

Wind Desktop Study for Holiday Inn Express building, Manchester



aeroeffect

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1. Executive summary of the study

Background

AeroEffect was commissioned to prepare a Wind Desktop Study to assess the impact on the local wind microclimate from a 2-storey extension of the Holiday Inn Express building located at 2-4 Oxford Road, Manchester M1 5QA. The existing state of the development has been approved under application No. 082205/FO/2007/C3 on March 4th, 2008. In this application, no wind microclimate study has been performed for this development. The initial application was for 11 storey building. The purpose of this Wind Desktop Study was to analyse the ability to develop an extension of 2 floors to the subject building and to assess the impact of this alteration on the local wind microclimate. The work was commissioned by Manchester Property Holdings Ltd under the Short Form Letter of Appointment signed on 2024-01-19. The consulting architects for the alteration are Stephenson Hamilton Risley STUDIO.

Conclusions

The conducted Wind Desktop Study for the 2-storey extension of the Holiday Inn Express building located at 2-4 Oxford Road, Manchester M1 5QA led to the conclusion that, in the professional opinion of the study authors, **the desired levels of pedestrian wind comfort at and around the building will not deteriorate due to the proposed alterations of the building and the impact of these alterations on the wind environment in its surroundings is mostly neutral and negligible.**

The wind microclimate in the area is largely dominated by the presence of several much taller buildings in the vicinity of the subject development, which even after the alteration will be of moderate height and in the average within its surroundings. The immediate surroundings of Holiday Inn Express are covered in dense development, with generally no sitting or outdoor dining places that could be particularly sensible to increased wind speeds. No additional mitigation measures against the effect of the proposed alteration on the local wind conditions are required.

Furthermore, the proposed alteration will not impact the local wind microclimate in such a way that could produce or increase risk or danger to pedestrian/cyclist safety.

2. Basis and scope of the study

Basis of the study

The following documents and materials are the basis for this study:

- Short Form Letter of Appointment signed by Manchester Property Holdings Ltd and AeroEffect Sp. z o.o. (along with its attachments), which details the scope and conditions of preparation of this study;
- E-mail correspondence between AeroEffect Sp. z o.o. and representatives of Stephenson Hamilton Risley STUDIO and Heeton SG 50 Ltd;
- Architectural drawings and visualisations of the current and proposed scheme of the development;
- 3D model of the subject development with its surroundings, including the terrain orography, in .skp format;
- Pedestrian activity and entrances map for the development.

Scope of the study

The scope of the Wind Desktop Study includes:

- General information about the wind and pedestrian wind comfort;
- Analysis of the current and proposed development scenario along with its surroundings;
- Analysis and description of the anemological conditions of the site and local wind characteristics;
- Conclusions and recommendations regarding the proposed alteration of the subject development.

3. Introduction and general information

3.1 Wind characteristics

Winds are meteorological phenomena which consist of motion of air – from high-pressure areas to low-pressure areas. Winds at the lowest level of the troposphere (layer of atmosphere that is closest to the earth's surface), where humans generally live and operate, are caused by macro- and mesoscale weather systems that are created at higher altitudes, as well as by local, microscale effects, which are caused by the terrain roughness elements. It is common knowledge that wind speed increases with altitude above the earth. Another characteristic of the wind is its **turbulence**, that is the fluctuation of a momentary speed around a mean value. Wind turbulence is mostly prevalent in the atmospheric boundary layer, closest to the earth surface, as it is caused by terrain roughness (topography, obstacles like buildings and trees). Wind turbulence decreases with altitude above the earth. Based on these two parameters, **vertical (mean) wind speed** and **wind turbulence intensity profiles** can be used to characterize the relation between wind speed (or turbulence intensity) with height above the ground. They usually can be described by power law or logarithmic functions. Examples of these profiles prepared for terrain roughness category IV, are shown in Fig. 3.1 [1]. They are easy to describe as a relationship of non-dimensional parameters by adopting a certain reference height z_{ref} and wind velocity at this level as V_{ref} , which is, in particular, useful for translating the model tests results to real-life scale.

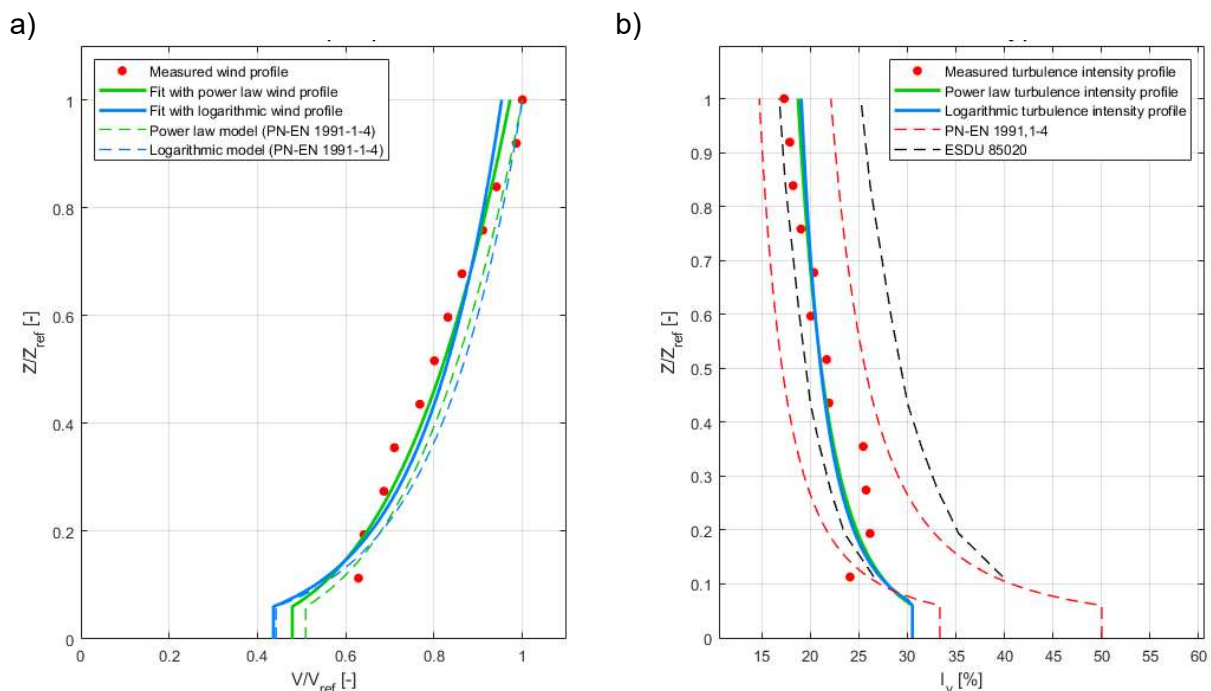


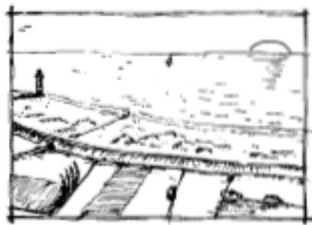
Fig. 3.1 Exemplary vertical wind profiles for a terrain category IV (based on wind tunnel model tests): a) vertical mean wind speed profile; b) vertical turbulence intensity profile

Different vertical wind profiles were the basis for creating terrain roughness categories, which are depicted in [2]. The standard highlights 5 different terrain categories, which are summarized in Tab. 3.1. Some of the works on the subject also indicate another terrain category which is linked with city centres with dense, tall or very tall, urban development [1].

During the year, the wind may blow from all different directions, some of which are more prevalent than others. This is characterized by seasonal or yearly **wind roses** (see chapter

4.2), which can vary between locations. Wind roses may show either the frequency or mean wind speeds in each direction. They are based upon data from meteorological stations, which usually average their measurements on a 10-minute basis.

Table 3.1. Different terrain roughness categories, according to [2]

Terrain category 0 Sea, coastal area exposed to the open sea	
Terrain category I Lakes or areas with negligible vegetation and without obstacles	
Terrain category II Area with low vegetation such as grass and isolated obstacles (trees, buildings) with separations of at least 20 obstacle heights	
Terrain category III Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (such as villages, suburban terrain, permanent forest)	
Terrain category IV Area in which at least 15% of the surface is covered with buildings and their average height exceeds 15 m	

Winds that are generally considered either for construction loadings and pedestrian wind comfort are **synoptic winds**, which are stationary and, by definition, do not change their velocity or direction rapidly. Such winds are dominant throughout most of the time, however, other frequent winds are **gusts**, which are rapid increases in wind speed and/or changes in direction that happen momentarily and can be generally more troublesome for pedestrians. Other types of winds are associated with **extreme weather conditions** which may happen either during thunderstorms (**downbursts**), **hurricanes** or **tornados**. These extreme cases are not discussed in this study, as their incidence is very rare and random, there is still research going on to find out more about their nature and they are generally considered as dangerous conditions for humans.

As mentioned above, obstacles such as buildings can vastly modify the structure of the winds in the boundary layer of the atmosphere ([3], [4]). It is common knowledge that wind speeds are highest in open terrain, such as sea shore or farmlands, while they decrease in an urban

environment. Buildings may block the paths of airstreams and natural channels of urban ventilation.

