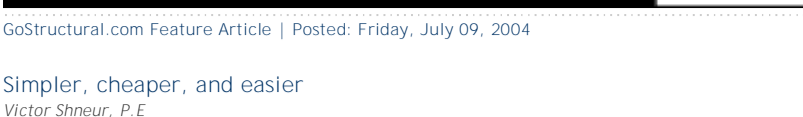




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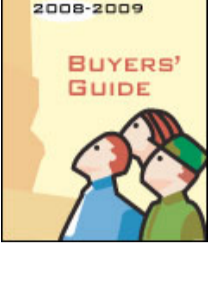
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Simpler, cheaper, and easier

Victor Shneur, P.E.

Typical structural steel erection begins with connections to a concrete foundation. These connections are common, but they have specific requirements that are frequently overlooked. If improperly designed and detailed, these simple connections can result in expensive field repairs and schedule delays. Based on my experience with structural steel connection design, detailing, fabrication, and erection for many different building types, I offer the following suggestions to make the most common anchor rod-to-base plate connections simpler to detail, cheaper to fabricate, and easier to erect.

Design and detailing tips

There are four, main differences between column base connections that incorporate anchor rods and other steel frame connections. First, anchor rods are installed during the foundation construction, and this occurs early enough in a project that the engineer and fabricator often have yet to communicate. If anchor rod specifications and details are not correctly shown on the contract drawings, there is no time for clarification or correction. Second, the steel details must accommodate relatively large anchor rod setting tolerances. This imprecision often is further aggravated by survey errors. Third, anchor rods can be easily damaged by heavy equipment used for excavation and grading as the foundation construction continues. And fourth, if the anchor rods are damaged prior to steel erection, the repairs are difficult and, if not properly made, can affect safety and/or structure serviceability.

All of these issues need to be considered for column base-plate connection design to avoid possible erection problems.

Don't specify bolts for anchor rods. As stated in Section 1.1 of the American Society for Testing and Materials (ASTM) A325 specification and Section 1.2 of ASTM A490, "The bolts are intended for use in structural connections/ joints." Standards ASTM A325 and A490 include defined threaded length and heading requirements, and when bolt length exceeds 9-1/2 inches, a special order typically is required. Therefore, don't specify ASTM A325 or A490 for anchor rods. Instead, specify ASTM F1554 for anchor rods. This standard covers anchor rods with 36, 55, and 105 kips per square inch (ksi) yield strength.

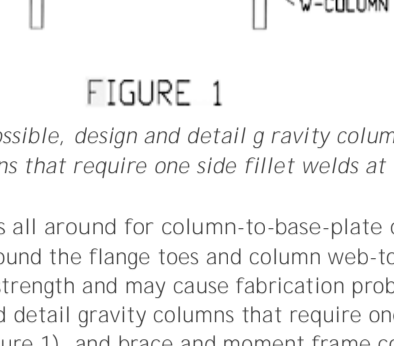


FIGURE 1

Figure 1: If possible, design and detail gravity column-to-base-plate connections that require one side fillet welds at the flanges.

Don't specify welds all around for column-to-base-plate connections. Fillet welds that wrap around the flange toes and column web-to-flange fillets provide very little strength and may cause fabrication problems. Instead, if possible, design and detail gravity columns that require one side fillet welds at the flanges (see Figure 1), and brace and moment frame columns that require fillet welds at both sides of the flanges and the web at most (see Figure 2). Columns are primary compression members and even many columns that are part of the lateral system realize only moderate uplift and shear.

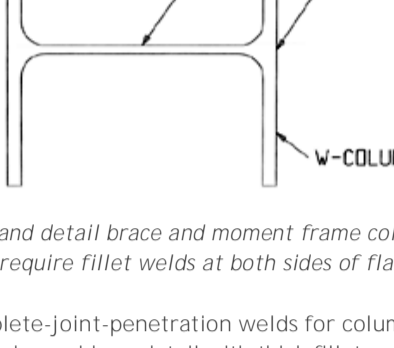


Figure 2: Design and detail brace and moment frame column-to-base-plate connections that require fillet welds at both sides of flanges and web only.

Don't specify complete-joint-penetration welds for column-to-base-plate connections. Instead, consider a detail with thick fillet welds. If a fillet weld can resist the uplift and/or shear demand of the connection, it is typically less expensive to specify them—up to 3/4-inch at both sides—than complete-joint-penetration welds. Also, apply a directional strength increase factor for fillet welds per Appendix J of the American Institute of Steel Construction's Manual of Steel Construction, Load and Resistance Factor Design (AISC LRFD, 3rd ed.) and Section 2.5.4.2 of the American Welding Society's Structural Welding Code—Steel (AWS D1.1 - 2004) during design. Again, remember that columns are compression members.

Don't add brackets or stiffener plates at base plates just because the column is subjected to uplift forces. Brackets and stiffeners are expensive to fabricate and also may make field correction of the base plate impossible. Instead, consider thicker base plates to eliminate the need for brackets or stiffeners. This will decrease the labor required to fabricate the columns.

