Wide Flange Column Splices

A typical wide flange column splice detail is shown below. These vary from engineer to engineer, but commonly show the web splice plate shop-welded to the lower column section with the upper column section field-bolted. In some instances, the web plates are substituted for channels or other structural shapes.

Figure 1: Shop Welded Web Splice Plate on WF Column
In all cases, these web connection plates should be bolted on both the top and bottom sections of the columns (see figure 2 below). It is also suggested that plate be the preferred choice for all column splice applications rather than channel or other shapes. There are several reasons for these suggestions.

First, let me address the preference for plate as column splice material.
Plate processing equipment is some of the most efficient shop equipment available. In fact, it is so efficient, that most fabricators with plate processing equipment have more capacity than they can use in their own shop. Many small fabricators will in fact sublet plate parts-making capacity to other small fabricators to help pay for their equipment.

Channel on the other hand, is typically processed on the same fabrication line and equipment as beams and columns. Most shops do not have any additional capacity on their beam lines. The beam line is much more likely to be the limiting constraint on overall shop throughput capacity. When the fabricator is busy processing channels on the beam line, they are not processing beams or columns. If you consider the structural steel fabrication shop to be a modified assembly line of sorts, you can imagine that slowing or stopping the flow of beams through the saw and drill at the front of the shop will potentially slow the flow through all of the shop processes.

Further, plate is normally about the same price per pound as channel. Therefore, there will be little or no extra cost to use plate rather than channel shapes. Even though the plate section may be slightly heavier than a comparable channel section, there is less overall waste when processing plate and no remnants to worry about with the plate since it is commonly used on every project. The channel will surely have remnants that the fabricator does not want to store or add to inventory. Any channel remnants will likely be thrown into the recycle bin as they are not commonly used on every project.

As to the connection itself, in all cases the plate should be bolted at both the top and the bottom. There are multiple reasons for using bolts on both the upper and lower shafts of the column splice.

First, it is slightly easier and less expensive in the shop to drill and bolt on the splice plate than it is to layout and weld it onto the lower column shaft. The cost savings is not significant, but it is a small amount multiplied over many columns. Second, it is possible to tack-weld a web plate into position and then forget to complete the weld. I have seen this occur several times over the years. Usually, the field ironworkers don’t notice the incomplete weld until they experience a negative result. If bolts are missing from the connection, this is easily noticeable while hooking on to the column in the field.

Further, and most importantly, if the plate is bolted at the lower and upper shafts, it allows for slightly more adjustment or flexibility when the field ironworker is connecting the two column pieces together. The lower bolts can be loosened slightly while waiting for the crane to swing in the upper column section so that there is a little “play” in the connection. Again, this might not seem like a significant issue, but if the plate is welded even 1/16” too low or slightly skewed, or the end of the column shafts are not cut perfectly square, there will be a fit-up issue in the field.

If a fit-up issue does occur, the connector will either leave out some of the bolts or grab a torch to oversize the holes. Either way, this slows the connectors and crane and reduces productivity. If one or more of the bolts are left out, or the holes are oversized with a torch, then the overall stability of the structure is lessened.
There are many instances when adding flange plates to your column splice will be beneficial to the steel erector. Two common examples are shown below.

Figure 3: Shop Welded Ears on the Lower Column Shaft
These “rabbit” or “dog” ears, as they are commonly called, provide for a much more structurally stable connection at the column splice as compared to only using a web plate. This makes the column, as well as the overall structure, very stable during erection (before welding / bolting is complete). These added splice plates are not typically necessary for small two-story gravity columns but can be very helpful for longer columns or brace-frame columns. Frame columns that have large gussets protruding off the column on one, two, or three sides cause an un-equal balance of weight which produces a moment force at the splice connection. If the connection relies solely on a web plate, the unbalanced weight can cause a problem should a column or girder in-coming on the hook strike the unbalanced frame column.
Further, for heavy columns with a web splice plate only, the stability of the free-standing column needs to be checked by an engineer for stability during erection. This adds yet another expense to the project.

If additional splice capacity is needed, I would recommend always using the rabbit ears made from plate and flat bar in figure 4: *Shop Bolted Ears on the WF Column*.

There are several reasons for using this connection as opposed to the welded ears as shown in figure 3. The reasoning is easier to explain by pointing out the deficiencies of this welded angle arrangement.

In figure 3, the angles are welded to the lower column section flanges in the shop. These are easy to detail, layout, and weld. In addition, they are made from inexpensive angle shapes. At first glance they appear to be a simple and easy way to add extra splice capacity at a low cost per column.

There are several inherent problems with this type of connection though.

1. If the upper and lower column sections vary dimensionally, which occurs quite frequently with given mill material tolerances, there could be a problem with field fit-up. Other problems may be caused by flange thickness variances, shop layout tolerances, and out-of-square end cuts on the main members. Upon close examination of the detail, any number of potential fit-up problems can be seen due to the fixity of the angles. In fact, it would be unlikely if fit-up problems did not occur regularly.

2. When the field ironworker is prepared to start welding the flanges at this column splice, the rabbit ear angles are in the way. They must be cut out and removed before welding can be completed.

3. When the weld is complete, the welds that attached the angles to the lower column shaft must be removed and ground flat before the inspection can take place. Inspectors typically UT the field welds and need a smooth clean surface for their transducers to work correctly. It takes a considerable amount of time to grind all eight welds within several inches above and below the column splice weld. Plus, any accidental gouges to the flange while cutting away the angles must then be repaired.

4. The angles are often bent during shipping (loading and unloading). These must then be cut off or straightened in the field before erecting the columns.

As shown in figure 4 with plate and flat bar, with the flat plates welded several inches away from the column splice weld groove, the problems listed above are eliminated. Further, the plates welded to the column do not have to be cut flush or the welds ground afterward. Simply cutting the plate at the toe of the weld and leaving behind about a ¼” of material poses no problem and will not be seen once fire-proofing and / or interior finishes are installed. This ensures that there is no accidental gouging of the column flange (and subsequent repair) during the removal of the erection aids.

In addition, the long vertical plates and their bolts can be removed and used again on upper columns (or future projects) if desired by the fabricator / erector. They need to be removed anyway, so saving them in a skip for future use is not much extra work.
I have been told that some ironworkers use these plates with porta-powers to help adjust the root gap in the two sections before welding. There may be some advantage to using the plates for help in root gap adjustment, but this is a minor aid at best.

While the reasons listed above may seem minor, taken together, they add up to a significant savings in the shop and field. Anything that lowers cost and increases production is worth pursuing, even if the savings seem minor at first glance.

The plates are shop installed facing down for handling and shipping, then flipped upright by the hook-on men or connectors. See the picture below for an example.

Figure 5: Shop Bolted Ears Ready for Shipping