Curious Case of Fire

Urban environment CFD: Campus Valla

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Introduction

Global urbanization is increasing drastically, and a better understanding is required to improve the quality of living and mitigate the associated risks leading to immense research in Urban aerothermal. The pollutant dispersion, fire safety, wind dynamics, and pedestrian comfort are essential concerns to slow down the urban heat island effect.

Computational Fluid Dynamics (CFD) useful tool to predict the nature of the fluid flow for the above-mentioned scenarios which can also be experimentally tested in a wind tunnel miniature model. Since the experimental costs are huge and control over the boundary conditions is less hence leads to significant research on the CFD domain from microscopic to macroscopic scenarios. This study focuses on the CFD modeling of the fire safety aspect in the Liu Campus and the identification of the potential safe zones.

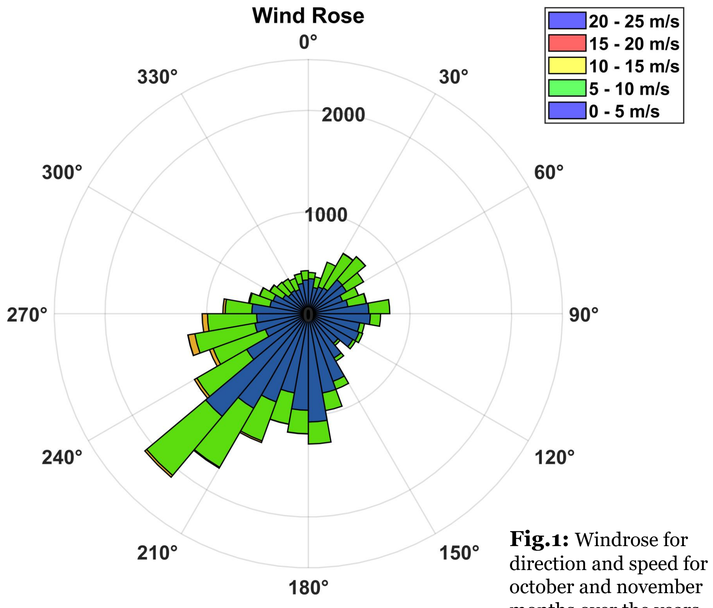

Fig.1: Windrose for direction and speed for october and november months over the years

Methodology

Verified mesh model of campus Valla is utilized to mimic fire smoke propagation based on the wind data and prescribed best pratices [1]. Domain is sufficiently large to minimize the influence of boundary conditions on the internal flow. The k-epsilon realizable turbulence model is used for the simulation which is suitable for high speed flows. Atmospheric boundary layer is the key consideration in order to create the inlet velocity profile [2]. The wind data analysis is performed to identify most probable wind direction (220 deg) and mean speed (4 m/s) for the month of october and november for the timeframe of 1200 to 1600 hrs, **Fig.1**.

