Masts and Mounting Posts for Antennas

(Some tips for the installation of tower mounted antennas and ground mounted verticals) VA3DDN

Masts

The "mast" of a sailing vessel is a tall spar erected more or less vertically on the center-line of a ship or boat. In amateur radio, the "mast" is also vertical, a metal tube or pipe, that extends above the top of the tower, to which the antennas are mounted. It is a very important part, because if it fails, so does most of your antenna installation. Potential safety implications are also considerable. The photo 1 to right shows a typical end result. Here the mast has bent at a right angle just above the top "bearing" of the tower. This particular mast was about 10 ft. long above the top of the tower.

Too often, many of us have gotten away with stacking tri-banders, along with assorted other Yagi antennas and even tall vhf/uhf base antennas on a piece of galvanized fence post, water pipe, EMT electrical conduit, etc., without much understanding of the dangers involved. True, the cost is low, and sometimes, if the mast height is only 1 or 2 feet above the tower top, the installation may survive.

I am certainly not an expert in the selection of masts, but I have learned enough to provide some guidance on how to go about doing it right. The key rating for an antenna mast is its specified minimum yield strength, usually stated as PSI. The yield strength in simple terms, is the bending stress amount at which the mast will bend and not return to its original shape. (again look at Photo 1)

The following is a paraphrased quote from "A Layman's Guide to Mast Material", by Tom Taormina, K5RC, CQ Magazine June 1995, which kind of outlines the problem:

> *"….Suppose you placed a Hy-Gain TH7DX (with 9.4sq.ft. wind load) one foot above the tower top, on a 2"OD x 0.25" wall thickness mast. At the advertised survival speed of the antenna, 100 mph, the mast would be required to have a yield strength of 16,000 PSI, which could be easily met. However, move that same antenna up to 10 ft. above the top of the tower, and the mast yield strength would now have to be over 91,000 PSI. "*

If you like doing your own calculations, you could refer to the ARRL Antenna Book 22nd Edition, 2012, Appendix B, "Calculating the Required Mast Strength". Otherwise go to DX Engineering's website and enter your antenna information into their Mast Load Estimator.

Once you know the yield strength you need for your installation, you can then shop intelligently for the mast you need. I can tell you it will not likely be inexpensive, which may prompt you to revise the number of antennas you planned to install, their positions on the mast and/or the length of the mast.

DX Engineering is the only amateur radio supplier I know of who actually sells a range of antenna mast sizes and yield strengths. Locally you could talk to the helpful folk at Metal Supermarkets who also have a very informative Metal Reference Guide for download.

Mounting Posts

Many times our most effective learning experiences are when something goes wrong and we set out to correct the problem. In this particular case I learned several hard lessons: one regarding the type of ground mounting post one should use to support a tall HF vertical antenna, and another regarding what is called “galling” which can occur when tightening (or loosening!) a nut on a U-bolt fastener.

This particular experience began when my son and I decided to expand the deck in the back yard. This in turn required moving my 14 year old Hustler 5BTV vertical antenna from its cherished spot in the center of the yard, to a less favorable location off to one side. This antenna is 19 feet high and for years had survived numerous high winds, sometimes swaying alarmingly - but always returning to a “mostly” vertical resting position. The antenna is mounted on a DX Engineering vertical antenna tilt base shown in photo 2. The tilt base plate is clamped with stainless steel U-bolts to a galvanized mounting post which is driven into the ground. When I removed the 5BTV from its previous mounting post, I was a bit surprised to see that the post was slightly bent from its prior use and was showing signs of crushing where the U-bolts had deformed the metal. It could not be reused. So, it will come as no surprise when I admit to you, that yes, I had used a cheap and readily available 1 ½” 18 gauge galvanized fence post, which had begun to fail just as predicted above! Going back to square one, I fished out the installation instructions. They read “*It is recommended that the 5-BTV be mounted on a 4 foot metal stake such as a 1-1/4" I.D. Water pipe.*” Okay, maybe not so good for a mast, but recommended by the antenna manufacturer for a mounting post! Doing a little on-line search, I found that Lowes had a 1 ¼ inch diameter by 5 ft. long ASTM A53 galvanized pipe. Made by Southland Pipe, the actual outside diameter is 1.67”and the wall thickness is a hefty 0.14”. (Compare with the 18 gage fence post at 0.05” !) Typical uses were described as a water supply pipe or scaffolding. I also found it very interesting to read a user recommendation posted on the Lowes web site by another HAM who used the same pipe with their 21 foot antenna.

In conclusion, the new pipe was pounded into the ground, leaving about 18” above as recommended. The top end which received the pounding was trimmed off using an abrasive cut-off grinder. Photo 2 shows the end result.

Galling

Galling is one of the most common problems that can occur when tightening threaded fasteners. Also known as cold welding, galling causes damaged threads, broken fasteners, weakened joints and seized bolts.
I do remember experiencing the problem, but I didn't connect it at the time to what is called galling. I knew the nut had jammed, but did not know why.

Galling can happen to threaded fasteners made of common alloys such as stainless steel or aluminum. For example, while the fastener nut is being tightened, pressure builds between the thread surfaces and breaks down the protective oxide coatings. Without the oxide coating, the thread's metal high points are exposed to each other. This, in turn, increases friction, which causes heat that seizes the metal.

If the galling is minor, slight damage may occur to the thread surfaces. In that case, the installer may be able to remove the fastener. On the other end, severe cases of galling can weld the nut and bolt together and there is then no way to remove the fastener.
If the fastener is tightened once galling begins, the fastener may even be twisted right off or see its threads stripped.

Photo 3 shows where this has happened to the U-bolt and nut on the left side. Photo 4 shows the broken off piece with the nut welded to it.

Galling Prevention

So simple, just smooth on a suitable lubricant to the threaded parts before assembly. Although almost any lubricant is better than none, there are readily available anti-seize lubricants offered by JetLube, Permatex and others. These lubricants usually contain tiny flakes of metal like copper or aluminum as well as graphite and have the consistency of thick grease.

References:

1. "A Layman's Guide To Mast Material", by Tom Taormina, K5RC, CQ Magazine June 1995
2. "Antenna Masts: Safety and Selection", by Don Dazo, K4ZA, ARRL QST September 2014
3. ARRL Antenna Book 22nd Edition, 2012, Appendix B, "Calculating the Required Mast Strength
4. DX Engineering Mast Load Estimator, www.dxengineering.com
5. Steel Tubing and Pipe Data and Specifications, Metal Reference Guide, Metal Supermarkets, www.metalsupermarkets.com

Note: Excerpts from the above article were published by ARRL in the Jan/Feb 2022 issue of "On The Air".