LECTURE NOTE ON

ESTIMATION & COST EVALUATION-II

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ATHAGARH, CUTTACK-29

COURSE CONTENT:

1. **Detailed estimate of culverts and bridges.**
   - 1.1. Detailed estimate of a RCC slab culvert with right angled wing walls with bar bending schedule.
   - 1.2. RCC Hume pipe culvert with splayed angled wing wall
2. **Estimate of irrigation structures**
   - 2.1. Detailed estimate of simple type of vertical fall to given specification]
   - 2.2. Detailed estimate of drainage siphon to given specification.
3. **Detailed estimate of roads**
   - 3.1. Detail estimate of a water bound macadam road
   - 3.2. Detailed estimate of a flexible pavement in cutting / filling
   - 3.3. Detailed estimate of septic tank and soak pit for 50 users
4. **Miscellaneous estimates**
   - 4.1. Tube well, Piles and Pile cap, Isolated and combined footings.
5. **PWD Accounts works**
   - 5.1. Works
     - 5.1.1. Classification of work-original, major, petty, repair work, annual repair, special repair, quadrantal repair.
     - 5.1.2. Concept of Method of execution of works through the contractors and department, contract and agreement, work order, types of contract, piece work agreement.
   - 5.2. Accounts of works –
     - 5.2.1. Explanation of various terms administrative approval, technical sanction, tender, preparation of notice inviting tender, quotations, earnest money, E-tendering, security deposit, advance payment, intermediate payment, final payment, running bill, final bill, regular and temporary establishment, cash, major & subhead of account, temporary advance (impress money), supervision charges, suspense account, debit, credit, book transfer, voucher, and related accounts.
     - 5.2.2. 2 Measurement book use & maintenance, procedure of marking entries of measurement of work and supply of materials, labour employed, standard measurement books and common irregularity.
     - 5.2.3. Muster roll: Its preparation & use for making payment of pay & wages
     - 5.2.4. Acquittance Roll: Its preparation & use for making payment of pay & wages
     - 5.2.5. Labour & labour report, method of labour payment, use of forms and necessity of Submission
     - 5.2.6. 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
   - 5.3. Building BYLAWS and REGULATORY Bodies, Development authorities, types and their levels, RERA etc.

INTRODUTION

ESTIMATION:

- It is the process of calculating the quantities and costs of the various items required in connection with the work for its satisfactory completion.
- An estimate is the anticipated or probable cost of work is usually prepared before the construction is taken up. Before undertaking any project it is necessary to know its probable cost shall be occurred.

TYPES OF ESTIMATION:

- Approximate Estimate or Preliminary estimate
- Plinth area estimate
- Cube rate estimate
- Labour estimate
- Detail estimate
- Abstract estimate
- Revised estimate
- Supplementary estimate
- Annual repair & maintenance estimate

ROAD ESTIMATE

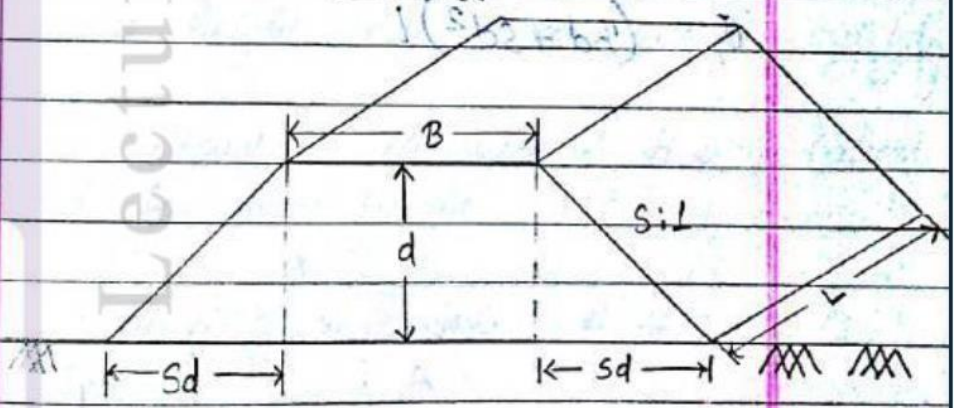
ROAD :- Road is a rigid pavement & flexible pavement through which one can travel from one place to another by means of road communication.

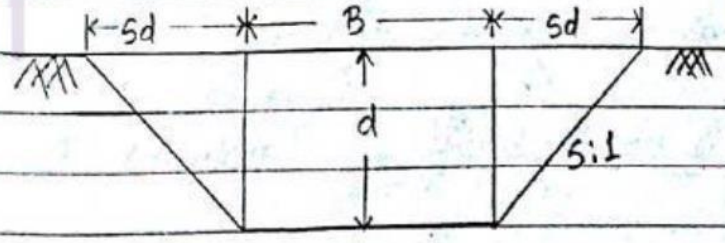
TYPES OF ROAD :-

i) NH (National Highway)
ii) SH (State Highway)
iii) MDR (Major District Road)
iv) ODR (other District Road)
v) VR (village Road)

S = Slope

Banking





Cutting

Cross-section of earthwork upto banking & cutting is usually in the form of trapezium and the quantity of earthwork may be calculated by

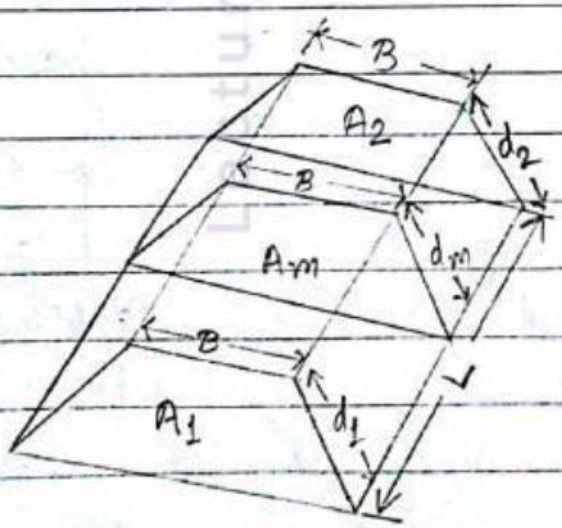
Q = Sectional area × length

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

Sectional Area = $B \cdot d \times 2 \times \left(\frac{1}{2} \times s d \times d\right)$

$= B \cdot d + s d^2$

$Q = (Bd + sd^2) L$



Mid Sectional Formula =

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

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

where, B = width of the Road,
d = depth of Road
Sd = side slope distance.
S:1 = Side slope ratio as horizontal : Vertical

when the ground is in longitudinal slope the height of the bank & the depth of the cutting will be different at end of the section & mean height may be taken as $\left\{d_m = \frac{d_1 + d_2}{2}\right\}$

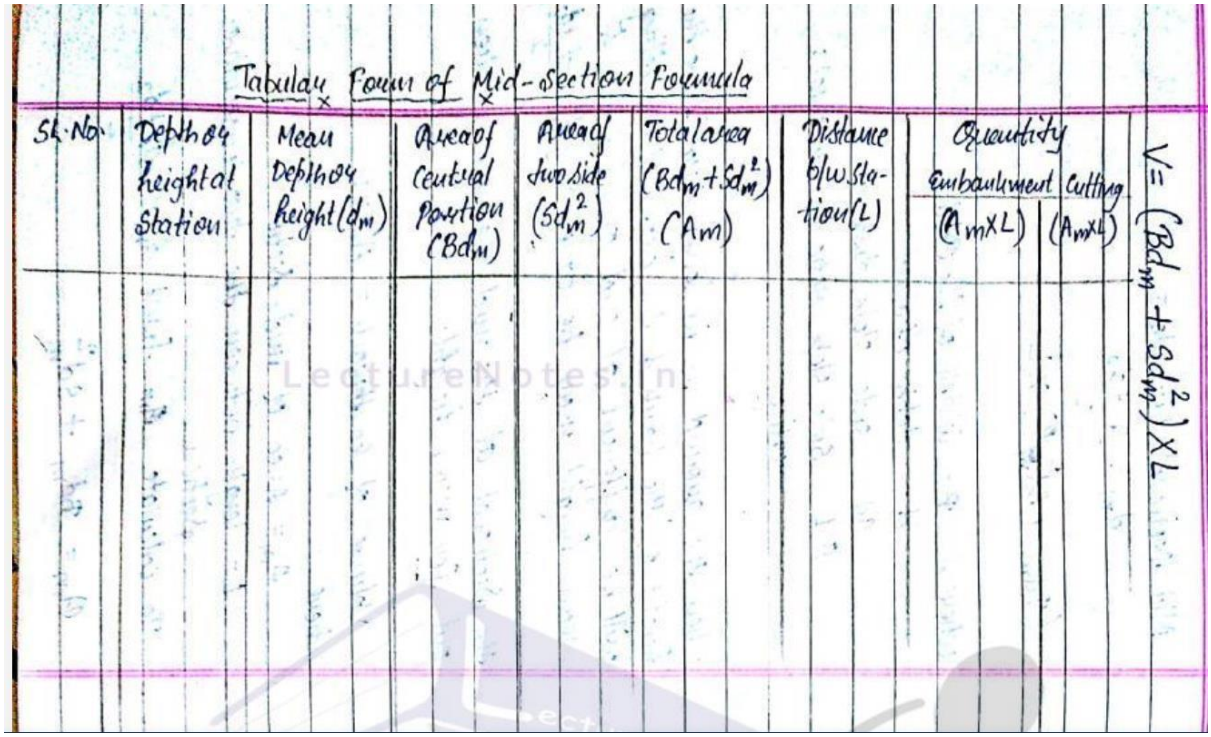
the Sectional at the mid section is taken out for mean height.

Volume of Earthwork = $A_m \times L$

where,
A_m = Area of mid-section
L = length between the two consecutive section

To calculate Am first $d_m = \frac{d_1 + d_2}{2}$

$$A_m = Bd_m + Sd_m^2$$



Tabular Form of Mid-Section Formula

Sl. No.	Depth of Height at Station	Mean Depth of Height (d_m)	Area of Central Portion (Bd_m)	Area of two side (Sd_m^2)	Total area ($Bd_m + Sd_m^2$) (A_m)	Distance b/w Station (L)	Quantity Embankment ($A_m \times L$)	Quantity Cutting ($A_m \times L$)	$V = (Bd_m + Sd_m^2) \times L$

WHAT IS EXCAVATION: -

In construction terms, excavation is the process of removing earth to form a cavity in the ground.

On small sites or in confined spaces, excavation may be carried out by manual means using tools such as picks, shovels and wheelbarrows. Larger scale excavation works will require heavy plant such as bulldozers and black actors.

