Table 3.7: Slip factor, μ, for pre-loaded bolts

Class of friction surfaces (see 1.2.7 Reference Standard: Group 7)	Slip factor μ
A	0,5
B	0,4
C	0,3
D	0,2

NOTE 1: The requirements for testing and inspection are given in 1.2.7 Reference Standards: Group 7.

NOTE 2: The classification of any other surface treatment should be based on test specimens representative of the surfaces used in the structure using the procedure set out in 1.2.7 Reference Standards: Group 7.

NOTE 3: The definitions of the class of friction surface are given in 1.2.7 Reference Standards: Group 7.

NOTE 4: With painted surface treatments a loss of pre-load may occur over time.

3.9.2 Combined tension and shear

(1) If a slip-resistant connection is subjected to an applied tensile force, $F_{t,Ed}$ or $F_{t,Ed,ser}$, in addition to the shear force, $F_{v,Ed}$ or $F_{v,Ed,ser}$, tending to produce slip, the design slip resistance per bolt should be taken as follows:

for a category B connection: $$F_{s,Rd,ser} = \frac{k_s\ n\ \mu\ (F_{p,C} - 0{,}8 F_{t,Ed,ser})}{\gamma_{M3,ser}} \qquad \text{... (3.8a)}$$

for a category C connection: $$F_{s,Rd} = \frac{k_s\ n\ \mu\ (F_{p,C} - 0{,}8 F_{t,Ed})}{\gamma_{M3}} \qquad \text{... (3.8b)}$$

(2) If, in a moment connection, a contact force on the compression side counterbalances the applied tensile force no reduction in slip resistance is required.

3.9.3 Hybrid connections

(1) As an exception to 2.4(3) , preloaded class 8.8 and 10.9 bolts in connections designed as slip-resistant at the ultimate limit state (Category C in 3.4) may be assumed to share load with welds, provided that the final tightening of the bolts is carried out after the welding is complete.

3.10 Deductions for fastener holes

3.10.1 General

(1) Deduction for holes in the member design should be made according to EN 1993-1-1.

3.10.2 Design for block tearing

(1) Block tearing consists of failure in shear at the row of bolts along the shear face of the hole group accompanied by tensile rupture along the line of bolt holes on the tension face of the bolt group. Figure 3.8 shows block tearing.

(2) For a symmetric bolt group subject to concentric loading the design block tearing resistance, $V_{eff,1,Rd}$ is given by:

$$V_{eff,1,Rd} = f_u A_{nt} / \gamma_{M2} + (1 / \sqrt{3}) f_y A_{nv} / \gamma_{M0} \quad \text{... (3.9)}$$

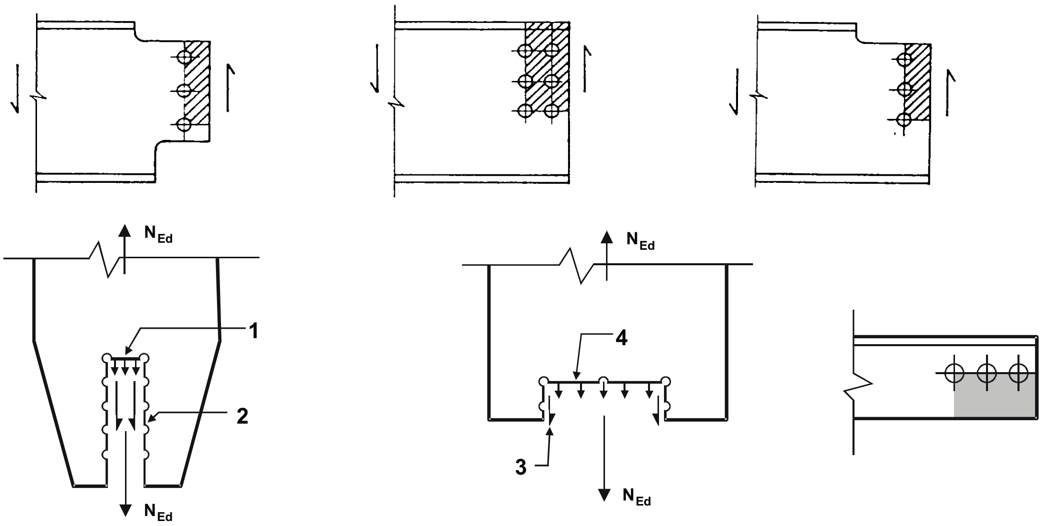
where:

A_{nt} is net area subjected to tension;

A_{nv} is net area subjected to shear.

(3) For a bolt group subject to eccentric loading the design block shear tearing resistance $V_{eff,2,Rd}$ is given by:

$$V_{eff,2,Rd} = 0{,}5 f_u A_{nt} / \gamma_{M2} + (1 / \sqrt{3}) f_y A_{nv} / \gamma_{M0} \quad \text{... (3.10)}$$



1 small tension force
2 large shear force
3 small shear force
4 large tension force

Figure 3.8: Block tearing

3.10.3 Angles connected by one leg and other unsymmetrically connected members in tension

(1) The eccentricity in joints, see 2.7(1), and the effects of the spacing and edge distances of the bolts, should be taken into account in determining the design resistance of:

- unsymmetrical members;
- symmetrical members that are connected unsymmetrically, such as angles connected by one leg.

(2) A single angle in tension connected by a single row of bolts in one leg, see Figure 3.9, may be treated as concentrically loaded over an effective net section for which the design ultimate resistance should be determined as follows:

with 1 bolt: $$N_{u,Rd} = \frac{2{,}0(e_2 - 0{,}5d_0)t\ f_u}{\gamma_{M2}} \qquad \text{... (3.11)}$$

with 2 bolts: $$N_{u,Rd} = \frac{\beta_2\ A_{net}\ f_u}{\gamma_{M2}} \qquad \text{... (3.12)}$$

with 3 or more bolts: $$N_{u,Rd} = \frac{\beta_3\ A_{net}\ f_u}{\gamma_{M2}} \qquad \text{... (3.13)}$$

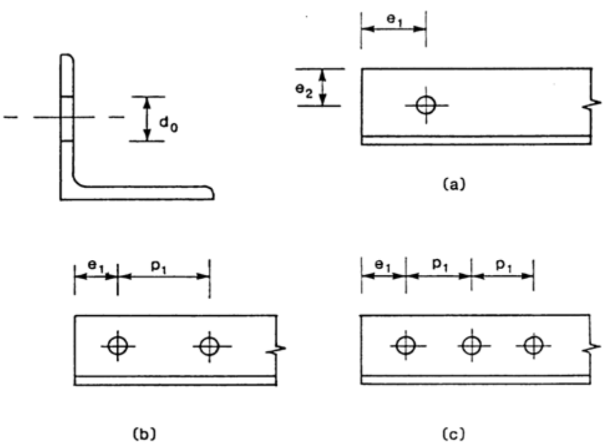
where:

β_2 and β_3 are reduction factors dependent on the pitch p_1 as given in Table 3.8. For intermediate values of p_1 the value of β may be determined by linear interpolation;

A_{net} is the net area of the angle. For an unequal-leg angle connected by its smaller leg, A_{net} should be taken as equal to the net section area of an equivalent equal-leg angle of leg size equal to that of the smaller leg.

Table 3.8: Reduction factors β_2 and β_3

Pitch	p_1	$\leq 2{,}5\ d_o$	$\geq 5{,}0\ d_o$
2 bolts	β_2	0,4	0,7
3 bolts or more	β_3	0,5	0,7



a) 1 bolt

b) 2 bolts

c) 3 bolts

Figure 3.9: Angles connected by one leg

3.10.4 Lug angles

(1) The Lug angle shown in Figure 3.10 connects angle members and their fasteners to a gusset or other supporting part and should be designed to transmit a force 1,2 times the force in the outstand of the angle connected.

(2) The fasteners connecting the lug angle to the outstand of the angle member should be designed to transmit a force 1,4 times the force in the outstand of the angle member.

(3) Lug angles connecting a channel or a similar member should be designed to transmit a force 1,1 times the force in the channel flanges to which they are attached.

(4) The fasteners connecting the lug angle to the channel or similar member should be designed to transmit a force 1,2 times the force in the channel flange which they connect.

(5) In no case should less than two bolts or rivets be used to attach a lug angle to a gusset or other supporting part.

(6) The connection of a lug angle to a gusset plate or other supporting part should terminate at the end of the member connected. The connection of the lug angle to the member should run from the end of the member to a point beyond the direct connection of the member to the gusset or other supporting part.

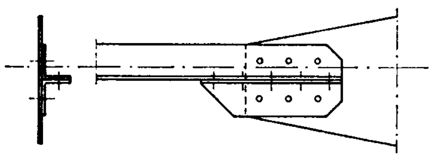


Figure 3.10: Lug angles

3.11 Prying forces

(1) Where fasteners are required to carry an applied tensile force, they should be designed to resist the additional force due to prying action, where this can occur.

NOTE: The rules given in 6.2.4 implicitly account for prying forces.

3.12 Distribution of forces between fasteners at the ultimate limit state

(1) When a moment is applied to a joint, the distribution of internal forces may be either linear (i.e. proportional to the distance from the centre of rotation) or plastic, (i.e. any distribution that is in equilibrium is acceptable provided that the resistances of the components are not exceeded and the ductility of the components is sufficient).

(2) The elastic linear distribution of internal forces should be used for the following:

- when bolts are used creating a category C slip-resistant connection,
- in shear connections where the design shear resistance $F_{v,Rd}$ of a fastener is less than the design bearing resistance $F_{b,Rd}$,
- where connections are subjected to impact, vibration or load reversal (except wind loads).

(3) When a joint is loaded by a concentric shear only, the load may be assumed to be uniformly distributed amongst the fasteners, provided that the size and the class of fasteners is the same.

3.13 Connections made with pins

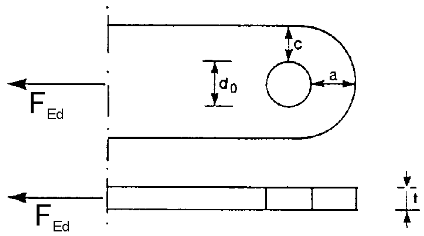
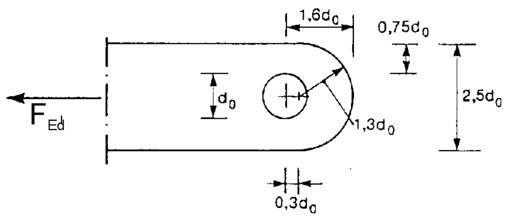
3.13.1 General

(1) Wherever there is a risk of pins becoming loose, they should be secured.

(2) Pin connections in which no rotation is required may be designed as single bolted connections, provided that the length of the pin is less than 3 times the diameter of the pin, see 3.6.1. For all other cases the method given in 3.13.2 should be followed.

(3) In pin-connected members the geometry of the unstiffened element that contains a hole for the pin should satisfy the dimensional requirements given in Table 3.9.

Table 3.9: Geometrical requirements for pin ended members

Type A:	Given thickness t  $a \geq \frac{F_{Ed}\gamma_{M0}}{2\,t\,f_y} + \frac{2\,d_0}{3}$: $c \geq \frac{F_{Ed}\gamma_{M0}}{2\,t\,f_y} + \frac{d_0}{3}$
Type B:	Given geometry  $t \geq 0{,}7\sqrt{\frac{F_{Ed}\gamma_{M0}}{f_y}}$: $d_0 \leq 2{,}5\,t$

(4) Pin connected members should be arranged such to avoid eccentricity and should be of sufficient size to distribute the load from the area of the member with the pin hole into the member away from the pin.

3.13.2 Design of pins

(1) The design requirements for solid circular pins are given in Table 3.10.

(2) The moments in a pin should be calculated on the basis that the connected parts form simple supports. It should be generally assumed that the reactions between the pin and the connected parts are uniformly distributed along the length in contact on each part as indicated in Figure 3.11.

(3) If the pin is intended to be replaceable, in addition to the provisions given in 3.13.1 to 3.13.2, the contact bearing stress should satisfy:

$$\sigma_{h,Ed} \leq f_{h,Rd} \qquad \text{... (3.14)}$$

where:

$$\sigma_{h,Ed} = 0{,}591 \sqrt{\frac{E\,F_{Ed,ser}\,(d_0 - d)}{d^2\,t}} \qquad \text{... (3.15)}$$

$$f_{h,Ed} = 2{,}5\,f_y/\gamma_{M6,ser} \qquad \text{... (3.16)}$$

where:

d is the diameter of the pin;

d_0 is the diameter of the pin hole;

$F_{Ed,ser}$ is the design value of the force to be transferred in bearing, under the characteristic load combination for serviceability limit states.

Table 3.10: Design criteria for pin connections

Failure mode	Design requirements
Shear resistance of the pin	$F_{v,Rd} = 0{,}6\,A\,f_{up}/\gamma_{M2} \geq F_{v,Ed}$
Bearing resistance of the plate and the pin If the pin is intended to be replaceable this requirement should also be satisfied.	$F_{b,Rd} = 1{,}5\,t\,d\,f_y/\gamma_{M0} \geq F_{b,Ed}$ $F_{b,Rd,ser} = 0{,}6\,t\,d\,f_y/\gamma_{M6,ser} \geq F_{b,Ed,ser}$
Bending resistance of the pin If the pin is intended to be replaceable this requirement should also be satisfied.	$M_{Rd} = 1{,}5\,W_{e\ell}\,f_{yp}/\gamma_{M0} \geq M_{Ed}$ $M_{Rd,ser} = 0{,}8\,W_{e\ell}\,f_{yp}/\gamma_{M6,ser} \geq M_{Ed,ser}$
Combined shear and bending resistance of the pin	$\left[\frac{M_{Ed}}{M_{Rd}}\right]^2 + \left[\frac{F_{v,Ed}}{F_{v,Rd}}\right]^2 \leq 1$

d is the diameter of the pin;

f_y is the lower of the design strengths of the pin and the connected part;

f_{up} is the ultimate tensile strength of the pin;

f_{yp} is the yield strength of the pin;

t is the thickness of the connected part;

A is the cross-sectional area of a pin.

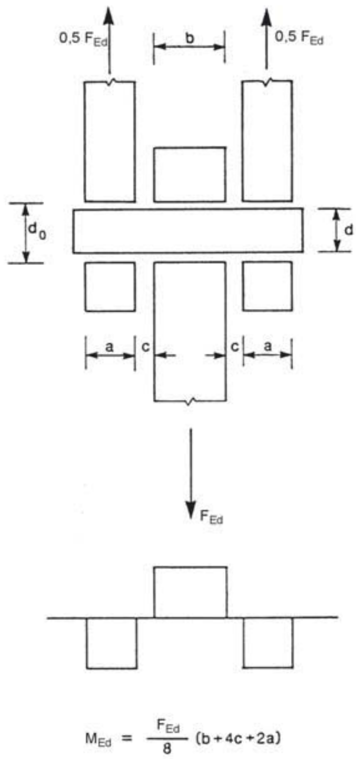


Figure 3.11: Bending moment in a pin

4 Welded connections

4.1 General

(1) The provisions in this section apply to weldable structural steels conforming to EN 1993-1-1 and to material thicknesses of 4 mm and over. The provisions also apply to joints in which the mechanical properties of the weld metal are compatible with those of the parent metal, see 4.2.

For welds in thinner material reference should be made to EN 1993 part 1.3 and for welds in structural hollow sections in material thicknesses of 2,5 mm and over guidance is given section 7 of this Standard.

For stud welding reference should be made to EN 1994-1-1.

NOTE: Further guidance on stud welding can be found in EN ISO 14555 and EN ISO 13918.

(2)P Welds subject to fatigue shall also satisfy the principles given in EN 1993-1-9.

(3) Quality level C according to EN ISO 25817 is usually required, if not otherwise specified. The frequency of inspection of welds should be specified in accordance with the rules in 1.2.7 Reference Standards: Group 7. The quality level of welds should be chosen according to EN ISO 25817. For the quality level of welds used in fatigue loaded structures, see EN 1993-1-9.

(4) Lamellar tearing should be avoided.

(5) Guidance on lamellar tearing is given in EN 1993-1-10.

4.2 Welding consumables

(1) All welding consumables should conform to the relevant standards specified in 1.2.5 Reference Standards; Group 5.

(2) The specified yield strength, ultimate tensile strength, elongation at failure and minimum Charpy V-notch energy value of the filler metal, should be equivalent to, or better than that specified for the parent material.

NOTE: Generally it is safe to use electrodes that are overmatched with regard to the steel grades being used.

4.3 Geometry and dimensions

4.3.1 Type of weld

(1) This Standard covers the design of fillet welds, fillet welds all round, butt welds, plug welds and flare groove welds. Butt welds may be either full penetration butt welds or partial penetration butt welds. Both fillet welds all round and plug welds may be either in circular holes or in elongated holes.

(2) The most common types of joints and welds are illustrated in EN 12345.

4.3.2 Fillet welds

4.3.2.1 General

(1) Fillet welds may be used for connecting parts where the fusion faces form an angle of between 60° and 120°.

(2) Angles smaller than 60° are also permitted. However, in such cases the weld should be considered to be a partial penetration butt weld.

(3) For angles greater than 120° the resistance of fillet welds should be determined by testing in accordance with EN 1990 Annex D: Design by testing.

(4) Fillet welds finishing at the ends or sides of parts should be returned continuously, full size, around the corner for a distance of at least twice the leg length of the weld, unless access or the configuration of the joint renders this impracticable.

NOTE: In the case of intermittent welds this rule applies only to the last intermittent fillet weld at corners.

(5) End returns should be indicated on the drawings.

(6) For eccentricity of single-sided fillet welds, see 4.12.

4.3.2.2 Intermittent fillet welds

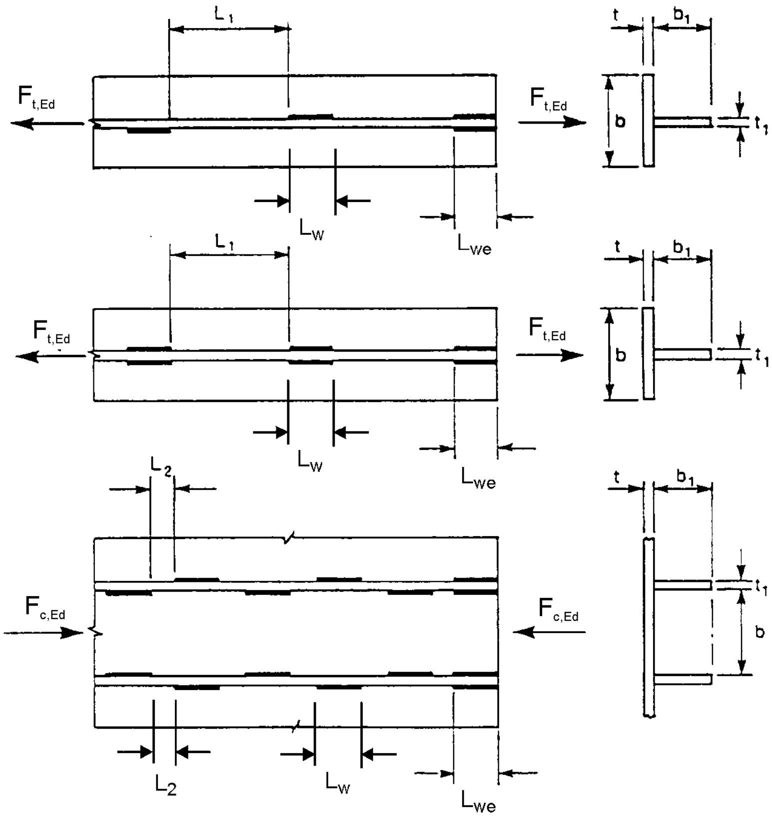
(1) Intermittent fillet welds should not be used in corrosive conditions.

(2) In an intermittent fillet weld, the gaps (L_1 or L_2) between the ends of each length of weld L_w should fulfil the requirement given in Figure 4.1.

(3) In an intermittent fillet weld, the gap (L_1 or L_2) should be taken as the smaller of the distances between the ends of the welds on opposite sides and the distance between the ends of the welds on the same side.

(4) In any run of intermittent fillet weld there should always be a length of weld at each end of the part connected.

(5) In a built-up member in which plates are connected by means of intermittent fillet welds, a continuous fillet weld should be provided on each side of the plate for a length at each end equal to at least three-quarters of the width of the narrower plate concerned (see Figure 4.1).



The smaller of $L_{we} \geq 0,75\ b$ and $0,75\ b_1$

For build-up members in tension:
The smallest of $L_1 \leq 16\ t$ and $16\ t_1$ and 200 mm

For build-up members in compression or shear:
The smallest of $L_2 \leq 12\ t$ and $12\ t_1$ and $0,25\ b$ and 200 mm

Figure 4.1: Intermittent fillet welds

4.3.3 Fillet welds all round

(1) Fillet welds all round, comprising fillet welds in circular or elongated holes, may be used only to transmit shear or to prevent the buckling or separation of lapped parts.

(2) The diameter of a circular hole, or width of an elongated hole, for a fillet weld all round should not be less than four times the thickness of the part containing it.

(3) The ends of elongated holes should be semi-circular, except for those ends which extend to the edge of the part concerned.

(4) The centre to centre spacing of fillet welds all round should not exceed the value necessary to prevent local buckling, see Table 3.3.

4.3.4 Butt welds

(1) A full penetration butt weld is defined as a weld that has complete penetration and fusion of weld and parent metal throughout the thickness of the joint.

(2) A partial penetration butt weld is defined as a weld that has joint penetration which is less than the full thickness of the parent material.

(3) Intermittent butt welds should not be used.

(4) For eccentricity in single-sided partial penetration butt welds, see 4.12.

4.3.5 Plug welds

(1) Plug welds may be used:

- to transmit shear,
- to prevent the buckling or separation of lapped parts, and
- to inter-connect the components of built-up members

but should not be used to resist externally applied tension.

(2) The diameter of a circular hole, or width of an elongated hole, for a plug weld should be at least 8 mm more than the thickness of the part containing it.

(3) The ends of elongated holes should either be semi-circular or else should have corners which are rounded to a radius of not less than the thickness of the part containing the slot, except for those ends which extend to the edge of the part concerned.

(4) The thickness of a plug weld in parent material up to 16 mm thick should be equal to the thickness of the parent material. The thickness of a plug weld in parent material over 16 mm thick should be at least half the thickness of the parent material and not less than 16 mm.

(5) The centre to centre spacing of plug welds should not exceed the value necessary to prevent local buckling, see Table 3.3.

4.3.6 Flare groove welds

(1) For solid bars the design effective throat thickness of flare groove welds, when fitted flush to the surface of the solid section of the bars, is defined in Figure 4.2. The definition of the design throat thickness of flare groove welds in rectangular hollow sections is given in 7.3.1(7).

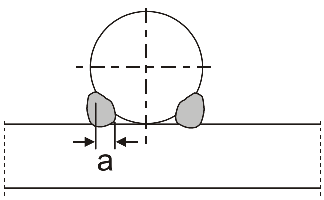


Figure 4.2: Effective throat thickness of flare groove welds in solid sections

4.4 Welds with packings

(1) In the case of welds with packing, the packing should be trimmed flush with the edge of the part that is to be welded.

(2) Where two parts connected by welding are separated by packing having a thickness less than the leg length of weld necessary to transmit the force, the required leg length should be increased by the thickness of the packing.

(3) Where two parts connected by welding are separated by packing having a thickness equal to, or greater than, the leg length of weld necessary to transmit the force, each of the parts should be connected to the packing by a weld capable of transmitting the design force.

4.5 Design resistance of a fillet weld

4.5.1 Length of welds

(1) The effective length of a fillet weld l should be taken as the length over which the fillet is full-size. This maybe taken as the overall length of the weld reduced by twice the effective throat thickness a. Provided that the weld is full size throughout its length including starts and terminations, no reduction in effective length need be made for either the start or the termination of the weld.

(2) A fillet weld with an effective length less than 30 mm or less than 6 times its throat thickness, whichever is larger, should not be designed to carry load.

4.5.2 Effective throat thickness

(1) The effective throat thickness, a, of a fillet weld should be taken as the height of the largest triangle (with equal or unequal legs) that can be inscribed within the fusion faces and the weld surface, measured perpendicular to the outer side of this triangle, see Figure 4.3.

(2) The effective throat thickness of a fillet weld should not be less than 3 mm.

(3) In determining the design resistance of a deep penetration fillet weld, account may be taken of its additional throat thickness, see Figure 4.4, provided that preliminary tests show that the required penetration can consistently be achieved.

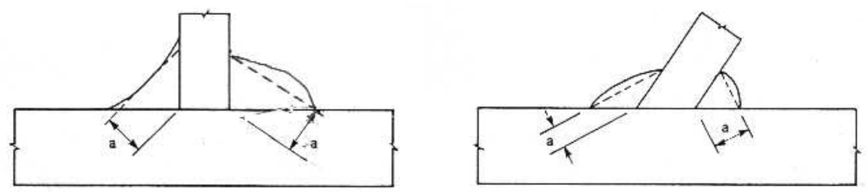


Figure 4.3: Throat thickness of a fillet weld

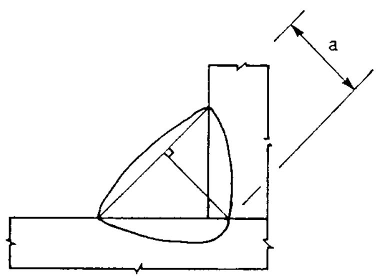


Figure 4.4: Throat thickness of a deep penetration fillet weld

4.5.3 Design Resistance of fillet welds

4.5.3.1 General

(1) The design resistance of a fillet weld should be determined using either the Directional method given in 4.5.3.2 or the Simplified method given in 4.5.3.3.

4.5.3.2 Directional method

(1) In this method, the forces transmitted by a unit length of weld are resolved into components parallel and transverse to the longitudinal axis of the weld and normal and transverse to the plane of its throat.

(2) The design throat area A_w should be taken as $A_w = \sum a\ \ell_{eff}$.

(3) The location of the design throat area should be assumed to be concentrated in the root.

(4) A uniform distribution of stress is assumed on the throat section of the weld, leading to the normal stresses and shear stresses shown in Figure 4.5, as follows:

- $\sigma_{\perp}$ is the normal stress perpendicular to the throat
- $\sigma_{\parallel}$ is the normal stress parallel to the axis of the weld
- $\tau_{\perp}$ is the shear stress (in the plane of the throat) perpendicular to the axis of the weld
- $\tau_{\parallel}$ is the shear stress (in the plane of the throat) parallel to the axis of the weld.

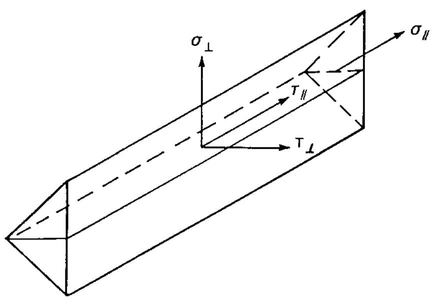


Figure 4.5: Stresses on the throat section of a fillet weld

(5) The normal stress $\sigma_{\parallel}$ parallel to the axis is not considered when verifying the design resistance of the weld.

(6) The design resistance of the fillet weld will be sufficient if the following are both satisfied:

$$[\sigma_{\perp}^2 + 3\ (\tau_{\perp}^2 + \tau_{\parallel}^2)]^{0,5} \leq f_u / (\beta_w\ \gamma_{M2}) \quad \text{and} \quad \sigma_{\perp} \leq\ 0.9 f_u / \gamma_{M2} \qquad \text{... (4.1)}$$

where:

f_u is the nominal ultimate tensile strength of the weaker part joined;

β_w is the appropriate correlation factor taken from Table 4.1.

(7) Welds between parts with different material strength grades should be designed using the properties of the material with the lower strength grade.

Table 4.1: Correlation factor β_w for fillet welds

Standard and steel grade			Correlation factor β_w
EN 10025	**EN 10210**	**EN 10219**	
S 235 S 235 W	S 235 H	S 235 H	0,8
S 275 S 275 N/NL S 275 M/ML	S 275 H S 275 NH/NLH	S 275 H S 275 NH/NLH S 275 MH/MLH	0,85
S 355 S 355 N/NL S 355 M/ML S 355 W	S 355 H S 355 NH/NLH	S 355 H S 355 NH/NLH S 355 MH/MLH	0,9
S 420 N/NL S 420 M/ML		S 420 MH/MLH	1,0
S 460 N/NL S 460 M/ML S 460 Q/QL/QL1	S 460 NH/NLH	S 460 NH/NLH S 460 MH/MLH	1,0

4.5.3.3 Simplified method for design resistance of fillet weld

(1) Alternatively to 4.5.3.2 the design resistance of a fillet weld may be assumed to be adequate if, at every point along its length, the resultant of all the forces per unit length transmitted by the weld satisfy the following criterion:

$$F_{w,Ed} \leq F_{w,Rd} \qquad \text{... (4.2)}$$

where:

$F_{w,Ed}$ is the design value of the weld force per unit length;

$F_{w,Rd}$ is the design weld resistance per unit length.

(2) Independent of the orientation of the weld throat plane to the applied force, the design resistance per unit length $F_{w,Rd}$ should be determined from:

$$F_{w,Rd} = f_{vw.d}\, a \qquad \text{... (4.3)}$$

where:

$f_{vw.d}$ is the design shear strength of the weld.

(3) The design shear strength $f_{vw.d}$ of the weld should be determined from:

$$f_{vw.d} = \frac{f_u / \sqrt{3}}{\beta_w \gamma_{M2}} \qquad \text{... (4.4)}$$

where:

f_u and β_w are defined in 4.5.3.2(6).

4.6 Design resistance of fillet welds all round

(1) The design resistance of a fillet weld all round should be determined using one of the methods given in 4.5.

4.7 Design resistance of butt welds

4.7.1 Full penetration butt welds

(1) The design resistance of a full penetration butt weld should be taken as equal to the design resistance of the weaker of the parts connected, provided that the weld is made with a suitable consumable which will produce all-weld tensile specimens having both a minimum yield strength and a minimum tensile strength not less than those specified for the parent metal.

4.7.2 Partial penetration butt welds

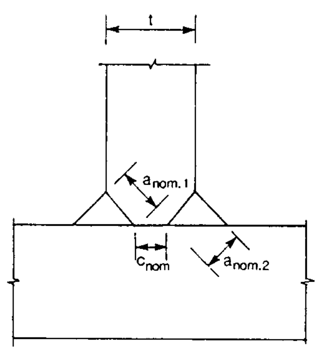
(1) The design resistance of a partial penetration butt weld should be determined using the method for a deep penetration fillet weld given in 4.5.2(3).

(2) The throat thickness of a partial penetration butt weld should not be greater than the depth of penetration that can be consistently achieved, see 4.5.2(3).

4.7.3 T-butt joints

(1) The design resistance of a T-butt joint, consisting of a pair of partial penetration butt welds reinforced by superimposed fillet welds, may be determined as for a full penetration butt weld (see 4.7.1) if the total nominal throat thickness, exclusive of the unwelded gap, is not less than the thickness t of the part forming the stem of the tee joint, provided that the unwelded gap is not more than (t / 5) or 3 mm, whichever is less, see Figure 4.6(a).

(2) The design resistance of a T-butt joint which does not meet the requirements given in 4.7.3(1) should be determined using the method for a fillet weld or a deep penetration fillet weld given in 4.5 depending on the amount of penetration. The throat thickness should be determined in conformity with the provisions for fillet welds (see 4.5.2) or partial penetration butt welds (see 4.7.2) as relevant.



$a_{nom,1} + a_{nom,2} \geq t$

c_{nom} should be the smaller of t/5 and 3 mm

Figure 4.6: Effective full penetration of T-butt welds

4.8 Design resistance of plug welds

(1) The design resistance $F_{w,Rd}$ of a plug weld (see 4.3.3) should be taken as:

$$F_{w,Rd} = f_{vw,d} A_w, \qquad \text{... (4.5)}$$

where

$f_{vw.d}$ is the design shear strength of a weld given in 4.5.3.3(3);

A_w is the design throat area and should be taken as the area of the hole.

4.9 Distribution of forces

(1) The distribution of forces in a welded connection may be calculated on the assumption of either elastic or plastic behaviour in conformity with 2.4 and 2.5.

(2) It is acceptable to assume a simplified load distribution within the welds.

(3) Residual stresses and stresses not subjected to transfer of load need not be included when checking the resistance of a weld. This applies specifically to the normal stress parallel to the axis of a weld.

(4) Welded joints should be designed to have adequate deformation capacity. However, ductility of the welds should not be relied upon.

(5) In joints where plastic hinges may form, the welds should be designed to provide at least the same design resistance as the weakest of the connected parts.

(6) In other joints where deformation capacity for joint rotation is required due to the possibility of excessive straining, the welds require sufficient strength not to rupture before general yielding in the adjacent parent material.

(7) If the design resistance of an intermittent weld is determined by using the total length ℓ_{tot}, the weld shear force per unit length $F_{w,Ed}$ should be multiplied by the factor $(e+\ell)/\ell$, see Figure 4.7.

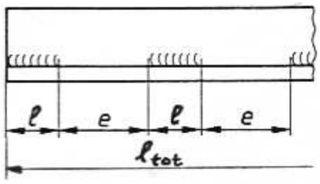


Figure 4.7: Calculation of weld forces for intermittent welds

4.10 Connections to unstiffened flanges

(1) Where a transverse plate (or beam flange) is welded to a supporting unstiffened flange of an I, H or other section, see Figure 4.8, and provided that the condition given in 4.10(3) is met, the applied force perpendicular to the unstiffened flange should not exceed any of the relevant design resistances as follows:

- that of the web of the supporting member of I or H sections as given in 6.2.6.2 or 6.2.6.3 as appropriate;
- those for a transverse plate on a RHS member as given in Table 7.13;
- that of the supporting flange as given by formula (6.20) in 6.2.6.4.3(1) calculated assuming the applied force is concentrated over an effective width, b_{eff}, of the flange as given in 4.10(2) or 4.10(4) as relevant.

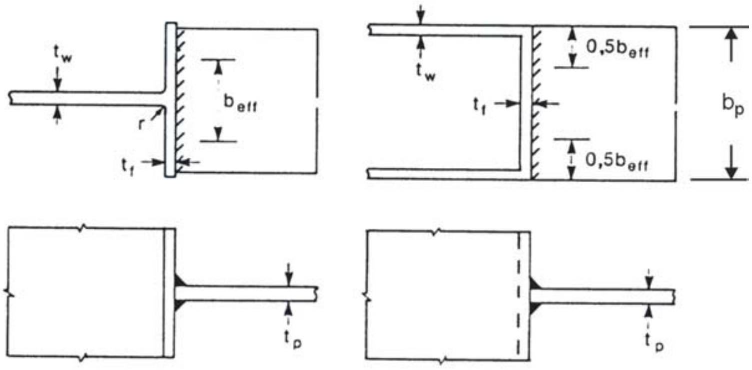


Figure 4.8: Effective width of an unstiffened T-joint

(2) For an unstiffened I or H section the effective width b_{eff} should be obtained from:

$$b_{eff} = t_w + 2s + 7kt_f \qquad \text{... (4.6a)}$$

where:

$$k = (t_f / t_p)(f_{y,f} / f_{y,p}) \text{ but } k \leq 1 \qquad \text{... (4.6b)}$$

$f_{y,f}$ is the yield strength of the flange of the I or H section;

$f_{y,p}$ is the yield strength of the plate welded to the I or H section.

