The Need for Post-Construction Microclimate Monitoring

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1 ABSTRACT

This paper presents the findings of wind monitoring conducted for a proposed high-rise development with the aim to compare the pedestrian wind comfort conditions measured at the site with the wind conditions predicted in the wind tunnel assessment.

The comparison reveals consistent pedestrian wind comfort results between the site monitoring and the wind tunnel assessment. This indicate site monitoring post-construction confirm the building is performing as they were predicted to during the design stage. Site monitoring is useful to confirm that wind mitigation measures are providing the important benefits that they were designed to, to reassure the designers, planning authorities and the future residents of the new development. Furthermore, site monitoring post-construction would allow the wind consultant to assess the viability of any wind mitigation measures designed at the design stage and where necessary replace and evaluate the effectiveness of any alternative measures that are feasible.

2 INTRODUCTION

In recent years, the importance of assessing the wind microclimate around buildings (especially around proposed new high-rise schemes) has gained significant attention. Undertaking a wind microclimate assessment demonstrates the impacts that the proposed massing of the building would have on the users of the spaces at and around the building, for the purpose of ensuring a safe and comfortable wind environment. Awareness of wind microclimate when designing a usable urban space have increased over the years, as local boroughs now require a new proposed scheme to undertake a detailed microclimate assessment (either via the Wind Tunnel or Computational Fluid Dynamics (CFD) method). Another indication of the growth in awareness and importance of microclimate is the adoption of Wind Microclimate guidelines in Leeds (1) and City of London (2).

Wind Microclimate assessments are conducted during the design stage and post planning and primarily use Wind Tunnel and CFD assessment to predict and evaluate the wind microclimate in urban environments and often both methods are used in complementary ways to ensure accurate and comprehensive wind assessments. And where necessary, the effectiveness of any required wind mitigation measures can be assessed and confirmed during the assessment process.

Though the wind conditions expected around a development can be predicted accurately and mitigate areas where building-induced wind issues would cause discomfort using the two methodologies described above, validation of the predicted wind microclimate post-construction tends to occur very rarely (based on the experience of the authors).

Often developments complete construction several years following the wind microclimate assessment. As such, post-construction on-site monitoring of the wind microclimate is important to validate wind tunnel/CFD predictions in real-world conditions. It can identify any unexpected wind patterns as changes could occur during the years of construction to the assumed surrounding context at the time of design and if any discrepancies are found then necessary modifications can be made to the built environment and can confirm (or disprove) the effectiveness of any wind mitigation measures implemented based on predicted wind conditions at the design stage.

To this end, this paper investigates the methods which can be implemented for on-site monitoring and the usefulness of post-construction on-site monitoring, using a real case study undertaken by RWDI in which monitoring data has been compared against wind tunnel measurements for the same development.

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3 SITE MONITORING PROCESS

RWDI was initially appointed by the developer to conduct a wind microclimate assessment of the Development at the design stage, using wind tunnel-based methodology and where conditions windier than suitable for the intended uses were identified, wind mitigation measures which would be expected to provide beneficial shelter were recommended.

When the construction of the Development was close to completion and following feedback from the design team on windy conditions experienced within the Development, RWDI performed a wind monitoring study for the new Development.

Prior to the site visit, the measurement locations were determined based on the information received form the design team, current usages within the Development and the wind conditions predicted from the wind tunnel analysis during the design stage.

RWDI visited the Development site, during a period that was determined based on the wind conditions ideal for wind speed measurements, based on the meteorological data forecasted by the nearest meteorological station.

During the site visit period, wind speeds were acquired at various locations across the site. This included the predetermined locations based on the wind tunnel assessment as well as locations chosen from the real observations during the site visit.

