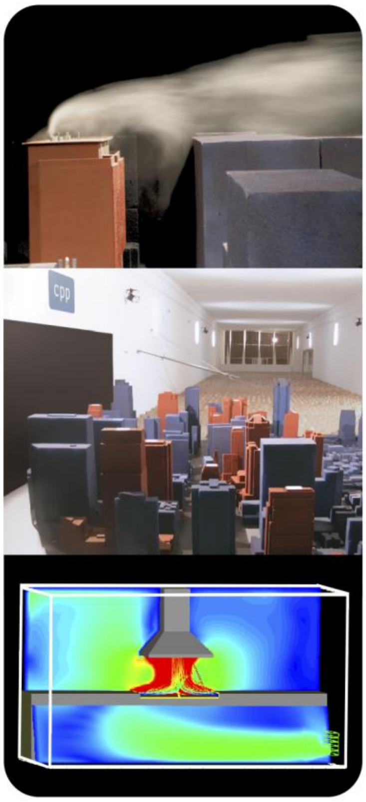
CERMAK
PETERKA
PETERSEN

WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Qualitative Wind Assessment for:

Westmead Catholic Community- Project 1

Stage 1

Darcy Road, Westmead, NSW

Prepared for:

The Trustees of the Roman Catholic

Church for the Diocese of Paramatta

12 Victoria Road

Paramatta, NSW, 2150

Australia

February 2020

CPP Project: 14199

Prepared by:

Joe Sun, Project Engineer

Joe Paetzold, Engineering Manager

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

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
14/02/20	Initial release	JS	JP	JP
26/02/20	Final Report	JS	JP	JP

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION (Client provided)

This report supports a State Significant Development Application for the Westmead Catholic Community (WCC) at 2 Darcy Road, Westmead.

The WCC project seeks to meet the needs of the growing population within the region by providing upgraded school facilities for Mother Teresa and Sacred Heart Primary Schools, as well as a new Parish church. WCC is a collaboration between Catholic Education Diocese of Parramatta (CEDP), the Diocese of Parramatta (DoP), the Sisters of Mercy and the Marist Brothers Province of Australia.

As the proposal is for the purposes of alterations and additions to an existing school and has a capital investment value in excess of $20 million, it is State Significant Development (SSD) for the purposes of the *Environmental Planning and Assessment Act 1979* (the Act). The Parish church is also SSD under clause 8(2)(a) of *State Environmental Planning Policy (State and Regional Development) 2011* as it forms part of the proposal which comprises a single, integrated development with significant functional links between the education and church uses.

1.1 Description of proposed development

The State Significant Development application will seek approval for:

- A primary school with capacity for approximately 1,680 students, to provide expanded facilities for the existing Mother Teresa Primary School on the site and to replace the existing Sacred Heart Primary School at Ralph Street;
- A new Parish church;
- A Catholic early learning centre (fit-out within an existing building);
- New landscaping.

1.2 The Site

The subject site is located at 2 Darcy Road, Westmead, approximately 2km to the north-west of the Parramatta CBD and approximately 300m to the west of Westmead Train Station. The site is located within the Parramatta Local Government Area (LGA).

The site has an area of approximately 12ha and a frontage of approximately 430m to Darcy Road. The site consists of two lots, which are legally described as Lot 1 in DP1095407, which is owned by the Trustees of the Roman Catholic Church of Parramatta, and Lot 1 in DP1211982, which is under the ownership of the Trustees of the Marist Brothers.

The site is bound by Darcy Road (to the north), the T1 North Shore & Western / T5 Cumberland train lines (to the south), the Western Sydney University Westmead Campus (to the east) and residential uses (to the west).

To the north of the site, across Darcy Road is the Westmead Health and Education Precinct comprising the Westmead Hospital, Westmead Private Hospital and the Western Sydney University Medical Research Institutes. The locational context of the site is shown at Figure 1.

The Westmead Health and Education Precinct, the WCC site and the surrounding residential land collectively form part of the recently nominated Westmead Priority Precinct Area.

