

Attachment A14

Wind Assessment

DRAFT REPORT



Qualitative Wind Assessment for:

232-240 ELIZABETH STREET

Surry Hills

CPP PROJECT: 17378

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PREPARED FOR:

Stasia Holdings Pty. Limited

C/ - Candalepas Associates

Sydney, NSW

Australia

PREPARED BY:

Siryana Rai, Junior Engineer

Thomas Evans, Senior Engineer

CPP Pty Ltd
Unit 2, 500 Princes Highway
St Peters, NSW 2044
info-syd@cppwind.com
www.cppwind.com

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Stasia Holdings Pty. Limited to provide a qualitative assessment of the impact of the proposed 232-240 Elizabeth Street development on the wind conditions in the surrounding areas.

The proposed development is located approximately 1.5 km to the south of the Sydney CBD, in a region of low to medium-rise suburban development, Figure 1. The proposed development will comprise of a 10-storey tower, reaching a maximum height of about 35 m above ground level. This report assesses the wind impacts of the massing envelope of the proposed development. While it is in similar size to the surrounding structures, the addition of the proposed development represents a significant change to the current site and may therefore have some impact on the local wind conditions, the extents of which are broadly discussed in this report.

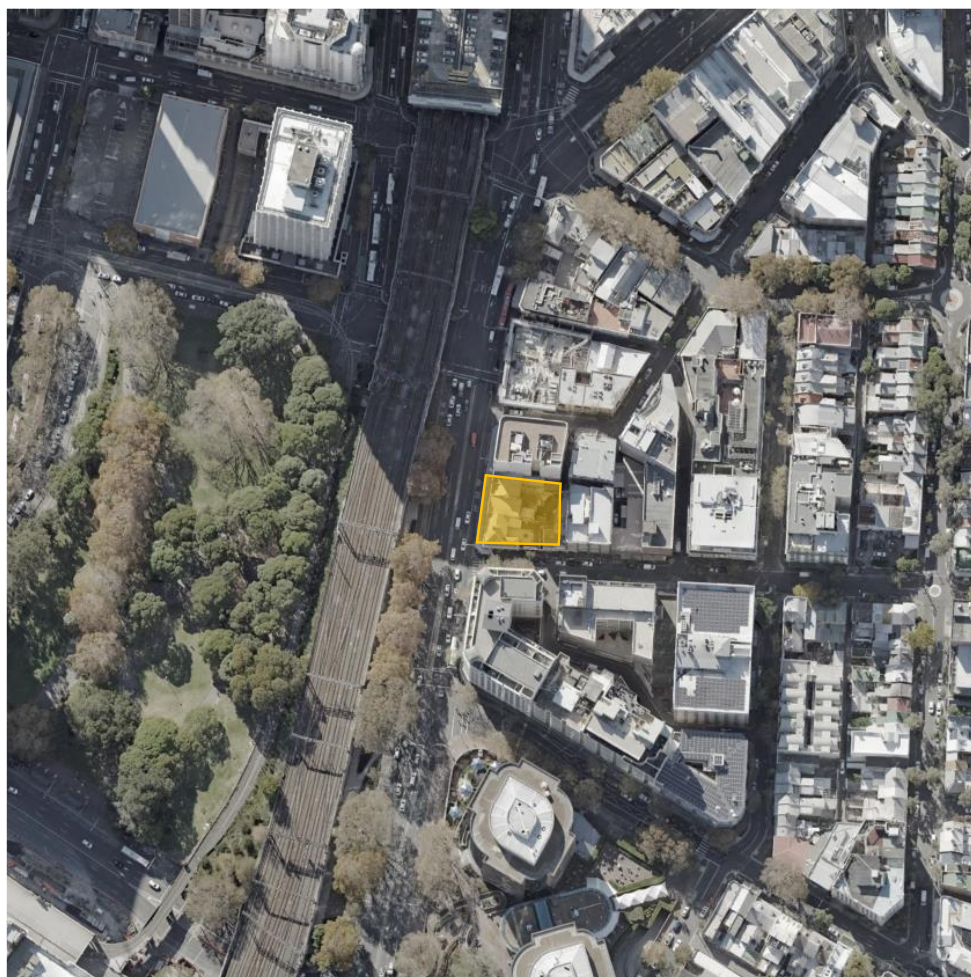


Figure 1: Aerial view of the proposed development site (Google Earth, 2022).

