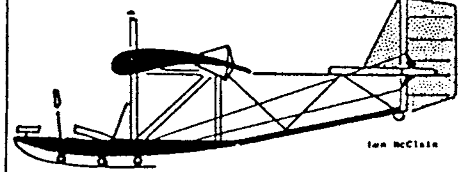

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R/C Soaring Digest

Vol. 6 No. 10 October, 1989

SPECIAL "HOW TO..." ISSUE

Featuring

The SUPER ZEBCO
...designed by Jim Harger

RUBBER HINGES
...designed by Harley Michaelis

The MITER TRAY
...designed by Jerry Slates

Keep it up! Keep it up!
Only 3 minutes to go...

...by Rob Smith
Madras, OR

Special Hints &
Tips on Sailplane Flying
Design & Techniques

On The Wing

...by B²

For the past two decades the most popular tailless RC sailplanes have been planks, and there are many full size plans available.

A common plank design consists of a constant chord wing with no sweep, a centrally mounted elevator, and a large rudder. Planks of this type have a very simple structure that lends itself to rapid building. Stability in pitch is achieved by reflexing the last 20 to 25% of the airfoil and having a forward CG.

The reflexed sections used by planks are essentially one speed airfoils. When flying too slow the forward CG pitches the model down and speed increases; when flown too fast the reflex pitches the model up and speed decreases. Planks are thus very stable and make great trainers — both of us learned to fly proportional with a plank, Dave Jones' "Raven MB." Full size plans are available from Dave at Western Plan Service, 5621 Michelle Drive, Torrance, CA 90503.

Plank type 'wings fly about 50% faster than conventional airplanes of the same wing loading, but with their inherently draggy reflexed airfoils their glide ratio is not good, and dead air duration is about one half that of a conventional sailplane. Yet a good plank, in capable hands, will outclimb a conventional sailplane in a thermal! Planks have a low wing loading, can turn tightly, and some, like the Raven, will automatically center themselves in a thermal, hands off!

The stable reflexed section brings with it two unique problems: (1) It's quite disconcerting to try to dethermalize a plank by diving. The wing has a positive camber with the elevator down and so its lift increases. As the 'wing gains speed the increased lift can actually offset the down elevator being applied. We've often found ourselves in nearly level relatively high speed flight with moderate down elevator! Ken Bates recommends diving inverted when dethermalizing his "Windlord". (Full size plans are available through *Model Aviation*.) (2) Thermaling with full up trim sets the turn and lowers flight speed. But this increases the effective reflex and applies a big down load to the wing — just the opposite of what you want in a thermal turn when attempting to make the best use of available lift.

Some flyers of both full size and model size planks, rather than relying on elevator trim which is always drag producing, have experimented with a sliding weight device that adjusts trim for high speed and thermaling flight modes. The trim in our Raven's is noticeably changed with the addition or removal of a 1/4" cube of lead, and so it doesn't take much weight shifting to change trim significantly. The system works well but entails an added mechanism.

Always make sure that the elevator servos pull for up. The elevator, being a part of the reflex of the airfoil, tends to have a consistent down load on it. When speeds are high you want to be able to have reliable up elevator, and having the servo pull rather than push for that function eliminates the possibility of pushrod buckle.

Several modifications can be made to the basic plank design we described at the start. First, the workable CG range can be extended by increasing the wing chord and sweeping the leading edge back. This is the form of Dave Jones' "Blackbird 2M", spoken of so often in this column. A second modification of the basic plank involves sweeping the trailing edge forward while maintaining a straight leading edge. The resulting planform is good for maintaining effective aileron control and nearly eliminates any pitch changes brought about by aileron differential. Jim Marske's full size Pioneer II is an excellent example of this planform.

Contrary to popular opinion, flaps can be used on planks. While tows are straight and steep without them, the climb rate is improved. Also, they are effective landing aids. Their area should be no more than 5% of the wing. Install them on the bottom wing surface at 40% local chord; they won't affect pitch much when located there. Deflections of 40° are effective.

A final comment

You must adhere to the FAI minimum wing loading of 3.96 oz./ft² when competing in AMA events, and it's very easy to build planks well below that minimum.

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Timers Revisited - Again!

...by Bob Biss

from The Storm King Flyer Newsletter

PILOTS — you have been reading about TIMERS here in CASA COMMENTS and in other leading sailplane journals, too. While gleaning through these articles once again, a few important thoughts ran through my mind while putting together a few other thoughts to write about and lo and behold, both thoughts go hand-in-hand.

♣ ♣ ♣

We all are or should be aware of how important a good timer can be during a contest and the roll they can play in one's success or failure. I personally know that a guy named Bill has told me on several occasions that he is a jinx when he times. I'm beginning to believe him, but I am the one that selected him. Hold that thought.

One of the pilot's responsibilities during the contest is to be prepared to compete when it is your turn. Knowing who your TRAFFIC is, is very important during a competition. When called to fly, you should have already picked out a timer, moved your sailplane to the ready area, developed an idea as to where or how you are going to compete this round, and briefed your timer on all of this and anything special that YOU might require from a timer. Try to remove any possibility of confusion before your flight is underway. Hold that thought, too.

