

1. Components

1.1 General

Slimdek is the proprietary name for an engineered flooring system formed with ComFlor 225 deep decking spanning between Asymmetric Slimflor Beams (ASBs) and/or Rectangular Hollow Slimflor Beams (RHSFBs). The various elements of the Slimdek system are described in this section.

1.2 ComFlor® 225 decking

ComFlor 225 decking is cold formed from 1.25mm thick, zinc-coated steel to BS EN 10326^[1], -S350GD+Z275 with a design yield strength of 350N/mm². The minimum zinc coating mass is 275g/m² in total, including both sides.

ComFlor 225 can achieve spans of up to 6.5m unpropped and up to 9.6m when propped during construction. The profile has re-entrant sections at the top of the crest and at the bottom of the trough. Its geometry is defined in *Figure 1.1*. Special hangers have been developed to facilitate servicing and fixing of ceilings, see *Section 5.4*. Alternatively, services can be attached using conventional fixings.

The minimum bearing requirement for the decking is 50mm on steelwork and the deep decking must be centred to provide an equal bearing at both ends.

Additional structural support is usually required to the web of columns to take the end bearing of the decking sheet and close off gaps. This is illustrated in *Figure 2.27*. A range of end and side closures, edge trim and accessories is available to complete the deck installation.

1.2.1 Section properties

The section properties for stiffness and strength of deep deck profiles rely on the effects of the longitudinal stiffeners and transverse ribs or embossments. Even so, only a proportion of the cross-section is fully effective in bending. The elastic bending resistance of deep decks has to be established by tests, as design to BS 5950-6^[2] is not directly appropriate to such highly stiffened deep profiles. The ComFlor 225 deep deck profile is considerably more effective in bending than previous deep profiles, largely because of the re-entrant portion in the top flange. The middle portions of the web and upper flange are largely ineffective because of the influence of local buckling. The effective section of the ComFlor 225 profile is illustrated in *Figure 1.2*. Load/span data are given in *Section 3, Tables 3.1 – 3.4*.

