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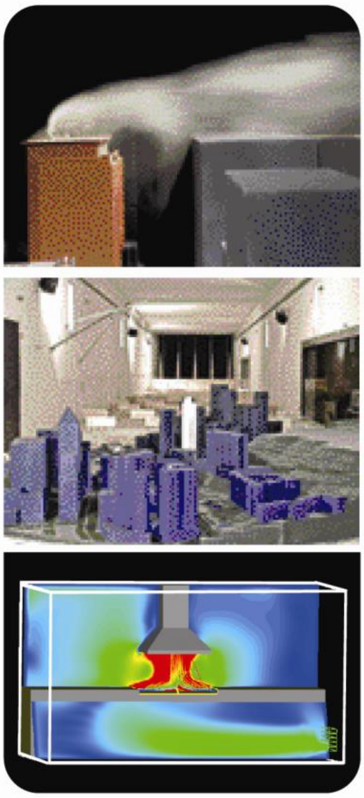
WIND ENGINEERING AND AIR QUALITY CONSULTANTS

FINAL REPORT



Wind Assessment for:

BANKSTOWN COMPASS CENTRE

83-99 North Terrace & 62 The Mall, Bankstown

Sydney, NSW 2200, Australia

Prepared for:

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Executive Summary

This report provides an opinion based qualitative assessment of the impact of the proposed Bankstown Compass Centre development on the local pedestrian-level wind environment. This assessment is based on knowledge of the local Bankstown wind climate and previous wind-tunnel test on similar buildings in the Bankstown area.

The proposed development is taller than surrounding buildings. Wind speeds are expected to be higher around the outer corners of the development, though the podium roof will prevent significant wind effects occurring at street level. The environmental wind conditions at ground level around the proposed development are expected to be suitable for pedestrian standing from a comfort perspective and pass the distress criterion. Within the development, wind conditions are expected to be suitable for pedestrian standing or walking activities and pass the distress criterion under Lawson.

For such a large development with several similar sized towers designed in such a complex manner, it would be recommended to quantify the wind conditions and confirm the qualitative findings using wind-tunnel testing.

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
04/02/16	Final Report	KF	GSW	GSW
10/02/16	Revision 1	KF	GSW	GSW
04/10/16	Amended design drawings	TE	GSW	GSW
05/10/16	Amended Figure	TE	GSW	GSW

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Introduction

Cermak Peterka Petersen Pty. Ltd. has been engaged by Fioson Pty Ltd to provide an opinion based assessment of the impact of the proposed development at Bankstown Compass Centre, Sydney, Figure 1, on the wind conditions in the surrounding areas. The proposed development consists of 4 prismatic residential buildings with heights ranging from 53 to 83 m above ground level with a four-storey podium, Figure 2.

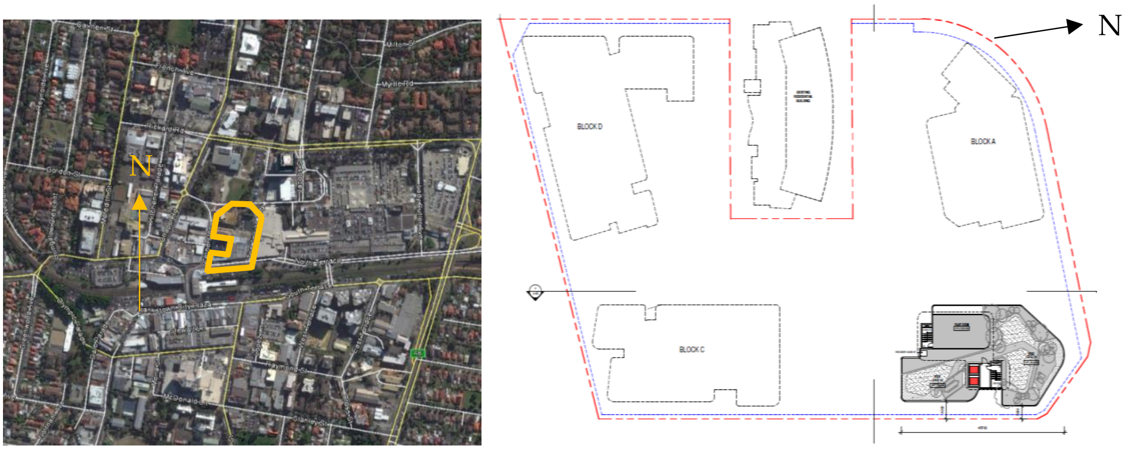

Figure 1: Aerial view with proposed development site highlighted (Google Earth, 2015) (L), and site plan of the proposed development (R)

