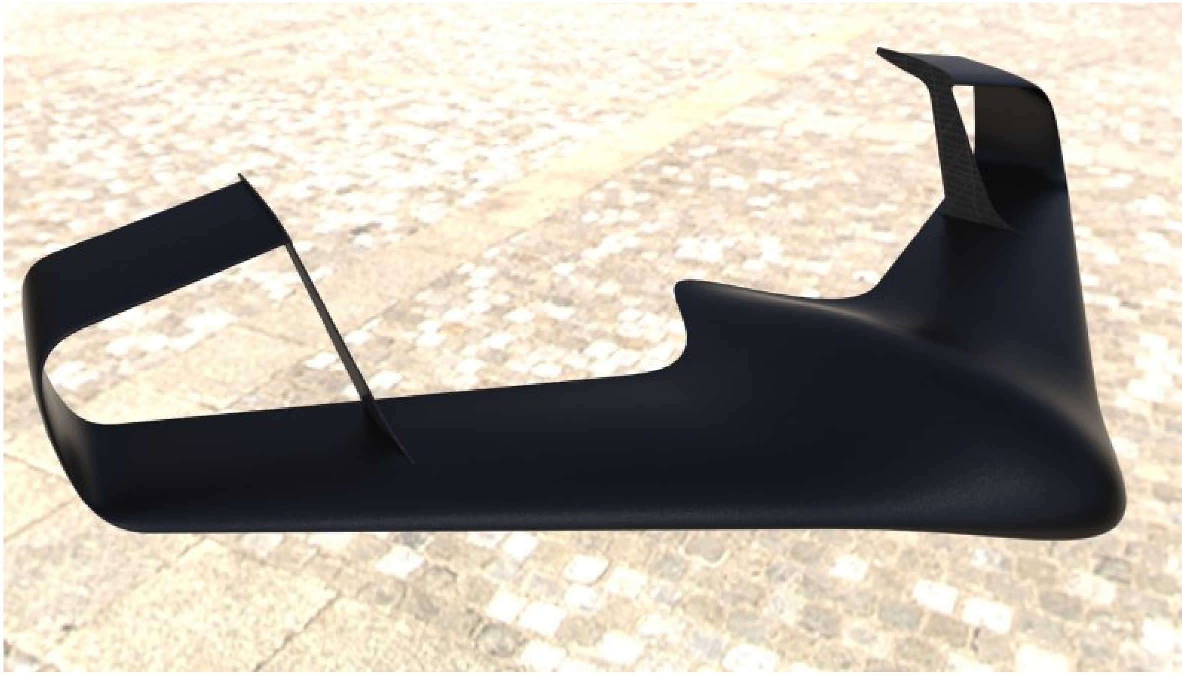
No. 329 NOVEMBER 2013

T.W.I.T.T. NEWSLETTER



Stability and Control of Tailless Airplanes (Andy_RR, Melbourne, Australia, circa 2009)
http://www.homebuiltairplanes.com/forums/aircraft-design-aerodynamics-new-technology/14011-stability-control-tailless-airplanes-3.html

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

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.

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Wt/#Issues	FRG	AUSTRALIA	AFRICA
1oz/1	1.75	1.75	1.00
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Meetings are held on the third Saturday of every other month (beginning with January), 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).

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PRESIDENT'S CORNER

This will be a short issue since I haven't received any letters to use and don't have any unpublished articles in the stockpile to offer up. I have elected to continue the Nurflugel bulleting board thread on bell shaped list distribution to a point that makes for a good break. This only takes the topic up to what was being discussed back in August and it continues to be a subject of further interest even today. There was one contribution that looks quite interesting but was too long to include this month, but I will see if it fits in the December issue.

As we move into the winter months I hope some of you will send me photos and text explaining what you are building or planning on building.

If you aren't building anything but have run across a particularly interesting subject that would be good for the group, please pass it along. If it is copyrighted, I can always try to get permission to re-print it for our members, which I have done in the past. It sort of depends on the subject and author, but it is always worth trying.

I hope everyone has a great Thanksgiving Holiday with friends and family.

Andy

LETTERS TO THE EDITOR

Greetings from Los Angeles.

I would like to join TWITT using my PayPal account for payment... is this still possible? How do I do that?

Also, I have a technical question that I'm sure that one or more of your members would know the answer to. If you could put me in touch with a TWITT member who might know this answer, I would appreciate it

Reading up on the Backstrom Plank series of gliders, I found a small amount of information on the final glider version, the EPB-1HR "Super Plank". I believe this may be the glider that the actor Larry Linville and a partner built. The only info I found online said that the aircraft was modified using a "modern laminar airfoil", and test flown, but that the aircraft was very unsuccessful and was physically dismantled.

