Case Study

WSP Environmental

Evaluation of wind comfort levels around building developments

WSP Company Profile

WSP Environmental is established as one of the world's leading environmental and energy consultancies, providing innovative and commercial solutions to environment related business issues. Operating in the global marketplace, they specialise in the identification, evaluation and mitigation of environmental and social risks, advising clients in managing risks and making sustainable business improvements.

Background

WSP Environmental advise designers on the environmental impacts of new development schemes and help designers achieve excellent BREEAM ratings. BREEAM (Building Research Establishment's Environmental Assessment Method) is the worlds most widely used means for auditing and improving the environmental performance of buildings and is established as offering best practice in environmental design and management.

When planning a new development, designers need to understand the local wind environment and what impact, if any, it will have on pedestrian comfort and safety. A pedestrian wind study, along with other wind environment studies, is required by planners as part of the Environmental Impact Assessment for new large developments.

IDAC www.idac.co.uk have carried out several wind engineering analyses using the ANSYS CFD capabilities for many large development projects for WSP Environmental. One such project has been the prestigious Shanghai Plaza. A major commercial office and entertainment complex, it is situated in Shanghai's southwestern Hongqiao business-diplomatic-residential district, over a major underground rail station.

The aim of these analyses has been to establish the comfort levels that a pedestrian will experience under certain wind velocities.

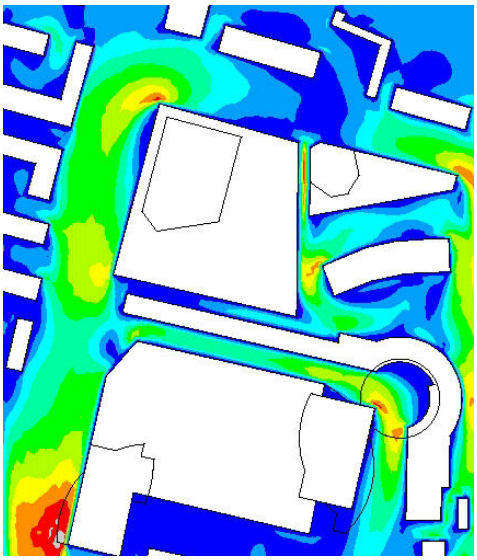
Analysis

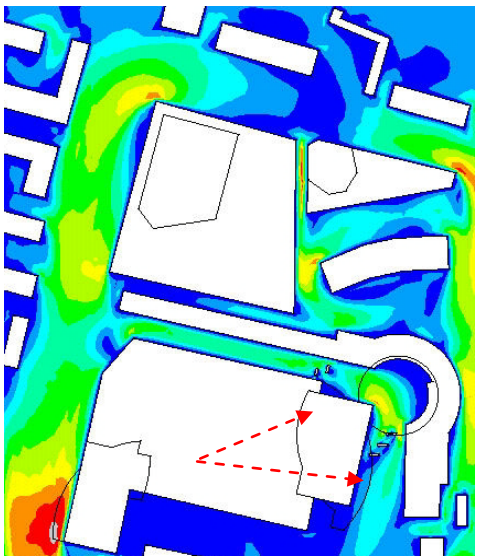
A geometric model of both the buildings and the terrain is provided by WSP Environmental in the form of SAT files. These are imported into ANSYS and "subtracted" from an encompassing cylindrical volume, leaving the total air surrounding the buildings and terrain. It is this air volume that is used for analysis. The air volume is then meshed, with a refined mesh being generated on the surface of the buildings and at ground level to enable a better resolution of the boundary layer flow. Based on previous analyses, WSP

mandates using an RNG turbulence model. Consequently, the boundary layer thickness and number of layers are adjusted to account for predominantly turbulent flow around the building development.

The wind loading conditions are characterised by a formula involving the average wind speed, a terrain factor and a height index and by the direction of wind. Knowing the wind direction means that certain nodes on the outer boundary of the air domain are selected, so that the wind velocity can be applied to them as a load. The programme then calculates the wind velocities along the ground, through and around the buildings.

The calculated wind velocities are presented as velocity contours at a height of 1.5m above ground as requested by WSP. Examples of these plots are shown below for the Shanghai Plaza project. Note how the addition of mitigation features – shown by the dotted red arrows – has reduced the wind speed around the corner of the building.





Design Benefit

IDAC have automated the analysis procedure so that new geometry supplied by WSP can be input very quickly and there is a quick turnaround of results. As such, IDAC have been able to carry out a great many of these analyses for WSP Environmental and they have proved to be very valuable design tool. The analyses are quick and cheap compared with wind tunnel testing, and have provided WSP with significant cost and timesavings.

CFD is becoming increasingly popular as a tool for predicting air flows and is particularly effective for assessing internal conditions such as ventilation air flow. Choosing an environmental system to control the indoor climate without assessing its suitability can be costly. IDAC are able to use the CFD technology within ANSYS to simulate HVAC (Heating Ventilation and Air Conditioning) problems, so that the performance or suitability of a HVAC system can be established.

Another similar application of the CFD technology within ANSYS is to analyse Nitrous Oxide (NOx) problems. Nitrous Oxide emissions from cars in an enclosed space such as a car park can be a real problem. CFD can be used to assess out where best a ventilation system is to be situated for the most effective ventilation of nitrous oxide emissions from cars in car parks.

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