

**ROWAN**

## How to Repair an Anchor Bolt

Revised September 03

Anchor bolts do break from time to time. The ability to make a quick repair is essential to minimizing downtime. Two very important considerations are:

1. Make a suitable anchor bolt repair with the minimum of lost time and disruption of the equipment.
2. Make a repair that is better than the original installation so recurrence is unlikely.

The question is often asked, "Why do anchor bolts break?" Usually, it is one of two reasons. The first is an improperly designed original installation which could be anything from a wrong specification of the steel to the improper physical sizing i.e., length, depth of embedment, amount of free stretch, or preload applied. The second is improper maintenance of the anchor bolt; such as not keeping the nut tight. More bolts break from being under-tightened, than over-tightened. It is extremely important that the proper preload be applied to the anchor bolt before equipment start up, and that the preload be maintained during the life of the installation. Nuts<sup>1</sup> can loosen in service and that means a loss of the preload. Critical anchor bolts should have load monitors to detect such a loss of preload, or a scheduled periodic check of the tightness using a torque wrench, so any loss of torque (or preload) can be corrected before a broken bolt or damage to the equipment occurs.

Torque wrenches are not very accurate, not because of the wrench, but because of field conditions, such as lubrication of the threads, etc., but they are much better than nothing. Much has been written on the subject and further information can be obtained from the reference noted below.

### **REPAIR PROCEDURES**

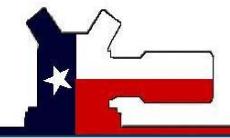
The most effective way to repair an anchor bolt is to cut off the old bolt low enough below the equipment base, so the replacement top section length will be at least 10 to 12 bolt diameters. Do not consider welding, as the steel in many anchor bolts does not weld satisfactorily. Mechanical threading with a coupling nut is the only sure repair. The length of the coupling nut should provide for vertical adjustment since making an exact cut in a hole chipped out underneath a machine is difficult.

A further note on the coupling nut is that if the old anchor bolt stub is of doubtful integrity, the coupling nut should incorporate a hold-down flange with holes so additional anchoring can be added. Steel all-threads can then be added and tied into angle drilled holes in the concrete. Using this system, an old, low strength steel bottom section can be upgraded in load carrying capacity to match a replacement top section of high strength 4140 steel.

### **REPAIR STEPS**

1. Chip away grout and concrete to expose several inches of old bolt below the equipment base. A 1" bolt will need a hole approximately 12" deep. Chip the hole wide enough to provide access for a portable band saw or other power driven saw.
2. Cut off the bolt 2" – 3" above the bottom of the chipped hole and then thread the old anchor bolt stub to match the threads in the coupling nut. Coupling nuts should have 8 pitch threads so a high strength top replacement section, such as our R-193, can be used. The top of the coupling nut to the top of the equipment flange should measure at least 10 bolt diameters and preferably 12 bolt diameters.
3. If the old bottom section is of unknown steel or doubtful integrity, add the optional slip-on flange (do not weld) to the top of the coupling nut. Before screwing the coupling nut in place, drill four 1" – 1 1/4" holes in the concrete foundation, at a 30° angle, and bend B7 all-thread studs, so they will fit through holes in the flange and into the drilled holes. The B7 studs are part of the standard repair kits. The nuts

<sup>1</sup> "Designing with Threaded Fasteners", by Girard S. Haviland, Mechanical Engineering Magazine, Oct., 1983

