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CONSTRUCTION OF THE REAL WING CLOSE TO THE IDEAL WING

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Abstract: *Building dihedral U wing Albatross glider, having 56 % horizontal part of the wingspan and dihedral $U_{optimum}$ Climber glider, having 30 % horizontal part of the wingspan, it was noticed, the Climber is better. It has a slight increase of lift and speed, better cruise stability, safety determalization, never broke at the dihedral start, never fallen on a wing and climb on the air (after 50 test flights).*

Key words: *Model airplanes, U wing, $U_{optimum}$ wing.*

1. INTRODUCTION

Lifting surfaces (of model airplanes and airplanes) are wings, having airfoil profiles. The ideal shape of a wing is a parabola seen from the front.

The practical building of such ideal surface is difficult, so its check is, deviations from ideal wing are hard to see, and maintaining the shape is also difficult. Repairing (result of different deteriorations) to bring the surface to initial shape is difficult.

In the present paper, it is treated the real wing construction by straight lines for model airplanes. Approximation by straight line of wing is treated for front view only: U and $U_{optimum}$ [1-3]. There are presented calculations for proper dimensions, together with some observations, deviations to parabola, and to V wing – the most resistant to the lateral shocks.

2. APPROXIMATION FOR U AND $U_{optimum}$ WINGS

U wing – dihedral wing [1-3] - is the wing approximated by three straight lines: d0 tangents parabola at wing root in (0, 0), d2 tangents parabola at the wing tip in (t, h), and the other one d2, respectively, in (-t, h), Figure 1, in a xy reference system.

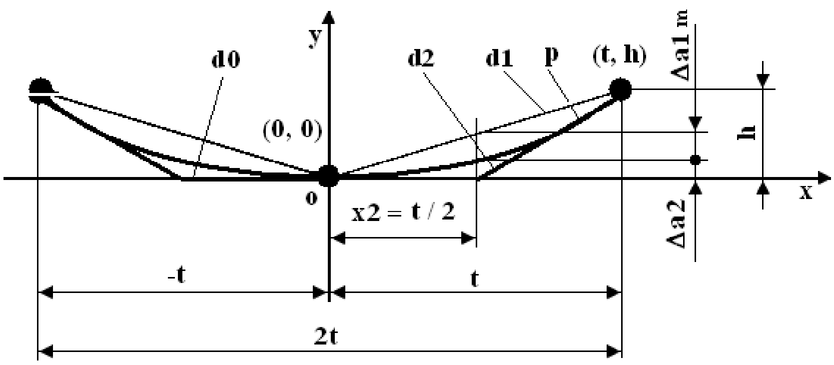

Fig.1. U wing: parabola, p, approximated by three straight lines: d0, d2, and symmetrically d2. d1 – V wing. 2t – wingspan, h – tip height over the wing base [1-3].

Note: x2 = 0.5t – dihedral start; Δa1m + Δa2 = h/2 – distance to line d1 of dihedral start; Δa1m = h/4 – distance to line d1 of parabola at x2; Δa2 = h/4 – distance to parabola of dihedral start; Δa1m + Δa2 makes a double bending moment for U wing comparative to V wing, when the wing falls vertical, as d1. The U wing looks very ease to brake at the dihedral start.

$U_{optimum}$ wing – dihedral wing [3], Figure 2, is approximated by three straight lines: d0 tangents wing in the central part at (0, 0) and d3 is passing thru (t, h) with deviation Δa3 = Δa4m (m-minimum), and its symmetrical, at(-t, h), respectively.

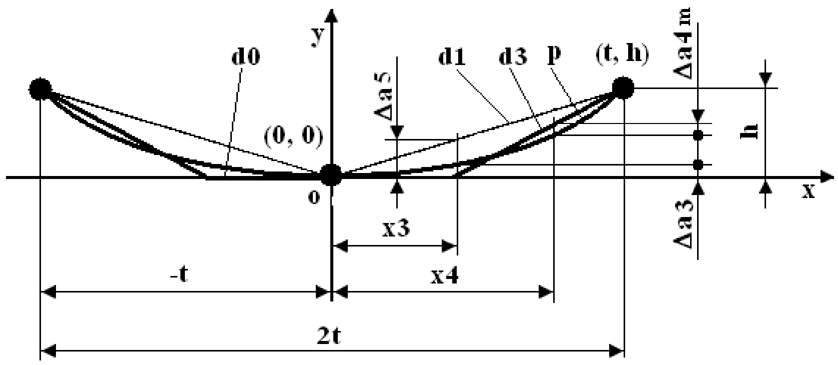

Fig. 2. $U_{optimum}$ wing: parabola, p, approximated by three straight lines: one tangent in the central part, d0, and d3 passing thru tips, as close as parabola, Δa3 = Δa4m [3].

