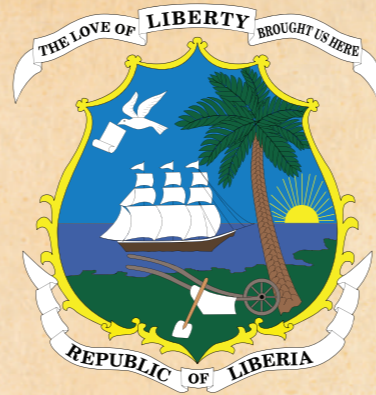


REPUBLIC OF LIBERIA



MINISTRY OF PUBLIC WORKS



MANUAL FOR LOW VOLUME ROADS

APPENDIX C.4: DRAINAGE STRUCTURAL DRAWINGS

2019

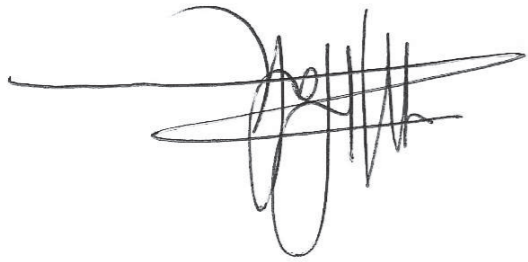
PREFACE

Part C of the Liberia Manual for Low Volume Roads addresses drainage-related aspects of the design of LVRs. These include the calculation of flows in watercourses, discharge rates, the location and design of appropriate drainage structures, associated road side stabilization measures, and provision for the anticipated effects of climate change. Tailored specifically for conditions in Liberia, it includes worked examples to help the reader understand the detailed application of the methods and practices described.

This Appendix to the Manual includes Standard Drawings for typical drainage structures.

Manual Updates

All suggestions to improve the manual or the Standard Drawings should be made in writing to the Ministry of Public Works, which is responsible for issuing periodic updated versions of the Manual.

A handwritten signature in black ink, consisting of several overlapping loops and vertical strokes, positioned above the name of the Minister.

Honorable Minister Mobutu Vlah Nyenpan

Ministry of Public Works

Monrovia

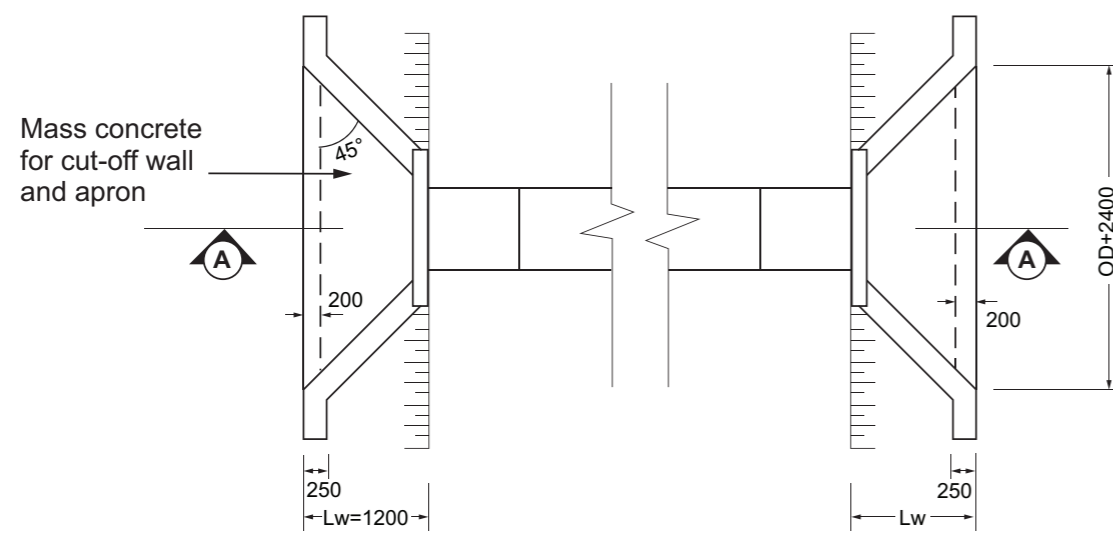
DRAINAGE STRUCTURAL DRAWINGS

Appendix to Part C of the Manual for Low Volume Roads presents general arrangement drawings and specifications for typical drainage structures. The standard designs vary depending on the size of structures required to accommodate the design discharge. The design details may need to be adapted to suit the site conditions.

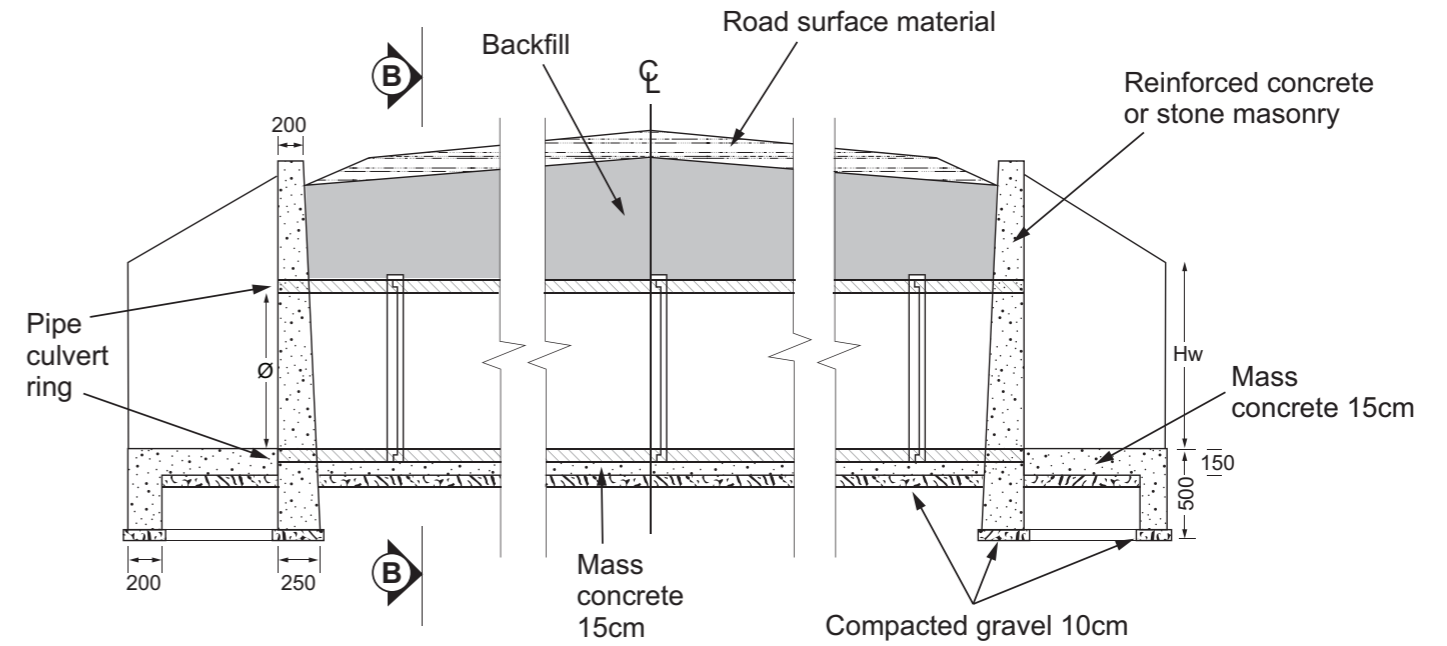
Details are provided for the following standard structures:

Standard Drawing 1: Single Pipe Culvert (600 and 900 diam) General Arrangement.....	1
Standard Drawing 2: Single Pipe Culvert (600 and 900 diam) Reinforcement Layout.....	2
Standard Drawing 3: Single Pipe Culvert (1200 and 1500 diam) General Arrangement.....	3
Standard Drawing 4: Single Pipe Culvert (1200 and 1500 diam) Reinforcement Layout.....	4
Standard Drawing 5: Single Pipe Culvert Bar Bending Schedules	5
Standard Drawing 6: Double Pipe Culvert (600 and 900 diam) - General Arrangement.....	6
Standard Drawing 7: Double Pipe Culvert (600 and 900 diam) - Reinforcement Layout.....	7
Standard Drawing 8: Double Pipe Culvert (1200 and 1500 diam) - General Arrangement.....	8
Standard Drawing 9: Double Pipe Culvert (1200 and 1500 diam) - Reinforcement Layout.....	9
Standard Drawing 10: Single Box Culvert - General Arrangement.....	10
Standard Drawing 11: Single Box Culvert - Reinforcement Layout.....	11
Standard Drawing 12: Double Box Culvert - General Arrangement	12
Standard Drawing 13: Double Box Culvert - Reinforcement Layout	13
Standard Drawing 14: Box Culvert - Bar Bending Schedules	14
Standard Drawing 15: Mass Concrete Relief Culvert (700 x 900) - General Layout	15
Standard Drawing 16: Mass Concrete Relief Culvert (700 x 900) - Reinforcement Layout.....	16
Standard Drawing 17: Mass Concrete Relief Culvert (900 x 1200) - General Layout	17
Standard Drawing 18: Mass Concrete Relief Culvert (900 x 1200) - Reinforcement Layout.....	18
Standard Drawing 19: Vented Drift - General Arrangement.....	19
Standard Drawing 20: Vented Drift - Reinforcement Layout	20
Standard Drawing 21: Vented Drift - Bar Bending Schedule.....	21

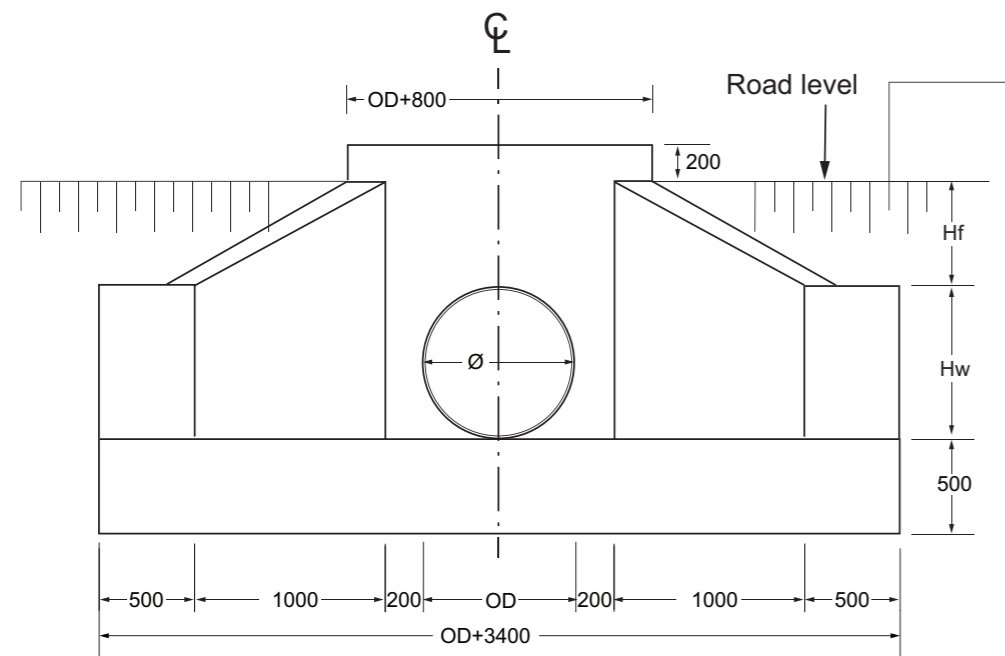
Standard Drawing 1: Single Pipe Culvert (600 and 900 diam) General Arrangement



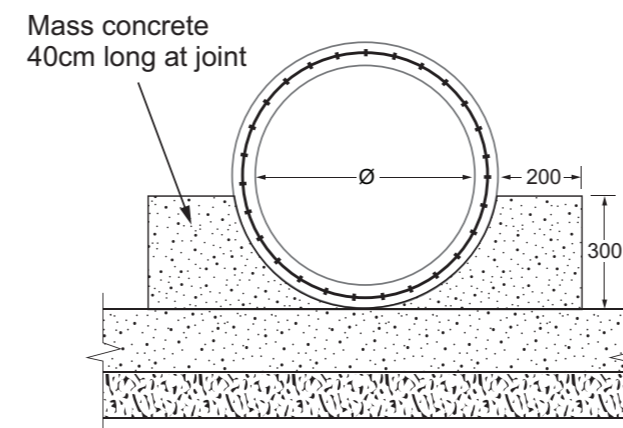
Plan view of culvert installation, headwall & wingwall



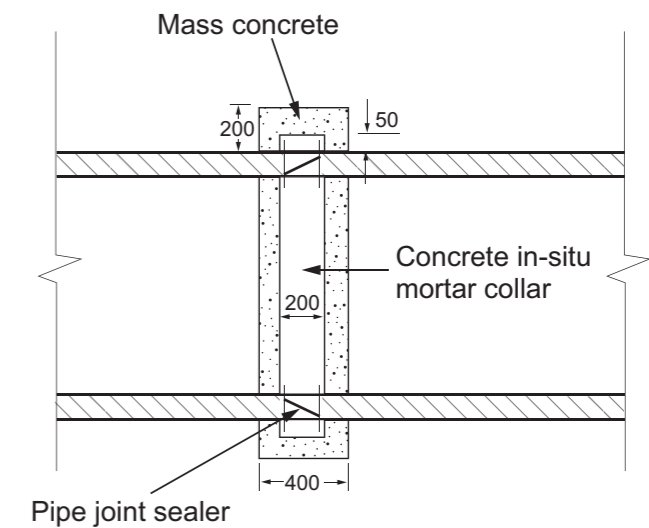
Section A-A longitudinal section of culvert structure



End elevation showing headwall and wing walls




Section B-B cross section of culvert pipe installation



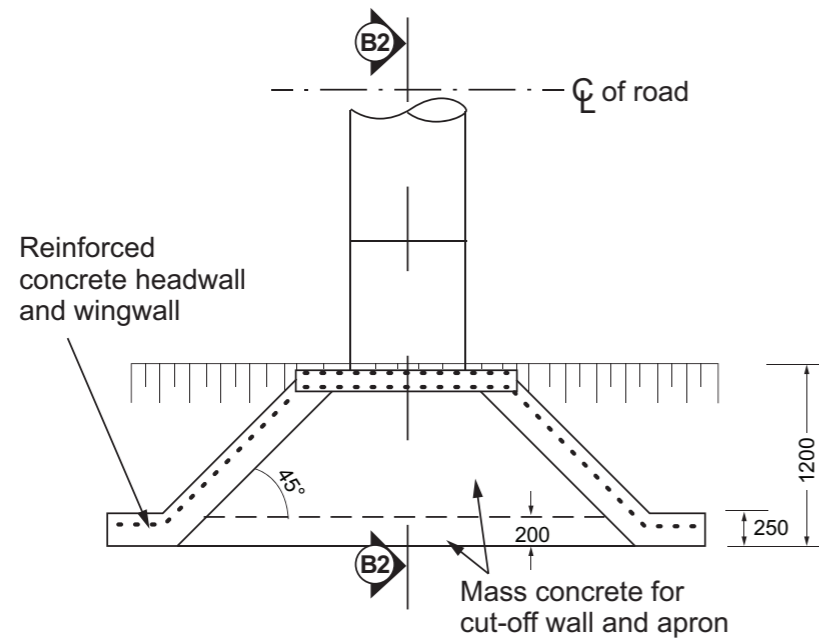
Detail of pipe joint

- NOTES:**
 1: All dimensions are in millimeters unless otherwise specified.
 2: Conversion factor. 1mm - 0.03937 Inches.
 3: Standard pipe length: 1.0 metre.
 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 5: Pipe joint sealer shall be cement mortar.
 6: OD = Outside Diameter = Inside Dia + 2*H.
 7: The Engineer shall specify the length (L) of the culvert structure.
 8: Provide 20mm x 20mm chamfer to all exposed concrete edges.

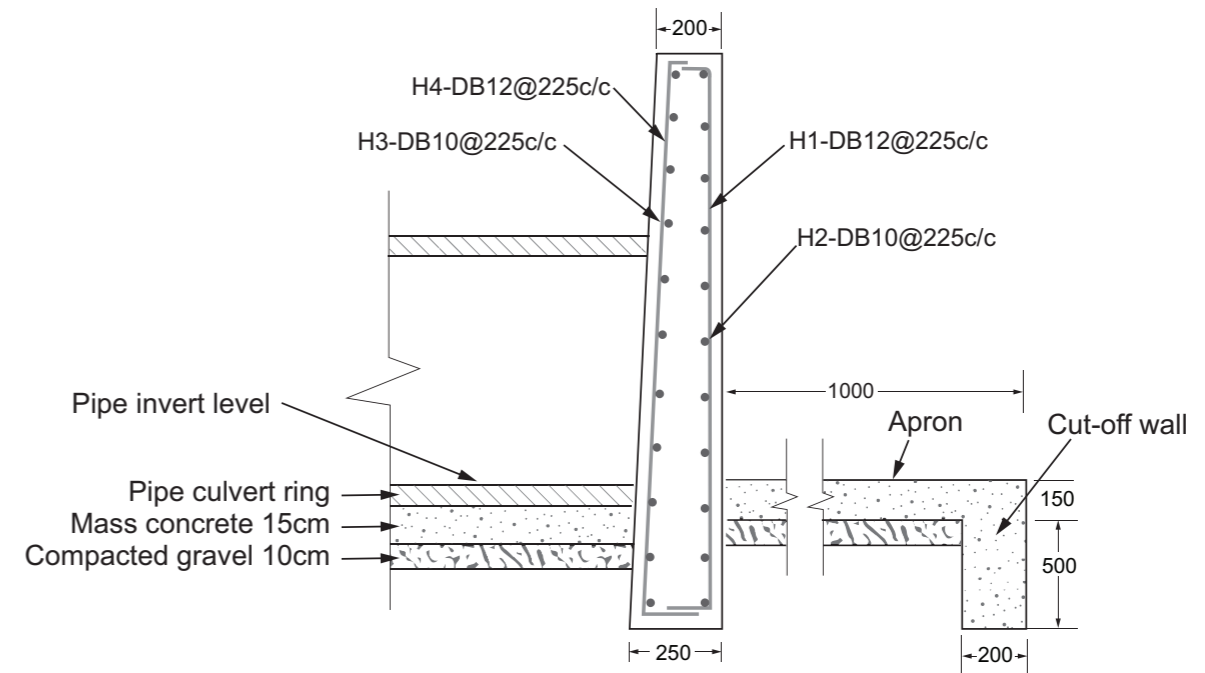
Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill	
				Concrete	Stone masonry	Minimum cover	Material
600	720	Varies	800	200 (top) 250 (base)	300	450	Approved gravel
900	1080	Varies	1100	200 (top) 250 (base)	300	600	Approved gravel

PROJECT:		DATE:/...../.....		DRAWING N°:	
TITLE: Typical Structures Drawing		Single Pipe Culvert: 600mm & 900mm general arrangement			
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY		SCALE: NTS		
	DESIGNED BY		DIMENSIONS: mm		
	CHECKED BY		SHEET N°:		
	APPROVED BY				

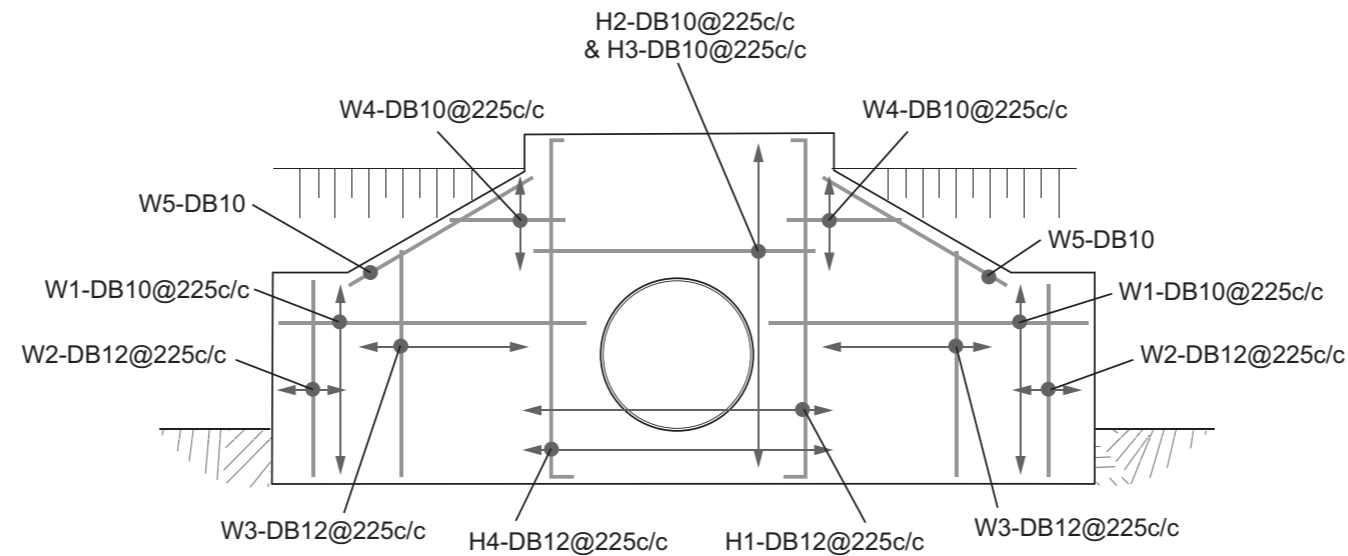
Standard Drawing 2: Single Pipe Culvert (600 and 900 diam) Reinforcement Layout



