Parkgate Street Residential Blocks B and C

Microclimatic Wind Analysis and Pedestrian Comfort - Balcony Railing Assessment

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1. Executive Summary

This report compiles the results of Microclimatic Wind Analysis and Pedestrian Comfort Conditions undertaken by IN2 Engineering Design Partnership for the proposed changes to the balconies on the development at Parkgate St based on 3D modelling information received from Reddy A+U, comprising of assessments for predicted Wind Conditions to the local environment.

The proposed development is located on the River Liffey across from Heuston Station and is bounded by Parkgate St to the north. The surrounding site terrain consists generall of densely developed buildings to all directions, with the exception of the Northwest, which comprises of the relatively open spaces of Phoenix Park. Each relevant surrounding terrain has been accounted for within the wind simulations undertaken.

The report summarises the analysis undertaken, and conclusions determined from simulations performed with regards to Wind/ Pedestrian Comfort, in all cases validating results in accordance with robust Best Practice Guidelines to ensure compliance in accordance with the methodologies described in Section 2.0.

Wind Analysis was assessed utilising Airflow Simulation techniques through Computational Fluid Dynamics (CFD) SimScale software for the proposed development as detailed in Section 3.0. This determined regions of positive and negative pressures and associated predicted wind velocities for the proposed development for varying wind speeds and directions.

These wind simulations were then compiled and assessed against Lawson Criteria (Lawson LDDC Comfort) Methodology - an assessment method for Pedestrian Comfort to predict activity suitability (sitting/ standing etc.) for the balcony amenity spaces.

The initial assessment included railings, as opposed to the original glass balustrade design, to all balconies on Blocks B and C, excepting those on the north façade facing Parkgate St. The analysis predicted comfortable levels on most of the balconies.

However, some balconies were determined to require the addition of 1.1 m tall solid panels, either in the form of an “L” placed on one end of the balcony or a full screen surrounding the entirety of the balcony. Through the addition of these mitigation measures to the affected areas, all balconies were predicted to have comfortable conditions.

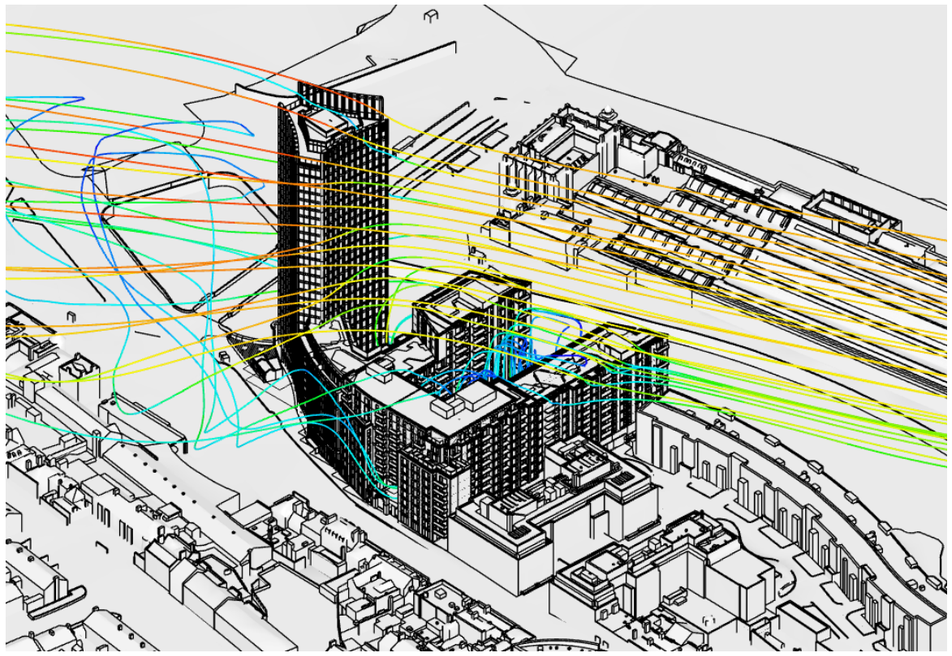


Figure 1.1: CFD Simulation Results – predicted wind velocity streamlines from the prevailing wind direction (SW).

2. Methodology

2.1. Microclimatic Wind Analysis

In order to determine the predicted wind patterns around the proposed development, airflow simulations were undertaken using Computational Fluid Dynamics (CFD) software (SimScale). This enabled an assessment of the site wind conditions: highlighting zones of high pressure, negative pressure, and air movement for varying wind conditions.

An initial 3D representational model of the existing buildings and their immediate surroundings was created, and simulations undertaken for 12 cardinal wind directions.

Wind Climate Data was taken from the Global Wind Atlas. This utilises a microscale modelling system, enabling localised wind data to be obtained for high resolution (250m grid) topography, including representation of both natural landscaping such as hills, ridges, as well as urban environments.

