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Effectiveness of Trees for Wind Mitigation

A.W. Rofail[1], J.H. Wilson[2]
[1]*Windtech Consultants, 607 Forest Road, Bexley NSW 2207* trofail@windtechglobal.com
[2]*Windtech Consultants, Clerkenwell, London* jwilson@windtechglobal.com

ABSTRACT

It is a well-known fact that trees tend to enhance the pedestrian environment in many ways including aesthetics, thermal comfort, glare from buildings and wind comfort. The focus of this study is to determine quantitatively through field measurements what effects trees have in ameliorating wind speeds and enhance the wind environment. In some cases, usually in cooler climates, such as in the ACT, planning controls limit street tree planting to only deciduous trees. Hence this study extends to both foliated trees as well as the effect of deciduous trees in winter. Field measurements are made of the effect of trees, located within a golf course in Bridlington, UK, on both the upstream and downstream wind conditions.

1. Introduction

Wind environment model studies often raise the need for some form of mitigation. A set of guidelines published by AWES (2014) does not recommend reliance on trees for when wind speeds exceed the safety limit. The reason being that placement of trees in excessively high wind areas would elevate the risk of branches breaking off, which would pose an undesirable risk to the public. However, in moderate wind environments where there is an exceedance of the relevant comfort criterion, trees are an effective means of wind mitigation as they tend to reduce the momentum of the wind without deflecting the problem elsewhere.

This study assists in understanding the potential effect of trees in mitigating wind environment impacts. It presents quantitative measurements of the effect of both foliated trees and deciduous trees in winter on the wind conditions downstream with some limited investigation of the effect of the trees on the area immediately upstream. The latter is of particular interest given the difficulty in accurately modelling this in a wind tunnel.

2. Experimental Setup

Two wind speed sensors are placed on tripods to obtain measurements at a height of 1.5m, which is the standard measurement height when undertaking a wind environment study. The sensors used in this study are the Testo 405i smart probe, which has a 30m/s range, accuracy of 0.3m/s + 5% of the mean velocity and a resolution of 0.01m/s. Readings are transmitted wirelessly via Bluetooth to a smartphone. Cotton threads are also attached to help monitor the wind direction. The arrangement is shown in Figure 1, below. One sensor served as a reference and the other acted as the roving sensor.

Most measurements were taken of a double tree cluster that is deciduous and in a very isolated area on a golf course in Bridlington, UK. Measurements were taken around the same tree cluster in both summer and winter, as shown in Figure 2, below. The subject trees are shown in Figure 3 and are approximately 6m in height. Measurements taken are in the form of 5minute means.

Additional tests were done using a different set of trees that are 18m in height (see Figure 4).

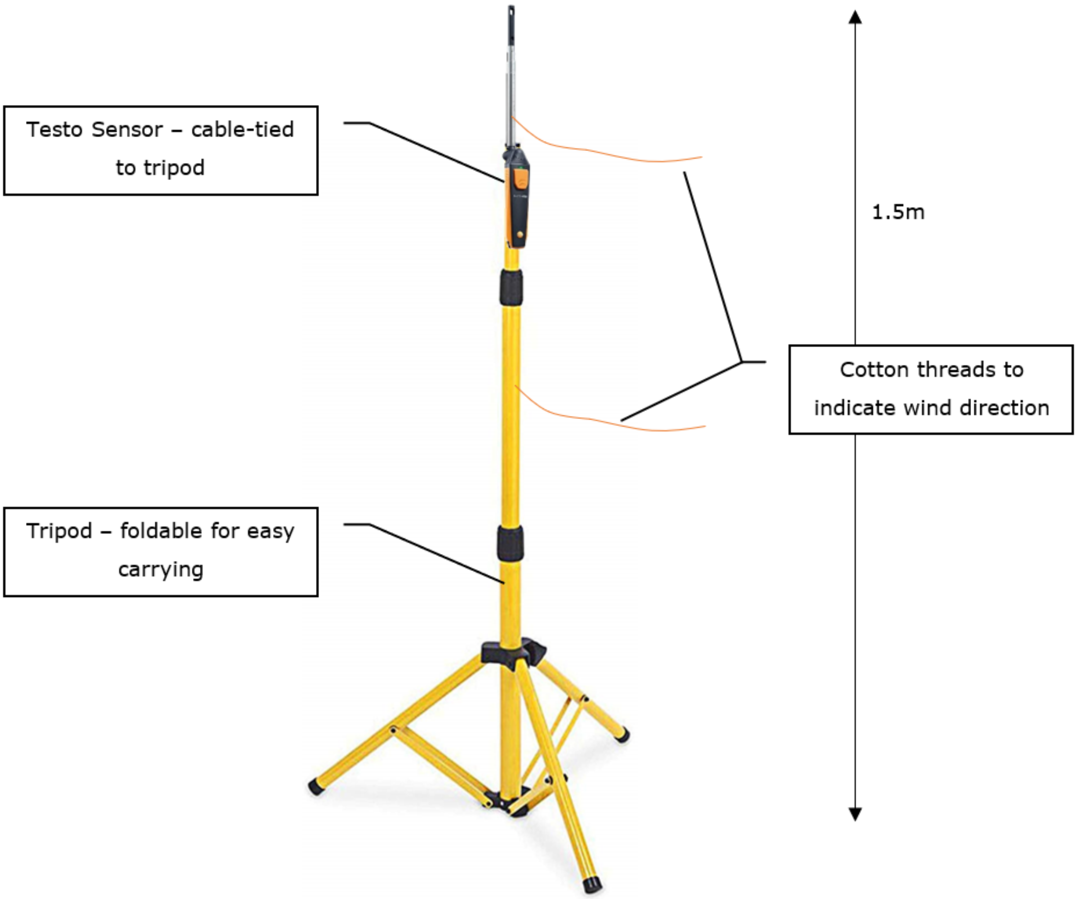


Figure 1. The Testo sensor and tripod used in the study

Figure 2. The main site used for the full-scale measurements

Figure 3. The 6m high double tree cluster in Winter (left) and Summer (right)

