

BHUBANANANDA ORISSA SCHOOL OF ENGINEERING, CUTTACK
DEPARTMENT OF CIVIL ENGINEERING



LECTURE NOTE ON: ESTIMATING AND COST EVALUATION- II, (TH-5),
5th SEMESTER

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LECTURER IN CIVIL ENGINEERING DEPT.

BOSE, CUTTACK

Th5. ESTIMATION & COST EVALUATION – II

Name of the Course: Diploma in Civil Engineering			
Course code:		Semester	5th
Total Period:	60	Examination	3 hrs
Theory periods:	4P/week	Class Test:	20
Maximum marks:	100	End Semester Examination:	80

A. RATIONALE

The course exposes the students to the techniques and best practices to prepare detailed estimates of roads, bridges, culverts, irrigation structures and PWD works.

B. COURSE OBJECTIVES

On completion of the course, students will be able to

1. Create detailed estimate of culverts and bridges
2. Prepare estimates of irrigation structures
3. Prepare estimates of a macadam road and a national highway in cutting and filling
4. Prepare detailed estimates for septic tank and soak pits
5. Prepare detailed estimates of miscellaneous works
6. Comprehend the management practices in Public Works Department
7. Interpret the building bylaws furnished by regulatory bodies

C. TOPIC WISE DISTRIBUTION OF PERIODS

Chapter	Name of topics	Hours
1.	Detailed estimate of culverts and bridges	12
2.	Estimate of irrigation structures	14
3.	Detailed estimate of roads	12
4.	Detailed estimates of miscellaneous works	12
5.	PWD accounts works	10

D. COURSE CONTENTS:

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
 - 3.2 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 (imprest money), supervision charges, suspense account, debit, credit, book transfer, voucher and related accounts .

5.2.2 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.

E. SYLLABUS COVERGE UPTO INTERNAL ASSESSMENT

Chapters 1, 2, 3

F. RECOMMENDED BOOKS

Sl. No	Name of Authors	Titles of Book	Name of Publisher
1	M.Chakraborty.	Estimating, Costing, specification & Valuation in Civil Engineering	Published by author
2	B.N.Dutta.	Estimating & Costing	UBSPD
3	Birdi & Ahuja.	Estimating & Costing	Dhanpat Rai Publication
4	Latest Orissa PWD Schedule of Rates & Analysis of rates		Govt. of Odisha

CHAPTER -1 Detailed estimate of culverts and bridges

CULVERT :-

- If the length of water way in a structure is less than 6m, then the structure is known as culvert.
- If the length of water way in a structure will be more than 6m & less than 30m, then the structure is known as minor bridge.
- If the length of water way in a structure will be more than 30m, then the structure is known as major bridge.

ABUTMENT :-

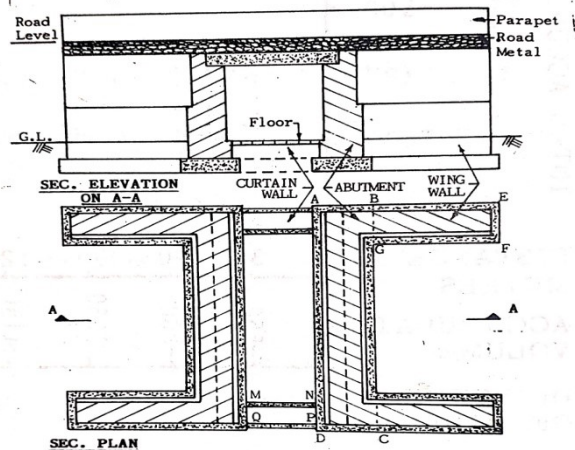
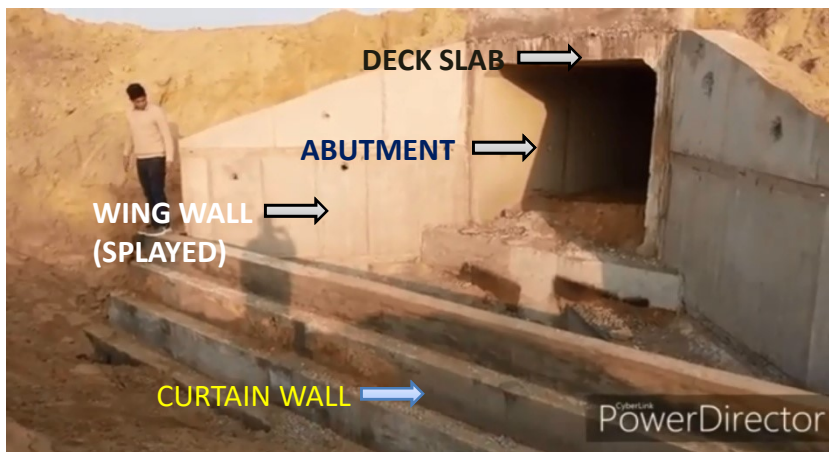
- The end support of a bridge or culvert is known as abutment.

WING WALL :-

- Wing wall is a retaining wall which retain the embankment.

CURTAIN WALL :-

- Curtain wall Are built up across the waterway of upstream or downstream or both side to protect our structure from erosion due to strong current of water flow.



DETAIL PART OF A CULVERT



<https://youtu.be/Cp-BvGx0R1c>

RETURN WALL

- A Return wall is a retaining wall which is built parallel to the road to retain embankment.
- Return wall is always provide in splayed wing wall not in straight wing wall.

TYPES OF CULVERT

Following are the different types of culvert generally used in construction:-

- Pipe culvert(single or multiple)
- Pipe arch culvert(single or multiple)
- Arch culvert(single or multiple)
- Box culvert(single or multiple)
- Bridge or slab culvert

a) PIPE CULVERT

- Pipe culvert are the most common types of culvert widely used in rural are.
- In this culvert single or no of circular pipes are used to make a pipe culvert.

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- The diameter of pipes varies from 1m to 6m.
- The pipes are made of concrete or steel.
- Pipe culvert is provided where the flow of water is very large.



b) Pipe arch culvert

- This culvert is similar to the pipe culvert, but we use half circular pipes in this type of culvert.
- The pipes are made of concrete or steel.
- Pipe arch culvert is suitable for large water flow, but the flow should be stable.



c) Arch culvert

- Arch culvert is similar to the pipe arch culvert but in arch culvert an artificial floor is provided below the arch.
- Here both artificial floor and arch are made of concrete.
- Steel arch culverts are also available but they are very expensive.
- Arch culvert is suitable for narrow water flow.



d) Box culvert

- Box culvert are in rectangular shape and generally construct by reinforced concrete.
- Box culvert is suitable for heavy rainfall area.
- Box culvert is also provide where the velocity of water flow is more.



Box culvert single

Box culvert multiple

e) Bridge culvert or slab culvert

- Bridge culverts are provided on canals or rivers for movement of vehicles.
- For this culvert a foundation is laid under the ground surface .
- This type of culvert is provided on canals and rivers.



Difference between plastering and pointing:-

I. Plastering

- Plastering is applied in both inside and outside part of structure.
- After plastering the plastering surface become smooth and plain.
- In plastering more material is needed

II. Pointing

- Pointing is applied outside part only or any joint.
- After pointing the pointing surface may not be smooth and plain.
- in pointing less material is needed.

