A look at some field-fix options for column anchor rods.

steelwise ADDRESSING ANCHORS

BY ERIC BOLIN

THE BEST-LAID SCHEMES of mice and engineers go often askew.

Even with thoughtful planning in the design phase, mistakes happen and you can be faced with a situation that requires repair or modification in the field. The difficulty in handling these types of problems is that you can't always predict what's going to go wrong or when it's going to happen—and anchor rods are no exception.

However, you can better prepare yourself to deal with these problems by determining what types of errors are more common than others and considering the solutions others have used in the past. Here, we've provided several practical fixes for the most commonly occurring anchor rod problems in the field.

Finding an Issue

When an issue is discovered in the field that requires fixing or modifying column anchor rods, OSHA 1926.75 requires that the engineer of record (EOR) must approve any changes that are made Even if the problems are created by others, it is important for the EOR to be involved with determining the fix. While the EOR is ultimately responsible for the final design, the erector, fabricator, general contractor and other involved parties should contribute to finding the solution to the problem. A simple phone call early on between these parties can facilitate a timely and efficient solution.

Since, like any other field problem, anchor bolt issues can throw a project off schedule, it is important that the solution is identified and approved in a timely manner. Following the repair or fix, the contractor is required to provide written documentation of all field work that was completed. Any fees for additional services performed by the EOR should be discussed early in the process with the owner.

Even Needed?

When looking at potential fixes, a good place to start is to analyze the as-built conditions to determine if a fix is even necessary. Sometimes, a deviation may need only minor or no corrective actions. An example of a problem needing only minor corrective action is a damaged or misplaced anchor rod on a gravity-only column. In this case, it has been provided only for erection to satisfy the OSHA requirement for the minimum number of anchor rods and erection loading. It may be possible to permanently remove the problem anchor rod if the column is temporarily braced during erection. Another possible example is a column found to be out of plumb. If the analysis indicates that the column, in its as-built condition, and structure around it are acceptable—and there is no other reason the out-of-plumb condition cannot be accepted—then no fix is needed.

If there is a bona fide error—and it's discovered early enough—it may be possible to fix a problem before the affected materials leave the shop. Consider, for example, when a survey finds an improperly located anchor rod. Some fix options that can be performed in the shop are as follows:

- If the base plate has not yet been fabricated, anchor rod holes can still be relocated. If this change necessitates increasing the base plate thickness, you should first confirm with the fabricator if new plate material can be procured, especially if very thick plate is required
- Existing holes can be slotted, or new holes added, to match up with the as-built anchor rod layout
- The base plate can be offset by removing and rewelding it to the column. If needed, the base plate can be flipped over to provide a clean surface to re-weld to the column

Table 14-2 in the AISC *Steel Construction Manual* lists the minimum washer sizes for typical anchor rod diameters. When a base plate hole is enlarged, the washer plate size will also need to be increased to bridge over the enlargement. It should be noted that washer plates may be need to transfer forces from the column into the foundation. If this is the case, the washer plate size and necessary welding will need to be designed by the EOR.

Eric Bolin (**bolin@aisc.org**) is a staff engineer with AISC.



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When a base plate is relocated, or when a new hole is added, you may end up with an interference between the anchor rod and the cross section of the column. In this case, it may be possible to cut access holes in the column flanges or web to allow enough clearance to install the column. Reinforcement may need to be added to the column around the access cuts to replace the strength lost from removing material. If interference exists between the washer plate and the weld at the column base, it may be an option to omit the weld in this location or trim the washer to clear any encroachment.

Fixed in the Field

It is more common that anchor rod fixes need to be performed in the field. When this is the case, you'll need to determine what options the contractor is able to perform and what constraints exist for the redesign. For instance, you may have to exclude the option of field welding if the rods are not made from a weldable grade of material. The most commonly specified anchor rod material type, ASTM F1554, permits welding of some but not all grades. As shown in Table 1, welding is possible with ASTM F1554 Grades 36 and 55 with supplement 1 but not for Grade 55 without supplement 1 or for Grade 105. If a different rod material is specified, its weldability should be confirmed prior to considering a welded fix option.

Table 1. ASTM 1554 Anchor Rod Identification			
Grade	Color	Die Stamp Identification	Weldable Material?
36	Blue	AB36	Yes
55	Yellow	AB55	No
55– weldable*	Yellow– at projecting end White– at encased end		Yes
105	Red	AB105	No

*Supplement 1, weldable Grade 55 rods

A commonly used field fix is to cut off a problem anchor rod and replace it with a post-installed anchor. A downside to using this method is that the base plate likely will need to use a modified hole pattern since the new post-installed anchor often cannot be placed where the abandoned embedded rod is located. Either cutting a new base plate hole in the field or relocating the base plate may allow the fabricated base plate to be used with a revised anchor pattern. Otherwise, a new base plate will need to be fabricated and installed.

Encountering concrete reinforcement can be a problem when drilling holes for post-installed anchors. If the location of the reinforcement in the concrete is known, it may be possible to provide a design with the exact number and placement of the post-installed anchors. However, it's a good idea to design a base plate that has more holes than needed. This way, if reinforcement is encountered when drilling a hole, then the hole can be abandoned and an alternative hole position drilled for the anchor. The engineer will need to specify the total number of anchors that are required to be installed in their design.

