

Anchoring Your Tent Safely

Site Survey

Layout

Anchoring

...the basics

The information contained supplements instructions or warnings that are provided by the manufacturer of the tent. You must consult the manufacturer's instruction and warnings each time you install a tent. The information contained does not replace the manufacturer's instructions.

All information presented is based on actual field experience and field anchoring tests with a dynamometer in various locations. Portions of this material also was supplemented by the IFAI Procedural Handbook For The Safe Installation and Maintenance of Tentage. Contact the IFAI Tent Rental Division for a copy of this manual.



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Q. How many of you do Site Surveys?

A. _____ of _____

Q. What is the major purpose of doing a site survey?

- A.
1. To gather all pertinent information regarding the proposed event or function.
 2. To ensure that the proper equipment is used for both the site and the function.
 3. To organize the information so that it becomes an effective means of clear communication for all parties involved.
 4. To serve as a permanent record of the entire transaction.
 5. To ensure that all codes and regulations are met.

Q. Who should do the site survey?

A. A qualified professional such as a sales consultant or job foreman.

The site survey consists of three (3) separate sheets.

1. Site Survey, Surface, Underground and Overhead Obstructions
2. Site Plan to Scale
3. Tent and Related Equipment Data

SITE SURVEY (Exhibit A)

Q. What are some of the most common problems encountered with a proposed site?

- A.
1. The area is not large enough for the proposed tent.
 2. Overhead obstacles (telephone or power lines, trees, etc.)
 3. Ground obstructions (shrubbery, fountains, pavement, trees, buildings, etc.)
 4. Unable to use standard staking methods.

Q. How many of you test the soil conditions for the proper type of staking.

A. _____ of _____. It would be highly recommended that you drive a stake in a few key areas to test the job site soil conditions.

Note: It would be in your best interests to develop some type of record keeping for conditions which you encounter at each job site, especially ones in which you do multiple events.

SITE PLAN (Exhibit B)

Q. What is the major purpose of the site plan?

- A.
1. To insure that the tents and related equipment are installed in the proper locations.
 2. To insure that the layout conforms to local codes.
 3. To locate obstructions.
 4. To show access to the site.
 5. To locate exit areas on tents with sidewalls.
 6. To locate areas with specialized anchoring.

Develop a Site Plan

1. It is recommended that you use some type of grid paper.
2. It is critically important to show all dimensions.
3. Show location of all safety equipment.

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Exhibit "A"

LOCATION, SURFACE, UNDERGROUND & OVERHEAD

For simplification, mark appropriate boxes.

Function Date: _____

Function: _____

SURFACE

- Grass
- Asphalt
- Gravel
- Concrete
- Wood

Level? YES NO

Clear? YES NO (no obstructions)

Describe _____

UNDERGROUND (one answer minimum)

- Electrical
- Gas (including B.B.Q.)
- Telephone
- Septic
- Sprinklers
- Pool lines
- None of the above

Describe _____

Person responsible for marking _____

Site contact _____

Describe ground _____

(ie., hard, soft, sandy, clay, etc.)

OVERHEAD (one answer minimum)