Figure 2.1 illustrates Global Wind Atlas data for the general Dublin area, indicating average wind speed at 10 m height. The relative sheltering of the Urban area can be seen, in contrast to Dublin Airport to the North, and Dublin/ Wicklow mountains to the South, and exposed coastal locations.

Recorded wind speeds for Dublin Airport are relatively high- in what is one of Europe's windier meteorological weather station locations. The identified site at Parkate Street, Dublin 8 is seen to be in a relatively sheltered area as highlighted in Figure 2.1. On a macro level, the site is surrounded by Phoenix Park to the Northwest, and a mixture of dense urban spaces on all other sides.

The CFD simulations utilised wind profiles accounting for terrain effects. Allowing for the nature of the site and location, a surface roughness layer profile representative of "Towns, villages, agricultural land with many or high hedges, forests and very rough and uneven terrain (z_0=0.4m height)" was utilised, derived from GIS survey analysis[1].

Figure 2.2 indicates the modelled long-term annual "Wind Rose" obtained from the Global Wind Atlas for the site at Parkgate Street. The rose diagrams illustrate the frequency that wind will be from a certain direction and at what speed. It can be seen how the prevailing South-westerly / Westerly winds entirely predominate due to the Atlantic gulf stream, with only lower occurrence from other directions.

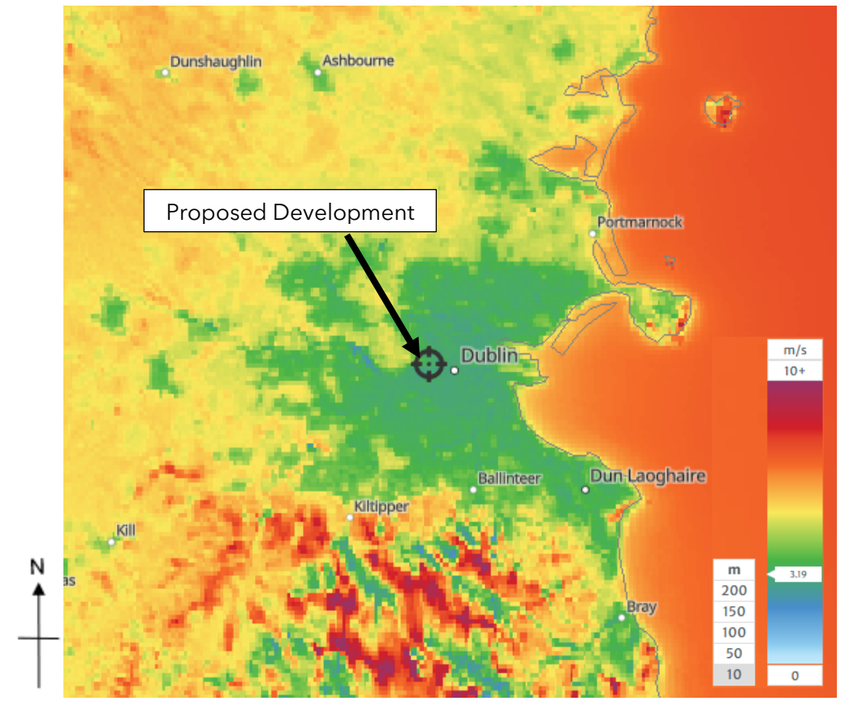


Figure 2.1: Mean wind Speeds across Dublin at 10m Height - Global Wind Atlas

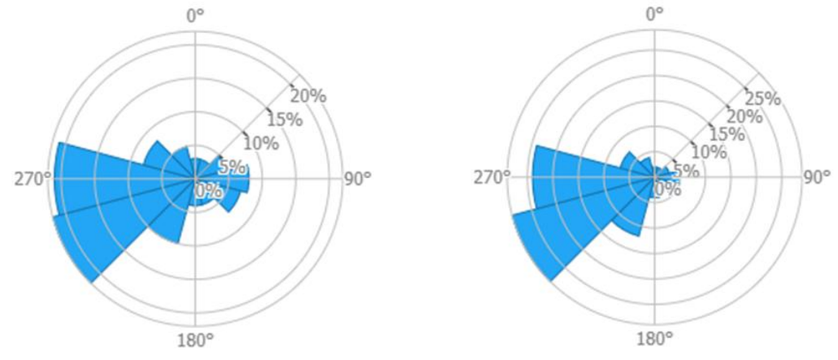


Figure 2.2: Wind Frequency Rose (left) and Wind Speed Rose (right) for Heuston Station - Global Wind Atlas

[1] European Space Agency's Climate Change Initiative Land Cover (CCI-LC) dataset v2.0.7.

As per Figure 2.3, 3D representational model of the proposed amendment and its surroundings was created, and simulations undertaken for 12 cardinal wind directions.