2 SYDNEY WIND CLIMATE

The proposed development lies approximately 6 km to the north-east of the Sydney Airport Bureau of Meteorology anemometer. To enable a qualitative assessment of the wind environment, the wind frequency and direction information measured by the Bureau of Meteorology at a standard height of 10 m at Sydney Airport from 1995 to 2019 have been used in this analysis. The wind rose for Sydney Airport is shown in Figure 2 and is considered to be representative of prevailing winds at the site. Strong prevailing winds are organised into three main groups which centre at about north-east, south, and west. This wind assessment is focused on these prevailing strong wind directions.

Winds from the north-east tend to be summer sea breezes and bring welcome relief on summer days, typically lasting from noon to dusk. These are small-scale temperature driven effects, the larger the temperature differential between land and sea, the stronger the breeze. Winds from the south are associated with large synoptic frontal systems and generally provide the strongest gust during summer. Winds from the west are the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year and can be cold or warm depending on the inland conditions.

Sydney Airport

Corrected to open country terrain
Annual, all hours
1995-2019

Calm 1.0 %

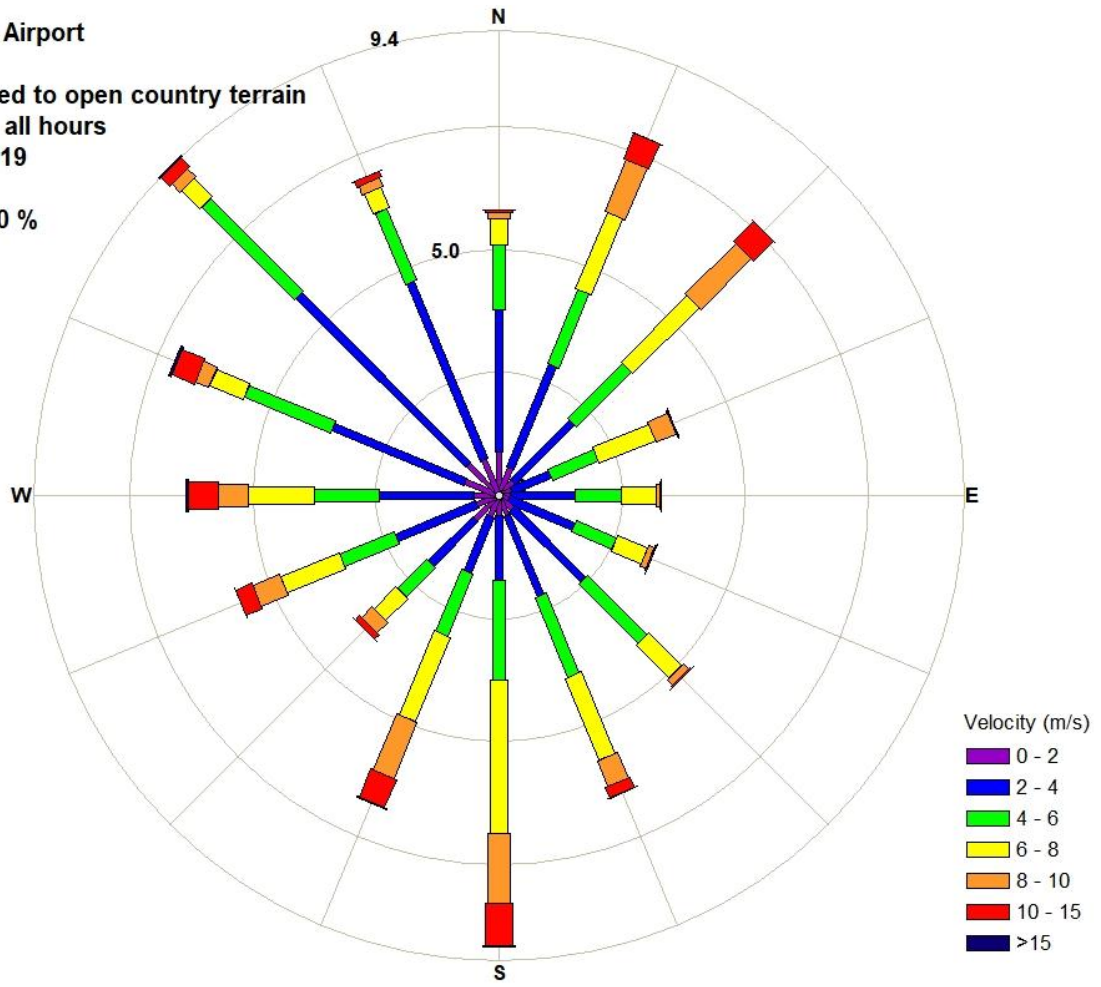


Figure 2: Wind rose for Sydney Airport.

3 ENVIRONMENTAL WIND CRITERIA

A number of researchers have suggested quantitative methods for assessing wind comfort and safety based on wind tunnel data and local climate statistics. These criteria provide a means of evaluating the wind amenity of location based on the frequency of threshold wind speeds, noting that pedestrians will tolerate higher wind speeds for a shorter time period than lower speeds. In addition, the acceptability of the location may be linked to its intended use, such as for a café seating area or pedestrian footpath.

The Sydney City Council DCP (2012) specifies wind effects not to exceed 10 m/s, as the area around the site is classified as an 'active frontage'. From discussions with Council, these wind speed thresholds are once per annum gust wind speeds similar to the 2004 DCP but are meant to be interpreted as a comfort level criterion to promote outdoor café style activities and is not a distress/safety requirement. The once per annum gust criterion is based on the work of Melbourne (1978), and 10 m/s is classified as generally acceptable for pedestrian sitting. This criterion gives the once per annum (0.1% of the time) gust wind speed and uses this as an estimator of the general wind conditions at a site.

