NUMERICAL AND PHYSICAL MODELLING TO ASSESS PEDESTRIAN WIND COMFORT

THE CASE STUDY OF AN OPEN SPACE AUDITORIUM IN PORTUGAL

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Abstract

Pedestrian wind comfort levels are an important requirement for comfort and safety in urban areas. The José Afonso auditorium, an open space owned by the municipality of Setúbal, in Portugal, is often exposed to strong wind conditions due to its location and configuration. The aim of this study is to assess the wind patterns for the auditorium area for the reference scenario through a set of experiments using a wind tunnel, together with a set of numerical simulations using the CFD model VADIS. Furthermore, a series of mitigation measures initially proposed by the municipality, including 4 front panels, 4 back panels and a set of new trees, were tested to assess their effectiveness in mitigating the wind discomfort in the area.

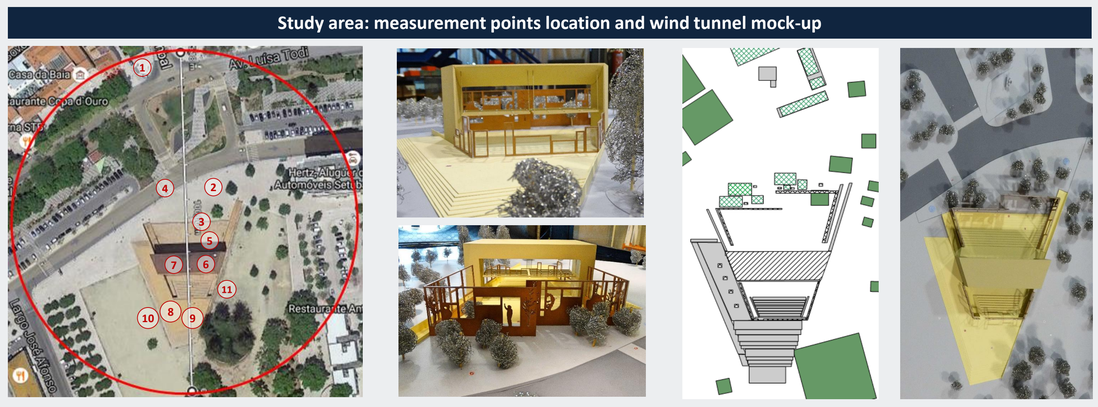
Methodology

Study area: auditorium, surrounding buildings and trees

The **wind tunnel experiments** and the **CFD simulations** were carried out for inflow wind conditions identified as prevailing meteorological conditions of the neighborhood:

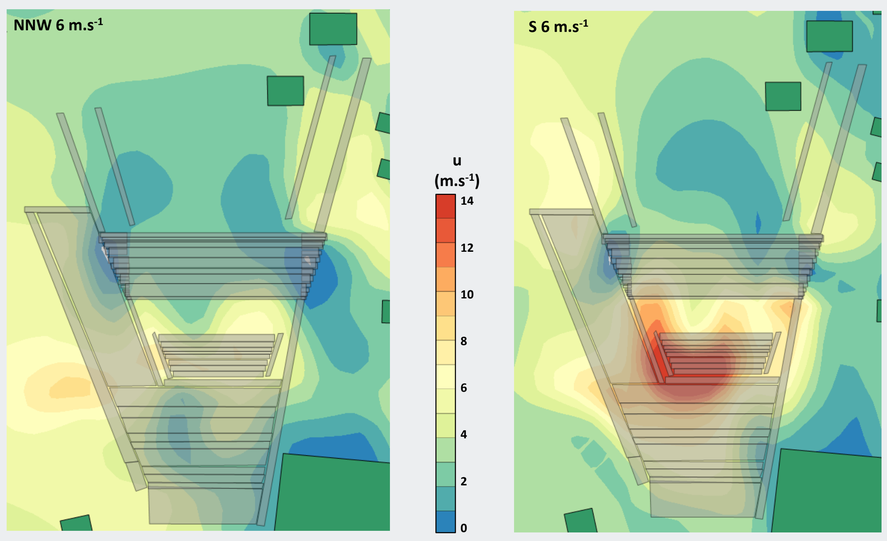
- Wind direction: **north-northwest and south**
- Wind speed: 2, 4 and 6 m.s^{-1}