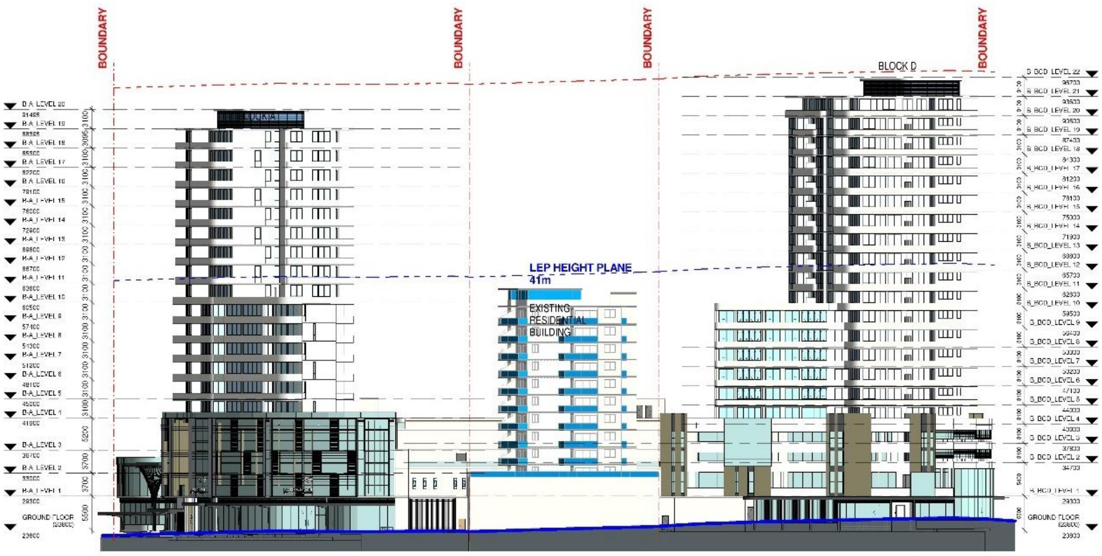

Figure 2: West Elevation of proposed development

Bankstown Wind Climate

The proposed development is located about 4 km to the west of the Bankstown Airport Bureau of Meteorology anemometer. The general wind rose for Bankstown Airport is presented in Figure 3 and is considered to be representative of prevailing incident winds at the site. The prevailing strong winds at Bankstown Airport come from the south-east and west quadrants.

Winds from the south-east, which tend to be cold, 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. This wind assessment is focused on these prevailing wind directions.

