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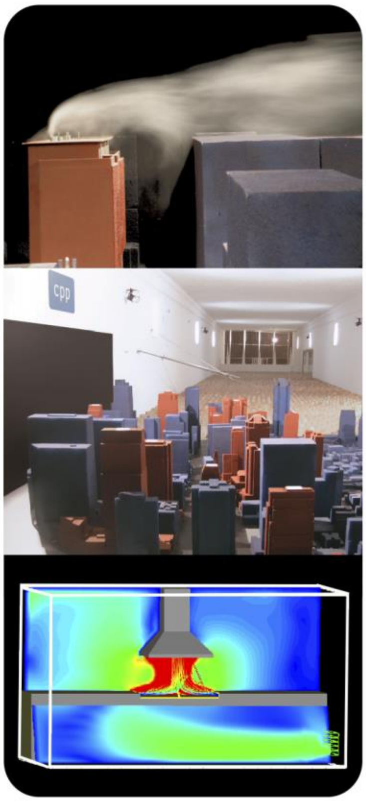
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

270 Pacific Highway

Crows Nest

Prepared for:

Ascent Property Group

c/o Fitzpatrick + Partners

Level 6, 156 Clarence Street

Sydney, NSW 2000

Australia

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CPP Project: 14559

Prepared by:

Adam van Duijneveldt, Senior Engineer

Thomas Evans, Project Engineer

CPP

Unit 2, 500 Princes Highway

St. Peters, NSW 2044, Australia

info-syd@cppwind.com

www.cppwind.com

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1 INTRODUCTION

Cermak Peterka Petersen Pty. Ltd. has been engaged by Ascent Property Group to provide a qualitative assessment of the impact of the proposed 270 Pacific Highway development on the wind conditions in the surrounding areas.

The proposed development is located between the North Sydney and St Leonards CBDs, approximately 4 km to the north of the Sydney CBD, in a region of low-rise suburban development, Figure 1. The proposed development will comprise a single mid-rise tower, reaching a maximum height of about 54 m above ground level, Figure 2. As it is slightly larger than most of the surrounding structures, the addition of the proposed development is expected to have some impact on the local wind conditions, and the extents are broadly discussed in this report.

Figure 1: Aerial view of the proposed development site (Google Earth, 2020).

Figure 2: West Elevation. Structures and massing within the proposed development.

2 SYDNEY WIND CLIMATE

The proposed development lies approximately 13 km to the north 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 3 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.