1.1 Detailed estimate of a RCC slab culvert with right angled wing walls with bar bending schedule :-

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

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

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

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

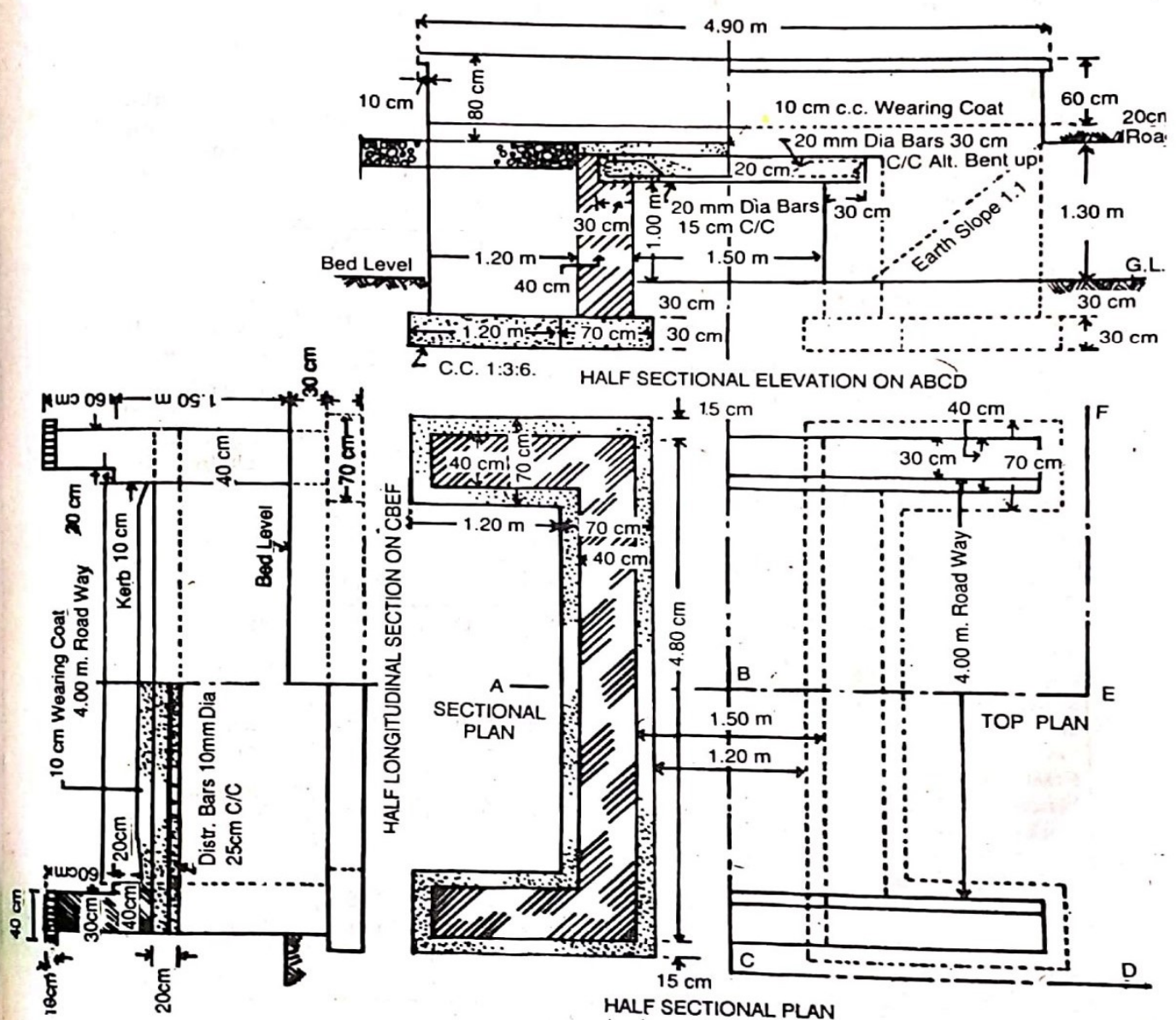
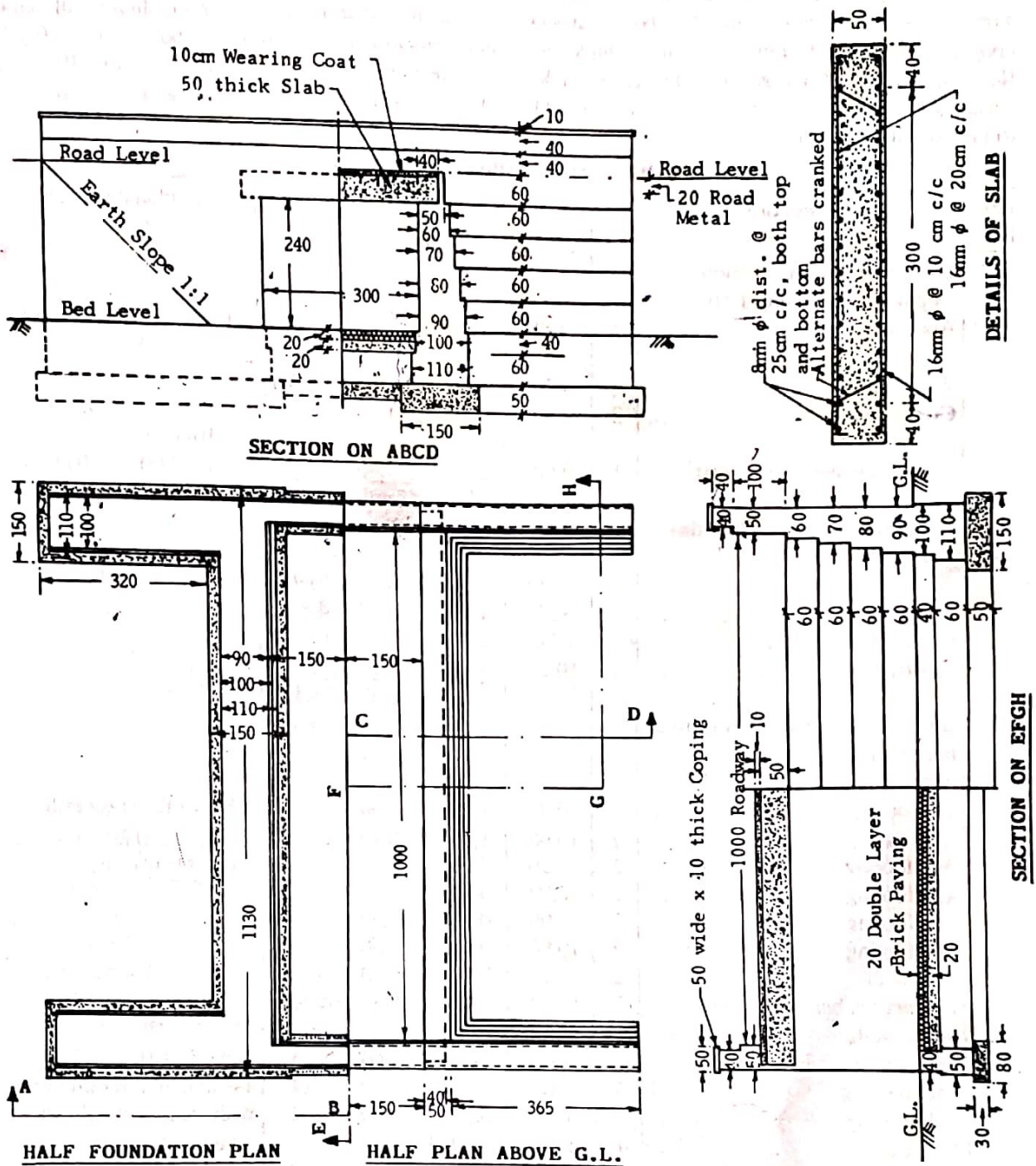


Fig. 8-5

Scanned with CamScanner

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ITEM NO	Particulars of item of work	NO	Length(m)	Breadth(m)	Height(m)	Quantity	Explanontary Note
1	Earth work in ExabitionIn Foundtaion						L=4.8+0.15+0.15=501 H=0.3+0.3=0.6
	A.Abbutment	2	5.1	0.7	0.6	4.284	
	B.Wing Wall	4	1.2	0.7	0.6	2.016	
				Total=	6.3 CU.M.		
2	cement concreate In 1:3:6 With Stone Ballast In Foundtaion						
	A.Abbutment	2	5.1	0.7	0.3	2.142	
	B.Wing Wall	4	1.2	0.7	0.3	1.008	
				Total=	3.15 CU.M.		
3	1st Class Brick Work 1:4cement Sand Mortar						H=0.310.2=1.5 L=1.2-0.5+0.5=1.2 L=4.9-0.1-0.1=4.7 H=0.6-0.1=0.5 (-VE)
	A)Abbutment	2	4.8	0.4	1.5	5.76	
	B)Wing Wall	4	1.2	0.4	0.5	0.96	
	C)Parapet						
	i)40cm layer	2	4.7	0.4	0.2	0.752	
	ii)30 cm layer	2	4.7	0.3	0.5	1.41	
	D)Coping	2	4.9	0.4	0.1	0.392	
	E)Diduction for bearing of slab in abbutment	2	4.8	0.3	0.2	0.576	
				TOTAL=	9.85CU.M.		
4	R.C.C work 1:2:4 for slab excluding bar bending	1	4.8	2.1	0.2	2.016CU.M.	b=1.5+0.3+0.3=2.1
5	Wearing concrete 1:2:4 in cement concrete	1	4	2.3	0.1	0.92CU.M.	b=1.5+0.4+0.4=2.3
6	Cement pointing 1:2 in brick work						H=1+0.1=1.1 L=4.9-0.1-0.1=4.7 H=0.1+1.3+0.2+0.6-0.1=2.1 H=0.2+0.1+0.6-0.1=0.8 H=0.6-0.1=0.5 B=0.1+0.4+0.1+0.1=0.7 (-ve) H=1+0.1=1.1 (-ve)
	A)Inner side of abutment	2	4.8		1.1	10.56	
	B)Fcewall(up to bottom of coping)	2	4.7		2.1	19.74	
	C)Inner side of parrapet	2	4.7		0.8	7.52	
	D)End of parapet						
	i)40 cm layer	4		0.4	0.2	0.32	
	ii)30 cm layer	4		0.3	0.5	0.6	
	iii)End of coping	4		0.4	0.1	0.16	
	E)Coping	2	4.9	0.7		6.86	
	F)Deduction for						
	i)Rectangular opening	2	1.5		1.1	3.3	
	II)Trangulation portion	4	0.845			3.38	
				TOTAL=	39.1SQ.M.		



