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UTILISATION OF COMPOSITE MATERIALS IN THE MODEL AIRCRAFT CONSTRUCTION

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***Abstract**: Constructing dihedral $U_{optimum}$ wing Super Climber glider, having 30 % horizontal part of the wingspan, using composite materials for wing and for horizontal stabilizer 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). It is more resistant to shocks. Super Climber (SC) has the same size as Climber (C) and uses the same airfoil profile for wing – B 7406f, for horizontal stabilizer – C is using CRD 921 and SC – Clark Y 70 %. Both are F1E class gliders – gliders with automatic steering – slope soaring gliders. The composite material construction is more favorable aerodynamically and in use (training and in contests).*

***Key words**: Model airplane, glider, $U_{optimum}$ wing, composite materials.*

1. INTRODUCTION

Composites materials based on a non-metallic matrix (resin) reinforced with glass or carbon fiber or kevlar are gaining more and more terrain in aircraft construction. It was a decision to change from classic materials (wood) to composite materials for better mechanical properties in the model airplane particularly in a glider model aircraft construction.

Aircraft is a device used for flight in the air.

The reduced size affects the model's Reynolds number which determines how the air reacts when flowing past the model, and compared to a full sized aircraft the size of control surfaces needed, the stability and the effectiveness of specific airfoil sections may differ considerably requiring changes to the design.

Flying model aircraft must be set up before flight so that its control surfaces and weight allow stable flight. Most free flying models are unpowered. This type of model pre-dates manned flight.

Lifting surfaces of model aircraft 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 using composite materials. Different authors treated in their work the composite [1-4]

Approximation by straight line of wing is treated for front view only: U and $U_{optimum}$ [5-8]. There are presented transformation of a glider constructed in classical manner by wood to one made of composite materials. It is preferred $U_{optimum}$ shape and is most resistant to the lateral shocks.

From the latest research [9] it was established that the longitudinal stability of the of glider airplane model is higher if the wing tip angle to the horizontal is as low as possible and if the tip wing is made of lines not curves.

2. APPROXIMATION FOR $U_{optimum}$ WING

<u>$U_{optimum}$ wing</u> – dihedral wing [7], Figure 1, 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.

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 [7].

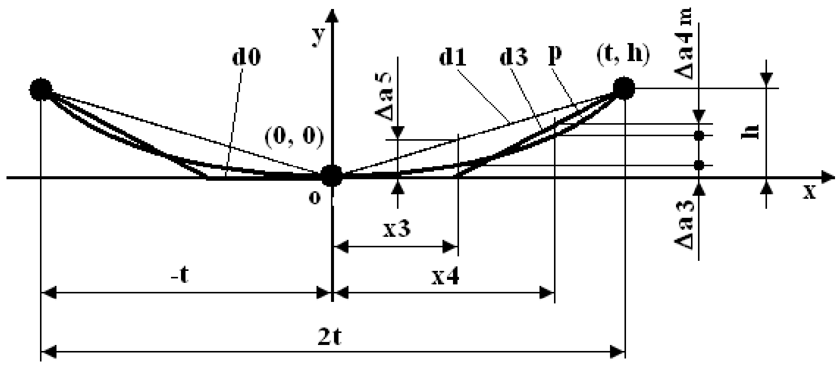

Fig. 1. $U_{optimum}$ wing: parabola, p, approximated by three straight lines: one tangent in the central part, d0, and d3 passing thru tips, as close as parabola, Δa3 = Δa4m [7].

3. CONSTRUCTION OF $U_{optimum}$ WING OF AN F1E MODEL AIRCRAFT

A glider – Climber – was designed and constructed, Figure 2, with dihedral $U_{optimum}$ wing, having horizontal part of 30 % of the wingspan, as Figure 1 suggested.

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 [3, figure2]. 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.

