THE LOW SINK GLIDER

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INTRODUCTION

This paper presents an investigation of the sink of modern gliders. It considers the influence of variations in span, wing chord and mass.

It is shown that the span is the main factor in obtaining low sink. The wing chord has less influence and the effect of the mass is small.

WHY A LOW SINK GLIDER?

A glider pilot likes a glider with low sink. He wants a glider to fly around in, without much effort, occasionally make a few circles to gain height and enjoy himself. The low sink glider is such a machine. It will stay up well, you can make use of every little upcurrent and fly in marginal conditions, such as weak and scattered thermals.

The beginner and the weekend flyer will benefit even more, as they often have great difficulty staying in the air. To them, flying is hard work and it requires a lot of practice to find a thermal and get into the center.

The low sink glider will afford this opportunity. This type glider is more tolerant of bad flying, more forgiving of missed opportunities, and more user-friendly.

RANGE OF THE INVESTIGATION

Calculations have been made for:

- 5 progressively larger spans, with constant wing chord and mass;
- 3 different wing chords with constant span and mass; and

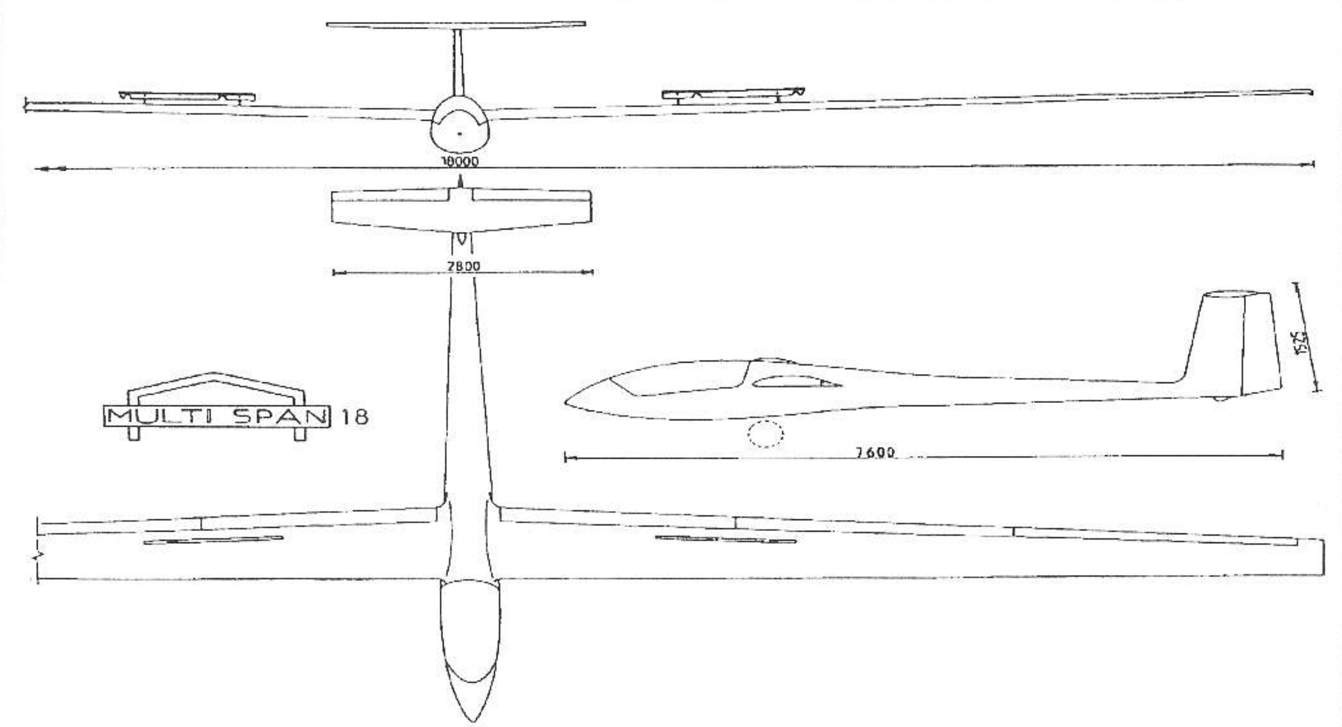

FIGURE 1. Three-view drawing.

3 masses with constant span and wing chord.

Results:

The results are illustrated mainly by figures and diagrams as follows. Detailed calculations are not presented here.

Figure 1 shows a three-view drawing of a typical 18m span glider. It has a streamlined body, long thin wing with camber flaps. The wheel is retractable.

