Secrets of Guyed Towers

—put 'em up and keep 'em there

Trade real estate for security.

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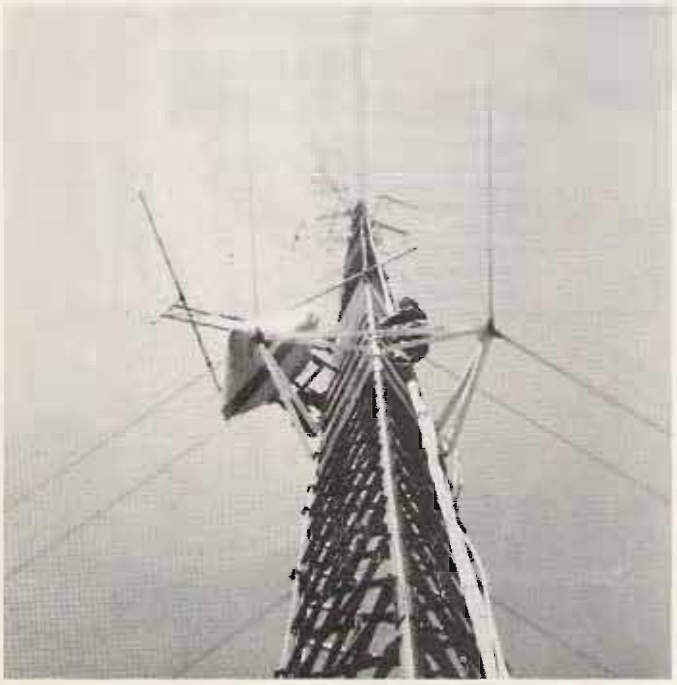
There is an old saying among hams that "if it stays up, it's too small." Who among us can truthfully say that on those long winter days we haven't spent a moment or two thinking how great it would be to have a five-element, 40-meter beam in the backyard, fed with 2 kW, and a hundred feet above ground? Dreams? Well, maybe. But it's sure that whatever your idea of the "ultimate" antenna array, it's got to be held up by something.

Since the best antenna farm starts with the support equipment, let's look at the best antenna support: the guyed tower. A tower is like a chain, in that it is only as strong as the weakest link. Self-supporting towers are linked to Mother Earth at one point—the base. Guyed towers, on the other hand, have four support points over which to spread the load—three anchors and the tower base. The penalty for this added strength is the larger chunk of real estate required to accommodate the guy-anchor supports.

In planning to erect a tower, there are some decisions and compromises to be made. One must be realistic about what will adorn the top of the tower and the worst case of wind loading that can be anticipated. The antenna load must be added to the wind loading to determine the total load environment in which the tower will be operating. Most antenna manufacturers publish load figures as part of their advertising, or will furnish data on request. The same goes for tower makers, and they also have data about



This is a commercial CATV tower. The dish at the left is a microwave receiving antenna. Mounted below it is a "star mount" anti-torque guy wire/frame system. The tower height is 500 feet.

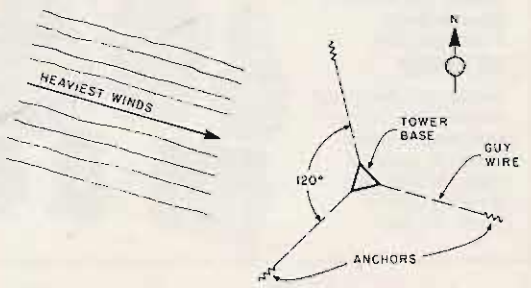


Fig. 1.

Here is a commercial tower anchor and "eyeplate." Note the length of guy wire laced through the turnbuckles to prevent loosening.

The bottom two guys shown here are attached to the anchor plate and to the "star mount" just below the microwave dish.

wind and ice conditions throughout the country to help in figuring the operating load.