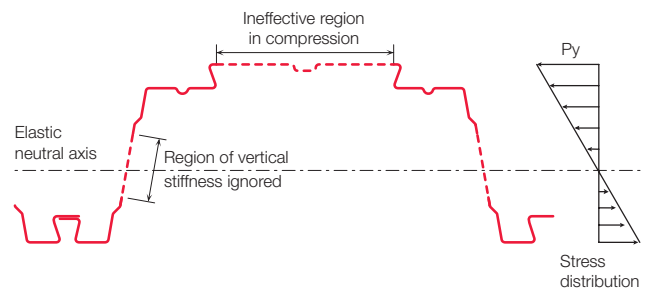


Figure 1.2 Effective section of ComFlor 225 decking

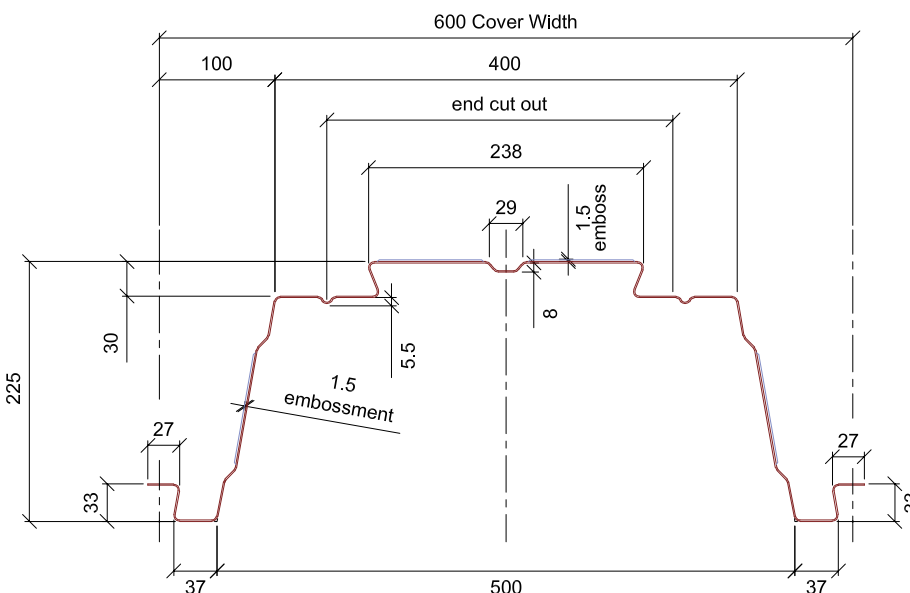


Figure 1.1 Geometry of ComFlor 225 decking

Table 1.1 ComFlor 225 properties

Nominal thickness	Design thickness	Depth profile	Weight profile	Area of steel	Height of neutral axis	Moment of inertia	Elastic modulus	Ultimate moment capacity		Shear resistance span P_v	Shear resistance end P_v	Shear resistance P_w
								Sagging	Hogging			
mm	mm	mm	kN/m ²	mm ² /m	mm	cm ⁴ /m	cm ³ /m	kNm/m	kNm/m	kN/m	kN/m	kN/m
1.25	1.21	225	0.17	2118	107	968	88.0	30.8	30.8	28.7	36.4	29.3

Yield stress = 350 N/mm²

Composite slab parameters:

$m_r = 367$ $k_r = 0.003$

m_r and k_r are empirical parameters to BS 5950-4^[3], established from six composite slab tests reduced through regression analysis for design purposes. They relate to 1.25mm thick ComFlor 225 decking in S350 steel only:

ComFlor 225 concrete volumes (nett)

Slab Depth (mm)	290	300	310	320	330	340	350	360
Nett Volume (m ³ /m ²)	0.121	0.131	0.141	0.151	0.161	0.171	0.181	0.191

Excluding casing to ASB

1.2.2 Decking accessories

1.2.2.1 End diaphragms

Deep decking is installed in single spans and located onto end diaphragms which have been pre-fixed to the lower flange of the support beams. These diaphragms are 1.6mm thick and manufactured in 1800mm lengths. In addition to locating the decking sheets and preventing loss of concrete, they provide a structural role as they resist vertical loading at the deck/support interface, allowing the full shear capacity of the decking to be utilised during the construction stage. Each diaphragm consists of three rib closures and is attached to the beam by shot-fired pins at 600mm centres. The decking is then fixed using self-drilling, self-tapping screws through the crests and the ribs. The closures must be fixed to the lower flanges of the beams at both ends of the steel work bay in advance of the decking. Each length must be fitted accurately so that the 600mm pitch of the decking section is located as shown on the decking layout drawings.

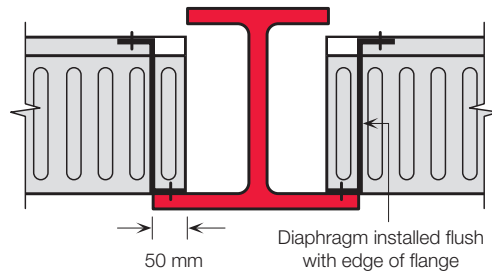


Figure 1.4 End diaphragm

1.2.2.2 Edge trims

Edge trims are usually supplied in 3m lengths of the appropriate gauge pressed steel, which may be cut down on site to suit the steelwork configuration. Each length should be fixed to the perimeter beams with the edge restraint straps fixed at 500mm centres.

