LiteSteel beam Part 3 Section Properties

Design Capacity Tables For LiteSteel® beam

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3.1 General

This part of the DCT provides all of the relevant section dimensions and section properties necessary for drawing, and for designing LiteSteel beam structures in accordance with AS/NZS 4600. An explanation of the methods used to calculate the full and effective section properties in these Tables is given in Sections 3.2 and 3.3. All section and member capacity tables included in other parts of this document are based on the values contained in these section property tables.

The Tables included in this part of the document are listed with the contents on the first page of this part.

All section properties are calculated by dividing the section shape into simple flat and bend elements in accordance with AS/NZS 4600 Clause 2.1.1, and are based on the nominal dimensions and nominal base steel thickness given in the tables.

3.2 Full Section Properties

AS/NZS 4600 Clause 2.1.2.1 requires the properties of full, unreduced sections to be based on the entire simplified shape with the flats and bends located along the element mid-lines unless the manufacturing process warrants consideration of a more accurate method. The full section properties of the LiteSteel beam sections are calculated using the overall dimensions and thickness of the sections, which is the most accurate method.

Conventional methods of structural mechanics have been used to calculate the properties of the full section by dividing it up into individual flat and bend elements. All full section property calculations have been verified using the computer program Thin-Wall (CASE 2001).

The torsional rigidity of the flange (GJ_F) is a parameter which is not required for other sections, but is used for the LSB to calculate the member moment capacity as described in Part 5.

3.3 Effective Section Properties

3.3.1 Effective Width Method

The Cold-formed steel structures standard AS/NZS 4600 uses the effective width method to account for local buckling of slender plates in axial compression. Flat plate elements of the cross-section are reduced to an effective width (b_e) which is capable of resisting the axial compression stress in that element. The remainder of the plate width is considered to be ineffective.

The LSB is quite unusual for a cold-formed section in that there are no free edges, because the edges of the steel strip from which it is manufactured are fully welded to form hollow flanges. Not only does this produce a very rigid cross-section, but it also simplifies the calculation of effective section properties because every flat element of the cross-section is a stiffened element. The effective width of each flat element is calculated in accordance with AS/NZS 4600 Clause 2.2.1 for uniformly compressed elements, or Clause 2.2.3 for elements with a stress gradient.

3.3.2 Axial Compression

For uniform axial compression in the member, the effective area of the section (A_e) is calculated for a uniform compression stress on all elements of the cross-section. The effective width of the web and flange elements is calculated in accordance with AS/NZS Clause 2.2.1.2 using the following parameters:

design stress $f^* = f_y$
plate buckling coefficient $k = 4.0$

The effective area is then calculated by adding the effective areas of each element of the cross-section. Figure 3.1 shows areas of the cross-section which may not be effective. For the LSB sizes included in the Tables, it is generally only the web which is not fully effective.

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Figure 3.1: Effective Widths for Axial Compression

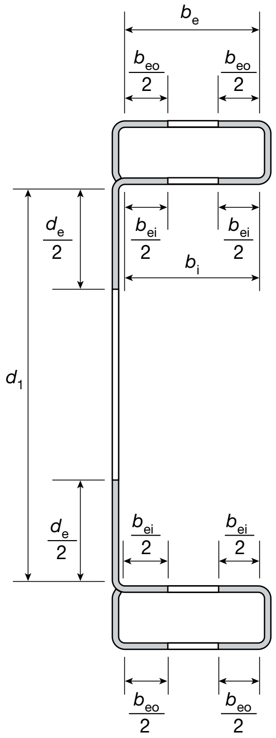
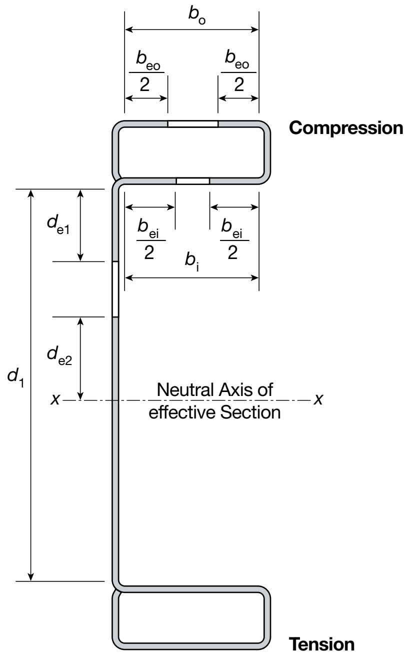


