armtec

A division of
WGI Westman Group Inc.

MultiPlate

Versatile bridge and culvert products made of curved corrugated steel-plates.

MultiPlate

MultiPlate a has a proven history of performance dating back to 1932.

MultiPlate is a versatile and economical bridge and culvert product that can be custom designed for almost any application. This Structural Plate Corrugated Steel Pipe (SPCSP) component system is made of specially designed curved and corrugated galvanized steel plates with optional polymer coating. Structures are easily assembled in the field and installed using light construction equipment. Spans up to 8.5 metres are available, depending on shape geometry. For shorter span applications, Mini MultiPlate is offered in diameters from 800 mm to 3,600 mm. **Our automated manufacturing process is the first of its kind to produce SPCSP with unprecedented consistency, increased efficiency and improved quality.**

Choosing a MultiPlate buried soil-steel structure eliminates the bridge deck, approach slabs and expansion joints common in traditional bridge design, significantly reducing maintenance and total life cycle costs. MultiPlate is most commonly used as the steel element of a buried soil-steel structure, but it can also be part of free-standing structures such as rock fall protection and portals, conveyer tunnels, aggregate storage bins, water intakes, caissons and more. Strata-CAT polymer coating is available for added protection in corrosive or acidic environments. With so many options available, you can count on MultiPlate to stand up to your most challenging demands.

TYPICAL APPLICATIONS

- Culverts
- Underpasses
- Conveyor Tunnels
- Bridges
- Storm Sewers
- Caissons
- Mining Gangways and Portals
- Stream Crossings
- Intakes
- Soil Void Forms
- Aerial Galleries
- Roof Ventilators
- Power Plant Discharge Lines
- Storage Bins

VARIETY OF OPTIONS

- A variety of shapes and sizes as well as custom structures available
- Strata-CAT polymer coating can be applied for additional corrosion protection

TRANSPORTATION EFFICIENCY

- Shipped in component form, nested on trucks or in containers

EASY INSTALLATION

- No specialized lifting equipment, tools or skills required
- Structures can be shop assembled and shipped as pre-finished units

OPTIMIZED DESIGN

- Engineered and manufactured to meet your specific project needs
- Plate thickness varies to accommodate applied loads

CUSTOM FABRICATIONS AVAILABLE

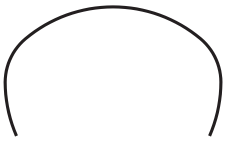
OUR ADVANCED MANUFACTURING PROCESSES ENSURE PRODUCT CONSISTENCY

SHAPES

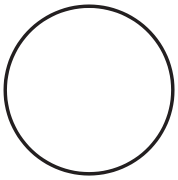
MultiPlate is available in a variety of shapes. Armtec can assist in shape and geometry selection based on project requirements for optimum span-to-rise ratio, clearance box analysis, cover height requirements and plate thickness. Custom shapes are also available from Armtec.

Single Radius Arch: This shape is commonly used for stream crossings, culverts and stormwater drains. Its open-bottom configuration makes it 'fish-friendly', minimizing disruption to the aquatic habitat and maintaining the natural stream bed.

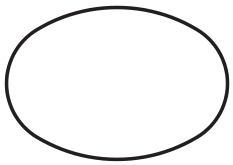
Low Profile Arch: Ideal for culverts, bridges and underpasses where overhead clearance is limited, the Low Profile Arch also maintains the natural stream bed.



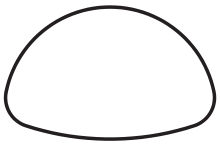
High Profile Arch: This shape is suitable for locations requiring large end areas or spans, where headroom is not restricted including culverts and bridges. It is also used for highway grade separations.



Round: The round shape is most commonly used for culverts, stream crossings and stormwater drains, especially where there are high cover requirements. It is also suitable for vehicular and pedestrian tunnel applications.