ALL DIMENSIONS IN CENTIMETRE

FIG. 10-27

ITEM NO	PARTITULARS OF ITEM OF WORKS	NO.	LENGTH(M)	BREADTH(M)	HEIGHT(M)	QUANTITY	EXPLANATORY NOTE
1	Earthwork exavation in foundation						
	a)Abutment	2	11.3	1.5	1.5	50.85	$H=0.4+0.6+0.5=1.5$
	b)Wingwall	4	3.2	1.5	1.5	28.8	$L=3-2*(0.05+0.1+0.2)=2.3$
	c)Cutrainwall	2	2.3	0.8	1.3	4.784	$H=0.4+0.6+0.3=1.3$
	d)Flooring	1	9.6	2.9	0.4	11.136	$L=10-2*9(0.05+0.150)=9.3$ $B=3-2*0.05=2.9$
					Total=	95.57 CU.M	
2	Cement concrete in foundtaion						
	a)abutment	2	11.3	1.5	0.5	16.95	
	b)wingwall	4	3.2	1.5	0.5	9.6	
	c)curtain wall	2	2.3	0.8	0.3	1.104	
	d)flooring	1	2.2	2.2	0.5	2.42	
					total=	33.45CU.M.	
3	1st class brick work in 1:4 cement mortar						
	1. abutment						
	b)110 cm layar	2	10.9	1.1	0.6	14.39	$L=11.3-(2*0.2)=10.9$
	c)100 cm layar	2	10.9	1	0.4	8.72	
	d)90 cm layar	2	10.8	0.9	0.6	11.66	$L=10.9-(2*0.05)=10.8$
	e)80 cm layar	2	10.9	0.8	0.6	9.07	
	f)70 cm layar	2	10.9	0.7	0.6	7.77	
	g)60 cm layar	2	10.9	0.6	0.6	6.48	
	h)50 cm layar	2	10.9	0.5	0.6	6.54	
	2.Deduction for slab bearing	2	10.8	0.4	0.6	5.18	(-ve)
	3. wingwalls						
	a)110 cm layar	4	3.2	1.1	0.6	8.45	$L=3.2-0.2+0.2=3.2$
	b)100 cm layar	4	3.2	1	0.4	5.12	
	c)90 cm layar	4	3.25	0.9	0.6	7.02	$L=3.2+0.05=3.25$
	d)80 cm layar	4	3.35	0.8	0.6	6.43	$L=3.25+0.1=3.35$
	e)70 cm layar	4	3.45	0.7	0.6	5.79	$L=3.35+0.1=3.45$
	f)60 cm layar	4	3.55	0.6	0.6	4.38	$L=3.45+0.1=3.55$
	g)50 cm layar	4	3.65	0.5	0.6	4.38	$L=3.55+0.1=3.65$
	4. parapet						
	a)50 cm layar	2	11.3	0.5	0.4	4.52	$L=2*(1.5+0.5+3.65)=11.3$
	b)40 cm layar	2	11.3	0.4	0.43	3.62	$H=1-(0.5+0.1)=0.4$
	5.curtain wall						
	a) 50 cm layar	2	2.7	0.5	0.6	1.62	$L=3-2*(0.05+0.1)=2.7$
	b)40 cm layar	2	2.9	0.4	0.4	0.93	$L=3-2*0.05=2.9$
					total=	116.27 cu.m.	
4	2o cm double layar brick paving	1	10	2.9		2.9sq.m.	
5	1:3 pointing work with cement mortar						
	a)inner side of abutment	2	10.3		2.4	51.84	
	b)face wall	2	11.3		3.8	85.88	$L=2*(1.5+0.5+3.65)=11.3$
	c)inner side of prapet	2	11.3		0.9	20.34	$H=0.6*5+0.4*2=3.8$
	d)end of parapet						$H=(1-0.5-0.1)+0.1+0.4=0.9$
	1 .50 cm layar	4		0.5	0.4	0.8	
	2. 40 cm layar	4		0.4	0.4	0.64	
	e)deduction						
	1. rectangular opening	2	3		2.4	14.4	(-ve)
	2. triangular portion of earth	4	$1/2*3*3=4.5$		3	18	$H=0.6*5=3(-ve)$
					total=	127.1sq. M.	

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1.2 RCC Hume pipe culvert with splayed angled wing wall

PIPE CULVERT

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Example 7.—Prepare a detailed estimate of Hume pipe Culvert of three pipes each of 60 cm diameter from the given plan and elevations Fig. 8-14. Foundation concrete shall be of 1 : 4 : 8 cement concrete and brickwork shall be of first class in 1 : 6 cement sand mortar. Exposed surfaces shall be pointed with 1 : 2 cement sand mortar.

Assume suitable rates.

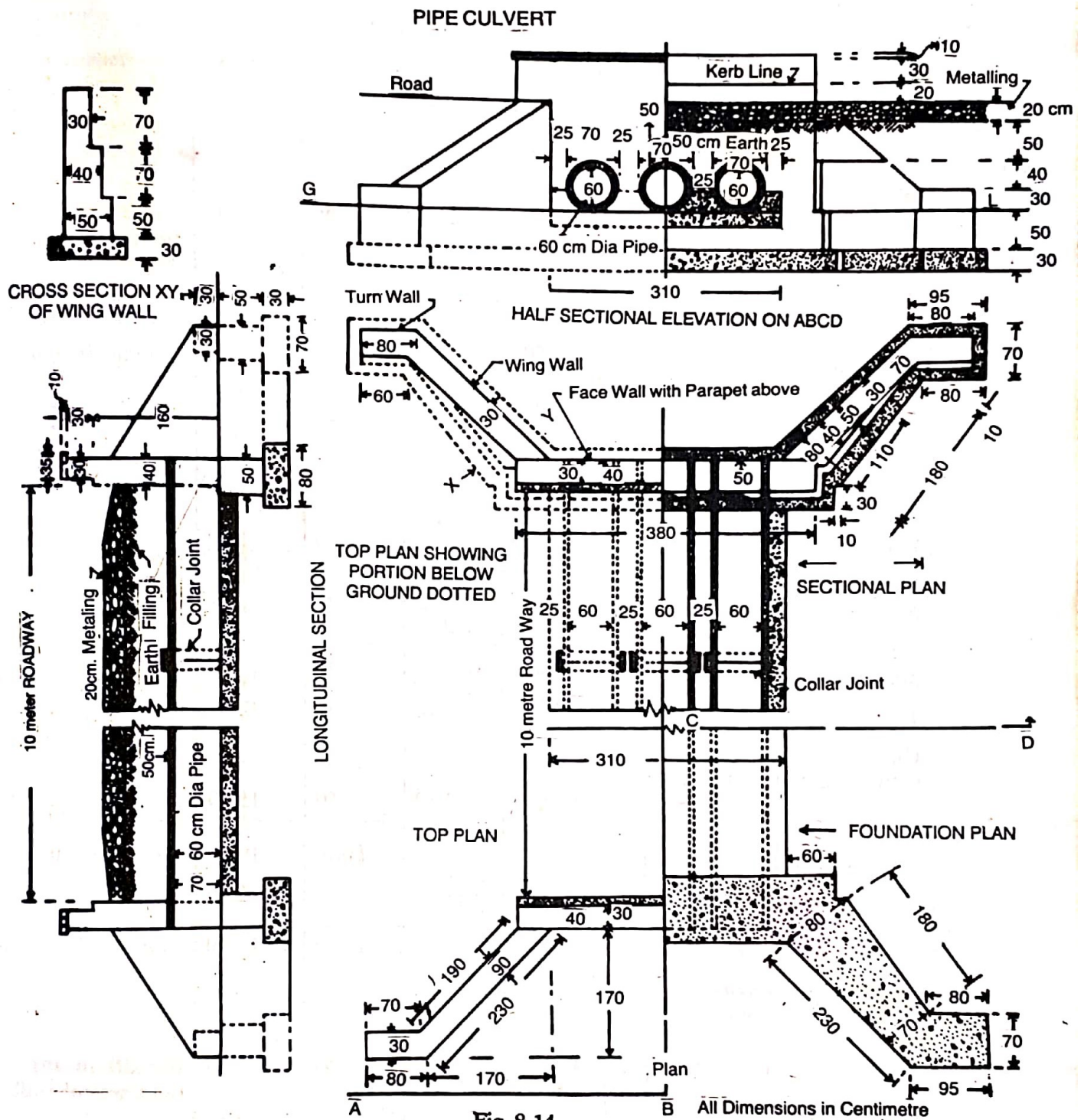


Fig. 8-14

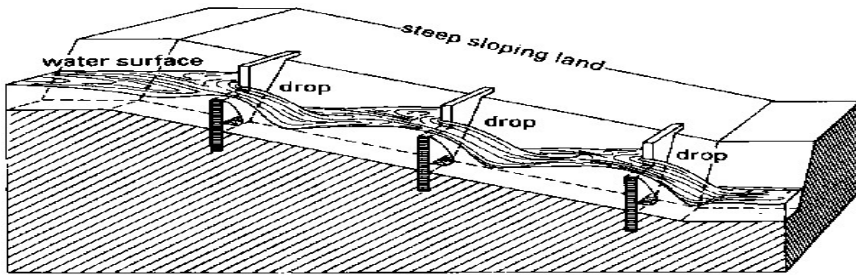
ITEM NO	PARTICULARS OF ITEM	NO	LENGTH(M)	BREADTH(M)	HEIGHT(M)	QUANTITY	EXPLANATORY NOTES
1	Earthwork in excavation						
	a- Face wall	2	3.1	0.8	0.8	3.968	h=0.5+0.3=0.8
	b-wing wall in inclined portion	4	2.05	0.75	0.8	4.92	
	c-wingwall triangular portion	4	2.4		0.8	0.77	
	d-turn wall	4	0.88	0.7	0.8	1.97	
	e-under pipe	1	9.5	3.1	0.15	4.42	L=10-2(0.1+0.15)=9.5
					TOTAL=	16.05CU.M.	
2	Cement concrete in foundation						
	a-Face wall	2	3.1	0.8	0.3	1.49	(-VE)
	b- wingwall inclined portion	4	2.05	0.75	0.3	1.85	
	c-wingwall triangular portion	4	0.75		0.3	0.29	
	d-turnwall	4	0.9	0.7	0.3	0.74	
	e-under pipe up to half pipe	1	9.8	3.1	0.5	4.42	
	f- deduction up to half of pipe	3	9.8	0.3		5.66	
					TOTAL=	13.9CU.M.	
3	First class brick work in 1:6 cement mortar						
	a-face wall						L=10-2(0.1)=9.8
	*50 cm layer	2	4	0.5	0.5	2	
	*40 cm layer	2	3.8	0.4	1.6	4.86	(-VE)
	b-deduction for pipe opening	6	0.38		0.4	0.92	
	c-Parapet						L=0.38+0.05+0.05=3.9
	*30 cm layer	2	3.8	0.3	0.3	0.68	
	*coping	2	3.9	0.35	0.1	0.27	
	d- wing wall						
	50 cm layer	4	1.1	0.5	0.5	1.1	
	40 cm layer	4	1.8	0.4	0.3	0.86	
	30 cm layer	4	(2.3+1.9)/2	0.3	0.35	0.88	
	e- turn wall						
	*40 cm layer	4	0.77	0.4	0.5	0.62	
	*30 cm layer	4	0.77	0.3	0.3	0.27	
					TOTAL=	11.19CU.M.	
4	1:2 cement pointing in brick work						
	a-face wall						
	*upto road level	2	3.1		1.4	8.68	H=0.3+0.5+0.4+0.2=1.4
	*up to bottom of coping	2	2.8		0.5	3.8	H=0.2+0.3=0.5
	*coping	2	3.9		0.6	4.68	
	*deduction for pipe opening	6	0.38			2.3	
	b- wing wall						
	*vertical surface	4	2.3		0.3	2.76	H=0.4+0.5+0.2=1.1
	*inclind surface	4	2.3		0.55	5.06	
	*tope surface	4	2.05	0.3		2.52	
	c-turn wall						
	*vertical surface	4	1.8		0.3	2.16	L=0.7+0.2+0.8=1.8
	*top portion	4	0.75	0.3		0.9	
	d- parapet						
	* inner side of parapet	2	3.8		0.6	4.56	H=0.2+0.1+0.3=0.6
					TOTAL=	32.82SQ.M.	

