
Wind Generator Towers

A strong tower is essential for any wind generator, otherwise it will come crashing to the ground. Plan on spending at least as much on your tower as you did on your wind generator, if not more.

Since a tall tower is a rather immobile structure, make sure your location is good! Your wind generator should fly at least 30 feet above any obstructions within 300 feet. If you can't do this, keep in mind that turbulence caused by nearby object will rob you of power, and cause much more stress on the mill...turbulent winds make the machine yaw violently, which put a huge amount of strain on the fast-spinning blades. If you are low on funds for your tower, you can still homebrew an inexpensive version-- we've done it many times. Check out our field-expedient tower at the bottom of this page, made from a fresh-cut stump and a lodgepole pine.

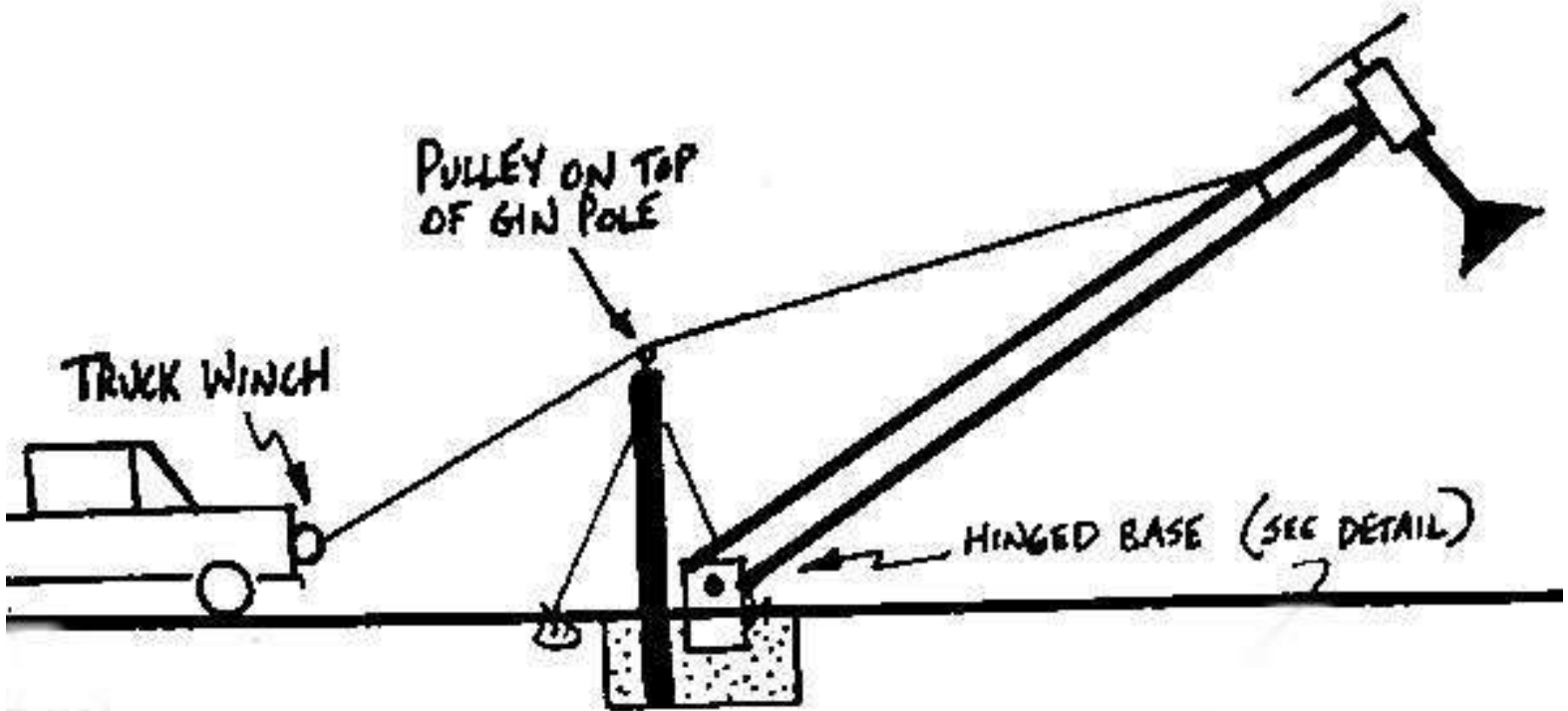
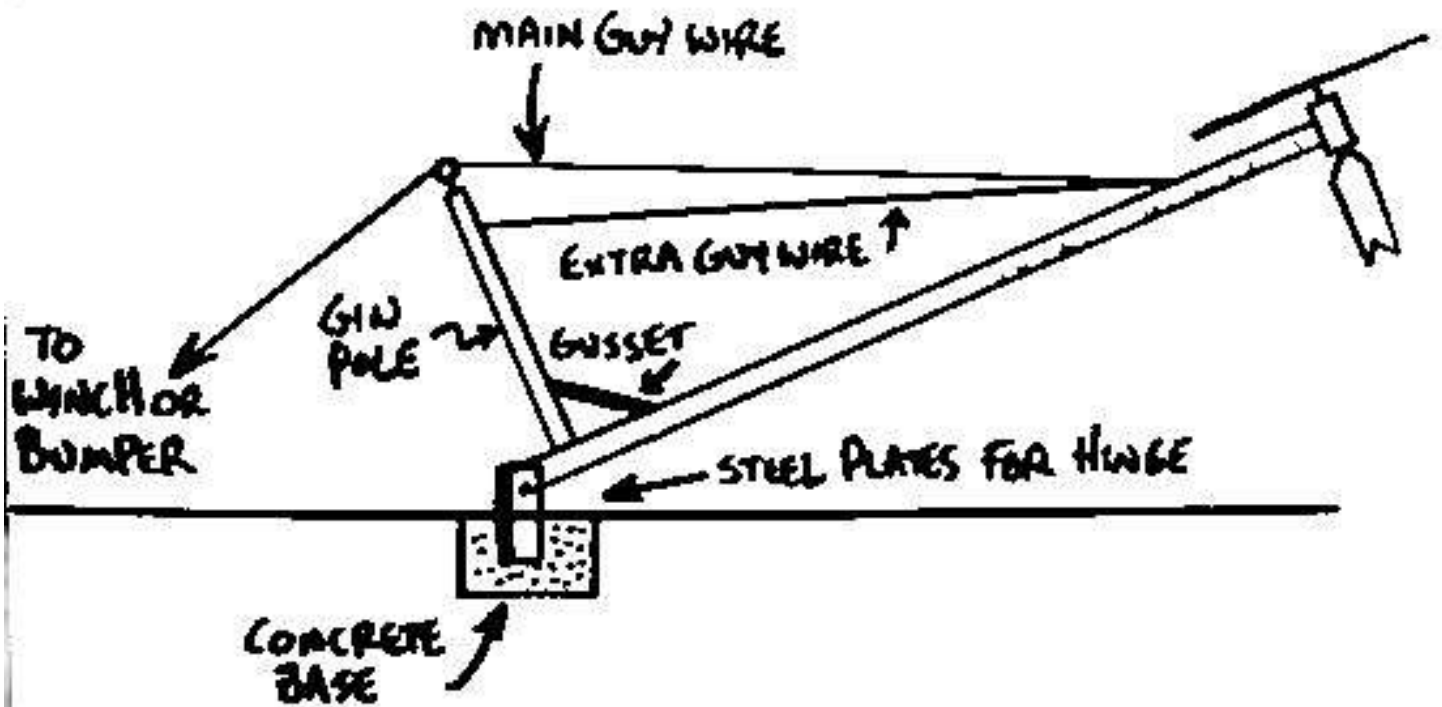
Tilt-Up Towers