The dimension s should be obtained from:

– for a rolled I or H section: $s = r$ ... (4.6c)

– for a welded I or H section: $s = \sqrt{2}\ a$ ... (4.6d)

(3) For an unstiffened flange of an I or H section , the following criterion should be satisfied:

$$b_{eff} \geq (f_{y,p} / f_{u,p}) b_p \qquad \text{... (4.7)}$$

where:

$f_{u,p}$ is the ultimate strength of the plate welded to the I or H section;

b_p is the width of the plate welded to the I or H section.

Otherwise the joint should be stiffened.

(4) For other sections such as box sections or channel sections where the width of the connected plate is similar to the width of the flange, the effective width b_{eff} should be obtained from:

$$b_{eff} = 2t_w + 5t_f \quad \text{but} \quad b_{eff} \leq 2t_w + 5\,k\,t_f \qquad \text{... (4.8)}$$

NOTE: For hollow sections, see Table 7.13.

(5) Even if $b_{eff} \leq b_p$, the welds connecting the plate to the flange need to be designed to transmit the design resistance of the plate $b_P\, t_P f_{y,P} / \gamma_{M0}$ assuming a uniform stress distribution.

4.11 Long joints

(1) In lap joints the design resistance of a fillet weld should be reduced by multiplying it by a reduction factor β_{Lw} to allow for the effects of non-uniform distribution of stress along its length.

(2) The provisions given in 4.11 do not apply when the stress distribution along the weld corresponds to the stress distribution in the adjacent base metal, as, for example, in the case of a weld connecting the flange and the web of a plate girder.

(3) In lap joints longer than 150a the reduction factor β_{Lw} should be taken as $\beta_{\mathrm{Lw.1}}$ given by:

$$\beta_{\mathrm{Lw.1}} = 1{,}2 - 0{,}2L_{\mathrm{j}} / (150a) \quad \text{but} \quad \beta_{\mathrm{Lw.1}} \leq 1{,}0 \qquad \text{... (4.9)}$$

where:

L_{j} is the overall length of the lap in the direction of the force transfer.

(4) For fillet welds longer than 1,7 metres connecting transverse stiffeners in plated members, the reduction factor β_{Lw} may be taken as $\beta_{\mathrm{Lw.2}}$ given by:

$$\beta_{\mathrm{Lw.2}} = 1{,}1 - L_{\mathrm{w}} / 17 \quad \text{but} \quad \beta_{\mathrm{Lw.2}} \leq 1{,}0 \quad \text{and} \quad \beta_{\mathrm{Lw.2}} \geq 0{,}6 \qquad \text{... (4.10)}$$

where:

L_{w} is the length of the weld (in metres).

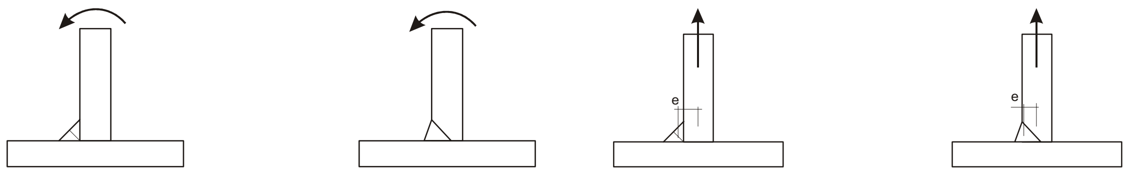
4.12 Eccentrically loaded single fillet or single-sided partial penetration butt welds

(1) Local eccentricity should be avoided whenever it is possible.

(2) Local eccentricity (relative to the line of action of the force to be resisted) should be taken into account in the following cases:

- Where a bending moment transmitted about the longitudinal axis of the weld produces tension at the root of the weld, see Figure 4.9(a);
- Where a tensile force transmitted perpendicular to the longitudinal axis of the weld produces a bending moment, resulting in a tension force at the root of the weld, see Figure 4.9(b).

(3) Local eccentricity need not be taken into account if a weld is used as part of a weld group around the perimeter of a structural hollow section.



(a) Bending moment produces tension at the root of the weld

(b) Tensile force produces tension at the root of the weld

Figure 4.9: Single fillet welds and single-sided partial penetration butt welds

4.13 Angles connected by one leg

(1) In angles connected by one leg, the eccentricity of welded lap joint end connections may be allowed for by adopting an effective cross-sectional area and then treating the member as concentrically loaded.

(2) For an equal-leg angle, or an unequal-leg angle connected by its larger leg, the effective area may be taken as equal to the gross area.

(3) For an unequal-leg angle connected by its smaller leg, the effective area should be taken as equal to the gross cross-sectional area of an equivalent equal-leg angle of leg size equal to that of the smaller leg, when determining the design resistance of the cross-section, see EN 1993-1-1. However when determining the design buckling resistance of a compression member, see EN 1993-1-1, the actual gross cross-sectional area should be used.

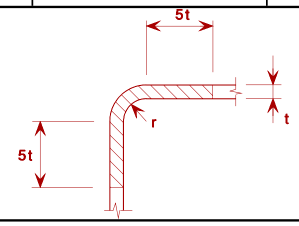
4.14 Welding in cold-formed zones

(1) Welding may be carried out within a length 5t either side of a cold-formed zone, see Table 4.2, provided that one of the following conditions is fulfilled:

- the cold-formed zones are normalized after cold-forming but before welding;
- the *r*/*t*-ratio satisfy the relevant value obtained from Table 4.2.

Table 4.2: Conditions for welding cold-formed zones and adjacent material

r/t	Strain due to cold forming (%)	Maximum thickness (mm)		
		Generally		Fully killed Aluminium-killed steel (Al ≥ 0,02 %)
		Predominantly static loading	Where fatigue predominates	
≥ 25	≤ 2	any	any	any
≥ 10	≤ 5	any	16	any
≥ 3,0	≤ 14	24	12	24
≥ 2,0	≤ 20	12	10	12
≥ 1,5	≤ 25	8	8	10
≥ 1,0	≤ 33	4	4	6



APPENDICES

NA.2.2 Nationally determined parameters for buildings

NA.2.2.1 *Clause A.1.2.1 (1)*

a) All effects of actions that can exist simultaneously should be considered together in combination of actions.

b) With regard to Note 2 of Clause A.1.2.1 (1) of EN 1990 no modifications are allowed through the National Annex for A1.2.1 (2) and (3).

NA.2.2.2 *Clause A.1.2.2*

Table NA.A1.1 provides values for the symbols of Table A1.1 of EN 1990.

Table NA.A1.1 – Values of Ψ factors for buildings

Action	Ψ_0	Ψ_1	Ψ_2
Imposed loads in buildings, category (see EN 1991-1.1)			
Category A: domestic, residential areas	0,7	0,5	0,3
Category B: office areas	0,7	0,5	0,3
Category C: congregation areas	0,7	0,7	0,6
Category D: shopping areas	0,7	0,7	0,6
Category E: storage areas	1,0	0,9	0,8
Category F: traffic area, vehicle weight $\leq$ 30 kN	0,7	0,7	0,6
Category G: traffic area, 30 kN < vehicle weight $\leq$ 160 kN	0,7	0,5	0,3
Category H: roofs[a]	0,7	0	0
Snow loads on buildings (see EN 1991-3)			
— for sites located at altitude H > 1 000 m a.s.l.	0,70	0,50	0,20
— for sites located at altitude H $\leq$ 1 000 m a.s.l.	0,50	0,20	0
Wind loads on buildings (see EN 1991-1-4)	0,5	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0
[a] See also EN 1991-1-1: Clause 3.3.2 (1)			

NA.2.2.3 *Clause A.1.3*

NA.2.2.3.1 *Values for the symbols γ of Table A1.2 (A)*

Table NA.A1.2 (A) provides the values for the symbols γ of Table A1.2 (A). The values chosen are:

$\gamma_{Gj,sup} = 1,10$

$\gamma_{Gj,inf} = 0,90$

$\gamma_{Q,1} = 1,50$ where unfavourable (0 where favourable)

$\gamma_{Q,i} = 1,50$ where unfavourable (0 where favourable)

NOTE For Ψ values see Table A1.1 (BS).

Table NA.A1.2 (A) – Design values of actions (EQU) (Set A)

Persistent and transient design situations	Permanent actions		Leading variable action[a]	Accompanying variable actions	
	Unfavourable	Favourable		Main (if any)	Others
(Eq. 6.10)	1,10 $G_{kj,sup}$	0,90 $G_{kj,inf}$	1,5 $Q_{k,1}$ (0 when favourable)		$1{,}5\Psi_{0,i}Q_{k,i}$ (0 when favourable)

[a] Variable actions are those considered in Table NA.A1.1.

In cases where the verification of static equilibrium also involves the resistance of structural members, as an alternative to two separate verifications based on Tables NA.A1.2 (A) and A1.2 (B), a combined verification, based on Table NA.A1.2 (A), should be adopted, with the following set of values.

$\gamma_{Gj,sup} = 1{,}35$

$\gamma_{Gj,inf} = 1{,}15$

$\gamma_{Q,1} = 1{,}50$ where unfavourable (0 where favourable)

$\gamma_{Q,i} = 1{,}50$ where unfavourable (0 where favourable)

provided that applying $\gamma_{Gj,inf} = 1{,}00$ both to the favourable part and to the unfavourable part of permanent actions does not give a more unfavourable effect.

NA.2.2.3.2 *Values for the symbols γ and ξ of Table A1.2 (B)*

Table NA.A1.2 (B) provides the values for the symbols γ and ξ of Table A1.2 (B). The values chosen are:

$\gamma_{Gj,sup} = 1{,}35$

$\gamma_{Gj,inf} = 1{,}00$

$\gamma_{Q,1} = 1{,}50$ where unfavourable (0 where favourable)

$\gamma_{Q,i} = 1{,}50$ where unfavourable (0 where favourable)

$\xi = 0{,}925$

NOTE For Ψ values see Table NA.A1.1.

Table NA.A1.2 (B) – Design values of actions (STR/GEO) (Set B)

Persistent and transient design situations	Permanent actions		Leading variable action	Accompanying variable actions[a]		Persistent and transient design situations	Permanent actions		Leading variable action[a]	Accompanying variable actions[a]	
	Unfavourable	Favourable		Main (if any)	Others		Unfavourable	Favourable	Action	Main	Others
(Eq. 6.10)	$1{,}35G_{kj,sup}$	$1{,}00G_{kj,inf}$	$1{,}5Q_{k,1}$		$1{,}5\psi_{0,1}Q_{k,i}$	(Eq. 6.10a)	$1{,}35G_{kj,sup}$	$1{,}00G_{kj,inf}$		$1{,}5\psi_{0,1}Q_{k,1}$	$1{,}5\psi_{0,1}Q_{k,i}$
						(Eq. 6.10b)	$0{,}925{*}1{,}35G_{kj,sup}$	$1{,}00G_{kj,inf}$	$1{,}5Q_{k,1}$		$1{,}5\psi_{0,1}Q_{k,i}$

NOTE 1 Either expression 6.10, or expression 6.10a together with and 6.10b may be made, as desired.

NOTE 2 The characteristic values of all permanent actions from one source are multiplied by $\gamma_{G,sup}$ if the total resulting action effect is unfavourable and $\gamma_{G,inf}$ if the total resulting action effect is favourable. For example, all actions originating from the self weight of the structure may be considered as coming from one source; this also applies if different materials are involved.

NOTE 3 For particular verifications, the values for γ_G and γ_Q may be subdivided into γ_g and γ_q and the model uncertainty factor γ_{sd}. A value of γ_{sd} in the range 1,05 to 1,15 can be used in most common cases and can be modified in the National Annex.

NOTE 4 When variable actions are favourable Q_k should be taken as 0.

[a] Variable actions are those considered in Table NA.A1.1.

3.4 Section properties

3.4.1 Gross cross-section

Gross cross-section properties should be determined from the specified shape and nominal dimensions of the member or element. Holes for bolts should not be deducted, but due allowance should be made for larger openings. Material used solely in splices or as battens should not be included.

3.4.2 Net area

The net area of a cross-section or an element of a cross-section should be taken as its gross area, less the deductions for bolt holes given in **3.4.4**.

3.4.3 Effective net area

The effective net area a_e of each element of a cross-section with bolt holes should be determined from:

$$a_e = K_e a_n \quad \text{but} \quad a_e \le a_g$$

in which the effective net area coefficient K_e is given by:

— for grade S 275: $K_e = 1.2$

— for grade S 355: $K_e = 1.1$

— for grade S 460: $K_e = 1.0$

— for other steel grades: $K_e = (U_s/1.2)/p_y$

where

a_g is the gross area of the element;

a_n is the net area of the element;

p_y is the design strength;

U_s is the specified minimum tensile strength.

3.4.4 Deductions for bolt holes

3.4.4.1 *Hole area*

In deducting for bolt holes (including countersunk holes), the sectional area of the hole in the plane of its own axis should be deducted, not that of the bolt.

3.4.4.2 *Holes not staggered*

Provided that the bolt holes are not staggered, the area to be deducted should be the sum of the sectional areas of the bolt holes in a cross-section perpendicular to the member axis or direction of direct stress.

3.4.4.3 *Staggered holes*

Where the bolt holes are staggered, the area to be deducted should be the greater of:

a) the deduction for non-staggered holes given in **3.4.4.2**;

b) the sum of the sectional areas of a chain of holes lying on any diagonal or zig-zag line extending progressively across the member or element, see Figure 3, less an allowance of $0.25s^2t/g$ for each gauge space g that it traverses diagonally, where:

g is the gauge spacing perpendicular to the member axis or direction of direct stress, between the centres of two consecutive holes in the chain, see Figure 3;

s is the staggered pitch, i.e. the spacing parallel to the member axis or direction of direct stress, between the centres of the same two holes, see Figure 3;

t is the thickness of the holed material.

For sections such as angles with holes in both legs, the gauge spacing g should be taken as the sum of the back marks to each hole, less the leg thickness, see Figure 4.

4.5.9 Connection of web stiffeners to flanges

4.5.9.1 *Stiffeners in compression*

Web stiffeners required to resist compression should either be fitted against the loaded flange or connected to it by continuous welds, fitted bolts or preloaded bolts designed to be non-slip under factored loads, see **6.4.2**.

The stiffener should be fitted against, or connected to, both flanges where any of the following apply:

a) a load is applied directly over a support;

b) the stiffener forms the end stiffener of a stiffened web;

c) the stiffener acts as a torsion stiffener.

4.5.9.2 *Stiffeners in tension*

Web stiffeners required to resist tension should be connected to the flange transmitting the load or reaction by continuous welds, fitted bolts or preloaded bolts designed to be non-slip under factored loads, see **6.4.2**. This connection should be designed to resist the lesser of the applied load or reaction or the capacity of the stiffener, see **4.5.2.2**.

4.5.10 Length of web stiffeners

Bearing stiffeners or tension stiffeners that do not also have other functions, see **4.5.1.1**, may be curtailed where the capacity P_{us} of the unstiffened web beyond the end of the stiffener is not less than the proportion of the applied load or reaction carried by the stiffener. The capacity P_{us} of the unstiffened web at this point should be obtained from:

$$P_{us} = (b_1 + w)tp_{yw}$$

where

b_1 is the stiff bearing length, see **4.5.1.3**;

w is the length obtained by dispersion at 45° to the level at which the stiffener terminates.

The length of a stiffener that does not extend right across the web should also be such that the local shear stress in the web due to the force transmitted by the stiffener does not exceed $0.6p_{yw}$.

4.6 Tension members

4.6.1 Tension capacity

The tension capacity P_t of a member should generally be obtained from:

$$P_t = p_y A_e$$

in which A_e is the sum of the effective net areas a_e of all the elements of the cross-section, determined from **3.4.3**, but not more than 1.2 times the total net area A_n.

4.6.2 Members with eccentric connections

If members are connected eccentric to their axes, the resulting moments should generally be allowed for in accordance with **4.8.2**. However, angles, channels or T-sections with eccentric end connections may be treated as axially loaded by using the reduced tension capacity given in **4.6.3**.

4.6.3 Simple tension members

4.6.3.1 *Single angle, channel or T-section members*

For a simple tie, designed as axially loaded, consisting of a single angle connected through one leg only, a single channel connected only through the web or a T-section connected only through the flange, the tension capacity should be obtained as follows:

— for bolted connections: $P_t = p_y(A_e - 0.5a_2)$

— for welded connections: $P_t = p_y(A_g - 0.3a_2)$

in which:

$$a_2 = A_g - a_1$$

where

A_g is the gross cross-sectional area, see **3.4.1**;

a_1 is the gross area of the connected element, taken as the product of its thickness and the overall leg width for an angle, the overall depth for a channel or the flange width for a T-section.

4.6.3.2 *Double angle, channel or T-section members*

For a simple tie, designed as axially loaded, consisting of two angles connected through one leg only, two channels connected only through the web or two T-sections connected only through the flange, the tension capacity should be obtained as follows:

a) if the tie is connected to both sides of a gusset or section and the components are interconnected by bolts or welds and held apart and longitudinally parallel by battens or solid packing pieces in at least two locations within their length, the tension capacity per component should be obtained from:

— for bolted connections: $P_t = p_y(A_e - 0.25a_2)$

— for welded connections: $P_t = p_y(A_g - 0.15a_2)$

b) if the components are both connected to the same side of a gusset or member, or not interconnected as given in a), the tension capacity per component should be taken as given in **4.6.3.1**.

In case a) the outermost interconnection should be within a distance from each end of ten times the smaller leg length for angle components, or ten times the smaller overall dimension for channels or T-sections.

4.6.3.3 *Other simple ties*

A simple tie consisting of a single angle connected through both legs by lug angles or otherwise, a single channel connected by both flanges or a T-section connected only through the stem (or both the flange and the stem), should be designed as axially loaded. The tension capacity should be based on the effective net area from **3.4.3**.

4.6.3.4 *Continuous ties*

The internal bays of continuous ties should be designed as axially loaded. The tension capacity should be based on the effective net area from **3.4.3**.

4.6.4 Laced or battened ties

For laced or battened ties, the lacing or battening systems should be designed to resist the greater of:

a) the axial forces, moments and shear forces induced by eccentric loads, applied moments or transverse forces, including self-weight and wind resistance;

b) the axial forces, moments and shear forces induced by a transverse shear on the complete member at any point in its length equal to 1 % of the axial force in the member, taken as shared equally between all transverse lacing or battening systems in parallel planes.

4.7 Compression members

4.7.1 General

4.7.1.1 *Segment length*

The segment length L of a compression member in any plane should be taken as the length between the points at which it is restrained against buckling in that plane.

4.7.1.2 *Restraints*

A restraint should have sufficient strength and stiffness to inhibit movement of the restrained point in position or direction as appropriate. Positional restraints should be connected to an appropriate shear diaphragm or system of triangulated bracing.

Positional restraints to compression members forming the flanges of lattice girders should satisfy the recommendations for lateral restraint of beams specified in **4.3.2**. All other positional restraints to compression members should be capable of resisting a force of not less than 1.0 % of the axial force in the member and transferring it to the adjacent points of positional restraint.

3.6.4 Equal-leg angle sections

For class 4 slender hot rolled equal-leg angle sections, the method given in **3.6.3** may be used. Alternatively, the effective cross-sectional area A_{eff} and effective section modulus Z_{eff} about a given axis may conservatively be obtained using:

$$\frac{A_{eff}}{A} = \frac{12\varepsilon}{b/t}$$

$$\frac{Z_{eff}}{Z} = \frac{15\varepsilon}{b/t}$$

where

b is the leg length;

t is the thickness.

3.6.5 Alternative method

As an alternative to the methods detailed in **3.6.2**, **3.6.3** and **3.6.4**, a reduced design strength p_{yr} may be calculated at which the cross-section would be class 3 semi-compact. The reduced design strength p_{yr} should then be used in place of p_y in the checks on section capacity and member buckling resistance given in **4.2**, **4.3**, **4.4**, **4.7** and **4.8**. The value of this reduced design strength p_{yr} may be obtained from:

$$p_{yr} = (\beta_3/\beta)^2 p_y$$

in which β is the value of b/T, b/t, D/t or d/t that exceeds the limiting value β_3 given in Table 11 or Table 12 for a class 3 semi-compact section.

NOTE Unless the class 3 semi-compact limit is exceeded by only a small margin, the use of this alternative method can be rather conservative.

3.6.6 Circular hollow sections

Provided that the overall diameter D does not exceed $240t\varepsilon^2$ the effective cross-sectional area A_{eff} and effective section modulus Z_{eff} of a class 4 slender circular hollow section of thickness t may be determined from:

$$\frac{A_{eff}}{A} = \left[\left(\frac{80}{D/t}\right)\left(\frac{275}{p_y}\right)\right]^{0.5}$$

$$\frac{Z_{eff}}{Z} = \left[\left(\frac{140}{D/t}\right)\left(\frac{275}{p_y}\right)\right]^{0.25}$$

Bracing systems that supply positional restraint to more than one member should be designed to resist the sum of the restraint forces from each member that they restrain, reduced by the factor k_r obtained from:

$$k_r = (0.2 + 1/N_r)^{0.5}$$

in which N_r is the number of parallel members restrained.

4.7.2 Slenderness

The slenderness λ of a compression member should generally be taken as its effective length L_E divided by its radius of gyration r about the relevant axis, except as given in **4.7.9**, **4.7.10** or **4.7.13**.

In the case of a single-angle strut with lateral restraints to its two legs alternately, the slenderness for buckling about every axis should be increased by 20 %.

4.7.3 Effective lengths

Except for angles, channels or T-sections designed in accordance with **4.7.10** the effective length L_E of a compression member should be determined from the segment length L centre-to-centre of restraints or intersections with restraining members in the relevant plane as follows.

a) Generally, in accordance with Table 22, depending on the conditions of restraint in the relevant plane, members carrying more than 90 % of their reduced plastic moment capacity M_r in the presence of axial force (see **I.2**) being taken as incapable of providing directional restraint.

b) For continuous columns in multistorey buildings of simple design, in accordance with Table 22, depending on the conditions of restraint in the relevant plane, directional restraint being based on connection stiffness as well as member stiffness.

c) For compression members in trusses, lattice girders or bracing systems, in accordance with Table 22, depending on the conditions of restraint in the relevant plane.

d) For columns in single storey buildings of simple design, see **D.1**.

e) For columns supporting internal platform floors of simple design, see **D.2**.

f) For columns forming part of a continuous structure, see Annex E.

Table 22 — Nominal effective length L_E for a compression member[a]

a) non-sway mode			
Restraint (in the plane under consideration) by other parts of the structure			L_E
Effectively held in position at both ends	Effectively restrained in direction at both ends		$0.7L$
	Partially restrained in direction at both ends		$0.85L$
	Restrained in direction at one end		$0.85L$
	Not restrained in direction at either end		$1.0L$
b) sway mode			
One end	Other end		L_E
Effectively held in position and restrained in direction	Not held in position	Effectively restrained in direction	$1.2L$
		Partially restrained in direction	$1.5L$
		Not restrained in direction	$2.0L$
[a] Excluding angle, channel or T-section struts designed in accordance with **4.7.10**.			

4.7.4 Compression resistance

The compression resistance P_c of a member should be obtained from the following:

a) for class 1 plastic, class 2 compact or class 3 semi-compact cross-sections:

$$P_c = A_g p_c$$

b) for class 4 slender cross-sections:

$$P_c = A_{eff} p_{cs}$$

Table 25 — Angle, channel and T-section struts

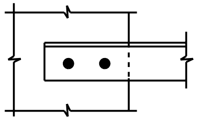
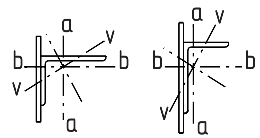
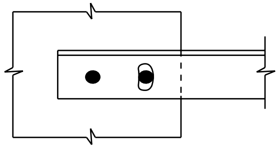
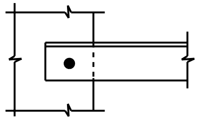
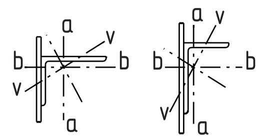
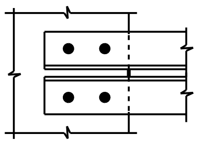
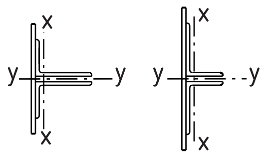
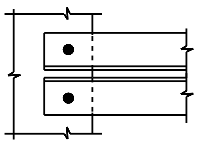
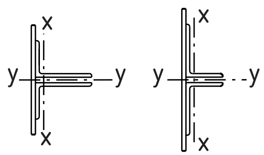
Clause	Connection	Sections and axes	Slenderness ratios (see notes 1 and 2)
4.7.10.2a)			v-v axis: $0.85L_v/r_v$ but $\geq 0.7L_v/r_v + 15$ a-a axis: $1.0L_a/r_a$ but $\geq 0.7L_a/r_a + 30$ b-b axis: $0.85L_b/r_b$ but $\geq 0.7L_b/r_b + 30$
4.7.10.2b) **4.7.10.2**c)	 (kidney-shaped slot)  (see note 3)		v-v axis: $1.0L_v/r_v$ but $\geq 0.7L_v/r_v + 15$ a-a axis: $1.0L_a/r_a$ but $\geq 0.7L_a/r_a + 30$ b-b axis: $1.0L_b/r_b$ but $\geq 0.7L_b/r_b + 30$ (see note 3)
4.7.10.3a)	 (see note 4)		x-x axis: $1.0L_x/r_x$ but $\geq 0.7L_x/r_x + 30$ y-y axis: $[(0.85L_y/r_y)^2 + \lambda_c^2]^{0.5}$ but $\geq 1.4\lambda_c$ (see note 5)
4.7.10.3b)	 (see note 4)		x-x axis: $1.0L_x/r_x$ but $\geq 0.7L_x/r_x + 30$ y-y axis: $[(L_y/r_y)^2 + \lambda_c^2]^{0.5}$ but $\geq 1.4\lambda_c$ (see note 5)

Table 25 — Angle, channel and T-section struts (*continued*)

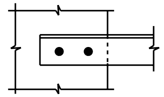
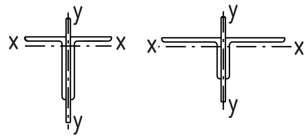
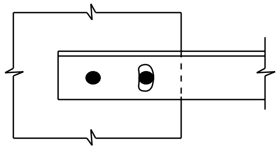
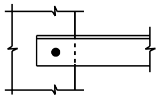
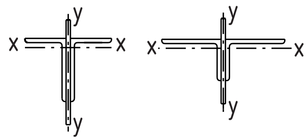
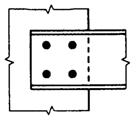
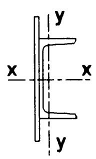
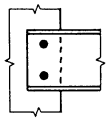
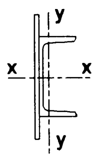
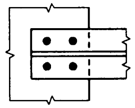
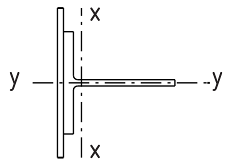
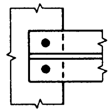
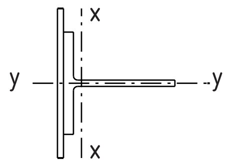
Clause	Connection	Sections and axes	Slenderness ratios (see notes 1 and 2)
4.7.10.3c)	 (see note 4)		x-x axis: $0.85L_x/r_x$ but $\geq 0.7L_x/r_x + 30$ y-y axis: $[(L_y/r_y)^2 + \lambda_c^2]^{0.5}$ but $\geq 1.4\lambda_c$ (see note 5)
4.7.10.3d) **4.7.10.3**e)	 (kidney-shaped slot)  (see notes 3 and 4)		x-x axis: $1.0L_x/r_x$ but $\geq 0.7L_x/r_x + 30$ y-y axis: $[(L_y/r_y)^2 + \lambda_c^2]^{0.5}$ but $\geq 1.4\lambda_c$ (see notes 3 and 5)
4.7.10.4a)			x-x axis: $0.85L_x/r_x$ y-y axis: $1.0L_y/r_y$ but $\geq 0.7L_y/r_y + 30$
4.7.10.4b)			x-x axis $1.0L_x/r_x$ y-y axis $1.0L_y/r_y$ but $\geq 0.7L_y/r_y + 30$

Table 25 — Angle, channel and T-section struts (*continued*)

Clause	Connection	Sections and axes	Slenderness ratios (see notes 1 and 2)
4.7.10.5a)			x-x axis: $1.0L_x/r_x$ but $\geq 0.7L_x/r_x + 30$ y-y axis: $0.85L_y/r_y$
4.7.10.5b)			x-x axis: $1.0L_x/r_x$ but $\geq 0.7L_x/r_x + 30$ y-y axis $1.0L_y/r_y$

NOTE 1 The length L is taken between the intersections of the centroidal axes or the intersections of the setting out lines of the bolts, irrespective of whether the strut is connected to a gusset or directly to another member.

NOTE 2 Intermediate restraints reduce the value of L for buckling about the relevant axes. For single angle members, L_v is taken between lateral restraints, perpendicular to either a-a or b-b.

NOTE 3 For single or double angles connected by one bolt, the compression resistance is also reduced to 80 % of that for an axially loaded member, see **4.7.10.2**b) or **4.7.10.3**d).

NOTE 4 Double angles are either battened (see **4.7.12**) or interconnected back-to-back (see **4.7.13**). Battens or interconnecting bolts are also needed at the ends of members.

NOTE 5 $\lambda_c = L_v/r_v$ with L_v measured between interconnecting bolts for back-to-back struts, or between end welds or end bolts of adjacent battens for battened angle struts.

Annex D (normative)
Effective lengths of columns in simple structures

D.1 Columns for single storey buildings

D.1.1 *Typical cases*

The effective lengths of columns for single storey buildings of simple design, see **2.1.2.2**, should be determined by reference to the typical cases illustrated in Figure D.1 to Figure D.5, provided that the following conditions apply.

a) In the plane of the diagram the columns act as cantilevers tied together by the roof trusses, but in this plane the tops of the columns are not otherwise held in position or restrained in direction.

b) Perpendicular to the plane of the diagram, the tops of the columns are effectively held in position by members connecting them to a braced bay, or by other suitable means. In the case of Figure D.3 to Figure D.5 the braced bay also holds the columns in position at crane girder level.

c) The bases of the columns are effectively held in position and restrained in direction in both planes.

d) The foundations are capable of providing restraint commensurate with that provided by the base.

D.1.2 *Variations*

Where the conditions differ from those detailed in **D.1.1**, the following modifications should be made to the effective lengths shown in Figure D.1 to Figure D.5.

a) If, in the plane of the diagram, the tops of the columns are effectively held in position by horizontal bracing or other suitable means, the effective lengths in this plane should be obtained from Table 22a).

b) If, in the plane of the diagram, the roof truss or other roof member is connected to the columns by a connection capable of transmitting appreciable moment, the effective length of the stanchion in this plane should be determined in accordance with Annex E.

c) If, perpendicular to the plane of the diagram, one flange only of the stanchion is restrained at intervals by sheeting rails, then for buckling out-of-plane the method given in Annex G should be used.

d) If, perpendicular to the plane of the diagram, the base of the column is not effectively restrained in direction, the effective lengths $0.85L$ or $0.85L_1$ in Figure D.1 to Figure D.5 should be increased to $1.0L$ or $1.0L_1$ respectively.

