screw slot: a semi-hollow in an extrusion intended to retain a screw parallel to the axis of the extrusion. (See Figure GL.2).

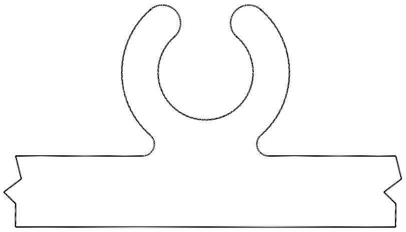

Figure GL. 2
TRANSVERSE CROSS SECTION OF A SCREW SLOT

self-drilling screw: a screw that drills and taps its own hole as it is being driven.

service load: load under which serviceability limit states are evaluated.

service load combination: load combinations under which serviceability limit states are evaluated.

slip-critical connection: a bolted connection designed to resist movement by friction on the faying surface of the connection under the clamping forces of the bolts.

stiffener: a structural element attached or integral to a member to distribute load, transfer shear, or prevent buckling.

structural component: member, connector, connecting element or assemblage.

structure: an object, including but not limited to buildings, walls, fences, towers, bridges, railings, signs, and luminaires, designed to support loads.

tapping screw: a screw that threads a preformed hole as it is being driven.

thread cutting screw: a tapping screw that is installed into a preformed hole, with internal mating threads formed as a result of cutting out the material being tapped to form the relief area of the threaded shank.

thread forming screw: a tapping screw that is installed into a preformed hole, with internal mating threads formed as a result of cold flow of the material being tapped into the relief area of the threaded shank.

torsional buckling: a buckling mode in which a compression member twists about its shear center axis.

unbraced length: the length of a member between brace points or between a brace point and a cantilever's free end, measured between the longitudinal centroidal axes of the bracing members. For columns, brace points are points at which lateral translation is restrained for flexural buckling or twisting is restrained for torsional buckling. For beams, brace points are points at which the compression flange is restrained against lateral deflection or the cross section is restrained against twisting.

weld-affected zone: metal within 1 in. (25 mm) of the centerline of a weld.

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B.5.2 Radius of Curved Elements

The radius of curved elements R_b shall be taken at the mid-thickness of the element.

B.5.3 Thickness of Elements

For uniform compression on elements with linearly varying thickness with $\delta \le 2.0$:

a) For tapered thickness elements with the thick edge supported and the thin edge free, the slenderness is $(1 - 0.12\delta)(b/t_{avg})$.

b) For tapered thickness elements with the thin edge supported and the thick edge free, the slenderness is b/t_{avg}

c) For tapered thickness elements supported on both edges, the slenderness is b/t_{avg}.

where

b = element width

$$t_{avg} = \frac{t_{\max} + t_{\min}}{2} \qquad \text{(B.5-1)}$$

= average thickness of the element

t_{min} = minimum thickness of the tapered thickness element

t_{max} = maximum thickness of the tapered thickness element

$$\delta = \frac{t_{\max} - t_{\min}}{t_{\min}} \qquad \text{(B.5-2)}$$

B.5.4 Strength of Elements in Uniform Compression

The stress F_c corresponding to the uniform compressive strength of elements is:

For unwelded elements:

$$F_c = F_{co} \qquad \text{(B.5-3)}$$

For welded elements:

$$F_c = F_{co}(1 - A_{wz}/A_g) + F_{cw} A_{wz}/A_g \qquad \text{(B.5-4)}$$

where

F_{co} = stress corresponding to the uniform compressive strength calculated using Sections B.5.4.1 through B.5.4.5 for an element if no part of the cross section were weld-affected. Use buckling constants for unwelded metal (Table B.4.1 or Table B.4.2) and F_{cy}.

F_{cw} = stress corresponding to the uniform compressive strength calculated using Sections B.5.4.1 through B.5.4.5 for an element if the entire cross section were weld-affected. Use buckling constants for weld-affected zones (Table B.4.1) and F_{cyw}. For transversely welded elements with $b/t \le \lambda_1$, $F_{cw} = F_{co}$.

A_{wz} = cross sectional area of the weld-affected zone

A_g = gross cross sectional area of the element.

