

x = cistern depression below d/s bed in 'm'

H = head of water over the crest in 'm'

= (u/s TEL − crest level)

Problem:

Given, $Q = 12 \text{ cumec}$

Fall = 1.5m

u/s bed level = 103.0m

Side slope = 1:1

d/s bed level = 101.5m

u/s FSL = 104.5m

u/s and d/s bed width = 10m

Soil = good loam

Bligh's coefficient = 6

Length of crest = d/s bed width = 10m

$$Q = 1.84 L H^{3/2} \left[\frac{H}{B_t}\right]^{1/6}$$

Assume top width of crest as 0.8m

$$\Rightarrow 12 = 1.84 \times 10 \times H^{3/2} \times \left[\frac{H}{0.8}\right]^{1/6}$$

$$\Rightarrow H = 0.755 \text{m} \simeq 0.76 \text{m}$$

approach velocity, $v_a = \frac{\text{discharge}}{\text{area}}$

$$= \frac{12}{(10+1.5)\,1.5}$$

$$= 0.696 \text{ m/sec}$$

(1.5 → depth of water)

Velocity head $= \frac{v_a^2}{2g}$

$= \frac{(0.696)^2}{2 \times 9.81} = 0.025m$

U/s TEL = U/s FSL + velocity head

$= 104.5 + 0.025 = 104.525m$

R.L. of the crest = U/s TEL − H

$= 104.525 - 0.755 = 103.77m$

Using crest level as 103.77m,

Ht. of crest above d/s floor $= 103.77 - 103$

$= 0.77m$

Width of crest $(B_t) = 0.55\sqrt{d}$

d = ht. of crest above d/s bed

$= 103.77 - 101.5 = 2.27m$

$\therefore B_t = 0.55\sqrt{2.27} = 0.825m$

Taking 0.825m as width of crest,

Thickness at base $= \frac{h+d}{2}$

$= \frac{(0.755 - 0.025) + 2.27}{2} = 1.5m$

- For u/s wing wall, it should be layed straight at an angle of 45° from u/s edge of crest and shall be embedded by 1m into the berm.
- For the d/s wing wall, it is kept straight and parallel upto the end of the floor.
- For u/s protection, 1.5m long brick pitching is done on u/s bed and sloping down towards crest at 1:10.
- 3 drain pipes of 15cm dia. at u/s bed level should be provided in the crest so as to drain out u/s bed

during the closure of canal.

Top of the crest should be capped with 20cm thick of C:C at 1:2:4 ratio.

Max. depth of u/s curtain wall

$$= \frac{y_u}{3} = \frac{1.5}{3} = 0.5m$$

0.4m × 0.8m deep curtain wall should be provided on u/s.

Depth of cistern, is given by

$$X = \frac{1}{4}(H \cdot H_L)^{2/3}$$

$$= \frac{1}{4}(0.76 \times 1.5)^{2/3} = 0.273m \simeq 0.3m$$

R.L. of cistern = 101.5 − 0.3 = 101.2m

Length of cistern $= 5\sqrt{H \times H_L}$

$= 5\sqrt{0.76 \times 1.5} = 5.34m \simeq 5.5m$

Detailed estimate of roads (Module 3)

1. Water bound macadam road:

By method 1

Quantity = $(Bd + Sd^2) \times$ length

By method 2

A_1 = sec. area at one end

$= Bd_1 + Sd_1^2$

A_2 = sec. area at other end

$= Bd_2 + Sd_2$

Mean sec. area $= \frac{A_1 + A_2}{2}$

Quantity = mean sec. area × length

By method 3 (by prismoidal formula)

$$\text{Quantity} = \frac{1}{6}(A_1 + A_2 + 4A_m)$$

A_1 = sec. area at one end

$= Bd_1 + Sd_1^2$

A_2 = sec. area at other end

$= Bd_2 + Sd_2$

A_m = mid sec. area

$= Bd_m + Sd_m^2$

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

Problem:

Q. Calculate the quantity of earthwork for 200m length for a portion of a road in an uniform ground the heights of banks at the two ends being 1m and 1.6m. The formation width is 10m and side slope 2:1 (H:V). Assume that there is no transverse slope