As a rule of thumb, anchors should be placed out from the tower base a distance of between one-half and two-thirds the tower height. For a hundred-foot tower, this means the distance from base to each anchor will be from fifty to seventy-five feet. Since this distance determines the angle of the guys at the tower, it represents a compromise between the ideal one-foot-up for one-foot-out, or guy angle of forty five degrees, and some even sharper guy angle which conserves real estate. These considerations outline the practical limits of tower height.

Other factors which limit tower height are: surrounding objects like houses and trees, sloping terrain, local building codes, and neighbors. Each should be taken into careful consideration since towers are no less expensive to take down than to put up.

Since the load of a tower is in two parts, it is best to look at each in choosing a brand and model of tower. The side load is the force which is supported by the anchors and guy lines. The vertical load is supported by the tower and base alone. Most towers are triangularly shaped, and the wider the spread between the vertical legs and the larger in diameter they are, the greater the vertical load they will hold. Knowing the antenna loading figures and the weather conditions for your area, it is possible to have a tower manufacturer recommend the proper size tower for your needs.

Two last considerations should be figured into the choice of heights. How far will the rig be from the antenna, and what will the cable loss be, compared to the benefit of added height? In addition, who will service the array? It seems that the number of volunteer climbers varies inversely with the height of the work!

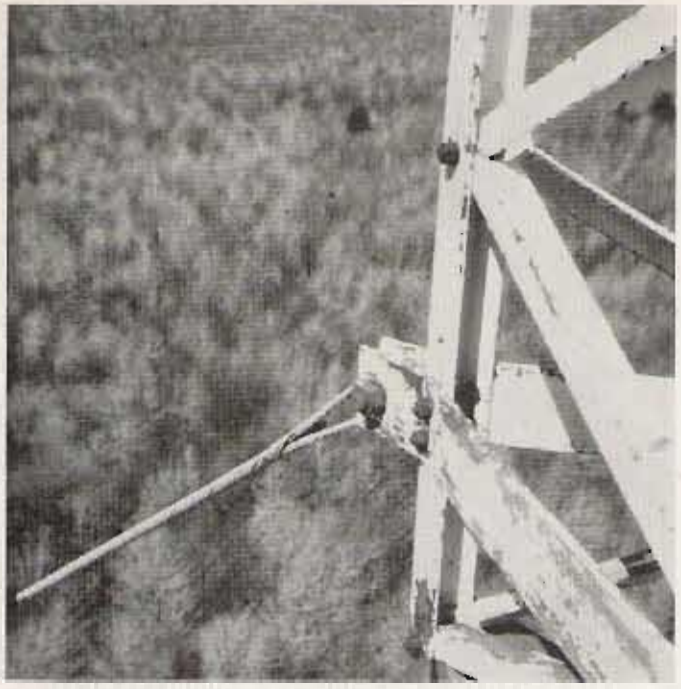
Planning the actual construction is the next step in the process. Survey the land for the locations of the base and anchors. Let's say you come up with a layout similar to the one in Fig. 1.

In this "helicopter" view of the project, we see that the anchors are laid out 120 degrees apart and that two of them are upwind of the tower base. This spreads the worst of the wind loading between two anchors.

The type of soil will determine what type of anchor should be used. There are screw-type units which don't need a hole but are screwed into the undisturbed earth. These are okay for smaller systems with light loading and with firm to slightly-rocky soil. The other type is the bell anchor which requires that a hole be dug. The bell-shaped bottom of this type of anchor is attached to a long rod which sticks out of the ground after the anchor is placed in the hole. When the bell is struck with a heavy bar, the anchor will spread out and dig into the sides of the hole. The hole is then backfilled using small rocks and well-tamped dirt. These bell anchors hold a larger load since they are bigger at the bottom and deeper in the ground than the screw type.

The tower base also is chosen after considering the type of soil at the construction site. Since the base has to support only the vertical load, it doesn't have to be very deep. It should be down far enough, however, so that frost will not cause it to shift position. Manufacturers' recommendations should be followed here so that a firm footing is assured.