When your sailplane touches a ground based object or the ground itself, it is the TIMER'S responsibility to stop the clock; and when the sailplane comes to rest in the landing circle, it is the TIMER'S responsibility to measure the landing — not the pilot's. The TIMER determines the degree of landing points and the time that is turned in to the scorekeeper. The TIMER has the FINAL word on the scores. Hold that thought, too.

Putting it Together

Your TIMER is responsible for the accuracy of your final score as determined by his stopwatch and landing tape measurement. It is YOUR responsibility to know what is going on at all times and be ready to fly when called to the stand-by area. Waiting to be called before you start to look for a timer, check your plane, or make that JOHNNIE call only slows down the competition and cuts down on your selection of a TIMER. Waiting for your TIMER to finish timing someone in the flight group ahead of you is definitely a no-no.

Rubber Hinging Tips

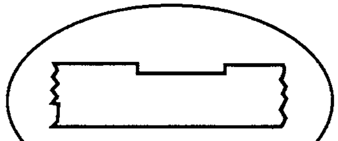
...designed by Harley Michaelis

&

available from ACE R/C

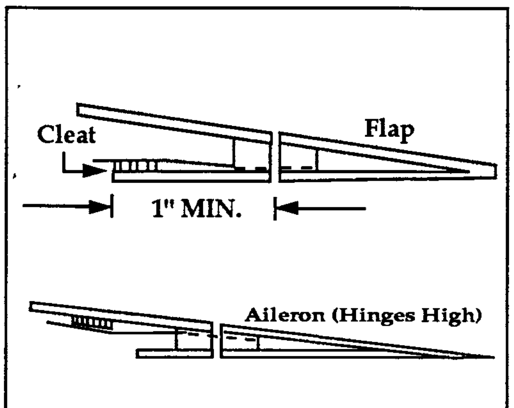
Use ACE R/C's "HARLEY'S HINGES", stock #50L317. These permit a sealed butt fit with no rounding, spacing or beveling for deflection. Wash and rinse the strips. Cut straight with a sharp scissors to avoid weak spots where a tear may start. If the strips are cut into thirds, the hinges will be a practical width. Use Pacer Instant Zap and the tiny tube that comes in the cap for controlled application.

Beveled hingeline strips for flaps and ailerons have to be notched where hinges pass before assembly. Use a 3/8" wide strip of #50 or 60 sandpaper glued to a block an inch or so wide.



The Notched Strip

Make practice notches in 1/4" sq. balsa and cap over them. See that a hinge strip can be readily inserted with the fingers and not fall out. If oversize, water applied with a syringe will swell the balsa for a good fit.



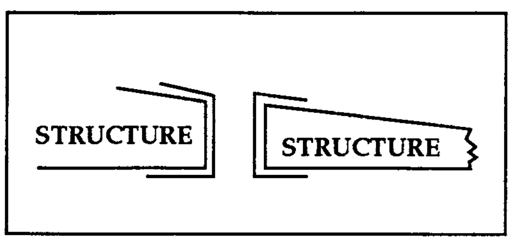
Sketches

Practice to judge how little Zap is needed to bound about 1/4" of rubber in a slot. Insert the hinge 1/4" and wick between rubber and wood on one side. Wipe glue residue so the protruding portion is totally floppy. Pull the hinge a little to check the bond.

In flaps or ailerons, first wick all hinges in these, then insert all in the wing and bond one by one. The slots must be wide enough so the edges of the hinges do not drag.

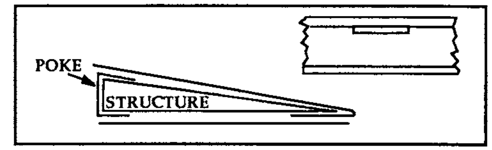
The sketches show typical installations for ailerons or flaps where the top may be fully sheeted and the underside partially.

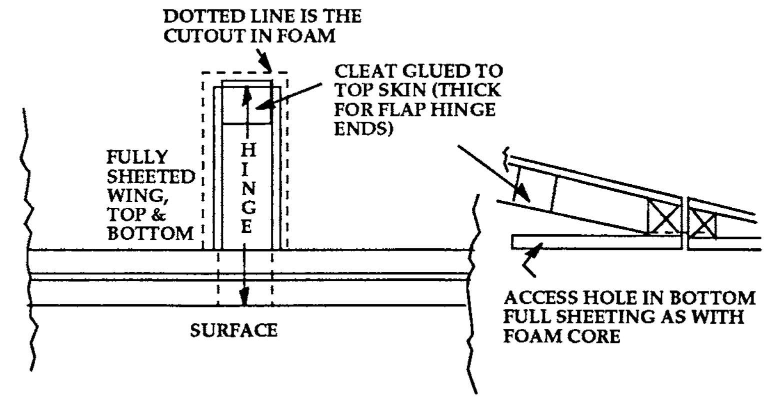
For flaps, there should be at least 3/4" of rubber free to stretch, so the sheeting forward should be at least 1" wide. Anchor the loose end to a 1/4" cleat on this.



