Procedure for the economic handling of sunscreens under wind action

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INTRODUCTION

Sunscreens at the outer surface of a façade are endangered by wind action. Therefore the screens must be pulled up at critical wind speed. This procedure requires a control system. The classical control system is to install several anemometers at many positions at the façade. Another control system is to use one central anemometer on the roof of the building. The first system has the disadvantage to install many anemometers, which is expensive and disturbs the image of the façade and the second system pulls up all screens at critical wind, also at façades where the wind action is low.

An improved control system is presented is this paper. It is based on the wind characteristics at the different façade areas and on the wind characteristic of the wind anemometer on the roof. Both informations are put together in the computer algorithm which enables an individual controlling of each façade area [1].

The wind characteristics are received by a wind tunnel test.

WIND CHARACTERISTICS AND CONTROL EQUATION

The wind characteristic, $\psi_i(\beta)$, is the ratio of the local wind speed, $v_i(\beta)$, at a façade point to the undisturbed wind speed, v_∞ :

$$\psi_i(\beta) = \frac{v_i(\beta)}{v_\infty} \tag{1}$$

where β = wind direction. If $\psi_{WW}(\beta) = \frac{v_{ww}(\beta)}{v_\infty}$ is the wind characteristic of the anemometer the undisturbed wind speed, v_∞, can be calculated with equation (2):

$$v_{\infty} = \frac{v_{WW}(\beta)}{\psi_{WW}(\beta)} \tag{2}$$

The value $v_{WW}(\beta)$ is the measured wind speed at the anemometer versus wind direction (β). With the wind characteristic of the façade area, $\psi_i(\beta)$, the local wind speed at the façade area can be calculated:

$$v_{i,facade} = \psi_i(\beta) \cdot v_{\infty} \tag{3}$$

If the value $v_{i,façade}$ is greater than the critical wind speed for the screen, v_{sreen} :

$$v_{i,façade} > v_{screen} \tag{4}$$

the sun screen must be pulled up. Combining equation (2), (3) and (4) we receive the control equation (5):

$$\frac{\psi_i(\beta)}{\psi_{WW}(\beta)} \cdot v_{ww}(\beta) > v_{screen} \tag{5}$$

If equation (5) is fulfilled the sun screen must be pulled up. It must be noticed, that the critical wind speed for the screen is the mean wind speed. If the manufacturer of the screen has defined the critical wind speed as a gust speed, the gust factor, φ_{gust} , must be considered. The critical wind speed in this case must be corrected by equation (6):

$$v_{screen} = \frac{v_{screen,gust}}{\varphi_{gust}} \tag{6}$$

WIND TUNNEL TESTS

For achieving the wind characteristics a wind tunnel test is required. A model of the building with adjacent buildings must be fabricated in a suitable scale. The shape of the model building can be kept simple but must include all flow relevant details. Figure 1 presents an example of a project which has been investigated. The local wind speed is measured near the façade surface at different positions. The optimal position of the anemometer at the building roof is investigated. The best position is this position where a full characteristic curve as shown in Figure 2 is achieved. Additional tests must be performed in order to verify the wind direction at the point of the anemometer. The wind direction must be indicated in a clear manner.

