5.2 Design Section Moment and Web Capacities

5.2.1 General

For RHS and SHS, the 5.2 Table Series – i.e. Tables 5.2-1 to 5.2-4 – contain values of design section moment capacities about the principal x- and y-axes (ϕM_{sx} , ϕM_{sy}) and the design shear capacity (ϕV_v) for shear forces acting in the principal y-axis direction (ie for RHS/SHS bending about the x-axis) and in the principal x-axis direction (for RHS only). These values provide the basic information necessary for checking shear-bending interaction. The Tables also provide listings of the design torsional section moment capacity (ϕM_z) for RHS and SHS.

The maximum segment length for full lateral restraint (FLR) for RHS is also listed. FLR values may be used to ensure appropriate spacing of restraints so that the design section moment capacity can be achieved for bending about the x-axis. The Tables also provide values of design web bearing capacities.

Due to there being no specific design provisions for web bearing in AS 4100, **CHS are not considered in the 5.2 Table series** though similar information (e.g. ϕM_{sx} , ϕV_v and ϕM_z) can be found in the 8.1 Table series.

5.2.2 Method

5.2.2.1 Design Section Moment Capacity

Designers must ensure that the design bending moment (M^*) $\leq \phi M_s$ for specific restraint conditions along the beam.

The design section moment capacity (ϕM_s) is determined from Clauses 5.1 and 5.2.1 of AS 4100 using:

$$\phi M_s = \phi f_y Z_e$$

where ϕ = 0.9 (Table 3.4 of AS 4100)

f_y = yield stress used in design

Z_e = effective section modulus (see Section 3.2.2.2)

For RHS, design section moment capacities are listed for bending about both principal axes. These actions are split into two separate tables – the type (A) table for bending about the x-axis (e.g Table 5.2-1(1)(A) for Grade C350 RHS which lists ϕM_{sx}) which is immediately followed by the type (B) table for bending about the y-axis (e.g. Table 5.2-1(1)(B) for Grade C350 RHS which lists ϕM_{sy}). Due to the section being doubly-symmetric, the SHS tables (i.e Tables 5.2-3 to 5.2.4) only consider design section moment capacities about the x-axis.

For RHS bending about the x-axis, the design member moment capacity (ϕM_b) equals the design section moment capacity for members which are adequately restrained against flexural-torsional buckling. For SHS bending about the x-axis and RHS bending about the y-axis, flexural-torsional buckling does not occur and ϕM_b equals ϕM_s.

5.2.2.2 Segment Length for Full Lateral Restraint (FLR)

The Tables only consider RHS bending about the major principal x-axis to be susceptible to flexural-torsional buckling. For such sections, a segment with full or partial restraints at each end may be considered to have full lateral restraint if its length satisfies Clause 5.3.2.4 of AS 4100, i.e.

$$\text{FLR} \le r_y \left(1800 + 1500\beta_m\right)\left(\frac{b_f}{b_w}\right)\left(\frac{250}{f_y}\right)$$

where FLR = maximum segment length for full lateral restraint

$r_y = \sqrt{\left(\frac{I_y}{A_g}\right)}$ (see Tables 3.1-3 to 3.1-4)

The FLR values listed in the (A) series tables of Tables 5.2-1 to 5.2-2 are calculated using β_m = -1.0 which is the most conservative case. However, β_m = -0.8 may be used for segments with transverse loads (as in the case of Tables 5.1-3 to 5.1-4) or β_m may be taken as the ratio of the smaller to larger end moments in the length (L) for segments without transverse loads (positive when the segment is bent in reverse curvature).

5.2.2.3 Design Torsional Moment Section Capacity

The design torsional moment section capacity (ϕM_z) listed in the 5.2 Table series is determined in accordance with (a) and (b) as noted below.

