TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Nr. 62, Issue I, March, 2019

ABOUT LARGE U SHAPE WING OF GLIDER AIRPLANE MODEL

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Abstract: *The U large wing is a new proposed shape of the glider airplane model wing. Its stability is compared to V wing. U large wing I/II has increased stability as the tilting angle increases, less than for V wing I/II. Its strong instability is at $\beta = 90^o$, when the wing is in vertical position. Its stability range is larger than for V wing. The V wing has the stability range limited by α, being $90^o - \alpha$., where α is the angle between wings and horizontal line, in normal flight. β is the tilting angle for the wing. It can be trigonometric or anti trigonometric rotation, seen from the tale.*

Key words: *U large wing, V wing, coefficient of restauration*

1. INTRODUCTION

The wing is the most important item of a glider airoplane model. It gives the sustentation of glider during the flight in the air. Its shape is very important. Seen from above it can be in eliptical shape and from the front in parabolic shape as ideal shapes [1]. A wing with no aerodynamic twist and no geometric twist, an eliptical lift distribution is generated by a wing with n eliptical planform [1]. Elliptic planforms are difficult to make than a rectangular wing [1]. A rectangular wing generates a lift distribution far away of optimum [1]. These ideal shapes are approximated by streight lines for an easy building and reparations. Many studies have been done in the field [2– 7]. It was studied the highly flexible aircraft wing to be as an ideal wing for flight improved performance [8].

The ideal shape using smart materials as shape memory alloys or polymers is a good one [9]. Another ideea is to use composite materials [10]. Introducing the winglet at the wing tip is a solution to reduce the drag [11]. The box wing can reduce more drag [12].

The streight line approximation seen from the front of the wing was studied in different papers [2 – 6]. The V wing appeared in [2], W, Voptim, and Woptim apeared in [3, 4], the real construction si presented in [5], the wing tips influence is presented in [6], and the approximation from the above is presented in [7]. It looks a new approximation of the wing by streight lines can develop, named U large. It was not discussed in the literature.

Present article is dealing with the stability of V and U large wings. Stability is a chance of the glider to come to the flight condition after it was tilted to the left or to the right around the longintudinal axis, seen the model from the tale of the flying direction.

2. V AND LARGE U WINGS CALCULATIONS

V Wing is presented in Figure 1, composed by the segments AB (right wing) and AC (left wing). The wingspan is t̲ and tip height is h̲, giving an angle α̲ between AB and AC to the horizontal line.

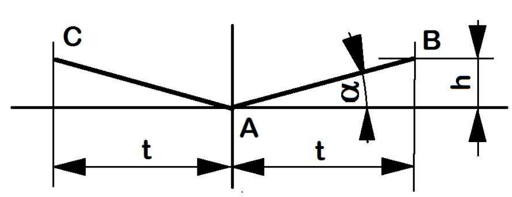

Fig. 1. V wing composed by AB and AC.

It was considered two variants of the wing as α is changed, Table 1. It seems for α of 15° the flight is more stable, the wing is a little bit heavier. The α of 10° was considered too, flight is still stable and the wing is lighter.

Table 1.

Variants of wings

Variant	α°
I	10
II	15

When the wing is tilted β, trigonometric rotation, it appears as in Figure 2.

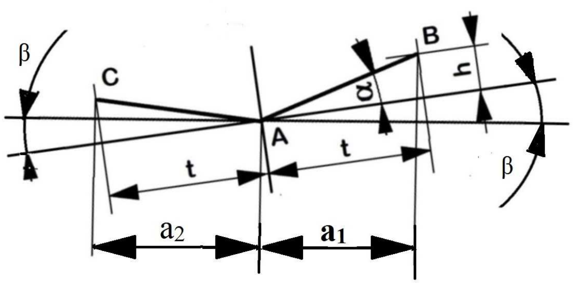

Fig. 2. V wing tilted β.

The projections of the wings on the horizontal are:

$a_1 = AB.\cos(\alpha + \beta) = t.(\cos(\alpha + \beta))/\cos \alpha;$ (1)
$a_2 = AC.\cos(\alpha - \beta) = t.(\cos(\alpha - \beta))/\cos \alpha;$ (2)
$AB = AC = t/\cos \alpha.$ (3)

The Coefficient of restauration for $+\beta$, as Fig. 2, is $CR_1 = a_2/a_1$ and for $-\beta$ is $CR_2 = a_1/a_2$.

