Rotational Capacity (ROCAP) tests are required to verify the quality of galvanized high strength fastener assemblies and any assembly used in certain AASHTO / FHWA bridge projects. Without getting into too much detail, the test checks the assembly’s performance regarding ductility, lubrication, thread stripping resistance, and strength. It can be done by in the field or in a laboratory. The tests we perform in our laboratory at Applied Bolting are “ROCAPs on steroids” in that we record a lot more information than is required. We provide these tests as a service to customers and to provide important insight into the details of high strength fastener performance.

We recently conducted an experiment where we evaluated the effect of lubrication on the ROCAP performance of fastener assemblies. Twenty tests were run on domestically sourced 3/4” X 4 3/4” Hot Dip Galvanized A325 high strength fastener assemblies. Ten of the assemblies were tested as received from the vendor (dry). Ten more assemblies were tested after the bolt threads were lubricated with stick wax (lubed). To be clear, “dry” is not an entirely accurate description because galvanized assemblies are supplied with a wax lubricant on the nut. The photograph shows a “dry” and “lubed” assembly after testing.

The ROCAP Test Procedure

When we conduct a ROCAP test, we tighten the assembly to the prescribed total turn in our tension calibrator, recording tension, torque and angle of rotation at every step along the way. For 3/4” X 4 3/4” assemblies, the ratio of length-to-diameter dictates that the total turn is 360 degrees. After each test, the assembly is then inspected for signs of thread stripping or thread shearing or cracking. All of the assemblies we tested passed with flying colors. However, there were some interesting differences to be noted between the “dry” and “lubed” assemblies.

Torque and Tension

Figures 1 and 2 show the torque – tension signatures of the dry and lubricated assemblies.
There was nothing unusual about the test results. There was a fair amount of scatter in the data, but that frequently happens with coated assemblies. We measured coating thickness, and while it too varied considerably, it conformed to specification ASTM F2329.

For reference, 29 kips is the tension required by pre-installation verification for 3/4" A325 bolts. The average torque required to reach 29 kips dropped 11% when the threads were lubricated (210 vs. 235 ft-lbs). Said another way, lubrication reduced the k-factor from 0.130 to 0.116. The torque range at 29 kips reduced over 40% (48 vs. 82 ft-lbs). And, the final turn of 360 degrees was achieved with significantly less torque.

While I have seen greater improvements when using lubrication, the differences are statistically significant. I have to conclude that these are high quality assemblies. Bottom line: lubrication makes installation easier. No surprises here.

**Tension and Turn**

Figures 3 and 4 below show the tension – turn signatures of the dry and lubricated assemblies.

In these figures there isn’t much difference between the dry and lubed assemblies. And again, there was a lot of scatter in the test results.

For reference, 180 degrees is the installation turn required by the turn-of-nut procedure for 3/4" bolts of this length. All 20 assemblies behaved similarly approaching 180 degrees. At 180 degrees the average tension was 4% higher with the lubricated assemblies (42.5 vs. 40.9 kips). It stands to reason that the lubed tensions were higher on average because less energy is consumed overcoming friction. The lubed tension range at 180 degrees shrunk by 12% (4.195 vs. 4.754 kips). And, slightly higher tensions were observed at the final 360 degree turn. These differences, while small, are statistically significant at 180 degrees.

**Conclusions**

The domestically sourced fastener assemblies evaluated in this experiment were top quality. They passed all requirements of the ROCAP test with flying colors. In general, the domestic assemblies we test usually pass the ROCAP test.

Lubrication will increase the tension achieved with a given torque. While this is an obvious conclusion, I must say that I expected more than an 11% improvement. I think this is related to the conclusion above. The bolts were high quality and the factory-supplied wax lubricant on the nuts was in good shape.

Lubrication will increase the tension achieved for a given turn. The 4% increase was small but statistically significant. Presumably this is because less friction, the bolt twists a little less and stretches a little more.

The only surprise of this experiment was that the lubrication did not have a bigger impact on performance. Since not all fasteners are created equally, we intend to conduct the same experiment with foreign fasteners. Given what we know about foreign fasteners, we should see some interesting results, so stay tuned.