5 Common Myths of Steel Design Debunked

By Larry Muir, P.E.

It has been said that an engineer is someone who can do for one dollar what any fool can do for two. However, sometimes reality can step in and derail what appear to be logical attempts to optimize structures or streamline the design process. What follows is an examination of five popular steel design myths. Where possible, resources are also provided to assist the designer.

Myth #1

Least Weight = Least Cost

This is one of the most discussed, yet most pervasive misconceptions concerning the design of steel structures. The emphasis should always be on economy and not weight.

If bolted connections are to be used, do not size the member based on gross area alone. Fortunately AISC provides some assistance. Table 5-1 in the *13th Edition AISC Manual* includes a capacity based on net section rupture. This value is based on an effective net area that is arbitrarily taken equal to 75% of the gross area. This relationship usually can be satisfied with a typical connection length. These values can be useful when designing bracing and truss members.

AISC also provides assistance for moment connections. A program called Clean Columns is available at **www.aisc.org**. The program will provide the lightest column section that will not require stiffeners or doublers.

Beams shallower than W18s should be avoided when designing beams in vertical bracing systems. This will allow more reasonable connections when transfer forces (axial forces transmitted from bracing on one side of a column to bracing on the other side of a column) must be accommodated. This suggestion applies equally to the beams outside of the bracing bays when they are also required to transfer axial loads.

Myth #2

Specifying slip-critical connections will provide more reserve strength for my structure.

Specifying slip-critical connections may result in more bolts, but more bolts does not necessarily translate into increased capacity or safety. Increasing the number of bolts usually results in an increased connection length that can then lead to a reduction in required weld size or plate thickness. The goal of reserve capacity is not attained and the result is merely a connection with special faying surface preparation requirements and more bolts that need to be installed and pretensioned in the field.

The *Specification for Structural Joints Using ASTM A325 or A490 Bolts* requires the use of slip-critical connections for only four conditions:

1) *Joints* that are subject to fatigue load with reversal of the loading direction.
2) *Joints* that utilize oversized holes.
3) *Joints* that utilize slotted holes when the loads are not perpendicular to the slots.
4) *Joints* in which slip would be detrimental to the performance of the structure.

Specifying slip-critical connections in other instances needlessly increases the cost of the connections and therefore the cost of the project. Specifying slip-critical Class A connections where X-type bolts could be used can double the number of bolts required to support a given load.

Myth #3

Specifying beam end reactions based upon the maximum uniform design load instead of providing shear loads is a big time saver and guarantees a safe structure.

It is often discussed that providing actual loads instead of shear requirements based on the uniform design load (UDL) increases economy. However, there are also other reasons to avoid the ubiquitous use of UDL instead of given shear loads; not all beams are subjected to uniform gravity loads. For instance, point loads can occur near the ends of beams. In such cases the UDL, as high as it often seems, may still not be enough to cover the beam reaction. Another instance occurs in moment frames, where the shear resulting from the uniform gravity load must be added to the end shear resulting from the lateral moments. Falling back on "canned" specifications project after project can set an engineering firm up to overlook shear loads that do not fall within the UDL envelope. An experienced fabricator or detailer will know to ask the question in unusual situations, but we as engineers cannot rely on others to catch mistakes.

The good news is it may be easier than ever to provide actual shear loads. Many structural analysis and design software packages have the ability to export the shear loads in a user friendly format, many times as CAD drawings. So there are no more excuses for not providing this valuable information.

Myth #4

In seismic design, a higher R will result in a more economical structure.

This one seems to be a no-brainer. The design seismic base shear is, in most instances, inversely proportional to the seismic response modification factor, R. So it follows that increasing the R reduces the base shear, which reduces the load in the members, which reduces the force in the connections, which reduces the cost of the project…right? If only it were that simple. Designing steel structures assuming an R greater than 3 invokes the requirements in the AISC *Seismic Provisions for Structural Steel Buildings* (the Seismic Provisions), so the process often works in reverse. Increasing the R reduces the base shear, but the increased R has member size requirements (such as minimum width-thickness ratios) and frame proportioning requirements (framing is often selected to develop the strength of another element) that can lead to a larger member, which leads to an increase in expected strength, which leads to an increased connection force, which leads to an increase in fabrication and erection costs.

Fortunately, there is an economical alternative. For steel structures designated as Seismic Design Categories A, B or C the engineer can choose to use an R equal to 3. Buildings designed using an R equal to 3 are not subject to the requirements of the Seismic Provisions, and ironically a building in a low Seismic Design Category originally designed using a higher R factor can many times be reanalyzed and designed using an R equal to 3 with few, if any, changes in member sizes.

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Myth #5

A fabricator is a fabricator is a fabricator.

It is easy to view fabricators (and erectors) as interchangeable, with the only thing differentiating them as price. But just as all structural engineers are not created equal, neither are fabricators or erectors. Good fabricators and erectors bring a wealth of experience to the table, and will see possibilities and pitfalls in your project that you probably have not considered.

Even on relatively simple projects, choosing a good fabricator and then granting the latitude required to optimize the project to suit its shop practices can make a significant difference to the bottom line.

Especially on complicated structures, the fabricator and erector should be chosen early. Then you should "dance with the one that brung ya," a tenet with both ethical and practical merits. From an ethical standpoint, there is something unseemly about squeezing all of the best ideas out of a fabricator or erector and then handing their work over to someone else. Unfortunately, dishonor may not be enough to dissuade some from the practice, but there are much more self-serving reasons to choose early and resist the urge to be fickle. First, the talented people that came up with the ideas that saved all that money might prove useful later in the project when some unforeseen and seemingly insurmountable problem arises. Second, the wonderful ideas that saved all that money might not be applicable given the low bidder's shop practices, or the low bidder may not properly implement the idea and therefore may encounter difficulties that could incur greater costs or a slip in schedule.

Partnership between the owner, design team, and construction team will work for all, provided that all are committed to the interests of the team.

Realities

The foregoing represents five common myths and the realities associated with them. There are many other myths that could be discussed, but those will be saved for another day. Suffice it to say that it is important to re-evaluate even the most long-held beliefs, and truly discover whether what is *myth* and what is *reality*.▪