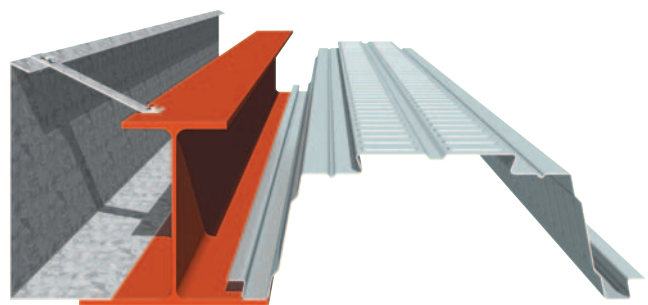


Figure 1.5 Edge trim

1.2.2.3 Closure flashing to cut decking

As buildings are not sized with a whole number of decking units in mind, it is often necessary to cut decking sheets longitudinally, particularly at tie beams or at the slab edge, to achieve the desired dimensions. In this case, a Z section is used to provide local support to the decking and to act as a closure flashing. Fixings should be at 500mm centres. Available options are illustrated in *Figure 1.6, opposite*.



Figure 1.3 Diaphragm fixing

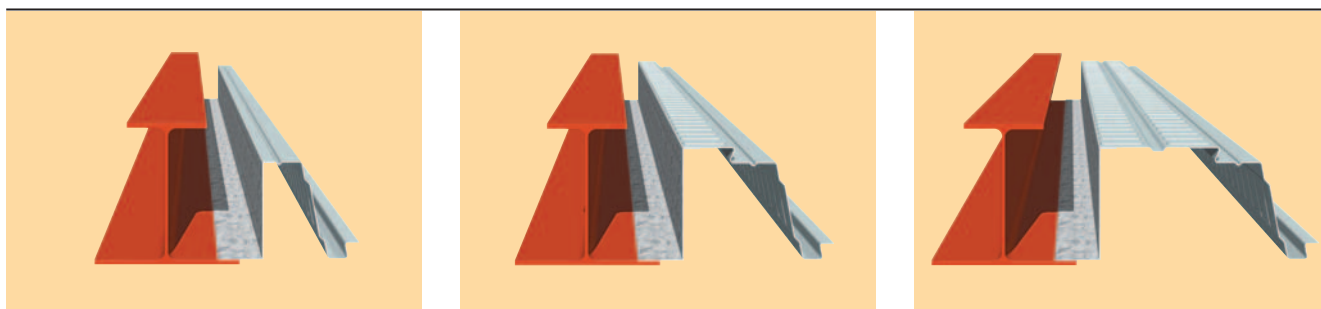


Figure 1.6 Closure options

1.3 ASB and ASB(FE) - Asymmetric Slimflor® Beams

Asymmetric Slimflor Beams (ASBs) are an integral part of the *Advance* sections range and are manufactured to the exacting standards demanded for CE marked products. Produced by hot rolling, the degree of asymmetry between the widths of the top and bottom flanges is approximately 60%, and the top flange is embossed to enhance composite action with the concrete encasement. The ASB has been specifically designed for use with deep decking, see *Figure 1.7* to create a ribbed slab of 290 to 370mm depth.

Design rules for normal and fire conditions are based on composite action, established from full-scale tests. A summary of tests is contained in Appendix A.

Two types of ASB section are available in S355JR, J0 and J2 steel to BS EN 10025-2⁽⁴⁾:

1. ASB - asymmetric sections with thin webs that require fire protection to the exposed bottom flange to achieve more than 30 minutes fire resistance, or where the web accommodates web penetrations, see *Figure 1.8(a)*.
2. ASB(FE) - asymmetric sections that are engineered for optimum characteristics in normal and fire conditions. The beams have a web thickness greater than that found in rolled sections to achieve a fire resistance up to 60 minutes when unprotected, assuming that the integrity of the web is not breached, see *Figure 1.8(b)*.



a) Asymmetric Slimflor® Beam ASB

b) Fire engineered Asymmetric Slimflor® Beam section ASB(FE)

Figure 1.8 Types of Asymmetric Slimflor® Beam

The structural engineer must decide which type of section is most economic for a given design situation. Guidance is available from Corus.

Selector tables are given in *Section 3.2, Tables 3.5 – 3.12*.

