ABSTRACT*)

Effect of Stabilizer Lift on Sailplane Performance

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Since the sailplane represents a highly optimized aerodynamic form, the influence on performance of small effects such as stabilizer lift is worth considering. This paper analyzes the induced drag of the stabilizer and its effect on sinking speed. An equation is derived relating the fractional increase in sinking speed to the stabilizer lift coefficient and the aircraft's shape parameters. The equation for aircraft pitching moment in steady flight is introduced in order to obtain the relation between fractional increases in sinking speed and airspeed and center of gravity location. Data from a Schleicher K-8B is used to illustrate the resulting formula. It is concluded that non-zero stabilizer lift increases sinking speed and for a K-8B the greatest effect is with a forward C.G. position and a high airspeed.

*) The complete text of this paper will be published in OSTIV PUBLICATION XII.

A UNIVERSAL TABLE FOR GLIDING

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INTRODUCTION

Some non-technical pilots or beginners are usually confused when faced with the problem of making a speed ring or computing final glide angles and speeds. Things become worse when the only known performance data are the best glide angle and corresponding speed.

The "universal" table was made for these people and gliders, but even highly technical people may find it useful when transforming a shower of test flight points into a polar or in analyzing non-quadratic drag characteristics caused by flaps, deep laminar bucket airfoil, flow separation, etc.

USE OF THE TABLE

For any particular glider, construct a similar table using the following steps:

1. Get (or choose) the values for the best gliding angle (L/D) and the corresponding speed (V*) from literature maker's data or flight measurements. Compute the sinking speed at best glide speed

$$v^*(m/s) = \frac{V^*\ (km/h)}{3.6 \cdot L/D} \quad \text{or}$$

$$v^*(ft/min) = \frac{87.93 \cdot V^*(mph)}{L/D}$$

2. Multiply columns 1, 3, 4, and 6 by this value of v*.

3. Multiply columns 2 and 7 by the best glide speed V*.

4. Multiply column 5 by the best gliding angle G.

U N I V E R S A L   T A B L E

			speed ring			
polar			final glide		handicapping	
①	②	③	④	⑤	⑥	⑦
$\frac{v}{v^*}$	$\frac{V}{V^*}$	$\frac{v_c + v}{v^*}$	$\frac{v_c}{v^*}$	$\frac{G}{L/D}$	$\frac{I}{v^*}$	$\frac{V_R}{V^*}$
.87742	.75984	----	----	.8660	----	-----
.920	.9	----	----	.9783	----	----
1.	1.	1.	0.	1.	1.3161	0.
1.1200	1.1	1.5419	.4219	.9821	1.7381	.3011
1.2856	1.2	2.1754	.8898	.9334	2.2058	.4908
1.4831	1.3	2.9116	1.4285	.8765	2.7444	.6378
1.7291	1.4	3.7590	2.0299	.8097	3.3459	.7560
2.0280	1.5	4.7294	2.7014	.7423	4.0244	.8591
2.3605	1.6	5.8478	3.4874	.6778	4.7870	.9523
2.7506	1.7	7.0670	4.3164	.6180	5.6408	1.0391
3.1938	1.8	8.4707	5.2769	.5636	6.5925	1.1213
3.6926	1.9	10.0259	6.3333	.5145	7.6488	1.2002
4.2500	2.0	11.7505	7.5005	.4706	8.8160	1.2766
4.8686	2.1	13.6539	8.7853	.4313	10.1007	1.3512
5.5512	2.2	15.7454	10.1942	.3963	11.5095	1.4243

V Flight speed v - sinking speed

V^* - Best glide flight speed

v^* - sinking speed at best glide flight speed

v_c - climbing speed

L/D - best glide angle G - glide angle

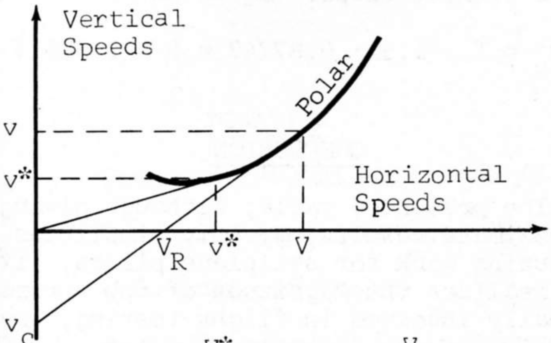
V_R - resultant speed (zero wind) I - Thermal intensity

Note: For the speed ring data of columns 2 and 3, the indicated values of glider instruments may be used.

GLIDER:			V* =	L/D =		v* =
① v	② V	③ v+v_c	④ v_c	⑤ G	⑥ I	⑦ V_R

Flight Polar

The values of columns 1 and 2 give a good approximation of the glider polar (see Fig. 1).



$$L/D = \frac{V^*}{v^*} \qquad G = \frac{V}{v}$$

FIGURE 1

Speed Ring (MacCready)

Mark in a moving ring around a linear scale variometer the speeds of column 2 at positions corresponding to variometer readings of column 3 values and make an index (arrow) at "O" reading position (see Figs. 2 and 3). If round numbers are desired, the values of V (column 2) versus v = v_c (column 3) plot on graph paper and then take the variometer positions corresponding to round numbers speed values (v).

