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Construction of an Integrating Adaptive Wake Rake for Profile Measurements

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http://www.hs-regensburg.de/fk/m/labore/562.php

1. Introduction

In the Regensburg Wind Tunnel there are two different options to determine the air drag coefficient of profiles. On the one hand by the force measurement, working with the aid of weighing cells, on the other hand by the pressure measurement. Using the pressure measurement requires a wake rake to determine the air drag coefficient.

Profiles which are flowed by air, reduce the velocity the air, thus causing a decrease of dynamic pressure. As the flow near the wing profile decelerates, a velocity distribution develops. This velocity distribution is formed like a dent, which is why it is called wake dent. The wake rake is able to detect this wake dent and working hand in hand with some other measuring instruments, the air drag coefficient can be calculated.

The adaptive wake rake is separated into three segments with equal size. In this way, it can change its measurement height, whereby the area behind the wing profile, in which the pressure distribution is measured, is mutable. That is to say the width measuring zone of the wake rake is adjustable to the size of the wake dent.

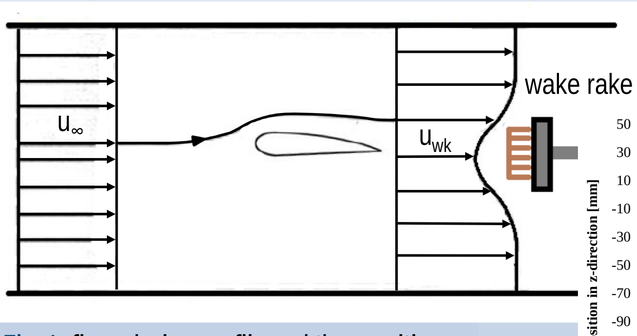

Fig. 1: flowed wing profile and the resulting velocity distribution.

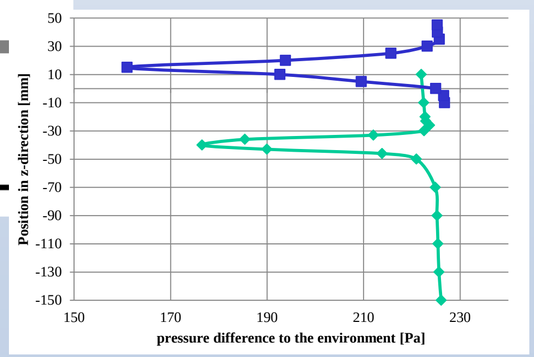

Fig. 2: wake dents of two different approach angles, measured in the Regensburg Windtunnel.

2. Construction

The adaptive wake rake is made of different parts which were found in the laboratory wind tunnel and parts, which were bought in the local hardware centers. The wake rake consists of 3x30 little pitot-tubes, which are in each case connected to one of the three compensating volumes. Inside these volumes the single pressures, coming out of each connected pitot tubes, are pneumatically integrated to an average pressure value. All required parts are joint together by a strong 2-components-dry adhesive.

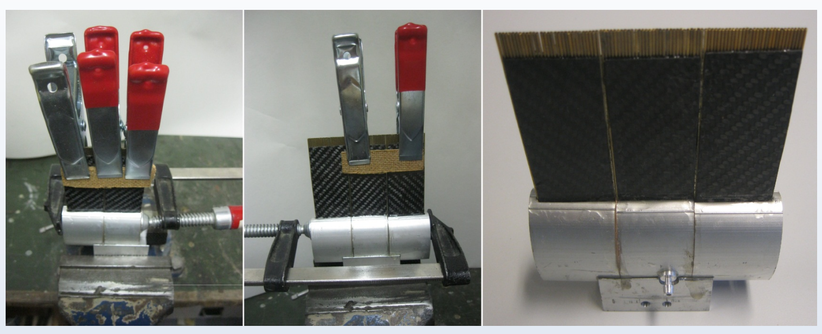

Fig. 3: The assembly of the adaptive wake rake

The adaptive wake rake is held on an adapter to the tubular arm, to allow the fixation of several different wake rakes.

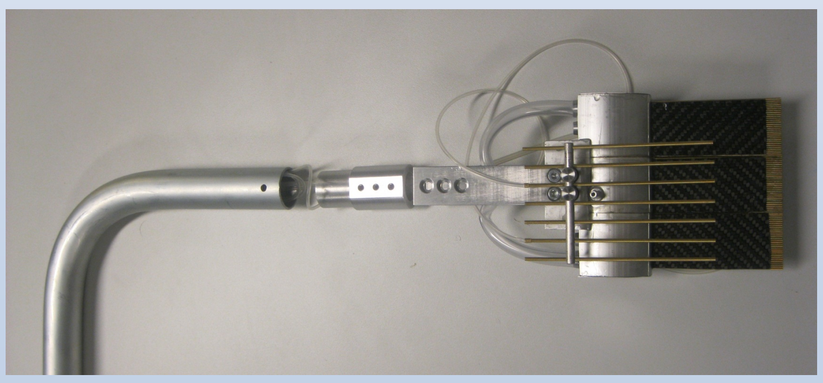

Fig. 4: The arrangement of the adaptive wake rake

3. Measurements in the wind tunnel

The first experiments for recording a profile measurement were conducted in the Regensburg wind tunnel with the RG 15 wing profile. The adaptive wake rake was tested in each modification, which means the measurement was running once with one, then with two and finaly with three compensating volumes. Figure 5 shows the measuring setup and its required elements to conduct a measurement.