(a) Although AS 4100 makes no provision for the design of members subject to torsion it is nevertheless considered appropriate to provide torsional capacities for hollow sections in the Tables. Hollow sections perform particularly well in torsion and their behaviour under torsional loading is readily analysed by simple procedures. An explanation of torsional effects is provided in Refs. [5.1, 5.2].

The general theory of torsion established by Saint-Venant is based on uniform torsion. The theory assumes that all cross-sections rotate as a body around the centre of rotation.

When the torsional moment that is applied is non-uniform, such as when the torsional load is applied midspan between rigid supports or when the free warping of the section is restricted, then the torsional load is shared between uniform and non-uniform torsion or warping. However, in the case of hollow sections, the contribution of non-uniform torsion is negligible and sections can be treated as subject to uniform torsion without any significant loss of precision.

(b) For hollow sections, torsional actions can be considered using the following formulae:

$M_z^* \le \phi M_z$

$\phi M_z = \phi 0.6 f_y C$

where

M_z^* = design torsional moment

ϕ = 0.9 (based on shearing loads and Table 3.4 of AS 4100)

ϕM_z = design torsional section moment capacity

f_y = yield stress used in design

C = torsional section modulus (see 3.1 Table series)

The angle of twist per unit length θ (in radians) can be determined from the following formula:

$$\theta = \frac{M_z^*}{GJ}$$

where

G = shear modulus of elasticity, 80 x 10^3 MPa

J = torsional section constant (see 3.1 Table series).

The method for determining the constants C and J is detailed in Section 3.2.1.1.

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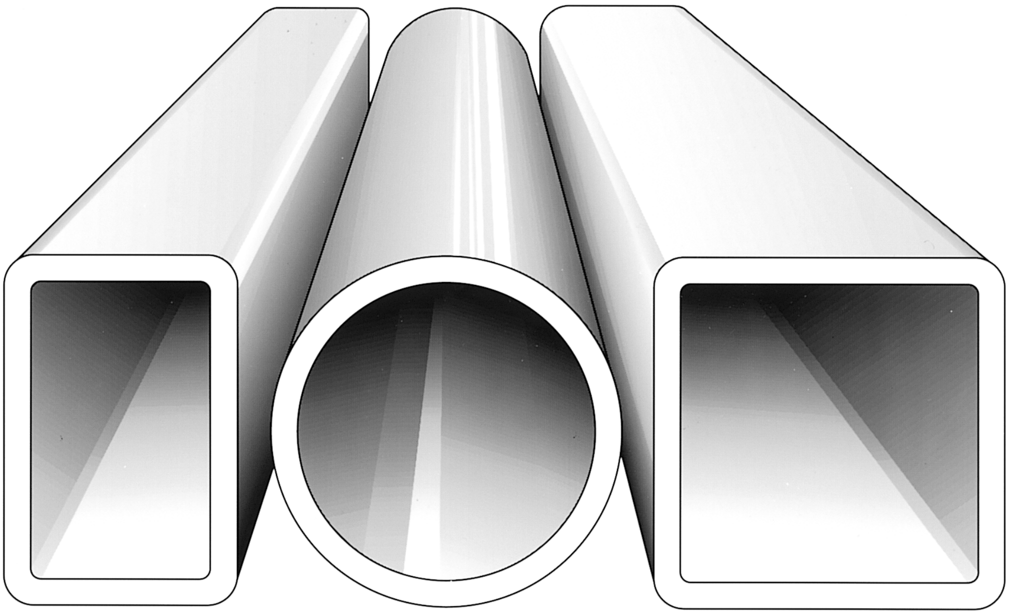

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CHS - Grade C250/C350 (to AS 1163)

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SHS - Grade C350/C450 (to AS 1163)

LIMIT STATES EDITION TO AS 4100-1998 $S^* \leq \phi R_u$

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TABLES

NOTE: SEE SECTION 2.1 FOR THE SPECIFIC MATERAL STANDARD (AS 1163) REFERRED TO BY THE SECTION TYPE AND STEEL GRADE IN THESE TABLES