Figure 3.2: Effective Widths for Bending about x-axis



3.3.3 Bending about the x-axis

For a member subject to bending about the major principal x-axis, the effective second moment of area (I_{ex}) and the effective section modulus (Z_{ex}) are calculated by considering the effect of local buckling of all compression elements with the extreme compression fibre of the effective section at yield. The outer and inner elements of the compression flange have been checked for their effectiveness due to a uniform compression stress. The design stress in the outer flange is assumed to be at yield ($f^* = f_y$), but the stress in the inner flange element has a lower stress based on the proportional distance from the neutral axis, and so is less susceptible to local buckling.

The web is also checked for local buckling due to a stress gradient. The design stress is the stress at the top of the web element for the effective section, and the plate buckling coefficient for a stress gradient is determined by the ratio of stresses at the top and bottom of the web element. Figure 3.2 illustrates the location of elements which may not be fully effective.

The sections in these tables are generally fully effective for bending about the major principal x-axis.

3.3.4 Bending about the y-axis

3.3.4.1 Web in Compression

The tables give the values of the effective second moment of area (I_{eyL}) and the effective section modulus (Z_{eyL}) for the web in compression, based on the lower yield stress of the web. The effective width of the web element is calculated for a uniform stress, and the effective width of each of the four flange elements is calculated for a stress gradient.

For the LSB sizes in the tables the flange elements are always fully effective for bending about the y-axis, as illustrated in Figure 3.3. The value of section modulus (Z_{eyL}) is the minimum value, and is generally based on yielding of the flange toes in tension rather than the web in compression.

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3.3.4.2 Flange Tips in Compression

The tables give the values of the effective second moment of area (I_{eyR}) and the effective section modulus (Z_{eyR}) for the tips of the flanges in compression. The web element is in tension, and the effective width of each of the four flange elements is calculated for a stress gradient.

For the LSB sizes in the tables the flange elements are always fully effective for bending about the y-axis, as illustrated in Figure 3.3. The value of section modulus (Z_{eyR}) is the minimum value, and is generally based on yielding of the flange toes in compression.

3.4 Application

The full section properties assume that all elements of the sections are fully effective when subject to compression stresses. Therefore they may be used for calculating member capacities and deflection when the compression stresses are sufficiently low so that local buckling of the compression elements will not occur.

The effective section properties are used to calculate the section capacities for bending and for axial compression, as well as for calculating deflection at these limiting stress levels.