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 difficult to construct due to the longer trapezoidal wing part. It is constructed classically using wood for strength parts, e. g. wing and horizontal stabilizer longerons. The area stabilizer to wing ratio is 0.239, which increases cruise stability, no turn, very good steering control and safety determalizing in any wind conditions.

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4. CONSTRUCTION OF AN F1E MODEL AIRCRAFT USING COMPOSITE MATERIALS

It was designed a new glider on the base of “Climber”. The name of “Super Climber” was attributed to this one, Figure 3.

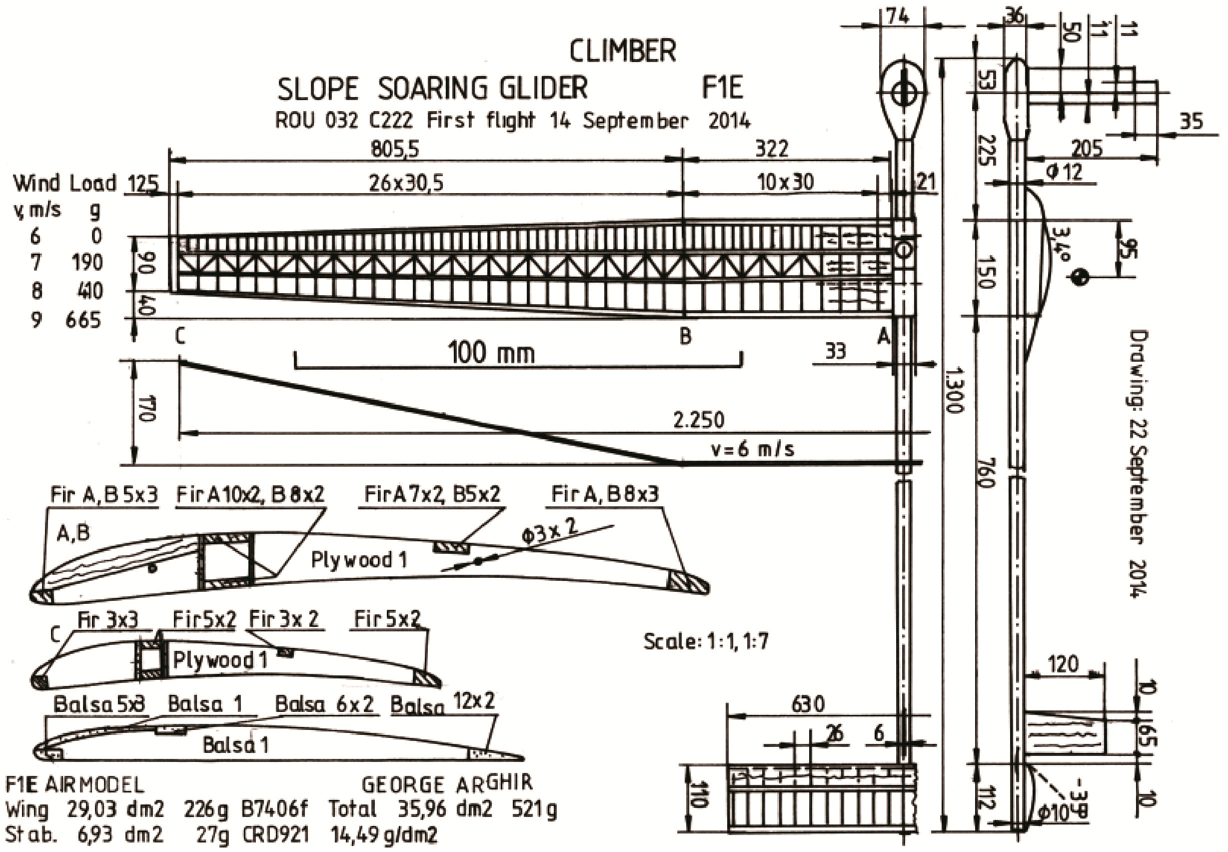

Fig. 2. CLIMBER (C) – slope soaring glider – glider with automatic steering. The scale line is 100 mm [8].

