

# *Instructions and Assembly Manual*

## ***Tilt-up and auto-standing towers***



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# Welcome to the world of the wind

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## Interesting information:

In this manual you will find all the information needed to construct and install a tilt-up or self-standing tower for your windmill. We strongly recommend you read this manual thoroughly and understand it before beginning installation.

At several points in this manual you will find special notes highlighted. These notes are to be taken with special care because they have critical importance, please, pay special attention to those points marked as the following example notices:

CAUTION:
Important details for the right functioning of the system.

WARNING:
Hazards or unsafe actions that could cause an injury to your system or yourself.

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## The best site for a tower

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The energy we can take from the wind is proportional to the cube of its speed. This basically means, that when the wind doubles its speed, the power we can produce is up to eight times higher.

Therefore, the best site to install a windmill will be a place where it is exposed to the most constant and highest wind speed possible. The wind speed depends enormously on the landscape the air moves over. In almost all locations the wind speed increases, as you get higher off the ground; vegetation, landscape, nearby buildings, etc. stop the wind and produce turbulences.

The best place for a wind machine, is an **obstructions free area, and the highest possible**.

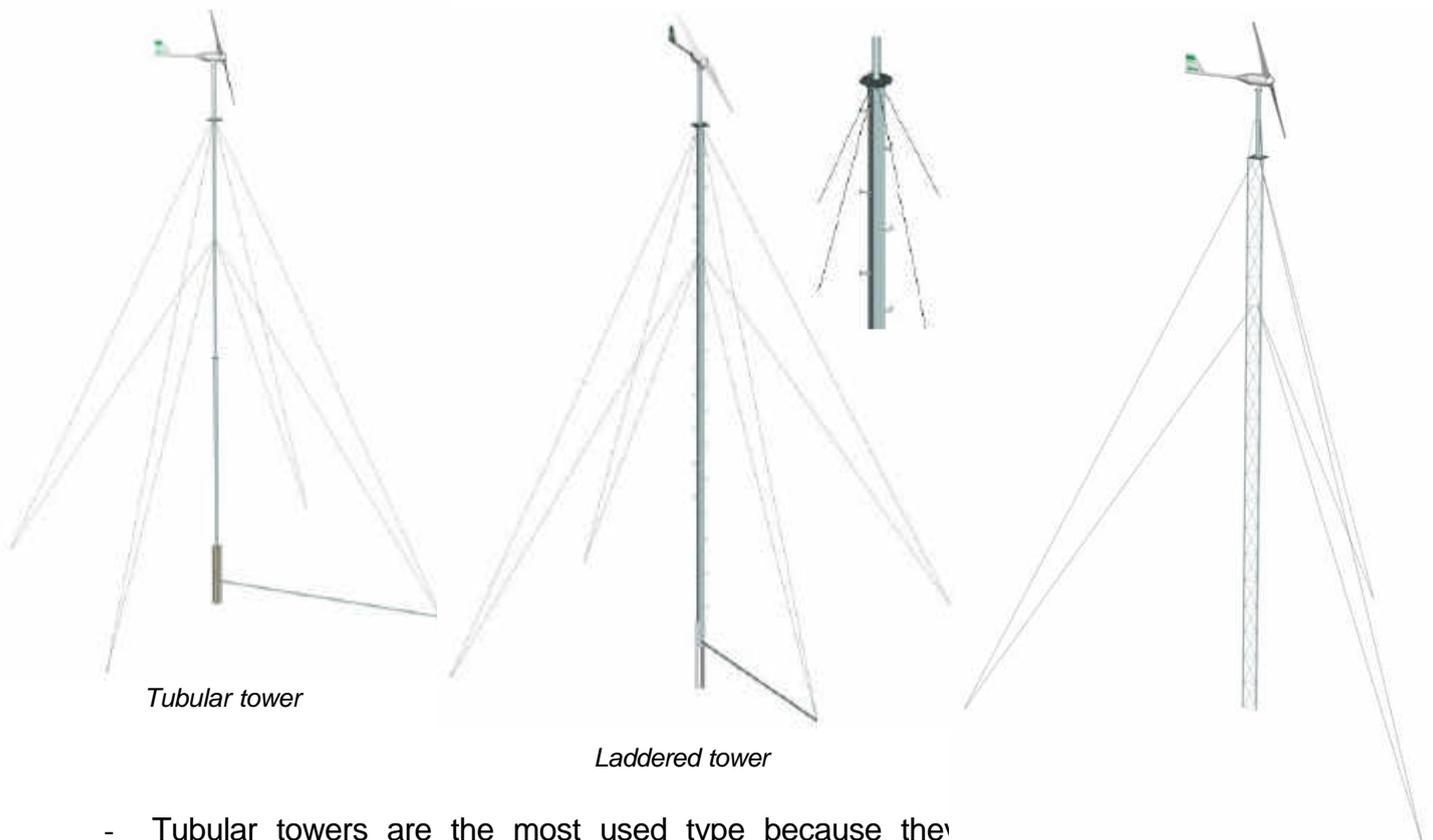
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## Tilt-up Towers

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Tilt-up towers are not the most beautiful towers, everybody prefers self-standing towers, but these are much more expensive. Tilt-up towers have several advantages that make of them a good option: they are relatively cheap, will do the required job, and they are easy to construct and assemble. Its characteristics permit to lower the wind turbine to ground level, minimizing the dangers that climbing tower supports. Reviewing and repairing the windmill will be a much easier job if installed on these types of towers. Because all the stress they are exposed to, they will need to be held by guy cables.

