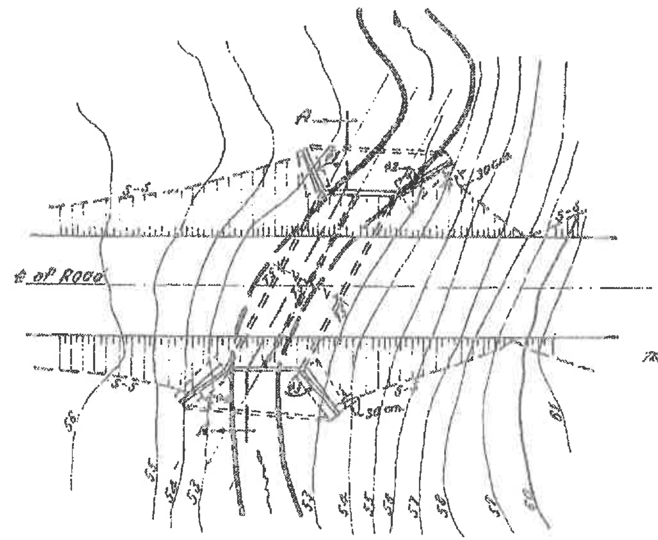
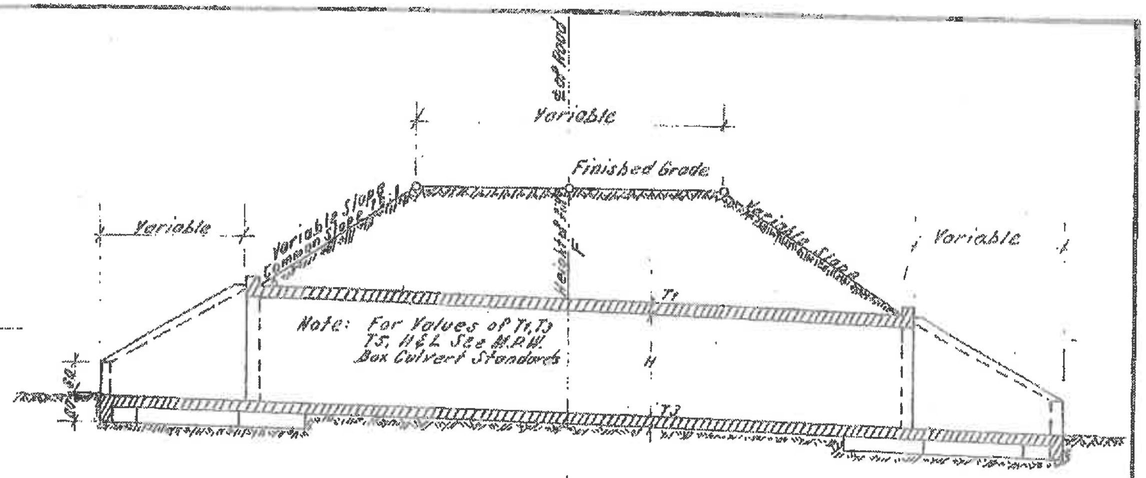
HASHEMITE KINGDOM OF JORDAN
MINISTRY OF PUBLIC WORKS
BRIDGE DESIGN SECTION

STANDARD DESIGNS
FOR
REINFORCED CONCRETE CULVERTS
Nº .1- 72





Sec. A-A

INSTRUCTIONS FOR ADAPTING M.P.W. STANDARD BOX CULVERT PLANS TO SKEW CROSSING

1- Prepare a topographic map of site of convenient scale say 1:250 or bigger, indicating contours, course of stream and centre line of road.

2- Determine the skew angle α such that the flow can be guided to follow a more or less natural course to avoid serious scouring and erosion.

3- From the required finished grade and stream section at crossing (from road profile) determine the width, height & length of culvert barrel needed.

4- On this map of site draw a plan view of barrel up to and including curbs only (head walls) omitting wing walls for the time being.

5- Indicate the road shoulder lines, and with the aid of contours, determine the lines of intersections of embankment slopes and ground surface indicated by heavy broken lines S-S

6- Determine the required length L1, L2, L3, & L4 of wing walls. Since the function of the wing wall is to prevent the embankment fill from spilling into the stream bed, therefore it should extend beyond the spilling lines S-S at least 30cm as shown.

7- In determining the position of wing walls which play an important part in guiding the proper flow of stream, the angles of flare ϕ1, ϕ2, ϕ3 and ϕ4 should never be less than 15°.

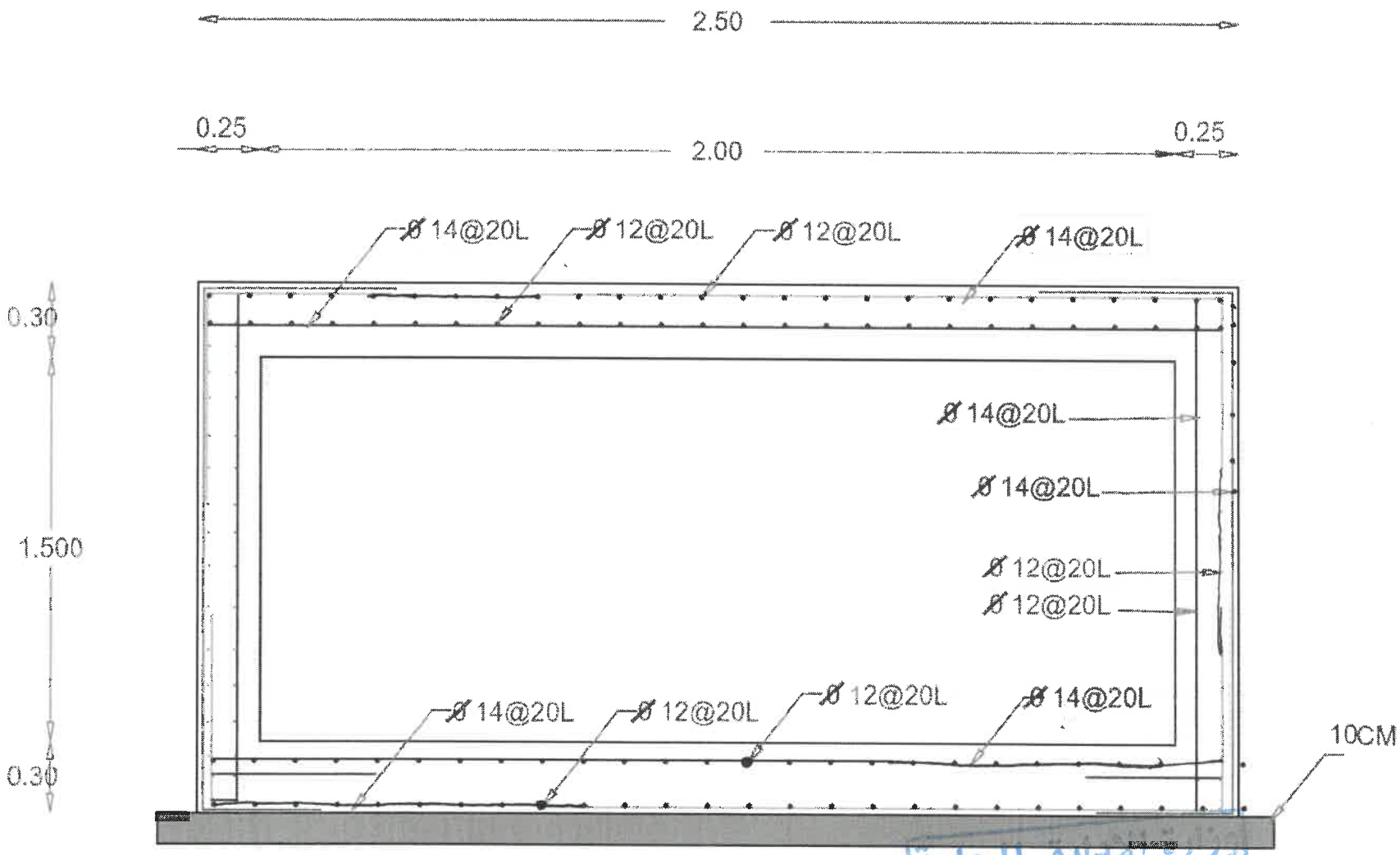
8- The face of apron does not have to be parallel with centre line of road. However, for a better looking structure, it can be done parallel, but without any considerable increase in cost.

9- With the lengths of wing walls fixed, it will now be a simple matter to find out the standard sections and reinforcement required for wing walls.

10- It will be very convenient to draw a longitudinal section of culvert as shown for establishing controlling elevations, especially the relation of culvert floor, apron cut-off wall to the stream or wadi bed.

