Web slenderness $\lambda_{ew} = \frac{d_1}{t_w}\sqrt{\frac{f_y}{250}} = 48.2\sqrt{\frac{320}{250}} = 54.5$

(a) To calculate Z_{ex} the plate element slenderness values are compared with the plate element slenderness limits in Table 5.2 of AS 4100.

Bending about the x-axis puts the flange in uniform compression. For one edge supported,

$\lambda_{ef} = 9.57$ $\lambda_{ep} = 9$ $\lambda_{ey} = 16$ $\lambda_{ef} / \lambda_{ey} = 0.598$

Bending about the x-axis places one edge of the web in tension and the other in compression, for which,

$\lambda_{ew} = 54.5$ $\lambda_{ep} = 82$ $\lambda_{ey} = 115$ $\lambda_{ew} / \lambda_{ey} = 0.474$

The flange has the higher value of λ_e / λ_{ey} and is the critical element in the section. From Clause 5.2.2 of AS 4100 the section slenderness and slenderness limits are the flange values, i.e.

$\lambda_s = 9.57$ $\lambda_{sp} = 9$ $\lambda_{sy} = 16$

Now $\lambda_{sp} < \lambda_s \leq \lambda_{sy}$. ∴The section is NON-COMPACT (Hence "N" in Table 3.1-3(B))

$Z_x = 689 \times 10^3 mm^3$ $S_x = 777 \times 10^3 mm^3$ (Table 3.1-3(A))

$Z_{cx} = \min [S_x , 1.5Z_x] = \min [777, 1.5 \times 689] \times 10^3 = 777 \times 10^3\ mm^3$

$$Z_{ex} = Z_x + \left[\frac{(\lambda_{sy} - \lambda_s)}{(\lambda_{sy} - \lambda_{sp})}(Z_{cx} - Z_x)\right] = 689 \times 10^3 + \left[\frac{(16 - 9.57)}{(16 - 9)}(777 - 689)\right] \times 10^3$$

$= 770 \times 10^3\ mm^3$ (as Table 3.1-3(B))

(b) To determine the form factor (k_f) the plate element slenderness for both the flange and web are compared with the plate element yield slenderness limits (λ_{ey}) in Table 6.2.4 of AS 4100.

Flange	λ_{ef}	= 9.57	<	λ_{ey} = 16	- i.e. flange is fully effective
Web	λ_{ew}	= 54.5	>	λ_{ey} = 45	- i.e. web is not fully effective

Effective width of web $= d_{ew} = \lambda_{ey} / \lambda_{ew} (d_1) = 45/54.5 \times 333 = 275$ mm