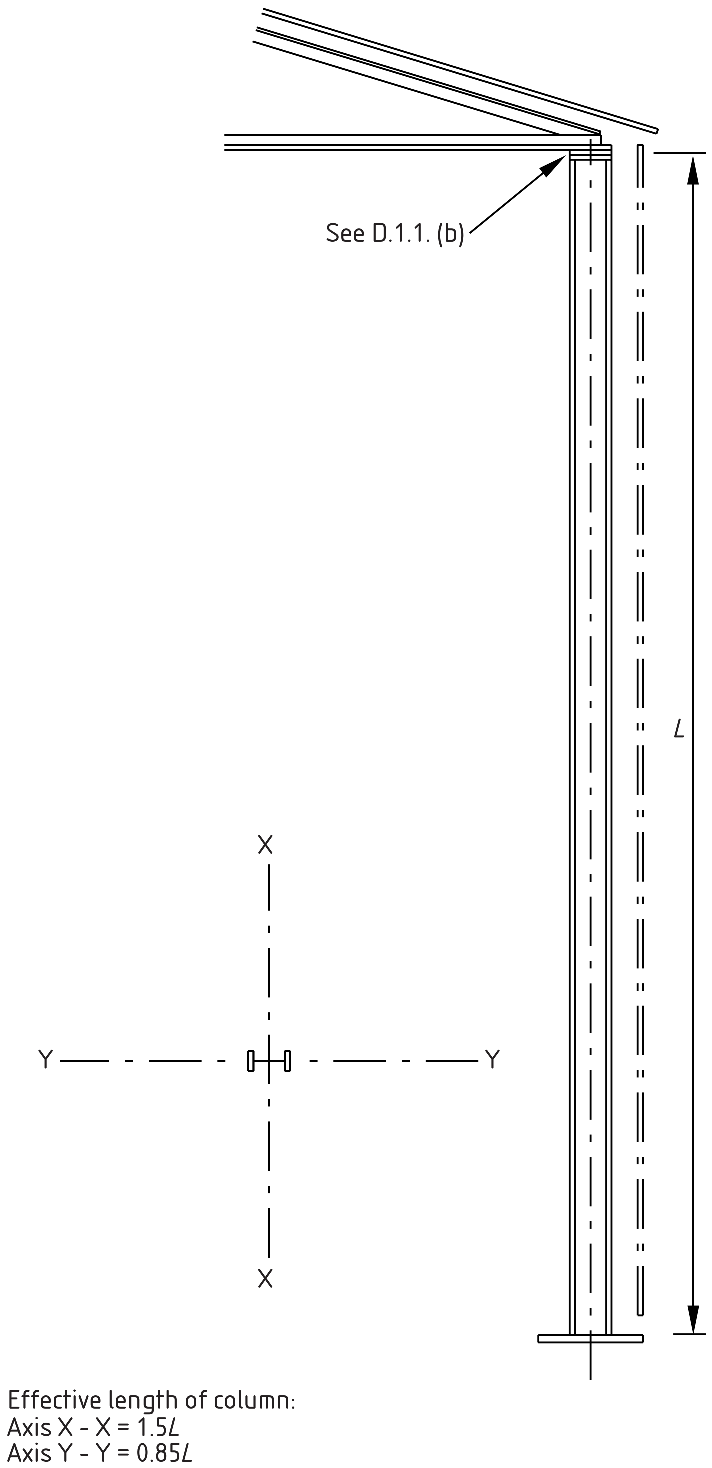


Figure D.1 — Side column without intermediate lateral restraint

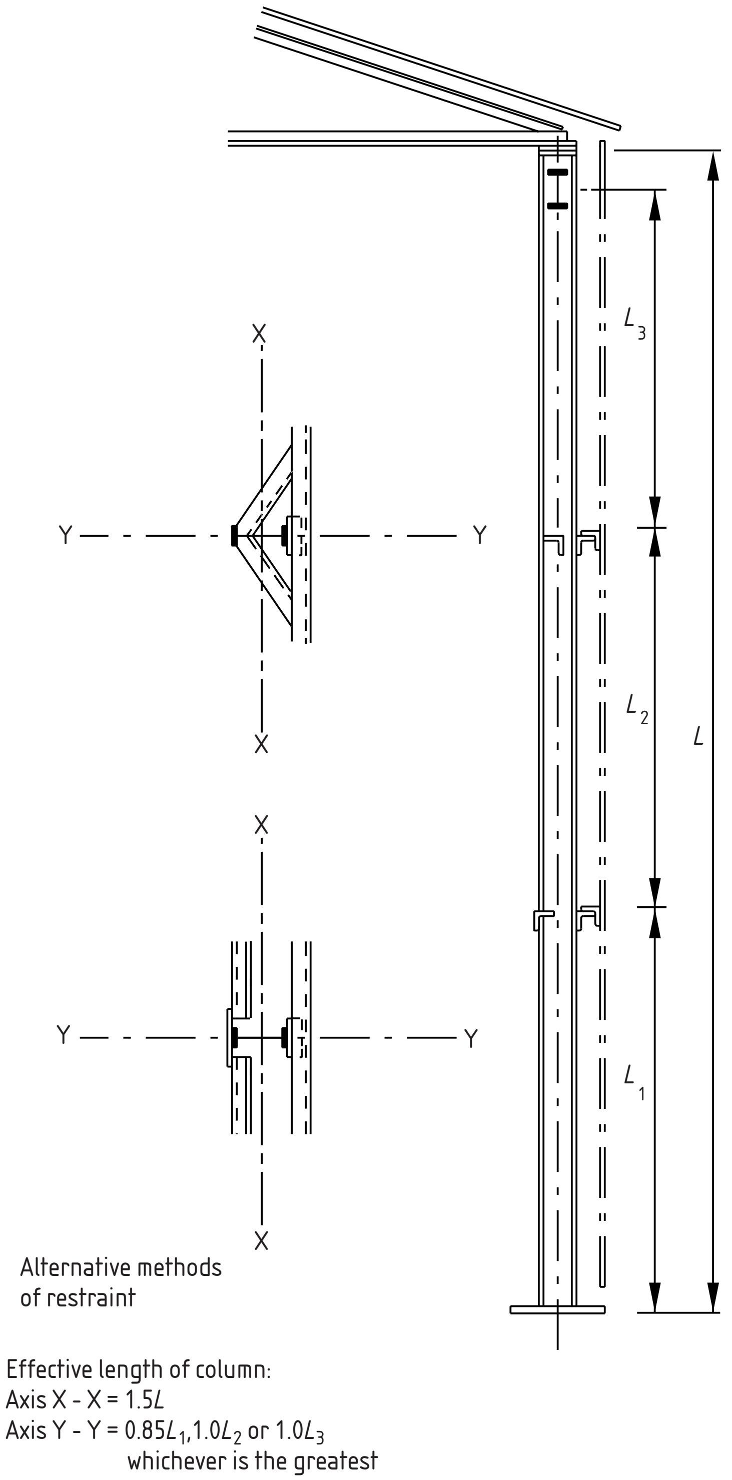


Figure D.2 — Side column with intermediate lateral restraint to both flanges

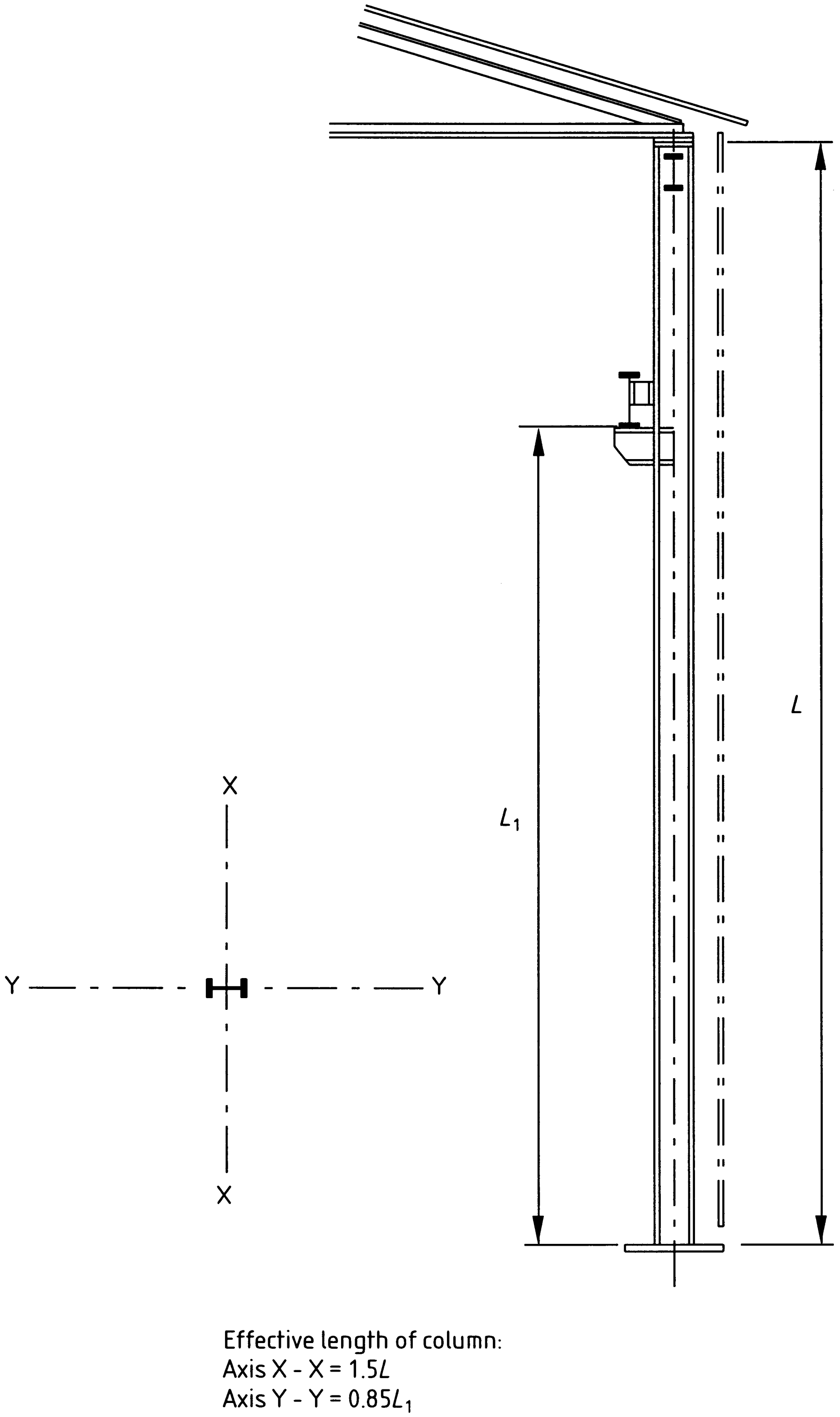


Figure D.3 — Simple side column with crane gantry beams

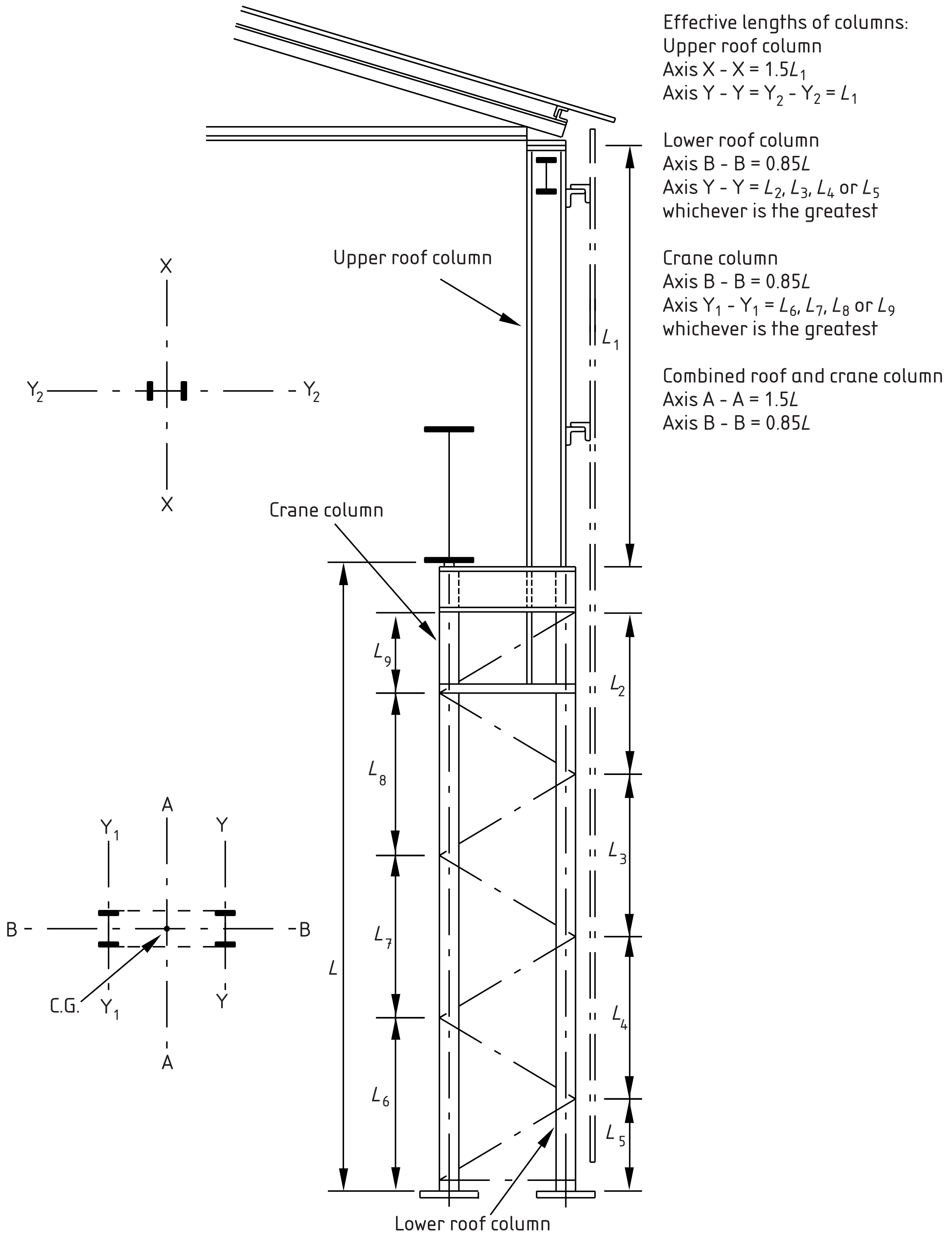


Figure D.4 — Compound side column with crane gantry beams

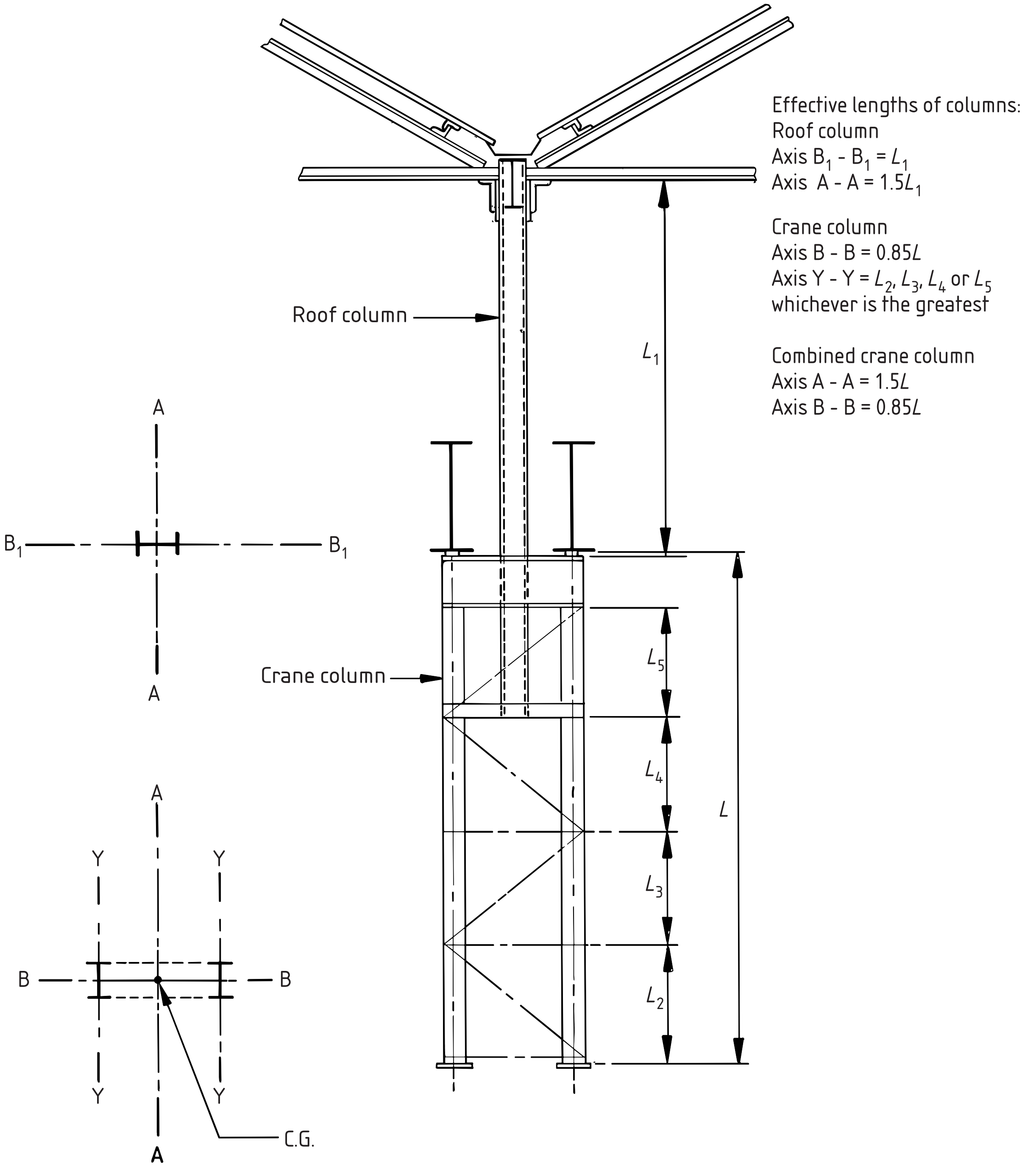


Figure D.5 — Compound valley column with crane gantry beams

D.2 Columns supporting internal platform floors

The effective lengths of columns supporting internal platform floors of simple design, see **2.1.2.2**, should be determined from Table D.1, depending on the conditions of directional restraint at the head and the base of the column in the relevant plane, and on whether the platform is braced against sway in that plane by some appropriate means other than the strength and stiffness of the columns themselves.

For columns that are unbraced in the relevant plane, where at least five columns act together to resist sway, the reduced effective lengths given in case c) of Table D.1 may be used, except for columns supporting storage loads.

In assessing the conditions of fixity, no greater directional restraint should be assumed than can reliably be provided at the head of a column by the cap-plate, the beams and the connection details, or at the base of a column by the baseplate, the base slab and the connection between them.

Table D.1 — Effective lengths of columns for internal platform floors

Case	Directional restraint at base of column	Directional restraint at head of column			
		Effectively restrained	Partially restrained	Nominally pinned	Truly pinned
a) Braced column	Effectively restrained	$0.70L$	$0.80L$	$0.85L$	$0.90L$
	Partially restrained	$0.80L$	$0.85L$	$0.90L$	$0.95L$
	Nominally pinned	$0.85L$	$0.90L$	$0.95L$	$1.00L$
	Truly pinned	$0.90L$	$0.95L$	$1.00L$	Avoid
b) Unbraced column Except as in case c)	Effectively restrained	$1.50L$	$2.00L$	$2.50L$	$3.00L$
	Partially restrained	$2.00L$	$2.50L$	$3.00L$	$4.00L$[a]
	Nominally pinned	$2.50L$	$3.00L$	Avoid	Avoid
	Truly pinned	$3.00L$	Avoid	Avoid	Avoid
c) Unbraced column	Effectively restrained	$1.20L$	$1.50L$	$2.00L$	$2.50L$
Five or more columns tied together	Partially restrained	$1.50L$	$2.00L$	$2.50L$	$3.00L$[a]
	Nominally pinned	$2.00L$	$2.50L$	Avoid	Avoid
No storage loads	Truly pinned	$2.50L$	Avoid	Avoid	Avoid

[a] For buckling about major axis only. To be avoided for buckling about minor axis.

Annex E (normative) Effective lengths of compression members in continuous structures

E.1 General

The effective length L_E for in-plane buckling of a column or other compression member in a continuous structure with moment-resisting joints, should be determined using the methods given in this annex.

Generally, the effective length ratio L_E/L should be obtained from Figure E.1 for the non-sway mode or Figure E.2 for the sway mode, as appropriate.

Distribution factors for columns in multi-storey buildings may be determined using the limited frame method given in **E.2**. The stiffening effect of infill wall panels may be taken into account as given in **E.3**.

Distribution factors for other compression members should be determined by reference to **E.4**.

In structures in which frames with moment-resisting joints provide sway resistance to simple columns (or other columns that do not contribute to the sway resistance in that plane), the in-plane effective lengths of the columns contributing to the sway resistance should be increased as detailed in **E.5**.

Alternatively, the effective length may be derived from the elastic critical load factor, taking account of the vertical loads supported by the whole structure, see **E.6**.

A1 NOTE Recommendations for the necessary stiffness of the moment-resisting joints are given in **6.1.5**. A1

E.2 Columns in multi-storey buildings

E.2.1 *Limited frame method*

For columns in multi-storey beam-and-column framed buildings with full continuity at moment-resisting joints and concrete or composite floor and roof slabs, the effective length L_E for in-plane buckling of a column-length may be determined on the basis of the limited frame shown in Figure E.3. The distribution factors k_1 and k_2 for the ends of the column-length should be obtained from:

$$k = \frac{\text{Total stiffness of the columns at the joint}}{\text{Total stiffness of all the members at the joint}}$$

If any member shown in Figure E.3 is not present in the actual structure, or is not rigidly connected to the column-length being designed, its stiffness should be taken as zero in determining distribution factors.

If the moment at one end of the column-length being designed exceeds 90 % of its reduced plastic moment capacity M_r in the presence of axial force, the distribution factor k for that end of the column-length should be taken as unity.

E.2.2 *Beam stiffness*

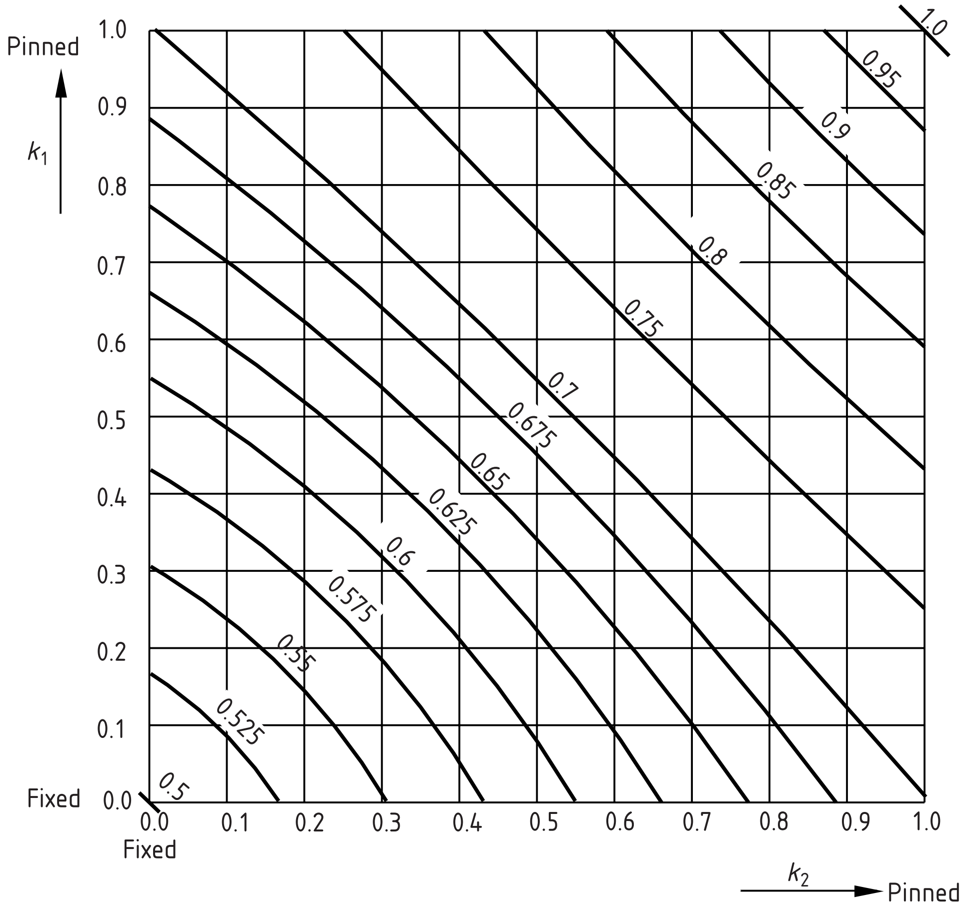
The stiffness coefficient K_b for a beam directly supporting a concrete or composite floor slab should normally be taken as I/L for both the sway mode and the non-sway mode, provided that the beam does not carry axial force, other than that due to sharing wind loads or notional horizontal loads between columns.

The stiffness coefficient K_b for any other beam should be obtained:

— from Table E.1 for other beams in buildings with concrete or composite floor slabs;

— by reference to **E.4.1** for beams in other rectilinear frames.

For beams with axial forces, reference should be made to **E.4.2**. If a beam has semi-rigid connections, its effective stiffness coefficient should be reduced accordingly.



NOTE This figure shows values of L_E/L that satisfy:

$$k_1 = \frac{1 - Ak_2}{A - Bk_2}$$

in which:

$$A = 1 - \frac{1}{4}\left[\frac{\alpha^2}{1 - \alpha\cot\alpha} + \alpha\cot\alpha\right]$$

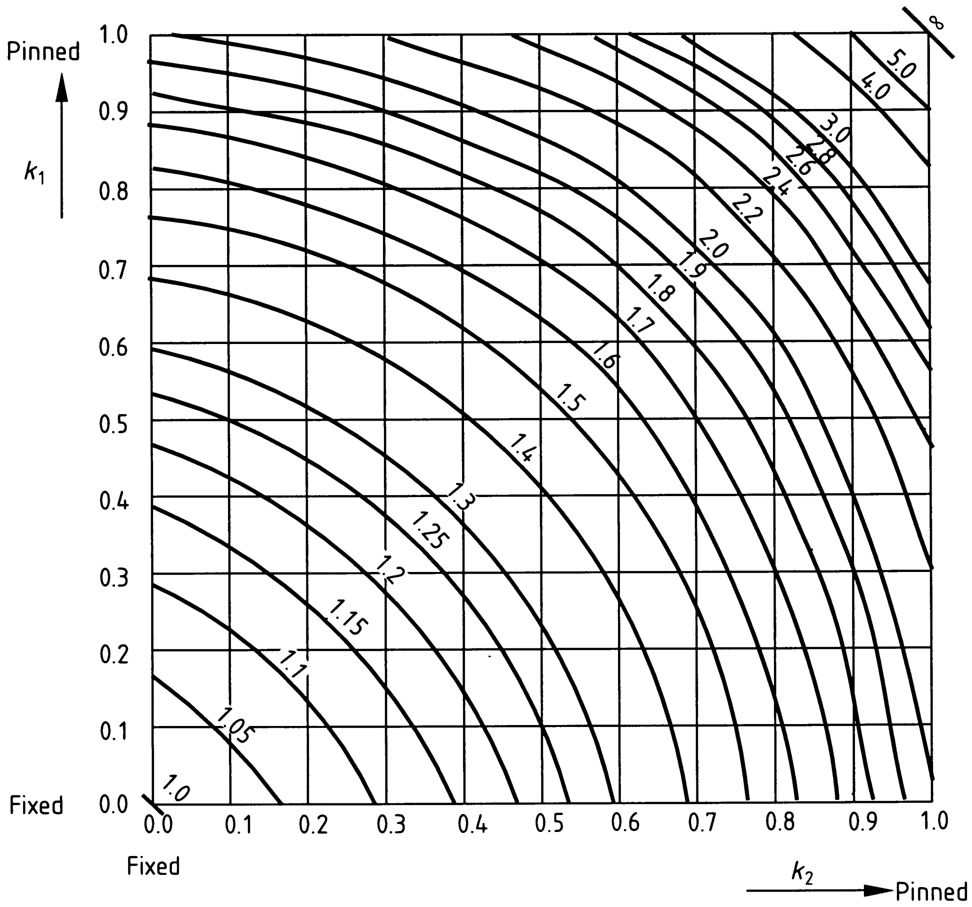
$$B = A^2 - \frac{1}{16}\left[\frac{\alpha^2}{1 - \alpha\cot\alpha} - \alpha\cot\alpha\right]^2$$

$$\alpha = \frac{\pi/2}{L_E/L}\text{[radians]}$$

A conservative value of L_E/L for given values of k_1 and k_2 may be obtained from:

$$L_E/L \approx 0.5 + 0.14(k_1 + k_2) + 0.055(k_1 + k_2)^2$$

Figure E.1 — Effective length ratio L_E/L for the non-sway buckling mode



NOTE This figure shows values of L_E/L that satisfy:

$$k_1 = \frac{1 - Ak_2}{A - Bk_2}$$

in which:

$$A = 1 - 0.25\alpha(\cot\alpha - \tan\alpha)$$

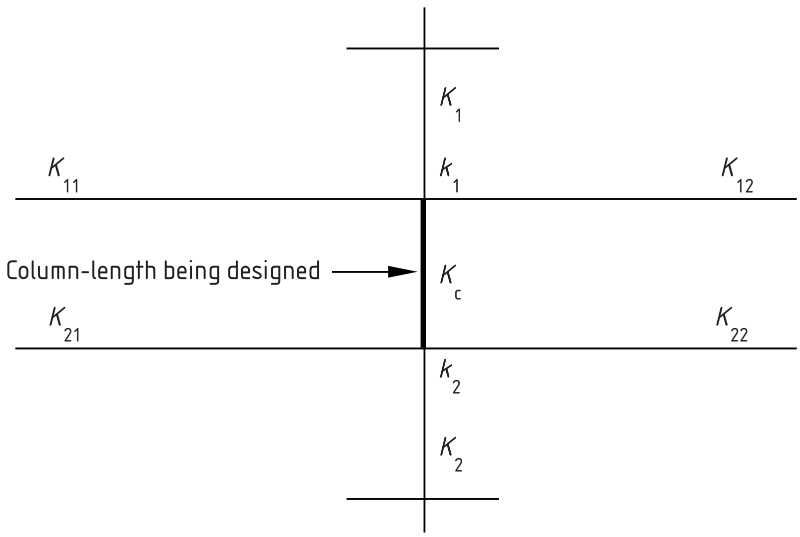
$$B = A^2 - [0.25\alpha(\cot\alpha + \tan\alpha)]^2$$

$$\alpha = \frac{\pi/2}{L_E/L}[\text{radians}]$$

A conservative value of L_E/L for given values of k_1 and k_2 may be obtained from:

$$L_E/L \approx \left[\frac{1 - 0.2(k_1 + k_2) - 0.12k_1k_2}{1 - 0.8(k_1 + k_2) + 0.6k_1k_2}\right]^{0.5}$$

Figure E.2 — Effective length ratio L_E/L for the sway buckling mode



Distribution factors:

$$k_1 = \frac{K_c + K_1}{K_c + K_1 + K_{11} + K_{12}}$$

$$k_2 = \frac{K_c + K_2}{K_c + K_2 + K_{21} + K_{22}}$$

where

K_1 and K_2 are the values of K_c for the adjacent column-lengths;

K_{11}, K_{12}, K_{21} and K_{22} are the values of K_b for the adjacent beams.

Figure E.3 — Distribution factors for continuous columns

Table E.1 — Stiffness coefficients K_b of beams in buildings with floor slabs

Loading conditions for the beam	Non-sway mode	Sway mode
Beams directly supporting concrete or composite floor or roof slabs	$1.0I/L$	$1.0I/L$
Other beams with direct loads	$0.75I/L$	$1.0I/L$
Beams with end moments only	$0.5I/L$	$1.5I/L$

Wherever a peak moment in a beam exceeds 90 % of its reduced plastic moment capacity M_r in the presence of axial force, it should be treated as pinned at that point. If such a point occurs only at the far end of the beam the value of K_b should be taken as $0.75I/L$ (or the value from Table E.1, if less), otherwise K_b should be taken as zero.

In a structure designed using plastic analysis, a beam should be taken as having a stiffness coefficient K_b of zero unless it has been designed to remain elastic.

E.2.3 ***Base stiffness***

The base stiffness should be determined by reference to **5.1.3**. In determining the distribution factor k at the foot of a column, the base stiffness should be treated as a beam stiffness, not a column stiffness.

E.2.4 ***Column stiffness***

The stiffness coefficient K_c of an adjacent column-length above or below the column-length being designed should be taken as I/L. A1 *Text deleted* A1

2.3 Simplified determination of slenderness

The basic definition of non-dimensional beam slenderness $\bar{\lambda}_{\mathrm{LT}}$ (Equation (2.18)) requires the explicit calculation of M_{cr}, given, for the most general case, by Equation (2.14). Use of this equation will generally lead to the most accurate assessment of lateral torsional buckling resistance and hence the most economic design. There are, however, a number of simplifications that can be made in the determination of $\bar{\lambda}_{\mathrm{LT}}$ that will greatly expedite the calculation process, often with little loss of economy. These simplifications are described in NCCI SN002 [7] and are summarised below. A number of the simplifications relate specifically to doubly-symmetric I sections.

As an alternative to Equation (2.18), the non-dimensional beam slenderness $\bar{\lambda}_{\mathrm{LT}}$ may be taken as:

$$\bar{\lambda}_{\mathrm{LT}} = \frac{1}{\sqrt{C_1}} UVD\bar{\lambda}_{\mathrm{z}}\sqrt{\beta_{\mathrm{w}}} \qquad (2.21)$$

C_1 is a factor that allows for the shape of the bending moment diagram and is discussed in Section 2.4. It may be conservatively taken as equal to 1.0.

U is a parameter that depends on section geometry, given by:

$$U = \sqrt{\frac{W_{\mathrm{pl,y}}\, g}{A}\sqrt{\frac{I_{\mathrm{z}}}{I_{\mathrm{w}}}}} \qquad (2.22)$$

where all symbols are as previously defined.

For UKB and UKC sections, values of U range between about 0.84 and 0.90; $U = 0.9$ is therefore a suitable conservative upper bound for such sections. The parameter g is defined in Section 2.2.1.

V is a parameter related to slenderness, and is given in full by:

$$V = \frac{1}{\sqrt[4]{\left(\frac{k}{k_{\mathrm{w}}}\right)^2 + \frac{\lambda_{\mathrm{z}}^2}{\frac{\pi^2 E}{G}\frac{A}{I_{\mathrm{T}}}\frac{I_{\mathrm{w}}}{I_{\mathrm{z}}}} + (C_2 z_{\mathrm{g}})^2\frac{I_{\mathrm{z}}}{I_{\mathrm{w}}}}} \qquad (2.23)$$

the symbols for which are defined in Section 2.2.1.
For doubly-symmetric hot-rolled UKB and UKC sections, and for cases where the loading is not destabilizing, V may be conservatively simplified to:

$$V = \frac{1}{\sqrt[4]{1 + \frac{1}{20}\left(\frac{\lambda_{\mathrm{z}}}{h/t_{\mathrm{f}}}\right)^2}} \qquad (2.24)$$

For all sections symmetric about the major axis and not subjected to destabilizing loading, V may be conservatively taken as equal to 1.0.

D is a destabilizing parameter to allow for destabilizing loads (i.e. loads applied above the shear centre of the beam, where the load can move with the beam as it buckles), given by:

$$D = \frac{1}{\sqrt{1 - V^2 C_2 z_g \sqrt{\frac{I_z}{I_w}}}} \tag{2.25}$$

Destabilizing loads are discussed in Section 2.5. For non-destabilizing loads, $D = 1.0$.

$\bar{\lambda}_z$ is the minor axis non-dimensional slenderness of the member, given by $\bar{\lambda}_z = \lambda_z / \lambda_1$, in which $\lambda_z = kL / i_z$, where k is an effective length parameter, values of which are given in Section 3 of this guide.

β_w is a parameter that allows for the classification of the cross-section; for Class 1 and 2 sections, $\beta_w = 1$ while for Class 3 sections $\beta_w = W_{el,y} / W_{pl,y}$.

For a hot-rolled doubly-symmetric I or H section with lateral restraints to the compression flange at both ends of the segment under consideration and with no destabilizing loads, the non-dimensional beam slenderness $\bar{\lambda}_{LT}$ may be conservatively obtained from Table 2.3. Table 2.3 has been derived on the basis of Equation (2.21) with the conservative assumptions of $C_1 = 1.0$, $U = 0.9$, $V = 1.0$, $D = 1.0$ and $\sqrt{\beta_w} = 1.0$.

Table 2.3 $\bar{\lambda}_{LT}$ for different steel grades

S235	S275	S355
$\bar{\lambda}_{LT} = \frac{L / i_z}{104}$	$\bar{\lambda}_{LT} = \frac{L / i_z}{96}$	$\bar{\lambda}_{LT} = \frac{L / i_z}{85}$

Note that the simplified method described in this Section can lead to more favourable results if in-plane curvature prior to buckling is accounted for in the calculation of the parameter U (through the parameter g described in Section 2.2.1). The slenderness would be less than that derived from Equation (2.18) using a simplified value of M_{cr} that neglects this beneficial effect.

2.4 Equivalent uniform moment factors C_1

The distribution of bending moments along the length of a beam influences the value of the elastic critical moment. Allowance for the variation of bending moments on the elastic buckling moment M_{cr} or slenderness $\bar{\lambda}_{LT}$ of a beam may be made by means of the equivalent uniform moment factor C_1 (see Equations (2.14) and (2.21)). Uniform bending moment is the most severe scenario, for which $C_1 = 1$. Taking $C_1 = 1$ is also conservative for other patterns of moment, but may become overly conservative when the bending moment distribution varies significantly from uniform.

Recommended values of C_1 and $1/\sqrt{C_1}$ are given in Table 2.4 and Table 2.5. These values are taken from P362 [12]. Similar values are also available elsewhere including

NCCI: Elastic critical moment for lateral torsional buckling

This NCCI gives the expression of the elastic critical moment for doubly symmetric cross-sections. Values of the factors involved in the calculation are given for common cases. For a beam under a uniformly distributed load with end moments or a concentrated load at mid-span with end moments, the values for the factors are given in graphs.

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2.	Method for doubly symmetric sections	2
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1. General

For doubly symmetric cross-sections, the elastic critical moment M_{cr} may be calculated by the method given in paragraph 2.

For cases not covered by the method given in paragraph 2, the elastic critical moment may be determined by a buckling analysis of the beam provided that the calculation accounts for all the parameters liable to affect the value of M_{cr} :

- geometry of the cross-section
- warping rigidity
- position of the transverse loading with regard to the shear centre
- restraint conditions

The ***LTBeam*** software is specific software for the calculation of the critical moment M_{cr}. It may be downloaded free of charge from the following web site:

http://www.cticm.com

2. Method for doubly symmetric sections

The method given hereafter only applies to uniform straight members for which the cross-section is symmetric about the bending plane.

The conditions of restraint at each end are at least :

- restrained against lateral movement
- restrained against rotation about the longitudinal axis

The elastic critical moment may be calculated from the following formula derived from the buckling theory :

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{(kL)^2} \left\{ \sqrt{\left(\frac{k}{k_w}\right)^2 \frac{I_w}{I_z} + \frac{(kL)^2 GI_t}{\pi^2 EI_z} + (C_2 z_g)^2} - C_2 z_g \right\} \quad \textbf{(1)}$$

where

E is the Young modulus (E = 210000 N/mm^2)

G is the shear modulus (G = 80770 N/mm^2)

I_z is the second moment of area about the weak axis

I_t is the torsion constant

I_w is the warping constant

L is the beam length between points which have lateral restraint

k and k_w are effective length factors

z_g is the distance between the point of load application and the shear centre.