Coefficient of restauration, CR, is defined asa value showing the tendency of the wing to come to horizontal position, when its value is 1.00, minimum value of it.

The results of calculations for Coefficient of restauration CR1 and CR2 of V wing for variant I is presented in Table 2 and for variant II is presented in Table 3.

Table 2.

Calculations for V wing, variant I

β°	a_1/t	a_2/t	$CR_{1/2}$
0	1.000	1.000	1.000
10	0.954	1.015	1.064
20	0.879	1.000	1.139
30	0.778	0.954	1.226
40	0.653	0.869	1.331
50	0.508	0.778	1.531
60	0.347	0.653	1.882
70	0.176	0.508	2.886
80	0.000	0.347	±∞
90	-0.176	0.176	-1.000

Table 3.

Calculations for V wing, variant II

β°	a_1/t	a_2/t	$CR_{1/2}$
0	1.000	1.000	1.000
10	0.938	1.031	1.099
20	0.848	1.031	1.216
30	0.732	1.000	1.366
40	0.594	0.938	1.579
50	0.438	0.848	1.936
60	0.268	0.732	2.731
70	0.090	0.594	6.600
75	0.000	0.000	±∞
80	-0.090	0.438	-4.867
90	-0.268	0.268	-1.000

Considering Table 2: Coefficient of restauration, CR_1, is increasing as β is increasing, up to 80° (90° – α (α = 10°)), when it becomes +∞ and instantly -∞. At β = 80°, it is strong instability of the V wing variant I.

When α = 15°, V wing variant II the Coefficient of restauration, CR_2, is increasing as the β is increasing 3.5 % for β = 10° and much faster for following increased β angles. The strongest instability is for β = 75° (90° – α (α = 15°)), when it comes from +∞ to -∞.

For V wing shape tilting with some angle β, variant I or II, will meet a strong instability, the wing will go up side down, at the (90° – α) angle of the dihedral wing, given by construction.

U large wing is presented in Figure 3, composed by the segments AE and EB (right wing), and AD and DC (left wing). The V wing is made by dotted lines, replaced by the U large wing. The wingspan is t and tip height is h, giving an angle α between AB and AC to the horizontal line.

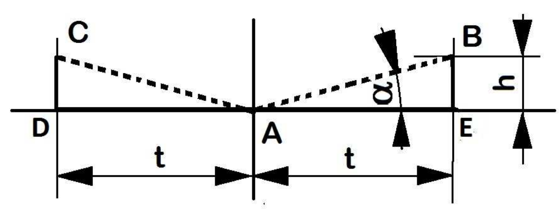

Fig. 3. Large U wing composed by AE and EB, and AD and DC.

When the U large wing is tilted β, trigonometric rotation, it appears as in Figure 4.

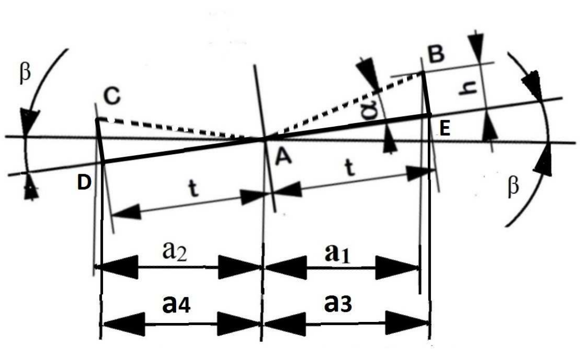

Fig. 4. U large wing tilted β.

The projections of the wings on the horizontal are:

$a_1 = AB.\cos(\alpha + \beta) = t.\cos(\alpha + \beta)/\cos \alpha;$ (4)
$a_2 = AC.\cos(\alpha - \beta) = t.\cos(\alpha - \beta)\cos \alpha;$ (5)
$a_3 = AE.\cos \beta = t.\cos \beta;$ (6)
$a_4 = AD.\cos \beta = t.\cos \beta.$ (7)

Coefficient of restauration for β, as Figure 4, is $CR_3 = a_2/a_3$; and for –β, $CR_4 = a_1/a_4$.

