August 27-31, 2023
FLORENCE - ITALY
ICWE 16
16th International Conference on Wind Engineering

Comparative study of surface wind speeds and gusts from field measurements of a low-rise building and terrain adjusted synoptic wind observations

R Mac Réamonn [1], A Opsomer [2], R Ramponi [3]

[1]*Arup, Dublin, Ireland, reamonn.macreamoinn@arup.com*
[2]*Arup, Dublin, Ireland, aviva.opsomer@arup.com*
[3]*Arup, Dublin, Ireland, rubina.ramponi@arup.com*

SUMMARY:
This study compares the surface wind measurements of two separate sites with wind observations of the nearest synoptic observation stations. The field measurements were measured using a four-blade helicoid propeller mounted above a low-rise building, while wind direction was determined by a vane attached to a precision potentiometer inside an internal housing. Continuous wind measurements with a temporal resolution of 0.5Hz are analysed to determine peak gust and mean hourly wind speed. The study examines the relationship of the peak gust and the 10-min mean wind speed for the two field measurement sites. The measured peak gusts and mean hourly wind speeds are compared with the same wind statistics of the nearest synoptic observation station transformed to the site to account for terrain roughness in accordance with ESDU 01008. The study examines the variation in the speed and direction of measured and calculated peak gusts and the implication this has on the structural and façade design of low-rise buildings.

Keywords: surface wind, field measurement, wind loading

1. INTRODUCTION

Buildings and their facades are designed to resist wind pressures. The wind pressure (i.e. peak velocity pressure) in the Eurocode is determined from the mean wind speeds and their fluctuations.

The determination of the mean wind speed considers different parameters including the reference height above ground, upstream exposure, and topographic effects. The mean wind speed is calculated from a fundamental value of the basic wind velocity, which is a 10-min mean wind speed with a 0.02 probability for annual exceedance. These extreme value estimates are based on historic wind observations for a given country. It is expected that the estimates are more reliable closer to the wind observation sites than more distant sites.

The contribution of wind fluctuations on wind pressure (i.e. peak velocity pressure) is determined from a formulation of the expected turbulence intensity rather than any measured gusts. It may be a sensible approach given it is typical that observation stations are situated in open country terrain with lower levels of turbulence suburban and urban areas. However, the

formulation may not reflect the turbulence buildings encounter in reality.

This study seeks to understand the deviation in the mean wind speeds and gusts measured on-site with the mean wind speeds and estimated gusts determined in accordance with the Eurocode for the structural design. It examines the implication these deviations have on the wind loadings adopted in structural and façade design of low-rise buildings.

2. METHODOLOGY

The methodology adopted for this study is outlined below:

1. Collect surface wind measurements for the two sites considered in this study.

2. Identify the nearest synoptic observation stations to the two field measurement sites and collate the historic wind observation data for the field measurement period.

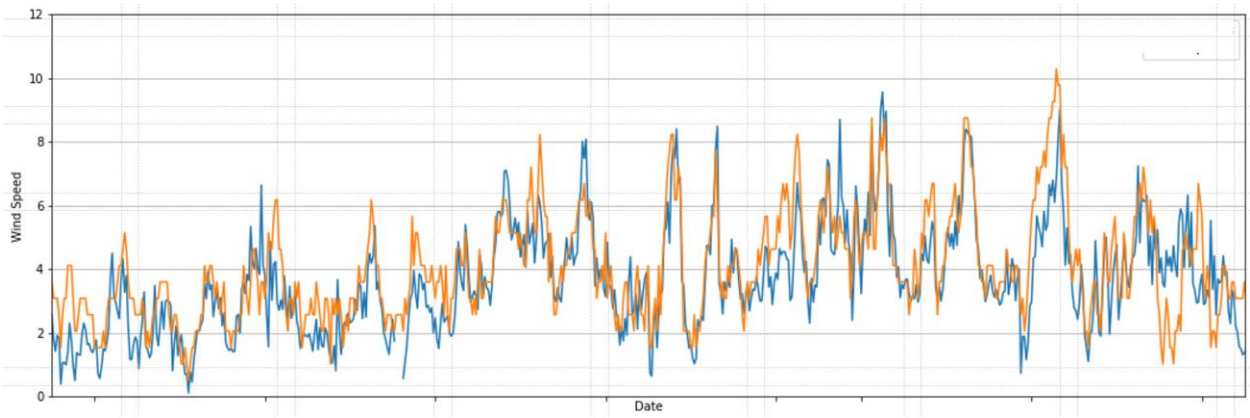

Figure 1. Time-series hourly comparison of 10-min mean wind speed at observation station (orange) with field measurement (blue)