وزارة الإدارة المحلية
مديرية المشاريع والعطاءات

MINISTRY OF PUBLIC WORKS	
BRIDGE SECTION	
BOX CULVERTS	
SHEET No. 14	1-1-1992



2×1.5(عبارة صندوقية)

Bill of Reinf. Steel for one Up Stream Wingwalls

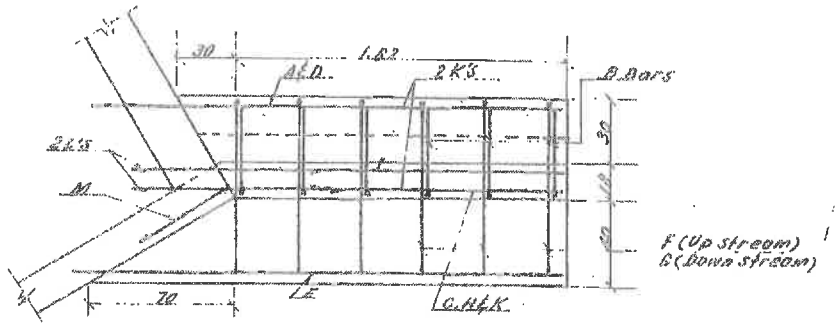
Bar	No	Size mm	Spacing	Length m	Wt. Kg
A	1	12	–	2.30	2.13
B1-6	6	12	30	7.74	6.88
C	1	12	–	3.20	1.96
D	1	12	–	2.70	2.40
E	1	12	–	2.70	2.40
F	6	12	30	8.10	7.20
H1-2	2	12	32	2.80	2.31
K	2	12	–	3.85	3.42
L	2	16	–	2.50	3.50
M	2	12	32	2.00	1.78
Total					34.10

Estimated Quant. for One Up Stream Wingwall

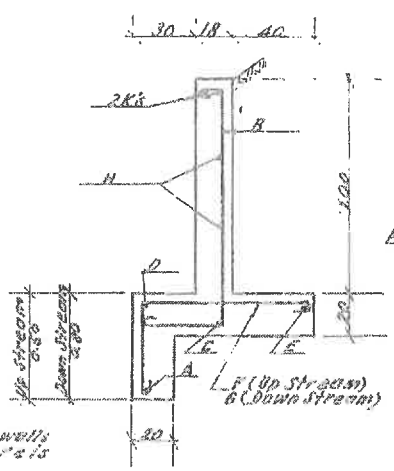
Item	Unit	Quant.
Concrete	Cubic m	0.73
Reinf. Steel	Kgs	34.10

Additional Quant. Per Down Stream Wingwall

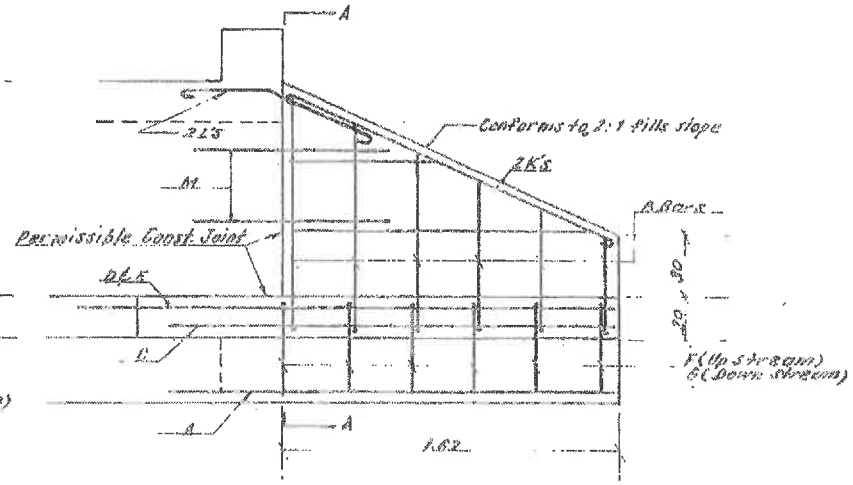
Item	Unit	Quant.
Concrete	Cubic m	0.12
Reinf. Steel	Kgs	1.15



Plan



Sec. A-A



Elevation

Note:
1- Toe walls for culvert end wingwalls shall be omitted when structure is founded on solid rock.
2- Min. concrete cover 2.5cm

MINISTRY OF PUBLIC WORKS

BRIDGE SECTION

30° FLARED WING WALL
1.00 m.

SHEET Nº 15 1-1-1982

Bill of Reinf. Steel For One Up Stream Wingwalls

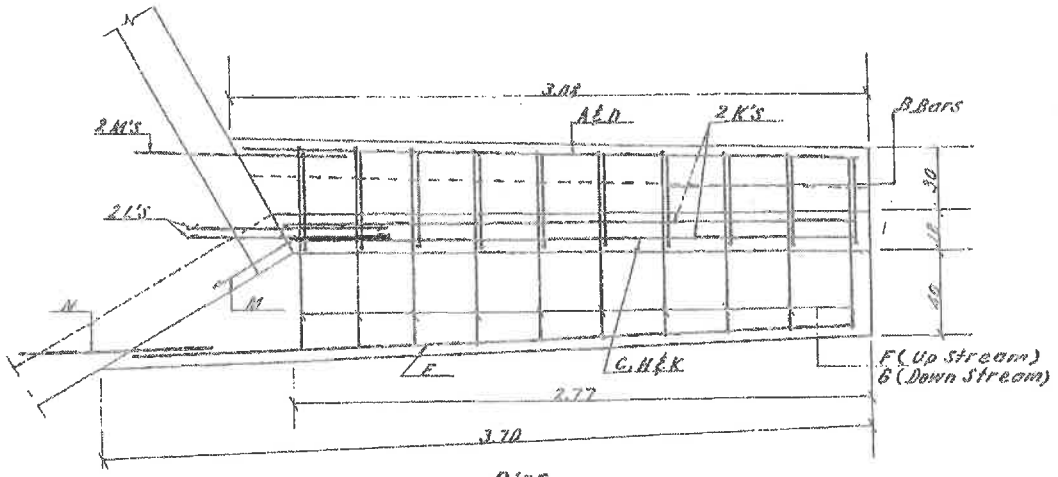
Bar	No.	Size mm	Spacing	Length m	Wt. Kg
A	1	12		3.16	2.81
B1-3	3	12	28	6.54	5.85
B4-10	7	12	30	11.00	9.85
C	1	12		2.86	2.55
D	1	12		3.18	2.81
E	1	16		3.80	8.00
F1-3	3	12	28	3.15	2.83
F4-10	7	12	30	6.30	8.10
H1-4	4	12	28.5	7.30	6.55
K	3	16		8.20	9.80
L	2	20		2.40	5.92
M	7	12	28	7.00	6.23
N	1	16		1.00	1.58
Total					68.90

Estimated Quant. For One Up Stream Wingwall

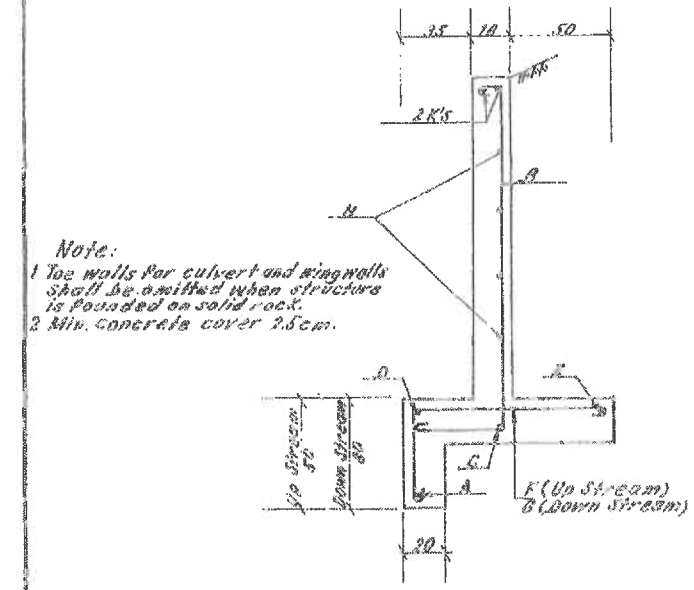
Item	Unit	Quant
Concrete	Cubic m	1.17
Reinf. Steel	Kgs	68.90