Reinforcement details for head wall and wing wall




Section B2-B2: Reinforcement details for head wall

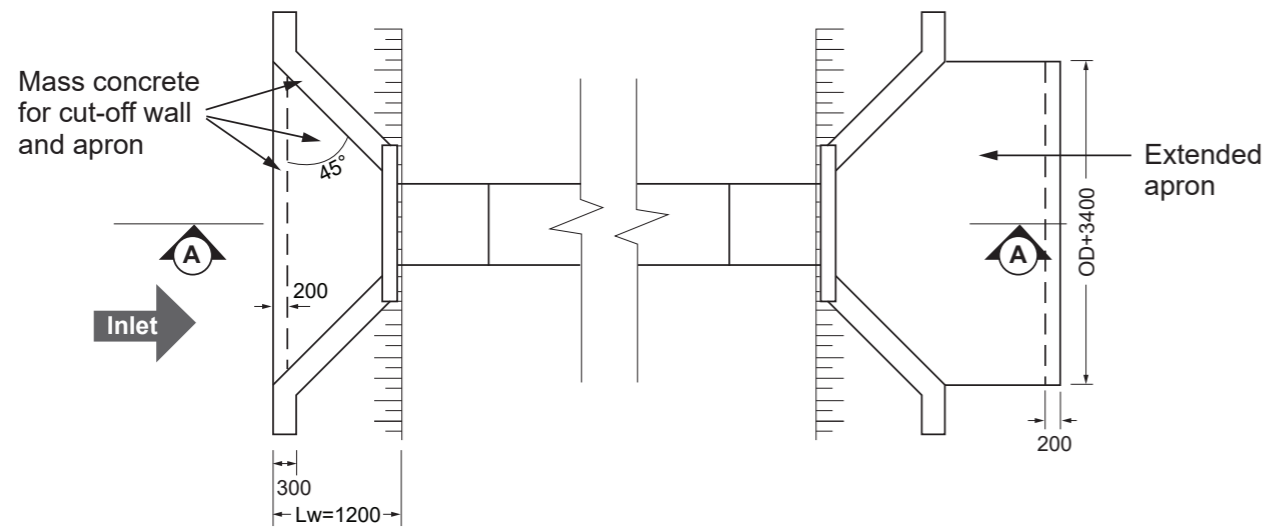


Head wall and wing wall reinforcement details

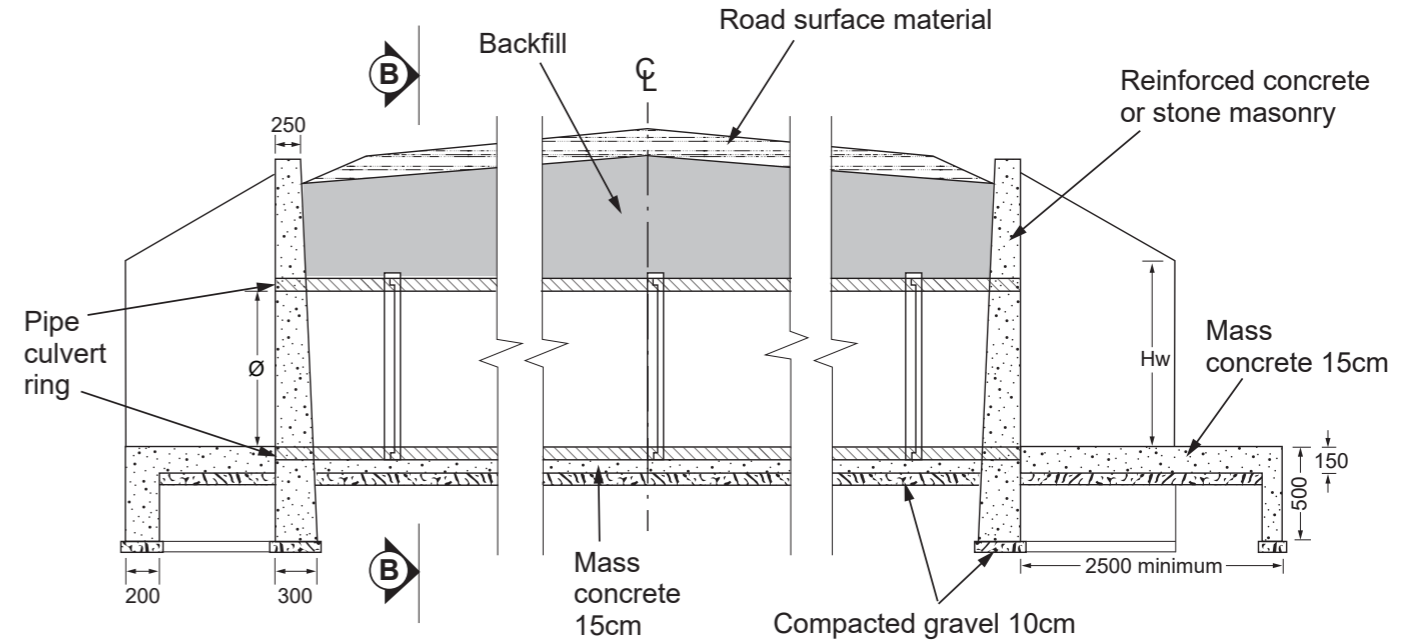
- NOTES:**
 1: All dimensions are in millimeters unless otherwise specified.
 2: Conversion factor. 1mm - 0.03937 Inches.
 3: Standard pipe length: 1.0 metre.
 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 5: Reinforcement shall be structural grade deformed bar (DB) with minimum yield strength 420 MPa.
 6: Pipe joint sealer shall be cement mortar.
 7: OD = Outside Diameter = Inside Dia +2*H.
 8: The Engineer shall specify the length (L) of the culvert structure.
 9. Provide 20mm x 20mm chamfer to all exposed concrete edges.

Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill		PROJECT:	DATE:/...../.....	DRAWING N°:	
				Concrete	Stone masonry	Minimum cover	Material				
600	720	Varies	800	200 (top) 250 (base)	300	450	Approved gravel	TITLE: Standard Structures Drawing	Single Pipe Culvert: 600 & 900 reinforcement layout		
900	1080	Varies	1100	200 (top) 250 (base)	300	600	Approved gravel	 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
									DESIGNED BY	DIMENSIONS: mm	
									CHECKED BY	SHEET N°:	
									APPROVED BY		

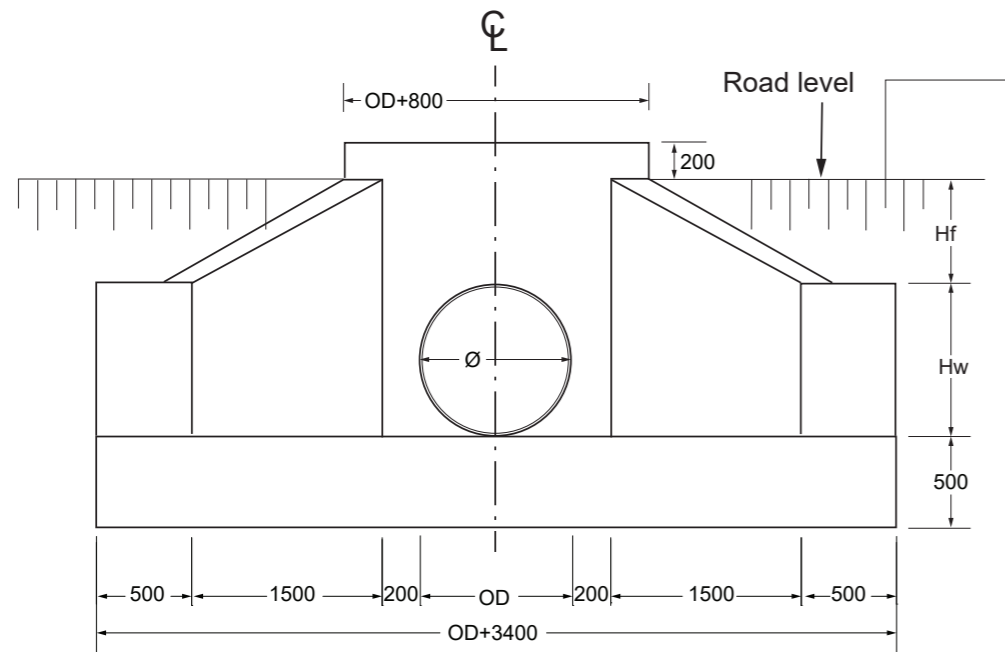
Standard Drawing 3: Single Pipe Culvert (1200 and 1500 diam) General Arrangement



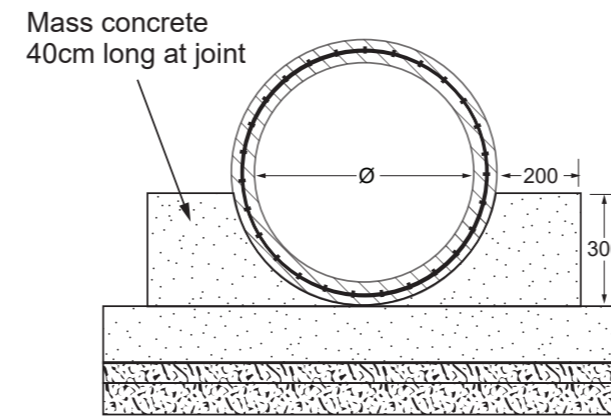
Plan view of culvert installation, headwall & wingwall



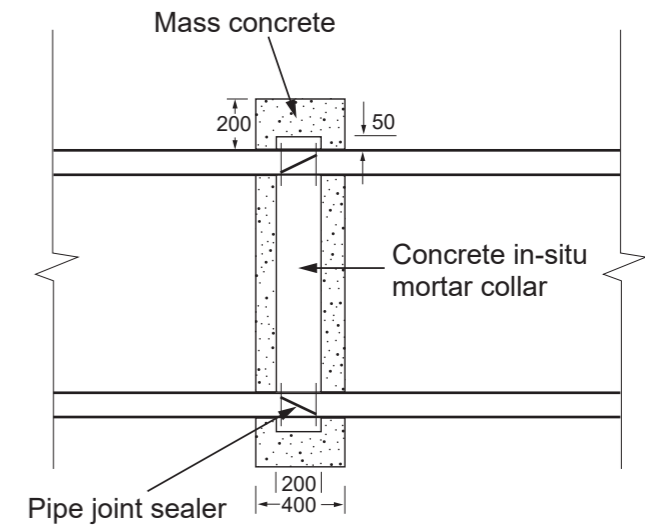
Section A-A longitudinal section of culvert structure



End elevation showing headwall and wing walls




Section B-B cross section of culvert pipe installation



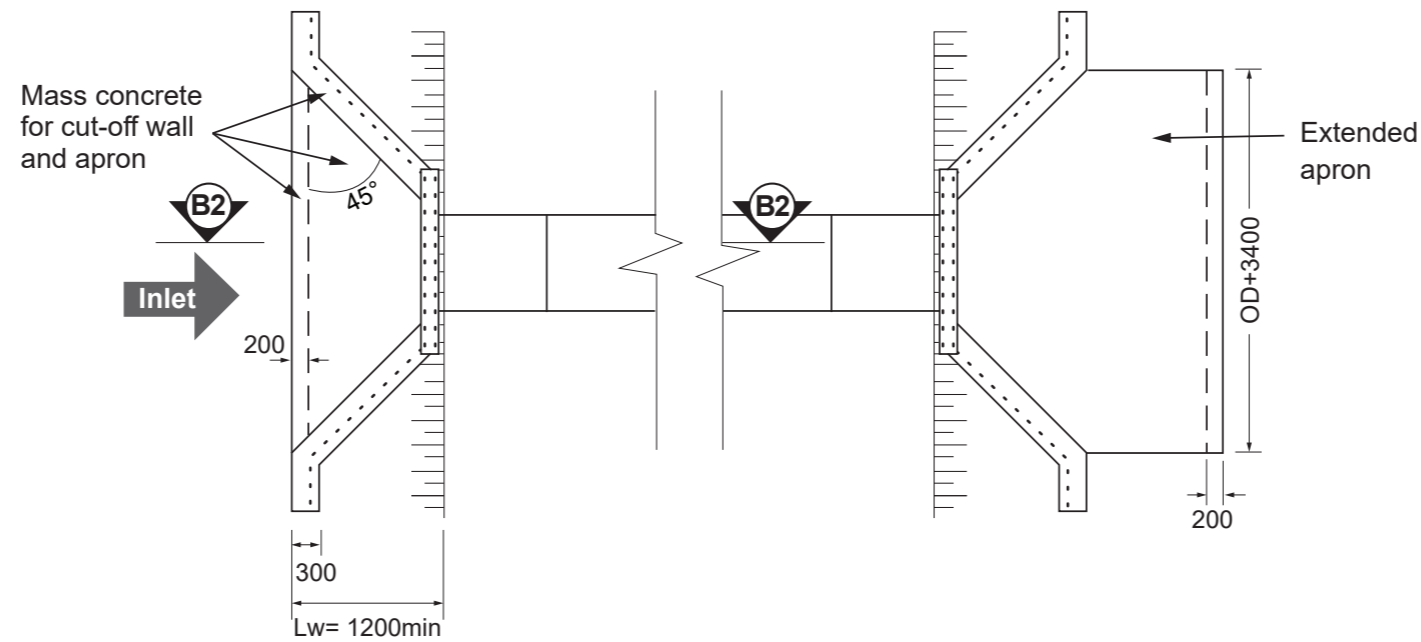
Detail of pipe joint

NOTES:
 1: All dimensions are in millimeters unless otherwise specified.
 2: Conversion factor. 1mm - 0.03937 Inches.
 3: Standard pipe length: 1.0 metre.
 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 5: Pipe joint sealer shall be cement mortar.
 6: OD = Outside Diameter = Inside Dia + 2*H
 7: The Engineer shall specify the length (L) of the culvert structure.
 8. Provide 20mm x 20mm chamfer to all exposed concrete edges.

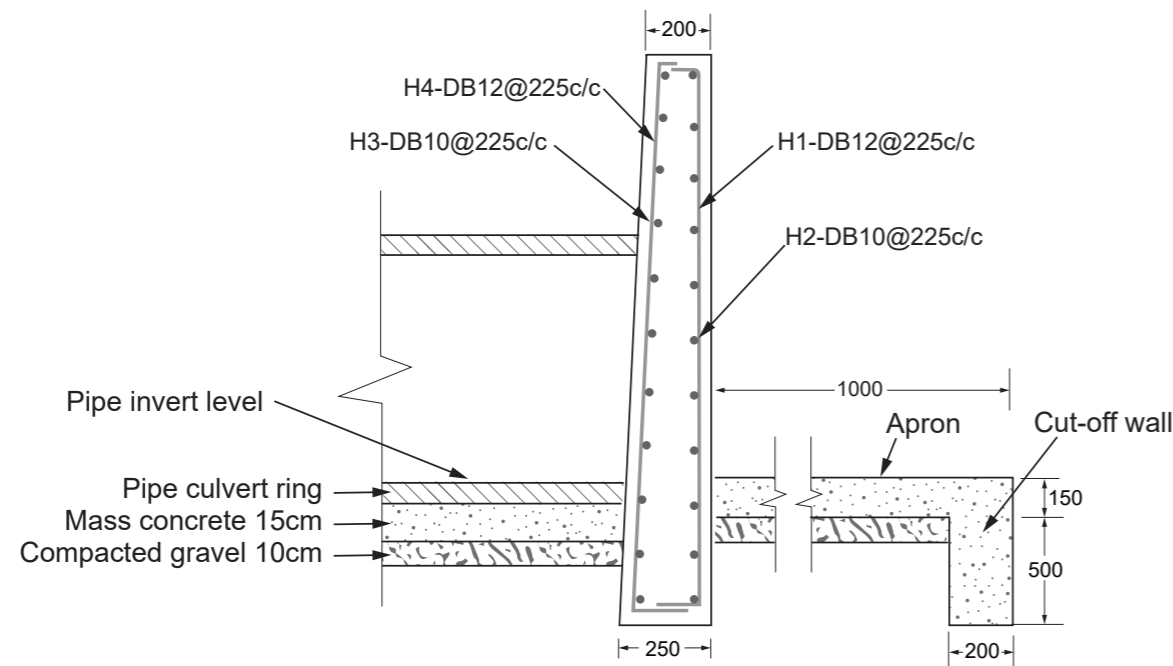
Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill	
				Concrete	Stone masonry	Minimum cover	Material
1200	1440	Varies	1400	250 (top) 300 (base)	300	700	Approved gravel
1500	1800	Varies	1700	250 (top) 300 (base)	300	800	Approved gravel

PROJECT:	DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing	Single Pipe Culvert: 1200 & 1500 general arrangement	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS
	DESIGNED BY	DIMENSIONS: mm
	CHECKED BY	SHEET N°:

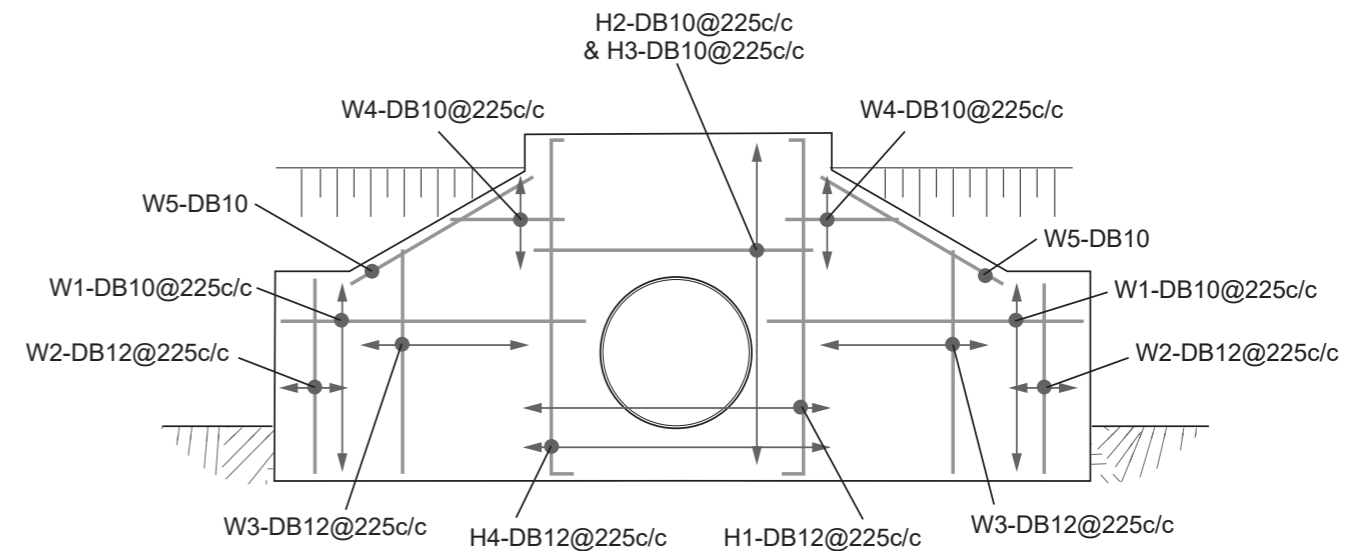
Standard Drawing 4: Single Pipe Culvert (1200 and 1500 diam) Reinforcement Layout



Reinforcement details for head wall and wing wall




Section B2-B2 reinforcement details for head wall



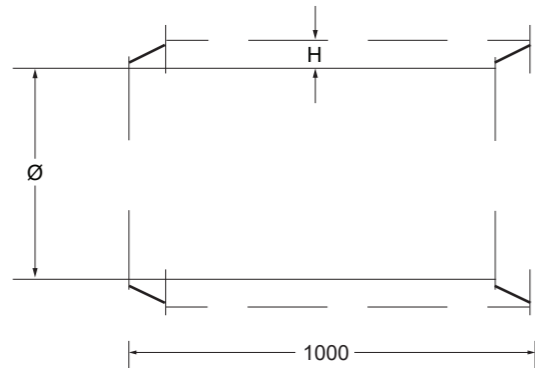
Head wall and wing wall reinforcement details

- NOTES:
 1: All dimensions are in millimeters unless otherwise specified.
 2: Conversion factor. 1mm - 0.03937 Inches.
 3: Standard pipe length: 1.0 metre.
 4: Concrete cylinder strength in 28 days shall be: 21 MPa
 5: Reinforcement shall be structural grade deformed bar (DB) with minimum yield strength 420 MPa.
 6: Pipe joint sealer shall be cement mortar.
 7: OD = Outside Diameter = Inside Dia + 2*H.
 8: The Engineer shall specify the length (L) of the culvert structure.
 9. Provide 20mm x 20mm chamfer to all exposed concrete edges.