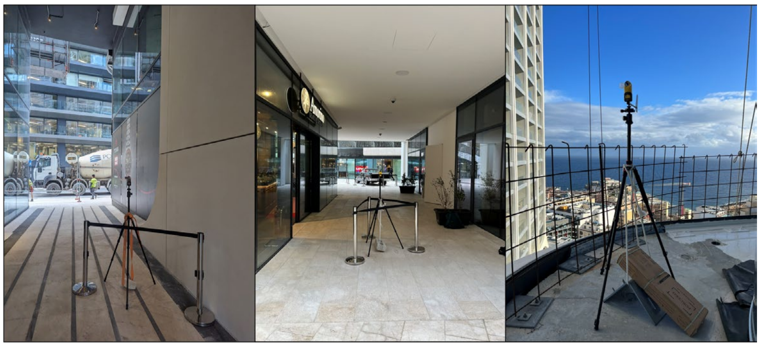

Figure 1, example of monitoring equipment setup on site

In order to acquire accurate data, the anemometers were secured to the ground to avoid accidental impacts due to harsh weather conditions and vandalism and regular checks were conducted to ensure measuring equipment were functioning as intended.

4 ON-SITE MONITORING DATA VALIDATION

During the site visit, it was noted that the surrounding existing buildings and the design of the Development itself had changed since they were initially tested in the wind tunnel. The differences were deemed significant to alter the winds approaching the site and the local building induced wind interactions. As such, an updated wind tunnel assessment for the current design of the Development and the updated surrounding context was completed to validate the on-site measurements.

On-site measurements were taken at a café space at ground level (Location 1), passageways within the buildings (Locations 2 and 3), 1st floor terrace (Location 4) and on upper-level balcony location (Location 5), as shown in Figure 2.

Wind speeds measured on-site were categorised in accordance with the RWDI Criteria (3-8) wind threshold, as indicated in Figure 3. As per the RWDI Criteria, an area is deemed to have acceptable wind conditions for the intended use when suitable wind conditions persist for at least 80% of the time. For example, the terrace amenity (Location 4) measured wind conditions suitable for sitting use for 86% of the time during the measured period, which is consistent with the wind conditions predicted in the wind tunnel model (Figure 4). As per RWDI Criteria this terrace is expected to have conditions suitable for its intended amenity use.

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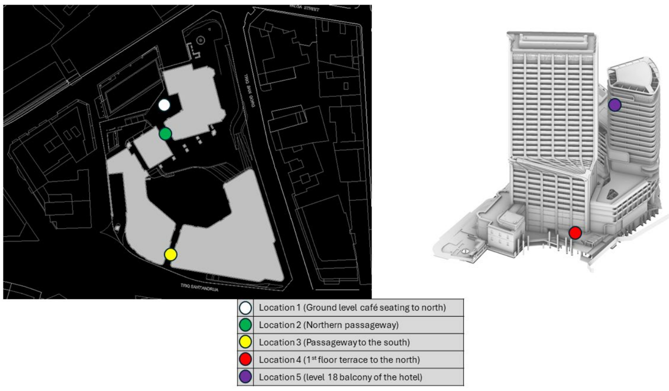

Figure 2, wind monitoring locations

During the measuring period, Location 1 measured wind conditions suitable for sitting use for 62% of the time. The wind tunnel assessment predicted that this area would be expected to have wind conditions suitable for sitting use for at least 80% of the time. Even though, the site monitoring indicated the majority of the time during the measured period this space would have suitable sitting use conditions, this indicated a potential limitation of the precision of short-term monitoring. As such, conducting the monitoring exercise over a longer period is expected to be beneficial to acquire more accurate wind speed measurements.

Comfort Category	Location 1	Location 2	Location 3	Location 4	Location 5
F of Sitting	62%	0.46%	80.4%	86.1%	0.3%
F of Standing	24%	0.13%	14.2%	10.5%	0.2%
F of Strolling	9%	0.13%	4.5%	2.3%	0.4%
F of Walking	3%	0.46%	0.7%	0.9%	1.8%
F of Uncomfortable	1%	98.8%	0.1%	0.1%	97.4%

Figure 3, wind speeds measured at the site (categorised as per the RWDI Criteria)

During the site monitoring visit, it was noted how the existing wind mitigation measures (specifically, the trees around the site) would perform in windy conditions. It was noted that young plants would not thrive in a windy environment. These observations have been taken into consideration when designing the necessary measures to increase the shelter to isolated areas with building-induced high winds.

