16th Australasian Wind Engineering Society Workshop
Brisbane, Australia
18-19 July, 2013

The Selection and Application of Pedestrian Wind Criteria

H.W. Fricke

JDH Consulting
Mentone, Victoria 3194, Australia

Abstract

Some ambiguities in the selection and application of appropriate pedestrian wind criteria are discussed and suggestions made.

Introduction

When conducting pedestrian wind effects assessments there is significant ambiguity and variability in a number of aspects regarding the selection and application of pedestrian wind effects criteria.

The choice of pedestrian wind criteria, and the way in which they are applied to areas surrounding a new development, can have a significant effect on the outcome of an assessment.

For this reason a possible approach is suggested for the application of pedestrian wind criteria, particularly for developments in dense urban areas.

Criteria Selection and Application

There are two important aspects to consider in the choice of criteria against which to assess wind conditions for pedestrians. The first and most obvious is the selection of the criteria set, eg. Alan G Davenport Wind Tunnel Group (2007), Lawson (2001), Melbourne (1978). Most of the discussions of pedestrian wind criteria are centred around the relative merits of various sets of criteria.

The second aspect is the application of the various levels of comfort or safety within the chosen criteria set to the various regions within the study area. Even the study area is relatively undefined. Should it include adjacent private property? How far should the study area extend?

Both the appropriate selection and application of criteria may seem a trivial exercise. However, the approach to both these varies widely in the wind engineering community and this results in widely varying assessment outcomes.

Criteria selection

The selection of appropriate criteria is rendered complex by the results of a number of studies demonstrating no universal agreement amongst the various criteria.

There are a number of studies which have demonstrated less than acceptable agreement amongst the various published criteria across a broad range of flow scenarios. Ratcliff and Peterka (1990), Koss (2006), Sparks and Elzebda (1983) all found significant disagreement amongst various published criteria. Only Melbourne (1978) indicated good agreement amongst five well known criteria, however, this comparison was based on the assumption of 15% turbulence intensity. Noting that the turbulence intensity at pedestrian height in the very open terrain category 1 (as defined in AS/NZS 1170.2) is 17%, significantly higher values would be expected in an urban environment close to a building

In many cases the discrepancy between criteria based on mean wind speeds and gusts is most marked. To overcome this, several consultants make use of a Gust Equivalent Mean approach which aims to use mean wind speeds when the mean is relatively high compared to gusts (low turbulence intensity) and uses the gusts when turbulence is high. The normal gust factor used is 1.85, i.e. when peak gusts are greater than 1.85 times the mean, the gust value is divided by 1.85 and compared to a mean criterion. If the peak gusts are less than 1.85 times greater than the mean, the mean is compared to mean criteria such as that of the Alan G Davenport Wind Tunnel Group (2007).

One disadvantage of this approach is still does not achieve broad agreement with various gust criteria. The following flow scenario may illustrate:

Take a hypothetical flow with the following parameters:

$$\hat{V} = \overline{V} + \overline{V}.g.I_z$$

where
$\overline{V}_{1\ year}$= 15 ms^{-1}
I_z = 0.28 or 28%
g = 3.0 (3 second gust duration)
then
$\hat{V}_{1\ year}$= 27.6ms^{-1}
and
$V_{GEM} = \hat{V}_{1\ year}/1.85$
V_{GEM} = 14.9ms^{-1}

Both the mean and gust equivalent mean in this hypothetical flow scenario meet some of the various mean criteria for safety for the general public such as Alan G Davenport Wind Tunnel Group (2007) and Lawson (2001). However, this hypothetical flow scenario is 20% higher than the Melbourne (1978) safety criterion of 23 m/s, in terms of gust wind speed and 44% higher in terms of peak wind force felt by pedestrians.

Whilst some minor discrepancies amongst the various criteria is understandable, it is suggested that a discrepancy of 40% in peak wind forces on pedestrians is unacceptable for the definition of a criterion for safety. It certainly would not be acceptable for the safety of structures.

Criteria application

Very little guidance for the consultant is available on the suitable application of criteria. In most cases, whether to apply a safety criterion or one of the various comfort criteria is left to the discretion of the wind consultant. There is very little preventing a consultant applying a safety criterion to a pool deck area and assessing it accordingly, even though this might result in disastrously uncomfortable conditions and an unacceptable facility.

Similarly, the lack of guidance on the appropriate application of criteria results in situations such as studies only assessing public areas adjacent to proposed developments and adjacent private property being ignored. Assessments that do not consider adjacent private property, even if these properties are likely to be adversely affected, may pass planning approval quite easily simply because town planners from the majority of planning authorities are quite unfamiliar with wind assessments.