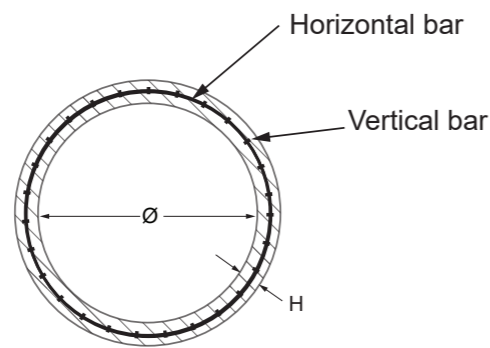
Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill		PROJECT:	DATE:/...../.....	DRAWING N°:	
				Concrete	Stone masonry	Minimum cover	Material				
1200	1440	Varies	1400	250 (top) 300 (base)	300	700	Approved gravel	TITLE: Typical Structures Drawing	Single Pipe Culvert: 1200 & 1500 reinforcement layout		
1500	1800	Varies	1700	250 (top) 300 (base)	300	800	Approved gravel	 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
									DESIGNED BY	DIMENSIONS: mm	
									CHECKED BY		SHEET N°:
									APPROVED BY		

Standard Drawing 5: Single Pipe Culvert Bar Bending Schedules

Details reinforced concrete pipe culvert rings



Details of pipe size



Reinforced bar details

Size of pipe Ø mm	Vertical bars (mm)		Horizontal bars (mm)		Thickness of pipe H (mm)
	Ø	Spacing	Ø	Spacing	
800	10	150	10	150	90
900	10	150	10	100	90
1200	12	150	12	100	120
1500	12	150	12	100	150

Reinforced bar details

Component	Bar shape	Bar mark	Ø (mm)	Spacing C/C (mm)	Length of each bar (m)	
Pipe culvert Ø 60cm single/double row	Wingwalls		W1	DB 10	225	1.95
			W2	DB 12	225	1.2
			W3	DB 12	225	Varies
			W4	DB 10	225	Varies
			W5	DB 10	225	1.4
	Head walls		H1	DB 12	225	Varies
			H2	DB 10	225	Varies
			H3	DB 10	225	Varies
			H4	DB 12	225	Varies
		Pipe culvert Ø 90cm single/double row	Wingwalls		W1	DB 10
	W2			DB 12	225	1.5
	W3			DB 12	225	Varies
	W4			DB 10	225	Varies
	W5			DB 10	225	1.4
Head walls			H1	DB 12	225	Varies
			H2	DB 10	225	Varies
			H3	DB 10	225	Varies
			H4	DB 12	225	Varies
	Pipe culvert Ø 120cm single/double row		Wingwalls		W1	DB 10
		W2		DB 12	225	1.85
		W3		DB 12	225	Varies
		W4		DB 10	225	Varies
		W5		DB 10	225	2.1
Head walls			H1	DB 12	225	Varies
			H2	DB 10	225	Varies
			H3	DB 10	225	Varies
			H4	DB 12	225	Varies

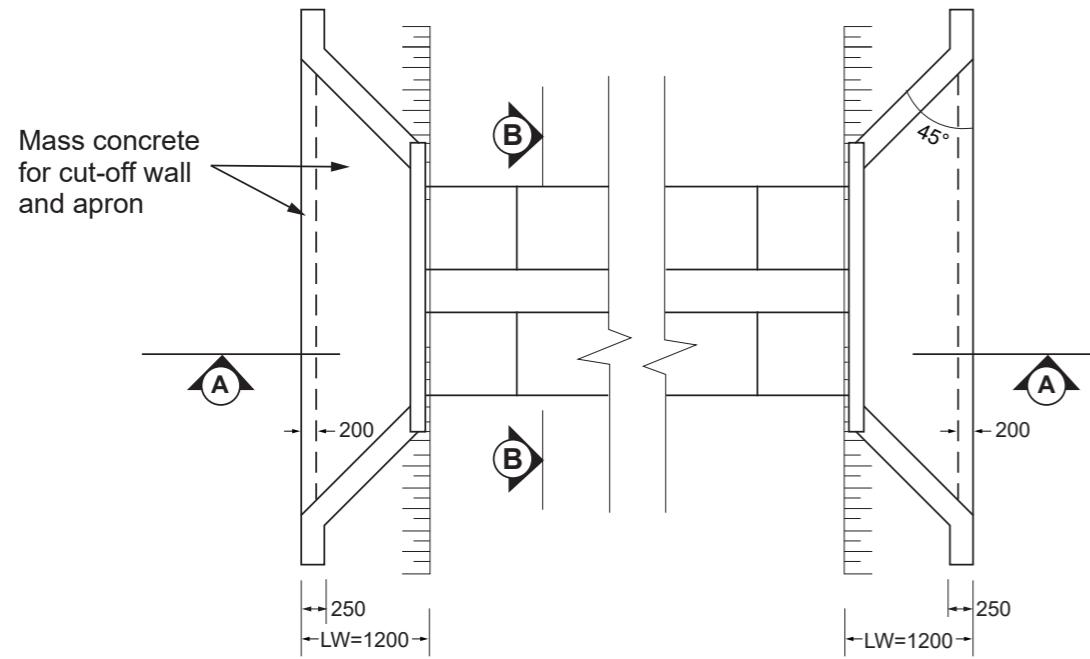
Bar bending schedule for pipe culvert installation

NOTES:

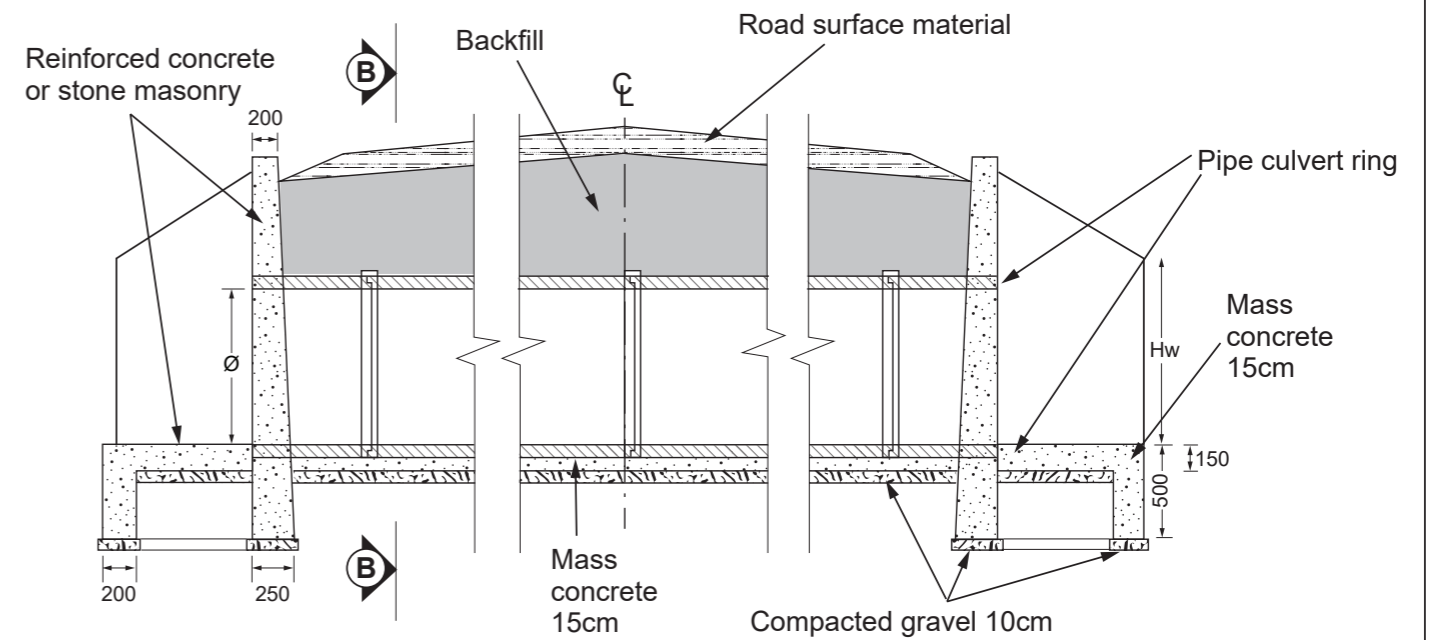
- 1: All dimensions are in millimeters unless otherwise specified.
- 2: Standard pipe length: 1.0 metre.
- 3: Concrete cylinder strength in 28 days shall be: 21 MPa.
- 4: Reinforcement shall be structural grade deformed bar (DB) with minimum yield strength 420 MPa.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Single Pipe Culvert: Bar bending schedule	
REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY		SCALE: NTS
	DESIGNED BY		DIMENSIONS: mm
	CHECKED BY		
	APPROVED BY		SHEET N°:

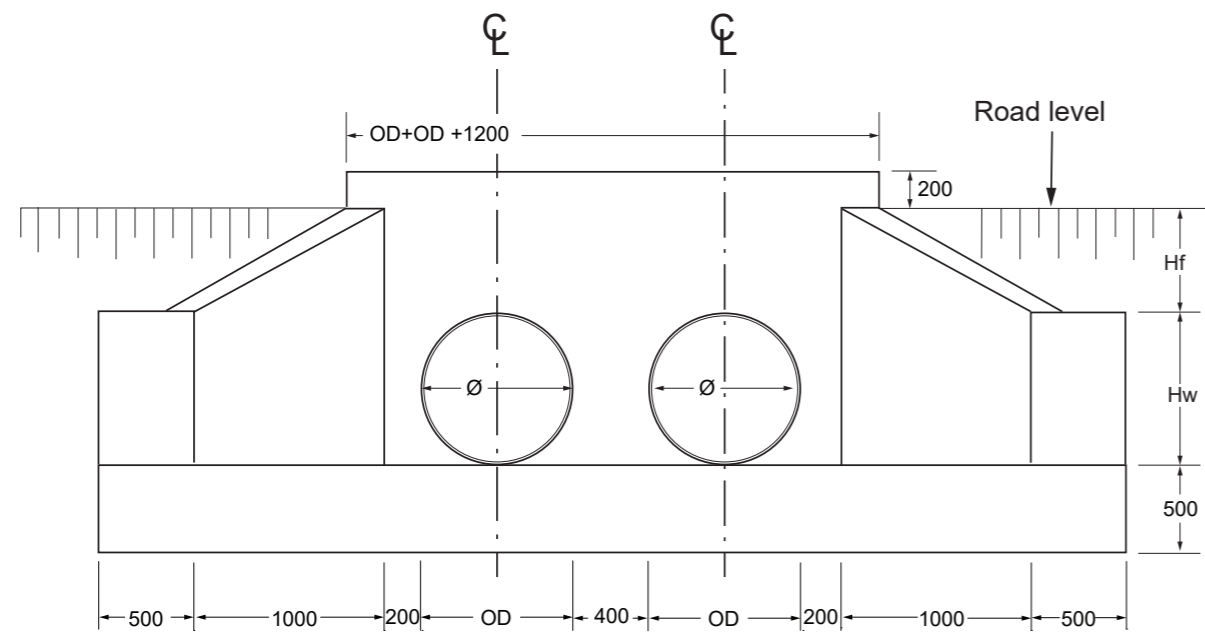
Standard Drawing 6: Double Pipe Culvert (600 and 900 diam) - General Arrangement



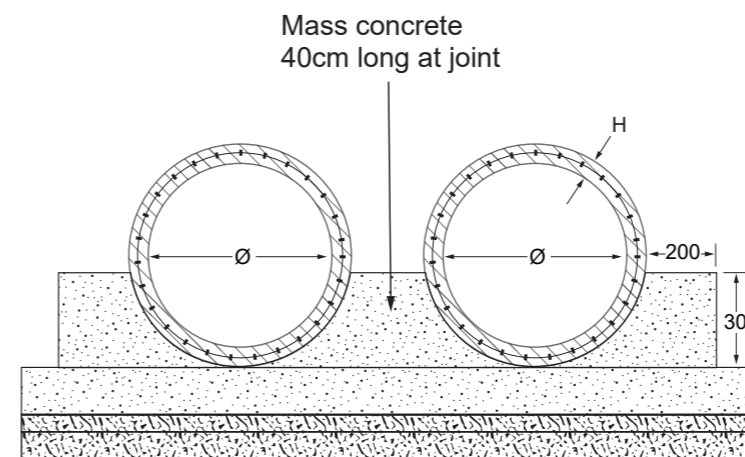
Plan view of culvert installation, headwall & wingwall



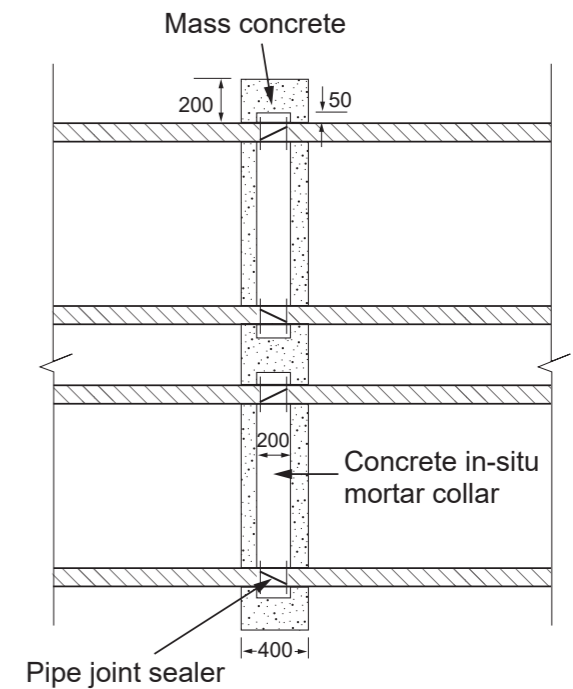
Section A-A longitudinal section of culvert structure



End elevation showing headwall and wing walls




Section B-B cross section of culvert pipe installation



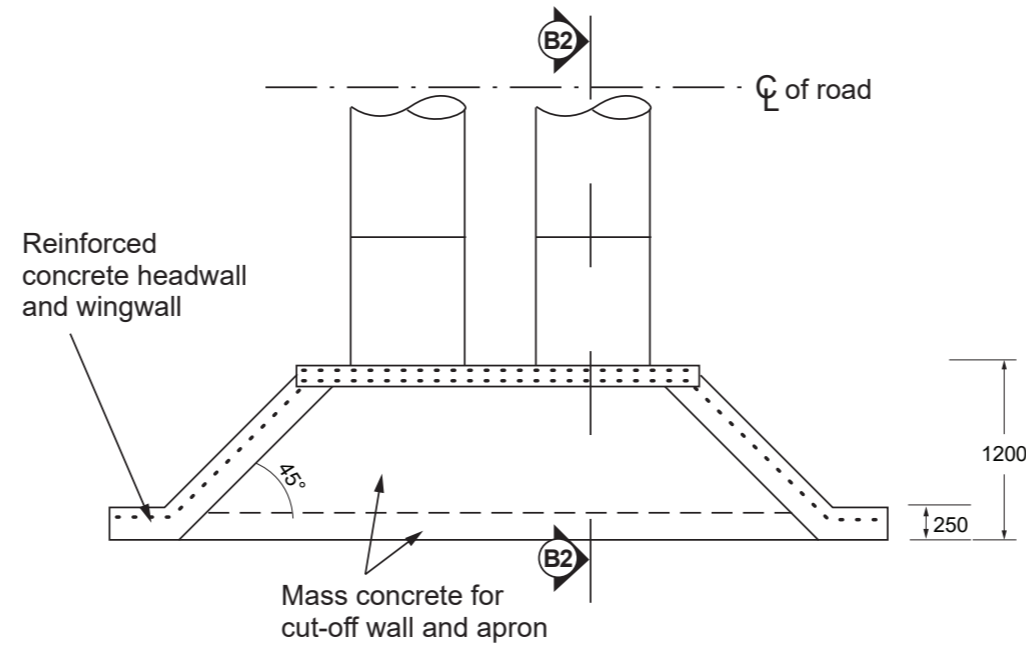
Detail of pipe joint

- NOTES:**
 1: All dimensions are in millimeters unless otherwise specified.
 2: Conversion factor. 1mm - 0.03937 Inches.
 3: Standard pipe length: 1.0 metre.
 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 5: Pipe joint sealer shall be cement mortar.
 6: OD = Outside Diameter = Inside Dia + 2*H.
 7: The Engineer shall specify the length (L) of the culvert structure.
 8. Provide 20mm x 20mm chamfer to all exposed concrete edges.

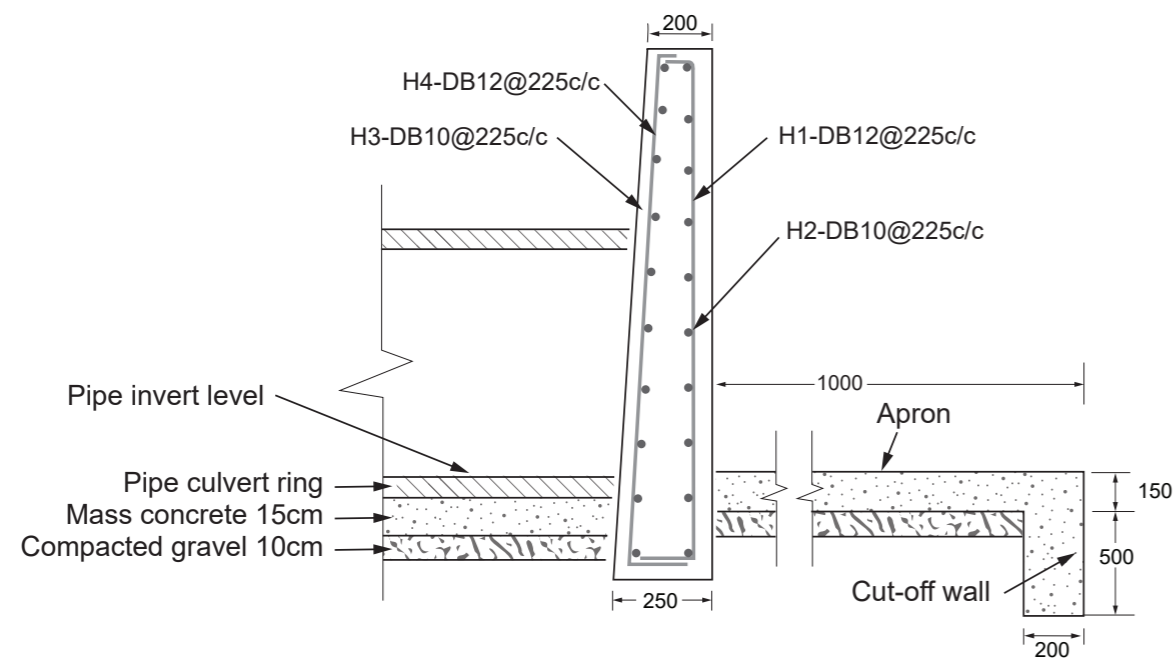
Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill	
				Concrete	Stone masonry	Minimum cover	Material
600	720	Varies	800	200 (top) 250 (base)	300	450	Approved gravel
900	1080	Varies	1100	200 (top) 250 (base)	300	600	Approved gravel

PROJECT:	DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing	Double Pipe Culvert: 600 & 900 general arrangement	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS
	DESIGNED BY	DIMENSIONS: mm
	CHECKED BY	SHEET N°:
	APPROVED BY	

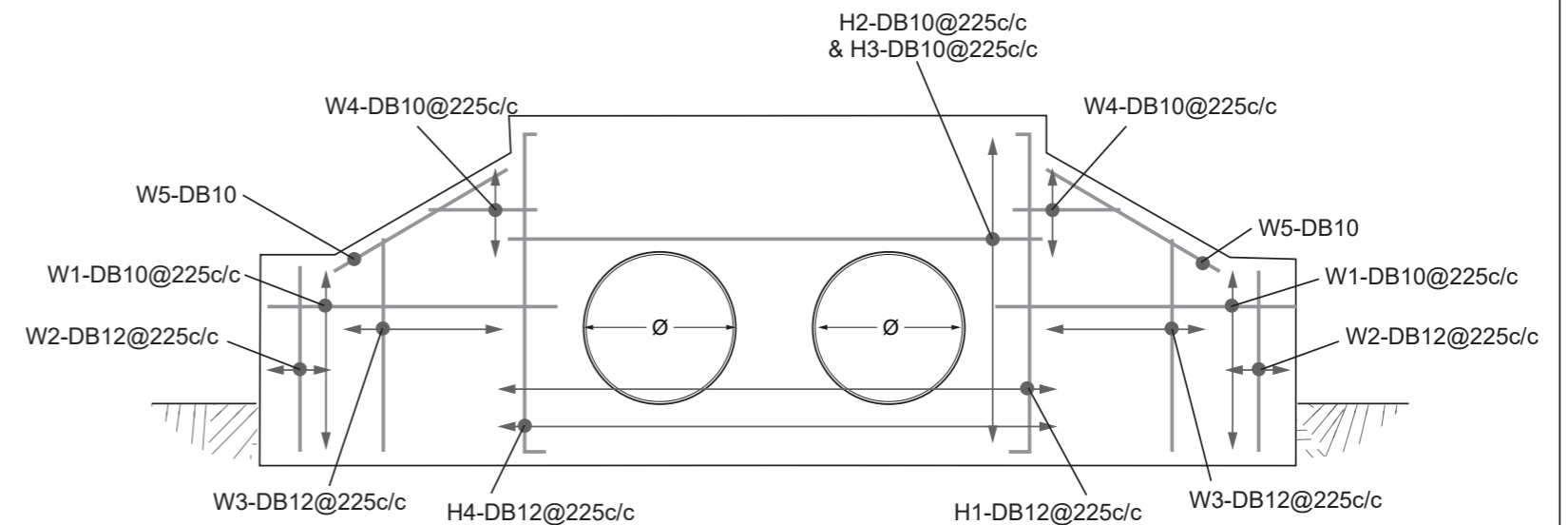
Standard Drawing 7: Double Pipe Culvert (600 and 900 diam) - Reinforcement Layout