The empty mass is me = 15b and the flying weight is m = me + 115, with masses in kg, b being the span in meters.

Figure 2 shows the wing section UAG-88-143/20 designed by D.J. Marsden, University of Alberta, Canada for ultralight sailplanes and presented at the OSTIV Conference, May, 1989, Wiener Neustadt (Ref. 1).

A sailplane wing section should have low drag, mild stalling characteristics and a wide low drag bucket. This section seems a suitable choice for this paper.

Polar diagrams for the Reynolds Numbers 0.5, 1.0 and 2.1 x 10^6 given in Ref. 1 showed almost constant drag over a wide range of lift coefficients. Most other wing sections show the C_d to increase with increasing C_l, i.e. the polar diagrams have a distinct slope.

Figure 3 shows the polar diagrams for the three Reynolds numbers combined in one drawing. Also marked in is the polar diagram of the multi span 18 wing with 1.0 m root chord and 0.5 m tip chord. Note that this curve lies almost entirely between Re = 2.1 and 1.0 x 10^6.

With wing chords increased by 20% the C_D is about 0.0002 lower, and with chords decreased by 20° it is about 0.0003 higher.

Figure 4 shows the polar diagram of the whole glider. The induced and the friction drag are shown separately.

Figure 5 shows the speed polars (sink versus airspeed) of the whole glider for all five spans. Again, the components due to the induced drag and due to the friction drag are shown separately. At low speed the induced drag component is very large, but at high speed the friction drag becomes more important. Note that the large spans have a much lower sink than the small spans.

Figure 6 shows the glide ratio versus the airspeed for the same five gliders. Note also the new term cruise speed. The cruise speed is 1.4 times the minimum speed. Most flying in gliders is done around this speed. This figure clearly shows the superiority of the large spans. Not only is the sink much less, but also the airspeed is little lower.

FIGURE 2. Wing section UAG-88-143/20 (Reference 1.)

Detailed calculations for 3 different masses showed only

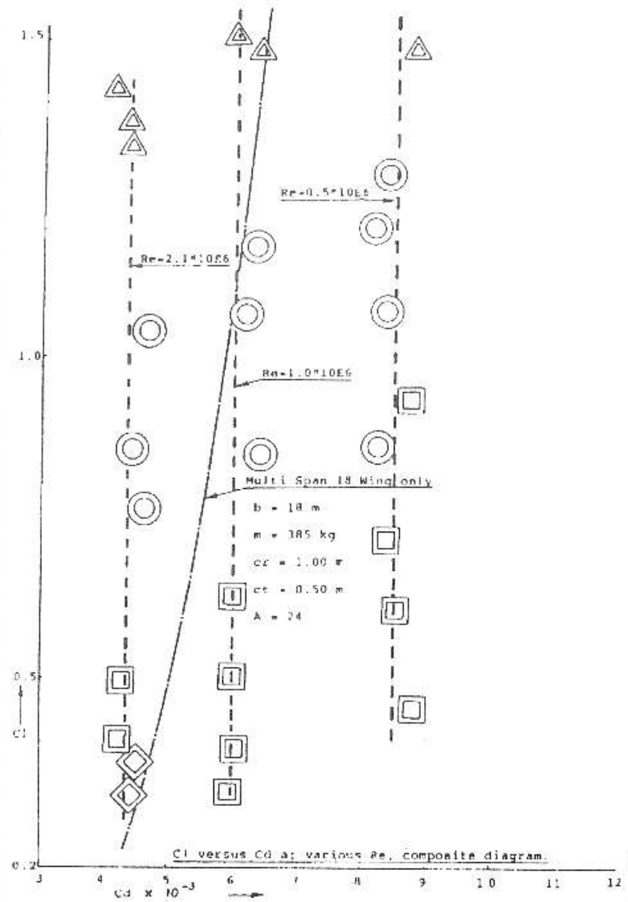

FIGURE 3.

