Specification of Fixon CSP

1. Dimension of CSP

1.1 Corrugation Type

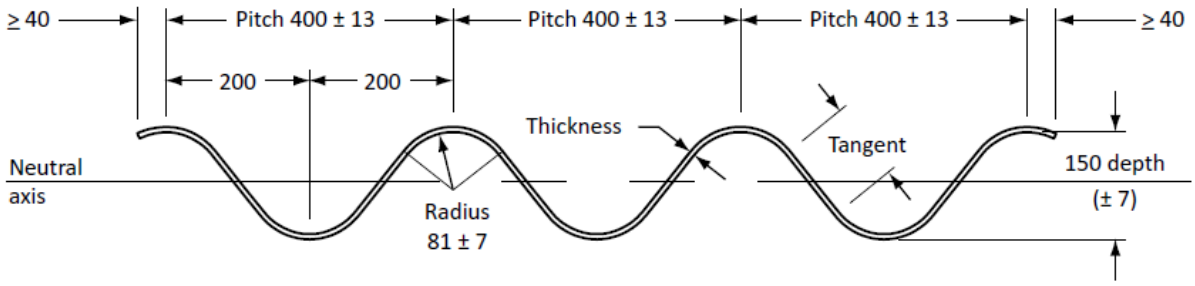
Table 1.1 - Corrugation Type

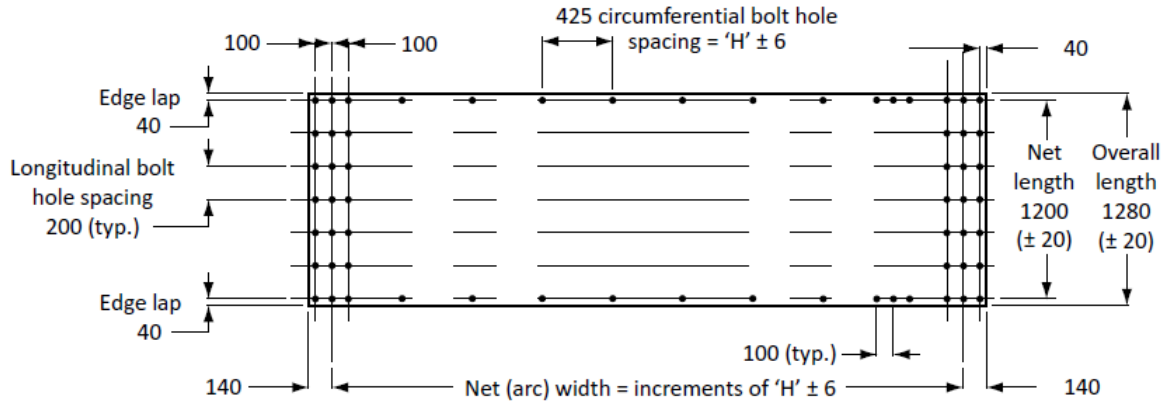
Type	Thickness (t), mm	Pitch (p), mm	Depth (d), mm	Radius (r), mm
Bridge-Plate	3.0 - 8.0	400	150	81
Supercor	3.42 - 8.0	381	140	76.2
Multi-Plate	2.7 - 7.0	150	50	28.6

Bridge-Plate and Supercor is used for heavy load condition and long span structures like open-cut tunnel, long span culvert and bridge.

Multi Plate is usually used for light load condition and shorter opening structures like pipe (a conduit having a full circular shape) and for pipe-arch (a pipe shape consisting of an approximate semi-circular top portion, small radius corners, and large radius invert).