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CHAPTER -2 **Estimate of irrigation structures**

FALL :-

A vertical drop which is provided to step down the canal bed and then it is continued with permissible slope is called canal fall structure or simply canal fall.



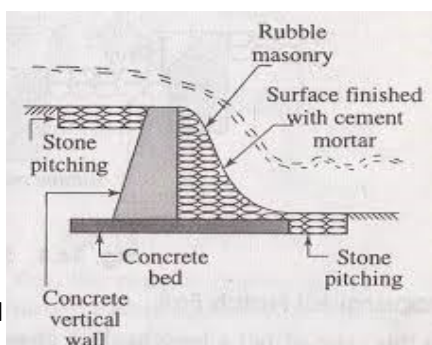
TYPES OF FALL :-

Followings are the different types of fall :-

- a) Ogee falls
- b) Rapid Fall
- c) Stepped fall
- d) Trapezoidal notch fall
- e) Simple vertical drop fall Or Sarada fall
- f) Straight glacis fall
- g) Montague type fall
- h) English fall or baffle fall

A - Ogee fall :-

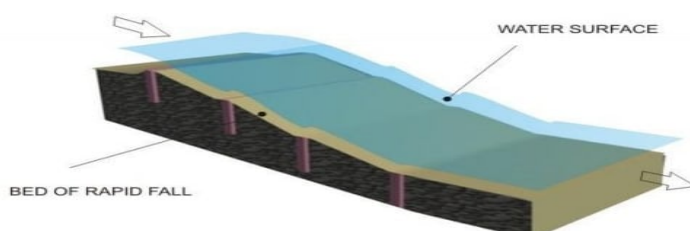
Ogee curve is the combination of convex and concave curves. So, Ogee fall consists of both convex and concave curves gradually. This gradual combination helps to provide smooth transition of flow and also reduce the impact. If the canal natural ground surface is suddenly changed to steeper slope, ogee fall is recommended for that canal. Stone pitching is provided in the upstream and downstream of the fall.



B-Rapid Fall



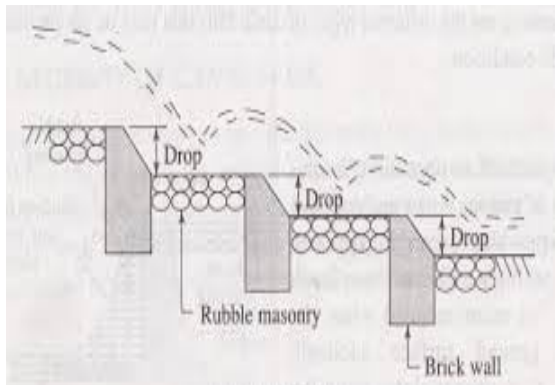
Rapid fall consists of a long sloping glacis. It is constructed if the available natural ground surface is plane and long. For this, a bed of rubble masonry is provided and it is finished with cement mortar of 1:3 ratio. To maintain the slope of bed curtain walls are provided at both upstream and downstream. Rapid falls are high priced constructions.



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C- Stepped fall :-

As in the name itself, stepped fall consist vertical steps at gradual intervals. Stepped fall is the modification of rapid fall. It is suitable for the canal which has it upstream at very high level as compared to downstream. These two levels are connected by providing vertical steps or drops as shown in figure.



D-Trapezoidal notch fall :-

In case of trapezoidal notch falls, a high crested wall is built across the channel and trapezoidal notches are provided in that wall. Trapezoidal falls are very economical and suitable for low discharges. Now a days this type of falls are using widely because of their simplicity and popularity.



E-Simple vertical drop fall Or Sarada fall :-

Simple vertical drop fall or sarda fall consists, single vertical drop which allows the upstream water to fall with sudden impact on downstream. The downstream acts like cushion for the upstream water and dissipate extra energy. This type of fall is tried in Sarda Canal UP (India) and therefore, it is also called Sarda Fall.



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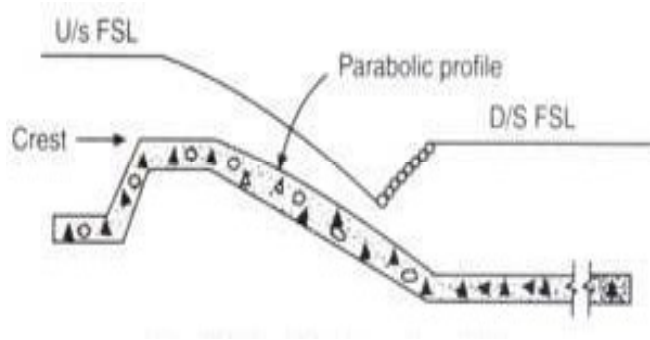
F-Straight Glacis Canal Fall :-

This is the modern type of construction, in which a raised crest is constructed across the canal and a gentle straight inclined surface is provided from raised crest to the downstream. The water coming from upstream crosses the raised crest and falls on inclined surface with sufficient energy dissipation.



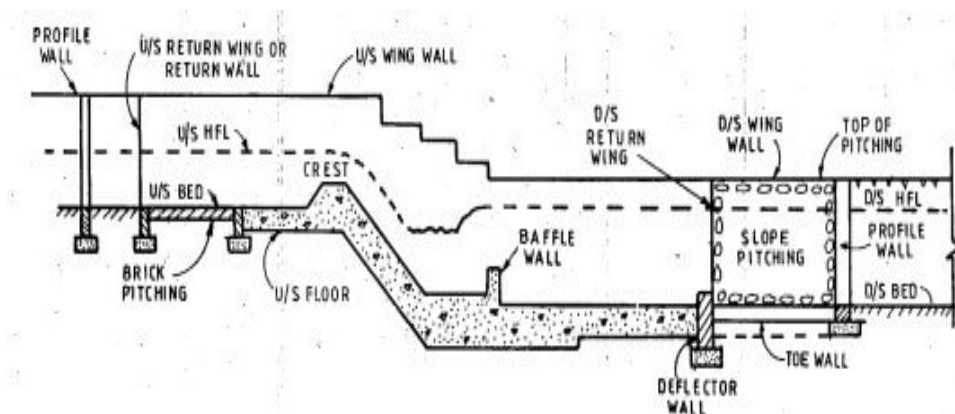
G-Montague Type Canal Fall :-

Montague fall is similar to straight glacis fall but in this case the glacis is not straight. It is provided in parabolic shape to introduce the vertical component of velocity which improves the energy dissipation to more extent.