There are different types of tower depending on how the pole is:



- Tubular towers are the most used type because they are simple, and low cost. These kinds of towers permit modify its height just adding new tubes trams and adding guy cables.
- The laddered tower permit be lowered and be climbed to make periodical revisions and maintenance with no necessity of lowering the system. This kind of towers is recommended for relatively big wind turbines. Its dimensions of course will be bigger than the previous type of tower.
- Triangular or rectangular frameworks towers, cannot usually be lowered. They are cheaper and lighter than self-standing towers, but not strong enough to support the stress. They will use the same reinforcement system than tilt-up towers.

The first part of the manual you will read about the installation of a 12 m tilt-up tower. You can learn from this example how to construct or install the other type or sized towers.

These towers are basically composed of:

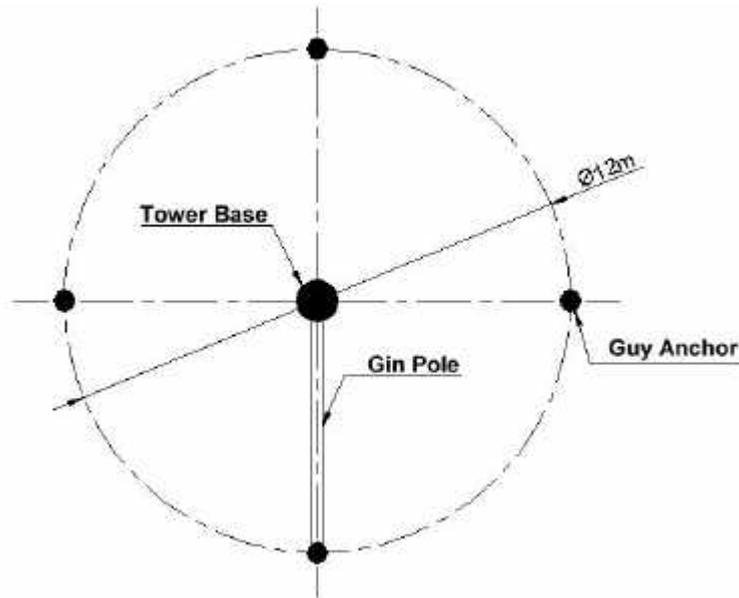
- Two 1,5 m long balks,
- Some 4" steel tubes (water pipes) (the total number will depend on their length and the total tower height),
- Eight 6 - 8 mm diameter guy cables (8 mm diameter cables for *Inclin 3000* and higher) and different lengths (depending on tower height),
- Four anchoring sticks,
- Gin pole (3" diameter steel tube, 6 m de long),
- Tower fixation plate for the tower.

This kind of towers can be installed on slopes and irregular grounds, but it is always better doing it on flat superficies.

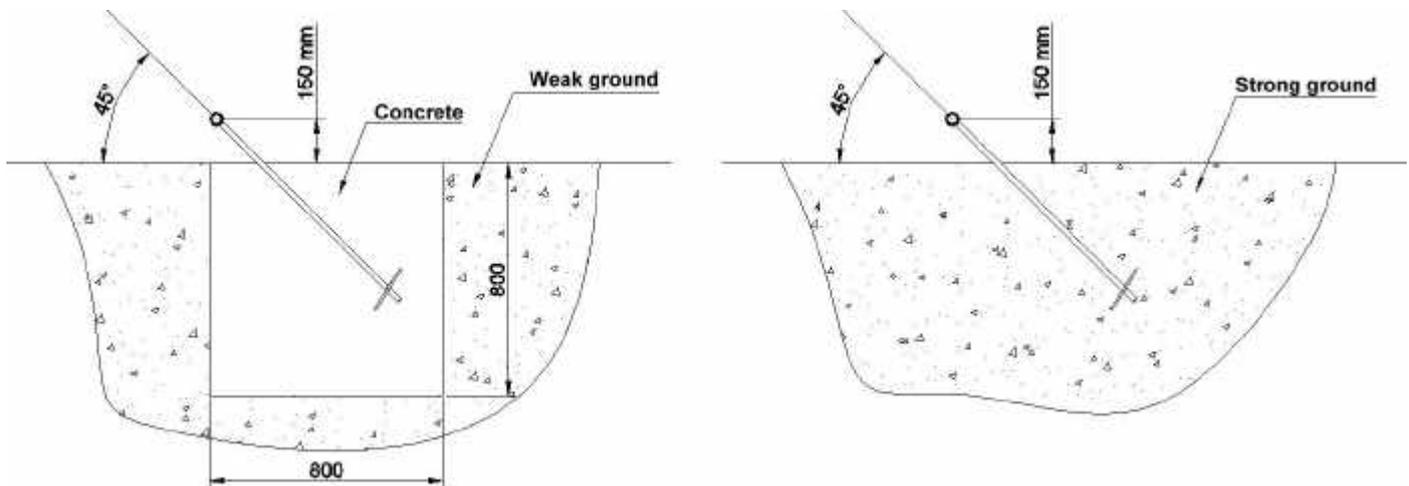
# Types of anchors

In first place, be sure there are no electric cables above or near you. Mark the exact point for the tower base plate, and as showed on the next figure, the anchoring locations.