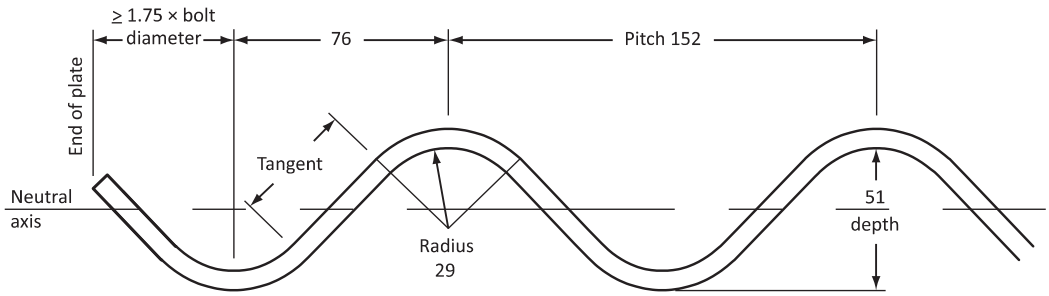


Elliptical: This shape is commonly used for vehicle and railway underpasses or service tunnels. Horizontal ellipses are best suited for low headroom multi-lane traffic applications; vertical ellipses for railway underpasses.



Pipe Arch: The Pipe Arch has a hydraulic advantage at low flow levels. It is a good choice for culverts, storm sewers, underpasses and stream crossings with limited headroom.

Corrugation Profile



COATINGS

Armtec MultiPlate is available in a number of coating options to accommodate different environmental parameters and design service life (DSL) requirements. MultiPlate components are hot-dip galvanized in accordance with CSA Standard G401 to provide a durable and corrosion resistant coating and can be applied in two different thicknesses (915 g/m^2 and 1220 g/m^2).

For extended service life and performance, Strata-CAT coating provides a two-coat polymer coating system. The base coat is a zinc-rich layer that provides outstanding corrosion resistance while the top-coat polymer layer provides superior resistance against impact, corrosion, abrasion and diluted inorganic acid or alkali. The Strata-CAT system is designed to provide a service life between 75 and 100 years, depending on environmental parameters.

STRATA-CAT POLYMER COATING PROVIDES EXTRA PROTECTION IN AGGRESSIVE ENVIRONMENTS

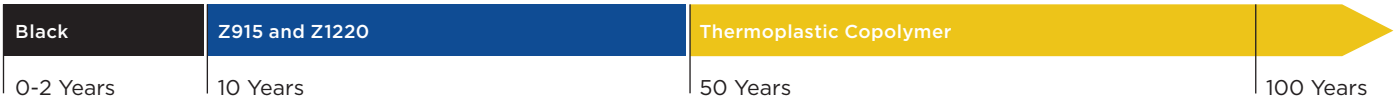
THE OPEN BOTTOM ARCH PRESERVES THE AQUATIC HABITAT

Environmental Limits for Galvanized Steel and Thermoplastic Copolymer Coated Steel

Environmental Parameter	Suggested Limits Galvanized Steel	Suggested Limits for Thermoplastic Copolymer Coated Steel		
		50 Year EMSL	75 Year EMSL	100 Year EMSL
pH Preferred Range	5 - 9	3 to 12	4 to 9	5 to 9
Resistivity[1]	2,000 - 8,000 ohm-cm	> 100 ohm-cm	> 750 ohm-cm	> 1,500 ohm-cm
Chlorides	< 250 ppm	NA[1]	NA[1]	NA[1]
Sulfates	< 600 ppm	NA[1]	NA[1]	NA[1]
Hardness	> 80 ppm $CaCO_3$	NA[1]	NA[1]	NA[1]

[1]Resistivity is relative to total dissolved solids (TDS) and therefore may indicate the presence of chlorides, sulfates, calcium and other ions.

Estimated Material Service Life (Typical Ranges)[2]



[2]Actual estimated material service life (EMSL) is dependent on local environment conditions

DESIGN STANDARDS

Canadian Highway Bridge Design Code (CHBDC)

Introduced in 2001, Section 7 – *Buried Structures of the Canadian Highway Bridge Design Code (CAN/CSA S6)* addresses the analysis and design of soil-metal structures. The CHBDC method is based upon Limit States Design Procedures which is the recognized design standard for soil-steel structures in Canada. The full CHBDC code is available from CSA Group entitled *CAN/CSA-S6 Canadian Highway Bridge Design Code.*

American Association of State Highway and Transportation Officials (AASHTO)

The AASHTO LRFD Bridge Design Specification, Section 12 for Buried Structures and Tunnel Liners is the standard design code used in the US. It can also be used in other jurisdictions outside of Canada, or as requested by an infrastructure owner.