- Electrical
- Telephone
- Trees/branches
- Other
- None of the above

Describe _____

JOB PROFILE

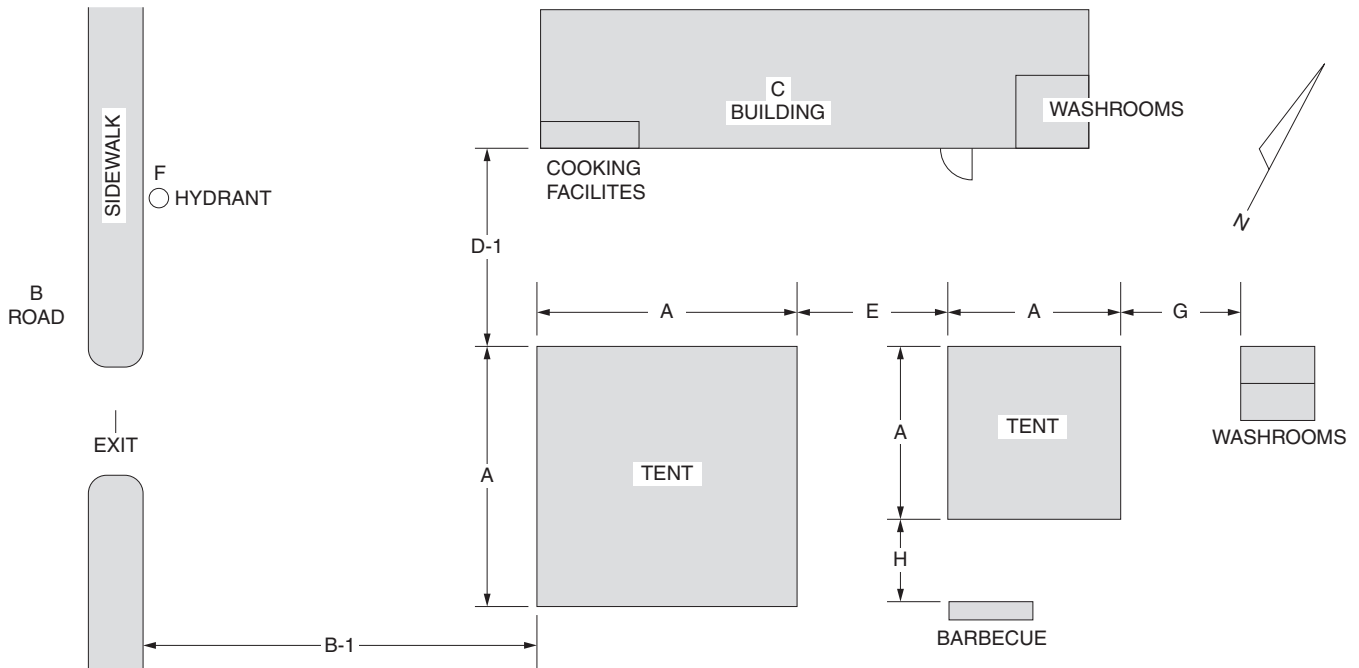
- Straightforward job
- Technically difficult
- Over Trees
- Attach to house
- Cable for anchoring
- Multiple levels
- Over pool
- Other

Describe _____

SPECIAL EQUIPMENT CONSIDERATIONS

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Exhibit "B"



- A** Location of tent or tents and show sizes of tents.
 - B** Roadways give names. Note: Distance from sidewalks should be approximate.
 - C** Adjacent buildings show exits and facilities if being used.
 - D** Dimensions between tent and adjacent buildings.
 - E** Dimensions between tents.
 - F** Locations of fire hydrants.
 - G** Location of washrooms.
 - H** Locations of cooking facilities.
 - I** Fire route.
- All layouts should conform to local codes.

ACTUAL EQUIPMENT TO BE RENTED										
TENT	TENT NO & COLOR	SECTIONS	SIDE POLES		CENTER & 1/4 POLES	ANCHORS			STL STK	HOOK
			HEAVY	LIGHT		SM.	SMH	LT.		
SITE PLAN ATTACHED YES <input type="radio"/> NO <input type="radio"/>			ODD POLE SIZES			WALL: YES <input type="radio"/> NO <input type="radio"/>				
						OPAQUE: _____				
						CLEAR: _____				
						FULCRON: _____				

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Equipment Data Sheet

Q.□ What is the purpose and use of an Equipment Data Sheet?

- A.□ 1.□ To list all the actual equipment needed at the job site.
- 2.□ To list what equipment is needed at each tent.
- 3.□ To have a checklist for loading/unloading.

Quality/Safety Checklist

The last item recommended is a checklist that will assure that you have a safe and top quality installation. Each of you should develop your own check list.