If the tower is being erected, be sure to mark the locations so the tower will be assembled to the uphill side of the base.



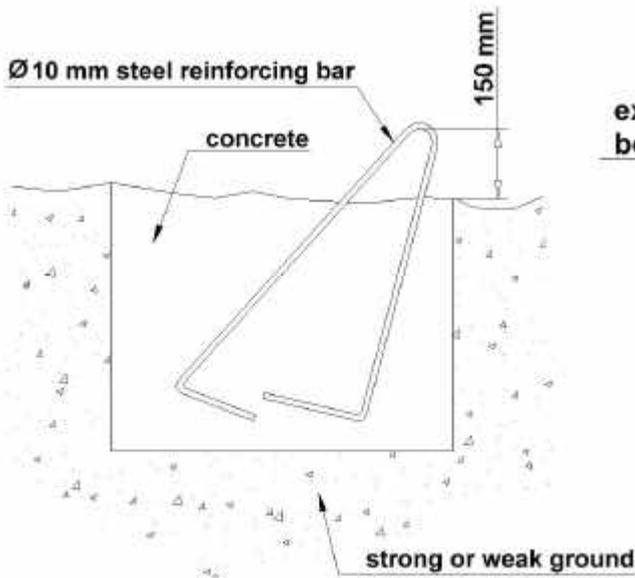
Once all the points are marked, install the sticks facing the tower and as shown on the figures below:



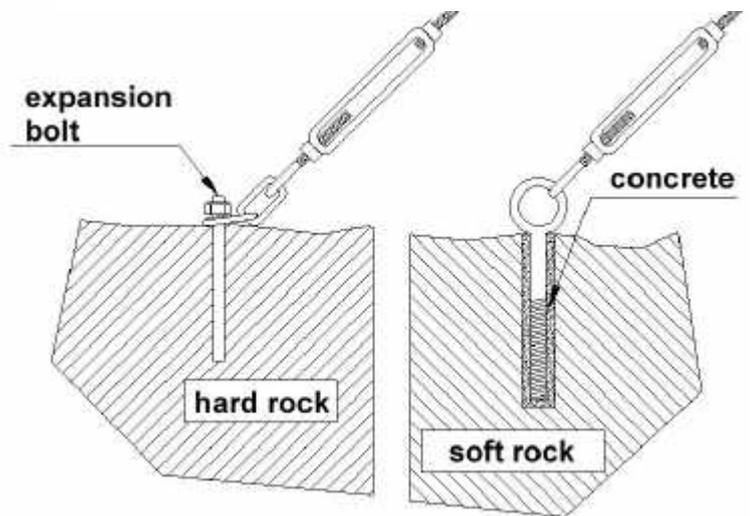
When the ground is too weak, it will be necessary the use of basements. But if the installation is to be done on a strong ground, you can rescind from them and anchor directly the augers to the ground. There are several anchoring systems on the market, you can choose the best depending the ground characteristics, or the price, home made anchors can be made, they are effective and easy to do.

Sometimes the ground we want to install the tower on, has big rocks, or it is just a big rock. There are specific anchoring systems for these cases. For hard rock cases, expansion bolts are used. Drill a 10 mm diameter hole on the rock and 100 mm deep. Place the bolt in the hole with an attachment hanger. In the market you will find different expansion bolts with different functioning systems.

When we have soft rock, it is not recommended using expansion bolts, the rock could break using this system. To anchor the guy rope in these cases, the best solution is using a normal bolt with concrete to hold it. To install it, drill a 25 mm diameter hole and 200 mm deep. Fill the hole with concrete and with the help of a straw, try to avoid bubbles rest in the bottom. Finally insert the bolt in the hole as shown below.



*Easy fabrication anchor*

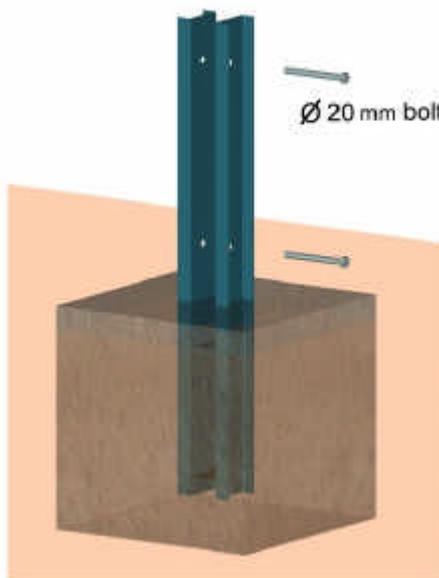


*Hard and soft rock anchoring systems*

There are also different anchoring systems for the tower base. You can use the most convenient depending on the ground or its construction.