Additional Quant. For Down Stream Wingwall

Item	Unit	Quant.
Concrete	Cubic m	0.17
Reinf. Steel	Kgs	2.88

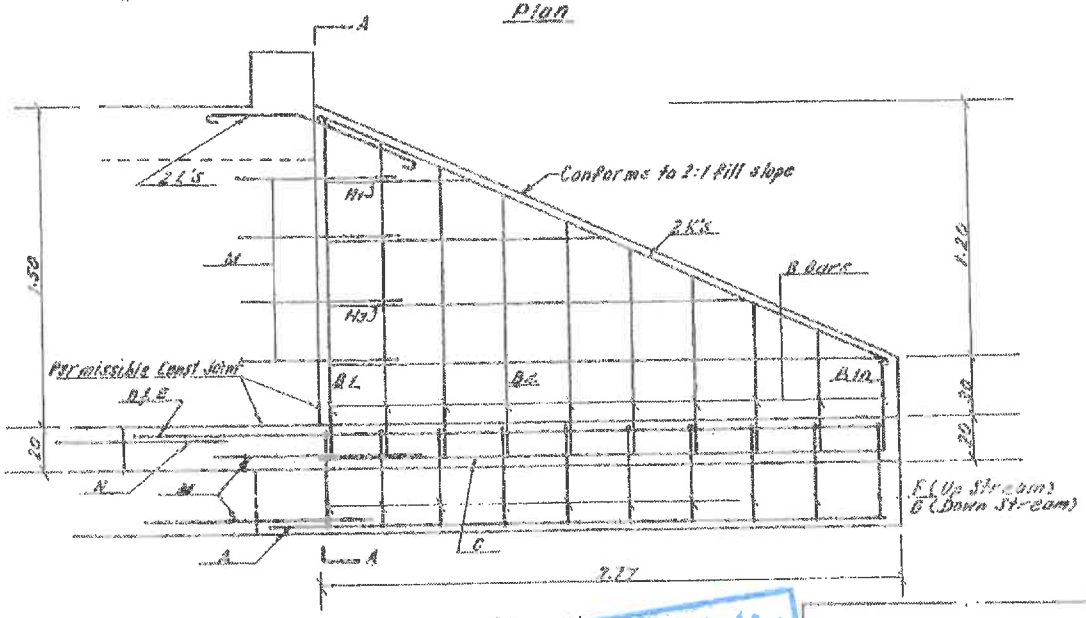


Plan



Sec. A-A

Note:
1 Toe walls for culvert and wingwalls shall be omitted when structure is founded on solid rock.
2 Min. Concrete cover 2.5cm.



Elevation

MINISTRY OF PUBLIC WORKS

BRIDGE SECTION

30° FLARED WING WALL
1.50 m.

SHEET No. 16 1-1-1972

Bill of Reinf. Steel for One Up Stream Wingwalls

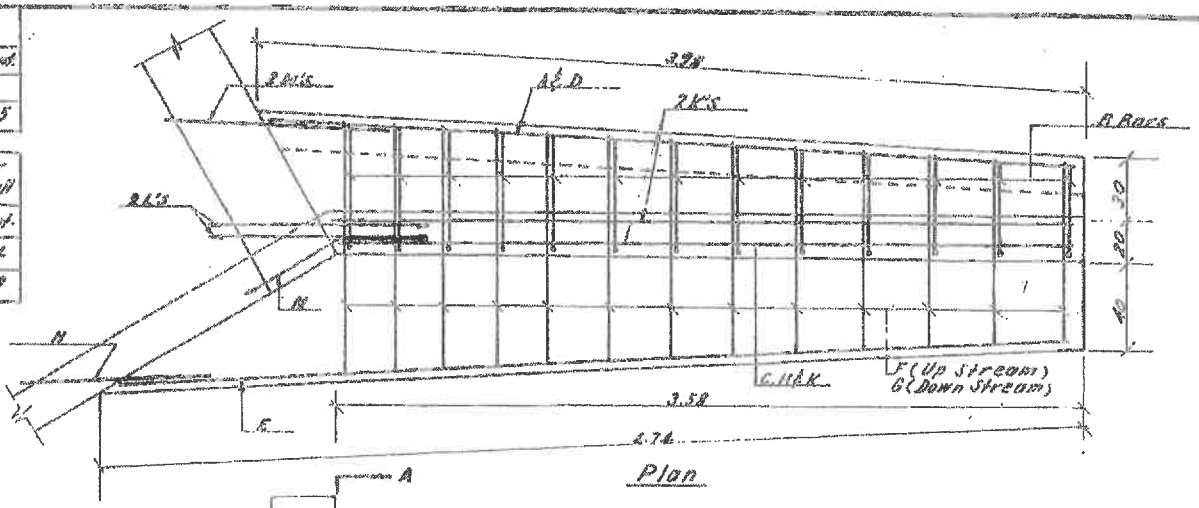
Bar	No	Size mm	Spacing cm	Length m	Wt Kgs
A	1	12		4.90	3.58
B1-5	5	12	25	15.15	11.70
B6-8	3	12	29	8.42	6.77
B9-13	5	12	32.5	7.85	6.81
C	1	12		3.88	3.25
D	1	12		4.00	3.36
E	1	16		4.71	7.49
F1-5	5	12	25	8.25	7.32
F6-8	3	12	29	4.70	4.11
F9-13	5	12	32.5	7.25	6.46
H1-4	4	12	32	8.25	7.32
H5	1	12	33	3.85	3.24
K	2	18		3.00	12.60
L	2	20		2.40	5.92
M	5	12	32	8.00	7.12
N	1	18		1.00	1.58
Total					98.85

Estimated Quant. for One Up Stream Wingwall

Item	Unit	Quant.
Concrete	Cubic m	1.98
Reinf. Steel	Kgs	98.85

Additional Quant. for Down Stream Wingwall

Item	Unit	Quant.
Concrete	Cubic m.	0.28
Reinf. Steel	Kgs	3.48



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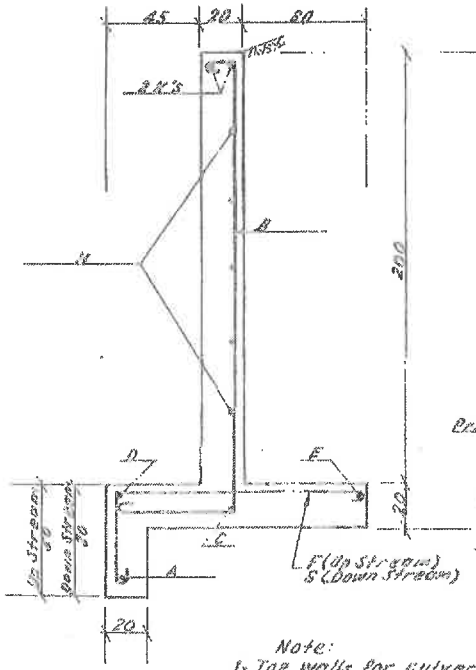
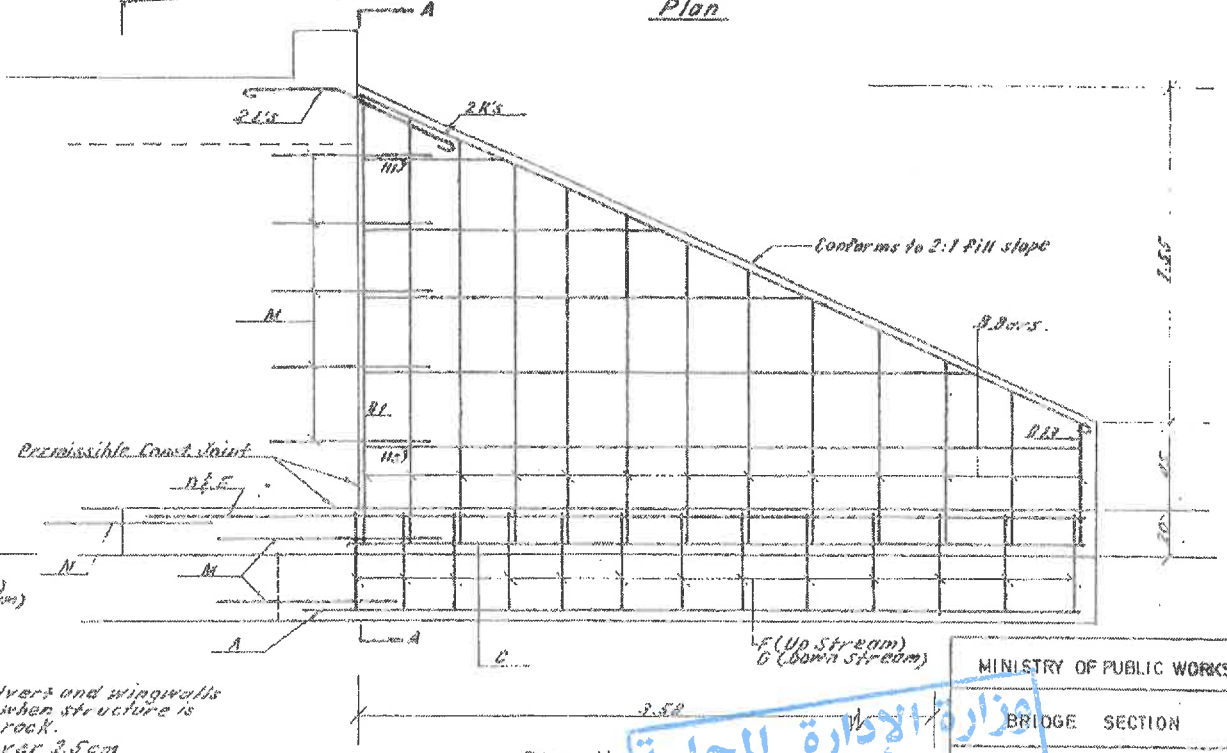


Sec. A-A



Note:
1- Toe walls for culverts and wingwalls shall be omitted when structure is founded on solid rock.
2- Min. concrete cover 2.5cm

MINISTRY OF PUBLIC WORKS

BRIDGE SECTION

30° FLARED WING WALL
2.00 m.