Study area: measurement points location and wind tunnel mock-up



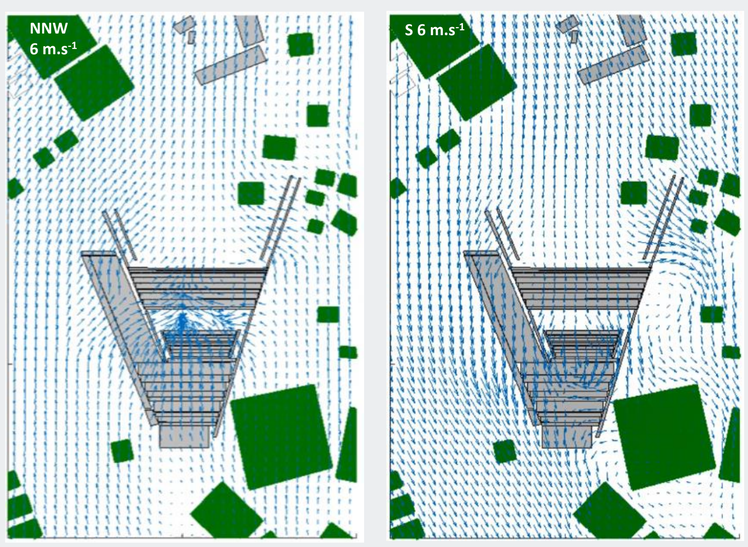
Results

Horizontal isocontour of the wind speed at pedestrian height – reference scenario



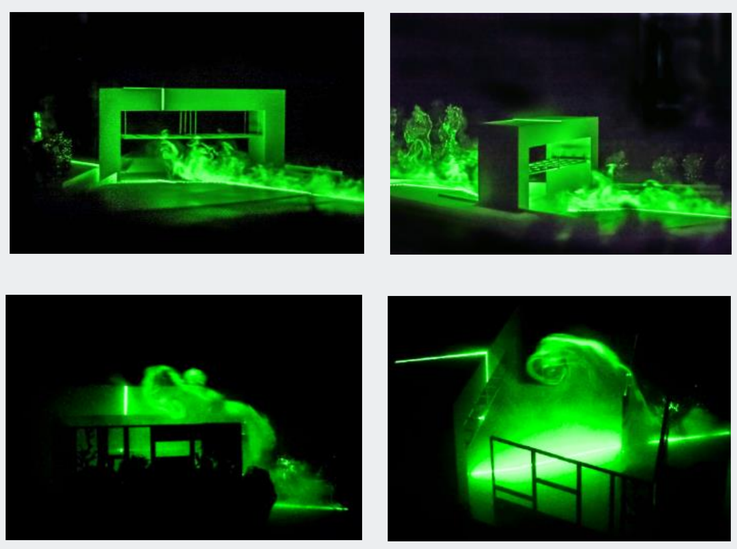
The turbulent flow is accelerated upstream the auditorium, as a result of the street canyon configuration of the surrounding avenue, followed by a deceleration of the flow induced by the vegetation.

Horizontal wind vector plot at pedestrian height – reference scenario



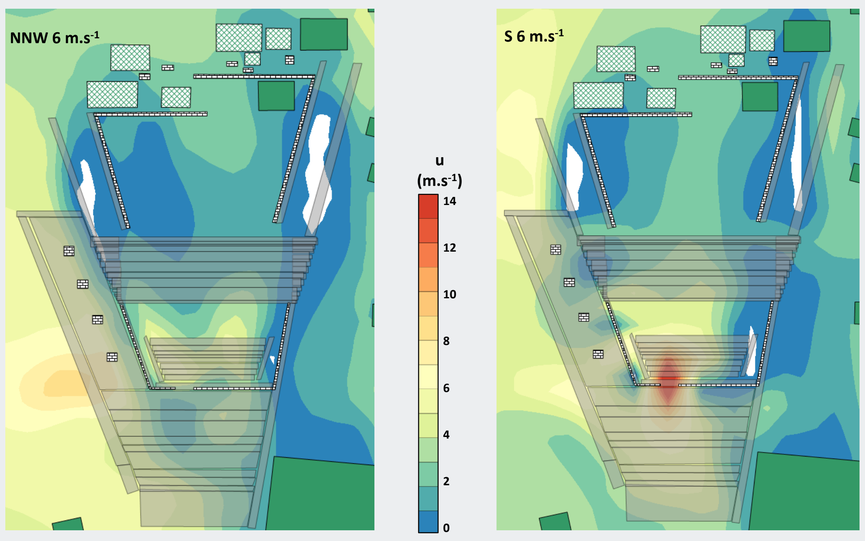
In front of the auditorium, the turbulent flow is channelled with an increase of wind speed, due to its configuration. The highest wind speeds are mainly simulated in the audience area.