Reinforcement details for head wall and wing wall




Section B2-B2: Reinforcement details for head wall

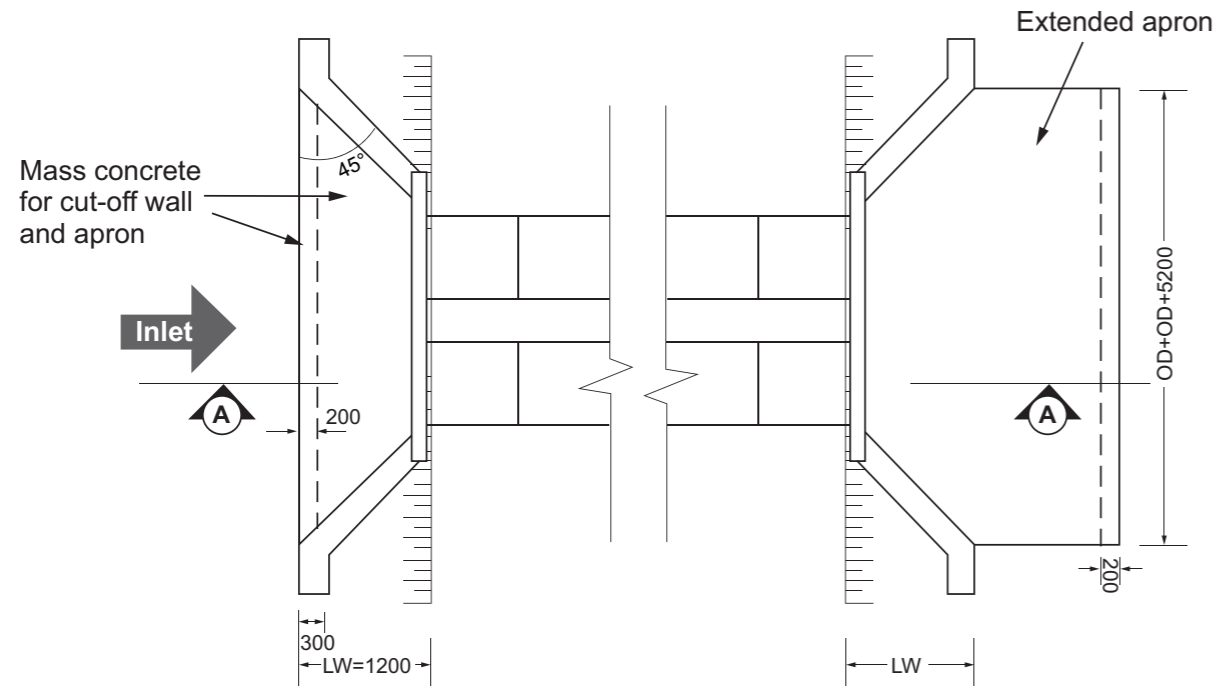


Head wall & wing wall reinforcement details

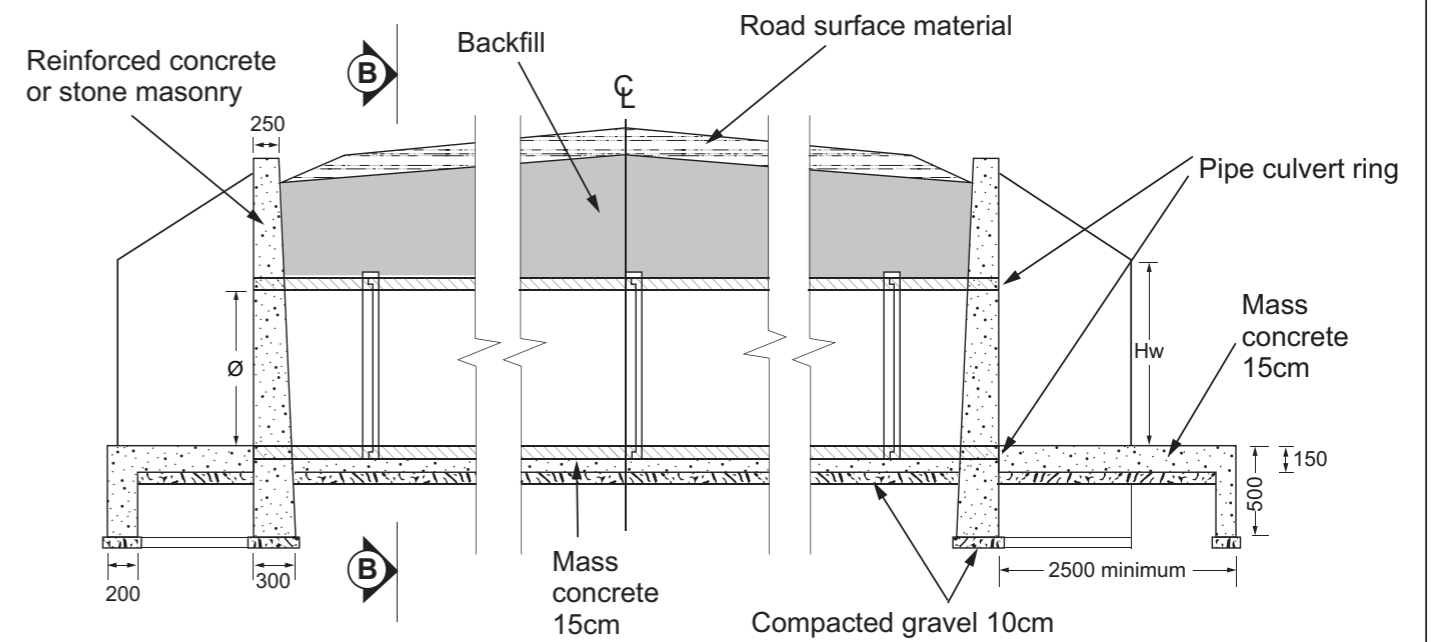
- NOTES:
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: Conversion factor. 1mm - 0.03937 Inches.
 - 3: Standard pipe length: 1.0 metre.
 - 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 - 5: Reinforcement shall be structural grade deformed bar (DB) with minimum yield strength 420 MPa.
 - 6: Pipe joint sealer shall be cement mortar.
 - 7: OD = Outside Diameter = Inside Dia +2*H.
 - 8: The Engineer shall specify the length (L) of the culvert structure.
 9. Provide 20mm x 20mm chamfer to all exposed concrete edges.

Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill		PROJECT:	DATE:/...../.....	DRAWING N°:	
				Concrete	Stone masonry	Minimum cover	Material				
600	720	Varies	800	200 (top) 250 (base)	300	450	Approved gravel	TITLE: Typical Structures Drawing	Double Pipe Culvert: 600 & 900 reinforcement layout		
900	1080	Varies	1100	200 (top) 250 (base)	300	600	Approved gravel	 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
									DESIGNED BY	DIMENSIONS: mm	
									CHECKED BY		
									APPROVED BY	SHEET N°:	

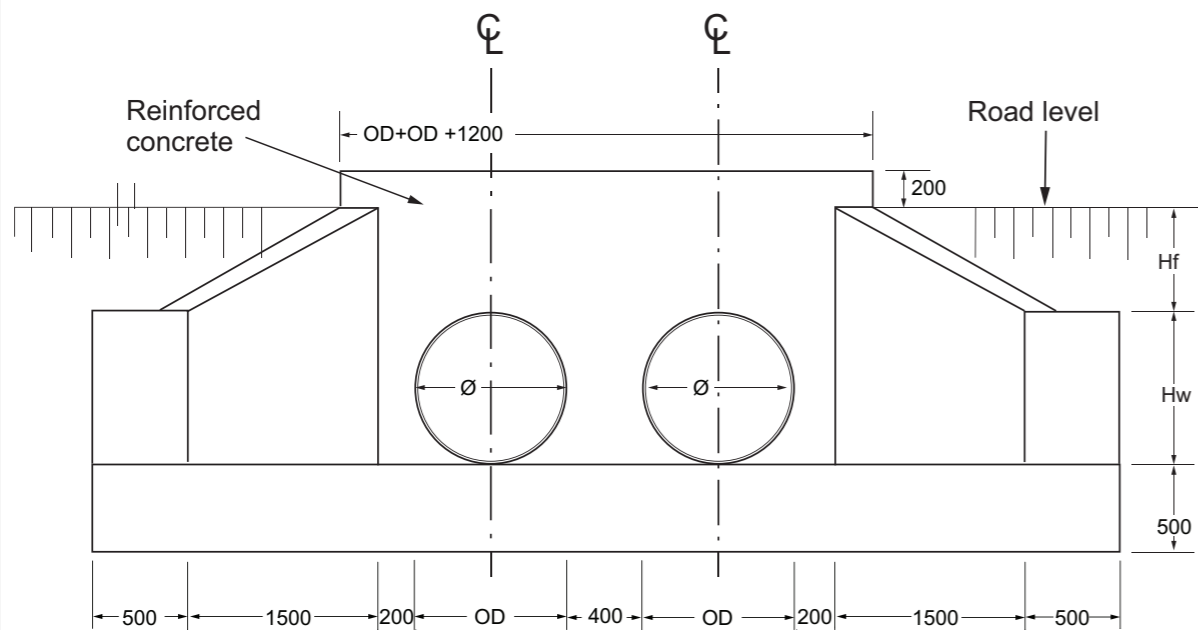
Standard Drawing 8: Double Pipe Culvert (1200 and 1500 diam) - General Arrangement



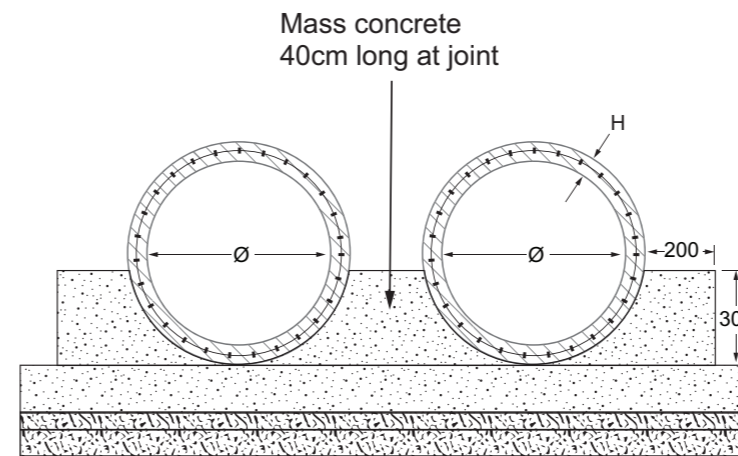
Plan view of culvert installation, headwall & wingwall



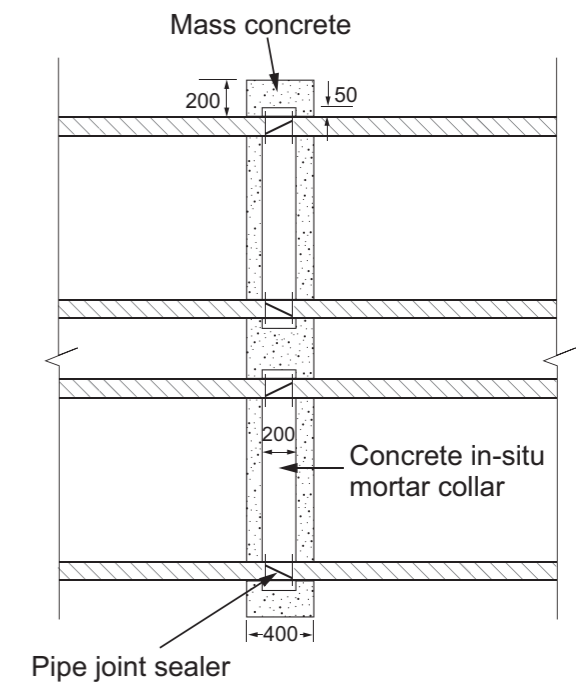
Section A-A longitudinal section of culvert structure



End elevation showing headwall and wing walls



Section B-B cross section of culvert pipe installation



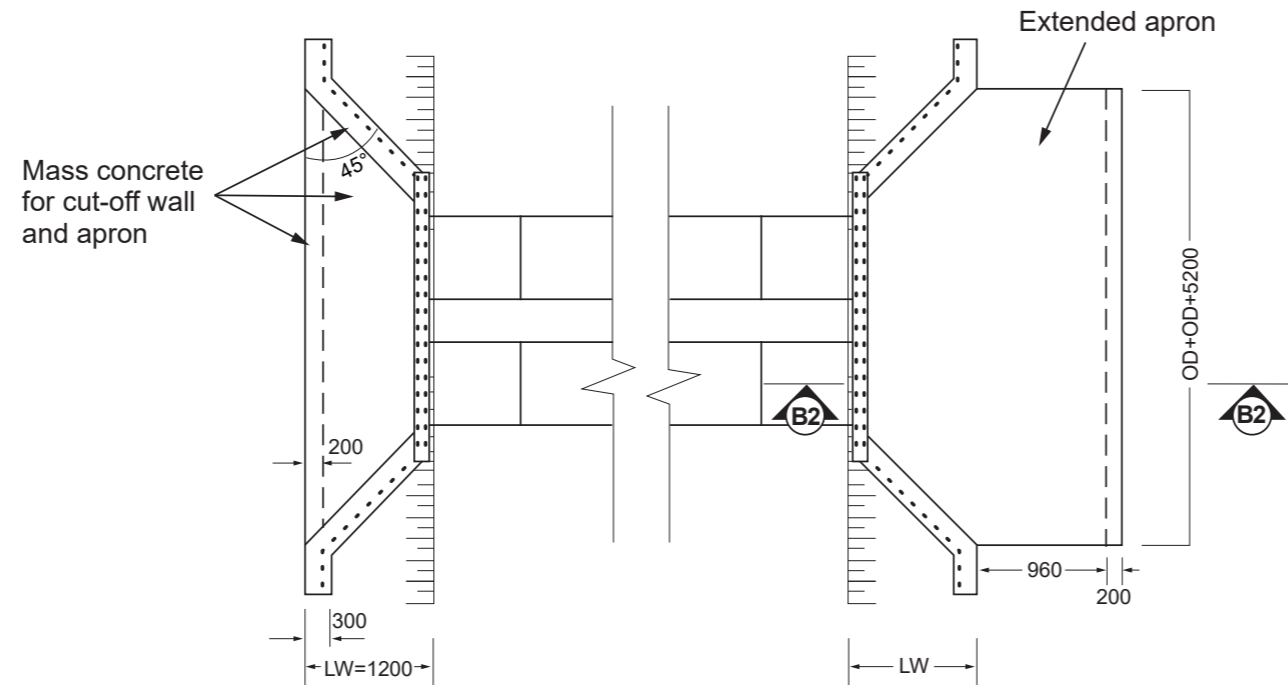
Detail of pipe joint

- NOTES:**
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: Conversion factor. 1mm - 0.03937 Inches.
 - 3: Standard pipe length: 1.0 metre.
 - 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 - 5: Reinforcement shall be structural grade deformed bar (DB) with minimum yield strength 420 MPa.
 - 6: Pipe joint sealer shall be cement mortar.
 - 7: OD = Outside Diameter = Inside Dia + 2*H.
 - 8: The Engineer shall specify the length (L) of the culvert structure.
 9. Provide 20mm x 20mm chamfer to all exposed concrete edges.

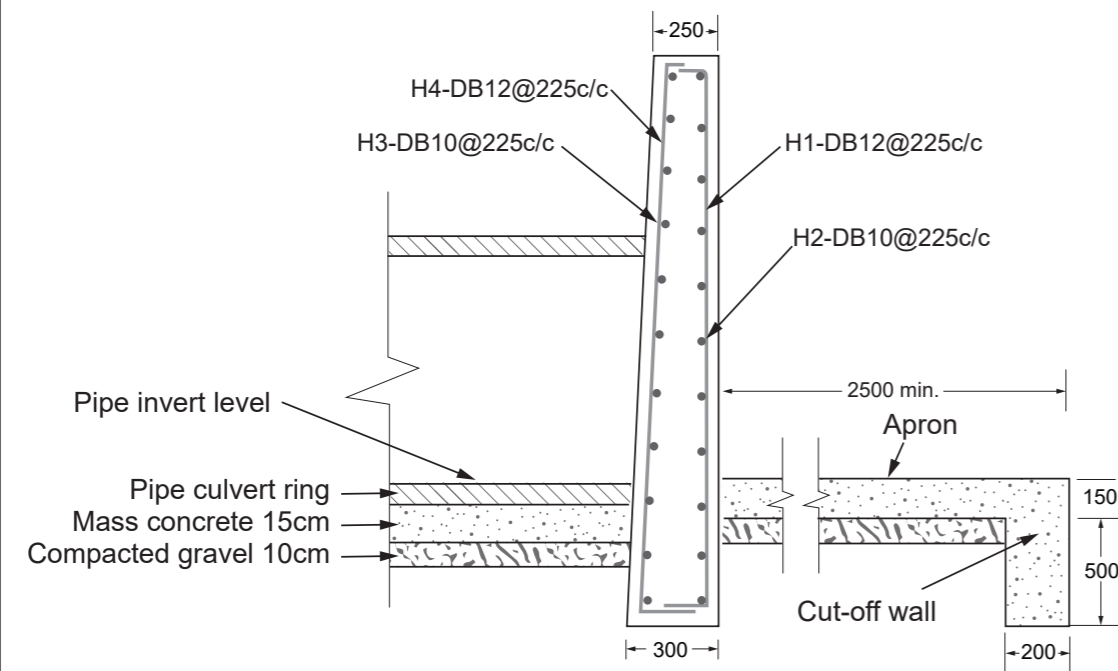
Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill	
				Concrete	Stone masonry	Minimum cover	Material
1200	1440	Varies	1400	250 (top) 300 (base)	300	700	Approved gravel
1500	1800	Varies	1700	250 (top) 300 (base)	300	800	Approved gravel

PROJECT:	DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing	Double Pipe Culvert: 1200 & 1500 general arrangement	
	DRAWN BY	SCALE: NTS
	DESIGNED BY	DIMENSIONS: mm
	CHECKED BY	SHEET N°:
	APPROVED BY	

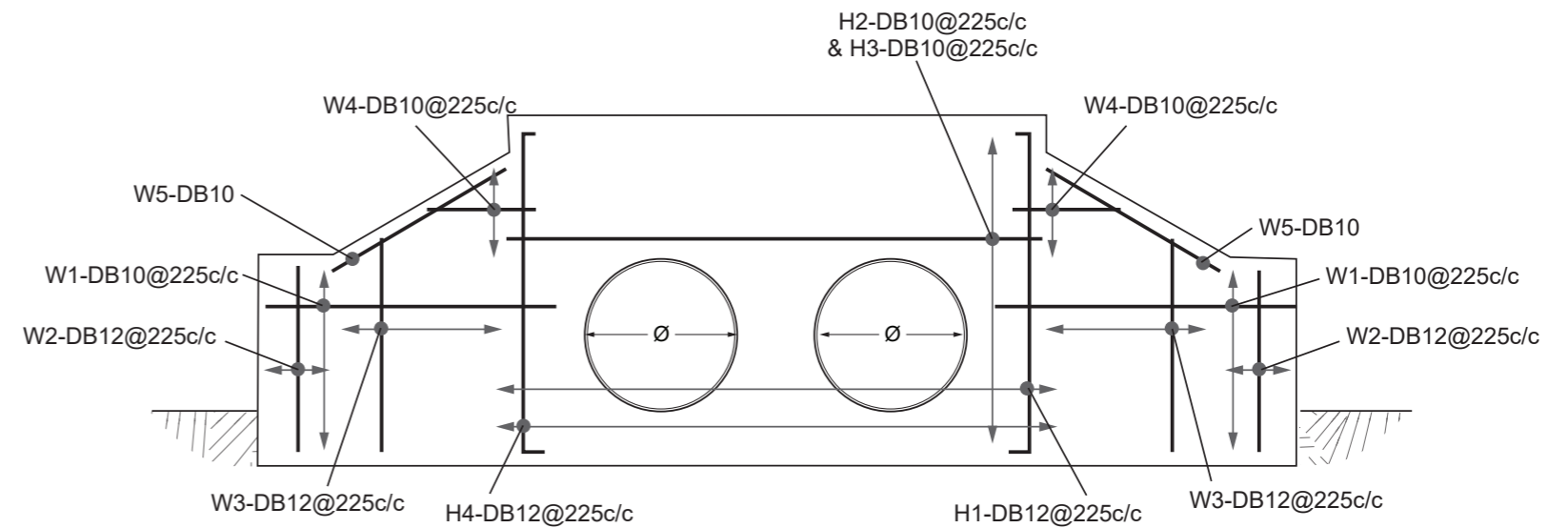
Standard Drawing 9: Double Pipe Culvert (1200 and 1500 diam) - Reinforcement Layout



