

Commercial Party Rental Tents for Sale
Made in the USA

        
(http://tents4sale.com/watch?v=4157231841&list=PL4157231841&index=198)

Staking Basics

Tent Anchoring

Stakes, Water Barrels, Concrete Weights ?

The purpose of this document is to provide a source of information aimed at installers, foremen, & customers that explains in laymen's terms, safe procedures for installing tents.

Tent installations are increasingly becoming dependent on alternative methods for anchoring a tent. These non-staking jobs are changing the way many companies do business. Regardless of your reason for considering a non-staking installation, the overwhelming consideration must always be safety. The safety of the public, the safety of your crew and the safety of your company should be your first priority. If you don't do things right, the public is at risk from a blown-away tent. If you don't pay attention to the project, your crew can get hurt installing the tent.

Remember: Manufacturers' recommendations are the final word in erecting any structure. Anything you make up on-site or in the office is a deviation from the manufacturer's guidelines. An engineer might be necessary for your conditions in your area.

Structural failures

The four ways a tent can fail catastrophically are by knocking down, rolling, shear failure and uplift failure. These are not technical descriptions, but they can help you understand the ways in which things can go very wrong. They are all the result of wind or storms.

Knocking down occurs when a downward force from the wind basically explodes or flattens the tent. Rolling occurs when the wind gets under the tent and one side of the anchoring fails. Rolling is a greater risk for narrower tents; wider tents are more stable.

When a tent is blown over sideways, it is referred to as shear failure. Uplift failure occurs when the tent lifts off its anchoring and "flies away." Uplift failure is definitely an anchoring issue. Strangely, wider buildings are more at risk than narrower buildings, as they have a more aerodynamic side profile, although failure is less likely to occur since wider tents are generally heavier.

Shear failure may or may not be a failure of anchoring (ballast), but it can be the first step in a catastrophic chain of events. Shear forces can slide a base plate out from under a ballast unit. Structural movement can dislodge ballast units. At this point, you would have no ballast to count on. In some cases, the wind can be lifting one part of the structure and crushing another area. These are extremely complex forces to understand, and their analysis and reporting should be left to professionals.

Historically, tent manufacturers have instructed customers to stake tents into the ground to anchor them. Instructions specified the number and size of stakes to use, and the stakes themselves may have been included when the tent was purchased. Recently, however, some manufacturers have begun indicating required holding power for their tents in terms of weight. Since water is essentially weight, doesn't that mean water barrels are adequate for anchoring tents? For tent safety experts, it's a matter of mathematics.

Staking

Deeper the stake, the greater the holding power. (<http://tents4sale.com/wp-content/uploads/2015/03/stakes-1.png>)

Stake pullout strength is directly related to stake depth. See **Figures 10 & 11**. This is true for several good engineering reasons.

1. Greater surface area
2. Soil pressure usually increases with depth
3. Larger soil wedge

The holding capacity of a tent stake is due to a significant degree to friction developed between the stake and the soil which surrounds it. It follows that the deeper the embedment of the stake in the soil, the greater the surface area of the stake which is in contact with the soil; thus the greater the holding power. A deep-sea diver is subjected to greater water pressure the deeper he dives. Similarly, the earth builds up greater and greater pressure the deeper you go below the surface. Thus it is obvious that the deeper the tent stake, the more the earth presses up against the stake and produces greater frictional forces, which increase its holding power.

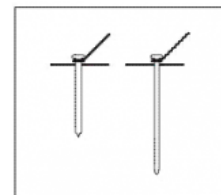


Figure 10. Stake Holding Power and Stake Depth

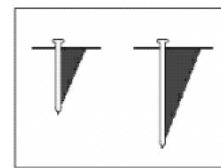


Figure 11. Soil Wedge Size and Sideways Resistance

The sideways component of forces on the tent stake, which is produced because of the angle of the guy rope, is resisted by a wedge of earth in front of it. This wedge of earth is deeper the deeper the stake is driven. The larger the wedge, the more sideways resistance it exerts to keep the stake from failing by pulling over.

The better the soil, the greater the holding power.