SHEET No. 17 1-1-1972

Bill of Reinf. Steel For One Up Str. Wingwalls

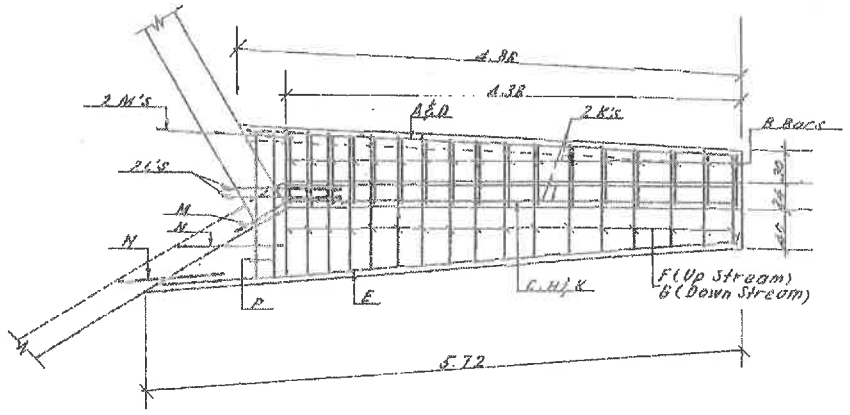
Bar	No	Size mm	Spacing cm	Length m	Wt. Kg.
A	1	12	–	4.88	4.34
B1-3	5	14	20	17.10	20.60
B4-9	4	12	25	14.70	10.40
B10-12	3	12	29	7.40	6.38
B13-17	5	12	32.5	9.30	8.26
C	1	16	–	4.50	7.11
D	1	16	–	4.75	7.80
E	1	16	–	5.85	9.24
F1-5	5	14	20	7.30	8.87
F6-9	4	12	25	5.36	4.76
F10-12	3	12	29	3.66	3.25
F13-17	5	12	32.5	5.50	4.89
H1-4	4	12	33	8.30	7.37
H5-7	3	12	28	13.10	11.62
K	2	16	–	9.60	15.13
L	2	20	–	2.40	5.70
M	10	16	9.26	10.00	15.80
N	2	18	–	2.00	3.15
P	2	14	15	3.10	3.74
Total					158.78

Estimated Quant. For One Up Stream Wingwall

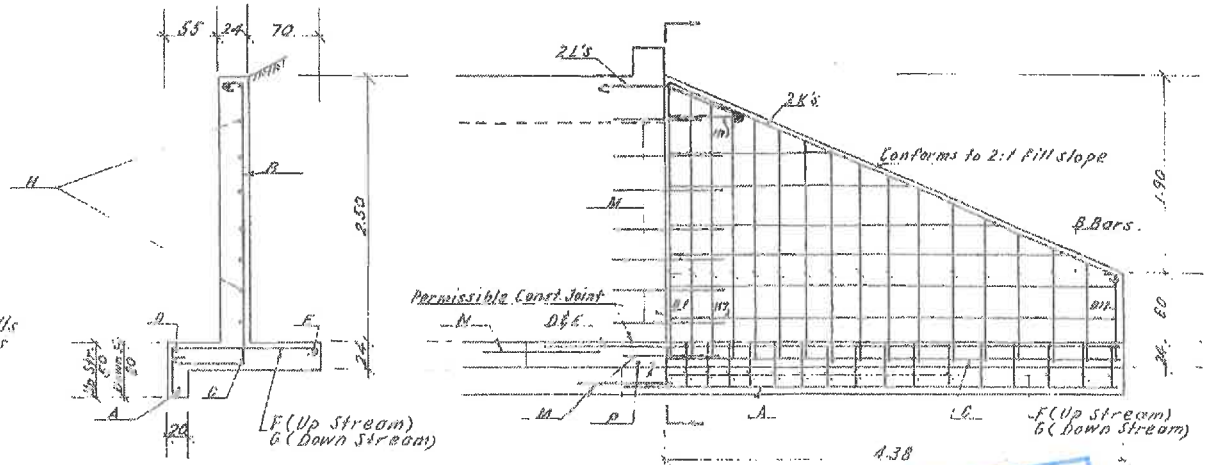
Item	Unit	Quant.
Concrete	Cubic m	3.35
Reinf. Steel	Kgs.	158.78

Additional Quant For Down Stream Wingwall

Item	Unit	Quant.
Concrete	Cubic m.	0.29
Reinf. Steel	Kgs	5.01



Plan



Sec. A-A

Elevation

Note

1- Toe walls for culvert and wingwalls shall be omitted when structure is founded on solid rock.
2- Min concrete cover 2.5cm.

MINISTRY OF PUBLIC WORKS

BRIDGE SECTION

30° FLARED WINGWALL
2.50 m.

SHEET Nº. 18 1-1-1972

Bill of Reinf. Steel for One Up Stream Wingwalls

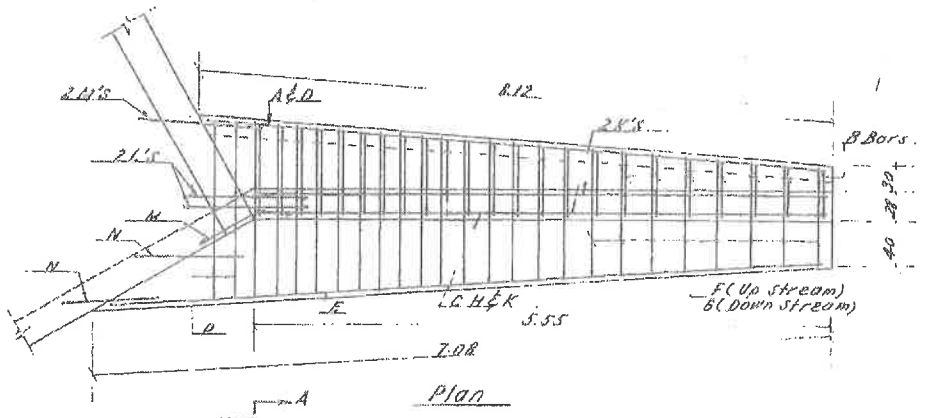
Bar	No	Size mm	Spacing	Length m	Wt. Kg
A	1	12	~	6.20	5.52
B1-6	6	16	17	24.66	38.98
B7-11	5	16	20	17.50	27.62
B12-15	4	12	25	12.16	10.82
B16-18	3	12	29	7.77	6.93
B19-23	5	12	32.5	9.80	8.72
C	1	16	~	5.88	3.72
D	1	18	~	8.23	9.84
E	1	20	~	7.22	17.80
F1-6	6	16	19	13.02	20.35
F7-11	5	16	20	10.10	12.20
F12-15	4	12	25	7.52	6.67
F16-18	3	12	29	5.28	4.68
F19-23	5	12	32.5	7.85	6.96
H1-4	4	13	33	8.00	7.10
H5-8	4	12	28	18.80	16.68
H9	1	12	26	5.80	4.96
K	2	16	~	11.85	18.70
L	2	20	~	2.40	5.92
M	9	16	16/32	12.00	18.96
N	2	16	~	2.00	3.16
P	2	16	15	3.35	5.28
Total					255.83

Estimated Quant. for One Up Stream Wingwall

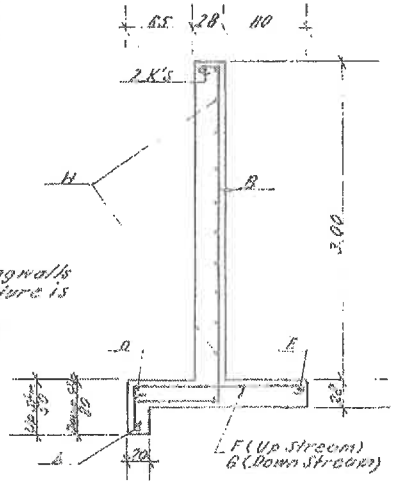
Item	Unit	Quant.
Concrete	Cubicm.	5.47
Reinf. Steel	Kgs.	255.83

