B.Sc. Thesis

Benchmarking OpenFOAM's Incompressible Flow Solver Using AIJ Test Cases for Urban Wind Comfort CFD Simulations

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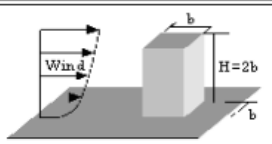
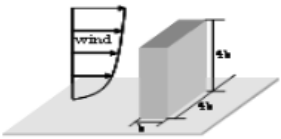
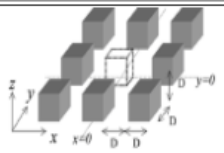
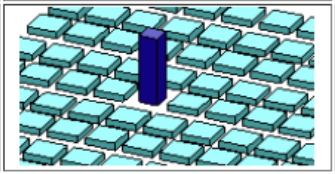
Motivation:

Computational Fluid Dynamics (CFD) has emerged as a critical tool in engineering for simulating fluid flow, replacing expensive physical experiments. The AIJ (Architectural Institute of Japan) Test Cases A to E are standard benchmarks for validating CFD models, especially in urban wind environments. OpenFOAM, an open-source CFD tool, is widely used in academia and industry due to its flexibility and robustness. However, its accuracy must be validated against established benchmarks to ensure the reliability of its incompressible flow solvers. This thesis will focus on using these AIJ Test Cases to evaluate and validate the performance of OpenFOAM's incompressible solver. The outcomes will help establish best practices for future applications, particularly in urban wind studies and related fields.

A	1:1:2 shape building model	
B	1:4:4 shape building model	
C	Simple building blocks	
D	A high-rise building in city blocks	
E	Building complexes with simple building shape in actual urban area (Niigata)	

Objectives:

The primary objective of this thesis is to perform CFD simulations using OpenFOAM's incompressible solver on AIJ Test Cases A to E, comparing the results with validated experimental data from AIJ. The performance of OpenFOAM's solvers will be assessed in terms of accuracy, stability, and computational efficiency. Additionally, the project will aim to identify potential improvements in solver settings and meshing strategies, especially for complex urban environments (Cases D and E), ultimately contributing to the development of best practices for urban wind simulations using OpenFOAM.

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References:

[1] Tominaga, Y., Mochida, A., Yoshie, R., Kataoka, H., Nozu, T., Yoshikawa, M., & Shirasawa, T. (2008). AIJ guidelines for practical applications of CFD to pedestrian wind environment around buildings. Journal of wind engineering and industrial aerodynamics, 96(10-11), 1749-1761.
[2] Guide, O. U. (2011). Programmers guide. JDT Core., retrieved from on Apr, 27(3).