EXPERIMENTAL STUDY OF GROUND EFFECT AND REYNOLDS EFFECT ON DRAG COEFFICIENT OF A TRAIN

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Because of the increasing importance of trains as a public way of transport and also the environmental conscience, an objective in railway industry is to decrease drag coefficient of trains in order to decrease its consumption as well. Therefore train aerodynamic studies are needed and wind tunnel tests are considered as the most efficient and cost-effective method to perform them. In this way, it is important to know and understand how to do correctly drag measurements in wind tunnels.

When train models are studied in a wind tunnel, some considerations have to be kept in mind. In this project, carried out in the L1-B and L2-B wind tunnels of the von Karman Institute, ground effect and Reynolds effect on the measurement of drag coefficient of a train have been analyzed. Ground effect consists basically in obtaining an uniform velocity profile, deleting the boundary layer and in this way not losing momentum and not underestimating the drag measured in the wind tunnel. Reynolds effect is related to the fact that big differences exist between the scaled model in wind tunnel and the real one. So, problems can appear when extrapolating results from the model to the real case.

An experimental investigation is performed to determine which technique available at von Karman Institute allows to simulate as close as possible the ground in the wind tunnel. Tangential blowing, suction of the boundary layer and a moving belt are used and the measured transversal velocity profiles are compared based on displacement and momentum thicknesses. Also Reynolds effect is studied, obtaining an extrapolation curve. Finally geometry effect is also considered, analyzing the effect of different train lengths on the drag coefficient.

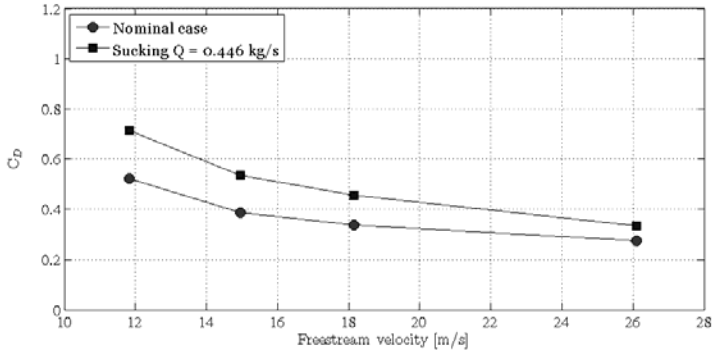

Figure 1: Comparison of drag coefficient between fixed ground (nominal case) and ground simulation (sucking boundary layer with flowrate Q)

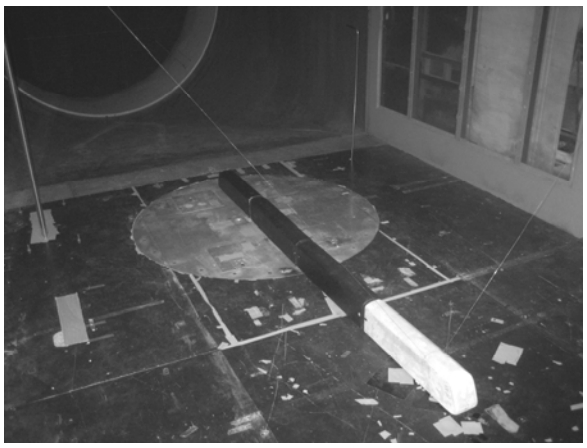

Figure 2: Picture of the model attached in L1-B wind tunnel