Additional Quant. for Down Stream Wingwall

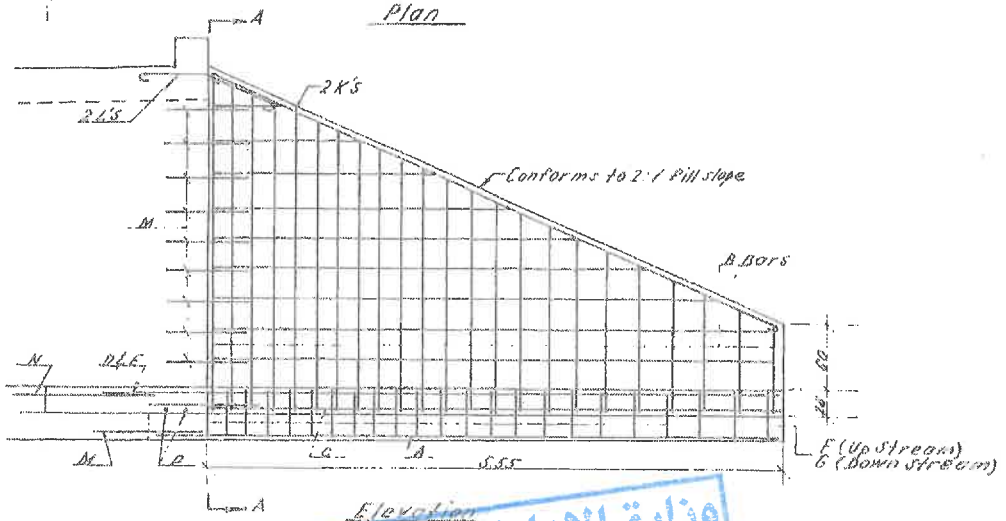
Item	Unit	Quant.
Concrete	Cubicm.	0.37
Reinf. Steel	Kgs	7.85



Plan



Sec. A-A



Elevation

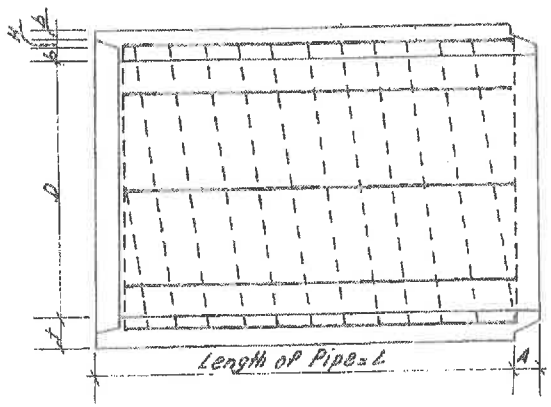
Note:
1- Toe walls for culvert and wingwalls shall be omitted when structure is founded on solid rock.
2- Min. concrete cover 2.5cm

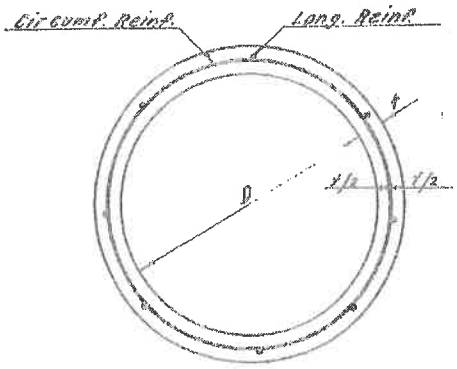
MINISTRY OF PUBLIC WORKS

BRIDGE SECTION

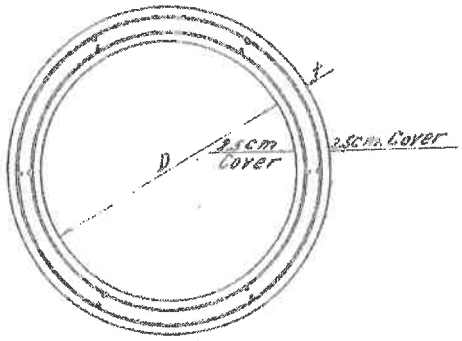
30° FLARED WINGWALL
3.00 m.

SHEET No. 19 1-1-1972





Reinforced Pipe
One Circular Line



Reinforced Pipe
Two Circular Lines

MATERIALS & DESIGN

"REINFORCED CONCRETE: shall consist of portland cement, mineral aggregates, and water, in which steel has been embedded in a manner that both act together.

"CEMENT: portland cement shall conform to the requirements of the specifications for portland cement (AASHO Designation: M85), or air-entraining portland cement (AASHO designation M134).

"STEEL REINFORCEMENT: Reinforcement shall consist of wire conforming to the specifications for cold-Drawn steel wire for concrete reinforcement (AASHO Designation: M32) and deformed steel wire (AASHO Designation M225); or welded steel wire fabric (AASHO Designation M55); or welded deformed steel wire fabric (AASHO Designation M221); or bars of Grade 40 steel (AASHO Designation M31);

"AGGREGATES: shall conform to the specification for concrete aggregates (AASHO Designation M6 and M80) except that the requirements for gradation shall not apply and a loss of 50% in the los Angeles test shall be permitted.

"MIXTURE: aggregates shall be so sized and so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water to obtain a homogeneous concrete mixture of good quality that will enable the pipe to conform to the test and design requirements. In no case shall the proportion of cement in mixture be less than 336 kg/m³

"PLACING REINFORCEMENTS: where one line of circular reinforcement is used, it shall be placed from 35-50 per cent of shell thickness from inner surface of pipe. In circular pipe having two lines of circular reinforcement the nominal protective cover of concrete shall be 25 mm. The 90 cm diameter pipe shall have extra one single ring reinforcement in the spigot. Any one line circumferential reinforcement of given total area may be composed of two layers in close proximity by not more than the thickness of one longitudinal layer plus 6.4 mm.

"LONGITUDINALS: each line of circumferential reinforcement shall be assembled into a cage with sufficient longitudinal Bars of pipe length.

"LAPS WELDS AND SPACING: if splices are not welded, the reinforcement shall be lapped not less than 20 diameters for deformed bars and deformed cold worked wire, and for plain bars and cold drawn wire. Minimum lap of 5cm shall be used for welded splices. Where lapped cages of welded wire fabric are used without welding, the lap shall contain a longitudinal wire. Spacing of adjacent rings in a cage shall not exceed 10cm for pipe up to and including pipe having 10cm wall thickness nor exceed the wall thickness for larger pipes, and in no case exceed 15cm. The continuity of the circumferential reinforcing steel shall not be destroyed during the manufacture of the pipe.

"JOINTS: the ends of reinforced concrete pipe sections shall be so formed that when the pipes are laid together they make a continuous and uniform line of pipe. The joints shall be of such design as will permit effective jointing to reduce leakage and infiltration to a minimum and to permit placement without irregularities to the flow line.

MANUFACTURE

"PLACEMENT OF CONCRETE: the transporting and placement of concrete shall be by methods that will prevent the segregation of concrete materials and the displacement of reinforcement steel from its proper position in the form.

"CURING: the pipe shall be cured for a sufficient length of time so that the concrete will develop the specified strength at 28 days or less.

"WATER CURING: concrete pipe may be water-cured by covering with water saturated material or by a system of perforated pipes, mechanical sprinklers or any other approved method that will keep the pipe moist during the specified curing period. Steam curing in a curing chamber or liquid Membrane-forming compounds are also used.

"LIFT HOLES: not more than two shall be permitted in the wall of each piece of pipe for the purposes of handling and laying.