WHAT IS CUTTING AND FILLING: -

Cut and fill excavation is a method of construction used on undulating terrain with ridges and troughs or more specifically terrain with elevated areas (hills and mountains) and low-lying areas (valleys). This method is widely used in the construction of roads, railways, canals, and other projects where embankments are to be built

ROAD ESTIMATION:

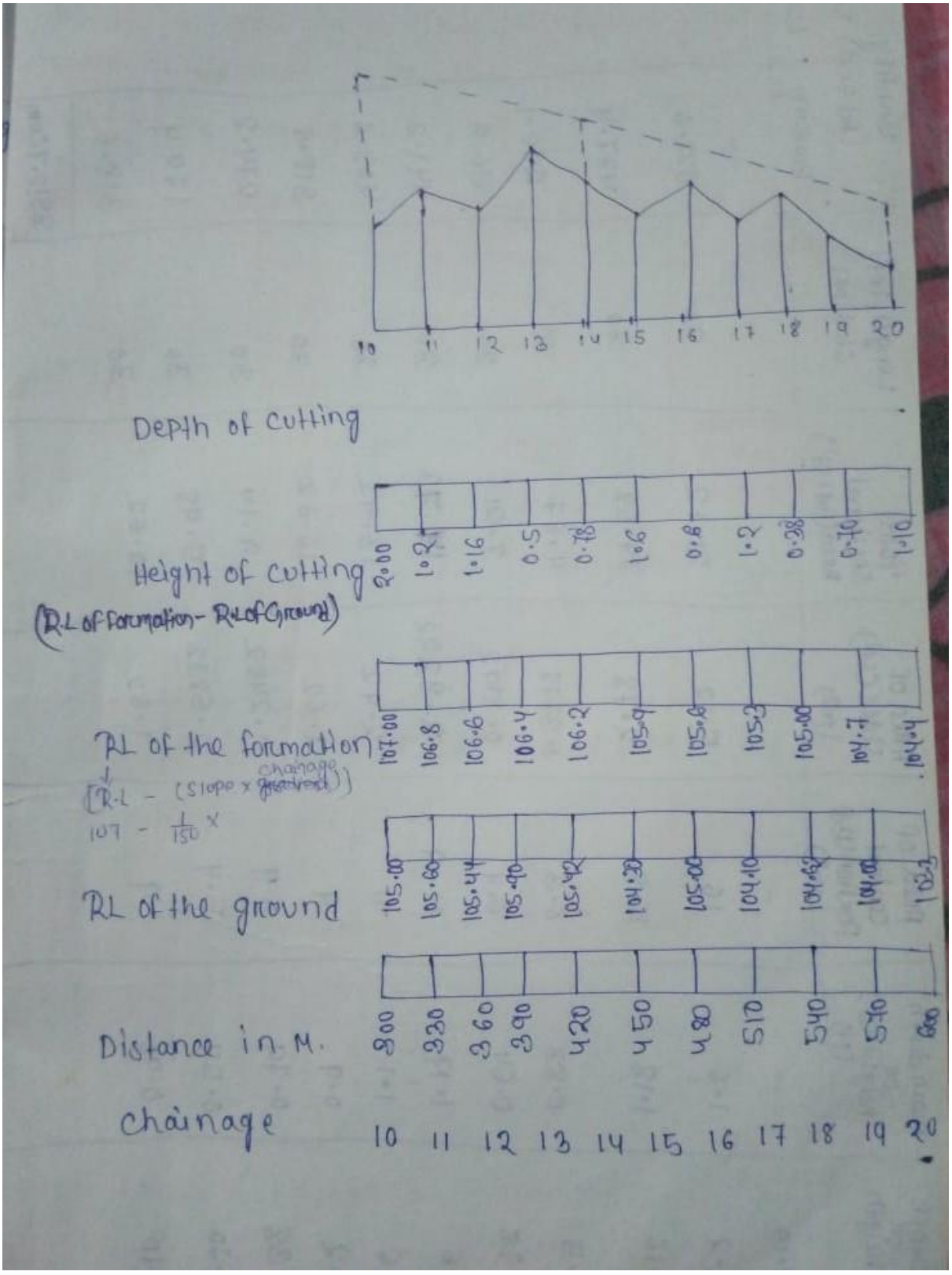
Problem

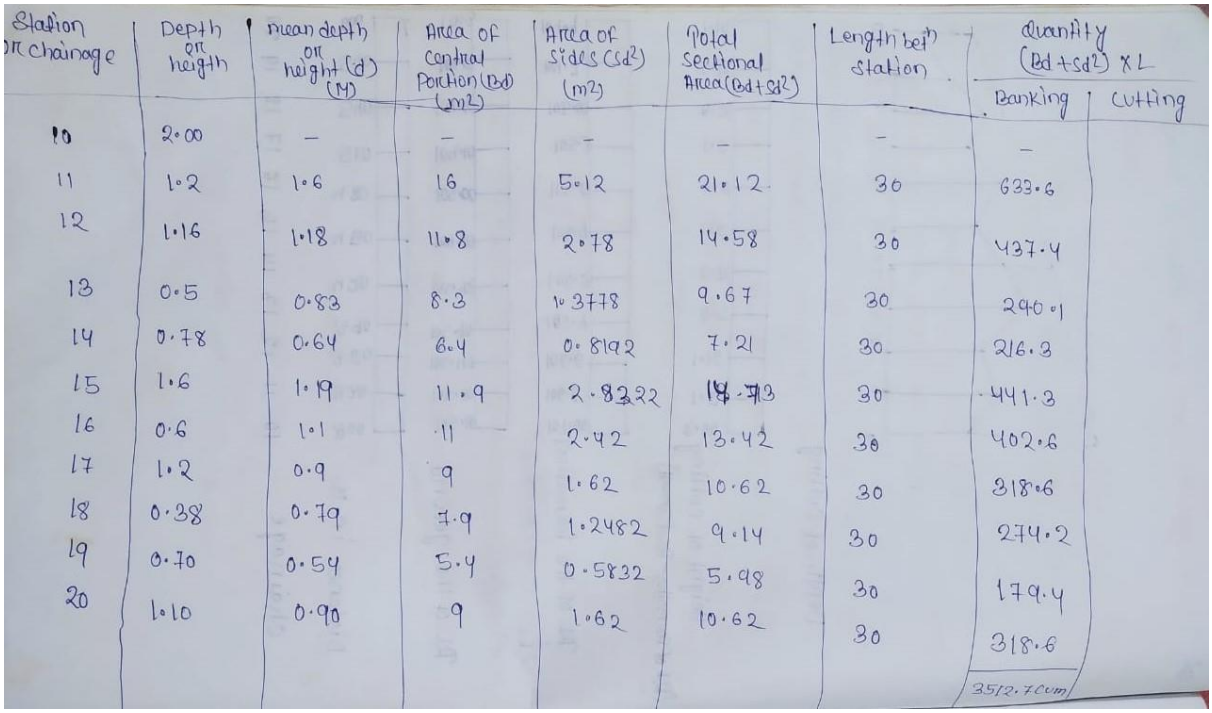
Q.1 RL of the ground along the center line of a road from chainage 10-20 are given below. The formation level at the 10th chainage is 107 and the road is down word gradient of 1 in 50 upto the chainage 14 and the gradient changes to 1 in 100 down word. Formation width of the road is 10m. and the side slopes of banking are 2:1. Length of the chain is 30m. Draw longitudnal section of the road and a tipical cross-sectional and prepare an estimate of earth work.

Chainage	10	11	12	13	14	15	16	17	18	19	20
RL of ground	105.00	105.60	105.44	105.90	105.42	104.30	105.00	104.10	104.02	104.00	103.30

Gradient ← down ward gradient 1 in 150 → ← down word grandient 1 in 100 →

SOLUTION:


10 11 12 13 14 15 16 17 18 19 20
Depth of Cutting
Height of Cutting
(R.L of formation - R.L of Ground)
2·00 1·2 1·16 0·5 0·78 1·6 0·8 1·2 0·38 0·70 1·10
RL of the formation
107·00 106·8 106·6 106·4 106·2 105·9 105·8 105·2 105·00 104·7 104·4
RL of the ground
105·00 105·60 105·44 105·40 105·42 104·30 105·00 104·10 104·62 104·00 103·3
Distance in M.
300 330 360 390 420 450 480 510 540 570 600
Chainage
10 11 12 13 14 15 16 17 18 19 20



Station or Chainage	Depth or height	mean depth or height (d) (M)	Area of central portion (Bd) (m^2)	Area of sides (Sd^2) (m^2)	Total sectional Area ($Bd+Sd^2$)	Length bet^n station	Quantity $(Bd+Sd^2) \times L$	
							Banking	Cutting
10	2.00	–	–	–	–	–	–	
11	1.2	1.6	16	5.12	21.12	30	633.6	
12	1.16	1.18	11.8	2.78	14.58	30	437.4	
13	0.5	0.83	8.3	1.3778	9.67	30	240.1	
14	0.78	0.64	6.4	0.8192	7.21	30	216.3	
15	1.6	1.19	11.9	2.8322	14.73	30	441.3	
16	0.6	1.1	11	2.42	13.42	30	402.6	
17	1.2	0.9	9	1.62	10.62	30	318.6	
18	0.38	0.79	7.9	1.2482	9.14	30	274.2	
19	0.70	0.54	5.4	0.5832	5.98	30	179.4	
20	1.10	0.90	9	1.62	10.62	30	318.6	
							3572.7 cum	

EXPLANOTARY:

RL OF FORMATION = RL – (SLOPE X CHAINAGE)

HEIGHT OF BANKING OR CUTTING = RL OF FORMATION – RL OF GROUND

MEAN DEPTH OR HEIGHT(d) = ex: - (2+1.2)/2 =1.6m. like that

AREA OF CENTRAL PORTION = B x d where B is width of road & d is mean depth.