The infrequent (0.1%) gust wind event in the Melbourne criteria may not adequately characterise the general wind conditions at the site. To combat this limitation, the wind assessment criteria that will be used in this study will be based upon the criteria of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress/safety. The benefits of these criteria over many in the field are that they use both a mean and gust equivalent mean (GEM) wind speed to assess the suitability of specific locations, the criteria based on the mean wind speeds define when the steady component of the wind causes discomfort, whereas the GEM wind speeds define when the wind gusts cause discomfort. The level and severity of these comfort categories can vary based on individual preference, so calibration to the local wind environment for all wind directions is recommended when evaluating with Lawson ratings. Another benefit of these from a comfort perspective is that the 5% of the time event is appropriate for a precinct to develop a reputation from the general public, the Lawson criteria from the basis of draft amendments to the DCP (City of Sydney, 2016), which require a wind speed of 8 m/s not to be exceeded for more than 5% of the time during daylight hours, aligning with the pedestrian walking category.

Table 1: Summary of Lawson criteria.

Comfort (maximum of mean or gust equivalent mean (GEM [†]) wind speed exceeded 5% of the time)		
< 4 m/s	Pedestrian Sitting (considered to be of long duration)	●
4 - 6 m/s	Pedestrian Standing (or sitting for a short time or exposure)	●
6 - 8 m/s	Pedestrian Walking	●
8 - 10 m/s	Business Walking (objective walking from A to B or for cycling)	●
> 10 m/s	Uncomfortable ¹	●
Distress (maximum of mean or GEM wind speed exceeded 0.022% of the time)		
<15 m/s	not to be exceeded more than two times per year (or one time per season) for general access area	○
<20 m/s	not to be exceeded more than two times per year (or one time per season) where only able-bodied people would be expected; frail or cyclists would not be expected	○

Note: [†] The gust equivalent mean (GEM) is the peak 3 s gust wind speed divided by 1.85.