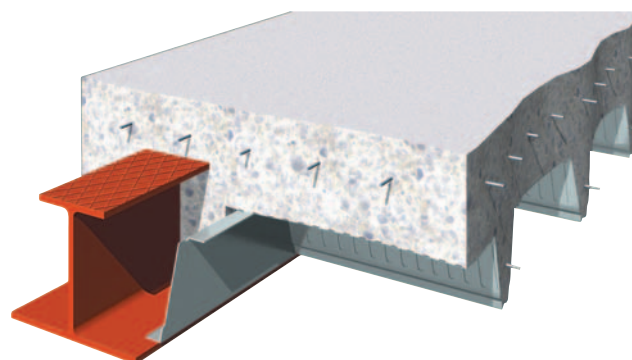


Figure 1.7 Typical Asymmetric Slimflor® Beam

1.3.1 Brittle fracture

The steel sub-grade should be selected from *Table 1.4 over*, which is in accordance with BS 5950-1⁽⁵⁾. This standard relates the service temperature, the material stress, the type of detail and the strain rate to a limiting thickness for each sub-grade. Sub-grades JR and J0 will be suitable for most situations but designers need to be careful when detailing welded joints for the thicker sections when the K factor is less than 1.

Asymmetric Slimflor® Beams

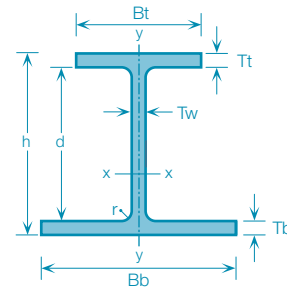


Table 1.2 ASB dimensions for detailing

Designation	Mass	Depth h	Width of flange		Thickness		Root radius r	Depth between flanges d
			Top B _t	Bottom B _b	Web T _w	Flange T _t & T _b		
Serial size	kg/m	mm	mm	mm	mm	mm	mm	mm
300ASB(FE) 249	249.2	342	203	313	40	40	27	262
300ASB 196	195.5	342	183	293	20	40	27	262
300ASB(FE) 185	184.6	320	195	305	32	29	27	262
300ASB 155	155.4	326	179	289	16	32	27	262
300ASB(FE) 153	152.8	310	190	300	27	24	27	262
280ASB(FE) 136	136.4	288	190	300	25	22	24	244
280ASB 124	123.9	296	178	288	13	26	24	244
280ASB 105	104.7	288	176	286	11	22	24	244
280ASB(FE) 100	100.3	276	184	294	19	16	24	244
280ASB 74	73.6	272	175	285	10	14	24	244

Note: ASB(FE) are fire engineered sections

Asymmetric Slimflor® Beams

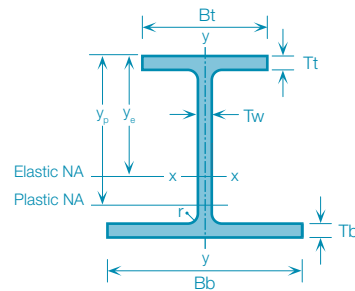


Table 1.3 ASB properties

Designation	Mass	Second moment of area		Radius of gyration		Elastic neutral axis y _e	Elastic modulus		
		I _x	I _y	r _x	r _y		Z _x Top	Z _x Bottom	Z _y
Serial size	kg/m	cm ⁴	cm ⁴	cm	cm	cm	cm ³	cm ³	cm ³
300ASB(FE) 249	249.2	52920	13194	12.9	6.45	19.2	2757	3528	843
300ASB 196	195.5	45871	10463	13.6	6.48	19.8	2321	3185	714
300ASB(FE) 185	184.6	35657	8752	12.3	6.10	18.0	1984	2547	574
300ASB 155	155.4	34514	7989	13.2	6.35	18.9	1825	2519	553
300ASB(FE) 153	152.8	28398	6840	12.1	5.93	17.4	1628	2088	456
280ASB(FE) 136	136.4	22216	6256	11.3	6.00	16.3	1367	1777	417
280ASB 124	123.9	23453	6410	12.2	6.37	17.2	1360	1891	445
280ASB 105	104.7	19249	5298	12.0	6.30	16.8	1145	1604	370
280ASB(FE) 100	100.3	15506	4245	11.0	5.76	15.6	995	1292	289
280ASB 74	73.6	12191	3334	11.4	5.96	15.7	776	1060	234

Note: ASB(FE) are fire engineered sections.