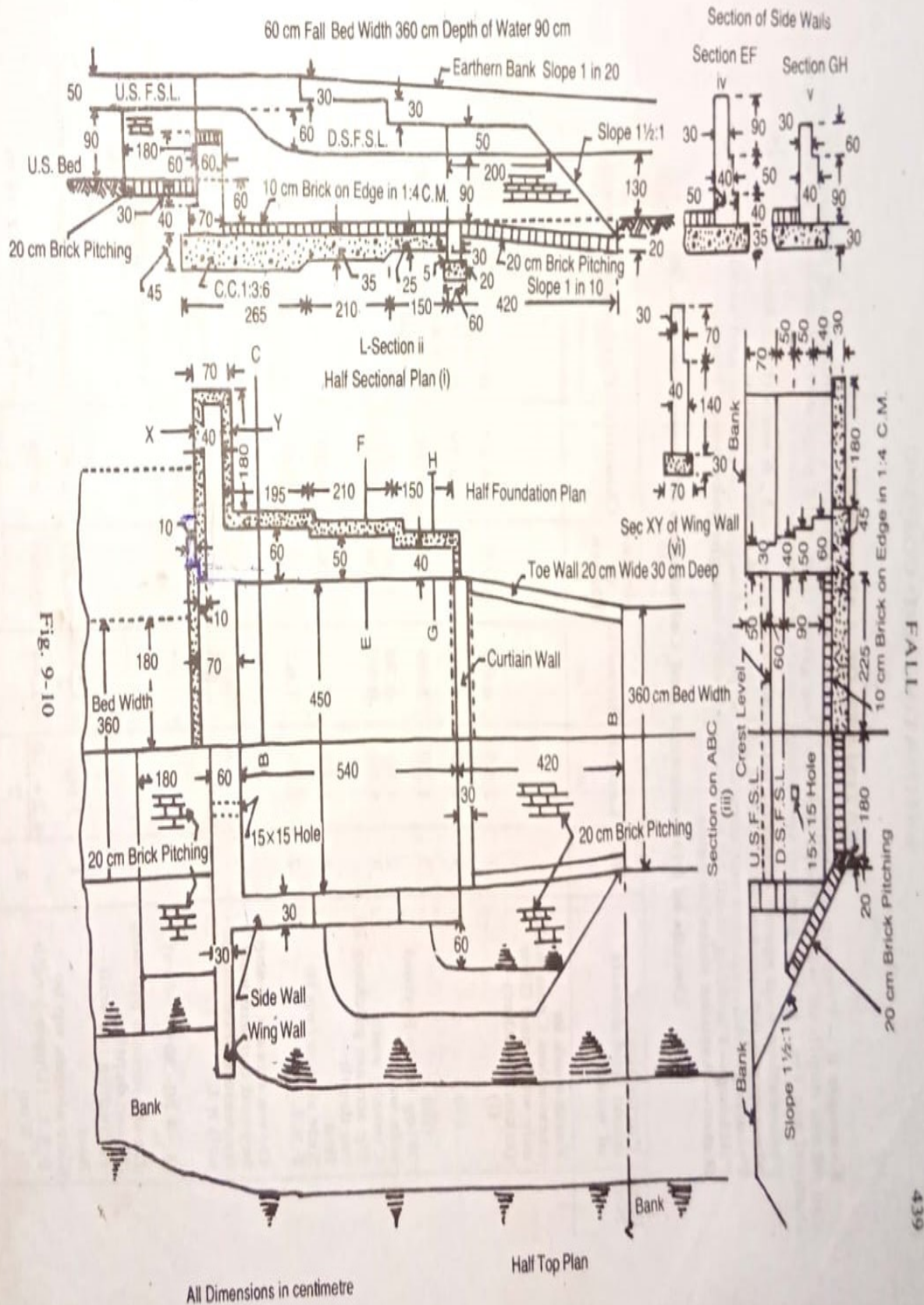


H-English or Baffle Canal Fall :-

In this case, straight glacis fall is extended as baffle platform with baffle wall. This is suitable for any discharge. The baffle wall is constructed near the toe of the straight glacis at required distance in designed height. The main purpose of the baffle wall is to create hydraulic jump from straight glacis to baffle platform.



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ITEM NO	PARTICULARS OF ITEM	NO	LENGTH(M)	BREADTH(M)	HEIGHT(M)	QUANTITY	EXPLA NATORY NOTE
1	EARTHWORK EXCAVATION						
	a.Creast wall and side wall						
	*1st floor	1	2.65	6	1.15	18.29	$B=4.5+2(0.6+0.15)=6$ $H=0.6+0.45+0.1$
	2nd floor	1	2.1	5.8	1.05	127.9	$B=4.5+2(0.5+0.15)=5.8$
	*3rd floor	1	1.5	5.6	0.95	7.98	$H=0.6+0.1+0.25=1.05$
	b. Wing wall	2	1.8	0.7	1	2.52	$B=4.5+3*(9.5+9.15)=5.6$
	c.Curtain wall	1	4.5	0.6	1.2	3.24	$H=0.6+0.1+0.25=0.95$
	d. toe wall	2	3.75	0.2	0.3	0.45	$H=(0.7+0.5+0.5+0.4+0.3)-0.9-0.5=1$
	e.Up stream side brick pitting						
	*In bed	1	1.55	3.6	0.2	1.12	$L=4.2-0.3-0.15=3.75$
	*Side slope	2	1.8	1.62	0.2	0.58	$H=0.6+0.1+0.3+0.2=1.2$
	f.Down stream side trapizodal section	1	3.9	4.05	0.8	16.38	$L=1.8-0.1-0.15=1.55$
	g.Down stream side brick pitching						$B=\sqrt{0.9^2+1.35^2}=1.62$
	*Bed	1	3.75	3.65	0.2	2.85	$L=4.2-0.3=0.9$
	*Side slope	2	3.1	1.62	0.2	2.01	$L=4.2-0.3-0.15=3.75$ $B=(4.1+3.2)/2=3.65$
	*Curved portion	2	1.13		0.2	0.45	$L=(4.2+2)/2=3.1$
	*Deduction for set back of wing wall	2	0.6	0.1	1.15	0.15(-ve)	$A=\pi*0.6^2=1.13$
					TOTAL=	69CU.M.	
2	1ST CLASS BRICK WORK IN 1:3 CEMENT MORTAR						
	a. Creast wall						
	*70 cm layer	1	4.5	0.7	0.4	1.26	
	*60 cm layer	1	4.5	0.6	0.9	2.43	$H=0.6+0.3=0.9$
	b.Side wall BC						
	*60cm layer	2	2.35	0.6	0.4	1.13	$L=1.95+0.4=2.35$
	*50 cm layer	2	2.35	0.5	0.5	0.94	
	*40 cm layer	2	2.35	0.4	0.5	0.94	
	*30 cm layer	2	2.35	0.3	0.7	0.99	
	c.Side wall EF						
	*50 cm layer	2	2.1	0.5	0.4	0.84	
	*40 cm layer	2	2.1	0.4	0.5	0.84	
	*30 cm layer	2	2.1	0.3	0.9	1.13	
	d. Side GH						
	*40 cm layer	2	1.5	0.4	0.9	1.08	
	*30 cm layer	2	1.5	0.3	0.6	0.54	
	e. Wing wall						
	*40 cm layer	2	1.8	0.4	1.4	0.58	$L=1.8-0.15+0.15=1.8$
	*30 cm layer	2	2.1	0.3	0.7	0.88	$L=2.0+0.1=2.1$
	f.Curtain wall	1	4.5	0.3	0.4	0.54	$H=0.1+0.25+0.05=0.4$
	g. Toe wall	2	3.9	0.2	0.3	0.47	$L=4.2-0.3=3.9$
					total=	16.23CU.M.	
3	CEMENT CONCRETE IN FOUNDATION						
	a.CREAST WALL AND FLOOR						
	1st floor	1	2.65	6	0.45	7.16	$B=4.5+2(0.6+0.15)=6$
	* 2nd floor	1	2.1	5.8	0.35	4.26	$B=6-2*0.1=5.8$
	*3rd floor	1	1.5	5.6	0.25	2.1	$B=5.8-2*0.1=5.6$
	b. wing wall	2	1.8	0.7	0.3	0.76	
	c. curtain wall	1	4.5	0.6	0.2	0.54	
	d.deduction for set back of wing wall	2	0.6	0.1	0.45	0.054(-VE)	$H=0.7+0.45+0.1=1.15$
					TOTAL=	14.77CU.M.	
4	BRICK PITCHING						
	a. Up stresm side						
	*Bed	1	18	3.6	0.2	1.37	
	*Side slope	2	1.8	1.62	0.2	1.37	
	b. Down stream side						
	*Trapizodal portion	1	3.9	3.65	0.2	2.05	$L=4.2-0.3=3.9$
	*Side slope	2	3.1	1.62	0.2	2.01	$L=(4.2+2)/2=3.1$
	c.curved portion	2	2*0.6^2		0.2	0.45	
					TOTAL=	7.78 CU.M.	
5	10 CM THICK BRICK FLOORING	1	4.5	5.4		24.3 SQ.M.	

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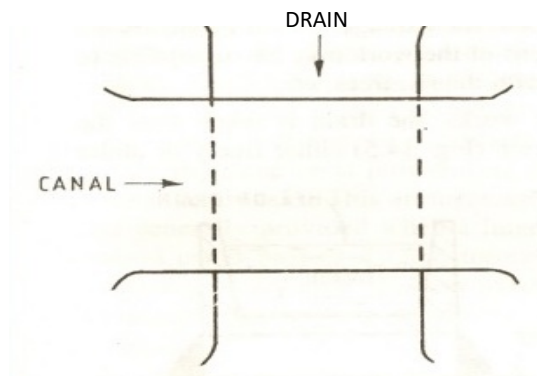
6	CEMENT POIN TING IN 1:3 CEMENT MORTAR						
	a. Creast wall	1	4.5	—	2.4	10.8	$H=0.6*4=2.4$
	b. Inner side of side wall						
	*Inner side wall BC	2	1.8	—	2	7.2	$L=1.95-0.15=1.8$ $H=0.9+0.6*2=2$
	*Side wall section EF	2	2.1	—	1.7	7.14	$H=(0.4-0.1)+0.5+0.9=1.7$
	*Side wall section GH	2	1.5	—	1.4	4.2	$H=0.8+0.6=1.4$
	c.Side wall portion above creast wall	2	0.6	—	0.8	0.96	$H=(0.9+0.6+0.5)-(0.6*2)=0.8$
	d. Vertical face of end	4	—	0.3	0.3	0.36	
	*40 cm layar	2	—	0.4	0.9	0.72	
	*30 cm layar	2	—	0.3	0.6	0.36	
	e. Top portion of side wall	2	6	3	—	0.36	$L=1.8+0.6+2.1+1.6=6$
	f. Top portion of curtain wall	1	4.5	0.3	—	1.36	
	g. Toe wall	2	3.9	0.2	—	1.56	$L=4.2-0.3=3.9$
	h. Top of curve portion	2	$(\pi/4)*0.6^2$		—	2.26	
	i.Top portion of wing wall	2	2.1	0.3	—	1.26	
	j. Wing wall up stream side triangular portion above slope	2	1.47			2.94	$A=(2.1*1.4)/2=1.47$
					TOTAL=	44.28SQ.M.	