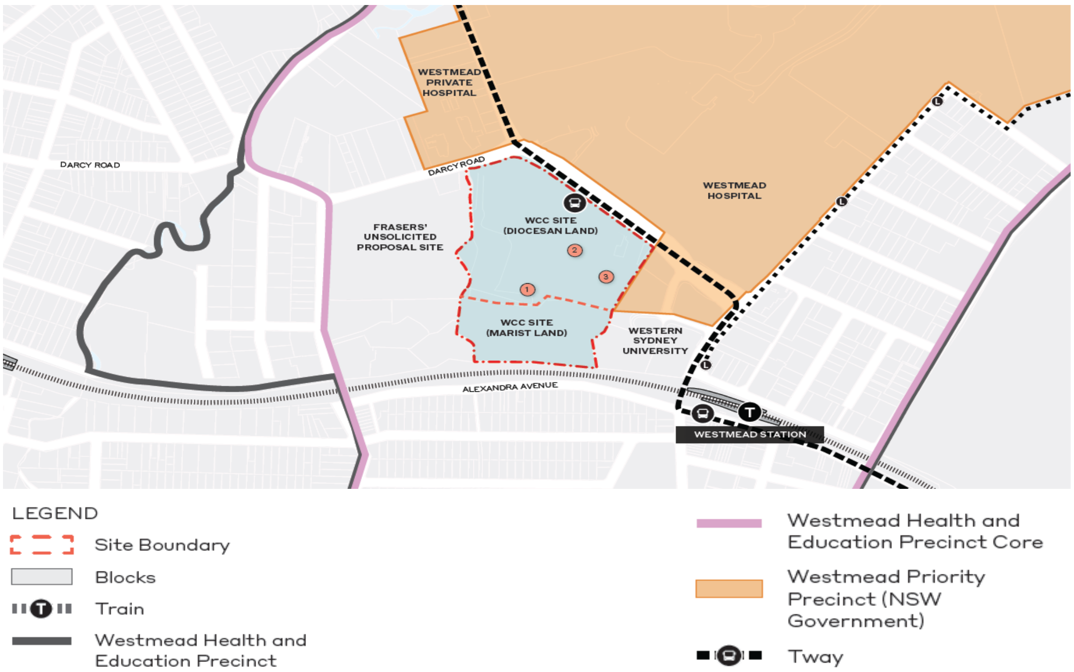


Figure 1 Location Plan

1.3 Existing Development

The site currently contains three separate schools being the Catherine McAuley Westmead (girls high school) which predominantly occupies the northern part of the site, and the Parramatta Marist High School (boys school) which occupies the eastern part of the site. The Mother Teresa Primary School occupies part of the Catherine McAuley school building in the centre of the site. The southern portion of the site contains open sports fields associated with the Parramatta Marist High School.

The existing Brother's residence is located in the north-eastern corner of the site, and an at grade car park occupies the western part of the site, to the north of the sports fields. Collectively, the three schools currently accommodate approximately 2,637 students and 190 staff.

2 WESTMEAD WIND CLIMATE

The proposed development lies approximately 12 km to the North of the Bankstown 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 Bankstown Airport from 1995 to 2017 have been used in this analysis. The wind rose for Bankstown 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 south-east, and west. This wind assessment is focused on these prevailing strong wind directions.

Winds from the south-east, which tend to be cold and humid, are often caused by frontal systems that can last several days and occur throughout the year. Winds from the west tend to be the strongest of the year and are associated with large weather patterns and thunderstorm activity. These winds occur throughout the year, but are reduced in frequency in summer, and can be cold or warm depending on the inland conditions. The prevailing wind directions associated with rain are from the south and west quadrants.

