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Assessment of Pedestrian Comfort Criteria using two different approaches for Melbourne, Australia

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SUMMARY
A comparison between the assessment of wind conditions for pedestrian comfort using the current Melbourne Planning Scheme criteria based on gust equivalent mean wind speeds for all wind directions combined (probabilities summed) and the previous Melbourne Planning Scheme criteria based on gust wind speeds for each wind direction has been presented for two case studies. It has been shown that the current wind criteria in Melbourne are generally less stringent which could result in many pedestrian areas to be unsuitable for the intended use, especially for the frequent north sector winds. Further analysis of wind conditions for other case studies will be presented.

Keywords: Melbourne wind criteria, GEM approach, Gust wind speed

1. INTRODUCTION

The wind speeds in the streetscapes surrounding proposed developments are influenced by many factors such as local wind climate, building design, surrounding buildings and approach terrain. To maintain the safety and comfort of people or occupants for the intended activity (e.g., transit areas, outdoor seating, etc), planning authorities need to ensure the wind conditions in the streetscapes surrounding a proposed development are assessed against a set of suitable criteria.

In Melbourne, Australia, Clause 58.04-4 in the current Melbourne Planning Scheme provides a Safety criterion based on gust wind speed for each wind direction sector and Comfort criteria based on gust equivalent mean (GEM) wind speed for all wind directions combined for the assessment of wind conditions around a proposed development of five or more storeys. Previously, the Melbourne Planning Scheme provided Safety and Comfort criteria based on gust wind speeds for each wind direction for the assessment of wind conditions around a proposed development over 40m.

The Safety criterion in both the current and previous Melbourne Planning Scheme is based on gust wind speed for each wind direction sector and is essentially the same in principle, and is not the subject of this paper which presents a comparison of the assessment of wind conditions using the current and previous Melbourne Planning Scheme Comfort criteria.

2. MELBOURNE PLANNING SCHEME WIND CRITERIA

The current comfort criteria wind speeds in the Melbourne Planning Scheme (post Amendment C270) are defined as the hourly mean wind speed for all wind directions combined based on a gust equivalent mean (GEM) speed (3 second gust wind speed divided by 1.85) with a probability of exceedance less than 20% of the time equal to or less than: 3 ms^{-1} for sitting areas; 4 ms^{-1} for standing areas; and 5 ms^{-1} for walking areas. The Melbourne Planning Scheme does not provide a methodology as how to obtain the 'from all wind directions combined'. Therefore, in this paper, the methodology described in Melbourne (1978) has been used to obtain the probability for all wind directions combined.

The previous comfort criteria wind speeds in the Melbourne Planning Scheme (pre Amendment C270) are defined as the peak gust speed during the hourly mean with a probability of exceedance of 0.1% in any 22.5^{o} wind direction sector not exceeding 10 ms^{-1} for stationary long exposure activities (outdoor seating); 13 ms^{-1} for stationary short exposure activities (window shopping, standing); and 16 ms^{-1} for walking in urban and suburban areas. For the purpose of comparison or integrating with local wind data, the local peak gust wind speeds have been expresses as a square ratio at a scaled reference height of 300m (i.e., a height clear of the influence of buildings).

3. CASE STUDIES

Two situations of known wind conditions are presented, one typical of where near dangerous wind conditions (based on previous criteria) and dangerous wind conditions (based on new criteria) have been experienced and one typical of conditions where outside dining/restaurant use is required.

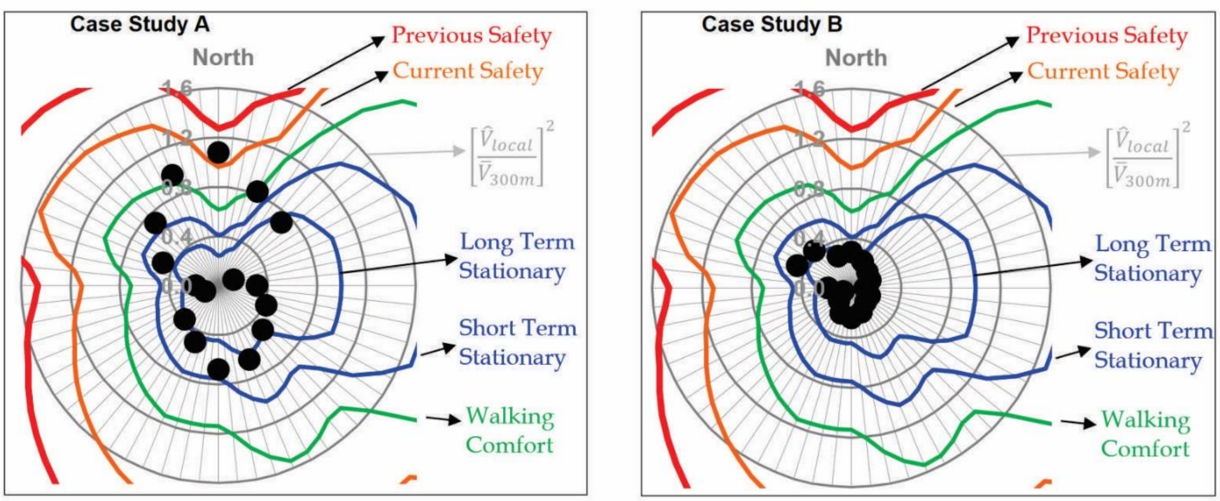
3.1. Case Study A – Corner of 14-storey building in a suburban environment