American Iron and Steel Institute (AISI)

While simple, easy to understand, and time-tested, the AISI design method has largely been displaced by the CHBDC method. Its use is generally limited to smaller structures, private development and non-goverment projects.

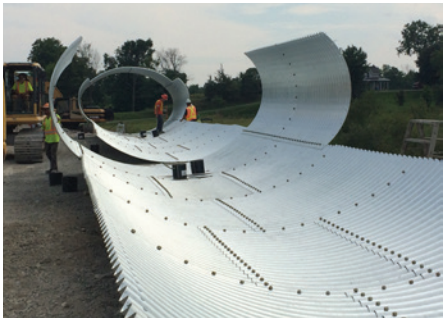
Live Loads

The most common live load is for highway vehicles in accordance with CHBDC or provincial requirements, however Armtec's in-house design expertise can provide solutions for a wide variety of loads. Live loads range from pedestrian, maintenance vehicles, standard highway vehicles and railways, plus custom applications such as special trailers, cranes and even the largest available mining haul truck.

Soil-Steel Interaction and Ring Compression Theory

Soil-steel interaction means that a flexible steel conduit (Corrugated Steel Plate or MultiPlate) acts with the surrounding soil (backfill) to support dead and live loads. In order to undertake a design using the theory of ring compression the following information is required:

- Live load
- Height or depth of cover
- Properties of the backfill [unit weight (density) and compaction level]
- Pipe shape and dimension (span and rise)



MULTIPLATE IS CUSTOM DESIGNED TO SUIT YOUR SITE-SPECIFIC JOB REQUIREMENTS

Section properties for Corrugated Structural Plate

Wall Thickness		Area	Tangent Length	Tangent Angle	Moment of Inertia	Section Modulus	Radius of Gyration
Specified	Design						
mm	mm	mm^2/mm	mm	Degrees	mm^4/mm	mm^3/mm	mm
3.0	2.84	3.522	47.876	44.531	1057.25	39.42	17.326
4.0	3.89	4.828	46.748	44.899	1457.56	53.30	17.375
5.0	4.95	6.149	45.582	45.286	1867.12	66.98	17.425
6.0	6.00	7.461	44.396	45.686	2278.31	80.22	17.475
7.0	7.00	8.712	43.237	46.083	2675.11	92.56	17.523

Dimensions are subject to manufacturing tolerances.

END TREATMENTS

End treatments for MultiPlate structures may be required or desirable for many reasons. These may include enhanced hydraulics, slope retention, aesthetics and protection against erosion, scour, piping, uplift, and ice damage.

SHEET PILE CUT-OFF WALLS

These are designed to prevent piping and scour at the inlet and outlet of pipes. They extend below the invert of the pipe, and up to one diameter width on each side. Normally cut-off walls do not extend above the spring line, and in the case of bevelled end pipes do not extend above the top of the bottom step of the bevel.

BEVELLED ENDS

These are generally provided in lengths of 3.05 m, 3.66 m or combinations of these two dimensions. Standard slopes are 1.5:1 and 2:1. Bevelled ends require additional structural support such as a concrete collar, tiebacks or thicker end plates. Special configurations are available upon request.

NOTE:
All headwalls may be configured with or without wingwalls.