AREA OF SIDES = Sd^2 where S is side slope

Here side slope = 2

TOTAL SECTIONAL AREA = AREA OF CENTRAL PORTION + AREA OF SIDES

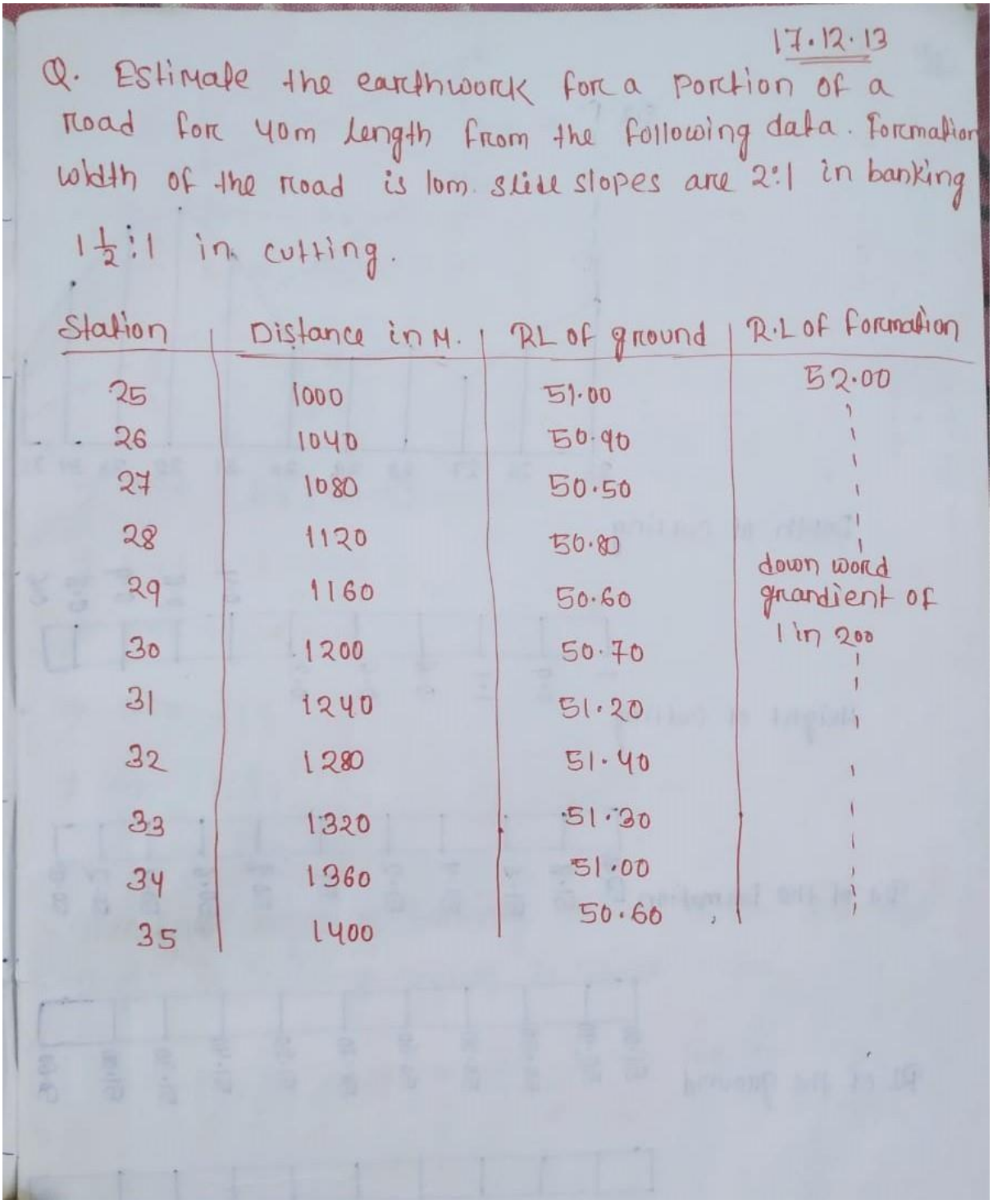
i.e $(Bd + Sd^2)$

LENGTH BETWEEN STATION(L) = LENGTH OF CHAIN

TOTAL QUANTITY = TOTAL SECTIONAL AREA x LENGTH BETWEEN STATION

i.e $(Bd + Sd^2) \times L$

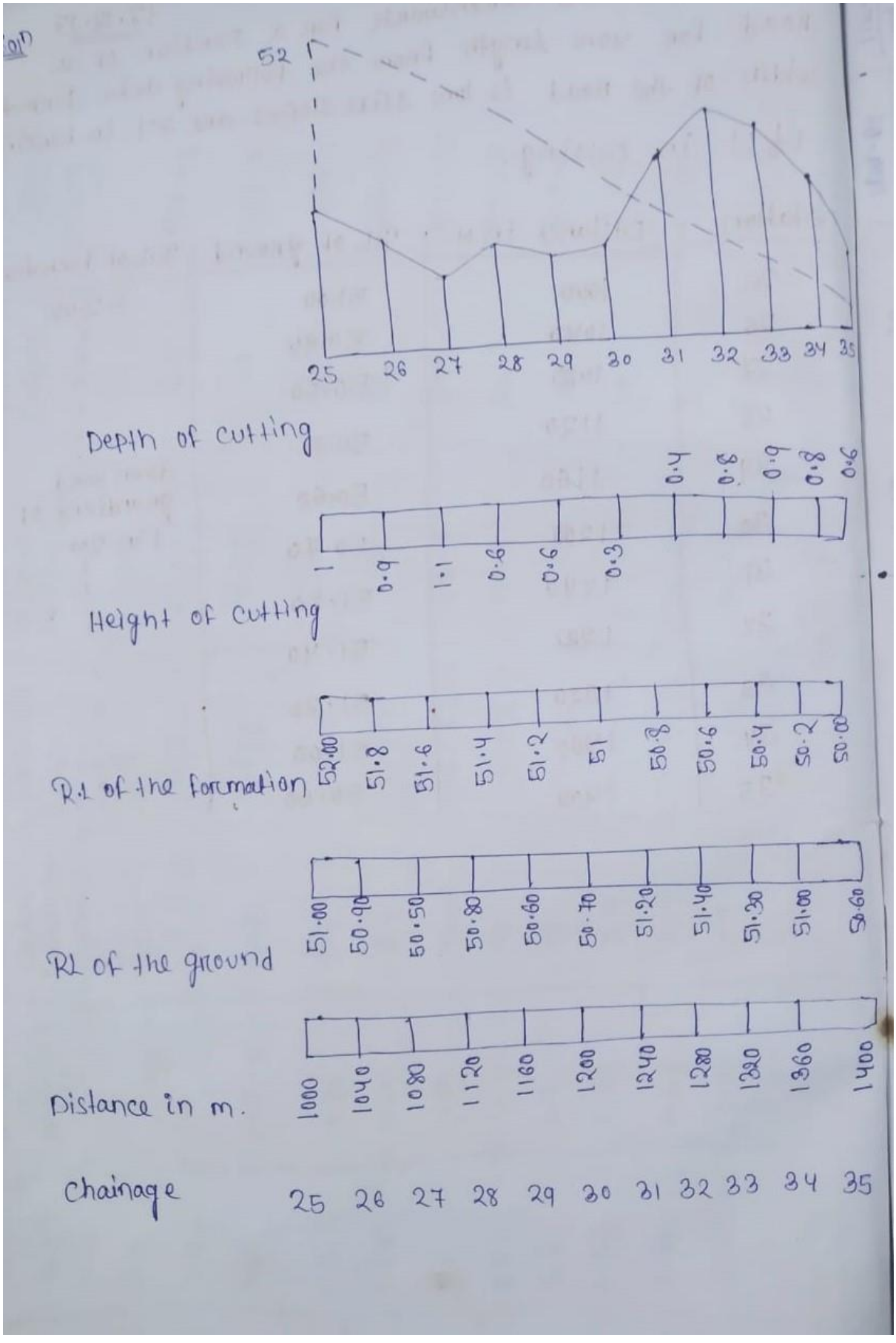
ROAD ESTIMATION:

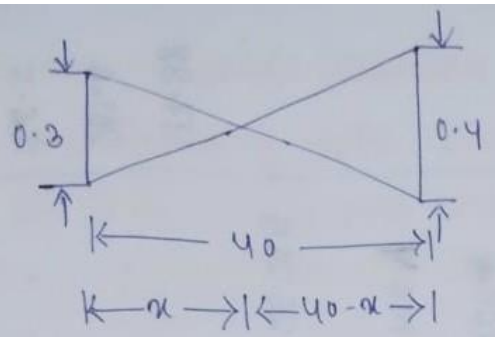


17.12.13

Q. Estimate the earthwork for a portion of a road for 40m length from the following data. Formation width of the road is 10m. Side slopes are 2:1 in banking $1\frac{1}{2}$:1 in cutting.

Station	Distance in M.	RL of ground	R.L of formation
25	1000	51.00	52.00
26	1040	50.90	
27	1080	50.50	
28	1120	50.80	
29	1160	50.60	down word 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	


52
25 26 27 28 29 30 31 32 33 34 35
Depth of cutting
0.4 0.8 0.9 0.8 0.6
1 0.9 1.1 0.6 0.6 0.3
Height of cutting
R.L of the formation
52.00 51.8 51.6 51.4 51.2 51 50.8 50.6 50.4 50.2 50.00
RL of the ground
51.00 50.90 50.50 50.80 50.60 50.70 51.20 51.40 51.30 51.00 50.60
Distance in m.
1000 1040 1080 1120 1160 1200 1240 1280 1320 1360 1400
Chainage
25 26 27 28 29 30 31 32 33 34 35



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

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

$\Rightarrow 0.4x = 12 - 0.3x$

$\Rightarrow 0.4x + 0.3x = 12$

$\Rightarrow 0.7x = 12$

$\Rightarrow x = 17.14$

$= 17\text{m. say}$

Therefore length of banking portion is 17m. and the length of cutting portion is $40-17 = 13$m.

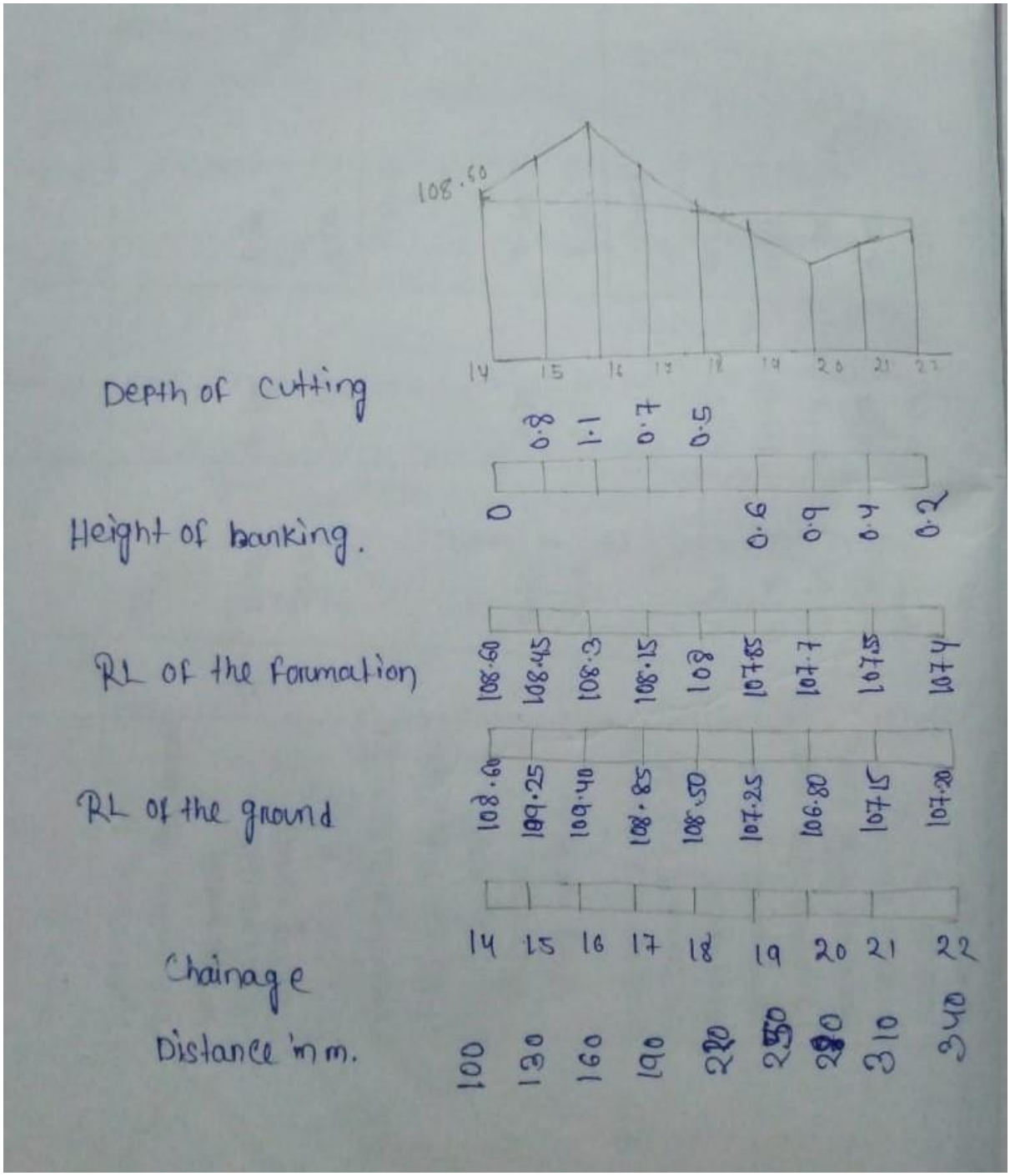
$B = 10$m., $S = 2$ for banking, $s = 1\frac{1}{2}$ for cutting.

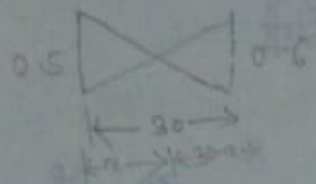
Station or Chainage	Distance in 'm'	height or depth	mean height or depth (d) 'M'	Central Area (B×d) (m^2)	Area of side (Sd²) (m^2)	Total sectional area (Bd+Sd²) (M^2)	Distance betn station	Quantity (Bd+Sd²) × L Banking	Quantity (Bd+Sd²) × L Cutting
25	1000	1.00	–	–	–	–	–	–	–
26	1040	0.9	0.95	9.5	1.80	11.31	40	452.4	
27	1080	1.1	1.00	10.0	2.0	12.0	40	480.00	
28	1120	0.6	0.85	8.5	1.44	9.94	40	396.00	
29	1160	0.6	0.6	6.0	0.72	6.72	40	268.8	
30	1200	0.3	0.45	4.5	0.40	4.91	40	196.4	
31	passes from banking to cutting								
–	1217	0.00	0.15	1.5	0.045	1.545	17	26.265	
31	1240	0.4	0.2	2	0.06	2.06	23		47.38
32	1280	0.8	0.6	6	0.54	6.54	40		261.6
33	1320	0.9	0.85	8.5	1.08	116.5	40		156.5
34	1360	0.8	0.85	8.5	1.08	9.58	40		383.2
35	1400	0.6	0.7	7	0.73	7.73	40		309.2
								1819.06	1157.58

ROAD ESTIMATION:

Q. Prepare an Estimate for a portion of a road from chainage 14 to 22. From the data given below. The width of the road is 12m. Side slope 1½:1 in cutting. 2:1 in banking. Falling gradient 1 in 200. Length of the Chainage is 30m.