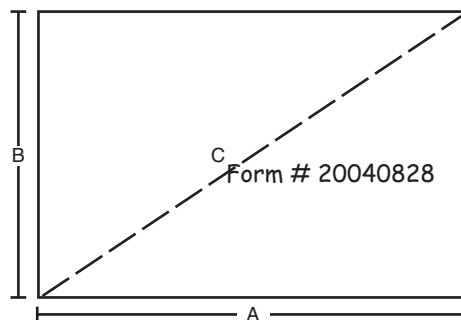
Layout Methods

Traditional Layout Method

- 1.□ The objective is to make the perimeter taut with the corners squared.
- 2.□ There will always be excess material in the interior portion of the tent due to the amount of □ material needed to make up the pitch of the tent.
- 3.□ Use ground cover to protect the fabric during installation.
- 4.□ Place one end of the tent where desired, drive a small stake through each of the corner pole side □ grommets on that end.
- 5.□ Proceed down the length of the tent, pulling every rope out from the center and away from the end.
- 6.□ When all have been staked, run a string line from corner stake to corner stake, then, place a stake □ opposite each side pole grommet along the string line.

Pre-Staking Method

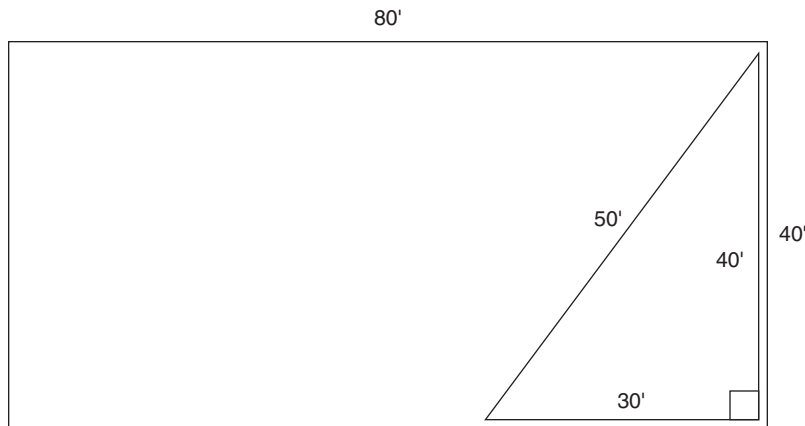
- 1.□ This is the most accurate and recommended method of laying out a square stake line.
- 2.□ This method measures the diagonal to square the perimeter.
- 3.□ Use the staking charts provided by your manufacturer to get the proper dimensions for the tent □ being installed.
- 4.□ Use the Pythagorean Theorem where "A" is the length of the stake line, "B" is the width of the □ stake line and "C" is the diagonal. $A^2 + B^2 = C^2$. $C = \text{the square root of } C^2$.



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The 3 - 4 - 5 Method

1. This method is used when a tent is too long to make measuring of the entire tent practical or there is some obstacle to prevent you from measuring the diagonal.
2. This method uses the Triangulation Method on a smaller scale. Measure 30 feet on one side and 40 feet on the opposite side and the diagonal will be 50 feet.
3. This method may be adapted to a larger or smaller scale by increasing or reducing the measurements proportionally. Example: 60 - 80 - 100 or 15 - 20 - 25, etc.



Staking

Proper staking is a prerequisite for a safe tent event. Stake failure occurs primarily in two ways. The first is in tension, here, the resisting frictional forces between the soil and the stake are insufficient to keep the stake from yielding to pullout forces along its axis.

The second results when the sideways force imposed by the stake against the surrounding soil is greater than the soil can push back, so the soil yields by bulging above the surface. Consequently, the stake pushes the unconfined soil out of its path.

Develop a Systematic Approach to Staking

A systematic approach to staking requires a general understanding of the engineering principals at work in the performance of a tent stake.

Develop a method for obtaining, accumulation, correlating and presenting data on stake performance. In time a large bank of data will be available that will be reliable, and take much of the guesswork out of the process. Equipping your tent installer with this technical information will enhance your tent staking safety and ensure a safe event.

