No. 388 DECEMBER 2018

T.W.I.T.T. NEWSLETTER

Merry Christmas and a perfect start into the New Year!
My best wishes to you and all the flying wing enthusiasts. Reinhold Stadler

T.W.I.T.T.
The Wing Is The Thing
P.O. Box 20430
El Cajon, CA 92021

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THE WING IS THE THING (T.W.I.T.T.)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation, which is dedicated to furthering education and research in a variety of disciplines.

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Gatherings are held on the third Saturday of every odd numbered month, at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive (#1720), east side of Gillespie or Skid Row for those flying in).

TABLE OF CONTENTS

PRESIDENT'S CORNER

First, my apologies for the lateness of this issue. I just let time get away from me this month.

On the positive side it allowed me to use Reinhold Stadler's Christmas card on the cover. Usually it comes in right after I have sent the issue to the printer do this is a treat. Thank you Reinhold.

As I noted last month this issue would have a split on subjects and it appears to have worked well. I will probably do the same thing next month.

For this month here is the source citation for the Karl Wood material. It is presented here to allow for a better presentation of the first page of the material.

The source for this month is: Wood, Karl, Technical Aerodynamics, New York & London: McGraw-Hill Book Company, 1935, pp 172-182.

Merry Christmas, Happy Holidays and a Happy New Year to all our members.

Andy

LETTERS TO THE EDITOR

Hi Andy & gang at the hangar,

Hope this letter finds you well and enjoying better flying weather than we have up here... miserable, cold, and wet. I will be sending in my next installment of membership fees for George and me.

I've transcribed my father's address to McGill University Fluid Dynamics Symposium, way back in '61. I embedded the graphics, hoping I've found the correct ones. You might check to see if it makes sense. I found them in the OSTIV report so I think they're OK. It's all attached below in pdf for you.

Stefanie Brochocki

(ed. - Here is the first installment of the translation.)

CANADIAN TAILLESS SAILPLANE – BKB-1

Presented Mar 10, 1961 by Stefan K. Brochocki and George Adams to McGill University, Fluid Dynamics Symposium, by invitation of Professor B. Newman Transcribed by Stefanie Brochocka from original hand-written document

Introduction

Speaking of the BKB-1 sailplane I am also speaking on behalf of my partners, Witold Kasprzyk and Fred Bodek, without whom this project would never have reached the flying stage. Although this partnership could be traced to the pre-war days*, the project actually started a few years ago when the three of us were employed by the engineering department of Canadair. Sailplanes and their majestic flight always seemed to hold some power over us, sparking the desire for engineering self-expression. In the jet era of today we firmly believe soaring to be more than a magnificent sport, but also the best source of practical airmanship.

Present Status of the Sport

Perhaps for perspective's sake a brief resume of the present state of the sport should be given here. Sailplanes are mostly single-seater flying machines of about 50 ft. span, capable of cruising between 50 to 100 mph using various forms of natural energy present in the atmosphere. These aircraft are chiefly of wooden construction, built to very high strength requirements to withstand loads imposed by gusts and rapid maneuvers. They can be flown locally for hours in a very relaxing manner. An average combination of pilot, sailplane, and weather may also result in some 200 mile flights completed in about 4 to 6 hours at altitudes varying between 1000 to 8000 ft. The chosen destination would be some airport; in practice, frequently some farmer's field. Having pre-arranged with a friend a retrieve by trailer, the pilot returns home richer by several hours of intense flying experience, by the emotion of having to make decisions, and the satisfaction of having exploited the forces of nature.

When it comes to competition, the contestant may have to face a variety of imposed tasks consisting of a race around the triangular course, of flight to a predetermined destination and return to starting point, reaching maximum altitude or maximum distance flying. On these occasions the pilot keeps in radio contact with his ground crew while it follows the flight path for quick retrieve by trailer.

What are the best international achievements today? Well, somebody covered the distance of over 600 miles. There are scores of flights to predetermined destinations 300 miles away. There are sailplanes flying above 40 000 ft. altitude. Someone really keen flew for over 60 hours.