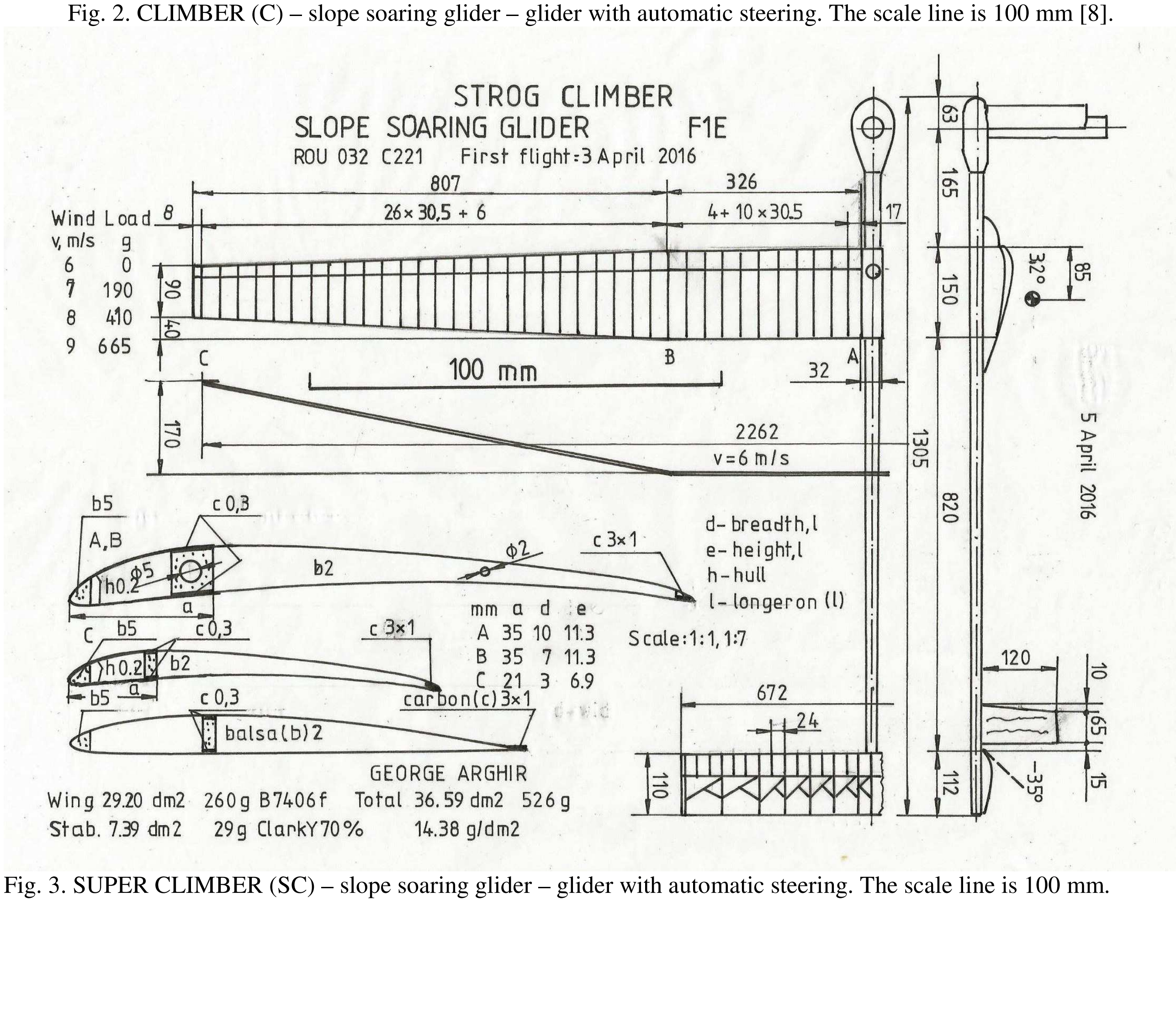

Fig. 3. SUPER CLIMBER (SC) – slope soaring glider – glider with automatic steering. The scale line is 100 mm.