4 ENVIRONMENTAL WIND ASSESSMENT

The development site is surrounded in most directions by mid-rise buildings, with high-rise buildings further to the north (Sydney CBD) and a region of parkland (Belmore Park) to the west across the railway line. Open approaches over sections of Sydney harbour lie further to the north-east. Topography surrounding the site is relatively flat from a wind perspective for most wind directions and unlikely to significantly affect the wind climate at the site. Existing buildings of a similar scale to the proposed development lie to the immediate north, west, and south of the subject site.

Winds in such densely built surrounds tend to be governed by channelling effects along streets between the combined massing of city blocks, with local effects being dictated by exposed buildings and their relation to prevailing strong wind directions. Several wind flow mechanisms such as downwash and channelling flow are described in Appendix 1, and the effectiveness of some common wind mitigation measures are described in Appendix 2. Previous wind tunnel testing carried out by CPP in the surrounding areas, for the existing configuration, has indicated that most streets in the vicinity would be classified as pedestrian standing to walking under the Lawson comfort criteria depending on their relative exposure to strong prevailing winds and proximity to tall buildings.

The subject site is located on a block bounded by Elizabeth Street to the west, Reservoir Street to the south, and Foster Lane to the north-east, which will form part of a through-site pedestrian link on the eastern boundary. The proposed development consists of a single prismatic tower with a generally rectangular planform. A ground floor plan is shown in Figure 3.



Figure 3: Ground floor of the proposed development.

4.1 Winds from the north-east

Winds from the north quadrant will approach over the mid- to high-rise buildings of Sydney CBD and Surry Hills. The alignment of Elizabeth Street and Wentworth Street with winds from the north quadrant may allow some channelling flow to develop, though the open area of Belmore Park to the west of the site will encourage dispersal of any accelerated flow on this frontage. Some incoming flow would be directed along Foster Street by the surrounding massing, and breezy conditions may develop in the pedestrian corridor at times, though this is considered largely an existing condition rather than an impact of the proposed development.

The proposed development will not receive significant direct wind exposure to wind from the north east direction as it is sheltered by the similarly sized towers at 230 Elizabeth Street (9 storeys tall) and 82-83 Foster Street (8 storeys) directly adjacent to, and to the north of the site. The pedestrian level wind environment is therefore likely to remain similar to the existing. Calmer conditions are likely to be available to pedestrians on the south side of the site during north-easterly winds.

For winds from the north-east quadrant, conditions around the proposed development site are expected to remain similar to the existing wind conditions and pass the safety/distress criterion.

4.2 Winds from the south

Winds from the south quadrant will pass over the low- to mid-rise developments of Waterloo and Redfern as well as the railway corridor leading to Central Station before reaching the site. Some immediate shielding for winds from this direction will be provided by the existing building located at 242-254 Elizabeth Street which is 14 storeys tall and broader compared to the proposed development. However, some channelling flow would be expected from prevailing winds as the southerly winds have a relatively unobstructed approach to the site over the railway and along Elizabeth Street, which runs north-south. Relatively strong conditions would therefore be expected on Elizabeth Street frontages during high wind periods from the south, though the proposed development is not likely to significantly contribute to this mechanism due to its relative scale and position. The street level awning

extending around the south-western corner will also help mitigate any downwash flow generated by the south façade of the building, thereby limiting impact to ground level.

For winds from the south quadrant, wind conditions at most locations around the site are expected to remain similar to the existing wind conditions and pass the safety/distress criterion.