The analysis included representational models of adjacent commercial and residential buildings, including buildings currently under construction.

The CFD simulations form the basis of the Pedestrian Wind Comfort Analysis undertaken, which is described in detail in Section 2.2 below.

The methodology calculates predicted airflow patterns around buildings for all wind orientations and calculates average velocity applying weighting based on probability of occurrence throughout the year. It should be noted that wind effects around buildings for prevailing westerly wind conditions are deemed to have more of a potential impact to pedestrian discomfort, as these will occur on a more regular occurrence.

However, it should be noted that the methodology assesses averaged (hourly) wind conditions for the purposes of general pedestrian comfort and does not intend to predict gusting, abnormal nor potential future climate change conditions.

Nevertheless, the Lawson Criteria methodology basis, as described in detail below, has been proven to be a robust means of analysing Pedestrian Comfort and its basis has been successfully adapted and implemented in both National Standards (Netherlands NEN.8100) and Design Guidelines (City of London – Wind Microclimate Guidelines (2019)). There are currently no Irish or European Standards for Pedestrian Comfort.

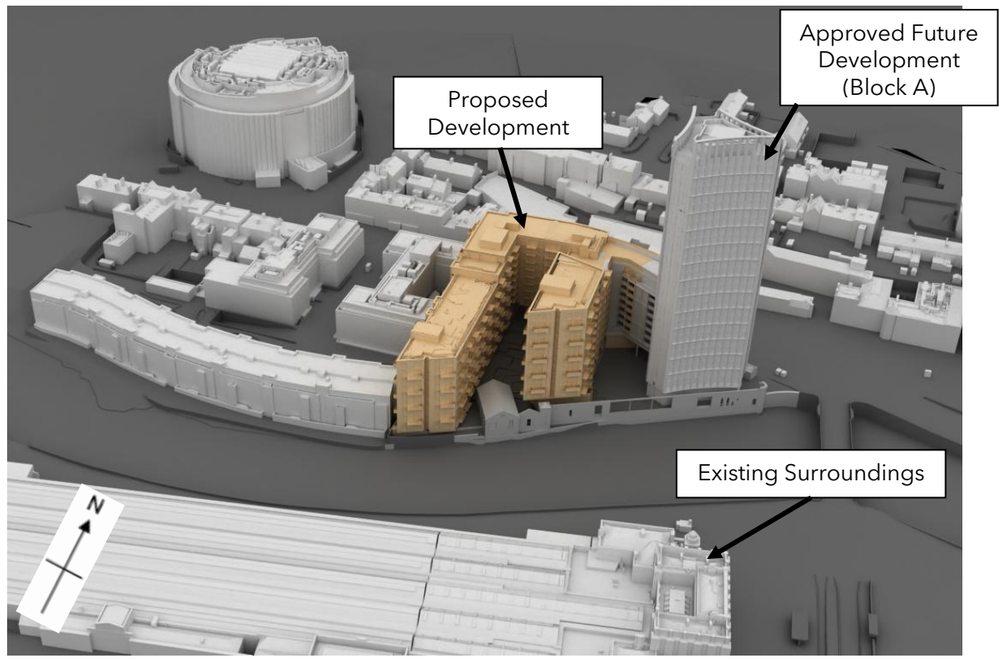


Figure 2.3: Model of Proposed Development and Neighbouring Buildings

2.2. Pedestrian Comfort

Pedestrian Wind Comfort was assessed utilising the "Lawson Criteria" scale, which has been developed as a means of assessing the long-term suitability of urban areas for walking or sitting, accounting for both microclimatic wind effects (i.e. site location and prevailing winds) and microclimatic air movement associated with wind forces influenced by the localised built environment forms and landscaping effects.

The original Lawson Criteria (as described in Building Aerodynamics, Tom Lawson, Imperial College Press, 2001) assesses probability of wind discomfort based on the Beaufort Scale as referenced in Figure 2.4.

Figure 2.5 illustrates the Lawson Criteria scale, as developed, and implemented to the City of London Guidelines as utilised and assessed within the report (termed LDDC Lawson Comfort Scale), which ranges from areas deemed suitable for long-term sitting through to regions uncomfortable for pedestrian comfort. "Pedestrian Walking" areas, for example, are defined as areas that would not experience wind velocities in excess of 8 m/s for more than 5% of the year, whereas uncomfortable areas would experience averaged wind velocities greater than 10 m/s for more than 5% of the year.

The assessment identifies areas where potential wind occurrence, based on probability of wind direction and speed, would either be mitigated (Outdoor Dining/ Pedestrian Sitting and Standing) or exacerbated (Business Walking/ Uncomfortable) due to proposed massing from potential developments.