Understanding the Engineering Principles

A. The larger the stake diameter, the greater the holding power.

- A larger diameter stake will displace more earth as it is driven into the ground than a smaller diameter stake. This greater compaction will produce greater soil resistance against the side of the stake. The greater sideways pressure will increase the friction acting along the sides of the stake and provide more resistance to pullout due to tension.

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B. The deeper the stake, the greater the holding power.

- Stake pullout strength is related directly to stake depth for several reasons:
- □ 1. Greater Surface Area
- □ 2. Soil Pressure Increases with Depth
- □ 3. Creates a Larger Soil Wedge

Stake Size	Average Holding Power	% Increase
	Full Depth	Holding Power *
5/8" x 18"	200 lbs.	Base Line
5/8" x 24"	500 lbs.	23 %
1" x 36"	1150 lbs.	30 %
1" x 42"	1450 lbs.	21 %

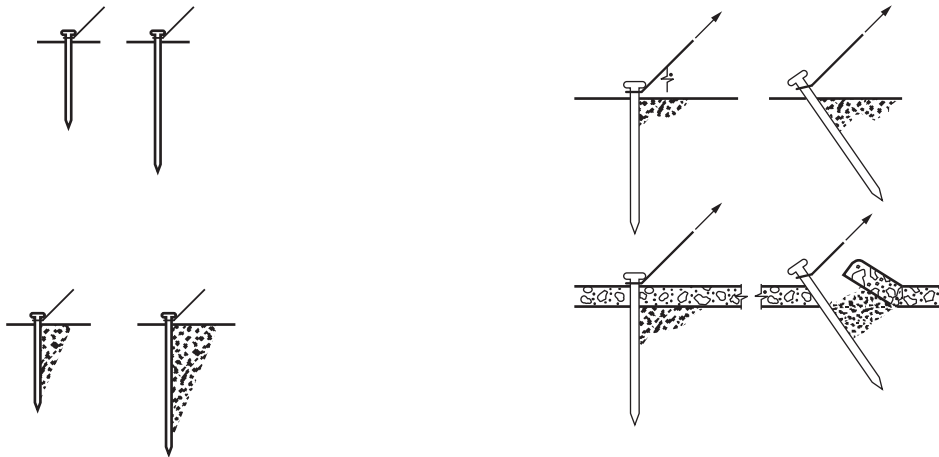
Stake Size	Average Holding Power	% Decrease
	Half - Depth	Holding Capacity *
5/8" x 18"	135 lbs.	33 %
5/8" x 24"	275 lbs.	45 %
1" x 36"	400 lbs.	65 %
1" x 42"	700 lbs.	52 %

C. The better the soil, the greater it's holding power.

D. The wetter the soil, the less it's holding power.

E. A proper drive angle Yields greater holding power

- Field practice indicates that installing stakes vertically is superior to installation at an angle. This
- technique also simplifies installation and removal of the stake.



Stake Size	Average Holding Power	% Decrease
	Angled Depth	Holding Power *
5/8" x 18"	100 lbs.	50 %
5/8" x 24"	200 lbs.	60 %
1" x 36"	275 lbs.	76 %
1" x 42"	400 lbs.	72 %

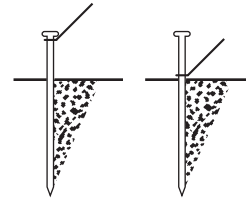
* Based on Average Stake Pull Out Tests over 4-Year Period - Hickory Tavern, SC

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F. Optimum guy rope angle provides optimum holding power.

- 1. If there is wind and no sidewalls, guy rope angles should be steeper (i.e., the stake should be closer to the tent).
- 2. If there is wind and, in addition, the tent is supplied with sidewalls, guy rope angles should be shallower (i.e., the stake should be further from the tent).
- 3. If staking against downloads or ponding, guy rope angles may have to be shallower (i.e., further out).
- 4. Soil type.
- 5. Ground moisture.
- 6. Presence or absence of moisture.
- 7. Need to keep side poles in compression.

