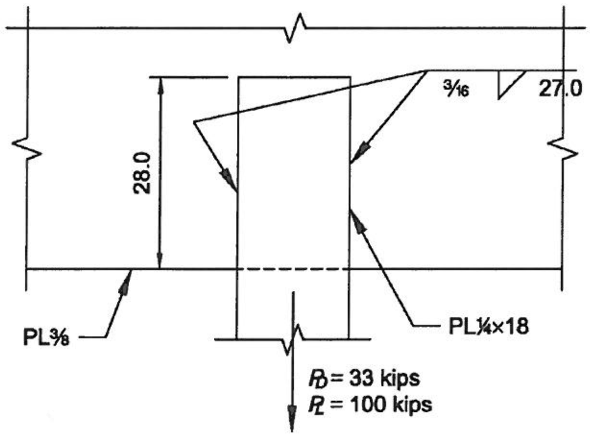
Example J.1 Fillet Weld in Longitudinal Shear

Given:

An ¼ in.×18-in. wide plate is fillet welded to a ⅜-in. plate. Assume that the plates are ASTM A572 grade 50 and have been properly sized. Assume F_{EXX} = 70 ksi. Note that plates would normally be specified as ASTM A36, but F_y = 50 ksi plate has been used here to demonstrate requirements for long welds.

Size the welds for the loads shown.



Solution:

Determine the maximum weld size

Because the overlapping plate is ¼ in., the maximum fillet weld size that can be used without special notation (built out to obtain full-throat thickness as required in AISC Specification Section J2.2b) is a 3⁄16-in. fillet weld. A 3⁄16-in. fillet weld can be deposited in the flat or horizontal position in a single pass (true up to 5⁄16-in).

Determine the required strength

LRFD	ASD
P_u = 1.2(33 kips) + 1.6(100 kips) = 200 kips	P_a = 33 kips + 100 kips = 133 kips

Determine the length of weld required

LRFD	ASD
The design strength per inch of a 3⁄16-in. fillet weld is ϕR_n = 1.392 (3) = 4.17 kips/ in. $\dfrac{P_u}{\phi R_n} = \dfrac{200 \text{ kips}}{4.17 \text{ kips/in.}} = 48 \text{ in.}$ or 24 in. of weld on each side	The allowable strength per inch of a 3⁄16-in. fillet weld is R_n/Ω= 0.928 (3) = 2.78 kips/ in. $\dfrac{P_a\Omega}{R_n} = \dfrac{133 \text{ kips}}{2.78 \text{ kips/in.}} = 48 \text{ in.}$ or 24 in. of weld on each side.

Manual Part 8

Check the weld for length to weld size ratio

$$\frac{l}{w} = \frac{24 \text{ in.}}{0.188 \text{ in.}} = 128 > 100,$$

Therefore Specification Equation J2-1 must be applied, and the length of weld increased, since the resulting β will reduce the available strength below the required strength.

Try a weld length of 27 in. Specification Eqn. J2-1

The new length to weld size ratio is 27 in. /0.188 in. = 144

For this ratio

$\beta = 1.2\text{-}0.002(l/w) \leq 1.0$; $1.2\text{-}\ 0.002(144) = 0.912$

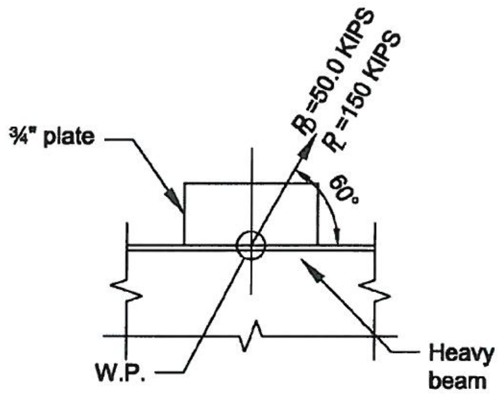
Recheck the weld at its reduced strength

LRFD	ASD
$\phi R_n = (0.912)(4.17 \text{ kips/in.})(54 \text{ in.})$ $= 205 \text{ kips} > P_u = 200 \text{ kips}$ **o.k.** Therefore, use 27 in. of weld on each side	$\frac{R_n}{\Omega} = (0.912)(2.78 \text{ kips/in.})(54 \text{ in.})$ $= 137 \text{ kips} > P_a = 133 \text{ kips}$ **o.k.** Therefore, use 27 in. of weld on each side

Example J.2 Fillet Weld Loaded at an Angle

Given:

Design a fillet weld at the edge of a gusset plate to carry a force of 50 kips due to dead load and a force of 150 kips due to live load, at an angle of 60 degrees relative to the weld. Assume the beam and the gusset plate thickness and length have been properly sized.



Solution:

Calculate the required strength

LRFD	ASD
P_u = 1.2(50 kips) + 1.6(150 kips) = 300 kips	P_a = 50 kips + 150 kips = 200 kips

Assume a 5⁄16-in. fillet weld is used on each side.

The shear strength of a 5⁄16-in. fillet weld is

LRFD	ASD
5(1.392) = 6.96 kip/in. And for two sides 2(6.96 kip/in.) = 13.9 kip/in.	5(0.928) = 4.64 kip/in. And for two sides 2(4.64 kip/in.) = 9.28 kip/in.