By method 1

$B = 10m$ $\qquad d = \frac{1 + 1.6}{2} = 1.3m$

$S = 2$

$L = 200m$

Quantity = $(Bd + Sd^2) \times$ length

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

$= 3276$ cumec

By method 2

A_1 = sec. area at one end

$= Bd_1 + Sd_1^2$

$= 10 \times 1 + 2 \times 1^2 = 12 m^2$

A_2 = sec. area at other end

$= Bd_2 + Sd_2^2 = 10 \times 1.6 + 2 \times 1.6^2$

$= 21.12 m^2$

Mean sec. area $= \frac{A_1 + A_2}{2}$

$= \frac{12 + 21.12}{2} = 16.56 m^2$

Quantity = mean sec. area × length

$= 16.56 \times 200 = 3312 m^3$

By method 3

Quantity $= \frac{1}{6}(A_1 + A_2 + 4A_m)$

A_1 = sec. area at one end

$= Bd_1 + Sd_1^2$

$= 10 \times 1 + 2 \times 1^2 = 12 m^2$

A_2 = sec. area at other end

$= Bd_2 + Sd_2^2$

$= 10 \times 1.6 + 2 \times 1.6^2 = 21.12 m^2$

A_m = mid sec. area

$= Bd_m + Sd_m^2$

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

$\therefore A_m = 10 \times 1.3 + 2 \times 1.3^2 = 16.38 m^2$

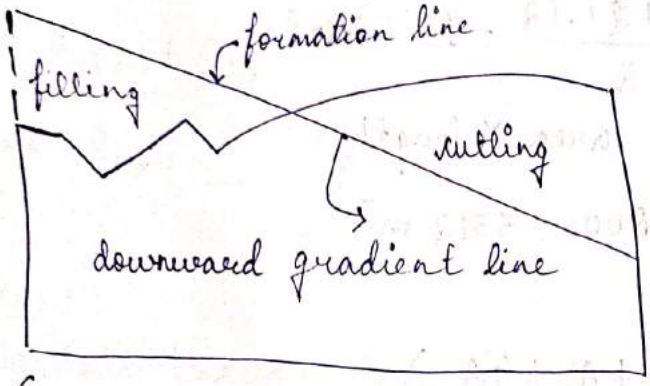
Quantity $= \frac{L}{6}(A_1 + A_2 + 4Am)$

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

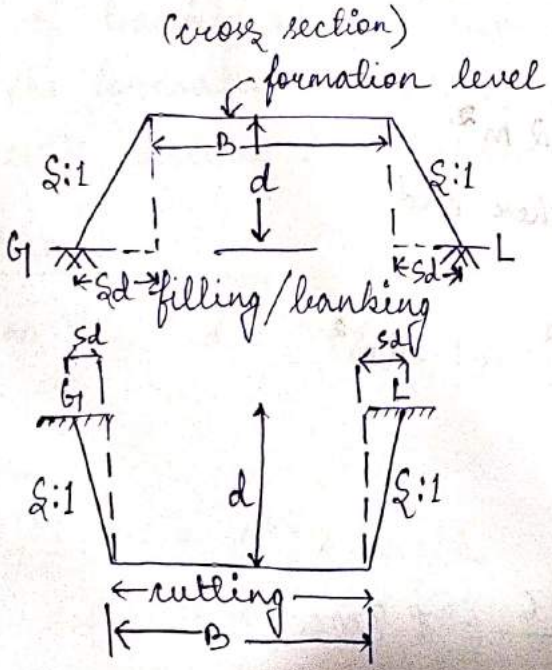
$= 3288 m^3$

Here, the difference by method 1 and 3 is less than $\frac{1}{2}$% and that the difference by method 2 and 3 is less than 1%.

2. Cutting and filling of a road:



(L-section metric dimension)



Sectional area = area of central rectangular portion + area of 2-side triangular portion

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

$= (Bd + \S d^2)$

$\S:1$ is the ratio of side slopes as H:V.

For 1 vertical, horizontal is $\S$, for d vertical, horizontal is $\S d$.

$Q = (Bd + \S d^2) \times L$

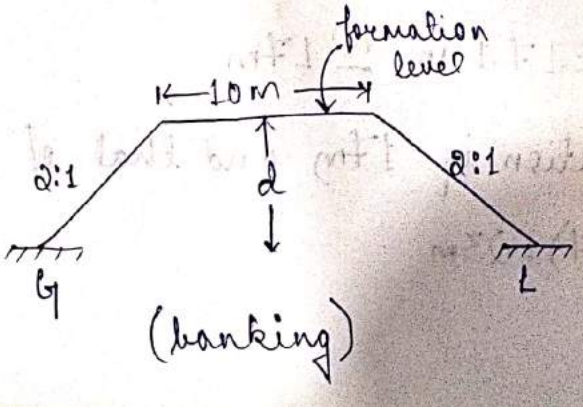
Problem:

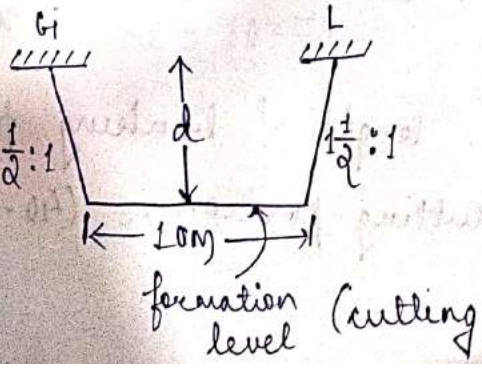
Q. Estimate the cost of earthwork for a portion of road for 400m length from the following data.

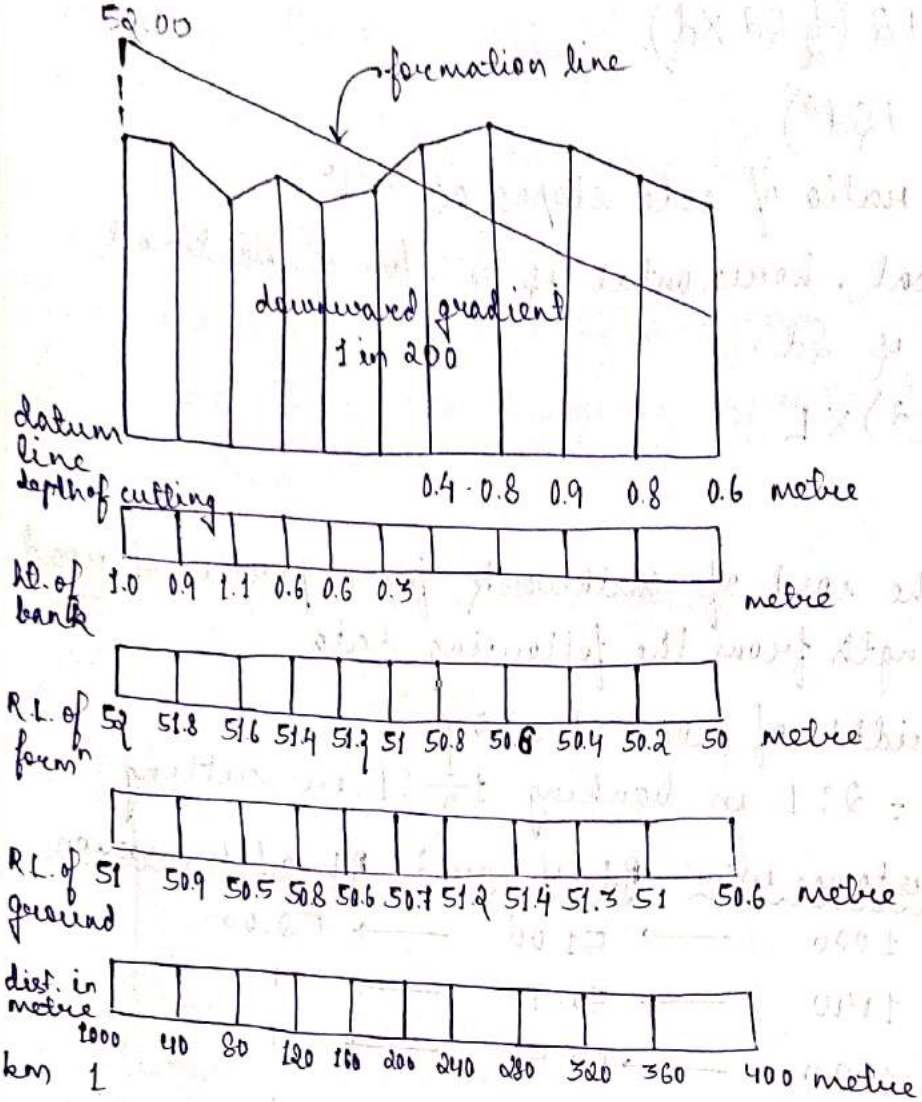
Formation width of road = B = 10m

Side slope = 2:1 in banking $1\frac{1}{2}$:1 in cutting

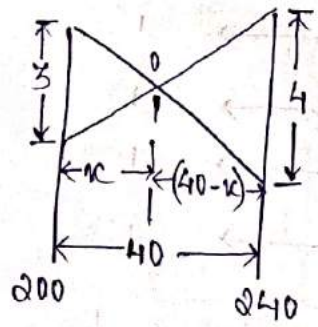
Station	Distance in m	R.L. of ground	R.L. of formation
25	1000	51.00	52.00
26	1140	50.90	"
27	1080	50.50	"
28	1120	50.80	"
29	1160	50.60	downward gradient of 1 in 200
30	1200	50.70	"
31	1240	51.20	"
32	1280	51.40	"
33	1320	51.30	"
34	1360	51.00	"
35	1400	50.60	"