Sailplanes capable of good performance cost today about 3000 - 4000 dollars depending on the type and country of origin. None are presently manufactured in Canada. In some countries soaring has a degree of government support. In others the sport has to stand on its own feet. Whatever the case may be, there is always a need for equipment that is easy to come by, yet capable of good performance. **Ed. note: Kasprzyk had been Stefan's gliding instructor for a few weeks in Poland before WW2.*

BKB Project

The subject of this talk, the BKB project, is a design exercise aiming at the development of such a machine. It was preceded by several other projects, carried out on paper to fairly advanced stages, to be eventually abandoned due to lack of manufacturing opportunities. One day however, amid one of our typical discussions, Fred came up with the fatal question: Why don't we build this one?

The simple little sailplane seemed promising enough to venture its construction. Before the second, sobering thought, the material was purchased, Witold's basement cleaned up, and the Department of Transport contacted for the applicable civil air regulations. In the course of the next 3 years, having survived the basement floods, and the strains imposed on our marriages *(ed. note: Stefan and Witold both had wives, Fred was single, Stefan had two children)* we finally secured the X (*experimental*) license from the D.O.T. Although the little sailplane has been flying for the last two seasons it is still very much experimental.

The goal of good performance, combined with low cost and easy handling constitutes a tough specification. To this end a departure has been made in the design from the standard configuration towards the flying wing concept. It is obvious that the reduction of size and number of components, brings down the weight, production costs, and solves some of the ground handling problems.

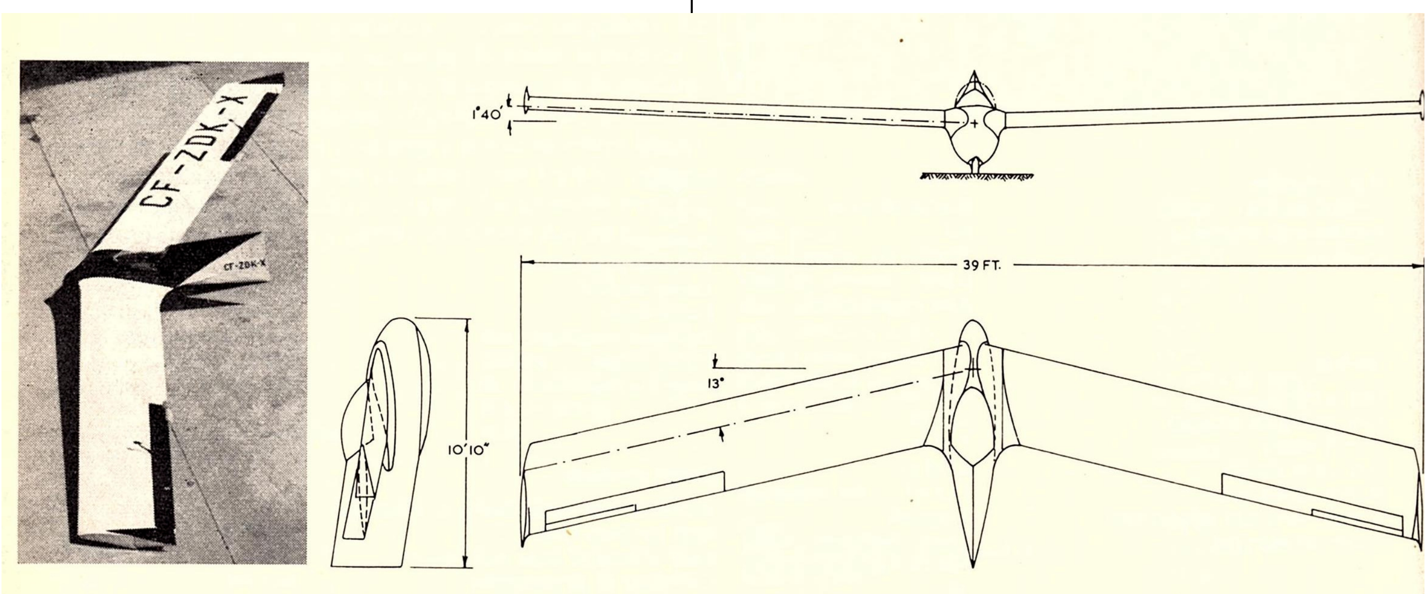
Geometry for Optimum Performance

Unfortunately, the drastic reduction of size brings deterioration of performance, which somehow must be made satisfactory for the Sunday flyer as well as for the contestant. The question thus arises; what features of performance to aim for?

well-substantiated study of the problem. The author expresses performance in terms of cross-country speed. Sailplanes capable of high cross-country speeds possess well-balanced characteristics consisting of good rate of climb, in thermals, and penetration, permitting fast flying with small loss of height.