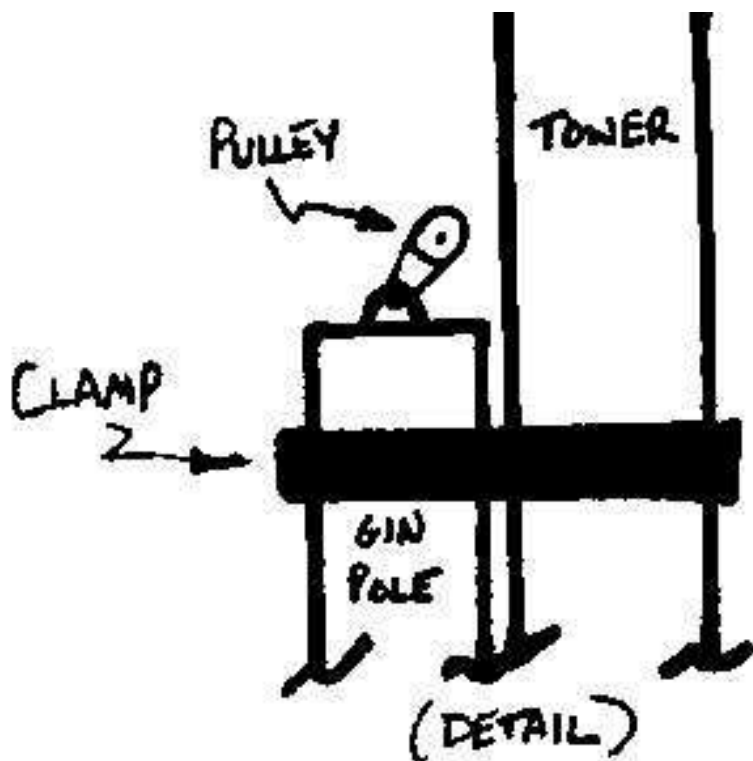
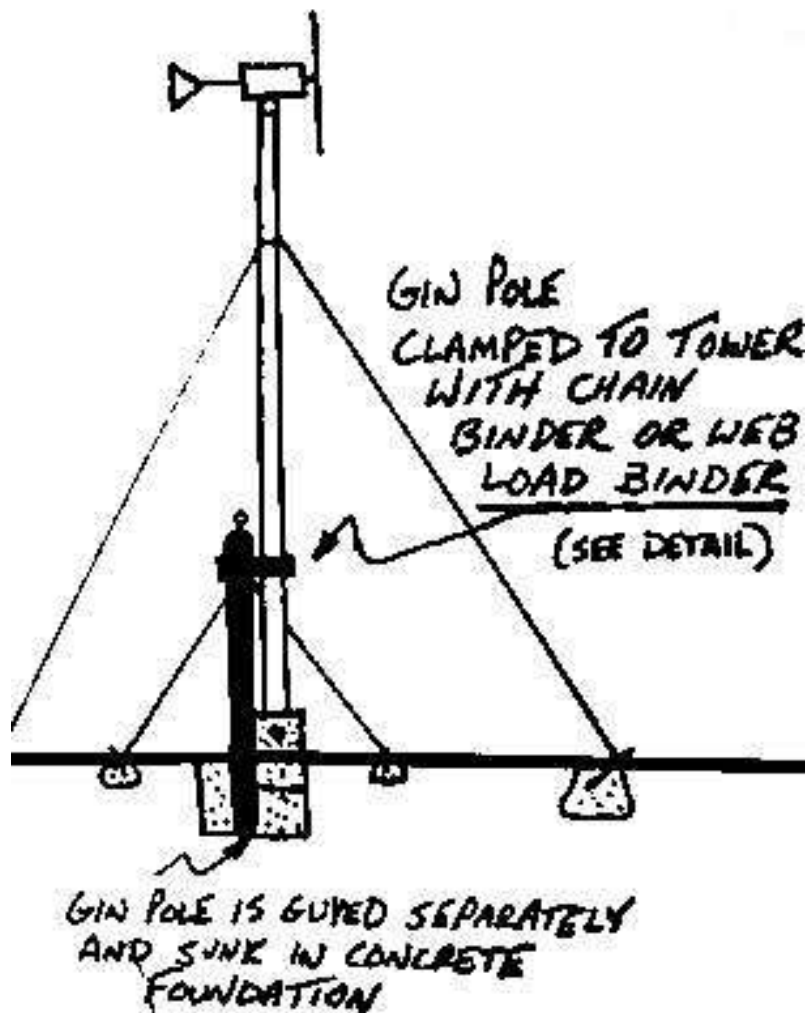
We are very fond of tilt-up towers around Otherpower.com headquarters. One of our Dans is deathly afraid of heights, and the other Dan feels that climbing a 60 foot tower is neither fun nor conducive to a long and healthy life. Therefore, this page will concentrate entirely on the tilt-up variety. This way, all work with tools and heavy wind generators can be done while safely standing on solid ground. Tilt-up towers can be made from wooden utility poles, steel lattice radio towers, or 21-foot sections of steel pipe coupled together.