Flow dynamics visualization for an inflow wind from NNW



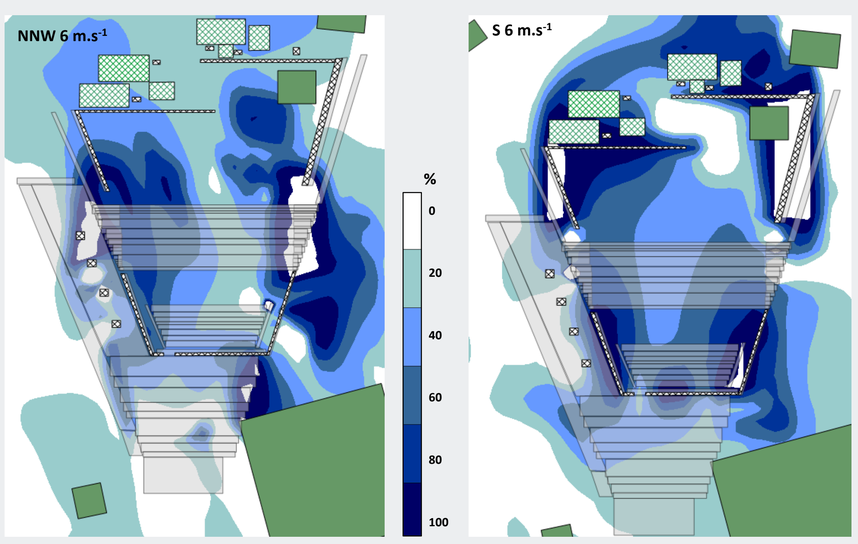
Turbulent vortices within the audience area, for the **reference scenario (above)**, and the **mitigation scenario (below).** In the latter, the vortices are driven over the portico due to the presence of the front panels.

Horizontal isocontour of the wind speed at pedestrian height – mitigation scenario



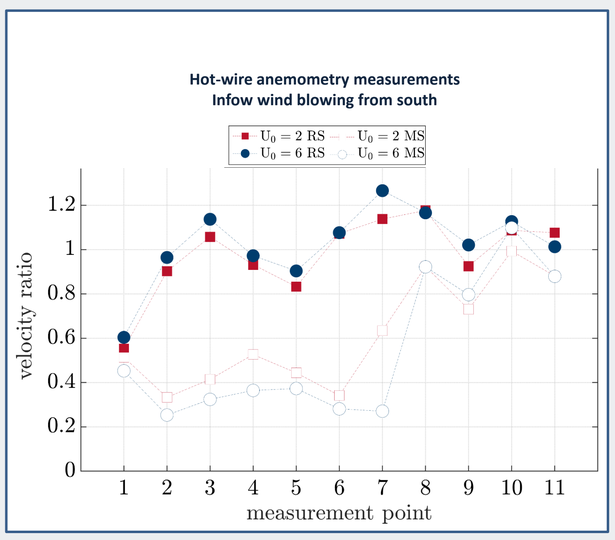
The results show a reduction of wind speed between 4 and 6 m.s^{-1} within the auditorium, with the mitigation measures. There is also an attenuation in recirculation near the wall, upstream from the auditorium, leading to an effective reduction of the wind speed.

Differences of wind speed between the mitigation and the reference scenarios



The effectiveness of the mitigation measures vary between 20% and 80% across the auditorium. At the audience area, the reduction is more pronounced, between 60% and 80%. It is noteworthy that less relevant reductions have been achieved at the south entrance, i.e. less than 20%.

Wind speed measurements for the reference and mitigation scenarios



The measurement points from 8 to 11 register a low wind speed reduction, denoting a lower effectiveness of the presence of back panels.

Conclusions

- The current configuration of the **José Afonso auditorium is unsuitable for public events** based on the average wind speed from **CFD results** and **wind tunnel measurements**.
- CFD results and wind tunnel measurements show the effective capacity of the proposed **mitigation measures** (80%) to **reduce the wind speed within the auditorium**.
- The wind tunnel measurements show **significant reductions** of the wind speed induced by the **mitigation measures**, with reductions up to 71% (NNW) and 80% (S).
- In urban areas, **wind turbulent flow dynamics** are a key criteria for **microclimate**. Therefore, for future work, this results will be used to assess **wind comfort criteria**.

Acknowledgments

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