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Force 12 XR6 20 – 6 Meter Yagi Antenna

This compact Yagi packs a punch on six bands with one feed line.

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In 2013, I cleared some trees and installed an InnovAntennas DESpole rotary dipole for 20, 15, and 10 meters on a decommissioned utility pole in my woods.[1] That antenna worked fine, and I made thousands of contacts with it. Last April, I installed inverted V antennas for 12 and 17 meters in preparation for operating as W1AW/1 during New Hampshire week. Again, those antennas served me well, but after a while I was hungry for more.

The Force 12 XR series of multiband Yagi antennas caught my eye. Although the XR model designator has been in the Force 12 lineup for years, the current antennas have undergone a complete electrical and mechanical redesign. (In 2013, Force 12 was acquired by the group that brings us InnovAntennas.) The new design was developed by InnovAntennas, Ltd founder Justin Johnson, GØKSC.)

The lineup includes several models ranging from the XR3 for 20, 15, and 10 meters to the XR6 for 20, 17, 15, 12, 10, and 6 meters. I picked the XR6 because I enjoy operating on all of those bands. I would be able to mount it on my utility pole using the same brackets, mast, and Tailtwister rotator I had used for the DESpole, and I could make room to turn it after clearing a couple more of those pesky trees to accommodate the antenna's 19.7-foot turning radius.

Overview

The XR6 incorporates 11 full-size elements on a 12-foot boom and uses a single feed line. It operates as a monoband two-element Yagi on each band. The 20, 17, and 15 meter Yagis use a driven element and reflector, while the 10 and 6 meter Yagis use a driven element and director. There is a 12 meter driven element, but that antenna uses the 15 and 10 meter elements for directivity rather than its own reflector or director. That's a lot of elements on such a short boom. To make the spacing work out, the 10 meter driven element is mounted on standoffs directly below the 20 meter driven element, and the 12 meter driven element is mounted on standoffs as well. The design goal was to hold pattern, SWR, and gain performance over a wide bandwidth while keeping the overall antenna compact.

Bottom Line

The Force 12 XR6 offers good performance with full-size elements on all bands from 20 through 6 meters. With its 12-foot boom, it's easy to find a spot for it when space is an issue. The quality materials and rugged mechanical design should mean that it will hold up well over time.

The XR6 boom is 2 inches OD with a ⅛-inch wall, and no support truss is required. Elements are made from high-strength aluminum tubing, and element joints are secured with rivets. All elements are insulated from their mounting brackets and from the boom using rugged Stauff clamp insulators. The feed system consists of a parallel-conductor transmission line made from square aluminum bar that is connected to all of the driven elements. Stainless steel hardware is used throughout. The assembled antenna weighs about 63 pounds.

Kurt Andress, K7NV, assisted in the mechanical design and calculated wind survival using the latest ANSI EIA/TIA-222 Revision G specifications. A detailed mechanical analysis of the antenna under various wind and icing conditions is available from the Force 12 website.

Instructions for the review antenna included a set of general instructions for XR series beams with sections specific to the XR6, a separate document covering general element construction and riveting techniques, and a third "best practices" document. Color photographs and a detailed assembly drawing are very helpful. Between the time I received the antenna and assembled it, Force 12 sent some im-

portant updates to the instructions with revised element tip dimensions, additional written assembly instructions, and more photographs. According to Force 12, a more comprehensive manual is in the works, but I didn't have any trouble using the instructions provided.

Construction

The XR6 arrived in two sturdy cartons. The boom is shipped in three pieces, with one end swaged to fit inside the adjacent section. Two ¼-inch bolts with locking nuts at each joint hold the boom sections in place. Boom-to-element brackets are factory installed and secured with multiple hefty rivets. (These elements won't be twisting in the wind as sometimes happens to elements mounted with U-bolts.) All of the insulator clamps were mounted in their proper locations. The boom is well-marked as to which element goes on which boom-to-element bracket.

