

Tagungsbericht 29/71

EUROMECH 26:

"AERODYNAMIC AND STRUCTURAL DESIGN OF GLIDERS"

July 5 through 9, 1971

The committee "Euromech" of the IUTAM (International Union of Theoretical and Applied Mechanics) organized a symposium devoted to the development of scientific and practical achievements in the aerodynamics and structural design of gliders as well as to the progress in soaring flight.

The coordination of the Symposium was in the hands of R. Eppler (Stuttgart) und H. Zacher (München).

Participants:

D. Althaus, Stuttgart
B.J. Cijan, Beograd/Jugoslavia
A.W.F. Edwards, Cambridge/UK
R. Eppler, Stuttgart
Th. Fischer, München
H. Förching, Göttingen
J. Gedeon, Budapest
D. Gregl, Ljubljana/Jugoslavia
G. Hefer, Göttingen
K.H. Horstmann, Braunschweig
F.G. Irving, London
H. Jung, München
G. Kretzschmar, Meudon/France
J.P. de Loof, Plaisir/France
P.A. Mackrodt, Göttingen
T. Magyar, Oberpfaffenhofen
D. Mühlhahn, Braunschweig
N. Niedbal, Stuttgart
B. Njamcul, Belgrad
D.A. Pirie, Glasgow
E. Rácz, Budapest
L. Rickert, München

K.Sherwin, Liverpool
J.B.Smielkiewicz, Bielsko Biala / Poland
W.T.Stafiej, Bielsko Biala / Poland
W.Stender, Germering
J.J.Tejlgard, Charlottenlund / Denmark
F.Thomas, Braunschweig
H.A.Torode, Bedford / England
H.Treiber, Braunschweig
W.Weber, Stuttgart
G.R.Whitfield, Reading / UK
H.Zacher, München
P.G.Thomsen, Hørsholm

In the programme of the Symposium there were included the following topics: all advanced aerodynamical and structural problems of gliders especially theoretical and experimental research in aerodynamics of wings, fuselages, tail units and aerofoils; boundarylayers, flight performances, controllability and stability as well as new materials, technology, new construction methods, stress analysis and aeroelasticity (especially flutter) and problems of optimization.

The sessions of the Symposium were devided in the following groups of problems:

1. Aerodynamics and Stability
2. Aerodynamic loads
3. Performance theory, Optimization
4. Aeroelasticity
5. Performance testing
6. Materials, Elasticity
7. Flaps and Spoilers
8. Other topics

1) Four papers were presented dealing with topic 1.

(i) B.CIJAN, Beograd, On the Determination of Temperature Profiles of Unsteady Thermal Boundary-Layers for given Temperature on the Wall.

The paper deals with the solution of the equations of the velocity and temperature fields. Coefficients of universal functions were tabulated for two Prandtl numbers. An example was shown of how the temperature profiles on a circular cylinder starting impulsively from rest could be obtained.

(ii) T.R.F. NONWEILER, Glasgow (represented by D. Pirie, Glasgow), The GU-Series of Low-Drag Aerofoils.

The GU-series of low-drag aerofoils are a family of wing sections patterned on the specification of the NACA 6-series of aerofoils: they have been designed to have uniform velocity over some prescribed forward portion of the chord, either on the lower surface, or else on the upper surface, at the two relevant extremes of the "low drag" incidence range. Their design is made possible by digital computer implementation of the Lighthill method.

(iii) H. JUNG, Oberpfaffenhofen, Bemerkungen zu Flugeigenschaftsprüfdaten.

A standard form of data sheet was proposed giving instructions for recording results of test flights.

(iv) N. NIEDBAL, Stuttgart, Längsstabilität des Nurflügels FS 26.

The author reported on the theoretical investigation and free flight measurements of the stability of the flying wing FS 26.

2) Two authors contributed to the session on aerodynamic loads.

(i) P.G. THOMSEN, Hørsholm, Denmark, A Programme for Calculating Lift Distribution, Induced Drag, Secondary Aileron Effects and Moment Distribution in an Arbitrary Glider Wing.

The lift distribution along the span in various aileron configurations has been programmed for computer to obtain data for stress analysis.

(ii) E. RÁCZ, Budapest, Dynamische Belastungen an Segelflugzeugen.

The wing is treated as an elastic body and from the differential equations of motion the bending moments and shearing forces are calculated.

3) Five authors contributed to the session on performance theory and optimization.

(i) G.TREIBER, Braunschweig, Rechenschema zur Bestimmung der Widerstandspolaren von Segelflugzeugen.

A method of calculation was presented which takes into account a great range of factors determining the accuracy of the results when calculating drag polars.

(ii) F.THOMAS, Braunschweig, Influence of Reynolds Number on the Optimum Aspect Ratio and Planform of a Glider Wing.

The influence of Reynolds number on the performance of the glider was discussed with reference to the main wing parameters.

(iii) A.W.F.EDWARDS, Cambridge, Cross-Country Theory and its Relevance to the Choice of Performance Characteristics.

Based on the main performance data of the glider the author has given an analysis of cross-country flight taking into account the stochastic character of thermals. It is possible to calculate the probability of reaching a certain goal as a function of the average cross-country speed.

(iv) F.G.IRVING, London, Computer Analysis of the Performance of 15 m Sailplanes Using Thermals with Parabolic Velocity Distribution.

A computer programme for the calculation of the performance of a sailplane of given characteristics in straight and circling flight has been given. Thermals having a parabolic velocity distribution were assumed and the corresponding average cross-country speed calculated. Allowance was made for Reynolds number effects.