Note: x3 = 0.3t and Δa5 = 0.29h – distance from d1 of the dihedral start at x3, which reduces the bending moment with 40 % when the wing falls vertically (weak point in wing strength structure). Δa5 is at x3, it makes the wing stronger, inertia static moments of the structural strength being bigger (solid of equally strength at bending) than for x2 [3].

3. CONSTRUCTION OF U AND $U_{optimum}$ WINGS OF F1E MODEL AIROPLANES

It was designed and constructed a model glider, Albatross, having U wing, Figure 3.

The main characteristics of the glider are mentioned on the design, for the last version

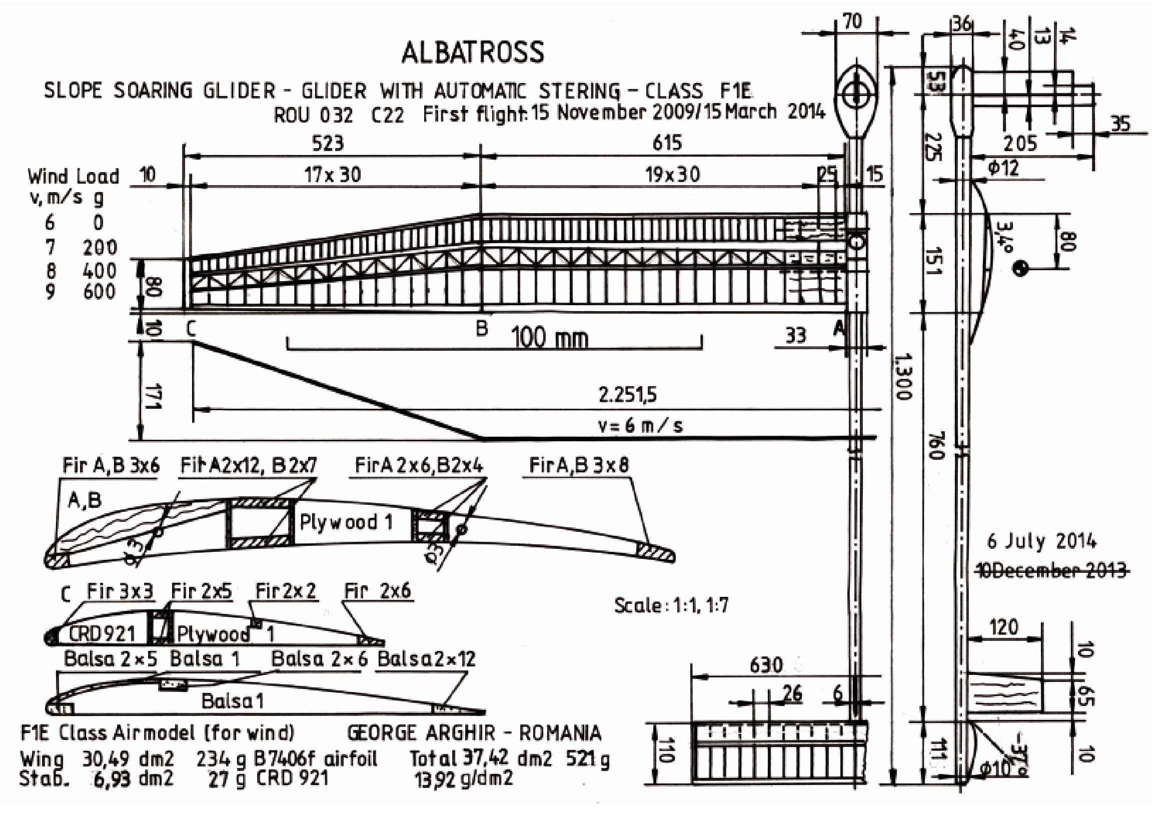

Fig. 3. ALBATROSS – slope soaring glider – glider with automatic steering. The scale line is 100 mm.