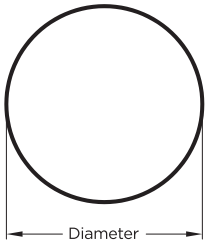
CAST-IN-PLACE HEADWALL WITH SEGMENTAL BLOCK RETAINING WING WALL

SHEET PILE HEADWALL

BEVELLED END WITH REINFORCED CONCRETE COLLAR

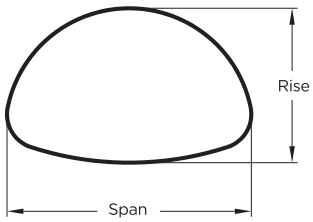
SIZES AND SHAPES

Round Pipe



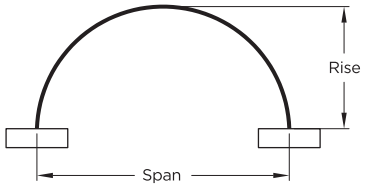
Structure	Diameter	End Area
mm	mm	m²
MP-RP-1	1,500	1.77
MP-RP-2	1,660	2.16
MP-RP-3	1,810	2.58
MP-RP-4	1,970	3.04
MP-RP-5	2,120	3.54
MP-RP-6	2,280	4.07
MP-RP-7	2,430	4.65
MP-RP-8	2,590	5.26
MP-RP-9	2,740	5.91
MP-RP-10	3,050	7.32
MP-RP-11	3,360	8.89
MP-RP-12	3,670	10.61
MP-RP-13	3,990	12.47
MP-RP-14	4,300	14.49
MP-RP-15	4,610	16.66
MP-RP-16	4,920	18.99
MP-RP-17	5,230	21.46
MP-RP-18	5,540	24.08
MP-RP-19	5,850	26.86
MP-RP-20	6,160	29.79
MP-RP-21	6,470	32.87
MP-RP-22	6,780	36.10
MP-RP-23	7,090	39.48
MP-RP-24	7,400	43.01
MP-RP-25	7,710	46.70
MP-RP-26	8,020	50.53

Pipe Arch



Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-PA-1	2,060	1,520	2.49
MP-PA-2	2,240	1,630	2.90
MP-PA-3	2,440	1,750	3.36
MP-PA-4	2,590	1,880	3.87
MP-PA-5	2,690	2,080	4.49
MP-PA-6	3,100	1,980	4.83
MP-PA-7	3,400	2,010	5.28
MP-PA-8	3,730	2,290	6.61
MP-PA-9	3,890	2,690	8.29
MP-PA-10	4,370	2,870	9.76
MP-PA-11	4,720	3,070	11.38
MP-PA-12	5,050	3,330	13.24
MP-PA-13	5,490	3,530	15.10
MP-PA-14	5,890	3,710	17.07
MP-PA-15	6,250	3,910	19.18
MP-PA-16	7,040	4,060	22.48
MP-PA-17	7,620	4,240	25.27

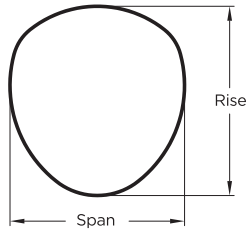
Arch



Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-A-1	1,520	810	0.98
MP-A-2	1,830	840	1.16
MP-A-3	1,830	970	1.39
MP-A-4	2,130	860	1.39
MP-A-5	2,130	1,120	1.86
MP-A-6	2,440	1,020	1.86
MP-A-7	2,440	1,270	2.42
MP-A-8	2,740	1,180	2.46
MP-A-9	2,740	1,440	3.07
MP-A-10	3,050	1,350	3.16
MP-A-11	3,050	1,600	3.81
MP-A-12	3,350	1,360	3.44
MP-A-13	3,350	1,750	4.65
MP-A-14	3,660	1,520	4.18
MP-A-15	3,660	1,910	5.48
MP-A-16	3,960	1,680	5.02
MP-A-17	3,960	2,060	6.50
MP-A-18	4,270	1,840	5.95
MP-A-19	4,270	2,210	7.43
MP-A-20	4,570	1,870	6.41
MP-A-21	4,570	2,360	8.55
MP-A-22	4,880	2,030	7.43
MP-A-23	4,880	2,520	9.75
MP-A-24	5,180	2,180	8.55
MP-A-25	5,180	2,690	11.06
MP-A-26	5,490	2,210	9.01
MP-A-27	5,490	2,720	11.71
MP-A-28	5,790	2,360	10.22
MP-A-29	5,790	2,880	13.01
MP-A-30	6,100	2,530	11.52
MP-A-31	6,100	3,050	14.59