Reinforcement details for headwall & wingwall




Section B2-B2: Reinforcement details for head wall

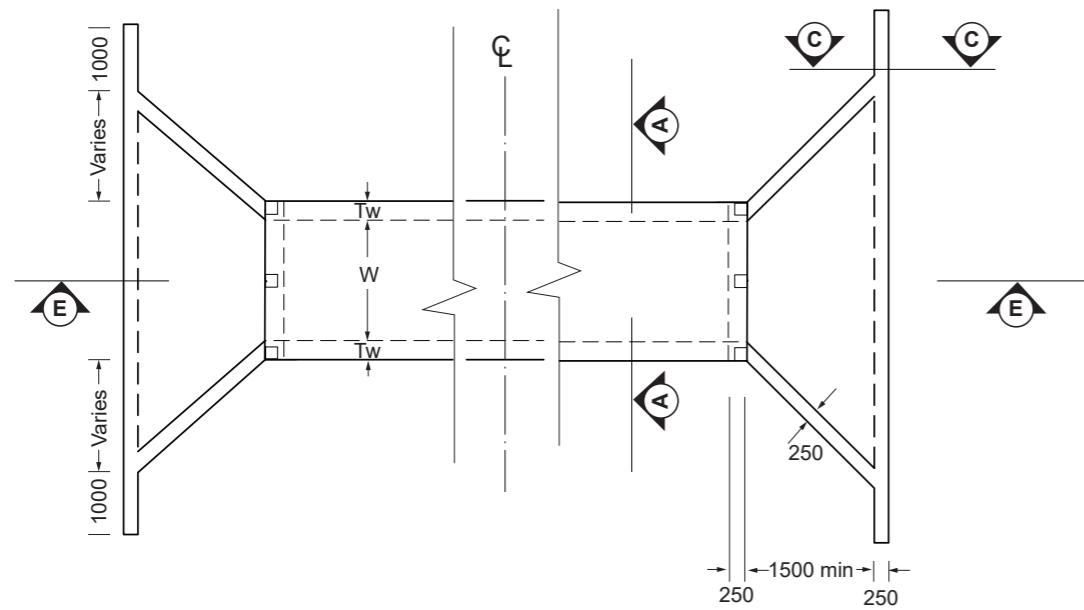


Head wall & wing wall reinforcement details

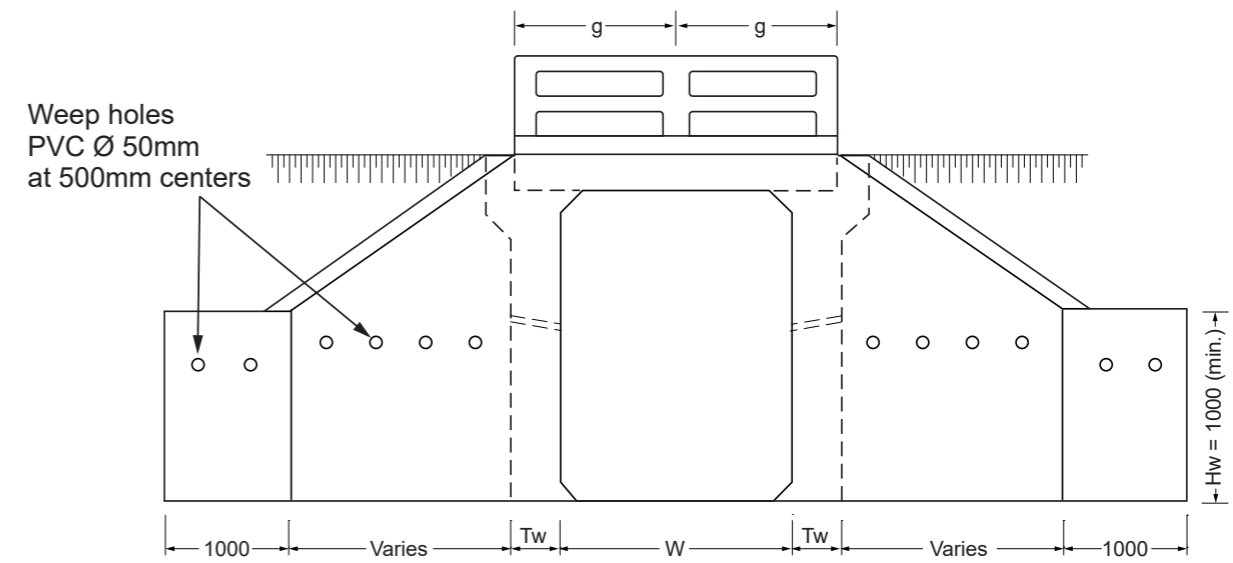
- NOTES:**
 1: All dimensions are in millimeters unless otherwise specified.
 2: Conversion factor. 1mm - 0.03937 Inches.
 3: Standard pipe length: 1.0 metre.
 4: Concrete cylinder strength in 28 days shall be: 21 MPa.
 5: Reinforcement shall be structural grade deformed bar (DB) with minimum yield strength 420 MPa.
 6: Pipe joint sealer shall be cement mortar.
 7: OD = Outside Diameter = Inside Dia + 2*H.
 8: The Engineer shall specify the length (L) of the culvert structure.
 9. Provide 20mm x 20mm chamfer to all exposed concrete edges.

Culvert size (Inside Ø)	OD	L	Hw	Headwall thickness		Backfill		PROJECT:	DATE:/...../.....	DRAWING N°:	
				Concrete	Stone masonry	Minimum cover	Material				
1200	1440	Varies	1400	250 (top) 300 (base)	300	700	Approved gravel	TITLE: Typical Structures Drawing	Double Pipe Culvert: 1200 & 1500 reinforcement layout		
1500	1800	Varies	1700	250 (top) 300 (base)	300	800	Approved gravel	 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
									DESIGNED BY	DIMENSIONS: mm	
									CHECKED BY		
									APPROVED BY	SHEET N°:	

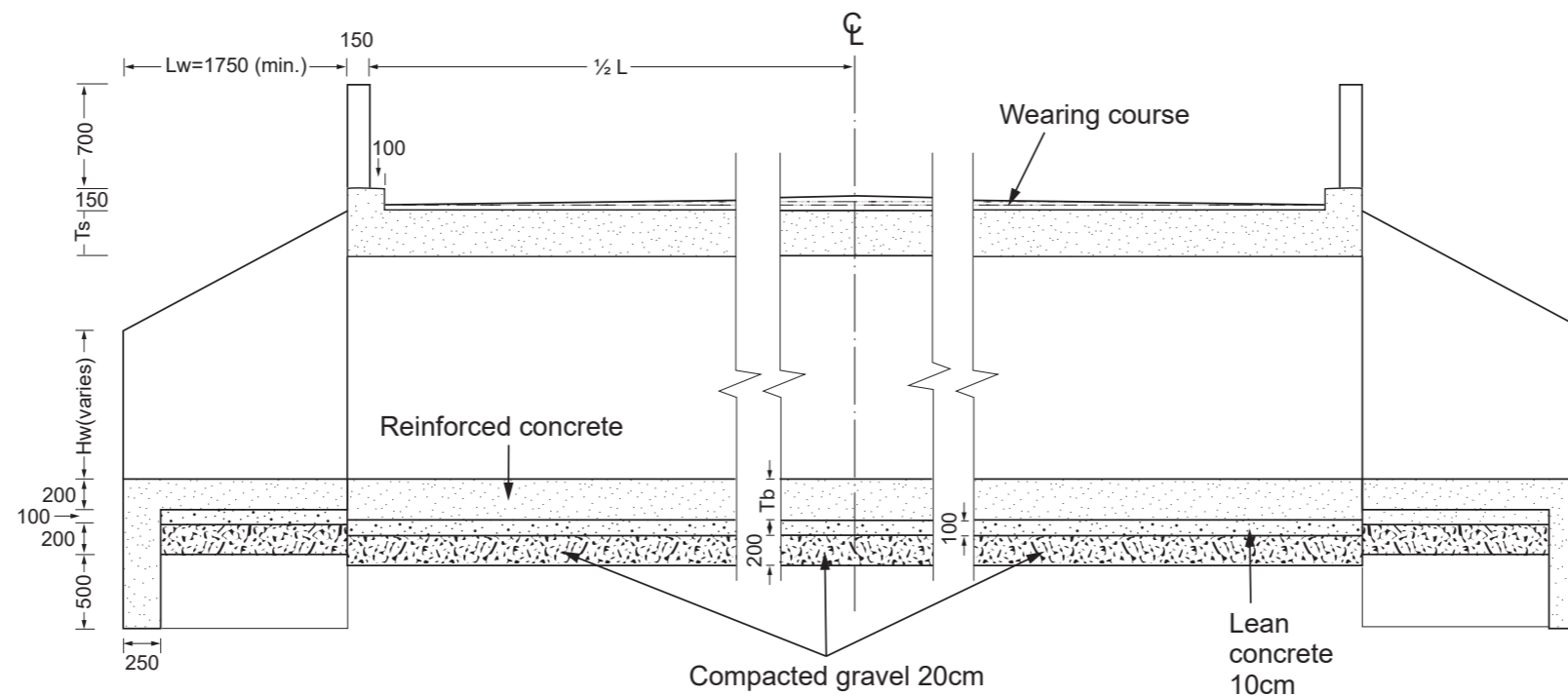
Standard Drawing 10: Single Box Culvert - General Arrangement



Plan of single cell box culvert




Single cell box culvert elevation



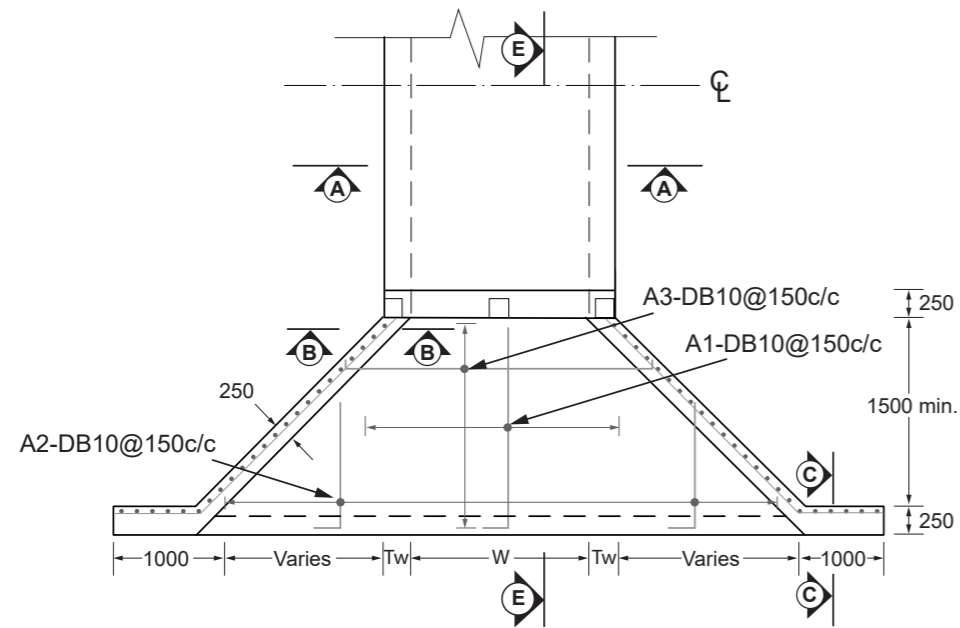
Section E-E: Longitudinal section of box culvert

NOTES:

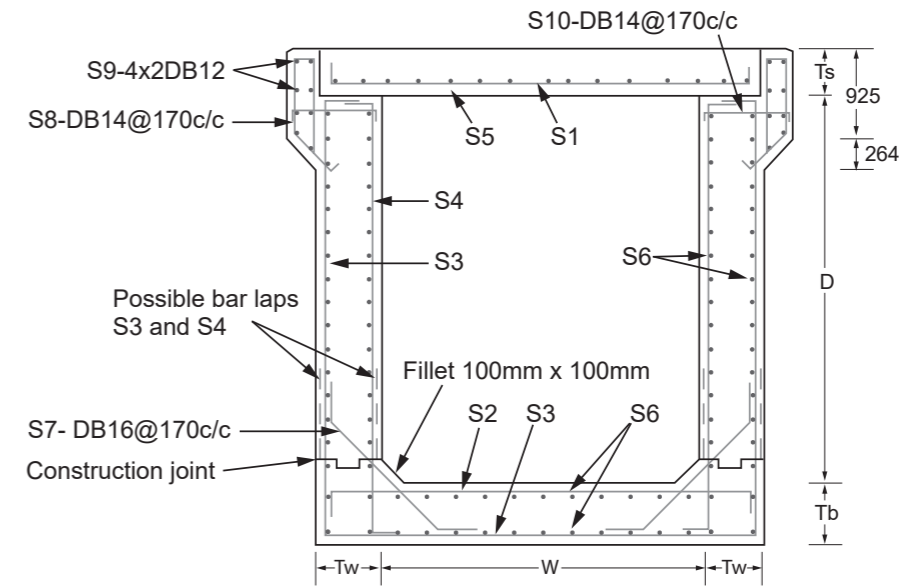
- 1: All dimensions are in millimeters unless otherwise specified.
- 2: Conversion factor. 1mm - 0.03937 Inches.
- 3: Concrete cylinder strength in 28 days shall be; a) box and end structures: 21 MPa; b) Lean concrete: 10 MPa.
- 4: Bed shall be approved compacted non-plastic gravel and lean concrete.
- 5: Crushed aggregate for concrete shall not be greater than 19mm.
- 6: The Engineer shall specify the length (L) of the culvert structure.
- 7: Lw and Hw vary depending on site conditions.
- 8: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Single Box Culvert: General arrangement	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
	DESIGNED BY	DIMENSIONS: mm	
	CHECKED BY	SHEET N°:	
	APPROVED BY		

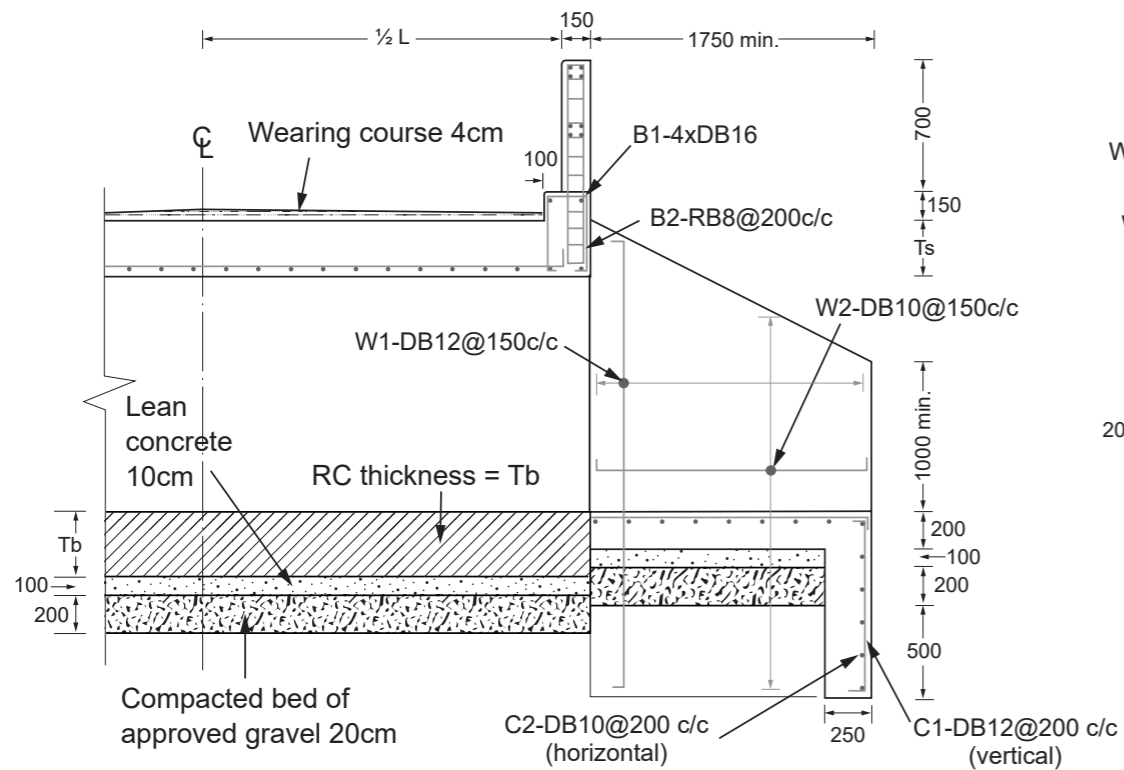
Standard Drawing 11: Single Box Culvert - Reinforcement Layout



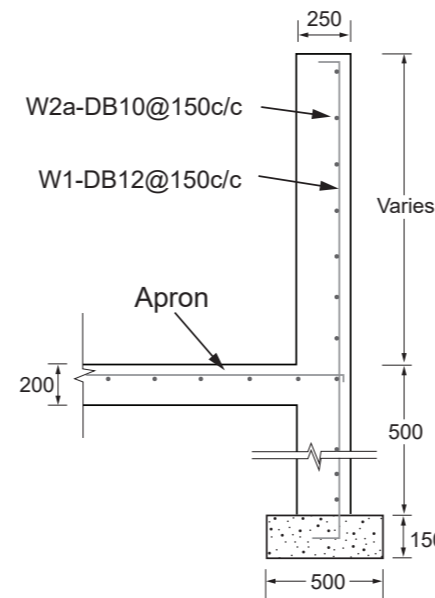
Plan of head/wing wall and apron & head/wing wall reinforcement detail



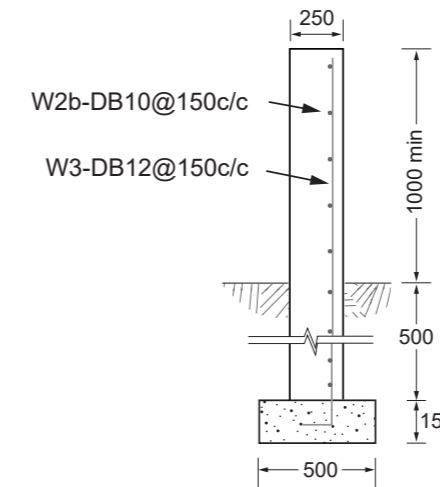
Section A-A: Reinforcement detail



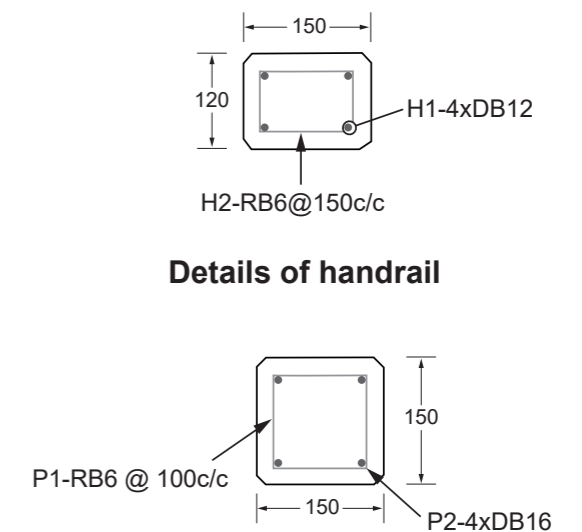
Section E-E: Culvert head/wing wall and apron reinforcement detail



Section B-B




Section C-C



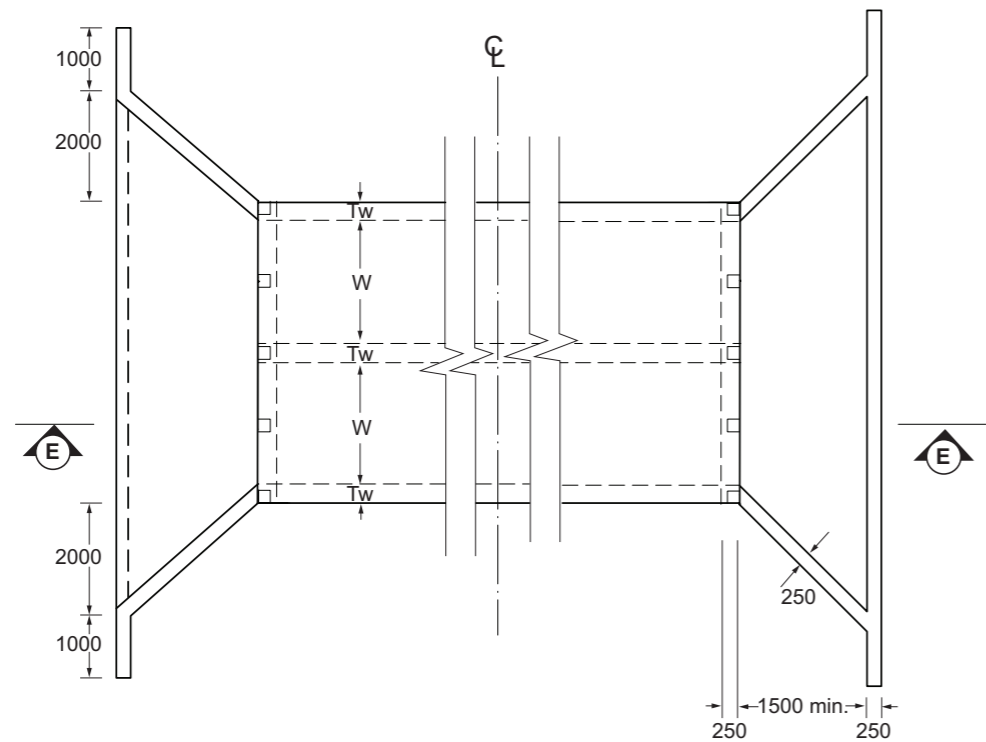
Details of handrail

Details of guardrail post

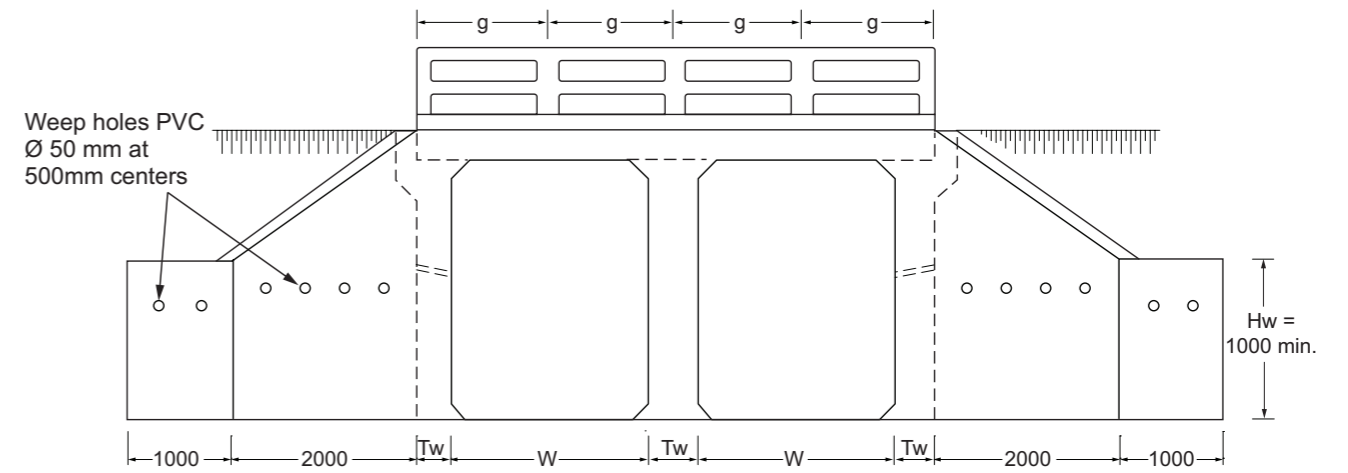
- NOTES:**
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: Conversion factor. 1mm - 0.03937 Inches.
 - 3: Concrete cylinder strength in 28 days shall be; a) box and end structures: 21 MPa; b) Lean concrete: 10 MPa
 - 4: Bed shall be stone and sand mix of ration 1:1 and lean concrete.
 - 5: Reinforcement shall be structural grade deformed bar (DB), with minimum yield strength 420 MPa or mild steel bar (RB) with minimum yield strength 250 MPa.
 - 6: Minimum 40mm cover to reinforcement.
 - 7: Minimum bar lap shall be 50xØ.
 - 8: Crushed aggregate for concrete shall not be greater than 19mm.
 - 9: The Engineer shall specify the length (L) of the culvert structure.
 - 10: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Single Box Culvert: Reinforcement layout	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
	DESIGNED BY	DIMENSIONS: mm	
	CHECKED BY	SHEET N°:	
	APPROVED BY		