4.3 Winds from the west

Winds from the west quadrant will pass over the low- to mid-rise buildings of Chippendale, Belmore Park, and the railway line before reaching the site. Elizabeth Street, the railway line, and Belmore Park to the west of the development form an open area where approaching westerly winds are relatively unimpeded upon reaching the site. Some degree of downwash flow from the western facade would be expected, however, the ground plane and the main entry to the commercial lobby would be protected by the proposed awning, which will redirect downwashing flow horizontally. Marginally stronger velocities may be expected along the Reservoir Street frontage, as the proposed development massing directs flow into the street corridor, though the awning will again limit impact to ground level. It is recommended this feature be retained. Mostly calm conditions would be anticipated in the eastern pedestrian link during winds from the west.

For winds from the west quadrant, wind conditions around the proposed development site on average are expected to remain mostly similar to the existing wind conditions and pass the safety/distress criterion.

4.4 Summary

For most locations, wind conditions within the proposed development are expected to remain similar to the existing wind conditions. From a pedestrian comfort perspective, the wind environment around the proposed development site is likely to be classified as acceptable for pedestrian standing or walking under Lawson. These pedestrian comfort levels would be suitable for public accessways, and for stationary short-term exposure activities. Localised amelioration measures would be suggested if calmer areas are desired for particular locations, such as café seating. All locations would be expected to satisfy the Lawson safety/distress criterion and the equivalent draft DCP safety criterion. Consistent with most

areas of Sydney, local shielding would likely be necessary to meet the conservative 10 m/s criterion of the 2012 DCP.

4.5 Wind conditions within the development

Some locations within the development may experience higher wind velocities at times, which may necessitate local amelioration depending on how these areas are to be used. Terraces at elevation are often windy areas due to exposure to higher velocities and local acceleration effects. The rooftop terrace on Level 9 and the mezzanine terrace on Level 8 are generally well situated, with shielding provided by adjacent levels on two sides as well as from the existing building at 242-254 Elizabeth Street to the south. The proposed planting zones will offer some beneficial effect, provided they contain dense foliage reaching a height of at least 1500 mm from local grade. A perimeter balustrade to the same minimum level will also assist in improving conditions. If the rooftop terrace spaces are to be activated for café-style seating or similar, then incorporating a horizontal canopy over some of this area would be suggested to further improve wind conditions.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed 232-240 Elizabeth Street project on the local wind environment in and around the development site. The scale of the proposed development and its position in the existing built massing environment are not indicative of any significant impacts to pedestrian wind comfort in the surrounding public domain areas. Overall, conditions in and around the site are expected to remain similar to the existing environment. Wind conditions around the development are expected to be classified as acceptable for pedestrian standing or walking from a Lawson comfort perspective and pass the distress/safety criterion. Local amelioration would likely be necessary for areas intended for long-term stationary or outdoor dining activities, similar measures would be suggested for outdoor terraces.

REFERENCES

City of Sydney, (2012), "Sydney Development Control Plan 2012".

City of Sydney (2016) Central Sydney Planning Strategy 2016-2036

Lawson, T.V. (1990), "The Determination of the Wind Environment of a Building Complex before Construction" Department of Aerospace Engineering, University of Bristol, Report Number TVL 9025.

Melbourne, W.H., 1978, Criteria for Environmental Wind Conditions, Journal of Wind Engineering and Industrial Aerodynamics, Vol.3, No.2-3, pp.241-249.

Penwarden, A.D. (1973), "Acceptable wind speeds in towns", Building Science, Vol.8, pp. 259-267.

Appendix 1: Wind flow mechanisms

When the wind hits a large, isolated building, the wind is accelerated down and around the windward corners, Figure 4; this flow mechanism is called downwash and causes the windiest conditions at ground level on the windward corners and sides of the building. In Figure 4, smoke is being released into the wind flow to allow the wind speed, turbulence, and direction to be visualised. The image on the left shows smoke being released across the windward face, and the image on the right shows smoke being released into the flow at about third height in the centre of the face.

Techniques to mitigate the effects of downwash winds on pedestrians include the provision of horizontal elements, the most effective being a podium to divert the flow away from pavements and building entrances. Awnings along street frontages perform a similar function, and the larger the horizontal element, the more effective it will be in diverting the flow.