However, it should be noted that in terms of pedestrian comfort, the Lawson Criteria assesses solely for wind/associated air velocity effects. Therefore, other environmental aspects that may influence a space's microclimate, such as exposure to sunlight and envisaged temperature variation throughout the year are not accounted for within this methodology.

Beaufort Force	Hourly-Average Windspeed m/s	Description of Wind	Noticable Effect of Wind
0	<0.45	Calm	Smoke rises vertically
1	0.45 - 1.55	Light	Direction shown by Smoke drift but not by vanes
2	1.55 - 3.35	Light	Wind felt on faces: leaves rustle: wind vane moves
3	3.35 - 5.60	Light	Leaves and twigs in motion: wind extends a flag
4	5.60 - 8.25	Moderate	Raises dust and loose paper: small branches move
5	8.25 - 10.95	Fresh	Small trees in leaf sway
6	10.95 - 14.10	Strong	Large branches begin to move: telephone wires whistle
7	14.10 - 17.20	Strong	Whole trees in motion

Figure 2.4: Beaufort Scale

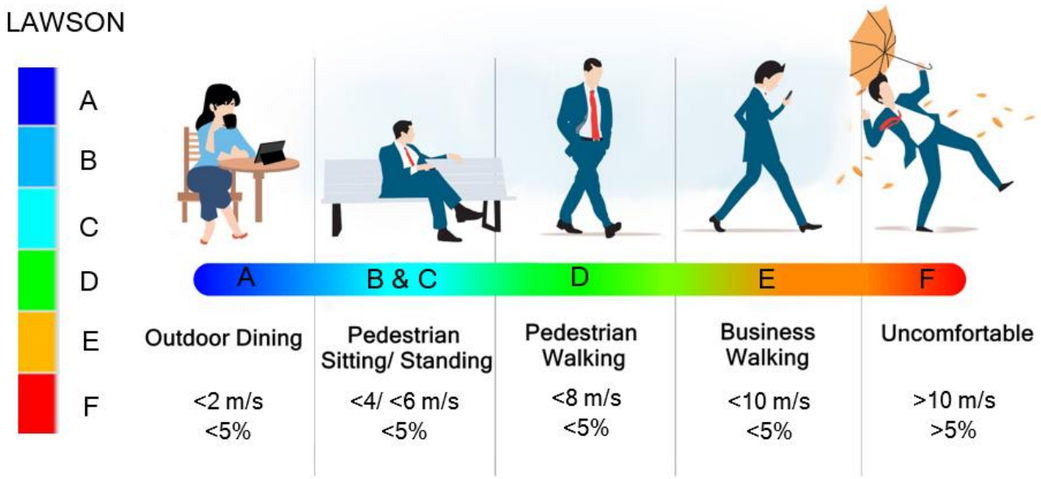


Figure 2.5: LDDC Lawson Comfort Scale

3. Prevailing Wind Analysis

Figure 3.1 illustrates the predicted wind velocity streamlines across the lower balconies on the east façade of Block B under the prevailing 240° (south-westerly) wind direction at average met wind speed (5.0 m/s).

The wind conditions in this region were analysed in more detail because the initial pedestrian comfort results indicated that the upper level balconies were sheltered, but the lower level balconies were experiencing acceleration. This is a deviation from typical results seen on apartment buildings.

As demonstrated in Figure 3.1, the acceleration across these lower balconies is a result of downwash off the much taller Block A. The prevailing wind flows freely over Blocks B and C before being forced down into the courtyard between Blocks A and B. It then moves across the east façade of Block B before circling around over the River Liffey and continuing onwards to the northeast.

The upper level balconies are too high to be affected by this downwash phemomenon, which explains why the pedestrian comfort analysis presented in Section 4.0 determined these spaces to be more sheltered than the lower balconies.

This analysis was used to inform the proposed mitigation measure in the form of an "L" solid panel on the north side of the affected balconies to prevent the downwash from coming across the space. Similar analysis was also conducted on other balconies across the scheme to optmise mitigation effectiveness. Further discussion on the mitigation measures in its effect on pedestrian comfort can be found in Section 4.0.