Element pieces are bundled together and color-coded with tape — the tubing pieces with two pieces of red tape were the 20 meter driver, and those with one piece of red tape were the 20 meter reflector, for example. Unfortunately, the instructions did not identify which bands the different colors indicated, nor were the elements marked (20 meter reflector, 10 meter driven element, and so on). I had to loosely assemble each bundle of tubing sections and put them in order by length. According to Force 12, the new manual will have more information about element identification and the elements themselves will be marked.

Dow-Corning silicone grease and a small brush are provided to lubricate the element joints, boom joints, and stainless steel hardware. Be sure to use it — it will help keep moisture out of the joints and keep the hardware from galling.

Element sections are fastened together using closed end aluminum pop rivets with steel mandrels. The larger tubing sections use six or eight 3/16-inch rivets at each joint (Figure 1), while the smaller tubing uses six of the ⅛-inch rivets at each joint. Holes for the rivets are drilled at the factory and no measuring is required, except for the tip section. The tip sections of each element are secured with stainless steel hose clamps, but rivets are supplied to lock these down, if desired, once any final tuning adjustments are performed.

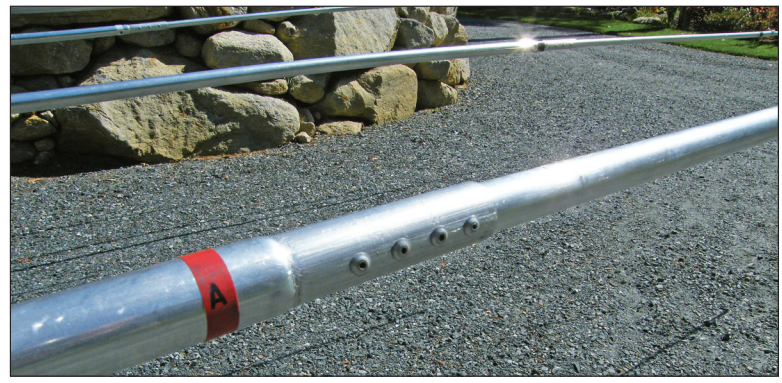

Figure 1 — Element joints use rivets to secure the sections. Element sections are well-marked with colored tape and labels.

Each element section is marked with a letter (A or B). The A and B sides are exactly the same length, but the holes for rivets didn't always line up if I failed to observe the A and B markings.

For the most part, the antenna went together easily. I started by assembling the boom and setting it on sawhorses with the elements on the top side for easy access. The XR6 mounts to the mast with elements down, but the boom is short enough that I had no trouble flipping over the finished antenna for installation.

Next I laid out the element tubing bundles in order, near their respective mounting plates, and started element assembly. I worked from the center of the boom toward the ends as recommended in the manual to distribute weight evenly. The last two elements assembled were the 20 meter reflector and 6 meter director.

For each element, first I mounted the center section loosely in its corresponding boom-to-element plate insulators. Next I assembled the riveted element sections. Those 3/16-inch pop rivets take considerable effort and hand strength to install with a standard hand tool, particularly the last squeeze just before the steel mandrel breaks off. My hands were sore for the next couple of days. I mentioned this to Chip Margelli, K7JA, at Force 12, and he suggested a two-handle riveting tool such as the "Pittsburgh Heavy-Duty 17½ inch Hand Riveter with Collection Bottle" available from Harbor Freight. That tool provides better leverage for the larger rivets. The Force 12 documentation also recommends using a pneumatic rivet tool with an air compressor, but I couldn't see buying one just for this project.

When I got to the 20 meter reflector, I found that was missing all of the 3/16-inch rivets (18 total). Force 12 sent replacement rivets and also included some new plastic spacers used to keep the ends of the closely spaced 20, 17, and 10 meter driven elements separated.

I carefully measured all of the element tips and tightened the hose clamps. I thought I was going to have to ask Force 12 for some replacement element tips, but it turned out that the 6 meter and 10 meter tips were just mismarked. The ones with pieces of colored tape that matched the driver were the right length for the director, and vice-versa.

Next, I turned my attention to the feed system, which uses two parallel square aluminum bars that connect to each driven element center with 10-24 stainless steel machine screws (see Figure 2). As with the rest of the antenna, the feeder bars were preassembled, drilled, and marked A and B. I had to fiddle with the hardware a bit to get everything lined up, but in the end it all went together smoothly.

