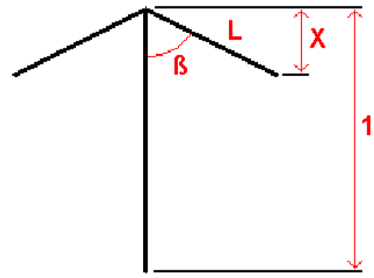
http://www.strobbe.eu/on7yd/136ant/#Umbrella

2.4. Umbrella antenna



For practical reasons many toploaded verticals have sloping topload wires. These kind of antennas are called umbrella antennas. A sloping topload wire has 2 contradictory effects on the radiation resistance (R_A) of the antenna. One the one hand it increases the top capacitance, thus increasing R_A. But on the other hand it will introduce a 'downward current' that cancels a part of the (upward) current through the vertical, thus decreasing R_A.

The influence of both effects depends of the number of topload wires, their length and their sloping angle. John Sexton (G4CNN) did develop a mathematical model for umbrella antennas with the goal to optimize the parameters (number of wires, length and sloping angle) for a maximum radiation resistance.

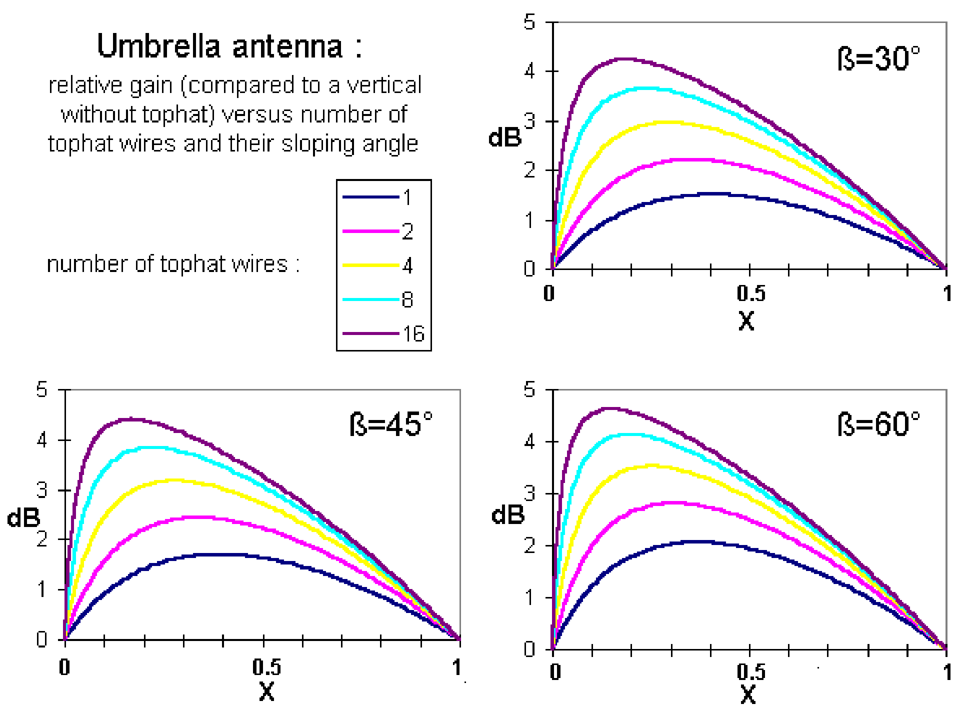
Detailed calculations how to optimize the slope and length of the topload wires can be found here. Assume an umbrella antenna with a unity height (1) and n topload wires of a length L, sloping under an angle ß. The topload wires will 'shield' the vertical part over a length X = L*cos(ß).

The gain (in dB, relative to a vertical without toploading) will be :

$$G = 20 \cdot \log\left(1 + \frac{L \cdot (1 - \cos(\beta) \cdot L)}{L + \frac{1}{n}}\right)$$

[6] (**log** = 10 based logaritm, L and X relative to the unity height '1')

The graphs below give the relative gain of an umbrella antenna for sloping angles of 30, 45 and 60 degrees - depending on the 'shielding length' (X) and the number of tophat wires :



As expected higher sloping angles give the better results, but also note that for a certain sloping angle many short tophat wires are more effective than a few long.

The above formula and graphs assume that the tophat wires do not affect each other. In practice this will not be true in the case of many short tophat wires, the effective gain will be less than the calculated one.