FIGURE 2

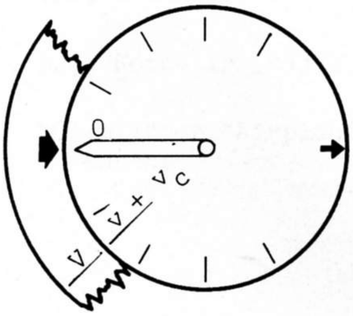
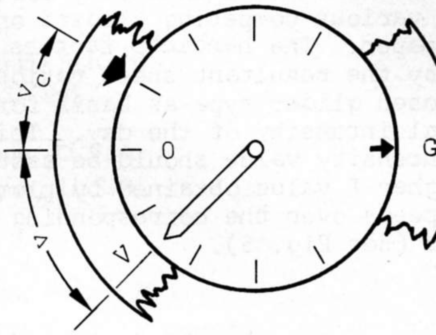


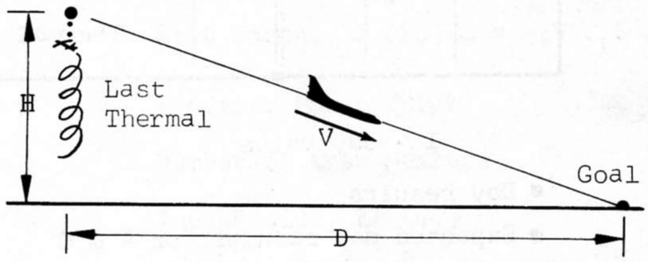
FIGURE 3



Final Glide

Column 5 gives the glide angles and column 2 the corresponding flight speeds to be flown when the climbing speed in the last thermal was the corresponding column 4 values.

FIGURE 4



$$H = \frac{D}{G}$$

The gliding angles (G) may also be marked in the speed ring at opposed positions (180 deg) to the "O" variometer reading with the arrow index placed on v_c (column 4) values.

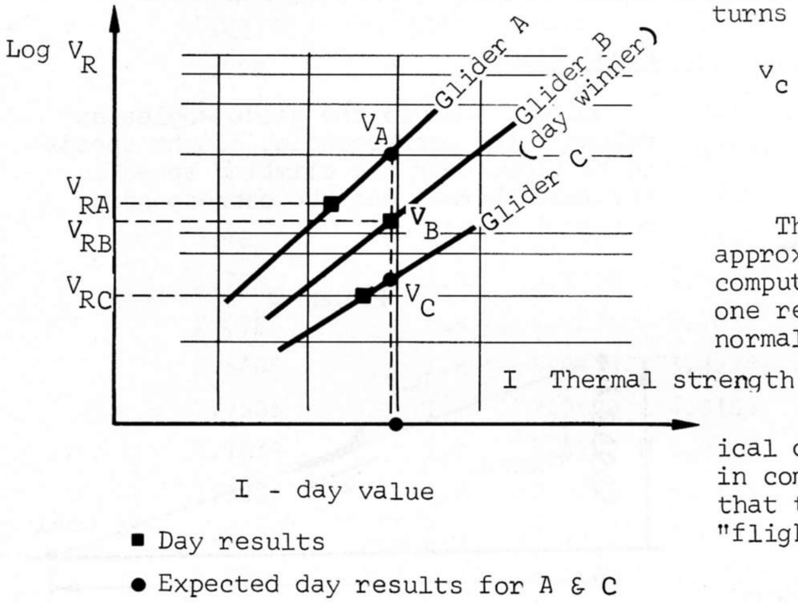
For round glide angles, make a graph as in "Speed Ring."

Handicapping

Columns 6 and 7 when calculated for different gliders give a direct way of comparing them at various thermal conditions.

Indeed, a complete handicapping system may be obtained by plotting the resultant speed Column 7 versus thermal intensity Column 6 for the various competing gliders on semi-log paper. The handicap factors will be given by the resultant speed ratios with a chosen glider type as basis for the thermal intensity of the day. This thermal intensity value should be assumed as the higher I value obtained by plotting the day speeds over the corresponding glider curves (see Fig. 5).

FIGURE 5



Handicapping

$$\text{for B} = 100 = \frac{V_A}{V_B}$$

$$\text{for C} = 100 \times \frac{V_A}{V_C}$$

BASIC ASSUMPTIONS

The numbers given in the table were calculated supposing that: All gliders have quadratic drag variations and so their flight polars may be described by an expression like

$$v = \frac{A}{V} + B \cdot V^3 \text{ that becomes}$$

$$\frac{v}{v^*} = 1/2 \, \frac{V^*}{L/D} \left[\left(\frac{V}{V^*}\right)^3 + \frac{1}{V/V^*} \right]$$

after imposing as boundary conditions, a point and a tangent value of one (unity) at the maximum glide conditions.

To calculate the resultant speeds (V_r), it was supposed that the sinking speeds when thermaling may be estimated as 150% of the glider minimum sink, as usual for medium bank (approximately 40 deg) turns without flaps. So we have:

$$v_c = I - 1.5 \cdot 0.87742 = I - 1.31613$$

CONCLUSION

The presented table, although giving approximate results, greatly simplifies computing work for sailplane pilots. If one realizes the magnitude of the errors normally involved in flight testing, graphical determination of tangent points and in commercial published data, he will see that the table may be useful, even when "flight tested" polars are available.