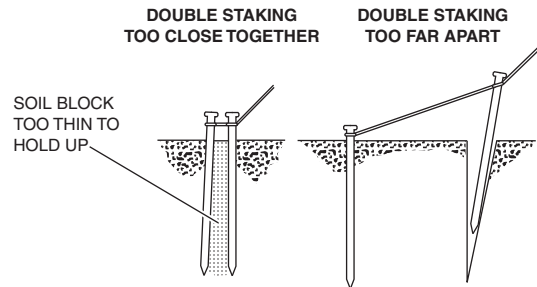
- G. Increasing the height of the stake knot above the ground decreases the stake holding capacity.



Double Staking

Double staking is the practice of driving another stake a short distance behind the primary stake and close-tying both stakes together with free end of the guy rope. Triple and/or quadruple staking may also be used applying the same concept.

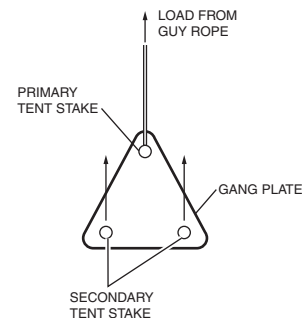
A rule of thumb for double staking suggests that the distance between the stakes be equal to 1/3 the depth of the stake in the ground.



Gang Staking

Gang staking is a staking technique related to double staking, in that it also increases staking capacity.

- Stake Plates - Use of Multiple Stakes
- Stake Bars - Use of Multiple Stakes



Anchoring Your Tent Safely

A tent will not remain erect unless it is properly anchored to the ground on which it sits. Anchoring is accomplished by fastening guys (ropes, webs, cables) to the tent at the top of the side pole or frame and attaching the other end to an anchor device such as a stake. The correct sizing of the guy and stake (breaking strength, stretch parameters, stake break-out force) is very important the safe and proper function of the tent.

Simplifying Tent Anchoring

A brief understanding of safety factors and engineering criteria that goes into the design and anchoring for tents or structures does matter. When tents are designed, engineers must use industry specified standards and safety factors that are predetermined by standards and model code authorities, such as ASTM, ANSI, NFPA, UFC, S.B.C., BOCA, U.B.C. and California Title Codes. Local, state, county, or port district authorities will determine which codes are used in your area. Many officials adopt one of the major building codes and some add their own rules.

Safety First

To account for all the uncertainties that occur in the design, manufacture, installation and use of structures, all kinds of safety factors must be used. There is always a chance that the loads imposed on a tent stake (or tent anchor) will exceed the ability to resist that load.

Always plan for high winds, heavy rain, the beer guy that unties a rope and reties it with the wrong tension, poor soil conditions and adverse weather conditions.

In conventional building design, the normal safety factor is approximately 1.7 to 1. For tents, practice varies, but most industry groups feel that a factor of 1.5 or 2 to one is appropriate for staking purposes.

A Simple Formula - Not Pure Science - But It Works

Without using an involved equation and employing hours of engineering time at every tent job, an easy system was figured to find the necessary amount of stakes to hold a tent at approximately 70 mph. Simply multiply the square footage of your tent by 15 psf (pounds per square foot). The result is the total number of anchor pounds needed. This is not pure science, 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 15 psf = 48,000 anchor lbs.
□ □ □	30' x 60' tent = 1,800 sq. ft. x 15 psf = 27,000 anchor lbs.
□ □ □	20' x 20' tent = 400 sq. ft. x 15 psf = 6,000 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 ??

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

□ 40 x 80□	48 Stakes (48,000 lbs) with 1.5 to 1 Safety Factor - 72 Stakes (72,000 lbs.)
□ 30 x 60□	27 Stakes (27,000 lbs.) with 1.5 to 1 Safety Factor - 41 Stakes (41,000 lbs.)
□ 20 x 20□	8 Stakes (6,000 lbs.) with 1.5 to 1 Safety Factor - 12 Stakes (12,000 lbs.)