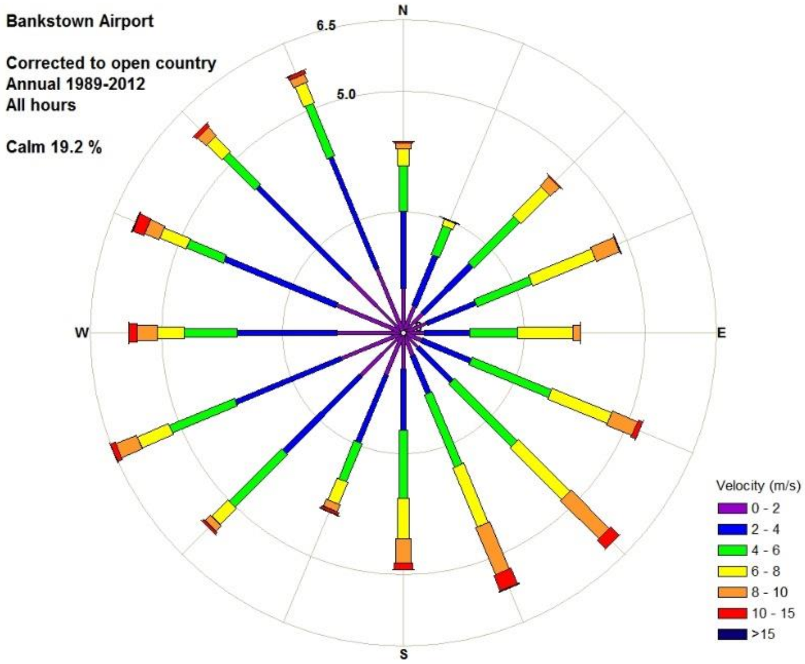

Figure 3: Wind rose for Bankstown Airport

From a wind perspective, Bankstown Airport is relatively mild, with an average wind speed at 10 m reference height of approximately 3 m/s (6 kt, 10.8 kph), 5 percent of the time the mean wind speed is approximately 8.5m/s (17 kt, 31 kph), and 0.6% of the time (once per week) wind speed is approximately 12 m/s (12 kt, 43 kph). Converting the 5 and 0.6 percent of the time mean wind speed to typical pedestrian level at the site using Standards Australia (2011) would result in about 5.4 m/s (10.5 kt, 19.5 kph) and 7.6 m/s (15 kt, 27 kph). Comparing this with the comfort criteria of Table 1 indicates that pre-existing winds at any Bankstown location with a similar built environment surrounding the proposed development site would be classified as acceptable for pedestrian standing. Specific building massing of the proposed development and their interaction with approaching wind flows will dictate the actual wind environment at the site and the resulting wind acceptability levels; these are explored in detail below.

Environmental Wind Speed 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.

Bankstown City Council has no specific wind assessment criteria. The wind assessment criteria used in this study are based upon the research of Lawson (1990), which are described in Table 1 for both pedestrian comfort and distress. 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.

Table 1: Pedestrian comfort criteria for various activities

Comfort (maximum 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 (maximum 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 a 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.

Wind Flow Mechanisms

When wind hits a large isolated building, it is accelerated down and around the windward corners, as shown in Figure 4; this flow mechanism is called downwash. 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. Figure 4 also shows that the wind at mid and upper levels on a building can accelerate substantially round the corners. When balconies are located on these corners they are likely to be breezy, Figure 5(L), and used less by the owner than intended. However, if the balconies are large enough, articulated, or have partition privacy fins then areas of local calmer conditions may exist. Owners quickly become familiar with when and how to use their balconies.

Channelling occurs when the wind is accelerated between two buildings, or along straight streets with buildings on either side, Figure 5(R).