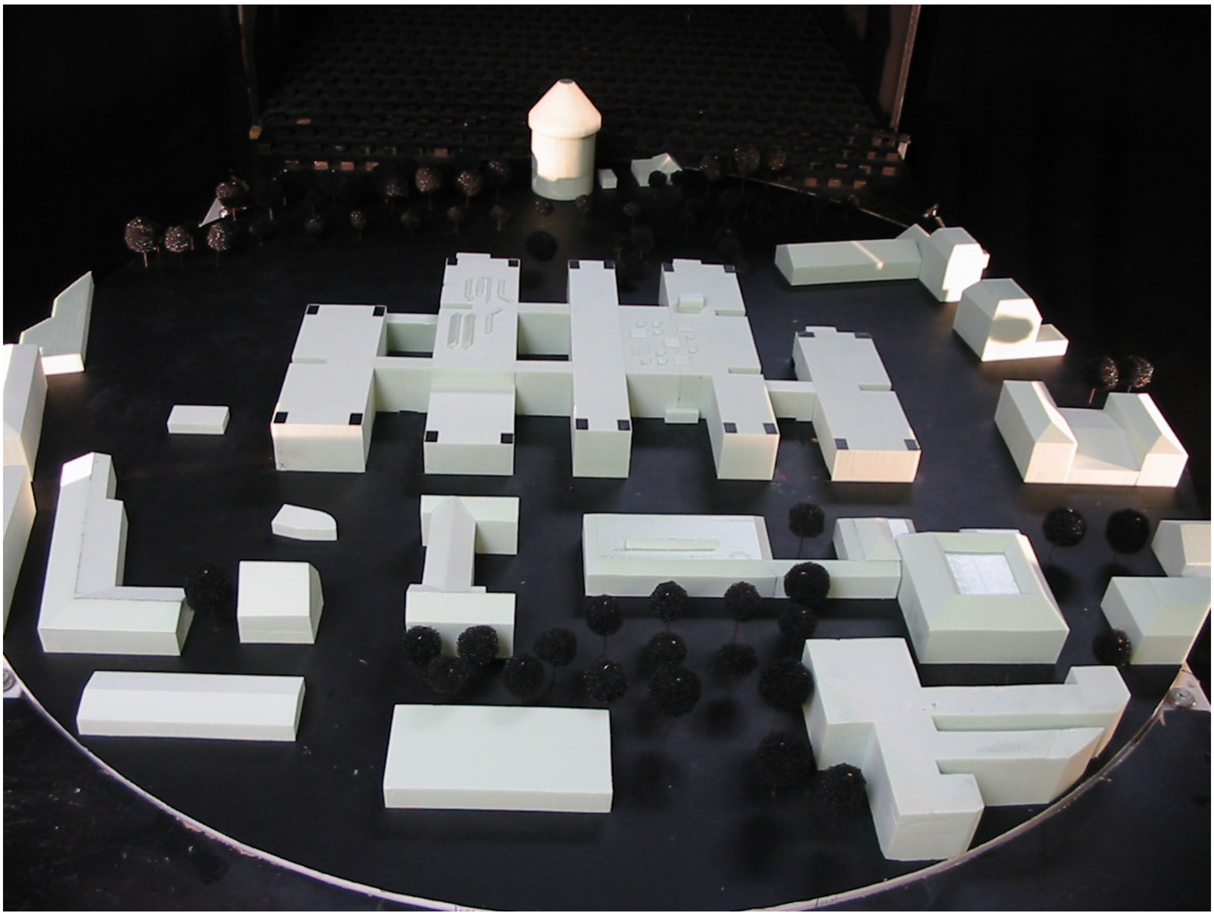

Figure 1. Example of a project tested in the wind tunnel

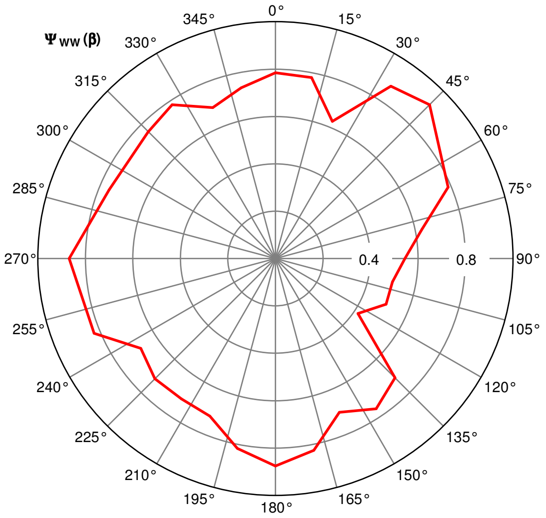

Figure 2. Wind characteristic of the anemometer

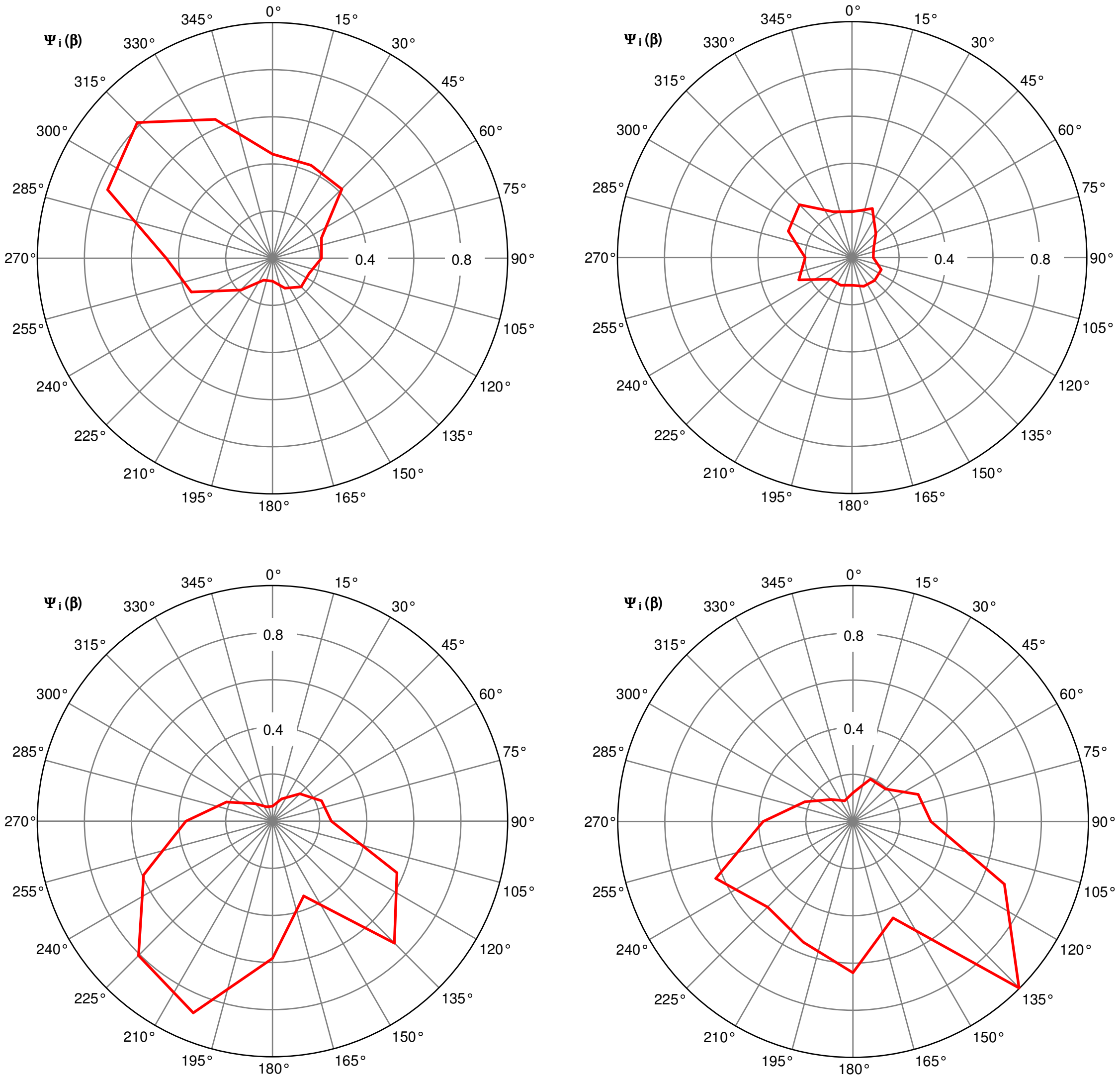

Figure 3. Examples of four wind characteristics of the project of Figure 1

Figure 3 shows four different wind characteristics at the façade of the project of Figure 1. For the practical handling several groups with nearly identical wind characteristics can be defined for the same control signal. This reduces the expenditure for controlling.

NOTES FOR THE PRACTICAL HANDLING

For the practical application of the wind characteristic technique it is necessary to equalize some areas of wind directions, because the curves of the wind characteristics are not smooth. At this smoothing-out process of the curves it must be noticed, that the higher ψ_{WW} (β)-points of the anemometer characteristic and the lower ψ_i (β)-points of the façade characteristics lead to control points at higher wind speeds. If the mechanical certainty of the screen is the criterion, the higher peaks of the anemometer wind characteristic and the lower points of the façade characteristics must be cut.

EXAMPLE OF PRACTICAL APPLICATION

In the final paper some executed projects of the Ventus GmbH using the wind characteristics will be presented. The behaviour of the control system during stormy winds will be analysed.

REFERENCES

1 [1] Ruscheweyh, H., Windhövel, R., 2001. Criteria for the automatic protection of exterior sunscreens, in: WtG-Reports No. 7 (in german)
2 [2] Ventus GmbH, 2007. Intelligent control by dint of dynamic wind monitoring, in: Architektur und Sonnenschutz 2/2007 (in german)
3 [3] Ventus GmbH, 2007. Optimal actuated sunscreens allow balanced compromise, in: Architektur und Sonnenschutz 2/2007 (in german)
4 [4] Ventus GmbH, 2007. User-friendly and effective sun protection control mechanism, in: Façade and sun protection 1/2007
5 [5] Ventus GmbH, 2006. Dynamic wind monitoring minimizes damages, in: Elektrobörse 12/2006 (in german)