BLOCKAGE EFFECT ON CIRCULAR CYLINDERS AND ITS WAKES

Nuno F. Moreira Ferraz de Gouveia Jorge, Portugal
Supervisor: J. Anthoine

The need to use a relatively large model, compared to the test section dimensions in wind tunnel measurements occurs due to many different reasons. One of those is related to the achievement of certain non-dimensional coefficients like the Reynolds number, in order to have dynamic similitude. The investigation of light poles carried out in Von Karman Institute in 2002-03 is an example, where cylinders in the critical and super-critical regimes were tested. These very large models cause the flow to accelerate more than in unconstraint flow in closed test section wind tunnels and the opposite in open test section wind tunnels. This effect is called blockage in both situations. In case of open section wind tunnel this effect tends to underestimate the drag and the opposite effect is verified in case of closed section wind tunnels. For both, correction of measured data, such as drag or pressure distribution is needed. The blockage ratio 'S/C', is defined as the ratio of the projected area of the model and the test section. The blockage effect is said to be negligible if this ratio is smaller than three percent.

This works intends to give a better understanding of the influence of blockage on drag, pressure and wake characteristics, and to propose a way to correct them. Six cylinders with different size were tested in a wind tunnel simulating different blockage ratios. The evolution of the drag, pressure distribution around the cylinder and the characteristics of the wake were studied for different blockage ratios in the sub-critical regime. The drag force was measured with a strain-gauge balance, while the pressure distribution was obtained with a pressure tap on the surface of the cylinder. Hotwires were used in order to characterize the wake and to find the Strouhal number.

The drag measurements showed that the Maskell's theory with the empirical parameter 'ε' equal to 0.96 was the one which showed the best results. However, new values for the empirical coefficients 'ε' and 'G' in Maskell's and Glauert's model were suggested in order to achieve a better correction. An expression to correct the measured drag is also suggested based on the measured data. The pressure measurements were in accordance with the literature, showing the tendency that the minimum pressure becomes higher in absolute value with the blockage ratio as well as the base pressure. Hot-wires showed that the size of the wake were not highly modified with the blockage although the vortex shedding frequency increases with blockage ratio.

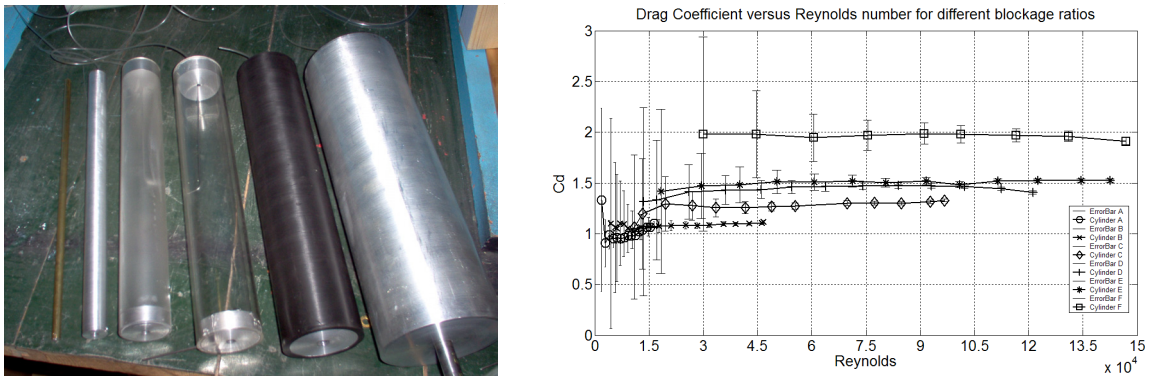

Figure 1: Tested Models and Measured Drag along Reynolds number