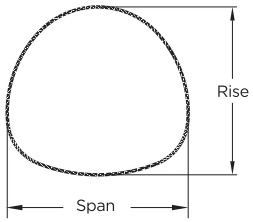
SIZES AND SHAPES

Pear Shape



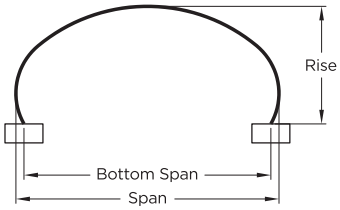
Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-PS-1	7,210	7,820	44.69
MP-PS-2	7,570	8,430	50.54
MP-PS-3	8,360	8,230	53.70
MP-PS-4	8,100	8,610	54.91
MP-PS-5	8,560	8,480	57.97
MP-PS-6	7,320	8,530	48.87

Pedestrian Underpass



Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-PU-1	3,745	3,330	10.00
MP-PU-2	3,985	3,695	11.80
MP-PU-3	4,115	3,985	13.27
MP-PU-4	4,515	4,095	14.67
MP-PU-5	4,735	4,375	16.75
MP-PU-6	4,995	4,710	19.05
MP-PU-7	5,255	4,845	20.83
MP-PU-8	5,505	5,235	23.33
MP-PU-9	5,960	5,415	26.23
MP-PU-10	6,285	5,685	29.07

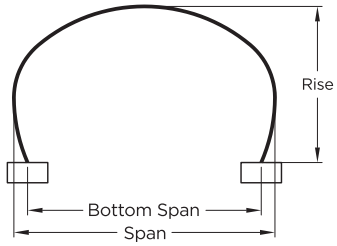
Low Profile Arch



Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-LPA-1	5,920	2,080	9.75
MP-LPA-2	6,120	2,290	11.18
MP-LPA-3	6,550	2,360	12.39
MP-LPA-4	6,780	2,410	13.01
MP-LPA-5	7,010	2,440	13.64
MP-LPA-6	7,240	2,490	14.29
MP-LPA-7	7,470	2,540	14.94
MP-LPA-8	7,670	2,570	15.62
MP-LPA-9	7,900	2,620	16.3
MP-LPA-10	8,310	3,280	22.04

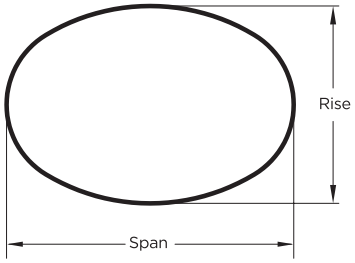
SIZES AND SHAPES

High Profile Arch



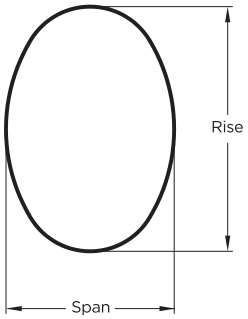
Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-HPA-1	6,300	3,680	19.85
MP-HPA-2	6,550	3,560	19.93
MP-HPA-3	6,780	3,610	20.85
MP-HPA-4	7,010	3,660	21.78
MP-HPA-5	7,240	3,680	22.71
MP-HPA-6	7,670	3,740	24.61
MP-HPA-7	7,870	4,655	31.56
MP-HPA-8	8,100	4,650	32.78
MP-HPA-9	8,560	5,020	36.92
MP-HPA-10	8,590	4,630	34.09

Horizontal Ellipse



Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-HE-1	1,630	1,350	1.74
MP-HE-2	2,130	1,420	2.41
MP-HE-3	2,540	1,630	3.24
MP-HE-4	2,790	1,630	3.57
MP-HE-5	2,900	1,930	4.36
MP-HE-6	3,200	2,260	5.64
MP-HE-7	3,760	2,260	6.62
MP-HE-8	3,680	2,440	6.85
MP-HE-9	4,420	2,790	9.78
MP-HE-10	4,826	3,429	12.86
MP-HE-11	5,156	3,683	14.87
MP-HE-12	5,283	3,531	14.59
MP-HE-13	5,715	3,988	18.08
MP-HE-14	6,120	3,960	18.77
MP-HE-15	6,230	3,840	18.40
MP-HE-16	6,460	3,910	19.42
MP-HE-17	6,680	3,990	20.49
MP-HE-18	7,010	4,290	23.15
MP-HE-19	7,470	4,470	25.49
MP-HE-20	7,950	5,540	34.25
MP-HE-21	8,280	5,820	37.59
MP-HE-22	8,560	5,210	34.28