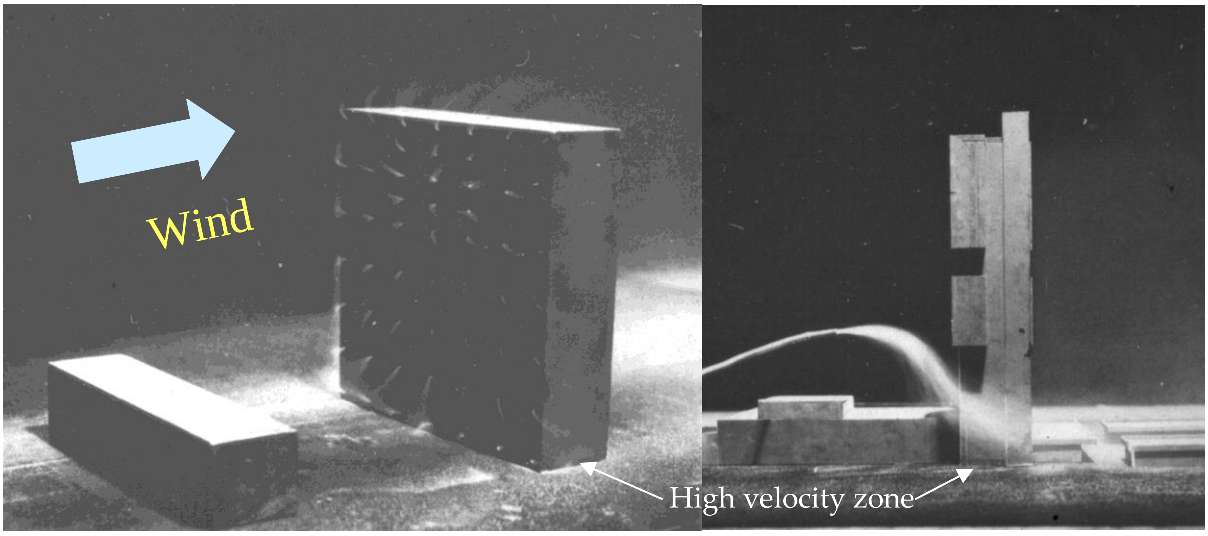

Figure 4: Flow visualisation around a tall building

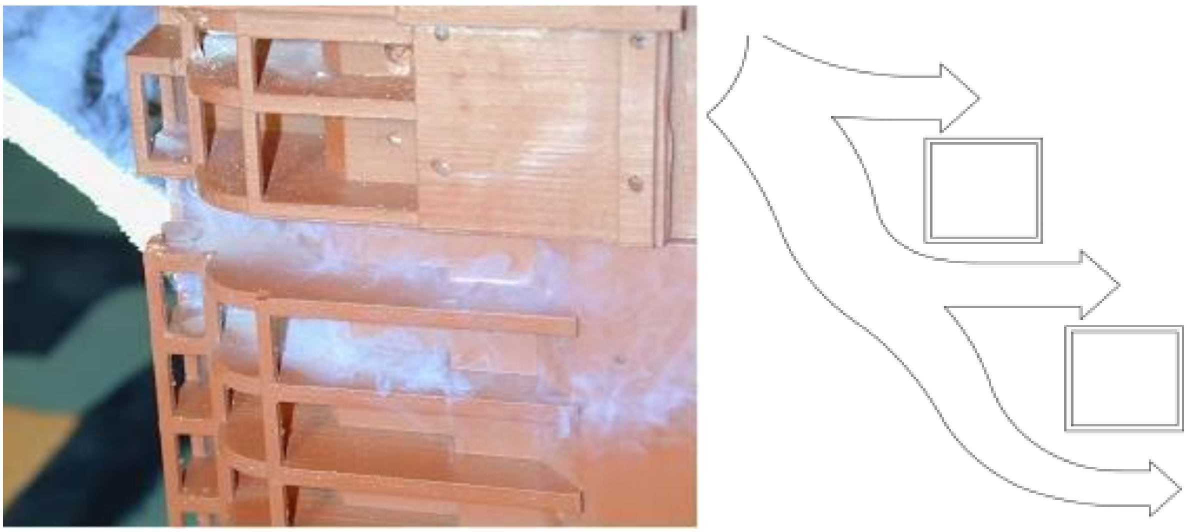

Figure 5: Visualisation through corner balconies (L) and channelling between buildings (R)

Environmental Wind Assessment

The proposed development is surrounded by low-rise buildings, with a handful of medium-rise buildings scattered in the vicinity, Figure 1. Topography surrounding the site is relatively flat. The site is opposite Bankstown train station, and is therefore likely to experience heavy pedestrian traffic. Pedestrian access around the site is open to the environment, and entrances to the site exist on each street bounding the development. The primary entrances on the North and South boundaries are connected by a through-site link, Figure 6, which varies in height along its length. The common podium roof is open to the environment and features outdoor recreational areas and a swimming pool, Figure 7(L). Additional communal outdoor rooftop areas are located on level 10 of buildings A and D, Figure 7(R). Balcony areas exist on both podium and all four towers.