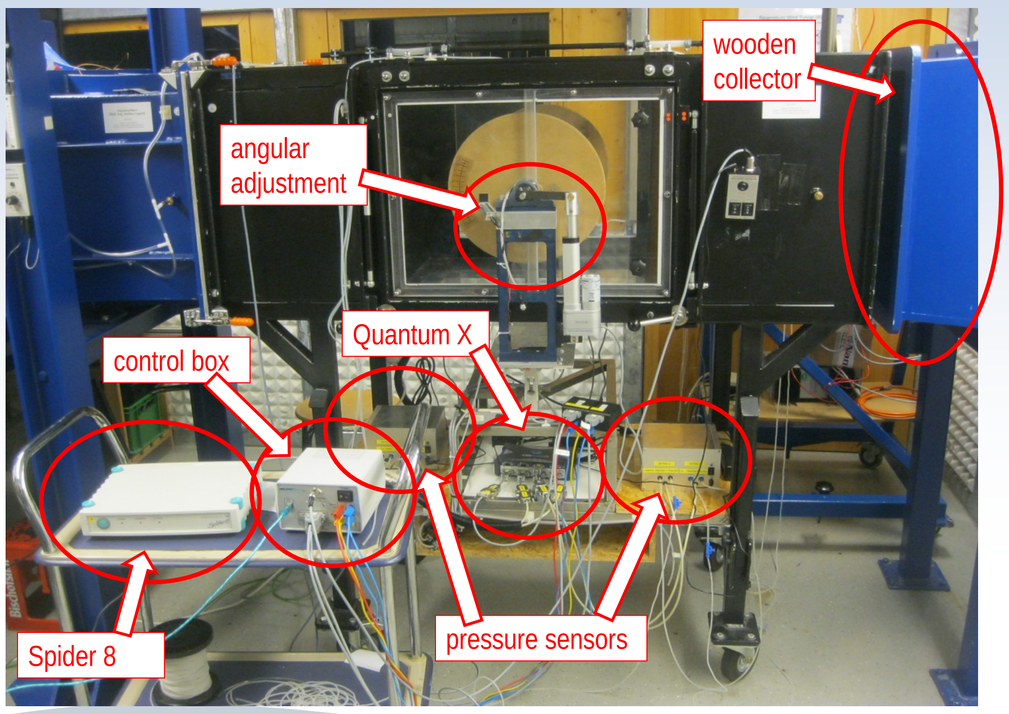

Fig. 5: The measuring setup tp determine the air drag coefficient of a profile

Subsequently, the measured values are compared to each other, to the wake rake which has already existed in the laboratory and to some reference measurements.

4. Results

Additionally, the polar diagrams result from the values of the air drag coefficient and the values of the air lift coefficient.

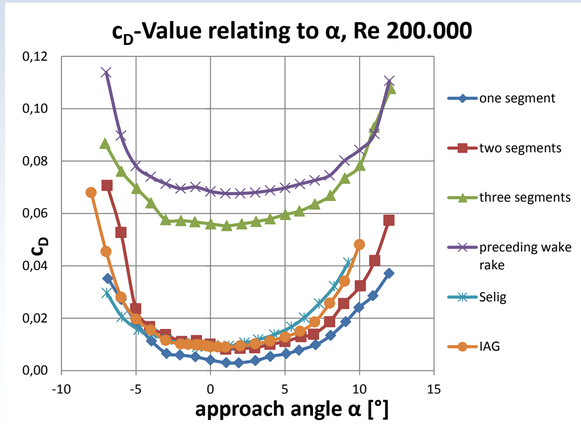

Fig. 6: Air drag coefficients relating to the approach angle **α** at Re = 200.000

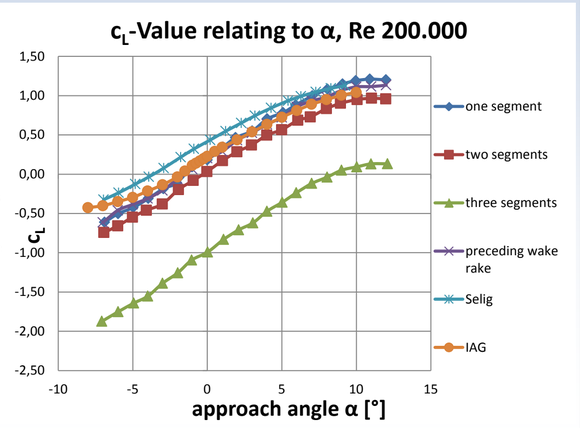

Fig. 7: Air lift coefficients relating to the approach angle **α** at Re = 200.000

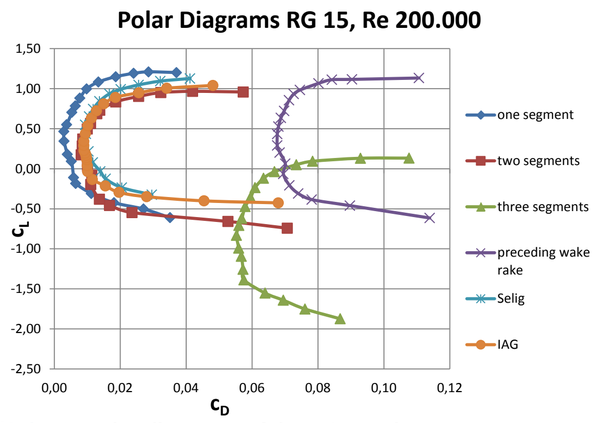

Fig. 8: Polar diagrams of the RG 15 wing at Re = 200.000

As you can see, the graphs of the operation with two segments accord very good to the reference measurements.
Unfortunately the operations with one and three segments are in no accordance with the reference measurements. The operation with one segment differs just a bit, however the operation with three segments differs a lot.