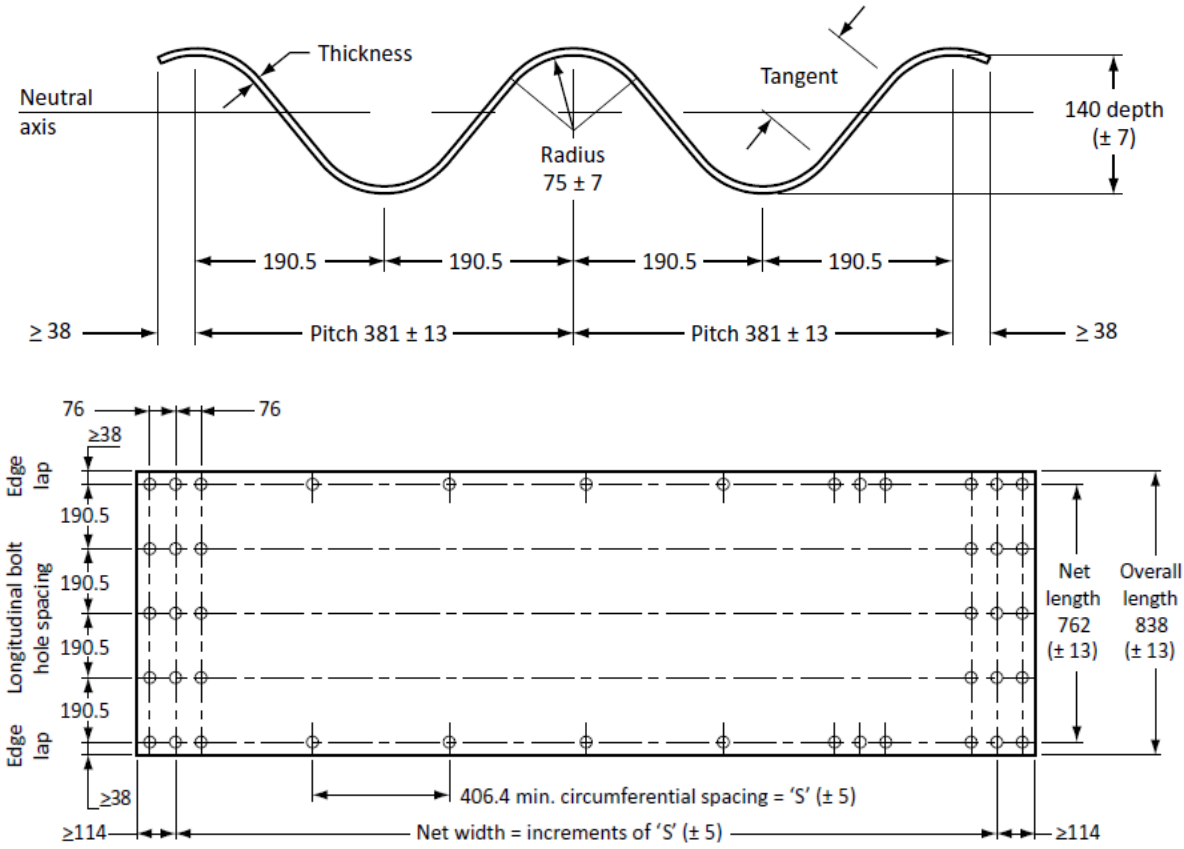
1.2 Dimension of Bridge-Plate





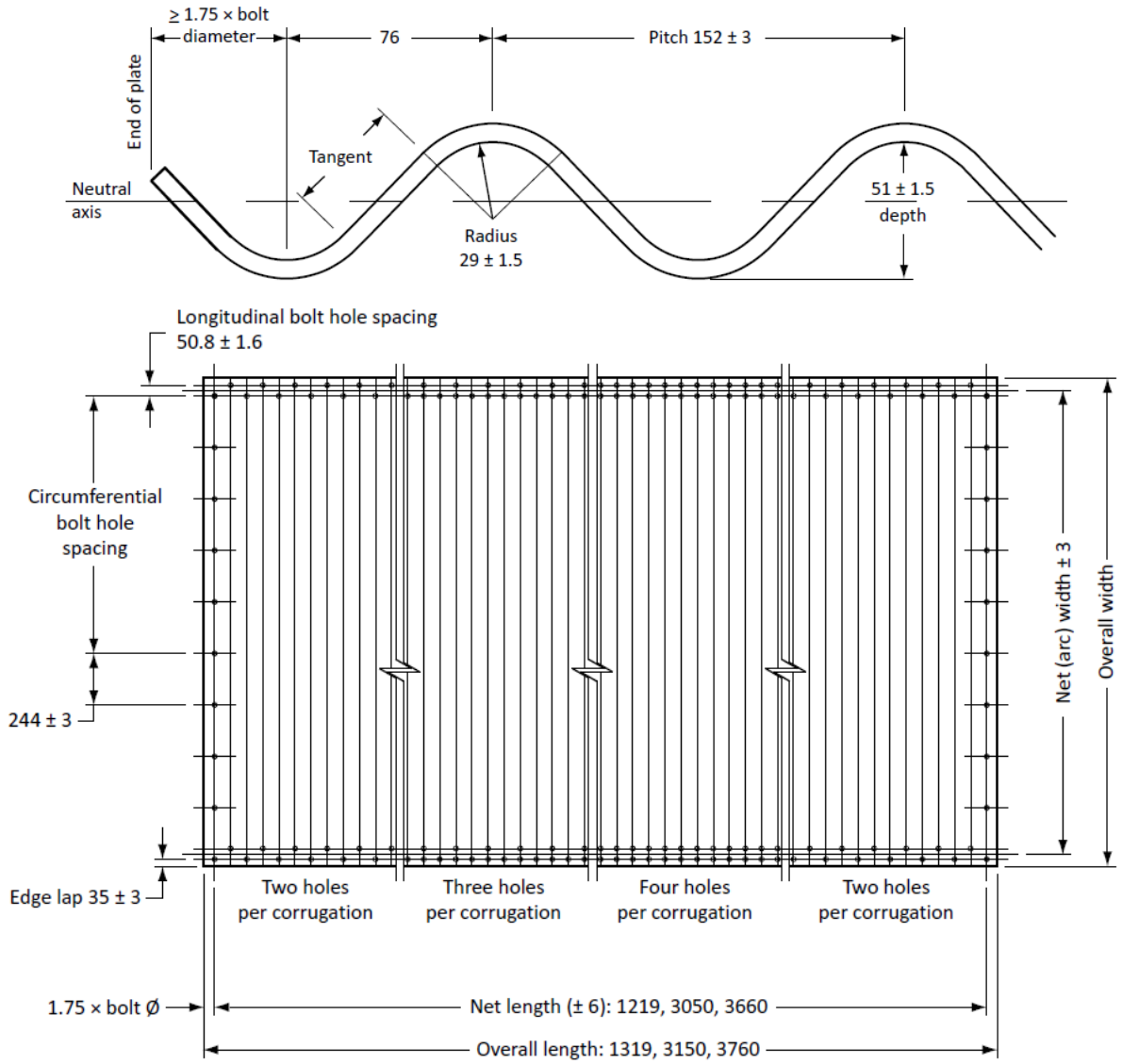
Width designation, number of hole spaces‡	Net arc width, mm	Overall width, mm	Number of circumferential bolt holes
4*H*	1700	1980	5
5*H*	2125	2405	6
6*H*	2550	2830	7
7*H*	2975	3255	8
8*H*	3400	3680	9
9*H*	3825	4105	10

1.3 Dimension of Supercor



Width designation, number of hole spaces†	Net arc width, mm	Overall width of barrel plates, mm	Minimum overall width of rib plates, mm	Number of circumferential bolt holes
1*S*	406	635	482	2
2*S*	813	1042	889	3
3*S*	1219	1448	1295	4
4*S*	1626	1855	1702	5
5*S*	2032	2261	2108	6
6*S*	2438	2667	2514	7
7*S*	2845	3074	2921	8
8*S*	3251	3480	3327	9
9*S*	3658	3887	3734	10
10*S*	4064	4293	4140	11
11*S*	4470	4699	4546	12
12*S*	4876	5105	4952	13