Vertical Ellipse



Structure	Span	Rise	End Area
mm	mm	mm	m²
MP-VE-1	2,310	2,570	4.63
MP-VE-2	2,460	2,740	5.24
MP-VE-3	2,620	2,900	5.89
MP-VE-4	2,920	3,230	7.30
MP-VE-5	3,200	3,560	8.86
MP-VE-6	3,580	3,890	10.57
MP-VE-7	3,810	4,220	12.42
MP-VE-8	4,140	4,570	14.41
MP-VE-9	4,340	4,830	16.60
MP-VE-10	4,650	5,160	18.92
MP-VE-11	4,950	5,460	21.38
MP-VE-12	5,260	5,820	23.99
MP-VE-13	5,540	6,120	26.75
MP-VE-14	5,840	6,450	29.67
MP-VE-15	6,120	6,780	32.74

INSTALLATION

Fabricated from factory-curved corrugated steel plates, MultiPlate is a field-assembled flexible soil-steel structure. As with any buried structure, proper installation is critical in providing long-term and worry-free performance. In practical terms, installation can be broken into three major operations:

1. FOUNDATION PREPARATION

Soil-steel structures depend upon the inherent flexibility of the steel shell to accommodate small deflections and fully mobilize the support of the granular backfill.

Under Haunches

A compressible soil cushion is installed under the invert of the pipe to allow the corrugations to settle into the granular material. Special attention must be paid to the area beneath the haunches of a full periphery pipe in order to provide full support. Hand tamping using rods may be required at these points.

Pipe Arch

Pipe arches generate radial corner pressures that are greater than the applied pressure at the bottom of the structure.

Arches

Plates are secured to a concrete or corrugated metal strip footing using an unbalanced channel supplied by Armtec.

2. ASSEMBLY

MultiPlate assembly is accomplished by bolting adjacent longitudinal and circumferential plates to form the full length and circumference of the structure. All structures are supplied with assembly drawings showing the correct positioning of the plates, plate lapping details, as well as comprehensive backfilling instructions.

Field Construction

Assembly may be undertaken plate-by-plate, or by sub-assembling arcs of the structure before lifting into the excavation to minimize field construction time.

Typical assembly tools

- Spud wrenches
- Clevises
- Cables and slings
- Air impact tools
- Turnbuckles
- Eyebolts
- Alignment pins, prybars

3. BACKFILL AND COMPACTION

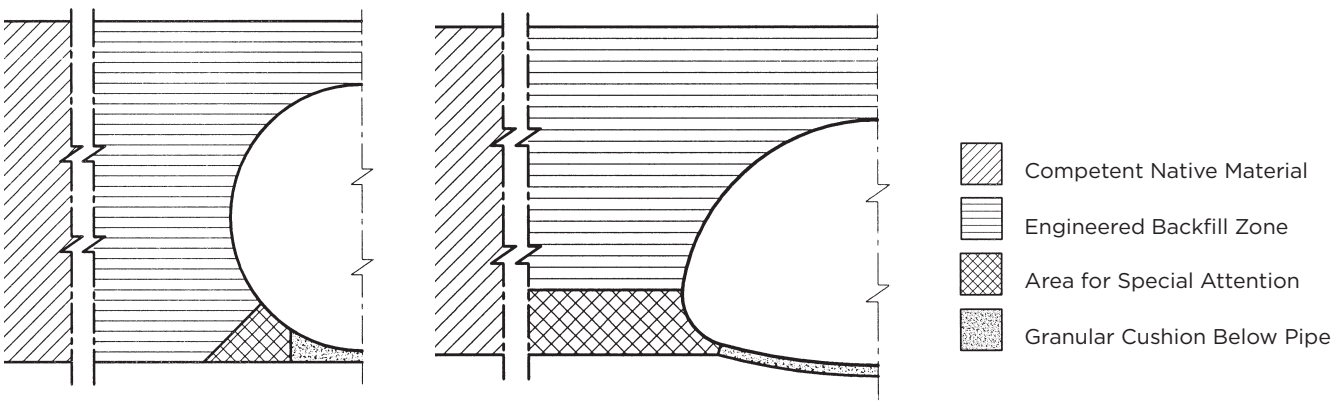
Free draining granular materials shall be used in the engineered backfill envelope. Backfill shall be placed in 200 mm lifts and compacted to a minimum of 95% Standard Proctor Dry Density.