In many cases consultants make well-considered choices based on the research available and their own, in some cases very significant, experience. However, in a competitive market without clear guidelines for minimum levels of acceptability, it is often difficult for a wind consultant to influence the design of developments. It is not hard to see why. In many cases it is difficult to convince a design team to consider redesigning their works with no clear regulatory basis. The design team and investors may ask, quite rightly, on what basis the modifications are required? In this situation, since there are no absolute criteria to meet, the wind consultant may be forced to back down. Perhaps sensing this as a likely scenario, in some cases it seems consultants tend to make sure the development achieves a "pass", so that an awkward situation is avoided.

In some cases, poor application of criteria may be simply due to lack of a clear process. In the author's experience it is worthwhile producing a schematic of the areas included in the study indicating the criteria applied to each such as shown in the following series of Figures.

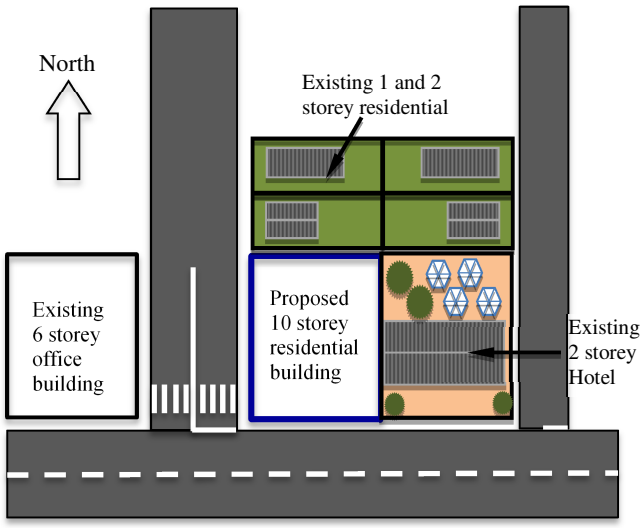

Figure 1. A ground level plan of a hypothetical proposed development and adjacent existing developments.

Figure 1 shows a schematic of a hypothetical pedestrian wind effects assessment scenario. A 10 storey development (shown in blue outline) is proposed for an urban street corner. To the west and south are public footpaths and roads. To the north are low rise residential properties and to the east is a low rise commercial building, in this case a hotel with an outdoor recreation area (eg. a beer-garden). Opposite the proposed development to the west across a fairly narrow street is a medium-rise building.

Given such a scenario it is fairly common to see the application of the chosen criteria described in pedestrian wind effects assessments as follows: "…*public access-ways adjacent to the proposed development should meet the criterion for safety*…" or words to that effect.

Schematically this can be represented as shown in Figure 2. As can be seen in Figure 2, although the proposed development is immediately adjacent to other properties, the wording of the criteria application is such that the criteria are only applied to adjacent public areas, which, in this case, are footpaths. It is common to see adjacent private property not receive a mention. In these cases, a suitable criteria is not applied to these areas, nor are they instrumented or reported on.

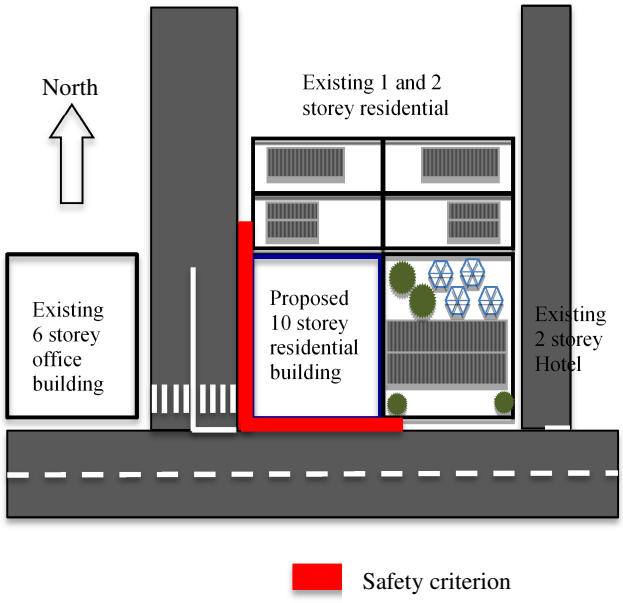

Figure 2. A ground level plan of a hypothetical proposed development indicating a possible application of criteria, i.e. safety criteria for adjacent public access-ways.