Finally, make a list of the required tools and gear for the actual job. Try to obtain the services of someone who has done similar work before, and rely on his experience. If no hams are around to fill the bill, try the local power or telephone company. Their construction crews routinely handle projects similar to this, and probably will know where you can obtain the ropes, guy jacks, strain dynomometers, and climbing equip-



Guy wires and preformed wrap-on grips are shown at the tower end. Note that the bolt acts as an axle for the grip. The height is 375 feet.

A Dill tower in CATV service is pictured here. The tower is 100 feet tall, in 10 foot sections weighing about 60 pounds each. The sections are 11 inches on a side.

ment you will need.

Before getting into the actual nuts and bolts of hanging up the tower, it's good to discuss various aspects of safety on the job. Advance planning on paper of each step in the process will allow each member of the crew to familiarize himself with the sequences involved. Line up enough people to do the job, and don't forget that at least one should be experienced. All climbing tools and small hand tools should be in first-class shape. Hardhats are a must for the ground crew, and no one should be closer than twenty feet to the tower base for any reason other than to attach gear to the ropes going up the tower. The auxiliary leg, which sometimes is used to hold the weight of a tower section as it is placed on already erected sections, should be inspected carefully. The combined weight of the leg and section can do considerable damage and injury if they fall.

The Dill tower base rests on a large flat rock two feet down and buried in small rocks and well-tamped dirt.

When everything needed is on hand, the anchors are dug in, and the necessary personnel have been lined up, it is time to pick a day to complete the job. Weather is the main consideration here since to be safe the entire job should be completed in one day. The Flight Service Center at the local airport is an excellent source of weather information, and their forecasts of wind conditions are especially good.

On the morning of the big day, begin by bolting the first three sections of tower together on the ground. Attach to the top of the assembly three guy wires which have been cut to roughly the correct length. Set the bottom of the assembly next to the tower base (which is in the ground) and lay out the guy wires down the length of the three-section assembly, over the base, and straight out beyond. With one man holding down on the bottom to make it dig into the ground, and three more pulling at the guy wires, have the remaining people lift the top of the tower and raise it over their heads. As they walk toward the base raising the tower above them, the guy wire attendants will steady the tower side-to-side while at the same time helping to pull the tower vertical.

When this move is completed, the tower should be standing on the ground next to the base, stabilized by the guy wires. Next, lift the tower onto the base and install the three bottom bolts. Attach the guy wires to their respective anchors, and, using a spirit level, a plumb bob, or other sighting line, snug up the guys until the tower is exactly vertical. This operation is important since when later sections are installed, the tower will be put into a bind if it is not

The anchor rod holds three guys using preformed grips. The rod is six feet long and is buried nearly five feet down.

This is a partly installed preformed grip. No tools are needed, and it may be removed for re-tensioning of the guys and easily reapplied.

exactly vertical.

The climbing people are now sent aloft, and the auxiliary leg (or stiff-leg), pulleys, and hand ropes are made ready to raise the next tower section. Since it is very hard for a person to get good lifting leverage while leaning back in a line belt, the ground crew should raise each section while the climbing crew steadies it and guides its placement atop the last section erected.

Remember that during this operation those on the ground should not stand near the tower base, or in an area where dropped tools or parts might fall.