Because the angle of the force relative to the axis of the weld is 60 degrees, the strength of the weld can be increased as follows:

$$k_w = 0.60F_{EXX}\left(1.0 + 0.50\ \sin^{1.5}\theta\right)$$
$$= 0.60(70)\left(1.0 + 0.50\ (0.866)^{1.5}\right)$$
$$= 1.40$$

Find the increased strength and the required length of weld

LRFD	ASD
Calculate the increased strength. 13.9 kip/in.(1.40) = 19.5 kip/in. *Determine the required length of weld.* 300 kips/19.5 kip/in. = 15.4 in. Use 16 in. **o.k.**	*Calculate the increased capacity.* 9.280 kip/in.(1.40) = 13.0 kip/in. *Determine the required length of weld.* 200 kips/13.0 kip/in. = 15.4 in. Use 16 in. **o.k.**

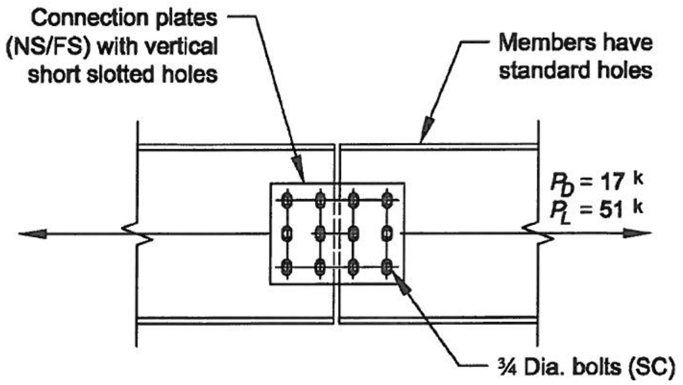
Example J.4 Slip-Critical Connection with Short Slotted Holes

High-strength bolts in slip-critical connections are permitted to be designed to prevent slip either as a serviceability limit state or as a strength limit state. The most common design case is design for slip as a serviceability limit state. The design of slip as a strength limit state should only be applied when bolt slip can result in a connection geometry that will increase the required strength beyond that of a strength limit state, such as bearing or bolt shear. Such considerations occur only when oversized holes or slots parallel to the load are used, and when the slipped geometry increases the demand on the connection. Examples include the case of ponding in flat-roofed long span trusses, or the case of shallow, short lateral bracing.

Given:

Select the number of ¾-in. ASTM A325 slip-critical bolts with a Class A faying surface that are required to support the loads shown when the connection plates have short slots transverse to the load. Select the number of bolts required for slip resistance only.

Assume that the connected pieces have short slots transverse to the load. Use a mean slip coefficient of 0.35, which corresponds to a Class A surface.



Solution:

Calculate the required strength

LRFD	ASD
P_u = 1.2(17 kips) + 1.6(51 kips) = 102 kips	P_a = 17 kips + 51 kips = 68 kips

For standard holes or slots transverse to the direction of the load, a connection can be designed on the basis of the serviceability limit state. For the serviceability limit state:

$$\phi = 1.00 \quad \Omega = 1.50$$

Specification Section J3.8

Find R_n, where:

μ = 0.35 for Class A surface
D_u = 1.13
h_{sc} = 0.85 (short slotted holes)
T_b = 28 kips
N_s = 2, number of slip planes

Table J3.1

$R_n = \mu D_u h_{sc} T_b N$

Eqn.J3-4

R_n = 0.35(1.13)(0.85)(28)(2) = 18.8 kips/bolt

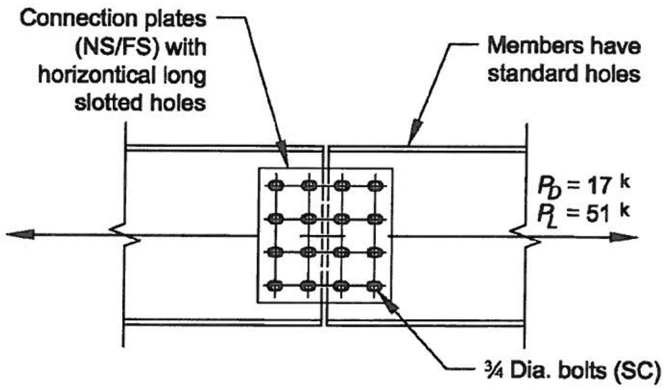
Determine the required number of bolts.

LRFD	ASD
102 kips/1.00(18.8 kips/bolt) = 5.42 bolts	$68\text{ kips}/\dfrac{18.8\text{ kips/bolt}}{1.50} = 5.42\text{ bolts}$
Use 6 bolts **o.k.**	Use 6 bolts **o.k.**

Manual Table 7-3

Given:

Repeat the problem with the same loads, but assuming that the connected pieces have long slotted holes in the direction of the load and that the deformed geometry of the connection would result in a critical load increase.



Solution:

P_u = 102 kips and P_a = 68 kips per the first solution

For this connection, the designer has determined that oversized holes or slots parallel to the direction of the load will result in a deformed geometry of the connection that creates a critical load case. Therefore, the connection is designed to prevent slip at the required strength level.

$$\phi = 0.85 \quad \Omega = 1.76$$

Specification Section J3.8

In addition, h_{sc} will change because we now have long slotted holes.

Find R_n

μ = 0.35 for Class A surface
D_u = 1.13
h_{sc} = 0.70 (long slotted holes)
T_b = 28 kips
N_s = 2, number of slip planes

Table J3.1

$R_n = \mu D_u h_{sc} T_b N_s$

R_n = 0.35(1.13)(0.70)(28)(2) = 15.5 kips/bolt

Specification Eqn. J3-4

Determine the required number of bolts

LRFD	ASD
$\dfrac{102\text{ kips}}{0.85(15.5\text{ kips/bolt})} = 7.73\text{ bolts}$	$\dfrac{68\text{ kips }(1.76)}{15.5\text{ kips/bolt}} = 7.63\text{ bolts}$
Use 8 bolts **o.k.**	Use 8 bolts **o.k.**

Manual Table 7-4