Note : for doubly symmetric sections, the shear centre coincides with the centroid.

C_1 and C_2 are coefficients depending on the loading and end restraint conditions (see §3).

The factor k refers to end rotation on plan. It is analogous to the ratio of the buckling length to the system length for a compression member. k should be taken as not less than 1,0 unless less than 1,0 can be justified.

The factor k_w refers to end warping. Unless special provision for warping fixity is made, k_w should be taken as 1,0.

In the general case z_g is positive for loads acting towards the shear centre from their point of application (Figure 2.1).

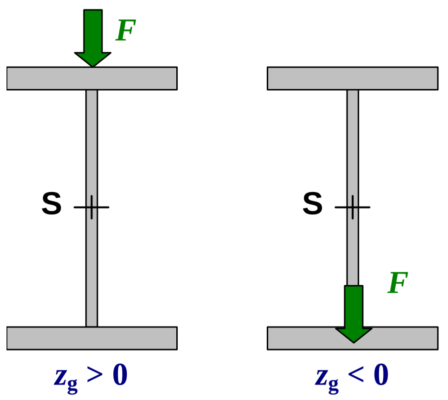


Figure 2.1 Point of application of the transverse load

In the common case of normal support conditions at the ends (fork supports), k and k_w are taken equal to 1.

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{L^2} \left\{ \sqrt{\frac{I_w}{I_z} + \frac{L^2 GI_t}{\pi^2 EI_z} + \left(C_2 z_g\right)^2} - C_2 z_g \right\} \qquad \textbf{(2)}$$

When the bending moment diagram is linear along a segment of a member delimited by lateral restraints, or when the transverse load is applied in the shear centre, $C_2\, z_g = 0$. The latter expression should be simplified as follows :

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{L^2} \sqrt{\frac{I_w}{I_z} + \frac{L^2 GI_t}{\pi^2 EI_z}} \qquad \textbf{(3)}$$

For doubly symmetric I-profiles, the warping constant I_w may be calculated as follows :

$$I_w = \frac{I_z \left(h - t_f\right)^2}{4} \qquad \textbf{(4)}$$

where

h is the total depth of the cross-section

t_f is the flange thickness

3. C_1 and C_2 factors

3.1 General

The C_1 and C_2 factors depend on various parameters :

- section properties,
- support conditions,
- moment diagram

It can be demonstrated that the C_1 and C_2 factors depend on the ratio :

$$\kappa = \frac{EI_w}{GI_t L^2} \qquad \textbf{(5)}$$

The values given in this document have been calculated with the assumption that $\kappa = 0$. This assumption leads to conservative values of C_1.

3.2 Member with end moments only

The factor C_1 may be determined from Table 3.1 for a member with end moment loading.

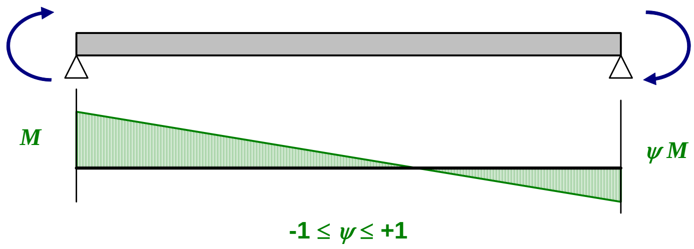


Figure 3.1 Member with end moments

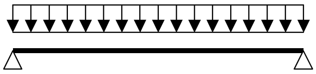
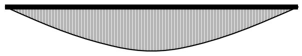
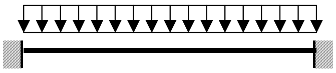
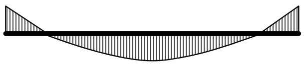
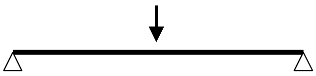
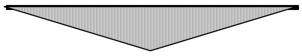
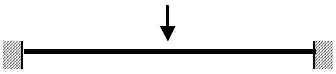
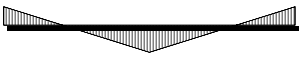
Table 3.1 Values of C_1 for end moment loading (for k = 1)

ψ	C_1
+1,00	1,00
+0,75	1,14
+0,50	1,31
+0,25	1,52
0,00	1,77
-0,25	2,05
-0,50	2,33
-0,75	2,57
-1,00	2,55

3.3 Member with transverse loading

Table 3.2 gives values of C_1 and C_2 for some cases of a member with transverse loading,

Table 3.2 ***Values of factors C_1 and C_2 for cases with transverse loading (for k = 1)***

Loading and support conditions	Bending moment diagram	C_1	C_2
		1,127	0,454
		2,578	1,554
		1,348	0,630
		1,683	1,645

Note : the critical moment M_{cr} is calculated for the section with the maximal moment along the member

3.4 Member with end moments and transverse loading

For combined loading of end moments and transverse loads as shown in Figure 3.2, values of C_1 and C_2 may be obtained from the curves given hereafter. Two cases are considered:

Case a) end moments with a uniformly distributed load

Case b) end moments with a concentrated load at mid-span

The moment distribution may be defined using two parameters :

ψ is the ratio of end moments. By definition, M is the maximum end moment, and so :

$-1 \leq \psi \leq 1$ ($\psi = 1$ for a uniform moment)

μ is the ratio of the moment due to transverse load to the maximum end moment M

Case a) $\mu = \dfrac{qL^2}{8M}$

Case b) $\mu = \dfrac{FL}{4M}$

Sign convention for μ:

$\mu > 0$ if M and the transverse load (q or F), each supposed acting alone, bend the beam in the same direction (e.g. as shown in the figure below)

$\mu < 0$ otherwise

The values of C_1 and C_2 have been determined for $k = 1$ and $k_w = 1$.

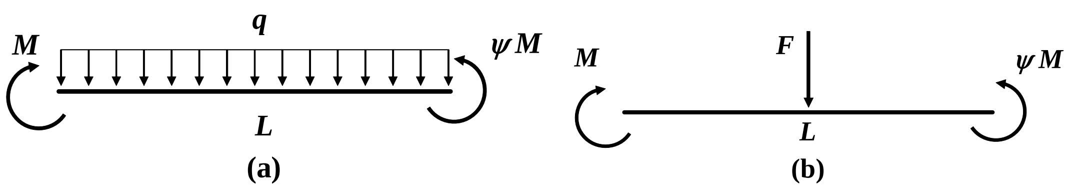
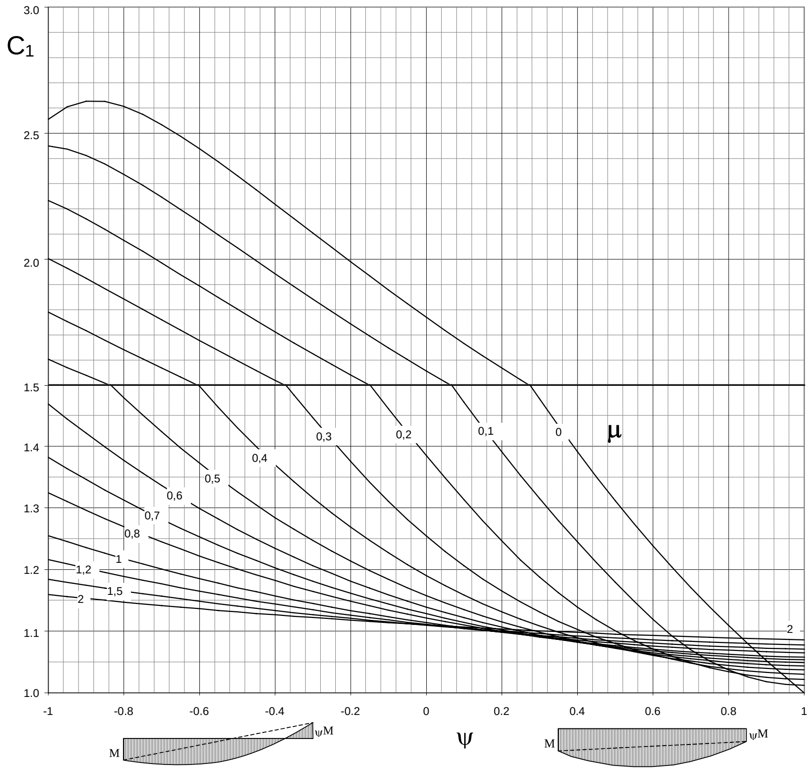
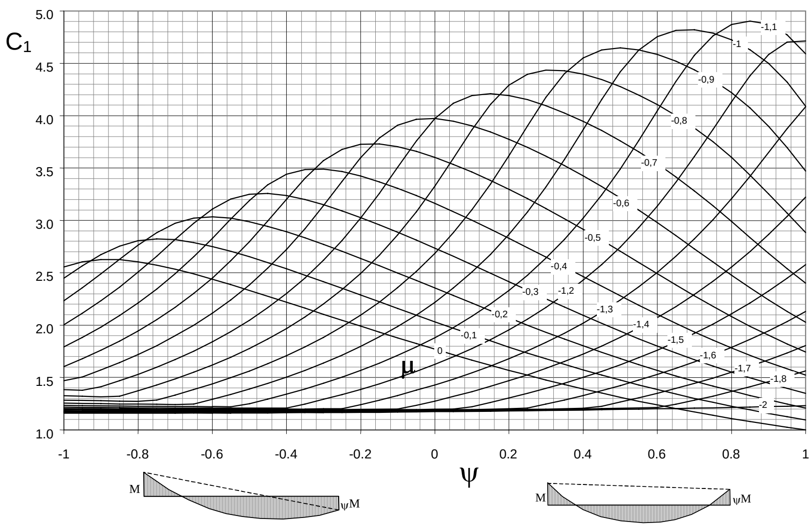


Figure 3.2 End moments with a transverse load

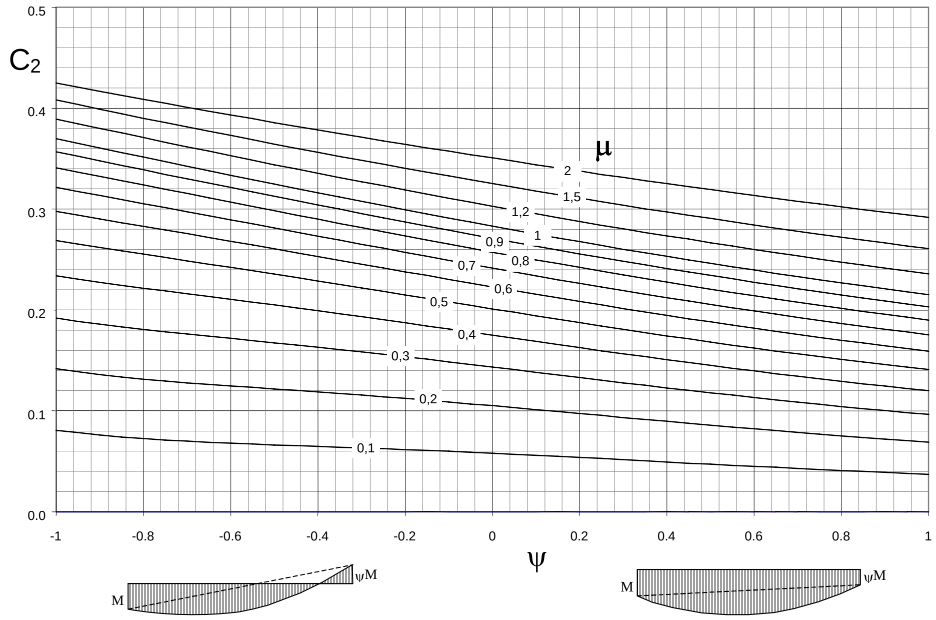


$\mu > 0$

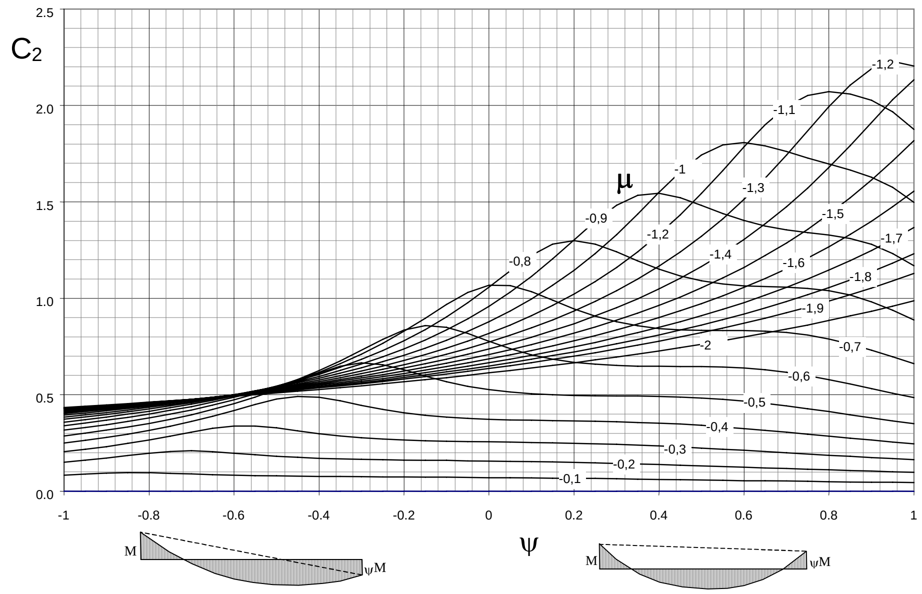


$\mu < 0$

Figure 3.3 End moments and uniformly distributed load – Factor C_1



$\mu > 0$



$\mu < 0$

Figure 3.4   End moments and uniformly distributed load – Factor C_2

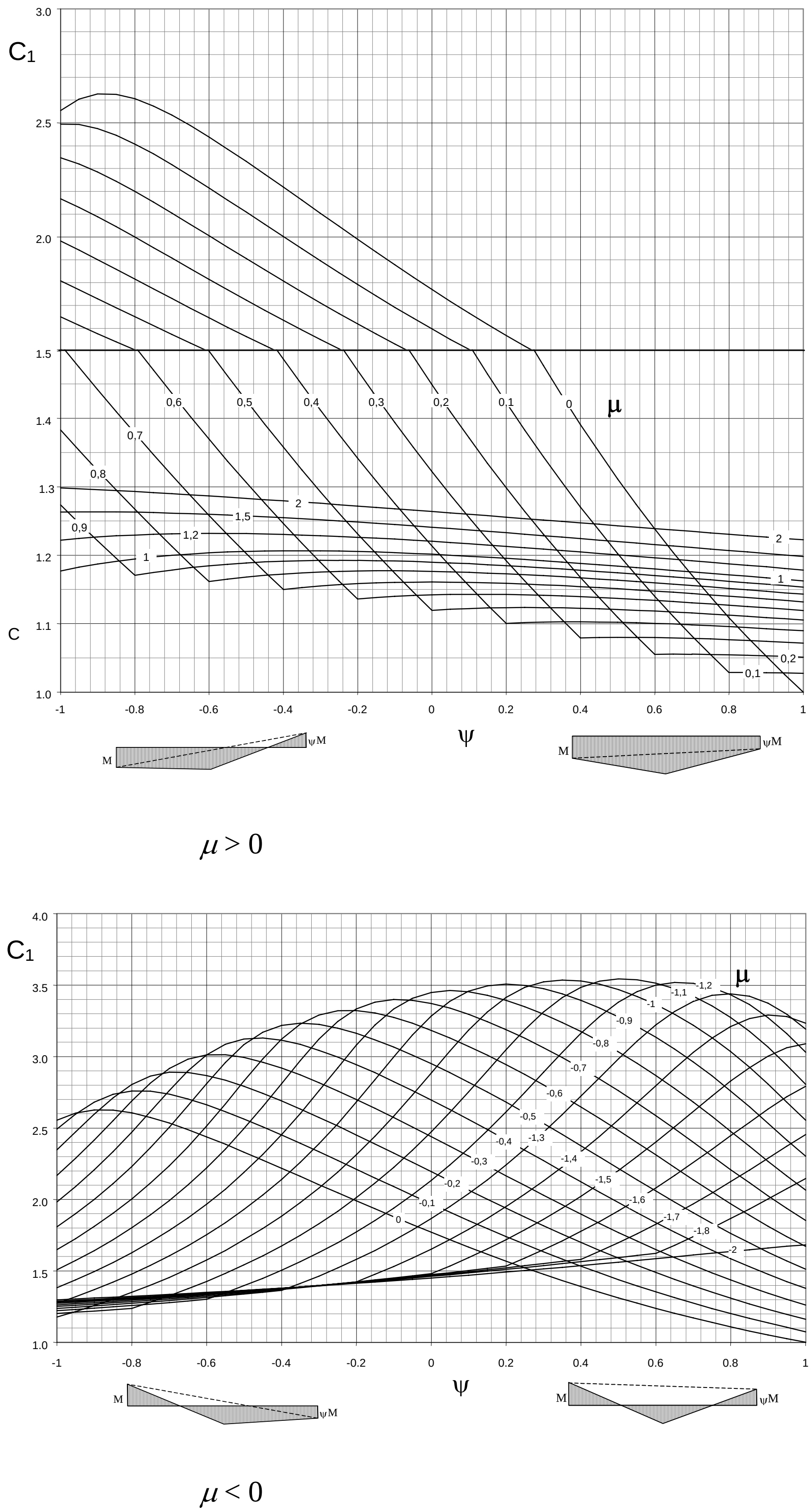
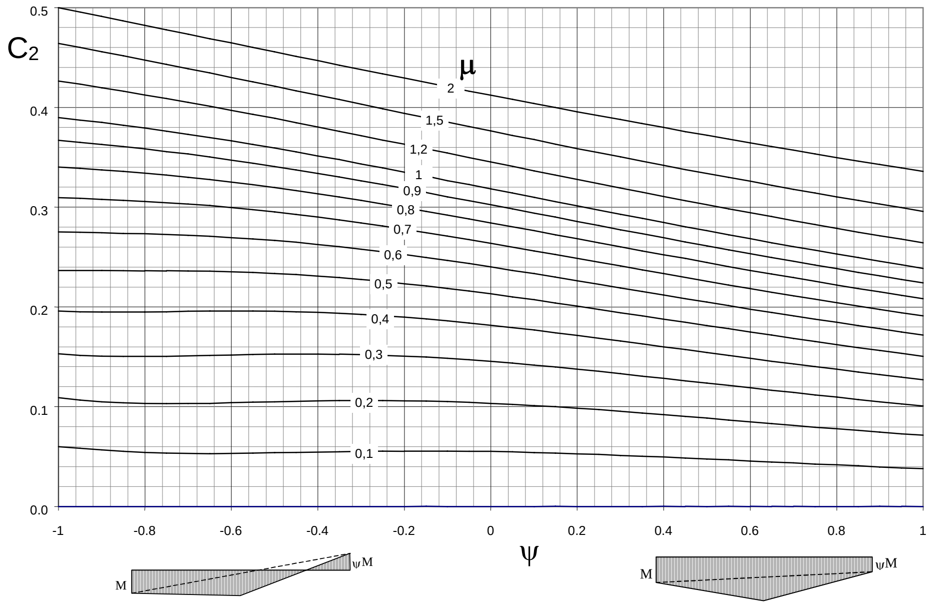
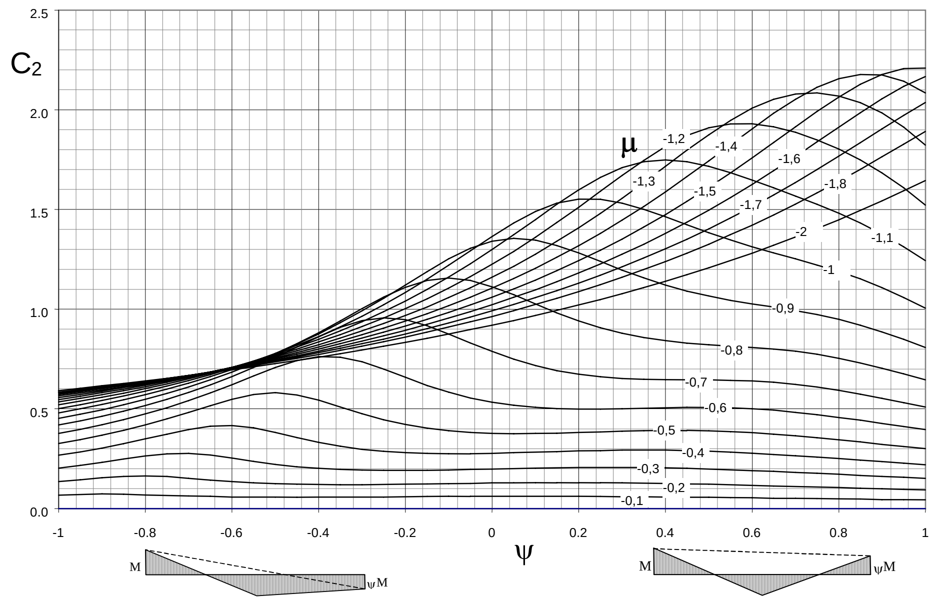


Figure 3.5 End moments and point load at mid-span – Factor C_1



$\mu > 0$



$\mu < 0$

Figure 3.6 End moments and point load at mid-span – Factor C_2

NCCI: Elastic critical moment for lateral torsional buckling
SN003a-EN-EU

4. References

1 ENV 1993-1-1

Eurocode 3 : Design of steel structures – Part 1.1 : General rules and rules for buildings. European Committee for Standardisation.

2 Timoshenko, S.P. and Gere, J. M.

Theory of elastic stability. 2nd Edition. Mc Graw-Hill. 1961.

3 Djalaly, H.

Calcul de la résistance ultime au déversement dans le cas de la flexion déviée. Revue Construction Métallique n°3-1974. CTICM.

4 Galéa, Y.

Déversement élastique d'une poutre à section bi-symétrique soumise à des moments d'extrémité et une charge repartee ou concentrée. Revue Construction Métallique n°2-2002. CTICM.

Quality Record

RESOURCE TITLE	NCCI: Elastic critical moment for lateral torsional buckling		
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ORIGINAL DOCUMENT			
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Table 13 — Effective length L_E for beams without intermediate restraint

Conditions of restraint at supports		Loading condition	
		Normal	Destabilizing
Compression flange laterally restrained. Nominal torsional restraint against rotation about longitudinal axis, as given in **4.2.2**.	Both flanges fully restrained against rotation on plan.	$0.7L_{LT}$	$0.85L_{LT}$
	Compression flange fully restrained against rotation on plan.	$0.75L_{LT}$	$0.9L_{LT}$
	Both flanges partially restrained against rotation on plan.	$0.8L_{LT}$	$0.95L_{LT}$
	Compression flange partially restrained against rotation on plan.	$0.85L_{LT}$	$1.0L_{LT}$
	Both flanges free to rotate on plan.	$1.0L_{LT}$	$1.2L_{LT}$
Compression flange laterally unrestrained. Both flanges free to rotate on plan.	Partial torsional restraint against rotation about longitudinal axis provided by connection of bottom flange to supports.	$1.0L_{LT} + 2D$	$1.2L_{LT} + 2D$
	Partial torsional restraint against rotation about longitudinal axis provided only by pressure of bottom flange onto supports.	$1.2L_{LT} + 2D$	$1.4L_{LT} + 2D$
D is the overall depth of the beam.			

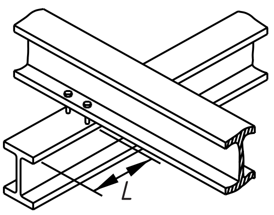
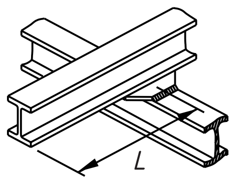
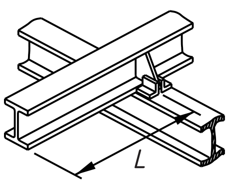
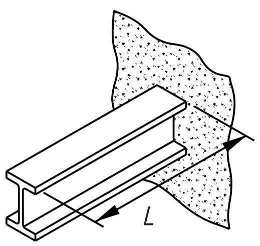
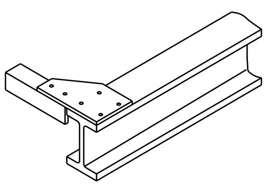
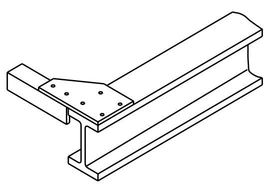
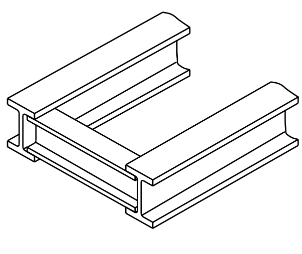
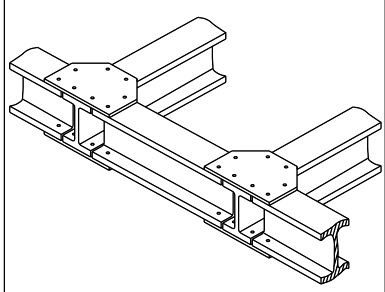
4.3.5.4 ***Cantilevers without intermediate restraints***

The effective length L_E for lateral-torsional buckling of a cantilever with no intermediate lateral restraint should be obtained from Table 14, taking L as the length of the cantilever. If a bending moment is applied at its tip, the effective length L_E from Table 14 should be increased by the greater of 30 % or $0.3L$.

4.3.5.5 ***Cantilevers with intermediate restraints***

Provided that the end restraint conditions correspond with cases c)4) or d)4) in Table 14, the effective length L_E for lateral-torsional buckling of a cantilever with intermediate lateral restraints to its compression flange should be taken as $1.0L$ for normal loading conditions, taking L as the length of the relevant segment between adjacent lateral restraints. However, for the destabilizing loading condition (see **4.3.4**) L_E should be obtained from Table 14, taking L as the length of the cantilever, unless the top flange also has intermediate lateral restraints.

Table 14 — Effective length L_E for cantilevers without intermediate restraint

Restraint conditions		Loading conditions	
At support	**At tip**	**Normal**	**Destabilizing**
a) Continuous, with lateral restraint to top flange 	1) Free	3.0L	7.5L
	2) Lateral restraint to top flange	2.7L	7.5L
	3) Torsional restraint	2.4L	4.5L
	4) Lateral and torsional restraint	2.1L	3.6L
b) Continuous, with partial torsional restraint 	1) Free	2.0L	5.0L
	2) Lateral restraint to top flange	1.8L	5.0L
	3) Torsional restraint	1.6L	3.0L
	4) Lateral and torsional restraint	1.4L	2.4L
c) Continuous, with lateral and torsional restraint 	1) Free	1.0L	2.5L
	2) Lateral restraint to top flange	0.9L	2.5L
	3) Torsional restraint	0.8L	1.5L
	4) Lateral and torsional restraint	0.7L	1.2L
d) Restrained laterally, torsionally and against rotation on plan 	1) Free	0.8L	1.4L
	2) Lateral restraint to top flange	0.7L	1.4L
	3) Torsional restraint	0.6L	0.6L
	4) Lateral and torsional restraint	0.5L	0.5L
Tip restraint conditions			
1) Free  (not braced on plan)	2) Lateral restraint to top flange  (braced on plan in at least one bay)	3) Torsional restraint  (not braced on plan)	4) Lateral and torsional restraint  (braced on plan in at least one bay)

4.3.6 Resistance to lateral-torsional buckling

4.3.6.1 *General*

Resistance to lateral-torsional buckling need not be checked separately (and the buckling resistance moment M_b may be taken as equal to the relevant moment capacity M_c) in the following cases:

— bending about the minor axis;

— CHS, square RHS or circular or square solid bars;

— RHS, unless L_E/r_y exceeds the limiting value given in Table 15 for the relevant value of D/B;

— I-, H-, channel or box sections, if λ_{LT} does not exceed λ_{L0}, see **4.3.6.5**.

Otherwise, for members subject to bending about their major axis, reference should be made as follows:

— for I-, H-, channel or box section members with equal flanges and a uniform cross-section throughout the length of the relevant segment L between adjacent lateral restraints, see **4.3.6.2**;

— for I-sections or box sections with unequal flanges but with a uniform cross-section throughout the length of the relevant segment L between adjacent lateral restraints, see **4.3.6.3**;

— for I-, H-, channel or box section members with a cross-section that varies within the length of the relevant segment L between adjacent lateral restraints, see **B.2.5**;

— for hot rolled angles, see **4.3.8**;

— for plates, flats or solid rectangular bars, see **B.2.7**;

— for T-sections see, **B.2.8**.

Table 15 — Limiting value of L_E/r_y for RHS

Ratio D/B	Limiting value of L_E/r_y	Ratio D/B	Limiting value of L_E/r_y	Ratio D/B	Limiting value of L_E/r_y
1.25	$770 \times (275/p_y)$	1.5	$515 \times (275/p_y)$	2.0	$340 \times (275/p_y)$
1.33	$670 \times (275/p_y)$	1.67	$435 \times (275/p_y)$	2.5	$275 \times (275/p_y)$
1.4	$580 \times (275/p_y)$	1.75	$410 \times (275/p_y)$	3.0	$225 \times (275/p_y)$
1.44	$550 \times (275/p_y)$	1.8	$395 \times (275/p_y)$	4.0	$170 \times (275/p_y)$

Key:

B is the width of the section;

D is the depth of the section;

L_E is the effective length for lateral-torsional buckling from **4.3.5**;

p_y is the design strength;

r_y is the radius of gyration of the section about its minor axis.

4.3.6.2 *I-, H-, channel and box sections with equal flanges*

In each segment of length L between adjacent lateral restraints, members of I-, H-, channel or box sections with equal flanges should satisfy:

$$M_x \le M_b/m_{LT} \quad \text{and} \quad M_x \le M_{cx}$$

where

M_b is the buckling resistance moment, see **4.3.6.4**;

M_{cx} is the major axis moment capacity of the cross-section, see **4.2.5**;

M_x is the maximum major axis moment in the segment;

m_{LT} is the equivalent uniform moment factor for lateral-torsional buckling, see **4.3.6.6**.

4.3.7 Equal flanged rolled sections

As a simple (but more conservative) alternative to **4.3.6.5**, **4.3.6.6**, **4.3.6.7**, **4.3.6.8** and **4.3.6.9**, the buckling resistance moment M_b of a plain rolled I, H or channel section with equal flanges may be determined using the bending strength p_b obtained from Table 20 for the relevant values of $(\beta_W)^{0.5}L_E/r_y$ and D/T as follows:

— *for a class 1 plastic or class 2 compact cross-section:*

$$M_b = p_b S_x$$

— *for a class 3 semi-compact cross-section:*

$$M_b = p_b Z_x$$

where

D is the depth of the section;

L_E is the effective length from **4.3.5**;

r_y is the radius of gyration of the section about its y-y axis;

S_x is the plastic modulus about the major axis;

T is the flange thickness;

Z_x is the section modulus about the major axis;

β_W is the ratio specified in **4.3.6.9**.

4.3.8 Buckling resistance moment for single angles

4.3.8.1 *General*

The design of unrestrained single angle members to resist bending should take account of the fact that the rectangular axes of the cross-section (x-x and y-y) are not the principal axes, either by using the basic method given in **4.3.8.2** or the simplified method given in **4.3.8.3**.

4.3.8.2 *Basic method*

For this method the applied moments should be resolved into moments about the principal axes u-u and v-v. The buckling resistance moment M_b for bending about the u-u axis should be based on the value of λ_{LT} obtained from **B.2.9**. The effects of biaxial bending should then be combined in accordance with **4.9**.

4.3.8.3 *Simplified method*

Alternatively to **4.3.8.2**, for equal angles the buckling resistance moment of a single angle with $b/t \leq 15\varepsilon$ subject to bending about the x-x axis, may be determined as follows:

— heel of angle in compression:

$$M_b = 0.8 p_y Z_x$$

— heel of angle in tension:

$$M_b = p_y Z_x \left(\frac{1\,350\varepsilon - L_E/r_v}{1625\varepsilon} \right) \quad \text{but} \quad M_b \leq 0.8 p_y Z_x$$

where

L_E is the effective length from **4.3.5**, based on the length L_v between restraints against buckling about the v-v axis;

r_v is the radius of gyration about the v-v axis;

Z_x is the smaller section modulus about the x-x axis.

If the member is bent with the heel of the angle in tension anywhere within the length L_v between restraints against buckling about the v-v axis, the relevant value of M_b should be applied throughout that segment.

For unequal angles the basic method given in **4.3.8.2** should be used.

The monosymmetry index ψ should be taken as positive when the flange of the T-section is in compression and negative when the flange is in tension. It may be evaluated using:

$$\psi = \left(2y_o - \frac{y_o B^3 T/12 + BTy_o{}^3 + \frac{t}{4}[(c-T)^4 - (D-c)^4]}{I_x}\right)\frac{1}{(D-T/2)}$$

in which:

$$y_o = c - T/2$$

where c is the distance from the outside of the flange to the centroid of the section.

When the flange is in tension the monosymmetry index ψ may conservatively be taken as –1.0.

B.2.8.3 *Warping constant*

For a T-section the warping constant H should be obtained from:

$$H = \frac{B^3 T^3}{144} + \frac{(D-T/2)^3 t^3}{36}$$

B.2.9 *Angle sections*

B.2.9.1 *Axes*

Except when using the approximate method given in **4.3.8**, moments applied to unrestrained angles should be related to their principal axes u-u and v-v, not their geometric axes x-x and y-y.

B.2.9.2 *Equal angles*

For a single equal leg angle, subject to moments about its major axis u-u, the equivalent slenderness λ_{LT} should be taken as:

$$\lambda_{LT} = 2.25(\phi_a \lambda_v)^{0.5}$$

in which:

$$\phi_a = \left(\frac{Z_u{}^2 \gamma_a}{AJ}\right)^{0.5}$$

$$\gamma_a = (1 - I_v/I_u)$$

$$\lambda_v = L_v/r_v$$

where

- A is the cross-sectional area;
- I_u is the second moment of area about the major axis;
- I_v is the second moment of area about the minor axis;
- J is the torsion constant;
- L_v is the length between points where the member is restrained in both the x-x and y-y directions;
- r_v is the radius of gyration about the minor axis v-v;
- Z_u is the section modulus about the major axis u-u.

B.2.9.3 *Unequal angles*

For a single unequal leg angle, subject to moments about its major axis u-u, the equivalent slenderness λ_{LT} should be taken as:

$$\lambda_{LT} = 2.25\nu_a(\phi_a\lambda_v)^{0.5}$$

in which:

$$\nu_a = \frac{1}{\left[\left(1+\left(\frac{4.5\psi_a}{\lambda_v}\right)^2\right)^{0.5}+\frac{4.5\psi_a}{\lambda_v}\right]^{0.5}}$$

The monosymmetry index ψ_a for an unequal angle should be taken as positive when the short leg is in compression and negative when the long leg is in compression. If the long leg is in compression anywhere within the segment length L_v then ψ_a should be taken as negative. It may be evaluated from:

$$\psi_a = \left[2\nu_o - \frac{\int \nu_i(u_i^2+\nu_i^2)\mathrm{d}A}{I_u}\right]\frac{1}{t}$$

in which u_i and ν_i are the coordinates of an element of the cross-section and ν_o is the coordinate of the shear centre along the v-v axis, relative to the centroid of the cross-section.

