Radio Controlled
# Soaring Digest
September 2010 Vol. 27, No. 9

# CONTENTS

**September 2010**

**Vol. 27, No. 9**

**Front cover:** Ren DiLeo's 1/4 scale Schweizer 1-26 in flight over the beach at Torrey Pines California.
For further information and more photos, please see pages 16 through 18 of this issue.
Photo courtesy of Ren DiLeo.
Olympus E-300, ISO 100, 1/500 sec., f8.0, 150mm



**Back Cover:** Mark Southall flying his Ascot during a F3F practice session at Rhossili Point, South Wales (GB). Rhossili is located at the most Western part of the Gower Peninsula. The slope is one of the most beautiful slopes I have seen. Coastal, for west wind direction, and the view is superb! Photo by Pierre Rondel.
Canon PowerShot A650 IS, ISO 80, 1/500 sec., f6.3

# R/C Soaring Digest

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# In the Air

As many readers likely know, all three of the US Junior F3J Team members (Brendon "Dippin' Dots" Beardsley, Michael "Chainsaw" Knight and Connor "Stealth" Laurel) are members of the Seattle Area Soaring Society and all made it to the finals of the F3J World Championships. The team placed first in the Junior standings and Brendon won the First Place Junior trophy as an individual. This past Wednesday night, the 18th, local Seattle TV Channel 5 came out to 60 Acres and spent about four hours interviewing the trio for an upcoming edition of *Evening Magazine*.


Karin Corea-Laurel

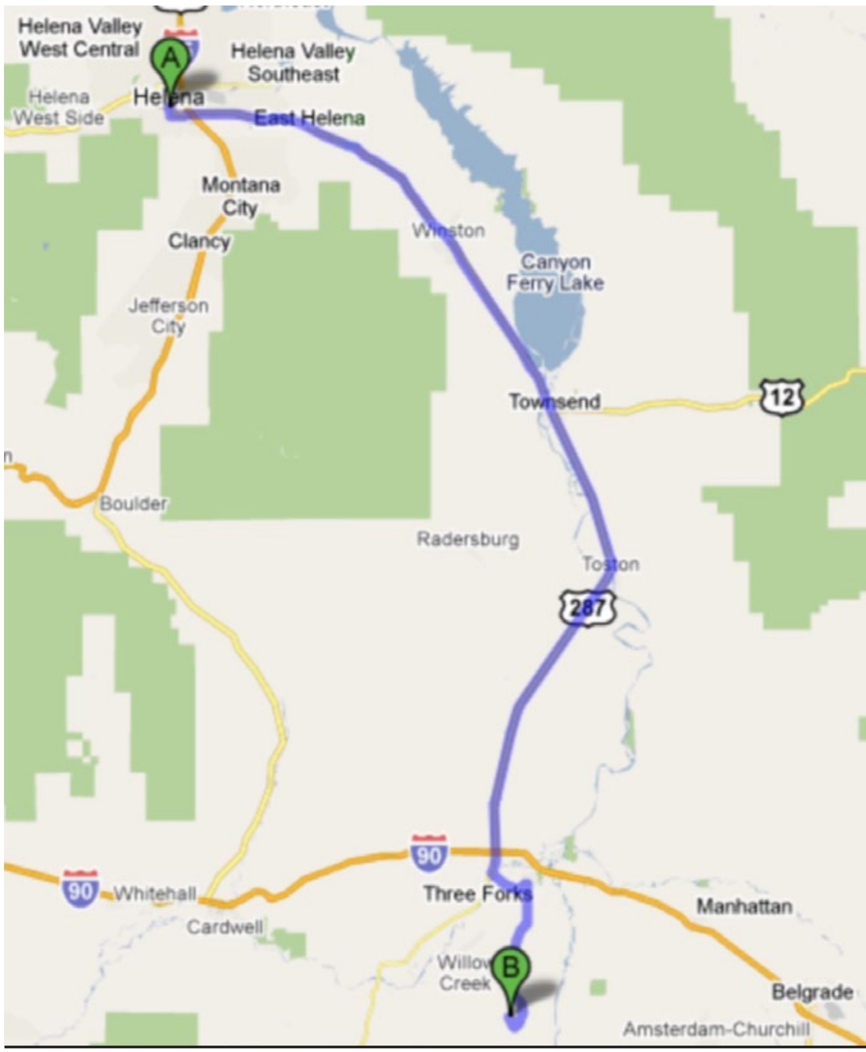
On August 3rd the *RCSD* Yahoo! Group marked a milestone when member #2000 signed up. The group currently has 2005 members and is the largest of 691 within the category Hobbies Crafts>Models>Radio-Controlled.