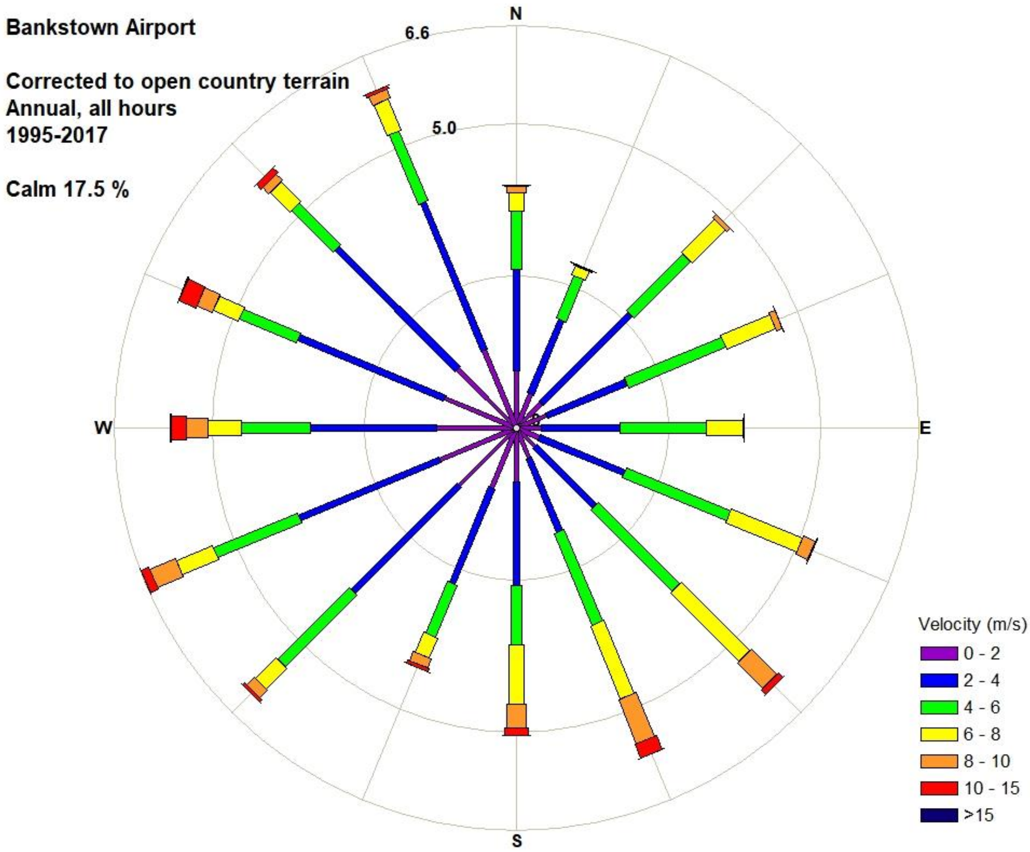


Figure 2: Wind rose for Bankstown Airport.

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 City of Paramatta Council DCP (2011) has a wind assessment criterion for major pedestrian streets of 13 m/s. The wind speed definition is unclear as it does not state the duration or probability of the wind event. This criterion is similar to other Council DCPs and is based on the work of Melbourne (1978) where the wind speed is the peak 3-second gust wind speed in an hour, that occurs for 0.1% of the time. The 13 m/s limit is a comfort criterion appropriate for pedestrian standing activities. There are few exposed locations in Parramatta that would meet this criterion without additional shielding to improve the wind conditions. This criterion wind speed is used as an estimator of the general wind conditions at a site, which may be more relevant. To combat this limitation, as well as the once per annum maximum gust wind speed, 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.

From ongoing findings using the criteria, and clients who have issues with strong wind, a more stringent criterion is required for outdoor dining style activities and a value of 2 m/s for 5% of the time is recommended for such intended use.

The 5% of the time corrected mean wind speed recorded at Bankstown airport is about 8 m/s. With the benefits of shielding from suburban buildings compared with the airport the 5% of the time mean wind speed would be about 7 m/s and the 0.1% gust wind speed would be about 19 m/s. These wind speeds would be classified as suitable for pedestrian walking from the Lawson comfort criteria, and pass both safety criteria. Most locations in the Parramatta region would require some level of shielding to meet more stringent comfort criteria.

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 located in the Westmead Health and Education precinct which is surrounded in most directions by low to mid-rise buildings, with a region of parkland to the east. Topography surrounding the site is relatively flat from a wind perspective and unlikely to significantly affect the wind climate at the site. 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 a block bounded by Darcy Road to the north, Western Sydney University to the west and Westmead station to the south. The proposed site consists of total 3 individual buildings of varying height between 1 and 6 storeys. A ground floor plan is shown in Figure 3.