Chainage	14	15	16	17	18	19	20	21	22
RL of the Ground	108.60	109.25	109.40	108.85	108.50	107.25	106.80	107.15	107.20


108.50
14 15 16 17 18 19 20 21 22
Depth of Cutting
0.8 1.1 0.7 0.5
Height of banking.
0 0.6 0.9 0.4 0.2
RL of the formation
108.60 108.45 108.3 108.15 108 107.85 107.7 107.55 107.4
RL of the ground
108.60 109.25 109.40 108.85 108.50 107.25 106.90 107.15 107.20
Chainage
14 15 16 17 18 19 20 21 22
Distance in m.
100 130 160 190 220 250 280 310 340



$$\frac{x}{0.5} = \frac{30-x}{0.6}$$

$\Rightarrow 0.6x = 0.5(30-x)$

$\Rightarrow 0.6x = 15 - 0.5x$

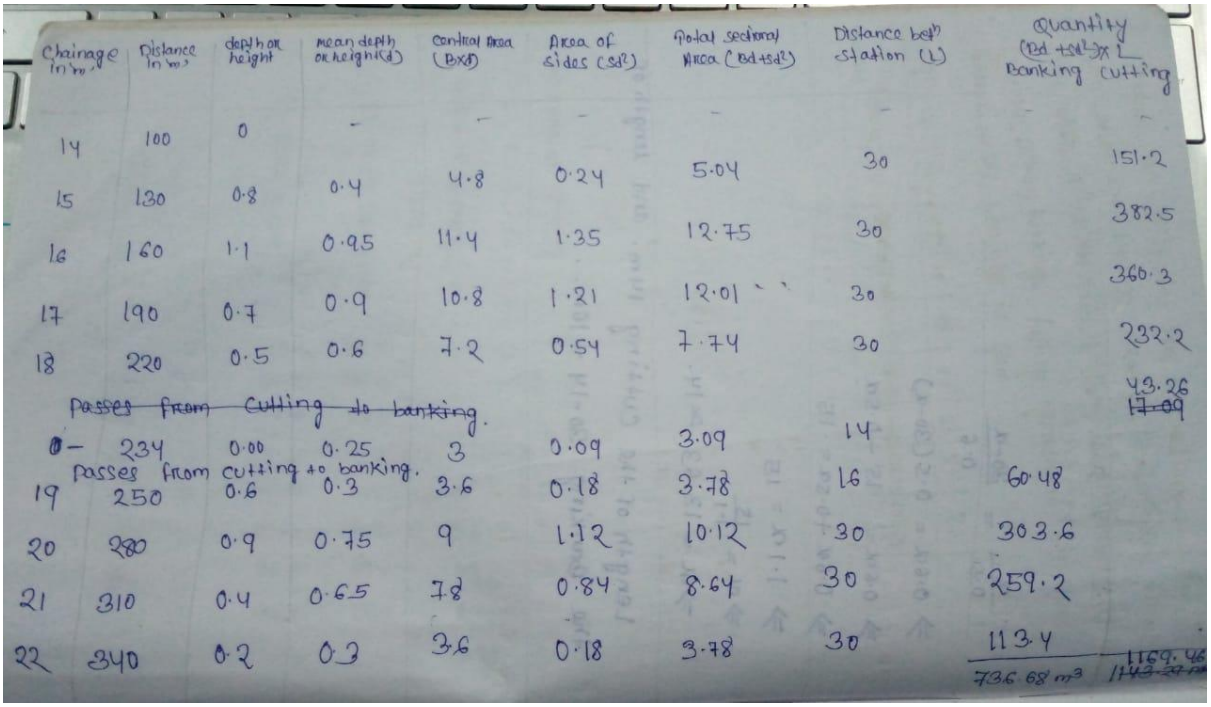
$\Rightarrow 0.6x + 0.5x = 15$

$\Rightarrow 1.1x = 15$

$\Rightarrow x = \frac{15}{1.1}$

$\Rightarrow x = 13.63 \approx 14.$

Length of the cutting 14m. and length of the Banking $30 - 14 = 16$m..



Chainage in m	Distance in m	depth or height	mean depth or height (d)	central area (B×d)	Area of sides (sd^2)	Total sectional Area ($Bd+sd^2$)	Distance bet^n station (L)	Quantity $\frac{(Bd+sd^2)}{2} \times L$ Banking	Quantity Cutting
14	100	0	-	-	-	-	-	-	-
15	130	0.8	0.4	4.8	0.24	5.04	30		151.2
16	160	1.1	0.95	11.4	1.35	12.75	30		382.5
17	190	0.7	0.9	10.8	1.21	12.01	30		360.3
18	220	0.5	0.6	7.2	0.54	7.74	30		232.2
	~~passes from cutting to banking.~~								43.26 ~~17.09~~
0 –	234	0.00	0.25	3	0.09	3.09	14		
	passes from cutting to banking.								
19	250	0.6	0.3	3.6	0.18	3.78	16	60.48	
20	280	0.9	0.75	9	1.12	10.12	30	303.6	
21	310	0.4	0.65	7.8	0.84	8.64	30	259.2	
22	340	0.2	0.3	3.6	0.18	3.78	30	113.4	1169.46
								736.68 m^3	1143.27 m^3

Q. Estimate the required for construction of a road.

Metal width = 3.6m.

Road length = 1.5km.

Thickness of brick soiling = 7.5 cm.

Wearing coat of stone/metal = 12cm.

Loose consolidated to 8cm thickness.

Surface to be finished with 2 coats of bitumen as given below.

1st coat painting = 12mm. size chips @ 0.018 m^3 and bitumen @ 1.2 kg/sqm. Of road surface.

2nd coat painting = 6mm. size chips @ 0.009m^3 and bitumen @ 1.2 kg/sqm of road surface.

Fuel used @ 0.3 kg per kg of bitumen.

Ans: - Given data,

Length of road = 1.5km. = 1500m.

Metal width = 3.6m.

Thickness of brick soiling = 7.5m. =0.075 m.

Area of road surface = 1500 x 3.6 = 5400m^2

Quantity of stone metal = 5400 x 0.12 = 648 m^3 Quantity of brick soiling = 5400 x 0.075 = 405 m^3 Surface finishing:

1st coat surface

Quantity of 12mm chips @ 0.018m^3 =5400 x 0.018 = 97.2m^3

Quantity of bitumen @ 1.2kg/sqm = 5400 x 1.2 = 6480 kg.

2nd coat surface:

Quantity of 6mm size chips @ 0.009 m^3 = 5400 x 0.009 = 48.6m^3

Quantity of bitumen @ 1.2 kg/sqm = 5400 x 1.2 =6480 kg

Total quantity of bitumen = 6480 + 6480 = 12960 kg

Fuel consumption @ 0.3 kg per kg of bitumen = 12960 x 0.3 = 3880 kg

PWD Accounts works

Work: -

Engineering department prepare a proposal on the basis of preliminary estimate by the concord department is known as work.

Classification of work according to their cost:

There are 3 types,

1. Major work
2. Minor work
3. Petty work

Major work: -

The work cost which is more than 2 lakhs rupees is called major work.

Minor work: -

The work cost which is more than 50000/- but not exceed 2 lakhs rupees is called minor work.

Petty work: -

The work cost which does not exceed 50000/- is called petty work.

Annual repair work

- The work and structure are repair and maintain in proper condition which comes under annual repair work.

- For annual repair of building 1 to 2 % of the original construction cost of whole building is provided.
- It is usually done by contract by inviting tender.

Special repair work

- Special repair work consists of renovation or renewal of structure or damaged work.
- It general consists of renewal of floor, roof etc.
- Repair of monsoon of flood damage work also comes under special repair work.

Quadrennial repair work

The repair work for every 4^{th} year is called quadrennial work.

Example: - white washing, colour washing

Contract

- It is an undertaking by a person or firm to do any work under certain term and condition.
- The work may be further construction or maintenance and repair, for the supply of material, for the supply of labour, for the transport of materials.
- Generally, contracts are 3types
    1. Lump-sum contract
    2. Schedule contract
    3. Item rate contract

Lump-sum contract

- In this contract the contractor undertakes the construction of a specific work to complete within a specified time for fixed amount.
- In this contract 10% of security money should be deposited
- In this contract penalty is also provided
- On completion of work no detail measurement of different items of work is require or compare or checked with plan and drawing.

Schedule contract

- In this contract the contractor also undertakes the execution or construction of a particular work with a specified time as per plan and drawing.
- The schedule of rate for various item of work are also provided which regulates the extra amounts to be paid or deducted for any addition or alteration if some work damage will come.

Item rate contract

- In this contract the contractor depends upon the quantities of various item of work which was actually done.
- In this contract includes quantities, rate, and amount for various item of work.
- In this contract the deposition of security money is 10%.
- In this contract penalty is also provided.

ASSIGNMENT:

Q.1 Estimate the required for construction of a road.

Metal width = 4 m.

Road length = 2 km.

Thickness of brick soiling = 7.5 cm.

Wearing coat of stone/metal = 8cm.

Loose consolidated to 8cm thickness.

Surface to be finished with 2 coats of bitumen as given below.

st coat painting = 12mm. size chips @ 0.02 m3 and bitumen @ 1.2 kg/sqm. Of road surface.

Nd coat painting = 6mm. size chips @ 0.010m3 and bitumen @ 1.2 kg/sqm of road surface.

Fuel used @ 0.3 kg per kg of bitumen.

Q.2 What is work? define types of work.

Q.3 Write short notes on

Annual repair work & special repair work

Q.4 what is contract? Define types of contracts.

Labour contract:

- In Labour contract the contractors undertake 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.
- Materials for scaffolding, centring and shuttering and other similar materials are supplied by the department or owner.
- contractor may also use his own materials for scaffolding, centring, 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. Dept.
- Private buildings which are constructed is undergoes by labour contract system.

Penalty:

- It is a short of fine for non-full-filament of terms of contract.
- Every contract usually contains certain provision or term & conditions for not maintaining the progress of work, delaying & also for bad work.

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.
- 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.

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 is 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.

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 authorises 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:

- Technical sanction means the sanction of the detailed estimate, design calculation, quantities of work , rate & cost of the work by the authority of engineering department.
- After the technical sanction of the estimate the construction work is taken up for the estimate.
- The power of technical sanction goes to chief engg.
- If the estimate is up to 15 lakhs the approval should grant or sanction by superintending engineer.
- If the estimate is up to 5lakhs the amount is sanction by executive engineer.

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.

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.

Sealed:

- Sealed tender is invited and the work is usually done for the lowest tenders
- While inviting the tender the bill of quantities, detail specification, condition of contract and plan & drawing are supplied on payment of requisite cost.

Earnest money:

- While submitting a tender the contractor is to deposit a certain amount about 2% of estimated cost with the department as earnest money as guaranty of the tender.
- This amount is for a check so that the contractor May not refuse the accept the work when the tender is accepted.
- Earnest money of the tenderer whose tender has not been accepted is refundable.
- Earnest money should be in cash or in cashable at any time.
- Earnest money may be in the form of deposit in treasury or state bank or any other approved bank or government security, post office, saving pass book, pledged to the executive engineer.

Security money:

- On acceptance of the tender the contractor has to deposit 10% of the tender amount as security money with the department.
- This amount is kept as a check so that the contractor full fill all terms and conditions of the contract and carries out the work satisfactorily according to the specification and maintain progress and complete the work in time.
- If the contractor fails to full fill the terms of contract his whole or part of the security money is forfeited by the department.
- The security money is refunded to the contractor after the satisfactory completion of the whole work after a specified time, usually after one rainy season or six months of the completion of the work.

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.

Bill:

- ❖ it is the account of work done or supply of material includes the particulars and quantities of work done or material supplied, their rates and amounts.
- ❖ It contains full or clear particulars of the amount.
- ❖ It cannot be over written.

Voucher:

- ❖ 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

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.

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:
    - to facilitate the correct calculation of the net wages of each person for the period of payment;
    - to render it difficult to tamper with or to make unauthorized additions to or alterations, in entries once made, and
    - 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.

Muster roll form:

Name of the labour	designation	Father's name	Date of attendance	rate	Total amount for each	Signature of the person taking attendance	Signature of the officer making payment

Acquittance Roll: Its preparation & use for making payment of pay & wages:

- 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.

Muster roll:

Item no.	Name	Designation	Net payable amount	Dated signature

Labour report:

- For large work or group of work which is done through daily labour consolidated labour report is prepared.
- The report consist of labour work, class of labour, labour rates.
- Labour can be formed in duplicate.

Labour report form

Daily report of the day…….of 19 ……

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

Signature

…….date……..

Store:

In the impressed of work or project it is found some desirable amount to keep in hand of government supply of certain passes of material.

The classification of store is: -

- ➢ Stock of general store
- ➢ Material charged direct to the work
- ➢ Road metal
- ➢ Tools & plants

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.

Tools and Plants. - Such equipment 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.

Road materials. – Metal, moorum, gravel etc. fall in this category.

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.

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.

Impressed:

- An impressed is a standing advance of a fixed sum of money given to assistant engineer to enable them to make day to day petty payments proper discharge of their duty.
- In the end of the month and of that expenditure will be made and sent to executive engineer for its knowledge and balance amount after the expenditure will be noted.

Receipt / issue statement on standard form:

- 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.
- 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 thereof 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.

