

Ian Lea's Rib Test Results

Dear Janice and Dan:

I enclose load test results on 6 "low tech" rib types (for fabric cover). I didn't want to get into this (It took about a month of spare time), but I don't remember seeing any comparative rib strengths, ever, and I had to make a choice. The goal is the easiest construction in a tapered wing.

Of course, after you finish the tests, you wish you could do them over with what you've learned about testing, but sometime, I'd like to get into construction, and life is too short! I did three tests over, but I still ended with three questionable tests.

The airfoil is deep (18%) and has a deeper trailing edge than most modern sailplane airfoils. A 16% airfoil with a thin trailing edge cusp might differ, but its all comparative.

The loading is severe, weighted at one spot only seven inches from the trailing edge. I noticed Dan distributed the load in his rib test.

A rib is a very narrow beam, and would buckle easily if the compression (top) flange is not restrained sideways, which is accomplished in the wing by the fabric (or other) cover. Also, the traditional tape "x" bracing between ribs (like the "bridging" in your house joists), which distributes the load between adjacent ribs, should be considered.

The basis for comparison is the traditional gusseted 1/4 x 1/4 truss which (thank goodness) was a good clean test. (Note a simple reinforcement increases strength 22%). Note also the diagonals in compression (reduces load in top cap) was successful.

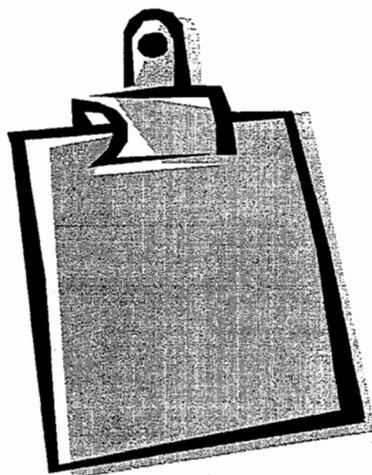
I feel bad about the "trussed plywood" (Cherokee style). I don't think it reached its potential. The diagonals bent out severely, distorting the whole rib. Perhaps they should be reversed (to be in tension). Which ever way, you'll be stuck with unsymmetrical loading. The wood capped foam ribs were very strong, even with faulty bracing. The 1" foam is very strong, and the 3/4" is strong and the lightest! (Jim Marske cautions he found these "squishy" with greater deflection. I didn't notice this, but didn't measure deflection). These ribs could be hot wired with Joe Alvarez' technique. Note also the successful use of the "D tube" ply lapping over the rib 2", with no side blocking rib to spar. This extra 2" also smooths the wing surface further aft. It would be great if these "low tech" ribs could be compared to some "high tech" ones, Dan's, Joe Alvarez', or others. This would involve some math to relate loading, or retest with similar loading.

Tentatively, I am inclined to use the foam ribs with somewhat greater spacing than the typical one foot. Does anyone have some comments on this?

I hope these tests will help some of the members.

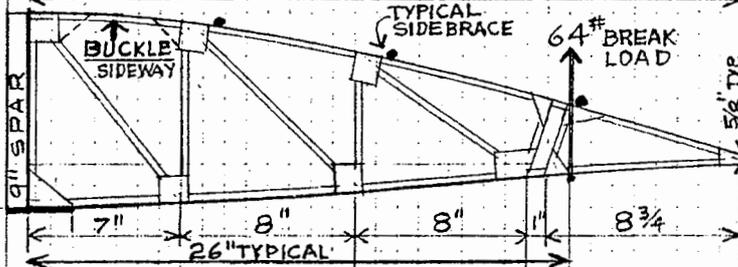
Regards,
Ian Lea
306 E. Witchwood
Lake Bluff, Illinois 60044

Editor's note: Thanks, Ian, for sharing this with us. See the next page for the actual results.



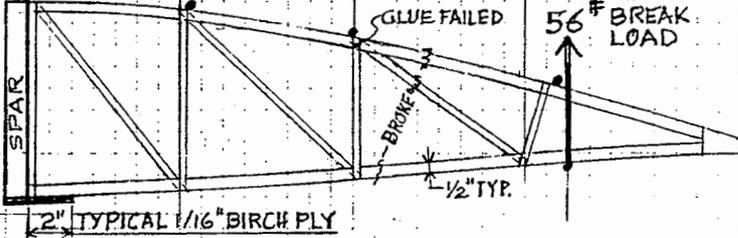
RIB TESTS - 18% AIRFOIL, 50" CHORD = 9" DEPTH - SPAR AT 30% CHORD

