

FLEXURAL PROPERTIES OF STRINGER SECTIONS (LIPPED AND UNLIPPED ANGLES, CHANNELS AND Z-SECTIONS)

1. NOTATION

A	area of section: for Z- and channel sections, $A = t(h + 2d)$ for lipped Z and lipped channel sections, $A = t(h + 2d + 2c)$ for lipped angle sections, $A = t(2d + 2c)$	m^2	in^2
c	width of each lip	m	in
d	width of each flange	m	in
h	depth of web	m	in
I	second moment of area of section about axis through centroid of section parallel to a flange.	m^4	in^4
k	radius of gyration of section, about same axis as I	m	in
t	thickness of web, flanges and lips	m	in

Both SI and British units are quoted but any coherent system of units may be used.

2. NOTES

2.1 Channel and Z-Sections

Figures 1, 2 and 3 present the ratio k^2/A , which equals I/A^2 , plotted against d/h for various values of h/t and A/t^2 for three different values of c/h . The chain dotted lines shown in Figure 1 represent the extreme practical range of values of d/t . At the lower end of this range premature lateral instability may occur and at the higher end the outstanding flanges may become laterally unstable.

It is assumed that the stringer is constrained to bend in the plane of the web, and therefore it should be noted that the moment of inertia of the stringer is about an axis through its centroid parallel to the flanges and is not the moment of inertia of an unconstrained strut.

2.2 Angle Sections

Figure 4 presents the ratio k^2/A , which equals I/A^2 , plotted against the ratio c/d for various values of d/t and A/t^2 . The chain dotted lines represent the extreme practical range of values of c/t . At the lower end of this range premature lateral instability of the flange may occur, and at the higher end the lips may become laterally unstable.

It is assumed that the stringer is constrained to bend in the plane of one flange, and therefore it should be noted that the moment of inertia of the stringer is about an axis through its centroid parallel to the other flange, and is not the moment of inertia appropriate to the bending of an unconstrained strut.

2.3 General

Of two struts of the same material and the same area, the one with the higher k^2/A ratio would fail in flexure at a higher load, so this ratio is, on a weight basis, a criterion for the efficiency of the strut in flexure.

The possibility of local instability must be examined separately.

The curves are drawn for sections with sharp angles, but they may be applied to sections with rounded corners provided that the actual cross-sectional area is used instead of A .

3. DERIVATION

For lipped angle sections the equation is

$$I = \frac{t}{12}[t^2(c+d) + 4(c^3 + d^3) + 12cd^2] - \frac{t}{8(c+d)}[d^4 + 4cd^3 + 6c^2d^2 + 4c^3d + c^4]. \quad (3.1)$$

For unlipped and Z- and channel sections the equation is

$$I = \frac{t}{12}(h^3 + 2dt^2 + 6dh^2). \quad (3.2)$$

For lipped Z- and channel sections the equation is,

$$I = \frac{t}{12}[(h^3 + 8c^3 - 12hc^2) + 6h^2(d+c) + dt^2]. \quad (3.3)$$