Don't throw caution to the wind

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A tent seems pretty simple — structure, fabric, anchorage — so why is it that erecting one gets so complicated? Of course there are building and fire codes to follow, permits to obtain, and both underground and overhead utilities to avoid, but what about just getting the tent to stay up and in place? It's a struggle between forces — wind versus anchoring power.

The idea is to anchor a tent with enough holding power so that the anchorage can withstand the opposing forces of wind, both vertically and laterally. However, with so many factors affecting the wind forces imposed on a tent — altitude, proximity to bodies of water, tent size, roof slope and more — how can a tent installer even begin to know how much holding power is needed?

Anchoring power. The first place to start is with the manufacturer's installation instructions. Experts recommend that a tent's anchoring power be 1½ to 2 times the forces imposed on the tent. Manufacturers provide anchorage guidelines to achieve that minimum for both wind-load certified and non-wind-load certified tents. A certified tent is engineered to withstand a stated wind speed, such as 70 mph. As long as that tent is anchored correctly, it will stay erect in winds up to 70 mph, with its structure, fabric and anchorage intact. The manufacturer's instructions indicate the minimum anchorage power needed to achieve 1½ to 2 times the opposing force of wind speeds up to 70 mph.

For non-wind-load certified tents, in general, manufacturers provide guidelines for securing them against 1½ to 2 times the forces imposed by 30- to 50-mph wind speeds, which is what can be expected at ground level in windy — but not stormy — conditions. Tent installers should use the manufacturer's anchorage guidelines as a minimum amount of holding power.

Next, increase anchoring power as necessary to comply with local codes where the tent will be installed. For example, if a municipality follows the International Fire Code, it may require that tents be anchored to withstand the forces imposed by 85-mph winds. The anchoring power recommended by the manufacturer for either a tent certified to 70-mph winds or a non-certified tent will have to be increased. In our examples, the code requires 20 percent more holding power than provided for the certified tent and about double that of the non-certified tent.

Finally, consider the location. If a tent will be installed on a hill or near a shoreline, find out what the typical wind speeds are at that location and adjust anchoring power upward accordingly. Never use less anchoring power than the manufacturer's instructions or local codes require.

Staklng options. Once a tent's required anchoring power for a given installation is determined, how is it achieved? The most common method is by staking. Manufacturers' installation instructions may call for a specific number and size of stakes, but they also stipulate that the anchorage suggested is for average soil density and will not be adequate for all installations. It's the responsibility of the tent installer to increase anchorage as necessary.

For example, one manufacturer's instructions for a non-wind load certified 20-ft.-by-40-ft. pole tent indicate that 16 stakes 30 in. long with a diameter of 1 in. are required to secure the tent in stiff soil. The manufacturer used one of the soil consistencies outlined in a handbook published by the Industrial Fabrics Association International (IFAI).

The University of Illinois at Urbana-Champaign was contracted by the Education Committee of IFAI's Tent Rental Division to conduct a study on the pullout capacity of tent stakes. This extensive and expensive study, published in The IFAI Procedural Handbook for the Safe Installation and Maintenance of Tentage, provides guidelines for determining a location's soil density and lists the holding power of stakes in a range of soil conditions.

Given the various factors contributing to the holding power of a stake — length, diameter, angle the stake is driven into the ground, and attachment point and angle of the guy line — the university study first came up with a "baseline" by determining the holding power in various soil conditions of a 1-in.-diameter, smooth-sided nail head-type stake driven vertically into the ground 36 in. deep with a guy attachment at 2 in. above the ground and attached to the tent at a 45-degree angle. The holding power of a baseline stake ranges from only 100 lbs. in very loose soil through 2,500 lbs. in very dense soil.

The study also calculated correction factors for deviations from the baseline. Simply stated, a stake's holding power increases with a larger diameter or deeper embedment. It decreases when the stake is driven in at an angle instead of vertically, when the guy line is attached at a point higher than 2 in. above the ground surface or when the angle of the guy line is greater than 45

degrees.

Our example 20-ft.-by-40-ft. pole tent requires 16 1-in.-diameter, 30-in.-long stakes in stiff soil. Assuming that all the baseline factors are met except the embedment depth and leaving 2 in. at the top of the stake for attaching the guy line, the stake will be driven into the ground 28 in. With this information, we can calculate the total holding power required for the tent:

stakes

x Holding power

x Correction factor for embedment depth

Total holding power required

16

x 800 lbs.

x 0.69 =

8,832 lbs.