Design Requirement For Reinforced Conc. Pipe

Concrete Strength 280 Kg/cm²

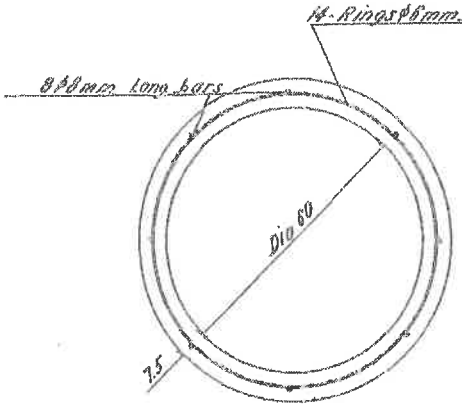
	Inter Diam. of Pipe	Wall thickness t	Min. Circular Reinforcement cm²/m'		Longitudinal Reinforcement	Ultimate load by Three edge Bearing test
	cm	cm	Innercage	outercage	No.	
Typical Ordinary Pipes	50	7.50	3.11	—	8ø8mm	6000
	60	7.50	3.96	—	8ø8mm	7000
	75	8.50	5.09	—	8ø8mm	8000
	90	10	11.50	—	8ø10mm	9000
	90	10	5.03	3.11	12ø8mm	9500
Extra Strength Pipes	60	7.50	5.40	—	8ø8mm	8000
	75	8.50	6.50	—	9ø8mm	10000
	90	10	18.50	—	8ø10mm	11000
	90	10	8.03	5.53	12ø8mm	11000

MINISTRY OF PUBLIC WORKS

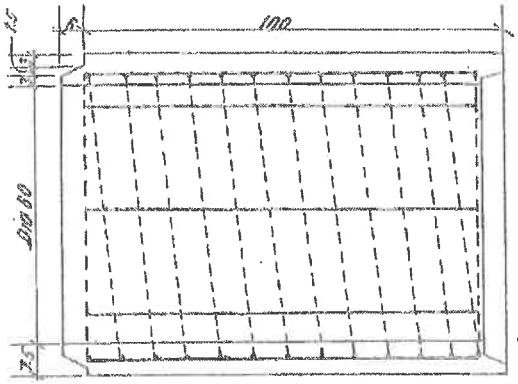
BRIDGE SECTION

REINFORCE CONCRETE PIPES

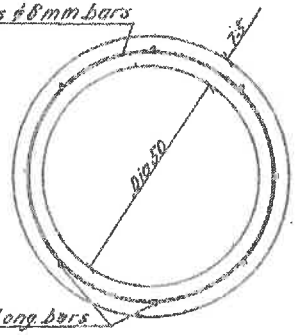
SHEET №23 MAI 1972



Cross Sec. For 60 Dia Pipe



Long. Sec. For 60 Dia Pipe



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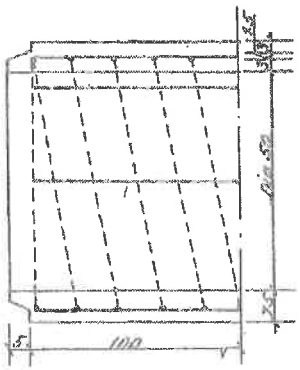

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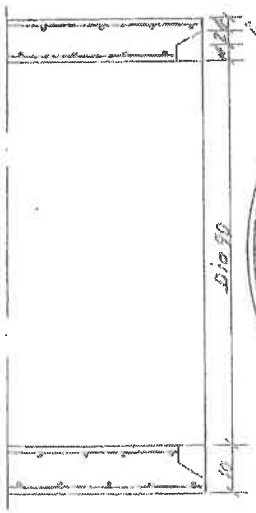
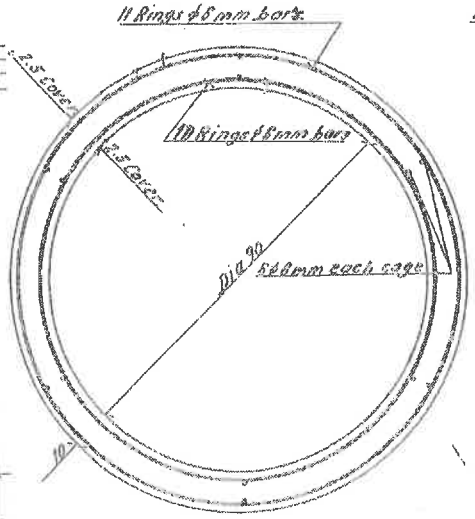
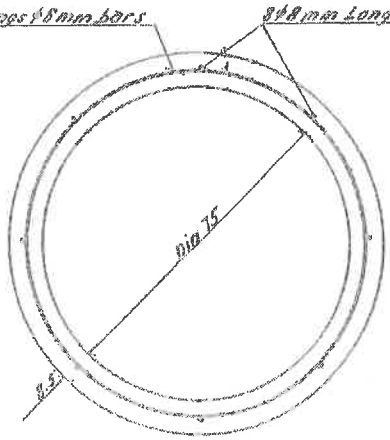


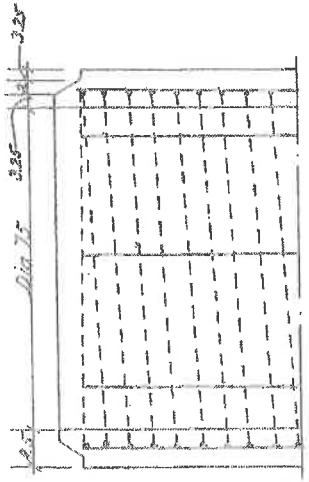
Long. Sec. For 90 Dia Pipe
(Two Rings Reinf.)



Cross Sec. For 90 Dia Pipe
(Two Rings Reinf.)



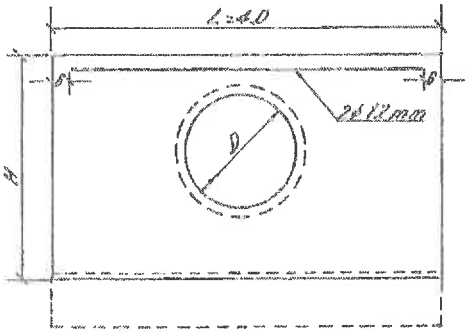
Cross Sec. For 75 Dia Pipe



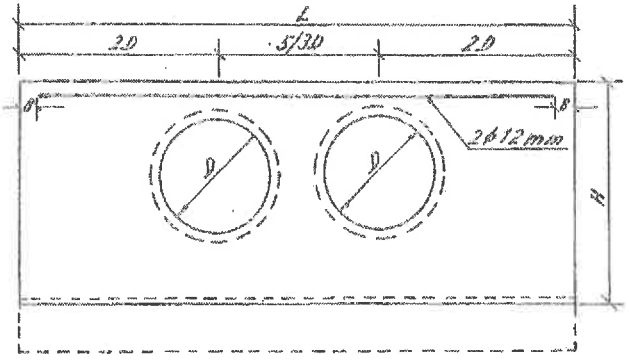
Long. Sec. For 75 Dia Pipe

Note: Reinforcement shown on these standards is according to the minimum of the specification, in case these pipes failed in test; the circumferencial steel must be increased

MINISTRY OF PUBLIC WORKS	
BRIDGE SECTION	
REINFORCE CONCRETE PIPES	
SHEET No. 24	11-1972



Elevation - Single Pipe



Elevation - Double Pipe

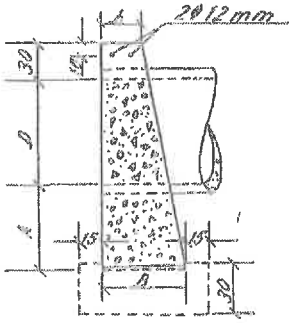
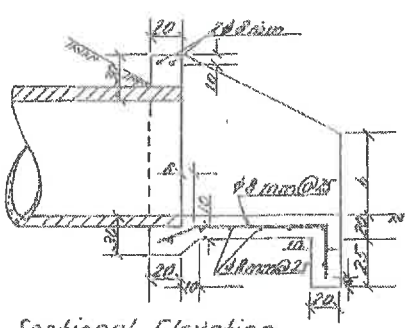
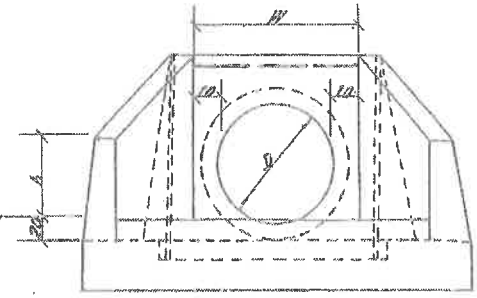


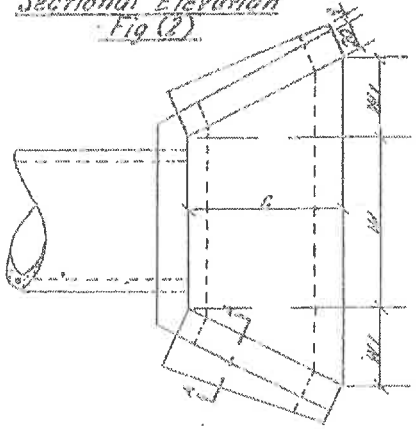
Fig (1)

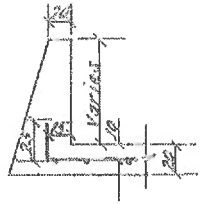


Sectional Elevation
Fig (2)



Side View





Sec. A-A

Straight Head-Walls Without Wingwalls

D	Headwalls Concrete 1:9 B	b	A	H	One Pipe L	Two Pipes L'	Three Pipes L''	Four Pipes L'''
50	40	20	40	120	200	285	365	450
60	45	20	45	135	240	340	440	540
75	50	25	50	155	300	425	550	675
90	60	30	60	180	360	510	660	810