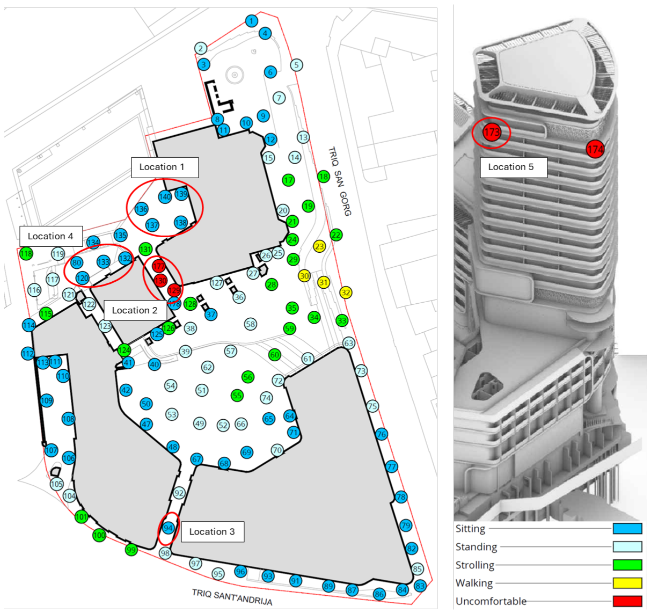

Figure 4, predicted wind conditions from the wind tunnel assessment

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5 CONCLUSION

This study investigated the methods and importance of on-site monitoring post construction. The site monitoring visit following the feedback from the design team was effective to identify local building-induced wind patterns around the Development and to note any changes to the surrounding context compared to the wind tunnel model assessed during the design stage. The visit was useful to identify how the existing wind mitigation measures (trees around the site) would perform in windy conditions. These observations were helpful when designing the necessary measures to increase the shelter to isolated areas with building-induced high winds. Furthermore, it should be noted that conducting a long-term monitoring assessment would be beneficial to acquire more accurate data.

The results of this monitoring assessment show a good correlation between the wind speeds measured during the site visit with the wind conditions predicted during the wind tunnel assessment. As such, it can be concluded that the wind conditions predicted during the wind tunnel/CFD assessment during the design stage can be validated through on-site monitoring post-construction.

REFERENCES

[1] Leeds City Council (July 2021). Draft Wind & Micro-climate Toolkit for Leeds.
[2] City Of London (August 2019). Wind Microclimate Guidelines For Development In The City Of London.
[3] ASCE Task Committee on Outdoor Human Comfort (2004). Outdoor Human Comfort and Its Assessment, 68 pages, American Society of Civil Engineers, Reston, Virginia, USA.
[4] Williams, C.J., Hunter, M.A. and Waechter, W.F. (1990). "Criteria for Assessing the Pedestrian Wind Environment," Journal of Wind Engineering and Industrial Aerodynamics, Vol. 36, pp. 811-815.
[5] Williams, C.J., Soligo M.J. and Cote, J. (1992). "A Discussion of the Components for a Comprehensive Pedestrian Level Comfort Criteria," Journal of Wind Engineering and Industrial Aerodynamics, Vol. 41-44, pp. 2389-2390.
[6] Soligo, M.J., Irwin, P.A., and Williams, C.J. (1993). "Pedestrian Comfort Including Wind and Thermal Effects," Third Asia-Pacific Symposium on Wind Engineering, Hong Kong.
[7] Soligo, M.J., Irwin, P.A., Williams, C.J. and Schuyler, G.D. (1998). "A Comprehensive Assessment of Pedestrian Comfort Including Thermal Effects," Journal of Wind Engineering and Industrial Aerodynamics, Vol.77&78, pp.753-766.
[8] Williams, C.J., Wu, H., Waechter, W.F. and Baker, H.A. (1999). "Experiences with Remedial Solutions to Control Pedestrian Wind Problems," Tenth International Conference on Wind Engineering, Copenhagen, Denmark.

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