1.3 Dimension of Multi-Plate



Width designation, number of hole spaces*	Net arc width, mm	Overall width, mm		Number of circumferential bolt holes
		Type I†	Type II‡	
3*N*	732	859	852	4
4*N*	975	1102	1095	5
5*N*	1219	1346	1339	6
6*N*	1463	1590	1583	7
7*N*	1707	1834	1827	8
8*N*	1951	2078	2071	9
9*N*	2195	2322	2315	10
10*N*	2438	2565	2588	11
11*N*	2682	2809	2802	12
12*N*	2926	3053	3046	13
13*N*	3170	3297	3290	14
14*N*	3414	3541	3534	15
15*N*	3658	3785	3778	16
16*N*	3901	4028	4021	17

2. CSP Fabrication

2.1. Sinusoidal Corrugation

CSP shall be fabricated from flat sheets or plates, punched for bolted lap seams, and curved to the required radius. Corrugations shall form smooth continuous curves and tangents and annular rings (complete or partial) about the axis of the structure.

2.2. Plate Tolerances

The plate thickness shall be measured on the tangents of the corrugations. The thickness shall include both the base metal and the coating. The required minimum thickness of the plate must not be lesser than the specified thickness minus 0.3 mm. There is no limit on over-thickness. Cross-section dimensions, such as diameter, span and rise, and radius of curvature, shall be measured to the inside crest of corrugations. The span and rise of pipe-arch, arch, underpass, and other noncircular structures shall be as specified within ±2 %.

2.3. Bolt holes

The bolt holes shall be punched ahead of bending and plates having like dimensions, curvature, and same size and number of bolts per foot of seam can be interchangeable. Holes shall be provided as required for connecting headwall anchors, structural reinforcement, and miscellaneous attachments.
For 400 mm x 150 mm corrugations, the diameter of bolt holes in the longitudinal seams shall not exceed the bolt diameter by more than 6 mm, except for those in the plate corners and two other locations (aligned with the center hole of the group of three corner holes, and in adjacent corrugations) which will be the same as the circumferential holes. The bolt holes in the circumferential seams shall be slotted holes with a width not greater than the bolt diameter plus 5 mm and a length not greater than the bolt diameter plus 110 mm.
For 380 mm x 140 mm corrugations, the diameter of the bolt holes in the longitudinal and circumferential seams shall not exceed the bolt diameter by more than 6 mm. Where circumferential reinforcing members are used, bolt holes in such members for attachment to the corrugated plates shall be slotted, with the length of the slot oriented parallel to the crest and valley of the corrugations. Such slots shall have a width not greater than the bolt diameter plus 6 mm and a length not greater than the bolt diameter plus 12 mm.

For 150 mm x 50 mm corrugations, the diameter of the bolt holes in the longitudinal seams shall not exceed the bolt diameter by more than 3 mm except those in plate corners. Bolt holes in circumferential seams, including plate corners, shall be round holes with the diameter not exceeding the bolt diameter by more than 6 mm, or shall be slotted holes with a width equal to the bolt diameter plus three 3 mm and a length equal to the bolt diameter plus ten 10 mm.

2.4. Plate Section Properties

The plate shall conform to the requirement of 1.2a - Bridge-Plate Section Properties (400 mm x 150 mm) or by Table 419.2.2b - Multi-Plate Section Properties (150 mm x 50 mm). Thickness shall be measured on the tangents of the corrugations. The thickness shall include both the base metal and the coating.

Table 2a - Bridge-Plate Section Properties
(400 mm x 150 mm)

Specified Thickness, mm	Area of Section, A, mm^2/mm	Moment of Inertia, l, mm^4/mm	Radius of Gyration, r, mm
3.0	3.905	10,886	52.80
4.0	5.351	14,944	52.85
5.0	6.811	19,060	52.90
6.0	8.260	23,154	52.95
7.0	9.640	27,071	52.99
8.0	10.935	30,759	53.04

Table 2b - Supercor Section Properties
(381 mm x 140 mm)

Specified Thickness, mm	Area of Section, A, mm^2/mm	Moment of Inertia, l, mm^4/mm	Radius of Gyration, r, mm
3.42	4.783	11,711	49.48
4.18	5.846	14,334	49.52
4.67	6.536	16,039	49.54
5.45	7.628	18,743	49.57
6.23	8.716	21,446	49.60
7.01	9.808	24,165	49.64

Table 2c - Multi Plate Section Properties (150 mm x 50 mm)

Specified Thickness, mm	Area of Section, A, mm^2/mm	Moment of Inertia, l, mm^4/mm	Radius of Gyration, r, mm
3.0	3.522	1,057.25	17.326
4.0	4.828	1,457.56	17.325
5.0	6.149	1,867.12	17.425
6.0	7.461	2,278.31	17.475
7.0	8.712	2,675.11	17.523

3. Steel

Steel shall be produced by the electric or oxygen process.