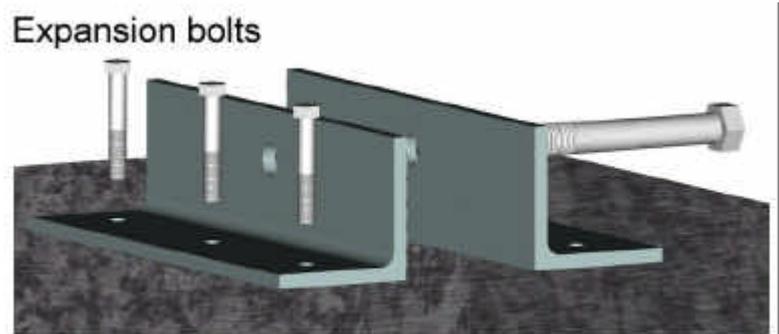
The tower base for weak grounds, requires a 750x750x750 cm foundation. However, there are other systems to hold the tower base; once more, as the anchors, the most appropriate system will be the one easier to use in your case, or easiest to construct.

Perfil U-100; 1500 mm long



*foundation 75x75x75 cm*

*Weak grounds foundation*



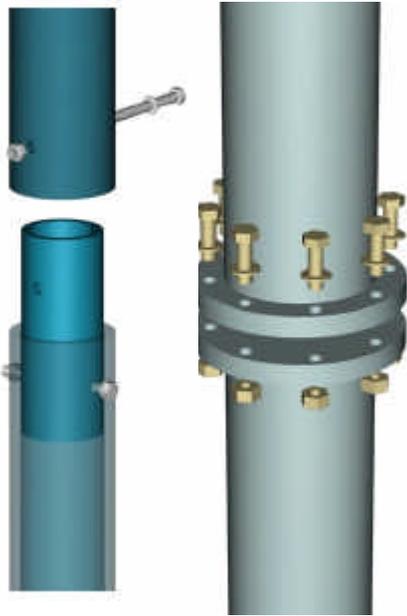
*hard rock*

*Rock anchoring*

## Getting ready before raising

Once the tower and the anchors are ready, we will proceed to connect the tower tubes that will conform the total tower height. We will place the tower adapter for the windmill as well. The tower will be placed at the base using the top bolt only.

There are different systems to unite the tubes:



The first system is the easiest to do. The second system will provide a better rigidity, but since the tower will be guyed, both cases will perfectly accomplish their function.

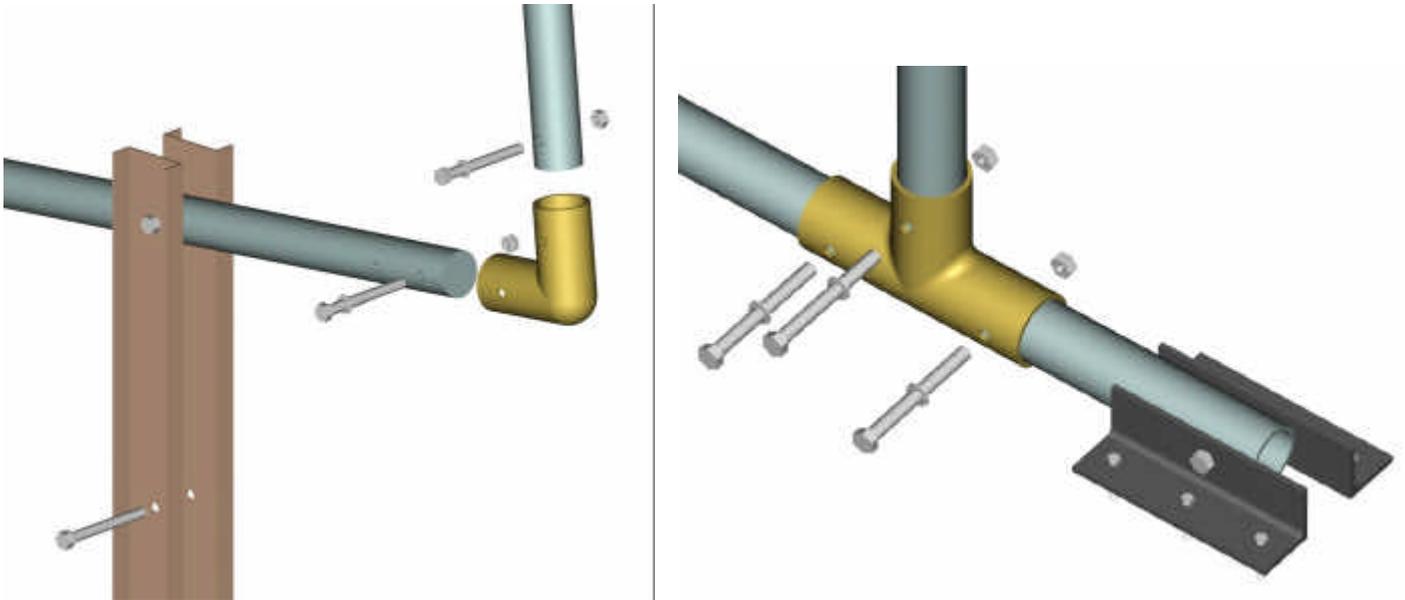
### CAUTION

In the second option, make sure the welding is done perfectly perpendicular, so the tower is straight.