On the other hand, urban development may also cause the amplification of wind speed in a given area. On a more local scale, this often happens around the corners or edges of buildings. In a larger area, the most common phenomena that can cause an increase in wind velocity at a given point are:

- **channelling**, the effect causing the narrowing of the air stream (*Venturi effect*), for example in the area between the tall buildings which are in close proximity (see Fig. 3.2),
- **vortex shedding** resulting from the presence of tall buildings (see Fig. 3.3),
- **downdrafting**, which is caused by the air hitting a tall building and then streaming down its height (usually at around 2/3 of its height, as some of the air stream should also bypass the building over the roof), occurring in particular at isolated buildings significantly higher than their surroundings (see Fig. 3.4).

As wind flow phenomena and fluid dynamics, in general, are very complex, it is not always clear or possible to analyse the exact causes of wind amplification at a given point. Various techniques, including CFD simulations and wind tunnel model tests (for example using PIV – Particle Image Velocimetry) are usually necessary to identify the causes of such effects and provide apt mitigation measures against them.

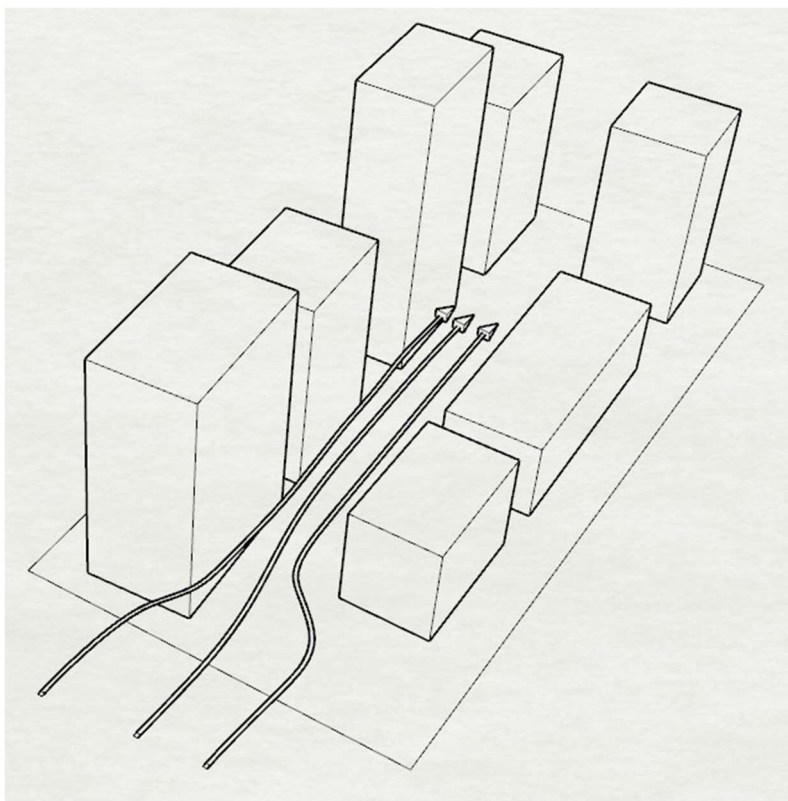


Fig. 3.2 The effect of wind channelling between two rows of buildings

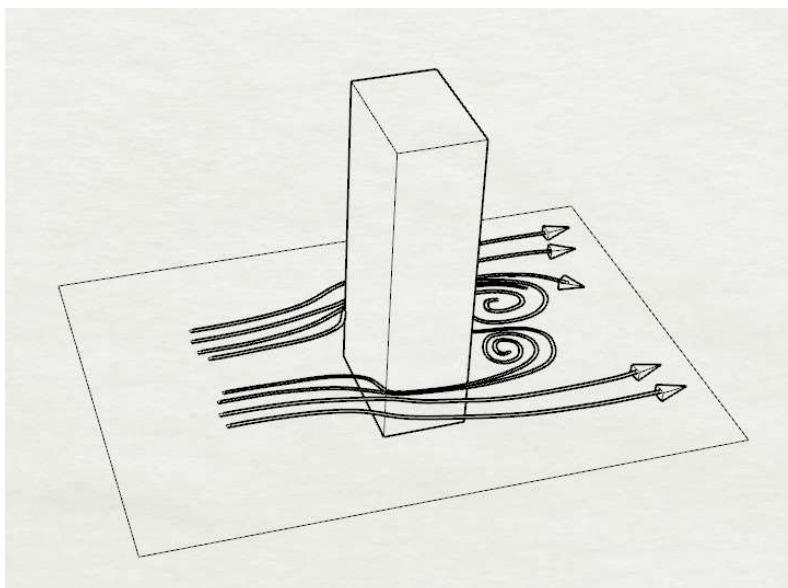


Fig. 3.3 The effect of vortex shedding in the wake of a tall building

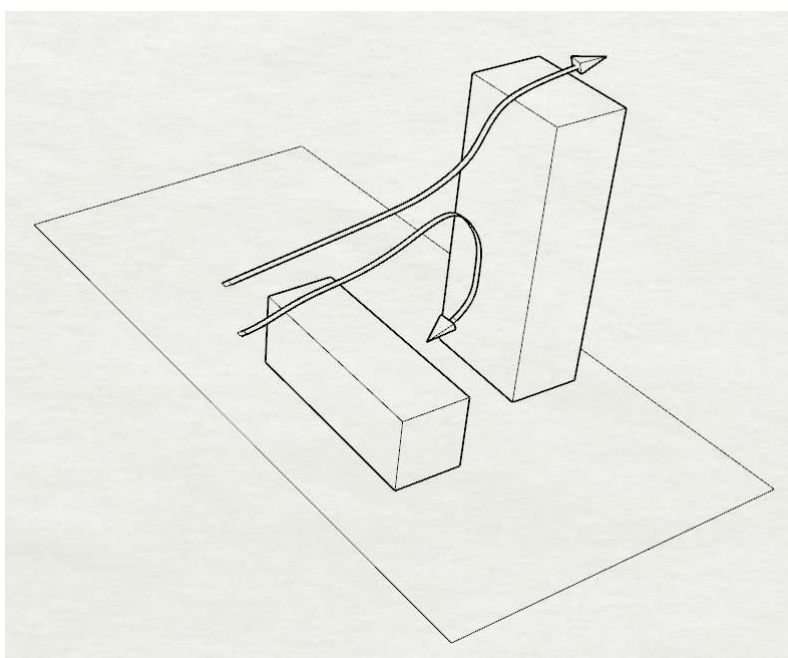


Fig. 3.4 Wind downdrafting down a windward wall of a tall building

3.2 Pedestrian wind comfort and safety

'Pedestrian wind comfort' is, in general, an individual sensation, subjective and different for each person. To properly analyse and evaluate it at a given location, one must adopt a set of criteria that would work for the general population and simplifying assumptions to quantify it over a limited number of variables. Table 3.2 provides a tangible list of links between a given wind speed (together with its type) and its observable effects on people. 'Steady wind' means the wind with little to no variance in speed and direction and low fluctuation, 'unsteady wind' means the wind with significant changes in speed and/or direction and high fluctuations, 'gusts' mean sudden and strong accelerations in wind speed lasting for only a few seconds. The sensation is based on many different factors, which can be divided into three main categories (the most significant factors usually applied in the analyses are marked in **bold**):

- Meteorological: **wind velocity and turbulence/gusts**, air temperature, humidity, sunlight, solar irradiance, cloudiness, precipitation, air pollution;
- Physiological: age, gender, **type of physical activity**, clothing, **time of exposure**;
- Psychological: weather expectations, health condition, mood, **level of accommodation**.

Tab. 3.2. Potential sensations and effects on the general population during basic wind events

Steady wind	Unsteady wind	Gusts	Effect on people
5 m/s	3 m/s	4 m/s (5 s)	Fluttering of hair and clothing
10 m/s	7 m/s	7 m/s (5 s)	Disheveling hair
25-33 m/s	17-22 m/s	15 m/s (2 s)	Losing balance
		20-23 m/s (2 s)	Toppling/falling over

Furthermore, assigning a certain wind comfort category at a given location does not mean that comfortable wind conditions are provided there at all times. Different types of wind comfort criteria have been developed [5] in an attempt to categorize what is referred to as ‘comfortable conditions’ for certain outdoor activities, but they are always based on two parameters: threshold wind speeds V_{TRH} and threshold probabilities of exceedance P_{TRH} (defined either directly as probabilities or indirectly as ‘number of wind events per a given time’). In the case of the most common wind comfort criteria, usually either the wind speed or the probability of exceedance assumes a fixed value, with the other parameter used to define the criteria for specific activities.

Another parameter that has to be taken into consideration is the height at which pedestrian wind comfort is determined. This height should correspond with the average person’s upper body or head level while in the location, which is usually adopted at 1.5-2.0 m, depending on the criteria. This value should always be related to the ground level at a given location, which is particularly important when considering uneven terrain.