The road passes from banking to cutting in between the stations 30(1200m) and 31(1240m).
The distance where it passes through zero i.e. G.L. may be determined as :—



Here both triangles are symmetrical, so

$$\frac{x}{3} = \frac{40-x}{4}$$

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

∴ length of banking portion is 17m and that of cutting portion is (40 − 17) = 23m

Station	Dist. km m	Ht. (diff. bet G/L & F.L)	Mean ht (d) m	Sectional Ar (Bd) m	Ar. of sides $(\frac{s}{2}d^2)$ m^2	Total sec. ar. $(B+\frac{s}{2}d^2)$ m^2	Dist. in bet. station (L) m	Quantity $\frac{L}{3}(A_1+A_2+4A_m)$ Banking (m^3)	Cutting (m^3)
25	1-00	1.0	—	—	—	—	—	—	—
26	1-40	0.9	0.95	9.5	1.81	11.31	40	452.40	—
27	1-80	1.1	1.00	10.0	2.0	12.00	40	480.00	—
28	1-120	0.6	0.85	8.5	1.45	9.95	40	398.00	—
29	1-160	0.6	0.60	6.00	0.72	6.72	40	268.80	—
30	1-200	0.3	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	—	383.2
35	1-400	-0.60	-0.70	7.00	0.74	7.74	40	—	309.6
						Total		1821.95	1384.98

Abstract of cost:—

Particular	Quantity	Unit	Rate (Rs)	Per	Cost
Banking	1821.95	m^3	275	% m^3	5010.36
Cutting	1384.98	m^3	350	% m^3	4847.43
				Total	9857.79

Add^n for contigencies (3%) = 295.73

Add^n for workcharged establishment (2%) = 197.16

Grand total = 10350.68

Works of PWD (Module-4)

Work:

For any original work, the engineering department prepare a proposal on the basis of preliminary estimate for the requirements and information supplied by the department contact. The department after due considerations approves proposal with respect to work and fund and convey their approval or administrative sanction to the engineering department.

Classification of work according to their nature:

The works according to their nature are classified under two main classes as original work and repaired work or maintenance work.

1. Original work:

→ Entirely new construction as construction of new building, bridge, road, dam, project, etc is referred as original work. In addition to it, any alternation to the existing work will increase the value of property as addition of rooms, conversion of verandha into rooms, dividing a weak room into two special rooms, etc.

→ Special repairs for renovation for thorough repair of the damaged work as changing of rooms, changing of floors, changing of doors and windows, etc are required.

2. Repair work:

→ The repair work is required to maintain the work in proper condition as annual repairs to building, roads, etc

→ Minor addition in alterations within certain maintaining limit which is not enough in increasing the value of property.

→ Eg: special repair, monsoon damage repair, etc.

Classification of work according to their cost:

With respect to the cost, the original work is classified as major work, minor work and pitty work.

1. Major work:

The work costing more than 2lakhs is termed as major work and the estimate for such works is known as major estimate.

2. Minor work:

The work costing more than 50-thousand but not exceeding 2lakh is known as minor work and the estimate for such work is termed as minor estimate.

3. Pitty work:

The work where cost doesn't exceed 50 thousand is called pitty work and the estimate done is known as pitty estimate.

Different types of repair work:

1. Annual repair or maintenance work:

→ All works of structure are repair and maintain in proper conditions. The normal repair works done annually comes under annual repair work.

→ Eg: All buildings are whitewashed, colour washed and repaired for minor repairs once in every year.

2. Quadrantal repair:

Besides annual repair work of white washing and colour washing every further year special repairs works are done for thorough repair as repainting of doors and windows, patch repair of plastering etc. Special repair works every 4th year is known as quadrantal repair.

3. Special repair:

Special repair work consist of renovations or renewals of structure of damage work. It generally consists of renewal of load, roofs and other items of work involving replacement according to long interval. Repair of monsoon damage work also come under special repair work.

Contract:

Contract is an undertaking by a person or farm to do any work under certain terms and conditions. The work may be for construction or maintenance and repair, for supply of materials, for the supply of labour, for the trasportation of material, etc.

Contractors:

The term contractors means a person or farm who takes any types of contract. Generally contractors are confined to the contractors engaged for construction or execution of work.