CONVENTIONAL TRUSS - 1/4" x 1/4" WEIGHT 3.9 oz. (EPOXY COATED)



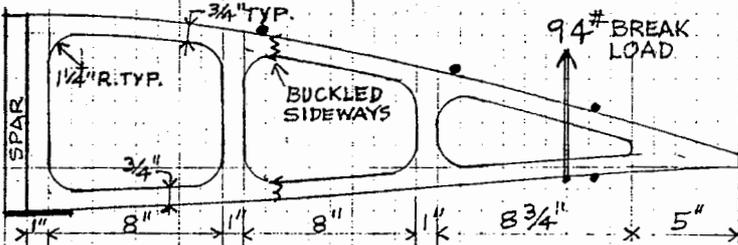
GOOD TEST, BROKE WHERE EXPECTED, (HIGHEST STRESS WHERE TOP CAP HAS MOST BEND). RIB COULD BE STRENGTHENED BY EXTENDING GUSSETS IN 1ST BAY, SHOWN DOTTED LINES). BARE WEIGHT 3.2 oz. GUSSETS WERE 1/8". EPOXY COATING WAS TOO THICK. WITH 1/16" GUSSETS AND THINNER COATING WEIGHT MIGHT BE UNDER 3.5 oz. NOTE DIAGONALS ARE IN COMPRESSION, (REDUCES COMPRESSION IN TOP CAP). RETESTED WITH 1ST BAY TOP CAP REINFORCED, 2ND BAY BUCKLED AT 78#.

TRUSSED PLYWOOD - 1/4" x 1/2" PLY, 1/4" x 1/4" TRUSS - W.T. 4.9 oz. (COATED)



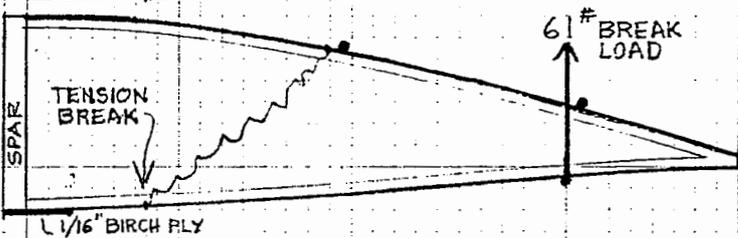
FAULTY TEST - POOR GLUE JOINT. SHOULD NOT HAVE FAILED, ESPECIALLY IN 3RD BAY. RIB IS STRONGER THAN TEST. (WITH TRUSSING ALL ON 1 SIDE, RIB BEGAN TO BUCKLE AT 1/2 LOAD. RIB WAS ALTERED TO PUT DIAGONALS ON OTHER SIDE WHICH IMPROVED IT, BUT THERE WAS STILL INDICATIONS OF UNSYMMETRICAL LOADING). ACTUAL W.T. 4.2 oz. EST. W.T. COATED 4.9 oz. PERHAPS DIAGONALS SHOULD BE IN TENSION (REVERSE DIRECTION). DIAGONALS BENT OUTWARD SEVERELY.)

1/4" PLY CUT OUT - WEIGHT 6.9 oz. COATED



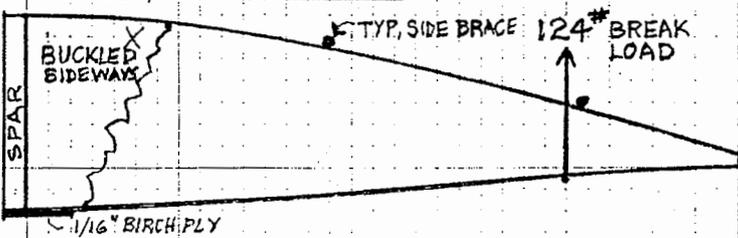
FAULTY TEST - RIB SHOULD BREAK IN 1ST BAY. VENEER WAS POOR AT BREAK. RIB IS STRONGER THAN TEST. ACTUAL W.T. 6.2 oz. EST. W.T. COATED 6.9 oz. RIB MIGHT BE STRONGER IF TOP CAP WAS 1" DEEP AND BOTTOM 1/2" DEEP?

1" FOAM, 1/2" 9oz. F.G. CAPS FOLD OVER SIDE - W.T. 5.0 oz.



FAULTY TEST? RIB APPARENTLY BROKE IN TENSION, PROBABLY BECAUSE FIBERGLASS WAS OVER SANDED. RIB IS PROBABLY STRONGER THAN TEST.