Pedestrian wind comfort is heavily location-specific, as aerodynamic interference – especially resulting from the proximity of several tall buildings – may have a large impact on pedestrian wind comfort [6]. In order to obtain reliable results, several wind directions around the site should be investigated, usually at least 12 (the exact number depending on the local requirements and varying from 12 to up to 36; it is customary to assume 16 wind directions with a step of 22.5°). For each of these directions, the local wind speed and turbulence intensity vertical profiles (which determine how the wind speed and turbulence change along the height of the boundary layer) should be determined, based on the terrain roughness category specified for that direction. This can be defined as boundary conditions for the CFD simulations or wind tunnel tests and has to be applied over a certain ‘fetch length’ for the inflow to properly form the equilibrium conditions at the windward edge of the model.

To account for different types of winds (as per Tab. 3.2), one can apply different statistical values of the wind speed from measurements/tests. It is customary to use either mean wind speed, maximal wind speed (which usually leads to overly conservative results) or ‘gust equivalent mean’ wind speed V_{GEM} , which is defined as:

$$V_{GEM} = \frac{V_{gust}}{1.85} \quad (3.1)$$

where V_{gust} is the highest wind speed sustained for at least 3 seconds with a 50-year return period (or probability of exceedance of 2% per year).

Finally, meteorological (anemological in particular) data for the site, usually obtained from the closest meteorological station, is required. This is commonly given in the form of wind roses, probability distribution plots or histograms. This data gives information about the frequency/probability of wind flow from each directional sector, but also, information on the distribution of wind speed from that sector, most often approximated by Weibull distribution.

To summarise, pedestrian wind comfort at any given location is calculated based on the following parameters [5], [7], [8]:

- Wind speed (mean, maximum or gust equivalent mean) at this location, at the pedestrian level height and from each considered wind direction;
- Adopted pedestrian level height;
- Anemological data (frequency and velocity distribution) from each considered wind direction;
- Terrain roughness category (resulting in potentially different wind speed and turbulence intensity vertical profiles) from each considered wind direction.

In the United Kingdom, the Lawson comfort criteria are most widely used and considered an industry standard [9]. These criteria set a fixed value of the probability of exceedance threshold (usually at 5% for pedestrian wind comfort). The criteria for a given activity depend on the wind speed that can be exceeded no more often than the probability threshold. There are several variants of these criteria sets, varying on the exact values of the probability threshold or wind speeds associated with different categories, as well as on the precise descriptions of these categories. Recently, the most common one is the London Docklands Development Corporation (LDDC) variant, which is described in Tab. 3.3.

Tab. 3.3. Lawson LDDC pedestrian wind comfort criteria

Category	Threshold wind speed	Threshold probability	Activity/description
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

3.3 Measures against strong winds

At a later stage, when proper model tests of wind flow velocity would have been conducted, there might be requirements for mitigation measures in certain areas to enhance the local wind microclimate.

The simplest, most common and environmental-friendly solution is locating rows of bushes or trees along the pavements where the probability of threshold wind velocity exceedance is too high. As mentioned above, tree canopies act as a natural way of shielding against stronger winds.

Another way of breaking stronger winds are windscreens located around the building, which would disperse stronger winds and slow them down. Such windscreens can be made from perforated, decorative metal sheets and/or used for advertisements, posters, information boards or even art exhibitions. An example of locating wind screens around a building is shown in Fig. 3.5.

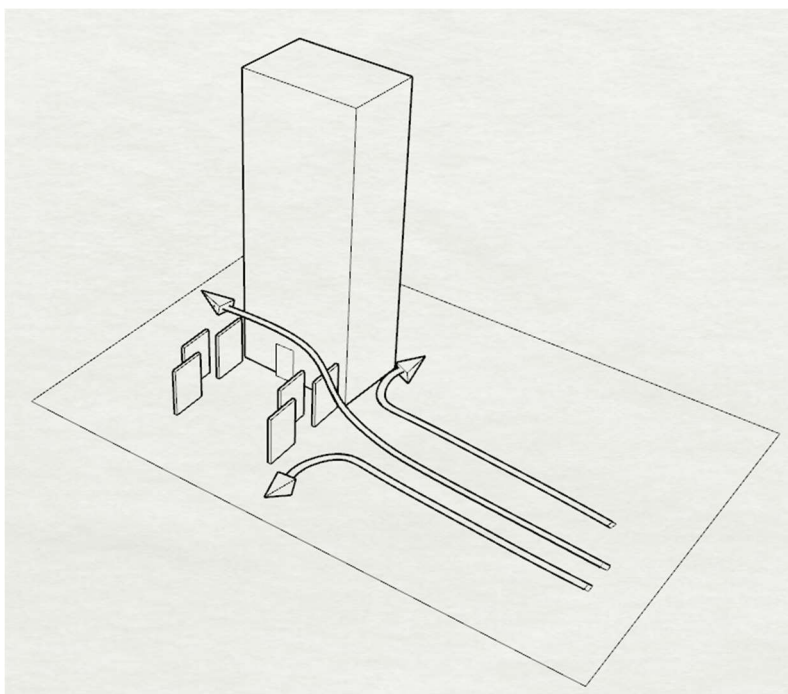
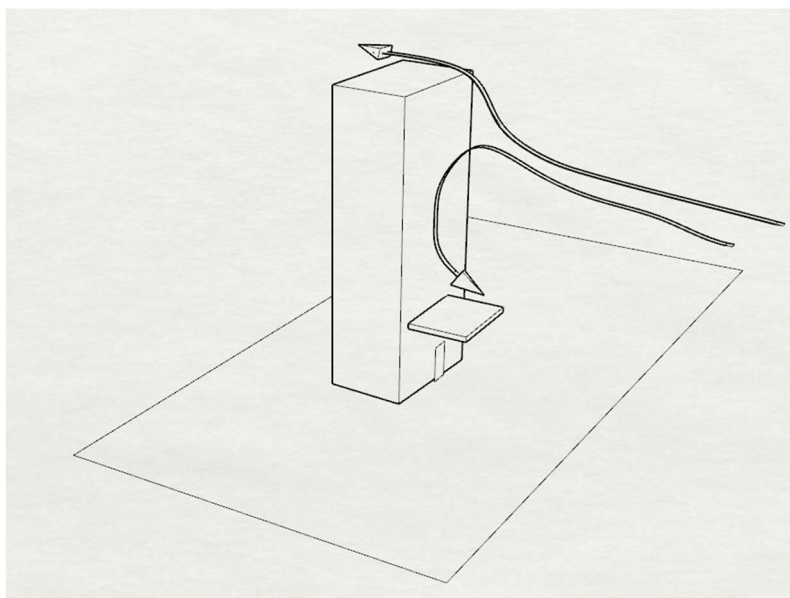


Fig. 3.5 Windscreens around a building

A countermeasure against downdrafts, which can have a large impact on human comfort and safety, can be done with short horizontal panels located just above the pedestrian level at the pavements. Such structures have shown large effectiveness in breaking down the stronger winds resulting from downdrafting. They can be either made as simple cantilever panels (Fig. 3.6a) or actual roofs above the pavement supported by poles and forming a kind of “tunnel” for pedestrians (Fig. 3.6b).

a)



b)

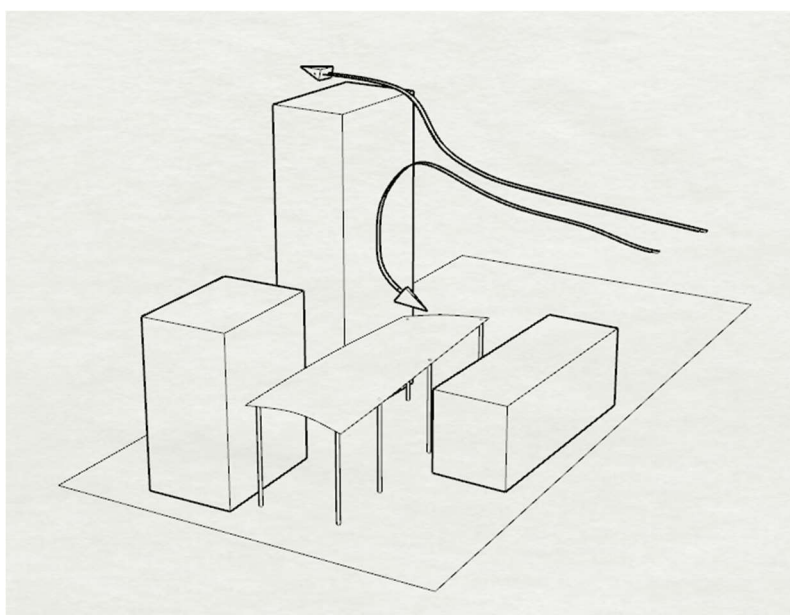


Fig. 3.6 Different types of mitigation measures against downdrafting: a) cantilever roof panels; b) passage for pedestrians supported by poles

4. Site information

4.1 The development

The Wind Desktop Study was carried out for the **Holiday Inn Express** building located at 2-4 Oxford Road, Manchester M1 5QA. Currently, the 11-storey building is 35.22 m tall, with its plan shape based on a triangle. The purpose of the Wind Desktop Study is to assess the impact on local wind microclimate from a 2-storey extension of the building, which would elevate its height by 7.87 m to a total height of 43.09 m. The building borders Hulme Street from the south and Oxford Road from the east, along its shortest façade, with the north-west façade situated directly along the River Medlock. The main entrances for the hotel guests are at Oxford Road and the service entrances are facing Hulme Street. The consulting architects for the alteration are Stephenson Hamilton Risley STUDIO. Visualisations of the building in its current state and after the planned 2-storey extension are shown in Fig. 4.1.