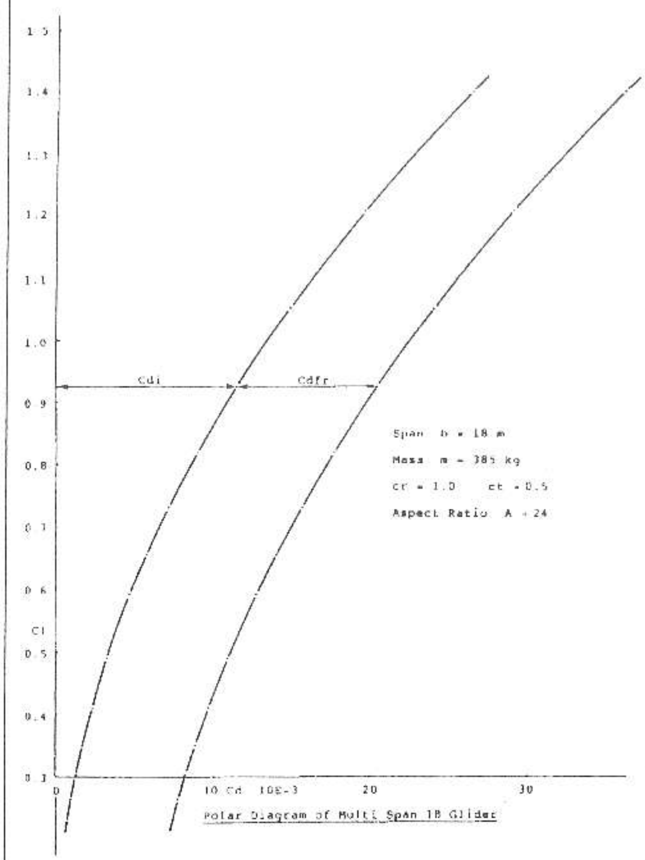

FIGURE 4.

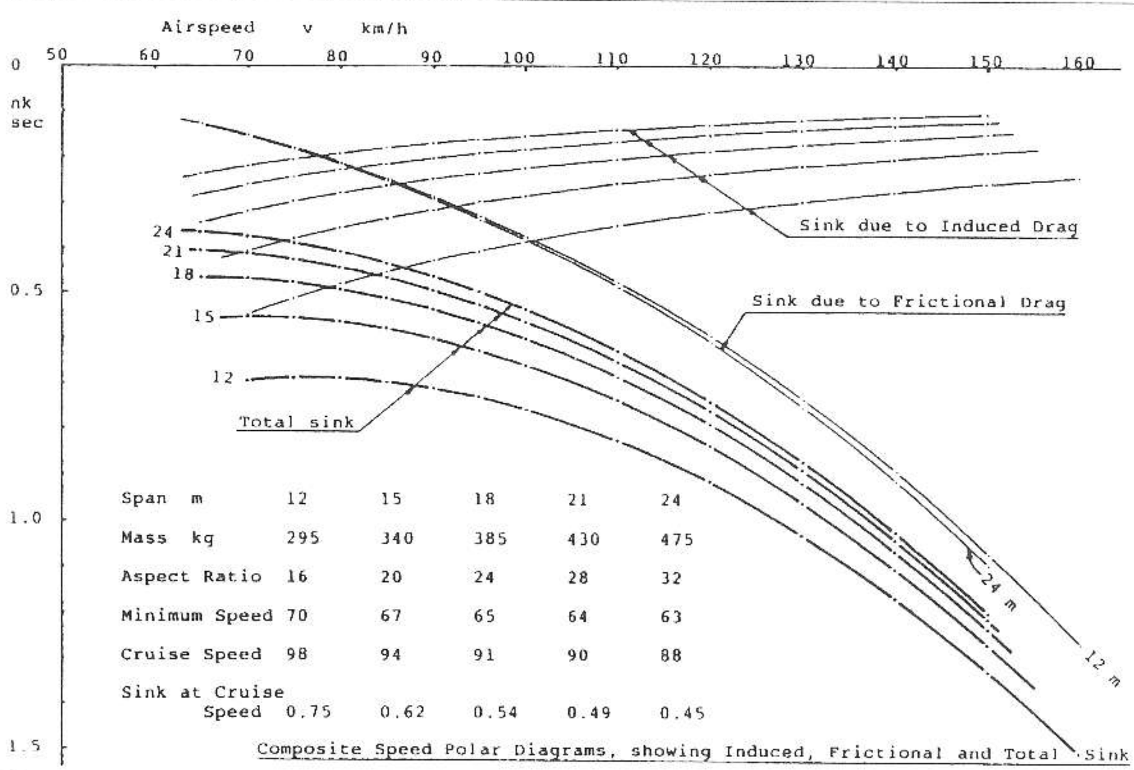

FIGURE 5.