B.5.4.1 Flat Elements Supported On One Edge

The stress F_c corresponding to the uniform compressive strength of flat elements supported on one edge is:

LIMIT STATE	F_c	b/t
yielding	F_{cy}	$b/t \le \lambda_1$
inelastic buckling	$B_p - 5.0D_p\, b/t$	$\lambda_1 < b/t < \lambda_2$
in columns whose buckling axis is not an axis of symmetry:		
elastic buckling	$\dfrac{\pi^2 E}{(5.0\, b/t)^2}$	$b/t \ge \lambda_2$
in all other columns and all beams:		
post-buckling	$\dfrac{k_2\sqrt{B_p E}}{5.0b/t}$	$b/t \ge \lambda_2$

where

$$\lambda_1 = \frac{B_p - F_{cy}}{5.0D_p}$$

$$\lambda_2 = \frac{C_p}{5.0} \quad \text{for elastic buckling}$$

$$\lambda_2 = \frac{k_1 B_p}{5.0D_p} \quad \text{for post-buckling}$$

B.5.4.2 Flat Elements Supported on Both Edges

The stress F_c corresponding to the uniform compressive strength of flat elements supported on both edges is:

LIMIT STATE	F_c	b/t
yielding	F_{cy}	$b/t \le \lambda_1$
inelastic buckling	$B_p - 1.6D_p\, b/t$	$\lambda_1 < b/t < \lambda_2$
post- buckling	$\dfrac{k_2\sqrt{B_p E}}{1.6b/t}$	$b/t \ge \lambda_2$

where

$$\lambda_1 = \frac{B_p - F_{cy}}{1.6D_p}$$

$$\lambda_2 = \frac{k_1 B_p}{1.6D_p}$$

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LIMIT STATE	F_b	b/t
yielding	$1.5F_{cy}$	$b/t \le \lambda_1$
inelastic buckling	$B_{br} - 3.5D_{br}\, b/t$	$\lambda_1 < b/t < \lambda_2$
elastic buckling	$\dfrac{\pi^2 E}{(3.5b/t)^2}$	$b/t \ge \lambda_2$

where

$$\lambda_1 = \frac{B_{br} - 1.5F_{cy}}{3.5D_{br}}$$

$$\lambda_2 = \frac{C_{br}}{3.5}$$

B.5.5.3 Flat Elements Supported on Both Edges and with a Longitudinal Stiffener

The stress F_b corresponding to the flexural compressive strength of flat elements supported on both edges and with a longitudinal stiffener located $0.4d_1$ from the supported edge that is in compression is:

LIMIT STATE	F_b	b/t
yielding	$1.5F_{cy}$	$b/t \le \lambda_1$
inelastic buckling	$B_{br} - 0.29D_{br}\, b/t$	$\lambda_1 < b/t < \lambda_2$
post- buckling	$\dfrac{k_2\sqrt{B_{br}E}}{(0.29b/t)}$	$b/t \ge \lambda_2$

where

$$\lambda_1 = \frac{B_{br} - 1.5F_{cy}}{0.29D_{br}}$$

$$\lambda_2 = \frac{k_1 B_{br}}{0.29D_{br}}$$

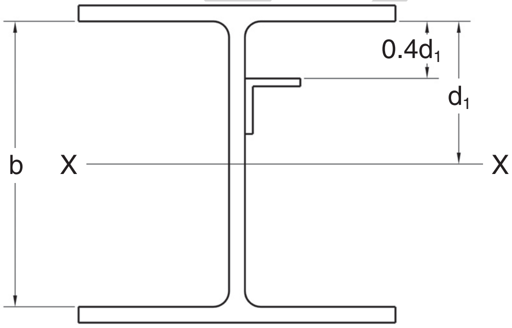

Figure B.5.5
FLAT ELEMENT WITH A LONGITUDINAL STIFFENER

The moment of inertia of the longitudinal stiffener I_L about the web of the beam shall equal or exceed

$$I_L = \frac{0.02\alpha_s f t b^3}{E}\left[\left(1 + \frac{6A_L}{bt}\right)\left(\frac{s}{b}\right)^2 + 0.4\right] \qquad \text{(B.5-14)}$$

where (see Figure B.5.5)

A_L = cross-sectional area of the longitudinal stiffener
d_1 = distance from the neutral axis to the compression flange
f = compressive stress at the toe of the flange
b = clear height of the web
s = distance between transverse stiffeners
t = web thickness
α_s = 1 for a stiffener consisting of equal members on both sides of the web
= 3.5 for a stiffener consisting of a member on only one side of the web

For a stiffener consisting of equal members on both sides of the web, the moment of inertia I_L shall be the sum of the moments of inertia about the centerline of the web. For a stiffener consisting of a member on one side of the web only, the moment of inertia I_L shall be taken about the face of the web in contact with the stiffener.

