THE WIND AND THE PANACEA OF THE STOW POSITION IN THE SOLAR TRACKERS

About the author

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ABSTRACT

The common belief that the support structure and the panel board stop receiving wind loads when the board is in horizontal position is unfortunate. In this horizontal position you can also get wind load and its dynamic effects amplify the effect of lead weights to reach very high loads.

This error is the reason of severe damage when the structure does not have sufficient strength and its survival is base don the adoption of such a horizontal position as the only defense.

THE EFFECTS OF THE WIND

The effect of the wind on a free plane depends on the angle formed by the wind and the plane of the element (Figure 1)

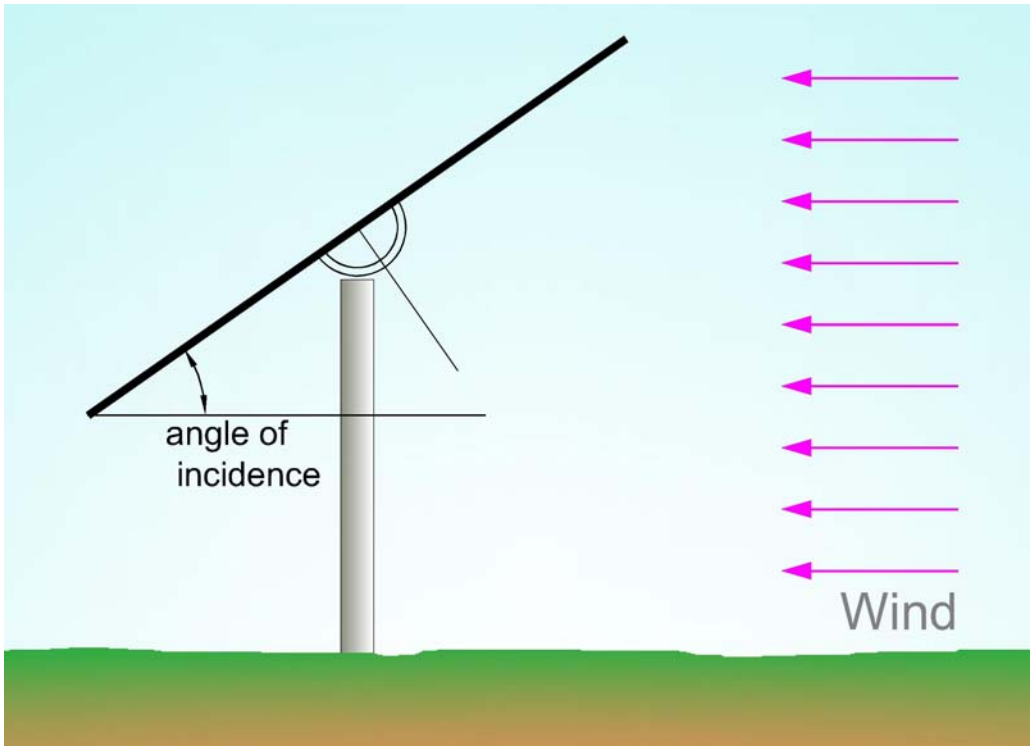


Figure 1

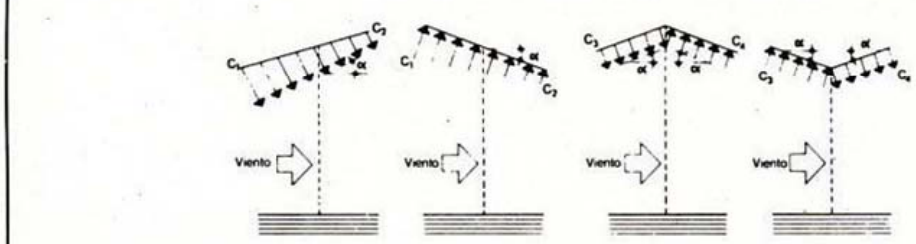
This effect may not be uniform as can be more or less at the top or at the bottom creating an imbalance, which is zero in vertical planes and increases as we approach the horizontal.

In Figure 2 it is described the effects of the wind as determined by the basic rules of the Spanish standard NBE-AE-88 for Buildings.

Not being legally binding the standard NBE AE-88 in the structural calculation of a solar tracker, its information is extremely useful to know which are rigorously the effects of wind on a static free dihedral and this information is consistent with given by other rules and international standards.