### WARNING:

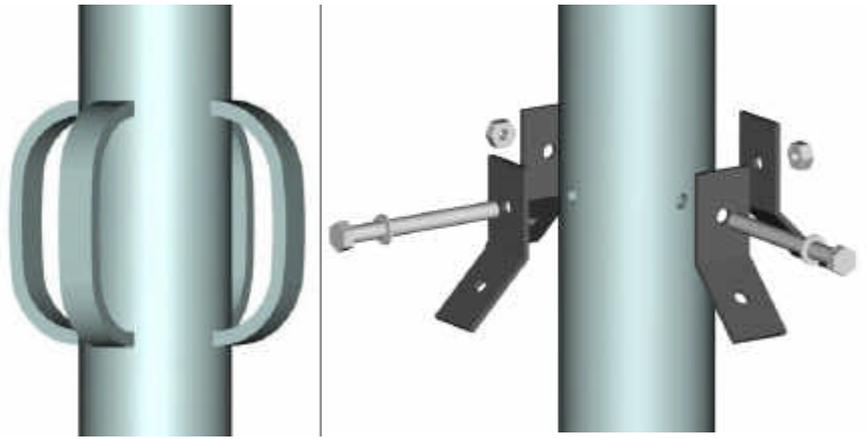
Steel water pipe usually is sold with screw. Do not twine them together because the pipe is very vulnerable in that section.

There are several ways to hold the tower base and gin pole together. But the simplest is maybe, using a steel pipe elbow. It is not recommended to twine these items, do it as shown in the following diagrams:



To get the guy ropes ready, unroll the cables, and leave each one in its position and attach the guy ropes to the tower. If you they are placed in their right place, four of the cables will be parallel to the tower, and the imaginary line that joins the other anchoring points forms a 90° angle with the tower.

To easily attach the guy cables to the tower, you can do it using different systems; we present here two examples that would permit to do it easily. Welding four twisted steel bars to the tower does the first figure. The second option is four angular steel plates bolted to the tower with 2 different bolts.



Attach all guy ropes to the top of the tower and to the anchoring points. You will not be able to attach this guy rope to its anchor, attach it to the gin pole instead. This guy will be the one to pull to raise the tower. The other guy ropes can be placed in their positions, but the adjustment will be done at the end.

**CAUTION**

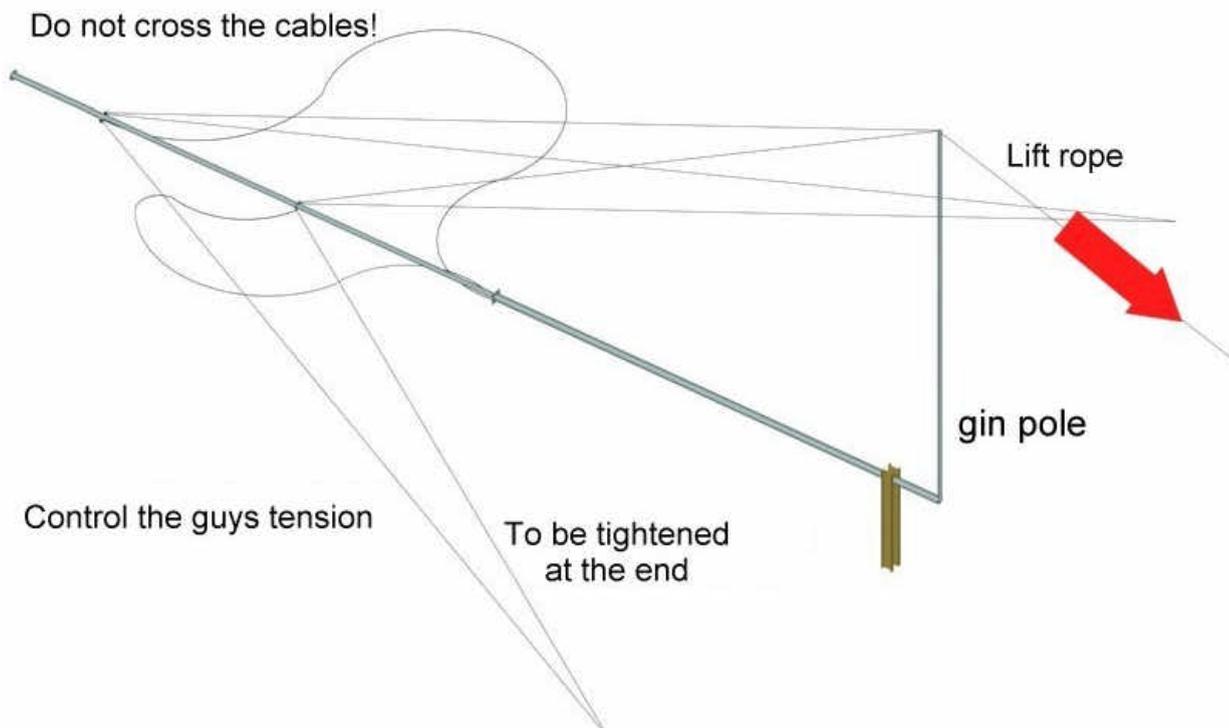
Notice the guy ropes may not have the appropriate length at this moment. They will need to be readjusted at the end, so every one of them has the same tension.

**WARNING:**

The rising towers on hills we will have to take special attention to the tension of the guy ropes and readjust the lengths while rising.

Before assembling the gin pole to the tower base, attach the rising guy to its top.

To raise the tower it is recommended the use of a tirfor hand winch. The force needed to raise the tower with a 40 kg wind turbine is around 300 kg. This tirfor hand winch will make the work easier for us, but it will make it more accurate and sure too.