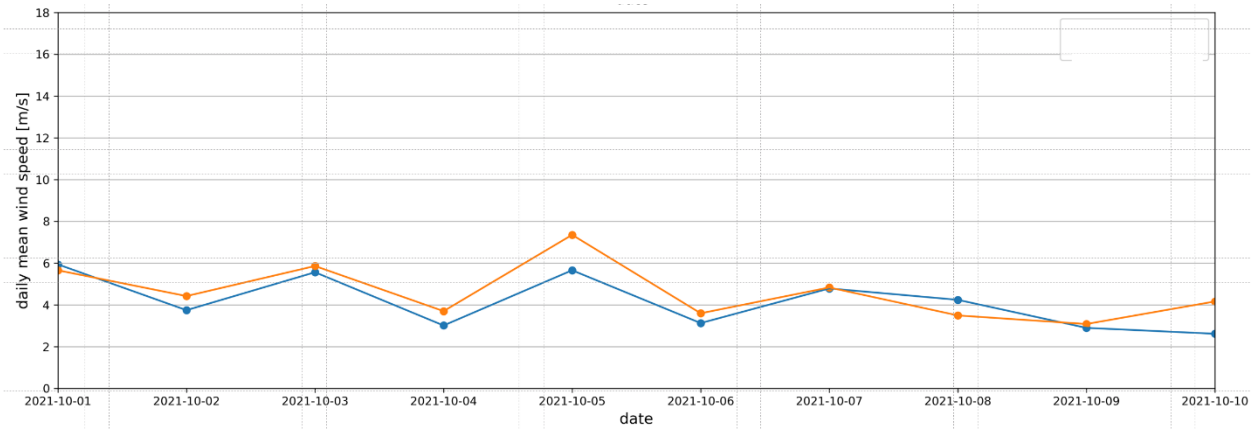

Figure 2. Time-series daily comparison of daily mean wind speed at observation station (orange) with field measurement (blue)

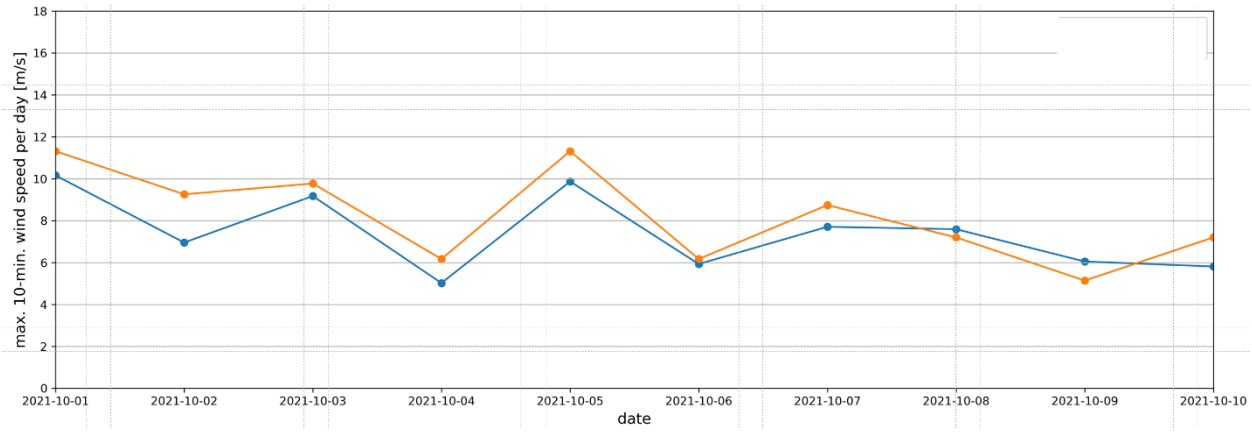

Figure 3. Time-series daily comparison of highest daily 10-min mean wind speed at observation station (orange) with field measurement (blue)

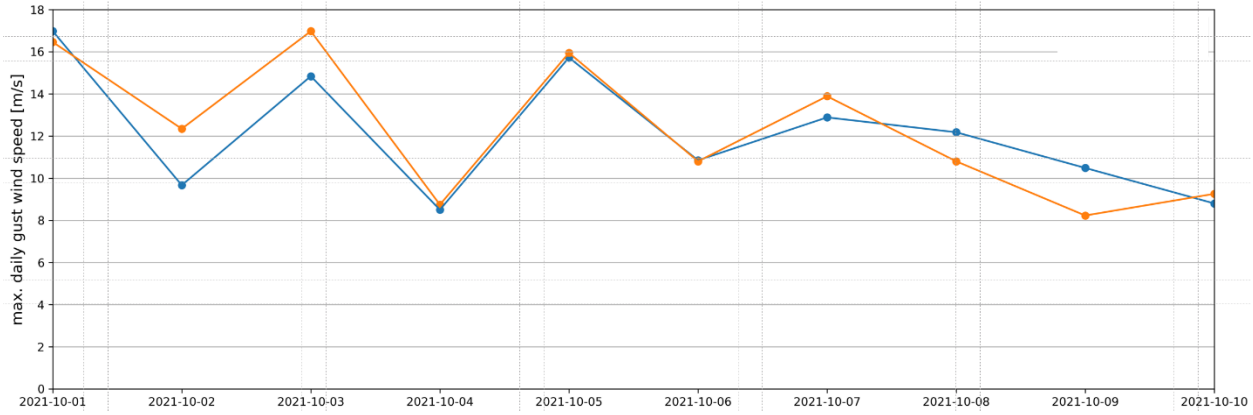

Figure 4. Time-series daily comparison of highest daily gust speed at observation station (orange) with field measurement (blue)

3. Characterise the upwind exposure of the nearest observation stations and the field measurement sites and transform the station data to the measurement site to account for terrain roughness using ESDU 01008.

4. Compare the wind statistics (i.e. daily mean, 10-min mean, peak gust) of the field measurement sites with transformed synoptic observation station data.

5. Examine the relationship between peak gust and the 10-min mean wind speed for the two field measurement sites and identify a representative peak gust ratio for both sites.

6. Calculate the dynamic wind pressure for the filed measurement sites.

7. Calculate the peak velocity pressure in accordance with Eurocode for both field measurement sites.

8. Compare the dynamic wind pressure with the peak velocity pressures for the same measurement sites.

3. CONCLUSIONS

The study examines the variation in the speed and direction of measured and calculated peak gusts and the implication this has on the structural and façade design of low-rise buildings.