Design File

Fillet Welds That Are "Too Long"

Practical Ideas for the Design Professional by Duane K. Miller, Sc.D., P.E.

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 may not add strength that is proportional to the increase in length. This situation rarely occurs, as will be seen, but the designer should be aware of when it occurs, why the capacity is diminished, and how to mitigate the effects.

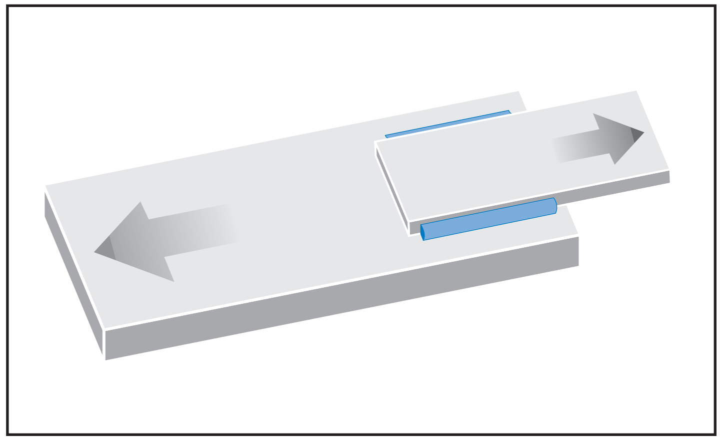

Figure 1.

"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 would have end loaded fillet welds, as would 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.

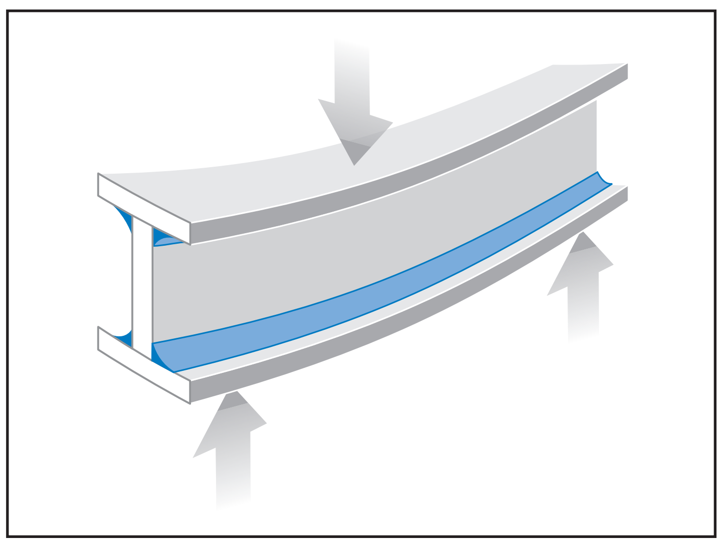

Figure 2.

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 may 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 may 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 in. (6 mm) welds less than 25 in. (600 mm) long, and 3/8 in. (10 mm) welds less than 37.5 in. (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 due to practical considerations.

For longer welds, however, the additional length may not be proportionally stronger. To address this, the AISC LRFD 2000 Specification has added an equation to calculate a β (beta) factor, which reduces the effective weld length as follows:

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

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

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 in. (6 mm) fillet weld that is 50 in. (1200 mm) long. Beta is 0.8 in this example, and the effective length is reduced to 40 in. (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. Columns 2 and 3 simply show the 100w and 300w values for the different weld sizes. Welds less than 100w are never "too long" and β = 1.0. Welds that are longer than 300w 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. Columns 4 and 5 show the maximum load that can be end loaded on a fillet weld of length 100w, assuming the use of an E70 (E48) electrode. Column 4 assumes the unusual case where only one fillet weld is involved, while Column 5 considers the more typical situation where a pair of welds is involved.

Columns 6 and 7 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% of yield, Column 6 provides the maximum cross sectional area of the connected material that can be joined by one fillet weld of 100w length. Column 7 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 300w 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.

ENGLISH

Weld Size, w in.	Critical Length, in. 100w	Critical Length, in. 300w	Capacity, kips 1 weld	Capacity, kips 2 welds	Member Size, in^2 1 weld	Member Size, in^2 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

METRIC

Weld Size, w mm	Critical Length, mm 100w	Critical Length, mm 300w	Capacity, kN 1 weld	Capacity, kN 2 welds	Member Size, mm^2 1 weld	Member Size, mm^2 2 welds
2	200	600	40.7	81.4	0.2	0.4
4	400	1,200	162.8	325.6	0.8	1.6
6	600	1,800	366.3	732.7	1.7	3.5
8	800	2,400	651.3	1,302.5	3.1	6.2
10	1,000	3,000	1,017.6	2,035.2	4.8	9.7
12	1,200	3,600	1,465.3	2,930.7	7.0	14.0
14	1,400	4,200	1,994.5	3,989.0	9.5	19.0
16	1,600	4,800	2,605.1	5,210.1	12.4	24.8
18	1,800	5,400	3,297.0	6,594.0	15.7	31.4
20	2,000	6,000	4,070.4	8,140.8	19.4	38.8
22	2,200	6,600	4,925.2	9,850.4	23.5	46.9
24	2,400	7,200	5,861.4	11,722.8	27.9	55.8
26	2,600	7,800	6,879.0	13,758.0	32.8	65.5