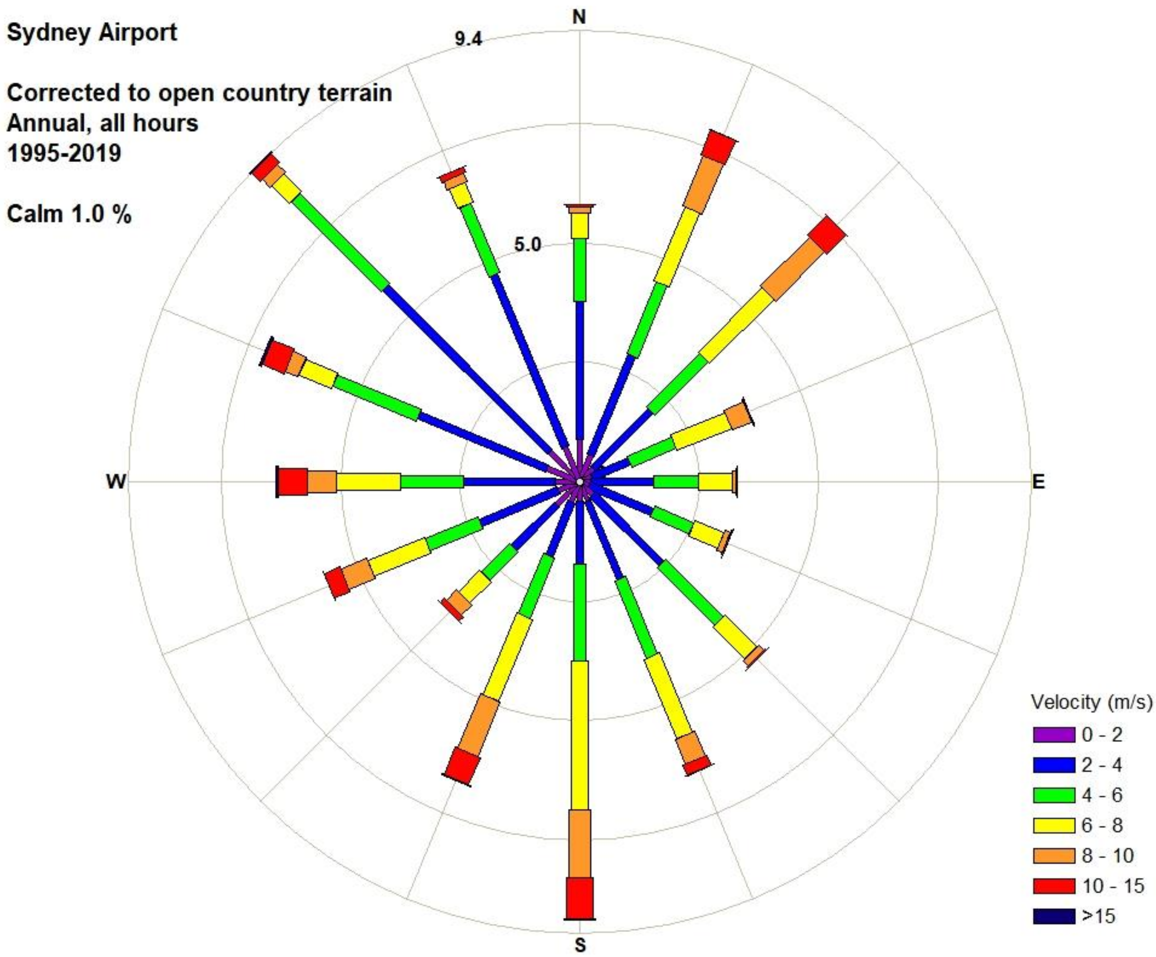

Figure 3: Wind rose for Sydney Airport.

3 ENVIRONMENTAL WIND CRITERIA

It is generally accepted that wind speed and the rate of change of wind velocity are the primary parameters that should be used in the assessment of how wind affects pedestrians. Local wind effects can be assessed with respect to a number of environmental wind speed criteria established by various researchers. Despite the apparent differences in numerical values and assumptions made in their development, it has been found that when these are compared on a probabilistic basis, there is remarkably good agreement.

The North Sydney Council DCP (2013) specifies that wind speeds along public streets, and in public spaces, should not exceed 13 m/s. It is not stated whether this wind speed is a gust or mean, as such it is assumed to correspond to a 3-second gust after the work of Melbourne (1978), and would relate to a "pedestrian standing" type classification. There are not many locations within Sydney that would satisfy this level of wind amenity without some form of shielding. This criterion would relate to the once per annum gust and uses this as an estimator of the general wind conditions at a site, which depending on the wind climate may not be relevant to frequent wind events.

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.

Table 1: Pedestrian comfort criteria for various activities.

Comfort (max. wind speed exceeded 5% of the time)	
<2 m/s	Outdoor dining
2 - 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
Distress/Safety (max. wind speed exceeded 0.022% of the time, twice per annum)	
<15 m/s	General access area
15 - 20 m/s	Acceptable only where able-bodied people would be expected; no frail people or cyclists expected
>20 m/s	Unacceptable

The wind speed is either an hourly mean wind speed or a gust equivalent mean (GEM) wind speed. The GEM wind speed is equal to the 3 s gust wind speed divided by 1.85.

4 ENVIRONMENTAL WIND ASSESSMENT

The development site is surrounded in most directions by low-rise buildings, with topography surrounding the site being relatively flat from a wind perspective except to the west of the site where the land declines significantly. Winds in such surrounds tend to experience less channelling than areas with many tall structures, with local effects instead 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.