My two questions are...

1) Was the "modern airfoil" they tried on the Super Plank the Wortmann FX-66H series that Wortmann was developing at Sikorsky for rotor blades?

2) What was so bad about this airfoil, that made the glider so unsuccessful that they destroyed the aircraft?

Thank you for your help,

Bill Berle

(ed. – I hope to see Bill's membership come through since I sent him the PayPal link that can be found on the TWITT homepage.

I hope there is an Al Backstrom follower out there that can help answer his question on the airfoil used on the Super Plank and what happened to it.)

Bell Shaped Lift Distribution

(ed. - This will continue the discussion from the Nurflugel Bulletin Board that was left off in the September issue.)

Thanks to all the people that have contributed to this group thread so far, lots of great information. I have managed to create a wing in XFLR5 that has close to a Sin^2.5 BSLD (will upload in my album), the problem is I have done this using a combination of geometric and airfoil induced twist, taper and by varying the sweep along the wing.

Looking at everyone's comments I am now wondering, if I want neutral/proverse yaw, do i need to have constant sweep along the wing and get my BSLD using varying twist and constant taper alone, in other words is the method of achieving the correct BSLD as important as its shape?

Help!

PS: If proverse yaw is achieved by washout twist and negative lift areas near wingtips, that bell-shaped-lift-distribution curve may stay bell-shaped, but dips below the zero-lift line near wingtips.

Sentence correction, re. achieving a right turn with proverse yaw: ""The right aileron travels up, from slightly negative lift and drag to stronger * negative* lift and drag."

Correction 2: Where I said that any *planform *with enough twist could make proverse yaw, that's again mixing apples and oranges, planform with lift distribution. Strong twist moves an elliptical or square wing's lift distribution *toward* bell-shaped.

But bell-shape with twist isn't the only lift distribution that can make proverse yaw. A flat, square inner wing with no ailerons, and negative lifting, square lift distribution, outer wing areas with ailerons would achieve proverse yaw. (Bad idea, for illustration only). It's lift distribution would look like

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__----------0----------__
           or,
_ _ +++++++0+++++++_ _
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Not bell-shaped at all! Stepped.

And a bell-shaped lift distribution, on a wing with no twist, might come from taper to a point.

John Newton

So again, the proverse yaw from negative-lifting tip areas and the bell-shaped lift distributions are separate subjects, sometimes combined for some sort of optimum.

Philip Randolph

Raises the Question, what was the difference in how the Bell Sin^3 was implemented in Germany
and Argentina?

Rodger

I am happy to be corrected, Don. You are right.

I drew a couple sketch polars for a left and right wingtip. As I now see it, the only requirement for wingtips with ailerons to produce proverse yaw, is that they need to be operating at below minimum drag angle of attack (in relation to the local airflow*). In cambered wings, minimum drag is above zero-lifting angle of attack. Then, for a right turn, the left aileron moves down, increasing lift while moving effective angle of attack up toward minimum drag. The right aileron moves up, effective AOA decreases, decreasing lift and increasing drag (moving down the curve away from minimum drag). Closer to the truth?

Plus, your discussion about catching thrust and lift out of the wingtip vortices is good.

*As you say, the local airflow near wingtips may angle up in the case of a BSLD wingtip sticking into the upflow of wingtip vortex, and so requires more twist to stay below minimum drag, which explains the severe twist of the Horten wings. The saving grace is, as you explained, that the twist of the wingtip and the upward angle of local airflows tips the lift vector forward, for thrust.

And Al Bowers' Ted talk, which you helpfully recommended, was excellent.

Again, I'm happy to be corrected. Your discussion helps make those Horten wings look more realistic.

Philip

A VERY good question! It seems to me now that it is crucial to understand not just what the lift distribution is shaped like but also how this distribution is achieved (i.e. by planform or twist etc.) if we are to truly understand what the effects on adverse yaw and all round performance will be for a given aircraft.

I was initially under the impression that as long as the wing had a Sin^2.5 BSLD it would have proverse yaw (provided the ailerons were in the right place), now I am thinking that the way this BSLD is achieved may be key.

So, are we saying that to achieve proverse yaw using the Sin^2.5 BSLD as per the Horten concept I need not only to achieve this BSLD shape but also achieve it using a specific amount of geometric and aerodynamic twist along with the right planform shape, if this is indeed the case does anyone have any idea what the correct taper, geometric and aerodynamic twist needs to be?