Steel shall have the chemical composition specified in Table 1.3a - Chemical Composition of Steel.

Steel used for manufacturing structural plate products shall have the mechanical properties specified in Table 1.3b - Mechanical Properties of Structural Plate.

Table 3a - Chemical Composition of Steel

Properties	Heat analysis, % maximum	Specification
Phosphorous	0.04	ASTM A 1018/A 1018M
Sulphur	0.04	ASTM A 1018/A 1018M

Table 3b - Mechanical Properties of Structural Plate

Material	Minimum Yield Strength, MPa	Minimum Tensile Strength, MPa	Minimum Elongation in 50mm, %	Specification
Structural Steel Plate SS-(Grade 40)	275	380	19	ASTM A 1018/A 1018M
High Strength Low-Alloy Steel HSLAS-(Grade 45)	310	410	22	ASTM A 1018/A 1018M
High Strength Low-Alloy Steel HSLAS-(Grade 65)	450	550	14	ASTM A 1018/A 1018M

4. Bolts and Nuts

Bolts shall be M20 (20 mm Ø) or M22 (22 mm Ø).

Bolts and nuts shall conform to the requirements specified in *ASTM A761 / A761M -15, Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches, Table 2*. Bolts shall have sufficient length to provide at least “full nut” engagement when tightened in place.

Washers may not be required.

5. Rubber Gaskets

Gaskets shall conform to *ASTM C564 - 14 Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings* or equivalent.

6. Base Channel

The base channel on footing shall be formed in accordance with the approved plans and specifications. It shall be formed from 5 mm thick galvanized steel. The zinc coating mass (total on both sides) on the base channel shall not be less than 900 g/m^2.

Bolt holes for anchoring bearings to foundation shall be punched as shown on the plans, with a spacing that is a multiple of the structural plate pitch, but not more than 600 mm on centers. Bolt holes shall be punched in the vertical leg of bearings to match corresponding bolt holes in the bottom arch plate.

7. Anchorage Bolts and Nuts

Anchorage bolts shall be M20 in diameter.

Bolts and nuts for head wall anchorage and for anchoring arch bearings to foundation shall be fabricated as shown on the plans and shall conform to the requirements of *ASTM A761/A761M – 15, Table 2, Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches*.

Table 7 - CSP Structure Material Components

Type	Dimensions	Length (mm)	Specification
Bolts	M20, M22	55 / 75	ASTM A 761/A 761M
Nuts	M20, M22	-	ASTM A 761/A 761M
Anchor bolts	M20	225 / 305	ASTM A 761/A 761M
Base channel (Bridge-Plate)	180 x 175 x 35	3600	ASTM A 761/A 761M
Base channel (Supercor)	175 x 157 x 38	3600	ASTM A 761/A 761M
Base channel (Multi-Plate)	118 x 76 x 45	3600	ASTM A 761/A 761M

8. Coating

The zinc coating of all fabricated parts shall be as specified in *ASTM B6, Standard Specification for Zinc*. The zinc coating mass on both sides shall be not less than 910 g/m^2.

For aluminum coated CSP, it shall be in accordance to *ASTM A 463M, Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process*. In the case that aluminum coating was applied, the aluminum coating mass on both sides shall be not less than 300 g/m^2.

Plate or accessory material on which the metallic coating has been burned by welding, or has been otherwise damaged in fabricating or handling shall be repaired. The repair shall be done so that the completed material shall show careful finished workmanship in all particulars. Zinc-rich paint shall be applied to a dry film thickness of at least 0.013 mm over the damaged section and surrounding cleaned area.