B.3 Internal moments

B.3.1 ***General***

The additional internal "second-order" minor-axis moment (equivalent to the strut action moment in a compression member) in a member subject to external applied major axis moment, should be taken as having a maximum value $M_{y,max}$ midway between points of inflexion of the buckled shape (the points between which the effective length L_E is measured) given by:

$$M_{y,max} = (p_y/p_b - 1)(M_{cy}/M_{cx})m_{LT}M_x$$

where

- M_{cx} is the major axis moment capacity of the cross-section, assuming zero shear, see **4.2.5**;
- M_{cy} is the minor axis moment capacity of the cross-section, assuming zero shear, see **4.2.5**;
- M_x is the maximum major axis moment in the length L of the segment;
- m_{LT} is the equivalent uniform moment factor for lateral-torsional buckling, see **4.3.6.6**;
- p_b is the bending strength for resistance to lateral-torsional buckling, see **4.3.6.5** (or **B.2.1**).

The additional internal minor axis moment M_{ys} at a distance L_z along the member from a point of inflexion should be obtained from:

$$M_{ys} = M_{y,max}\sin(180L_z/L_E)$$

B.3.2 ***T-sections***

In applying **B.3.1** to a T-section, the subscripts x and y should always be taken as referring to the major axis and the minor axis respectively, even where the opposite subscript is used in **B.2.8.2**b).

B.3.3 ***Angles***

In applying **B.3.1** to an angle, the subscripts x and y should be taken as referring to the major axis u–u and minor axis v–v respectively.

SECTION PROPERTIES

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

B-2

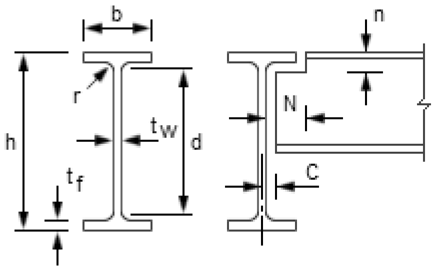
Table 2.1.1.1

SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB

DIMENSIONS



Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
1016 x 305 x 487 +	486.7	1036.3	308.5	30.0	54.1	30.0	868.1	2.02	28.9	17	150	86	3.20	6.58
1016 x 305 x 437 +	437.0	1026.1	305.4	26.9	49.0	30.0	868.1	2.23	32.3	15	150	80	3.17	7.25
1016 x 305 x 393 +	392.7	1015.9	303.0	24.4	43.9	30.0	868.1	2.49	35.6	14	150	74	3.14	8.00
1016 x 305 x 349 +	349.4	1008.1	302.0	21.1	40.0	30.0	868.1	2.76	41.1	13	152	70	3.13	8.96
1016 x 305 x 314 +	314.3	999.9	300.0	19.1	35.9	30.0	868.1	3.08	45.5	12	152	66	3.11	9.89
1016 x 305 x 272 +	272.3	990.1	300.0	16.5	31.0	30.0	868.1	3.60	52.6	10	152	62	3.10	11.4
1016 x 305 x 249 +	248.7	980.1	300.0	16.5	26.0	30.0	868.1	4.30	52.6	10	152	56	3.08	12.4
1016 x 305 x 222 +	222.0	970.3	300.0	16.0	21.1	30.0	868.1	5.31	54.3	10	152	52	3.06	13.8
914 x 419 x 388	388.0	921.0	420.5	21.4	36.6	24.1	799.6	4.79	37.4	13	210	62	3.44	8.87
914 x 419 x 343	343.3	911.8	418.5	19.4	32.0	24.1	799.6	5.48	41.2	12	210	58	3.42	9.96
914 x 305 x 289	289.1	926.6	307.7	19.5	32.0	19.1	824.4	3.91	42.3	12	156	52	3.01	10.4
914 x 305 x 253	253.4	918.4	305.5	17.3	27.9	19.1	824.4	4.48	47.7	11	156	48	2.99	11.8
914 x 305 x 224	224.2	910.4	304.1	15.9	23.9	19.1	824.4	5.23	51.8	10	156	44	2.97	13.2
914 x 305 x 201	200.9	903.0	303.3	15.1	20.2	19.1	824.4	6.19	54.6	10	156	40	2.96	14.7
838 x 292 x 226	226.5	850.9	293.8	16.1	26.8	17.8	761.7	4.52	47.3	10	150	46	2.81	12.4
838 x 292 x 194	193.8	840.7	292.4	14.7	21.7	17.8	761.7	5.58	51.8	9	150	40	2.79	14.4
838 x 292 x 176	175.9	834.9	291.7	14.0	18.8	17.8	761.7	6.44	54.4	9	150	38	2.78	15.8
762 x 267 x 197	196.8	769.8	268.0	15.6	25.4	16.5	686.0	4.32	44.0	10	138	42	2.55	13.0
762 x 267 x 173	173.0	762.2	266.7	14.3	21.6	16.5	686.0	5.08	48.0	9	138	40	2.53	14.6
762 x 267 x 147	146.9	754.0	265.2	12.8	17.5	16.5	686.0	6.27	53.6	8	138	34	2.51	17.1
762 x 267 x 134	133.9	750.0	264.4	12.0	15.5	16.5	686.0	7.08	57.2	8	138	32	2.51	18.7
686 x 254 x 170	170.2	692.9	255.8	14.5	23.7	15.2	615.1	4.45	42.4	9	132	40	2.35	13.8
686 x 254 x 152	152.4	687.5	254.5	13.2	21.0	15.2	615.1	5.02	46.6	9	132	38	2.34	15.4
686 x 254 x 140	140.1	683.5	253.7	12.4	19.0	15.2	615.1	5.55	49.6	8	132	36	2.33	16.6
686 x 254 x 125	125.2	677.9	253.0	11.7	16.2	15.2	615.1	6.51	52.6	8	132	32	2.32	18.5
610 x 305 x 238	238.1	635.8	311.4	18.4	31.4	16.5	540.0	4.14	29.3	11	158	48	2.45	10.3
610 x 305 x 179	179.0	620.2	307.1	14.1	23.6	16.5	540.0	5.51	38.3	9	158	42	2.41	13.5
610 x 305 x 149	149.2	612.4	304.8	11.8	19.7	16.5	540.0	6.60	45.8	8	158	38	2.39	16.0
610 x 229 x 140	139.9	617.2	230.2	13.1	22.1	12.7	547.6	4.34	41.8	9	120	36	2.11	15.1
610 x 229 x 125	125.1	612.2	229.0	11.9	19.6	12.7	547.6	4.89	46.0	8	120	34	2.09	16.7
610 x 229 x 113	113.0	607.6	228.2	11.1	17.3	12.7	547.6	5.54	49.3	8	120	30	2.08	18.4
610 x 229 x 101	101.2	602.6	227.6	10.5	14.8	12.7	547.6	6.48	52.2	7	120	28	2.07	20.5
610 x 178 x 100 +	100.3	607.4	179.2	11.3	17.2	12.7	547.6	4.14	48.5	8	94	30	1.89	18.8
610 x 178 x 92 +	92.2	603.0	178.8	10.9	15.0	12.7	547.6	4.75	50.2	7	94	28	1.88	20.4
610 x 178 x 82 +	81.8	598.6	177.9	10.0	12.8	12.7	547.6	5.57	54.8	7	94	26	1.87	22.9
533 x 312 x 272 +	273.3	577.1	320.2	21.1	37.6	12.7	476.5	3.64	22.6	13	160	52	2.37	8.67
533 x 312 x 219 +	218.8	560.3	317.4	18.3	29.2	12.7	476.5	4.69	26.0	11	160	42	2.33	10.7
533 x 312 x 182 +	181.5	550.7	314.5	15.2	24.4	12.7	476.5	5.61	31.3	10	160	38	2.31	12.7
533 x 312 x 150 +	150.6	542.5	312.0	12.7	20.3	12.7	476.5	6.75	37.5	8	160	34	2.29	15.2

Table 2.1.1.1. Advance® UKB. Dimensions

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

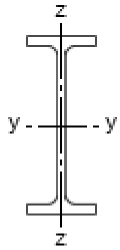
B-3

SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB

PROPERTIES



Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
1016 x 305 x 487 +	1020000	26700	40.6	6.57	19700	1730	23200	2800	0.867	21.1	64.4	4300	620
1016 x 305 x 437 +	910000	23400	40.4	6.49	17700	1540	20800	2470	0.868	23.1	56.0	3190	557
1016 x 305 x 393 +	808000	20500	40.2	6.40	15900	1350	18500	2170	0.868	25.5	48.4	2330	500
1016 x 305 x 349 +	723000	18500	40.3	6.44	14300	1220	16600	1940	0.872	27.9	43.3	1720	445
1016 x 305 x 314 +	644000	16200	40.1	6.37	12900	1080	14800	1710	0.872	30.7	37.7	1260	400
1016 x 305 x 272 +	554000	14000	40.0	6.35	11200	934	12800	1470	0.872	35.0	32.2	835	347
1016 x 305 x 249 +	481000	11800	39.0	6.09	9820	784	11300	1240	0.861	39.9	26.8	582	317
1016 x 305 x 222 +	408000	9550	38.0	5.81	8410	636	9810	1020	0.850	45.7	21.5	390	283
914 x 419 x 388	720000	45400	38.2	9.59	15600	2160	17700	3340	0.885	26.7	88.9	1730	494
914 x 419 x 343	626000	39200	37.8	9.46	13700	1870	15500	2890	0.883	30.1	75.8	1190	437
914 x 305 x 289	504000	15600	37.0	6.51	10900	1010	12600	1600	0.867	31.9	31.2	926	368
914 x 305 x 253	436000	13300	36.8	6.42	9500	871	10900	1370	0.865	36.2	26.4	626	323
914 x 305 x 224	376000	11200	36.3	6.27	8270	739	9530	1160	0.860	41.3	22.1	422	286
914 x 305 x 201	325000	9420	35.7	6.07	7200	621	8350	982	0.853	46.9	18.4	291	256
838 x 292 x 226	340000	11400	34.3	6.27	7980	773	9160	1210	0.869	35.0	19.3	514	289
838 x 292 x 194	279000	9070	33.6	6.06	6640	620	7640	974	0.862	41.6	15.2	306	247
838 x 292 x 176	246000	7800	33.1	5.90	5890	535	6810	842	0.856	46.5	13.0	221	224
762 x 267 x 197	240000	8170	30.9	5.71	6230	610	7170	958	0.869	33.1	11.3	404	251
762 x 267 x 173	205000	6850	30.5	5.58	5390	514	6200	807	0.865	38.0	9.39	267	220
762 x 267 x 147	169000	5460	30.0	5.40	4470	411	5160	647	0.858	45.2	7.40	159	187
762 x 267 x 134	151000	4790	29.7	5.30	4020	362	4640	570	0.853	49.8	6.46	119	171
686 x 254 x 170	170000	6630	28.0	5.53	4920	518	5630	811	0.872	31.8	7.42	308	217
686 x 254 x 152	150000	5780	27.8	5.46	4370	455	5000	710	0.871	35.4	6.42	220	194
686 x 254 x 140	136000	5180	27.6	5.39	3990	409	4560	638	0.870	38.6	5.72	169	178
686 x 254 x 125	118000	4380	27.2	5.24	3480	346	3990	542	0.863	43.8	4.80	116	159
610 x 305 x 238	209000	15800	26.3	7.23	6590	1020	7490	1570	0.886	21.3	14.5	785	303
610 x 305 x 179	153000	11400	25.9	7.07	4930	743	5550	1140	0.885	27.7	10.2	340	228
610 x 305 x 149	126000	9310	25.7	7.00	4110	611	4590	937	0.886	32.7	8.17	200	190
610 x 229 x 140	112000	4510	25.0	5.03	3620	391	4140	611	0.875	30.6	3.99	216	178
610 x 229 x 125	98600	3930	24.9	4.97	3220	343	3680	535	0.875	34.0	3.45	154	159
610 x 229 x 113	87300	3430	24.6	4.88	2870	301	3280	469	0.870	38.0	2.99	111	144
610 x 229 x 101	75800	2910	24.2	4.75	2520	256	2880	400	0.863	43.0	2.52	77.0	129
610 x 178 x 100 +	72500	1660	23.8	3.60	2390	185	2790	296	0.854	38.7	1.44	95.0	128
610 x 178 x 92 +	64600	1440	23.4	3.50	2140	161	2510	258	0.850	42.7	1.24	71.0	117
610 x 178 x 82 +	55900	1210	23.2	3.40	1870	136	2190	218	0.843	48.5	1.04	48.8	104
533 x 312 x 272 +	199000	20600	23.9	7.69	6890	1290	7870	1990	0.891	15.9	15.0	1290	348
533 x 312 x 219 +	151000	15600	23.3	7.48	5400	982	6120	1510	0.884	19.8	11.0	642	279
533 x 312 x 182 +	123000	12700	23.1	7.40	4480	806	5040	1240	0.886	23.4	8.77	373	231
533 x 312 x 150 +	101000	10300	22.9	7.32	3710	659	4150	1010	0.885	27.8	7.01	216	192

Table 2.1.1.2. Advance® UKB. Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

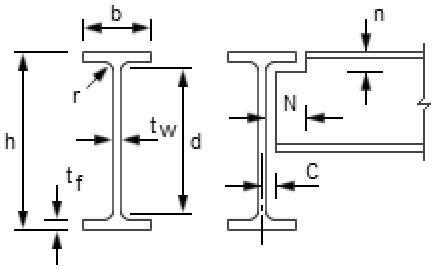
B-4

SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB

DIMENSIONS



Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
533 x 210 x 138 +	138.3	549.1	213.9	14.7	23.6	12.7	476.5	3.68	32.4	9	110	38	1.90	13.7
533 x 210 x 122	122.0	544.5	211.9	12.7	21.3	12.7	476.5	4.08	37.5	8	110	34	1.89	15.5
533 x 210 x 109	109.0	539.5	210.8	11.6	18.8	12.7	476.5	4.62	41.1	8	110	32	1.88	17.2
533 x 210 x 101	101.0	536.7	210.0	10.8	17.4	12.7	476.5	4.99	44.1	7	110	32	1.87	18.5
533 x 210 x 92	92.1	533.1	209.3	10.1	15.6	12.7	476.5	5.57	47.2	7	110	30	1.86	20.2
533 x 210 x 82	82.2	528.3	208.8	9.6	13.2	12.7	476.5	6.58	49.6	7	110	26	1.85	22.5
533 x 165 x 85 +	84.8	534.9	166.5	10.3	16.5	12.7	476.5	3.96	46.3	7	90	30	1.69	19.9
533 x 165 x 74 +	74.7	529.1	165.9	9.7	13.6	12.7	476.5	4.81	49.1	7	90	28	1.68	22.5
533 x 165 x 66 +	65.7	524.7	165.1	8.9	11.4	12.7	476.5	5.74	53.5	6	90	26	1.67	25.4
457 x 191 x 161 +	161.4	492.0	199.4	18.0	32.0	10.2	407.6	2.52	22.6	11	102	44	1.73	10.7
457 x 191 x 133 +	133.3	480.6	196.7	15.3	26.3	10.2	407.6	3.06	26.6	10	102	38	1.70	12.8
457 x 191 x 106 +	105.8	469.2	194.0	12.6	20.6	10.2	407.6	3.91	32.3	8	102	32	1.67	15.8
457 x 191 x 98	98.3	467.2	192.8	11.4	19.6	10.2	407.6	4.11	35.8	8	102	30	1.67	17.0
457 x 191 x 89	89.3	463.4	191.9	10.5	17.7	10.2	407.6	4.55	38.8	7	102	28	1.66	18.6
457 x 191 x 82	82.0	460.0	191.3	9.9	16.0	10.2	407.6	5.03	41.2	7	102	28	1.65	20.1
457 x 191 x 74	74.3	457.0	190.4	9.0	14.5	10.2	407.6	5.55	45.3	7	102	26	1.64	22.1
457 x 191 x 67	67.1	453.4	189.9	8.5	12.7	10.2	407.6	6.34	48.0	6	102	24	1.63	24.3
457 x 152 x 82	82.1	465.8	155.3	10.5	18.9	10.2	407.6	3.29	38.8	7	84	30	1.51	18.4
457 x 152 x 74	74.2	462.0	154.4	9.6	17.0	10.2	407.6	3.66	42.5	7	84	28	1.50	20.2
457 x 152 x 67	67.2	458.0	153.8	9.0	15.0	10.2	407.6	4.15	45.3	7	84	26	1.50	22.3
457 x 152 x 60	59.8	454.6	152.9	8.1	13.3	10.2	407.6	4.68	50.3	6	84	24	1.49	24.9
457 x 152 x 52	52.3	449.8	152.4	7.6	10.9	10.2	407.6	5.71	53.6	6	84	22	1.48	28.3
406 x 178 x 85 +	85.3	417.2	181.9	10.9	18.2	10.2	360.4	4.14	33.1	7	96	30	1.52	17.8
406 x 178 x 74	74.2	412.8	179.5	9.5	16.0	10.2	360.4	4.68	37.9	7	96	28	1.51	20.4
406 x 178 x 67	67.1	409.4	178.8	8.8	14.3	10.2	360.4	5.23	41.0	6	96	26	1.50	22.3
406 x 178 x 60	60.1	406.4	177.9	7.9	12.8	10.2	360.4	5.84	45.6	6	96	24	1.49	24.8
406 x 178 x 54	54.1	402.6	177.7	7.7	10.9	10.2	360.4	6.86	46.8	6	96	22	1.48	27.3
406 x 140 x 53 +	53.3	406.6	143.3	7.9	12.9	10.2	360.4	4.46	45.6	6	78	24	1.35	25.3
406 x 140 x 46	46.0	403.2	142.2	6.8	11.2	10.2	360.4	5.13	53.0	5	78	22	1.34	29.1
406 x 140 x 39	39.0	398.0	141.8	6.4	8.6	10.2	360.4	6.69	56.3	5	78	20	1.33	34.1
356 x 171 x 67	67.1	363.4	173.2	9.1	15.7	10.2	311.6	4.58	34.2	7	94	26	1.38	20.6
356 x 171 x 57	57.0	358.0	172.2	8.1	13.0	10.2	311.6	5.53	38.5	6	94	24	1.37	24.1
356 x 171 x 51	51.0	355.0	171.5	7.4	11.5	10.2	311.6	6.25	42.1	6	94	22	1.36	26.7
356 x 171 x 45	45.0	351.4	171.1	7.0	9.7	10.2	311.6	7.41	44.5	6	94	20	1.36	30.2
356 x 127 x 39	39.1	353.4	126.0	6.6	10.7	10.2	311.6	4.63	47.2	5	70	22	1.18	30.2
356 x 127 x 33	33.1	349.0	125.4	6.0	8.5	10.2	311.6	5.82	51.9	5	70	20	1.17	35.4
305 x 165 x 54	54.0	310.4	166.9	7.9	13.7	8.9	265.2	5.15	33.6	6	90	24	1.26	23.3
305 x 165 x 46	46.1	306.6	165.7	6.7	11.8	8.9	265.2	5.98	39.6	5	90	22	1.25	27.1
305 x 165 x 40	40.3	303.4	165.0	6.0	10.2	8.9	265.2	6.92	44.2	5	90	20	1.24	30.8

Table 2.1.1.3. Advance® UKB. Dimensions

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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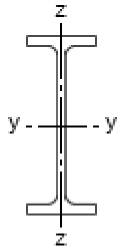
Table 2.1.1.4

SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB

PROPERTIES



Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
533 x 210 x 138 +	86100	3860	22.1	4.68	3140	361	3610	568	0.874	24.9	2.67	250	176
533 x 210 x 122	76000	3390	22.1	4.67	2790	320	3200	500	0.878	27.6	2.32	178	155
533 x 210 x 109	66800	2940	21.9	4.60	2480	279	2830	436	0.875	30.9	1.99	126	139
533 x 210 x 101	61500	2690	21.9	4.57	2290	256	2610	399	0.874	33.1	1.81	101	129
533 x 210 x 92	55200	2390	21.7	4.51	2070	228	2360	355	0.873	36.4	1.60	75.7	117
533 x 210 x 82	47500	2010	21.3	4.38	1800	192	2060	300	0.863	41.6	1.33	51.5	105
533 x 165 x 85 +	48500	1270	21.2	3.44	1820	153	2100	243	0.861	35.5	0.857	73.8	108
533 x 165 x 74 +	41100	1040	20.8	3.30	1550	125	1810	200	0.853	41.1	0.691	47.9	95.2
533 x 165 x 66 +	35000	859	20.5	3.20	1340	104	1560	166	0.847	47.0	0.566	32.0	83.7
457 x 191 x 161 +	79800	4250	19.7	4.55	3240	426	3780	672	0.881	16.5	2.25	515	206
457 x 191 x 133 +	63800	3350	19.4	4.44	2660	341	3070	535	0.879	19.6	1.73	292	170
457 x 191 x 106 +	48900	2510	19.0	4.32	2080	259	2390	405	0.876	24.4	1.27	146	135
457 x 191 x 98	45700	2350	19.1	4.33	1960	243	2230	379	0.881	25.8	1.18	121	125
457 x 191 x 89	41000	2090	19.0	4.29	1770	218	2010	338	0.878	28.3	1.04	90.7	114
457 x 191 x 82	37100	1870	18.8	4.23	1610	196	1830	304	0.879	30.8	0.922	69.2	104
457 x 191 x 74	33300	1670	18.8	4.20	1460	176	1650	272	0.877	33.8	0.818	51.8	94.6
457 x 191 x 67	29400	1450	18.5	4.12	1300	153	1470	237	0.873	37.8	0.705	37.1	85.5
457 x 152 x 82	36600	1180	18.7	3.37	1570	153	1810	240	0.872	27.4	0.591	89.2	105
457 x 152 x 74	32700	1050	18.6	3.33	1410	136	1630	213	0.872	30.1	0.518	65.9	94.5
457 x 152 x 67	28900	913	18.4	3.27	1260	119	1450	187	0.868	33.6	0.448	47.7	85.6
457 x 152 x 60	25500	795	18.3	3.23	1120	104	1290	163	0.868	37.5	0.387	33.8	76.2
457 x 152 x 52	21400	645	17.9	3.11	950	84.6	1100	133	0.859	43.8	0.311	21.4	66.6
406 x 178 x 85 +	31700	1830	17.1	4.11	1520	201	1730	313	0.880	24.4	0.728	93.0	109
406 x 178 x 74	27300	1550	17.0	4.04	1320	172	1500	267	0.882	27.5	0.608	62.8	94.5
406 x 178 x 67	24300	1360	16.9	3.99	1190	153	1350	237	0.880	30.4	0.533	46.1	85.5
406 x 178 x 60	21600	1200	16.8	3.97	1060	135	1200	209	0.880	33.7	0.466	33.3	76.5
406 x 178 x 54	18700	1020	16.5	3.85	930	115	1050	178	0.871	38.3	0.392	23.1	69.0
406 x 140 x 53 +	18300	635	16.4	3.06	899	88.6	1030	139	0.870	34.1	0.246	29.0	67.9
406 x 140 x 46	15700	538	16.4	3.03	778	75.7	888	118	0.871	39.0	0.207	19.0	58.6
406 x 140 x 39	12500	410	15.9	2.87	629	57.8	724	90.8	0.858	47.4	0.155	10.7	49.7
356 x 171 x 67	19500	1360	15.1	3.99	1070	157	1210	243	0.886	24.4	0.412	55.7	85.5
356 x 171 x 57	16000	1110	14.9	3.91	896	129	1010	199	0.882	28.8	0.330	33.4	72.6
356 x 171 x 51	14100	968	14.8	3.86	796	113	896	174	0.881	32.1	0.286	23.8	64.9
356 x 171 x 45	12100	811	14.5	3.76	687	94.8	775	147	0.874	36.8	0.237	15.8	57.3
356 x 127 x 39	10200	358	14.3	2.68	576	56.8	659	89.0	0.871	35.2	0.105	15.1	49.8
356 x 127 x 33	8250	280	14.0	2.58	473	44.7	543	70.2	0.863	42.1	0.081	8.79	42.1
305 x 165 x 54	11700	1060	13.0	3.93	754	127	846	196	0.889	23.6	0.234	34.8	68.8
305 x 165 x 46	9900	896	13.0	3.90	646	108	720	166	0.890	27.1	0.195	22.2	58.7
305 x 165 x 40	8500	764	12.9	3.86	560	92.6	623	142	0.889	31.0	0.164	14.7	51.3

Table 2.1.1.4. Advance® UKB. Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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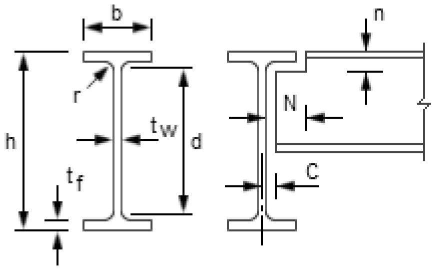
Table 2.1.1.5

SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB

DIMENSIONS



Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
305 x 127 x 48	48.1	311.0	125.3	9.0	14.0	8.9	265.2	3.52	29.5	7	70	24	1.09	22.7
305 x 127 x 42	41.9	307.2	124.3	8.0	12.1	8.9	265.2	4.07	33.2	6	70	22	1.08	25.8
305 x 127 x 37	37.0	304.4	123.4	7.1	10.7	8.9	265.2	4.60	37.4	6	70	20	1.07	28.9
305 x 102 x 33	32.8	312.7	102.4	6.6	10.8	7.6	275.9	3.73	41.8	5	58	20	1.01	30.8
305 x 102 x 28	28.2	308.7	101.8	6.0	8.8	7.6	275.9	4.58	46.0	5	58	18	1.00	35.5
305 x 102 x 25	24.8	305.1	101.6	5.8	7.0	7.6	275.9	5.76	47.6	5	58	16	0.992	40.0
254 x 146 x 43	43.0	259.6	147.3	7.2	12.7	7.6	219.0	4.92	30.4	6	82	22	1.08	25.1
254 x 146 x 37	37.0	256.0	146.4	6.3	10.9	7.6	219.0	5.73	34.8	5	82	20	1.07	28.9
254 x 146 x 31	31.1	251.4	146.1	6.0	8.6	7.6	219.0	7.26	36.5	5	82	18	1.06	34.0
254 x 102 x 28	28.3	260.4	102.2	6.3	10.0	7.6	225.2	4.04	35.7	5	58	18	0.904	31.9
254 x 102 x 25	25.2	257.2	101.9	6.0	8.4	7.6	225.2	4.80	37.5	5	58	16	0.897	35.7
254 x 102 x 22	22.0	254.0	101.6	5.7	6.8	7.6	225.2	5.93	39.5	5	58	16	0.890	40.5
203 x 133 x 30	30.0	206.8	133.9	6.4	9.6	7.6	172.4	5.85	26.9	5	74	18	0.923	30.8
203 x 133 x 25	25.1	203.2	133.2	5.7	7.8	7.6	172.4	7.20	30.2	5	74	16	0.915	36.5
203 x 102 x 23	23.1	203.2	101.8	5.4	9.3	7.6	169.4	4.37	31.4	5	60	18	0.790	34.2
178 x 102 x 19	19.0	177.8	101.2	4.8	7.9	7.6	146.8	5.14	30.6	4	60	16	0.738	38.7
152 x 89 x 16	16.0	152.4	88.7	4.5	7.7	7.6	121.8	4.48	27.1	4	54	16	0.638	40.0
127 x 76 x 13	13.0	127.0	76.0	4.0	7.6	7.6	96.6	3.74	24.2	4	46	16	0.537	41.4

Table 2.1.1.5. Advance® UKB. Dimensions

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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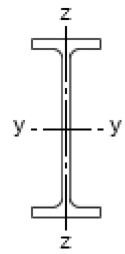
Table 2.1.1.6

SECTION PROPERTIES

UNIVERSAL BEAMS

Advance® UKB

PROPERTIES



Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
305 x 127 x 48	9570	461	12.5	2.74	616	73.6	711	116	0.873	23.3	0.102	31.8	61.2
305 x 127 x 42	8200	389	12.4	2.70	534	62.6	614	98.4	0.872	26.5	0.0846	21.1	53.4
305 x 127 x 37	7170	336	12.3	2.67	471	54.5	539	85.4	0.872	29.7	0.0725	14.8	47.2
305 x 102 x 33	6500	194	12.5	2.15	416	37.9	481	60.0	0.867	31.6	0.0442	12.2	41.8
305 x 102 x 28	5370	155	12.2	2.08	348	30.5	403	48.4	0.859	37.3	0.0349	7.40	35.9
305 x 102 x 25	4460	123	11.9	1.97	292	24.2	342	38.8	0.846	43.4	0.027	4.77	31.6
254 x 146 x 43	6540	677	10.9	3.52	504	92.0	566	141	0.891	21.1	0.103	23.9	54.8
254 x 146 x 37	5540	571	10.8	3.48	433	78.0	483	119	0.890	24.3	0.0857	15.3	47.2
254 x 146 x 31	4410	448	10.5	3.36	351	61.3	393	94.1	0.879	29.6	0.0660	8.55	39.7
254 x 102 x 28	4000	179	10.5	2.22	308	34.9	353	54.8	0.873	27.5	0.0280	9.57	36.1
254 x 102 x 25	3410	149	10.3	2.15	266	29.2	306	46.0	0.866	31.4	0.0230	6.42	32.0
254 x 102 x 22	2840	119	10.1	2.06	224	23.5	259	37.3	0.856	36.3	0.0182	4.15	28.0
203 x 133 x 30	2900	385	8.71	3.17	280	57.5	314	88.2	0.882	21.5	0.0374	10.3	38.2
203 x 133 x 25	2340	308	8.56	3.10	230	46.2	258	70.9	0.876	25.6	0.0294	5.96	32.0
203 x 102 x 23	2100	164	8.46	2.36	207	32.2	234	49.7	0.888	22.4	0.0154	7.02	29.4
178 x 102 x 19	1360	137	7.48	2.37	153	27.0	171	41.6	0.886	22.6	0.0099	4.41	24.3
152 x 89 x 16	834	89.8	6.41	2.10	109	20.2	123	31.2	0.890	19.5	0.00470	3.56	20.3
127 x 76 x 13	473	55.7	5.35	1.84	74.6	14.7	84.2	22.6	0.894	16.3	0.00200	2.85	16.5

Table 2.1.1.6. Advance® UKB. Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

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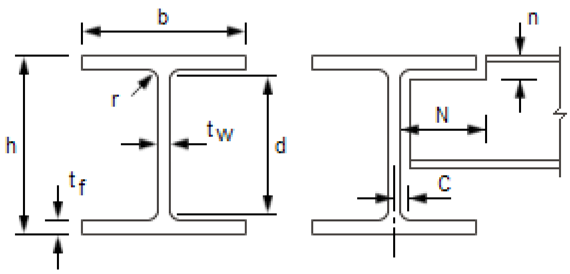
Table 2.1.2.1

SECTION PROPERTIES

UNIVERSAL COLUMNS

Advance® UKC

DIMENSIONS



Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
356 x 406 x 634	633.9	474.6	424.0	47.6	77.0	15.2	290.2	2.25	6.10	26	200	94	2.52	3.98
356 x 406 x 551	551.0	455.6	418.5	42.1	67.5	15.2	290.2	2.56	6.89	23	200	84	2.47	4.48
356 x 406 x 467	467.0	436.6	412.2	35.8	58.0	15.2	290.2	2.98	8.11	20	200	74	2.42	5.18
356 x 406 x 393	393.0	419.0	407.0	30.6	49.2	15.2	290.2	3.52	9.48	17	200	66	2.38	6.06
356 x 406 x 340	339.9	406.4	403.0	26.6	42.9	15.2	290.2	4.03	10.9	15	200	60	2.35	6.91
356 x 406 x 287	287.1	393.6	399.0	22.6	36.5	15.2	290.2	4.74	12.8	13	200	52	2.31	8.05
356 x 406 x 235	235.1	381.0	394.8	18.4	30.2	15.2	290.2	5.73	15.8	11	200	46	2.28	9.70
356 x 368 x 202	201.9	374.6	374.7	16.5	27.0	15.2	290.2	6.07	17.6	10	190	44	2.19	10.8
356 x 368 x 177	177.0	368.2	372.6	14.4	23.8	15.2	290.2	6.89	20.2	9	190	40	2.17	12.3
356 x 368 x 153	152.9	362.0	370.5	12.3	20.7	15.2	290.2	7.92	23.6	8	190	36	2.16	14.1
356 x 368 x 129	129.0	355.6	368.6	10.4	17.5	15.2	290.2	9.4	27.9	7	190	34	2.14	16.6
305 x 305 x 283	282.9	365.3	322.2	26.8	44.1	15.2	246.7	3.00	9.21	15	158	60	1.94	6.86
305 x 305 x 240	240.0	352.5	318.4	23.0	37.7	15.2	246.7	3.51	10.7	14	158	54	1.91	7.96
305 x 305 x 198	198.1	339.9	314.5	19.1	31.4	15.2	246.7	4.22	12.9	12	158	48	1.87	9.44
305 x 305 x 158	158.1	327.1	311.2	15.8	25.0	15.2	246.7	5.30	15.6	10	158	42	1.84	11.6
305 x 305 x 137	136.9	320.5	309.2	13.8	21.7	15.2	246.7	6.11	17.90	9	158	38	1.82	13.3
305 x 305 x 118	117.9	314.5	307.4	12.0	18.7	15.2	246.7	7.09	20.6	8	158	34	1.81	15.4
305 x 305 x 97	96.9	307.9	305.3	9.9	15.4	15.2	246.7	8.60	24.9	7	158	32	1.79	18.5
254 x 254 x 167	167.1	289.1	265.2	19.2	31.7	12.7	200.3	3.48	10.4	12	134	46	1.58	9.46
254 x 254 x 132	132.0	276.3	261.3	15.3	25.3	12.7	200.3	4.36	13.1	10	134	38	1.55	11.7
254 x 254 x 107	107.1	266.7	258.8	12.8	20.5	12.7	200.3	5.38	15.6	8	134	34	1.52	14.2
254 x 254 x 89	88.9	260.3	256.3	10.3	17.3	12.7	200.3	6.38	19.4	7	134	30	1.50	16.9
254 x 254 x 73	73.1	254.1	254.6	8.6	14.2	12.7	200.3	7.77	23.3	6	134	28	1.49	20.4
203 x 203 x 127 +	127.5	241.4	213.9	18.1	30.1	10.2	160.8	2.91	8.88	11	108	42	1.28	10.0
203 x 203 x 113 +	113.5	235.0	212.1	16.3	26.9	10.2	160.8	3.26	9.87	10	108	38	1.27	11.2
203 x 203 x 100 +	99.6	228.6	210.3	14.5	23.7	10.2	160.8	3.70	11.1	9	108	34	1.25	12.6
203 x 203 x 86	86.1	222.2	209.1	12.7	20.5	10.2	160.8	4.29	12.7	8	110	32	1.24	14.4
203 x 203 x 71	71.0	215.8	206.4	10.0	17.3	10.2	160.8	5.09	16.1	7	110	28	1.22	17.2
203 x 203 x 60	60.0	209.6	205.8	9.4	14.2	10.2	160.8	6.20	17.1	7	110	26	1.21	20.2
203 x 203 x 52	52.0	206.2	204.3	7.9	12.5	10.2	160.8	7.04	20.4	6	110	24	1.20	23.1
203 x 203 x 46	46.1	203.2	203.6	7.2	11.0	10.2	160.8	8.00	22.3	6	110	22	1.19	25.8
152 x 152 x 51 +	51.2	170.2	157.4	11.0	15.7	7.6	123.6	4.18	11.2	8	84	24	0.935	18.3
152 x 152 x 44 +	44.0	166.0	155.9	9.5	13.6	7.6	123.6	4.82	13.0	7	84	22	0.924	21.0
152 x 152 x 37	37.0	161.8	154.4	8.0	11.5	7.6	123.6	5.70	15.5	6	84	20	0.912	24.7
152 x 152 x 30	30.0	157.6	152.9	6.5	9.4	7.6	123.6	6.98	19.0	5	84	18	0.901	30.0
152 x 152 x 23	23.0	152.4	152.2	5.8	6.8	7.6	123.6	9.65	21.3	5	84	16	0.889	38.7