Channelling occurs when the wind is accelerated between two buildings or along straight streets with buildings on either side.

Figure 5 shows the wind at mid and upper levels on a building being accelerated substantially around the corners of the building. When balconies are located on these corners, they are likely to be breezy, and will be used less by the owner due to the regularity of stronger winds. Owners quickly become familiar with when and how to use their balconies. If the corner balconies are deep enough, articulated, or have regular partition privacy fins, then local calmer conditions can exist.

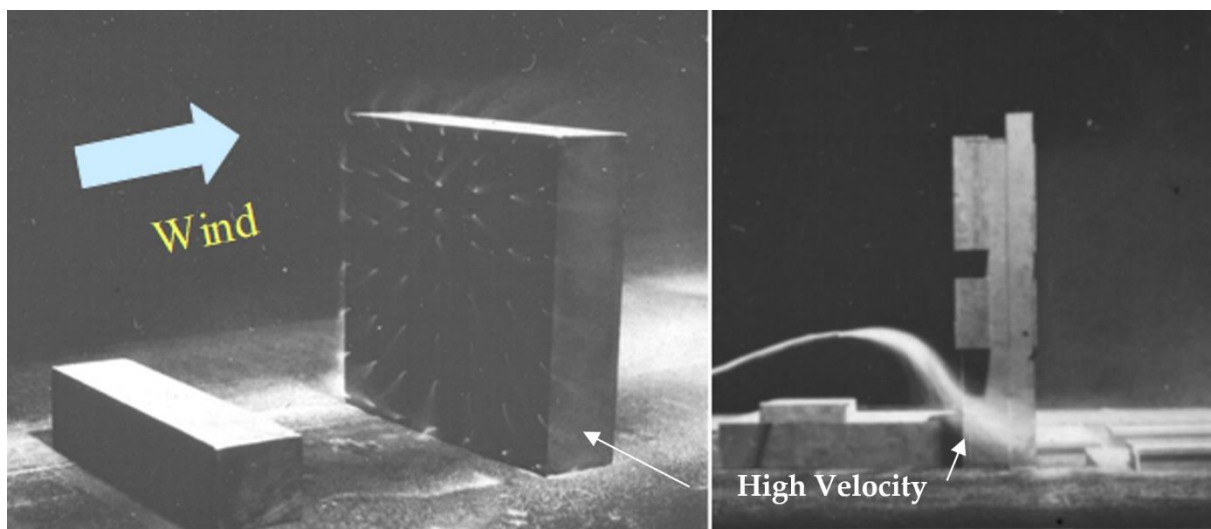


Figure 4: Flow visualisation around a tall building.



Figure 5: Visualisation through corner balconies (L) and channelling between buildings (R).

Appendix 2: Wind Impact Planning Guidelines

It is well known that the design of a building will influence the quality of the ambient wind environment at its base. Below are some suggested wind mitigation strategies that should be adopted into precinct planning guidelines and controls (see also Cochran, 2004).

Building form – Canopies

A large canopy may interrupt the flow as it moves down the windward face of the building. This will protect the entrances and sidewalk area by deflecting the downwash at the second storey level, Figure 6. However, this approach may have the effect of transferring the breezy conditions to the other side of the street. Large canopies are a common feature near the main entrances of large office buildings.



Figure 6: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

Building form – Podiums

The architect may elect to use an extensive podium for the same purpose if there is sufficient land and it complies with the design mandate, Figure 7. This is a common architectural feature for many major projects in recent years, but it may be counterproductive if the architect wishes to use the podium roof for long-term pedestrian activities, such as a pool or tennis court.