Different methods of carrying of work:

1. Daily labour
2. Piece work aggrement
3. Work order
4. Lumpsum contract
5. Lumpsum and schedule contract
6. Schedule contract and item rate contract
7. Labour contract
8. Cost plus percentage contract

1. Daily labour:

→ Work may be executed departmentally, by employing daily labour as coolies, bhisties, carpenters, etc. The material required for the construction are bricks, cement, sand, lime, surkhi, timbers, steel, etc. and tools and plants required for the operation are to be issued from the store by purchasing directly for the work.

→ The attendance of the labourers are kept in muster roll by the overseer or by mills otherwise agent as work supervisor, mistri, etc.

→ The attendance of the labourers are checked by the assistant engineer or sub-divisional or divisional engineer frequently during their inspection.

→ The labourers are paid quickly or daily or monthly or at completion of work according to the requirement.

2. Piece work agreement:

Piecework agreement form

District - ____ Division - ____

Name of work - ____ Name of party tendering.

I hereby agree to execute the under mentioned description of work by piecework and in accordance with the conditions noted below in consideration of payment being made by the executive engineering / sub-divisional officer. Division for the quantity of work executed at the rates specified in the following schedule.

Name of the work	No. of item	Class and description to be executed	Unit of cal^{n}	Rate of payment

N.B.

→ Piecework is that which involves the payment for the work done at the stipulated rate only without reference to the total quantity or time.

Dated - ____

Witness - ____

Signature of party making tender

Residence - ____

Accepted by me (sign)

Executive engg. / ....

Conditions:—

a) The piecework workers would carry on the work with due deligence and in workman like manner. He would use the best available materials subject to the approval of the executive engineer or — whose decision is considered for the rate of progress and quality of work or material would be final.

b) Payments would be made after measurements of work on its completion or termination of the agreement in works of long duration, payments may be made at convinient intervals usually once a month.

c) The executive engineer or — may put an end to this agreement at his option at any time.

d) In case of bad work or materials, the executive engineer/— may remove the same and have them replaced, deducting the value of the work rejected and materials removed, or the cost of replacing the same and he may think proper from any amount due or that may become due.

e) If the goverment have to pay any compensation to any of the piecework under the workmen's compensation act, the amount would be recovered from the later.

f) When the aggrement is terminated before the work is completed, the executive engineer/— would take over the materials required for its

completion if the piecework accepts his evaluation. If he doesn't accept the valuation, he must remove the materials from the site of work within 14 days otherwise they would be removed at his expense.

Defination:—

→ Piecework 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 stipulated rate.

→ Small works or piece work upto Rs200000 may be certified out through contractors by piece work agreement.

→ The piecework agreement contains only the description of different items of works to be done and the rate to be paid for but doesn't provide the quantities of different items will be executed nor the time within which the work is to be completed.

3. Work order:

→ Small work upto Rs2,00,000 may be carried out by work order. This is a contract and facilitate the approximate quantities of different items of work, detailed specification of each item of work, time for completion of the whole work, penalty that will be imposed for not fulfilling terms and conditions.

→ Payment is made on the measurement of the work done 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 contractors as satisfactory completion of the work.

4. Lumpsum contract:

→ In this the contractor undertakes the executions or construction of a specific work with all its contingencies to complete it in all respects within a specified time for a fixed amount.

→ The detailed specification of all items of works portioning to the whole work, plans and detailed drawings and deposit of 10% security money, penalty, progress and other conditions of contract which are included in the contract agreement.

5. Scheduled contract or item rate contract:

→ In this the contractor undertakes the execution or construction of a work on the item rate basis.

→ The amount agreement includes quantities, rates amount for various items of work actually done.

→ Item rate contract may also be percentage above or below the printed schedule of rates of the department.

6. Labour contract:

→ In this the contractor undertakes 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 work done according to specifications.

→ The contract is on item rate basis for labour portion and contractor is paid for the quantities of work done on measurement of the different items of work and the stipulated rate in the contract agreement.

7. 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 for the whole cost together with certain percentage, say 10% as his profit as agreed before hand.

Accounts of Works (Module 5)

Contingencies:

→ It indicates incidental expenses of miscellaneous character which can't 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 contingencies of 3% - 5% of estimated cost, is provided to allow for the expenses for miscellaneous petty items which don't fall under any sub-head of items of work.

→ Miscellaneous incidental expenses which can't be classified under any sub-head or item are met from the amount provided under contingencies.