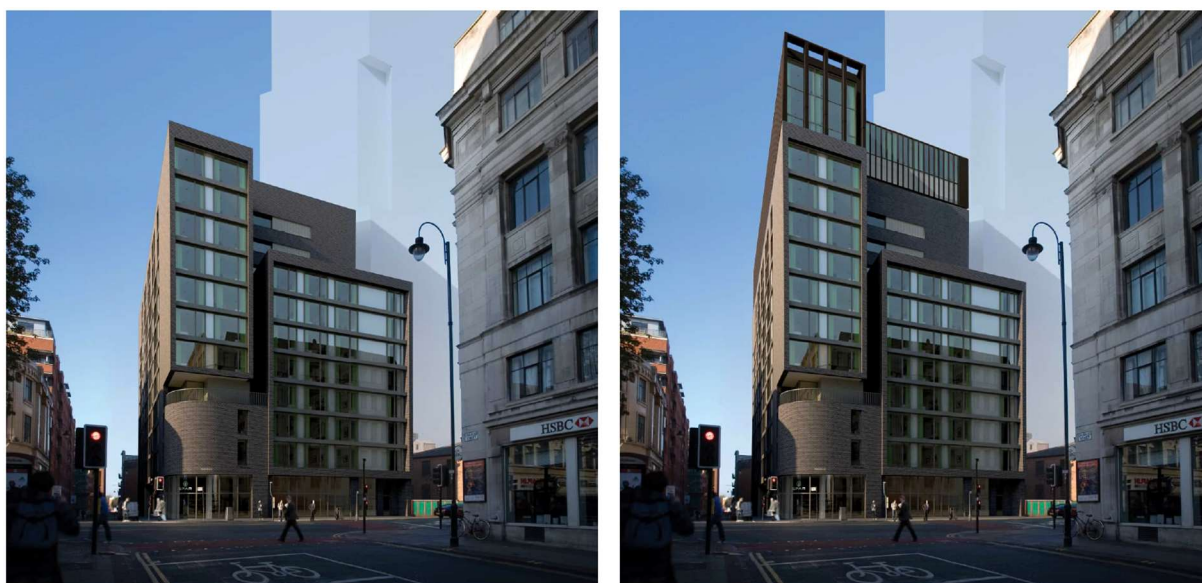


Fig. 4.1. Holiday Inn Express building in its existing form (left) and a visualisation of the proposed modification (right)

The subject development is located in the inner centre of Manchester at 53°28'24.2"N latitude and -2°14'24.8"E longitude, at the elevation of about 41 m above sea level. It is situated in a dense urban environment, in close proximity to several tall buildings and next to the Manchester Oxford Road railway station. Due to this, the main urban wind channels around its block are the railway track to the north and Oxford Road to the east. The location of the building in its urban context is shown in Fig. 4.2, with the Holiday Inn Express marked in red.

There are four buildings of significant heights located in close proximity to the subject development. Immediately to the north, across the canal of River Medlock, is **Artisan Heights** (1-5 New Wakefield Street), a 95 m tall (32 storeys plus ground floor) building erected in 2020. Its main function is student accommodation. Slightly to the northwest, about 60 m from the subject development, another apartment and student accommodation tower is located, which is **Bridgewater Heights** (17 New Wakefield Street), a 106 m (32 storeys) tall skyscraper completed in 2012. Further to the west, a number of tall residential buildings erected in 2016 are present, with **Cambridge Street Block A** being the tallest at 83 m (26 storeys) and located about 200 m from the subject development. About 90 m to the east of Holiday Inn Express is **Affinity Living Circle Square**, a 116 m (36-storey) residential building completed in 2021.

The immediate surroundings of the subject development, in a perspective view, are shown in Fig. 4.3. Fig. 4.4 presents these surroundings in a CAD model, with the subject development marked in red and the mentioned tall buildings marked in green.

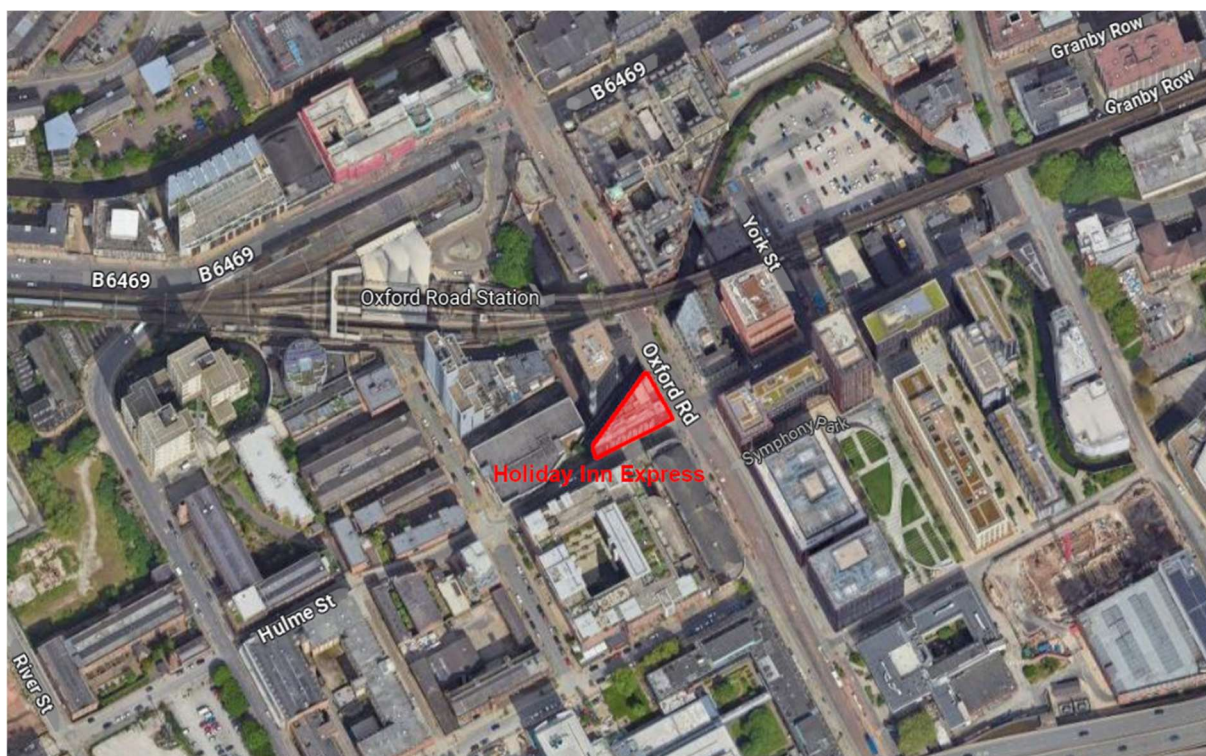


Fig. 4.2 Location of the Holiday Inn Express on the map of Manchester city centre

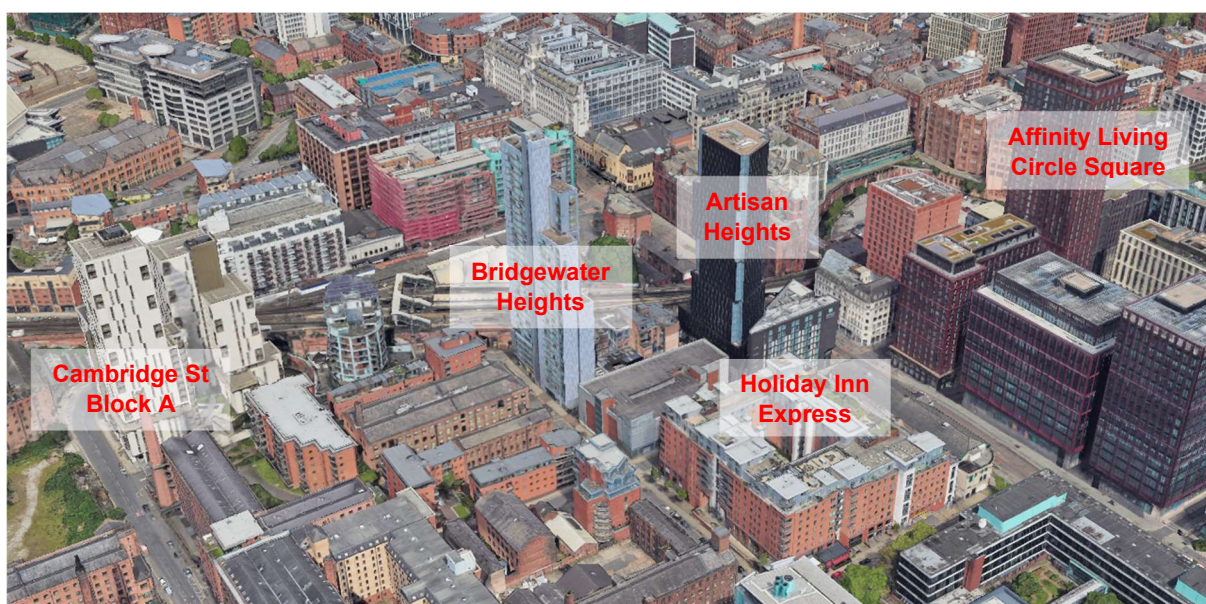


Fig. 4.3. View of the subject development and its immediate surroundings, with the tall buildings marked