Table 2.1.2.1. Advance® UKC. Dimensions

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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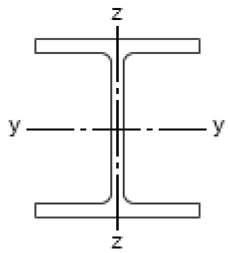
Table 2.1.2.2

SECTION PROPERTIES

UNIVERSAL COLUMNS

Advance® UKC

PROPERTIES



Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
356 x 406 x 634	275000	98100	18.4	11.0	11600	4630	14200	7110	0.843	5.46	38.8	13700	808
356 x 406 x 551	227000	82700	18.0	10.9	9960	3950	12100	6060	0.841	6.05	31.1	9240	702
356 x 406 x 467	183000	67800	17.5	10.7	8380	3290	10000	5030	0.839	6.85	24.3	5810	595
356 x 406 x 393	147000	55400	17.1	10.5	7000	2720	8220	4150	0.837	7.86	18.9	3550	501
356 x 406 x 340	123000	46900	16.8	10.4	6030	2330	7000	3540	0.836	8.84	15.5	2340	433
356 x 406 x 287	99900	38700	16.5	10.3	5070	1940	5810	2950	0.835	10.17	12.3	1440	366
356 x 406 x 235	79100	31000	16.3	10.2	4150	1570	4690	2380	0.834	12.04	9.54	812	299
356 x 368 x 202	66300	23700	16.1	9.60	3540	1260	3970	1920	0.844	13.35	7.16	558	257
356 x 368 x 177	57100	20500	15.9	9.54	3100	1100	3460	1670	0.844	15.00	6.09	381	226
356 x 368 x 153	48600	17600	15.8	9.49	2680	948	2960	1430	0.844	17.01	5.11	251	195
356 x 368 x 129	40200	14600	15.6	9.43	2260	793	2480	1200	0.844	19.81	4.18	153	164
305 x 305 x 283	78900	24600	14.8	8.27	4320	1530	5110	2340	0.855	7.64	6.35	2030	360
305 x 305 x 240	64200	20300	14.5	8.15	3640	1280	4250	1950	0.854	8.73	5.03	1270	306
305 x 305 x 198	50900	16300	14.2	8.04	3000	1040	3440	1580	0.854	10.23	3.88	734	252
305 x 305 x 158	38700	12600	13.9	7.90	2370	808	2680	1230	0.851	12.46	2.87	378	201
305 x 305 x 137	32800	10700	13.7	7.83	2050	692	2300	1050	0.851	14.13	2.39	249	174
305 x 305 x 118	27700	9060	13.6	7.77	1760	589	1960	895	0.850	16.14	1.98	161	150
305 x 305 x 97	22200	7310	13.4	7.69	1450	479	1590	726	0.850	19.19	1.56	91.2	123
254 x 254 x 167	30000	9870	11.9	6.81	2080	744	2420	1140	0.851	8.48	1.63	626	213
254 x 254 x 132	22500	7530	11.6	6.69	1630	576	1870	878	0.850	10.32	1.19	319	168
254 x 254 x 107	17500	5930	11.3	6.59	1310	458	1480	697	0.848	12.38	0.898	172	136
254 x 254 x 89	14300	4860	11.2	6.55	1100	379	1220	575	0.850	14.46	0.717	102	113
254 x 254 x 73	11400	3910	11.1	6.48	898	307	992	465	0.849	17.24	0.562	57.6	93.1
203 x 203 x 127 +	15400	4920	9.75	5.50	1280	460	1520	704	0.854	7.38	0.549	427	162
203 x 203 x 113 +	13300	4290	9.59	5.45	1130	404	1330	618	0.853	8.11	0.464	305	145
203 x 203 x 100 +	11300	3680	9.44	5.39	988	350	1150	534	0.852	9.02	0.386	210	127
203 x 203 x 86	9450	3130	9.28	5.34	850	299	977	456	0.850	10.20	0.318	137	110
203 x 203 x 71	7620	2540	9.18	5.30	706	246	799	374	0.853	11.90	0.250	80.2	90.4
203 x 203 x 60	6120	2060	8.96	5.20	584	201	656	305	0.846	14.10	0.197	47.2	76.4
203 x 203 x 52	5260	1780	8.91	5.18	510	174	567	264	0.848	15.80	0.167	31.8	66.3
203 x 203 x 46	4570	1550	8.82	5.13	450	152	497	231	0.847	17.70	0.143	22.2	58.7
152 x 152 x 51 +	3230	1020	7.04	3.96	379	130	438	199	0.848	10.10	0.061	48.8	65.2
152 x 152 x 44 +	2700	860	6.94	3.92	326	110	372	169	0.848	11.50	0.050	31.7	56.1
152 x 152 x 37	2210	706	6.85	3.87	273	91.5	309	140	0.848	13.30	0.040	19.2	47.1
152 x 152 x 30	1750	560	6.76	3.83	222	73.3	248	112	0.849	16.00	0.031	10.5	38.3
152 x 152 x 23	1250	400	6.54	3.70	164	52.6	182	80.1	0.840	20.70	0.021	4.63	29.2

Table 2.1.2.2. Advance® UKC. Properties

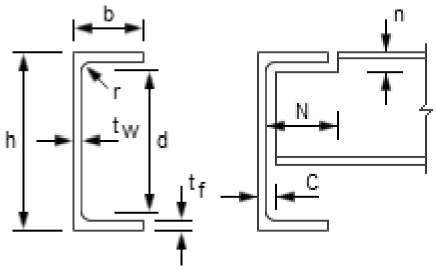
Table 2.1.4.1

SECTION PROPERTIES

PARALLEL FLANGE CHANNELS

Advance® UKPFC

DIMENSIONS



Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Distance	Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web		End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	e_0	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			cm	mm	mm	mm	m^2	m^2
430 x 100 x 64	64.4	430	100	11.0	19.0	15	362	3.89	32.9	3.27	13	96	36	1.23	19.0
380 x 100 x 54	54.0	380	100	9.5	17.5	15	315	4.31	33.2	3.48	12	98	34	1.13	20.9
300 x 100 x 46	45.5	300	100	9.0	16.5	15	237	4.61	26.3	3.68	11	98	32	0.969	21.3
300 x 90 x 41	41.4	300	90	9.0	15.5	12	245	4.45	27.2	3.18	11	88	28	0.932	22.5
260 x 90 x 35	34.8	260	90	8.0	14.0	12	208	5.00	26.0	3.32	10	88	28	0.854	24.5
260 x 75 x 28	27.6	260	75	7.0	12.0	12	212	4.67	30.3	2.62	9	74	26	0.796	28.8
230 x 90 x 32	32.2	230	90	7.5	14.0	12	178	5.04	23.7	3.46	10	90	28	0.795	24.7
230 x 75 x 26	25.7	230	75	6.5	12.5	12	181	4.52	27.8	2.78	9	76	26	0.737	28.7
200 x 90 x 30	29.7	200	90	7.0	14.0	12	148	5.07	21.1	3.60	9	90	28	0.736	24.8
200 x 75 x 23	23.4	200	75	6.0	12.5	12	151	4.56	25.2	2.91	8	76	26	0.678	28.9
180 x 90 x 26	26.1	180	90	6.5	12.5	12	131	5.72	20.2	3.64	9	90	26	0.697	26.7
180 x 75 x 20	20.3	180	75	6.0	10.5	12	135	5.43	22.5	2.87	8	76	24	0.638	31.4
150 x 90 x 24	23.9	150	90	6.5	12.0	12	102	5.96	15.7	3.71	9	90	26	0.637	26.7
150 x 75 x 18	17.9	150	75	5.5	10.0	12	106	5.75	19.3	2.99	8	76	24	0.579	32.4
125 x 65 x 15	14.8	125	65	5.5	9.5	12	82.0	5.00	14.9	2.56	8	66	22	0.489	33.1
100 x 50 x 10	10.2	100	50	5.0	8.5	9	65.0	4.24	13.0	1.94	7	52	18	0.382	37.5

Table 2.1.4.1. Advance® UKPFC. Dimensions

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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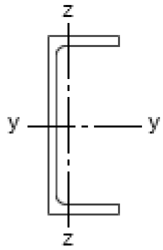
Table 2.1.4.2

SECTION PROPERTIES

PARALLEL FLANGE CHANNELS

Advance® UKPFC

PROPERTIES



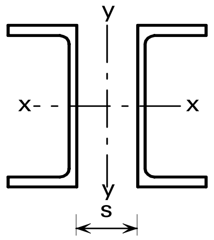
Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
430 x 100 x 64	21900	722	16.3	2.97	1020	97.9	1220	176	0.917	22.5	0.219	63.0	82.1
380 x 100 x 54	15000	643	14.8	3.06	791	89.2	933	161	0.933	21.2	0.150	45.7	68.7
300 x 100 x 46	8230	568	11.9	3.13	549	81.7	641	148	0.944	17.0	0.0813	36.8	58.0
300 x 90 x 41	7220	404	11.7	2.77	481	63.1	568	114	0.934	18.3	0.0581	28.8	52.7
260 x 90 x 35	4730	353	10.3	2.82	364	56.3	425	102	0.943	17.2	0.0379	20.6	44.4
260 x 75 x 28	3620	185	10.1	2.30	278	34.4	328	62.0	0.932	20.5	0.0203	11.7	35.1
230 x 90 x 32	3520	334	9.27	2.86	306	55.0	355	98.9	0.949	15.1	0.0279	19.3	41.0
230 x 75 x 26	2750	181	9.17	2.35	239	34.8	278	63.2	0.945	17.3	0.0153	11.8	32.7
200 x 90 x 30	2520	314	8.16	2.88	252	53.4	291	94.5	0.952	12.9	0.0197	18.3	37.9
200 x 75 x 23	1960	170	8.11	2.39	196	33.8	227	60.6	0.956	14.7	0.0107	11.1	29.9
180 x 90 x 26	1820	277	7.40	2.89	202	47.4	232	83.5	0.950	12.8	0.0141	13.3	33.2
180 x 75 x 20	1370	146	7.27	2.38	152	28.8	176	51.8	0.945	15.3	0.00754	7.34	25.9
150 x 90 x 24	1160	253	6.18	2.89	155	44.4	179	76.9	0.937	10.8	0.00890	11.8	30.4
150 x 75 x 18	861	131	6.15	2.40	115	26.6	132	47.2	0.945	13.1	0.00467	6.10	22.8
125 x 65 x 15	483	80.0	5.07	2.06	77.3	18.8	89.9	33.2	0.942	11.1	0.00194	4.72	18.8
100 x 50 x 10	208	32.3	4.00	1.58	41.5	9.89	48.9	17.5	0.942	10.0	0.000491	2.53	13.0

Table 2.1.4.2. Advance® UKPFC. Properties

BS 5950-1: 2000
BS 4-1: 2005

TWO PARALLEL FLANGE CHANNELS LACED

TWO Advance UKPFC LACED



Dimensions and properties

Composed of Two Channels	Total Mass per Metre	Total Area	Space between Webs s	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus	
				Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y	Axis x-x	Axis y-y
	kg/m	cm^2	mm	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3
430x100x64	129	164	270	43900	44100	16.3	16.4	2040	1880	2440	2650
380x100x54	108	137	235	30100	30400	14.8	14.9	1580	1400	1870	2000
300x100x46	91.1	116	170	16500	16600	11.9	12.0	1100	898	1280	1340
300x90x41	82.8	105	175	14400	14400	11.7	11.7	962	811	1140	1200
260x90x35	69.7	88.8	145	9460	9560	10.3	10.4	727	588	849	886
260x75x28	55.2	70.3	155	7240	7190	10.1	10.1	557	472	656	692
230x90x32	64.3	81.9	120	7040	7190	9.27	9.37	612	479	709	731
230x75x26	51.3	65.4	135	5500	5720	9.17	9.35	478	401	557	592
200x90x30	59.4	75.7	90.0	5050	5030	8.16	8.15	505	372	583	577
200x75x23	46.9	59.7	105	3930	3910	8.11	8.09	393	306	454	462
180x90x26	52.1	66.4	75.0	3640	3730	7.40	7.49	404	292	464	459
180x75x20	40.7	51.8	90.0	2740	2770	7.27	7.31	304	231	352	358
150x90x24	47.7	60.8	45.0	2320	2380	6.18	6.26	310	212	357	338
150x75x18	35.7	45.5	65.0	1720	1810	6.15	6.30	230	168	264	265
125x65x15	29.5	37.6	50.0	966	1010	5.07	5.18	155	112	180	178
100x50x10	20.4	26.0	40.0	415	427	4.00	4.05	83.1	61.0	97.7	97.1

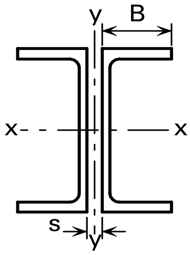
Advance and UKPFC are trademarks of Corus. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance range of sections manufactured by Corus is given on page A - 42.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS 5950-1: 2000
BS 4-1: 2005

TWO PARALLEL FLANGE CHANNELS BACK TO BACK

TWO Advance UKPFC BACK TO BACK



Dimensions and properties

Composed of Two Channels	Total Mass per Metre	Total Area	Properties about Axis x-x				Radius of Gyration r_y about Axis y-y (cm)				
			I_x	r_x	Z_x	S_x	Space between webs, s (mm)				
	kg/m	cm^2	cm^4	cm	cm^3	cm^3	0	8	10	12	15
430x100x64	129	164	43900	16.3	2040	2440	3.96	4.23	4.31	4.38	4.49
380x100x54	108	137	30100	14.8	1580	1870	4.14	4.42	4.49	4.57	4.68
300x100x46	91.1	116	16500	11.9	1100	1280	4.37	4.66	4.73	4.81	4.92
300x90x41	82.8	105	14400	11.7	962	1140	3.80	4.08	4.16	4.23	4.35
260x90x35	69.7	88.8	9460	10.3	727	849	3.93	4.22	4.29	4.37	4.48
260x75x28	55.2	70.3	7240	10.1	557	656	3.11	3.40	3.47	3.55	3.66
230x90x32	64.3	81.9	7040	9.27	612	709	4.09	4.38	4.46	4.53	4.65
230x75x26	51.3	65.4	5500	9.17	478	557	3.29	3.58	3.66	3.73	3.85
200x90x30	59.4	75.7	5050	8.16	505	583	4.25	4.55	4.63	4.71	4.83
200x75x23	46.9	59.7	3930	8.11	393	454	3.44	3.74	3.82	3.89	4.01
180x90x26	52.1	66.4	3640	7.40	404	464	4.29	4.59	4.67	4.75	4.87
180x75x20	40.7	51.8	2740	7.27	304	352	3.39	3.68	3.76	3.84	3.95
150x90x24	47.7	60.8	2320	6.18	310	357	4.39	4.69	4.77	4.85	4.98
150x75x18	35.7	45.5	1720	6.15	230	264	3.52	3.82	3.90	3.98	4.10
125x65x15	29.5	37.6	966	5.07	155	180	3.05	3.36	3.44	3.52	3.64
100x50x10	20.4	26.0	415	4.00	83.1	97.7	2.34	2.65	2.73	2.82	2.94

Advance and UKPFC are trademarks of Corus. A fuller description of the relationship between Parallel Flange Channels (PFC) and the Advance range of sections manufactured by Corus is given on page A - 42.

Properties about y axis:

I_y = (Total Area).$(r_y)^2$

$Z_y = I_y/(B+0.5s)$

where s is the space between webs.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1: 2005
BS EN 10056-1: 1999

UK EUROCODES

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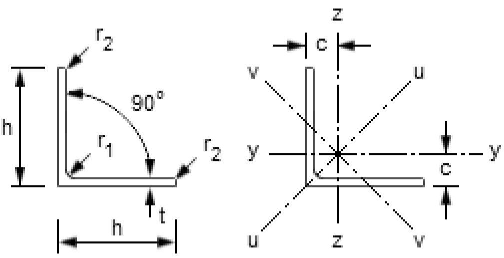
Table 2.1.5.1

SECTION PROPERTIES

EQUAL ANGLES

Advance® UKA - Equal

DIMENSIONS AND PROPERTIES



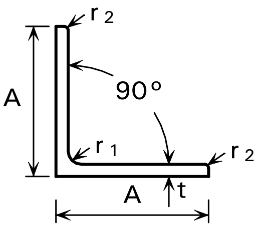
Section Designation		Mass per Metre	Radius		Area of Section	Distance to Centroid	Second Moment of Area			Radius of Gyration			Elastic Modulus	Torsional Constant	Equivalent Slenderness Coefficient
Size	Thickness		Root	Toe			Axis y-y, z-z	Axis u-u	Axis v-v	Axis y-y, z-z	Axis u-u	Axis v-v	Axis y-y, z-z		
h x h	t		r_1	r_2		c								I_T	φ_a
mm	mm	kg/m	mm	mm	cm^2	cm	cm^4	cm^4	cm^4	cm	cm	cm	cm^3	cm^4	
200 x 200	24	71.1	18.0	9.00	90.6	5.84	3330	5280	1380	6.06	7.64	3.90	235	182	2.50
	20	59.9	18.0	9.00	76.3	5.68	2850	4530	1170	6.11	7.70	3.92	199	107	3.05
	18	54.3	18.0	9.00	69.1	5.60	2600	4150	1050	6.13	7.75	3.90	181	78.9	3.43
	16	48.5	18.0	9.00	61.8	5.52	2340	3720	960	6.16	7.76	3.94	162	56.1	3.85
150 x 150	18 +	40.1	16.0	8.00	51.2	4.38	1060	1680	440	4.55	5.73	2.93	99.8	58.6	2.48
	15	33.8	16.0	8.00	43.0	4.25	898	1430	370	4.57	5.76	2.93	83.5	34.6	3.01
	12	27.3	16.0	8.00	34.8	4.12	737	1170	303	4.60	5.80	2.95	67.7	18.2	3.77
	10	23.0	16.0	8.00	29.3	4.03	624	990	258	4.62	5.82	2.97	56.9	10.8	4.51
120 x 120	15 +	26.6	13.0	6.50	34.0	3.52	448	710	186	3.63	4.57	2.34	52.8	27.0	2.37
	12	21.6	13.0	6.50	27.5	3.40	368	584	152	3.65	4.60	2.35	42.7	14.2	2.99
	10	18.2	13.0	6.50	23.2	3.31	313	497	129	3.67	4.63	2.36	36.0	8.41	3.61
	8 +	14.7	13.0	6.50	18.8	3.24	259	411	107	3.71	4.67	2.38	29.5	4.44	4.56
100 x 100	15 +	21.9	12.0	6.00	28.0	3.02	250	395	105	2.99	3.76	1.94	35.8	22.3	1.92
	12	17.8	12.0	6.00	22.7	2.90	207	328	85.7	3.02	3.80	1.94	29.1	11.8	2.44
	10	15.0	12.0	6.00	19.2	2.82	177	280	73.0	3.04	3.83	1.95	24.6	6.97	2.94
	8	12.2	12.0	6.00	15.5	2.74	145	230	59.9	3.06	3.85	1.96	19.9	3.68	3.70
90 x 90	12 +	15.9	11.0	5.50	20.3	2.66	149	235	62.0	2.71	3.40	1.75	23.5	10.5	2.17
	10	13.4	11.0	5.50	17.1	2.58	127	201	52.6	2.72	3.42	1.75	19.8	6.20	2.64
	8	10.9	11.0	5.50	13.9	2.50	104	166	43.1	2.74	3.45	1.76	16.1	3.28	3.33
	7	9.61	11.0	5.50	12.2	2.45	92.6	147	38.3	2.75	3.46	1.77	14.1	2.24	3.80

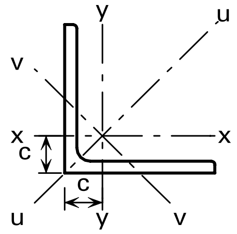
Table 2.1.5.1. Advance® UKA - Equal. Dimensions and Properties

BS 5950-1: 2000
BS EN 10056-1: 1999

EQUAL ANGLES

Advance UKA - Equal Angles





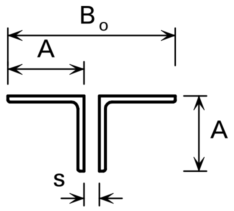
Dimensions and properties

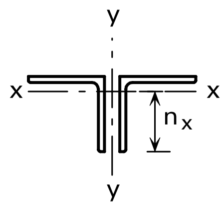
Section Designation Size A x A mm	Thickness t mm	Mass per Metre kg/m	Radius Root r_1 mm	Radius Toe r_2 mm	Area of Section cm^2	Dimension c cm	Second Moment of Area Axis x-x, y-y cm^4	Second Moment of Area Axis u-u cm^4	Second Moment of Area Axis v-v cm^4	Radius of Gyration Axis x-x, y-y cm	Radius of Gyration Axis u-u cm	Radius of Gyration Axis v-v cm	Elastic Modulus Axis x-x, y-y cm^3	Torsional Constant J cm^4	Equivalent Slenderness Coefficient ϕ_a
200x200	24	71.1	18.0	9.00	90.6	5.84	3330	5280	1380	6.06	7.64	3.90	235	182	2.50
	20	59.9	18.0	9.00	76.3	5.68	2850	4530	1170	6.11	7.70	3.92	199	107	3.05
	18	54.3	18.0	9.00	69.1	5.60	2600	4150	1050	6.13	7.75	3.90	181	78.9	3.43
	16	48.5	18.0	9.00	61.8	5.52	2340	3720	960	6.16	7.76	3.94	162	56.1	3.85
150x150	18 +	40.1	16.0	8.00	51.2	4.38	1060	1680	440	4.55	5.73	2.93	99.8	58.6	2.48
	15	33.8	16.0	8.00	43.0	4.25	898	1430	370	4.57	5.76	2.93	83.5	34.6	3.01
	12	27.3	16.0	8.00	34.8	4.12	737	1170	303	4.60	5.80	2.95	67.7	18.2	3.77
	10	23.0	16.0	8.00	29.3	4.03	624	990	258	4.62	5.82	2.97	56.9	10.8	4.51
120x120	15 +	26.6	13.0	6.50	34.0	3.52	448	710	186	3.63	4.57	2.34	52.8	27.0	2.37
	12	21.6	13.0	6.50	27.5	3.40	368	584	152	3.65	4.60	2.35	42.7	14.2	2.99
	10	18.2	13.0	6.50	23.2	3.31	313	497	129	3.67	4.63	2.36	36.0	8.41	3.61
	8 +	14.7	13.0	6.50	18.8	3.24	259	411	107	3.71	4.67	2.38	29.5	4.44	4.56
100x100	15 +	21.9	12.0	6.00	28.0	3.02	250	395	105	2.99	3.76	1.94	35.8	22.3	1.92
	12	17.8	12.0	6.00	22.7	2.90	207	328	85.7	3.02	3.80	1.94	29.1	11.8	2.44
	10	15.0	12.0	6.00	19.2	2.82	177	280	73.0	3.04	3.83	1.95	24.6	6.97	2.94
	8	12.2	12.0	6.00	15.5	2.74	145	230	59.9	3.06	3.85	1.96	19.9	3.68	3.70
90x90	12 +	15.9	11.0	5.50	20.3	2.66	149	235	62.0	2.71	3.40	1.75	23.5	10.5	2.17
	10	13.4	11.0	5.50	17.1	2.58	127	201	52.6	2.72	3.42	1.75	19.8	6.20	2.64
	8	10.9	11.0	5.50	13.9	2.50	104	166	43.1	2.74	3.45	1.76	16.1	3.28	3.33
	7	9.61	11.0	5.50	12.2	2.45	92.6	147	38.3	2.75	3.46	1.77	14.1	2.24	3.80
80x80	10	11.9	10.0	5.00	15.1	2.34	87.5	139	36.4	2.41	3.03	1.55	15.4	5.45	2.33
	8	9.63	10.0	5.00	12.3	2.26	72.2	115	29.9	2.43	3.06	1.56	12.6	2.88	2.94
75x75	8	8.99	9.00	4.50	11.4	2.14	59.1	93.8	24.5	2.27	2.86	1.46	11.0	2.65	2.76
	6	6.85	9.00	4.50	8.73	2.05	45.8	72.7	18.9	2.29	2.89	1.47	8.41	1.17	3.70
70x70	7	7.38	9.00	4.50	9.40	1.97	42.3	67.1	17.5	2.12	2.67	1.36	8.41	1.69	2.92
	6	6.38	9.00	4.50	8.13	1.93	36.9	58.5	15.3	2.13	2.68	1.37	7.27	1.09	3.41
65x65	7	6.83	9.00	4.50	8.73	2.05	33.4	53.0	13.8	1.96	2.47	1.26	7.18	1.58	2.67
60x60	8	7.09	8.00	4.00	9.03	1.77	29.2	46.1	12.2	1.80	2.26	1.16	6.89	2.09	2.14
	6	5.42	8.00	4.00	6.91	1.69	22.8	36.1	9.44	1.82	2.29	1.17	5.29	0.922	2.90
	5	4.57	8.00	4.00	5.82	1.64	19.4	30.7	8.03	1.82	2.30	1.17	4.45	0.550	3.48
50x50	6	4.47	7.00	3.50	5.69	1.45	12.8	20.3	5.34	1.50	1.89	0.968	3.61	0.755	2.38
	5	3.77	7.00	3.50	4.80	1.40	11.0	17.4	4.55	1.51	1.90	0.973	3.05	0.450	2.88
	4	3.06	7.00	3.50	3.89	1.36	8.97	14.2	3.73	1.52	1.91	0.979	2.46	0.240	3.57
45x45	5	3.06	7.00	3.50	3.90	1.25	7.14	11.4	2.94	1.35	1.71	0.870	2.20	0.304	2.84
40x40	5	2.97	6.00	3.00	3.79	1.16	5.43	8.60	2.26	1.20	1.51	0.773	1.91	0.352	2.26
	4	2.42	6.00	3.00	3.08	1.12	4.47	7.09	1.86	1.21	1.52	0.777	1.55	0.188	2.83
35x35	4	2.09	5.00	2.50	2.67	1.00	2.95	4.68	1.23	1.05	1.32	0.678	1.18	0.158	2.50
30x30	4	1.78	5.00	2.50	2.27	0.878	1.80	2.85	0.754	0.892	1.12	0.577	0.850	0.137	2.07
	3	1.36	5.00	2.50	1.74	0.835	1.40	2.22	0.585	0.899	1.13	0.581	0.649	0.0613	2.75
25x25	4	1.45	3.50	1.75	1.85	0.762	1.02	1.61	0.430	0.741	0.931	0.482	0.586	0.1070	1.75
	3	1.12	3.50	1.75	1.42	0.723	0.803	1.27	0.334	0.751	0.945	0.484	0.452	0.0472	2.38
20x20	3	0.882	3.50	1.75	1.12	0.598	0.392	0.618	0.165	0.590	0.742	0.383	0.279	0.0382	1.81

Advance and UKA are trademarks of Corus. A fuller description of the relationship between Angles and the Advance range of sections manufactured by Corus is given on page A - 42.
+ These sections are in addition to the range of BS EN 10056-1 sections.
c is the distance from the back of the leg to the centre of gravity.
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

EQUAL ANGLES BACK TO BACK

Advance UKA - Equal Angles BACK TO BACK





Dimensions and properties

Composed of Two Angles A x A mm	t mm	Total Mass per Metre kg/m	Distance n_x cm	Total Area cm^2	Properties about Axis x-x I_x cm^4	r_x cm	Z_x cm^3	Radius of Gyration r_y about Axis y-y (cm) Space between angles, s, (mm) 0	8	10	12	15
200x200	24	142	14.2	181	6660	6.06	470	8.42	8.70	8.77	8.84	8.95
	20	120	14.3	153	5700	6.11	398	8.34	8.62	8.69	8.76	8.87
	18	109	14.4	138	5200	6.13	362	8.31	8.58	8.65	8.72	8.83
	16	97.0	14.5	124	4680	6.16	324	8.27	8.54	8.61	8.68	8.79
150x150	18 +	80.2	10.6	102	2120	4.55	200	6.32	6.60	6.67	6.75	6.86
	15	67.6	10.8	86.0	1800	4.57	167	6.24	6.52	6.59	6.66	6.77
	12	54.6	10.9	69.6	1470	4.60	135	6.18	6.45	6.52	6.59	6.70
	10	46.0	11.0	58.6	1250	4.62	114	6.13	6.40	6.47	6.54	6.64
120x120	15 +	53.2	8.48	68.0	896	3.63	106	5.06	5.34	5.42	5.49	5.60
	12	43.2	8.60	55.0	736	3.65	85.4	4.99	5.27	5.35	5.42	5.53
	10	36.4	8.69	46.4	626	3.67	72.0	4.94	5.22	5.29	5.36	5.47
	8 +	29.4	8.76	37.6	518	3.71	59.0	4.93	5.20	5.27	5.34	5.45
100x100	15 +	43.8	6.98	56.0	500	2.99	71.6	4.25	4.54	4.62	4.69	4.81
	12	35.6	7.10	45.4	414	3.02	58.2	4.19	4.47	4.55	4.62	4.74
	10	30.0	7.18	38.4	354	3.04	49.2	4.14	4.43	4.50	4.57	4.69
	8	24.4	7.26	31.0	290	3.06	39.8	4.11	4.38	4.46	4.53	4.64
90x90	12 +	31.8	6.34	40.6	298	2.71	47.0	3.80	4.09	4.16	4.24	4.36
	10	26.8	6.42	34.2	254	2.72	39.6	3.75	4.04	4.11	4.19	4.30
	8	21.8	6.50	27.8	208	2.74	32.2	3.71	3.99	4.06	4.13	4.25
	7	19.2	6.55	24.4	185	2.75	28.2	3.69	3.96	4.04	4.11	4.22
80x80	10	23.8	5.66	30.2	175	2.41	30.8	3.36	3.65	3.72	3.80	3.92
	8	19.3	5.74	24.6	144	2.43	25.2	3.31	3.60	3.67	3.75	3.86
75x75	8	18.0	5.36	22.8	118	2.27	22.0	3.12	3.41	3.49	3.56	3.68
	6	13.7	5.45	17.5	91.6	2.29	16.8	3.07	3.35	3.43	3.50	3.62
70x70	7	14.8	5.03	18.8	84.6	2.12	16.8	2.89	3.18	3.26	3.33	3.45
	6	12.8	5.07	16.3	73.8	2.13	14.5	2.87	3.16	3.23	3.31	3.42
65x65	7	13.7	4.45	17.5	66.8	1.96	14.4	2.83	3.14	3.21	3.29	3.42
60x60	8	14.2	4.23	18.1	58.4	1.80	13.8	2.52	2.82	2.90	2.97	3.10
	6	10.8	4.31	13.8	45.6	1.82	10.6	2.48	2.77	2.85	2.92	3.04
	5	9.14	4.36	11.6	38.8	1.82	8.90	2.45	2.74	2.81	2.89	3.01
50x50	6	8.94	3.55	11.4	25.6	1.50	7.22	2.09	2.38	2.46	2.54	2.66
	5	7.54	3.60	9.60	22.0	1.51	6.10	2.06	2.35	2.43	2.51	2.63
	4	6.12	3.64	7.78	17.9	1.52	4.92	2.04	2.32	2.40	2.48	2.60

Advance and UKA are trademarks of Corus. A fuller description of the relationship between Angles and the Advance range of sections manufactured by Corus is given on page A - 42.

+ These sections are in addition to the range of BS EN 10056-1 sections.