NBE AE-88

Tabla 5.4
Coeficiente eólico en planos y diedros exentos



Angulo de incidencia del viento α	Coeficiente eólico en: Planos exentos (Se calcularán los efectos más desfavorables con α ± 10°)		Diedros exentos (Se calculará cada elemento en los casos más desfavorables)			
			Caso I		Caso II	
	En el borde a barlovento c_1	En el borde a sotavento c_2	En el plano a barlovento c_3	En el plano a sotavento c_4	En el plano a barlovento c_3	En el plano a sotavento c_4
90° a 60°	1,2	1,2	1,2	0	0,8	0,4
50°	1,4	1,0	1,2	0	0,6	0,6
40°	1,6	0,8	1,2	0	0,4	0,8
30°	1,6	0,8	1,2	0	0,4	0,8
20°	1,2	0,4	1,0	0	0,2	0,8
10°	0,8	0	0,8	0	0	0,8
0°	0	0	0	0	0	0

Valores intermedios pueden interpolarse linealmente.

Figure 2

Given the variability of wind features in the analysis, it should be considered that its characteristic vector will not always be parallel to the ground, which can vary widely in some ± 10 ° with a plane parallel to the ground made up of the installation (Figure 3)

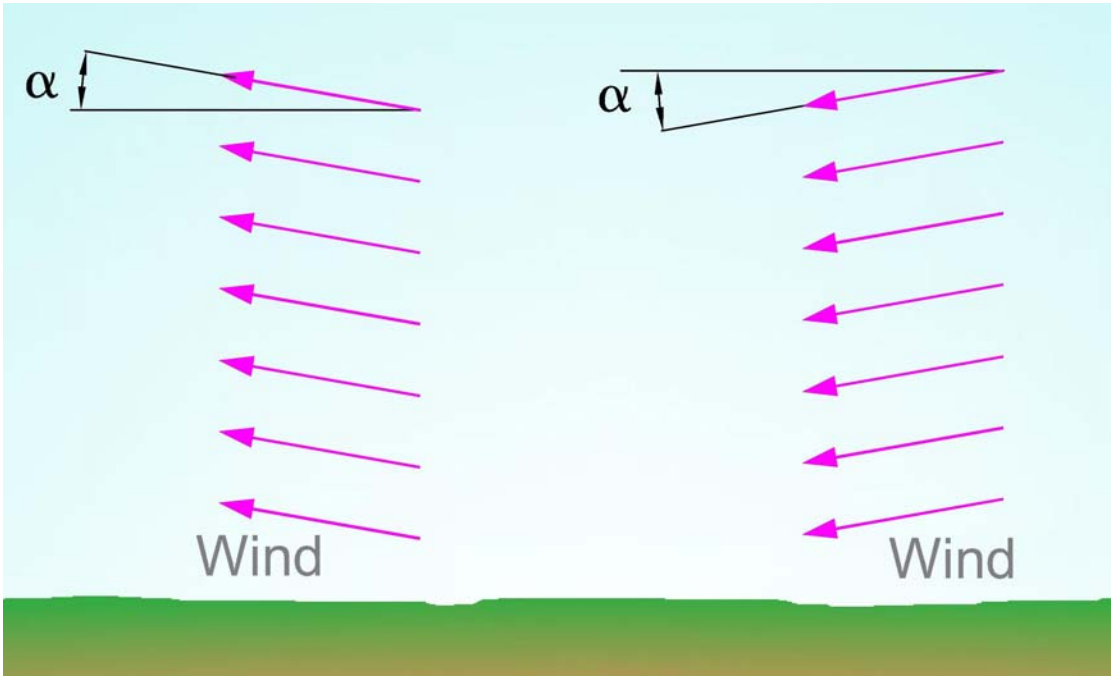


Figure 3

We should also consider that not all fields are flat and, in many cases, the plane parallel to the ground and, in turn, the wind is not to be parallel to the ground and hence the horizontal (Figure 4), and, in addition, there are many unique elements (foot of embankment, bottom of valley, barriers, etc.) which also change the direction and therefore the incidence angle of wind (Figure 5)