And a final reminder... Please note the *RCSD* email address is now <rcsdigest@centurytel.net>.

Time to build another sailplane!

# TABLE TOP

## A Montana Slope Soaring Adventure




In January of this year I received an email from Arlen Tofslie. He had visited my website and noticed that I live in Helena Montana. He lives a few hours east in Paradise Valley which is south of Livingston. He and his two brothers, Wayne and Tracy, who are also avid R/C pilots, have been flying for many years at a slope site south of the town of Three Forks. The official name of the place is Platte Mountain, but it's called Table Top by the locals. Arlen thought perhaps some folks from the Helena area would like to meet them there for some slope soaring. Winter, as it is in Montana, kept me from going to the slope for quite some time, but in July I was finally able to make the short trip.

I put out a call to my flying buddies to let them know that I was going slope soaring. Jim Loughrin, Joe Longmire, Ken Stewart, Chip Baber, his kids Mikalae and Robbie and a young man visiting from Arizona, Cody Kuntz, were able to make the trip, too.

I've flown on a lot of slopes in the last 22 years, from California and Oregon to Denmark and Germany; but none were quite like Table Top. The best part of this particular slope is the feature that gave it its name. The entire top of the mountain is a huge flat landing area, and I mean really huge! You could land a Learjet there! So having to repair crashed models due to rough landings is rare. Also, if the wind doesn't blow, bring a winch, hi-start or DLG. Any type of glider flying can be done in the knee high grasses on top.

So please join me as I travel to Table Top for my first slope soaring adventure in the great state of Montana.

*Courtesy of Google Maps*

*Here's a view of the north and northeast slopes*

I left about 40 minutes later than planned. That's just how it goes some mornings! I drove east on Highway 287 out of the Capital of Montana. This is a beautiful easy two lane drive with a 70 mph speed limit. Just a little ways out of town you get a beautiful view of Canyon Ferry Lake on the left. This is actually the Missouri river but there are many, many dams making lakes as the river meanders its way to the Mississippi. The first town along the route is Townsend. It's a small little town with very nice people, a few small shops, and good restaurants.
I saw a bunch of antelope along the highway prior to town, and as is usually the case, when you see one antelope you see twenty! Leaving Townsend the drive takes you by large farm fields and along the Missouri river, to soon arrive at another small town called Tosten. There the road crosses the Missouri and turns south, leaving the river behind until arriving in Three Forks, which is the last stop that has any facilities such as gas, food, hotels and bathrooms!

Table Top is eight miles south of the town of Three Forks down a very well maintained dirt road. I easily drove 45 mph till making the final climb up the hill for the last mile or so. On the way, I stopped where a pickup truck was parked along the road. I met a nice retired couple who I chatted with for a bit, and discovered that they were bird watching. They commented that the Three Forks area is the headwaters of the Missouri, consisting of the Gallatin, Jefferson and Madison rivers. This is a wonderful area with lots of wildlife, fishing, hunting and bird watching. However, so far they hadn't seen the type of birds they'd hoped to view. As I continued my drive south the slope easily comes into view.