Table 1.4 Choice of sub grade for ASBs dependant upon situation and exposure

				K value for Internal conditions (-5°)							K value for External conditions (-15°)						
				0.5	0.75	1	1.5	2	3	4	0.5	0.75	1	1.5	2	3	4
300 ASB	249	Web,	40	NA	J2	J0	J0	JR	JR	JR	NA	J2	J2	J0	J0	JR	JR
		Flange,	40	NA	J2	J0	J0	JR	JR	JR	NA	J2	J2	J0	J0	JR	JR
300 ASB	196	Web,	20	J0	J0	JR	JR	JR	JR	JR	J2	J0	J0	JR	JR	JR	JR
		Flange,	40	NA	J2	J0	J0	JR	JR	JR	NA	J2	J2	J0	J0	JR	JR
300 ASB	185	Web,	32	J2	J0	J0	JR	JR	JR	JR	NA	J2	J0	J0	J0	JR	JR
		Flange,	29	J2	J0	J0	JR	JR	JR	JR	NA	J2	J0	J0	J0	JR	JR
300 ASB	155	Web,	16	J0	JR	JR	JR	JR	JR	JR	J0	J0	J0	JR	JR	JR	JR
		Flange,	32	J2	J0	J0	JR	JR	JR	JR	NA	J2	J0	J0	J0	JR	JR
300 ASB	153	Web,	27	J2	J0	J0	JR	JR	JR	JR	J2	J0	J0	J0	JR	JR	JR
		Flange,	24	J2	J0	JR	JR	JR	JR	JR	J2	J0	J0	J0	JR	JR	JR
280 ASB	136	Web,	25	J2	J0	JR	JR	JR	JR	JR	J2	J0	J0	J0	JR	JR	JR
		Flange,	22	J0	J0	JR	JR	JR	JR	JR	J2	J0	J0	J0	JR	JR	JR
280 ASB	124	Web,	13	J0	JR	JR	JR	JR	JR	JR	J0	J0	JR	JR	JR	JR	JR
		Flange,	26	J2	J0	J0	JR	JR	JR	JR	J2	J0	J0	J0	JR	JR	JR
280 ASB	105	Web,	11	JR	JR	JR	JR	JR	JR	JR	J0	J0	JR	JR	JR	JR	JR
		Flange,	22	J0	J0	JR	JR	JR	JR	JR	J2	J0	J0	J0	JR	JR	JR
280 ASB	100	Web,	19	J0	J0	JR	JR	JR	JR	JR	J0	J0	J0	JR	JR	JR	JR
		Flange,	16	J0	JR	JR	JR	JR	JR	JR	J0	J0	J0	JR	JR	JR	JR
280 ASB	74	Web,	10	JR	JR	JR	JR	JR	JR	JR	J0	JR	JR	JR	JR	JR	JR
		Flange,	14	J0	JR	JR	JR	JR	JR	JR	J0	J0	JR	JR	JR	JR	JR

Steel grades indicated in Table 1.4 are based on the requirements of Cl. 2.4.4 of BS EN 5950-1⁵¹

JR means that steel grade S355 JR is suitable for the combination of K factor and steel thickness

J0 means that steel grade S355 J0 is suitable for the combination of K factor and steel thickness

J2 means that steel grade S355 J2 is suitable for the combination of K factor and steel thickness

NA means that no suitable grade exists for the combination of K factor and steel thickness