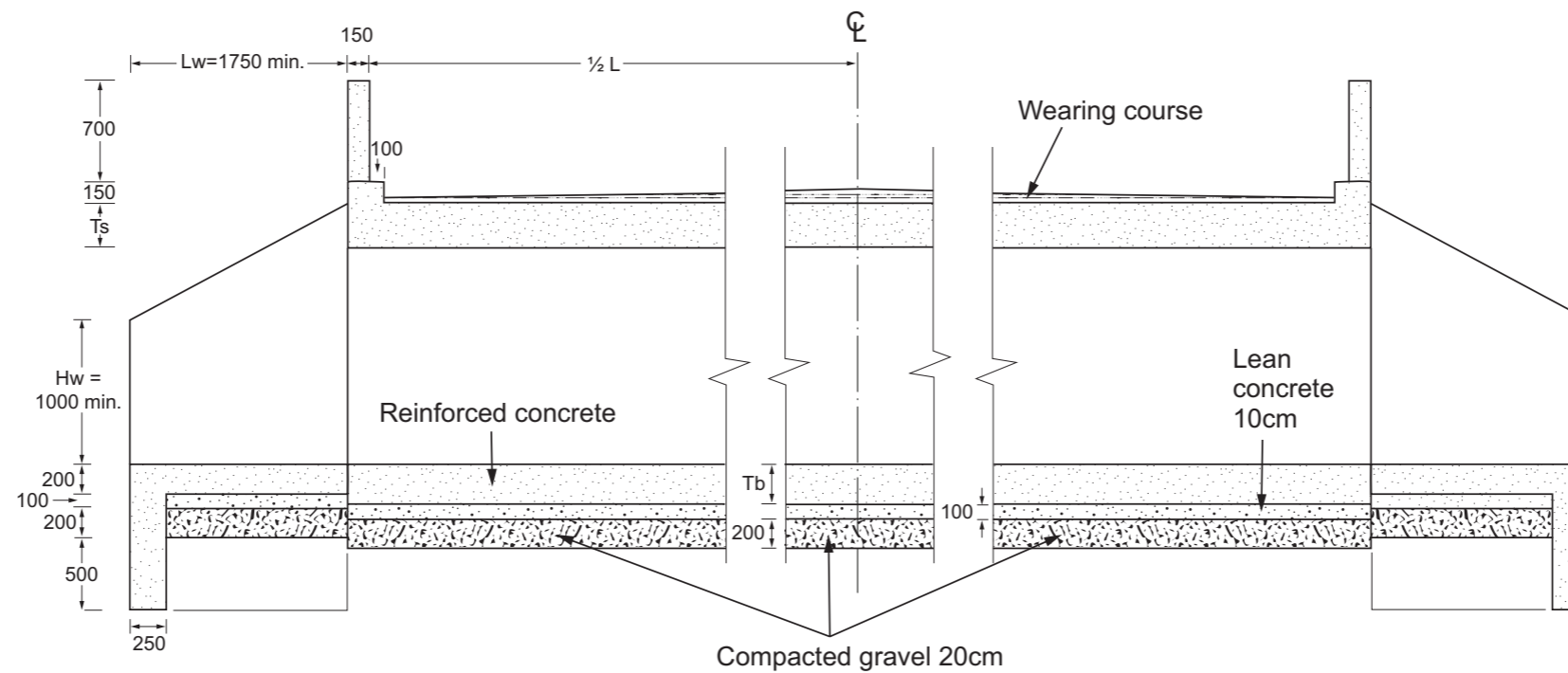
Standard Drawing 12: Double Box Culvert - General Arrangement



Plan of multiple cell box culvert




Double, multiple cell box culvert elevation



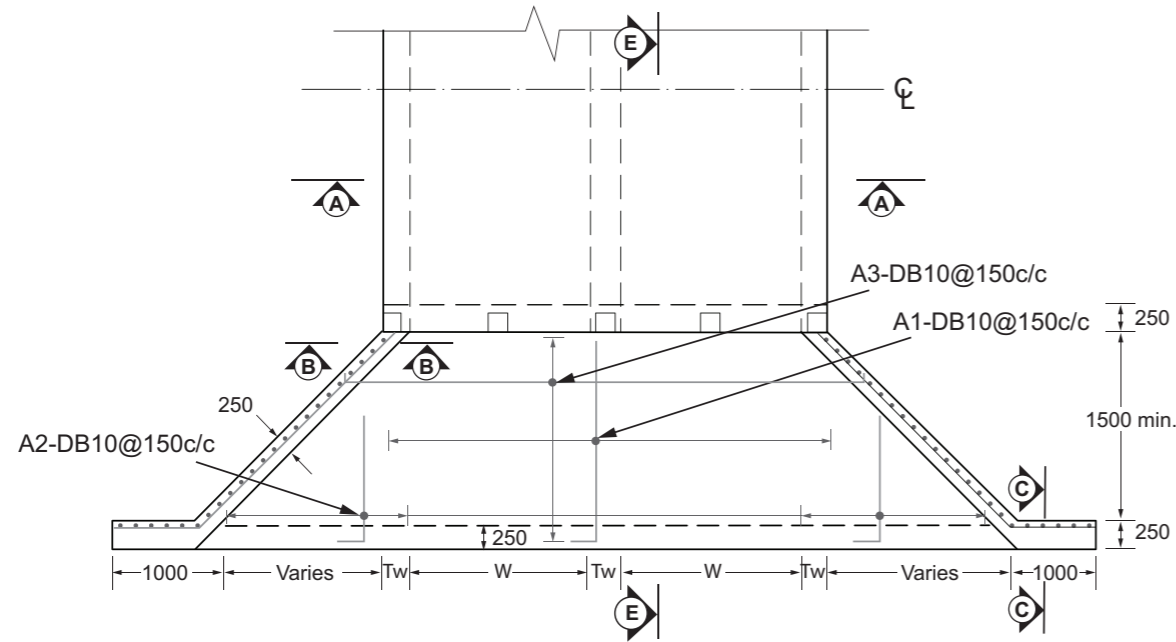
Section E-E: Longitudinal section of box culvert

NOTES:

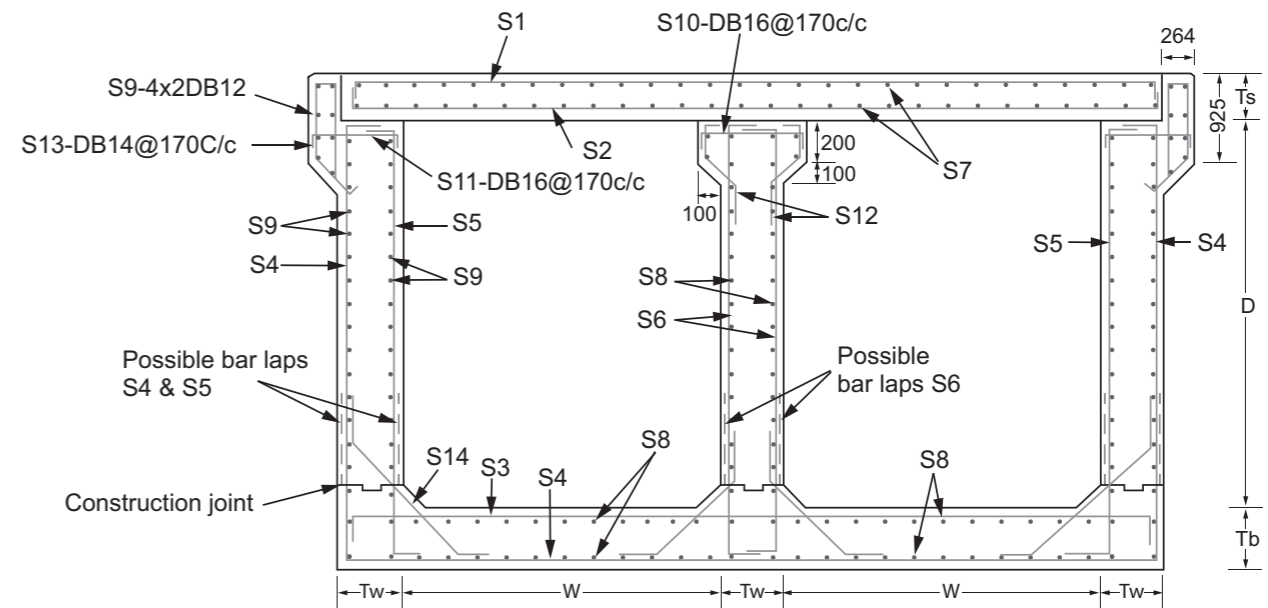
- 1: All dimensions are in millimeters unless otherwise specified.
- 2: Conversion factor. 1mm - 0.03937 Inches.
- 3: Concrete cylinder strength in 28 days shall be; a) box and end structures: 21 MPa; b) Lean concrete: 10 MPa
- 4: Bed shall be stone and sand mix of ration 1:1 and lean concrete.
- 5: Crushed aggregate for concrete shall not be greater than 19mm.
- 6: The Engineer shall specify the length (L) of the culvert structure.
- 7: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Double Box Culvert: General arrangement	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY		SCALE: NTS
	DESIGNED BY		DIMENSIONS: mm
	CHECKED BY		SHEET N°:
	APPROVED BY		

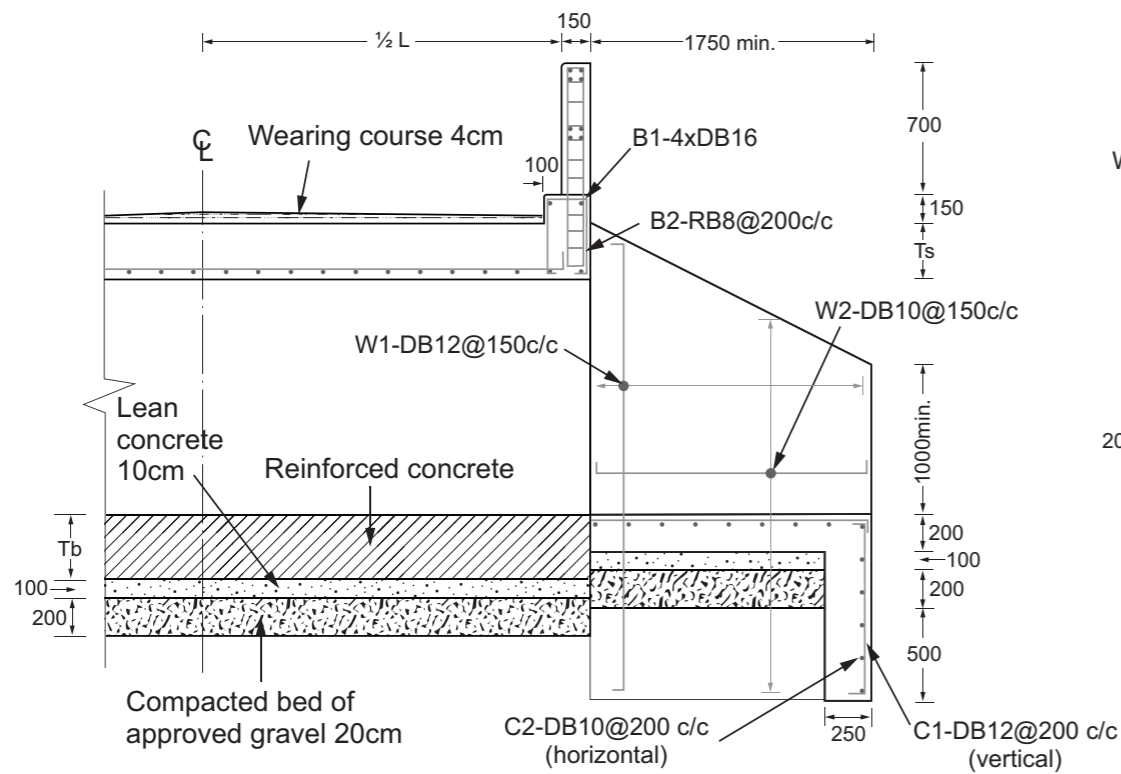
Standard Drawing 13: Double Box Culvert - Reinforcement Layout



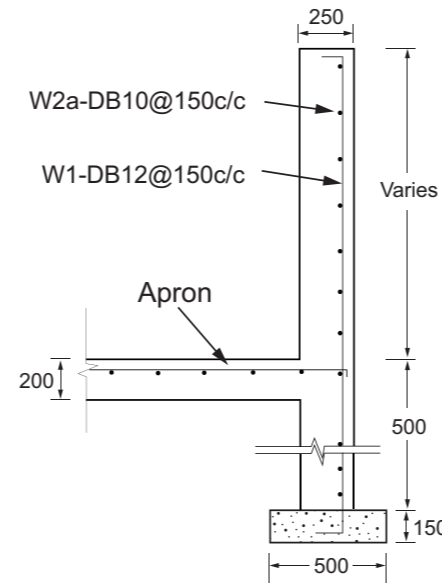
Plan of head/wing wall and apron & head/wing wall reinforcement detail



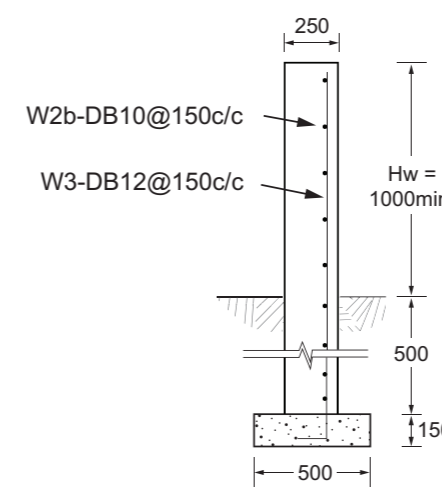
Section A-A: Reinforcement detail - double box culvert



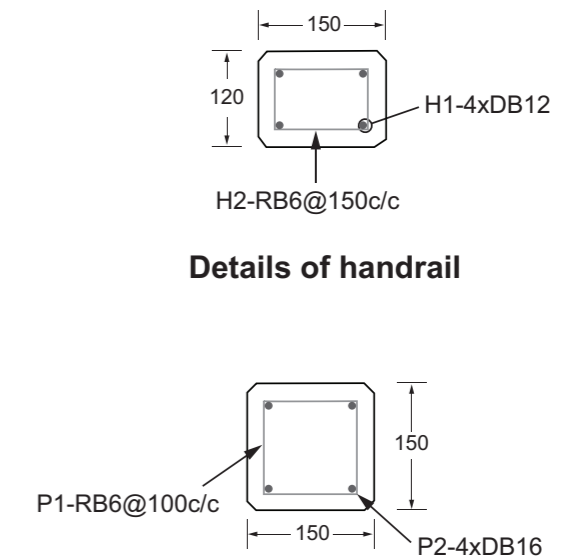
Section E-E: Culvert head/wing wall and apron reinforcement detail



Section B-B




Section C-C



Details of handrail

Details of guard post

- NOTES:
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: Conversion factor. 1mm - 0.03937 Inches.
 - 3: Concrete cylinder strength in 28 days shall be; a) box and end structures: 21 MPa; b) Lean concrete: 10 MPa.
 - 4: Bed shall be stone and sand mix of ratio 1:1 and lean concrete.
 - 5: Reinforcement shall be structural grade deformed bar (DB), with minimum yield strength 420 MPa or mild steel (RB) with minimum yield strength 250 MPa.
 - 6: Minimum 40mm cover to reinforcement.
 - 7: Minimum bar lap shall be 50xØ.
 - 8: Crushed aggregate for concrete shall not be greater than 19mm.
 - 9: The Engineer shall specify the length (L) of the culvert structure.
 - 10: Height of fill Hf shall be determined by the conditions on site.
 - 11: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Double Box Culvert: Reinforcement layout	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
	DESIGNED BY	DIMENSIONS: mm	
	CHECKED BY	SHEET N°:	
	APPROVED BY		

Standard Drawing 14: Box Culvert - Bar Bending Schedules

W (mm)	D (mm)	Ts (mm)	Tb (mm)	Tw (mm)	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1500	1500	250	250	250	DB16@150	DB16@200	DB16@200	DB16@200	DB10@200	DB10@200	DB16@170	DB14@170	4x2DB12	DB16@170
	2500	250	250	250	DB16@150	DB16@200	DB16@200	DB16@200	DB10@200	DB10@200	DB16@170	DB14@170	4x2DB12	DB16@170
	3500	250	350	350	DB16@150	DB16@200	DB16@200	DB16@200	DB10@200	DB12@200	DB16@170	DB14@170	4x2DB12	DB16@170
2000	1500	300	250	250	DB16@125	DB16@175	DB16@175	DB16@175	DB10@200	DB10@200	DB16@170	DB14@170	4x2DB12	DB16@170
	2500	300	300	300	DB16@125	DB16@200	DB20@200	DB16@200	DB10@200	DB10@200	DB16@170	DB14@170	4x2DB12	DB16@170
	3500	300	400	400	DB16@125	DB16@200	DB25@200	DB16@200	DB10@200	DB12@200	DB16@170	DB14@170	4x2DB12	DB16@170
3000	1500	400	350	350	DB20@150	DB16@200	DB20@200	DB16@200	DB12@200	DB12@200	DB16@170	DB14@170	4x2DB12	DB16@170
	2500	400	400	400	DB20@150	DB16@200	DB20@200	DB16@200	DB12@200	DB12@200	DB16@170	DB14@170	4x2DB12	DB16@170
	3500	400	400	400	DB20@150	DB16@200	DB25@200	DB16@200	DB12@200	DB12@200	DB16@170	DB14@170	4x2DB12	DB16@170

NOTE 1. Values of d1, d2, ...,dn and y1, y2, ...,yn vary with design and shall be specified by the Engineer for each design. 2. DB 16 @ 175 = Deformed Bar of Ø 16mm placed 175mm centre to centre. 3. Conversion factor 1mm = 0.03937 inches

Reinforcement bar/steel details of single cell box culvert - mild steel - and maximum cover not exceeding 500mm

W (mm)	D (mm)	Ts (mm)	Tb (mm)	Tw (mm)	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
1500	1500	250	250	250	DB16@125	DB16@125	DB16@200	DB16@200	DB16@200	DB16@200	DB10@200	DB10@200	4x2DB12	DB16@170	DB16@170	DB14@170	DB14@170
	2500	250	250	250	DB16@125	DB16@125	DB16@200	DB16@200	DB16@200	DB16@200	DB10@200	DB10@200	4x2DB12	DB16@170	DB16@170	DB14@170	DB14@170
	3500	250	350	350	DB16@125	DB16@125	DB16@200	DB16@200	DB20@200	DB16@200	DB10@200	DB12@200	4x2DB12	DB16@170	DB16@170	DB14@170	DB14@170
2000	1500	300	250	250	DB20@175	DB20@175	DB16@175	DB16@175	DB16@175	DB16@175	DB10@200	DB10@200	4x2DB12	DB16@170	DB16@170	DB14@170	DB14@170
	2500	300	300	300	DB20@175	DB20@175	DB20@200	DB16@200	DB16@200	DB16@200	DB10@200	DB10@200	4x2DB12	DB16@170	DB16@170	DB14@170	DB14@170
	3500	300	400	400	DB20@175	DB20@175	DB25@200	DB16@200	DB16@200	DB16@200	DB10@200	DB12@200	4x2DB12	DB16@170	DB16@170	DB14@170	DB14@170

NOTE 1. Values of d1, d2, ...,dn and y1, y2, ...,yn vary with design and shall be specified by the Engineer for each design. 2. DB 16 @ 175 = Deformed Bar of Ø 16mm placed 175mm centre to centre. 3. Conversion factor 1mm = 0.03937 inches

Reinforcement bar/steel details of double cell box culvert - mild steel - and maximum cover not exceeding 500mm