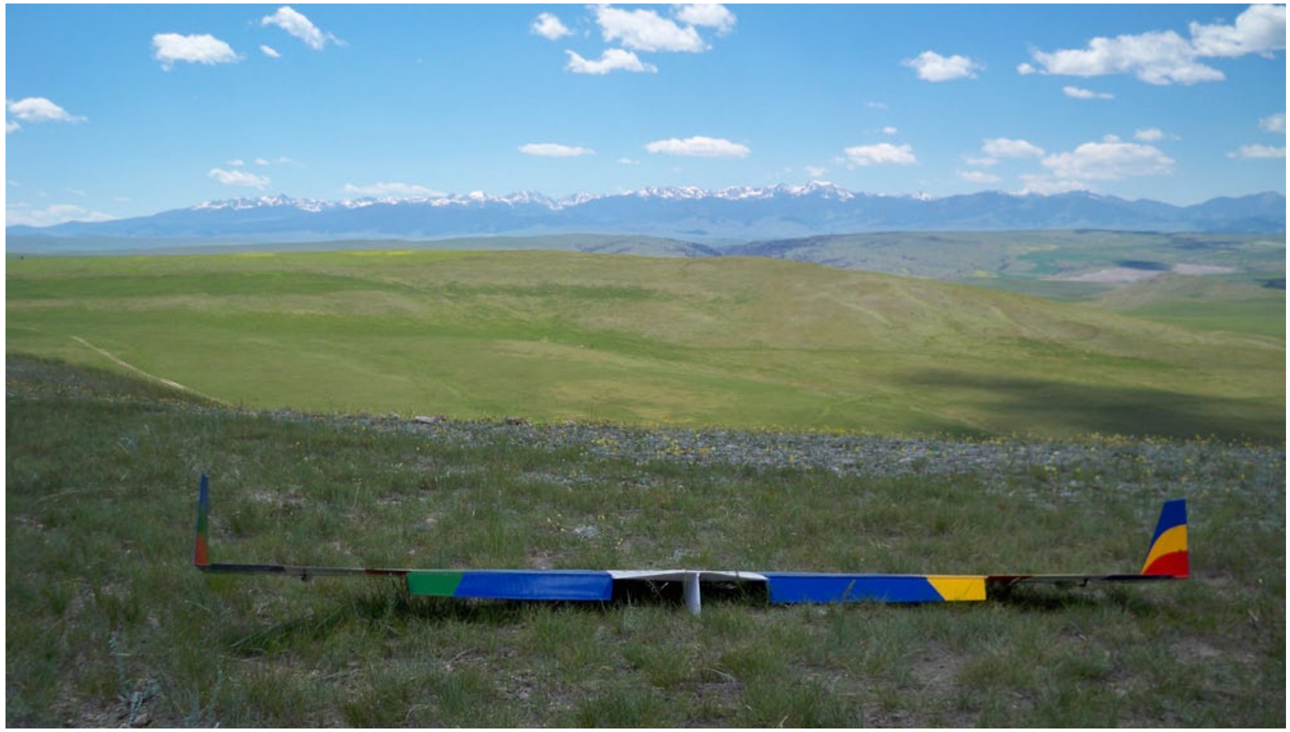
When I found my way to the top of the hill Jim, Ken, Joe and Wayne were already there, but no one was flying as the wind was about dead calm. I introduced myself to Wayne and greeted my friends from Helena. Since the wind was barely blowing I grabbed my Phantom DLG, which is my scratch built SuperGee II of sorts, and caught some nice thermals. Soon afterwards the wind picked up a bit so I put together my Art Hobby Fantasy III glider. This is a motor glider that allows me to test the lift as the motor gives me some insurance if lift isn't present. I threw it off the hill and had a great time with it. High speed runs across the face of the hill, loops, rolls and beautiful stall turns. So on this day the motor was not necessary.

The wind really started to pick up consistently now, probably 20 mph or

Chip Baber's fleet of planes


Author's Simprop Sagitta

*Author and Cody's first slope experience*



*Tinamou*

more. Chip showed up with his daughter, son and Cody and a whole bunch of planes. I have no idea how he got all of it in his SUV.

I put my Simprop Sagitta together and threw it off the hill; and this hill was made for the Sagitta. Fun! Chip flew it for awhile and I could tell he really enjoyed it, too. It was great watching him think through the model's capabilities. I could tell he was testing the model's capabilities as he slowly worked his way up to some awesome aerobatics. He really seemed to be in his own element on the slope.

I relaunched the Fantasy glider and let Cody fly it. He is a competent 3D foamie pilot, but had never flown a glider on the slope. He had a nice time, but I could tell it didn't quite give him the adrenalin rush he was used to.

I took a short break for a little lunch and watched Jim fly his Manta flying wing from Icare-RC, then I put together Tinamou.

I was a little nervous about her first flight on the slope. She flies fine off the hi-start, and thermals fairly well, but I was a little concerned about the structure. Would the spar system and wing be torsionally strong enough for hi-speed flight? I didn't want to destroy this beautiful model. However, there is no way I would be able to fly her on the slope without a few high speed passes. Chip launched her for me and she immediately gained 20 feet and off we went!

*This page and opposite: Tinamou in flight.*

Mikalae and her Katie II

Chip and his daughter

I was flying a little too slowly for the first few minutes and she just mushed around the sky. Then I trimmed a little nose down and she really began to pick up speed and fly much better. How much better? Phenomenally well! I have to tell you this is one fine model for the slope. You can't just bang the sticks from one side to the other, but if you just let her gracefully carve turns around the sky she flies like a dream. I think she looks great in the huge Montana sky!