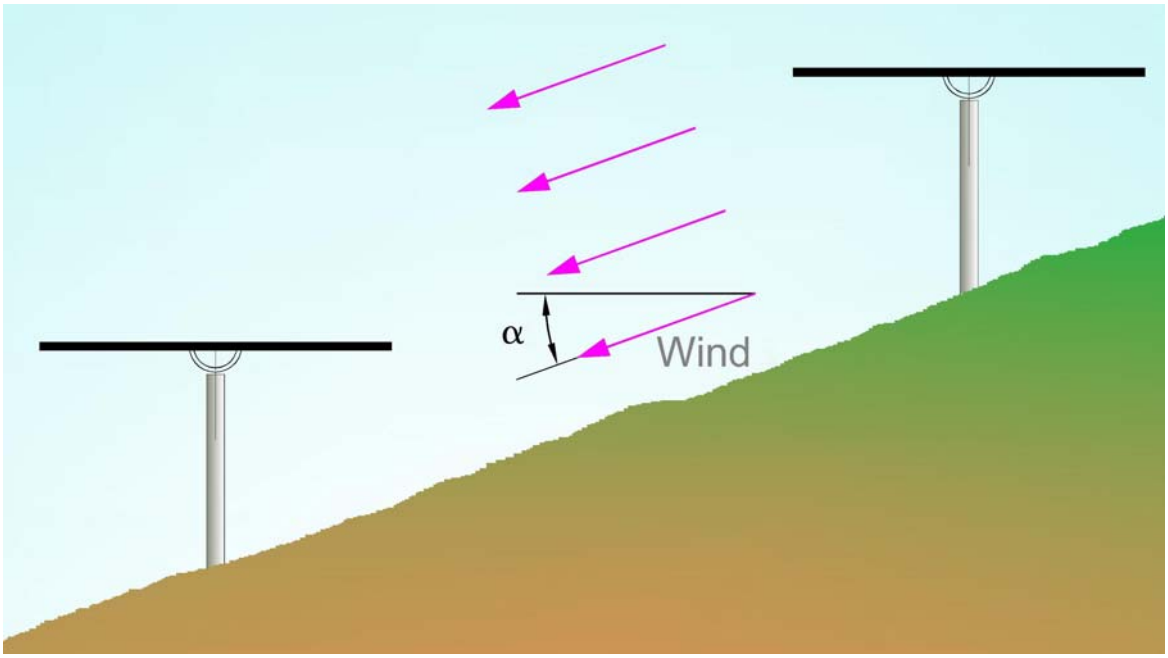


Figure 4

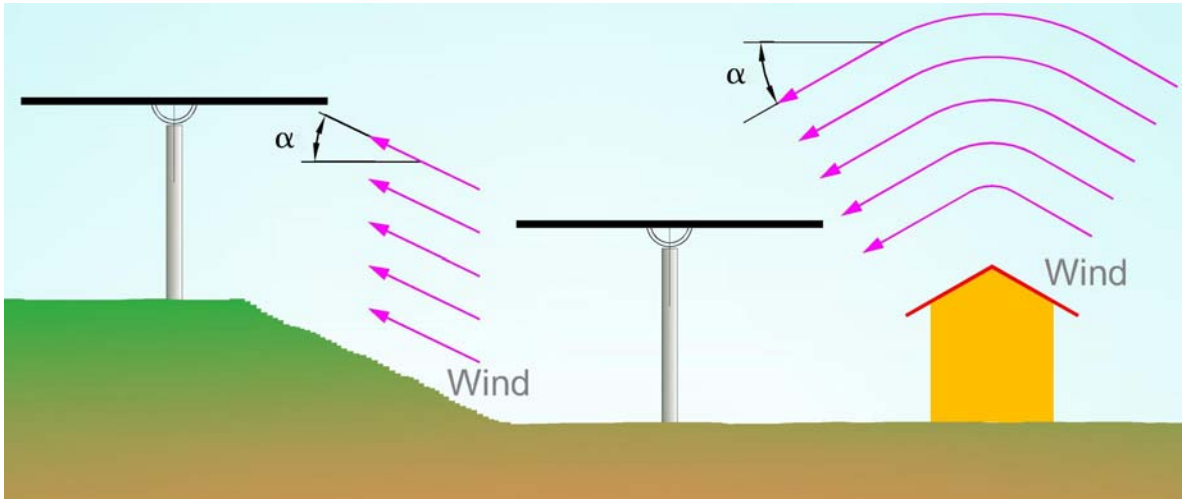


Figure 5

THE STOW POSITION

The stow position has its theoretical justification in that the effect of wind on a plane parallel is zero and the implementation is to put the board horizontally. The problem is that the because of the reasons given previously the wind is not always horizontal.

Clearly on a board placed horizontally the effect of the wind far from zero, due to the impact of the wind with the overall angle of the resulting variable angle of the wind blade, the angle corresponding to the slope of the land and the angle induced by the effect of the singular elements in their case.

Easily in many cases on this board that is positioned horizontally and theoretically is safe, we can have the effect of wind with an angle of between 20 and 30 degrees.

According to Table 2 at an angle of 25 degrees correspond to a factor of 1.4 and 0.6 wind. These coefficients for a wind of 125 km/h implies a dynamic pressure of 105 kg/m^2 and 45 kg/m^2 in the board edges.