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Cross drainage work :-

- Cross drainage work is a structure carrying a discharge of a stream across another stream.
- Cross drainage work is of two types:-
 - 1-A canal cross over a drain.
 - 2-A drain cross over a canal.

1-A canal cross over a drain.



- In this CD work canal is carried over a natural drain.
- This type of structure is constructed when the size of drain is very large as compare to the canal.
- This type of structure is classified into 2 types :-

A – Aqueduct

B – Syphon aqueduct

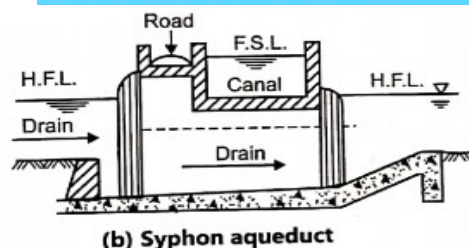
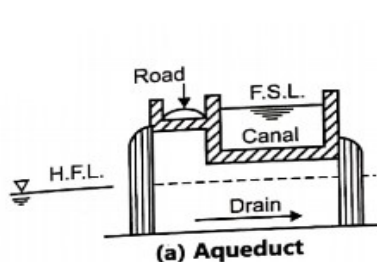
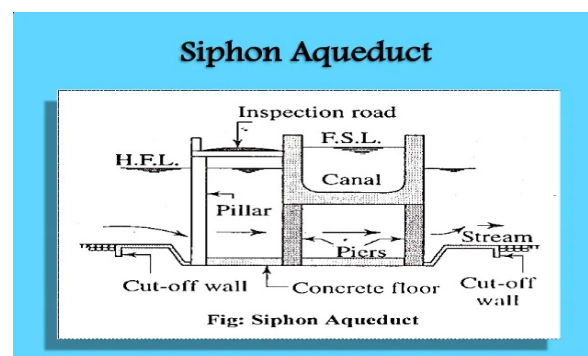
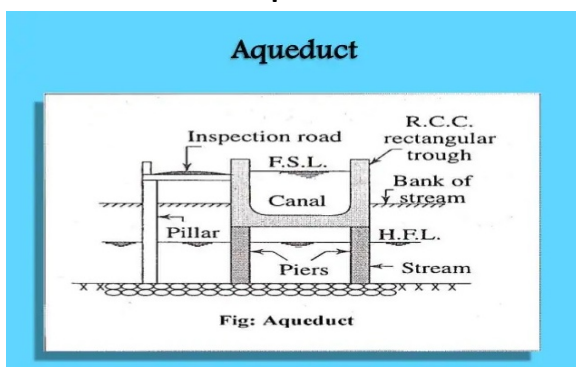
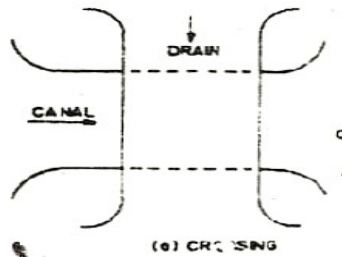


Fig. 6.11

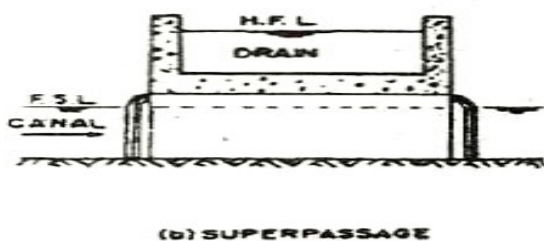
- Due to the canal running perennially (Always contain water) we have to construct a road for the purpose of inspection, which is known as inspection road.
- When HFL (Highest Flood Level) of the drain is much lower than the bottom of canal, then we have to construct a CD structure, which is known as "AQUEDUCT".
- In aqueduct drain water flow freely under gravity.
- When HFL of the drain is much higher than the bottom of the canal, then we have to construct a CD structure which is known as "SYPHON AQUEDUCT".
- In syphon aqueduct drain water flow under a syphonic action.

2-A drain cross over a canal :-

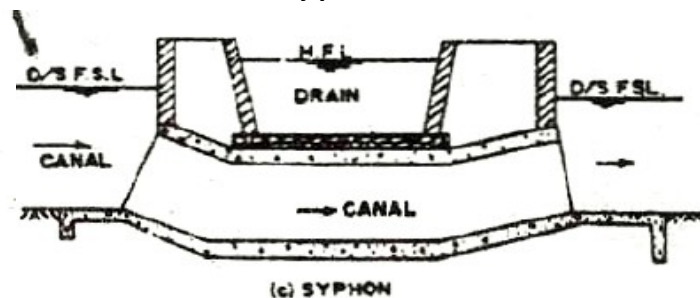


- In this CD work drain is carried over a canal.
- This type of CD structure is classified into two types :-

A – Superpassage



B - Syphon



- When FSL of a canal is much lower than the bottom of drain then we have to construct a CD structure is known as "SUPERPASSAGE"
- In super passage canal water flow freely under gravity.
- When FSL of canal is much higher than the bottom of the drain then we have to construct a CD structure known as "SYPHON".
- In syphon canal water flow under a syphonic action.

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

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

Assume suitable rates for the different items of work.

