

Anchor Guidelines

The anchors used with the WindMast tower are critical components of the tower installation, safety, and preparation work. The following information is provided as an aid in determining the proper anchors and installation methods. However, all sites are different and it is your responsibility to assess the site and install the appropriate anchors.

Before the tower and anchors are installed, the soil type must be determined. It is very important to determine the type of soil to several feet below the ground surface before purchasing anchors. In addition to the soil type at the site, it is also important to know the weather conditions at the site, such as maximum winds and icing that may collect on the tower. Soil conditions can soften or change markedly with heavy rains. Since there can be variations in the precise soil condition at a site, you may want to purchase two or more types of anchors or sizes for the installation, and choose the appropriate anchor once you have begun installation. Seek the advice of a professional engineer if you are not confident that you can install the appropriate anchors.

⚠ CAUTION

The application of the anchors to the site requires knowledge and judgment. Consult a professional engineer if you have any concerns about the application of any of the anchors to the site. All anchors should be proof tested to the load required by the application prior to being put into service. The anchors should be proof tested with a winch, an extended jack, or a come-along, and we recommend the use of a dynamometer to indicate the load during proof testing.

If in doubt, install more anchors than the minimum required. Always attempt to keep the anchors in alignment with the tower, and use the widest radius possible with the given guy wire lengths.



Figure 1. A 5,000-pound dynamometer and a 3-ton grip puller are useful tools for testing load anchors. The grip puller can also be used to lift the tower.

Types of Anchors

Screw-In Anchors

Screw-in anchors are recommended for softer soil types, Classes 5-7 in Table 1. They do not work well in rocky soils. The screw-in anchor is a 66" (1.67m) hot-dip galvanized steel bar with an eye on one end for attaching the guy wires and a 6" or 8" (152.4mm or 203.2mm) diameter screw at the bottom (see Figure 2). These are standard anchors used in the utility industry.

Screw-in anchors are usually installed by two people rotating a log bar threaded through the eye, but may also be installed with a power drive machine. The 8" (203.2mm) anchor may be difficult to install, so it may be more practical to install two 6" (152.4mm) anchors at some locations. The screw-in anchors must be installed at approximately a 45° angle so that the load on the anchor is in line with the guy wire axis.

Screw-in anchors can also be used in applications where an anchor will be embedded in concrete. Always consult a professional engineer if you intend to use a concrete foundation at your site.

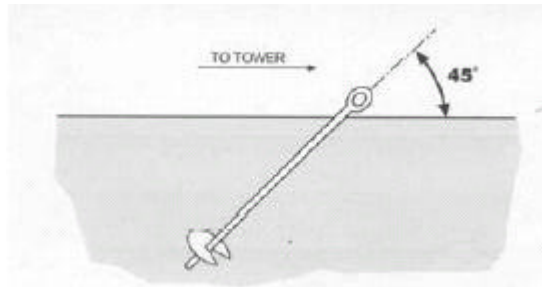


Figure 2. Install a screw-in anchor at 45° so that it is aligned with the guy loads.

Drive-In Anchors

Drive-in anchors are recommended for denser, rocky soils, Classes 2-5 in Table 1. The anchor is a 6" (152.4mm) wide malleable iron triangle with a 48" (1.22m) long cable attached to it. A drive-rod is used to drive the anchor into the ground. Drive rods can be driven manually with a sledge or with power equipment if available. The drive-in anchor must be "set" by pulling the anchor until it rotates 90°, as shown in Figure 3. We recommend proof testing each anchor with a dynamometer (Figure 1) to ensure that it is properly installed.

These anchors are useful in denser soils because they can be forced into the soil more easily, and the triangle design tends to thread around rocks in the soil.

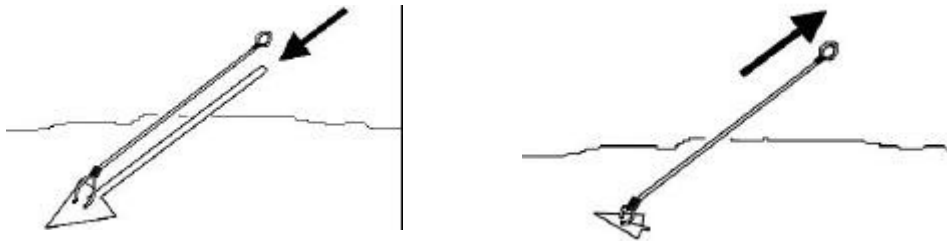


Figure 3. Installing a drive-in anchor. Attach a drive-rod to the drive-in anchor and hammer it into the ground at approximately 45° to the tower. Remove the drive-rod and pull on the cable so that the anchor rotates into place.

Rock Anchors

Rock anchors are standard in the construction industry for rocky areas. They are appropriate for soil Classes 0-1 in Table 1. They require drilling a hole for insertion of a threaded rock anchor. The anchor can then be cemented into place if desired. Grouting is necessary with soft, crumbling rocks or if weathering is expected.

The hole is bored with a hand or power drill (*Figure 5*), 1/8" (3.175mm) larger than the diameter of the unexpanded anchor. The anchor is then dropped into the hole, and the eye is threaded with a bar and rotated until the anchor has expanded firmly against the sides of the hole. The anchor must be aligned with the guy loads, and should be installed at least 12" (305mm) into solid rock.

Figure 4. An expanding rock anchor in the closed position (not expanded).



Figure 5. To install a rock anchor, first drill a hole by hand or with a power tool.



