PART 3 SECTION PROPERTIES

3.1 General

The section property tables include all relevant section dimensions and properties necessary for designing steel structures in accordance with AS 4100. The structural hot-rolled open sections included in these tables are:

- Welded Beams [WB] – Grades 300 and 400
- Welded Columns [WC] – Grades 300 and 400
- Universal Beams [UB] – Grade 300
- Universal Columns [UC] – Grade 300
- Structural Tees cut symmetrically from Universal Beams [BT] – Grade 300
- Structural Tees cut symmetrically from Universal Columns [CT] – Grade 300
- Parallel Flange Channels [PFC] – Grade 300
- Taper Flange Beams [TFB] – Grade 300
- Equal Angles [EA] – Grade 300
- Unequal Angles [UA] – Grade 300
- Round and Square Bars
- Square Edge Flat Bars

The relevant Australian Standards for the above sections are noted in Section 2.1.

3.2 Section Property Tables

For each group of sections the tables include:

- Dimensions, Ratios and Properties (Table type (A)), followed by
- Properties for Assessing Section Capacity to AS 4100 (Table type (B)).

These parameters are considered in Tables 3.1-1 to 3.1-10 inclusive (with Dimension and Properties only being considered for Bars).

Dimensions, Ratios and Properties

The type (A) tables give standard dimensions and properties for the sections noted in Section 3.1. These properties, such as gross cross-section area (A_g), second moments of area (I_x, I_y), elastic and plastic section moduli (Z_x, S_x, Z_y, S_y) and the torsion and warping constants (J, I_w) are the fundamental geometric properties required by AS 4100.

3.2.1 Properties for Assessing Section Capacity to AS 4100

These properties are necessary for calculating the section capacities of hot-rolled open sections in accordance with AS 4100. The flange and web yield stress, section form factor (k_f), compactness and effective section moduli (Z_{ex}, Z_{ey}) are tabulated. These properties are dependent on steel grade, as explained below.

3.2.1.1 Compactness

In Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100, sections subject to bending moment are described as **compact, non-compact** or **slender** (C, N or S respectively). This categorisation provides a measure of the likelihood of either yielding or local buckling of the plate elements which make up a section occurring when subject to compression caused by bending.

For I-sections, the tables include a column headed “Compactness” where the compactness or otherwise of the section is indicated for each principal axis of bending.

The compactness of an I-section is also important when selecting the methods of analysis (elastic or plastic) used to determine the design action effects (Clause 4.5 of AS 4100) or in using the higher tier provisions of Section 8 of AS 4100 for designing members subject to combined actions.

General worked examples for calculating section compactness are provided in Section 3.2.4 and Ref [3.1]. Additional comments on the calculation of section slenderness are given in Section 3.2.2.3.

3.2.2.2 Effective Section Modulus

Having evaluated the compactness of an open section, the effective section modulus (Z_e) is then determined. This parameter is based on the section moduli (S, Z) and is used in the determination of the design section moment capacity (ϕM_S). Z_e is calculated using Clauses 5.2.3, 5.2.4 and 5.2.5 of AS 4100. The equations for determining Z_e reflect the proportion of the open section that is effective in resisting the compression in the section caused by flexure – that is, whether the section is compact, non-compact or slender.

3.2.2.3 Form Factor

The form factor (k_f) is defined in Clause 6.2.2 of AS 4100. k_f is used to determine the design section capacity of a concentrically loaded compression member (ϕN_S). The calculation of k_f indicates the degree to which the plate elements which make up the column section will buckle locally before yielding. k_f represents the proportion of the open section that is effective in compression and is based on the effective width of each element in the section (i.e. k_f = 1.0 signifies a column section which will yield rather than buckle locally in a short or stub column test). The evaluation of k_f is also important when designing to the higher tier provisions for members subject to combined actions as noted in Section 8 of AS 4100.

In calculating both section slenderness for flexure and k_f the following assumptions have been used:

- for hot-rolled sections, the HR (hot-rolled) residual stress classification
- for welded sections, the HW (heavily welded longitudinally) residual stress classification
- the values of plate element slenderness depend on the element width, thickness and yield stress. For sections where the web and flange yield stresses (f_{yw} and f_{yf} respectively) are different the **lower** of the two yield stresses is applied to both the web and flange to determine the slenderness of these elements.

General worked examples for calculating Z_e, k_f are provided in Section 3.2.4 and Ref [3.1].

3.2.3 I-Sections with Holed Flanges

Tables of selected section properties were given for I-sections with holes on one flange in previous editions of this publication based on selected bolt gauges and hole diameters. Holes in either flange can result in a reduction in the effective section modulus and section moment capacity when applying Clause 5.2.6 of AS 4100 since, once the area of the holes exceed the limit in Clause 5.2.6 of AS 4100, a net section must be used which accounts for the presence of holes. If the area of the holes is less than the limit in Clause 5.2.6 of AS 4100, then the section properties of the gross section may be used. I-sections with holed flanges typically occur in bolted flange cover plate splices and bolted/welded flange cover plate splices and as such are considered when the splice is designed rather than when the member itself is being designed. Formulae for calculating the net section properties may be found in Handbook 1 [Ref 3.7], while section moment capacities for the I-sections with holed flanges may be found in Handbook 1 and in Design Guide 13 [Ref 3.8]. The design of splices using bolted flange cover plates may be found in Design Guide 13.

3.2.4 Example

Determine Z_{ex} and k_f for a 360UB44.7 – Grade 300 steel section.

Solution: (All relevant data are obtained from Tables 3.1-3(A) and 3.1-3(B))

Design Yield Stress, f_y = 320 MPa

Flange slenderness $\lambda_{ef} = \dfrac{b_f - t_w}{2t_f}\sqrt{\dfrac{f_y}{250}} = 8.46\sqrt{\dfrac{320}{250}} = 9.57$