It is really important connecting the tower to earth before raising it. This grounding will protect the wind turbine of lightning strikes and static electricity. However, this protection does not guarantee the system will survive a lightning strike, but in the worst of the cases, it will reduce its effects.

To make this connection, bury a 3 to 4 m copper wire near the tower base and connect it to the tower base using a wire.

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## Tower raising

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Once all the preparations have been done, it is strongly recommended to raise the tower without the wind turbine in place. This way when we will do the final raising the guy ropes will have the right tension, the tower will be leveled and we will be sure the raising system works.

Start raising the tower. Do it smoothly and checking the lateral guy ropes have a similar tension. It is ok if one is tighter than the other, but if there is a significant difference, stop rising the tower, and adjust them. If a guy rope is too tight, a failure may occur and the tower may fall down. The guy rope will have the right tension if it has a little curvature in it.

When the initial rising is done, insert the tower base bolt in its place so the tower will not move and tight all the guy ropes cables. Be sure to level it with the help of a spirit level, so it remains perfectly perpendicular. At this moment all your guy ropes will have the appropriate length to keep the tower in its working position. Lower the tower following the raising steps but in inverse order. Lower it slowly and controlling the movements of the system at all time.

When the tower top is one meter over ground level, set the tower down on blocks. This will allow you to easily install the wind turbine on its place. Once it is installed, raise again the tower. The guy ropes on the gin pole will have to be attached to their anchoring. Immobilize the gin pole in first place with the guy rope we used to raise the tower and after that assure the longest guy rope, the exterior one. Assure finally the shortest one, the interior one. Check one last time the tower is perfectly vertical.

### CAUTION

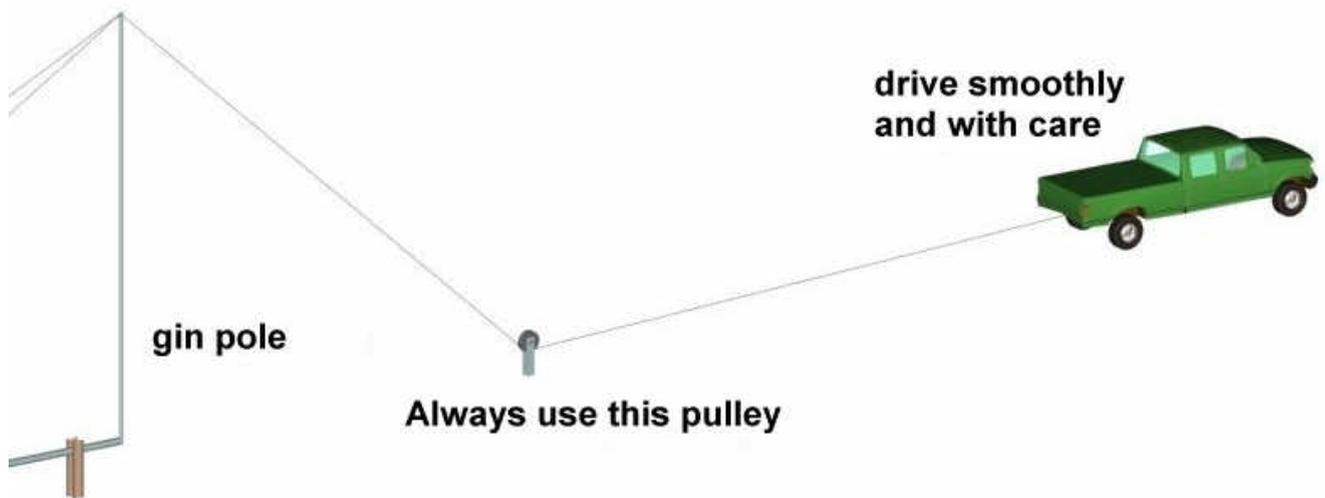
Raising a tower is a dangerous job; work carefully and keeping the system under control.  
It is recommended getting help for the raising, and very important that exists a good communication between the workers.

### WARNING:

Do not allow anybody to be underneath the tower when the tower is being raised and perfectly assured with guy ropes.

Note: The gin pole does not have any function from the moment all guy ropes are tight. We can remove it or just leave it attached to the closest anchoring point in order to avoid it moving and producing any potential danger.

If you do not dispose of a tirror hand winch, and the tower can be reached with a vehicle (as a car, a tractor, etc.), you can use this vehicle to raise it pulling the gin pole guy rope.



When all preparations have been done, install a pulley on the ground, as shown in the picture. The distance between the tower base to the pulley should be greater than gin pole's length.

CAUTION
A guy rope rightly tightened will have a smooth curve in it.

WARNING:
Be extra careful when the tower comes to the end of its run. If you continue pulling, the back guy rope could broke and the tower thrown down.

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## Warnings

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- Do not climb the tower.
- Do not raise the tower near power lines.
- Do not allow unauthorized persons site on the tower raising area at any moment.
- Use appropriate materials and tools.
- Regularly check guy ropes tension while raising. Do not allow them to be too tight or too loose.
- Check with special attention the back guy rope is correctly installed. This cable will avoid the tower cross the vertical point of its run.
- Work in calm and assure a good communication between the team of workers.
- Ground the tower in order to protect it against static electricity and lightning strikes.
- Before raising the wind turbine on the tower, raise it at least once with out it on place.
- Do understand the tower erection procedure before attempting to install it.
- If you will be using a vehicle to raise the tower, exercise extreme caution.