Don't assume that the wall around the column will be constructed after the column is erected. Concrete stem walls, or other walls, constructed immediately adjacent to a column can cause constructability problems (see Figure 3). Instead, in cases where the wall may interfere with column erection, clearly specify the construction sequence on design drawings or provide a design and detail that eliminates the interference.

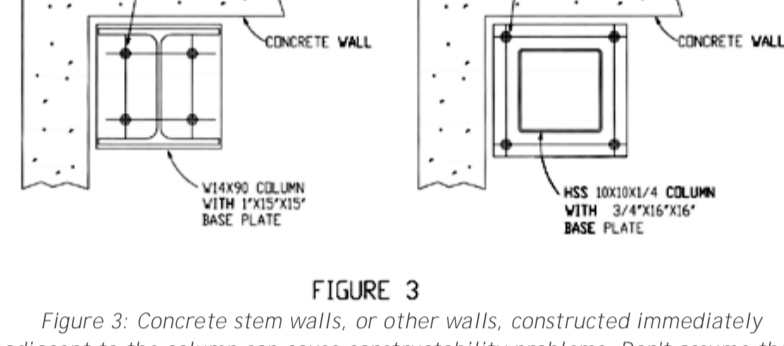


FIGURE 3

Figure 3: Concrete stem walls, or other walls, constructed immediately adjacent to the column can cause constructability problems. Don't assume that the walls will be constructed after the column is erected.

Don't try to develop substantial shear forces with anchor rods. The oversized holes and grout make it difficult to transmit shear to the concrete. Instead, if a large horizontal shear force must be transferred from column base to foundation, consider shear keys or embedded plates with field-welded side plates. Also, consider that the concrete floor can transmit shear force. Reference the AISC Design Guide #1 for more information.

Don't always weld plate washers to column base plates. Instead, be selective. Weld plate washers to column base plates only to transfer shear force, and check welds for accessibility at each side.

Don't assume that everything is readily available. Instead, correspond with the local fabricator for material availability or be open to substitution. Remember that anchor rods almost always are the first item fabricated and usually in a rush.

Don't specify different anchor rod settings and base plates for every column size. Instead, reduce the number of different anchor rod settings and base plate sizes to a minimum. If, for example, there are W14 x 90 to W14 x 145 gravity columns on the project, specify the same anchor rod settings and base plates for all of them based upon the largest size. It may be conservative for lighter columns, but it will simplify detailing, fabrication, and rod installation. In addition, it will greatly reduce the number of possible mistakes and subsequent repair costs.

Don't specify odd anchor rod settings and base plates, if possible. Instead, design and detail the rods and base plates doubly symmetrical about column centerlines. Simplicity prevents many problems.

Don't specify too many different anchor rod sizes. Instead, use a maximum of two (or three for special projects) different anchor rods, if possible. In some cases, it may be conservative, but, again, it will prevent possible installation mistakes.

Don't specify base plates that are too small. Instead, provide sufficient plan dimensions to accommodate oversized holes, clearances, and possible field fixes (for example, to enlarge holes and to add plate washers if required).

Don't require grout holes in small base plates. Instead, only provide grout hole(s) when the smaller dimension of base plates exceed 24 inches, and space the holes approximately 18 inches apart if more than one hole is required. Remember that grout holes should be 2 to 3 inches in diameter.

Don't assume that concrete and anchor rods will be placed precisely at the elevation per design or erection details. Instead, detail the anchor rods to accommodate construction tolerances during placement. Always specify enough anchor rod projection above theoretical top of the nut—include a minimum of 1/2 inch, but 3/4 inch to 1 inch is recommended. Specify adequate grout thickness—for example, provide 1-1/2 inches of grout for 3/4-inch diameter rods with leveling nuts and washers. And, always specify extra threaded length in case the rod projects too high from the concrete. Usually, the threads extend only 1 inch below the theoretical top of the concrete.

Don't specify hooked anchor rods to resist substantial axial loads. The only axial load that hooked anchor rods should be designed for are overturning from erection loads or accidental collision during erection. Do not design hooked rods to resist uplift from lateral loads. Instead, design and detail threaded anchor rods with end nuts for anchorage into the foundation.

Don't weld the nut for anchorage all around. This weld is required only to prevent the rod from turning out when the top nut is tightened. Instead, tack weld this nut at the bottom or use a jamb nut. (Note that per Part 14 of the AISC LRFD, 3rd, ed., Headed or Threaded and Nuted Anchor Rods, Marsh and Burdette showed that the head of the anchor rod usually provides sufficient anchorage and the use of an additional washer or plate does not add significantly to the anchorage.)

Don't assume that anchor rods have been installed perfectly. And, do not assume they have not been damaged before column erection. Instead, consider the need to hire an independent surveyor to locate misplaced or damaged anchor rods and to correct them prior erection. Communicate the importance of accurately placed anchor rods to the contractor.

Conclusion
 Nothing can eliminate all anchor rod connection problems or construction mishaps, but consideration of construction aspects can reduce many of the inherent conflicts and make the anchor rod to column base plate connections simpler, cheaper, and easier for the entire design and construction team.

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