→ If there is any saving against the amount provided under contingencies, this amount may be utilised with the sanction of the competent authority, to meet the expenses of extra items of work, if any unforeseen, expenditure, expenses to

minor changes in design, etc.

Administrative approval or sanction:

→ 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.

→ It denotes the formal acceptance by the department concerned of the proposal and after this it is given to the engineer of the department (P.W.D) to take up the work and prepare detailed designs, plans and estimates and the executes the work.

Technical sanction:

It means the sanction of the detailed estimate, design calculations, quantities of work, rates and cost of the work by the competent authority of the engineering department.

Tender:

→ It is an offer in writing to execute some specified work or to supply some specified articles at certain rates within a fixed time under certain condition of contract and agreement, between the contractor and the department or owner or party.

→ The construction of work is usually done. Contract sealed tenders are invited and the work is usually given to the lowest tender.

→ While inviting tenders, the bill of quantities, detailed specifications, condition of contract and

plans and drawings are supplied on payment of the requisite cost to the contractors who tender or quotes their rates.

Tender notice:

Tender for work or supply are inviting or 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 completion.
vi) Cost of complete set of tender from conditions.
vii) Date, time and place of tender.
viii) Amount of earnest money and security money.
ix) Validity of tender.

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

Regular establishment:

* Both permanent and temporary employees of the department are included in the regular establishment.

→ The permanent establishment are not liable for refreshment and they are entitled for leave, provisions and other amenities as per service rule.

→ The temporary establishment are employed when the work is increased and their services can be terminated at any time with proper notice as per rules.

Earnest money:

While submitting a tender the contractor has 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 mayn't refuse to accept the work or run away when his tender is accepted.

Security money:

→ 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 deposit.

→ This amount is kept as a check so that the contractor fulfills 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.

Suspense heads:

→ These are such heads which are reserved for the temporary booking of the transactions of the following nature.

i) When the fixed head of account to which the cost is ultimately debitable cannot be determined at once, eg - in case of cost of ultimately debitable cannot be determined at once.

ii) When materials have been received from a supplier or some other divisions and bills of the same have not been received, in such cases the approximate cost of materials debited to work or 'stock' as the case may be and 'credited' to purchase the last two being suspense heads.

iii) To watch recovery of cost of materials on their sales of other shortages, pending adjustment by recovery or otherwise. In such cases suspended head 'miscellaneous P.W.D. vacancies' is operated upon.

Issue rate:

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

→ It is fixed for each article of stock on the book of actual cost plus, other expenses including storage charges.

Storage charges:

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

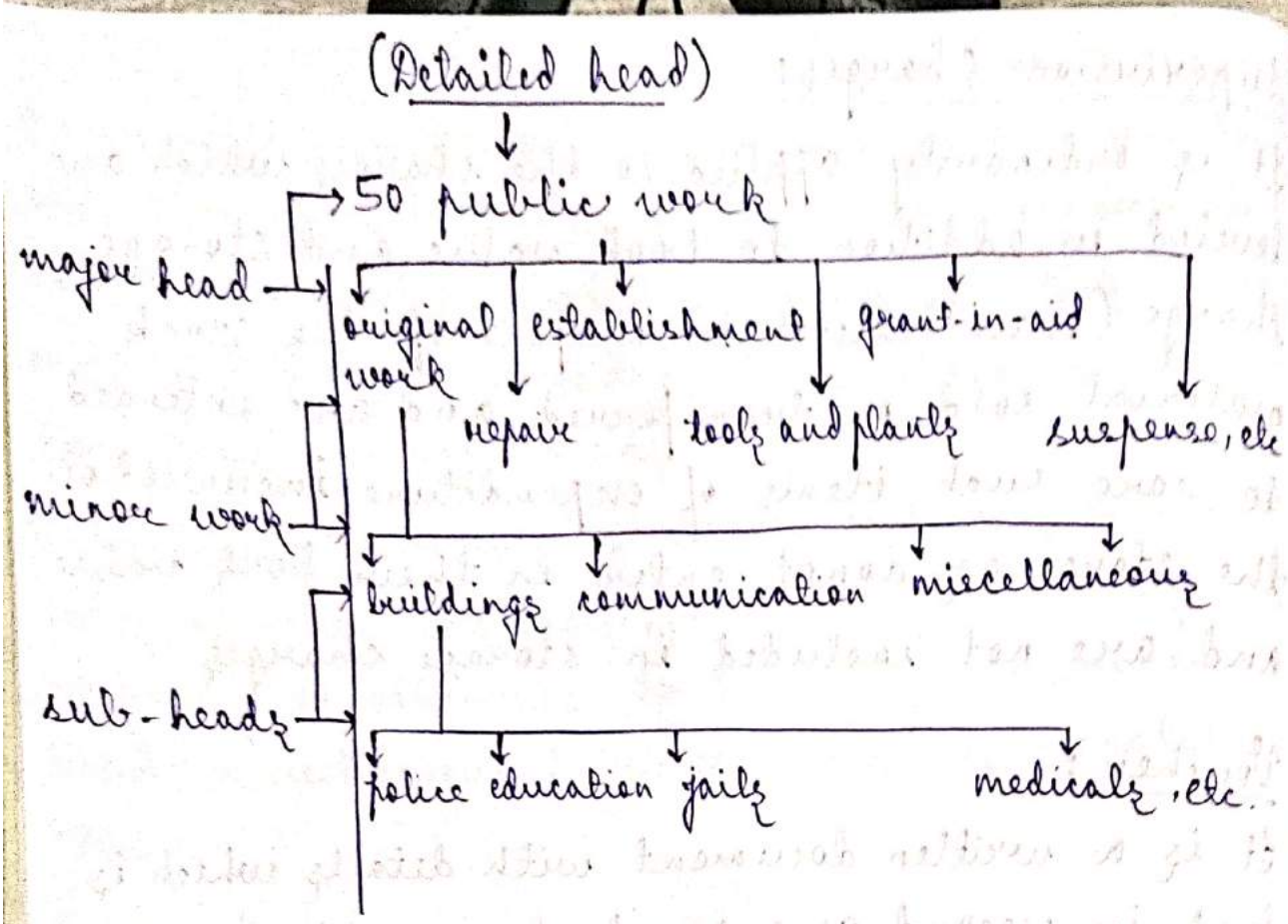
Supervision Charges:
It is ordinarily applied to the charges which are leveled in addition to book value and storage charge (issue rates) in respect of the stock material sold or transferred and are intended to cover such items of expenditure incurred on the stores as donot enter in their book value and are not included in storage charges.