The subject site is located on the block bounded by Pacific Highway, Bruce Street, Sinclair Street and Shirley Road. The existing site comprises two 5-storey buildings, given the similar height to surrounding buildings no significant downwash would be expected in the existing configuration. The proposed development consists of a single prismatic tower with a rectangular planform. A ground floor plan is shown in Figure 4, and indicates retail tenancies along the Pacific Highway frontage, including the main pedestrian entrance.

Figure 4: Ground floor of proposed development.

4.1 Winds from the north-east

Winds from the north-east quadrant will approach relatively unimpeded over the low-rise buildings of Crows Nest before impinging on the broad façade of the proposed development. This incident flow would be expected to generate a degree of downwash, which would accelerate around the north-east and south-east corners of the tower before discharging over the roofs of the neighbouring low-rise buildings which would act to keep the majority of this flow elevated above ground level. The recessed nature of the tower entrance on Pacific Highway and podium awning are considered good design features from a wind perspective, as they will provide shielding to patrons from downwash for winds from the north-east by redirecting flow horizontally, Figure 5. Considering the protection to pedestrians provided by these features and the separation between the tower and street level provided by neighbouring structures, the impacts of winds from this direction are expected to be minor. 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 Lawson distress criterion.

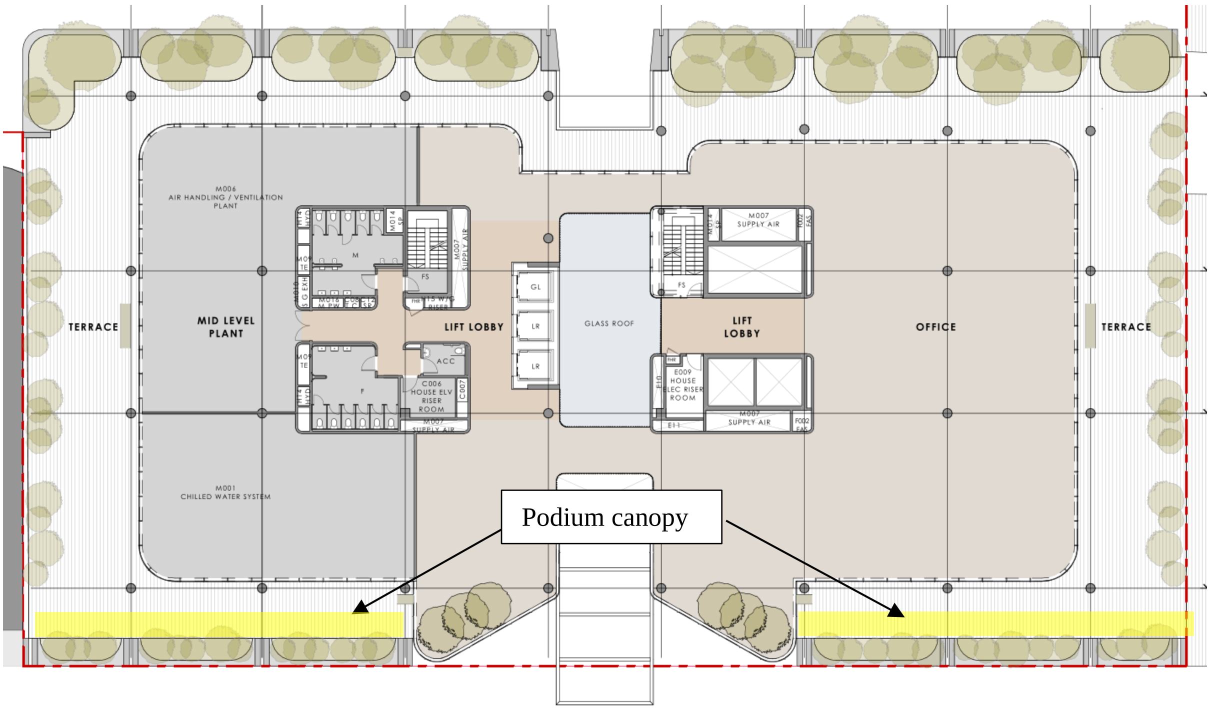

Figure 5: Level 3 floor plan with podium rooftop canopy indicated.