(W_A = 30.49 dm^2, S_A = 6.93 dm^2), Figure 3. It had horizontal part of the wing of 56 % of the wing span, close to 50 %, suggested by Figure 1. Initial glider had a smaller stabilizer of 4.41 dm^2, Table 1, which was increased to make it more stable in the wing gales.

The Albatross glider had tested different wings and stabilizers with different areas, having different stabilizer area to wing area ratio, Table 1. As the ratio was increased (from 0.144 to 0.227) the cruise direction was more stabilized. This was an advantage in flight.

Being stabilized no more hieratically turns and flight was safety. Determination was safety.

Table 1
Wing area (W_A) and stabilizer area (S_A)

Glider	W_A, dm^2	S_A, dm^2	S_A/W_A
ALBATROSS Fig. 3	30.68	4.41	0.144
	29.88	4.37	0.146
	30.61	5.88	0.192
	30.49	6.93	0.227
CLIMBER, Fig. 4	29.03	6.93	0.239

A new glider – Climber – was designed and constructed, Figure 4, with dihedral $U_{optimum}$ wing, having horizontal part of 30 % of the wingspan, as Figure 2 suggested.

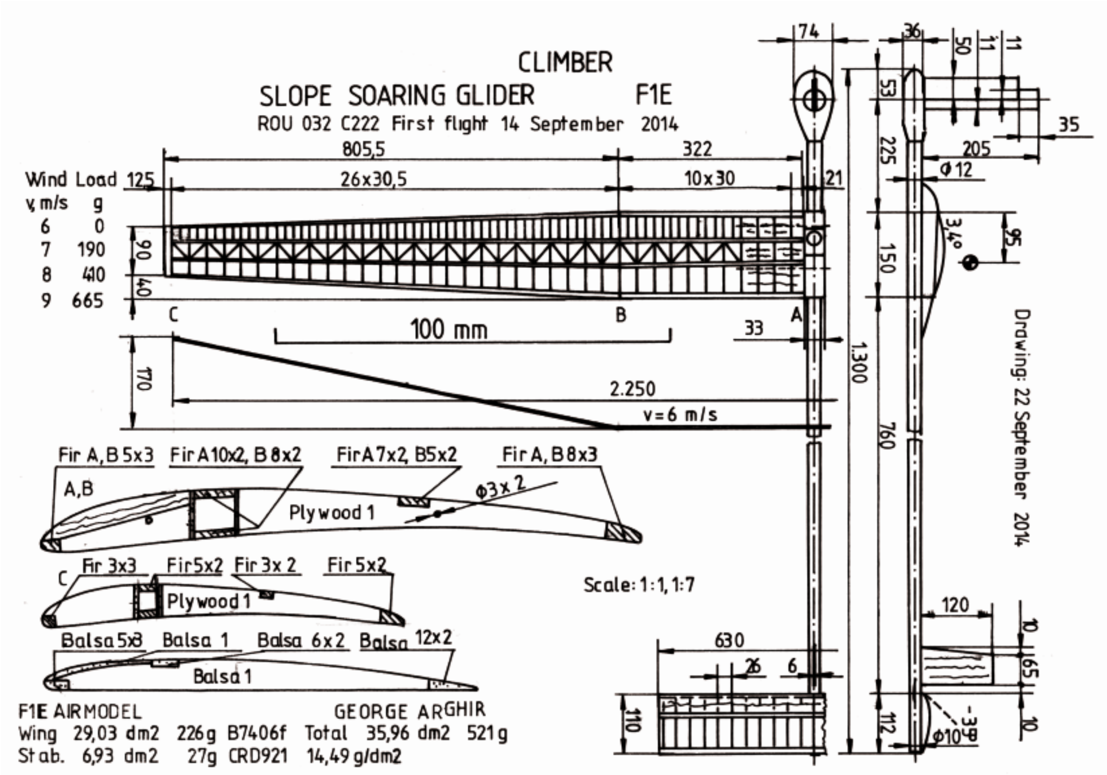

Fig. 4. CLIMBER – slope soaring glider – glider with automatic steering. The scale line is 100 mm

The Climber has smaller wing, 29.03 dm^2 comparative to Albatross (last version), 30.49 dm^2, maintaining the same stabilizer area of 6.93 dm^2. Smaller wing area at the same total weight means bigger specific load from Albatross (13.92 g/dm^2) to Climber (14.49 g/dm^2), giving a slight increase of speed (2 %), which is good for F1E gliders.