Regardless of tent style (pole, frame, tension), the anchoring power will be similar if such factor as leg height, overall height, and basic slope of the roof are within known present day patterns. Pole tents require anchors to shape them and stand them up - Frame tents require anchors to hold them down.

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Test Data

The following information might be beneficial when reviewing your anchoring methods and in determining the types of anchoring methods used and the holding power required.

Stake Testing Results In lbs. of Breakout Force

Stake Type	18"	24"	1" x 36"	1" x 36"	1" x 42"	1" x 42"	1" x 42"	3-Hole	5-Hole
Angle	Stright	Straight	Straight	30 degree	Straight	30 Degree	Top Tied	Straight	Staight
Baltimore	N/T	N/T	800	600	1200	N/T	N/T	2500	3300
Simpsonville	350	500	1150	800	1450	1000	1100	3900	5100
Average	350	500	975	700	1325	1000	1100	3200	4200

☐ Baltimore Soil Conditions = Very Wet Test Date: November, 1999 - Baltimore, MD
 ☐ Simpsonville Soil Conditions = Dry "Normal" Test Date: December, 1999 - Simpsonville, SC

Get Good at Driving Stakes

Increasing holding power of anchors will become an important aspect of future tenting practices. The first item to tackle is getting proficient at driving and pulling tent stakes. If you look at the numbers, the only safe method is to add more stakes in the ground. The following anchoring aides should also be explored; stake plates, stake bars, gang staking, screw anchors, etc.

Anchoring Values - Pounds of Force as Dead Weight

Designers and engineers refer to the term "pounds" to set the needed values when anchoring a tent. The best way to visualize "pounds" is as dead weight and/or how to achieve the equivalent with friction from anchors. You must know your anchor weight and/or how much holding power (in pounds) your anchor will develop.

Weight Required - Deadman

Variables: ☐ 1,000 lb. Pull
 ☐ ☐ .5 cof (cement against cement)

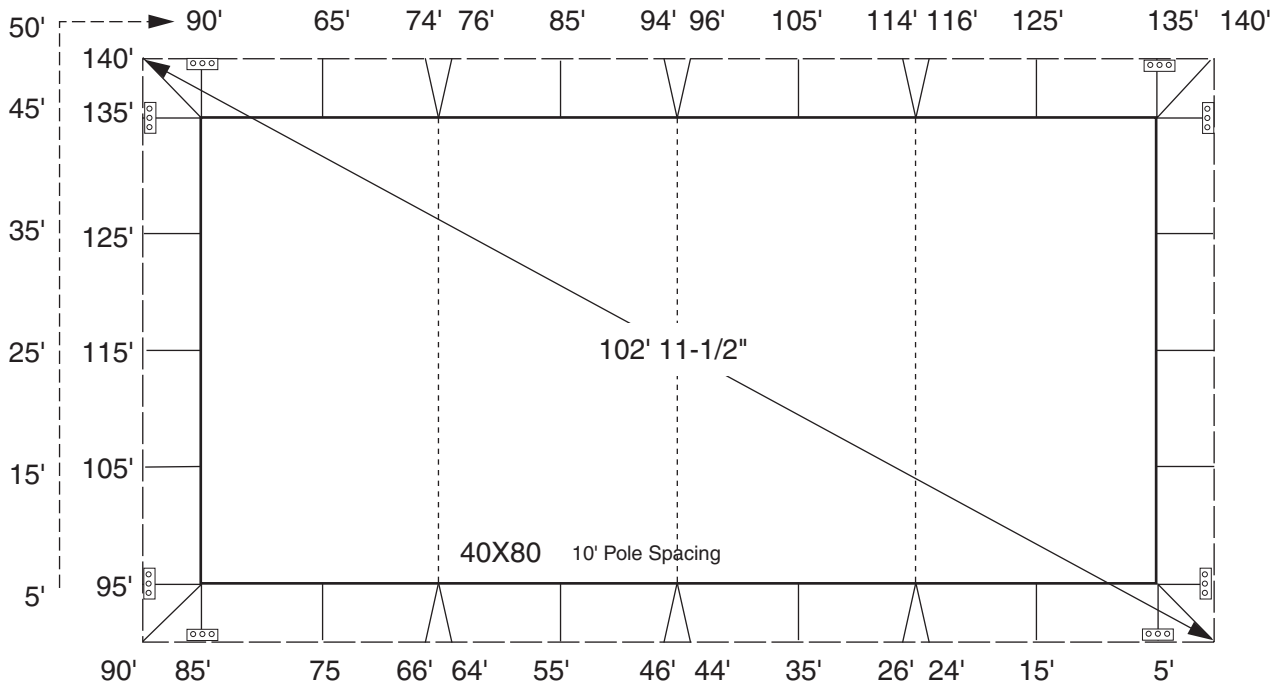
Angle	Height	Distance	Weight
☐	☐	Out	Required
45 degree	7 ft.	7 ft.	2,121 lbs.
49 degree	7 ft.	6 ft.	2,165 lbs.
54 degree	7 ft.	5 ft.	2,205 lbs.
60 degree	7 ft.	4 ft.	2,234 lbs.
66 degree	7 ft.	3 ft.	2,233 lbs.

