steelwise

DESIGNING WELDS FOR SKEWED SHEAR TABS

How to choose the best welding option for skewed single-plate shear tabs.

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IMAGINE YOU'VE BEEN ASKED to design a skewed single-plate shear connection.

Everything seems to be going well, you're making all of the same calculations that you normally would… and then you get to the welds and ask yourself, now what?

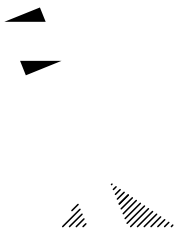
What part of the AISC *Speci cation* should I use? Am I limited to the designs shown in Table 10-14C of the 14th Edition AISC *Manual*? What if a connection has a skew angle greater than 45° and doesn't fall within the required angle ranges provided in the design tables??

Fear not! We have answers for you.

Welding Well

Before we get started, let's make sure we're all on the same page. If we are talking about a shear tab with a skew angle of 10°, the connection con guration should look something like what is shown in Figure 1. Essentially, the shear tab is skewed 10° off of a standard perpendicular shear tab connection.

This is also a good time to talk brie y about potential edge conditions for shear tabs. Figure 2 compares a shear tab that has a square edge versus one that is beveled. In most cases, leaving a square edge will be more economical than beveling. However, it will also result in a gap or root opening. As the skew angle increases, the gap increases and if this dimension becomes too large, beveling may be required, since AWS D1.1 Clause 5.22.1 limits the gap to 3⁄16 in. The square edge usually requires a larger weld size than the beveled edge.



Section J2 of the AISC *Speci cation* states:

> "All provisions of AWS D1.1/D1.1M apply under this *Speci cation*, with the exception that the provisions of the listed AISC *Speci cation* sections apply under this *Speci cation* in lieu of the cited AWS provisions..."

There are a few options available when sizing llet welds for a skewed shear tab, and Figure 3 highlights these different paths. Each path is explained in further detail later in this article; partial joint penetration (PJP) and complete joint penetration (CJP) groove welds will also be discussed.

1 10-14 (14 *Manual*). Table 10-14C on page 10-176 of the 14th Edition AISC *Manual* provides the easiest and quickest way to determine the required l-let weld sizes for a skewed shear tab. As long as the plate thickness equals 5⁄16 in., 3⁄8 in. or ½ in. and will have a skew angle of 45° or less, this table will provide a solution. The provided llet weld leg sizes in the table account for root openings and the Z-loss dimension when it is applicable (see Figure 4). The root opening is the gap at the location of the root of the weld, between the shear tab and the steel to which it is being welded. The Z-loss dimension accounts for the incomplete fusion that is likely in some cases at the root of the joint (on the acute side

of the connection) due to restricted welding access. The Z-loss dimension depends on the acute angle, the welding process and the position of welding.

It is important to point out the note at the bottom of Table 10-14C, which says that the tabular information "satis es single-plate weld requirements for these thicknesses." This refers to

In specifying a fillet weld with an effective throat thickness of 0.138 in. for a 5/16-in. shear tab that is skewed 31° (again, see Figure 6), the fabricator would then have the ability to select a weld configuration that works best for that particular situation. Figure 7 provides two examples of how a fabricator may size the fillet welds based on the detail shown in Figure 6. Both options shown in Figure 7 provide an effective weld throat that meets the 0.138-in. design requirement provided in Figure 6. The weld position that the fabricator chooses has an impact on the required fillet weld size. A vertical weld position used in Example 1 would result in a Z-loss dimension, whereas the flat weld position used in Example 2 would not.

the required effective throat thickness, there is an opportunity to reduce weld costs. Another example where a calculated fillet weld leg size is smaller than what is shown in Table 10-14C is for the 22° to 45° weld detail for the ½-in. plate. At a 23° angle, a ⅜-in. fillet weld would be required for the near-side weld. But if Table 10-14C is used, a ½-in. fillet weld would be specified. This example is looking at the extreme end of any potential difference between what is provided in Table 10-14C versus what could be calculated. For most projects, the use of Table 10-14C is economical with the added benefits of being easy and fast to use. If a project will require a substantial amount of skewed shear tab connections, there may be an opportunity to reduce weld costs by calculating the required fillet weld leg sizes.

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Z-loss Dimension

Per AWS D1.1 Clause 2.4.3.3, for welds in angles greater than 30° and less than or equal to 60°, the effective throat shall be increased by the Z-loss allowance, which is provided in Table 2.2 of AWS D1.1/D1.1M:2010. The Z-loss dimension was described earlier as a way to account for the incomplete fusion that could occur at the root of a weld when the acute angle is narrow. When this is the case, fusion to the root is unlikely, which is why an adjustment of the fillet weld leg sizes is required. The required fillet weld leg can be calculated using the same method (Annex B) described earlier. The only difference here is that the Z-loss value that is provided in Table 2.2 needs to be added to the required effective throat. The following example demonstrates this additional step (see Figure 9).

Required effective throat size,

A single-sided PJP groove or llet weld detail should not be used for shear tabs either. For a skewed shear tab that has a skew angle greater than 60°, the best option is typically to use a CJP groove weld (see Figure 11).

You Have Options

There are a lot of options when designing welds for skewed shear tabs. Having a lot of choices, though, can make it dif cult for the engineer to pick the best one. The following recommendations will help you avoid mistakes and at the same time, achieve more economical weld designs:

1. For skews that are less than or equal to 10°, provide the same llet weld leg size as for a 90° angle.
2. For skews that are larger than 10°, state the required effective throat in the design drawing and let the fabricator determine the best weld type and process to use.
3. Aside from making changes to the framing layout, when the skew angle exceeds 60°, a CJP groove weld is typically the best option.
4. Avoid single-sided llet and PJP groove welds for shear tabs. MSC