AEROFLEX

Aerodynamic and Flexible Trucks for Next Generation of Long Distance Road Transport

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Document information

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Publishable Executive Summary

This document forms Deliverable D3.4 of the AEROFLEX project and describes the performed wind tunnel tests. The first wind tunnel test was completed in July 2019 and the second wind tunnel test was done in January 2020. The wind tunnel model has been designed and built by NLR, with help of SCANIA and WABCO, the wind tunnel tests are performed at FCA in close collaboration with all other WP3.4 partners.

The document describes the design and manufacture of the 1:3 scale wind tunnel model, shown in the figure below. The model consists of an internal load bearing structure, on which outer shells and plates are mounted. An agile design process was adopted and the drag reducing concepts were designed modular. Special attention was given to the wheels and the maximum allowable vertical load on the moving belt. The model was able to withstand wind loads up to 180 km/h (maximum air speed in the wind tunnel) without problematic bending or vibration. The wheels were able to spin continuously at 180 km/h and remained attached to the moving belt without significant vertical loading. A description of the wind tunnel is given together with an overview of the instrumentation used during both test entries.

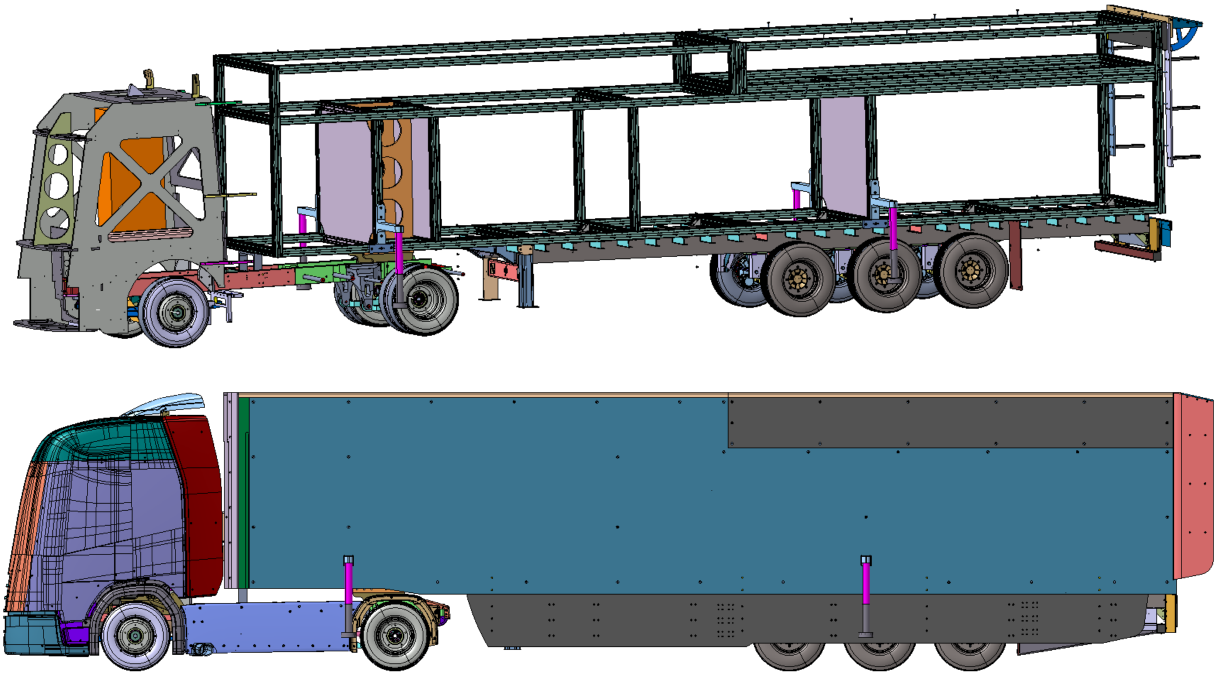

Figure 1-1: Wind tunnel model, scale 1:3. Top) Internal load bearing structure. Below) Baseline wind tunnel model.

During the first wind tunnel test, aerodynamic forces, static pressures along the model and wake flow angles were measured. A small deviation between the CFD model and the wind tunnel installed model was observed. The tractor had a pitch angle that was 0.5 degree larger (nose down) compared to the CFD baseline model. Taking this effect into account and modelling the wind tunnel environment (different Reynolds number) and the model support struts in CFD, a good correlation was found in terms of absolute drag coefficients. Full validation of CFD is not described in this document, but is part of D3.2, However, some comparison between CFD and experimental data is presented in this document. This is done to preliminarily show that no macro deviations were found, both in the aerodynamic performance of the prototyped model and in concepts effect, with respect to expectations. In general wind tunnel data shows higher absolute drag coefficients, mainly attributed to the model support struts. The model support strut effects are quite similar for all test points, therefore relative drag comparisons for different configurations at the same yaw angle seem to be representative for full scale.

In the second wind tunnel test, aerodynamic forces, static pressures, unsteady pressures and flow fields by means of PIV were measured. During the second wind tunnel test high quality pictures and video recordings were made for PR purposes, shown in Figure 1-2. An active flow control device in the form of a plasma actuator was installed and integrated in the wind tunnel model. Functionality checks showed proper functioning of the plasma actuator. Unfortunately, the supplementary (irreplaceable) electrical equipment malfunctioned during the first plasma test

point and it was not possible to solve this issue on site. Possible drag savings with plasma flow control are deduced from measurements with vortex generators that strive to reduce drag in a similar way as the plasma actuator. Besides plasma flow control, change in drag coefficient for other concepts were measured.

During the two test campaigns, various drag reduction concepts were tested. The tested concepts were a down selection based on CFD computations (described in D3.1 and D3.2), the wind tunnel results aid in further down selection and improvements. Finally, different combinations of drag reducing concepts were installed. A maximum drag reduction of 84 counts was achievable, corresponding to a drag reduction of 20% with respect to the baseline configuration.

The work and results described in this deliverable focus on one aspect of the AEROFLEX project; development of novel aerodynamics, flexible, and adaptable vehicles which are needed for efficient long-distance transport and low emission inter-urban transport. This work aids the European Commission in achieving its ambitious emission targets for the transport sector in its Transport White Paper [1].

Figure 1-2: Pictures for PR purposes.

1 Acknowledgement

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