The following figure illustrates instrumentation locations to test the criteria as applied in Figure 2. Naturally, only the areas noted for consideration in the assessment are instrumented. However, an unstated result in this case is that the assessment ignores adjacent private property.

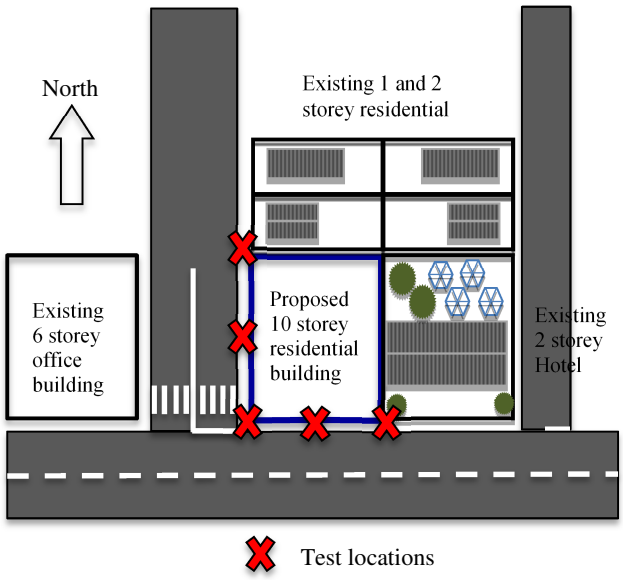

Figure 3. A ground level plan of a hypothetical proposed development indicating locations for test instrumentation matching the criteria application shown in Figure 2, i.e. safety criteria for adjacent public access-ways.

Consideration of adjacent private property

While the assessment of private property raises many questions, ignoring the issue does not seem appropriate.

In the following Figure 4, a more appropriate application of suitable criteria is suggested. Adjacent private properties are considered.

It will not be possible for adjacent private properties in the hypothetical example to be completely unaffected by the new development. However, if they are strongly and adversely affected, this may reasonably be seen as an unfair imposition.

As a first suggestion for these areas, the new development, as a minimum, should not cause exceedences of the criterion for safety. In addition, the overall wind conditions in these areas due to the new development should not be significantly in excess of the existing conditions when integrated for a full range of wind directions.

Essentially, whilst the new development will almost certainly increase wind conditions in some adjacent private properties during some wind directions it may also shelter those properties for other wind directions. If the probability of exceedence of a reasonable comfort criterion in these areas is not greatly changed by the proposed development, it may be fair to consider the wind conditions in these properties acceptable.

This approach clearly requires before-and-after testing of the proposed development in adjacent private properties.

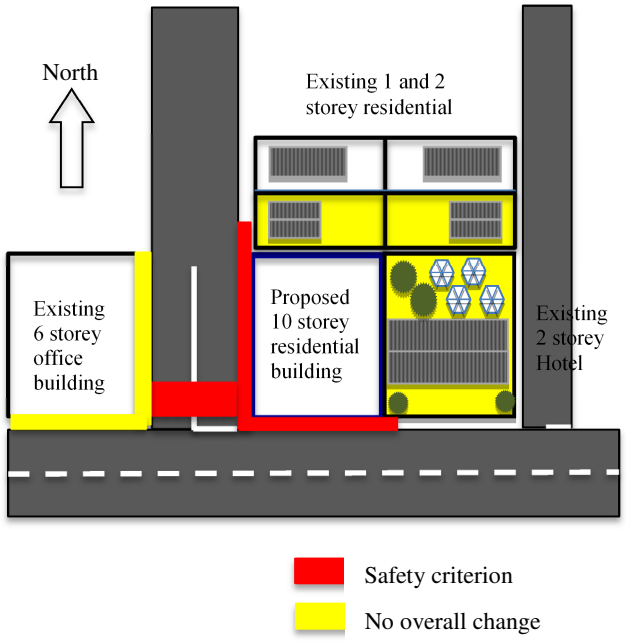

Figure 4. A ground level plan of a hypothetical proposed development indicating a more appropriate application of criteria to include adjacent private properties.

Without such a schematic, it may be relatively easy for a town planner or even a wind consultant to overlook an adjacent business or residence in their study. A report might state that wind conditions on public footpaths adjacent to the proposed development should meet a criterion for public safety. At first glance this might appear reasonable, but in many cases when this is expressed schematically it raises many more questions:

1) How far from the proposed development should we consider?
2) The footpaths in front of adjacent businesses may be assumed on reading the report to be simply public access-ways – a reasonable first assumption. But on depicting it schematically it often raises the question of whether that business uses the footpath area for trade, as many do these days
3) When a consultant assessing a high-rise development overlays a safety criterion on an adjacent low-rise private residence's open space it makes one think – is this fair? Would this be satisfactory if it were my residence? My elderly relative's residence?