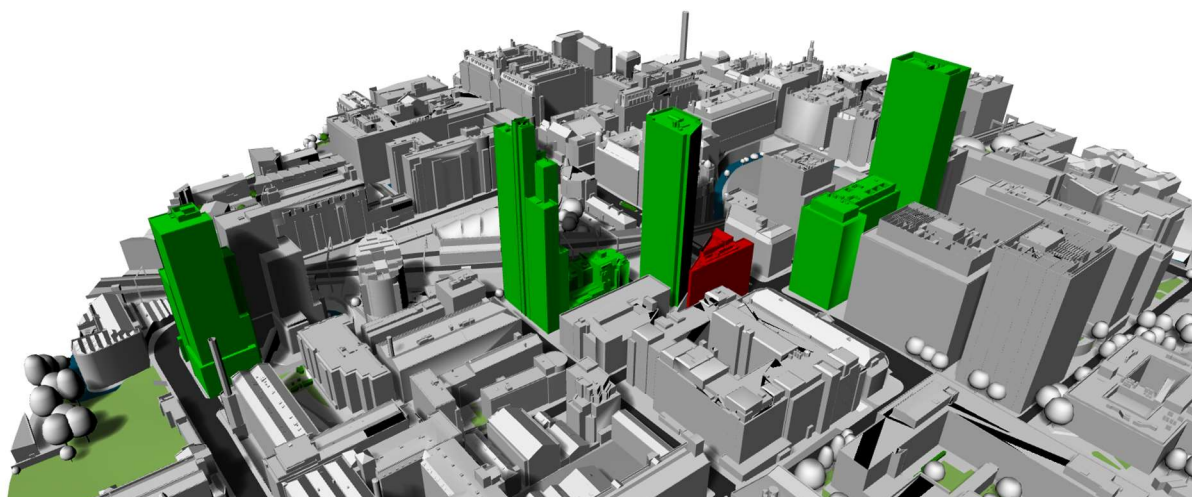
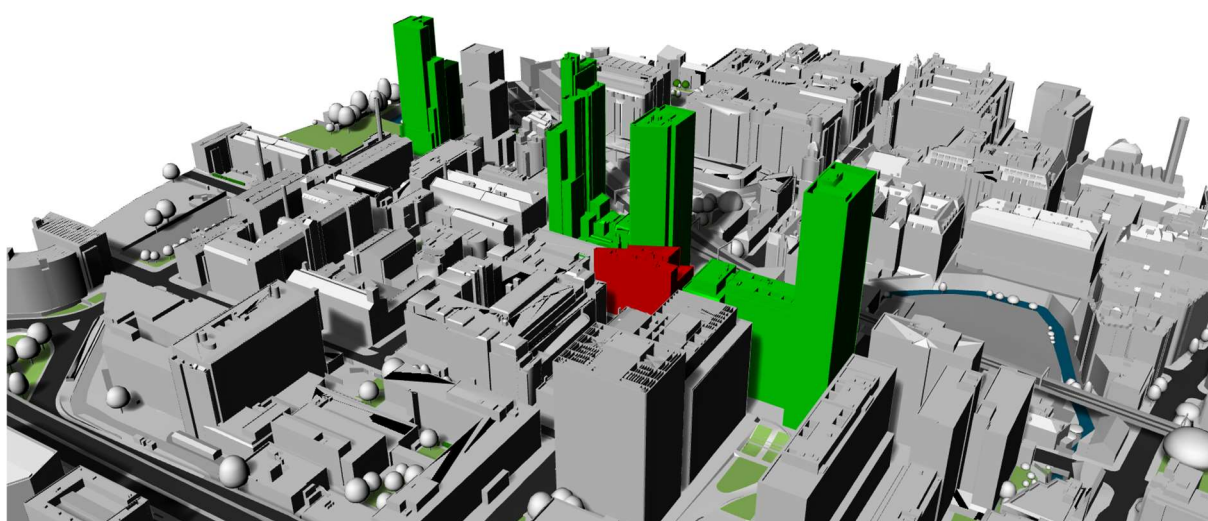


Fig. 4.4 CAD model of the surroundings, with Holiday Inn Express marked in red and the tall buildings in its proximity marked in green

4.2 Wind conditions around the development

Manchester is located in the North West region of England, in the city region of Greater Manchester. The city lies in a bowl-shaped land area, which is bowled to the north and east by the Pennines upland chain and to the south by the Cheshire Plain. The city centre is located on the east bank of the River Irwell, with Rivers Medlock and Irk also present in the area and River Mersey flowing through the south of the city. Much of the inner city is flat, with the city centre lying at a relatively low altitude of 35-42 metres above sea level.

Manchester is famous for being the first industrial city in the world, which can be largely attributed to its geography and climate: close proximity (about 56 km) of a seaport at Liverpool, availability of waterpower from its rivers and coal reserves. It experiences a temperate oceanic climate (Cfb according to the Köppen climate classification), with relatively warm summers and cold winters compared to other parts of the United Kingdom. The precipitation is regular but light, with an average annual rainfall of 806.6 mm and a mean 140.4 rain days per year, and the humidity level is relatively high. Snowfalls are not common because of the urban warming effects, besides the West Pennine Moors to the northwest, South Pennines to the northeast and Peak District to the east, which receive more snow.

The city lies at the centre of a green belt region, which extends into the wider surrounding countries, which reduces urban sprawl and further convergence of the nearby towns. The largest open space in the city is Heaton Park, covering an area of around 260 hectares. Manchester also contains protected green-belt areas with minimal development opportunities at Clayton Vale, Chorlton Water Park (which includes Chorlton Ees & Ivy Green nature reserve), the surroundings of the River Mersey and the area around Manchester Airport located on the south of the city.