- The signatures of the contractors or their authorised Agents to whom the materials are required to be issued are attested by the Asst. Engineer and the indent is countersigned by the Executive Engineer of the indenting Division.
- The Contractors are required to obtain identity photo passes for themselves or their authorised agents, duly attested by the Executive Engineer of the Indenting Divisions and of the Central Stores Division. On the photo pass 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.
- While sending the photographs of the Contractors or their authorised agents for drawl 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 Messer ..... 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.
- 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.
- The indent shall be presented at the Central Stores within 15 days of EE signing the same.
- 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 at least 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.

Differentiate between stock & tools & plant:

Stock	Tools and plant
➢ Both quantity and value accounts are maintained. ➢ Value of stock material is charged direct to the work. ➢ Stock material found shortly. ➢ Stock account found surplus. ➢ Monthly purchasing of all material is made in the 'abstract of stock receipt' form no.9 closed monthly. ➢ Half yearly return of stock ending every 6-month interval on 31st march and 30th September in form no.11	➢ Only quantity account is kept. ➢ Value of tools & plant for concerned work is purchased. ➢ Material found continuously. ➢ There is no adjustment T & P ➢ Day to day account of receipt are entered in form 13. ➢ Annual ending on 30th September.

Surplus store:

- ➢ This stock is checked regularly.
- ➢ It is verified physically by counting, measuring, or weighing is every year for the period ending by 31st march.

Assignment

1. What is labour report?
2. What is surplus store?
3. What is impressed?
4. What is store & define the classification of store.
5. Differentiate between stock and tools & plants.

Irrigation work:

There are three type of canal section generally involved in irrigation work and they are,

1. Canal fully in excavation
2. Canal partly in excavation and partly in embankment
3. Canal fully in embankment

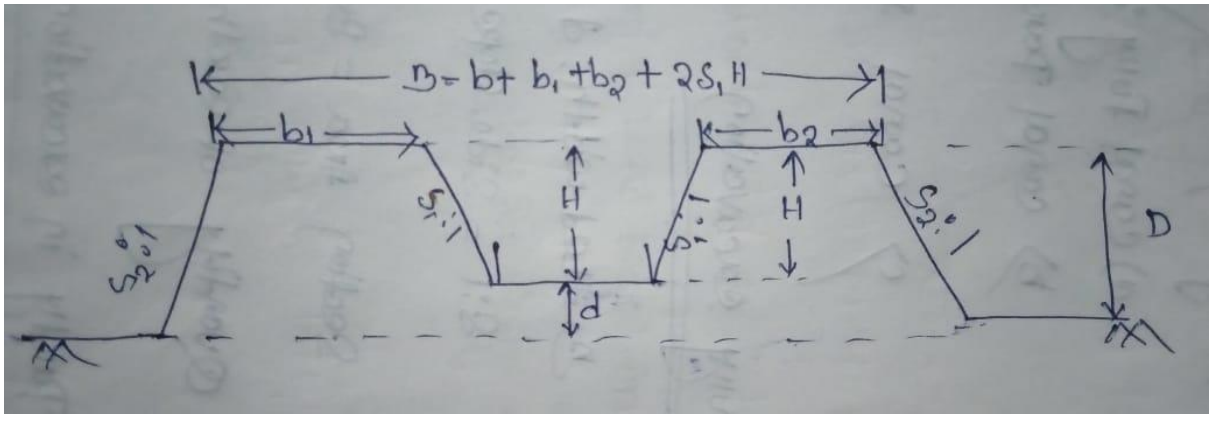
Canal fully in excavation:

Sectional area = $Bd^2 + Sd^2$

Quantity of earthwork = sectional area x length

B=bed width d=depth of excavation

S:1 = side slope (horizontal: vertical)



Partly excavation & partly in embankment:

Sectional area in digging = $Bd + Sd^2$

Sectional area in banking = $(b_1 + b_2)h +$

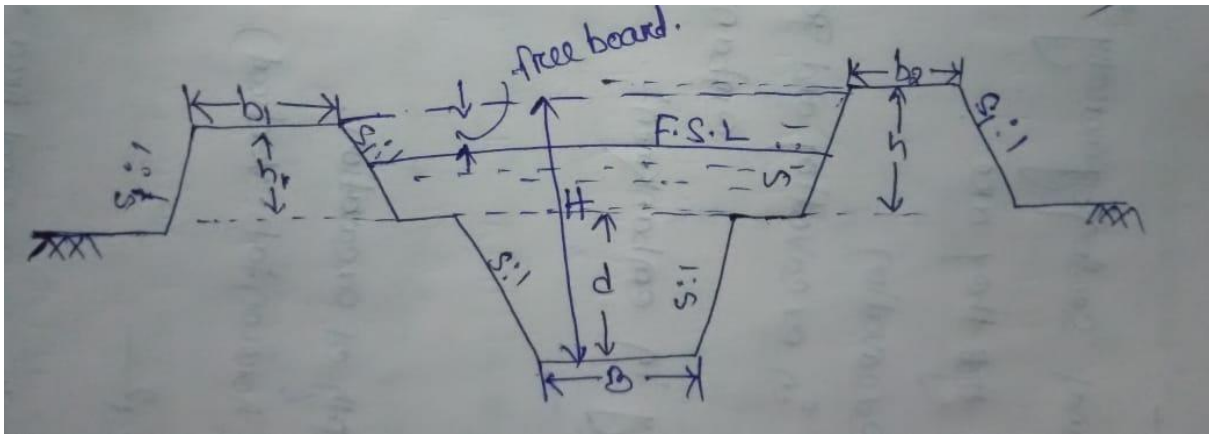
$2S_1h^2$ h= H - d

B=bed width d=depth of

excavation h=height of

embankment

H = height of banking from bed of the canal



Fully in embankment:

Sectional area = $(b_1 + b_2)h + 2S_1h^2$

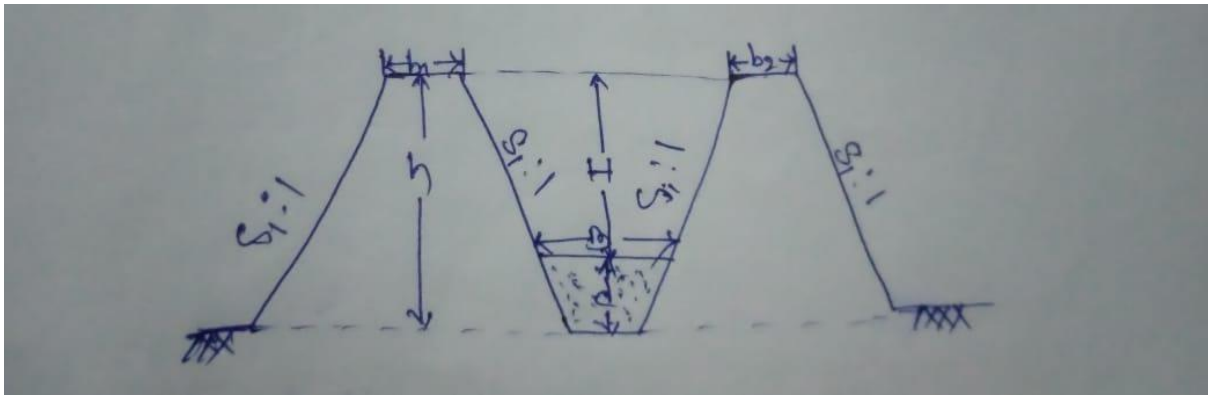
h= height of banking = H-(-d)

where, B= bed width

H = height of banking from bed of the canal

d= depth of filling between G.L and bed of canal for cutting

'd' is denoted by +ve sign, but for filling -ve sign.



Problem no- 1

Calculate the quantity of earth work in an irrigation channel 'L' section. The bed width of the channel is 5m. and top width of banks are 3m.for the left & 1.5m. for the right bank. Side slope of excavation 1:1 and another bank 1.5:1. Height of bank from bed level is 2.55m. The longitudinal slope of the bed of the channel is 1 in 5000. Estimate the cost of earth work at the rate 275/- per cubic meter.

station	Distance	RL of ground	RL of bed
10	500	100	98.5
11	550	100.31	98.49
12	600	100.52	98.48
13	650	100.57	98.47
14	700	99.68	98.46
15	750	99.21	98.45
16	800	99.34	98.44
17	850	99.67	98.43
18	900	99.38	98.42
19	950	100.55	98.41
20	1000	100.24	98.40

Solution:

-

Depth of excavation (RL of ground – RL of bed)
1.5m
1.82m
2.04m
2.1m

1.22m
0.76m
0.9m
1.24m
0.96m
2.14m
1.84m

Here, B =5 m ,S= 1 , b_1= 3m , b_2=1.5m , S_2=1.5m

St.	Depth of digging	Mean depth (d)	Central area (Bd)	Side area (Sd^2)	Total area($Bd+Sd^2$)	Total length(L)	Quantity ($(Bd+Sd^2) \times L$ (Q_2)	Ht. of bank(H)	ht. above G.L (h=H-d)	Central area= $(b_1+b_2)h$	Side area $2S_2h^2$	Total area $(b_1+b_2)h + 2S_2h^2$	length	Quantity (Q_1)	Q_2-Q_1
10	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	1.82	1.66	8.3	2.75	11.05	50	552.5	2.55	0.89	4.005	2.376	6.381	50	319.05	+
12	2.04	1.93	9.65	3.72	13.37	50	668.5	2.55	0.62	2.790	1.152	3.943	50	197.15	+
13	2.1	2.07	10.35	4.28	14.63	50	731.5	2.55	0.48	2.160	0.691	2.851	50	142.55	+
14	1.22	1.66	8.3	2.75	11.05	50	552.5	2.55	0.89	4.005	2.376	6.381	50	319.05	+
15	0.76	0.99	4.95	0.98	5.93	50	296.5	2.55	1.56	7.020	7.301	14.321	50	716.05	-419.55
16	0.9	0.83	4.15	0.68	4.85	50	241.5	2.55	1.72	7.740	8.875	16.615	50	830.75	-589.25
17	1.24	1.07	5.35	1.14	6.49	50	324.5	2.55	1.48	6.66	6.571	13.231	50	661.55	-337.05
18	0.96	1.1	5.5	1.23	6.71	50	335.5	2.55	1.45	6.525	6.308	12.833	50	641.65	-306.15
19	2.14	1.55	7.75	2.43	10.15	50	507.5	2.55	1	4.500	3	7.5	50	375	+
20	1.84	1.99	9.95	3.96	13.91	50	695.5	2.55	0.56	2.520	0.941	3.461	50	173.05	+
								4906 m^3						87.201m^3	

1652m^3

Total quantity=4906+1652=6558m^3

item no	details & particular	Quantity	Unit	Rate	amount
1.	Earth work	6558	M_3	RS275	18034.50

5% contingencies

= 901.725

Grand

total=18034.50+901.725=18936.225m^3

Problem no- 2

Calculate the quantity of earth work in an irrigation channel. The bed width of the channel is 6m. and top width of banks are 4m.for the left & 2m. for the right bank. Side slope of excavation 1:1 and another bank 1.5:1. Height of bank from bed level is 3m. The longitudinal slope of the bed of the channel is 1 in 3000. Estimate the cost of earth work at the rate 250/- per cubic meter.

station		RL of ground	RL of bed
300		100	98.7
330		100.21	98.6
360		100.42	98.59
390		100.53	98.58
420		99.78	98.57
450		99.41	98.56
480		99.32	98.55
510		99.67	98.54
540		99.38	98.53
570		100.45	98.52
600		100.23	98.51

Solution: -

Depth of excavation (RL of ground – RL of bed)
1.3m
1.61m
1.83m
1.95m
1.21m
0.85m
0.77m
1.13m
0.85m
1.93m
1.72m