B.5.5.4 Pipes and Round Tubes

The stress F_b corresponding to the flexural compressive strength of pipes and round tubes is:

LIMIT STATE	F_b	R_b/t
upper inelastic buckling	$B_{tb} - D_{tb}\sqrt{\dfrac{R_b}{t}}$	$R_b/t \le \lambda_1$
lower inelastic buckling	$B_t - D_t\sqrt{\dfrac{R_b}{t}}$	$\lambda_1 < R_b/t < \lambda_2$
elastic buckling	$\dfrac{\pi^2 E}{16\left(\dfrac{R_b}{t}\right)\left(1 + \dfrac{\sqrt{R_b/t}}{35}\right)^2}$	$R_b/t \ge \lambda_2$

where

$\lambda_1 = C_{tb}$
$\lambda_2 = C_t$

B.5.5.5 Direct Strength Method

As an alternate to Sections B.5.5.1 through B.5.5.3 for flat elements in flexure without welds, the stress F_b corresponding to the flexural compressive strength may be determined as:

ERRATA

Chapter E Design of Members for Compression

This chapter addresses members subjected to axial compression through the centroidal axis.

E.1 GENERAL PROVISIONS

The available compressive strength of members is the least of the available strengths for the limit states of member buckling (E.2), local buckling (E.3), and the interaction between member buckling and local buckling (E.4). The available compressive strength ($\phi_c P_{nc}$ for LRFD and P_{nc}/Ω_c for ASD) shall be determined in accordance with Chapter E where P_{nc} is the nominal compressive strength and

ϕ_c = 0.90 (LRFD)
Ω_c = 1.65 (ASD building-type structures)
Ω_c = 1.85 (ASD bridge-type structures)

E.2 MEMBER BUCKLING

The nominal member buckling strength P_{nc} is

$$P_{nc} = F_c A_g \qquad \text{(E.2-1)}$$

where

LIMIT STATE	F_c	λ
yielding	F_{cy}	$\lambda \le \lambda_1$
inelastic buckling	$(B_c - D_c\lambda)\left(0.85 + 0.15\dfrac{C_c - \lambda}{C_c - \lambda_1}\right)$	$\lambda_1 < \lambda < C_c$
elastic buckling	$\dfrac{0.85\pi^2 E}{\lambda^2}$	$\lambda \ge \lambda_2$

where

$$\lambda_1 = \frac{B_c - F_{cy}}{D_c}$$

$$\lambda_2 = C_c$$

λ = greatest column slenderness determined from Sections E.2.1 and E.2.2.

For members without welds determine the nominal member buckling strength $P_{nc} = P_{no}$ using B_c, D_c, and C_c for unwelded material using Table B.4.1 or B.4.2 and F_{cy}.

For members that are fully weld-affected determine the nominal member buckling strength $P_{nc} = P_{nw}$ using B_c, D_c, and C_c for welded material using Table B.4.1 and F_{cyw}.

For members with transverse welds and:

a) supported at both ends with no transverse weld farther than 0.05L from the member ends, $P_{nc} = P_{no}$

b) supported at both ends with a transverse weld farther than 0.05L from the member ends or supported at only one end with a transverse weld $P_{nc} = P_{nw}$,

For members with longitudinal welds, the nominal member buckling strength is:

$$P_{nc} = P_{no}(1 - A_{wz}/A_g) + P_{nw}(A_{wz}/A_g) \qquad \text{(E.2-2)}$$

E.2.1 Flexural Buckling

For flexural buckling, λ is the largest slenderness kL/r of the column. The effective length factor k for calculating column slenderness kL/r shall be determined using Section C.3.

E.2.2 Torsional and Flexural-Torsional Buckling

For torsional or flexural-torsional buckling,

$$\lambda = \pi\sqrt{\frac{E}{F_e}} \qquad \text{(E.2-3)}$$

where F_e is the elastic buckling stress determined by analysis or as follows:

a) For doubly symmetric members:

$$F_e = \left(\frac{\pi^2 E C_w}{(k_z L_z)^2} + GJ\right)\frac{1}{I_x + I_y} \qquad \text{(E.2-4)}$$

b) For singly symmetric members where y is the axis of symmetry:

$$F_e = \left(\frac{F_{ey} + F_{ez}}{2H}\right)\left[1 - \sqrt{1 - \frac{4F_{ey}F_{ez}H}{(F_{ey} + F_{ez})^2}}\right] \qquad \text{(E.2-5)}$$

c) For unsymmetric members, F_e is the lowest root of the cubic equation:

$$(F_e - F_{ex})(F_e - F_{ey})(F_e - F_{ez}) - F_e^2(F_e - F_{ey})(x_o/r_o)^2 - F_e^2(F_e - F_{ex})(y_o/r_o)^2 = 0 \qquad \text{(E.2-6)}$$

where

$$r_o^2 = x_0^2 + y_0^2 + \frac{I_x + I_y}{A_g} \qquad \text{(E.2-7)}$$

$$H = 1 - \frac{x_0^2 + y_0^2}{r_0^2} \qquad \text{(E.2-8)}$$

$$F_{ex} = \frac{\pi^2 E}{\left(\dfrac{k_x L_x}{r_x}\right)^2} \qquad \text{(E.2-9)}$$

$$F_{ey} = \frac{\pi^2 E}{\left(\dfrac{k_y L_y}{r_y}\right)^2} \qquad \text{(E.2-10)}$$

$$F_{ez} = \frac{1}{A_g r_o^2}\left(GJ + \frac{\pi^2 E C_w}{(k_z L_z)^2}\right) \qquad \text{(E.2-11)}$$

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In the as-welded condition, the distance between the edge of the base metal and the toe of the weld is permitted to be less than 1/16 in. (2 mm) provided the weld size is clearly verifiable.