Figure 3.3: Effective Widths for Bending about y-axis

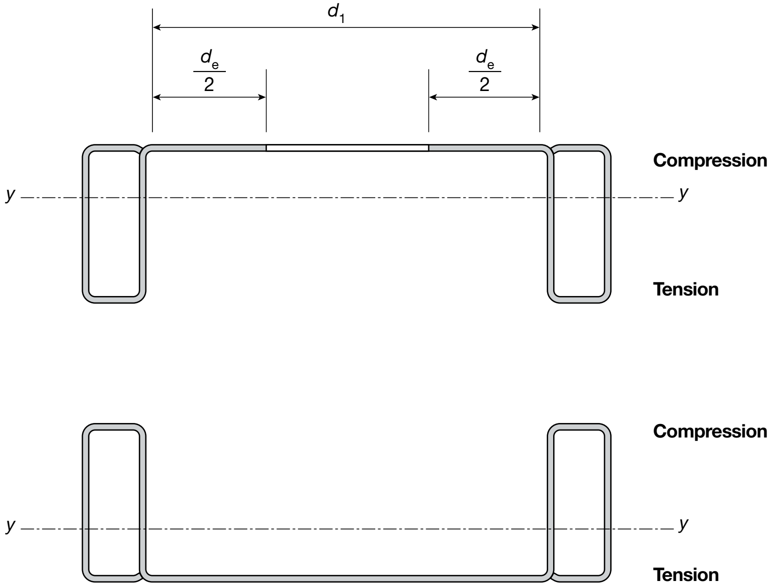

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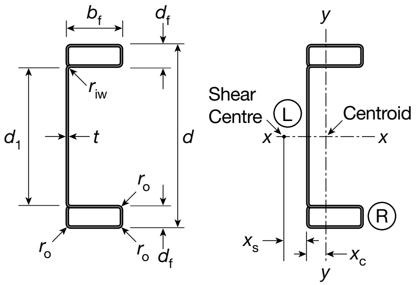
Table 3.1-1

LiteSteel beam

Dimensions and Full Section Properties



Dimensions											Properties										
Designation			Mass per m	Flange Depth	Outside Flange Radius	Inside Web Radius	Web Flat Depth	Coord. of Centroid	Coord. of Shear Centre	External Surface Area	Gross Area of Section	About x-axis			About y-axis				Torsional Rigidity of Flange	Torsion Constant	Warping Constant
d	b_f	t		d_f	r_o	r_{iw}	d_1	x_c	x_s		A_g	I_x	Z_x	r_x	I_y	Z_{yL}	Z_{yR}	r_y	$G J_f$	J	I_w
mm	mm	mm	kg/m	mm	mm	mm	mm	mm	mm	m²/m	mm²	10⁶mm⁴	10³mm³	mm	10⁶mm⁴	10³mm³	10³mm³	mm	10⁶Nmm²	10³mm⁴	10⁹mm⁶
300 ×	75 ×	3.0 LSB	14.5	25.0	6.00	3.00	244	22.7	26.8	0.877	1840	24.6	164	116	1.23	54.3	23.5	25.9	13000	328	17.1
		2.5 LSB	12.2	25.0	5.00	3.00	244	22.8	27.1	0.881	1550	20.8	139	116	1.06	46.6	20.3	26.2	11400	287	14.7
300 ×	60 ×	2.0 LSB	8.80	20.0	4.00	3.00	254	16.4	20.5	0.825	1110	14.5	96.8	114	0.466	28.5	10.7	20.5	4670	118	6.47
250 ×	75 ×	3.0 LSB	13.3	25.0	6.00	3.00	194	24.6	27.9	0.777	1690	15.9	127	96.9	1.16	47.1	23.0	26.2	13000	328	11.1
		2.5 LSB	11.2	25.0	5.00	3.00	194	24.7	28.2	0.781	1420	13.4	107	97.2	0.998	40.5	19.8	26.5	11400	286	9.58
250 ×	60 ×	2.0 LSB	8.00	20.0	4.00	3.00	204	17.9	21.5	0.725	1010	9.38	75.0	96.4	0.440	24.6	10.4	20.9	4670	117	4.24
200 ×	60 ×	2.5 LSB	8.86	20.0	5.00	3.00	154	19.7	22.3	0.621	1120	6.74	67.4	77.5	0.490	24.9	12.1	20.9	5500	138	3.00
		2.0 LSB	7.21	20.0	4.00	3.00	154	19.7	22.6	0.625	910	5.50	55.0	77.7	0.408	20.7	10.1	21.2	4670	117	2.51
200 ×	45 ×	1.6 LSB	4.95	15.0	3.20	3.00	164	13.0	15.9	0.568	624	3.67	36.7	76.8	0.150	11.5	4.68	15.5	1550	39.1	0.923
150 ×	45 ×	2.0 LSB	5.31	15.0	4.00	3.00	114	14.7	16.8	0.465	670	2.26	30.1	58.1	0.163	11.0	5.38	15.6	1820	45.8	0.560
		1.6 LSB	4.32	15.0	3.20	3.00	114	14.8	17.0	0.468	544	1.84	24.6	58.2	0.136	9.20	4.51	15.8	1550	39.0	0.469