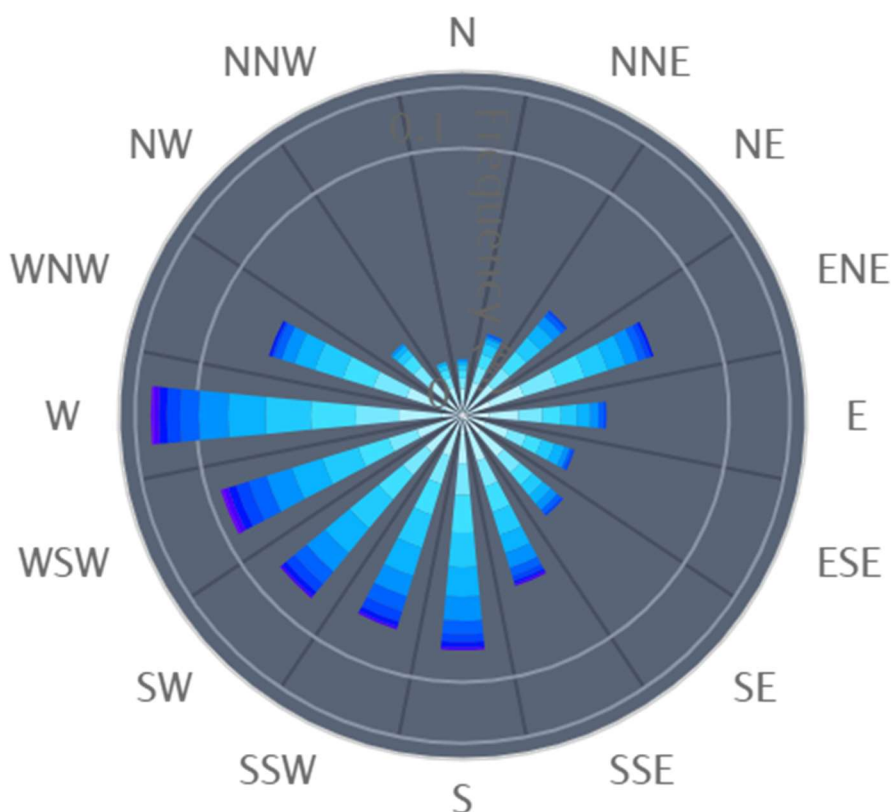


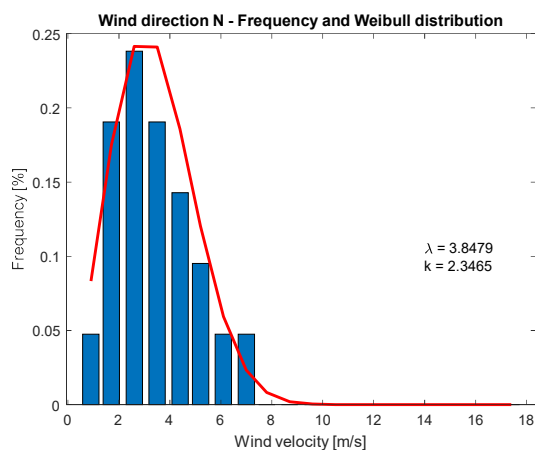
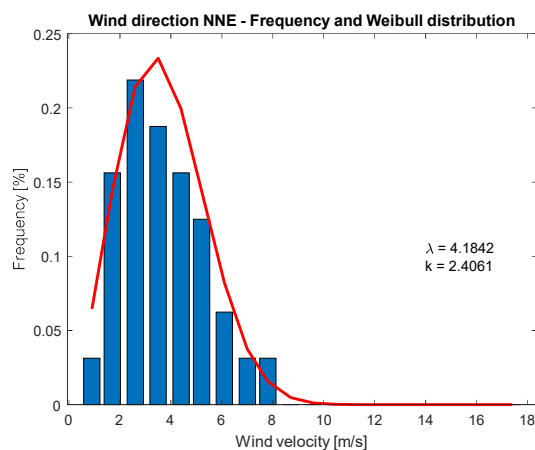
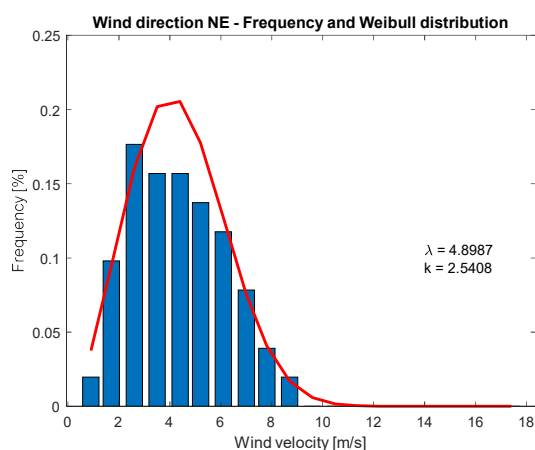
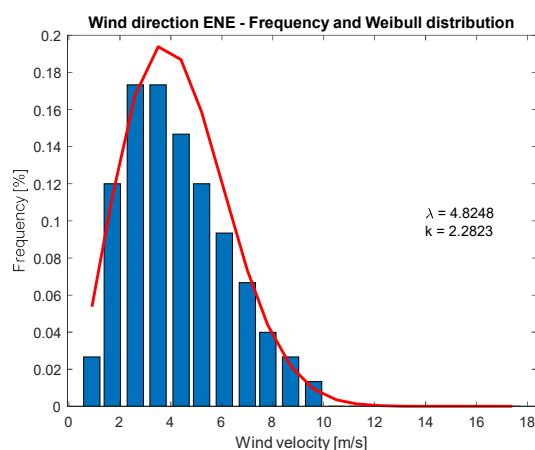
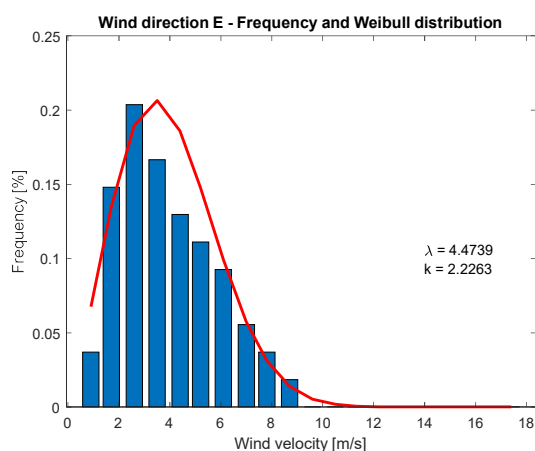
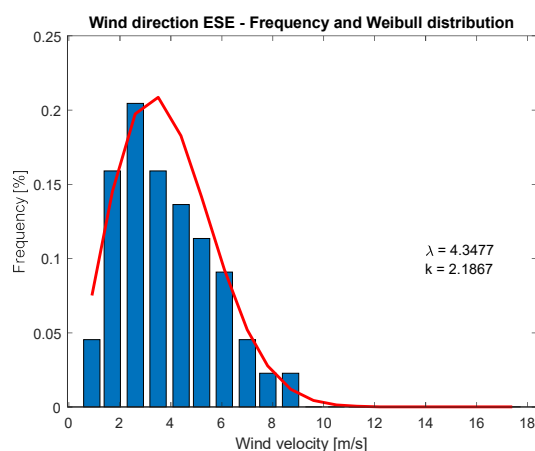
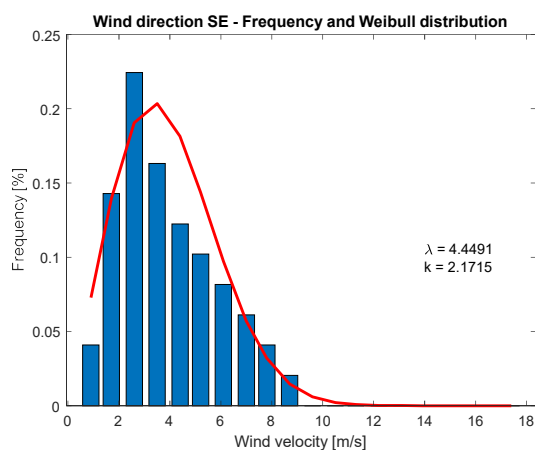
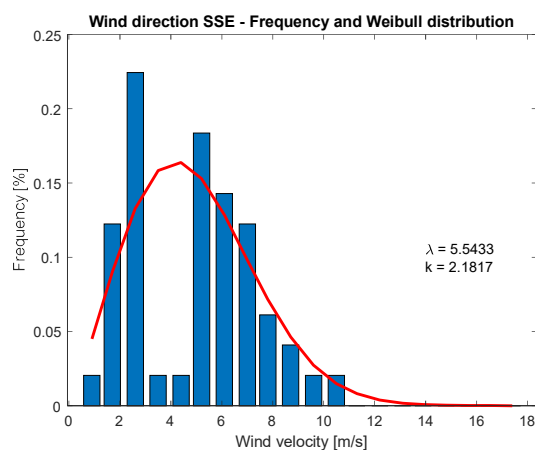
Fig. 4.5. Frequency wind roses for the location of the development in Manchester

Fig. 4.5 shows the yearly wind rose for the location. The wind rose was provided by *Meteoblue*. The frequency data, regardless of the wind speed, along with Weibull distribution parameters for each wind direction is shown in Tab. 4.1. As can be seen, west, south and south-west directions are most prevalent in the distribution, amassing about 55% of the total wind frequency between south and west north-west directional sectors. This can be partially attributed to westerlies, macrometeorological anti-trade winds which are predominantly southwest-bound in the middle latitudes of the Northern Hemisphere, but also from the local topography of the terrain around the city: proximity to the ocean from the west and Cheshire Plain to the south, together with the Pennines shielding the area from the north and east.

Tab. 4.1. Frequency wind data for the location

Wind direction	Frequency	Scale parameter λ	Shape parameter k
N	2.2%	3.85	2.35
NNE	3.4%	4.18	2.41
NE	5.4%	4.90	2.54
ENE	7.9%	4.82	2.28
E	5.7%	4.47	2.23
ESE	4.6%	4.35	2.19
SE	5.1%	4.45	2.17
SSE	5.1%	5.54	2.18
S	9.2%	5.59	2.57
SSW	7.9%	6.06	2.87
SW	9.3%	5.72	2.59
WSW	9.0%	5.84	2.36
W	12.3%	5.75	2.46
WNW	8.0%	4.92	2.54
NW	2.7%	4.12	2.52
NNW	2.2%	3.60	2.58

Based on the anemological data for the location, a series of plots was created for the Weibull distribution data on each wind direction, which are shown in Fig. 4.6. The collected data for all wind directions is shown in Fig. 4.7.