Weight Required - Deadman

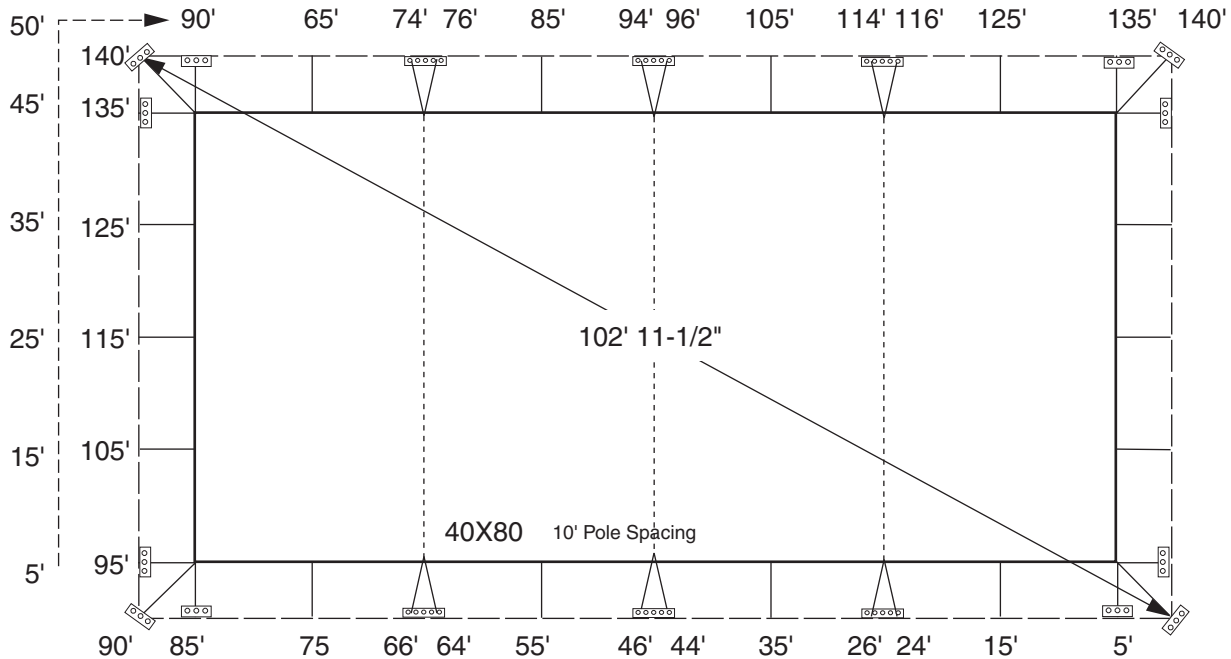
Variables: ☐ 1,000 lb. Pull
 ☐ ☐ .3 cof (plastic against cement)

Angle	Height	Distance	Weight
☐	☐	Out	Required
45 degree	7 ft.	7 ft.	3,064 lbs.
49 degree	7 ft.	6 ft.	3,172 lbs.
54 degree	7 ft.	5 ft.	3,284 lbs.
60 degree	7 ft.	4 ft.	3,387 lbs.
66 degree	7 ft.	3 ft.	3,452 lbs.