The study results in somewhat surprising conclusions with regards to sailplane size and optimum aspect ratio. It indicates that if one can fly on good soaring days, when the thermal diameters are large, high aspect ratio is permissible since the slight loss in circling time is made up for by better penetration. However, if one is going to operate under marginal conditions or at low altitudes (narrow thermals) then the low aspect ratio is imperative.

With regard to optimum span the article states that, "*Below a span of 50 ft. the performance falls off rather rapidly and the empty weight decreases rather slowly. Above 50 ft. span however the gains in performance come slowly while the weight increases at an alarming rate.*" It is fortunate that modest proportions, considered best with respect to performance, favour a simpler and lighter machine.



One should consider performance under a variety of conditions. These include seasonal and daily atmospheric changes, geographical location, and the type of atmospheric energy usable for soaring. Most sailplane flying is accomplished utilizing thermals which are highly dependent on the above variables.

An article, *What Price Performance?* by B.H. Carmichael, published in *Soaring Magazine*, offers a

BKB-1 Configuration

Shown here is the configuration of the BKB.

Its span of 40 ft. and aspect ratio of 10 are somewhat smaller than the suggested optimum of say 50 ft. and 12 respectively, due to limitations imposed by the size of the basement. Due to the small size, departures from the ideal of the flying wing had to be made at the start. Thus, the pilot is housed in a nacelle which is blending with the wing to keep the interference drag low. From these two components, good lift-to-drag ratio and the desirable degree of stability and control must be obtained.

The longitudinal static stability is secured by combining the nose-up moment of the slightly stable airfoil with the moment due to the twisted swept wing, in conjunction with location of the center of gravity forward of the aerodynamic center.

The temptation of using the alternative of the straight wing of the Fauvel, or the "Flying Plank" type was discarded on two accounts: First is the lack of sufficiently stable airfoils of the low drag type and, secondly the straight wing has no directional stability. In conjunction with the nacelle, which would have to protrude forward of the wing leading edge (to provide forward c.g.), the combination would be decidedly unsuitable directionally. The sweep of **13°** chosen for this design is low enough to keep out of troubles associated with higher values and yet is sufficient to ease directional stability problems.

(To be continued.)

ART. 8:8] *LATERAL AND DIRECTIONAL STABILITY* 177

4. Operation of ordinary ailerons (as in Fig. 148) produces a secondary yawing moment (C_{My}') because the down-aileron has more drag than the up-aileron; this is spoken of as an *adverse yawing moment* because it turns the airplane in the wrong direction for a normal banked turn. Below the stall, C_{My}' is roughly proportional to aileron deflection (δ_A) and to absolute angle of attack; the value of C_{My}' at $\alpha_a \approx 15°$ for maximum aileron deflection may be taken as a measure of the secondary yawing moment.

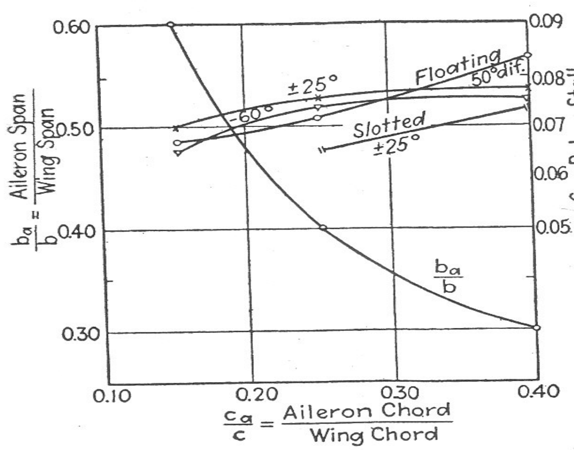


FIG. 156.—Proportions of test ailerons and mean rolling moment coefficients below stall.