At the moment I am guessing, constant sweepback angle around 20 degrees at quarter chord, constant taper ratio of about 1/6, reflexed, cambered airfoil at the root, tapering to symmetrical at the tip and the use non linear geometric twist to achieve the final BSLD Sin^2.5 shape lift dist. The biggest problem is I don't really know how these various factors effect the adverse yaw although I suspect that the correct amount of twist must play a strong part in imparting proverse yaw to the design.

At the moment I am achieving a BSLD shape that approximates the Sin^2.5 curve by using less twist than a Horten design but reducing the sweepback on the outboard panels to flatten out the lift dist curve near the tips, I wonder if this will reduce the proverse yaw or not compared to a similar wing with the same BSLD shape but a constant sweepback and greater twist?

Any help on the above greatly appreciated, I am reluctant to begin detailed drawing up if I am heading down the wrong track, its a lot of ribs!!!

John

I seem to recall that Horten used Symmetrical airfoil sections on his wing tips..

Question, can one achieve proverse yaw with a wing designed for a low coefficient of wing lift, less than say , (0.30)such as the HIX / 8-229. That design is reported to have a total aerodynamic twist of around Three(3deg).?

Rodger

If the above is indeed true that would make designing for proverse yaw a lot easier, anyone able to verify this? I'm just thinking, would this not mean that for a symmetrical airfoiled wing tip that the airfoil would have to be lifting slightly downwards (relative to the incoming local airflow) to achieve proverse yaw? This is not the case on Horten style

Sin^2.5 wings I am led to believe.

John

Some specific lift coefficient(s) is/are not a specific requirement for a BSLD. As long as you have a wing that is making non-zero lift, you have a lift distribution of some sort in the way that lift is spread over the span of the wing, whether that's a BSLD, elliptical, or something else. The local lift coefficients along the wing are the result of that lift distribution interacting with the planform. Likewise, the amount of camber and the associated airfoil shapes are not a prerequisite. All you need is for whatever airfoil exists at a given span wise location to be at an angle of attack that gives it the required local lift coefficient in the local flow field existing at that point. You could have a highly cambered airfoil at the tip, with enough twist in the wing to put that airfoil at zero lift coefficient, and have zero lift at that tip. EVERY airfoil, regardless of its shape, has a zero-lift angle, and a dCl/d-alpha (i.e.: "lift curve slope", the slope of the Cl vs alpha curve, the amount the lift coefficient changes for a unit change in angle of attack), and therefore any airfoil can be made to have any lift coefficient, within the limits set by its positive and negative stall lift coefficients.

That said, obviously a very high-lift airfoil in a low-lift location is probably not going to be as efficient as an airfoil that is optimized for efficiency at that required local lift coefficient.

When I design a wing, I generally do a brief look at airfoils at the Reynolds number range likely to be needed for that project, just to get a realistic idea of what's reasonable. However, the actual airfoils (note the plural) along the wing are the LAST things to be defined. After the planform analysis is complete and I have a map of the range of lift coefficients needed for the range of operating points for the entire mission profile at each location along the wing, only then can I design/define the local airfoil shapes that will best achieve those local requirements.

A BSLD can be achieved with planform alone, or some combination of planform and twist (both geometric and aerodynamic). Doing it with planform alone and zero twist results in vanishingly small chords at the tips, with major issues with local Reynolds numbers and structural issues.

Doing it with twist alone generally results in a lot of twist, which is not a problem at the design operating point, but is potentially a major problem at other operating points, where the now-incorrect twist causes distortions in the lift distribution and associated efficiency problems and possible handling issues. The Hortens mitigated that problem by using multiple elevons along the span, with different amounts of elevator deflection at each location so that the overall lift distribution would at least approximate the desired BSLD at a variety of operating conditions. Complicated to design and implement, but better than some of the alternatives.

I went through a study of the various approaches on a project a while back (with some very helpful input from Al B., thank you!), and it appears that the induced drag benefits of a BSLD apply regardless of what method is used to achieve it, but the adverse yaw benefits appear to require at least some twist to achieve.

Don Stackhouse

Thanks Don, very interesting, particularly the last point regarding the fact that twist may be needed to get the proverse yaw I am after. After some considerable playing about on XFLR5 I now have a wing that approximates a Sin^2.5 lift distribution (see latest pics in my album). It uses a combination of non linear twist taper and planform to achieve it as per the Hortens, I am now beginning to understand why the Horten wings are the shape they are, deviate too far from this and you don't get the benefits they were looking for.

John

Chris,

Thank you for the very kind compliment, I assume you are referring to my draft excel spreadsheet for calculating neutral points of a wing allowing for sweep effects. I checked what my calculation gives for the Horten gliders from data published in the book by K. Nickel and it seems to agree pretty well. My aim was to get a better neutral point estimation for swept and tapered wings as per the Hortens than the commonly used 1/4 chord of the MAC approach.

