

5.2 Design Section Moment and Web Capacities

5.2.1 General

Tables 5.2-1 to 5.2-10 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 (note that such a shear force is related to bending about the x-axis).

The maximum segment length for full lateral restraint (FLR) 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 for all sections except Structural Tees.

Angle sections are not considered in the 5.2 series tables though listings of principal axis design section moment capacities are given in Part 8 (i.e. Tables 8.1-11 and 8.1-12).

5.2.2 Method

5.2.2.1 Design Section Moment Capacity

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 $\phi = 0.9$ (Table 3.4 of AS 4100)

f_y = yield stress used in design (for a section where the web and flange yield stresses (f_{yw} & f_{yf}) are different, the flange value is used which is always the lower value)

Z_e = effective section modulus (see Section 3.2.2.2)

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

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

For sections subject to bending about an asymmetric principal axis (e.g. Structural Tees, Channels and Angles), ϕM_s may depend on the direction of the bending moment due to the fact that Z_e depends on the dimension from the neutral axis to the extreme fibre. In such cases, two values of ϕM_s are quoted in the relevant table.

5.2.2.2 Segment Length for Full Lateral Restraint (FLR)

For I-sections and channels, a segment with full or partial restraint at each end may be considered to have full lateral restraint if its length satisfies Clause 5.3.2.4 of AS 4100, where

$$FLR \leq r_y (K_1 + K_2 \beta_m) \sqrt{\left(\frac{250}{f_y}\right)}$$

Where FLR = maximum segment length for full lateral restraint

K_1 = 80 (for equal flanged I-sections) or 60 (for equal flanged Channels)

K_2 = 50 (for equal flanged I-sections) or 40 (for equal flanged Channels)

$$r_y = \sqrt{\left(\frac{I_y}{A_g}\right)} \quad (\text{see Tables 3.1-1 to 3.1-4, 3.1-7 and 3.1-8})$$

For Structural Tees cut from Universal Beams (BT sections), the value of FLR has been determined by alternate means as AS4100 does not provide specific guidance for these sections. The alternate method calculates FLR by evaluating the maximum effective length for which ϕM_b equals ϕM_s assuming $\alpha_m = 1.0$. This is listed in Tables 5.2-7 as “Effective Length”. However, for BT sections bending about the x-axis causing compression in the stem, there is no effective length listed as $\phi M_b < \phi M_s$ generally – i.e. these types of loaded sections require continuous restraint if the design section moment capacity is to be attained. Additionally, Structural Tees cut from Universal Columns (CT sections) and some BT sections bent about the principal axis parallel to the flange do not buckle laterally and no “Effective Length” values are given in Tables 5.2-7 and 5.2-8.

As noted in Ref[5.1], there is generally not much guidance available on the design of open section members subject to torsion loading. However, further information on analysis and design of such loaded members is given in Refs.[5.1, 5.2].

Designers must ensure that the design shear force (V^*) $\leq \phi V_v$ along the beam.

$$\begin{aligned} \phi V_v &= \phi (0.6 f_{yw} A_w) & \text{for } \frac{d_1}{t_w} \sqrt{\left(\frac{f_{yw}}{250}\right)} \leq 82 \\ \phi V_v &= \phi (0.6 f_{yw} A_w) \left[\frac{82}{\left(\frac{d_1}{t_w}\right) \sqrt{\left(\frac{f_{yw}}{250}\right)}} \right]^2 & \text{for } \frac{d_1}{t_w} \sqrt{\left(\frac{f_{yw}}{250}\right)} > 82 \end{aligned}$$

For Structural Tees the shear stress distribution is non-uniform and the web shear capacity is

Where f_{vm}^* , f_{va}^* = the maximum and average design shear stresses respectively determined from an elastic analysis.