Hinges can be put in the flap or aileron after it is fully covered, or as illustrated on the left, a strip of Monokote may be applied along the vertical faces and wrapped around.

Slit where the slots are and poke a heated strip of .030 aluminum in to seal the edges. Main pieces can then be sealed to the overlap after hinging is completed.





If the wing is to be Monokoted, a fully sheeted underside can have "access holes" cut in it for hinging the loose hinge ends. The monokote will cover these holes.

Don't fight short hinges. Cut them 1-1/2" or so. Mark each 1/4" in. Insert that far in the flap or aileron and wick in. Be sure they are at right angles so edges stretch evenly.

Regarding tension, it is important to avoid excess work for the flap servo in moving flaps up (reflex). In the butt fit the flap will be pivoting on the top edge when reflexed, stretching all hinges. If tension is used on all, the servo may balk. Therefore, bond the hinge and center hinges with a bit of tension. Check the hingeline fit and the operation. NONE may be needed in the rest.

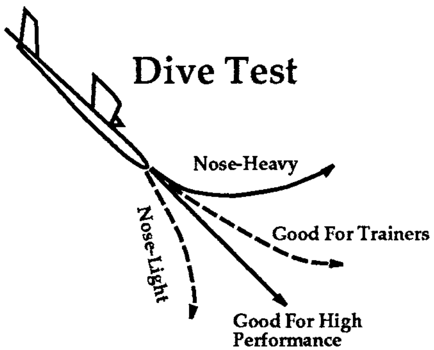
Since open bottoms are commonly sheeted out a bay or two, for flap hinging there cut 1/16 X 3/8 openings in the sheeting and fish the loose ends through with a bent pin. Pull the loose end out, apply Zap and let it wick back so the rubber is bonded inside with a little tension. Then pull and trim the excess. Before adding sheeting trim away the foam in the area where hinges will pass or attach.

On a fully sheeted bottom, flap hinges would have to be anchored on thicker cleats glued to the underside of the top skin. The core would have to be trimmed away there before the top skin is put on, then cleats added. The bottom skin could be added after hinging. Pins passed through will establish where a straight edge can be placed for trimming precisely at the hingeline. Adhesive on hinges there must be avoided, or the hinge waxed so it is not bonded in the hingeline area.

The rubber has some UV resistance, but will last longest if shaded. REPLACEMENTS: Open the covering as needed. Apply debonder with a small syringe. Several applications will be needed. Be patient. When the glue is softened, remove the hinge. Slip a new one in one side and bond it. Work in the loose end, bond it and cover.

Wings & Things

...by Dieter Eberbach



What I would like to explain here are a few tips for the newer glider pilot.

Having built the new glider, how does one go about flying it? To start with the center of gravity (CG) is very important. To find out if the glider is nose heavy or tail heavy, place a finger under each wing about 1/4th back from the leading edge, or under the main wing spar, or as indicated on the plan. It is better to have the glider nose heavy, as tail heavy makes for waltzing with the control box.. Normally, the glider stalls down over the tail. Also, make sure that the rudder and elevator have enough movement. Once the batteries are charged, it's off to the field. Select a field with long grass and no rocks. Switch on the equipment and hand launch into the wind. I hand launch every glider no matter what size (1 meter to 5 meter). There is one thing for sure: if it flies from a hand launch, it will fly off the winch and bungee.

Strips & Covering

I see a lot of the newer aspiring glider pilots make the same mistake we all made as to colors. In the words of Paul Beaty: "The smoother the wings and body of the glider, THE BETTER IT FLYS."

The colors are very important. White or yellow should be on top, while black, dark blue or dark green are better on the bottom. The reason for all of this is to be able to see the glider when it is very high. All dark colors go black as it gets high. Also, cream and light blue make it disappear. If you wish to put strips on the wings, make sure it is only across the tips. Strips along the wings are a no-no unless the kit or plan says to put a thin strip just off the leading edge. The rudder and elevator must also be kept clean. As Paul always says, "The LAMINAR flow is important." Or, in easy terms, KEEP IT CLEAN. Some will not agree, but I have tried strips and they may look pretty, but one can see the flight difference once they are removed.

How to find a thermal

At first, it is not easy, but here are a few pointers:

A) Watch the birds as they will find a thermal long before you. Fly in below them and circle around in the same direction that they circle in.

B) Watch the glider in flight. If it suddenly picks its nose up and you have not moved the stick, then move into a turn around the same spot. Remember, there are left and right hand thermals. So, try either way, but remember to keep the wing at about 10° to 20° and fly just before the stall. This is not easy at first.

C) Watch for the dust buster or dust devil. These can be seen in the field coming toward you. These thermals are very violent and strong, and can throw a 5 meter 6kg glider around like a piece of paper. So, be warned. A large amount of skill is needed to keep the glider flying and upright. An aileron glider is at its best due to it being able to pick up the stalled wing. So take care when trying out the new glider, and happy flying.