My calculation does not need to know what twist (geometric or aerodynamic) is used, just the planform of the wing. The way I understand it is that the Neutral point of a wing is not appreciably changed by the amount of twist used, I may be wrong however!

If you let me know your wing planform dimensions I would be happy to run it through my spread sheet, would be interesting to compare this to XFLR results.

John

Dear all,

I appreciate you guys. In more ways than you can know. I am so ordinary in so many ways. Every last one of you is as smart as I am. No, I take that back. Some of you are a LOT smarter than me.

I've crossed paths with some of the greatest minds in this area. I got to work a little with RT Jones and Paul MacCready. I worked with the protégés of Eppler and Whitcomb and Wortmann. I know Drela and Liebeck and Boermanns. And I value the critique of Marske, Lednicer, Selinger, Krauss and Lee.

But I am nobody. The only difference between me and a lot of you is that I got to think about a very hard problem. And I got to solve part of it. I am very ordinary. It really is only by the grace of God that I have been gifted to be in this place at this time to do the small things I have done. I really am nobody...

Reimar was brilliant. He had his foibles (boy you should see mine!!!), but every time I stumble into one of his design rules I am amazed and astounded. He was brilliant beyond words, like Einstein. In fact I have only found 4 intellects at this level: Newton, Einstein, Prandtl, and Horten. Having studied them all, I am truly humbled.

The differences between Horten and us are 1/ the materials we have and 2/ the airfoils. We can vastly beat his designs because of these two facts. But in design technique we can only hope to equal him, and only on the path he has blazed for us. IMHO.

Best regards,

Al Bowers

Dear Al:

What a great e-mail. If you feel humbled by the giants then consider the way I feel when I read statements from you like this one. I am not a lot of things, an engineer being one of them, or an aerodynamicist like many others on this site. That is why I still remain on it..to gather knowledge crumbs that are dropped by the guys who are in the "know". I have read a few articles defining the terms and the language, but do not know how to calculate the values, hoping that computer models will suffice.

But I do acknowledge structures and how to build them. Overbuilt? probably. Flyable? probably, especially with help from others, and using already proven designs that have flown in the past.

Thanks,

Rich Nunn

I second that!, you understate your achievements Al, I agree that we should be able to do a lot better using todays airfoils, materials and analysis software available to us.

Even Newton said he only got where he was "by standing on the shoulders of giants" all progress is usually based to some extent on what went before but that does not in anyway reduce your achievements in my mind Al.

John

It's been my experience that the more you learn, the more you realize how much you still don't know.

It's quite apparent that our friend Al B. has learned a very, very, very great deal!

What's really wonderful about that is that he is willing to share it with the rest of us.

Don

So, I have had a further play about on XFLR5 and have managed to achieve a BSLD close to sin^2.5 at my trimmed lift co-efficient. See my album for the latest images, thanks for all the help so far, my question to you all is:

1: Is this close enough to allow me to acheive proverse/neutral yaw at the design lift co-efficient?

2: If not how do I need to alter the wing to get closer to the right shape, not sure how to proceed, more twist at the tips? Smaller tips? Not really sure how to proceed.

John

What is your Design Wing coefficient of lift.??

(1) I have perused much of the group archives and have not found a clear (to me) definition of how much adverse span flow must be present to provide proverse capable flow.

Most everyone post that "Much Twist" is required,but if one has a light wing load,little twist is required to get the Sin^3 loading distribution at cruise speed.

Example; The layout I am enamored with is a 57% scale of the HIX aka 8-229, If I set the Cntr Line Lift coefficient at ONE ,Sin^3 distribution requires 8 or so degrees twist using symmetrical airfoils only.

When I set the Cntr Line lift coefficient to around 0.38 which satisfies the total load weight required at cruse, the twist is reduced to 3 or so deg. Not counting the small additional twist to balance the moments of added fwd CG for stability.

That hardly qualifies as "Lots of Twist" and is actually Less than that published for Northrop's B49.

So there clearly is a further consideration or limit not pointed out distinctly, in the application of a Bell shaped distributions for proverse yaw.

Of course there is the possibility I've got it all wrong...;^)

Rodger

Some interesting points.

Well I have 8 degrees GEOMETRIC washout at the tips (it gets progressively greater along the span (made up of a series of tapered panels each one having linear washout of 0,-1,-4,-6,-8 degrees respectively. I also go from MH60 to E168 airfoils to give aerodynamic washout as well.