Head-Walls With Wingwalls

		Slope 4:1 & 3:1				Slope 1½:1 & 2:1			
D		50	60	75	90	50	60	75	90
M1		85	80	100	120	50	60	80	100
C		100	120	150	180	75	90	120	150
h		40	40	50	50	30	30	40	40
W	One Pipe Line	70	80	95	110	70	80	95	110
	Two Pipes Line	155	180	220	260	155	180	220	260
	Three Pipes Line	235	280	345	410	235	280	345	415

Notes

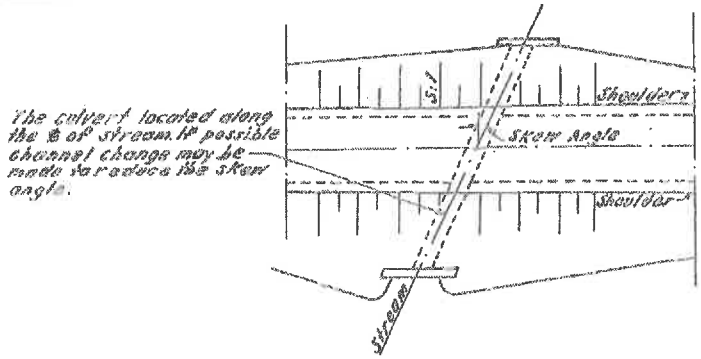
Headwalls with wingwalls shall be used only when specifically called for on the improvement plans.
Straight headwalls are built of concrete as Fig (1)
Headwalls with wingwalls are built of reinforced concrete (little steel) as in Fig (2)
Foundation of straight headwalls is build of rubble concrete (40% Rubble) & the dimensions depend on the type of soil as shown by the broken line in Fig. (1) in case of rock this kind of foundation may be omitted.
Headwalls must be parallel to shoulders of roadway in case of straight roadways and tangent in case of curves.

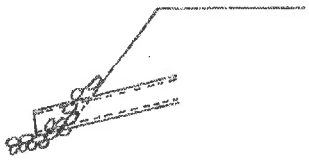
MINISTRY OF PUBLIC WORKS

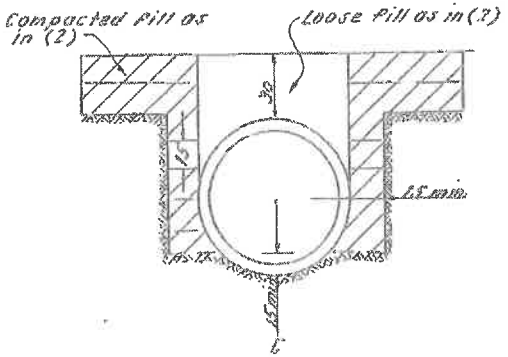
BRIDGE SECTION

HEADWALLS & WINGWALLS FOR PIPE CULVERTS

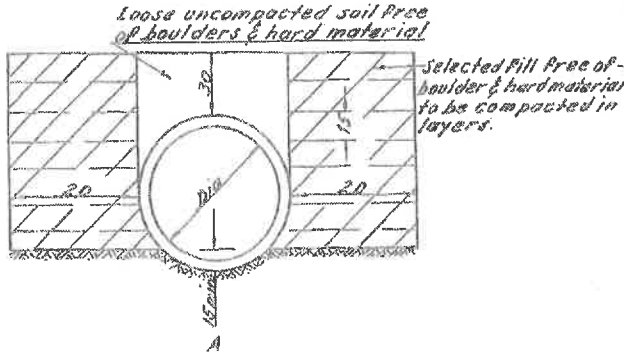
SHEET No. 25 1-1-1972



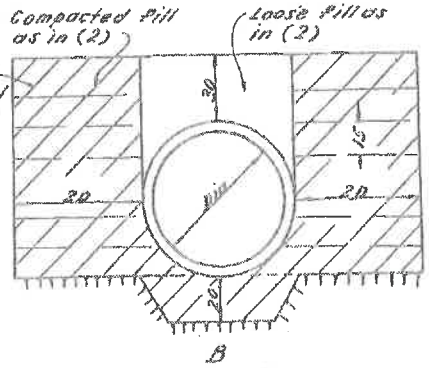




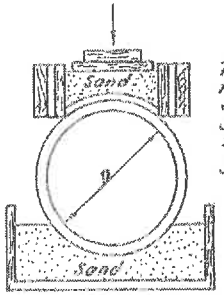
Laying Pipe in Trench
Case (1)



Embedding Pipe in Ordinary Soil
Case (2)

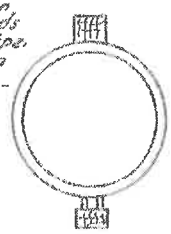


Laying Pipe on Rock
Case (3)



Tests as described in the Standard Methods of Testing, culvert pipe, sewer pipe, & drain tile (A.A.S.H.O. Designation (T 33-56)

Sand Pressure Test

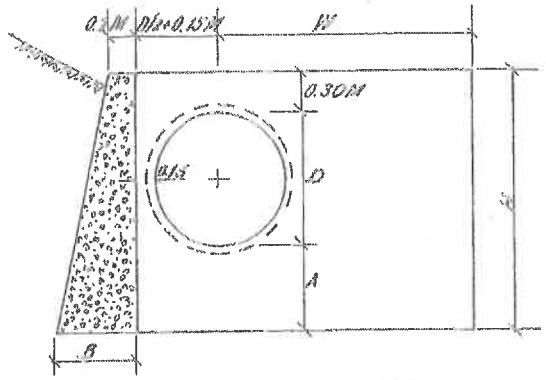


Three-edge Bearing Test

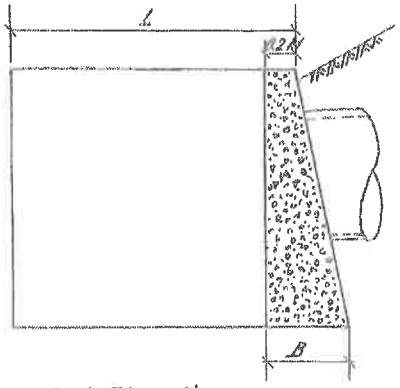
NOTES

1. Where indicated all backfill shall be compacted to 95% maximum density by mechanical methods in layers not exceeding 15 cms in thickness.
2. Backfill immediately above the pipes shall remain loose as indicated on the sketch, or the embankment can be compacted above the culvert then backfill directly above culvert must be removed and replaced in the loosest possible condition.
3. Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials to provide a compacted earth cushion of min. thickness of 20 cm.

MINISTRY OF PUBLIC WORKS	
BRIDGE SECTION	
CONCRETE PIPE BEDDING	
SHEET No. 26	14-4-1972

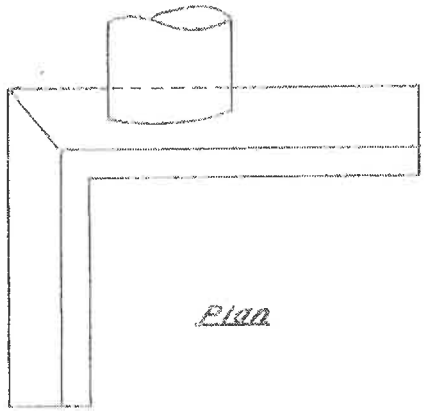


Front Elevation

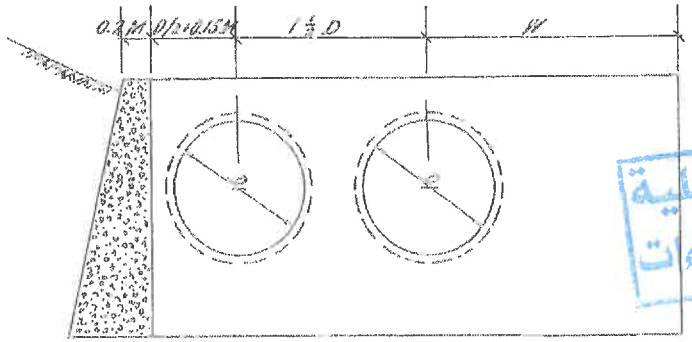


End Elevation

Diam of Pipe	Dimensions					Single Pipe	Double Pipe
	A.M	B.M	H.M	W.M	L.M	Conc.m³	Conc.m³
50	0.40	0.40	1.20	1.00	1.10	1.18	1.48
60	0.45	0.45	1.35	1.20	1.20	1.63	2.06
75	0.50	0.50	1.55	1.50	1.50	2.40	3.03
90	0.60	0.60	1.80	1.80	1.80	3.71	4.67



Plan



Multiple Pipe Headwall

Note:
On shallow fills where headwalls are 0.30 m or less below shoulder line, the headwalls shall be constructed parallel to the line and grade of the road

