Fillet Welds that are "Too Long"

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When fillet welds are sized beyond a certain leg size-to-length ratio, their capacity might not be what you think it is.

When fillet welds exceed a certain leg size-to-length ratio, and when such welds are "end loaded," they can become "too long"; that is, the added length might not add strength that is proportional to the increase in length. This situation is rare, but designers should be aware of when it occurs, why the capacity is diminished and how to mitigate the effects.

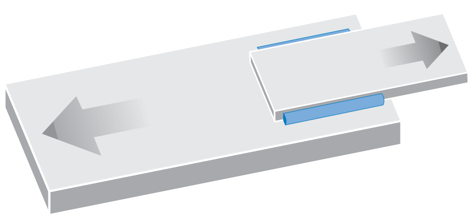
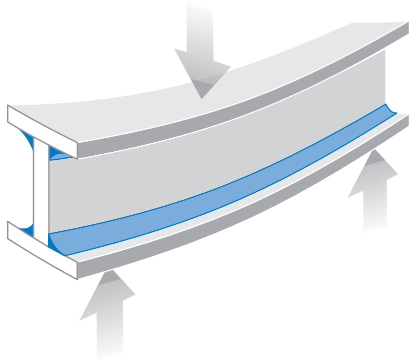


Figure 1, *above*. An "end-loaded" connection, where the load is transferred to the end of a weld.

Figure 2, *below*. Weld subject to shear loading due to bending forces.



"End loaded" applies to connections where the load is transferred to the end of a weld. Figure 1 illustrates one such example. Many lap joints with longitudinal welds have end-loaded fillet welds, as do bearing stiffeners. Welds subject to shear loading due to bending forces, such as those shown in Figure 2, are not included in end-loaded applications. In addition, transversely loaded welds are not considered end loaded.

The distribution of stress at the end of welds, such as the one shown in Figure 1, is far from uniform. The relative stiffness of the weld versus the two lapped members might be significantly different. Shear lag further complicates the stress distribution. Due to these factors, and perhaps others as well, the full length of the weld might not be uniformly loaded. At some length, it becomes unconservative to assume the full length of the weld is equally effective in transferring stress. For the purposes of this article, it is at that point that the weld is considered to be "too long."

Based on experience and research, a ratio of the weld leg size to weld length has been determined to be a critical factor in determining the effective length. When this ratio is 100 or less, the entire length can be considered effective. Thus, ¼" (6 mm) welds less than 25" (600 mm) long, and 3/8" (10 mm) welds less than 37.5" (1000 mm) long are no problem and can be treated in the conventional manner. Therefore, for many applications, concern about welds that are "too long" will not occur.

For longer welds, however, the additional length might not be proportionally stronger. To address this, the 1999 AISC LRFD *Specification* has added an equation to calculate a β

TABLE

Weld Size, *w*	Critical Length, in.		Capacity, kips		Member Size, in^2	
in.	100*w*	300*w*	1 weld	2 welds	1 weld	2 welds
1/16	6.3	18.8	5.8	11.6	0.2	0.4
1/8	12.5	37.5	23.2	46.4	0.8	1.5
3/16	18.8	56.3	52.2	104.3	1.7	3.5
1/4	25.0	75.0	92.8	185.5	3.1	6.2
5/16	31.3	93.8	144.9	289.8	4.8	9.7
3/8	37.5	112.5	208.7	417.4	7.0	13.9
1/2	50.0	150.0	371.0	742.0	12.4	24.7
5/8	62.5	187.5	579.7	1,159.4	19.3	38.7
3/4	75.0	225.0	834.8	1,669.5	27.8	55.7
7/8	87.5	262.5	1,136.2	2,272.4	37.9	75.8
1	100.0	300.0	1,484.0	2,968.0	49.5	99.0

(beta) factor, which reduces the effective weld length as follows:

$$\beta = 1.2 - 0.002\ (L/w) \leq 1.0$$

$$L_{eff} = \beta\, L$$

where,

β = length reduction factor

L = actual length of end-loaded weld, in. (mm)

w = weld leg size, in. (mm)

L_{eff} = effective length, in. (mm).

When the length of the weld exceeds 300 times the leg size, the value of β shall be taken as 0.60.

Consider a weld with a w/L ratio of 200: a ¼″ (6 mm) fillet weld that is 50″ (1200 mm) long. β is 0.8 in this example, and the effective length is reduced to 40″ (960 mm).

Note for w/L less than 100, the equation would generate an invalid value of β that is greater than 1.0.

Once w/L is greater than 300, β remains fixed at 0.6, according to the above equation.

Table 1 summarizes key issues surrounding the leg size-to-weld-length ratio. The second and third columns simply show the 100*w* and 300*w* values for the different weld sizes. Welds less than 100*w* are never "too long" and β = 1.0. Welds that are longer than 300*w* will have their length adjusted by β = 0.6. Between these two values, the simple equation shown above must be used.

In the design process, before the weld size or length is determined, the load transferred through the connection is calculated. Then, the corresponding weld length and size is determined for the electrode strength classification that will be used. The fourth and fifth columns show the maximum load that can be end-loaded on a fillet weld of length 100*w*, assuming the use of an E70 (E48) electrode. Column four assumes the unusual case where only one fillet weld is involved, while column five considers the more typical situation where a pair of welds is involved.

The last two columns examine the applications of the equation described above in yet another manner; that is, by considering the size of the connected materials. Assuming the use of a 50 ksi (350 MPa) steel, and a maximum allowable stress of 60 percent of yield, column six provides the maximum cross sectional area of the connected material that can be joined by one fillet weld of 100*w* length. Column seven provides the same data for a pair of such fillet welds.

Careful examination of the data in this table demonstrates that the need to consider an adjustment on the weld length will not arise often. The 300*w* ratio will only occur in very unique circumstances. Nevertheless, the designer should be aware of the situations where the weld is "too long" and adjust the effective length in accordance with the equation shown above. ★

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