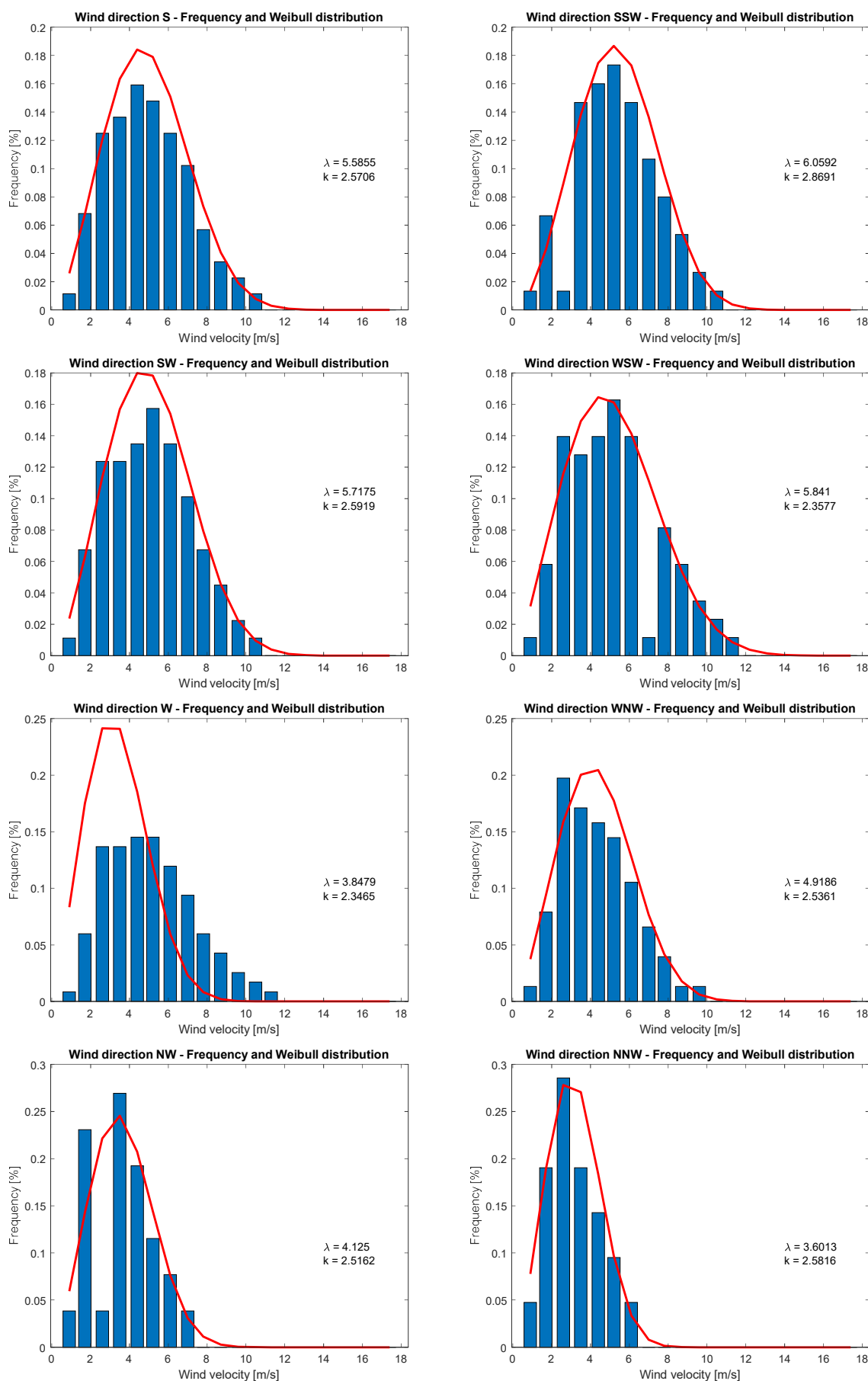


Fig. 4.6. Frequency and Weibull distribution plots for each of the 16 wind directional sectors

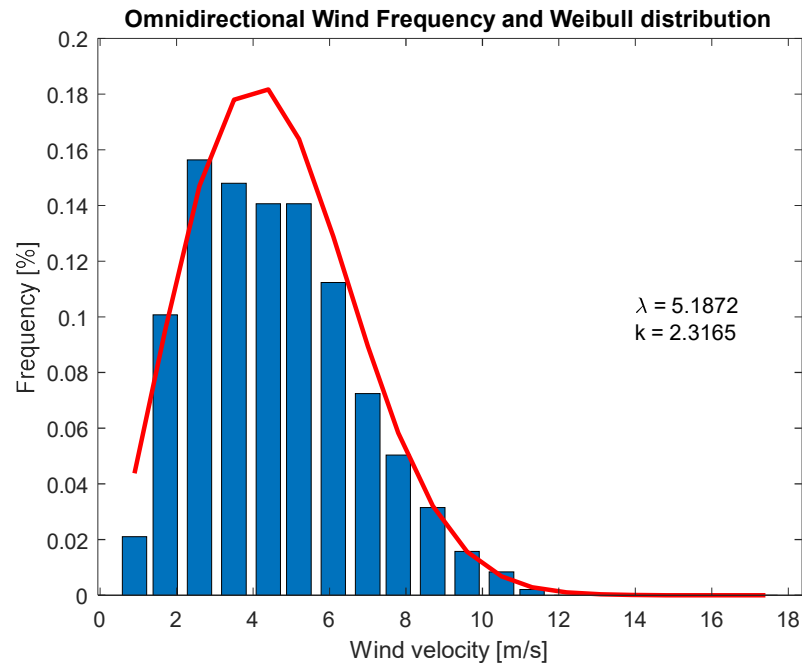


Fig. 4.7. Omnidirectional frequency and Weibull distribution plot

As can be seen from these plots, the mean wind speeds rarely exceed 10 m/s and are predominantly between 3 and 6 m/s. Directional sectors between S and W, which are the dominant ones in the frequency wind rose, are also characterised by slightly higher average (distribution-wise) mean wind speeds of about 5 m/s than the other sectors, where the mean wind speed is most often at about 3-4 m/s.

4.3 Planned pedestrian activities in the vicinity of the development

The surrounding streets are very busy with car and bus traffic, providing student routes for the nearby university. Therefore, there are, in general, no outside seating spots and the prime concern in the area is with wind comfort during regular pedestrian transit/business walking, crossing streets and building entrances. Fig. 4.8 shows the street views of the entrances of the Holiday Express Inn, while Fig. 4.9 presents the plan of pedestrian walking routes and entrances to the nearby buildings.

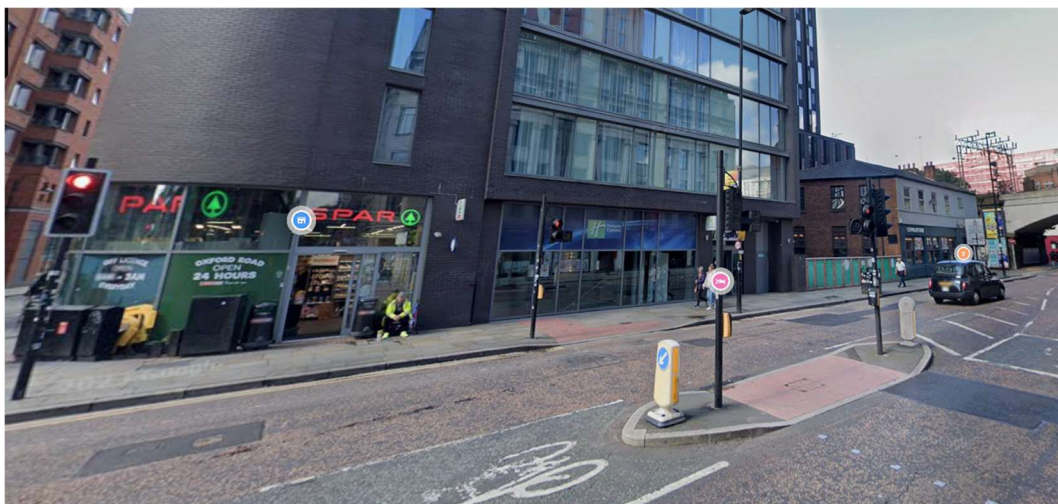




Fig. 4.8. Building entrances of Holiday Inn Express – street view

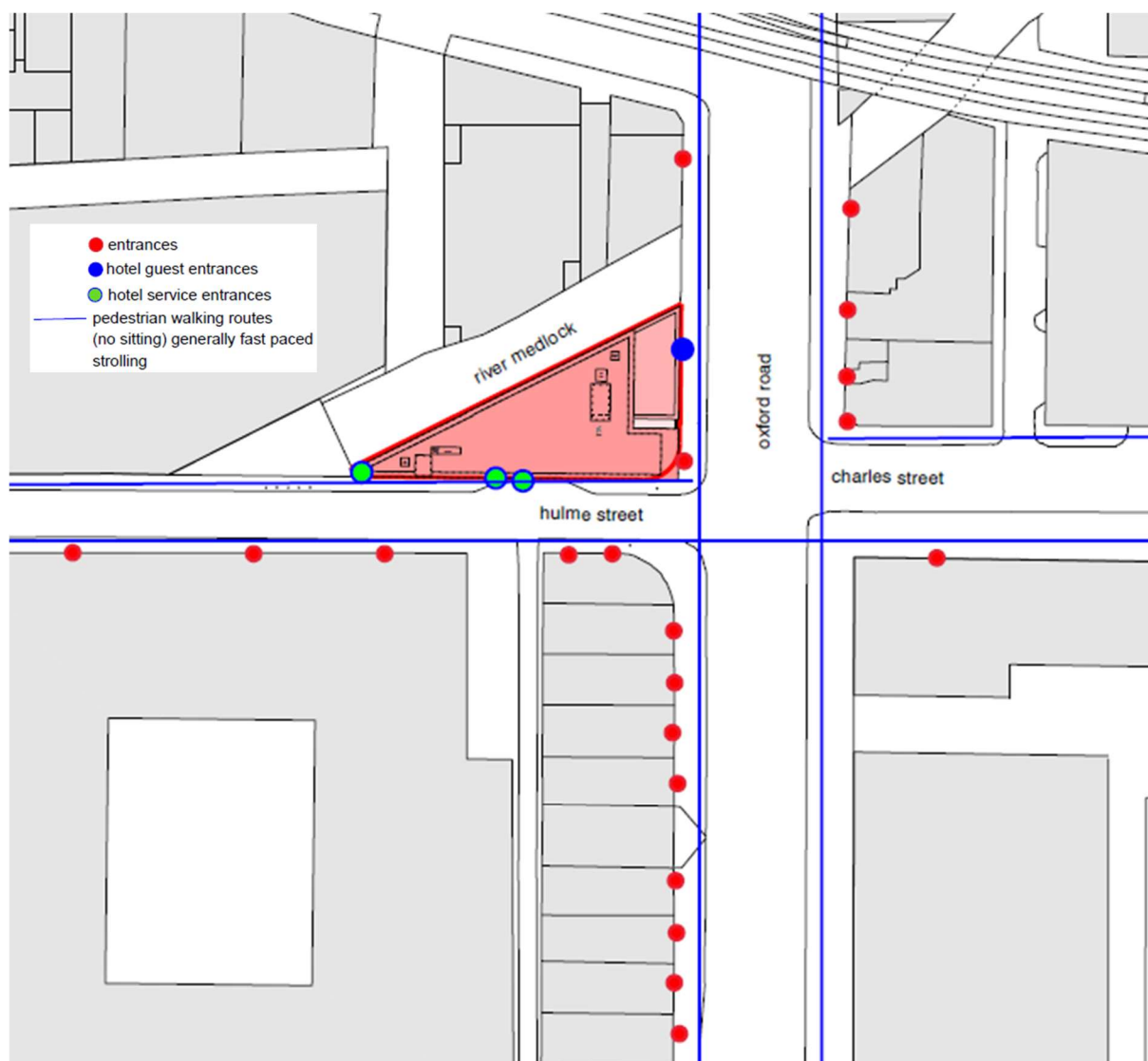


Fig. 4.9. Building entrances and pedestrian activity zones around the Holiday Inn Express building and its surroundings