Even when areas such as a building main entrance are identified in a report as requiring a certain level of comfort distinct from others it is important to provide a schematic to illustrate this. For example, a wind consultant might say, when outlining the application of the criteria in a report, that the footpaths should meet a comfort criterion suitable for walking comfort, and the main building entrance should meet a criterion suitable for short-term comfort.

How far should this distinct main entrance area extend from the door? One metre? Five metres? Ten metres? A schematic indicating the area considered as adjacent to the main entrance is most helpful in clarifying what is otherwise exceedingly ambiguous in purely written form.

Suitable criteria should be applied to any areas in the near vicinity of the new development that are likely to be affected by the development. Having applied criteria to such areas it is necessary to instrument and test them accordingly. This may include areas adjacent to neighbouring larger buildings which could experience significant aerodynamic interaction with the new development.

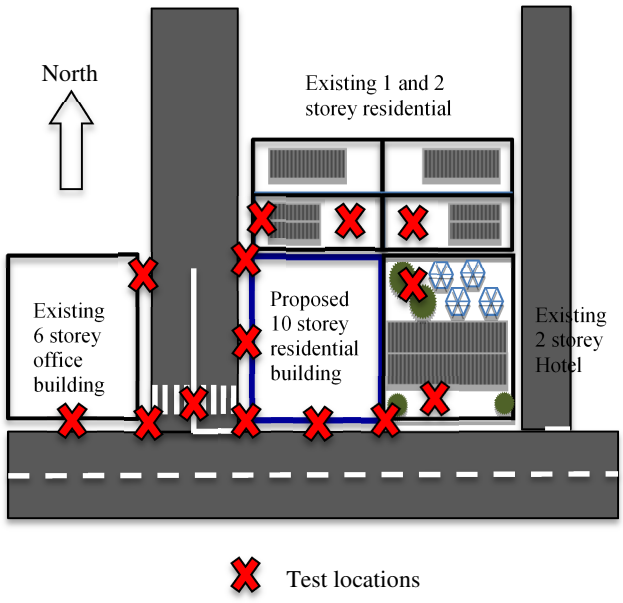

Figure 5. A ground level plan of a hypothetical proposed development indicating locations for test instrumentation matching the criteria application shown in Figure 4, i.e. safety criteria for adjacent public access-ways and no overall change to adjacent private property.

Conclusions

There are a variety of published pedestrian wind effects criteria the consulting wind engineer may choose from, and agreement amongst them is not always as good as may be hoped.

Even if a set of criteria has been selected, there is very little guidance regarding the appropriate application of criteria to a given pedestrian area. Yet the criteria selected and the way in which they are applied can have a very significant effect on the outcome of an assessment. Of particular difficulty is the application of appropriate assessment criteria to private property adjacent to new developments. It is not clear whether only a moderate increase in wind conditions in such areas is tolerable, or whether these areas should be treated in a similar manner to a public space and simply have a criteria applied irrespective of the wind conditions that existed previously.

The selection and application of pedestrian wind criteria is, therefore, rather open ended. As a result, the outcomes of pedestrian wind effects assessments are equally open-ended and the author has observed, at first hand, a wide variation in the advice being provided to property developers and town planners as a result.

The development of guidelines on the selection and application of pedestrian wind criteria are recommended.

References

Alan G. Davenport Wind Engineering Group (2007) Wind Tunnel Testing: A General Outline, The University of Western Ontario, Faculty of Engineering Science

ESDU International (2002) Strong winds in the atmospheric boundary layer. Part 2: discrete gust speeds. ESDU Data Item 83045, issued November 1983, revised March 2002.

Koss H (2006) On differences and similarities of applied wind comfort criteria, Journal of Industrial Aerodynamics, Vol. 94 pp 781-797

Lawson (2001) Building Aerodynamics, Imperial College Press

Melbourne W (1978) Criteria for Environmental Wind Conditions, Journal of Industrial Aerodynamics, Vol. 3 pp 241-249

Ratcliff M, Peterka J (1990) Comparison of Pedestrian Wind Acceptability Criteria, Journal of Industrial Aerodynamics, Vol. 36 pp 791-800

Sparks P, Elzebda J (1983) A comparison of pedestrian comfort criteria applied to a city center, Journal of Industrial Aerodynamics, Vol. 15 pp 123-132

Standards Australia (2011) Structural Design Actions, Part 2: Wind Actions, Standards Australia