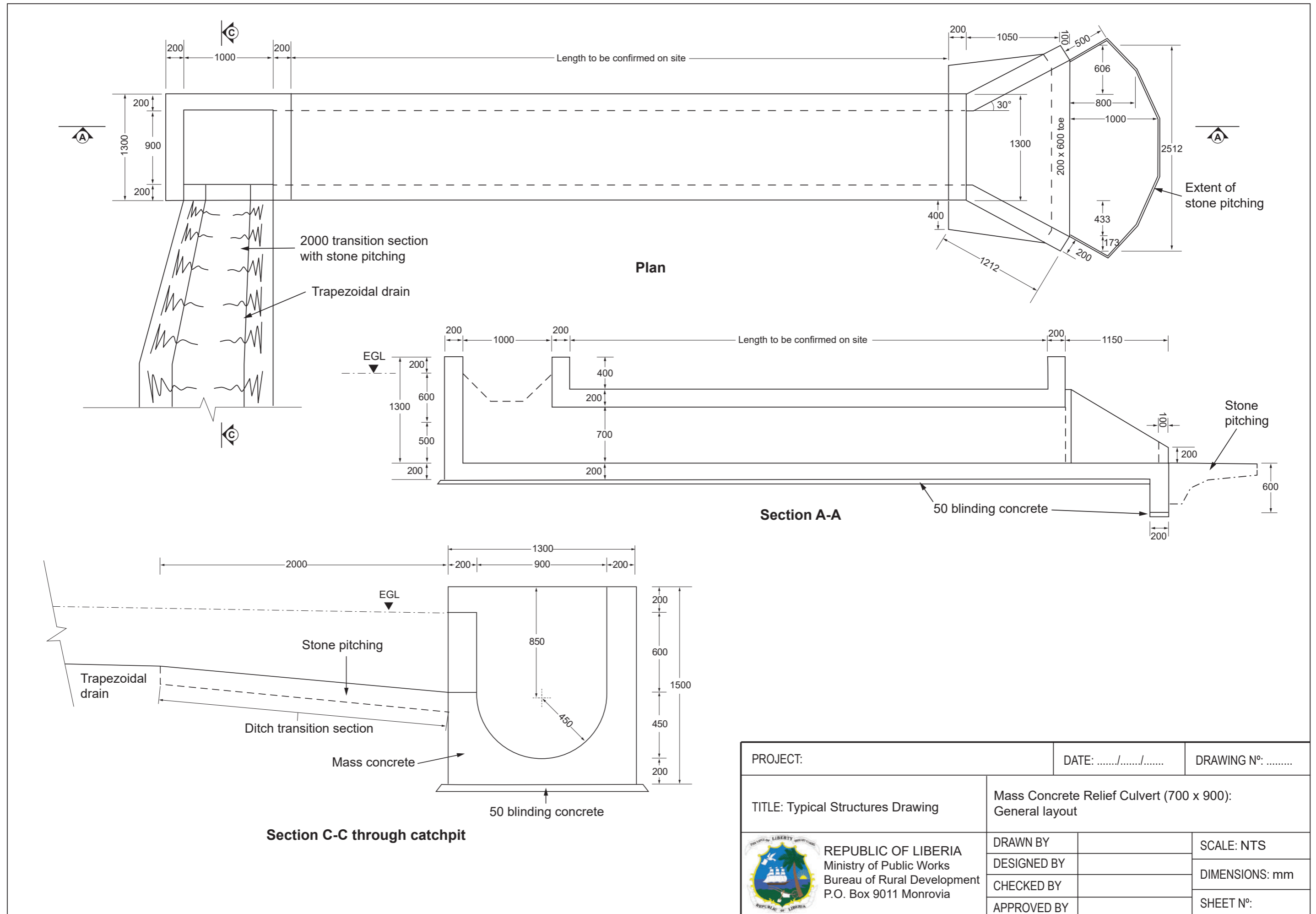
Bar Mark	A1	A2	A3	C1	C2
Shape					
Reinforcement	DB10@150	DB10@150	DB10@150	DB12@200	DB10@200


Bar Mark	H1	H2	P1	P2	B1	B2
Shape						
Reinforcement	DB12	RB6@150	RB6@100	DB16	DB16	RB8@200

Reinforcement bar/steel details of wing wall

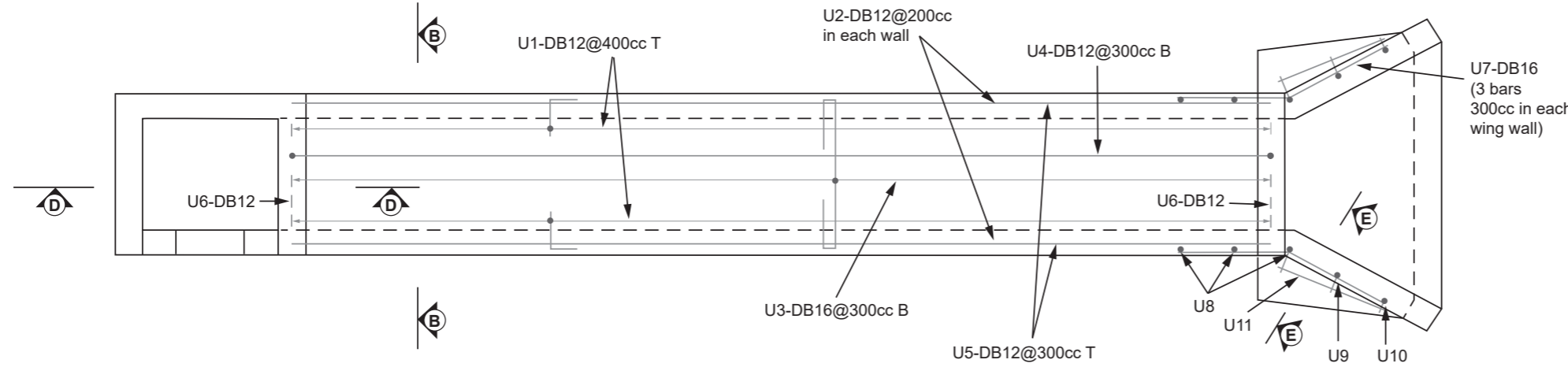
PROJECT:		DATE:/...../.....		DRAWING N°:	
TITLE: Typical Structures Drawing			Box Culvert: Bending bar schedules		
REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY		SCALE: NTS		
	DESIGNED BY		DIMENSIONS: mm		
	CHECKED BY		SHEET N°:		
	APPROVED BY				

Standard Drawing 15: Mass Concrete Relief Culvert (700 x 900) - General Layout

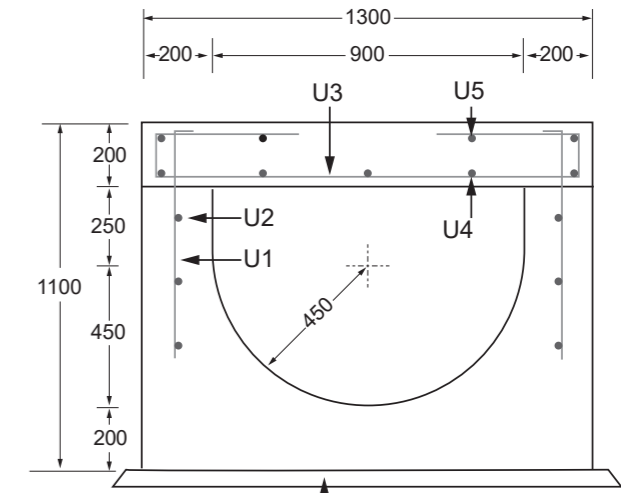


PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Mass Concrete Relief Culvert (700 x 900): General layout	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY		SCALE: NTS
	DESIGNED BY		DIMENSIONS: mm
	CHECKED BY		SHEET N°:
	APPROVED BY		

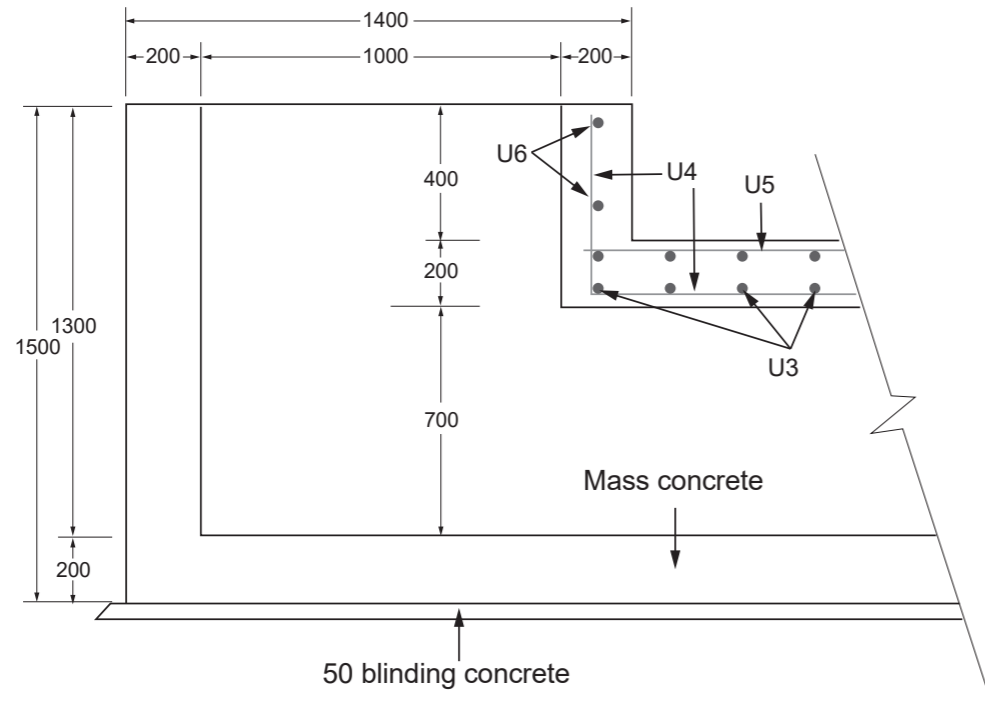
Standard Drawing 16: Mass Concrete Relief Culvert (700 x 900) – Reinforcement Layout



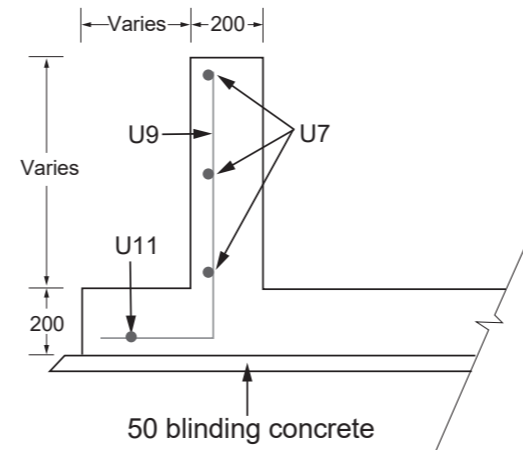
Plan - Deck slab details



Section B-B through deck



Section D-D through catchpit



Section E-E through wing wall

Location	Bar Code	Bar type	Ø (mm)	Shape
Culvert Wall	U1	DB [deformed Bar or Ribbed]	12	
Culvert Wall	U2	DB [deformed Bar or Ribbed]	12	
Deck Slab	U3	DB [deformed Bar or Ribbed]	16	
Deck Slab	U4	DB [deformed Bar or Ribbed]	12	
Deck Slab	U5	DB [deformed Bar or Ribbed]	12	
Parapet	U6	DB [deformed Bar or Ribbed]	12	
Wing Wall / Culvert Wall	U7	DB [deformed Bar or Ribbed]	16	
Wing Wall / Culvert Wall	U8	DB [deformed Bar or Ribbed]	12	
Wing Wall	U9	DB [deformed Bar or Ribbed]	12	
Wing Wall	U10	DB [deformed Bar or Ribbed]	12	
Wing Wall	U11	DB [deformed Bar or Ribbed]	12	

Bending schedule

NOTES:

- All dimensions are in millimeters unless otherwise specified.
- All angles are in degrees (360°).
- Structural concrete 28 day crushing strength = 25 MPa.
- Reinforcement shall be structural grade deformed bar (DB), with minimum yield strength 420 MPa or mild steel (RB) with minimum yield strength 250 MPa.
- Minimum depth of cover to reinforcement = 40mm.
- This 700 x 900mm Ø U culvert is the hydraulic equivalent of a 1000 x 600mm deep rectangular aperture.
- Conversion factor 1mm = 0.0394 Inches.
- Provide 20mm x 20mm chamfer to all exposed concrete corners.

PROJECT:

DATE:/...../.....

DRAWING N°:

TITLE: Typical Structures Drawing

Mass Concrete Relief Culvert (700 x 900):
Reinforcement details



REPUBLIC OF LIBERIA
Ministry of Public Works
Bureau of Rural Development
P.O. Box 9011 Monrovia

DRAWN BY

DESIGNED BY

CHECKED BY

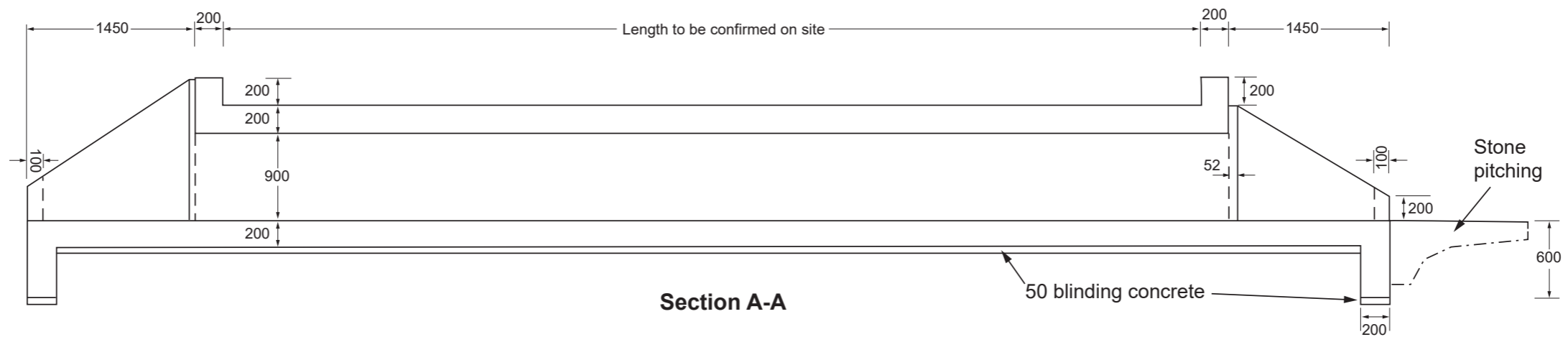
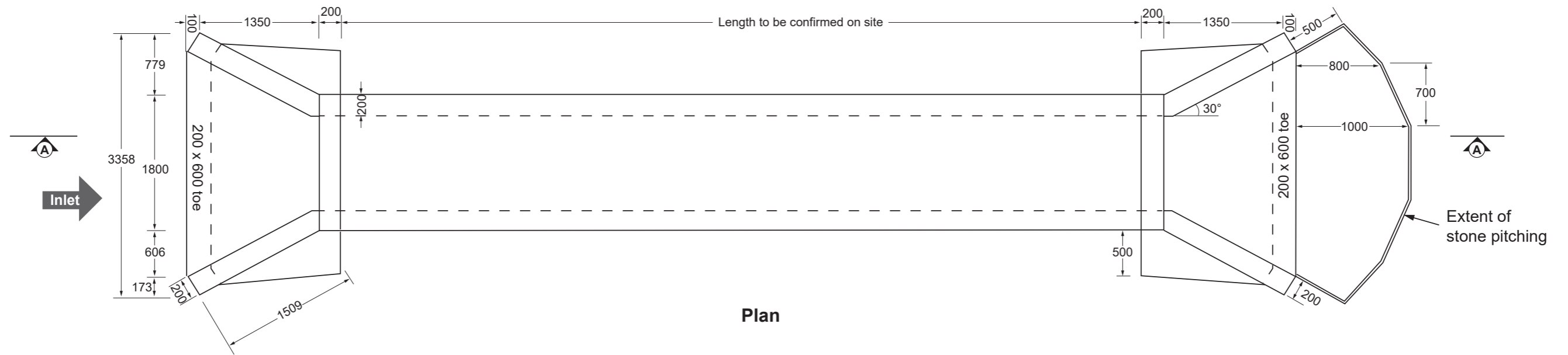
APPROVED BY


SCALE: NTS

DIMENSIONS: mm

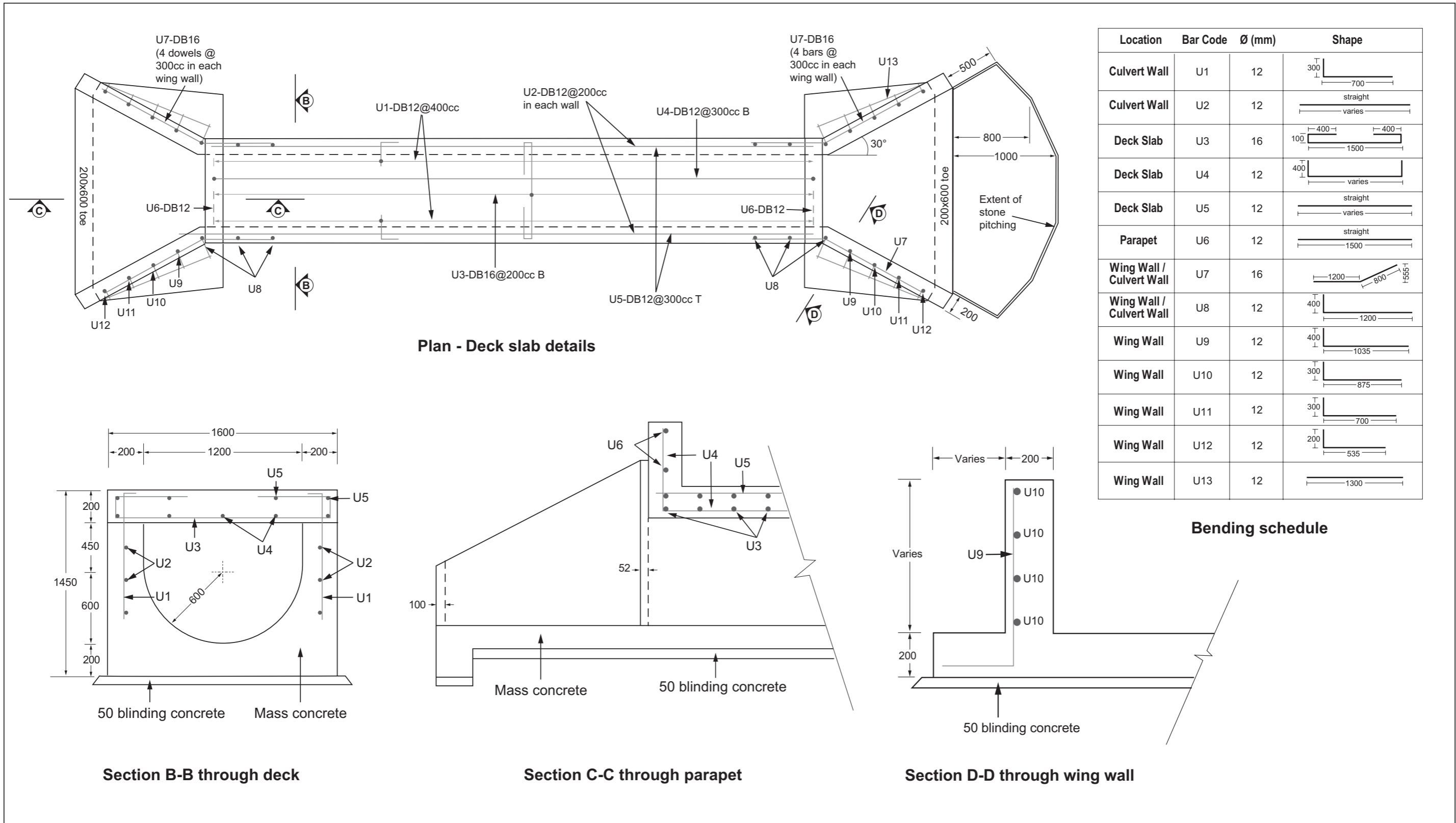
SHEET N°:

Standard Drawing 17: Mass Concrete Relief Culvert (900 x 1200) - General Layout



PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Mass Concrete Relief Culvert (900 & 1200): General layout	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
	DESIGNED BY	DIMENSIONS: mm	
	CHECKED BY	SHEET N°:	
	APPROVED BY		

Standard Drawing 18: Mass Concrete Relief Culvert (900 x 1200) – Reinforcement Layout



