Effects of Aspect Ratio and Wind Direction on Flow Characteristics around Rectangular Obstacles

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ABSTRACT

It has long been studied about the flow around bluff bodies, but the effect of aspect ratio and wind directions on the sharp-edged bodies in a thick turbulent boundary layer is still argued. This study is aiming to understand the surface pressure distribution around the bodies such as the suction pressure in the leading edge on the top surface when the aspect ratio and wind direction of bodies are changed. Therefore, the authors firstly carried out the wind tunnel measurement around a series of rectangular bodies ($40^d\times80^w\times80^h$, $80^d\times80^w\times80^h$, $160^d\times80^w\times80^h$, $80^d\times40^w\times80^h$ and $80^d\times160^w\times80^h$ in mm) placed in a deep turbulent boundary layer. With modern numerical calculations, the RANS based on the k-ε model and the DES turbulence model were used, and the numerical results were compared with wind-tunnel experiments. The results show that the change of the transverse width has a substantial effect on the variation of surface pressure around the bodies, while the longitudinal length has relatively less influence. Regarding to the turbulence model, the DES model seems to be better than k-ε model when simulating the wind flow around a variety of bluff body. In order to observe the effect of wind direction on the pressure variation around the cube (e.g., $80^d\times80^w\times80^h$ in mm), it rotates at 0°, 10°, 20°, 30° and 45°, which stand for the salient wind directions in the tunnel measurement. The results of the wind direction effect show that the surface pressure variation is highly sensitive to the wind direction, especially the top-face and side-face as well as the back-face of the cube.

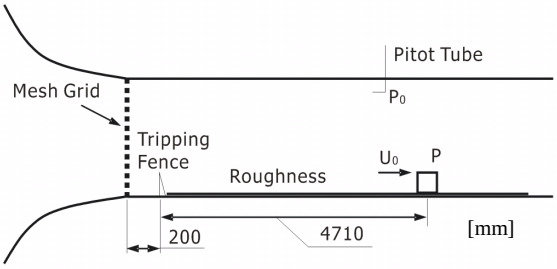

Figure 1 The 0.6m×0.72m×6m wind tunnel test section and model set up.

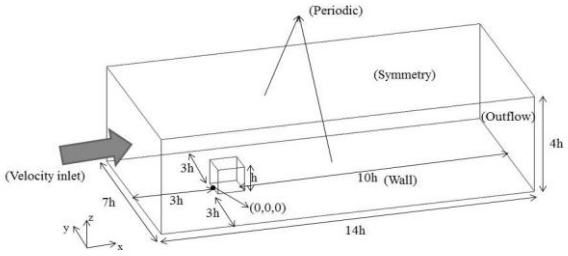

Figure 2 The computational domain and boundary conditions.

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