Labor Windkanal/Strömungsmesstechnik

HOCHSCHULE REGENSBURG
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Three Dimensional Wake Rake

Project *zora*

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

1. Introduction

The aim of this master thesis was to realize a three-dimensional wake rake, based on the existing two-dimensional wake rake of the laboratory.

The idea behind this concept is to model the total pressure probes no longer linear, but to spread them on a zone. The total pressure probes are measuring the total pressure deficit in the wake integrally. Together with the help of a static pressure probe near the wake rake and a Prandtl-Probe in front of the body, the drag coefficient can be determined in one step.

The time of a measurement of an airfoil polars should be reduced at the time of the spanwise procedure of the two-dimensional rake (necessary because of the spanwise drag variation of a 2D testwing) with the allocation of the pressure probes on a zone. Furthermore it is considered, that the new three-dimensional rake also allows to measure three-dimensional bodies.

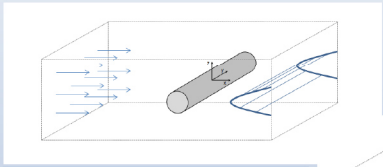


Fig. 1: typical wake, which is built by a steady current over a cylinder, should be adjusted by the new three-dimensional wake rake

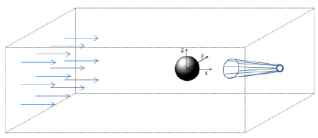
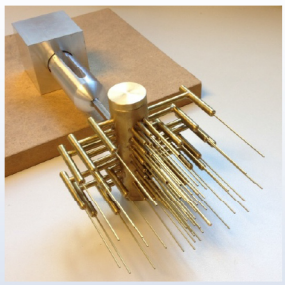


Fig. 2: typical wake, which is built by a steady current over a sphere, should be adjusted by the new three-dimensional wake rake

2. Realization

The first step to realize the new wake was to work out different principal solutions. After that, the preferred version was exactly designed in CAD.
According to the drawing, the individual parts of the wake rake were manufactured.
The assembling was realized with a two-components-epoxy adhesive.



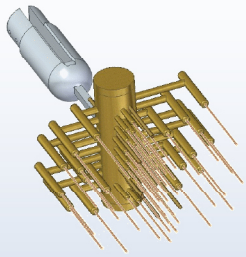


Fig. 3: Comparison between the CAD-construction and the realization of the three-dimensional wake rake

The three-dimensional wake rake is positioned inside the test section by a tubular arm of the FloSSy (Flow Scan System). The wake rake is named ***zora*** (**zo**ne **ra**ke), due to the measurement characteristic.

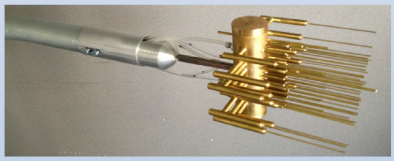
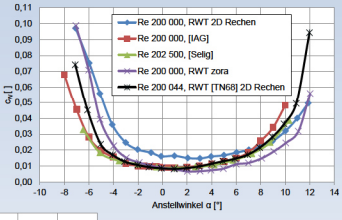


Fig. 4: The arrangement of the three-dimensional wake rake (*zora*) with the correctly fixture on the tubular arm of the FloSSy

3. Measurements of Wing Profiles

The measurement for recording of an airfoil polar was performed in the closed test section of the Regensburg wind tunnel (RWT) with a RG 15 testwing.
Figures 5 and 6 are outlining typical measurement results. The Diagrams constitute the measurements with ***zora***, the 2D rake of the laboratory and different curves from the literature at a Reynolds number of 200 000.

Fig. 5: Drag coefficients relating to the angle of attack α at Re = 200 000; measured in the closed test section of the RWT



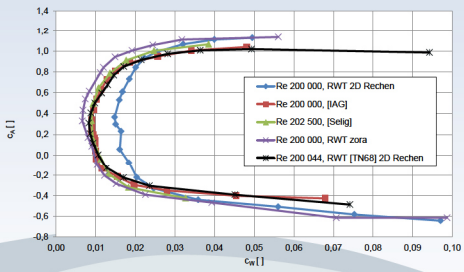


Fig. 6: Polar diagram of the RG 15 profile at Re = 200 000; measured in the closed test section of the RWT

In addition to this diagram, further charts were produced for two other Reynolds numbers (100 000, 300 000).
They all show consistent results: the values of zora are qualitative better than the values of the 2D rake (spanwise: three position of measurements)

4. Measurements of a Sphere

Additional to the measurement of wing sections, it is possible to determine the drag coefficient of an three-dimensional body in the closed section of the RWT. As a three-dimensional body a sphere was chosen, because values from the literature are available easily.
In contrast, a suitable equation was not available.
Therefore, a first attempt was chosen as follows:

z-range of the rake; y-range of the rake; dynamic pressure of the wake

$$c_W = 2\frac{z_R \cdot y_R}{A_R}\sqrt{\frac{q_{wk}}{q_\infty}}\left(1-\sqrt{\frac{q_{wk}+\Delta p_{wk,\infty}}{q_\infty}}\right)$$

reference surface; Dynamic pressure of the undisturbed flow

difference from the static pressure of the wake and the static pressure of the undisturbed flow

The results of the measurement of a sphere with an diameter of 100mm, is displayed exemplary in figure 7.

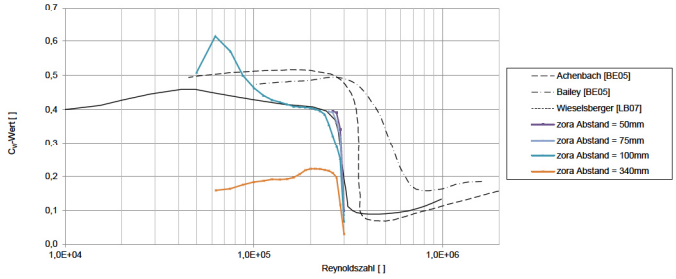


Fig. 7: Drag coefficients relating to the Reynolds number; measured in the closed test section of the RWT with a sphere (diameter = 100mm)

The distance between the wake rake and the sphere was changed. The best configuration in agreement with the diagram is "zora Abstand = 100mm".