Too Short or Tall

Several fix options are available when the threaded portion of the anchor rod is set in a position that is either too short or too tall to allow for the nut to be tight and at least flush with the point/top end of the anchor rod. Note that when an anchor rod is too tall, the rod's embedded length should be verified since the extra length above the concrete may have come from the rod being set too shallow.

One option for an anchor rod that is set too tall is to stack plates or washers above the base plate to give an elevated surface to tighten the nut against (see Figure 1). Another option for a rod that's too tall is to increase the length of the threaded portion using a die.



▲ Figure 1. Plate washers for a too-long anchor rod.

If the anchor rod is made from a weldable grade of material, directly welding the rod to the base plate may be a good field fix as shown in Figure 2. This option can be used for both a too-tall condition and a too-short condition. Access for welding a too-short rod may be an issue when the top of the anchor rod is recessed below the top of the base plate.

The gaps between the anchor rod and edges of the base plate hole must be considered when designing a field-welded fix since the length spanning the gap does not contribute to the strength of the weld. The weld size needed for strength will need to be increased by the gap dimension. Large gaps, such as with slotted or oversized holes, may require multiple weld passes, which may not end up being the optimal solution. A washer plate with a smaller hole can be used to make this option work as well.



▲ Figure 2. Directly welded anchor rod.

For a rod that's short relative to the base plate, one option is to weld an additional length of threaded rod to the embedded rod. As shown in Figure 3 (page 20), an additional section of threaded rod can be prepared with a double-Vtype groove weld. This is generally preferred over a "pencil point" shaped bevel.



Figure 3. Welded anchor rod extension.

An alternative to directly welding the rods together is to join the extra length of threaded rod using lap plates (see Figure 4). The lap plates are joined to the rods using flare bevel groove welds. It may be necessary to chip out the concrete to provide adequate clearance for the bottom of these lap plates. Additionally, clearance may be an issue between the lap plates and base plate. The base plate holes may need to be enlarged and covered with a larger plate washer (as suggested earlier for enlarged holes).

A coupling nut is another possibility for joining an additional threaded section to the embedded rod (see Figure 5). The coupling nut is a larger diameter than the rods, which may require the base plate holes to be enlarged.



Figure 4. Welded anchor rod splice.

Figure 5. Anchor rod extension using coupling nut.



Yet another fix option for a rod that's too short is to install an extended nut, such as the Elocone elongated nut produced by Canam. This product features an internally threaded portion that extends below the top surface of the base plate, which can connect to an anchor rod set too low (see Figure 6).

The engineer may also investigate using an anchor rod with a partially engaged nut. Information on this option can be found in the second edition of AISC Design Guide 1: *Base Plate and Anchor Rod Design*.



Figure 6. Extended nut option.

Damaged Rods

When anchor rods are installed in an out-of-plumb position or are bent after being placed, it may be possible to straighten them in the field. In Design Guide 1, the recommendation is that bending a rod in the field should be limited to 36-ksi material and a bend angle no greater than 45°. A rod-bending device called a hickey is also recommended to assist in this process of field straightening rods.

It may be possible to cold bend rods for diameters up to 1 in. For larger-diameter rods, the effort needed to cold bend rods into position increases and can be made easier by applying heat. The maximum temperature allowed for hot bending ASTM F1554 Grade 36 material is 1,300 °F.

If the rod is bent within its threaded portion, the threads may end up being damaged during straightening. If the nut cannot be installed, the rod may need to be trimmed below the damaged portion and, if needed, extended using one of the methods that was previously discussed for a rod that's too short.

Other Column Base Issues

An improperly plumbed column can typically be fixed by adjusting the amount of grout placed under the base plate. When this type of fix is performed, there is a chance that the anchor rod may end up being too tall or short to install the nut. If this happens, the solutions discussed earlier may be workable. This may also affect the elevation at the top of the column and its connections to adjacent members.

Problems can also be caused by grout being installed too late after column erection. If grout is not in place before the column is loaded, the shim stacks or leveling nuts will have to support the column and may be subjected to forces they cannot resist. The base plate is also loaded differently than in the design condition, which can cause problems. This is why the AISC *Code of Standard Practice* requires that grouting be performed promptly after the installation of a column. This provision is intended to prevent a condition where loads in the column cause the base plate to deform unacceptably, leveling nuts to punch through the base plate, rods to punch through the bottom of the concrete foundation or a similar undesirable outcome. It is much less problematic and costly to grout in time than to have to jack a column back up into position to after it's been loaded without grout.

This article is based on the 2014 NASCC: The Steel Conference presentation "Field Fixes: Common Problems in Design Fabrication and Erection: Solutions and Prevention" and AISC Design Guide 1. You can watch the full presentation at www.aisc.org/2014nascconline. For more pre-field work tips, see the August 2015 SteelWise article "Field Fixes, Minimizing Fixes in the Field Starts in the Design Phase" at www.modernsteel.com.