Figure 4. The 18m high additional tree samples

3. Results

3.1 Foliated trees

Tests on the subject trees shown in Figure 3 during summer showed a significant reduction in the wind speed downstream of the subject tree. The results presented with the downstream distance normalized by the tree height, are summarised in Figure 4, below. Separate measurements in the form of 2minute averages were obtained around a set of evergreen trees within the same golf course, which indicate an 8% reduction in wind speed at a distance of 1H upstream and a 12% reduction at 0.5H upstream.

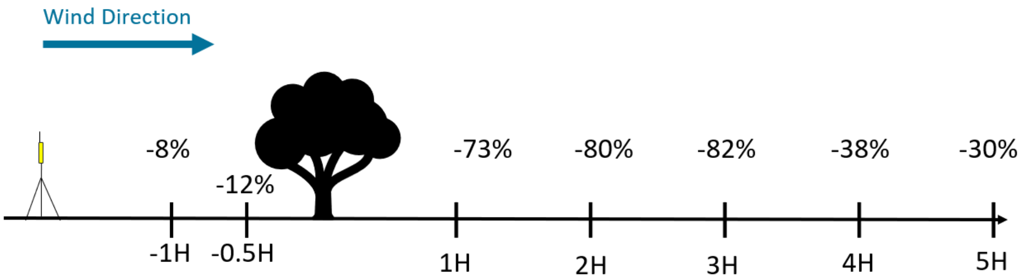


Figure 5. The percentage reduction in wind speeds downstream due to subject double tree cluster in Summer

3.2 Deciduous trees in winter

Tests on the subject trees shown in Figure 3 during winter showed that even with all the leaves being shed, a substantial reduction in the wind speed downstream of the subject trees was still observed. The results presented with the downstream distance normalized by the tree height, are summarised in Figure 6, below. Separate measurements in the form of 2minute averages were obtained around a different deciduous tree within the same golf course are presented in plan view in Figure 7, below. For this tree, points were not just tested directly downwind along the centreline of the tree but also just within the radius of the tree canopy. The results from the two different sets of deciduous trees show a similar pattern and overall effect, although there are some differences between the two. However, it can be seen in Figure 7 that deciduous trees do not offer any protection for any distance upstream during winter.

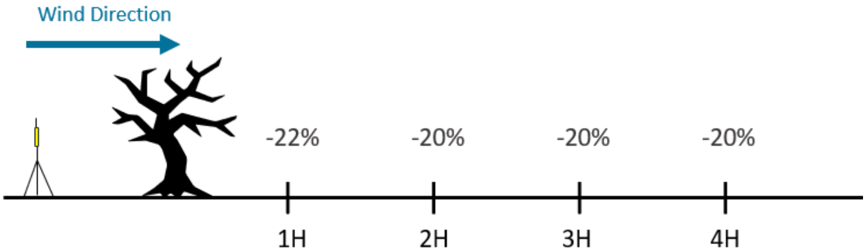
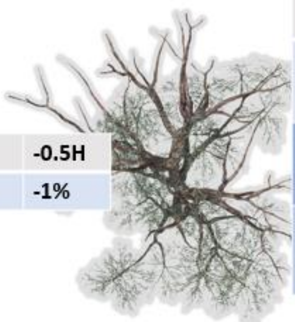


Figure 6. The percentage reduction in wind speeds downstream due to subject double tree cluster in Winter

-1.5H	-1H	-0.5H
0%	-4%	-1%



0.5H	1H	2H	3H	4H	5H
-3%	11%	-23%	-25%	-9%	5%
-39%	-33%	-25%	-9%	-16%	-8%
-16%	-18%	-33%	-11%	-2%	-11%

Increase in wind speed	Up to 10% reduction in wind speed	10-25% reduction in wind speed	25%-50% reduction in wind speed	Greater than 50% reduction in wind speed

Figure 7. The percentage reduction in wind speeds downstream due to a different tree cluster in Winter

4. Conclusions

This preliminary study shows some variability amongst different trees within the same category (foliated and deciduous during winter). We hope to extend the study in the future to see the effect of a wider range of trees and tree sizes and to see the effect of a more turbulent setting such as in a city centre. However, these preliminary findings confirm the effectiveness of foliated trees in substantially mitigating wind impacts in the downstream direction as well as providing some mitigation upstream within a distance equivalent to the height of tree.

One interesting finding is that deciduous trees in winter can still have some effect in mitigating winds in the downstream zone.

Reference

Australasian Wind Engineering Society, 2014. Guidelines for Wind Pedestrian Effects Criteria