P3.16 **LES ANALYSIS ON WIND PROFILE OVER COMPLEX ROUGHENED GROUND SURFACE IN URBAN AREA**

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1. INTRODUCTION

For the risk estimation due to strong wind on buildings and structures in urban area, wind characteristics in the boundary layer developing over densely arranged buildings should be investigated. Thus far the recommendations for wind loads on buildings have been proposed and published in various countries in the world, where roughness aspect of ground surface are usually classified into several categories to prescribe the wind flow profile for providing the design wind velocity. Although this classification should be performed by the field observation data, almost cases were intentionally determined only by surveying of building arrangement on the ground. Especially the validity of vertical profiles of mean wind velocity and turbulence intensity over the categorized ground surface cannot be confirmed due to the lack of fundamental data of wind flows generally obtained by full scale measurement. Here we adopt the numerical technique for the prediction of wind profile over complex urban area. As a numerical model, we use directly the roughened ground surface in actual urban area. Accordingly the present study aims to establish the numerical technique which can predict strong wind and provide the data for wind-resistant design of buildings in any urban area. Also, the flexibility of the technique is clarified for various roughness shapes on the ground. Hence this study employs the LES (Large eddy simulation) technique. According to the LES results for flow over uniformly arrayed roughness blocks (Nozawa and Tamura), the numerical results are in good agreement with the experimental data. We compare the LES results between the actual urban model and conventional simple roughness block model. Especially we bring into focus the turbulence structures in the near region of the roughened surface. Also, we consider how to determine the vertical profiles of mean wind velocity and turbulence structures in the actual urban area.

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2. NUMERICAL MODEL AND METHOD

In order to get the data for building shapes in a local area, the electronic mapping information is utilized. The present study uses height data of surface roughness (RAMS-e, kokusai kougyo) and expresses directly surface shapes of urban area for the numerical simulation. The previous numerical simulation of the boundary layers usually has employed the wall layer model, that is to say, the Monin-Obkhov concept for the treatment of the ground surface condition. It means that the integral quantities are utilized for representing total boundary effects, but not local effects. Recent data for building height determining the surface roughness have a resolution with about 2m, so it might be enough to simulate roughness shapes placed on the ground surface in urban areas. Further, in case of the numerical simulations for winds in urban canopies, which need to deal with details of complex flows throughout spaces between buildings, so the RANS(Reynolds Averaged Navier-Stokes) technique might have advantage to compute the flow field highly resolved by the grid from standpoints for computer costs. However the complete RANS modeling of turbulence has not been developed yet for such a complex flow with separation-reattachment behavior of shear layer around a roughness and its unsteadiness. Also, in the field of strong wind hazard, the numerical method which can predict turbulence phenomena including time sequential data, is appropriate, because unsteady characteristics of wind velocities and pressures, such as their gust and peak, determine the scale of hazard. In this study the LES (Large eddy simulation) technique is applied to the wind flow over actual roughened ground surface in Tokyo. Dynamic procedure based on Smagorinsky-type modeling is used for the formulation of the subgrid scale model. To approximate numerically the convection terms of the incompressible Navier-Stokes equations, the higher-order interpolation method is employed. For the details of the numerical method, please refer to the previous paper (Nozu and Tamura).

3. COMPUTED WIND CHARACTERISTICS IN URBAN AREA

Figure 1 illustrates numerical results of the instantaneous velocity contours in the surface layer of the large city. We can recognize the local structures of the velocity fluctuations in the urban canopies. It can be also imagined that the unsteadiness of the flows is very strong among buildings. The wind velocity becomes high along the large streets.

Figure 2 shows the various parameters with regard to the roughness placed on the ground. According to the vertical profile of the roughness density for unit height, the parts of buildings or trees, which cause the aerodynamic drag, are largely scattered in the vertical direction in large cities. The roughness density equals 0.27.

Figure 3 shows the vertical profile of wind velocity in the large city. We can estimate that the index of power law is equal to 0.25. This is consistent with the data obtained by the previous studies.