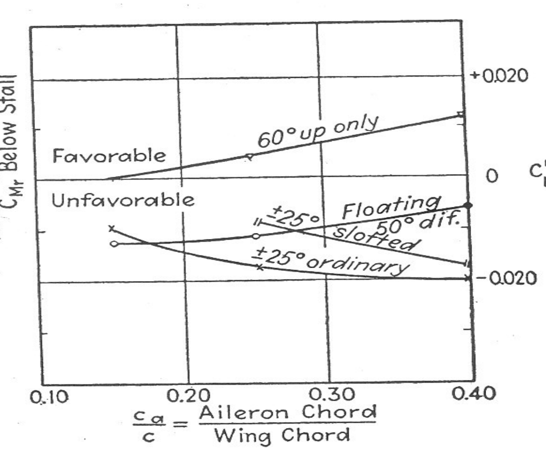


FIG. 157.—Yawing moments due to maximum aileron deflection at $\alpha_2 \approx 15°$.

5. In comparing floating ailerons with ordinary ailerons two special factors should be considered: (*a*) the effect of the floating ailerons in reducing the lift and increasing the drag of the wings, and (*b*) the effect of the floating ailerons in changing the angle of attack at which the wings begin to be laterally unstable under various conditions (discussed under Spinning, Art. 8:9).

6. In comparing balanced ailerons with ordinary ailerons, the aileron hinge moments and their effect on the forces necessary for control should also be considered.

Test data from NACA *Repts.* 419 and 422 on items 1 and 4, above, are given in Figs. 156 and 157. The proportions of the test ailerons were intended to give approximately the same rolling moment coefficient below the stall, and the test results show that the proportions are approximately correct. The data on secondary yawing moments (Fig. 157) show that ailerons which operate only upward give the most favorable effect, but they may be objectionable in that they cause more loss of altitude in a gliding turn. Floating ailerons appear to give more roll and less yaw than ordinary ailerons, but they have such adverse effects on the lift and drag of the wings that they are usually considered undesirable. Slotted ailerons (and Frise-type ailerons) give less yaw but also less roll.

Regarding item 3, control in side slip, *no ailerons* of the simple flap type (whether plain or slotted, and regardless of rigging) will give control much beyond the stall, and most of them become inoperative several degrees below the yawed stall. Floating wing-tip ailerons with impractically large end plates will give control under these conditions, but at such cost in $C_{L\max}$ and $C_{D\min}$ to make them not worth considering. Short wide ailerons (30 per cent span, 40 per cent chord) with spoilers (Fig. 149) or spoiler slots [Fig. 151*b* (*B*)] are also effective beyond the stall, and probably auxiliary trailing-edge airfoil ailerons [Fig. 151*b* (*A*)] are still more effective. No airplane has yet been built (with the possible exception of the unusual Weick W-1) with adequate control beyond the stall, so that the most economical combination of flaps and slots or spoilers to obtain such control must be determined by trial.

Most present-day airplanes are controllable when stalled only by means of the rudder (sometimes elevators); the task of avoiding a premature stall while landing is left to the pilot; so pilots do not live very long unless they are both skillful and alert.

8:9. Autorotation—Spinning.—Below the stall, wings resist being rolled because the wing moving downward gets a larger angle of attack (see Fig. 158), and hence gets more lift, but beyond the stall larger angle of attack gives *less* lift (see Fig. 159), so the wings roll themselves when held at a fixed angle of attack. This is called *autorotation*. It is, in a way, part of the penalty for a high value of $C_{L\max}$, because, in general, the higher C_L goes, the faster it falls beyond the stall.