The best staking job in the world will be subject to variation in the soil in which the stakes are driven. Stakes perform differently depending upon whether they are driven into clay, sand, loam, dirt, etc. Most of the time, the soil is a mixture of the basic varieties: perhaps sandy clay, or clayey sand, for example.

Furthermore, soil classification may change among soil layers depending upon depth. It is not uncommon to discover that one corner of a tent may be located on one type of soil and another corner on an entirely different type of soil. Remember wetter the soil, lesser the holding power.

A Proper driving angle yields greater holding power. (<http://tents4sale.com/wp-content/uploads/2015/03/stakes-2.png>)

Field practices indicate that installing stakes vertically is superior to installation at an angle. This also simplifies and removal of the stake. See **Figure 13**.

Optimum guy rope angle provides optimum holding power.

There are a number of factors to consider for the right situation. See **Figure 14**.

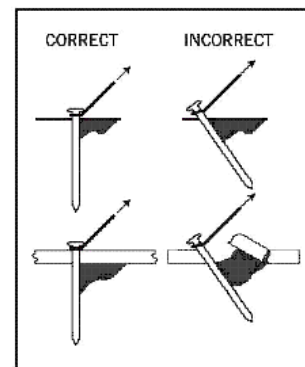


Figure 13. Stake Driving Angle

1. Tent geometry – Style of tent

2. Tent geometry – wind factor

Note: If there is wind and no sidewalls, guy rope angles should be steeper, i.e., the stake should be closer to the tent.

3. Tent geometry – ponding factor

Note: If staking against downpours or ponding, guy rope angles may have to be shallower, i.e., the stake should be farther from the tent.

4. Presence or absence of sidewalls

Note: If there is no wind and, in addition, the tent is supplied with sidewalls, guy rope angles should be shallower, i.e., the stake should be farther from the tent.

5. Soil type
6. Ground moisture
7. Presence or absence of pavement
8. Need to keep side poles in compression

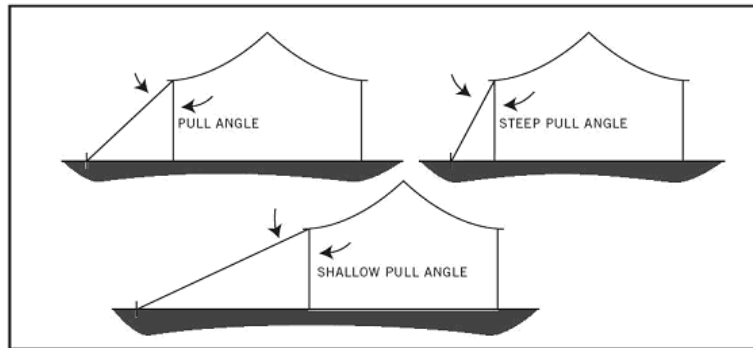


Figure 13. Stake Driving Angle

Figure 14. Pull Angles and Stake Location

(<http://tents4sale.com/wp-content/uploads/2015/03/stakes-3.png>)

Note: When staking against wind lift forces, the guy rope must be at an angle that will keep the side poles from jumping. Consequently, the stake should be located relatively closer to the tent. A pull angle of 45 degrees produces vertical forces on the stake which are equal to the lateral forces. At 45 degrees or slightly steeper, the traditional pole tent could reasonably be expected to withstand the forces of wind uplift while maintaining a balance between vertical and lateral stake forces. If alternate sidepole heights are used, that should be taken into account in maintaining proper guy rope angles.

Increasing the height of the stake knot above the ground decreases stake holding capacity.

The creeping force generated on the stake varies with the distance above the ground where (<http://tents4sale.com/wp-content/uploads/2015/03/stakes-4.png>) the guy rope is secured to the stake. See **Figure 15.**

The greater this distance, the greater the creeping force on the stake. In order for the stake to be stable in the ground, the possibility of its creeping must be eliminated. The earth pushing against the side of the stake accomplishes this purpose. It is absolutely essential that the guy rope be kept as low as possible on the stake, not higher than two or three inches, to maintain maximum stake holding capacity.