Voucher:
It is a written document with details which is kept in record as a proof of payment.

Final payment:
It is the payment made on running account, made to a contractor on the completion or determination of the contract and in full settlement of the account.

Advance payment:
It is the payment made on a running account to a contractor for work done by them but not measured.

Major head:
(50 public heads) ⟶ Minor heads ⟶ organising works, repairs, establishment, tools and plants, grants-in-aid, suspense, etc. ⟶ Sub-heads ⟶ buildings, communication, miscellaneous ⟶ Heads ⟶ police, education, jail, medicals, etc.



Cash:

It includes legal tender coins where cheque are payable on demand, remittance transfer of receipts and demand drafts.

Debit and credit:

Debit means expenditure and credit means receipt.

Temporary advance:

→ It is also known as temporary impress. It is the amount which is advanced by a distributing officer to sub-ordinate officer to enable them to make a no. of specific payment out of a muster-roll or any other voucher which has already been passed for payment.

→ The amount is advanced for payment of passed bills.

Advice of transfer debit/credit (A.T.D):

The payment between two divisions are made by book transfer through advice for transfer debit or credit. For transfer of transaction between public works divisions within state, the originating divisions sends an advice of transfer for debit or credit in prescribed form.

Running bill:

i) Running account bill C, form 24 white:—

It is used for making an account of payment or running payment for measured works or supplies i.e. both of works and supplies which are measured.

ii) Running amount bill A, form 25 white:—

It is used for advance payment or bill payment without any measured for works only but not for supply.

iii) Running account bill B, form 26 white:—

It is used for selected advance payment only for works.

iv) Running account bill D, form 27A:—

It is used for making on-account or intermediate payment to contractor on lumpsum contract.

Muster roll:

It consists of 2 parts.

Part 1 :-

→ Here daily attendance are recorded.

→ In this part, there are columns and spaces for names of the labour who are designated, date of attendance, rates, total amount due for each, total amount due for whole, signature of the person taking attendance, signature of the officer making payment, etc and these column are duely filled up.

Part 2 :—

→ Details of the quantity of work done by the labourers and the progress of work are recorded in this part.

→ Details of measurement are taken and entered in the measurement book and an abstract of quantities is prepared sub-head wise and this abstract of quantities is recorded in part 2 of the muster roll.

Preparation of muster roll :—

→ One or more muster roll may be kept for each work but M.R. shouldn't be prepared in duplicate. It is permissible to keep one M.R. for labourers employed on several small work in near about places.

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

→ The daily attendance and absence of labourers and fines, if any imposed on them should be

recorded in sink 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 classifications of cost on works and sub-heads of works may be kept separately.