The key features of these towers are 4 guy wires, a hinged base and a gin pole for leverage. To raise a tower, the 2 side guy wires are attached and tightened while the tower is laying on the ground to prevent lateral movement during the process, and the guy wire opposite the winch side is cut to the correct length and attached to the earth anchor to prevent the tower from falling over if it passes plumb. A winch or vehicle is attached to the remaining free side over a gin pole for leverage, and the tower is slowly pulled up. When it is plumbed with the turnbuckles, all guy wires are tightened. To lower it, simply reverse the process. This whole procedure is rather exciting, but not as exciting (terrifying) as climbing 60 feet in the air!

The diagrams below show some simple plans for a basic tilt-up tower design.

WARD'S 40 FT TILT-UP TOWER



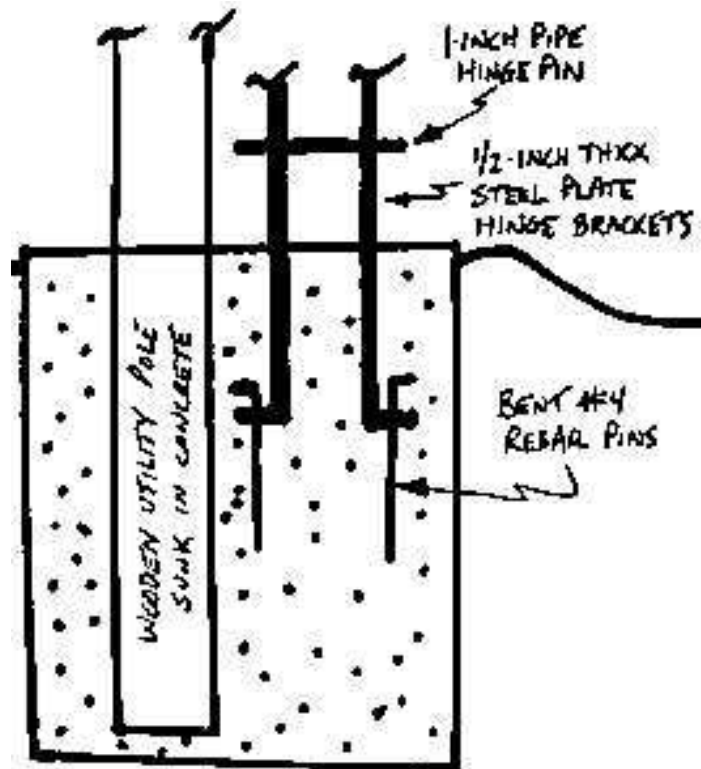


Tower Materials

- **Wood**--Wooden poles can be very effective and economical. Some of our neighbors have simply used a tall tree from the forest, bored a 1 inch hole near the bottom for the hinge, built a metal collar on which to mount the wind machine, and gone right ahead with the project. None of these towers has yet failed, but the heights average only 20-30 feet. I would be leery of this method with a higher tower! A straight, treated utility pole would make for a much more permanent tower. These are fairly easy to find in 20-30 foot lengths, and can be found (with difficulty) in more useful 50-60 foot sizes too. Topping, limbing and guying a tree has been suggested to us, but we don't recommend that either--trees will eventually rot, they are hard to climb, and sway too much in the wind.
- **Metal Pipe**--This is my personal favorite. I've had great success using 2 inch galvanized steel water pipe for towers. The maximum recommended height for a 2 inch water pipe tower is 42 feet, which is 2 pieces of pipe. Attach another set of guy wires at the coupling between the two pipes. Also, it would be wise to make couplers between each section that extend into the pipe on both sides for added strength.
- **Steel Lattice**--These towers are very strong and lightweight, but expensive if purchased new. Used lattice towers can sometimes be found in rural areas, or through ham radio enthusiasts. Though generally not designed for tilt-up use, the base can be modified to be hinged. Contact [Lake Michigan Wind and Sun](#) to learn more about this conversion, and for prices and availability of used and new towers. You'll be pleasantly surprised at how little lattice towers weigh--a typical 10 foot section weighs less than 80 pounds!

Foundations

A wind generator foundation must be *very* strong, especially the hinge. If your tilt-up tower, foundation, or hinge is not strong enough, you will probably find out during the erection process when the entire mess comes crashing to the ground! That is the only time when there is a great deal of sideways stress on the base--during raising and lowering. Pouring a concrete foundation that extends down below frost line is highly recommended. I have successfully used 1/4 inch steel hinge brackets embedded directly in the concrete. 1/2 inch steel plate would be better. See the diagram below for details.



Earth Anchors

Your earth anchors for the guy wires must also be very strong--they have to resist the lateral thrust that is put on the windmill. As your propellor rpm increases, the blades act more and more like a solid sheet of plywood sitting up in the wind. There are a number of different earth anchors that can be used; a rugged mountain installation in the rocks might require a couple of different kinds. Generally, anchors are designed to utilize the weight and shear strength of the surrounding soil to help hold them in place.

The radius of your guy wires should be between 50 and 75 percent of the tower height. It is very important to lay out your 4 anchor foundations perfectly perpendicular to each other around the tower foundation--otherwise, the 2 side guys will not stay tight while raising and lowering the tower. Leveling is an issue too. If the guy wire pads are at different elevations, you will run into the same problems with loose and tight guy wires.