Figure 7: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

Building form – Arcades

Another massing issue, which may be a cause of strong ground-level winds, is an arcade or thoroughfare opening from one side of the building to the other. This effectively connects a positive pressure region on the windward side with a negative pressure region on the lee side; a strong flow through the opening often results, Figure 8. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

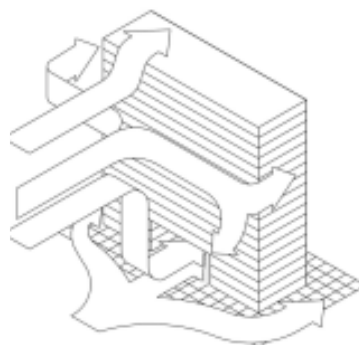


Figure 8: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 9(L). In some cases, a canopy may not be necessary with this scenario, depending on the local geometry and directional wind characteristics. The same undercut design at a building corner is usually quite unsuccessful, Figure 9(R), due to the accelerated flow mechanism described in Figure 4 and the ambient directional wind statistics.

If there is a strong directional wind preference, and the corner door is shielded from those common stronger winds, then the corner entrance may work. However, it is more common for a corner entrance to be adversely impacted by this local building geometry. The result can range from simply unpleasant conditions to a frequent inability to open the doors.

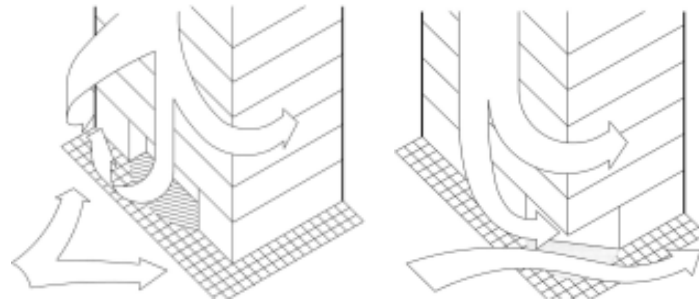


Figure 9: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

Building form – Façade profile and balconies

The way in which a building's vertical line is broken up may also have an impact. For example, if the floor plans have a decreasing area with increased height the flow down the stepped windward face may be greatly diminished. To a lesser extent the presence of many balconies can have a similar impact on ground level winds, although this is far less certain and more geometry dependent. Apartment designs with many elevated balconies and terrace areas near building ends or corners often attract a windy environment to those locations. Mid-building balconies, on the broad face, are usually a lot calmer, especially if they are recessed. Corner balconies are generally a lot windier and so the owner is likely to be selective about when the balcony is used or endeavours to find a protected portion of the balcony that allows more frequent use, even when the wind is blowing.

Use of canopies, trellises, and high canopy foliage

Downwash Mitigation – As noted earlier, downwash off a tower may be deflected away from ground-level pedestrian areas by large canopies or podium blocks. The downwash then effectively impacts the canopy or podium roof rather than the public areas at the base of the tower, Figure 7. Provided that the podium roof area is not intended for long-term recreational use (e.g. swimming pool or tennis court), this massing method is typically quite successful. However, some large recreational areas may need the wind to be deflected away without

blocking the sun (e.g. a pool deck), and so a large canopy is not an option. Downwash deflected over expansive decks like these may often be improved by installing elevated trellis structures or a dense network of trees to create a high, bushy canopy over the long-term recreational areas. Various architecturally acceptable ideas may be explored in the wind tunnel prior to any major financial commitment on the project site.

Horizontally accelerated flows between two tall towers, Figure 5(R), may cause an unpleasant, windy, ground-level pedestrian environment, which could also be locally aggravated by ground topography. Horizontally accelerated flows that create a windy environment are best dealt with by using vertical porous screens or substantial landscaping. Large hedges, bushes or other porous media serve to retard the flow and absorb the energy produced by the wind. A solidity ratio (i.e. proportion of solid area to total area) of about 60-70% has been shown to be most effective in reducing the flow's momentum. These physical changes to the pedestrian areas are most easily evaluated by a model study in a boundary-layer wind tunnel.

References

Cochran L., (2004) Design Features to Change and/or Ameliorate Pedestrian Wind Conditions, Proceedings of the ASCE Structures Congress, Nashville, Tennessee, May 2004.