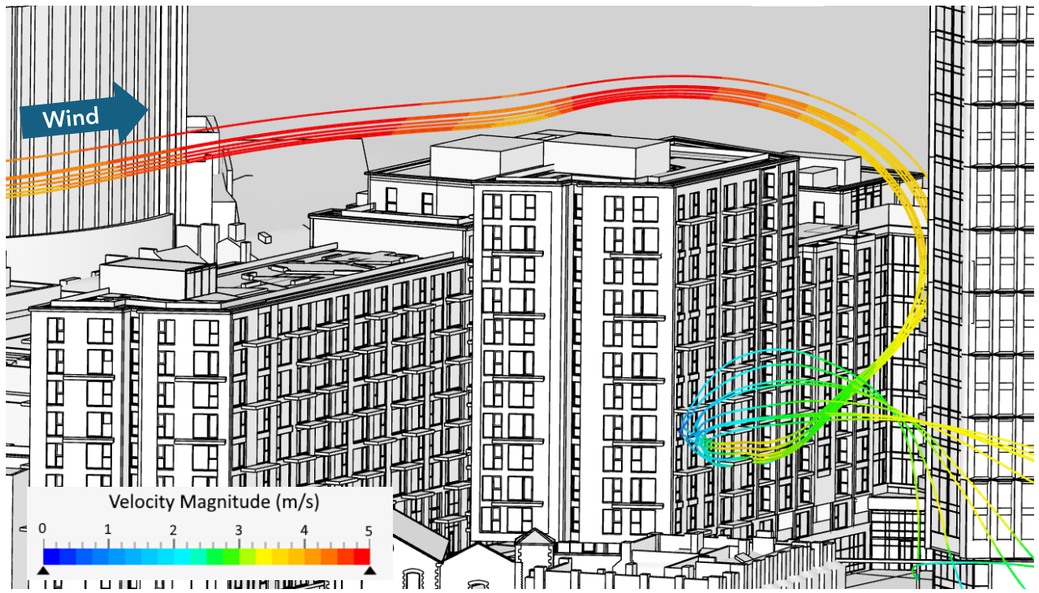


Figure 3.1: Wind velocity streamlines from prevailing SW wind direction across the train platforms north of the proposed development.

4. Pedestrian Comfort Analysis

4.1. Initial Assessment – No Mitigation

The Pedestrian comfort on the balconies of the proposed development was assessed by predicted the Lawson LDDC Comfort values at 1.5 m above floor level. The initial assessment analysed all balconies which were proposed to have their guarding changed from a glass balustrade to open railings. No solid panels, partial or full, were included.

The scale in Figure 4.1 outlines the Lawson LDDC Scale utilised. Blue contours illustrate the most sheltered regions, areas deemed "Suitable for Outdoor Dining". Light Blue / Cyan contours indicate regions "Suitable for Pedestrian Sitting" and "Pedestrian Standing", respectively. Green contours indicate areas "Suitable for Pedestrian Walking", with orange being illustrative of "Suitable for Business Walking". Red areas highlight zones as "Uncomfortable".

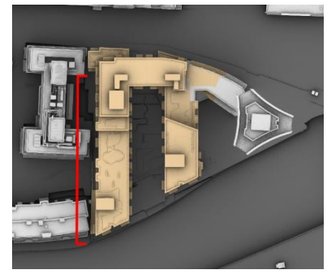
Figure 4.2 presents the pedestrian comfort results for the balconies on the west façade of Block C. These spaces were predicted to be sheltered from the wind despite the removal of the balustrade.

Many balconies across the scheme were similarly predicted to remain comfortable with the change to an open railing. However, some were determined to experience a degradation of comfort to a level unsuitable for a balcony. An example on the upper levels of the south façade of Block B is presented in Figure 4.3.

To improve conditions to these areas, solid panels were added to the affected balconies. The mitigation measures added are discussed in the following section.

	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

Figure 4.1: Lawson LDDC Criteria



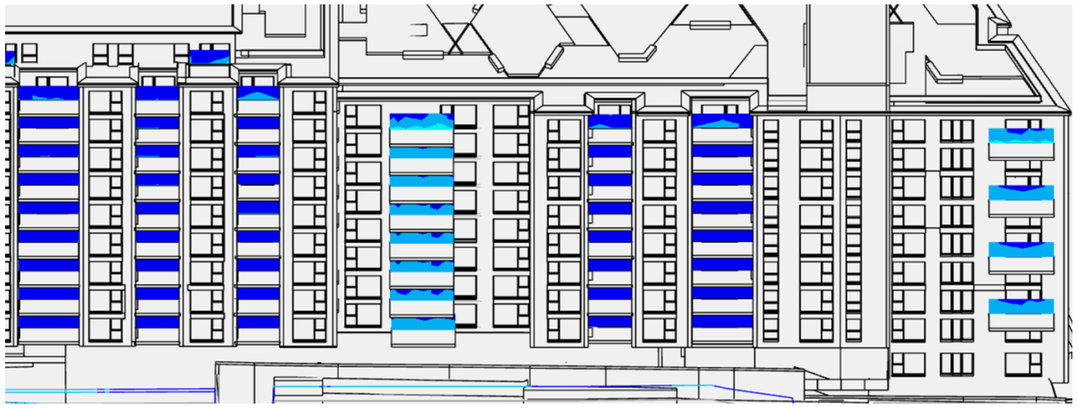
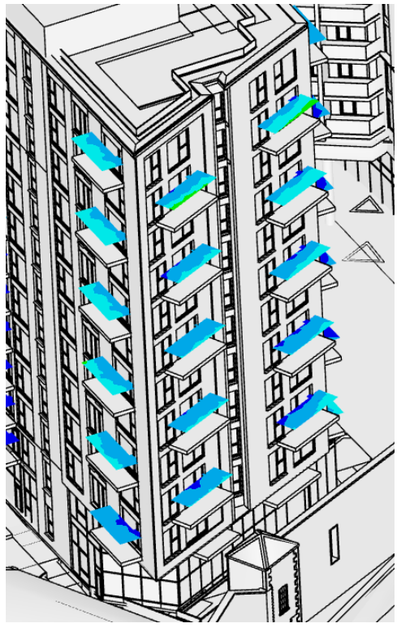


