ANTENNA WIND LOADING

G3UDO

For the growing number of radio amateurs and s.w.l.s putting up beams, it is useful to be able to calculate the wind resistance of the antenna and extension mast. A number of antenna manufacturers specify wind loadings, but in many cases these are not true figures as they include a factor of safety. This means you could end up using a tower, mast or rotator that is much larger than is really necessary for the antenna it carries.

It is a relatively simple matter to work out the wind resistance of an antenna so long as some basic rules are followed—there is no mystery.

Horizontal Antennas

A typical 5-element Yagi is shown in Fig. 1. To obtain the wind resistance, one must first find the maximum area that the antenna will present to the wind at any time. This is **not** the area of the side profile.

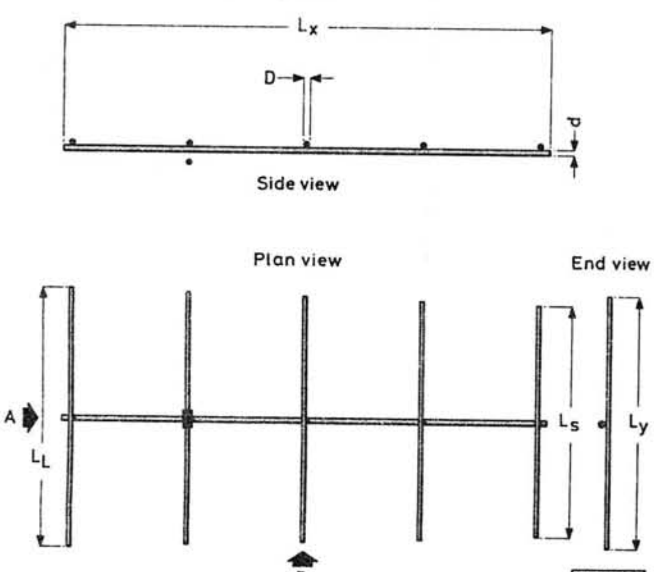


Fig. 1

To find the maximum area, we must first calculate the area of the antenna as viewed from the end "A", and the area as viewed from the side "B".

Area A is the average area of a single element multiplied by the number of elements N in the antenna, though if the driven element is a folded dipole that counts as two. The average area is found by taking the average length L_Y and multiplying it by the diameter D. The average length is simply obtained by using the formula:

$$L_Y = \frac{L_L + L_S}{2}$$

Since the end profile of the boom is small in comparison to the area of the elements, it can be ignored except by the purists, so the Area A is:

$$A = D \times L_Y \times N.$$

Area B is basically the area of the boom, which is equal to its length L_X multiplied by its diameter d. Again, the ends of the elements can be ignored. Where traps are fitted, find the area of the circle corresponding to their diameter, multiply by the number of traps, and add this figure to the area of the boom.

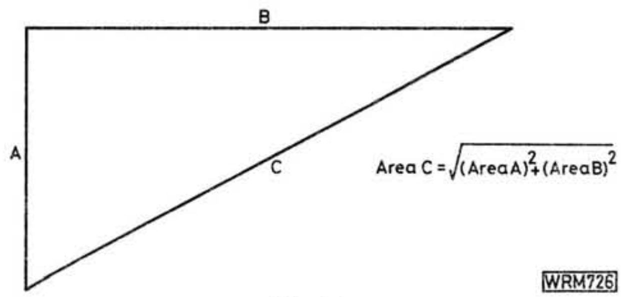


Fig. 2

Referring to Fig. 2, you will see a right-angled triangle whose sides represent the areas in question. This shows that C is the maximum area to be found. This is obtained by using Pythagoras (remember him?), thus:

$$\text{Area C} = \sqrt{(\text{Area A})^2 + (\text{Area B})^2}$$

The area calculated is as it would be for a flat plate of equivalent size at right angles to the air flow. However, if the antenna is made of round-section tubes or rods, it presents a much better aerodynamic shape, and the resulting wind pressure would be much less than that on the equivalent flat plate. This should be allowed for by multiplying the maximum area C by an aerodynamic factor of 0·6.

Having got the maximum effective area of the antenna, the wind resistance is calculated by multiplying the area by the wind pressure relative to the wind speed being used. There are a number of variables that have to be considered in relation to wind speed and pressure, but in order not to confuse the issue, the wind speed used here is applicable to antennas at a height of 15 metres, situated in open country with scattered wind breaks.