The coefficient of restauration of U large wing for variant I is presented in Table 4 and for variant II is presented in Table 5.

Table 4.

Calculations for U large wing variant I

β^o	a_1/t	a_2/t	$a_{3,4}/t$	$CR_{3/4}$
0	1.000	1.000	1.000	1.000
10	0.954	1.015	0.985	1.030
20	0.879	1.000	0.940	1.064
30	0.778	0.954	0.866	1.102
40	0.653	0.879	0.766	1.148
50	0.508	0.778	0.643	1.210
60	0.347	0.653	0.500	1.306
70	0.176	0.508	0.342	1.485
80	0.000	0.347	0.174	1.994
90	-0.176	0.176	0.000	±∞

Table 5.

Calculations for U large wing variant II

β^o	a_1/t	a_2/t	$a_{3,4}/t$	$CR_{3/4}$
0	1.000	1.000	1.000	1.000
10	0.938	1.031	0.985	1.047
20	0.848	1.031	0.940	1.097
30	0.732	1.000	0.866	1.155
40	0.594	0.938	0.766	1.225
50	0.438	0.848	0.643	1.319
60	0.268	0.732	0.500	1.464
70	0.090	0.594	0.342	1.737
80	-0.090	0.438	0.174	2.517
90	-0.268	0.268	0.000	±∞

Considering Table 4: Coefficient of restoration, CR_3, is increasing as β is increasing, up to 90°, when it becomes +∞ and instantly -∞. At β = 90°, it is strong instability of the U large wing variant I.

When α = 15°, U large wing variant II, the Coefficient of restauration, CR_4, is increasing as β is increasing, 1.6 % for β = 10° and much faster for following increased β angles. The strongest instability is for β = 90°, when it comes from +∞ to -∞.

For U large wing shape tilting with some angle β, variant I or II, will meet a strong instability at β = 90°, the wing will go upside down.

3. DISCUSION OF THE RESULTS

The U large wing is a new shape of the glider airplane model wing. Its stability is compared to V wing.

It was considered two variants for V wing; one with α = 10° (I) and another one with α = 15° (II). The β angle is for tilting the wing to the left or –β to the right, seen from the tale. V wing I: coefficient of restauration, CR_1, is increasing as β is increasing, up to 80° (90° – α (α = 10°)), when it becomes +∞ and instantly -∞. At β = 80°, it is strong instability of the V wing variant I. V wing II: coefficient of restauration, CR_2, is increasing as the β is increasing 3.5 % for β = 10° and much faster for following increased β angles. The strongest instability is for β = 75° (90° – α (α = 15°)), when it comes from +∞ to -∞. Strong instability at the (90° – α) angle of the dihedral wing,

U large wing I: coefficient of restauration, CR_3, is increasing as β is increasing, up to 90°, when it becomes +∞ and instantly -∞. U large wing II has the Coefficient of restauration, CR_4, increasing as β is increasing, 1.6 % for β = 10°, and much faster for following increased β angles. The strongest instability is for β = 90°, when it comes from +∞ to -∞. Strong instability at β = 90°.

U large wing I/II has increased stability as the tilting angle increases, less than for V wing I/II. Its strong instability is at β = 90°, when the wing is vertical. Its stability range is larger than for V wing. The V wing has the stability range limited by α, being 90° – α.

Considering the asymmetric profile for wing the U large wing could be considered as a V wing.

The U large wing can be a proper solution for new free flight airplane models.

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DESPRE ARIPA U MARE A AEROMODELELOR PLANOARE

Aripa U mare este o nouă formă de aripă ppentru aeromodele planoare. Stabilitatea sa este comparată cu aripa V. Aripa U mare I/II are stabilitatea crescutăcu creșterea înclinării, dar mai redusă decât al aripii V I/II. Instabilitatea puternică este la $\beta = 90^o$, când aripa este în poziţie verticală. Domeniul său de stabilitate este mai mare decât la aripa V. Aripa V are domeniul de stabilitate limitat de unghiul α, fiind $90^o – \alpha$., unde α este unghiul dintre aripi și linia orizontală, în zbor normal.. β este unghiul de înclinare al aripii. Rotaţia poate fi în sens trigonometric sau antitrigonometric, privind din spre coadă.

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