Use the highest quality turnbuckles that you can find. Try to find turnbuckles that have removable bolts at each end to hold the guy wire in. Use the thimbles that come with your cable clamps to avoid fraying the cable. Avoid turnbuckles that have hook ends--if you can't find them with bolts or solid loops, be **SURE** to using baling wire on each hook so nothing pulls loose during raising or lowering.

We recently learned a good lesson about guy wires--fortunately it was not a hard lesson! When fastening your guy wires with Crosby U-shaped cable clamps (see photo), **make sure** to use enough clamps on each connection (3 is recommended), orient them correctly, and tighten them **VERY** hard! The clamps should all be oriented the same way, with the forged saddle on the live end of the cable. Remember the saying..."Never saddle a dead horse..." don't ever put the saddle of the clamp on the dead end of the cable!



Fortunately we learned this lesson while building a washtub bass for our bluegrass band, and **NOT** while erecting the windmill! Had we not learned this from building the bass, we would not have oriented the clamps correctly or tightened them enough. We used a length of 3/32 inch aircraft cable for the string, and fastened it at the peghead and at the washtub with cable clamps. But every time we tightened the string enough to play in the key of G, the cable clamps slipped. After about 4 tightenings and the addition of more cable clamps, success was achieved. But it was sure better to find out about these clamps on a bass instead of a windmill! [Click HERE](#) for more information about our washtub bass...it's a great instrument that's easy to play with no musical knowledge--all you need is a good ear and strong arms and legs. It's also a bit of an aerobic workout to play, as you raise and lower the pitch of the single string by pull and pushing on the neck while bracing the tub with your foot. And sorry for the diversion....back to the topic now!



- **Concrete**--This is the all-around strongest solution. The hole for the concrete should be bell-shaped, so it is wider at the bottom than at the top--this allows the soil over the anchor to help hold it in place (see diagram below). A metal loop for the guy wire can be embedded directly in the concrete, preferably at close to a 90° angle from the attachment point near the tower top. Your footing should extend down below frost line. If you set an auger with a plate into concrete, the end should point toward the tower...In other words it should be parallel to the guy wire.
- **Augers**--If your soil has good shear strength (i.e. it is not loose, dry and crumbly) you can purchase earth augers to anchor your guy wires. These metal rods have an angled plate at the end that allows you to screw it into the ground. Again, they should be angled into the ground so that they are parallel with the guy wire.
- **Rock Anchors**--We have successfully (so far!) anchored guy wires directly into large rock outcroppings using a homemade 'piton' made of rebar. Drill a 3/4 inch hole in the rock with a hammer drill, again angled away from the windmill. Pound in a #6 rebar and weld a loop for the guy wire on the end. Epoxy in the hole might also help. Our first version used #4 rebar and seems very strong, but a larger diameter would be better.
- **Fence Posts**--Metal T posts can make fast and easy earth anchors for 20 to 30 foot towers if you can pound them in deep enough. If not, we have successfully dug out around the post and poured in concrete for a very strong anchor on a 30 foot metal pipe tower. With fence posts, they should be angled into the ground at 90 degrees to the guy wire.

Vibration

Windmill towers are subject to all sorts of vibration. The propellor, changing wind direction, generator noise, and effects of the wind directly on the tower can cause all sorts of harmonic vibration, some audible and some not. Be sure to Loc-tite® all bolts on the tower. If harmonics are causing problems (such as a swaying metal pipe tower), the problem can sometimes be fixed by changing where the guy wires attach to the tower, or by adding extra guy wires farther down the tower.

Field Expedient Windmill Tower

One of our Dans was running into some serious power problems...his batteries (inherited from the previous owner of the house) were trashed, and the new Starband satellite uplink through which we run our website draws about 300 watts. He needed more power, and fast! He didn't have time to build a proper tower, and the ground was frozen solid, eliminating any possibility of digging or pouring concrete for a foundation or guy anchors. Pictured is the result--Dan cut down a live tree, and carved the stump into a hinged base. The tower is a lodgepole pine that was standing dead, and the hinge pin is one inch pipe with another smaller pipe inside it. Two of the guy wires are anchored into rock with pitons made of 1/2 inch rebar, the others are guyed directly to the bases of live trees (he tried metal fence posts, but the ground was too rocky and frozen to pound them in). This tower is intended as a temporary measure; the windmill involved is one of our homebuilt models made with minimal monetary investment, so it's not a great loss if the tower fails--we'll chalk it up to a learning experience!

Hinged base made from tree stump



Improvised guy anchor piton



We would like to include more home made tower designs on this page. If you have built a windmill tower from scratch and are willing to share your experiences and photos, please email us!

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