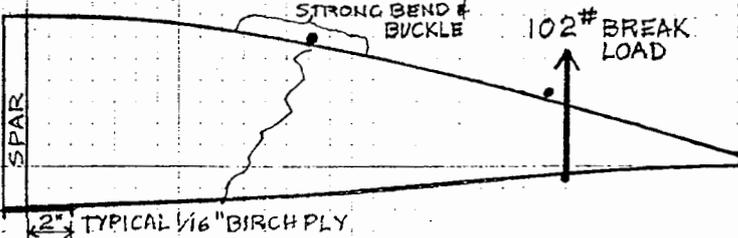
1" FOAM, 1/16" x 1" WOOD CAPS. WEIGHT 4.9 oz.



EXPECTED FAILURE WAS CAPS SHEARING OFF FOAM, BUT RIB FAILED BUCKING. WOULD HAVE BEEN STRONGER IF BETTER BRACED.

GENERAL NOTES:
 1. MATERIALS: WOOD: SOFTWOOD, 1/4" PLY A-C FIR, 1/16" PLY BIRCH. FOAM DOW STYRO. 1.6#/c.f. (STANDARD "BLUEBOARD")
 2. RIB STRENGTH DEPENDS ON TOP CAP BRACING (FABRIC OR PLY. WING COVERING)
 3. RIBS WERE GLUED TO SPAR WITH NO SIDE BLOCKS; ONLY THE 1/16" PLY "D TUBE" LAPPED 2" OVER RIB (BOTTOM ONLY). NO SIGNS OF STRESS AND APPEARS TO BE SUFFICIENT. (IN REAL WING TOP PLY SHOULD ALSO LAP (TENSION WITH NEGATIVE "G") AND WOULD HELP PREVENT BUCKLING)
 4. NO HOLES WERE PUT IN FOAM RIBS AND MIGHT REDUCE STRENGTH; SHOULD BE TESTED

3/4" FOAM, 3/4" x 3/32" WOOD CAPS. WEIGHT 3.8 oz.



LIGHTEST WEIGHT RIB. WOULD HAVE BEEN STRONGER IF BETTER SIDE BRACED (SUSPECT BRACE SLIPPED)

1L 1/11/99

Ian Lea's Rib Test Revision

If you pull out your January-February issue of *Sailplane Builder*, you will remember that Ian Lea shared with us some load test results on six rib types. He has continued some work on this rib testing, and here is how it has progressed, as recorded by notes from Ian to Dan and I:

2/8/99

Janice and Dan: I'm embarrassed to submit another rib test revision (I didn't anticipate another), but I couldn't leave the "1/4 ply cut out" rib with such a faulty test. The re-test was good (though the rib was patched up). Again, not quite comparable to our basic truss rib because I added the top "D tube" overlap.

I can't promise I won't be sucked into another retest, but I'll try to resist it! Ian Lea

2/18/99

Janice and Dan: I'm sorry, I did it again - I was so impressed with the capped foam ribs I had to find the real strength of the 1" capped foam rib, and was rewarded with 131# (I weigh 130# - I could have hung on it!). So, here is another revision. These ribs are so light and strong and easy to make, and these strengths with common 1.6 #/SF blueboard! What strengths could you get with a higher density-stronger foam and slightly thicker caps??

Strength to weight ratio:

Standard wood truss	64#/3.9oz	=16.4 (reinforced - 78#/4oz = 19.5)	
1/4" cut-out fir plywood	123#/6.9oz	=17.8	
3/4" foam with 3/4"x3/22" cap	123#/3.8oz	=32.4	
1" foam with 1"x 1/16" cap	131#/4.9oz	=26.7	Ian Lea

2/22/99

Janice and Dan: I'm sorry, another test, another revision (2/21). Since the 3/32" cap on the 3/4" foam rib didn't tear off easily (which I had expected) the potential of the 1" foam rib hadn't been reached, so I retested with the 3/32" cap, with impressive results: 176# didn't break. I added the hole and it broke at 172#, so a modest size hole near the spar does reduce the strength (could be easily reinforced with fiberglass).

The 1" thick ribs are noticeably stiffer sideways than the others, with much less tendency to buckle. The top "D" tube ply overlap also stiffens, so the truss ribs tested without the top ply were not strictly comparable (although the traditional truss rib was retested to 78# with the 1st bay reinforced, as noted).

I have removed "faulty test" notes, where retested. I also note these are unusually deep ribs for sailplanes, shallower ribs would have higher stress, but the test loading is extreme (1 point load, 3/4 out from spar) which should compensate. I also added the strength weight ratios.

