Seventh HRLM Symposium, 19-21 September 2018, Berlin, Germany

Session:

PANS simulations of a dynamic motion of a simplified truck with active flow control at the trailer

G. Minelli[1], M. Calixto de Sousa[1], B. Basara[2], S. Krajnović[1]

[1]Department of Mechanics and Maritime Sciences, Chalmers University of Technology, Gothenburg 41296, Sweden.

[2]AVL List GmbH, Advanced Simulation Technologies, Hans-List-Platz 1, 8020 Graz, Austria.

Abstract

The aerodynamic effect of wind gusts creates a dynamic force that causes a truck driver to overreact, increasing the dynamic instability of the vehicle. The experimental measurements in wind tunnels are normally performed under so called quasi-steady conditions, i.e. the yaw angle of the model is kept constant during each experiment. However, the comparison of the previous experimental investigations has shown that lower magnitudes of the aerodynamic forces and moments were measured compared with the real situations on the road. One solution is to perform ”on road” experiments, which directly verify the aerodynamic performance of a model or a prototype. On the other hand, this approach does not allow understanding of the flow mechanisms, which is a crucial step to develop better and effective aerodynamic solutions. For this reason, it would be fruitful to recreate a closer to ”on road” condition and conduct vehicle aerodynamic research in a controlled environment like a wind tunnel test section or by the use of CFD. The use of an oscillating model to recreate realistic flow conditions was first explored in [1] and later investigated numerically and experimentally for a simplified car model in [2] and [3]. More recently, using a CFD approach, an active flow control solution has also been optimized under a gusty flow condition [4]. In this work, the flow around a simplified truck model (Fig. 1) at *Re*=2.5x10^5 is considered. Partially-Averaged Navier-Stokes (PANS) simulations and experimental study are made to verify the efficacy of such a control under the effect of dynamic boundary conditions which represent wind gusts. The AFC technique was previously applied to a rudimentary truck cabin and its efficacy was demonstrated with experiments [5] and CFD simulations [4, 6]. To summarize, the main purpose of this paper is twofold. First, the AFC application to a full truck configuration is tested, verifying the contribution of such a control when applied to its trailer.

Session:

Second, PANS results are compared to LES and experiments and later used to reproduce the effect of AFC to mitigate gusts, and lower aerodynamic drag.

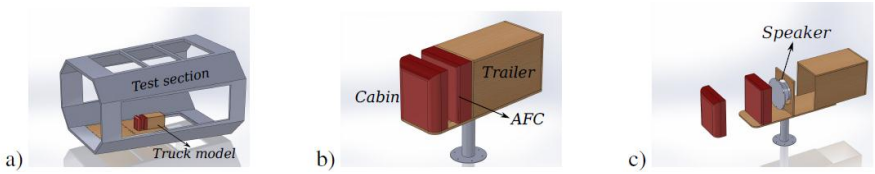

Fig. 1: The CAD design of the experimental model. a) The model placed in the wind tunnel test section. b) The model is composed by the cabin and the trailer; the AFC is placed at the front of the trailer. c) An exploded view of the experimental model (under development).

References

[1] K. P. Garry and K. R. Cooper, Comparison of quasi-static and dynamic wind tunnel measurements on simplified tractor-trailer models, *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 22, no. 2-3, pp. 185–194, 1986.

[2] S. Krajnović, A. Bengtsson, and B. Basara, Large Eddy Simulation Investigation of the Hysteresis Effects in the Flow Around an Oscillating Ground Vehicle, *Journal of Fluids Engineering*, vol. 133, no. 12, p. 121103, 2011.

[3] E. Guilmineau and F. Chometon, "Numerical and Experimental Analysis of Unsteady Separated Flow behind an Oscillating Car Model," SAE International Journal of Passenger Cars - Mechanical Systems, vol. 1, no. 1, pp. 646–657, 2008.

[4] G. Minelli, S. Krajnović, and B. Basara, PANS Study of the Flow Around an Oscillating, Simplified Truck Cabin with Flow Control, in ASME 2017 Fluids Engineering Division Summer Meeting, FEDSM2017, July 30-August 3, 2017, Waikoloa, USA, 2017.

[5] G. Minelli, E. A. Hartono, V. Chernoray, L. Hjelm, and S. Krajnović, Aerodynamic flow control for a generic truck cabin using synthetic jets, *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 168, pp. 81–90, 2017.

[6] G. Minelli, E. Adi Hartono, V. Chernoray, L. Hjelm, S. Krajnović, and B. Basara, Validation of PANS and active flow control for a generic truck cabin, *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 171, pp. 148–160, 2017.