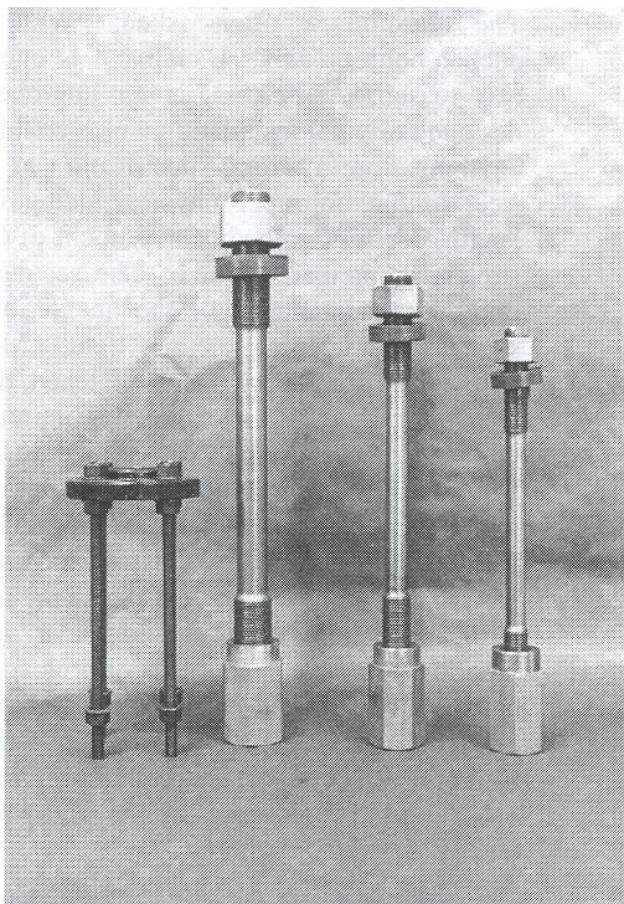


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provided should be put on the all-thread studs to hold them to the flange and also at the bottom ends to lock them into the epoxy grout that will be poured later.



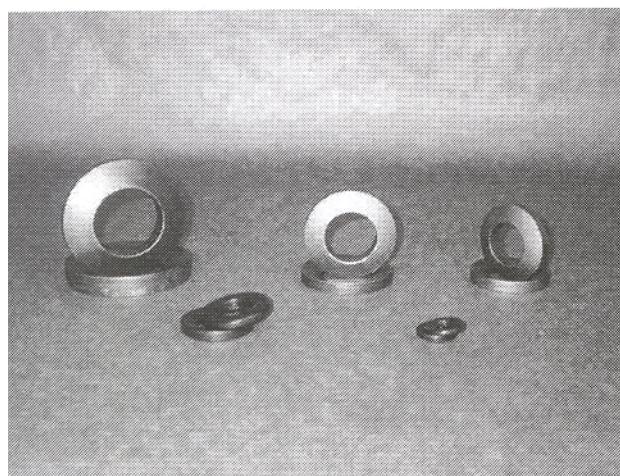
**4140 Hex coupling nut with optional flange (to increase anchoring when repairing lower strength broken anchor bolts).**

**Figure 1**

3A. If upgrading of the old bottom section is not necessary, then the coupling nut can be screwed onto the threaded bottom section. Use a liquid thread locker and measure to be sure 1.25 times the bolt diameter in threads are engaged. This will leave room for the replacement top section to be

screwed in and still leave room for vertical length adjustment.

4. The length of the top section can now be determined from the coupling nut to the proper projection, through the equipment base. The projection, besides that necessary for the nut, should also include an extra  $\frac{3}{4}$ " – 1" for the double spherical washers (self-aligning) to be added under the nut. These hardened steel washers of 4140 will insure uniform nut-to-stud loading and greatly reduce future breakage.

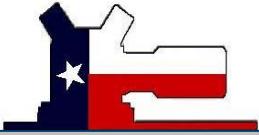


**Self-Aligning, Double Spherical Washer**

**Figure 2**

5. Add the top section, screwing it by hand, without thread locker, into the coupling nut. Wrap the exposed stud from the top of the coupling nut to the bottom of the equipment flange in  $\frac{1}{4}$ " thick foam insulation such as is used for refrigeration piping. This will keep grout from contacting the top section and allow the "free stretch" length of 10 – 12 bolt diameter to work without interference from the grout.

6. After checking for proper thread embedment in the coupling nut and enough projection for the top nut and spherical washer, the excavated hole can be filled with a good high modulus epoxy grout, such as



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Rowan Resin 427 epoxy grout. If the optional flange with hold-down all-thread B7 studs has been chosen, be sure grout is first worked into the four slanted drilled holes and then fill the balance of the cavity.

7. Allow the grout to cure according to the manufacturer's instruction and then torque the top nut to achieve the design preload. The equipment can be put in service after verification of proper equipment alignment. After operating for 48 hours, the preload on the bolt should be rechecked and any loss of load corrected by retorquing. (CAUTION! Certain critical equipment will require a shut-down during bolt torquing and alignment monitoring to be sure the bolt tightening operation does not cause distortion).