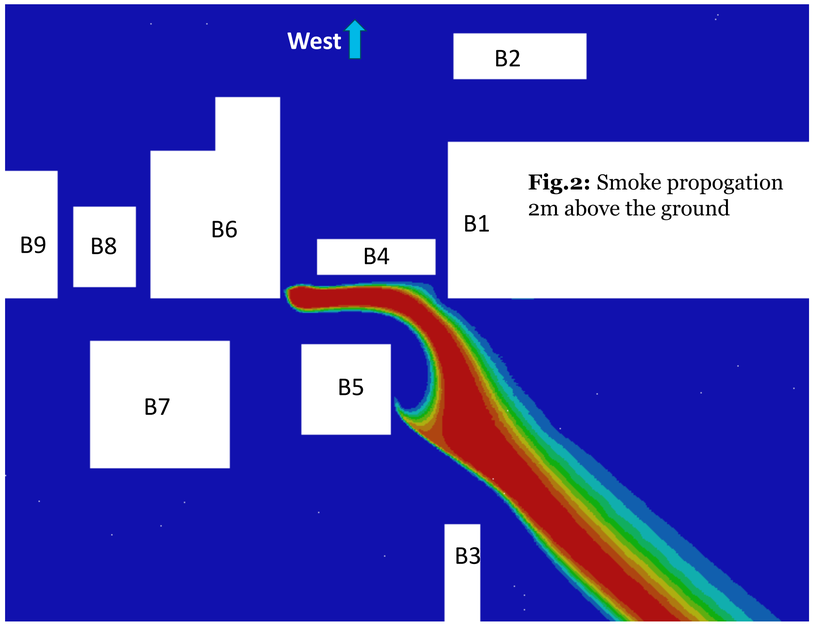

Fig.2: Smoke propogation 2m above the ground

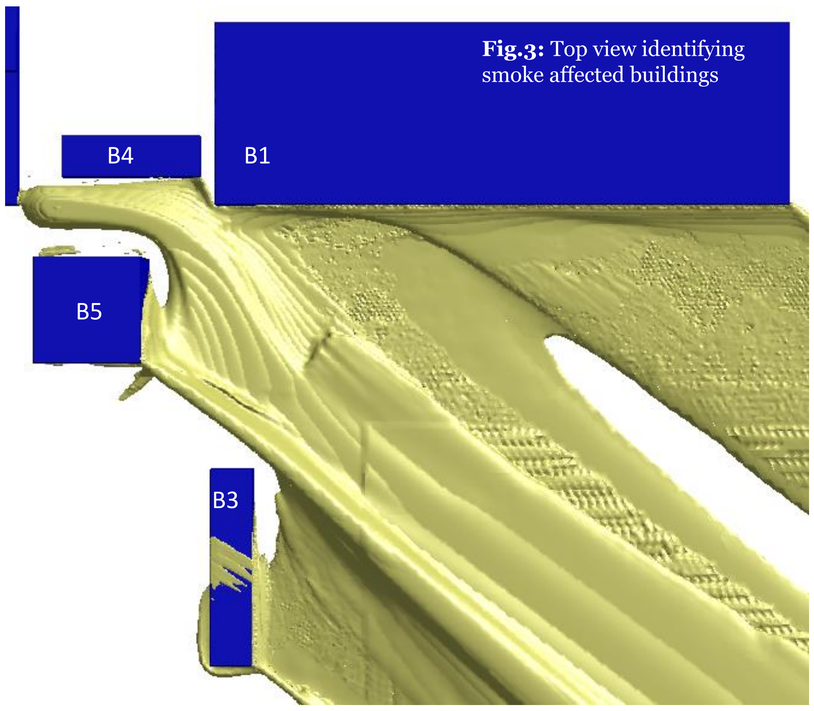

Fig.3: Top view identifying smoke affected buildings

Results & Discussions

Windrose is the primary input for the CFD simulations resulting in the most probable wind direction and speed. Since the wind comes from south-west (SE) direction, the smoke spreads out in north-east (NE) direction. This significantly affects B5 and B3, and due to high diffusion and upward movement, the upper portions of B1, B4 and B5 are affected, **Fig. 3 and 4.** The crowd control and evacuation are vital hence, smoke propogation on a pane 2m above the ground is shown, **Fig. 2** which shows B1 and B3 are unaffected but the west and north passages are blocked by the smoke streams. Some traces of smoke can also be seen infront of B5 which potentally can affect the B5 entrances on west and north faces.

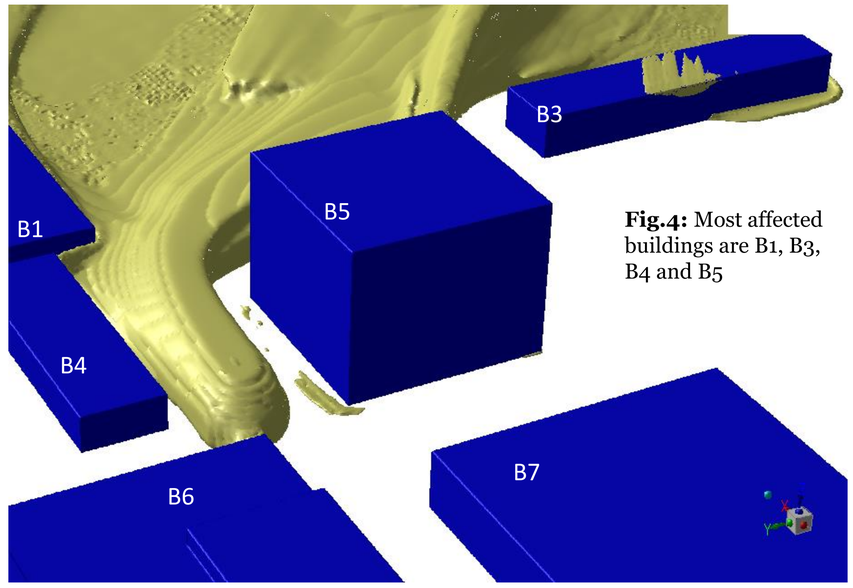

Fig.4: Most affected buildings are B1, B3, B4 and B5

Conclusion

The SE wind blocks the west and north passages on the campus, hence east and south directions are recommended for safe zones and exit routes. Any kind of constrcution should also restricted in the NE direction to allow free movement of smoke in NE and upward direction. If constructions are necessity, the height should be kept low to avoid capturing the smoke between the buildings and pathways.

References

[1] Blocken, B., 2015. Computational fluid dynamics for urban physics: Importance, scales, possibilities, limitations and ten tips and tricks towards accurate and reliable simulations. Building and Environment 91, 219-245
[2] Stull, R., 2017. Practical Meteorology: An Algebra-Based Survey of Atmospheric Science; Version 1.02 b; University of British Columbia: Vancouver, BC, Canada, 2017. Technical Report. ISBN 978-0-88865-283-6

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