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Windy Weather

... by Pancho Morris

Flying in the wind can be very intimidating...

Just flying faster at any weight will help.

Spring, in particular, and Texas in general provides us with more wind than we would really like to fly in. Around here it is said that you learn to fly in the wind or you don't fly. I have always enjoyed hearing fliers that have just moved here from other parts of the country when they arrive at the field on what we consider just an average flying day with a wind from 8-15 mph. They're always amazed that there are so many people flying in all this wind. "Back home" even the good fliers left their planes in the car on a day like this.

Flying in the wind can be very intimidating, especially to the newer fliers. Once basic flying skills are achieved, wind flying is more a matter of confidence than anything else. Once you fly in the wind with some help and support from an experienced flier, you see that it is really not all that hard.

There are several things to do to make windy flying work. Adding weight to your plane will help. You can make your plane slightly more nose heavy...but only slightly. Too much nose weight can make things worse. Adding extra weight or ballast at the CG (center of gravity) is the best place. This weight must be very well secured. A changing CG makes for a very exciting flight. Ballast has also been defined as a means of removing bulkheads. The extra weight raises your wing loading which causes your plane to fly faster. Since your plane is now heavier, it is less easily upset by gusts.

Just flying faster at any weight will help. Most people, especially beginners with light planes, actually fly too slow in all conditions. Put in an extra click or two of down trim and let the plane speed up a little. You may be surprised at how that sluggish floater now becomes quite responsive and handles much more positively. Without sufficient airflow over the control surfaces, they can not be effective. AIRSPEED IS CONTROL. Practice flying faster on calm days. Get used to it so that it feels comfortable and doesn't scare you.

One of the places that airspeed can really get you in windy weather is the difference between apparent airspeed and real airspeed. This is most apparent when you are flying down wind. It looks like you are really moving. Yet, when you try to turn, nothing happens. This is because you really do not have much airspeed, you are just floating with the wind. You need to put the nose down and dive a little to get enough airspeed to make your controls effective.

The main mistake people make is floating around too slowly and letting themselves get blown downwind. FLY UPWIND AND STAY UPWIND. When you launch, get off the line and fly upwind as far as you can stand and stay upwind. Under no circumstances let your plane get back to where you are standing. You can fly upwind as far as you can see and the wind will try and blow the plane back closer to you. If you make a mistake, the plane will come closer to you. If you get downwind, each mistake will just blow it farther away until you are finally blown off the field.

Landing is the most difficult part of wind flying. It is also the scariest. The fear is what causes the most mistakes. People are afraid to put their plane on the ground and thus get flying too slow and loose control. You must get the plane down and on the ground quickly. Remember, AIRSPEED IS CONTROL. If you have spoilers, use them to get the plane down fast. When you get within 20 feet of the ground, get the nose *...continued on page 12*

Product Review

PC-SOAR

...revisited

(version 1.3)

...by Doug Klassen

FEATURES of PC-SOAR

- Improved on-line documentation
- Now plots and overlays airfoil polar data
- Use polars and sailplanes provided or enter own
- Multiple Reynolds Numbers on Airfoil Polars
- English/Metric input capability
- Plots sink rate and lift / drag versus flying speed
- Overlay plots to compare aircraft performance
- Calculates standard design parameters such as: areas, aspect ratios, aerodynamic centers, average chords, tail volumes, instability factors and more...

About this time last year, I recounted to you all my painful story of learning to use the desktop computer at work. At that time the saving grace of the situation was the arrival of a copy of the sailplane design program "PC Soar" by LJM Associates. I had my struggles with the program and at the time freely admitted my computer illiteracy may have been a contributing factor. I feel comfortable now in saying that my assessment of the program and my computer skills was accurate. I was just as dumb as I felt and PC Soar was not the easiest program in the world to use.

Just as I improved, so has PC Soar. I received a revised edition back in January along with a nice letter from Lee Murray (LJM). Along the way, I also bought the additional library of airfoils that LJM had made available.

There is an addendum to the program documentation aimed specifically at the novice computer user. Other improvements in the program include the ability to drop out of a data input sequence without having to drop completely out of the program and somewhat clearer on-screen explanations with some of the menu choices. The ability to back out of a given program area is the best improvement of all and, really, when you get right down to it, that was probably my biggest complaint about the earlier version of PC Soar. PC Soar, as far as I can tell, doesn't really have any noticeable glitches in it, and the computation portion of the program runs smoothly and without any hang-ups. I've run it on the IBM XT, a generic AT clone, and my Northgate 386 without any real function problems.

The biggest quirk so far is that, for whatever reason, I can't do a proper printout or screen dump on my Panasonic 1124 printer at home. The trusty old IBM Pro Printer at work cranks out the graphs and such just fine, but the one at home gives me gibberish. I'm not sure it's that big a deal and I'm not sure it isn't as much the printer as the program. Program/printer interface problems are common with programs costing a whole lot more than PC Soar.