Final assembly consisted of tightening up all of the hardware, attaching the boom-to-mast plate, and connecting the feed line. At the feed point I used the optional Force 12 EB-2 balun (Figure 3). I spaced it off the boom ¾ inch with a scrap of PVC trim left over from my house construction and secured it with some electrical tape and plastic cable ties. That way I could work on the connector with the balun secured to the boom and it shortened up the leads a little. (A sturdy balun mounting bracket is now available from Force 12 and would be a better solution.)

The instructions indicate that the boom-

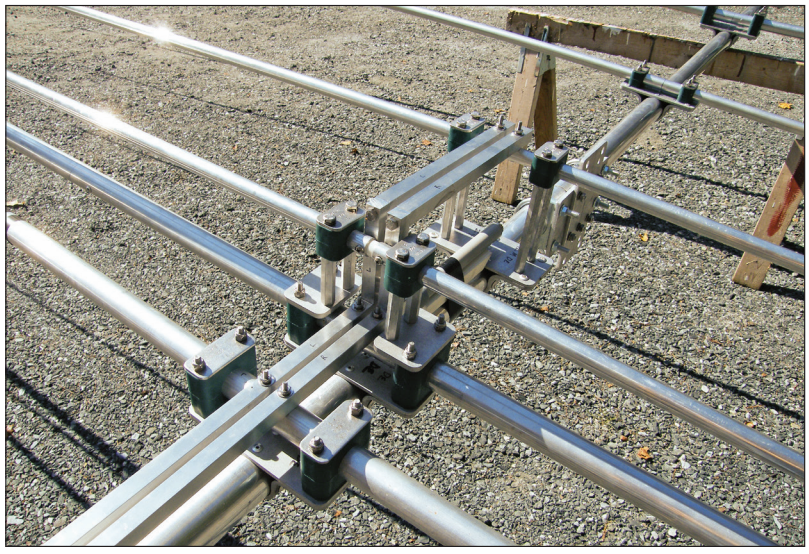

Figure 2 — The 10 meter and 12 meter driven elements are mounted on standoffs below the rest of the elements on the boom. (Note that the antenna is upside down in these photos, so those elements appear to be above the boom.) The square aluminum feeder bar assembly connects to each driven element.

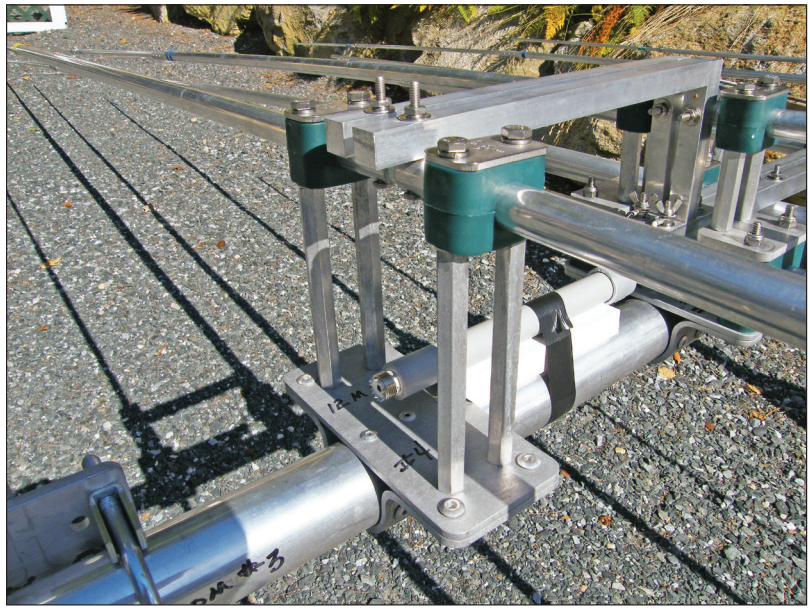

Figure 3 — The feed line connects to the balun near the center of the boom.

to-mast bracket should be placed at the physical center of the boom, not the weight balance point, and suggests adding weight to the light end of the boom if imbalance is a concern. On the tower, I have always found it much easier to handle antennas that are weight balanced, so I spent some time getting that right. I stole some 8-ounce cigar-shaped weights from my wife's adjustable ankle weight set and added them inside the reflector end of the boom one at a time until the XR6 balanced, then tacked them in place with silicone caulk. There's probably a better way to do it, but I wanted to get the antenna in the air and that's what I had handy. I found that 2 pounds of weight balanced the antenna perfectly.

