PRELIMINARY RESULTS OF WINDTUNNEL MEASUREMENTS ON SOME AIRFOIL SECTIONS AT REYNOLDS NUMBERS BETWEEN $0.6 \times 10^5$ AND $5.0 \times 10^5$

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FIG. 11: SECTION CHARACTERISTICS OF THE EPPLER 387 AIRFOIL WITH TRIP WIRE (d = 0.6 [mm])
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The airfoil sections employed for the investigation are presented in fig. 1, the coordinates have been taken from Ref. 1, 2 and 3.

All tests have been performed in the low-speed, low-turbulence windtunnel of the Department of Aerospace Engineering at the Delft University of Technology.

To determine the two-dimensional aerodynamic characteristics of the airfoils, the test section is specially equipped for this purpose. See figs. 2 and 3.

Pressures on tunnelwalls, from the wake rake and from the pitot-static tube are measured by means of a Mensor Quartz Manometer. The wake measurements at midchord of the model yielding the profile-drag coefficient, $c_D$.

Forces are measured by a balance system, which is connected to a PDP-8/L processor, yielding the section lift coefficient, $c_L$. The section characteristics are determined at constant windspeed as function of the angle of attack.

The models are made of steel and wood, sanded to smoothness and painted black. Standard modelsize is 750 mm span and 150 mm chord. Manufacturing tolerances of the tested airfoil sections are tight in comparison to actual applications in model airplanes.

A comparison with earlier measurements on the Wortmann FX-66-S-196V1 airfoil - a very accurate model with 360 mm chord and 105 pressure orifices, Ref. 1 - shows only small differences at Reynolds number $Re = 5.0 \times 10^5$, fig. 4.

Investigation of the flow behaviour with an oilfilm technique showed that the flow was two-dimensional even at lower Reynolds numbers: see fig. 5 as an example.

Fig. 6 shows the effect of the Reynolds number on the $c_L$-$\alpha$ curve for the Wortmann FX-66-S-196V1 airfoil. This airfoil was used as testcase for examining the optimal position and diameter of a tripwire, in order to prevent bursting of the laminar separation bubble.

The optimal position of the wire, obtained by translating the wire in front of the model, is presented in fig. 7.

Figs. 8 and 9 show the effect of the trip wire diameter on the section characteristics at two Reynolds numbers.

Figs. 10 to 13 present the section characteristics of both Eppler airfoils with and without trip wire. Position and diameter of the trip wire guarantee attached flow at Reynolds number $Re = .6 \times 10^5$.

Figs. 14 and 15 show the section characteristics of two simplified airfoils.

A final report, with a complete description of the test technique and the results, including some additional photographs of surface flow patterns determined with the oilfilm technique, is in preparation.
FIG. 13: SECTION CHARACTERISTICS OF THE EPPLER 385 AIRFOIL WITH TRIP WIRE (d = 0.6 [mm])
SYMBOLS

c  airfoil chord
\(c_d\)  section profile-drag coefficient
\(c_l\)  section lift coefficient
d  diameter of trip wire
Re  Reynolds number based on free-stream conditions and airfoil chord
\(\alpha\)  angle of attack

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FIG. 1: AIRFOIL SECTIONS EMPLOYED FOR THE INVESTIGATION
FIG. 2: SIDE-VIEW OF TEST SECTION
Pressure orifices in tunnel sidewalls not shown

connected to balance system

model

wake rake

0.5 mm

connected to Mensor quartz manometer

.36 m

R = .50 m

FIG. 3: FRONT-VIEW OF TEST SECTION
FIG. 4: SECTION CHARACTERISTICS OF THE WORTMANN FX-66-S-196 V1 AIRFOIL.
FIG. 5: EXAMPLES OF FLOW VISUALIZATION WITH THE OIL FILM TECHNIQUE FOR THE EPPLER 387 AIRFOIL. (UPPER SURFACE)
FIG. 6: EFFECT OF REYNOLDS NUMBER ON THE $C_l - \alpha$ CURVE FOR THE WORTMANN FX-66-S-196V1 AIRFOIL.
CHORD: C = 150 [mm]

FX-66-S-196V1

EPPLER 385

EPPLER 387

FIG.7: POSITION OF TRIP WIRE.
FIG. 8: FX-66-S-196 V1 AIRFOIL, EFFECT OF TRIP WIRE DIAMETER, $R_C = 1.5 \times 10^5$
FIG. 9: EFFECT OF TRIP WIRE DIAMETER ON THE SECTION CHARACTERISTICS OF THE WORTMANN FX-66-S-196V1 AIRFOIL FOR $R_c=1.0 \times 10^5$
FIG. 10: SECTION CHARACTERISTICS OF THE EPPLER 387 AIRFOIL
FIG. 11: SECTION CHARACTERISTICS OF THE EPPLER 387 AIRFOIL WITH TRIP WIRE (d = 0.6 [mm])
FIG. 13: SECTION CHARACTERISTICS OF THE EPPLER 385 AIRFOIL WITH TRIP WIRE (d = 0.6[mm])
FIG. 15: SECTION CHARACTERISTICS OF THE DOUBLE WEDGE AIRFOIL.