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Assessment of Pedestrian Comfort in a Portuguese City Using Computational Fluid Dynamics Modelling and Wind Tunnel

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Abstract : Wind comfort for pedestrians is an important condition in urban areas. In Portugal, a country with 900 km of coastline, the wind direction are predominantly from Nor-Northwest with an average speed of 2.3 m·s -1 (at 2 m height). As a result, a set of city authorities have been requesting studies of pedestrian wind comfort for new urban areas/buildings, as well as to mitigate wind discomfort issues related to existing structures. This work covers the efficiency evaluation of a set of measures to reduce the wind speed in an outdoor auditorium (open space) located in a coastal Portuguese urban area. These measures include the construction of barriers, placed at upstream and downstream of the auditorium, and the planting of trees, placed upstream of the auditorium. The auditorium is constructed in the form of a porch, aligned with North direction, driving the wind flow within the auditorium, promoting channelling effects and increasing its speed, causing discomfort in the users of this structure. To perform the wind comfort assessment, two approaches were used: i) a set of experiments using the wind tunnel (physical approach), with a representative mock-up of the study area; ii) application of the CFD (Computational Fluid Dynamics) model VADIS (numerical approach). Both approaches were used to simulate the baseline scenario and the scenarios considering a set of measures. The physical approach was conducted through a quantitative method, using hot-wire anemometer, and through a qualitative analysis (visualizations), using the laser technology and a fog machine. Both numerical and physical approaches were performed for three different velocities (2, 4 and 6 m·s-1) and two different directions (NorNorthwest and South), corresponding to the prevailing wind speed and direction of the study area. The numerical results show an effective reduction (with a maximum value of 80%) of the wind speed inside the auditorium, through the application of the proposed measures. A wind speed reduction in a range of 20% to 40% was obtained around the audience area, for a wind direction from Nor-Northwest. For southern winds, in the audience zone, the wind speed was reduced from 60% to 80%. Despite of that, for southern winds, the design of the barriers generated additional hot spots (high wind speed), namely, in the entrance to the auditorium. Thus, a changing in the location of the entrance would minimize these effects. The results obtained in the wind tunnel compared well with the numerical data, also revealing the high efficiency of the purposed measures (for both wind directions).

Keywords : urban microclimate, pedestrian comfort, numerical modelling, wind tunnel experiments
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