THE OWN WEIGHT

On the horizontal board, the own weight of the panels as well as the panel that holds and supports get worse and amplifies the effect of wind.

With the board in vertical or in positions closer to this position, the own weight practically induces only loads that does not pose any problem since the board has high resistance in this plane.

On the contrary, if the board is horizontal weights implies forces perpendicular to its plane in addition to the wind leading to transverse bending, bending over very problematic in any plane.

Moreover, as we all know, the wind is a dynamic load which is commonly studied as static for easy analysis. This simplification is valid only for structures of high stiffness, and this is not exactly the main characteristic of the elements in transverse planes.

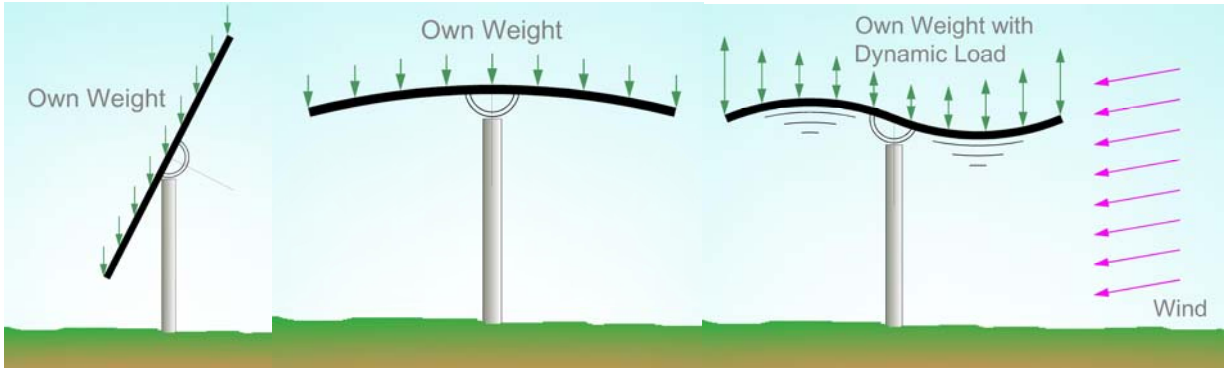


Figure 6

OVERALL LOAD

Over the panel in horizontal position it will always act the own weight of the panels and the structure of the board resulting in the same transverse bending.

In case of wind, this load due to the weight adds to the deflection produced by the wind directly as its angle of incidence.

If we consider the own weight of modules and boards) about 25 kg/m^2 we will have on the horizontal board, roughly, with a wind of 25 degrees of incidence angle as follows:

- *Top or bottom edge: 105 + 25 = 130 kg/m^2*
- *Higher or lower edge: 45 + 25 = 70 kg/m^2*
- *Average Value: = 100 kg/m^2*

We reach therefore the average value of 111% and 144% of the maximum value (edge) of the charges would have on the board in vertical or near this position (Table 2, angle between 90 and 60 degrees wind ratios 1.2 and 1.2 for wind of 125 km/h mean 90 kg/m^2 in both upper and lower, and average 90 kg/m^2) These increases are higher the greater with the weight supported (concentration of solar modules, etc.)

LOWER STRUCTURE

The lower structure is between the board and the ground.

Obviously this structure is that it is appropriate that the board adopt the horizontal supports it as a defense, because they receive less.

In contrast, it was justified, the board in positions close to the horizontal is exposed to loads that, far from zero, is reaching 144% of the maximum value attained at or near vertical position.

Given this context, the most rigorous for the proper design and construction of a solar tracker that for a expected life about 25 or 30 years, is the calculation of the lower structure to withstand wind board design with vertically and the board for the unbalanced load of wind, added to the weight of its own structure and panels.

There are solar trackers that do not reach the vertical position of the board, but this serious defect that prevents the full tracking in elevation range will be corrected by the lower economic returns that result.

The wind design should be such as statistically determined as the value of life insurance for that 25 or 30 years.

CONCLUSIONS

- *The positions of defense in which the effect of wind is zero only at the theoretical level.*
- *Land, location, unique features and unpredictable dynamics of wind can cause the maximum load to the board is in the theoretical position of the defense horizontally.*
- *For a life of 25 to 30 years rigorous calculation of a solar tracker should comply with the following:*
    - *Wind Design of statistical value of life insurance for 30 years.*
    - *Calculation of the board to unbalanced loads and maximum wind design combined with the weight of modules and board.*
    - *Calculation of the lower structure for the wind design with the board in vertical. If the design does not achieve the vertical is calculated for maximum vertical reach (not reaching the vertical harms directly tracking and hence the energy production)*

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