Properties about y-y axis:

I_y = (Total Area).$(r_y)^2$

$Z_y = I_y / (0.5B_o)$

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1: 2005
BS EN 10056-1: 1999

UK EUROCODES

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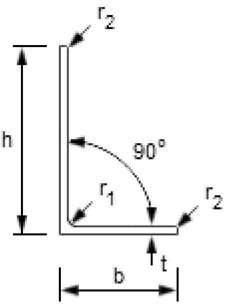
Table 2.1.6.1

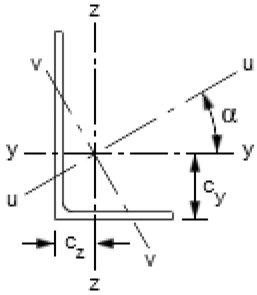
SECTION PROPERTIES

UNEQUAL ANGLES

Advance® UKA - Unqual

DIMENSIONS AND PROPERTIES





Section Designation		Mass per Metre	Radius		Dimension		Second Moment of Area				Radius of Gyration			
Size h x b	Thickness t		Root r_1	Toe r_2	c_y	c_z	Axis y-y	Axis z-z	Axis u-u	Axis v-v	Axis y-y	Axis z-z	Axis u-u	Axis v-v
mm	mm	kg/m	mm	mm	cm	cm	cm^4	cm^4	cm^4	cm^4	cm	cm	cm	cm
200 x 150	18 +	47.1	15.0	7.50	6.33	3.85	2380	1150	2920	623	6.29	4.37	6.97	3.22
	15	39.6	15.0	7.50	6.21	3.73	2020	979	2480	526	6.33	4.40	7.00	3.23
	12	32.0	15.0	7.50	6.08	3.61	1650	803	2030	430	6.36	4.44	7.04	3.25
200 x 100	15	33.8	15.0	7.50	7.16	2.22	1760	299	1860	193	6.40	2.64	6.59	2.12
	12	27.3	15.0	7.50	7.03	2.10	1440	247	1530	159	6.43	2.67	6.63	2.14
	10	23.0	15.0	7.50	6.93	2.01	1220	210	1290	135	6.46	2.68	6.65	2.15
150 x 90	15	33.9	12.0	6.00	5.21	2.23	761	205	841	126	4.74	2.46	4.98	1.93
	12	21.6	12.0	6.00	5.08	2.12	627	171	694	104	4.77	2.49	5.02	1.94
	10	18.2	12.0	6.00	5.00	2.04	533	146	591	88.3	4.80	2.51	5.05	1.95
150 x 75	15	24.8	12.0	6.00	5.52	1.81	713	119	753	78.6	4.75	1.94	4.88	1.58
	12	20.2	12.0	6.00	5.40	1.69	588	99.6	623	64.7	4.78	1.97	4.92	1.59
	10	17.0	12.0	6.00	5.31	1.61	501	85.6	531	55.1	4.81	1.99	4.95	1.60
125 x 75	12	17.8	11.0	5.50	4.31	1.84	354	95.5	391	58.5	3.95	2.05	4.15	1.61
	10	15.0	11.0	5.50	4.23	1.76	302	82.1	334	49.9	3.97	2.07	4.18	1.61
	8	12.2	11.0	5.50	4.14	1.68	247	67.6	274	40.9	4.00	2.09	4.21	1.63
100 x 75	12	15.4	10.0	5.00	3.27	2.03	189	90.2	230	49.5	3.10	2.14	3.42	1.59
	10	13.0	10.0	5.00	3.19	1.95	162	77.6	197	42.2	3.12	2.16	3.45	1.59
	8	10.6	10.0	5.00	3.10	1.87	133	64.1	162	34.6	3.14	2.18	3.47	1.60
100 x 65	10 +	12.3	10.0	5.00	3.36	1.63	154	51.0	175	30.1	3.14	1.81	3.35	1.39
	8 +	9.94	10.0	5.00	3.27	1.55	127	42.2	144	24.8	3.16	1.83	3.37	1.40
	7 +	8.77	10.0	5.00	3.23	1.51	113	37.6	128	22.0	3.17	1.83	3.39	1.40

Table 2.1.6.1. Advance® UKA - Unequal. Dimensions and Properties

BS EN 1993-1-1: 2005
BS EN 10056-1: 1999

UK EUROCODES

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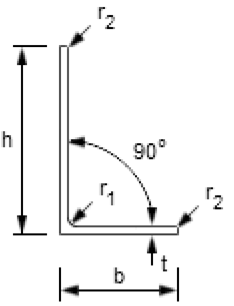
Table 2.1.6.2

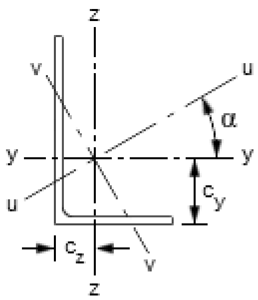
SECTION PROPERTIES

UNEQUAL ANGLES

Advance® UKA - Unqual

DIMENSIONS AND PROPERTIES





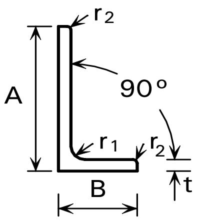
Section Designation Size h x b mm	Thickness t mm	Elastic Modulus Axis y-y cm^3	Elastic Modulus Axis z-z cm^3	Angle Axis y-y to Axis u-u Tan α	Torsional Constant I_T cm^4	Equivalent Slenderness Coefficient Min φ_a	Equivalent Slenderness Coefficient Max φ_a	Mono-symmetry Index ψ_a	Area of Section cm^2
200 x 150	18 +	174	103	0.549	67.9	2.93	3.72	4.60	60.0
	15	147	86.9	0.551	39.9	3.53	4.50	5.55	50.5
	12	119	70.5	0.552	20.9	4.43	5.70	6.97	40.8
200 x 100	15	137	38.5	0.260	34.3	3.54	5.17	9.19	43.0
	12	111	31.3	0.262	18.0	4.42	6.57	11.5	34.8
	10	93.2	26.3	0.263	10.66	5.26	7.92	13.9	29.2
150 x 90	15	77.7	30.4	0.354	26.8	2.58	3.59	5.96	33.9
	12	63.3	24.8	0.358	14.1	3.24	4.58	7.50	27.5
	10	53.3	21.0	0.360	8.30	3.89	5.56	9.03	23.2
150 x 75	15	75.2	21.0	0.253	25.1	2.62	3.74	6.84	31.7
	12	61.3	17.1	0.258	13.2	3.30	4.79	8.60	25.7
	10	51.6	14.5	0.261	7.80	3.95	5.83	10.4	21.7
125 x 75	12	43.2	16.9	0.354	11.6	2.66	3.73	6.23	22.7
	10	36.5	14.3	0.357	6.87	3.21	4.55	7.50	19.1
	8	29.6	11.6	0.360	3.62	4.00	5.75	9.43	15.5
100 x 75	12	28.0	16.5	0.540	10.05	2.10	2.64	3.46	19.7
	10	23.8	14.0	0.544	5.95	2.54	3.22	4.17	16.6
	8	19.3	11.4	0.547	3.13	3.18	4.08	5.24	13.5
100 x 65	10 +	23.2	10.5	0.410	5.61	2.52	3.43	5.45	15.6
	8 +	18.9	8.54	0.413	2.96	3.14	4.35	6.86	12.7
	7 +	16.6	7.53	0.415	2.02	3.58	5.00	7.85	11.2

Table 2.1.6.2. Advance® UKA - Unequal. Dimensions and Properties

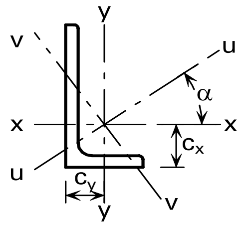
BS 5950-1: 2000
BS EN 10056-1: 1999

UNEQUAL ANGLES

Advance UKA - Unequal Angles



Dimensions and properties



Section Designation		Mass per	Radius		Dimension		Second Moment of Area				Radius of Gyration			
Size A x B mm	Thickness t mm	Metre kg/m	Root r_1 mm	Toe r_2 mm	c_x cm	c_y cm	Axis x-x cm^4	Axis y-y cm^4	Axis u-u cm^4	Axis v-v cm^4	Axis x-x cm	Axis y-y cm	Axis u-u cm	Axis v-v cm
200x150	18 +	47.1	15.0	7.50	6.33	3.85	2380	1150	2920	623	6.29	4.37	6.97	3.22
	15	39.6	15.0	7.50	6.21	3.73	2020	979	2480	526	6.33	4.40	7.00	3.23
	12	32.0	15.0	7.50	6.08	3.61	1650	803	2030	430	6.36	4.44	7.04	3.25
200x100	15	33.8	15.0	7.50	7.16	2.22	1760	299	1860	193	6.40	2.64	6.59	2.12
	12	27.3	15.0	7.50	7.03	2.10	1440	247	1530	159	6.43	2.67	6.63	2.14
	10	23.0	15.0	7.50	6.93	2.01	1220	210	1290	135	6.46	2.68	6.65	2.15
150x90	15	33.9	12.0	6.00	5.21	2.23	761	205	841	126	4.74	2.46	4.98	1.93
	12	21.6	12.0	6.00	5.08	2.12	627	171	694	104	4.77	2.49	5.02	1.94
	10	18.2	12.0	6.00	5.00	2.04	533	146	591	88.3	4.80	2.51	5.05	1.95
150x75	15	24.8	12.0	6.00	5.52	1.81	713	119	753	78.6	4.75	1.94	4.88	1.58
	12	20.2	12.0	6.00	5.40	1.69	588	99.6	623	64.7	4.78	1.97	4.92	1.59
	10	17.0	12.0	6.00	5.31	1.61	501	85.6	531	55.1	4.81	1.99	4.95	1.60
125x75	12	17.8	11.0	5.50	4.31	1.84	354	95.5	391	58.5	3.95	2.05	4.15	1.61
	10	15.0	11.0	5.50	4.23	1.76	302	82.1	334	49.9	3.97	2.07	4.18	1.61
	8	12.2	11.0	5.50	4.14	1.68	247	67.6	274	40.9	4.00	2.09	4.21	1.63
100x75	12	15.4	10.0	5.00	3.27	2.03	189	90.2	230	49.5	3.10	2.14	3.42	1.59
	10	13.0	10.0	5.00	3.19	1.95	162	77.6	197	42.2	3.12	2.16	3.45	1.59
	8	10.6	10.0	5.00	3.10	1.87	133	64.1	162	34.6	3.14	2.18	3.47	1.60
100x65	10 +	12.3	10.0	5.00	3.36	1.63	154	51.0	175	30.1	3.14	1.81	3.35	1.39
	8 +	9.94	10.0	5.00	3.27	1.55	127	42.2	144	24.8	3.16	1.83	3.37	1.40
	7 +	8.77	10.0	5.00	3.23	1.51	113	37.6	128	22.0	3.17	1.83	3.39	1.40
100x50	8	8.97	8.00	4.00	3.60	1.13	116	19.7	123	12.8	3.19	1.31	3.28	1.06
	6	6.84	8.00	4.00	3.51	1.05	89.9	15.4	95.4	9.92	3.21	1.33	3.31	1.07
80x60	7	7.36	8.00	4.00	2.51	1.52	59.0	28.4	72.0	15.4	2.51	1.74	2.77	1.28
80x40	8	7.07	7.00	3.50	2.94	0.963	57.6	9.61	60.9	6.34	2.53	1.03	2.60	0.838
	6	5.41	7.00	3.50	2.85	0.884	44.9	7.59	47.6	4.93	2.55	1.05	2.63	0.845
75x50	8	7.39	7.00	3.50	2.52	1.29	52.0	18.4	59.6	10.8	2.35	1.40	2.52	1.07
	6	5.65	7.00	3.50	2.44	1.21	40.5	14.4	46.6	8.36	2.37	1.42	2.55	1.08
70x50	6	5.41	7.00	3.50	2.23	1.25	33.4	14.2	39.7	7.92	2.20	1.43	2.40	1.07
65x50	5	4.35	6.00	3.00	1.99	1.25	23.2	11.9	28.8	6.32	2.05	1.47	2.28	1.07
60x40	6	4.46	6.00	3.00	2.00	1.01	20.1	7.12	23.1	4.16	1.88	1.12	2.02	0.855
	5	3.76	6.00	3.00	1.96	0.972	17.2	6.11	19.7	3.54	1.89	1.13	2.03	0.860
60x30	5	3.36	5.00	2.50	2.17	0.684	15.6	2.63	16.5	1.71	1.91	0.784	1.97	0.633
50x30	5	2.96	5.00	2.50	1.73	0.741	9.36	2.51	10.3	1.54	1.57	0.816	1.65	0.639
45x30	4	2.25	4.50	2.25	1.48	0.740	5.78	2.05	6.65	1.18	1.42	0.850	1.52	0.640
40x25	4	1.93	4.00	2.00	1.36	0.623	3.89	1.16	4.35	0.700	1.26	0.687	1.33	0.534
40x20	4	1.77	4.00	2.00	1.47	0.480	3.59	0.600	3.80	0.393	1.26	0.514	1.30	0.417
30x20	4	1.46	4.00	2.00	1.03	0.541	1.59	0.553	1.81	0.330	0.925	0.546	0.988	0.421
	3	1.12	4.00	2.00	0.990	0.502	1.25	0.437	1.43	0.256	0.935	0.553	1.00	0.424

Advance and UKA are trademarks of Corus. A fuller description of the relationship between Angles and the Advance range of sections manufactured by Corus is given on page A - 42.

+ These sections are in addition to the range of BS EN 10056-1 sections.

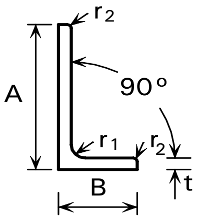
c_x is the distance from the back of the short leg to the centre of gravity.

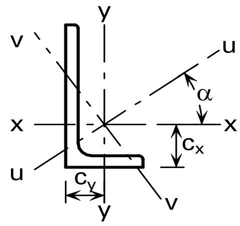
c_y is the distance from the back of the long leg to the centre of gravity.

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

UNEQUAL ANGLES

Advance UKA - Unequal Angles





Dimensions and properties (continued)

Section Designation		Elastic Modulus		Angle Axis x-x to Axis u-u Tan α	Torsional Constant	Equivalent Slenderness Coefficient		Mono-symmetry Index	Area of Section
Size A x B mm	Thickness t mm	Axis x-x cm³	Axis y-y cm³		J cm⁴	Min ϕ_a	Max ϕ_a	ψ_a	cm²
200x150	18 +	174	103	0.549	67.9	2.93	3.72	4.60	60.0
	15	147	86.9	0.551	39.9	3.53	4.50	5.55	50.5
	12	119	70.5	0.552	20.9	4.43	5.70	6.97	40.8
200x100	15	137	38.5	0.260	34.3	3.54	5.17	9.19	43.0
	12	111	31.3	0.262	18.0	4.42	6.57	11.5	34.8
	10	93.2	26.3	0.263	10.66	5.26	7.92	13.9	29.2
150x90	15	77.7	30.4	0.354	26.8	2.58	3.59	5.96	33.9
	12	63.3	24.8	0.358	14.1	3.24	4.58	7.50	27.5
	10	53.3	21.0	0.360	8.30	3.89	5.56	9.03	23.2
150x75	15	75.2	21.0	0.253	25.1	2.62	3.74	6.84	31.7
	12	61.3	17.1	0.258	13.2	3.30	4.79	8.60	25.7
	10	51.6	14.5	0.261	7.80	3.95	5.83	10.4	21.7
125x75	12	43.2	16.9	0.354	11.6	2.66	3.73	6.23	22.7
	10	36.5	14.3	0.357	6.87	3.21	4.55	7.50	19.1
	8	29.6	11.6	0.360	3.62	4.00	5.75	9.43	15.5
100x75	12	28.0	16.5	0.540	10.05	2.10	2.64	3.46	19.7
	10	23.8	14.0	0.544	5.95	2.54	3.22	4.17	16.6
	8	19.3	11.4	0.547	3.13	3.18	4.08	5.24	13.5
100x65	10 +	23.2	10.5	0.410	5.61	2.52	3.43	5.45	15.6
	8 +	18.9	8.54	0.413	2.96	3.14	4.35	6.86	12.7
	7 +	16.6	7.53	0.415	2.02	3.58	5.00	7.85	11.2
100x50	8	18.2	5.08	0.258	2.61	3.30	4.80	8.61	11.4
	6	13.8	3.89	0.262	1.14	4.38	6.52	11.6	8.71
80x60	7	10.7	6.34	0.546	1.66	2.92	3.72	4.78	9.38
80x40	8	11.4	3.16	0.253	2.05	2.61	3.73	6.85	9.01
	6	8.73	2.44	0.258	0.899	3.48	5.12	9.22	6.89
75x50	8	10.4	4.95	0.430	2.14	2.36	3.18	4.92	9.41
	6	8.01	3.81	0.435	0.935	3.18	4.34	6.60	7.19
70x50	6	7.01	3.78	0.500	0.899	2.96	3.89	5.44	6.89
65x50	5	5.14	3.19	0.577	0.498	3.38	4.26	5.08	5.54
60x40	6	5.03	2.38	0.431	0.735	2.51	3.39	5.26	5.68
	5	4.25	2.02	0.434	0.435	3.02	4.11	6.34	4.79
60x30	5	4.07	1.14	0.257	0.382	3.15	4.56	8.26	4.28
50x30	5	2.86	1.11	0.352	0.340	2.51	3.52	5.99	3.78
45x30	4	1.91	0.910	0.436	0.166	2.85	3.87	5.92	2.87
40x25	4	1.47	0.619	0.380	0.142	2.51	3.48	5.75	2.46
40x20	4	1.42	0.393	0.252	0.131	2.57	3.68	6.86	2.26
30x20	4	0.807	0.379	0.421	0.1096	1.79	2.39	3.95	1.86
	3	0.621	0.292	0.427	0.0486	2.40	3.28	5.31	1.43

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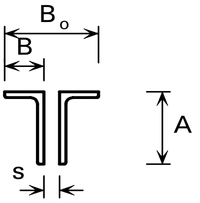
+ These sections are in addition to the range of BS EN 10056-1 sections.

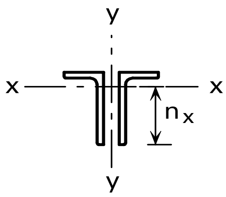
FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS 5950-1: 2000
BS EN 10056-1: 1999

UNEQUAL ANGLES BACK TO BACK

Advance UKA - Unequal Angles BACK TO BACK





Dimensions and properties

Composed of Two Angles		Total Mass per Metre	Distance	Total Area	Properties about Axis x-x			Radius of Gyration r_y about Axis y-y (cm)				
A x B	t		n_x		I_x	r_x	Z_x	Space between angles, s, (mm)				
mm	mm	kg/m	cm	cm^2	cm^4	cm	cm^3	0	8	10	12	15
200x150	18 +	94.2	13.7	120	4750	6.29	348	5.84	6.11	6.18	6.25	6.36
	15	79.2	13.8	101	4040	6.33	294	5.77	6.04	6.11	6.18	6.28
	12	64.0	13.9	81.6	3300	6.36	238	5.72	5.98	6.05	6.12	6.22
200x100	15	67.5	12.8	86.0	3520	6.40	274	3.45	3.72	3.79	3.86	3.97
	12	54.6	13.0	69.6	2880	6.43	222	3.39	3.65	3.72	3.79	3.90
	10	46.0	13.1	58.4	2440	6.46	186	3.35	3.61	3.67	3.74	3.85
150x90	15	53.2	9.79	67.8	1522	4.74	155	3.32	3.60	3.67	3.75	3.86
	12	43.2	9.92	55.0	1250	4.77	127	3.27	3.55	3.62	3.69	3.80
	10	36.4	10.0	46.4	1070	4.80	107	3.23	3.50	3.57	3.64	3.75
150x75	15	49.6	9.48	63.4	1430	4.75	150	2.65	2.94	3.01	3.09	3.21
	12	40.4	9.60	51.4	1180	4.78	123	2.59	2.87	2.94	3.02	3.14
	10	34.0	9.69	43.4	1000	4.81	103	2.56	2.83	2.90	2.97	3.08
125x75	12	35.6	8.19	45.4	708	3.95	86.4	2.76	3.04	3.11	3.19	3.30
	10	30.0	8.27	38.2	604	3.97	73.0	2.72	2.99	3.07	3.14	3.26
	8	24.4	8.36	31.0	494	4.00	59.2	2.68	2.95	3.02	3.09	3.20
100x75	12	30.8	6.73	39.4	378	3.10	56.0	2.95	3.24	3.31	3.39	3.51
	10	26.0	6.81	33.2	324	3.12	47.6	2.91	3.19	3.27	3.34	3.46
	8	21.2	6.90	27.0	266	3.14	38.6	2.87	3.15	3.22	3.29	3.41
100x65	10 +	24.6	6.64	31.2	308	3.14	46.4	2.43	2.72	2.79	2.87	2.99
	8 +	19.9	6.73	25.4	254	3.16	37.8	2.39	2.67	2.74	2.82	2.93
	7 +	17.5	6.77	22.4	226	3.17	33.2	2.37	2.65	2.72	2.79	2.91
100x50	8	17.9	6.40	22.8	232	3.19	36.4	1.73	2.02	2.09	2.17	2.29
	6	13.7	6.49	17.4	180	3.21	27.6	1.69	1.97	2.04	2.12	2.24
80x60	7	14.7	5.49	18.8	118	2.51	21.4	2.31	2.59	2.67	2.74	2.86
80x40	8	14.1	5.06	18.0	115	2.53	22.8	1.41	1.71	1.79	1.87	2.00
	6	10.8	5.15	13.8	89.8	2.55	17.5	1.37	1.66	1.74	1.82	1.94
75x50	8	14.8	4.98	18.8	104	2.35	20.8	1.90	2.19	2.27	2.35	2.47
	6	11.3	5.06	14.4	81.0	2.37	16.0	1.86	2.14	2.22	2.30	2.42
70x50	6	10.8	4.77	13.8	66.8	2.20	14.0	1.90	2.19	2.26	2.34	2.46
65x50	5	8.70	4.51	11.1	46.4	2.05	10.3	1.93	2.21	2.28	2.36	2.48
60x40	6	8.92	4.00	11.4	40.2	1.88	10.1	1.51	1.80	1.88	1.96	2.09
	5	7.52	4.04	9.58	34.4	1.89	8.50	1.49	1.78	1.86	1.94	2.06

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+ These sections are in addition to the range of BS EN 10056-1 sections.

Properties about y-y axis:

I_y = (Total Area).$(r_y)^2$

$Z_y = I_y / (0.5B_o)$

FOR EXPLANATION OF TABLES SEE NOTES 2 AND 3

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

B-44

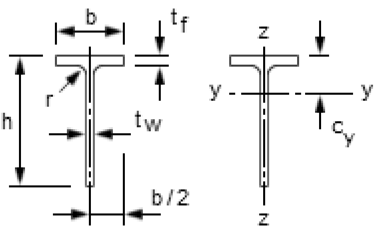
Table 2.1.7.1

SECTION PROPERTIES

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS

UKT Split from Advance® UKB

DIMENSIONS AND PROPERTIES



Section Designation	Cut from Universal Beam Section Designation	Mass per Metre (kg/m)	Width of Section b (mm)	Depth of Section h (mm)	Thickness Web t_w (mm)	Thickness Flange t_f (mm)	Root Radius r (mm)	Ratios for Local Buckling Flange c_f / t_f	Ratios for Local Buckling Web c_w / t_w	Dimension c_y (cm)	Second Moment of Area Axis y-y (cm^4)	Second Moment of Area Axis z-z (cm^4)
254 x 343 x 63	686 x 254 x 125	62.6	253.0	338.9	11.7	16.2	15.2	6.51	29.0	8.85	8980	2190
305 x 305 x 119	610 x 305 x 238	119.0	311.4	317.9	18.4	31.4	16.5	4.14	17.3	7.11	12400	7920
305 x 305 x 90	610 x 305 x 179	89.5	307.1	310.0	14.1	23.6	16.5	5.51	22.0	6.69	9040	5700
305 x 305 x 75	610 x 305 x 149	74.6	304.8	306.1	11.8	19.7	16.5	6.60	25.9	6.45	7410	4650
229 x 305 x 70	610 x 229 x 140	69.9	230.2	308.5	13.1	22.1	12.7	4.34	23.5	7.61	7740	2250
229 x 305 x 63	610 x 229 x 125	62.5	229.0	306.0	11.9	19.6	12.7	4.89	25.7	7.54	6900	1970
229 x 305 x 57	610 x 229 x 113	56.5	228.2	303.7	11.1	17.3	12.7	5.54	27.4	7.58	6270	1720
229 x 305 x 51	610 x 229 x 101	50.6	227.6	301.2	10.5	14.8	12.7	6.48	28.7	7.78	5690	1460
178 x 305 x 50 +	610 x 178 x 100	50.1	179.2	303.7	11.3	17.2	12.7	4.14	26.9	8.57	5890	829
178 x 305 x 46 +	610 x 178 x 92	46.1	178.8	301.5	10.9	15.0	12.7	4.75	27.7	8.78	5450	718
178 x 305 x 41 +	610 x 178 x 82	40.9	177.9	299.3	10.0	12.8	12.7	5.57	29.9	8.88	4840	603
312 x 267 x 136 +	533 x 312 x 272	136.6	320.2	288.8	21.1	37.6	12.7	3.64	13.7	6.28	10600	10300
312 x 267 x 110 +	533 x 312 x 219	109.4	317.4	280.4	18.3	29.2	12.7	4.69	15.3	6.09	8530	7790
312 x 267 x 91 +	533 x 312 x 182	90.7	314.5	275.6	15.2	24.4	12.7	5.61	18.1	5.78	6890	6330
312 x 267 x 75 +	533 x 312 x 151	75.3	312.0	271.5	12.7	20.3	12.7	6.75	21.4	5.54	5620	5140
210 x 267 x 69 +	533 x 210 x 138	69.1	213.9	274.5	14.7	23.6	12.7	3.68	18.7	6.94	5990	1930
210 x 267 x 61	533 x 210 x 122	61.0	211.9	272.2	12.7	21.3	12.7	4.08	21.4	6.66	5160	1690
210 x 267 x 55	533 x 210 x 109	54.5	210.8	269.7	11.6	18.8	12.7	4.62	23.3	6.61	4600	1470
210 x 267 x 51	533 x 210 x 101	50.5	210.0	268.3	10.8	17.4	12.7	4.99	24.8	6.53	4250	1350
210 x 267 x 46	533 x 210 x 92	46.0	209.3	266.5	10.1	15.6	12.7	5.57	26.4	6.55	3880	1190
210 x 267 x 41	533 x 210 x 82	41.1	208.8	264.1	9.6	13.2	12.7	6.58	27.5	6.75	3530	1000
165 x 267 x 43 +	533 x 165 x 85	42.3	166.5	267.1	10.3	16.5	12.7	3.96	25.9	7.23	3750	637
165 x 267 x 37 +	533 x 165 x 75	37.3	165.9	264.5	9.7	13.6	12.7	4.81	27.3	7.46	3350	520
165 x 267 x 33 +	533 x 165 x 66	32.8	165.1	262.4	8.9	11.4	12.7	5.74	29.5	7.59	2960	429
191 x 229 x 81 +	457 x 191 x 161	80.7	199.4	246.0	18.0	32.0	10.2	2.52	13.7	6.22	5160	2130
191 x 229 x 67 +	457 x 191 x 133	66.6	196.7	240.3	15.3	26.3	10.2	3.06	15.7	5.96	4180	1670
191 x 229 x 53 +	457 x 191 x 106	52.9	194.0	234.6	12.6	20.6	10.2	3.91	18.6	5.73	3260	1260
191 x 229 x 49	457 x 191 x 98	49.1	192.8	233.5	11.4	19.6	10.2	4.11	20.5	5.53	2970	1170
191 x 229 x 45	457 x 191 x 89	44.6	191.9	231.6	10.5	17.7	10.2	4.55	22.1	5.47	2680	1040
191 x 229 x 41	457 x 191 x 82	41.0	191.3	229.9	9.9	16.0	10.2	5.03	23.2	5.47	2470	935
191 x 229 x 37	457 x 191 x 74	37.1	190.4	228.4	9.0	14.5	10.2	5.55	25.4	5.38	2220	836
191 x 229 x 34	457 x 191 x 67	33.5	189.9	226.6	8.5	12.7	10.2	6.34	26.7	5.46	2030	726
152 x 229 x 41	457 x 152 x 82	41.0	155.3	232.8	10.5	18.9	10.2	3.29	22.2	5.96	2600	592
152 x 229 x 37	457 x 152 x 74	37.1	154.4	230.9	9.6	17.0	10.2	3.66	24.1	5.88	2330	523
152 x 229 x 34	457 x 152 x 67	33.6	153.8	228.9	9.0	15.0	10.2	4.15	25.4	5.91	2120	456
152 x 229 x 30	457 x 152 x 60	29.9	152.9	227.2	8.1	13.3	10.2	4.68	28.0	5.84	1880	397
152 x 229 x 26	457 x 152 x 52	26.1	152.4	224.8	7.6	10.9	10.2	5.71	29.6	6.04	1670	322

Table 2.1.7.1. UKT Split from Advance® UKC. Dimensions and Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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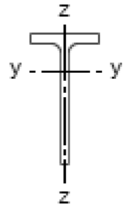
Table 2.1.7.2

SECTION PROPERTIES

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS

UKT Split from Advance® UKB

PROPERTIES



Section Designation	Radius of Gyration		Elastic Modulus			Plastic Modulus		Buckling Parameter	Torsional Index	Mono-symmetry Index	Warping Constant (*)	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y Flange	Axis y-y Toe	Axis z-z	Axis y-y	Axis z-z	U	X	Ψ	I_w	I_T	A
	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^3				cm^6	cm^4	cm^2
254 x 343 x 63	10.6	5.24	1010	358	173	643	271	0.651	21.9	0.740	2090	57.9	79.7
305 x 305 x 119	9.03	7.23	1740	501	509	894	787	0.483	10.6	0.662	11300	391	152
305 x 305 x 90	8.91	7.07	1350	372	371	656	572	0.484	13.8	0.664	4710	170	114
305 x 305 x 75	8.83	7.00	1150	307	305	538	469	0.483	16.4	0.666	2690	99.8	95.0
229 x 305 x 70	9.32	5.03	1020	333	196	592	306	0.613	15.3	0.727	2560	108	89.1
229 x 305 x 63	9.31	4.97	915	299	172	531	268	0.617	17.1	0.728	1840	76.9	79.7
229 x 305 x 57	9.33	4.88	826	275	150	489	235	0.626	19.0	0.731	1400	55.5	72.0
229 x 305 x 51	9.40	4.76	732	255	128	456	200	0.644	21.6	0.736	1080	38.3	64.4
178 x 305 x 50 +	9.60	3.60	688	270	92.5	490	148	0.694	19.4	0.768	1230	47.3	63.9
178 x 305 x 46 +	9.64	3.50	621	255	80.3	468	129	0.710	21.5	0.774	1050	35.3	58.7
178 x 305 x 41 +	9.64	3.40	545	230	67.8	425	109	0.722	24.3	0.778	780	24.3	52.1
312 x 267 x 136 +	7.81	7.69	1690	469	644	857	993	0.247	7.96	0.613	17300	642	174
312 x 267 x 110 +	7.82	7.48	1400	389	491	696	757	0.332	9.93	0.617	8730	320	139
312 x 267 x 91 +	7.72	7.40	1190	317	403	562	619	0.324	11.7	0.618	4920	186	116
312 x 267 x 75 +	7.65	7.32	1010	260	330	458	505	0.326	14.0	0.619	2780	108	95.9
210 x 267 x 69 +	8.24	4.68	862	292	181	520	284	0.609	12.5	0.719	2490	125	88.1
210 x 267 x 61	8.15	4.67	775	251	160	446	250	0.600	13.8	0.719	1660	88.9	77.7
210 x 267 x 55	8.14	4.60	697	226	140	401	218	0.605	15.5	0.721	1200	63.0	69.4
210 x 267 x 51	8.12	4.57	650	209	128	371	200	0.606	16.6	0.722	951	50.3	64.3
210 x 267 x 46	8.14	4.51	593	193	114	343	178	0.613	18.3	0.724	737	37.7	58.7
210 x 267 x 41	8.21	4.38	523	179	96.1	320	150	0.634	20.8	0.730	565	25.7	52.3
165 x 267 x 43 +	8.34	3.44	519	192	76.6	346	122	0.672	17.7	0.758	670	36.8	54.0
165 x 267 x 37 +	8.39	3.30	449	176	62.7	321	100	0.693	20.6	0.765	514	23.9	47.6
165 x 267 x 33 +	8.41	3.20	390	159	52.0	291	83.1	0.708	23.6	0.771	378	15.9	41.9
191 x 229 x 81 +	7.09	4.55	830	281	213	507	336	0.573	8.24	0.699	3780	256	103
191 x 229 x 67 +	7.01	4.44	702	231	170	414	267	0.576	9.82	0.702	2130	146	84.9
191 x 229 x 53 +	6.96	4.32	569	184	130	328	203	0.583	12.2	0.706	1070	72.6	67.4
191 x 229 x 49	6.88	4.33	536	167	122	296	189	0.573	12.9	0.705	835	60.5	62.6
191 x 229 x 45	6.87	4.29	491	152	109	269	169	0.576	14.1	0.706	628	45.2	56.9
191 x 229 x 41	6.88	4.23	452	141	97.8	250	152	0.583	15.5	0.709	494	34.5	52.2
191 x 229 x 37	6.86	4.20	413	127	87.8	225	136	0.583	16.9	0.709	365	25.8	47.3
191 x 229 x 34	6.90	4.12	372	118	76.5	209	119	0.597	18.9	0.713	280	18.5	42.7
152 x 229 x 41	7.05	3.37	436	150	76.3	267	120	0.634	13.7	0.740	534	44.5	52.3
152 x 229 x 37	7.03	3.33	397	135	67.8	242	107	0.636	15.1	0.742	396	32.9	47.2
152 x 229 x 34	7.04	3.27	359	125	59.3	223	93.3	0.646	16.8	0.745	305	23.8	42.8
152 x 229 x 30	7.02	3.23	322	111	52.0	199	81.5	0.648	18.8	0.746	217	16.9	38.1
152 x 229 x 26	7.08	3.11	276	102	42.3	183	66.6	0.671	22.0	0.753	161	10.7	33.3

Table 2.1.7.2. UKT Split from Advance® UKC. Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

B-46

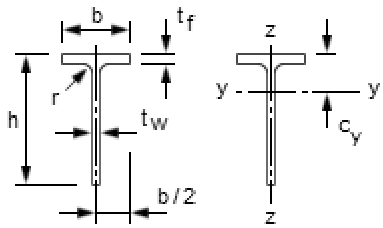
Table 2.1.7.3

SECTION PROPERTIES

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS

UKT Split from Advance® UKB

DIMENSIONS AND PROPERTIES



Section Designation	Cut from Universal Beam Section Designation	Mass per Metre	Width of Section	Depth of Section	Thickness		Root Radius	Ratios for Local Buckling		Dimension	Second Moment of Area	
					Web	Flange		Flange	Web		Axis y-y	Axis z-z
			b	h	t_w	t_f	r	c_f / t_f	c_w / t_w	c_y		
		kg/m	mm	mm	mm	mm	mm			cm	cm^4	cm^4
178 x 203 x 43 +	406 x 178 x 85	42.6	181.9	208.6	10.9	18.2	10.2	4.14	19.1	4.91	2030	915
178 x 203 x 37	406 x 178 x 74	37.1	179.5	206.3	9.5	16.0	10.2	4.68	21.7	4.76	1740	773
178 x 203 x 34	406 x 178 x 67	33.5	178.8	204.6	8.8	14.3	10.2	5.23	23.3	4.73	1570	682
178 x 203 x 30	406 x 178 x 60	30.0	177.9	203.1	7.9	12.8	10.2	5.84	25.7	4.64	1400	602
178 x 203 x 27	406 x 178 x 54	27.0	177.7	201.2	7.7	10.9	10.2	6.86	26.1	4.83	1290	511
140 x 203 x 27 +	406 x 140 x 53	26.6	143.3	203.3	7.9	12.9	10.2	4.46	25.7	5.16	1320	317
140 x 203 x 23	406 x 140 x 46	23.0	142.2	201.5	6.8	11.2	10.2	5.13	29.6	5.02	1120	269
140 x 203 x 20	406 x 140 x 39	19.5	141.8	198.9	6.4	8.6	10.2	6.69	31.1	5.32	979	205
171 x 178 x 34	356 x 171 x 67	33.5	173.2	181.6	9.1	15.7	10.2	4.58	20.0	4.00	1150	681
171 x 178 x 29	356 x 171 x 57	28.5	172.2	178.9	8.1	13.0	10.2	5.53	22.1	3.97	986	554
171 x 178 x 26	356 x 171 x 51	25.5	171.5	177.4	7.4	11.5	10.2	6.25	24.0	3.94	882	484
171 x 178 x 23	356 x 171 x 45	22.5	171.1	175.6	7.0	9.7	10.2	7.41	25.1	4.05	798	406
127 x 178 x 20	356 x 127 x 39	19.5	126.0	176.6	6.6	10.7	10.2	4.63	26.8	4.43	728	179
127 x 178 x 17	356 x 127 x 33	16.5	125.4	174.4	6.0	8.5	10.2	5.82	29.1	4.56	626	140
165 x 152 x 27	305 x 165 x 54	27.0	166.9	155.1	7.9	13.7	8.9	5.15	19.6	3.21	642	531
165 x 152 x 23	305 x 165 x 46	23.0	165.7	153.2	6.7	11.8	8.9	5.98	22.9	3.07	536	448
165 x 152 x 20	305 x 165 x 40	20.1	165.0	151.6	6.0	10.2	8.9	6.92	25.3	3.03	468	382
127 x 152 x 24	305 x 127 x 48	24.0	125.3	155.4	9.0	14.0	8.9	3.52	17.3	3.94	662	231
127 x 152 x 21	305 x 127 x 42	20.9	124.3	153.5	8.0	12.1	8.9	4.07	19.2	3.87	573	194
127 x 152 x 19	305 x 127 x 37	18.5	123.4	152.1	7.1	10.7	8.9	4.60	21.4	3.78	501	168
102 x 152 x 17	305 x 102 x 33	16.4	102.4	156.3	6.6	10.8	7.6	3.73	23.7	4.14	487	97.1
102 x 152 x 14	305 x 102 x 28	14.1	101.8	154.3	6.0	8.8	7.6	4.58	25.7	4.20	420	77.7
102 x 152 x 13	305 x 102 x 25	12.4	101.6	152.5	5.8	7.0	7.6	5.76	26.3	4.43	377	61.5
146 x 127 x 22	254 x 146 x 43	21.5	147.3	129.7	7.2	12.7	7.6	4.92	18.0	2.64	343	339
146 x 127 x 19	254 x 146 x 37	18.5	146.4	127.9	6.3	10.9	7.6	5.73	20.3	2.55	292	285
146 x 127 x 16	254 x 146 x 31	15.5	146.1	125.6	6.0	8.6	7.6	7.26	20.9	2.66	259	224
102 x 127 x 14	254 x 102 x 28	14.1	102.2	130.1	6.3	10.0	7.6	4.04	20.7	3.24	277	89.3
102 x 127 x 13	254 x 102 x 25	12.6	101.9	128.5	6.0	8.4	7.6	4.80	21.4	3.32	250	74.3
102 x 127 x 11	254 x 102 x 22	11.0	101.6	126.9	5.7	6.8	7.6	5.93	22.3	3.45	223	59.7
133 x 102 x 15	203 x 133 x 30	15.0	133.9	103.3	6.4	9.6	7.6	5.85	16.1	2.11	154	192
133 x 102 x 13	203 x 133 x 25	12.5	133.2	101.5	5.7	7.8	7.6	7.20	17.8	2.10	131	154