The design lift co-efficient is currently 0.45. (if you set my album pictures to large you can read the numbers on the XFLR5 plots I have uploaded).

I agree re the comments about wing loading and twist, I saw a finless model published in a magazine recently that apparently had little or no adverse yaw, it had a flat plate depron wing and elevons near the tips, I wondered if the very low wing loading meant the designer could get away with a flat wing (it relied purely on raising the elevons to get trim and lift dist required), it also did not appear to have a large static margin which I would have expected.

Out of interest, what is the static margin on the HIX model you mention below?

Good point about further limits/considerations, the more I look into this the more it appears that it is not just the shape of the lift distribution but how it is achieved that is important in reducing/eliminating adverse yaw, would be great to pin down some general rules as to what is required (i.e. minimum twist/taper etc.) if only to guideline figures.

John

John,

Eight degrees sounds a little low for the amount of washout. Even with the aero washout from the airfoils.

To get proverse yaw, you need to be able to calculate 3 things.

1/ spanload across the span

2/ downwash across the span

3/ induced drag across the span

The last 2 are critically important. The downwash will cross over from downwash to upwash at about the 70% semi-span on both tips. This is where you want to place your elevon control surfaces, in the upwash region of the wing. This is also where the induced drag crosses from positive induced drag to NEGATIVE induced drag (INDUCED THRUST).

Sorry gotta run. I'm on vacation and I'm fixing a boat. Deck to hull seam that has split. I've got epoxy curing for a boat repair!

Al Bowers

AVAILABLE PLANS & REFERENCE MATERIAL

Tailless Aircraft Bibliography

My book containing several thousand annotated entries and appendices listing well over three hundred tailless designers/creators and their aircraft is no longer in print. I expect *eventually* to make available on disc a fairly comprehensive annotated and perhaps illustrated listing of pre-21st century tailless and related-interest aircraft documents in PDF format. Meanwhile, I will continue to provide information from my files to serious researchers. I'm sorry for the continuing delay, but life happens.

Serge Krauss, Jr. skrauss@ameritech.net
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Books by Bruce Carmichael:
Personal Aircraft Drag Reduction: $30 pp + $17 postage outside USA: Low drag R&D history, laminar aircraft design, 300 mph on 100 hp.
Ultralight & Light Self Launching Sailplanes: $20 pp: 23 ultralights, 16 lights, 18 sustainer engines, 56 self launch engines, history, safety, prop drag reduction, performance.
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VIDEOS AND AUDIO TAPES

(ed. – These videos are also now available on DVD, at the buyer's choice.)

VHS tape containing First Flights "Flying Wings," Discovery Channel's The Wing Will Fly, and ME-163, SWIFT flight footage, Paragliding, and other miscellaneous items (approximately 3½+ hours of material).
Cost: $8.00 postage paid
Add: $2.00 for foreign postage

VHS tape of Al Bowers' September 19, 1998 presentation on "The Horten H X Series: Ultra Light Flying Wing Sailplanes." The package includes Al's 20 pages of slides so you won't have to squint at the TV screen trying to read what he is explaining. This was an excellent presentation covering Horten history and an analysis of bell and elliptical lift distributions.
Cost: $10.00 postage paid
Add: $ 2.00 for foreign postage

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.
Cost: $8.00 postage paid
Add: $2.00 for foreign postage

An Overview of Composite Design Properties, by Alex Kozloff, as presented at the TWITT Meeting 3/19/94. Includes pamphlet of charts and graphs on composite characteristics, and audio cassette tape of Alex's presentation explaining the material.
Cost: $5.00 postage paid
Add: $1.50 for foreign postage

VHS of Paul MacCready's presentation on March 21,1998, covering his experiences with flying wings and how flying wings occur in nature. Tape includes Aerovironment's "Doing More With Much Less", and the presentations by Rudy Opitz, Dez George-Falvy and Jim Marske at the 1997 Flying Wing Symposiums at Harris Hill, plus some other miscellaneous "stuff".
Cost: $8.00 postage paid in US
Add: $2.00 for foreign postage

VHS of Robert Hoey's presentation on November 20, 1999, covering his group's experimentation with radio controlled bird models being used to explore the control and performance parameters of birds. Tape comes with a complete set of the overhead slides used in the presentation.
Cost : $10.00 postage paid in US
$15.00 foreign orders

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BLUEPRINTS – Available for the Mitchell Wing Model U-2 Superwing Experimental motor glider and the B-10 Ultralight motor glider. These two aircraft were designed by Don Mitchell and are considered by many to be the finest flying wing airplanes available. The complete drawings, which include instructions, constructions photos and a flight manual cost $250 US delivery, $280 foreign delivery, postage paid.

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