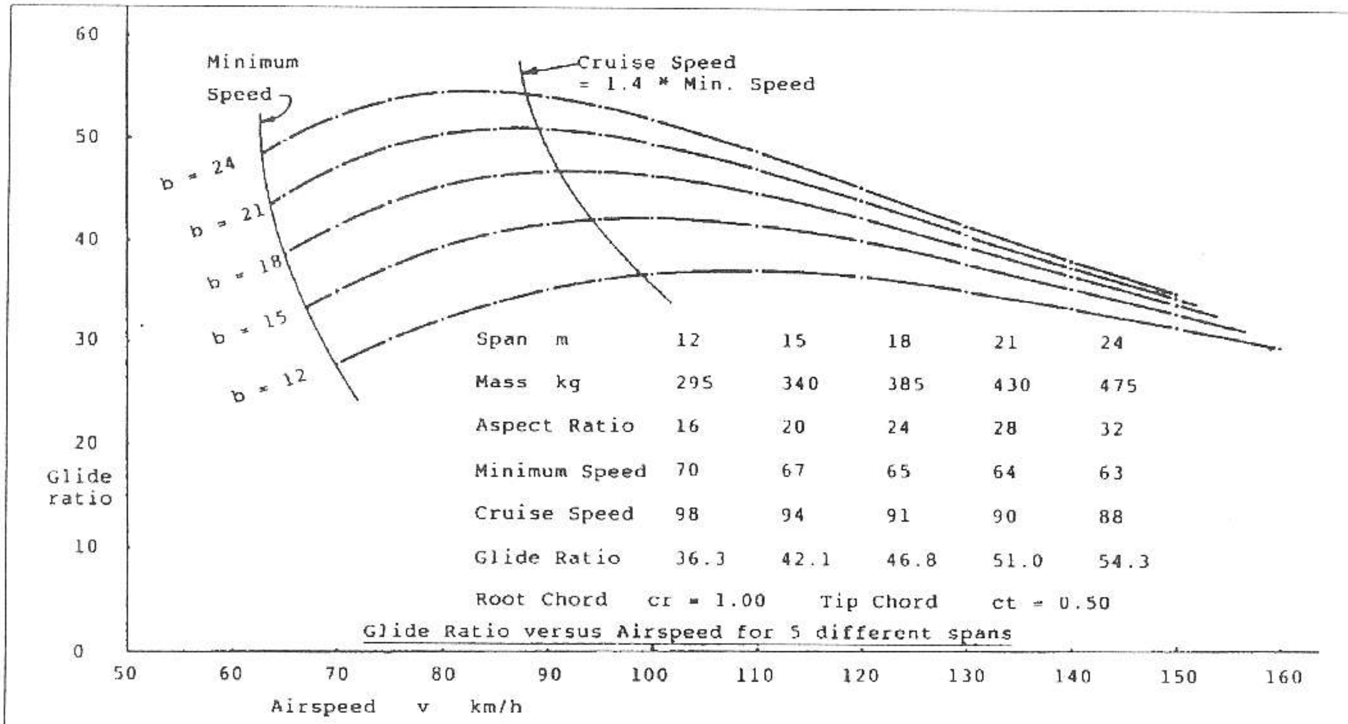

FIGURE 6.

little differences at cruise and low speed, but a substantial improvement for the higher masses at high speed.

This result torpedoes the notion that the light glider is better. In fact the heavy glider has a better performance in most conditions. Therefore, competition gliders often carry water ballast.

Calculations for a multi span 18 glider with 3 different wing chords, of 1.20, 1.00 and 0.80 m at the root with a taper ratio 0.5, showed that the differences in sink are not large, but the smaller wing chord is superior over the whole range.

The circling diameter for the 5 different span gliders for $C_l = 1.0$ and 30° bank is shown in the following table. Note the big span gliders have smaller circle diameters than the small span gliders. The reason is the lower wing loading of the big span machines.

TABLE

span m	Wing loading kg/m²	circle diameter m
12	32.8	210
15	30.2	193
18	28.5	182
21	27.3	175
24	26.4	169

CONCLUSION

It is shown that the performance of modern gliders can be improved. The use of a large span and a high aspect ratio produces a glider with a good glide ratio and a low sink. Calculations show that a standard glider can be built with a glide ratio of 47 and a sink of 0.45 m/sec.

The low sink glider will fly more hours per day, more days per year. It will open up gliding for more people and in more places. The development of such a glider would substantially promote the sport.

REFERENCES

1. Marsden, D.J. Wind tunnel tests of an ultralight sailplane wing section. *Technical Soaring*, Vol. 14, No. 1