J.2.2.2 Fillet Weld Effective Length

A fillet weld's effective length L_{we} is the overall length of the weld, including boxing. If the effective length is less than four times its nominal size S_w, the effective weld size shall be considered to be 25% of its effective length.

The length of any segment of intermittent fillet welds shall not be less than the greater of four times the weld size and 1½ in. (40 mm).

The maximum effective length of an end-loaded fillet weld is $100S_w$.

J.2.3 Plug and Slot Welds

The effective area A_{we} of plug or slot welds is the nominal area of the hole or slot in the plane of the faying surface. Slot lengths shall not exceed 10 times the slotted material's thickness.

J.2.4 Stud Welds

The base metal thickness for arc stud welding shall not be less than 50% of the stud diameter. The base metal thickness for capacitor discharge stud welding shall not be less than 25% of the stud diameter.

J.2.5 Strength

The nominal strength R_n of groove, fillet, plug, and slot welded joints shall be the lesser of the base material strength for the limit states of tensile rupture and shear rupture and the weld metal strength for the limit state of rupture as follows:

(a) For the base metal

$$R_n = F_{nBM} A_{BM} \qquad \text{(J.2-1)}$$

(b) For the weld metal

$$R_n = F_{nw} A_{we} \qquad \text{(J.2-2)}$$

where

F_{nBM} = nominal stress of the base metal corresponding to its welded ultimate strength from Table A.3.3 or Table A.3.3M

F_{nw} = nominal stress of the weld metal corresponding to its ultimate strength from Table A.3.6

A_{BM} = cross-sectional area of the base metal

A_{we} = effective area of the weld

F_{nBM} , F_{nw} , A_{BM}, and A_{we} are given in Table J.2.2.

Table J.2.2
NOMINAL STRENGTH OF WELDED JOINTS

Load Type and Direction Relative to Weld Axis	Metal	Nominal Stress F_{nBM} or F_{nw}	Effective Area A_{BM} or A_{we}
COMPLETE-JOINT PENETRATION GROOVE WELDS			
tension or compression normal to weld axis	Base	F_{tuw}	$S_w L_{we}$
	Weld	F_{tuw}	$S_w L_{we}$
tension or compression parallel to weld axis	tension or compression in parts parallel to a weld need not be considered in designing welds joining the parts		
shear	Base	$0.6F_{tuw}$	$S_w L_{we}$
	Weld	$0.6F_{tuw}$	$S_w L_{we}$
PARTIAL-JOINT PENETRATION GROOVE WELDS			
tension or compression parallel to weld axis	tension or compression in parts parallel to a weld need not be considered in designing welds joining the parts		
shear	Base	$0.6F_{tuw}$	$S_w L_{we}$
	Weld	$0.6F_{tuw}$	$S_w L_{we}$
FILLET WELDS			
shear	Base	$0.6F_{tuw}$	$S_w L_{we}$
	Weld ①	$0.6(0.85F_{tuw})$	$S_{we} L_{we}$
tension or compression parallel to weld axis	tension or compression in parts parallel to a weld need not be considered in designing welds joining the parts		
PLUG AND SLOT WELDS			
shear parallel to faying surface	Base	$0.6F_{tuw}$	see J.2.3
	Weld	$0.6F_{tuw}$	
STUD WELDS			
shear	Base	$0.6F_{tuw}$	$\pi D^2/4$
	Weld	$0.6F_{tuw}$	$(\pi/4)(D - 1.191/n)^2$
tension	Base	F_{tuw}	$\pi D^2/4$
	Weld	F_{tuw}	$(\pi/4)(D - 1.191/n)^2$

① Alternately, the strength of fillet welds loaded transversely shall be taken as 1.36 times the strength given in Table J.2.2.

② F_{tuw} for base metal is listed in Tables A.3.3 and A.3.3M.

③ F_{tuw} for filler metal is listed in Table A.3.6.

J.2.6 Combination of Welds

If two or more of the types of welds (groove, fillet, plug, or slot) are combined in a single joint, the strength of each shall be separately computed with respect to the axis of the group in order to determine the strength of the combination.

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