Here, B =6 m ,S= 1 , b_1= 4m , b_2=2m , S_2=1.5m

St.	Depth of digging	Mean depth (d)	Central area (Bd)	Side area (Sd^2)	Total area($Bd+Sd^2$)	Total length(L)	Quantity ($(Bd+Sd^2) \times L$ (Q_2)	Ht. of bank(H)	ht. above G.L (h=H-d)	Central area= $(b_1+b_2)h$	Side area $2S_2h^2$	Total area $(b_1+b_2)h + 2S_2h^2$	length	Quantity (Q_1)	Q_2-Q_1
300	1.3m	-	-	-	-	-	-	-	-	-	-	-	-	-	-
330	1.61m	1.45	8.7	2.10	10.8	30	324	3	1.55	9.3	7.20	16.5	30	495	171
360	1.83m	1.72	10.32	2.95	13.27	30	398.1	3	1.28	7.68	4.91	12.59	30	377.7	+
390	1.95m	1.89	11.34	3.57	14.91	30	447.3	3	1.11	6.66	3.69	10.35	30	310.5	+
420	1.21m	1.58	9.48	2.49	11.97	30	359.1	3	1.42	8.52	6.04	14.56	30	436.8	77.7
450	0.85m	1.03	6.18	1.06	7.24	30	217.2	3	1.97	11.82	11.64	23.46	30	703.8	486.6
480	0.77m	0.81	4.86	0.65	5.51	30	165.3	3	2.19	13.14	14.38	27.52	30	825.6	660.3
510	1.13m	0.95	5.7	0.90	6.6	30	198	3	2.05	12.3	12.60	24.9	30	747	549
540	0.85m	0.99	5.94	0.98	6.92	30	207.6	3	2.01	12.06	12.12	24.18	30	725.4	517.8
570	1.93m	1.39	8.34	1.93	10.27	30	308.1	3	1.61	9.66	7.77	17.43	30	522.9	214.8
600	1.72m	1.82	10.92	3.31	14.23	30	426.9	3	1.18	7.08	4.17	11.25	30	337.5	+

3051.6 m^3

2677.2m^3

Total quantity=3051.6+2677.2=5728.8m^3

item no	details & particular	Quantity	Unit	Rate	amount
1.	Earth work	5728.8	M_3	RS250	14322

5%

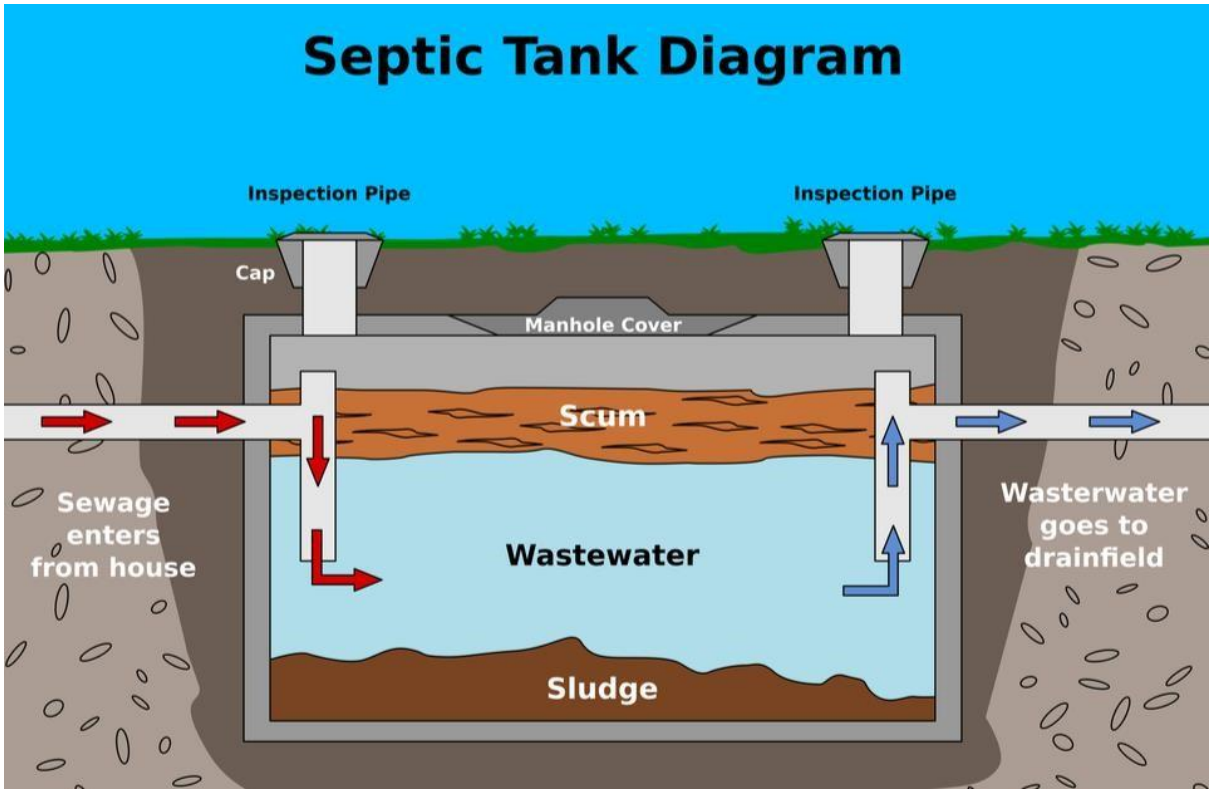
contingencies = 716.1

Grand total=14322+716.1=15038.1/-

Septic tank:

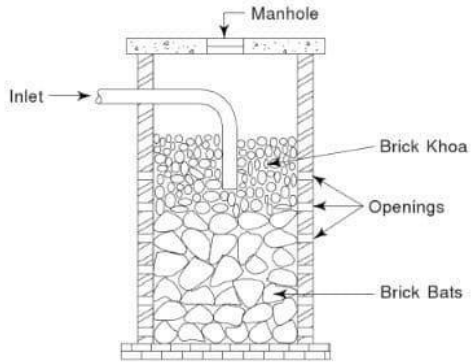
A septic tank is an underground chamber made of concrete, fiberglass, or plastic through which domestic wastewater (sewage) flows for basic treatment. Settling and anaerobic processes reduce solids and organics, but the treatment efficiency is only moderate (referred to as "primary treatment"). Septic tank systems are a type of simple onsite sewage facility (OSSF). They can be used in areas that are not connected to a sewerage system, such as rural areas. The treated liquid effluent is commonly disposed in a septic drain field, which provides further treatment. Nonetheless, groundwater pollution may occur and can be a problem.

The septic tank is a sealed round or rectangular container which is used to break down the sewage so that it becomes effluent through the action of bacteria living on the waste matter.



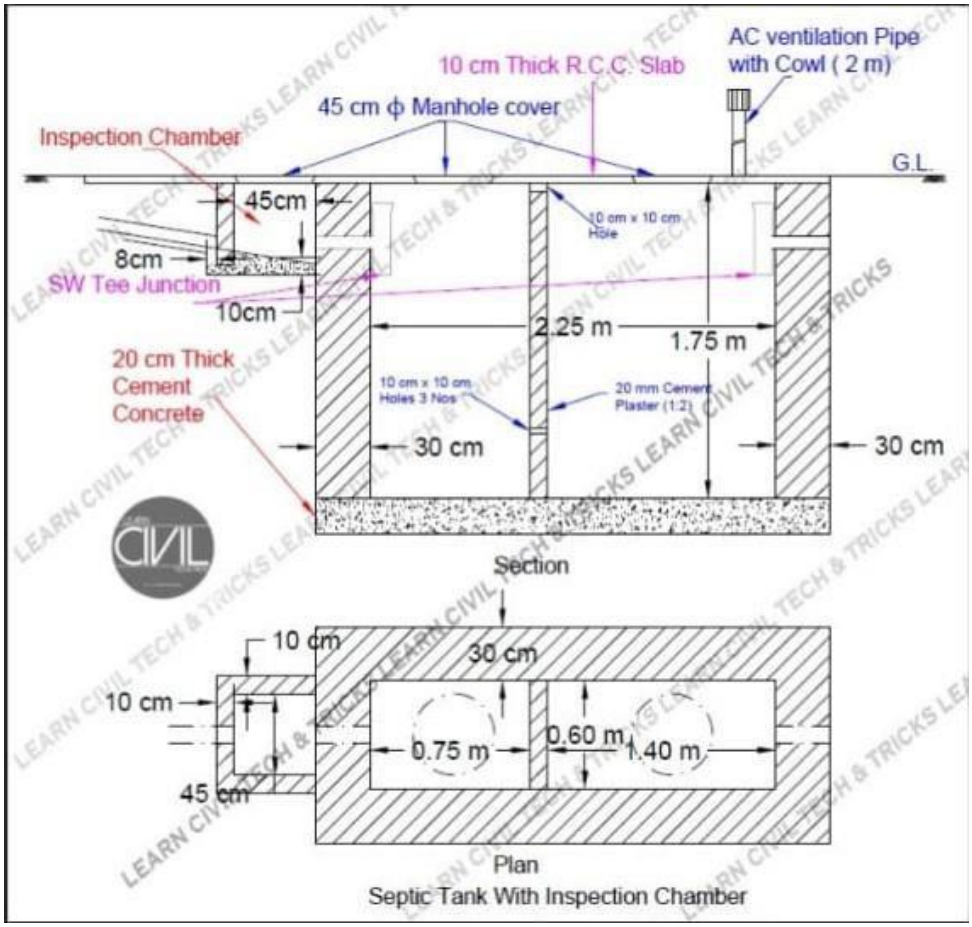
Soak pit:

A soak pit is a covered, porous-walled chamber that allows water to slowly soak into the ground and also known as a soakaway or leach pit, and the pre-settled sewage from the septic tank is release to the underground chamber from where it infiltrates into the neigh boring soils.



Problem:

Prepare a detail estimate of septic tank from the given plan.



Solution:

Measurement Sheet:-

Sr. No.	Particulars of item	No.	Length (m.)	Width (m.)	Height (m.)	Quantity	Remark
1.	**Earthwork in excavation**						L = 2.25+0.3+0.3 = 2.85 m H = 1.75+0.2+0.1 = 2.05 m
	a. Septic Tank	1	2.85	1.20	2.05	**7.011 m³**	
	b. Inspection Pit	1	0.63	0.65	0.65	**0.266 m³**	L=0.45+0.1+0.08 = 0.63 m H = 0.45+0.1+0.1 = 0.65 m
		Total = 7.277 m³					
2.	**W.C.C. (1:3:6) in Foundation**						
	a. Septic Tank	1	2.85	1.20	0.20	**0.684 m³**	
	b. Inspection Pit	1	0.63	0.65	0.10	**0.041 m³**	
		Total = 0.725 m³					
3.	**First class Brickwork 30 cm** a. Septic Tank	1	6.90	0.30	1.75	**3.623 m³**	Using Centre line method L=2.25+0.15+0.15=2.55m B=0.60+0.15+0.15=0.90m T.L. = 2×(2.55+0.90) = **6.90 m**
4.	**10 cm Thick Brickwork**						For Inspection Pit
	a. Partition wall	1	0.60	–	1.75	**1.05 m²**	L = 0.45+0.05 = 0.50 m
	b. Inspection Pit	3	0.50	–	0.45	**0.675 m²**	
		Total = 1.725 m²					
5.	**20 mm Thick Plaster (1:2) on floor & walls (inside only)**						
	Septic Tank						
	a. Floors	1	1.40	0.60	–	**0.84 m²**	
		1	0.75	0.60	–	**0.45 m²**	
	b. Walls	2	1.40	–	1.75	**4.90 m²**	
		2	0.75	–	1.75	**2.63 m²**	
		4	0.60	–	1.75	**4.20 m²**	
	Inspection Pit						
	a. Floor	1	0.45	0.45	–	**0.20 m²**	
	b. Walls	4	0.45	–	0.45	**0.81 m²**	
		Total = 14.03 m²					
6.	**10 cm R.C.C. Slab (1:2:4)**						
	a. Septic Tank	1	2.85	1.20	0.10	**0.342 m³**	
	b. Inspection Pit	1	0.55	0.65	0.10	**0.036 m³**	
	c. Manhole Cover	3	$\frac{\pi \times 0.45^2}{4} = 0.16$		0.10	**0.048 m³ (-ve)**	
		Total = 0.33 m³					

7.	45 cm ϕ C.I. Manhole cover	3	–	–	–	168 kg	Weight of 1 cover is 52-56 kg = 3×56 = 168 kg
8.	Step Iron Built in wall	2×3	–	–	–	18 kg	Weight of 1 piece is 2.5 - 3 kg = 6×3 = 18 kg
9.	Leaving 10 cm×10 cm holes in partition wall	4	–	–	–	4 Nos	
10.	Supplying & Building SW Tee Junction (10 cm×10 cm×60 cm)	2	–	–	–	2 Nos	
11.	Supplying & fitting 80 mm dia. AC ventilation Pipe	1	2.00	–	–	2 rm	
12.	Supplying & fixing AC ventilation cowl over 80 mm dia. AC Pipe	1	–	–	–	1 Nos	
13.	Charging Septic Tank with water Full	–	–	–	–	1 Item	