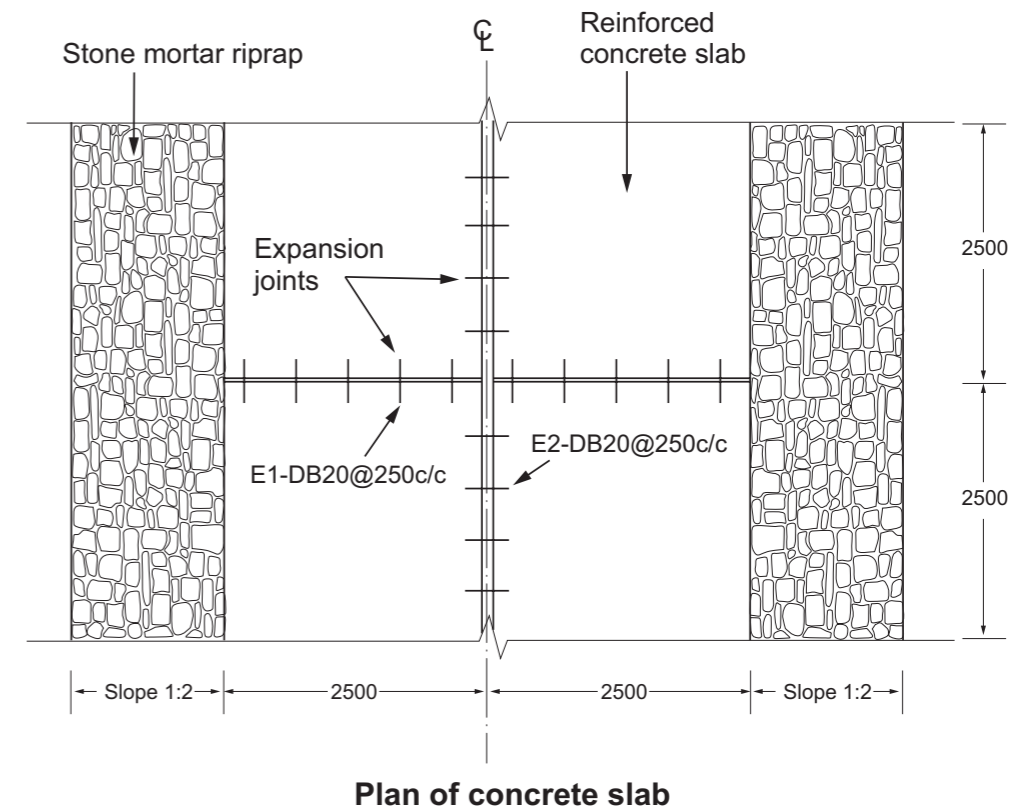
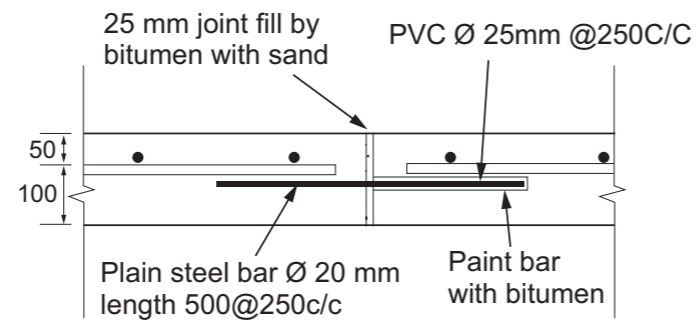
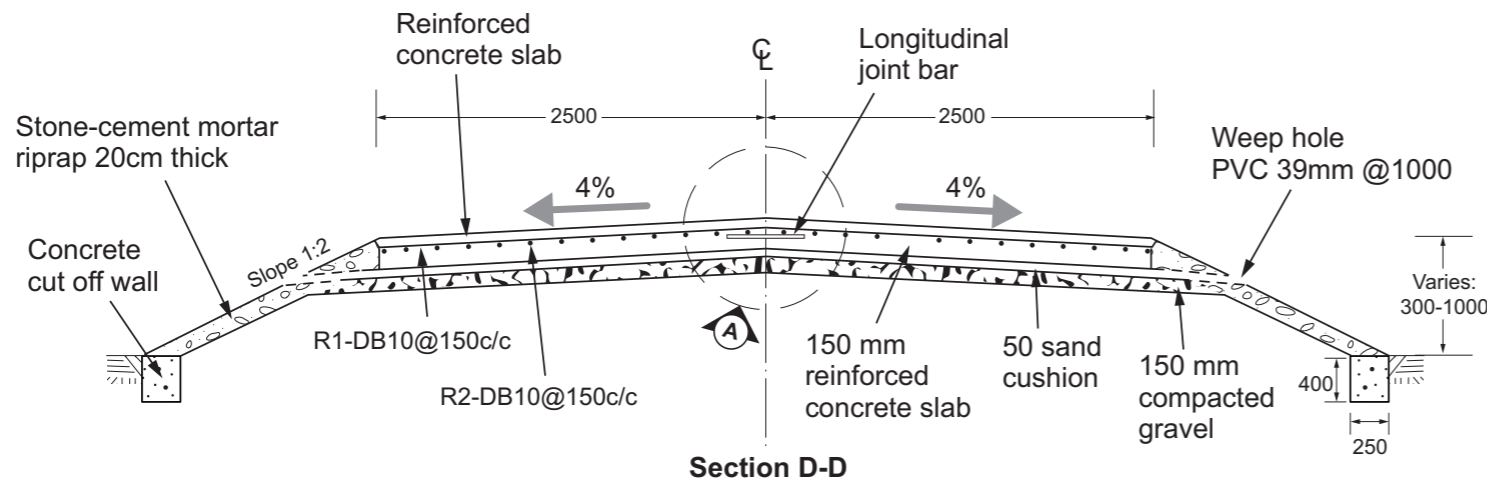
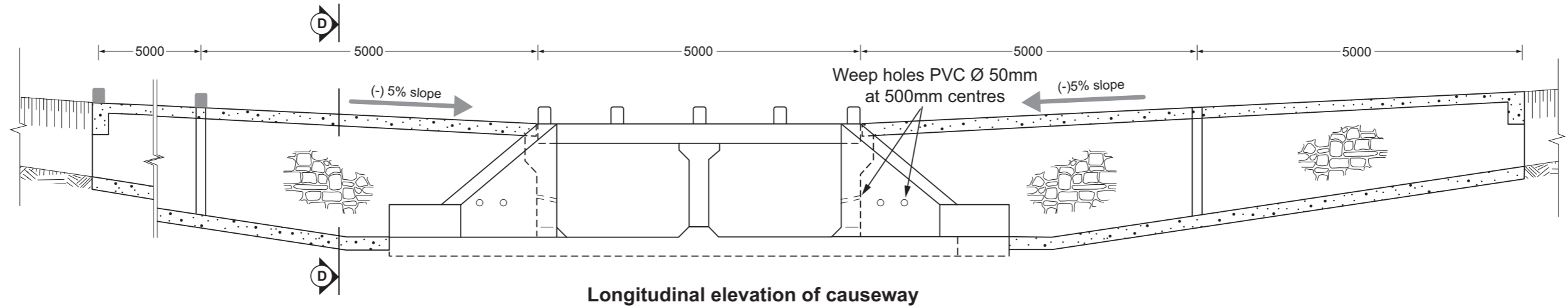
Location	Bar Code	Ø (mm)	Shape
Culvert Wall	U1	12	
Culvert Wall	U2	12	straight varies
Deck Slab	U3	16	
Deck Slab	U4	12	
Deck Slab	U5	12	straight varies
Parapet	U6	12	straight 1500
Wing Wall / Culvert Wall	U7	16	
Wing Wall / Culvert Wall	U8	12	
Wing Wall	U9	12	
Wing Wall	U10	12	
Wing Wall	U11	12	
Wing Wall	U12	12	
Wing Wall	U13	12	

Bending schedule


- NOTES:
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: All angles are in degrees (360°).
 - 3: Structural concrete 28 day crushing strength = 25 MPa.
 - 4: Reinforcement shall be structural grade deformed bar (DB), with minimum yield strength 420 MPa or mild steel (RB) with minimum yield strength 250 MPa.
 - 5: Minimum depth of cover to reinforcement = 40mm.
 - 6: This 700 x 900mm Ø U culvert is the hydraulic equivalent of a 1000 x 600mm deep rectangular aperture.
 - 7: Conversion factor 1mm = 0.0394 Inches.
 - 8: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:	DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing	Mass Concrete Relief Culvert (900 & 1200): Reinforcement layout	
REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS
	DESIGNED BY	DIMENSIONS: mm
	CHECKED BY	SHEET N°:
	APPROVED BY	

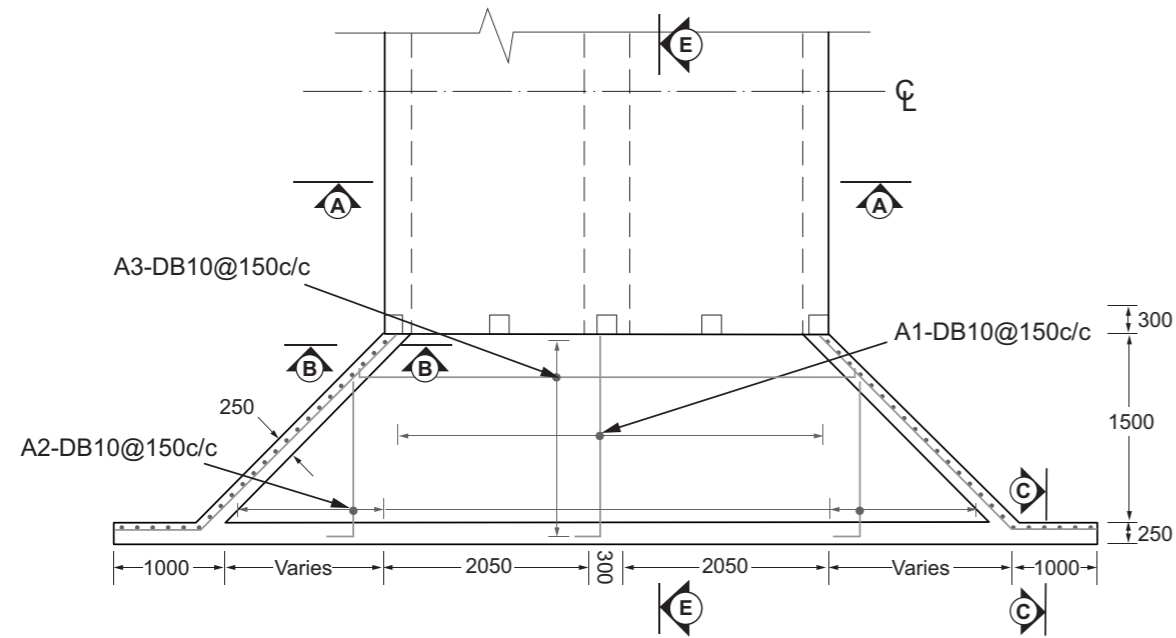
Standard Drawing 19: Vented Drift – General Arrangement



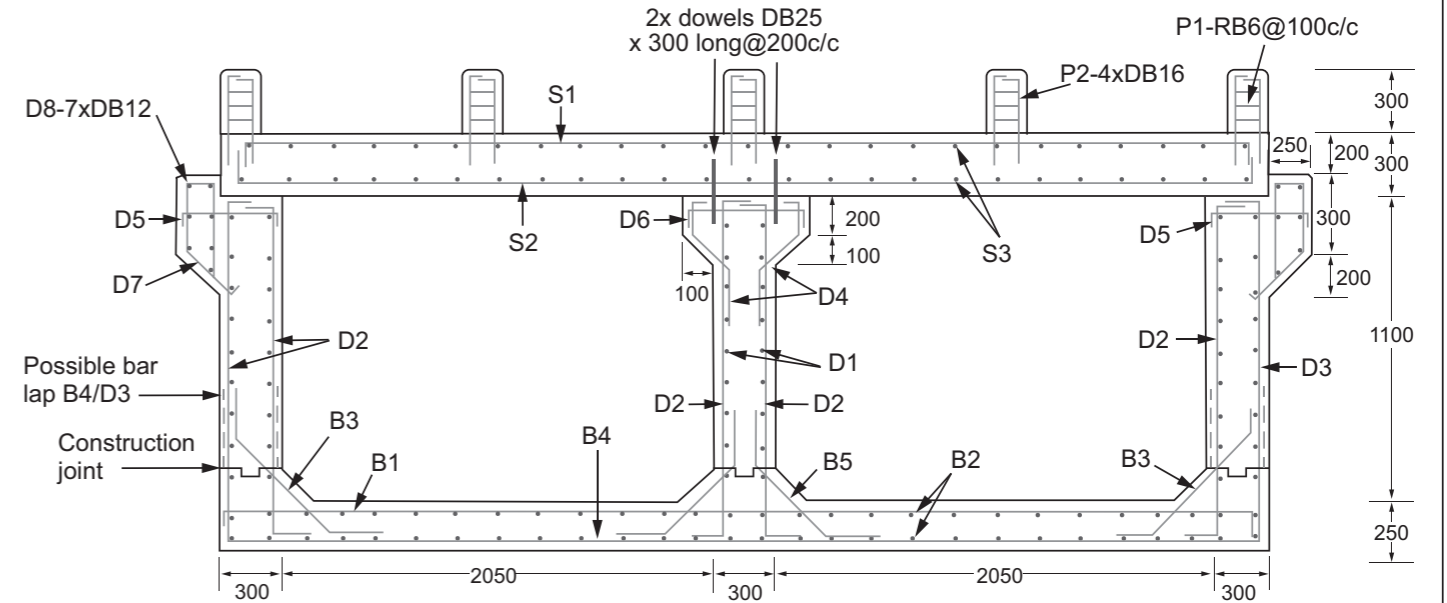
- NOTES:
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: Conversion factor. 1mm - 0.03937 Inches.
 - 3: Concrete characteristic strength at 28 days shall be: a) box and end structures: 25 MPa; b) Lean concrete: 10 MPa
 - 4: Stone and sand mix bed of ratio 1:1 shall be placed under lean concrete.
 - 5: Reinforcement shall be structural grade deformed bar (DB), with minimum yield strength 420 MPa.
 - 6: Minimum 40mm cover to reinforcement.
 - 7: Minimum bar lap shall be 50xØ of bar.
 - 8: Crushed aggregate for concrete shall not be greater than 19mm.
 - 9: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Vented Drift: General arrangement	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
	DESIGNED BY	DIMENSIONS: mm	
	CHECKED BY	SHEET N°:	
	APPROVED BY		

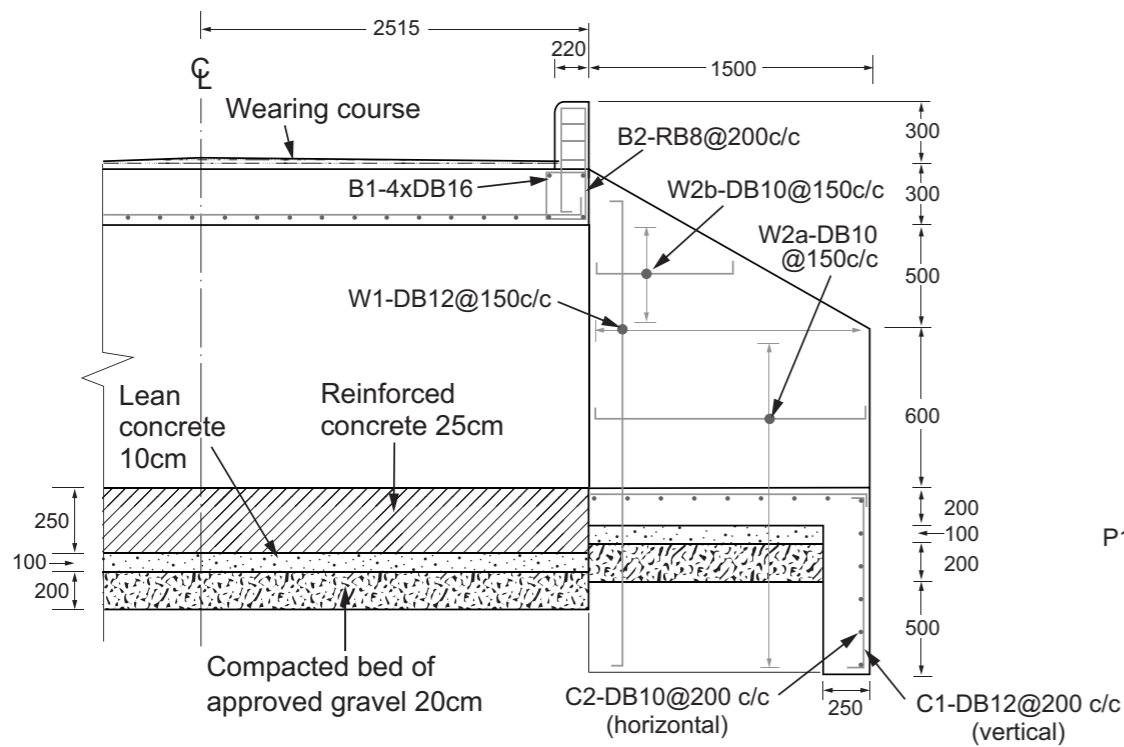
Standard Drawing 20: Vented Drift – Reinforcement Layout



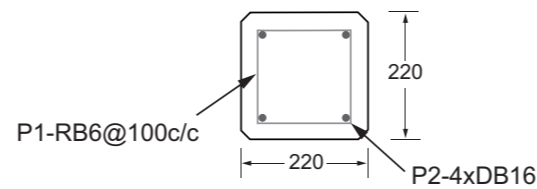
Plan of head/wing wall and apron & head/wing wall reinforcement detail



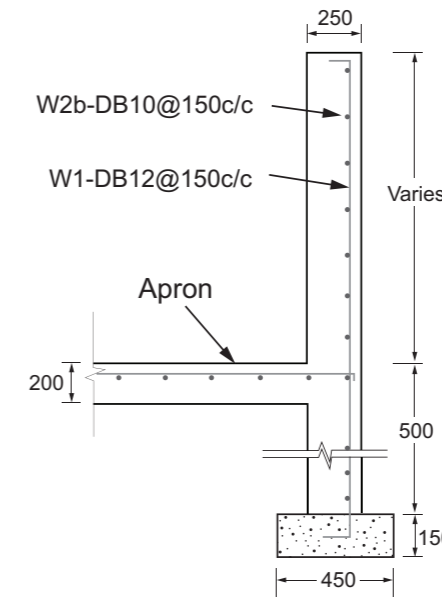
Section A-A: Reinforcement details



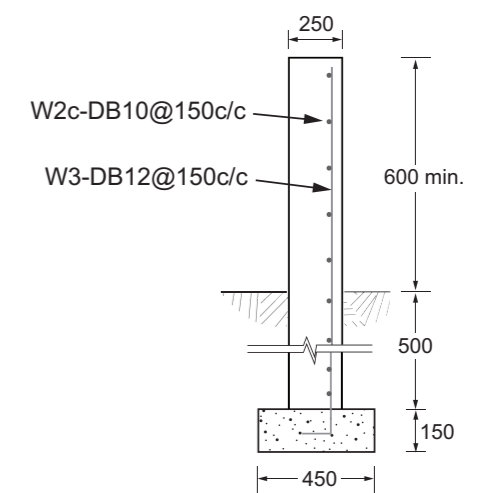
Section E-E: Culvert head/wing wall and apron reinforcement detail



Details of guard post




Section B-B



Section C-C

- NOTES:
- 1: All dimensions are in millimeters unless otherwise specified.
 - 2: Conversion factor. 1mm - 0.03937 Inches.
 - 3: Concrete characteristic strength after 28 days shall be: a) box and end structures: 25 MPa; b) Lean concrete: 10 MPa.
 - 4: Stone and sand mix bed of ratio 1:1 shall be placed under lean concrete.
 - 5: Reinforcement shall be structural grade deformed bar (DB), with minimum yield strength 420 MPa.
 - 6: Minimum 40mm cover to reinforcement.
 - 7: Minimum bar lap shall be 50xØ of bar.
 - 8: Crushed aggregate for concrete shall not be greater than 19mm.
 - 9: Provide 20mm x 20mm chamfer to all exposed concrete edges.

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Vented Drift: Reinforcement Layout	
 REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY	SCALE: NTS	
	DESIGNED BY	DIMENSIONS: mm	
	CHECKED BY	SHEET N°:	
	APPROVED BY		

Standard Drawing 21: Vented Drift – Bar Bending Schedule

Bars bending schedule for causeway

Component	Bar shape	Barmark	Ø (mm)	Spacing CC (mm)	Length of each bar (m)
Wingwalls		W1	DB 12	150	Varies
		W2a	DB 10	150	1.6
		W2b	DB 10	150	Varies
		W2c	DB 10	150	3.0
		W3	DB 12	150	Varies
Bottom slab		B1	DB 16	170	5.3
		B2	DB 16	170	5.6
		B3	DB 16	170	0.95
		B4	DB 20	170	5.3
		B5	DB 16	170	0.88
Abutment walls & middle wall		D1	DB 10	200	5.2
		D2	DB 16	170	1.5
		D3	DB 16	170	1.05
		D4	DB 14	170	0.82
		D5	DB 14	170	0.59
		D6	DB 14	170	0.64
		D7	DB 14	170	1.2
		D8	DB 14		5.2
Slab		S1	DB 20	170	5.2
		S2	DB 20	170	5.2
		S3	DB 12	200	5.0
Edge beam		B1	RB8	200	0.6
		B2	DB 16		5.0

Note: DB 12-Deformed Bar, Dia 12mm, RB 10-Round Bar, Dia 10mm

Component	Bar shape	Barmark	Ø (mm)	Spacing CC (mm)	Length of each bar (m)
Aprons		A1	DB 10	150	1.5
		A2	DB 10	150	Varies
		A3	DB 10	150	Varies
Cut off walls		C1	DB 12	200	1.0
		C2	DB 10		7.3
Post guard		P1	RB6	100	0.6
		P2	DB 16		0.55
Rcc slab approach		R1	DB 10	150	2.5
		R2	DB 10	150	2.5
Extension joint		E1	DB 20	250	0.5
		E2	DB 20	250	0.5

Note: DB 12-Deformed Bar, Dia 12mm, RB 10-Round Bar, Dia 10mm

PROJECT:		DATE:/...../.....	DRAWING N°:
TITLE: Typical Structures Drawing		Vented Drift: Bar bending schedule	
REPUBLIC OF LIBERIA Ministry of Public Works Bureau of Rural Development P.O. Box 9011 Monrovia	DRAWN BY		SCALE: NTS
	DESIGNED BY		DIMENSIONS: mm
	CHECKED BY		SHEET N°:
	APPROVED BY		