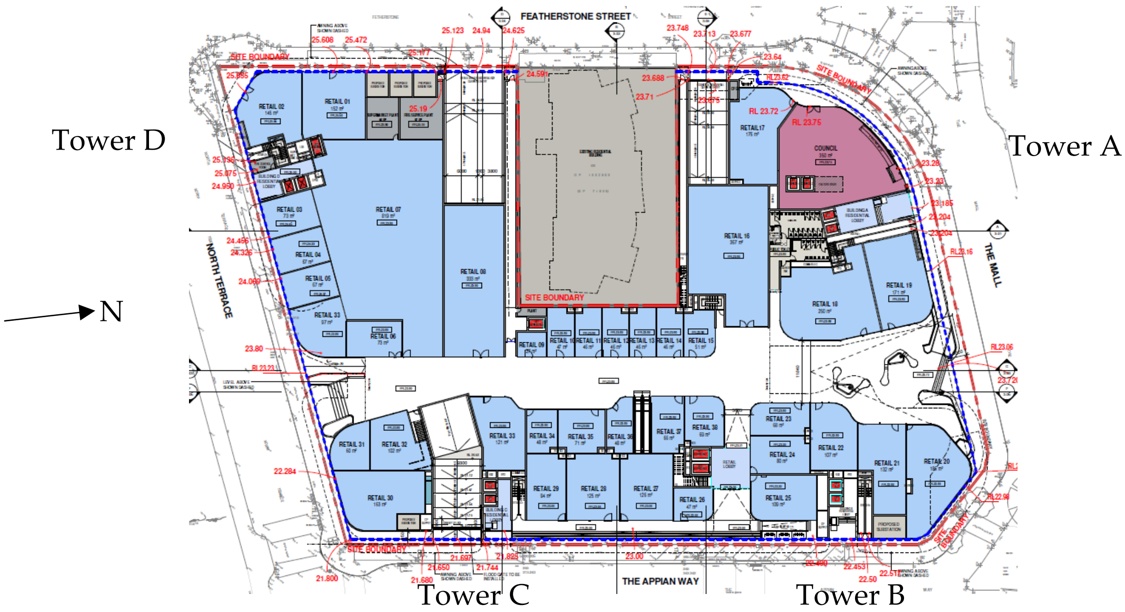

Figure 6: Ground floor plan of proposed development

Figure 7: Floor plans of Level 4 (L) and Level 10 (R) of proposed development

General wind conditions on the ground plane

The size of the development is relatively large compared with the surroundings, and is consequently exposed to the approaching wind from all directions. Combined with the existing large building on the block, the proposed towers are relatively close together and will therefore act as a compound shape from a wind perspective. The geometry is expected to accelerate the wind between the towers and around the external corners of the block. Between the closely spaced buildings, the flow is expected to have reduced turbulence, being relatively strong but constant in speed. At street level, the effect of downwash from the towers will be mitigated by the presence of the podium and canopies for most cases; the wind conditions on the podium roof are likely to be windy between the towers as the podium roof is protecting the ground plane from downwash flow. The intended use of the space is critical for the level of amelioration required. It is assumed that safety would be of primary concern around the perimeter of the site, whereas window shopping and potentially café-style areas are required in the centre of the precinct and along the through-site link. Wind conditions suitable for outdoor dining in and around the development may not be achievable without appropriate local amelioration treatments such as screening or significant landscaping. Wind tunnel testing would be required to quantify the wind conditions in these areas and appropriate amelioration would be developed with the design team during detailed design. The main entries to the podium are well located from a wind perspective, being well recessed and protected from downwash by overhanging levels and awnings.

Winds from the south-east quadrant

Winds from south-east quadrant are unimpeded on reaching the site. Winds from the south-east will strike the south-east corners of buildings B, C, and D, encouraging the winds to pass around the towers horizontally and reduce the amount of downwash reaching ground level. These winds are expected to channel into the outdoor area on level 4, accelerating between towers B and C. The resulting downwash is likely to create windy conditions across the roof space between the towers.

Winds from the south-west quadrant

Winds from the south-west quadrant are unimpeded on reaching the site. Winds from the south-west will strike the south-west corners of buildings A and D, which will encourage the wind flow to pass around the towers horizontally and reduce the amount of downwash reaching ground level. Prevailing winds from the south will strike the south façade of buildings C and D orthogonally, generating downwash flows that will impinge on the podium roof and along Featherstone Street. The channelling of southerly winds between the five towers, is expected to produce windy conditions over the podium roof at the tower bases including the residential pool and BBQ areas. These locations are expected to be classified as more suitable for transient activities rather than sitting activities. To ameliorate the wind conditions, local amelioration would be required such as fixed vertical solid or porous screens barriers around the outdoor seating areas or significant landscaping such as dense planting. Any amelioration would be developed during detailed design after quantification through wind-tunnel testing.

The setback of the towers means that the downwash will be redirected by the podium and is therefore unlikely to cause any significant issues along Appian Way and Fetherstone Street. Street level awnings offer further protection. Prevailing winds from the south will develop pressure-driven flow in the through-site link. This pressure-driven flow will be accelerated into the corridor due to the reduction of the cross sectional area of the south entrance, before slowing down as it expands to the north entrance. The fastest winds will be felt at the smallest cross-sectional area along the link and will be steady rather than turbulent. The pressure-driven effect can be reduced by limiting the cross-sectional area such as by placing screens inside the entrance area or having the cross sectional area increase in the centre of the walkway. The walkway is expected to be classified as suitable for pedestrian walking or standing activities rather than outdoor seating.

Winds from the north-west quadrant

Winds from the north-west quadrant are unimpeded when reaching the site. Winds from the west will impinge on the west façade of Building D, generating downwash flows accelerating through the undercroft on the south-west corner of the site. The Building D stepped nature with height and façade articulation would be expected to assist in reducing the amount of downwash reaching ground level along North Terrace.

Winds from the north-west will downwash from the north-west façade of building A. The articulation of this tower and curved nature of the podium are expected to assist in reducing the amount of downwash reaching ground level. The awning wrapping around the corner is expected to be of further benefit to the wind and wind-driven rain conditions for pedestrians.