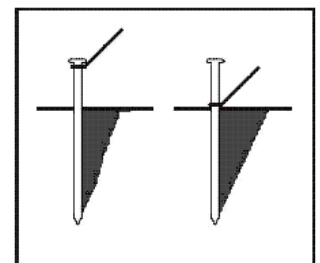


Figure 15. Stake Knot Height

Anchoring Your Tent Safely

An easy system was figured to find the necessary amount of stakes to hold a non rated tent. Simply multiply the square footage of your tent by 9 psf (pounds per square foot for up to a 30-45 mile-per-hour wind). The result is the total number of anchor pounds needed. This is not pure science. Some tents are designed to withstand wind better than others, but when verified against numerous tent specifications from major manufacturers, most sizes up to 60 ft. in width will fall into these parameters.

Sample Formula 40' x 80' tent = 3,200 sq. ft. x 9 psf = 28,800 anchor lbs.

30' x 60' tent = 1,800 sq. ft. x 9 psf = 16,200 anchor lbs.

20' x 20' tent = 400 sq. ft. x 9 psf = 3,600 anchor lbs.

There can be a wide range of holding power for tent stakes depending on soil conditions. By testing a typical 1" diameter stake, driven most of the way into the ground (average lawn), we know it has a holding

power of about 1,000 lbs. The same stake in an aged parking lot generally holds more, about 2,000 lbs.

So What Does All This Mean?

Experts recommend that a tent's anchoring power be 1½ to 2 times the forces imposed on the tent.

The sample tents installed on an average lawn will have the following stake requirements:

40 x 80	28 Stakes (28,800 lbs.) with 1.5 to 1 Safety Factor – 44 Stakes (43,200 lbs.)
30 x 60	16 Stakes (16,200 lbs.) with 1.5 to 1 Safety Factor – 24 Stakes (24,300 lbs.)
20 x 20	4 Stakes (3,600 lbs.) with 1.5 to 1 Safety Factor – 6 Stakes (5,400 lbs.)

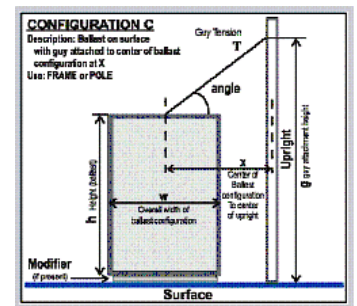
Water Barrels

Experts recommend installing tents so that the holding power is 1½ to 2 times the forces imposed on the tent. In 30 – 45 mile-per-hour wind – much less than that produced during a severe thunderstorm – a tent withstands about nine pounds of force per square foot of area. For a 20-foot by 20-foot frame tent, that's 400 square feet and 3600 pounds of force, so the minimum holding power needed is 5400 pounds. A gallon of water weighs 8 pounds, so a plastic 55-gallon barrel full of water weighs approximately 440 pounds, including the barrel itself.

So, how many barrels would it take to achieve a holding power of 5400 pounds – 12, right?
(<http://tents4sale.com/wp-content/uploads/2015/03/stakes4.png>) Nope.

As a fairly smooth material, plastic's friction coefficient is only .4, so the effective weight of a full water barrel is only 40 percent of its actual weight, or 176 pounds. The number of barrels needed for our example tent increases to 30, but we're not done yet.

When tents are staked, the guy lines are attached close to the ground. When they're attached at a height of three feet, as with water barrels, the anchors lose about a third of their holding power. You need a third more barrels to secure the tent, or a total of **39** in our example.



Concrete Weights

A study conducted by one tent manufacturer verified through testing that one – 1000# concrete weight has the equivalent holding power of 9 – 440# water barrels, and ultimately presents a much cleaner finish to the tent installation.

Concrete is much more effective than water barrels. Though the weight of a block of concrete can differ depending upon its consistency, on average, a cubic foot weighs 150 lbs. A block essentially the same size as a 55-gal. barrel (3600 lbs.), at twice the barrel's coefficient of friction, with a guy line attachment point at the top, produces more than 580 lbs. of holding power.

Sources:

American Rental Association Insurance Services

IFAI Procedural Handbook for the Safe Installation and Maintenance of Tents

The Tent Rental Division of IFAI Ballasting Study

Event Central article, Mechanicsburg, PA

Rental Management Magazine

All Seasons 5050 Kansas Ave. Kansas City, KS 66106 2012

Customer Resources

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