> "PC Soar isn't perfect, but it's the best model airplane design program I've run across. It does what it is supposed to do in a relatively orderly fashion and returns good value for the dollar."

With some time and detective work, I'll resolve the printer problem.

The only real inconvenience is that when you load and manipulate a glider design in the program and then go back and try to add a second or third design, you lose all the accumulated data on the first plane. It would be nice to look at a design and then be able to go back to the sailplane library and grab different designs one after another for comparison purposes. It's quite possible to compare performance and design specs on different gliders, and you can load up to five designs at once in the working memory, but you must decide before starting down the menu tree which gliders you want to compare. If you want to compare more than five, you must compute them in batches and then sort them and recompute them for further comparisons. It's not really difficult, but it is a little time consuming.

The only other negative things I could really pick out were the screen selection and text appearance. You don't have a lot of choices in graphics and configurations to choose from. You get three: 720 X 348 Hercules with HBasic, 640 X 200 IBM HRG2 and a "Specify" option. I played with all three and found that if you picked the wrong one, boink, you get an error message and you're locked out of the graph displays until you exit and reload the program. A real pain if you just spent time selecting five designs to look at. Once you know what works with your system, it shouldn't be a problem, but it's annoying the first time, anyway. The three machines that I have run the program on are equipped with CGA, EGA, and VGA+ monitors, respectively. In each case, after sorting out which graphics display to choose from the menu, the screen display functioned without a hitch.

The screen text display is in a normal looking font until after you cycle through the graph portion of the program the first time. After the graph portion, the text switches to a large, difficult to read blocky text that seems to be common to programs written in Basic.

Do I sound too critical? It's not my intention to be. PC Soar isn't perfect, but it's the best model airplane design program I've run across. It does what it is supposed to do in a relatively orderly fashion and returns good value for the dollar. It's endlessly entertaining to crank out theoretical designs without having to spend a fortune in time and materials. At this point in my modeling career, I wouldn't scratch-build a sailplane without first running the specs through PC Soar. If you have access to a desktop computer, PC Soar can be as indispensable as CA glue. Both can save you a lot of time and frustration.

Earlier, I mentioned buying the additional airfoil and sailplane library disk that is now available. It is an excellent selection of about 60 new airfoils not found on the first program disk. Included in the update are some airfoils suitable for slopers that were absent in the original program volume. The library disk is worth the bucks, so do right and buy the whole package.

And a Final Note

PC Soar is not shareware nor is it "giftware". It is a commercial effort and it's author deserves payment for each and every copy. The disk is not copy protected which means that you cannot make as many copies as you want and give them to your friends. It's a violation of copyright law to do so and, beyond that, it's a poor way to treat a fellow modeler who put a lot of time and effort into giving us an excellent tool. Write LJM Associates and buy a copy. You'll be glad you did. (LJM Associates, 1300 Bay Ridge Rd., Appleton, WI 54915)

Doug Klassen
17601 N.
Kennison Lane
Ldoi, CA
95240

Windy ...continued

down and put the plane on the ground. Keep the nose directly into the wind or, if you have to, land HOT downwind. Do not try to land crosswind. Don't go far downwind on your landing pattern. In fact, sometimes you will make your crosswind turn in front of you and let the plane drift back as you make your crosswind leg.

The next day the wind is up a little more than you like. Ask one of the more experienced flyers to coach and support you and try flying. Once you try it and see that it isn't so bad, you will find you have a lot more flying days.

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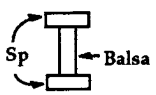
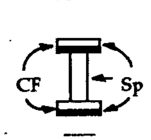
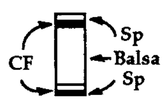
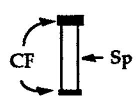
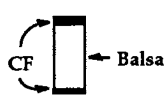
Wing Spar Design & Strength Analysis

...via the Portland Area Sailplane Society Newsletter (PASS)

The following are the results of extensive (over 94 test samples) testing done by **Bob Bayard** and **Reinhard Lahde** and published in the South Bay Soaring Society newsletter. The complete article is 6 1/2 pages long so the following is just a summary of the results:

The testing began as a follow-on to previous testing of how to reinforce spars with carbon fiber on the tension side of the spruce spar. The results showed the carbon fiber on the compression side would buckle too easily to be effective. In these tests, the carbon fiber on the compression side was increased in thickness to prevent buckling, and more construction techniques were tried.