Plastic neutral axis y_p cm	Plastic modulus		Buckling parameter u -	Torsional index x -	Warping constant H cm ⁶	Torsional constant J cm ⁴	Area of section A cm ²	Designation
	s_x cm ³	s_y cm ³						Serial size
22.6	3761	1512	0.825	6.80	1998105	2004	317	300ASB(FE) 249
28.1	3055	1229	0.845	7.86	1498135	1177	249	300ASB 196
21.0	2658	1030	0.822	8.56	1203025	871	235	300ASB(FE) 185
27.3	2361	949	0.843	9.40	1068165	620	198	300ASB 155
20.4	2160	816	0.822	9.97	894772	513	195	300ASB(FE) 153
19.2	1806	740	0.814	10.19	709504	379	174	280ASB(FE) 136
25.8	1730	761	0.832	10.54	720657	332	158	280ASB 124
25.4	1441	632	0.831	12.08	573540	207	133	280ASB 105
18.4	1295	510	0.815	13.13	450943	160	128	280ASB(FE) 100
21.3	979	402	0.830	16.63	337956	72.2	93.7	280ASB 74

1.4 RHSFBs - Rectangular Hollow Slimflor® Beams

At the perimeter of the building, it is often structurally more efficient and often architecturally desirable, to use an RHS which can resist torsional forces caused by eccentric loading on the beam, as shown in *Figure 1.9*.

The RHSFB comprises a Corus Celsius hot-rolled Rectangular Hollow Section in S355J2H steel to BS EN 10210[®], with a 15mm thick S355 steel plate welded to the underside of the RHS. The RHSFB can achieve 60 minutes fire resistance without protection to the bottom plate where the bare outer face of the RHS is fire protected by fire stopping required to ensure the integrity of the compartmentation.

Selector tables are given in *Section 3, Tables 3.13 – 3.16*.

1.4.1 Brittle fracture

Table 5 of BS 5950-1[®] allows a maximum thickness of 55mm at $K=1$ for external steelwork using S355J2H structural hollow sections to BS EN 10210. The normal hot-finished range rolled by Corus has a maximum wall thickness of 20mm, so even in the case of welded tubular joints where a K factor of 0.5 applies, the standard J2 quality rolled by Corus will be suitable.

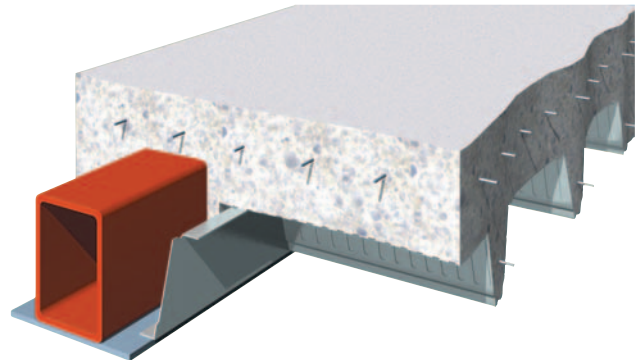


Figure 1.9 Typical RHS edge beam

Rectangular Hollow Slimflor® Beams

Table 1.5 RHSFB dimensions and properties

Designation $D_{RHS} \times B_{RHS}$ ($W \times t$)	Thickness T mm	Mass kg/m	Second moment of area		Radius of gyration		Elastic neutral axis	
			I_x cm ⁴	I_y cm ⁴	r_x cm	r_y cm	x_e cm	y_e cm
200 x 150 (240 x 15)	8.0	69.7	5451	4055	7.8	6.8	9.3	14.4
	10.0	79.3	6251	4461	7.9	6.6	9.1	13.8
	12.5	90.8	7107	4903	7.8	6.5	8.9	13.3
250 x 150 (240 x 15)	8.0	76.0	9087	4484	9.7	6.8	9.2	17.4
	10.0	87.1	10449	4975	9.7	6.7	9.0	16.8
	12.5	100.6	11938	5517	9.7	6.6	8.8	16.2
300 x 200 (290 x 15)	8.0	94.4	16614	8795	11.8	8.6	11.6	20.7
	10.0	108.6	19226	9931	11.8	8.5	11.4	20.0
	12.5	126.0	22147	11228	11.7	8.4	11.2	19.3
400 x 200 (290 x 15)	8.0	106.9	32322	10308	15.4	8.7	11.4	26.6
	10.0	124.3	37511	11772	15.4	8.6	11.2	25.7
	12.5	146.1	43409	13461	15.3	8.5	11.1	24.9
450 x 250 (340 x 15)	8.0	125.4	48873	17759	17.5	10.5	13.9	29.9
	10.0	146.0	56914	20482	17.5	10.5	13.7	28.8
	12.5	171.0	66155	23677	17.4	10.4	13.6	27.9