It was maintained the general shape and characteristics of "Climber" glider, for "Super Climber", Table 1. On the base of Figure 2 and Figure 3, there were constructed the two gliders. Table 1 contains the data after the glider were constructed and adjusted.

The difference between these two gliders is insignificant. The single main difference is between the wing and stabilizer distance: 760 mm and, respectively, 820 mm, which can give more transversal stability and more secure cruise for "Super Climber" glider.

The horizontal stabilizer was changed from CRD 921 to Clark Y 70 %. The Clark Y profile was modified at 70 % thickness (and curvature) of the original one.

The construction of the "Super Climber" glider starts with the longerons. All components are stacked with Ciano acrylic extra thin glue. Plenty of Ciano acrylic activator must be used on all glued parts. The glue layer is applied on the carbon fiber first and then the part is applied on balsa wood in all cases. It is very important, the surfaces to be perpendicular of parallel. The demoldant should be used on all surfaces used to help in work. Avoid dust in all cases.

Table 1. Main data of "Climber" and "Super Climber" gliders

		Area, dm2	Weight, g	Profile	Total		
					Area, dm2	Weight, g	Load, g/dm2
Climber	Wing	29.03	226	B7406f	36.59	526	14.38
	Stab.	6.93	27	CRD921			
Super Climber	Wing	29.20	260	B7406f	35.96	521	14.49
	Stab.	9.20	29	Clark Y 70 %			

Horizontal longeron is made of two parts: one left, Figure 4, and one right, identical as left one in a mirror. The longeron has at the base a brass tube (Ø5 with 0.5 mm wall, external Ø6 mm), parallel to AC, Figure 4, long for 50 mm, imbedded in a plastic material, parallel to leading edge of the glider. The tube is for fixing and locating the wing on the fuselage. It continues with balsa wood. The longeron has 0.3 mm fiber carbon band on the upper and lower side of wing on the entire length. From Figure 4, it is seen the longeron has a height of 11.3 mm on the entire length and a breadth of 10 mm at the base and respectively 7 mm at the other end. The entire length is spliced with Kevlar wire: the first 50 mm wire next to wire, then on the upper and lower side at 5 mm distance and on lateral in X. The entire longeron is covered with a thin two components resin. The AC is at 35 mm from the leading edge of the wing. B axis is parallel to AC.

U longeron of left, Figure 5, and right wing is of balsa wood having a 0.3 mm fibber carbon band on the upper and lower side of wing on the entire length. Its sizes are: height: 11.3, respectively 6.9 mm and breadth: 7, respectively 3 mm. The smallest values are at the top. The entire length is spliced with Kevlar string, on the upper and lower side at 5 mm distance and on lateral in X. The entire longeron is covered with a thin two components resin. D is at 35 mm and E is at 21 mm from the leading edge of the left, respectively right wing.

The entire wing, central (horizontal) and left and right U side from the leading edge to the longeron should be covered with a 0.2 mm thick hull, upper side by the end and lower side 1 mm longer than the longeron. Horizontal stabilizer longeron, Figure 6, is of balsa covered with a 0.3 mm fibber carbon band on the upper and lower side. All dimensions are in the figure: 9.5 mm height and 3 mm wide. In wing and horizontal stabilizer construction when the longeron is less high than it should be, the ribs are adjusted.