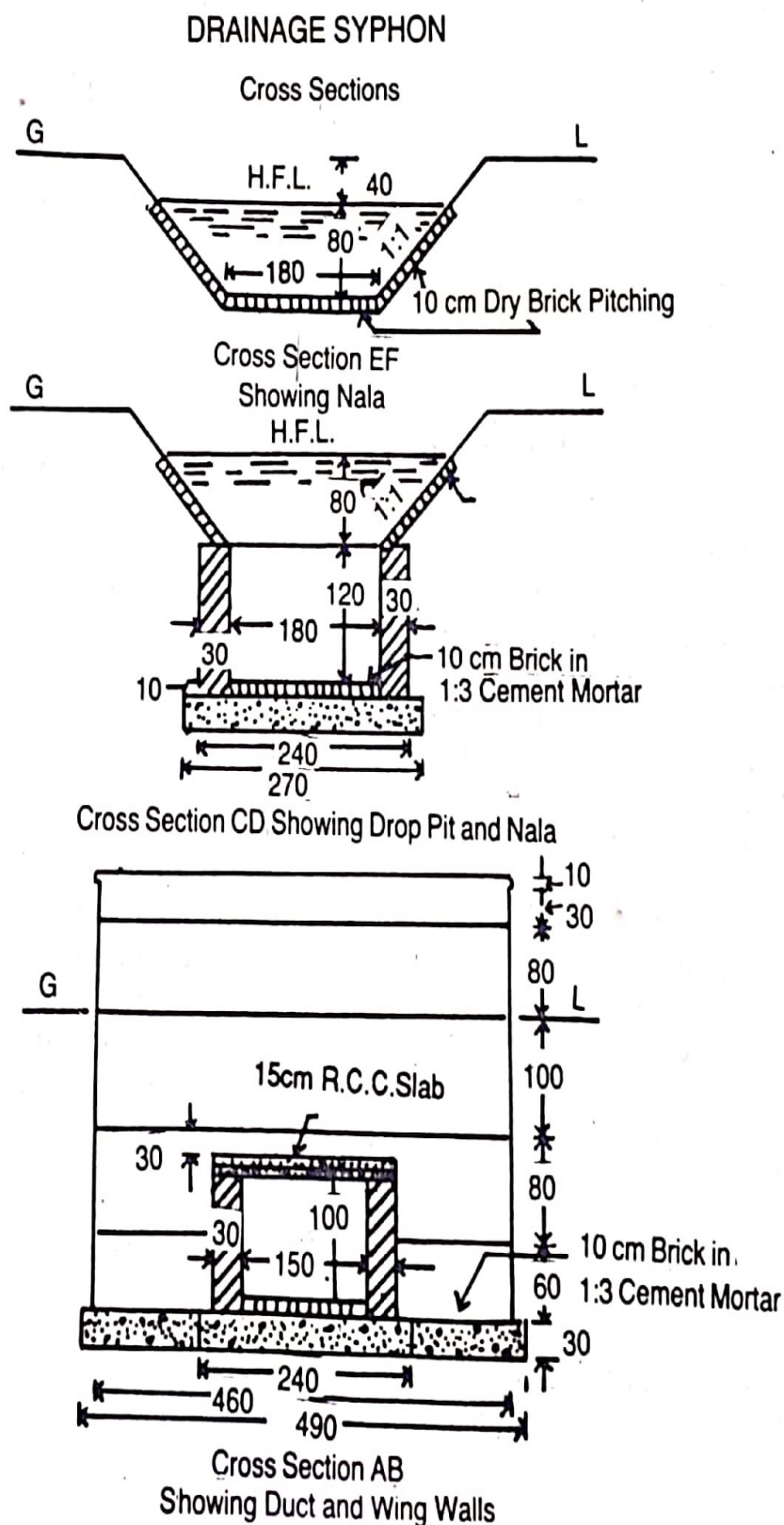


Fig. 9-8

SL NO	PARTICULARS OF ITEM OF WORK	NO	LENGTH(M)	BREADTH(M)	HEIGHT(M)	QUANTITY	EXPLANATORY NOTE
1	EARTH WORK IN EXCAVATION IN FOUNDATION a. Syphon duct b. Drop pit c. Wing wall	1	9.5	2.4	1.6	36.48	$L=9.2+(2*0.15)=9.5$ $B=1.5+(2*0.3)+(2*0.15)=2.4$ $H=0.1+1.2+0.3=1.6$ $L=1.1+0.15=1.25$
		2	2.1	2.7	1.6	18.14	
		4	1.25	1	1.6	8	
					TOTAL=	62.62CU.M.	
2	CEMENT CONCRETE IN FOUNDATION a. Syphon duct b. Drop pit c. Wing wall	1	9.5	2.4	0.3	6.84	
		2	2.1	2.7	0.3	3.4	
		4	1.25	1	0.3	1.5	
					TOTAL=	11.74CU.M.	
3	1ST CLASS BRICKWORK a. Syphon duct side wall b. Drop pit wall *long wall *short wall c. Wing wall *70 cm layer *60 cm layer up to top of the slab *60 cm layer above the slab *50 cm layer *40 cm layer *30 cm layer d. Coping	2	9.2	0.3	1.3	7.17	$H=1.2+0.1=1.3$ $L=1.8+0.3=2.1$ $H=0.6+0.1=0.7$ $H=0.8-0.2=0.6$ $H=0.6+0.2=0.8$ $L=4.6+(2*0.050)=4.7$
		4	2.1	0.3	1.3	3.28	
		2	1.8	0.3	1.3	1.4	
		4	1.25	0.7	0.7	2.45	
		4	1.25	0.6	0.6	1.8	
		4	4.6	0.6	0.2	2.2	
		4	4.6	0.5	1	9.2	
		4	4.6	0.4	0.8	5.89	
		4	4.6	0.3	0.3	1.65	
		2	4.7	0.35	0.1	0.33	
					TOTAL=	35.37CU.M.	
4	10CM. THICK BRICK FLOORING a. syphon duct b. sideslope and nalla	2	3	1.8		10.8	$B=\sqrt{0.8^2+0.8^2}=1.13$
		4	3	1.13		13.56	
					TOTAL=	24.36SQ.M.	

5	CEMENT POINTING 1:3 CEMENT MORTAR a. Syphon duct side wall b. Drop pit 3 vertical inner face c. Drop pit wall top face d. Parapet wall inner face , top and outer face up to ground level e. Outer face of wing wall above slab *Rectangular portion *Trangular portion	2	9.2		1.05	19.32	$L=2*(1.8+0.3)+1.8=6$ $2*0.2+3*0.3+0.35+0.6=2.3$ $H=0.8+0.4=1.2$
		6	1.8		1.2	12.96	
		2	6	0.3		3.6	
		2	4.6		2.3	21.16	
		2	1.8		1.2	4.32	
		4	0.72			2.88	
					TOTAL=	64.24SQ. M.	
6	15CM. LAYAR R.C.C. SLAB ABOVE SYPHON DUCT	1	9.2	2.1	0.15	2.9CU.M.	$H=1.5+0.3+0.3=2.1$
7	10 CM. THICK BRICK PITCHING OF NALA *Bed of nala *Side slope of nala	2	3	1.8		10.8	$B=\sqrt{0.8^2+0.8^2}=1.13$
		4	3	1.13		13.56	
					TOTAL=	24.36SQ. M.	

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Classification of Work :-

A-As per Nature of Work →

1. **Original Work** : Any type of new construction work is known as original work. Example may be construction of new road, new bridge, new building etc.

2. **Repair Work →**

i. **Annual Repair Work**: The repair work which is taken up annually is known as annual repair work. Examples may be repairing of pot holes on the road, white washing/colour washing/ painting of buildings etc

ii. **Special Repair Work**: Certain repair works which is taken up occasionally as & when required is known as special repair work. Examples may be repair of roads damaged during flood/earthquake, damaged pipe line or sewer line, repair to damaged plaster, replacement of doors or glass panes in buildings, patch repair of roads etc

iii. **Quadrantal Repair Work**: repair works taken up once in every 3 months in a year is known as Quadrantal repair work. Examples may be cleaning of sewer lines in a building, repair of sanitary & electrical installations in a building etc.

B-As per Amount of Work →

1. **Petty Work** : Upto Rs. 50,000/-

2. **Minor Work** : More than Rs. 50,000/- & Upto
Rs. 2,00,000/-

3. **Major Work**: More than Rs. 2,00,000/-

Method of Execution of Works

1-Departmentally → In case of emergency/urgent nature of work, the department can execute the work by arranging labours and materials under their own supervision.

2-Through Contractors → Normally the works are executed through contractors who procure materials and engage the required labours under the supervision of departmental engineers.

Various methods of carrying out the works

1. **Item Rate contract →** This contract is based on units put in place rather than a single price. The contractor quotes rates of individual items involved in a particular project. The payment is calculated at the specific quoted rate of individual items after taking measurement of the quantities executed by the contractor.

This type of contract is normally utilized where the quantity of work cannot be established such as civil engineering construction projects where excavation of soil and rock are involved. The contractor is paid based on the units that have been put in place and verified by the owner. Unit Cost contracts provide more flexibility in discrepancies in field quantities and because of this, it is always used on heavy and highway construction contracts.

2. Lump sum contract → In a lump sum contract an owner agrees to pay a contractor a specified lump sum after the completion of work without a cost breakdown. After work no detailed measurements is required.

3. Labour contract → In this type of contract, the contractor quotes the rate for supplying labour only for execution of the work and gets payment for the labours actually engaged.

4. Daily Labour or Muster Roll System → When the work is carried out by the department directly by employing the daily labour such as masons, beldars, carpenters, coolies, blacksmiths, plumbers etc. it is known as daily labour or muster roll system. All the materials required for the construction are issued from stores or purchased directly chargeable to the concerned work.

5. Piece Work agreement → It is the agreement for doing the work at the agreed rates, without reference to the total quantity of work or time. Such works or piece works upto Rs. 2000/- are got done through the contractors by piece work agreement.

6. Scheduled contract → It is like lump sum contract. Here the complete work as per plan and specifications is carried out by contractor for certain fixed amount as per agreement. The owner provides required information and contractor charges certain amount. This contract is suitable when the number of items is limited or when it is possible to work out exact quantities of work to be executed. The detailed specifications of all items of work, plans and detail drawings, security deposit, penalty, progress and other condition of contract are included in agreement. Though it is lump sum and scheduled contract, contractor will be paid at regular interval of 2-3 months as per progress of work on the basis of certificate issued by engineer in charge. A scheduled of rate is included in agreement for making payment of extra items.

7. Cost plus percentage contract → In cost plus percentage, the owner pays greater than 100 percent of the documented cost, usually requiring detailed expense accounting. In this type of contract, contractor is paid the actual cost of work plus certain percentage as profit. Various contract documents, drawing, specifications are not necessary at the time of signing the agreement. Contractor has to keep all records for cost of material and labour and contractor will be paid accordingly to engineer in-charge. This type of contract is suitable for emergency work like difficulties in foundation conditions, construction of expensive structure etc.

8. Work order → This method of getting the work done is employed for doing small works upto Rs.5000/-. This is a type of contract and is done without calling quotations or tenders. The work order is done on the prescribed terms and conditions of the department. Every department has printed work order books for doing such works.

Explanation of Various Terms

1. Administrative Approval → This is an approval given by the competent authority of the parent department whose construction project work is to be taken up by the P.W.D. department. The parent department after ascertaining the funds position, technical feasibility of the project usually gives the approval. After getting the administrative approval the executing department proceeds for preparing detail drawings & estimates for actual execution.

2. Technical Sanction → This is a sanction usually accorded by the competent authority of the executing department i.e. P.W.D. after proper verification of detail estimate, detailed drawing and specification of the project. After getting technical sanction the executing authority of the department calls for tender process.

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3. 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.

4. Tender → It is an offer in writing to execute some specified works or to supply some specified articles subject to certain terms and conditions like rates, time limits etc. Depending upon the type of contract, the tender may be lump-sum tender, item-rates tender, cost-plus tender, labour tender, demolition tender etc. Tenders which is always sealed in manner should be invited in the most open and public manner possible by advertisements in news papers or notices pasted in public places. The tenders after receiving date & time is over, are opened at the fixed time and date by the authorized officer in the presence of the intending contractors or their agents.

5. Preparation of Notice inviting tender → Tender notice is issued in the prescribed form for calling tenders for the construction works or supply works etc. in the prescribed form of the department.

➤ Following particulars are given in the tender notice.

- a. Name of the authority deptt. Inviting tenders.
- b. Name of the work & its location
- c. Estimated cost
- d. Time of completion
- e. Cost of tender forms & condition of contracts
- f. Date, place & time of receiving & opening of tenders
- g. Earnest Money & Security money
- h. Validity of tender etc.

6. Receiving of quotations → Usually the tender form or quotations are received in the office notifying the tender notice up to a certain time and date which is given in the notice. Such quotations may be received by Registered post / drop box kept in the office for the purpose, the actual mode is notified in the notice.