Abstract Sheet:-

Sr. No.	Particulars of item	Unit	Quantity	Rate	Amount	
					₹	P.
1.	Earthwork in excavation	m^3	7.277	50	363	85
2.	Weak Cement concrete (1:3:6)	m^3	0.725	300	217	50
3.	First class Brickwork 30 cm	m^3	3.623	450	1630	35
4.	First class Brickwork 10 cm	m^2	1.725	250	431	25
5.	12 mm thick cement plaster in circular portion (1:2)	m^2	14.03	30	420	90
6.	10 cm R.C.C. slab (1:2:4)	m^3	0.33	800	264	00
7.	45 cm ϕ C.I. Manhole cover	Nos	3	2500	7500	00
8.	Step Iron Built in wall	Nos	6	85	510	00
9.	Leaving 10 cm×10 cm holes in partition wall	Nos	4	10	40	00
10.	Supplying & Building SW Tee Junction (10 cm×10 cm×60 cm)	Nos	2	125	250	00
11.	Supplying & fitting 80 mm dia. AC ventilation Pipe	rm	2	180	360	00
12.	Supplying & fixing AC ventilation cowl over 80 mm dia. AC Pipe	Nos	1	25	25	00
13.	Charging Septic Tank with water Full	Item	1	100	100	00
		Total Amount = ₹ 12,117.85				
14.	Add 5% for contingencies & work charged establishment	5% of 12,117.85			605	89
		Grand Total = ₹ 12,723.74 (Say ₹ 12,724.00)				

QUANTITY ESTIMATION IN BRIDGES AND CULVERTS

4.1. Terminology:

Culvert: A culvert is a cross-drainage structure having a total length (liner waterway) of 6m or less between the inner faces of the dirt wall or extreme vent-way boundaries measured at right angles thereto. As a general rule, a minimum of 6m of linear waterway should be provided per 15.km of the road for efficient drainage. The types of culverts are:

- Hume pipe culvert
- Slab culvert
- Box culvert

Bridge: A bridge is a structure having a total length above 6m between the inner face of the dirt walls for carrying traffic or other moving loads over a depression or obstruction such as channel, road or railway. They are classified as minor or major bridges as per the criteria given below:

- Minor Bridge: Span greater than 6m up to 60m
- Major Bridge: Span greater than 60m

Abutment: Abutment is the structures at the ends of a bridge whereon the structure's superstructure joins the bank of waterway. Abutments function as both a vertical load carrying structure and as an earth retaining structure.

Pier: Single-span bridges have abutments at each end. However, multi-span bridges require piers to support the ends of individual spans between these abutments.

Retaining Wall: A retaining wall is a structure that holds back the soil and prevents it from sliding or eroding away when there is a drastic change in elevation. It is designed so that to resist the material pressure of the material that it is holding back.

Return Wall: A return wall is retaining wall built parallel to the center line of a road to retain the embankment.

Wing Wall: Wing wall is a retaining wall which sustains the embankments of the approaches where they join the bridge.

Curtain Wall: Cross walls are built across the stream on the up-stream or down-stream in order to protect the structure from erosion due to strong current of water induced by the restriction of free passage of water through the water way.

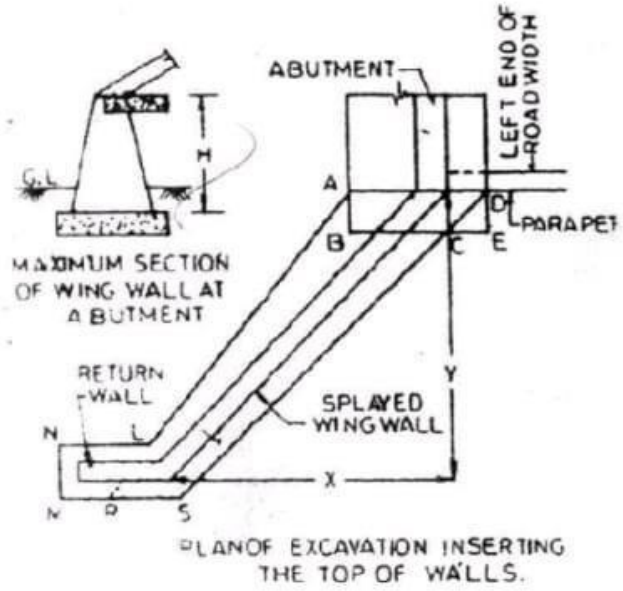


Fig. 4.1 (Plan showing abutment, wing wall and return wall)

4.2. Quantity estimation

4.2.1. Abutment

For each or concrete work:

- Length = Road width+2 (parapet thickness + one side end efforts).
- Breadth and depth are shown in the section of the abutment.

For masonry work below G.L.:

- Length = same as concrete work as above – 2 x offset of concrete.

  (*Length for each individual offset differs and should be calculated individually by deduction of the projections from the each end.*)

- Breadth and depth for each individual offset are shown in the section of the abutment.

For masonry work above G.L.:
With vertical inner face:

- Length = Road width + 2parapet thickness (outer face battering should not be accounted if any).

Breadth and depth are as shown in the section.

With battered inner face :

When the inside the face of Abutment is continued to wing wall the extra bottom length due to batter may be considered as if included in the wing wall i.e. the two walls join on a vertical plane.

- Length = Road width + 2 parapet thickness.

When the width of abutment at the ends is not equal to the inclined width of the wing wall joining with abutment:

- Length = ½ (Top length + Bottom length).
- Bottom length – Top length + 2 x offset due to inner batter face of Abutment.

ASSIGNMEMT:

1. **Difference between culvert & bridge?**
2. **What is abutment?**
3. **What is pier?**
4. **What is retaining wall?**
5. **How to calculate length of concrete work in abutment?**

4.2.2. Wing wall

The thickness and height of the wall is the maximum at the junction with its abutment and both the dimensions are gradually reduced to the section as that at return wall with which it joins.

For earth or concrete work:

- Length = Y + offsets from the outer edge of return wall
- Breadth = ½ × (AD+RS)
  - Where, AD is the inclined trench width of wing wall parallel to the center line of the road and generally the trench width of the abutment. If not equal, the offset (as shown in Fig. 11-1) is mentioned.
  - RS = Inclined foundation trench width of Return wall parallel to the center line of the road

    $= \text{Foundation width of Return wall} \times \sqrt{\sum \text{sq. of prop. of splay.}}$

    Usually, proportion of splay = X : Y = 1 : 1 (*for* 45^0)

    Then, $\sqrt{\sum \text{sq. of prop. of splay.}} = \sqrt{1^2 + 1^2} = 1.414$
- Depth = usually the same depth of excavation as that of abutment is provided.

Deduction for end offset of abutment:

During excavation for abutment, a part for wing wall (the portion ABCD in Fig. 11.1) has already been excavated. Therefore, the volume of work for this portion should be deducted from the volume of work for the wing wall.

Deduction for Abutment offset

$$= \frac{1}{2} \times \left[\text{trench width} + \left(\text{trench width} - \text{offset} \times \frac{X}{Y}\right)\right] \times \text{depth}$$

For concrete work the depth of concrete instead of depth earthwork shall be considered.

For masonry work below G.L.:

- Length = Y + offset of masonry in foundation of return wall
- Breadth = same process as that of earthwork
- Depth = thickness of the footing.

The construction of wing wall may be with its battered inner and outer faces starting from the top of the foundation concrete up to top. In such cases the whole mass shell is calculated in one operation considering this as *Frusta of Pyramid*, erected vertically on AD as base.

- $Volume = {}^{h}/_{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$,

Where, A_1 and A_2 are the areas of the ends, *i.e.* vertical sectional area at the abutment and the vertical sectional area at the end; h is the measurement of Y.

Deduction for end offset of abutment:

Following the same procedures as in the case of earthwork deduction for Abutment offset for the corresponding footing of wing wall $= ½ \times \left[\text{width of Abut. Footing} + \left(\text{width of Abut footing} - \text{projection}\right) \times {}^{X}/_{Y}\right\} \times \text{depth}$. The projection is form top face of the Abutment up to the edge of the corresponding footing.

For masonry work above G.L.:

Wing walls above G.L. may have the following shapes:

1. Inside face vertical or battered but at the outer face with offsets;
2. Both the faces are battered.

Inside face vertical with offsets at the outer face:

Before starting the estimate, let us clarify how offsets are provided at the outside face of the wing wall. Let the top plan of wall is ABCD with three offsets, D_1D, E_1E and F_1F of lengths L_1, L_2 and L_3 respectively as shown in Fig . 11.2.

The height of the wing wall is h_1 at the end and h_2 at Abutment. The top of ABCD of the wing wall is sloped downward uniformly from AB to DC. To have a clear picture regarding the shape of the outside offsets, let us assume that, we are to reach the inclined level AF of the from the left side ground level. For this purpose three numbers steps ADD_1, AEE_1 and AFF_1 are constructed with uniform rise h_1 and $h_2 = 4h_1$.

But, actually these triangular steps are known as offsets of the wing wall. The projections are shown on plan and height on elevation drawn by the side of section of the Abutment. The purpose of these offset is to strengthen the core part ABCD of the wing wall.

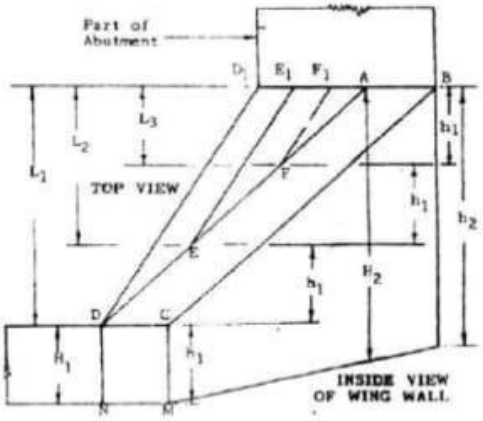


Fig. 4.2 (Inside view of wing wall)

Masonry work above G.L. excluding offsets but including inside batter:

Considering mass as a Frusta of Pyramid, $Volume = {}^{h}/_{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$. The notations are same as before. When there be no battered at the face, the volume for the rectangular mass within the same inclined width through its length shall be calculated for different heights at the ends by ordinary method, *i.e.*, average depth × inclined breadth × straight length.

- $Vol.\ of\ 1^{st}\ offset = \frac{h}{2} L_1 \times AD_1 \times h_1$
- $Vol.\ of\ 2^{nd}\ offset = \frac{h}{2} \times L_2 \times AE_1 \times h_1$
- $Vol.\ of\ 3^{rd}\ offset = \frac{h}{2} \times L_3 \times AF_1 \times h_1$

Deduction of Abutment offset:

When the width of Abutment at the ends is not equal to the inclined width of the wing wall as the well as the inside face of the Abutment is battered then the length of the Abutment includes the offsets at the end. In this case deduction for the offset projection is made from the volume of wing wall.

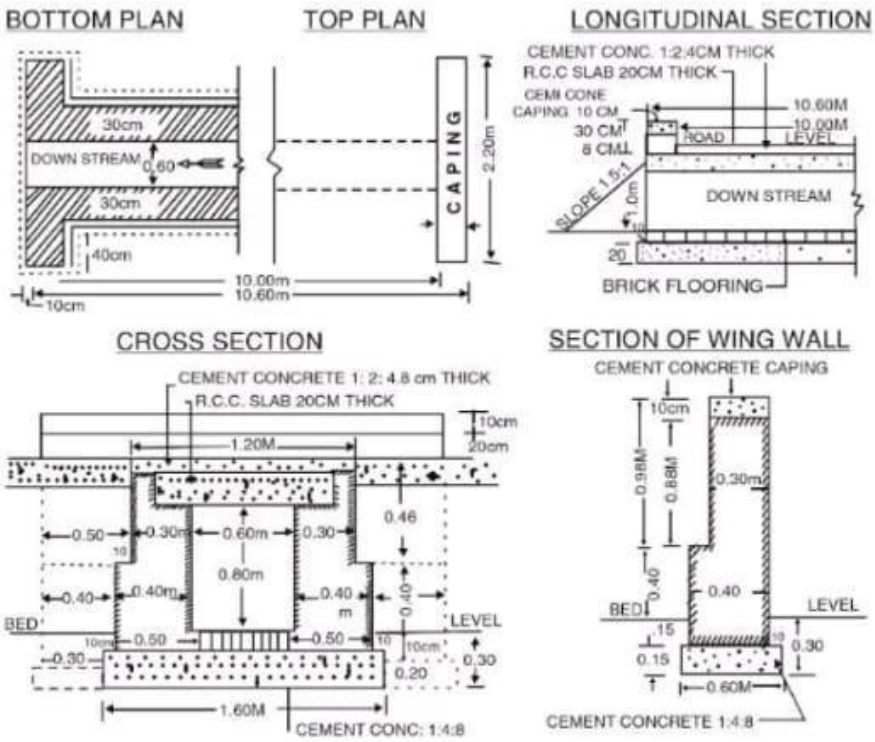
4.2.3. Return wall

For earthwork in excavation (Refer Fig. 11.1)

- Length = Average length for the RMNL = ½ (RM + NL)
- RM = MS − RS, where length of RS is same as calculated before.
- NL = RM + MN $\times \frac{X}{Y}$, where, MN is the trench width.