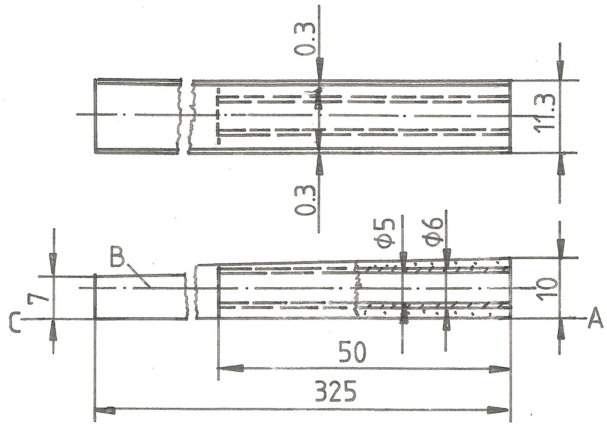

Fig. 4. Left wing longeron. AC is parallel to the leading edge. Sketched axis (of the Ø5 mm tube) is parallel to AC.

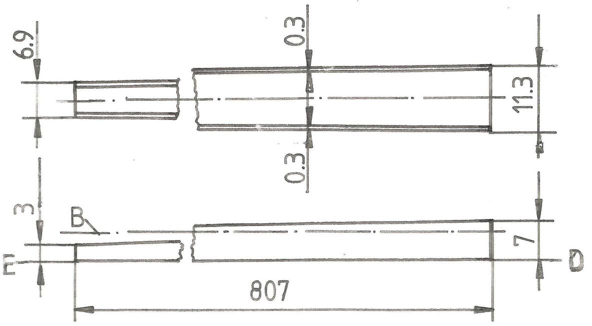

Fig. 5. Left wing U longeron. DE is parallel to the leading edge. Sketched axis (of the Ø5 mm tube) is parallel to DE.

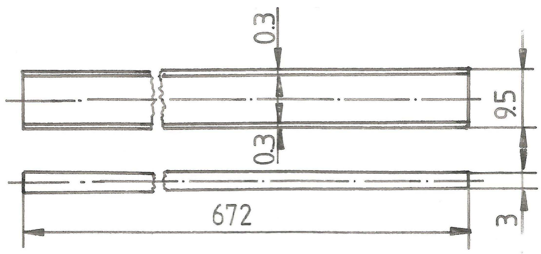

Fig. 6. Horizontal stabilizer longeron.

5. CONCLUSION

Constructing dihedral $U_{optimum}$ wing SC glider, having 30 % horizontal part of the wingspan, using composite materials for wing and for horizontal stabilizer 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). It is more resistant to shocks.

SC has the same size as C and uses the same airfoil profile for wing – B 7406f, for horizontal stabilizer uses Clark Y 70 %, respectively, CRD 921. Both are F1E class gliders – gliders with automatic steering – slope soaring gliders.

The composite material construction is more favorable aerodynamically and in use (training and contests).

When the one of the tip wing is vertical the glider passes from a mode of stability to another mode of instability [9]. So the wing tip angle to the horizontal should be as low as possible.

The tip end should be made of lines, no rounded forms, usual recommended [9]. Making wing tip of lines is less aerodynamically and when the wing in vertical position the model fails and the tip being having some aerodynamically resistance, stops the failing of the air model and the aircraft recover normal flying position.

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UTILIZAREA MATERIALELOR COMPOZITE IN CONSTRUCȚIA AEROMODELELOR

Rezumat: Construind Super Climber planor cu aripă U_{optim} diedru, având 30% parte orizontală din anvergura aripilor, folosind materiale compozite pentru aripă și pentru stabilizator orizontal se constată că este mai bine. Aeromodelul are o ușoară creștere de urcare și de viteză, o mai bună stabilitate de zbor, determalizare de siguranță, niciodată nu s-a rupt la diedru, nu a căzut pe o aripă și parcă urca pe aer (după 50 de zboruri de test). Este mult mai rezistent la şocuri. Super Climber (SC) are aceeaşi dimensiune ca şi Climber (C) şi folosește același profil pentru aripa - B 7406f, pentru stabilizator orizontal - C utilizează CRD 921 și SC - Clark Y 70%. Ambele sunt planoare clasa F1E. Varianta din material composite este mai favorabilă aerodinamic și în utilizare (antrenamente și concursuri).

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