I did loops and stall turns with her but somehow I don't think I performed any rolls. Hmm, I guess I was having too good of a time and forgot to do that. I couldn't resist not performing a hi-speed

*Opposite page:*
*Wyoming Wind Works Slope Monkey*

*The Spider-Sixty after landing. What a great area to land!*

*Robbie Baber having fun!*

pass so I pitched the nose down into a vertical dive across the front of the slope. Not only was she fast and smooth but the lack of wind noise was amazing. This is one clean model. Best of all, there was no flutter. The spar setup I was worried about worked perfectly! Thanks to Herk Stokely for helping with the structure when I was building her a few years ago. Landing was a cinch with those big barn door flaps. I really enjoyed flying Tinamou, more so on the slope than the flat land. This is the element she was built for.

I also enjoyed watching Chip train his daughter, Mikalae, to fly their Bob Martin/Dynaflight Katie II. They have had bad luck in the past with minor mishaps but this time they had an awesome experience. The photos on page 11 say it all; look at the smile on her face!

Wayne's Spirit Elite camera plane

*From left to right; Joe, Jim and Ken making an adjustment.*

*Joe and his relaxed flying style with Jim looking on.*


*Oh, yeah!*

Chip spent a lot of time flying his Slope Monkey, from Wyoming Wind Works, and his molded glass slipper, the Spider-Sixty, from Soaring USA. Chips son didn't fly, but as you can tell, he was having a great time!

Wayne flew off and on most of the day and he was an excellent host. He's a competent pilot, too. He really enjoyed his camera mounted Great Planes Spirit Elite. His brother Tracy had to work, but was able to come up later in the day. He introduced himself and flew some of his brother's and Chip's models. Arlen wasn't able to make it; I hope to get to meet him on my next trip to Table Top.

Ken is new to slope soaring but had a great time flying his Multiplex Easy Star. Joe flew his Pulsar from Esprit Models and a Carl Goldberg Gentle Lady.

The day was getting long and folks were starting to pack up and head home. So, I took the Sagitta out for one last flight. The wind was blowing over 40 mph and the lift was very smooth. I had the sky to myself and really turned in some great aerobatics. I just existed in my own little world for about twenty minutes. It was real nice to disconnect from everyday life for while.

Table Top can be a mixed bag of all things, depending on the season. You can find snow, very cold temperatures and high winds. On the rare occasion, you might find a snake too. However, on this July day it was warm, sunny and just perfect!

Thanks to all the folks who made my first trip to Table Top a fantastic adventure, and to the Tofslie brothers for inviting us to join them. The Helena gang is sure to return soon.

If you're ever in Montana please don't hesitate to look up one of the "Montana Slopers." We have a thread on RCGroups Forum called just that, here's a link; http://www.rcgroups.com/forums/showthread.php?t=797605

We would enjoy meeting you at this most fabulous of soaring sites.

Oh, and if you are addicted to your cell phone devices please don't worry; all those antennas on top will give you excellent service!

Photos are courtesy of myself, Chip and Mikalae Baber, Joe Longmire and Arlen and Wayne Tofslie.

Curtis Suter
<http://www.TailwindGliders.com>
suterc@msn.com

## Sources:

Tinamou — I wrote a build article for Tinamou in the April 2008 issue of *RCSD*, here's a link:
<http://www.tailwindgliders.com/Files.html#Articles>
Plans are available. Email me and I'd be happy to supply a copy for free.

*Opposite page: Author's Sagitta*

# More about the plane on the cover

Here are a few photos of my new 1/4 scale Schweizer 1-26 flying at Torrey Pines yesterday, August 8th.

This model uses a glass fuselage with laser-cut built-up wings flying a Clark Y airfoil for good lift and scale flight.

The tail feathers are also laser-cut and assembly is quick and builds to a light strong structure.

I used Hitec 225 servos for ailerons and HS 85s for spoilers. And of course a Premier Pilot! All up weight is 9 lbs.

I have also had Propag, based in the Czech Republic, make scale instrument panels specifically for this Schweizer.