Gross Area $= A_g = 5720\ mm^2$

Effective Area $= A_e = A_g - (d_1 - d_{ew})\ t_w$

$= 5720 - (333 - 275) \times 6.9 = 5320\ mm^2$

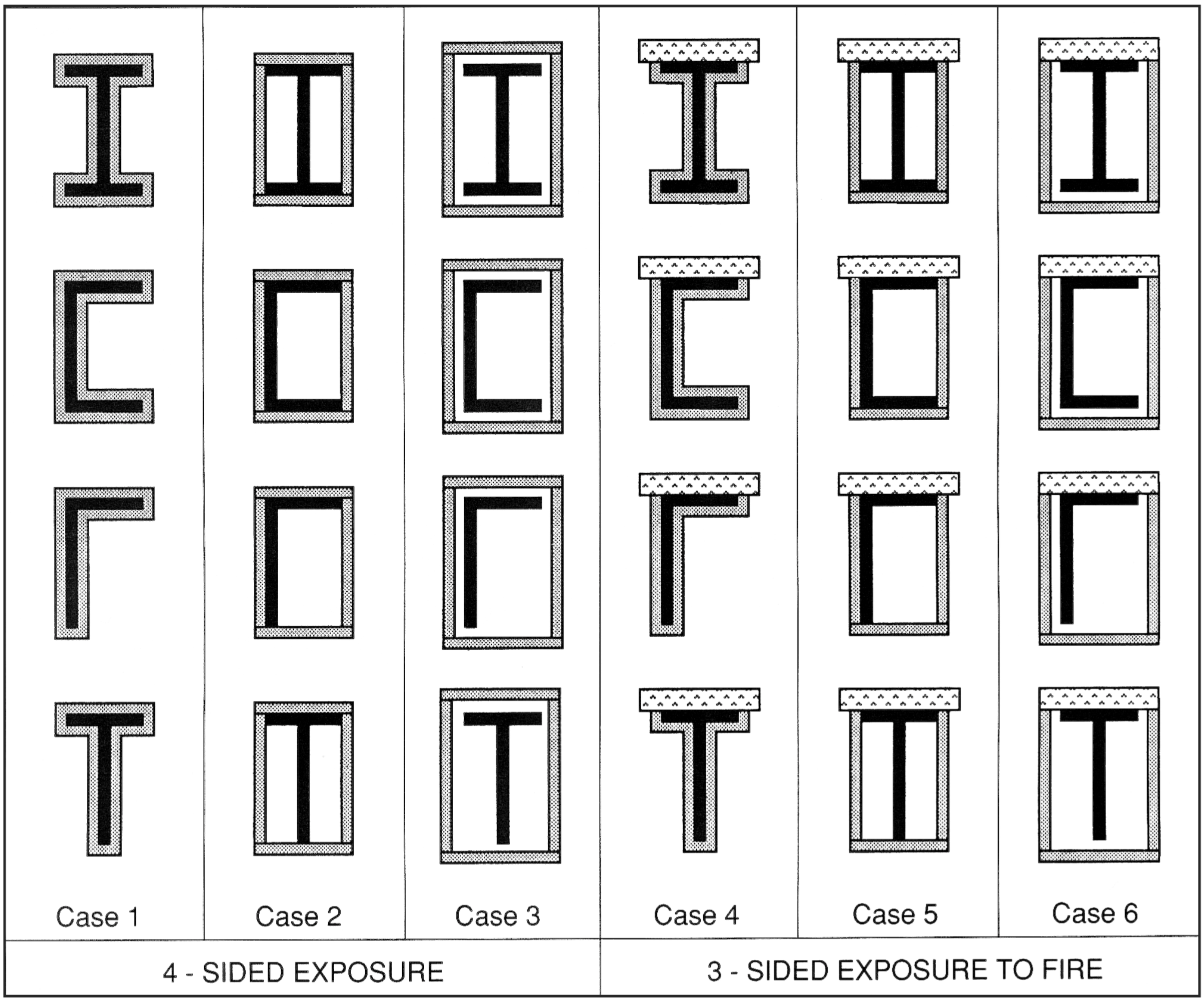
$\therefore k_f = A_e / A_g$ $= 5320/5720 = 0.930$ (as Table 3.1-3(B))

3.3 Surface Areas & Properties for Fire Design

Tables 3.2-1(A) to 3.2-10(A) – i.e. the (A) type tables in the 3.2 Table Series – list surface areas for hot-rolled open sections. In addition, to assist with the design of structural steel sections for fire resistance (Section 12 of AS 4100), values of exposed surface area to mass ratio (k_{sm}) are tabulated in Tables 3.2-1(B) to 3.2-10(B) for the various cases shown in Figure 3.1. The (B) type tables immediately follow the (A) type tables for each respective section group.

For **unprotected steel open sections** the values of k_{sm} corresponding to four- and three-sided exposure should be taken as those corresponding to Cases 1 and 4 respectively in Figure 3.1.

For members requiring the addition of fire protection materials, Ref.[3.3] may be used to determine the thickness of proprietary materials required for a given value of k_{sm} and Fire Resistance Level (FRL). It should be noted that k_{sm} is equivalent to E in Ref.[3.3]. Further information and worked examples on fire design to Section 12 of AS 4100 can be found in Refs.[3.4, 3.5].



Cases of fire exposure considered:

1 = Total Perimeter, Profile-protected

2 = Total Perimeter, Box-protected, No Gap

3 = Total Perimeter, Box-protected, 25 mm Gap

4 = Top Flange Excluded, Profile-protected

5 = Top Flange Excluded, Box-protected, No Gap

6 = Top Flange Excluded, Box-protected, 25 mm Gap

Figure 3.1: Cases for calculation of Exposed Surface Area to Mass Ratio