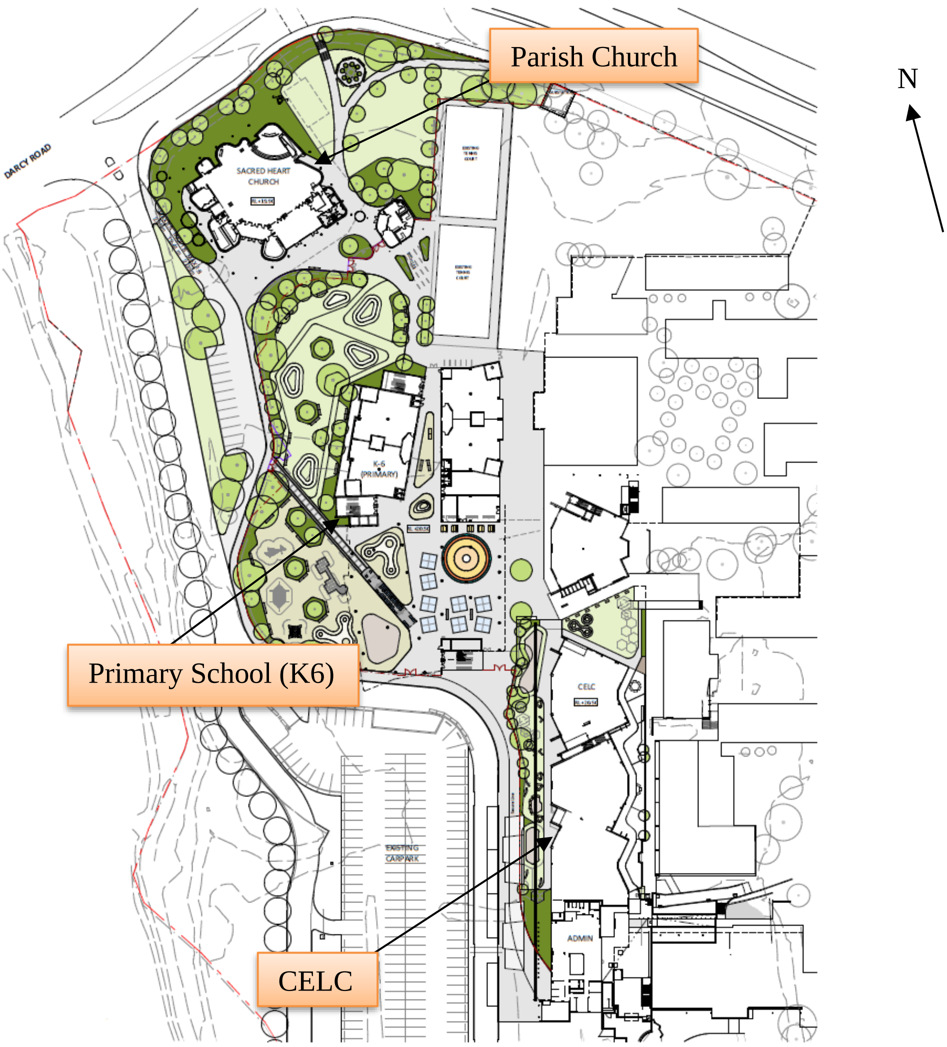


Figure 3: Site Plan of the proposed development.

Surrounding wind conditions

From Figure 2, prevailing strong wind directions in this wind assessment are centred about south-east and west. Winds from the south-east distributed over large areas of low-rise residential development of Westmead before reaching proposed site. Winds from the west quadrant will approach over a mixture of low- to medium rise residential and commercial buildings to the south-west and west. Winds from north-west will pass over large areas of Parabianga Reserve and Milson Park, remains relatively unimpeded upon reaching Westmead Private Hospital.

4.1 Primary School (K6)

The K6 building is 6 levels high and has a rectangular platform. For ground-level wind, the proposed development is relatively shielded from wind from the south-east quadrant by other school buildings including the CELC situated directly adjacent to the east and south-east of the proposed development. As the proposed primary school is slightly larger than most of the surrounding structures, slightly stronger breezes may be anticipated at the south-east corner as portion of incoming winds will hit the upper level of south-east corner and will be directed towards ground plane by the presence of the building.

The development will be relatively exposed to winds from the west quadrant which would impinge on the west façade as there are no significant upstream obstacles, and some strong breezes would be anticipated at the base particularly on the windward corners due to acceleration of winds around the corners.