7. Earnest Money Deposit (EMD) → It is the amount which accompanies the tender form while submitting it, which is usually 1% to 2% of the total estimated cost of the work. The main objective of collecting the EMD with the tender are as follows.

a. Restriction of unnecessary competition : If no EMD is collected, unnecessary competition will start. Those contractors who do not have any sound financial position to complete the work will submit their tenders at low rates, which may cause difficulties in completing the work.

b. Punishment: In case the contractor quotes lower rates, without intention of doing the work, the EMD shall be forfeited by the department as a punishment to such contractors.

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c. Compensation: In case the lowest contractor refuses to do the work, the work can be allotted to the second lowest contractor. The EMD forfeited from the first contractor compensates to great extent the loss of the department.

After accepting the tender of the qualified contractor, EMD of other contractors are refunded.

8. Security Deposit(SD) → After calling the tenders, they are scrutinized and the department accepts the reasonable tender usually the lowest. After accepting the tender the contractor whose tender is accepted is asked to deposit the SD which is usually 2.5 to 10% of the total estimated cost of the work. The main objective of SD are as follows.

a. Deposit for Loans: The SD serves as security against the materials or the plants and machineries supplied by the department to the contractor on loan.

b. Punishment: In case the contractor does not complete the work in time, uses inferior quality materials or has left the work incomplete, the SD amount is forfeited as punishment to the contractor as well as in view of getting compensation of the damages done by the contractor to the department.

When the contractor completes the work as per drawings, specifications and direction of the department within specified time, the SD is refunded to the contractor. Normally it is refunded after the maintenance period which is usually six months after completion and handing over of the work.

9. Advance Payment → Advances to the contractors are as a rule prohibited, but in exceptional case it is permitted. Cases in which a contractor whose contract is for finished work, requires an advance on the security of materials brought to site, Divisional officers may, in such case make advances up to an amount not exceeding 25% of the current value of the materials, provided that they are of an imperishable nature. But the department people should be very sure that this advance amount will not put the department in trouble if the contractor leaves the work in between.

10. On Account Payment → On account payment may be done to the contractor as per actual measurements done in the field for the completed portion of the work as per the norms of the contract.

11. Intermediate Payment → Intermediate payments may be done to the contractor as per the terms & conditions of the contract basing on actual measurements in the field against the works done by the contractor. But it should not be the whole amount measured rather less percentage of actual measurement calculated. This type of payment is done subject to preparation of running bills.

12. Final Payment → Final payment is usually done to the contractor after successful completion of the work done and full measurements taken and checked by the competent authorities of the department and subject to preparation of final bill.

13. Running Bill → This is otherwise known as running account bill (Form No.26) which is used for all running and final payments to contractors and suppliers including cases where advance payments are proposed to be made or are already outstanding in respect of the same work against the contractor.

14. Final Bill → This is also known as first & final bill (Form No. 24) which is used for making payments both to contractors for work and to suppliers, when a single payment is made for a job contract on its completion. A single form may be used for making payments to several payees, if they relate to the same work and are billed for at same time.

15. Regular & Temporary Establishment → All the regular staff of the department are known as regular establishment and the staff assigned to a specific project for completion of the project is known as temporary establishment.

16. Measurement Book (MB) → Payments to contractors and suppliers for all the work done by them which requires measurement are done on the basis of measurements recorded in a book known as Measurement Book (MB) in accordance with the rules. It is a very important account of record.

Usually Junior Engineer (JE) who is actually assigned to supervise the quality & progress of the work is authorized to make the entry of detailed measurements of the work. He records all the measurements after completion of the work or interim as required and puts his dated signature in the book. The same is being check measured by his superior authorities time to time and they also put their dated signature in it. When the bill is prepared (running / final) the measurements are taken from this book.

17. Standard Measurement Book (SMB) → A set of measurement books which is used to maintain standard measurements-books of buildings in order to facilitate the preparations of estimates for periodical repairs are known as standard measurement book (SMB). Where such SMB are maintained, it is also permissible to utilize them for the purpose of preparing for contractor's bill for such repairs, so that it may not be necessary to take detailed measurements on each occasion.

18. Muster Roll → The attendance of the labourers is maintained in a muster roll. The presence of each labourer in muster roll should be marked by the proper officer at the starting hour of the day. Periodic inspections by the higher authority are done to check the actual labourers working.

On the basis of the muster roll payment is made to the labourers, weekly, fortnightly, monthly or at the completion of the work according to the requirement. In the muster roll names of the workers, designation, date of attendance, rate of wages, total amount due to each worker, signature of person taking the attendance, signature of the officer checking, making payment etc. are entered.

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19. Acquittance Roll → The workers actually paid the due charges after signing in the acquittance roll. In this roll the name of the worker, no. of days worked, rate of wage, total amount received, signature or acquittance of the worker are recorded. This is used as a paid voucher or bill in the department for official record of payments to the workers and is supported by the muster roll.

20. Temporary Advance → While a disbursing officer makes a remittance to a subordinate officer to enable him to make a number of specific petty payments on a muster roll or other voucher which has already been passed for payment, the amount remitted is known as temporary advance and accounted for as imprest. This account should be closed as soon as possible.

21. Cash → The term 'cash' as defined in the CPWD code includes legal coins, notes, cheques, deposit-at-call receipts of scheduled banks, drafts and payments on demand.

Cash charges on works consists of payment to :

- a. Labourers and members of the work-charged establishment, of their wages.
- b. Contractors and others for work done or other services rendered.

The cost of materials procured specially for works is charged to the accounts of works by transfer credit to the purchases account, but payment to suppliers are governed by the same rules as payments to the contractors for work done.

22. Major & Subhead of Accounts → All the expenditure related to a work are known as major head of accounts. Further these expenditures are divided into different subheads as applicable. Examples may be as follows.

Major head of accounts

Construction of a building

Establishment charges

Subhead of accounts

Material cost, labour cost, rent of tools & plants, supervision charges etc.

Salary , Allowances, Travelling expenses etc.

23. Supervision Charges → It is the amount kept in the estimate to meet the expenses towards supervision of the project work. Usually 5% amount on the cost of estimate is kept for this purpose.

24. Debit → Expenses made in executing the work is known as Debit.

25. Credit → Payments received for expense towards work is known as Credit.

Prepared By :- Er Pitabas Mishra

STORE

Classification of Store :-

The PWD classify the stores into the following types.

1. Stock.
2. Machinery and equipment.
3. Road metal.
4. Materials charged to works.

Stock → Items of common use in construction work, such as bricks, aggregates, cement, steel, etc., are kept in the stock of a division and are issued as and when required for the execution of works. The following are the advantages of keeping a stock of materials.

- a. The procedure for the procurement of the same item is not repeated for different works.
- b. The use of approved materials of the prescribed specifications is ensured.

'Stock' is a **suspense head** of account. When an item of stock is purchased, its cost is debited to the suspense head 'Stock'. When the item is issued for use in a work, the cost of the item issued is credited to the suspense, head 'Stock' and debited to the final head of the work concerned.

Machinery and equipment → The machinery equipment, vehicles, furniture and instruments required for use in construction works are known as machinery and equipment. The machinery and equipment are of two kinds.

- a. General machinery and equipment. These are required for general use in the division
- b. Special machinery and equipment. These are not required for general use in the division, but are procured for use in the specific works.

Road metal → A record of Road metal is kept in measurement books and claims for payment examined on the basis of the recorded measurements. Road metal is often kept by the road side before use and an account of its quantity is kept in the sub-divisional office in Form 16, statement of receipts, issues and balance of road metal. Copies of these statements are submitted to the divisional office.

Road metal found surplus, as a result of physical verification or otherwise should immediately be brought on account, treating it as a receipt, Shortage should be noted in the form of a remark in red ink and should be carried forward from month to month, until the discrepancy is set right by recovery, write-off or other means.

Materials charged to works → In addition to the charges falling under the main classes namely, cash and stock, there are other transactions affecting the cost of work. They may be charges incurred in other divisions or departments, materials received from them or services rendered by them or there may be cash receipts that are taken in reduction of expenditure in accordance with the rules.

Issue of Stores Material → Materials are issued from stock for the following purposes.

- for use on works either by contractors or departmentally.
- for dispatch to other subdivisions or departments.
- for sale to contractors, employees and other outside parties.

Bin Card → This is a card, which is attached to each Bin, or the container for stores a record of all materials entering or leaving the bin and the balance of materials in hand is kept in this card.

FORM 8 BIN CARD

Article.....
Code No.....
Unit.....
Issue rate.....

Maximum Stock.....
Minimum Stock.....
Ordering Level.....

Bin Card No.....

From.....

From.....

Signature of Issuing Officer

Date	GRS/ Indent No.	Quantity		Balance	Initials of store- keeper/ Sectional officer	Remarks	Date	GRS/ Indent No.	Quantity		Balance	Initials of store- keeper/ Sectional officer	Remarks
		In	Out						In	Out			
1	2	3A	3B	4	5	6	1	2	3A	3B	4	5	6

Verification of stocks, shortage and excess → The stock is verified by the competent authority at least once in a year and physical position of the materials are checked with the stock register & bin card. Then the articles found in shortage or excess are recorded properly.

Normally no steps are taken if found excess but the value of the stores found shortage or deficit should, however, not be debited to the relevant final head of account, but kept under 'Miscellaneous P.W. Advance' pending recovery or adjustment.