I still find these foam ribs remarkable with such a weak foam. I can think of two possible weaknesses: (1) top fabric is pulling directly up on the relatively weak foam to wood bond, which under stress may lead to earlier compression failure, and (2) rough handling, knocks, could create local failure, leading to above failure. That's where the fiberglass caps, lapped over the sides would be superior. Sorry I had an apparently faulty test. (Fiberglass caps are almost as easy to build as the wood caps.) (By the way, these last ribs were cut out on a table saw, freehand, with a small blade. This wouldn't work with a pronounced trailing edge cusp). Anyway, I hope this may be useful to the readers. Final apologies, for sending so many revisions. Ian Lea

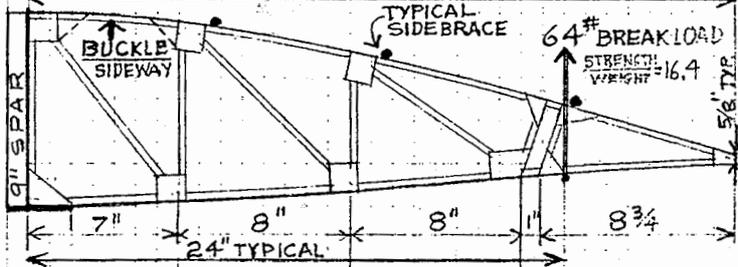
Editor's Note:

So, there you have it! Thanks so much, Ian, for sharing not only the test results, but the process with us. On the next page is the final version (we think) of Ian's Rib Tests.

RIB TESTS - 18% AIRFOIL, 50" CHORD = 9" DEPTH - SPAR AT 30% CHORD

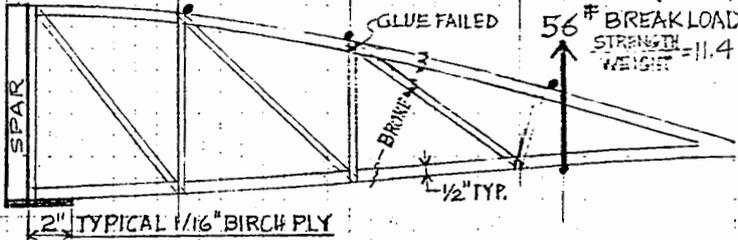
SCALE 1/2"=1"

CONVENTIONAL TRUSS - 1/4" x 1/4" WEIGHT 3.9 oz. (EPOXY COATED)
32 3/4"



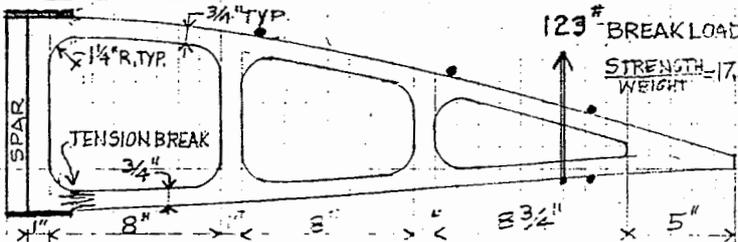
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2ND TEST: WITH 1ST BAY TOP CAP REINFORCED, 2ND BAY BUCKLED AT 78#. STRENGTH=19.5 WEIGHT

TRUSSED PLYWOOD - 1/4" x 1/2" PLY, 1/4" x 1/4" TRUSS - WT. 4.9 oz (COATED)



FAULTY TEST - POOR GLUE JOINT, SHOULD NOT HAVE FAILED, ESPECIALLY IN 3RD BAY. RIB IS STRONGER THAN TEST. (WITH TRUSSING ALL ON 1 SIDE, RIB BEGAN TO BUCKLE AT 1/2 LOAD. RIB WAS ALTERED TO PUT DIAGONALS ON OTHER SIDE, WHICH IMPROVED IT, BUT THERE WAS STILL INDICATIONS OF UNSYMMETRICAL LOADING). ACTUAL WT. 4.2 oz. EST. WT. COATED 4.9 oz. PERHAPS DIAGONALS SHOULD BE IN TENSION (REVERSE DIRECTION). DIAGONALS BENT OUTWARD SEVERELY.)

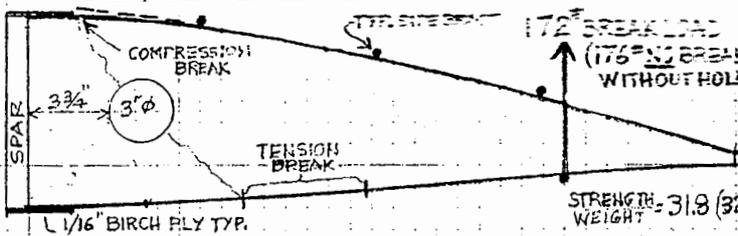
1/4" PLY CUT OUT - WEIGHT 6.9 oz. COATED EST.