The proposed primary school features several open spaces throughout the building, with the majority of the ground level being open, Level 3 being open, as well as corridors with openings to all sides. The upper level open areas mostly have 1.2m balustrades around the perimeter with full height vertical blades in some locations. The open nature of the floorplates is prone to pressure driven flow across the open floors and corridors with highest speeds occurring in the area with the smallest cross section in the corridors. As these areas are open to all sides, there would be a cross flow expected for winds from any direction. The suitability in terms of wind comfort for these spaces depends on the intended use. With a very open layout strong winds from any direction can cause breezy directions in the covered outdoor spaces. It is understood that the large covered outdoor spaces on ground level, Level 3 and 5 are intended as play areas. To provide for some calmer areas during windy conditions, it is suggested to provide some screening in these areas to maximize the usable time for these play areas from a wind perspective. For the corridors it may be considered to include the possibility of closing off the external opening of the corridors on one side to have the possibility of providing a calmer area during strong cross flows.

Surrounding the perimeter of open roof is a full height 1.2m balustrade. While the balustrades would provide protection up to its height in the area close to the balustrade, main part of the open roof area would not experience any significant protection. Depending on the intended use of the rooftop, additional local mitigation such as screens around intended seating areas potentially in combination with a horizontal canopy over some of this area may be considered to improve wind conditions.

4.2 New Parish Church

The New Parish Church is located at the north-west corner of the block and relatively shielded by slightly taller building massing located at south-east. Thus, relatively calm conditions would be expected at the south entrances during winds from the south-east quadrant.

The main entrances to the church are well located from a wind perspective away from the building corners. The additional level of inside doors from the narthex to the main worship area would prevent internal flow issues through the main church area. For strong winds from the west, the entrance area to the north-west would be expected to be relatively windy. It is understood that this is a side entrance only; the main entrances would experience calmer wind conditions.

4.3 CELC

Winds from the south-east will pass over open areas (Cumberland Oval) with minimum obstruction before approaching CELC and impinge on the corner of the proposed development. Due to the low height of the building, no significant downwash is expected, however the large width of the building may promote strong wind conditions near the windward corners for the wind flowing horizontally around the building, particularly at the north-eastern corner.

The west façade is exposed to the prevailing winds from west and the relatively large width of the building would lead to the horizontal flow around the building massing to accelerate along west façade and around the building corners. The building entrances are mostly well located from a wind perspective, in recessed locations due to the articulated shape of the building.

4.4 Summary

For most locations, wind conditions within 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 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 to extend the amount of time with comfortable wind conditions e.g. in any seating areas. The entrances to the buildings are well located from a wind perspective, away from the building corners and recessed within the façade. All locations would be expected to satisfy the safety/distress criterion.

5 CONCLUSION

Cermak Peterka Petersen Pty. Ltd. has provided a qualitative assessment of the impact of the proposed Westmead Catholic Community- Project 1 Stage 1 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/safety criterion. Local amelioration may be necessary for some of the indicated open areas.

To quantify the wind conditions around the site, a wind-tunnel test would be recommended during detailed design.

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.

Standards Australia (2011), Australian/New Zealand Standard, Structural Design Actions, Part 2: Wind Actions (AS/NZS1170 Pt.2).

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.