Figure 4.2: Lawson Criteria results at 1.5 m above balcony level on the west façade of Block C.



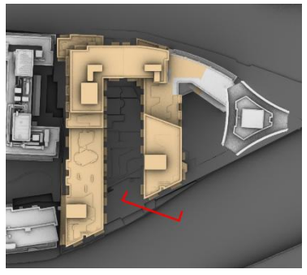


Figure 4.3: Lawson Criteria results at 1.5 m above balcony level on the south façade of Block B.

4.2. Proposed Mitigation

In order to improve the predicted comfort conditions on some of the balconies, solid panels were added where required. The type of solid panel and orientation for each balcony was informed by the predicted wind patterns across the area. Architectural input from Reddy A+U was also considered in the development of these solutions.

Two types of solid panels were used, and these are presented in blue in Figure 4.5. For most balconies, a smaller "L" panel to one side of the balcony was sufficient to shelter the space. However, more exposed balconies were determined to require full sceens to protect the occupants from acceleration.

Figure 4.6 present the predicted Lawson Criteria values on the south façade of Block B including the proposed mitigation. These are the same balconies presented in Figure 4.3. Due to exposed position of these balconies, a full screen was added. These screens were determined to provide significant improvement to the predicted wind conditions, with the majority of the area deemed suitable for "Outdoor Dining / Pedestrian Sitting".

Overall, with the addition of the mitigation panels to some areas, all balconies were predicted to be comfortable for occupant usage. Full results for all balconies can be found in Appendix A.

	A	2 m/s	< 5%	Outdoor Dining
	B	4 m/s	< 5%	Pedestrian Sitting
	C	6 m/s	< 5%	Pedestrian Standing
	D	8 m/s	< 5%	Pedestrian Walking
	E	10 m/s	< 5%	Business Walking
	U	10 m/s	> 5%	Uncomfortable

Figure 4.4: Lawson LDDC Criteria

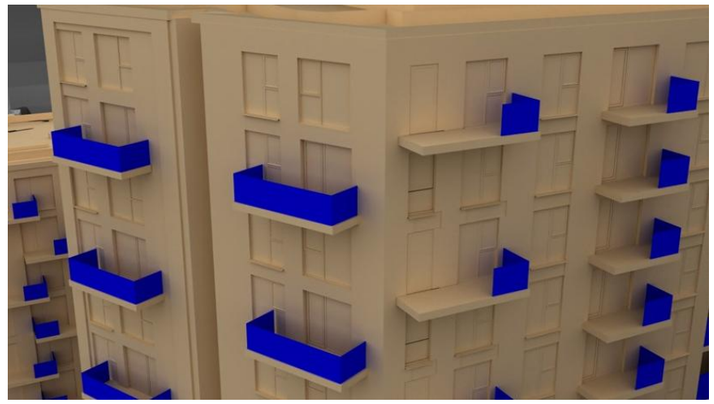
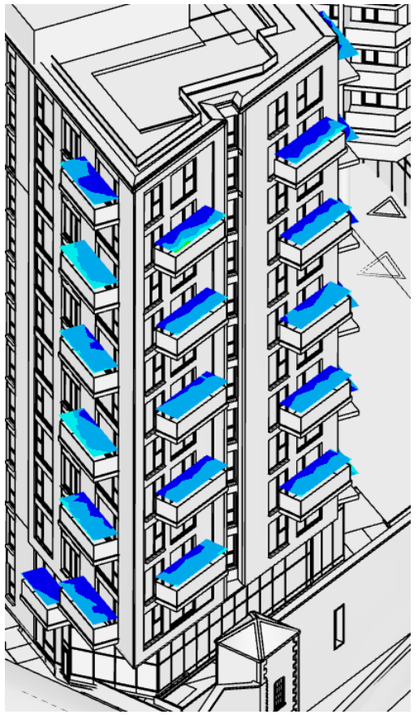


Figure 4.5: Lawson Criteria results at 1.5 m above ground level on elevated entry walkway, viewed from the top.