Table 1. Spar Cap / Shear Web Dimensions & Failure Values

Sample	Top cap*	Bottom cap*	Shear web*	Weight oz/ft	Force to break
	Spruce Wide .400 Thick .125	Spruce Wide .345 Thick .125	Balsa Wide .125	.328	26 lb.
	Spruce-CF Wide .250 Thick SP .059 CF .037	Spruce-CF Wide .250 Thick Sp .059 CF .014	Spruce Wide .125	.328	70 lb
	Same as #2	Same as #2	Balsa Wide .250	.266	58 lb
	CF Wide .203 Thick .062	CF Wide .203 Thick .021	Spruce Wide .125	.328	69 lb
	CF Wide .250 Thick .080	CF Wide .250 Thick .031	Balsa Wide .250	.328	80 lb

Highlights of Spar Research

- 1/16 carbon would not buckle.
- Carbon was 4.5 times stronger than spruce.
- Carbon was glued between top spar and shear web.
- Spar caps were stronger under tension than compression.
- Compresion spars should be heavier (thicker) than tension spars.
- Vertical grain (balsa) shear webs were 25% stronger than horizontal grain webs.
- Slow gap-filling cyanoacrylate was used in constructing the test spars.
- The shear web is a vital element of the spar.

Spar Summary

"The very best design, considering overall strength for a given weight and ease of construction, seems to be a full width balsa shear web supporting pure carbon fiber laminates, with three times as much carbon fiber on the compression cap as on the tension cap. A similar spar but with a thinner horizontal grain spruce shear web is equally good. Mixed spruce and carbon fiber caps are pretty good, and binding with thread doesn't add much, if any, strength to an already good design. Using carbon fiber you can make a wing weighing the same as one with a conventional spruce cap, balsa shear web spar, but about three times as strong."

"In our study, we have tried to find the best combination of carbon fiber, spruce and balsa for making light, strong wings. This task, however, is a difficult and complex one and clearly we haven't exhausted the subject. There are many things unexplored; for example: the effect of sheathing on a built-up wing, a more thorough-going study of the shear web question, and the whole question of how to best use carbon fiber in foam core wings. However, the results reported here will permit modelers to drastically reduce weight and/or increase strength of model wings."

"The drill rod was sold as being water hardened, but it clearly wasn't hardened. A hacksaw cut it easily."

Carbon VS Steel Wing Rods

...by Bob Bayard

via the Silent Flyer (SBSS)

This is unplanned follow-up to the work on wing spar strength that Reinhard Lahde and I reported recently in the Silent Flyer. It began at our March contest when I noticed a fellow hammering a wing rod out of his fuselage. He said it was the second one that had bent. What was the material? Drill rod, from Orchard Supply. I decided to investigate that material as well as carbon fiber and the more commonly used music wire wing rods. Having done that, I began wondering if usual wing rod arrangements could take the kind of forces Reinhard and I showed could be taken by some carbon fiber spars, so I looked into that, too.

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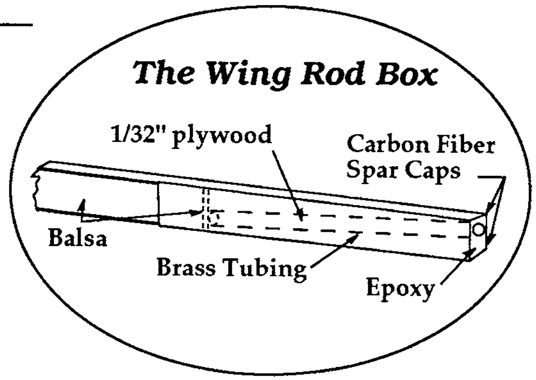
Wing Rod Strengths

To measure comparative strength of wing rod material, I used the same apparatus Reinhard and I had used in the wing spar study. This test set-up gives force readings which are equal to the tow line forces which would exist on a two-meter model with typical tapered planform. The test rods were 1/4" dia. and were supported by 1/4" ID by 4" long pieces of brass tubing epoxied into pieces of wood. To determine relative strength I would put a rod in the set-up and put a force of say 20 lbs. on the "tow

...continued on page 16

Carbon VS Steel Wing Rods. ..continued

So, carbon fiber is not stronger than steel on an equal basis.



line", remove it and see if a 4" piece of the brass tubing would still slip over its length. The different measurements showed that a rod bent less than about a quarter of a degree (1/64" in about 4" length) would let the tubing slide past the bend, but that a bend of half of a degree was too much. Each time the rod was put in the apparatus, the force was increased by 5 lbs. until it wouldn't let the tubing slip over it anymore. I counted the strength of a sample as the maximum "towline" force that didn't bend the rod beyond the point where the tubing would slip over it afterward.

The drill rod was sold as being water hardened, but it clearly wasn't hardened. A hacksaw cut it easily. Its strength was only 25 lbs. No wonder the fellow at the contest found them bent after launching.

I took another piece of drill rod and hardened it by heating it cherry red and quenching it in water without annealing it. At a "towline" force of 50 lbs. it broke, a very brittle fracture. Another piece I hardened and then annealed. I may have annealed it at a bit too high a temperature — its color is supposed to be gun-metal blue, but it went a trace past that. It bent rather than breaking, but its strength was exactly the same as the fully hardened piece, namely 50 lb.

A piece of music wire was also tested. This material can't be hacksawed, at least with only one blade. Its strength was the best of the steel pieces, 75 lbs.

