

Effect of slant angle and Reynolds number on regimes of flow around Ahmed body —Dependence on RANS turbulence models—

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Flow around Ahmed body has been a paradigm for the fundamental study of fluid dynamics and automobile body shapes. The drag coefficient C_D of the flow around Ahmed body changes depending on the angle θ of the slanted surface at the top-rear part of the body. Previous experiments have shown that the flow field around Ahmed body undergoes a significant change in flow regime, accompanied by the drastic C_D change at $\theta = 30^\circ$. Note, that the two different flow regimes may appear and transit to each other at $\theta = 30^\circ$ with sudden C_D change. This sudden C_D change may lead unstable driving, so the slant angle 30° is not preferable in the vehicle body design. Understanding the mechanism and control of the sudden C_D change, which has not been clarified, are expected to enable flexible design of the car body without restriction of the slant angle. Although previous studies have attempted to reproduce sudden changes in flow regimes at $\theta = 30^\circ$ by numerical simulations (Computational Fluid Dynamics: CFD), no successful result has been reported. For high Reynolds number (Re) flows, direct numerical simulations (DNS) require a huge computational resource. If the sudden C_D change occurs also for lower Re , computational costs for the DNS can be reduced. Thus, to know the lower limit of Re where the change in flow regimes occurs is important. Regarding the lowest value of Re so far reported for experiments, to the best in authors' knowledge, is 7.31×10^4 , nevertheless, the lower limit of Re has not been thoroughly investigated.

This study aimed to investigate the dependence of flow regimes on the Re and slant angle θ using CFD with steady RANS models. Although it has been reported that RANS models cannot precisely reproduce the vortex structure at the rear of the body and that the vortex structure varies significantly depending on the turbulence model, we thought that RANS models may give us qualitative information to find lower limit of Re where the sudden C_D change occurs. In this study, two turbulence models were used: the $k-\omega$ SST model and the $k-\omega$ SSTLM model. The slant angle was varied from 15° to 35° with intervals of 1° . Regarding Re , three different values were tested in the range from 5×10^4 to 1×10^5 . As a result, both models reproduced the slant-angle-dependent flow transition and the obtained vortex structures are qualitatively the same as reported by previous experiments. However, in a quantitative view, the transition occurred between 16° and 17° , which is much smaller than the values reported by previous experiments. Also, the sudden C_D change is not reproduced by the two models. These results suggest that fundamental flow physics relevant for the slant-angle-dependent transition might be reproduced even by the steady RANS models.

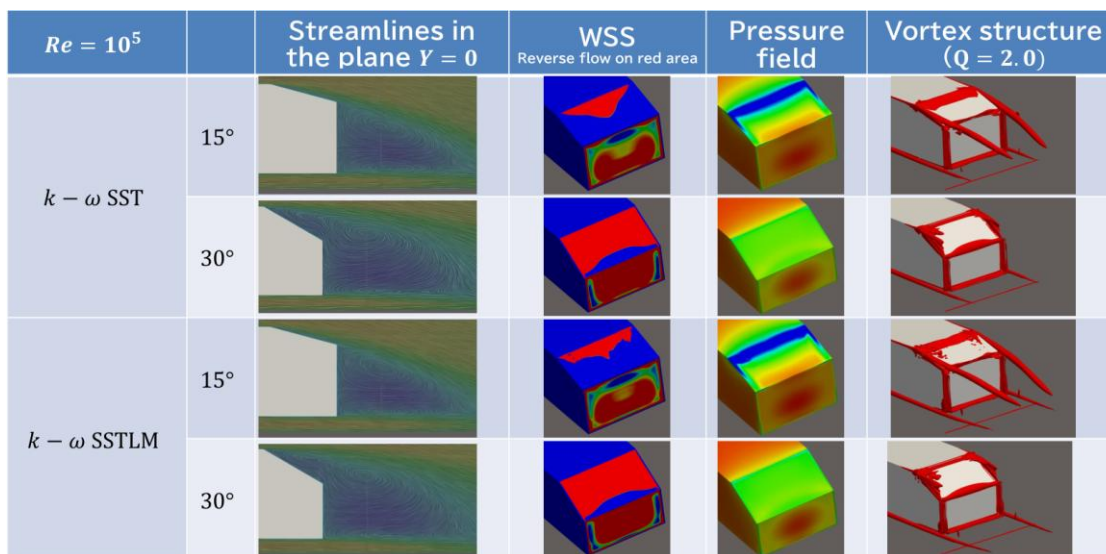


Fig.1 Flow structures for different slant angles and turbulence models