Figure 6. Thread a rod through the eyehole and turn the rod until the anchor expands tightly against the sides of the hole.

Types of Soil

Table 1. Definition of soil classifications and the corresponding load capabilities of the anchors. All loads are in pounds.

Soil Classification & Description	Rock Anchor	6" (152.4mm) Drive-in Anchor	6" (152.4mm) Screw-in Anchor	8" (203.2mm) Screw-in Anchor
Class 0: Unweathered sound hard rock. Includes granite, basalt, massive, limestone.	23,000			
Class 1: Very dense and/or cemented sands; coarse gravel and cobbles. Includes caliche (nitrate-bearing gravel/rock).	23,000			
Class 2: Dense fine sand; very hard silts and clays (may be preloaded). Includes basal till, boulder clay, caliche, weathered laminated rock.		5,000		
Class 3: Dense sands and gravel; hard silts and clays. Includes glacial till, weathered shales, schist, gneiss, and siltstone.		4,200		
Class 4: Medium dense sand and gravel; very stiff to hard silts and clays. Includes glacial till, hardpan, marls.		3,000		
Class 5: Medium dense coarse sand and sandy gravel; stiff to very stiff clays and silts. Includes saprolites, residual soils.		2,000	6,500	11,000
Class 6: Loose to medium dense, fine to coarse sand; stiff clays and silts. Includes dense hydraulic fill, compacted fill, residual soils.		1,200	5,000	9,000
Class 7: Loose fine sand; alluvium; loess; medium stiff and varied clays; fill. Includes flood plain soils, lake clays, adobe, gumbo, fill.		600	2,500	6,000
Class 8: Peat and organic silts; inundated silts, fly ash, very loose sands, and very soft to soft clays. Includes miscellaneous fill, swamp marsh.				

Guy Loads

Table 2. Guy loads and lifting anchor loads of the 30-, 40-, and 50-meter WindMasts.

Anchors	50M WindMast*	40M WindMast**	30M WindMast
1 Anchor	7346 lbs (guys 1-6)	6622 lbs (guys 1-7)	5643 lbs (guys 1-5)
2 Anchors	2185 lbs (guys 1-3) 5161 lbs (guys 4-6)	3696 lbs (guys 1-5) 2992 lbs (guys 6-7)	
3 Anchors	1181 lbs (guys 1-2) 2506 lbs (guys 2-3) 3639 lbs (guys 5-6)	1925 lbs (guys 1-3) 1868 lbs (guys 4-5) 2997 lbs (guys 6-7)	
Lifting Anchor	4620 lbs	1760 lbs	1652 lbs

*The conditions for the guy loads are: 71.4 m/s (160 mph) at 50m, no ice.

**The conditions for the guy loads are: 60.0 m/s (134 mph) at 40m, 12mm ice.

Anchor Recommendations



These are only recommendations. Consult a professional engineer to ascertain your soil type, anchor layout, and anchor holding capacities and to ensure that the anchors you choose will hold the guy loads of your tower!

Table 3. Anchor recommendations for the 30-, 40- and 50-meter WindMasts, based on soil classifications, anchor holding capacities, and guy loads.

Soil Classification	50M WindMast	40M WindMast	30M WindMast
Class 0	(5) rock anchors 1 anchor per guy location 1 lifting anchor	(5) rock anchors 1 anchor per guy location 1 lifting anchor	(5) rock anchors 1 anchor per guy location 1 lifting anchor
Class 1	(5) rock anchors 1 anchor per guy location 1 lifting anchor	(5) rock anchors 1 anchor per guy location 1 lifting anchor	(5) rock anchors 1 anchor per guy location 1 lifting anchor
Class 2	(13) 6" drive-in anchors** 3 anchors per guy location 1 lifting anchor	(9) 6" drive-in anchors 2 anchors per guy location 1 lifting anchor	(9) 6" drive-in anchors 2 anchors per guy location 1 lifting anchor
Class 3	(14) 6" drive-in anchors 3 anchors per guy location 2 lifting anchors	(9) 6" drive-in anchors 2 anchors per guy location 1 lifting anchor	(9) 6" drive-in anchors 2 anchors per guy location 1 lifting anchor
Class 4	(18) 6" drive-in anchors 4 anchors per guy location 2 lifting anchors	(13) 6" drive-in anchors 3 anchors per guy location 1 lifting anchor	(9) 6" drive-in anchors 2 anchors per guy location 1 lifting anchor
Class 5	(9) 6" screw-in anchors* 2 anchors per guy location 1 lifting anchor	(5) 6" screw-in anchors 1 anchor per guy location 1 lifting anchor	(5) 6" screw-in anchors 1 anchor per guy location 1 lifting anchor
Class 6	(5) 8" screw-in anchors* 1 anchor per guy location 1 lifting anchor	(5) 8" screw-in anchors* 1 anchor per guy location 1 lifting anchor	(5) 8" screw-in anchors 1 anchor per guy location 1 lifting anchor
Class 7	(9) 8" screw-in anchors 2 anchors per guy location 1 lifting anchor	(9) 8" screw-in anchors 2 anchors per guy location 1 lifting anchor	(5) 8" screw-in anchors 1 anchor per guy location 1 lifting anchor

* Different combinations of 6" or 8" screw-in anchors may be used to meet the load requirements of the guys and the lift.

** It may only be necessary to use (9) 6" drive-in anchors, depending on the stiffness of the soil and the recommendations of an engineer.