Melbourne is seeing an increase in mid-rise apartment buildings (> 5 storeys) in suburban areas which predominantly consist of generally low-rise buildings (1 to 3 storeys). These new mid-rise buildings are often designed with retail and restaurants on the ground level tenancies which would increase pedestrian activities around the development. This case study investigates the wind conditions around a 14-storey (~50m high) rectangular planform building with surrounding buildings that are less than 5 storeys. A 1/400 scale model of the development and 2 to 4 storeys surrounding buildings within a 300m radius from the centre of the main building were tested in a model of the natural wind (flow over Terrain Category 3) in the MEL Consultants boundary layer wind tunnel. Peak gust wind speeds measurements using a hot wire anemometer were made near the northeast corner for 16 wind directions at 22.5^{o} intervals. The wind conditions as a function of wind direction based on the gust wind speed (i.e., previous comfort criteria) and for all wind directions combined based on a GEM wind speed (i.e., current comfort criteria) are shown in Figure 1. From the previous criteria polar plot, it can be seen that for the north and north-northwest wind directions, wind conditions are above the walking comfort criterion (and is close to being dangerous) but when assessed using the new criteria with all wind directions combined, the probability of exceedance for the walking comfort is less than 20% and thus passes the walking comfort criterion.

3.2. Case Study B – Laneway between two 30-storey buildings in an urban environment

The number of high-rise apartment and office buildings in Melbourne Central Business District (CBD) has also been steadily increasing over the years and many of these buildings also have ground level restaurant tenancies with outdoor seating. This case study investigates the wind conditions in a laneway between two 30-storeys (~100m high) buildings which could be targeted for outdoor restaurant activities. A 1/400 scale model of the development with surrounding high-rise buildings similar to those in Melbourne CBD within a 300m radius from the centre of the main building were tested in a model of the natural wind (flow over Terrain Category 3) in the MEL Consultants boundary layer wind tunnel. A canopy over the laneway and local 2m high wind break screens were also used as wind amelioration strategies, as would be typical for laneway intended for outdoor restaurant seating in Melbourne CBD. However, the main wind related issue with such scenario is due to pressure driven wind flow, which is difficult to mitigate without effectively sealing all but one entrance to the laneway. Similarly, to the above case study, the development and surrounding buildings were tested in a model of the natural wind (flow over Terrain Category 3) and peak gust wind speeds measurements were made for 16 wind directions at 22.5^{o} intervals. The results are shown in Figure 1. From the previous criteria polar plot, it can be seen that for the west-northwest and northwest wind directions, wind conditions are above the sitting comfort criterion but when assessed using the new criteria with all wind directions combined, the probability of exceedance for the sitting comfort is less than 20% and thus passes the sitting comfort criterion.

Previous Comfort Criteria



Current Comfort Criteria

Case Study	A		
Comfort Criteria	Probability of exceedance <20% of the time		
	≤ 3 m/s (Sitting)	≤ 4 m/s (Standing)	≤ 5 m/s (Walking)
Results	42.4%	29.5%	19.5%

Case Study	B		
Comfort Criteria	Probability of exceedance <20% of the time		
	≤ 3 m/s (Sitting)	≤ 4 m/s (Standing)	≤ 5 m/s (Walking)
Results	19.2%	8.7%	3.4%

Figure 1. Wind conditions results using previous and new comfort criteria for the Case Studies

4. CONCLUSIONS

Wind tunnel measurements of wind conditions for two case studies have been presented. The first case study is a situation where near dangerous (based on previous criteria) and dangerous (based on new criteria) wind conditions have been experienced at the northeast corner of a mid-rise building in a suburban environment (i.e., surrounding buildings being much lower in height). The second case study is a situation where outside seating/restaurant use is required along an outdoor laneway between two tall towers in an urban environment. The results have been presented as a function of wind direction based on gust wind speed (i.e., previous comfort criteria) and for all wind directions combined based on a GEM wind speed (i.e., current comfort criteria).

At the northeast corner of the mid-rise building in the suburban environment (i.e., Case Study A), the directional gust-based approach showed that wind conditions for the frequent north and north-northwest wind directions were above the walking comfort criterion (and are close to being dangerous for the north wind direction) but passed the walking comfort criterion when analysed with the combined wind directions GEM wind speed approach.

Similarly, along the laneway between the two high-rise buildings in the urban environment (i.e., Case Study B), the directional gust-based approach showed that wind conditions were above the sitting comfort criterion for the west-northwest and northwest wind directions but passed the sitting comfort criterion when analysed with the combined wind directions GEM wind speed approach.

This would suggest that the current Melbourne Planning Scheme comfort wind criteria based on gust equivalent mean (GEM) wind speed for all wind directions combined is less stringent and may result in wind conditions at many locations in Melbourne to be unsuitable for the intended activity. Wind conditions for other case studies are currently being analysed and will be presented.

REFERENCES

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