The Force 12 "Easy-On" boom-to-mast mount deserves special mention. It consists of two thick aluminum plates. One plate attaches to the boom with 2-inch U-bolts, and the other attaches to the mast. The standard mast plate is drilled for 2-inch U-bolts, but plates for larger masts can be ordered. The plates have five sets of matching holes for bolts that will hold them together in the final installation. Before mounting the mast plate, a bolt is placed through the center hole such that the head is trapped between the plate and mast. When the antenna is raised, the center hole in the boom plate is mated to the protruding bolt, and a lock washer and nut installed. This holds the antenna in place while antenna is aligned and the remaining bolts are installed.

Installation

My wife, Jean, N1OJS, and I installed the XR6 on the 25-foot utility pole one sunny day in late September. I didn't have any guy wires to worry about, so it was pretty easy to get the antenna to its final resting spot. Based on experience with other Yagis on guyed towers, I suspect that the closely spaced elements at the center of the boom would make snaking it around guy wires tough. A tram system is probably the way to go. I really liked the Easy-On boom-to-mast clamp — much easier than trying to line up the antenna swinging on a rope to get U-bolts positioned.

The antenna is fed with about 200 feet of RG-213. SWR at the station end of the feed line measured 1.5:1 or less across the bands except for 10 meters and 17 meters. On 10 meters, the antenna tuned toward the top of the band, and I am most interested in the low end, so I lengthened each side of the 10 meter driver by ½ inch. That gave me low SWR at the bottom end and 1.8:1 at 29 MHz. On 17 meters, SWR was 2.3:1 at the bottom and 1.8:1 at the top. I lengthened each side of the driver by 1 inch, and now SWR is 1.9:1 at the bottom and 1.6:1 at the top. I was tired and stopped there, as it was good enough for my transmitter and amplifier. I mentioned the 17 meter SWR to Chip at Force 12 and in December he sent revised tip lengths for the 17 meter elements. I'll try that when the weather warms up.

On the Air

Listening to signals on the air, the XR6 has a good pattern, with noticeable front-to-side (F/S) and front-to-back (F/B) ratio on all bands. F/B is typically two to three S units on my TS-590S, and F/S is typically two to four S units, although signals vary from moment to moment with ionospheric conditions as well.

I was able to compare the XR6 to a multiband vertical and to inverted Vs for several bands. Signals on the XR6 are usually better than on the other antennas, sometimes by a lot. (Of course, some of that may have to do with orientation of the inverted Vs).

I used the XR6 extensively during the final months of 2014, working contests and DXpeditions and W1AW portable stations and the ARRL Centennial QSO party — some 17,000 QSOs in all, spread across 20, 17, 15, 12, and 10 meters. Although no antenna at 25 feet is going to be a band burner, I had a lot of fun with the XR6 cracking pileups, running stations at good rates, working weak stations on backscatter, and so on.

I wondered how well a tiny two-element beam would work on 6 meters. Then we had a single-hop sporadic E opening one evening, and I found myself switching back and forth between working W4/8/9 stations on 6 meters and chasing some of the W1AW portable operations on HF. With all those bands available on one antenna, band changes required little thought or effort.

The Force 12 XR6 is a good match for my needs. It covers all of the bands I'm interested in, yet is small enough to fit in the space available. After years of working with dipoles and verticals, it's nice to have a directional antenna again.

Manufacturer: RF Acquisitions International, Force 12, 566 West Crete Circle, Unit 1, Grand Junction, CO 81505; tel 888-998-8541; **www.force12inc.com**. *Price*: XR6, $1599.95; EB-2 balun, $59.95.

[1]M. Wilson, K1RO, "InnovAntennas DESpole 20/15/10 Meter Rotary Dipole," Short Takes, *QST*, Mar 2014, p 54.