Notes:

1. **Always ensure that you are using current information on the LSB product range. This can be verified by comparing the document version date (noted at the bottom of the page) with the current version date of each publication. The current version date and downloadable versions of all LSB publications can be obtained by referring to www.litesteelbeam.com.au or by contacting LST.**
2. Steel grade DuoSteel (flange f_{yf} = 450 MPa and f_{uf} = 500 MPa; web f_{yw} = 380 MPa and f_{uw} = 490 MPa).
3. Full section properties are calculated in accordance with AS/NZS 4600.

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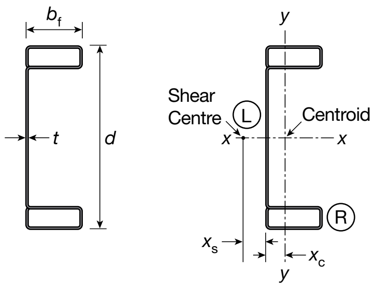
Table 3.1-2
LiteSteel beam
Dimensions and Effective Section Properties



Designation			Mass per m	Yield Stress		Axial Compression		Bending					
				Flange	Web	Effective Area	Coord. of Centroid	About x-axis		About y-axis			
d	b_f	t		f_{yf}	f_{yw}	A_e	x_c	I_{ex}	Z_{ex}	I_{eyL}	Z_{eyL}	I_{eyR}	Z_{eyR}
mm	mm	mm	kg/m	MPa	MPa	mm^2	mm	10^6mm^4	10^3mm^3	10^6mm^4	10^3mm^3	10^6mm^4	10^3mm^3
300 ×	75 ×	3.0 LSB	14.5	450	380	1450	22.7	24.6	164	1.09	22.4	1.23	23.5
		2.5 LSB	12.2	450	380	1180	22.8	20.8	139	0.901	19.0	1.06	20.3
300 ×	60 ×	2.0 LSB	8.80	450	380	763	16.4	14.5	96.8	0.379	9.84	0.466	10.7
250 ×	75 ×	3.0 LSB	13.3	450	380	1440	24.6	15.9	127	1.06	22.1	1.16	23.0
		2.5 LSB	11.2	450	380	1180	24.7	13.4	107	0.881	18.8	0.998	19.8
250 ×	60 ×	2.0 LSB	8.00	450	380	760	17.9	9.38	75.0	0.371	9.75	0.440	10.4
200 ×	60 ×	2.5 LSB	8.86	450	380	967	19.7	6.74	67.4	0.453	11.7	0.490	12.1
		2.0 LSB	7.21	450	380	755	19.7	5.50	55.0	0.361	9.64	0.408	10.1
200 ×	45 ×	1.6 LSB	4.95	450	380	462	13.0	3.67	36.7	0.127	4.38	0.150	4.68
150 ×	45 ×	2.0 LSB	5.31	450	380	587	14.7	2.26	30.1	0.153	5.23	0.163	5.38
		1.6 LSB	4.32	450	380	458	14.8	1.84	24.6	0.122	4.31	0.136	4.51

Notes:

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2. Steel grade DuoSteel (flange f_{yf} = 450 MPa and f_{uf} = 500 MPa; web f_{yw} = 380 MPa and f_{uw} = 490 MPa).
3. Effective section properties are calculated in accordance with AS/NZS 4600.
4. I_{eL} and Z_{eL} are for bending about the y-axis that causes compression in the web “L”.
5. I_{eR} and Z_{eR} are for bending about the y-axis that causes compression in the flange tips “R”.