Notes: A full list of available sections is included in the SIDS software package.
Section properties are based on a plate extending 90mm beyond the RHS.

1.5 Tie members

Tie members are required to provide robustness by tying together columns at each floor level. Generally tie members are formed from inverted Tees although smaller UKB or RHS with a welded plate are often used where the tie supports other local loads. The general arrangement for tie members is illustrated in *Figure 1.10* where the Tee section allows for placement of a Z section to suit a deck layout which is not in multiples of 600mm. To avoid visible sag, the depth of the Tee is normally taken to be at least span/40.

The Tee section does not resist loads applied to the slab so reinforcement is placed in the ribs adjacent to the Tee. Fire protection is not normally required where the tie is partially encased in the slab. Tees may be attached by an end plate to the column web or to a stiffener located between the column flanges. The same stiffener may act as a compression stiffener in a moment-resisting connection to the major axis of the column.

The design of tie members is considered further in *Section 2.7*.

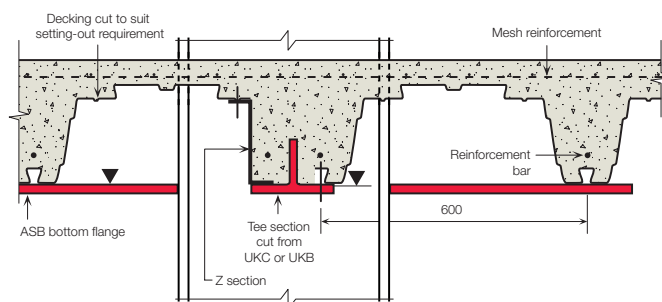


Figure 1.10 Inverted Tee section as a tie member

Z_x Top cm ³	Elastic modulus			Plastic neutral axis y_p cm ³	Plastic modulus S_x cm ³	Torsional constant J cm ⁴	Area of section A cm ²	Designation $D_{RHS} \times B_{RHS}$ ($W \times t$)
	Z_x Bottom cm ³	Z_y Left cm ³	Z_y Right cm ³					
380	763	435	276	19.4	549	3670	88.8	200 x 150
452	816	490	300	18.9	661	4436	100.9	(240 x 15)
532	872	551	325	17.2	783	5314	115.6	
521	1002	489	302	23.7	775	5048	96.8	250 x 150
622	1077	555	331	21.5	926	6117	110.9	(240 x 15)
736	1162	629	362	19.7	1087	7353	128.1	
803	1538	756	506	28.6	1169	10595	120.3	300 x 200
964	1665	870	565	25.9	1404	12941	138.4	(290 x 15)
1149	1811	1001	631	23.7	1661	15710	160.5	
1214	2173	901	587	33.6	1810	15768	136.3	400 x 200
1460	2373	1048	663	30.9	2146	19292	158.5	(290 x 15)
1746	2610	1218	750	28.7	2507	23471	185.5	
1634	2946	1274	885	38.4	2401	27121	160.0	450 x 250
1971	3229	1491	1011	35.2	2861	33322	186.0	(340 x 15)
2368	3564	1747	1158	32.7	3383	40757	218.0	

