Unsteady Flow Simulation of the Ahmed Reference Body using the Lattice Boltzmann Approach

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The external flow over road vehicles is usually determined by complex three dimensional vortex wake interactions and regions of massive separation. The accurate prediction of the dynamics of this behavior still constitutes a challenge to numerical simulations especially to turbulence modeling approaches. The Ahmed Reference body [1] represents a simplified car geometry that can be used to investigate the main flow features of such vehicle flows. It has been recently investigated experimentally [2] and continously investigated numerically using various turbulence modeling approaches, e.g. [3, 4] within the conventional framework of the Navier-Stokes equations.
The present work presents unsteady flow simulations at the challenging critical rear slant angles of the geometry between 25° and 35° using the PowerFLOW 4.0 software, which employs a $D3Q19$ Lattice Boltzmann model and incorporates an improved unsteady two equations *RNG* k-ε turbulence model combined with an advanced wall model.
The aerodynamics of the unsteady flow of the wake is discussed and mean aerodynamic values as well as distributions of averaged velocities are compared with available experimental findings. The predictive capability and the feasibility of the URANS/VLES approach within the Lattice Boltzmann framework is demonstrated and the applicability to similar exterior flows over realistic road vehicles is discussed.

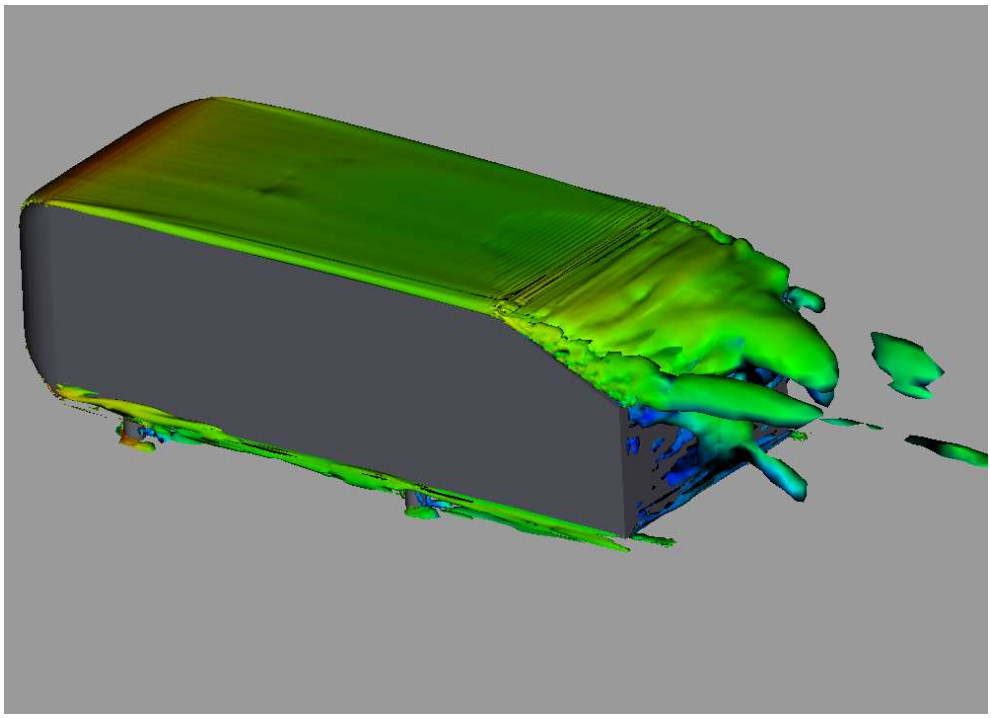

Figure 1: Instantenous flow structures in the wake of the Ahmed Body at slant angle 25° showing total pressure deficit colored by velocity magnitude

References

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[4] R. J. A. Howard, M. Pourquie. Large eddy simulation of an Ahmed reference model. Journal of Turbulence, Vol. 3, 2002.