The values of wind pressure quoted are taken from *CP3, Chapter V, Part 2, 1972* and are as follows:

Wind speed (miles/hour)	50	60	70	80	90	100	110	120
Dynamic pressure (lb/ft^2)	6·4	9·2	12·5	16·4	20·7	25·6	31·0	36·9

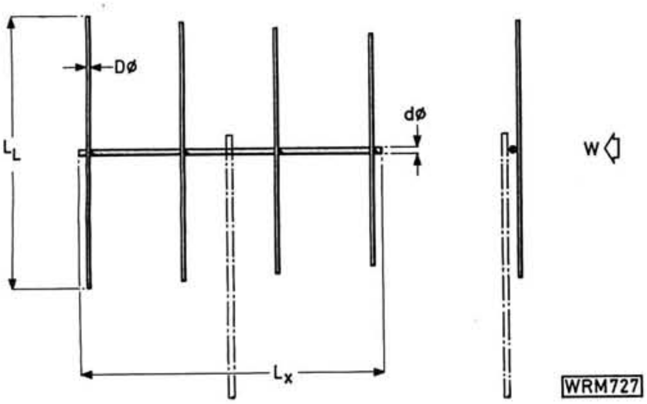
Note that CP3 states that the basic wind speed is taken as a 3-second gust speed estimated to be exceeded on average once in 50 years. It is assessed for the UK on a statistical basis from continuous wind records.

Vertical Antennas

Antennas mounted with their elements in the vertical plane, i.e., for vertically polarised signals, are considered a little differently from those mounted horizontally. In this case the maximum wind force will result when the wind is sideways on to the antenna (Fig. 3). The effective area is then worked out as follows. Area of the longest element multiplied by the total number of elements, plus the area of the supporting boom. Thus:

$$\text{Total area} = (L_L \times D \times N) + (L_X \times d).$$

Fig. 3



If the boom and elements are made of round rod or tube, then the result must be multiplied by the aerodynamic factor of 0·6, as for horizontal antennas.

Television-type antennas are a little more difficult to deal with because they are generally constructed from flat formed strips screwed onto square section tube (Fig. 4). These behave quite differently from round tube in an air stream and produce more turbulence and drag, i.e. wind resistance. However, without going into the domain of pundits of aerodynamics, for our purpose it will be enough to consider the antenna as being made of flat strips or plates of the equivalent dimensions. The total area of the antenna can be worked out as before, but in this case no correction is made for aerodynamic effect as with round tube; i.e., total area = effective area. In order to allow for "turbulence" add an extra 10 per cent to the wind pressure to get a reasonable approximation to the wind load.

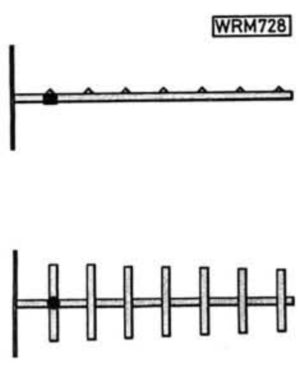
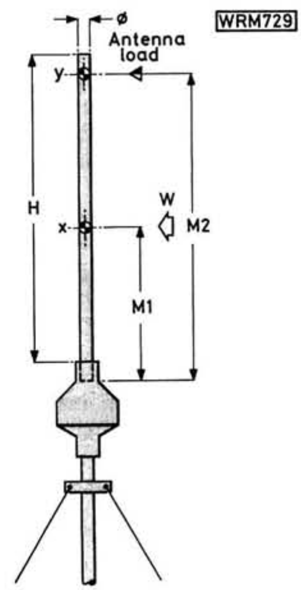


Fig. 4

When considering wind load for antennas, it is advisable to take into account the wind load of the supporting mast or extension, i.e., the bit above the rotator or mast top. The total area, effective area and wind pressure are worked out as for antennas using round section tube. However, there are two things to take into account (see Fig. 5): 1. The sideways load caused by the wind load of the antenna; 2. The sideways load due to the wind pressure on the extension mast itself. These two forces (loads) result in a bending load being exerted at the bottom of the extension tube, which is transmitted to the rotator or mast top.

The bending load due to the antenna is found by multiplying the antenna wind load at point Y by its distance above the bottom of the extension (M2). Taking these in pounds and inches respectively gives an answer in lb in.

Fig. 5



The wind load on the extension mast is taken as acting at the mid-point X of the exposed length H, i.e., half of the length which is above the rotator or mast. The bending load due to the wind resistance of the extension is then equal to the wind load at point X multiplied by its distance above the bottom of the extension (M1), which is half of the length H plus the bit inside the rotator clamp.

The total bending load at the bottom of the extension is the total of the two bending loads, again in lb in.

Ice

Iced-up antennas will present a greater area to the wind than a clear un-iced array as so far considered. However, we are now in no-man's-land with no real guidelines. For all practical purposes, iced-up conditions as applicable on average to the UK can be allowed for by adding 25 per cent to the final value of wind resistance calculated.

Conclusion

This is not intended as a scientifically precise method of getting a value for wind resistance, but is intended to enable the average radio amateur to get some idea of the forces acting upon the antenna he puts up. ●