If a model wing or airplane is mounted in a wind tunnel so as to be free to rotate *about the axis of the tunnel* (wind axis) and is set at an angle of attack beyond the stall, it will rotate itself at an angular velocity ω radians per second. The ratio of ω to V is practically independent of speed, and the quantity

$\omega b/2V$ is known as the rate of stable autorotation. A typical characteristic curve for $\omega b/2V$ against angle of attack is shown in Fig. 160. The curves for positive and negative autorotation are not quite the same, because of rotation of the wind stream

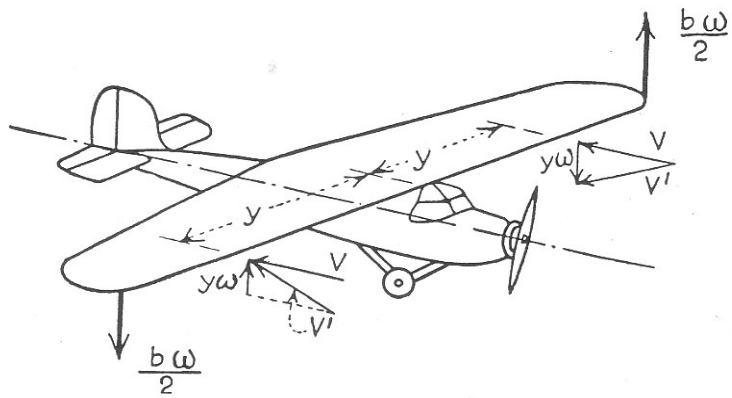


FIG. 158.—Resultant wind velocities due to roll.

in the tunnel. If a model airplane in a wind tunnel is also given a fixed angle of yaw, the rate of stable autorotation is greatly increased.

When an airplane in free flight is stalled, it is likely to be laterally unstable because the vertical tail is below the line of the

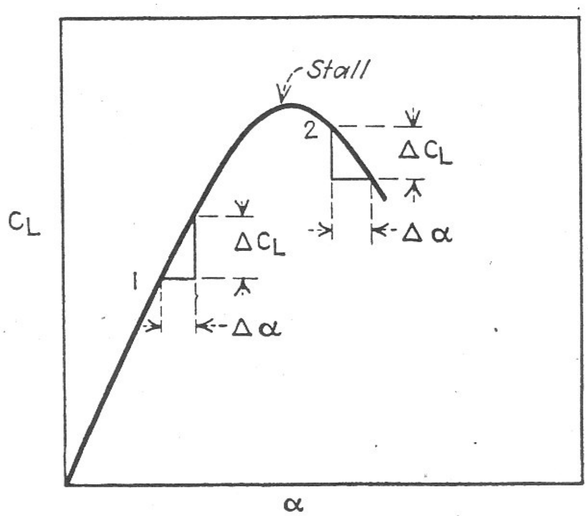


FIG. 159.—Effect of change in angle of attack on lift below stall and beyond stall

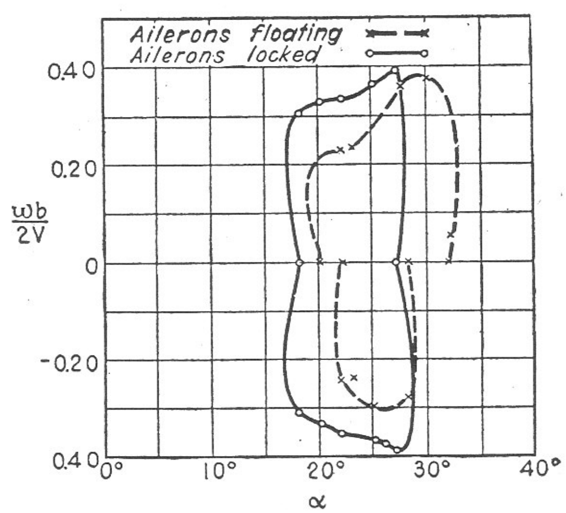


FIG. 160.—Rate of stable autorotation for Clark Y wing with locked ailerons.

flight path; the ailerons, moreover, are ineffective beyond the stall, and, regardless of how the pilot moves the controls, the airplane starts to roll and because of the autorotative couple discussed above continues to roll itself. When it is on its side, moreover, the vertical tail causes a yawing displacement, and

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VHS tape of July 15, 2000 presentation by Stefanie Brochocki on the design history of the BKB-1 (Brochocki,Kasper,Bodek) as related by her father Stefan. The second part of this program was conducted by Henry Jex on the design and flights of the radio controlled Quetzalcoatlus northropi (pterodactyl) used in the Smithsonian IMAX film. This was an Aerovironment project led by Dr. Paul MacCready.

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