4.2 Winds from the south

Winds from the south quadrant will be approximately aligned with the corner of the tower, and will tend to be directed horizontally around the tower, reducing the amount of downwash descending to ground level. For large thoroughfares such as Pacific Highway some degree of channelling flow would still be experienced for certain wind directions, as incoming flow is gradually collected onto the path of least resistance by the low-rise buildings on either side of the thoroughfare. A small quantity of downwash would be expected to reach the ground plane along Pacific Highway for winds from the south-east, with the proposed awnings along the Pacific Highway frontage providing some local shielding to pedestrians. This downwash flow would provide a small additional contribution to the existing channelling flow along Pacific Highway. This notwithstanding, the addition of the proposed development is not expected to have a significant impact on the local wind conditions during winds from this direction.

4.3 Winds from the west

Approach flow from the west will accelerate as the terrain rises to the subject site, before striking the tower at an oblique angle, encouraging flow to pass horizontally around the tower. Some downwash would still be expected for winds from the west, with flow accelerating around the windward corners of the tower before discharging over the roofs of the neighbouring buildings. Wind conditions around the proposed development site are expected to remain similar to the existing wind conditions and pass the distress criterion.

4.4 Summary

For most locations, local wind conditions around the proposed development site 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 walking or standing 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. All locations would be expected to satisfy the distress criterion.

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. The podium rooftop terrace is likely to experience windy conditions, particularly for winds from the north-east and west quadrants. Downwash generated from these winds would be expected to create windy conditions near to the windward corners of the tower, with calmer conditions experienced closer to the centre of each façade.

Mitigation measures may be implemented where calmer conditions are required, such as at seating areas, and may include landscaping with dense foliage, cabana-type structures, or screening elements.

The proposed rooftop terraces are quite exposed to winds from the west quadrant. These winds would accelerate over the roof of the tower, thereby creating the potential for windy conditions on the terraces. Depending on the intended use of these spaces, mitigation in the form of tall balustrades may be required to encourage flow to pass over the rooftop. The mitigation measures suggested for the podium terrace are also applicable here.

Further, if the proposed landscaping for the rooftop terraces is to include trees that extend beyond the height of the terrace balustrades, quantification of the wind speeds likely to be experienced by the trees would be recommended as there is the potential for limbs to be dislodged from trees in high winds, which could create a risk to safety if debris is not contained within the terrace.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed 270 Pacific Highway project on the local wind environment in and around the development site. Being slightly larger than most surrounding structures, the proposed development will have some effect on the local wind environment, though any changes are not expected to be significant from the perspective of pedestrian comfort or safety. 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 criterion. Local amelioration would likely be necessary for areas intended for long-term stationary or outdoor dining activities.

6 REFERENCES

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.

Appendix 1: Wind flow mechanisms

When the wind hits a large isolated building, the wind is accelerated down and around the windward corners, Figure 6; 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 6, 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 7 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.