Typical equipment required for backfilling in critical backfill zone

- Small tracked/wheeled equipment for spreading
- Walk-behind compactor
- Vibrating plate tampers
- Ride-on compactor up to 15 tonnes (where feasible)
- Tracked equipment for spreading material when backfill is more than 1.5 m above structure
- Water supply
- Shovels/rakes/other equipment as appropriate for available manpower
- Material supply by truck as required

NOTE:
Armtec Recommended Installation Guidelines are provided for assembling MultiPlate. Drawings, including the granular cushion, haunch and foundation treatment details for pipe arches; the unbalanced channel and footing details for arches, are provided to account for project specific requirements.

SPECIAL INSTALLATION CONSIDERATIONS



Typical Specification for MultiPlate Structure

1. General

1.1 This specification is for_____[number of structures] of _____mm span x_____mm rise galvanized Armtec MultiPlate structure[s]. The length is_____m with a nominal plate thickness of_____mm.

1.2 Armtec shall submit MultiPlate Assembly Drawings and Installation Guidelines prior to the commencement of construction.

1.3 Armtec Installation Guidelines are intended to be used in conjunction with the project specifications and are not to supersede them.

1.4 Assembly and backfilling shall follow Armtec's recommendations as described on the approved shop drawings and the contract requirements.

1.5 All earthworks, de-watering, site works and plate assembly are performed by the contractor.

1.6 Monitoring compliance and inspection of works shall be the responsibility of the Owner's Project Management team.

2. Products

2.1 Design of the MultiPlate shall follow the Canadian Highway Bridge Design Code CAN/CSA-S6.

2.2 Manufacturing of the MultiPlate shall be fabricated in accordance with CSA G401 Corrugated Steel Pipe Products.

2.3 Each MultiPlate sheet shall be hot dip galvanized in accordance with CSA G401 with a zinc mass as specified in CSA G401 unless an alternate coating mass is specified.

3. Basis of Design

3.1 Strength requirements for wall strength, buckling strength, seam strength, construction bending and compression strength, shall be analyzed and designed in accordance with Section Seven of the CAN/CSA-S6 code for soil-metal structures. Rigorous method of analysis is used for technically demanding complex applications.

3.2 The governing live load shall be the maximum live load induced on the structure during its natural service life.

3.3 Design unit weight of soil used over the structure for the complete range of minimum to maximum cover shall be 22 kN/m^3, or as specified by the owner.

3.4 The design service life shall be specified and designed in accordance with the AASHTO corrosion model and CSPI Performance Guidelines.

4. Assembly of Plates

4.1 Offloading of the MultiPlate at the job site is the responsibility of the Owner or contractor.

4.2 The Owner, during plate assembly and placement of backfill, shall provide a dry and accessible work site and excavation area.

4.3 A qualified contractor, who has a minimum of five years experience in similar work, shall perform the MultiPlate assembly.

4.4 The structure shall be assembled in accordance with the Armtec Assembly Instructions provided.

4.5 Bolting must be done with the curved surface of the nut against the plate.

4.6 Before backfilling, all bolts shall be tightened to a torque between 200 and 350Nm (150 to 250ft-lbs).

5. Winter Construction

5.1 Winter construction shall be avoided whenever possible.

5.2 If winter construction is required, special conditions for cold weather construction must be followed in accordance with the owner's geotechnical engineer and industry standards.

NOTE:
Polymer coating can be specified as per the Strata-CAT product guide. Please contact an Armtec representative for more information.

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