What's up with the new Design Procedures?

LRFD & The Steel Detailer

By Charles J. Carter, S.E., P.E.

Detailers familiar with older ASD manuals should quickly feal comfortable with the format of the silver *LRFD Manual of Steel Construction*.

"Load and resistance factor design" is a phrase that makes a lot of people uneasy. And judging from a few of the past email exchanges that have discussed LRFD on the Steel-Link.com steel detailing list server, steel detailers are no exception. Opinions converged and diverged, which will come as a surprise to nobody who has seen or participated in an exchange on the typical email list server. (That's what makes email list servers like the ones offered on Steel-Link.com so great. But back to the point of this article.)

After the email exchanges regarding LRFD had run their course, I was left with an unanswered question: What does the ongoing transition to LRFD really mean for the steel detailer? For some steel detailers, the short answer may simply be "business as usual". For the rest, "business as usual with a twist" may be more like it. Now for the longer answers.

Steel Detailers that Just Say No!
To connection design, that is.

Some steel detailers do not provide connection design services in the course of their business practices. Using information shown in the design drawings and contract information prepared and/or provided by others, these steel detailers transform the complete design (including connections) into shop and erection drawings. With a job well done, the resulting shipping pieces are efficient to fabricate in the shop and erect in the field. Thank the steel detailer when the job flies through the shop. Then thank the steel detailer again when it fits in the field. End of story.

Oh, wait! The answer about what LRFD means in this case is "business as usual". When others provide the complete design (including connections), the steel detailer's task is distilled to the art of making the job fly through the shop and fit in the field.

Steel Detailers that Inhale
Or maybe "delve into connections" would have been a better choice of words.

It happens, probably more often than not. Perhaps it is limited to the steel detailer selecting or completing the detailed configurations of simple shear connections based upon criteria specified by the structural engineer of record. An experienced steel detailer may go further than this and develop moment or bracing connections. At the extreme, a properly licensed, legally permitted and otherwise empowered steel detailer may choose to practice engineering as a part of his or her business practices. Issues of connection design responsibility aside, if only because that's not the subject of this article, "business as usual with a twist" is more likely the answer.

The "business as usual" part comes in because everything mentioned earlier under "Steel Detailers that Just Say No!" applies here too. Now, let's cover the twist, which really gets at how are connections different in LRFD.

Are You Sure LRFD is Different?
Philosophically speaking, connection design is no different in LRFD than it is in ASD.

• Manuals. The 2nd Edition *LRFD Manual of Steel Construction* is silver. The *9th Edition ASD Manual* is green (It's companion *Volume II—Connections* is green and blue). Other than that, if you're familiar with the green 9th *Edition*, or red 8th *Edition* or blue 7th Edition for that matter, the 2nd Edition *LRFD Manual* will be quite familiar to you. You might actually find the connection design examples in it to be more thorough and descriptive of what is being checked and why.

• Loads and load factors. In LRFD, the

design loads are calculated using load combinations with load factors that vary for each type of load. In ASD, the design loads are calculated the same way, except the load factor is always taken as 1. The result in LRFD is called the factored load. The result in ASD is called the service load.

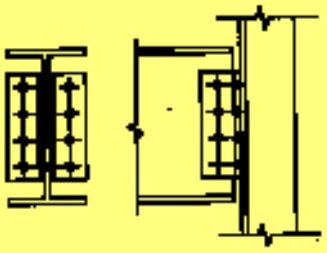
Sometimes, the design criteria for the connections are instead expressed as a function of the member strength. For example, simple shear connections might be specified to carry 50 percent of the uniform load capacity of the member. I'm not advocating this, just recognizing that some engineers specify that connections be designed this way. If so, just make sure you use the LRFD beam strength for LRFD connection designs and the ASD beam strength for ASD connection designs.

When reactions are provided in the design drawings for use in connection design, it is important that the loads given be properly identified as factored loads or service loads. The selection of connections to support loads given at the service-load level using LRFD design strengths would be quite incorrect!

Note that service loads are sometimes used in LRFD. For example, service loads are of interest in calculations that involve fatigue considerations.

• Design strength. In LRFD, the design strength is calculated by multiplying the nominal strength by the resistance factor. In ASD the allowable strength is essentially the nominal strength divided by the factor of safety.

Generally speaking, the LRFD design strength will be about equal to the ASD allowable strength multiplied by 1.5. This isn't always true, but quite often it is. So the 1.5 factor is a good rule of thumb for a seasoned ASD connection designer who is trying to get a handle on LRFD. Also keep in mind that the connection designs you get in LRFD



Typical shear connection from the *LRFD Manual*.

are almost always going to be about the same connection designs you would have gotten in ASD. So if it doesn't look right, it probably isn't.

Keep in mind as you get into LRFD that the loads are factored. Said more simply, the design loads are higher, but so are the design strengths.

• Minimum connection strength. In LRFD, it's 10 kips. In ASD it's 6 kips. Just multiply the ASD value of 6 kips by 1.5, round up to an even integer, and you'll see where the 10 kips came from in LRFD.

• Weld strength. Welds are treated exactly the same way in LRFD and ASD with one exception. A transversely loaded fillet weld qualifies for a 50-percent strength increase in LRFD (see LRFD Specification Appendix J2.4).

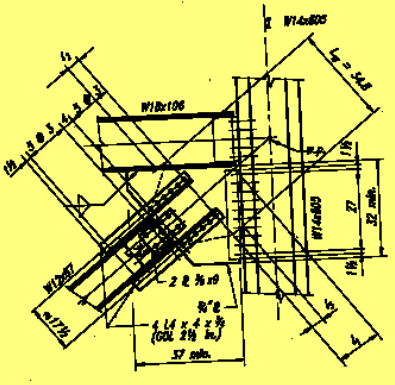
One case where this provision applies is to fillet-welded end connections of column stiffeners, which qualify for a full 50-percent strength increase (or a one-third reduction in the size required for strength; see AISC Design Guide #13 Wide-Flange Column Stiffening at Moment Connections: Wind and Seismic Applications). Most other weld groups are not perfectly transversely loaded, so the strength increase may not be a full 50 percent, but every little bit helps. The usual strength increase in the eccentrically loaded weld group tables in the LRFD Manual is in the range of from 10 to 30 percent.

• Block shear rupture strength. In LRFD, the model used to predict the block shear rupture strength is predicated upon the occurrence of yielding on one edge of the block with fracture on the other edge. In ASD, the model used is predicated upon the occurrence of fracture on both edges simultaneously. Despite this difference, block-shear rupture is just as easily checked in LRFD and ASD.

• Slip resistance in slip-critical connections. In LRFD, slip resistance can be checked at the factored-load level or the service-load level. Since LRFD is primarily based upon factored loads, the former option is quite commonly selected. In ASD, slip resistance is checked at the service-load level.

• Software. Arguments aside about whether "riding the board" is or isn't the best way to learn how to detail, almost everybody uses software today. And almost every piece of software has a button or some other simple feature that allows the user to switch it from ASD to LRFD. If not, call their technical support people and ask why not!

Could these be the only differences in connection design between LRFD and ASD? No, probably not, but the point is simply that there's nothing earth shattering here.



Typical bracing connection from the *LRFD Manual*.

One Last Thing

Many steel detailers have tattered old cards and charts that have been handed down from generation to generation. I saw one beautifully worn specimen that dated back to the navy blue 5th Edition of the AISC Manual of Steel Construction. The format of information that card held was superb, even if the actual numbers were a bit past their prime. Perhaps this makes for an opportune time to update all those old steel detailer's treasures.

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