If the tent is going to be staked in medium soil rather than stiff, the same stakes would only have a holding power of 400 x 0.69 lbs. each, meaning they would only provide a total holding power of 4,416 lbs. Tent installers would have to double the number of stakes and guy lines to 32 to achieve the minimum anchoring power required by the manufacturer. However, if the installers were to exchange the 30-in.-long stakes with stakes long enough to achieve the baseline embedment depth of 36 in., each stake would produce it's full 400 lbs. of holding power in medium soil and only 22 stakes would be required to achieve the same total holding power of 8,832 lbs.

The IFAI handbook also discusses the effectiveness of double-staking and gang-staking as well as different types of stakes, such as helical steel and buried wedge cable that produce more holding power than the baseline.

Anchoring with ballast. Though staking is the most common method for anchoring tents, weight or ballast is sometimes used for frame tents, especially in locations where staking is impractical. However, there is some degree of controversy surrounding ballast as an anchoring method, because often too little weight is used to achieve adequate holding power.

Suppose a renter wants a 30-ft.-by-30-ft. frame tent, but does not want it staked into his new asphalt parking lot. To calculate the required anchoring power, we consult the manufacturer's installation instructions, which call for 8 11/8 -in.-diameter, 42-in.-long stakes in stiff soil. Using the IFAI staking study guidelines:

stakes

x Holding power

x Correction factor for embedment depth

x Correction factor for diameter

Total holding power required

8

x 800 lbs.

x 1.00

x 1.125

7,200 lbs.

It seems logical that 7,200 lbs. of weight would anchor the tent just as well as eight stakes, except the holding power of dead weight is significantly reduced by both its level of friction and the attachment point of the guy line.

For example, suppose tent installers use 55-gal. barrels full of water as ballast and position them in the same locations as stakes to anchor the tent both vertically and laterally. Each barrel weighs about 480 lbs. It would seem that 15 barrels would meet the required 7,200 lbs. of anchoring power. However, plastic is a smooth material with a coefficient of friction on asphalt of 0.4, meaning a force of only 40 percent of the object's weight will be able to move it. In other words, the coefficient of friction reduces a water barrel's holding power to 40 percent of its weight or 192 lbs.

Its holding power is further reduced by the attachment height of the guy line. Most water barrels are 3 ft. tall with attachment points at the top. Remember that the IFAI study's baseline is for attachments at 2 in. above the ground. The correction factor for 36 in. is 0.66, so a water barrel's holding power is further reduced to 127 lbs. To secure the renter's 30-ft.-by-30-ft. frame tent with water barrels as ballast, it would take not 15, but 57 barrels.

Concrete is another popular type of ballast and 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 tips the scales at 150 lbs. A block essentially the same size as a 55-gal. barrel, 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. It would take only 12 concrete blocks to anchor the same 30-ft.-by-30-ft. frame tent.

The holding power of ballast can be improved by decreasing the height of the guy attachment, which may be easier with concrete weights than water barrels. Holding power also can be improved by increasing the coefficient of friction between the ballast and the surface, such as by using rubber mats. However, friction will be decreased — with or without rubber mats — when the surface or the ballast is wet.

Additional factors. Other considerations in adequate tent anchorage are the angle, type and condition of the guy lines. The IFAI study's baseline uses an angle of 45 degrees between the ground and the guy line. To create this angle, the anchor must be the same distance from the tent as the pole or frame is high. A 45-degree angle of pull produces equal holding power in both the vertical and lateral directions.

As for the type of guy line, most tent installers are moving away from ropes to webbed ratchet straps. It's difficult, at best, to tie a knot in a rope that will hold at the stake. Also, rope can stretch, its polypropylene coating allows for slippage, and its breaking point is roughly half that of webbed guys. However, installers also should be cautioned against using webbed guy lines with fraying or loose threads as those can no longer produce their full holding power.

In essence, every tent installation is different and is going to present its own challenges, but these guidelines are designed to help tent installers safely meet those challenges. Remember, to correctly anchor a tent, you have to consider the manufacturer's instructions; local codes; the installation location; the soil density; the number, type, size, and angle of stakes; the type, condition, and angle of the guy lines; and whether or not to use weights.