# Self standing towers

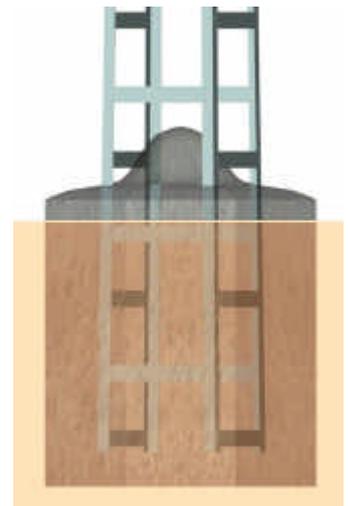


There is another very used kind of towers, they do not need guy ropes, and have different characteristics, the self-standing towers. This type of towers is stronger and heavier. They are preferred to the tilt-up towers, but they are more expensive and need a hoist for their installation. There are several tower constructors, but all of them have to follow a construction rule, so basically all fabricants make the same model of tower.

To install wind turbines, the tower used by J.Bornay is the "P" series towers. There are different combinations of trams depending on the total height of the tower, and on the force we require from it. In the annex you will find a table with the models available and their physics and mechanical characteristics.

- The *P-400* tower is used for the: **Inclin 250, 600 and 1500** models.
- The *P-750* tower can stand perfectly the **Inclin 3000 and 6000** models; It can be used in strong winds areas for the **Inclin 1500** model.
- The *P-1250* tower is reserved for the biggest Inclin series wind turbines, the **BK-12**, and for **Inclin 6000** in extremely strong wind areas.

Self-standing towers need a basement to be erected; in the annex you will find a table with the appropriate dimensions for the basement depending on the ground type and its height.



## WARNING:

Ground the tower in order to protect the system against static electricity and lightning strikes.



To install the wind turbine on the tower, you will need a tower adapter that will allow the blades turn avoiding crashing with the tower. Install the wind turbine once the tower adapter has been installed. It can be raised to its position using the hoist once the tower has been placed, or using a pulley system as shown on the picture.

## CAUTION

It is recommended using the second meted, so we will not depend on the hoist to lower it when we want.

## WARNING:

To install the wind turbine, you will need to climb the tower, **use a security harness.**

# Annexes

- The Beaufort wind force scale is a simple numerical relationship to wind speed based on an observation of the effects of the wind.

FORCE	Wind speed (m/s)	Wind speed (km/h)	Denomination
0	0 - 0.5	0 - 1	Calm
1	0.6 - 1.7	2 - 6	Light air
2	1.8 - 3.3	7 - 12	Light breeze
3	3.4 - 5.2	13 - 18	Gentle breeze
4	5.3 - 7.4	19 - 26	Moderate breeze
5	5.7 - 9.8	27 - 35	Fresh breeze
6	9.9 - 10.4	36 - 44	Strong breeze
7	12.5 - 15.2	45 - 54	Near gale
8	15.3 - 18.2	55 - 65	Gale
9	18.3 - 21.5	66 - 77	Strong gale
10	21.6 - 25.1	78 - 90	Storm
11	25.2 - 29	91 - 104	Violent storm
12	More than 29	More than 104	Hurricane

- In the next table you will find the lateral pressure in *kg* done by the wind depending on wind speed and your **J.BORNAY** wind turbine.

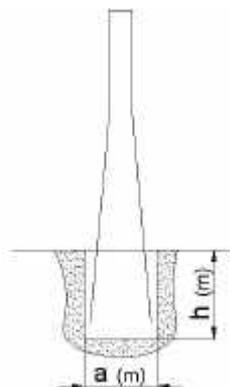
Wind turbine V winds (m/s)	3	5	7	11	13	15	55*
<b>Inclin 250</b>	0,683	1,898	3,721	9,188	12,833	17,086	229,711
<b>Inclin 600</b>	1,500	4,167	8,167	20,167	28,167	37,500	504,167
<b>Inclin 1500 neo</b>	3,067	8,520	16,700	41,239	57,598	76,684	1030,970
<b>Inclin 3000 neo</b>	6,000	16,667	32,667	80,667	112,667	150,000	2016,667
<b>Inclin 6000 neo</b>	6,000	16,667	32,667	80,667	112,667	150,000	2016,667

\* In the case the wind turbine would no use its automatic breaking system.