5. Conclusions, recommendations and final remarks

The presence of significantly taller buildings in the vicinity of *Holiday Inn Express*, in particular *Artisan Heights* (planning application No. 119380/FO/2018) and *Bridgewater Heights* (planning application No. 091920/FO/2009/C1), which are located in the same block as the subject development (see Fig. 4.3 and Fig. 4.4), will have a dominating effect on any potential deterioration of local wind microclimate in the area. The other key factor for the local wind conditions is the dense development with similar average height, which includes the subject development. The proposed alteration will only result in about a 20% increase in height of the building, which will still classify it in the average height within its surroundings.

From the south and southwest directions, which are prevailing in the local wind rose, the building will be the first taller obstacle for the wind, however, its height even after the alteration will not be significantly taller than the buildings located to the south to cause the downdrafting effect. Furthermore, the immediate neighbourhood of the *Artisan Height* building to the north will likely have a key impact on these wind directions and on shaping the wind microclimate further down Oxford Road and at New Wakefield Street.

North, northeast and east wind directions are of mostly insignificant frequency in the local wind rose, besides east-northeast with 7.9% frequency. Directly from the north, the subject development is shielded by *Artisan Heights* and from the eastern directions, it is in the wake of several taller buildings, in particular, of the *Affinity Living Circle Square* (planning application No. 111026/FO/2016/C1). This will result in the impact of the proposed alteration on the local pedestrian wind comfort from these directions being negligible.

For the dominating western wind directions, a channelling effect (see Fig. 3.2) may occur along Hulme Street, which is caused by the dense developments of moderate heights on both sides of the street. The proposed increase of *Holiday Inn Express* height should not have any significant impact on this phenomenon. Furthermore, a mildly positive effect during the wind events from these directions may be caused by the alteration on Oxford Road directly behind it, where the wake of the building should be slightly longer, thus potentially shielding a further distance in this area where pedestrian transit routes are located. This is particularly useful considering the main/guest entrance of the hotel is located there.

For the southeast wind directions, the subject development is shielded by taller buildings and within their wake, thus its effects before or after the proposed alteration should be negligible.

For the northwest wind directions, where west-northwest is the prevailing wind direction, *Holiday Inn Express* is the first obstacle on the path of the wind, but this should not pose any adverse effects as the windward side of the building is located at the bank of Medlock River where no pedestrian activities are planned, so the impact is negligible. For other wind directions from this sector, the subject development is once again shielded by taller buildings.

Since the pavements along Hulme Street and Oxford Road in the immediate surroundings of the development, where any of its impact on the local wind microclimate could be non-negligible, are pedestrian transit routes (requiring the Lawson criteria categories D and E or higher, as per tab. 3.3) and building entrances (requiring Lawson criteria category C or higher), which should be fulfilled in the current state of the development and after the proposed alteration, without any additional mitigation measures. There are, in general, no sitting or outdoor dining places that could be particularly sensible to increased wind speeds. The recessed entrances for the hotel service along Hulme Street (see Fig. 4.8) are sufficient for mitigating the potential deterioration of the wind microclimate due to the channelling effect.

Based on the conducted analysis of the local wind conditions, the urban context of the subject development and the professional experience of the authors of this study, the following conclusions can be drawn:

1. The impact of the proposed alteration (addition of 2 storeys on *Holiday Inn Express* building located at 2-4 Oxford Road, Manchester M1 5QA) will have a **neutral and negligible impact on the local wind microclimate and pedestrian wind comfort**.
2. **No additional wind mitigation measures are required** for this alteration.
3. The proposed alteration will **not impact the local wind microclimate in such a way that could produce or increase risk or danger to pedestrian/cyclist safety**.

6. Authors of the study

Agnieszka Kocoń has a PhD degree in technical sciences in the field of civil engineering, with a specialisation in wind engineering and is a senior scientific and technical specialist at the Wind Engineering Laboratory of the Cracow University of Technology. She has 9 years of research experience in a wind tunnel where she participated in over 30 scientific and commercial projects in the field of wind engineering. She has also academic experience, having taught various subjects related to wind engineering. She has authored or co-authored over 20 journal and conference publications and she has presented her research at 4 international conferences on wind engineering, structural dynamics and computer methods in mechanics. She is a member of the Polish Association for Wind Engineering. She was a member of the organising committee of two international conferences on *Environmental Effects on Buildings and People* (EEBPVII, EEBPVIII) held in Poland. In her research work, she focuses on pedestrian wind comfort in urban areas, wind loads on buildings and wind actions on trains and railway vehicles.

Aleksander Pistol has a PhD degree in technical sciences in the field of civil engineering, with a specialisation in wind engineering and is a senior scientific and technical specialist at the Wind Engineering Laboratory of the Cracow University of Technology. He has authored or co-authored 6 papers related to wind-structure interactions and snow loads on buildings in renowned international scientific journals and presented his research at 8 international conferences on wind engineering, fluid mechanics and structural dynamics. He has over 7 years of experience in wind tunnel tests, mainly for structural applications, having worked on over 35 projects (including about 25 tall buildings) in Poland and the United Kingdom, concerning wind action on buildings, wind turbines or other structural elements. In his research and commercial work for the industry, he is mostly interested in issues such as wind loads on the structure and cladding, pedestrian wind comfort, wind-induced vibrations of tall buildings, vibrational comfort of the occupants of buildings and snow load on large-span roofs. He has a background in structural engineering, having worked for 2 years as a steel structures designer. He also serves as the Secretary of the Polish Association for Wind Engineering.

Marcin Baj, Managing director at Aeroeffect sp. z o.o., has 17 years of experience in civil and structural engineering. He has worked on designing and managing the design of bridges, tunnels, wind turbines, tall buildings, warehouses, shopping centres, façades/cladding, deep excavations and foundations among other projects, as well as working on structural health monitoring. He has been leading projects from extensions and refurbishments to schemes of multi-block developments worth over £1M. He has experience working on projects in various countries. Chartered in two disciplines:

- Certified Builder's Qualifications to design and manage construction work in construction and building specialisation without any restrictions (Polish chartered qualification equivalent to ICE and ISTuctE);
- Certified Builder's Qualifications to design in bridge construction specialisation without any restrictions (Polish chartered qualification equivalent to ICE and ISTuctE).

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References

- [1] A. Pistol, *Influence of terrain roughness on boundary layer simulation in wind tunnel*, doctoral dissertation, Cracow University of Technology (2023).
- [2] EN 1991-1-4, *Actions on Structures. General Actions. Wind Actions*, 2 (2011).
- [3] J. Hang, M. Sandberg, Y. Li, *Effect of urban morphology on wind condition in idealized city models*, Atmos. Environ. 43 (2009) 869–878. <https://doi.org/10.1016/j.atmosenv.2008.10.040>.
- [4] E. Ng, *Policies and technical guidelines for urban planning of high-density cities – air ventilation assessment (AVA) of Hong Kong*, Build. Environ. 44 (2009) 1478–1488. <https://doi.org/10.1016/j.buildenv.2008.06.013>.
- [5] A. Sanz-Andres, A. Cuerva, *Pedestrian wind comfort: Feasibility study of criteria homogenisation*, J. Wind Eng. Ind. Aerodyn. (2006). <https://doi.org/10.1016/j.jweia.2006.06.004>.
- [6] A. Flaga, A. Kocoń, R. Kłaput, G. Bosak, *The environmental effects of aerodynamic interference between two closely positioned irregular high buildings*, J. Wind Eng. Ind. Aerodyn. (2018) 276–287.
- [7] H. Holger Koss, *On differences and similarities of applied wind comfort criteria*, J. Wind Eng. Ind. Aerodyn. (2006). <https://doi.org/10.1016/j.jweia.2006.06.005>.
- [8] M.A. Ratcliff, J.A. Peterka, *Comparison of pedestrian wind acceptability criteria*, J. Wind Eng. Ind. Aerodyn. (1990). [https://doi.org/10.1016/0167-6105\(90\)90076-O](https://doi.org/10.1016/0167-6105(90)90076-O).
- [9] RWDI, *Wind Microclimate Guidelines for Developments in the City of London*, (2019).