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THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF INCOMPRESSIBLE LAMINAR BOUNDARY LAYERS WITH AND WITHOUT SUCTION

Ph.D THESIS

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This PDF-file contains chapter 12:

Conclusions

12. Conclusions

From the investigations described in this thesis the following general conclusions may be drawn. For more detailed concluding remarks the final sections of different chapters may be consulted.

Two methods for the calculation of laminar boundary layers with and without suction have been presented in chapters 5 and 7 respectively. It is shown in chapters 10 and 11 by comparison with experiments that both methods provide a good prediction of the actual boundary layer characteristics. Near separation difficulties may arise however, since in this region the boundary layer calculation is very sensitive to changes in the pressure gradient which is difficult to determine with sufficient precision. The results of the experiments discussed in chapter 11 suggest that no difficulties may arise when the pressure distribution is measured with less accuracy. It is likely that in this case a mean value for the adverse pressure gradient is assumed, which is on the high side upstream of separation so that separation is found earlier than for the accurate pressure distribution.
A remaining problem is to answer the question whether the boundary layer equations will predict separation at the right position if the pressure gradient is determined with the utmost precision. This problem has arisen already in connection with Schubauer's experiments on the boundary layer flow around an elliptic cylinder. Also the present experiments do not provide an answer to this question. It appears that the measurements have to be performed with still more accuracy than has been achieved in the present work.

A method has been designed which enables the calculation of the transition position for two dimensional laminar boundary layers with and without suction. In typical cases the beginning of transition is predicted within $\pm$ 10^{o}/o of the chord length if transition is not preceded by laminar separation. Some improvement of the method will be welcome however. To achieve this it will be necessary to calculate more accurate stability diagrams for an extended range of velocity profiles.

with the experiments. The multimoment method is slightly superior to the momentum method. It is remarkable that separation is predicted rather accurately but - strange enough - this may be due to inaccuracies in the determination of the pressure distribution.

The proposed method for the prediction of transition is reasonably accurate also in cases with suction.

The drag reduction due to suction obtained in the experiments is of the order expected from calculations for the flat plate with constant suction velocity or from earlier investigations by different authors. At full scale values of the Reynoldsnumber based on chord ($R_c \lesssim 25 \times 10^6$) reductions in total drag of about $75^o/o$ may be expected.