- In this table you will find the characteristics for type "P" (presilla) self-standing towers. They are classified in three different models available:

Tower	Total height (m)	Mechanical characteristics		Size		Total weight (kg)
		Nominal force	Esfuerzo útil en punta con viento CS 1,5	Tower top (mm)	Base (mm)	
P-400	12	408	408	320	620	226
	14				687	271
	16				754	334
	18				821	387
	20				888	446
P-750	12	765	765	320	620	270
	14				687	334
	16				756	409
	18				821	480
	20				888	552
P-1250	12	1275	1275	320	620	429
	14				687	533
	16				756	650
	18				821	765
	20				888	877

- Next table shows the cementation size needed depending on the tower and windmill choose and ground;



Tipo terreno		P-400					P-750					P-1250				
		12	14	16	18	20	12	14	16	18	20	12	14	16	18	20
FLOJO K = 8	h	1,6	1,6	1,7	1,8	1,8	2,0	2,0	2,0	2,0	2,1	2,0	2,1	2,2	2,2	2,3
	a	0,8	1,0	1,0	1,0	1,0	0,9	1,0	1,1	1,1	1,1	1,3	1,3	1,4	1,4	1,4
NORMAL K = 12	h	1,4	1,4	1,5	1,6	1,6	1,7	1,7	1,7	1,8	1,8	1,7	1,8	1,9	1,9	2,0
	a	0,8	1,0	0,9	1,0	1,0	0,9	1,0	1,1	1,1	1,2	1,3	1,3	1,3	1,4	1,5
ROCOSO K = 16	h	1,3	1,3	1,4	1,5	1,5	1,6	1,6	1,6	1,7	1,7	1,6	1,7	1,8	1,8	1,9
	a	0,8	3,0	0,9	1,0	1,0	0,9	1,0	1,1	1,1	1,1	1,3	1,3	1,3	1,4	1,5

Note: K (kg/cm<sup>2</sup>)

### CAUTION

Prevent that the cementation top is not flat to avoid rainwater to stay and oxidize the tower legs.

If you wish to enlarge or improve your installation with water heaters, change the windmill voltage, or you just have a doubt about your installation, do not hesitate in contacting us at:

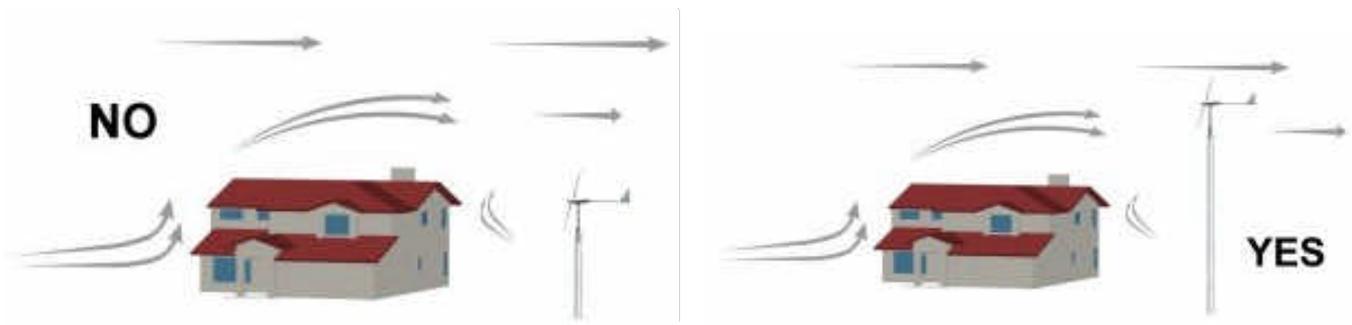
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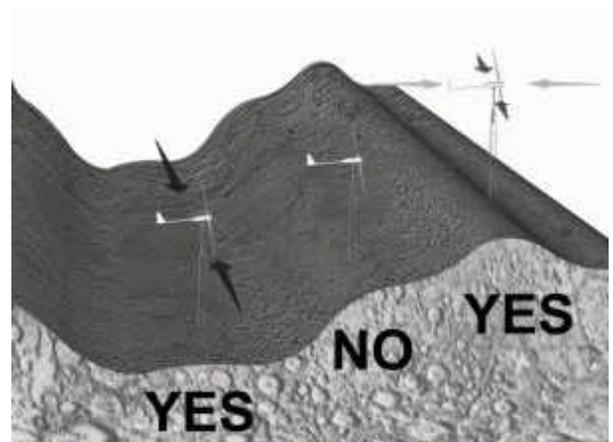
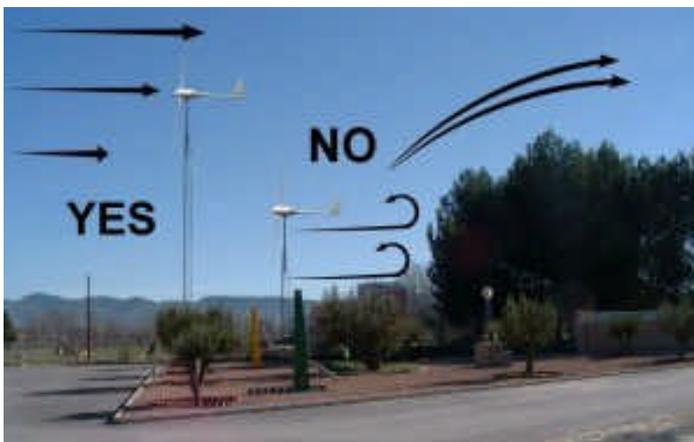
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## Landscape and objects that influence on windmills



When the wind is eclipsed by the objects it finds in its way, it reduces its speed and results in turbulences. A windmill installed on the wrong place will not perform as it would in a non-influenced place.



To maximize the performance of your wind turbine, it should be installed the farthest away possible from the obstacle and over a tower higher of this obstacle.

If the windmill is going to be installed in a valley, it should be done on the top where it will catch the wind from any direction, or on the bottom where the wind is canalized.