GOOD TEST - ACTUAL WEIGHT 6.2 oz. NO APPARENT DEFECTS IN PLYWOOD AT BREAK. LARGER RADIUS AT BREAK SUGGESTED?

NOT ILLUSTRATED: 1" FOAM WITH 1/2" 9oz. FG. CAPS FOLD OVER SIDES. WT. 5.0oz. BROKE IN TENSION 6" FROM SPAR AT 6#. BELIEVE FIBERGLASS WAS OVERSANDED.

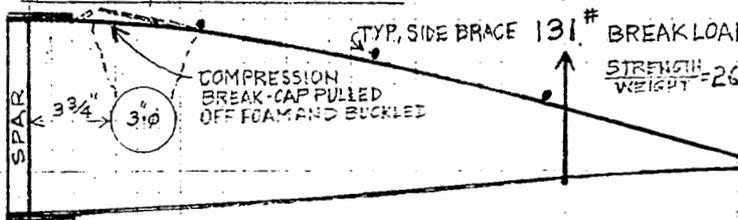
1" FOAM 3/32" x 1" WOOD CAPS WEIGHT 5.4 oz.



GOOD TEST. 1ST TEST NO HOLE, HELD 176# FOR OVER 30 SEC. WITHOUT BREAK. ULTIMATE STRENGTH UNKNOWN. 2ND TEST HOLE PLACED, BROKE AT 172# NOT KNOWN WHETHER TENSION OR COMPRESSION INITIATED FAILURE. SUSPECT COMPRESSION. MODERATE SIZE HOLE NEAR SPAR DOES AFFECT STRENGTH.

(1/2 oz. ADDED TO CAPS INCREASED STRENGTH FROM 131# (SEE NEXT RIB) TO 172#.) 1" THICK FOAM WITH CAPS IS CLEARLY STIFFER SIDEWAYS THAN OTHER RIBS (RESISTS BUCKLING)

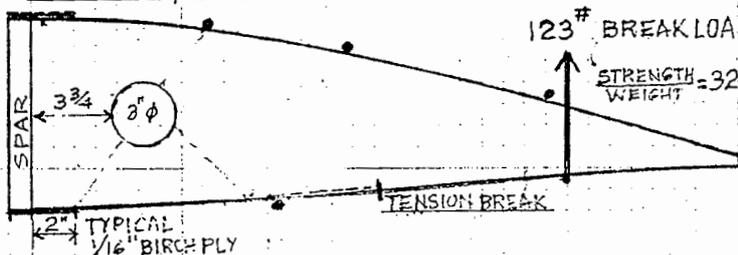
1" FOAM, 1/16" x 1" WOOD CAPS WEIGHT 4.9 oz.



GOOD TEST - AS EXPECTED, COMPRESSION CAP PULLED OFF FOAM & BUCKLED. HELD LOAD ± 30 SEC. BEFORE FAILURE.

GENERAL NOTES:
1. MATERIALS: WOOD - SOFTWOOD, 1/4" PLY: A-C
R. 1/8" PLY - BIRCH. FOAM: DOW STYRO.
1.5#/C.F. (STANDARD "BLUEBOARD")
2. RIB STRENGTH DEPENDS ON TOP CAP BRACING (FABRIC OR PLY, WING COVERING)
3. RIBS WERE GLUED TO SPAR WITH NO SIDE BLOCKS; ONLY THE 1/2" PLY "D" TUBE LAPPED 2" ON RIB (BOTTOM ONLY, TRUSS RIBS) NO SIGNS OF STRESS AND APPEARS TO BE SUFFICIENT. (TOP OVERLAP STIFFENS RIB.)
4. TEST RESULTS VERY CONSERVATIVE IN COMPRESSION AS SIDE BRACE WIRES WERE GUYED DIAGONALLY BACK TO SPAR. INCREASING COMPRESSION AS LOAD WAS APPLIED.
5. THIS IS AN UNUSUALLY DEEP RIB. THE STRESS WILL BE HIGHER IN A SHALLOWER RIB (AND SHOULD BE TESTED) HOWEVER, THE TEST LOADING IS SEVERE (POINT LOAD 3/4 OUT) SHOULD COMPENSATE.

3/4" FOAM, 3/4" x 3/32" WOOD CAPS WEIGHT 3.8 oz.



GOOD TEST. HELD 121#, BROKE 123#

1L 1/1/99 REV. 1/13 REV. 2/3 REV. 2/5 REV. 2/18 REV. 2/21