4. CONCLUSIONS

We carried out the LES analysis on wind profile over large cities. The numerical model is made by use of the complex roughened ground surface in actual urban area. We successfully obtained the good numerical results for the unsteady wind flows in the surface layer of large cities. Also, the wind profile is clarified over the actual roughened surface which is represented by the buildings and trees on the ground.

REFERENCE

Nozawa, K. and Tamura, T., 2001: Simulation of rough-wall turbulent boundary layer for LES inflow data, TSFP-2, II, 443-448.

Nozu, T. and Tamura, T., 2001: DNS for aerodynamic characteristics of a 3D square cylinder in the turbulent boundary layer, APCWE V, J of Wind Engrg., 89, 325-328.

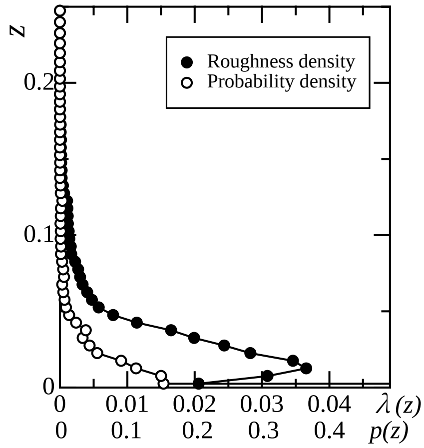

Fig. 2 Vertical profiles of various parameters for roughness on the ground

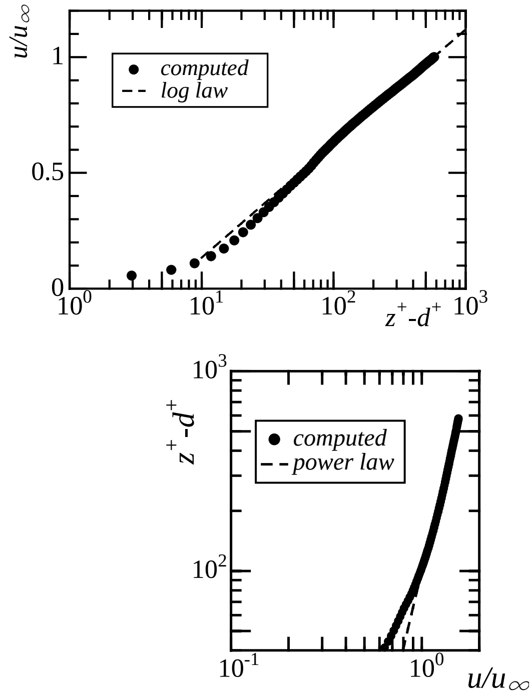

Fig. 3 Vertical profile of wind velocity

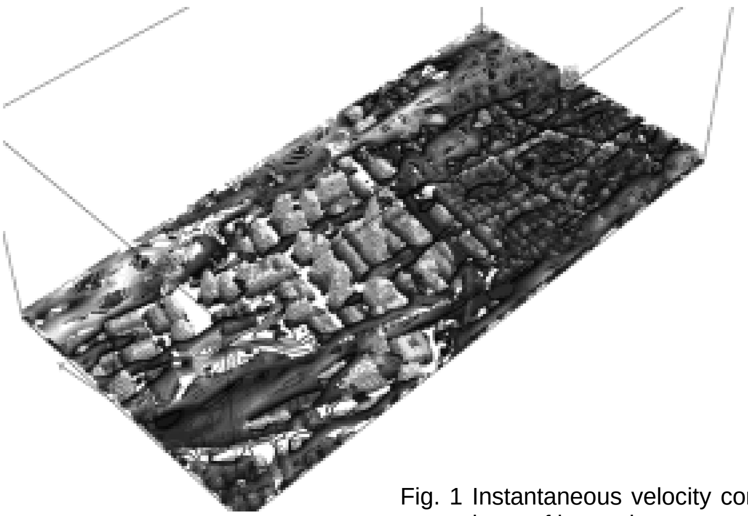

Fig. 1 Instantaneous velocity contours at height of 40m in the surface layer of large city.