I also tested a solid carbon fiber rod obtained from Aerospace Composite Products (Box 16621, Irvine, CA 92714). I had heard that carbon fiber was more than twice as strong as a similar sized piece of steel. If true, this would tax the test apparatus. However, it isn't true. My first sample went to 40 lbs. without incident but at 45 lbs. it failed. The failure was in compression of the fibers at the top of the rod, the place of maximum compression stress. To see if it was a fluke, I broke two more samples. They failed at about the same force, one failing just like the first one, and the other by breaking in half.

So, carbon fiber is not stronger than steel on an equal size basis. How about an equal weight basis? My crude measurements showed steel to be nearly five times as heavy per volume as carbon fiber. So a reasonable comparison between carbon fiber and steel might be a carbon fiber rod 1/2" in diameter vs. a 1/4" steel rod. (The 1/2" carbon fiber rod would be four times as heavy as the 1/4" one and it would have twice as much brass tubing as the 1/4" rod, so the weight comparison between 1/2" carbon fiber and 1/4" steel should be very close.) Assuming the theoretical ratio of rod strengths as a function of different size rods, namely the cube of the diameter, this carbon fiber rod should be eight times as strong as a 1/4" diameter carbon fiber rod, or about 360 pounds. This is clearly overkill, as the rest of

the system — the tow line, the brass tubing, the balsa/foam, etc. — would probably fail in all sorts of ways before reaching that force. A more reasonable comparison might be a 3/8" diameter carbon fiber rod against 1/4" steel rod. Again using the cube relationship between diameter and strength, this carbon fiber rod should tolerate a tow line pull of about 150 pounds. This is twice as strong as the 1/4" steel rod and yet the 3/8" carbon fiber rod would weigh less than half as much as the 1/4" steel rod. The difference in weight for a typical wing rod set-up would be about one ounce. Of course, the carbon fiber would cost a lot more — $11 for a one-foot length versus $2 for a three-foot length of music wire.

Wing Rod Box Strength

To see if a typical rod construction would tolerate the kind of forces Reinhard and I were able to develop in carbon fiber spars, I took our best sample spar and built a wing rod box at one end. The sample was 5/8" high and had a 1/4" thick vertical grain balsa shear web, a .031" thick carbon fiber lower spar cap and an .080" thick upper spar cap, both caps being 1/4" wide.

The wing rod box was very simple (see sketch). The balsa shear web stopped 4" from the end of the carbon fiber caps. A piece of 1/32" plywood was glued to each side of the spar over those last four inches and continued over the sides of the balsa shear web for an additional inch. A 4" length of the brass tubing was inserted between the two pieces of plywood and the empty spaces around it filled with epoxy.

With a music wire rod carrying the load, this sample took 70 lbs. without incident. At about 80 lbs. it gave way. The failure was the same sort (and at the same force on the "towline") that Reinhard and I had found for the equivalent carbon fiber spar, namely, shear web failure and upper spar cap buckling. Although the music wire rod had bent to nearly a four degree angle, the wing rod box assembly was completely unharmed!!

"Although the music wire rod had bent to nearly a four degree angle, the wing rod box assembly was completely unharmed!!"

SUMMARY

The best steel rod is music wire. If you are a competent metallurgist and could properly temper a piece of drill rod it might come up equal to music wire, but why bother?

A carbon fiber rod having the same diameter as a music wire rod is only about half as strong. A carbon fiber rod with twice the diameter would weigh about the same as the steel rod but it would be outlandishly strong. A more reasonable comparison would be a carbon fiber rod that is half again as big in diameter as the music wire rod. This carbon fiber rod would weigh less than half as much as the steel (saving an ounce in a typical design) and yet be twice as strong.

A simple wing rod box with 1/32" plywood sides extending 1" beyond the 4" long box space and the box space filled with epoxy is more than adequate to take all that a very strong carbon fiber spar can tolerate.

Using Turbulators

...by Ray Reiffer

I recently flew in a strong but strange thermal in the company of several swallows, and I had a rough time of it. The ship was thrown about and acted weird. A rain front was coming and smoke lay on the ground...

Earlier, a brief note was written on my success with a turbulator on my SAGITTA. The success has been a flash in the pan as it has turned out. Many years ago I used turbulators on towline gliders with super results. Thus, sooner or later it would be natural to apply this method to R/C sailplanes, or so it would seem. The tremendous range of operating conditions has caused a problem in application for me.

I made the comment, "Don't they know?" Well, I believe, "No they don't." It seems the subject is in the black arts category. It also seems, from what I've done so far, that the turbulator placement is only good at one spot per the flying conditions.

I've increased the range of my SAGITTA considerably via hand toss, but it turns out very tricky in actual thermalling conditions. I'll come back to this in a minute. First, to describe the parameters of my experiments on the SAGITTA 900, with stock E-205 foil.