Similarly, downwash generated from westerly and nor-westerly winds impinging on Building A will primarily affect the level 10 outdoor area, making it classified as suitable for pedestrian standing or walking activities without mitigation measures. The presence of the podium and awnings will limit the effects of downwash at street level.

Winds from the north-west will be channelled between the existing residential building and Buildings A and D. Combined with downwash from the facades, this channelling effect will contribute to windy conditions on the level 4 podium roof. For these wind directions, the pool area is offered significant shielding by the existing tower.

Summary of wind conditions on ground plane

Qualitatively, integrating the expected wind conditions around the site with the wind climate, it is considered that wind conditions around the proposed site would be expected to be classified as acceptable for pedestrian standing or walking from a Lawson comfort perspective and pass the distress criterion. The presence of a large podium and tower setbacks assist in preventing downwash from reaching the ground level around the development perimeter. Serviceability wind conditions at specific locations requiring improved wind conditions, such as the through-site link, could be improved through local treatment during detailed design.

For such a large development with several similar sized towers designed in such a complex manner, it would be recommended to quantify the wind conditions and confirm the qualitative findings using wind-tunnel testing.

Wind conditions within the development

There are several wind amelioration issues that could be employed within the development and private areas to improve the serviceability wind conditions. As the primary purpose of the podium roof is to divert flow away from ground level, windy areas will exist on the podium roof, particularly around the corners of the towers. Activating these spaces will require local amelioration such as fences or landscaping to create calmer areas. The placement of awnings along the base of the towers may be beneficial in locally mitigating any downwash flows from the building façades. Similar conclusions apply to the rooftop areas on level 10 of buildings A and D although these areas would be expected to have a large component of horizontal flow and therefore vertical amelioration elements would be more appropriate.

The communal outdoor area on the podium roof will be prone to steady high wind speeds, due to the wind channelling through the gaps between the buildings, combined with facade downwash effects as discussed. Placement of porous screens near these gaps to channel the flow away from the recreational areas, creating local landscaped protected areas, or moving primary communal areas closer to the shielding provided by the buildings would be recommended. The residential pool is likely to be exposed to prevailing winds from the south. Wind conditions around the pool are expected to be suitable for the wind speed associated with the pedestrian sitting criterion for about 70% of the time, which is considered normal for a podium roof pool without mitigation. To further improve the wind conditions in this area, the pool could be moved to the shielded area on the north-east corner of building D. Alternatively, localised screening or landscaping around this area could be used to improve the wind conditions in this area. These design details to improve the amenity for residents would be best developed during detailed design through wind tunnel testing to quantify the local wind environment.

The primary ground-floor pedestrian through-site link that traverses the development from north to south will experience steady pressure-driven flows for all wind direction, but most noticeably for winds from the south. Amelioration measures such as screens inside the entry could be used to manage this effect.

Balconies on high-rise buildings generally experience uncomfortable wind conditions for outdoor sitting activities during certain wind conditions. In general, balconies should not be exposed on corners as they are more prone to high wind speeds accelerating around the corner. Fins should be placed on balcony corners wherever possible to improve resident comfort so that the balcony is only open on one face. For all wind directions, wind conditions on upper levels will be used at the residents' discretion. Residents will rapidly determine when the environmental conditions are suitable for the intended use of the space. The lift lobbies to the residential buildings have also been isolated from the outdoor areas, which is beneficial in avoiding internal flow issues.

Conclusion

The proposed development is taller than surrounding buildings. The four towers are expected to affect the pedestrian level wind environment around the perimeter of the development with certain areas becoming windier and others calmer depending on the wind direction. However due to the presence of the podium and canopies over exposed areas the overall impact is not expected to be significant. The environmental wind conditions at ground level around the proposed development are expected to be suitable for pedestrian standing or walking from a comfort perspective and pass the distress criterion, which is considered acceptable for an urban development.

Within the development, downwash from facades and channelling effects between towers are expected to create issues for planned outdoor spaces under certain wind conditions. The through-site link is expected to have constant flow along the smallest cross-sectional area and may not be suitable for café style activities without additional amelioration. Wind conditions are expected to be suitable for pedestrian standing or walking activities and pass the distress criterion under Lawson. To quantify the qualitative advice, a more detailed analysis using wind-tunnel testing would be required.

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.