Table 2.1.7.3. UKT Split from Advance® UKC. Dimensions and Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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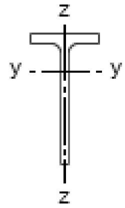
Table 2.1.7.4

SECTION PROPERTIES

STRUCTURAL TEES CUT FROM UNIVERSAL BEAMS

UKT Split from Advance® UKB

PROPERTIES



Section Designation	Radius of Gyration		Elastic Modulus			Plastic Modulus		Buckling Parameter	Torsional Index	Mono-symmetry Index	Warping Constant (*)	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y Flange	Axis y-y Toe	Axis z-z	Axis y-y	Axis z-z	U	X	Ψ	I_w	I_T	A
	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^3				cm^6	cm^4	cm^2
178 x 203 x 43 +	6.11	4.11	413	127	101	226	157	0.556	12.2	0.694	538	46.3	54.3
178 x 203 x 37	6.06	4.04	365	109	86.1	194	133	0.555	13.8	0.696	350	31.3	47.2
178 x 203 x 34	6.07	3.99	332	100	76.3	177	118	0.561	15.2	0.698	262	23.0	42.8
178 x 203 x 30	6.04	3.97	301	89.0	67.6	157	104	0.561	16.9	0.699	186	16.6	38.3
178 x 203 x 27	6.13	3.85	268	84.6	57.5	150	89.1	0.588	19.2	0.705	146	11.5	34.5
140 x 203 x 27 +	6.23	3.06	256	87.0	44.3	155	69.5	0.636	17.1	0.739	148	14.4	34.0
140 x 203 x 23	6.19	3.03	224	74.2	37.8	132	59.0	0.633	19.5	0.740	93.7	9.49	29.3
140 x 203 x 20	6.28	2.87	184	67.2	28.9	121	45.4	0.668	23.8	0.750	66.3	5.33	24.8
171 x 178 x 34	5.20	3.99	288	81.5	78.6	145	121	0.500	12.2	0.672	249	27.8	42.7
171 x 178 x 29	5.21	3.91	248	70.9	64.4	125	99.4	0.514	14.4	0.676	154	16.6	36.3
171 x 178 x 26	5.21	3.86	224	63.9	56.5	113	87.1	0.521	16.1	0.677	110	11.9	32.4
171 x 178 x 23	5.28	3.76	197	59.1	47.4	104	73.3	0.546	18.4	0.683	79.2	7.90	28.7
127 x 178 x 20	5.41	2.68	164	55.0	28.4	98.0	44.5	0.632	17.6	0.739	57.1	7.53	24.9
127 x 178 x 17	5.45	2.58	137	48.6	22.3	87.2	35.1	0.655	21.1	0.746	38.0	4.38	21.1
165 x 152 x 27	4.32	3.93	200	52.2	63.7	92.8	97.8	0.389	11.8	0.636	128	17.3	34.4
165 x 152 x 23	4.27	3.91	174	43.7	54.1	77.1	82.8	0.380	13.6	0.636	78.6	11.1	29.4
165 x 152 x 20	4.27	3.86	155	38.6	46.3	67.6	70.9	0.393	15.5	0.638	52.0	7.35	25.7
127 x 152 x 24	4.65	2.74	168	57.1	36.8	102	58.0	0.602	11.7	0.714	104	15.8	30.6
127 x 152 x 21	4.63	2.70	148	49.9	31.3	88.9	49.2	0.606	13.3	0.716	69.2	10.5	26.7
127 x 152 x 19	4.61	2.67	132	43.8	27.2	77.9	42.7	0.606	14.9	0.718	47.4	7.36	23.6
102 x 152 x 17	4.82	2.15	118	42.3	19.0	75.8	30.0	0.656	15.8	0.749	36.8	6.08	20.9
102 x 152 x 14	4.84	2.08	100.0	37.4	15.3	67.5	24.2	0.673	18.7	0.756	25.2	3.69	17.9
102 x 152 x 13	4.88	1.97	85.0	34.8	12.1	63.9	19.4	0.705	21.8	0.766	20.4	2.37	15.8
146 x 127 x 22	3.54	3.52	130	33.2	46.0	59.5	70.5	0.202	10.6	0.613	64.9	11.9	27.4
146 x 127 x 19	3.52	3.48	115	28.5	39.0	50.7	59.7	0.233	12.2	0.616	41.0	7.65	23.6
146 x 127 x 16	3.61	3.36	97.4	26.2	30.6	46.0	47.1	0.376	14.8	0.623	24.5	4.26	19.8
102 x 127 x 14	3.92	2.22	85.5	28.3	17.5	50.4	27.4	0.607	13.8	0.720	21.0	4.77	18.0
102 x 127 x 13	3.95	2.15	75.3	26.2	14.6	46.9	23.0	0.628	15.8	0.727	15.9	3.20	16.0
102 x 127 x 11	3.99	2.06	64.5	24.1	11.7	43.5	18.6	0.656	18.2	0.736	12.0	2.06	14.0
133 x 102 x 15	2.84	3.17	73.1	18.8	28.7	33.5	44.1	-	-	0.569	21.7	5.13	19.1
133 x 102 x 13	2.86	3.10	62.4	16.2	23.1	28.7	35.5	-	-	0.572	12.6	2.97	16.0

Table 2.1.7.4. UKT Split from Advance® UKC. Properties

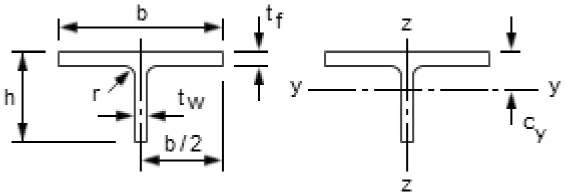
UK EUROCODES

SECTION PROPERTIES

STRUCTURAL TEES CUT FROM UNIVERSAL COLUMNS

UKT Split from Advance® UKC

DIMENSIONS AND PROPERTIES



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Section Designation	Cut from Universal Column Section Designation	Mass per Metre	Width of Section	Depth of Section	Thickness		Root Radius	Ratios for Local Buckling		Dimension
					Web	Flange		Flange	Web	
			b	h	t_w	t_f	r	c_f / t_f	c_w / t_w	c_y
		kg/m	mm	mm	mm	mm	mm			cm
305 x 152 x 79	305 x 305 x 158	79.0	311.2	163.5	15.8	25.0	15.2	5.30	10.3	3.04
305 x 152 x 69	305 x 305 x 137	68.4	309.2	160.2	13.8	21.7	15.2	6.11	11.6	2.86
305 x 152 x 59	305 x 305 x 118	58.9	307.4	157.2	12.0	18.7	15.2	7.09	13.1	2.69
305 x 152 x 49	305 x 305 x 97	48.4	305.3	153.9	9.9	15.4	15.2	8.60	15.5	2.50
254 x 127 x 84	254 x 254 x 167	83.5	265.2	144.5	19.2	31.7	12.7	3.48	7.53	3.07
254 x 127 x 66	254 x 254 x 132	66.0	261.3	138.1	15.3	25.3	12.7	4.36	9.03	2.70
254 x 127 x 54	254 x 254 x 107	53.5	258.8	133.3	12.8	20.5	12.7	5.38	10.4	2.45
254 x 127 x 45	254 x 254 x 89	44.4	256.3	130.1	10.3	17.3	12.7	6.38	12.6	2.21
254 x 127 x 37	254 x 254 x 73	36.5	254.6	127.0	8.6	14.2	12.7	7.77	14.8	2.05
203 x 102 x 64 +	203 x 203 x 127	63.7	213.9	120.7	18.1	30.1	10.2	2.91	6.67	2.73
203 x 102 x 57 +	203 x 203 x 113	56.7	212.1	117.5	16.3	26.9	10.2	3.26	7.21	2.56
203 x 102 x 50 +	203 x 203 x 100	49.8	210.3	114.3	14.5	23.7	10.2	3.70	7.88	2.38
203 x 102 x 43	203 x 203 x 86	43.0	209.1	111.0	12.7	20.5	10.2	4.29	8.74	2.20
203 x 102 x 36	203 x 203 x 71	35.5	206.4	107.8	10.0	17.3	10.2	5.09	10.8	1.95
203 x 102 x 30	203 x 203 x 60	30.0	205.8	104.7	9.4	14.2	10.2	6.20	11.1	1.89
203 x 102 x 26	203 x 203 x 52	26.0	204.3	103.0	7.9	12.5	10.2	7.04	13.0	1.75
203 x 102 x 23	203 x 203 x 46	23.0	203.6	101.5	7.2	11.0	10.2	8.00	14.1	1.69
152 x 76 x 26 +	152 x 152 x 51	25.6	157.4	85.1	11.0	15.7	7.6	4.18	7.74	1.79
152 x 76 x 22 +	152 x 152 x 44	22.0	155.9	83.0	9.5	13.6	7.6	4.82	8.74	1.66
152 x 76 x 19	152 x 152 x 37	18.5	154.4	80.8	8.0	11.5	7.6	5.70	10.1	1.53
152 x 76 x 15	152 x 152 x 30	15.0	152.9	78.7	6.5	9.4	7.6	6.98	12.1	1.41
152 x 76 x 12	152 x 152 x 23	11.5	152.2	76.1	5.8	6.8	7.6	9.65	13.1	1.39

Table 2.1.8.1. UKT Split from Advance® UKC. Dimensions and Properties

Table 2.1.8.2

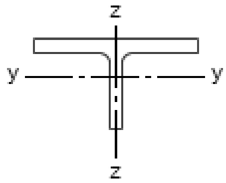
SECTION PROPERTIES

UK EUROCODES

STRUCTURAL TEES CUT FROM UNIVERSAL COLUMNS

UKT Split from Advance® UKC

PROPERTIES



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Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus			Plastic Modulus		Mono-symmetry Index	Warping Constant (*)	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y Flange	Axis y-y Toe	Axis z-z	Axis y-y	Axis z-z	ψ	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3	cm^3		cm^6	cm^4	cm^2
305 x 152 x 79	1530	6280	3.90	7.90	503	115	404	225	615	0.268	3650	188	101
305 x 152 x 69	1290	5350	3.84	7.83	450	97.7	346	188	526	0.263	2340	124	87.2
305 x 152 x 59	1080	4530	3.79	7.77	401	82.8	295	156	448	0.262	1470	80.3	75.1
305 x 152 x 49	858	3650	3.73	7.69	343	66.5	239	123	363	0.258	806	45.5	61.7
254 x 127 x 84	1200	4930	3.36	6.81	391	105	372	220	569	0.261	4540	312	106
254 x 127 x 66	871	3770	3.22	6.69	323	78.3	288	159	439	0.250	2200	159	84.1
254 x 127 x 54	676	2960	3.15	6.59	276	62.1	229	122	348	0.245	1150	85.9	68.2
254 x 127 x 45	524	2430	3.04	6.55	237	48.5	190	94.0	288	0.242	660	51.1	56.7
254 x 127 x 37	417	1950	2.99	6.48	204	39.2	153	74.0	233	0.236	359	28.8	46.5
203 x 102 x 64 +	637	2460	2.80	5.50	233	68.2	230	145	352	0.279	2050	212	81.2
203 x 102 x 57 +	540	2140	2.73	5.45	211	58.8	202	123	309	0.270	1430	152	72.3
203 x 102 x 50 +	453	1840	2.67	5.39	190	50.0	175	103	267	0.266	951	104	63.4
203 x 102 x 43	373	1560	2.61	5.34	169	41.9	150	84.6	228	0.257	605	68.1	54.8
203 x 102 x 36	280	1270	2.49	5.30	143	31.8	123	63.6	187	0.254	343	40.0	45.2
203 x 102 x 30	244	1030	2.53	5.20	129	28.4	100	54.3	153	0.245	195	23.5	38.2
203 x 102 x 26	200	889	2.46	5.18	115	23.4	87.0	44.5	132	0.243	128	15.8	33.1
203 x 102 x 23	177	774	2.45	5.13	105	20.9	76.0	39.0	115	0.242	87.2	11.0	29.4
152 x 76 x 26 +	141	511	2.08	3.96	79.0	21.0	64.9	41.4	99.5	0.281	122	24.3	32.6
152 x 76 x 22 +	116	430	2.04	3.92	70.0	17.5	55.2	34.0	84.4	0.281	76.7	15.8	28.0
152 x 76 x 19	93.1	353	1.99	3.87	60.7	14.2	45.7	27.1	69.8	0.277	44.9	9.54	23.5
152 x 76 x 15	72.2	280	1.94	3.83	51.4	11.2	36.7	20.9	55.8	0.269	23.7	5.24	19.1
152 x 76 x 12	58.5	200	2.00	3.70	41.9	9.41	26.3	16.9	40.1	0.278	9.78	2.30	14.6

Table 2.1.8.2. UKT Split from Advance® UKC. Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

UK EUROCODES

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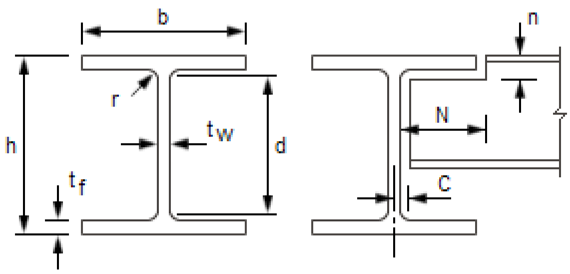
Table 2.1.3.1

SECTION PROPERTIES

UNIVERSAL BEARING PILES

Advance® UKBP

DIMENSIONS



Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f / t_f	c_w / t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
356 x 368 x 174	173.9	361.4	378.5	20.3	20.4	15.2	290.2	8.03	14.3	12	190	36	2.17	12.5
356 x 368 x 152	152.0	356.4	376.0	17.8	17.9	15.2	290.2	9.16	16.3	11	190	34	2.16	14.2
356 x 368 x 133	133.0	352.0	373.8	15.6	15.7	15.2	290.2	10.44	18.6	10	190	32	2.14	16.1
356 x 368 x 109	108.9	346.4	371.0	12.8	12.9	15.2	290.2	12.71	22.7	8	190	30	2.13	19.5
305 x 305 x 223	222.9	337.9	325.7	30.3	30.4	15.2	246.7	4.36	8.14	17	158	46	1.89	8.49
305 x 305 x 186	186.0	328.3	320.9	25.5	25.6	15.2	246.7	5.18	9.67	15	158	42	1.86	10.0
305 x 305 x 149	149.1	318.5	316.0	20.6	20.7	15.2	246.7	6.40	12.0	12	158	36	1.83	12.3
305 x 305 x 126	126.1	312.3	312.9	17.5	17.6	15.2	246.7	7.53	14.1	11	158	34	1.82	14.4
305 x 305 x 110	110.0	307.9	310.7	15.3	15.4	15.2	246.7	8.60	16.1	10	158	32	1.80	16.4
305 x 305 x 95	94.9	303.7	308.7	13.3	13.3	15.2	246.7	9.96	18.5	9	158	30	1.79	18.9
305 x 305 x 88	88.0	301.7	307.8	12.4	12.3	15.2	246.7	10.77	19.9	8	158	28	1.78	20.3
305 x 305 x 79	78.9	299.3	306.4	11.0	11.1	15.2	246.7	11.94	22.4	8	158	28	1.78	22.5
254 x 254 x 85	85.1	254.3	260.4	14.4	14.3	12.7	200.3	7.71	13.9	9	134	28	1.50	17.6
254 x 254 x 71	71.0	249.7	258.0	12.0	12.0	12.7	200.3	9.19	16.7	8	134	26	1.49	20.9
254 x 254 x 63	63.0	247.1	256.6	10.6	10.7	12.7	200.3	10.31	18.9	7	134	24	1.48	23.5
203 x 203 x 54	53.9	204.0	207.7	11.3	11.4	10.2	160.8	7.72	14.2	8	110	22	1.20	22.2
203 x 203 x 45	44.9	200.2	205.9	9.5	9.5	10.2	160.8	9.26	16.9	7	110	20	1.19	26.4

Table 2.1.3.1. Advance® UKBP. Dimensions

BS EN 1993-1-1: 2005
BS 4-1: 2005

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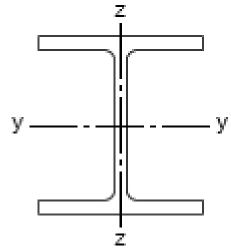
Table 2.1.3.2

SECTION PROPERTIES

UNIVERSAL BEARING PILES

Advance® UKBP

PROPERTIES



Section Designation	Second Moment of Area		Radius of Gyration		Elastic Modulus		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	Axis y-y	Axis z-z	U	X	I_w	I_T	A
	cm^4	cm^4	cm	cm	cm^3	cm^3	cm^3	cm^3			dm^6	cm^4	cm^2
356 x 368 x 174	51000	18500	15.2	9.13	2820	976	3190	1500	0.822	15.8	5.37	330	221
356 x 368 x 152	44000	15900	15.1	9.05	2470	845	2770	1290	0.821	17.9	4.55	223	194
356 x 368 x 133	38000	13700	15.0	8.99	2160	732	2410	1120	0.823	20.1	3.87	151	169
356 x 368 x 109	30600	11000	14.9	8.90	1770	592	1960	903	0.822	24.2	3.05	84.6	139
305 x 305 x 223	52700	17600	13.6	7.87	3120	1080	3650	1680	0.827	9.5	4.15	943	284
305 x 305 x 186	42600	14100	13.4	7.73	2600	881	3000	1370	0.827	11.1	3.24	560	237
305 x 305 x 149	33100	10900	13.2	7.58	2080	691	2370	1070	0.828	13.5	2.42	295	190
305 x 305 x 126	27400	9000	13.1	7.49	1760	575	1990	885	0.829	15.7	1.95	182	161
305 x 305 x 110	23600	7710	13.0	7.42	1530	496	1720	762	0.830	17.7	1.65	122	140
305 x 305 x 95	20000	6530	12.9	7.35	1320	423	1470	648	0.829	20.2	1.38	80.0	121
305 x 305 x 88	18400	5980	12.8	7.31	1220	389	1360	595	0.831	21.6	1.25	64.2	112
305 x 305 x 79	16400	5330	12.8	7.28	1100	348	1220	531	0.833	23.8	1.11	46.9	100
254 x 254 x 85	12300	4220	10.6	6.24	966	324	1090	498	0.826	15.6	0.607	81.8	108
254 x 254 x 71	10100	3440	10.6	6.17	807	267	904	409	0.826	18.4	0.486	48.4	90.4
254 x 254 x 63	8860	3020	10.5	6.13	717	235	799	360	0.828	20.4	0.421	34.3	80.2
203 x 203 x 54	5030	1710	8.55	4.98	493	164	557	252	0.827	15.8	0.158	32.7	68.7
203 x 203 x 45	4100	1380	8.46	4.92	410	134	459	206	0.827	18.6	0.126	19.2	57.2

Table 2.1.3.2. Advance® UKBP. Properties

BS EN 1993-1-1: 2005
Tata Steel ASB

UK EUROCODES

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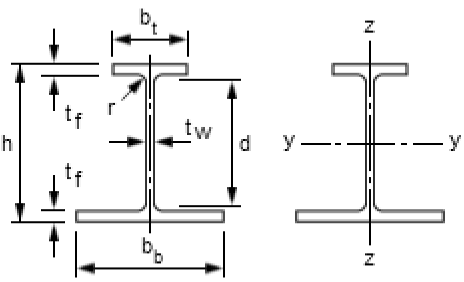
Table 2.1.9.1

SECTION PROPERTIES

ASB
(ASYMMETRIC BEAMS)

DIMENSIONS AND PROPERTIES



Section Designation	Mass per Metre	Depth of Section	Width of Flange		Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling			Second Moment of Area		Surface Area	
			Top	Bottom	Web	Flange			Flanges		Web	Axis y-y	Axis z-z	Per Metre	Per Tonne
		h	b_t	b_b	t_w	t_f	r	d	c_{ft} / t_f	c_{fb} / t_f	c_w / t_w				
	kg/m	mm	mm	mm	mm	mm	mm	mm				cm^4	cm^4	m^2	m^2
300 ASB 249 ^	249	342	203	313	40.0	40.0	27.0	208	1.36	2.74	5.20	52900	13200	1.59	6.38
300 ASB 196	196	342	183	293	20.0	40.0	27.0	208	1.36	2.74	10.4	45900	10500	1.55	7.93
300 ASB 185 ^	185	320	195	305	32.0	29.0	27.0	208	1.88	3.78	6.50	35700	8750	1.53	8.29
300 ASB 155	155	326	179	289	16.0	32.0	27.0	208	1.70	3.42	13.0	34500	7990	1.51	9.71
300 ASB 153 ^	153	310	190	300	27.0	24.0	27.0	208	2.27	4.56	7.70	28400	6840	1.50	9.81
280 ASB 136 ^	136	288	190	300	25.0	22.0	24.0	196	2.66	5.16	7.84	22200	6260	1.46	10.7
280 ASB 124	124	296	178	288	13.0	26.0	24.0	196	2.25	4.37	15.1	23500	6410	1.46	11.8
280 ASB 105	105	288	176	286	11.0	22.0	24.0	196	2.66	5.16	17.8	19200	5300	1.44	13.7
280 ASB 100 ^	100	276	184	294	19.0	16.0	24.0	196	3.66	7.09	10.3	15500	4250	1.43	14.2
280 ASB 74	73.6	272	175	285	10.0	14.0	24.0	196	4.18	8.11	19.6	12200	3330	1.40	19.1

Table 2.1.9.1. ASB - Asymmetric Beams. Dimensions and Properties

BS EN 1993-1-1: 2005
Tata Steel ASB

UK EUROCODES

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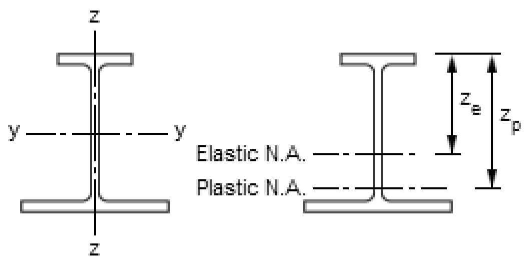
SECTION PROPERTIES

ASB
(ASYMMETRIC BEAMS)

PROPERTIES



Section Designation	Radius of Gyration		Elastic Modulus			Neutral Axis Position		Plastic Modulus		Buckling Parameter	Torsional Index	Mono-symmetry Index *	Warping Constant	Torsional Constant	Area of Section
	Axis y-y	Axis z-z	Axis y-y Top	Axis y-y Bottom	Axis z-z	Elastic z_e	Plastic z_p	Axis y-y	Axis z-z	U	X	Ψ	I_w	I_T	A
	cm	cm	cm^3	cm^3	cm^3	cm	cm	cm^3	cm^3				dm^6	cm^4	cm^2
300 ASB 249 ^	12.9	6.40	2760	3530	843	19.2	22.6	3760	1510	0.820	6.80	0.663	2.00	2000	318
300 ASB 196	13.6	6.48	2320	3180	714	19.8	28.1	3060	1230	0.840	7.86	0.895	1.50	1180	249
300 ASB 185 ^	12.3	6.10	1980	2540	574	18.0	21.0	2660	1030	0.820	8.56	0.662	1.20	871	235
300 ASB 155	13.2	6.35	1830	2520	553	18.9	27.3	2360	950	0.840	9.40	0.868	1.07	620	198
300 ASB 153 ^	12.1	5.93	1630	2090	456	17.4	20.4	2160	817	0.820	9.97	0.643	0.895	513	195
280 ASB 136 ^	11.3	6.00	1370	1770	417	16.3	19.2	1810	741	0.810	10.2	0.628	0.710	379	174
280 ASB 124	12.2	6.37	1360	1900	445	17.3	25.7	1730	761	0.830	10.5	0.807	0.721	332	158
280 ASB 105	12.0	6.30	1150	1610	370	16.8	25.3	1440	633	0.830	12.1	0.777	0.574	207	133
280 ASB 100 ^	11.0	5.76	995	1290	289	15.6	18.4	1290	511	0.810	13.2	0.616	0.451	160	128
280 ASB 74	11.4	5.96	776	1060	234	15.7	21.3	978	403	0.830	16.7	0.699	0.338	72.0	93.7

Table 2.1.9.0. ASB - Asymmetric Beams. Properties

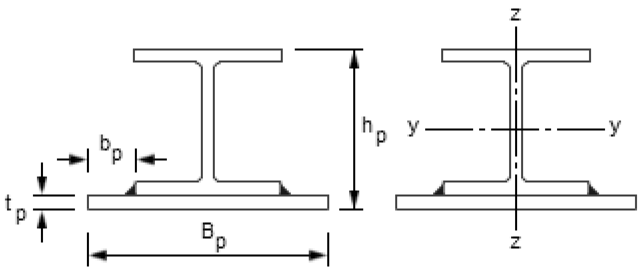
BS EN 1993-1-1: 2005
BS 4-1: 2005

Table 2.1.10.1

SECTION PROPERTIES

Slimflor® Beams

DIMENSIONS



Designation		Thickness of Plate	Width of Outstand	Mass per Metre of Compound Section	Depth of Compound Section	Width of Compound Section	Area of Section comp	Second Moment of Area		Radius of Gyration	
Base Section	SFB	t_p	b_p		h_p	B_p	A	Axis y-y	Axis z-z	Axis y-y	Axis z-z
		mm	mm	kg/m	mm	mm	cm^2	cm^4	cm^4	cm	cm
356 x 406 x 634	356 SFB 707	15	100	707	490	624	901	325128	128496	19.0	11.9
356 x 406 x 551	356 SFB 624	15	100	624	471	619	795	272325	112246	18.5	11.9
356 x 406 x 467	356 SFB 539	15	100	539	452	612	687	223580	96514	18.0	11.9
356 x 406 x 393	356 SFB 464	15	100	464	434	607	592	182911	83323	17.6	11.9
356 x 406 x 340	356 SFB 411	15	100	411	421	603	523	155777	74260	17.3	11.9
356 x 406 x 287	356 SFB 358	15	100	358	409	599	456	129997	65543	16.9	12.0
356 x 406 x 235	356 SFB 305	15	100	305	396	595	389	106050	57297	16.5	12.1
356 x 368 x 202	356 SFB 270	15	100	270	390	575	343	90779	47415	16.3	11.8
356 x 368 x 177	356 SFB 244	15	100	244	383	573	311	79968	43997	16.0	11.9
356 x 368 x 153	356 SFB 220	15	100	220	377	571	280	69732	40763	15.8	12.1
356 x 368 x 129	356 SFB 196	15	100	196	371	569	250	59541	37590	15.4	12.3
305 x 305 x 283	305 SFB 344	15	100	344	380	522	439	102152	42435	15.3	9.83
305 x 305 x 240	305 SFB 301	15	100	301	368	518	384	85149	37729	14.9	9.92
305 x 305 x 198	305 SFB 259	15	100	259	355	515	330	69530	33323	14.5	10.1
305 x 305 x 158	305 SFB 218	15	100	218	342	511	278	55009	29268	14.1	10.3
305 x 305 x 137	305 SFB 197	15	100	197	336	509	251	47776	27203	13.8	10.4
305 x 305 x 118	305 SFB 178	15	100	178	330	507	226	41397	25388	13.5	10.6
305 x 305 x 97	305 SFB 156	15	100	156	323	505	199	34504	23435	13.2	10.8
254 x 254 x 167	254 SFB 222	15	100	222	304	465	283	42160	22454	12.2	8.91
254 x 254 x 132	254 SFB 186	15	100	186	291	461	237	32941	19802	11.8	9.13
254 x 254 x 107	254 SFB 161	15	100	161	282	459	205	26597	18000	11.4	9.37
254 x 254 x 89	254 SFB 143	15	100	143	275	456	182	22366	16733	11.1	9.60
254 x 254 x 73	254 SFB 127	15	100	127	269	455	161	18546	15651	10.7	9.85
203 x 203 x 127 +	203 SFB 176	15	100	176	256	414	225	22831	13783	10.1	7.83
203 x 203 x 113 +	203 SFB 162	15	100	162	250	412	206	20077	13034	9.86	7.95
203 x 203 x 100 +	203 SFB 148	15	100	148	244	410	188	17457	12313	9.63	8.08
203 x 203 x 86	203 SFB 134	15	100	134	237	409	171	14994	11686	9.36	8.27
203 x 203 x 71	203 SFB 119	15	100	119	231	406	151	12479	10927	9.08	8.50
203 x 203 x 60	203 SFB 108	15	100	108	225	406	137	10408	10418	8.71	8.71
203 x 203 x 52	203 SFB 100	15	100	99.6	221	404	127	9144	10038	8.49	8.89
203 x 203 x 46	203 SFB 94	15	100	93.6	218	404	119	8128	9766	8.25	9.05
152 x 152 x 51 +	152 SFB 93	15	100	93.3	185	357	119	5760	6729	6.96	7.53
152 x 152 x 44 +	152 SFB 86	15	100	85.9	181	356	109	4953	6495	6.73	7.70
152 x 152 x 37	152 SFB 79	15	100	78.7	177	354	100	4172	6270	6.45	7.91
152 x 152 x 30	152 SFB 72	15	100	71.6	173	353	91.2	3412	6054	6.12	8.15
152 x 152 x 23	152 SFB 64	15	100	64.4	167	352	82.1	2579	5861	5.61	8.45

Table 2.1.10.1. Section Properties. Slimflor® Beams. Dimensions and Properties

BS EN 1993-1-1: 2005
BS 4-1: 2005

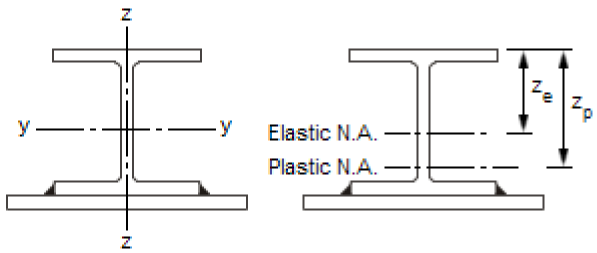
UK EUROCODES

Table 2.1.10.2

SECTION PROPERTIES

Slimflor® Beams

PROPERTIES



Designation		Elastic Modulus			Neutral Axis Position		Plastic Modulus		Buckling Parameter	Torsional Index	Warping Constant	Torsional Constant
Base Section	SFB	$W_{el,y,t}$ cm^3	$W_{el,y,b}$ cm^3	$W_{el,z}$ cm^3	Elastic z_e cm	Plastic z_p cm	$W_{pl,y}$ cm^3	$W_{pl,z}$ cm^3	U	X	I_w dm^6	I_T cm^4
356 x 406 x 634	356 SFB 707	12375	14331	4118	22.7	15.4	16065	8568	0.797	6.31	57.4	13790
356 x 406 x 551	356 SFB 624	10668	12647	3630	21.5	13.3	13747	7492	0.793	6.98	46.3	9310
356 x 406 x 467	356 SFB 539	8997	11008	3153	20.3	10.5	11486	6440	0.787	7.89	36.4	5878
356 x 406 x 393	356 SFB 464	7530	9571	2745	19.1	7.57	9520	5535	0.776	9.03	28.7	3613
356 x 406 x 340	356 SFB 411	6501	8569	2463	18.2	5.75	8139	4907	0.764	10.2	23.7	2411
356 x 406 x 287	356 SFB 358	5483	7580	2188	17.2	4.96	6788	4295	0.748	11.7	19.2	1508
356 x 406 x 235	356 SFB 305	4495	6626	1927	16.0	4.16	5491	3710	0.724	13.8	15.1	879
356 x 368 x 202	356 SFB 270	3843	5918	1650	15.3	3.78	4687	3158	0.723	15.2	11.6	623
356 x 368 x 177	356 SFB 244	3375	5468	1537	14.6	3.37	4085	2900	0.703	16.9	9.98	445
356 x 368 x 153	356 SFB 220	2923	5036	1429	13.8	2.97	3510	2655	0.677	18.8	8.51	315
356 x 368 x 129	356 SFB 196	2469	4598	1322	12.9	2.57	2943	2411	0.643	21.1	7.08	217
305 x 305 x 283	305 SFB 344	4716	6240	1625	16.4	5.88	6024	3365	0.782	8.90	10.3	2093
305 x 305 x 240	305 SFB 301	3988	5529	1456	15.4	5.08	5040	2958	0.767	10.1	8.25	1329
305 x 305 x 198	305 SFB 259	3287	4849	1295	14.3	4.29	4104	2573	0.744	11.8	6.46	792
305 x 305 x 158	305 SFB 218	2610	4187	1145	13.1	3.50	3226	2210	0.710	14.2	4.88	436
305 x 305 x 137	305 SFB 197	2261	3848	1068	12.4	3.09	2775	2025	0.685	15.9	4.12	306
305 x 305 x 118	305 SFB 178	1947	3543	1001	11.7	2.71	2374	1861	0.654	17.6	3.46	218
305 x 305 x 97	305 SFB 156	1602	3209	928	10.8	2.28	1939	1683	0.606	19.7	2.78	148
254 x 254 x 167	254 SFB 222	2315	3455	965	12.2	4.20	2936	1949	0.721	9.98	2.87	678
254 x 254 x 132	254 SFB 186	1824	2976	859	11.1	3.39	2281	1676	0.679	11.9	2.12	371
254 x 254 x 107	254 SFB 161	1473	2630	785	10.1	2.81	1826	1486	0.628	13.9	1.63	224
254 x 254 x 89	254 SFB 143	1229	2397	733	9.33	2.38	1506	1356	0.575	15.5	1.31	153
254 x 254 x 73	254 SFB 127	1008	2178	689	8.52	1.99	1228	1240	0.493	17.0	1.04	109
203 x 203 x 127 +	203 SFB 176	1462	2277	666	10.0	3.85	1890	1347	0.684	8.82	1.03	474
203 x 203 x 113 +	203 SFB 162	1296	2112	633	9.51	3.45	1664	1255	0.657	9.61	0.877	351
203 x 203 x 100 +	203 SFB 148	1133	1950	600	8.95	3.05	1445	1166	0.620	10.5	0.734	256
203 x 203 x 86	203 SFB 134	976	1795	571	8.35	2.65	1236	1084	0.566	11.6	0.608	183
203 x 203 x 71	203 SFB 119	808	1633	538	7.64	2.21	1011	993	0.477	12.9	0.481	126
203 x 203 x 60	203 SFB 108	673	1487	513	7.00	1.88	843	923	0.000	13.9	0.381	92.9
203 x 203 x 52	203 SFB 100	586	1401	497	6.53	1.64	728	877	0.000	14.5	0.324	77.3
203 x 203 x 46	203 SFB 94	518	1328	484	6.12	1.48	642	842	0.000	14.9	0.278	67.6
152 x 152 x 51 +	152 SFB 93	454	988	377	5.83	1.87	593	678	0.000	10.6	0.124	89.0
152 x 152 x 44 +	152 SFB 86	390	920	365	5.39	1.59	505	644	0.000	11.1	0.102	71.7
152 x 152 x 37	152 SFB 79	327	851	354	4.90	1.41	421	611	0.000	11.5	0.081	59.1
152 x 152 x 30	152 SFB 72	265	781	343	4.37	1.29	340	579	0.000	11.7	0.062	50.2
152 x 152 x 23	152 SFB 64	198	691	333	3.73	1.17	259	545	0.000	11.5	0.043	44.3

Table 2.1.10.2. Section Properties. Slimflor® Beams. Dimensions and Properties