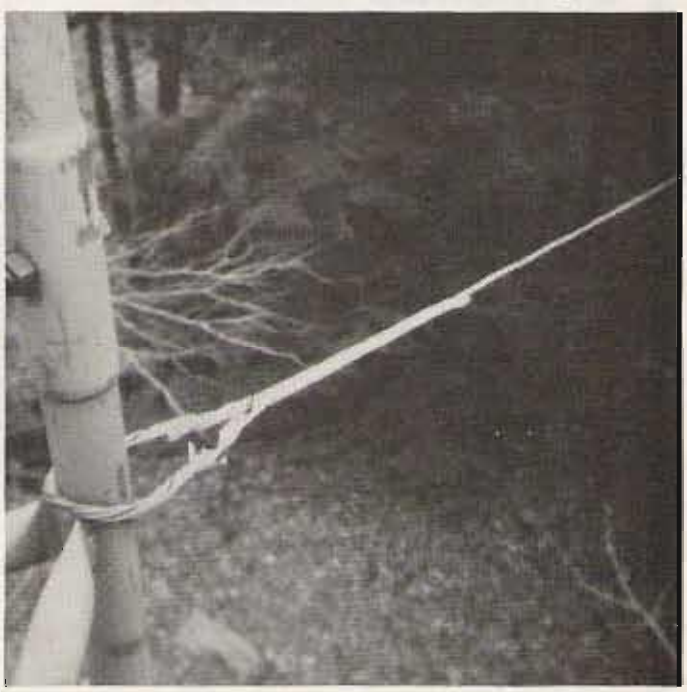
Continue adding tower sections and guy wire sets until the tower is complete. Since the last section normally is built to accept an antenna rotator and mast, these items are more easily installed before that section is raised.

Having aligned the tower each time that a set of wires was installed, the complete unit should be pretty close to vertical. By sighting upward along each leg of the tower, any bends will be seen easily and can be removed by adjusting tension on the appropriate guy wire.

Now that the tower is straight, the next step is to equalize the tension on each set of guy wires. A device called a strain dynomometer is used to read tension on a cable. If this is not available, the only recourse is to pull each guy wire slightly out of line and feel the tension by hand. Sighting up each guy wire from anchor toward the tower and judging the sag is another method, but it is not as reliable due to the varying lengths of the lines. The aim is that each guy wire should carry the same strain as every other.

The tower is now complete and ready to accept antennas and downleads. Even though it is ground-mounted and is attached to guy wires and anchors which also are at earth ground potential, it still is wise to electrically ground the tower. Most commercial installations use a six-foot ground rod at each tower leg, driven as close to the base as possible. This is sufficient to protect the tower, although lightning protection at the shack end of the downleads still should be used. In the event that lights are required, or any source of commercial power is used at the tower, the ground system should be tied into the neutral of the electric line.

When very large arrays are rotated on a tower, the torque will cause twisting of the structure. While this does not affect the life of the tower, it does affect the aiming accuracy of VHF directional arrays during windy conditions. The cure is to install another guy system by bolting to the tower a length of pipe or angle iron about six feet long, as per Fig. 2.



Guy wires and grip are attached to a tower leg.

Since this guy system carries only the twisting load applied to the tower, it need not be as heavily constructed as the main system. Screw-type anchors and number ten steel fence wire are more than adequate, along with TV-type U-bolts connecting the pipe to the tower legs. With this arrangement mounted about three-fourths of the way up the tower, it should remove most of the twisting action and considerably reduce the whiplash effect on the antenna elements.

There you have it. Guyed towers offer the most stable platform for large arrays and greater heights under the most extreme weather conditions. They also offer confidence in the knowledge that those expensive antennas are mounted up where they operate best and are supported by a system which will offer safe and reliable operating for years to come.■

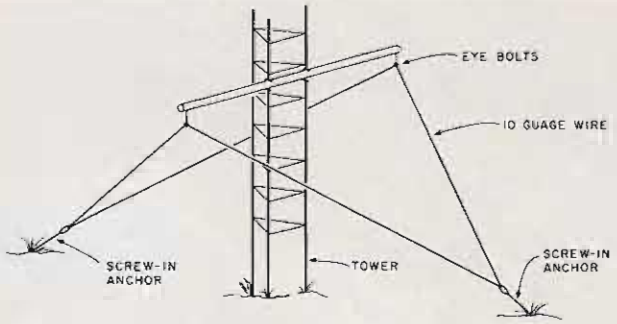


Fig. 2.

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