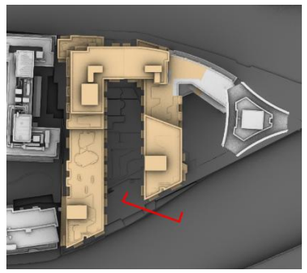
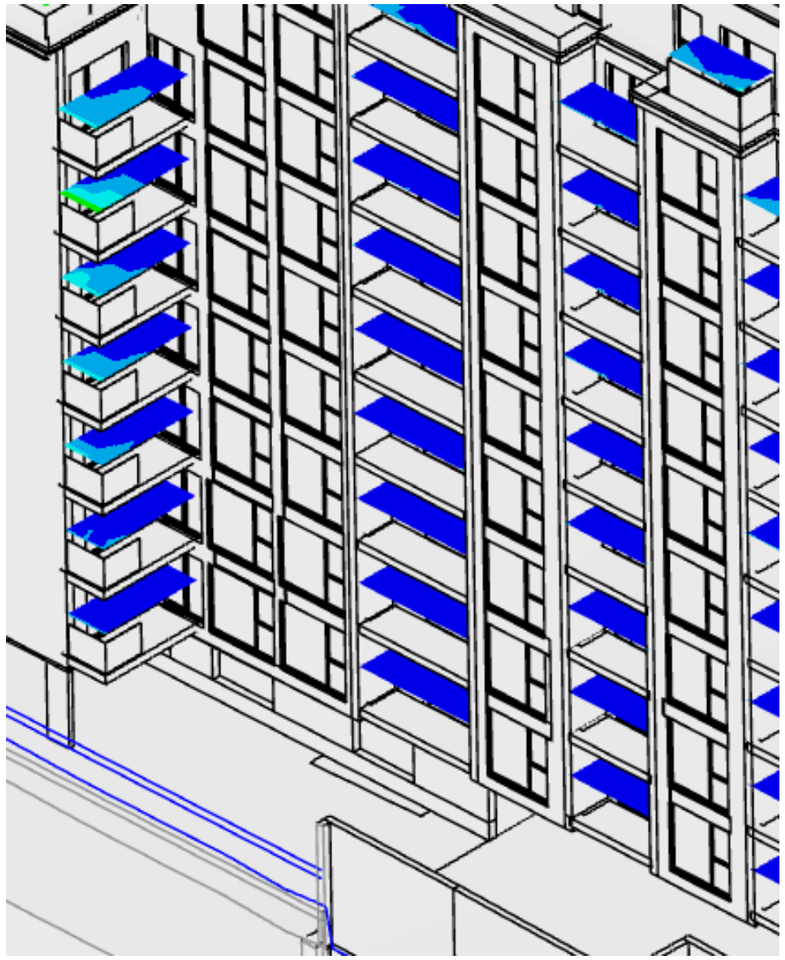
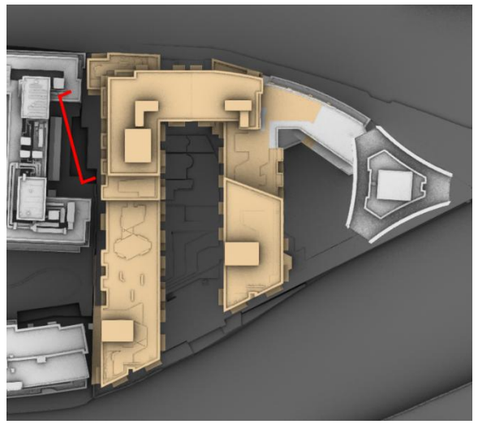


Figure 4.6: Lawson Criteria results at 1.5 m above balcony level on the south façade of Block B including mitigation measures.