(v) K.SHERWIN, Liverpool, Man-powered Aircraft.

Analysing the possibilities for man-powered flight the author showed the British achievements in this field. The explanations were illustrated by a film.

4) The aeroelasticity problems were covered by three papers.

(i) H.FÖRSCHING, Göttingen, Aerolastische Gesichtspunkte beim Entwurf von Segelflugzeugen.

This was a basic introduction to the aeroelasticity problems giving a systematic classification of the phenomena occurring under static and dynamic conditions.

(ii) W.STENDER, München, Flutter.

This was a review of contributions of the author to the special aeroelastic problems gathered through many years of active experience as designer and pilot of gliders and aircraft. He made original observations which are extremely useful in daily practice.

(iii) H.TREIBER, Braunschweig, Flatteruntersuchungen am Segelflugzeug SB 9

Flutter-tests in flight were performed on a SB 9 glider which had its wing span increased in an attempt to improve its flying qualities. This investigations have been recorded on a unique film showing different modes of flutter in flight in a very impressive manner.

5) In the field of performance testing four papers were given.

(i) G.R.WHITFIELD, Whiteknights, UK, Glider Performance Testing with Results of Tests of the Scheibe FS 25 Falke.

The use of a tape recorder for in-flight measurements was discussed. These recordings could be used directly as input data for a computer programme which calculated the speed polar and error bounds.

(ii) H.TREIBER, Braunschweig, Ergebnisse von Flugleistungsmessungen an einigen Segelflugzeugen.

The paper deals with the comparison flight of two gliders one of which is calibrated. During this flight the height differences have to be recorded. A special method has been introduced to eliminate the scatter of measured points.

(iii) H.ZACHER, München, On the Question of Performance Measurements of Sailplanes.

From a collection of flight polars of different sailplanes it was possible to estimate the aerodynamic characteristics. The author drew attention to several conditions necessary to obtain the true values.

(iv) H.TORODE, Cranfield, UK, Flight Tests of Schempp-Hirth Cirrus B.

Using a special trailing static pressure tube (cone) the speed polar has been obtained with an estimation of scattering error. The author also showed a picture of the flow at the wing-fuselage junction made visible by tufts.

6) Five papers were devoted to the problems of materials and elasticity.

(i) J.GEDEON, Budapest, Einige Probleme der Lebensdauerberechnung.

Two-stress level rotating bending and axial tensile fatigue tests were run in order to test the applicability of the double linear damage rule as proposed for high strength steels by MASON et.al. to two nearly identical dural type alloys.

(ii) J.TEJLGARD, Charlottenlund, Denmark, Bonding of Metal in Glider Structures.

The author presented practical achievements in Redux-Bonding of metal sandwich structure employing the honey-comb core. Some specimens of the elements of the structure were shown.

(iii) W.WEBER, Stuttgart, Einige Gesichtspunkte zu Sandwich-Kernmaterialien im Hinblick auf Verklebung mit GFK-Deckschichten.

The application of three kinds of core have been considered as follows: Balsa, foam and honey-comb cores. The results of tests and reference formulae were shown.

(iv) D.MÜHLHAHN, Braunschweig, Ergebnisse aus Festigkeitsversuchen mit kohlenstoff-faserverstärkten Kunststoffen.

The advantage of carbon fibre reinforced plastics compared with conventional structural materials as well as GFK were shown graphically. Some measured mechanical properties were shown from which is evident the quality of the new material.

(v) R.EPPLER, Stuttgart, Torsionsschalen optimaler Steifigkeit.

Starting from the membrane theory of shells a steepest descent method was used to solve statically undetermined shells. Based on the configuration of the shell the author showed how to optimize the structure.

7) Four papers dealt with flaps and spoilers.

(i) H.ZACHER, München, Simple Flaps for Standard Class Sailplanes.

Different types of hinged flaps for standard class sailplanes were described. The practical benefits were discussed and the opinions of pilots and the Gliding Panel of FAI were considered.

(ii) Th.FISCHER, München, Flap-Construction for a Glider with Variable Wing Area.

The author has shown a variety of kinematic devices for flap extension similar to those use in the SIGMA project.

(iii) R.EPPLER, Stuttgart, Kinematic Problems of Attachment of Camber-Flaps and Control Surfaces.

An analytical approach to the problem of flap hingeing has resulted in a new design of hinge. Two different models of the device were shown.

(iv) D.ALTHAUS, Stuttgart, Messungen an einem Flügelprofil mit neuartiger Lagerung der Wölbungsklappen.

The results of measurements performed in low-turbulence tunnel at Stuttgart Technical University have shown the advantage of the new flap under (iii) when compared with a conventional one.

8) In addition to the fixed programme several other problems were discussed:

(i) G.R.Whitfield discussed his studies of the flying techniques of Pteranodon (a member of the Pterodactyl family) based on the structure of the body as deduced from fossil remnants.

(ii) A general exchange of opinions on various problems, particularly:

- a) influence of wing tips on aerodynamic performance
- b) dynamic soaring
- c) automatic cross-country flight
- d) the methods of the speed polar measurements and analytic approach for calculation of drag polars.

Finally a great number of very effective discussions in small groups and new international friendships, and last but not least the excellent conditions and the fine organization by the "Mathematisches Forschungsinstitut Oberwolfach", to which we express our warm thanks, contributed to the remarkable success of the Symposium Euromech 26. We hope, that in the future another Euro-mech can be held at this excellent place.

B. Cijan, Beograd-Zemun