Anchoring Your Tent Safely



$40 \times 80 = 3,200 \text{ SF} \times 200 \times 15 \text{ psf} = 48,000 \text{ lbs.}$ $[48000 \times 1.5 = 72,000 \text{ lbs.}]$
 As Staked = 54,850 lbs.
 $(8 @ 3200 \text{ lbs.} = 25,800 \text{ lbs.}) + (30 @ 975 \text{ lbs.} = 29,250 \text{ lbs.}) = 54,800 \text{ lbs.}$



- | | | | |
|-------------------|--|-------|---|
| Corners - □ | Three Hole Stake Bars at each location | □□□ | Adding 18 stakes at lace lines (with 5-hole stake bars and adding 12 stakes at hip line (with 3-hole stake bars) increases the anchor holding power to 77, 250 lbs. |
| Hips - □ | Three Hole Stake Bars at each location | □□□ | |
| Intermediates - □ | Double Head Stakes Only | □—□ | |
| Lace Liner - □ | Five Hole Stake Bars at each Lace Line | □□□□□ | |

Anchoring Your Tent Safely

Staking Worksheet

Definitions: PSF - Pounds per Square Foot - Industry Standard
SF - Safety Factor - Industry Standard

Width	Length	Square Foot	PSF	Safety Factor
40	80	3200	15	1.5

Anchor Pounds Required 72000
 = Width x Length x PSF x Safety Factor

Procedure:

1. Count staking locations and put number in quantity column.
2. Put stake system rating in rating column.
3. Multiply quantity x rating and put in Total Column
4. Add Total column to get grand total of holding power required.
5. Grand Total should be equal to or greater than the Anchor Pounds Required above.

	Quantity	Rating	Total	Anchor Type
Corners	8	3200	25600	3-Hole Stake Bar
Hips	4	975	3900	Single Stake
Intermediate	14	975	13650	Single Stake
Lace Line	12	975	11700	Single Stake
Grand Total			54850	

This equals the sum of staking locations x pound rating of staking system.

By changing the lace line system from a single stake set-up to 5 - Hole Stake Bars and adding 18 stakes, plus 3 - Hole Stake Bars and 8 stakes to the hip line increases the anchor holding power to 77250 lbs.

	Quantity	Rating	Total	Anchor Type
Corners	8	3200	25600	3-Hole Stake Bar
Hips	4	3200	12800	3-Hole Stake Bar
Intermediate	14	975	13650	Single Stake
Lace Line	6	4200	25200	5-Hole Stake Bar
Grand Total			77250	

This equals the sum of staking locations x pound rating of staking system.

Staking Worksheet

Width	x	Length	=	Square Ft.	psf	Safety Factor
					15	1.5

Anchor Pounds
Required

This equals width x length x psf x safety factor.

Pounds per square foot (psf) is an industry standard.
Safety Factor is also an industry standard.

Instructions

- Count staking locations and put # in quantity column.
- Put stake system rate in rating column.
- Multiply quantity x rating and put total in total column.
- Add total column to obtain grand total of holding power.
- This should be equal to or greater than the anchor pounds needed from the simple worksheet above.

	Quantity	Rating	Total	Anchor Type
Corners				
Hips				
Intermediates				
Lace Lines				

Total

This equals the sum of stacking locations x the pound rating of the staking system.

Make changes to the stake quantity or rating to get a total that equals the sum or exceeds the anchor pounds needed from the above.

	Quantity	Rating	Total	Anchor Type
Corners				
Hips				
Intermediates				
Lace Lines				

Total

This equals the sum of stacking locations x the pound rating of the staking system.