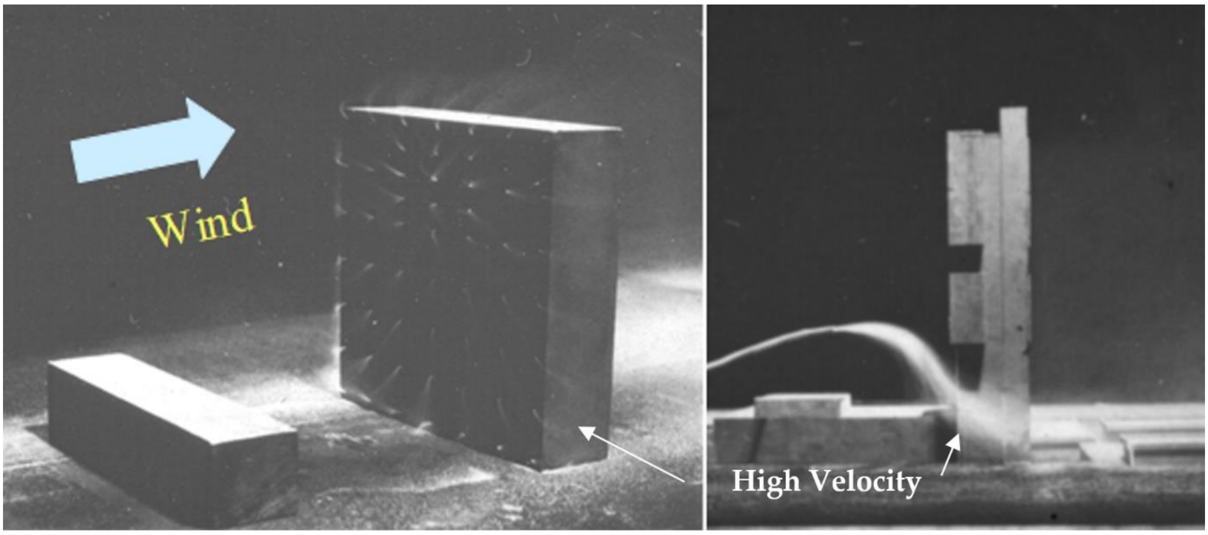


Figure 4: Flow visualisation around a tall building.

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.

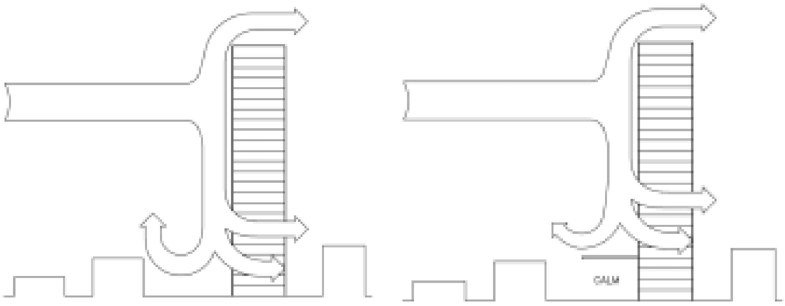


Figure 6: Canopy Windbreak Treatment. (L) Downwash to street level may generate windy conditions for pedestrians. This is particularly true for buildings much taller than the surrounding buildings. (R) A large canopy is a common solution to this pedestrian-wind problem at street level.

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.

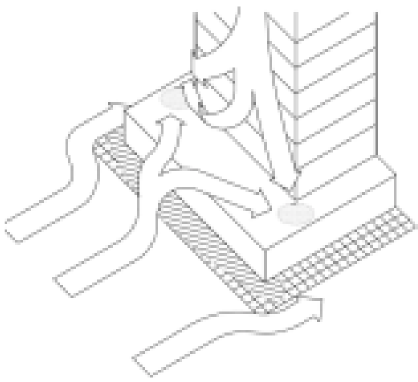


Figure 7: The tower-on-podium massing often results in reasonable conditions at ground level, but the podium may not be useable.

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).

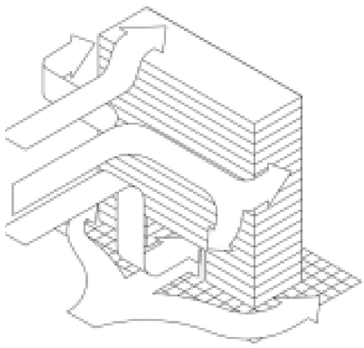


Figure 8: An arcade or open column plaza under a building frequently generates strong pedestrian wind condition.

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.

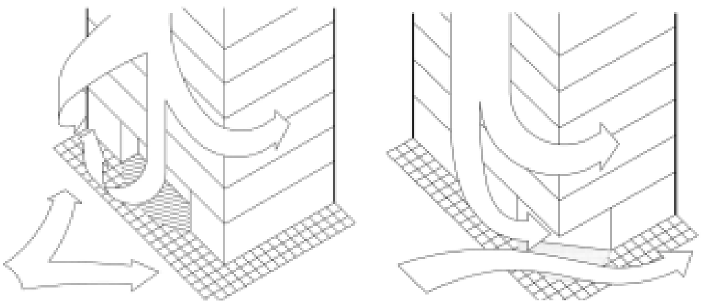


Figure 9: Alcove Windbreak Treatment. (L) A mid-building alcove entrance usually results in an inviting and calm location. (R) Accelerated corner flow from downwash often yields an unpleasant entrance area.

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.