MINISTRY OF PUBLIC WORKS	
BRIDGE SECTION	
STANDARD 'C' TYPE CONCRETE HEADWALLS	
SHEET Nº 27	1.1.1972

Concrete And Steel Quantities For Straight Headwalls And Headwalls With Wingwalls
As Shown On Sheet № 25

Straight Headwalls (One End)

One Pipe				Two Pipes			Three Pipes			Four Pipes		
Diameter	Concrete (m^3)	Rubble Conc. Footing (m^3)	Steel (Kg)	Concrete (m^3)	Rubble Conc. Footing (m^3)	Steel (Kg)	Concrete (m^3)	Rubble Conc. Footing (m^3)	Steel (Kg)	Concrete (m^3)	Rubble Conc. Footing (m^3)	Steel (Kg)
50	0.62	0.42	3.34	0.83	0.60	4.85	1.02	0.77	6.27	1.23	0.95	7.78
60	0.92	0.54	4.05	1.23	0.77	5.82	1.53	0.99	7.60	1.84	1.22	9.37
75	1.50	0.72	5.11	1.99	1.02	7.33	2.47	1.32	9.55	2.96	1.62	11.77
90	2.51	0.97	6.18	3.32	1.38	8.84	4.13	1.78	11.50	4.95	2.19	14.17

Headwalls With Wingwalls (One End)

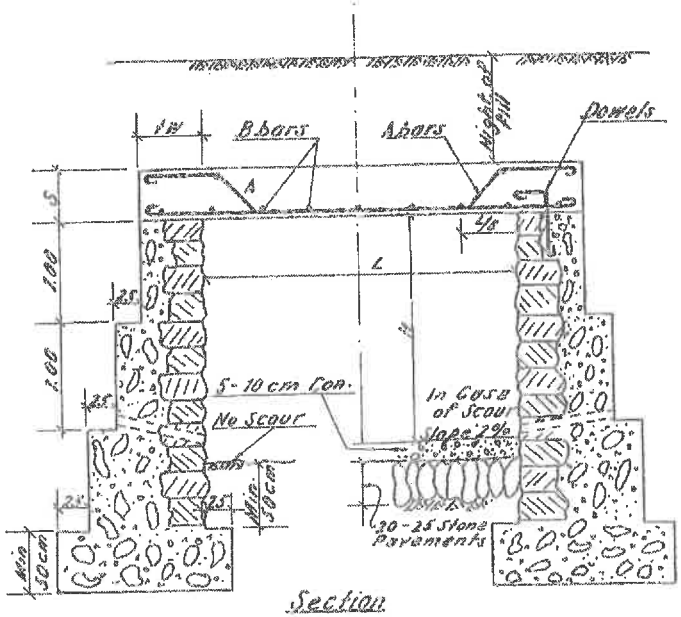
Slope 4:1 & 3:1								Slope 2:1 & 1½:1					
One Pipe			Two Pipes		Three Pipes			One Pipes		Two Pipes		Three Pipes	
Diameter	Concrete (m^3)	Steel (Kg)	Concrete (m^3)	Steel (Kg)	Concrete (m^3)	Steel (Kg)		Concrete (m^3)	Steel (Kg)	Concrete (m^3)	Steel (Kg)	Concrete (m^3)	Steel (Kg)
50	1.04	8.06	1.57	12.53	1.89	16.39		0.79	6.32	1.09	9.71	1.36	12.96
60	1.34	10.58	1.78	16.32	2.23	21.97		1.01	8.43	1.40	13.21	1.78	17.99
75	1.87	14.93	2.52	23.11	3.17	31.25		1.48	11.73	2.06	18.78	2.63	25.86
90	2.48	20.45	3.34	32.12	4.23	43.29		2.02	16.56	3.82	25.33	3.61	35.90

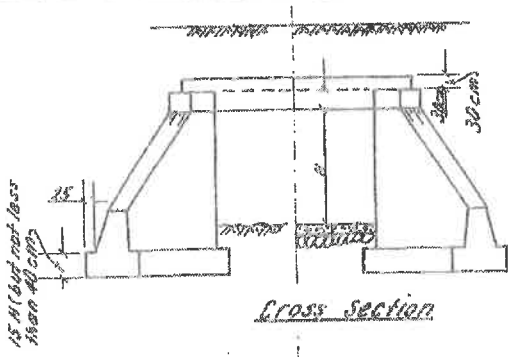
MINISTRY OF PUBLIC WORKS

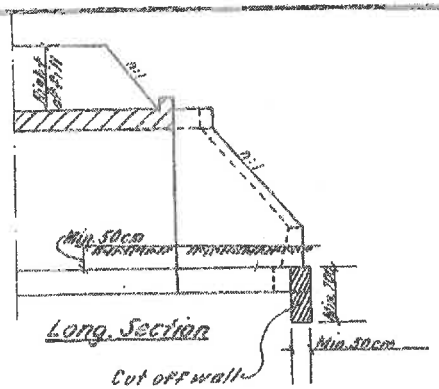
BRIDGE SECTION

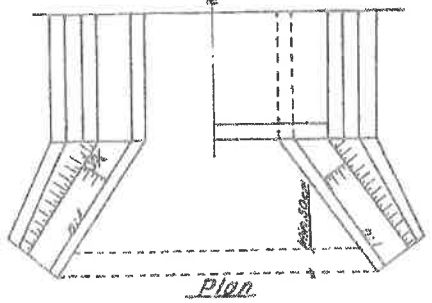
HEADWALLS & WINGWALLS (QUANT) FOR PIPE CULVERTS

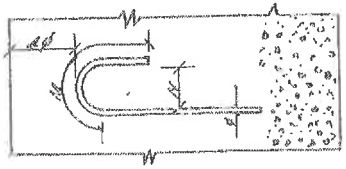
SHEET № 28 1.1.1972











ϕ	10	12	14	16	18	22	25
N	5	6	7	8	9	12	13
M	15	18	22	25	28	34	36

Alternative Reinforcement

Notes:

1- Design L.L : H20 - S16 - 44
2- Reinforcing steel tensile stress f_s = 1200
   Ultimate Compressive (tested on cylinders) f_c = 210 Kg/cm²
3- For Abutment walls use class C concrete with 40% hard stones.
4- Min. concrete cover for reinforcing bars should be 2 diam, but not less than 3 cm.
5- Channel course shall be paved as shown in sketch if scour is anticipated. Cutoff walls 100 cm high and 50 cm thick should be constructed at both inlet and outlet.
6- This type of culvert should be built on rock foundation or firm soil.
7- Dowels spaced @ 30 cm ϕ - ϕ should be of min. Reinforcement bar diam used in culvert.

		Fill from 0.30 to 4.00 m.														Fill from 4.00 to 8.00 m														Fill from 8.00 to 18.00 m													
Distance	Span (L)	75	100	125	150	175	200	225	250	275	300	350	400	500	600	75	100	125	150	175	200	225	250	275	300	350	400	75	100	125	150	175	200	225	250	275	300	350	400	500	600		
	tw	40	40	45	45	55	45	45	50	50	50	50	50	50	50	50	50	50	50	50	50	50	55	55	55	55	55	50	50	50	55	55	55	55	60	60	60	60	60				
	Thickness of Slab	18	20	22	24	25	28	28	30	32	35	38	40	45	50	18	20	22	24	28	28	30	32	35	40	42	45	18	20	22	25	28	32	34	38	40	44	50	55				
Main Reinf. Bars A	ϕ mm	12	12	14	14	14	16	16	16	16	18	18	22	22	22	12	12	14	14	14	16	16	18	18	22	22	22	12	12	14	16	18	18	18	22	22	22	25	25				
	No. of bars /m. run	8	10	10	10	12	8	9	10	12	10	12	8	10	12	10	12	10	10	12	9	10	10	12	9	10	12	10	12	10	10	12	10	12	9	11	12	10	12				
	bar Length	-	-	-	280	305	330	355	380	405	440	490	545	645	750	-	-	-	285	310	360	380	385	440	445	485	550	-	-	-	285	310	360	360	385	440	445	485	550	650	750		
	bar Length	180	205	245	-	-	-	-	-	-	-	-	-	-	-	190	215	255	-	-	-	-	-	-	-	-	-	190	215	255	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dist. bars B	ϕ mm	10	10	10	10	10	12	12	12	12	12	12	12	12	12	10	10	10	10	10	10	12	12	12	12	12	12	10	10	10	10	10	12	12	12	12	12	12	12				
	No. of bars /m. run	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5				
	No. of bars in the Sec.	8	9	11	12	14	15	18	18	19	20	23	25	30	35	8	9	11	12	14	15	16	18	19	20	23	25	8	9	11	12	14	15	16	18	19	20	23	25				

MINISTRY OF PUBLIC WORKS

BRIDGE SECTION

WALL MASONRY CULVERT

SHEET No. 29 1.1.1972