5. Appendix A – Balcony Comfort Results





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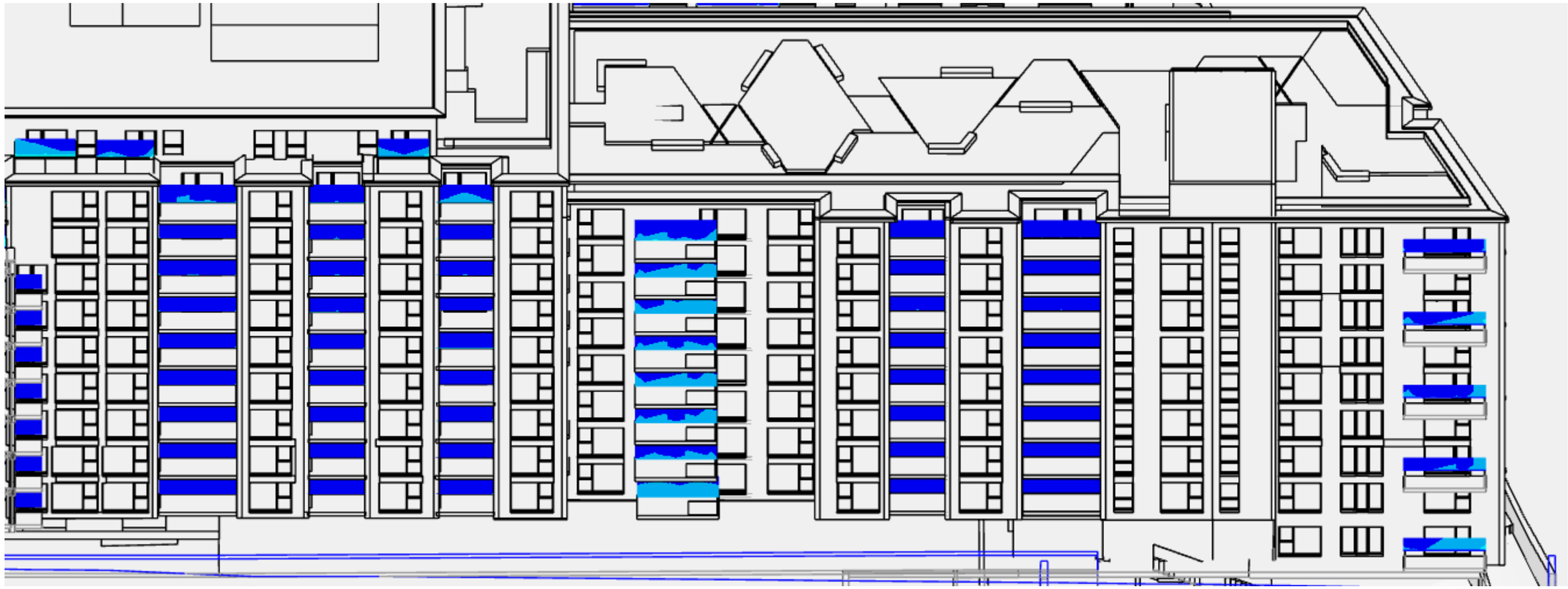

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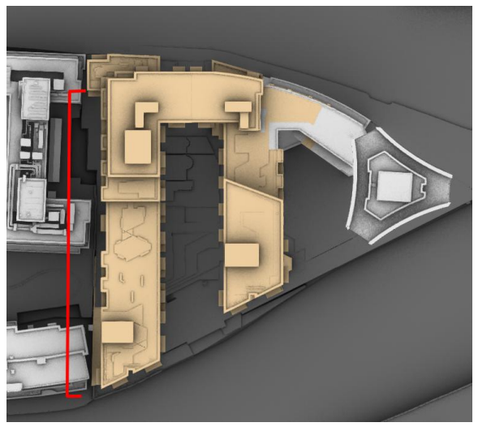

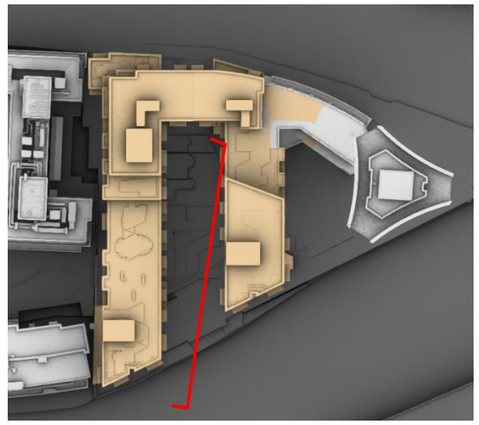

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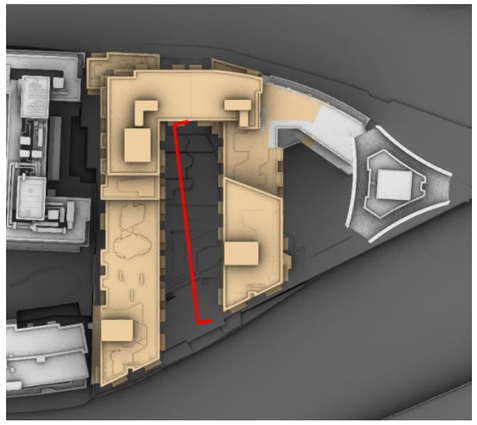

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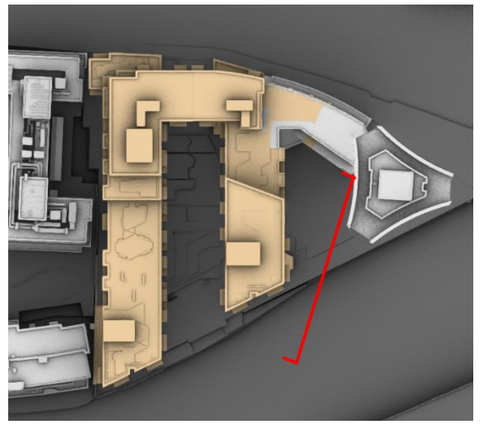

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