The area stabilizer to wing ratio is 0.239, which increases cruise stability, no turn, very good steering control and safety determination in any wind conditions.

There were constructed both variants: Albatross, Figure 5 and Climber, Figure 6, the horizontal part of each wing: Albatross is 56 % and Climber is 30 % from the wing span.

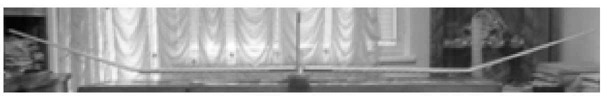

Fig. 5. Albatross – F1E class glider.

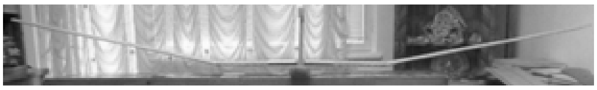

Fig. 6. Climber – F1E class glider.

During Climber glider test flights (more then 50) was noticed: lift was slight increased, speed was slight increased, better cruise stability, safety determalization, never broke at the dihedral start, never fallen on a wing, climb on the air (the wing lifts then the stabilizer does, it may be repeated in thermals or proper wind).

The Climber wing is more difficult to construct than of Albatross due to the longer trapezoidal part.

For wings storage was built a support for each wing, Fig. 7. To show the size of them it

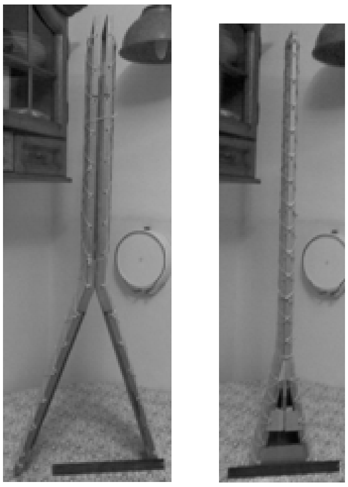

Fig. 7. Albatross (left) (root wing is at the upper side) glider and Climber (right) (root wing is at the lower side) glider wings on storage supports.

was included a 305 mm long ruler. The Albatross sizes for the support are bigger than for Climber.

4. CONCLUSION

Constructing dihedral U wing Albatross glider, having 56 % horizontal part of the wingspan and dihedral $U_{optimum}$ wing Climber glider having 30 % horizontal part of the wingspan, it was noticed, the Climber is better. It has a slight increase of lift and speed, better cruise stability, safety determalization, never broke at the dihedral start, never fallen on a wing and climb on the air (after 50 test flights).

Albatross and Climber has the same sizes and use the same airfoil profiles (wing – B 7406f, stabilizer – CRD 921). Both are F1E class gliders – gliders with automatic steering – slope soaring gliders.

8. REFERENCES

[1] Arghir, G., *Die Ausgleichsflanche des Ruderblattes (On the Shape of the Wings)*, Der Hangflieger (Germany), 21, October 1981, p. E21/39 – 41.

[2] Arghir, G., *Aproximarea aripii ideale prin drepte*, Ştiinţă şi Inginerie, An X, Vol. 17, Lucrările celei de A X-a Conferințe Naționale Multidisciplinare – cu participare internațională "Profesorul Dorin PAVEL – fondatorul hidroenergeticii romanesti", Sebeş, 2010, Editura AGIR, Bucureşti, 2010, p. 229-236,.ISSN: 2067-7138

[3] Arghir, G., *On the front view of real wing*, Acta Technica Napocensis, Series: Applied Mathematics and Mechanics, 54, Issue 1, 2011, p. 7-12. ISSN: 1221-5872.

CONSTRUIREA ARIPII REALE APROPIATA DE ARIPA IDEALA

Rezumat: Construind un aeromodel planor cu aripa diedru U, având 56 % parte orizontală din anvergură și un planor cu aripa diedru $U_{optimum}$, având 30 % parte orizontală din anvergură s-a remarcat ca ultimul are o ușoară creștere de portanță şi de viteză, o stabilitate mai bună de zbor, determalizare mai sigură, nu s-a rupt la diedru, nu a căzut pe o aripă şi aparent se urca pe aer (după 50 zboruri de incercare).

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