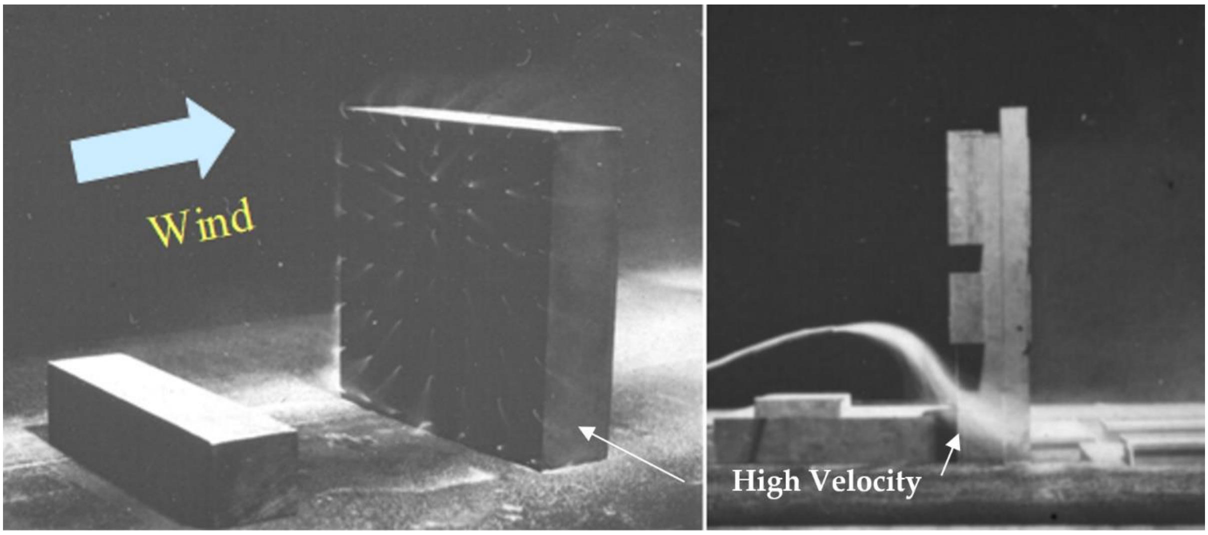

Figure 6: Flow visualisation around a tall building.

Figure 7: 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 8. 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.

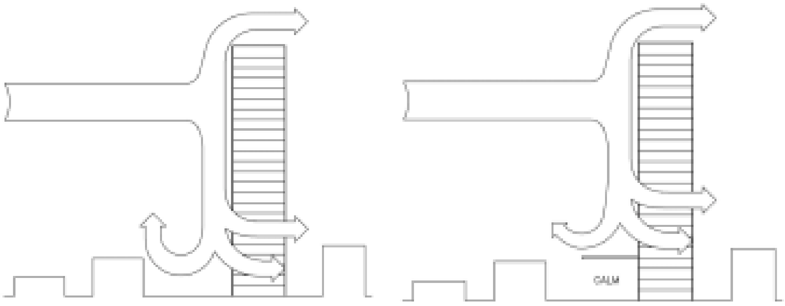

Figure 8: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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 9. 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.

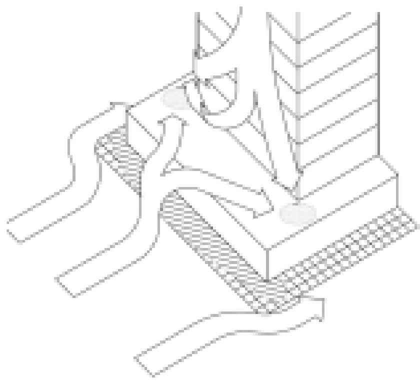

Figure 9: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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 10. The uninvitingly windy nature of these open areas is a contributing reason behind the use of arcade airlock entrances (revolving or double sliding doors).

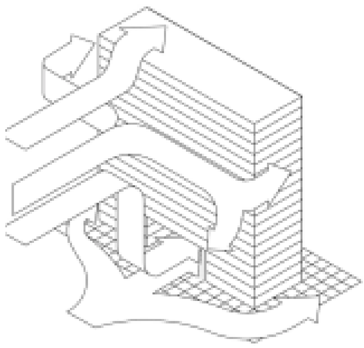

Figure 10: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

Building form – Alcove

An entrance alcove behind the building line will generally produce a calmer entrance area at a mid-building location, Figure 11(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 11(R), due to the accelerated flow mechanism described in Figure 6 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.

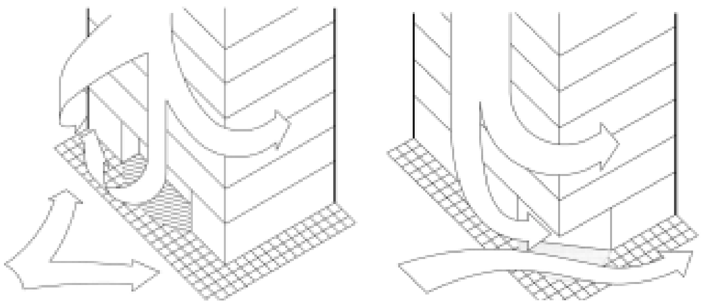

Figure 11: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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 9. 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 7(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.