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LES OF FLOW AROUND NACA 4412 AIRFOIL AT HIGH ANGLE-OF-ATTACK

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ABSTRACT

The flow field around a NACA 4412 airfoil is numerically investigated by means of large eddy simulation (LES), an advanced mathematical model for turbulent flows which solves for the low-pass filtered numerical solution. A subgrid-scale model is used to account for the effects of unresolved small-scale turbulent structures on the resolved scales, while the flow behavior near walls is modeled by wall functions [1]. Here, the investigated operating conditions are a chord Reynolds number of 1.5 million and a Mach number of 0.2 at a high angle-of-attack of 14°, where strong separation at the aft part of the airfoil suction side can be observed. This validation case is chosen from the experimental dataset described and available in [2]. The finest computational grid contains approximately 9 million control volumes. Fluid flow computations are performed by the second-order low-dissipation finite-volume solver charLES developed by Cascade Technologies, Inc. The Dynamic Smagorinsky subgrid-scale model is employed, while a no-penetration stress-based algebraic equilibrium wall model is applied along the airfoil walls. Velocity and pressure values are defined at inlet and outlet boundaries, respectively, while periodic walls are used in the span. The obtained numerical results are validated through comparison to experimental data. Fig. 1 illustrates the pressure coefficient distributions. In addition, the instantaneous velocity field visualized in Fig. 2 illustrates that the flow structures resolved by the LES exhibit a wide range of length scales.

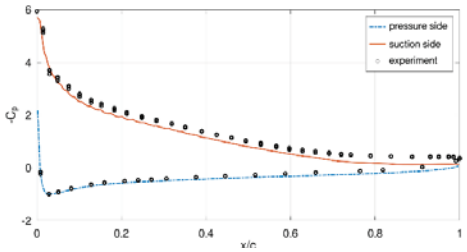

Fig. 1. Pressure coefficient distribution

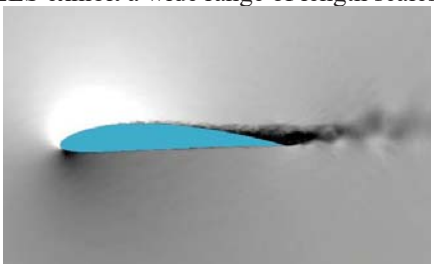

Fig. 2. Instantaneous velocity field

REFERENCES

[1] Moin, P., Bodart, J., Bose, S., Park, G.I. (2016), "Wall-modeling in complex turbulent flows," *Notes on Numerical Fluid Mechanics and Multidisciplinary Design,* 133, pp. 207-219.

[2] Wadcock, A. (1978), "Flying-hot-wire study of two-dimensional turbulent separation on an NACA 4412 airfoil," PhD thesis, California Institute of Technology, Pasadena, California.