

## DATA STORING METHOD FOR LARGE EDDY SIMULATION OF FLOW AROUND A BUILDING

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### Introduction

Computational Fluid Dynamics (CFD) is now widely used in the prediction and the assessment of pedestrian wind environment around buildings. The mainstream of these CFD in academic research purpose is moving to Large Eddy Simulation (LES). LES provides not only improved results than Reynolds-averaged models but also detailed turbulent structure. The goal of our study is to provide guidelines for practical CFD users to execute reliable LES calculation. We are planning to do large numbers of validation works about sub-grid scale models, discretization schemes of convection term, grid resolution and others with previous wind tunnel experiment [1][2].

### Inflow boundary condition

One of the most important things in LES of wind environment around buildings is inflow boundary condition. Transient and non-uniform inflow which satisfies physical constraint of fluid flow is necessary for accurate prediction. In the point of view of comparison with the wind tunnel experiment, it seems better that transient inflow is calculated directly by LES with all roughness elements represented. However, it costs lots of time and computational resource because an approach section to represent atmospheric boundary layer usually becomes very long. We therefore have done calculation of whole wind tunnel at once and stored transient inflow data at vertical plane in front of the target building. Stored inflow data have been used for validation cases. Figure 1 shows the overview of calculation domain.

By the way, cell-centre velocities computed in co-location grid with Rhie-Chow interpolation [3], as OpenFOAM is so, does not satisfy the conservation of kinetic energy [4]. The conservation of kinetic energy is only satisfied in face flux  $\phi$ . However,  $\phi$  does not include any information about span-wise or vertical-wise velocity. We therefore took cell pairs which are located on both sides of the target plane and used average of them. We developed a utility to do that and formatting data to use with `timeVaryingMappedFixedValue` boundary condition. Figure 2 shows the error of flow rate at the target plane.  $U_f$  means the velocity overbearingly sampled on the face with cyclic patch.  $U_{c1}$  and  $U_{c2}$  mean the velocity of the windward side cell-centre and the leeward side cell-centre respectively. Green line and blue line of the figure perfect agreed. Our method shows minimum error of the flow rate.

### Results

For example, a result of our control case, WALE sub-grid scale model, filtered-linear scheme and moderate grid resolution and was shown below. Figure 3 shows distributions of stream-wise mean velocity at centre plane. Flow pattern of LES is almost same as that of wind tunnel result. LES slight overestimated a circulation behind the building than wind tunnel. Figure 4 shows the point by point comparison of mean velocity. The results of LES shows good corresponding with the wind tunnel result.

### Conclusion

Data storing methods to reduce the error of total flow rate was investigated. We found that using interpolated velocity of cell centres of both sides was best and developed the utility for OpenFOAM. Flow around the building was accurately represented with inflow boundary condition of stored inflow data and our standard conditions. Validation results of sub-grid scale model, discretization schemes of convection term, grid resolution and others will be presented in the workshop.

### Acknowledgements

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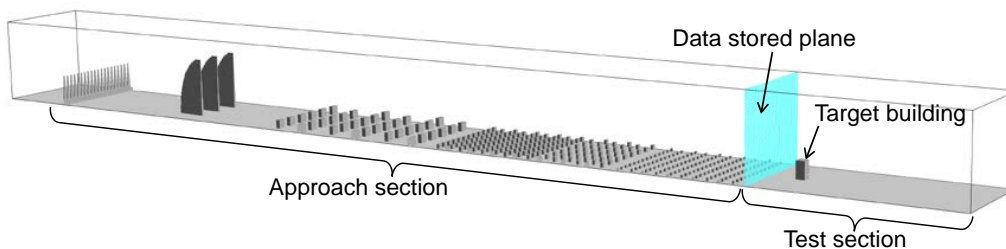


Figure 1: Calculation domain of whole wind tunnel

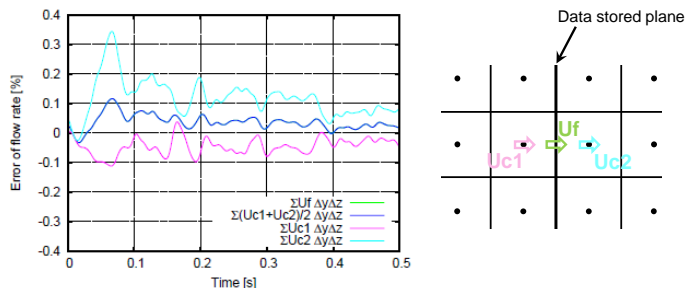


Figure 2: Comparison of the error of flow rate

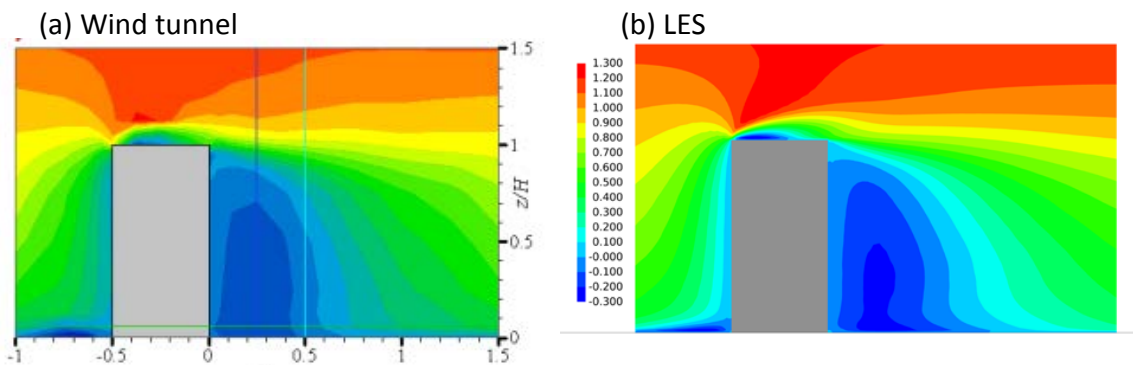


Figure 3: Distributions of stream-wise mean velocity

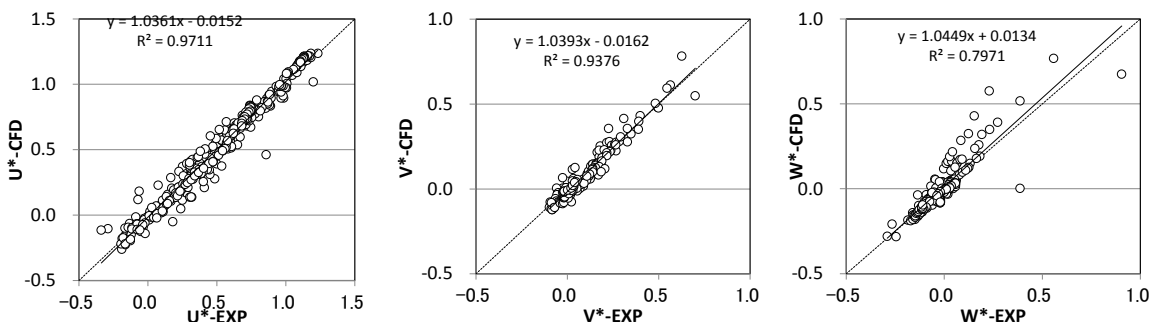


Figure 4: Comparisons of mean velocity at each measured points

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