The tape I used on the wings is the kind executives use to show graphs on display boards, and can be purchased from office supply houses. It is .007" thick and about .060" wide. I used two layers. Per Frank Zaic's formula, I placed the tape at 1 1/4" from the leading edge. This setting did not produce any results of merit, so I moved it back 1/8". This was better. So, again I moved it back 1/8". Now, at 1 1/2" things are definitely working to great advantage and the gliding distances are much better. At this point, I had a helper time the flights with a stop watch and, though this is not all that accurate, of course, within reason it is O.K. Time being 8 seconds at 180 ft. measured, thus equalling 22 ft. per second. I think this is why Zaic's formula didn't work out: I flew it too slow. As a result of the hand launching method, I was aware of the problem. I figured that in a thermalling turn it would be flying slower and thus, maybe, I'd accomplish something.

My wings are sheeted with 1/16" balsa and fiberglassed with 3/4 oz. cloth and one coat of polyester resin applied heavy. The excess is removed via T.P. after the cloth was brushed into place. The trailing edges were pre-sanded sharp and, after glassing, they were slightly rounded to prevent chipping. Thus, they are now approximately .015 - .020" thick. Wing loading is 9.4 oz. per square foot. Actual final flight tests were via winch launch. I had trouble right off in the first thermal, which required tight turning. The craft acted as if it were tail heavy, galloping around the circle. Upon removing the tape, all was well in the turns, again.

To conclude this aspect of the experiment, I think the turbulator failed in the turns because of the many things we know happens in a turn. To keep this simple and direct, I will name just a few: (1) Increased angle of attack in the thermalling turn, (2) Higher loadings, and (3) Side slipping air currents. Thus, we have a different animal than was test glided by hand. The turbulator apparently caused the center of pressure to move during the increased angle of attack while in the turn, thus affecting a forward movement center of pressure at this altitude, or a major separation was occurring in a cycle of several seconds.

Now, back to Zaic. The information I used to start all of this was for 200,000 Reynolds, while my test glides were only at 105,000. Thus, we cannot expect things to match up; yet the test glides were beautiful. When the turbulator was moved back to 1 5/8" or more (during hand launches), all was lost again. Thus, at 105,000, the turbulator should be at 1 1/2" or 15% of chord.

What next?

I'm going to time a few "fly-bys" to get a better idea of the ft./min. airspeed. There, I can ballast up for more hand launches and, thus, glides at the proper speed. Hopefully, an optimized location for the trip strip can be found and that it will also function under the task of the thermal turn, which at this time I think indicates a more rearward location because of the speed. I'll start at 15% and work back for the next flight tests.

I'm afraid that two locations (or more) may be required to operate a turbulator under soaring conditions, at least for the E-205 (or my 205). Perhaps my wing, alone, suffers from this problem during thermalling, or at least the condition shows itself in very tight turning as done low in small thermals. I'm afraid more testing in a thermal is required to find a workable location. All authors I've read on the subject agree that triangular shapes work better than a single trip strip, yet it would be very time consuming to try this approach.

I recently flew in a strong but strange thermal in the company of several swallows, and I had a rough time of it. The ship was thrown about and acted weird. A rain front was coming and smoke lay on the ground, and yet I could find these isolated thermals. The whole thing reminded me of thermalling with the turbulator in place. I wonder if the conditions are not as important as any other factor?

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Comments: Yes, Ray, you're right...the whole business of turbulation is tricky. Sometimes it works, as you pointed out, and sometimes it doesn't. In my response to your last letter, I mentioned something about terraces placed from about the spar rearward, and I think I may have incorrectly called them turbulators. They are NOT turbulators...they are INVIGORATORS. Apparently, turbulation refers to something done to the airfoil from its leading edge (or slightly ahead of it) back to about the point of minimum pressure...but aft of that, they term it invigoration. While it's true that not everyone uses turbulation, I think it is correct to say that almost everyone knows about it — and the reason they don't use it very often on R/C sailplanes is the very reason you have found out: it doesn't always work.

Let's talk about the Eppler 205 airfoil for a minute. It is well known that the E205 must be kept flying fast to perform well; that is, at a high L/D...and it has been common experience that at low speeds (low R.N.) it "falls out of the sky". Not exactly true, but at the very least the drag rises appreciably and the L/D deteriorates badly. When you thermal your E205 - equipped sailplane, it must be flown faster in the thermal than you'd normally expect because of the decrease in L/D and the tendency to behave erratically. I suspect a couple of things in the behavior you mention: You may be trying to force the ship to turn tightly and it wants to fall off because of incipient stall (solution: fly faster) or the horizontal tail may be stalling (solution: use the NACA 0009 or the NACA 63009 airfoil for the stab).

Something I've wanted to try for a long time on a sailplane is a leading edge device to increase lift at high angles of attack. The Handley-Page automatic slot is a good example...it "pops" out when needed. Did you know that both the low-speed Tiger Moth and the Messerschmitt Me-109 fighter use these? In sharp, high-angle of attack maneuvers they pop out and keep the tips flying. Not only a safety factor in the trainer, but a very useful ability in a fighter.

Servo-operated leading edge slats or slots might work very well, but I'd put them only in front of the ailerons from the tips inboard no farther than about a quarter span. I tried it full-span once, and the sudden application caused an abrupt lift that caused the spar to fold! Be careful, but give it a try...gently! JHG

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