4.3. Example 4.1

Prepare a detailed estimate for a 60 cm span slab culvert of the given details and plans, and elevation as shown in Fig. 4.3.



Minimum offset for abutment = 10 cm

Fig 4.3 detailed drawings of the slab culvert

Detail Measurement and Calculation of Quantities

Item No.	Descriptions	Unit	No.	Length	Width	Ht./Th.	Quantity
1	**Earthwork Excavation of Foundation**	Cum					
	Abutments and floors (10.60+0.10×2)		1	10.80	1.60	0.30	5.18
	Wing walls		4	0.40	0.60	0.30	0.29
	Total Quantity =						**5.47**

2	**Cement Concrete 1:4:8 in foundation**	Cum					
	Abutments and floors		1	10.80	1.60	0.30	3.46
	Wing walls		4	0.40	0.60	0.15	0.14
	Total Quantity =						**3.60**
3	**Cement Concrete 1:2:4**	Cum					
	In parapet coping		2	2.20	0.30	0.10	0.13
	Wearing coat over the slab		1	10.00	1.20	0.08	0.96
	Total Quantity =						**1.09**
4	**Reinforced Cement concrete 1:2:4 including reinforcements**	Cum					
	In Slab		1	10.60	1.00	0.20	2.12
	Total Quantity =						**2.12**
5	**First class burnt brick laid in cement mortar (1:5) in foundation and superstructure**	Cum					
	Abutment 1st step		2	10.60	0.50	0.10	1.06
	Abutment 2nd step		2	10.60	0.40	0.40	3.39
	Abutment 3rd step		2	10.60	0.30	0.60	3.82
	Wing walls 1st step		4	0.30	0.50	0.50	0.24
	Wing walls 2nd step		4	0.40	0.30	0.50	0.32
	Wing walls 3rd step		4	0.50	0.30	0.88	0.53
	Parapet walls on the slab		2	1.20	0.30	0.28	0.20
	Deductions						
	Bearing of the slab		(-) 2	10.60	0.20	0.20	(-) 0.85
	Total Quantity =						**8.71**
6	**Brick flooring laid in cement mortar (1:6)**	Sq.m	1	10.60	0.40	-	4.24
	Total Quantity =						**4.24**

7	**Cement pointing deep variety (1:2)**	Sq.m.					
	Inside the abutment		2	10.60	-	0.80	16.96
	Outside the faces (1.28+0.20)		2	2.20	-	1.48	6.51
	Deductions						
	Side openings		(-) 2	0.60	-	0.80	(-) 0.96
	Side faces		(-) 2	1.00	-	0.20	(-) 0.40
	Total Quantity =						**22.11**
8	**Cement pointing flush floor**	Sq.m.	1	10.60	0.60	-	6.36
	Total Quantity =						**6.36**

Abstract of Estimation

Details of work	**Unit**	**Quantity**	**Rate**	**Amount**
Excavations for foundation	Cu m	5.47	22.50	123.10
Cement Concrete 1:4:8 in foundation	Cu m	3.60	170.00	612.00
Cement Concrete 1:2:4	Cu m	1.09	322.00	351.00
Reinforced Cement concrete 1:2:4 including reinforcements	Cu m	2.12	750.00	1590.00
First class burnt brick laid in cement mortar (1:5) in foundation and superstructure	Cu m	8.70	165.00	1435.00
Brick flooring laid in cement mortar (1:6)	Sq. m	4.24	16.00	68.00
Cement pointing deep variety (1:2)	Sq. m	22.11	5.80	128.50
Cement pointing flush floor	Sq. m	6.36	6.10	39.00
			Total Amount =	**4346.60**

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

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

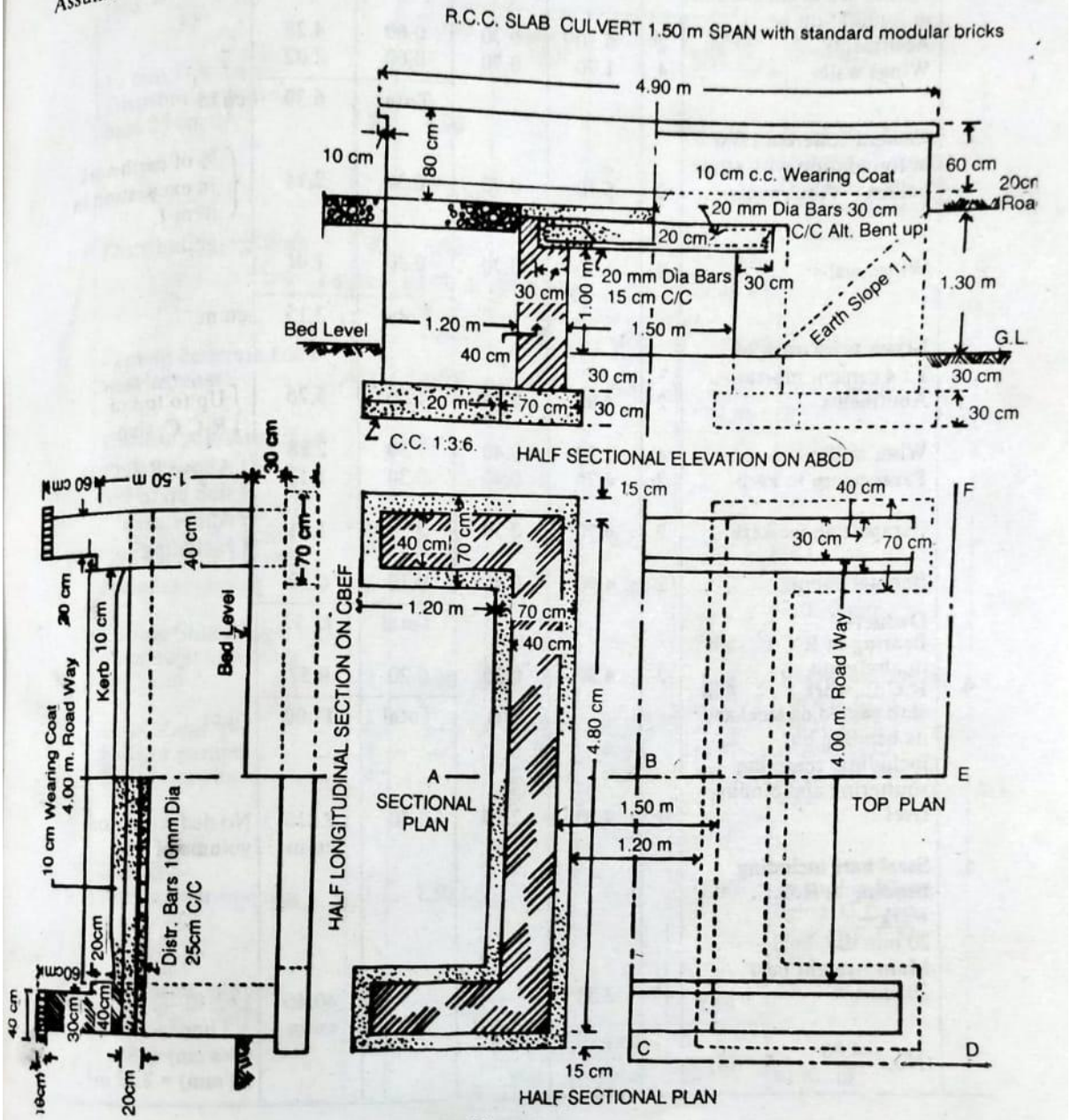


Fig. 8-5

Details of Measurement and Calculation of Quantities (Ex. 1)

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 ...	2	5.10	0.70	0.60	4.28	
	Wings walls ...	4	1.20	0.70	0.60	2.02	
					Total	6.30	cu m
2.	**Cement concrete** 1:3:6 in foundation with stone ballast— Abutments ...	2	5.10	0.70	0.30	2.14	½ of earthwork in excavation in item 1.
	Wings walls ...	4	1.20	0.70	0.30	1.01	
					Total	3.15	cu m
3.	**I-class brickwork in 1 : 4** cement mortar—						
	Abutments ...	2	4.80	0.40	1.50	5.76	Up to top of R.C.C. slab.
	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	
	Deduct— Bearing of R.C.C. slab in abutment	2	4.80	0.30	0.20	0.57	
4.	**R.C.C. work 1 : 2 : 4 in** slab excluding steel and its bending but including centering shuttering and binding steel			Net	Total	11.00	cu m
		1	4.80	2.10	0.20	2.016 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 ...	17	2.38	—	—	40.46 cu m	L=2.10—2 side covers + 2 hooks = 2.10—(2×4 cm)+(18× 20 mm) = 2.38 m
	(No.= $\frac{4.80}{.30}$ + 1 = 17)						

	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. = $\frac{4.80}{.30}$ = 16)	16	2.54	—	—	40.64 m	Adding one depth, 16 cm for two bent ups
			Total	81.10 m	@ 2.47	kg m= 200.32kg	L=2.38+.16 = 2.54 m
	10 mm Dia. bars— Distributing bottom bars 25 cm c/c ...	9	4.90	—	—	44.10 m	L=4.80—2 end covers +3 hooks =4.80— (2×4 cm) + (18× 10mm)= 4.90 m
	Distributing top bars	4	4.90	—	—	19.60 m	
	To	tal	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	0.92 cu m	In between parapets
7.	**Cement pointing 1:2 in walls—**						
	Face wall from 10 cm below G.L. up to bottom of coping	2	4.70	—	2.10	19.74	
	Inner side of parapet excluding coping	2	4.70	—	0.80	7.52	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	
	Deduct— Rectangular opening	2	1.50		1.30	3.90	Including 10 cm below G.L. and edge of R.C.C. slab.
	Triangular portion below earth slope	2	(½×1.30	×1.30)		1.69	
				Total of	deductio	n 5.59	
				Net	Total	29.77	sq m

SLAB CULVERT

ABSTRACT OF ESTIMATED COST (Ex. 1)

Item No.	Particulars of items of work	Quantity	Unit	Rate Rs. P.	Per	Amount Rs. P.
1.	Earthwork in excavation in foundation ...	6.30	cu m	350.00	% cu m	22.05
2.	Cement concrete 1 : 3 : 6 in foundation with stone ballast ..	3.15	cu m	400.00	cu m	1260.00
3.	I-class brickwork in 1 : 4 cement mortar	11.00	cu m	365.00	cu m	4015.00
4.	R.C.C. work 1 : 2 : 4 in slab excluding steel and its bending but including centering. shuttering and binding steel ...	2.016	cu m	775.00	cu m	1562.40
5.	Steel bars including bending in R.C.C. work ...	2.398	quintal	515.00	quintal	1234.97
6.	Cement concrete 1 : 2 : 4 in wearing coat	0.92	cu m	450.00	cu m	414.00
7.	Cement pointing 1 : 2 in wall ...	29.77	sq m	5.60	sq m	166.71
					Total ...	8675.13
	Add 5%-(3% for Contingencies and 2% for Workcharged Establishment) ...					433.75
					Grand Total ...	9108.88

Rate per running metre of span = $\frac{\text{Total Cost}}{\text{span}} = \frac{9108.88}{1.5}$ = Rs. 6072.58 per metre.