→ After a M.R. has been passed, payment should be made as quickly as possible and each payment is installed and dated by the paying officer. If any item remains unmentioned, the details of such item should be recorded in the register of unpaid wages.

→ The amount of unpaid wages are deposited in the cash and the amount is kept as deposit. The amount may be paid later on hand receipt from 28 duly signed and a note of payment is entered in the register of unpaid wages against the original entry.

Use of muster roll :—

→ It is used to consist of three parts. Part 1 → nominal roll, Part 2 → register of areas of wages, Part 3 → details of work done.

→ But it has been revised to consist of two parts by C.P.W.D. code of accounts. In the M.R. from the account of unpaid wages is kept in Part 2 of the M.R.

Acquittance roll:

It is a record of payments made to each labourer on a payroll type by cash.

Preparation of acquittance roll :—

Acquittance roll
(Payment of Salary by Cash)

Acquittance roll of permanent (or temporary) establishment of _____ for pay or

Item no.	Name	Designation	Net amount payable		Dated signatures (with stamp where necessary, unpaid items to be noted as such and attested
			Rs.	P.	
		Total			Total unpaid Rs _____

Passed for Rs _____ (in figures) {Rupees _____ (in words)} on the authority of establishment Bill of _____ for _____.

Cashier Drawing officer

Labour:

Construction industry is one of the largest industry in India, where about four crores of workers are employed and most of them are unskilled labourers. In general, construction labourers are classified as unskilled, semi-skilled and skilled persons. The labourers employed in construction industry are paid wages on daily basis as the construction work is temporary. Hence the job in construction industry is also temporary and workers have no job security. Therefore, construction labourers can easily be shifted from one place to another

Labour report:

This report records the number of labourers employed, payment made to them and their output which is compared with the labour schedule. In case any excess in noticed, corrective action is initiated by the competent authority.

Method of labour payment:

Payment mode of labour is generally referred to as wages. It can be time-rated or piece rated. It can be rate per hour, per day, per week, per month or per year. This is the remuneration paid to the workers for the actual work they do. The wages can be paid to ordinary skilled, unskilled or semi-skilled workers as daily basis, or weekly basis. The wages are both monetary and non-monetary. The monetary wages are money paid to workers as wage. But non-monetary payment may be known as fringe-benefits.

Classification of stores:

→ Stores can be divided into four categories according to public work department.

a) Stock

b) Tools and plants

c) Road metal

d) Materials charged directly to works

Stock:—

The stock is the store which is required for general work and kept under suspense head and finally issued for the work.

Tools and plants:—
The materials are used for the execution of different kinds of work, different materials such as machinery, instruments and furnitures and vehicles are known as tools and plants.

Receipt statement on standard form:
→ The account of all receipts should be examined carefully and their record is to be kept. The receipt is prepared in triplicate form.
→ One copy is retained by the stores incharge and other two copies are sent to the sub-divisional officers who sends the other copy to the divisional officer.

Issue statement on standard form:
→ This form consists of three parts.
i) First part is for the articles in hand.
ii) Second part is for the articles given on loan or sent out for short time period.
iii) Third part is for the shortage awaiting adjustment.

Stock account:
→ A transaction of receipt and issue of materials are recorded day-to-day in the register of stock receipts and issue.
→ The account is maintained separately for every month and closed once in the march. For a big stock when there are large no. of transaction of receipts and issue.

→ On closing of the monthly account 'abstract of stock receipt' prepared in form 9 and a single 'abstract of stock issue' prepared in form 10 and submitted to S.D.O. or AE incharge of store to the divisional officer for inclusion in the monthly divisional account.

→ Half yearly balance returns of the stock for every six month periods ending in september and 31st march also prepared in form 11 by the S.D.O. or AE incharge of store.

→ The divisional officer where these are checked and compared with the 'half-yearly' register of stock.

Verification of stocks:

There are 2 broad methods of stock verification.

a) Annual physical verification:—

This method is suitable for small plants involving a limited no. of store items but not suitable for a large plant involving huge inventory because it is not economical to shutdown it for a number of days.

b) Perpetual inventory and continuous stock taking system:—

A more appropriate method for large plant is the prepetual inventory and continuous stock taking system which records store balances after every receipt and issue and facilitates regular checking and obviates closing down of

the plant for stock taking.

Surplus and shortages:

→ Surplus in stores are treated as receipts and posted in part 1 of the yearly return maintained in the sub-divisional office.

→ Shortages in stores are entered in the part 3 of the tools and plants register under debits.