



Shear centre and primary warping constant for lipped and unlipped channel and Z-sections

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THE PREPARATION OF THIS DATA ITEM

The work on this particular Data Item which supersedes Item Nos. Struct 00.06.02, 00.06.03, 00.07.02, 00.07.05 and 00.07.06, was monitored and guided by the Aerospace Structures Committee. This Committee first met in 1940 and now has the following membership:

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SHEAR CENTRE AND PRIMARY WARPING CONSTANT FOR LIPPED AND UNLIPPED CHANNEL AND Z-SECTIONS

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SHEAR CENTRE AND PRIMARY WARPING CONSTANT FOR LIPPED AND UNLIPPED CHANNEL AND Z-SECTIONS

1. NOTATION

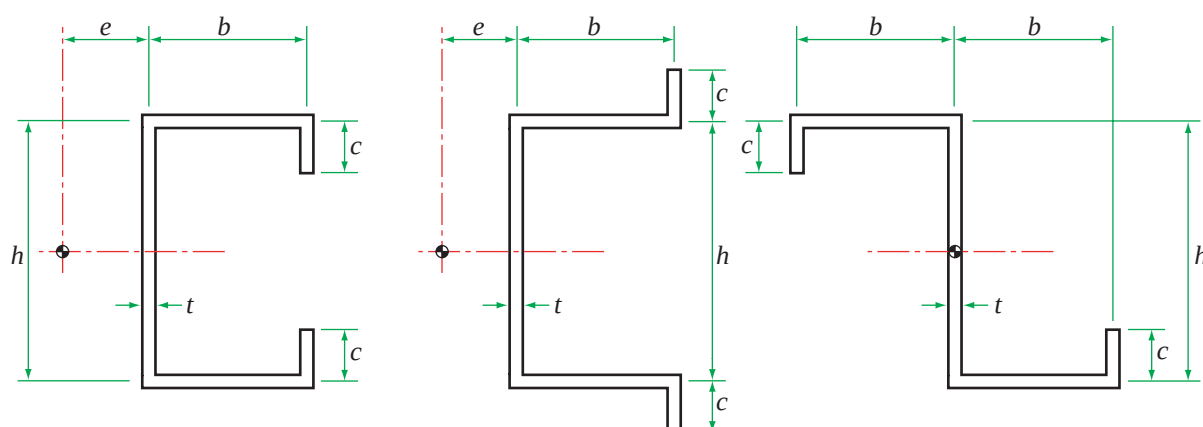
b	width of each flange (see Sketch 2.1)	m	in
c	depth of each lip (see Sketch 2.1)	m	in
e	perpendicular distance of shear centre from centre of web wall (see Sketch 2.1)	m	in
E	modulus of elasticity of material	N/m ²	lbf/in ²
G	shear modulus of material	N/m ²	lbf/in ²
h	depth of web (see Sketch 2.1)	m	in
J	torsion constant of section (see Equation (4.1))	m ⁴	in ⁴
t	thickness of section wall	m	in
T	applied torque	N m	lbf in
z	distance along member	m	in
β	b/h		
γ	c/h		
ε	e/h		
Γ	total warping constant (see Equation (4.2))	m ⁶	in ⁶
Γ_1	primary warping constant (see Section 4)	m ⁶	in ⁶
Γ_2	secondary warping constant (see Section 4)	m ⁶	in ⁶
ϕ	twist per unit length	rad/m	rad/in

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

2. INTRODUCTION

This Item provides curves and formulae for the determination of the shear centre and warping constant of uniform thin-walled open sections. The sections covered by this Item are channels with inward or outward facing lips and lipped Z-sections, illustrated in Sketch 2.1. As no allowance is made for shear variation across the wall thickness the data presented relate to sections having uniform wall thickness, t , of less than about $h/15$ where h is the depth of the web.

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• Indicates position of shear centre

(a) Channel section with inward facing lips

(b) Channel section with outward facing lips

(c) Lipped Z-section

Sketch 2.1 Illustrating the types of section to which this Item relates

3. SHEAR CENTRE

The shear centre is defined as that point through which an applied transverse load must pass for bending to be unaccompanied by torsion. Figure 1 gives the shear centre for channel sections with inward facing lips and Figure 2 for channel sections with outward facing lips. The shear centre of a lipped Z-section is on the web as indicated in Sketch 2.1.

Formulae for shear centres are:

for channel sections with inward facing lips

$$\varepsilon = \beta \left[\frac{\gamma + \frac{1}{2}\beta - \frac{4}{3}\gamma^3}{\gamma + \beta + \frac{1}{6} - 2\gamma^2\left(1 - \frac{2}{3}\gamma\right)} \right], \quad (3.1)$$

for channel sections with outward facing lips

$$\varepsilon = \beta \left[\frac{\gamma + \frac{1}{2}\beta - \frac{4}{3}\gamma^3}{\gamma + \beta + \frac{1}{6} + 2\gamma^2\left(1 + \frac{2}{3}\gamma\right)} \right] \quad (3.2)$$

and for Z-sections

$$\varepsilon = 0. \quad (3.3)$$