Ren DiLeo, rdent4885@sbcglobal.net

*One of Ren's Premier Pilots <http://www.premierpilots.net/> is in the cockpit, adding to the realism.*



*Above: Flying over Torrey Pines Beach. This photo was taken directly after the image on the cover of this issue.*

*Left: The very detailed Propag 1-26 instrument panel.*

*In recent weeks I've been flying the old Craftaire Sailaire, a 12 foot ship from several centuries ago. These days are warm, with low wind speed and plenty of lift so the Sailaire is in its element. The ship runs 1800 ma flight packs with the solar cells to charge them in flight and on the ground so I only have to worry about the transmitter battery. That is cycled to provide just under two hours of airtime and has an external dry-cell pack ready to plug into the earphone type jack on the transmitter case. With a good chair, some sun screen and an iPod it makes for a wonderful afternoon.*

*I also fly a 12 foot version of the Northeast Sailplanes Kestrel which is modified to include full wing sheeting and a flying stab. It weighs a bit more than the Sailaire but is about twice as fast. It also has flaps so that descent from great height isn't a problem. It also carries a big battery but has no solar cells and no way to plug an external battery into its transmitters. I generally try to keep flights with the Kestrel to about an hour.*

*The two ships have one thing in common. Due to their wing area and dead weight, they really load down the winch. The winch battery is a Marine type of about 650 cold cranking amps with 170 pound line on the standard size drum. While I rarely break a winch line the motor of the winch would bog down as the ship rotated into the nose-high position. It wouldn't completely stall the motor but the loss of winch speed made it necessary to to add some down trim so the launch angle would reduce the winch stress.*

# Re-engineering a Sailplane Winch

by Pete Carr WW3O, wb3bqo@yahoo.com

There are all sorts of dynamics that enter into a winch launch. The ship is going from a dead stop to cruise speed plus a factor of 1.5 to 2 while on tow. Its launch angle provides a variable drag coefficient which also varies at the square of the speed. The power factor applied to the ship is a variable caused by the pilots speed and duration of the pulses applied to the winch pedal as well as the amount of stretch stored in the line at any given moment. A big sailplane like the Sailaire is a poster child for these dynamics and will work the winch to its absolute limits if there is any head wind at all.

The Kestrel is heavier but cleaner. That makes it harder to throw, which forces the winch to assume a greater load just after the throw. I also trim the ship down somewhat so the launch angle isn't so extreme but it still rotates faster and will bog down the winch sharply.

The good news is that just about any reasonable launch will get the ships high enough to find climbing air and allow the winch to cool down and rest the battery.

That really wasn't good enough.

I decided to do some research on launching heavy/large sailplanes and to modify my winch based on the info. It was also time to solve some niggling little problems that had detracted from the fun of flying with the winch.

The Little Big Winch web site offered am interesting bit of data which said that the average 70 ounce Unlimited sailplane would use about 1 Ampere-hour of battery capacity per launch.  The Sailaire weighs in at 112 ounces. In addition, the total area of the ship is about three times the area of those skinny, slippery F3J types.

The normal winch launch is where the turnaround is placed at around 300 meters from the winch where I stretch mine out to over 600 meters. That means that each launch is of longer duration. It would be a nearly impossible task to get the Sailaire to top height in less that 60 seconds and the winch would be working hard the entire time.

Then there is the human factor. The winch is about 40 pounds of dead weight with the motor on one side so it's not easy to carry. The battery is about the same size as a car battery and has a carrying handle. It weights about 25 pounds. I try not to carry these two items very far but still have to lift them in and out of the van, both at home and at the field. The problem of weight was a major component in the search for a better launch.

I briefly toyed with the idea of going to higher voltage. You "experienced" pilots who flew in the '60s and '70s may remember using a 12 volt motor with a 6 volt battery to keep from tearing the wings off the sailplanes. I thought about reversing that idea to go to 24 volts with two batteries in series. That would have shredded my ships in a hurry!

Then I decided that the real problem was the sag in winch speed caused by a lack of battery current. There were larger batteries available but they all weighed about double the one I was using. In addition, there were no carrying handles on them. As a matter of fact, Marine batteries are being made now without handles. too. I asked about that and the store clerk said that straps and handles were a legal liability issue.

In the end I decided to use a second battery, with a handle, of the same ampere-hour capacity, and run it in parallel with the main battery. That meant building a cable harness that would connect the two batteries together. I found some number 4 cable which is fairly stiff. A friend who does welding mentioned some flexible cable he used for arc welding but couldn't locate a piece. I went to the auto parts store and bought some copper terminals and soldered them onto the cable ends. I then shaped the cable into the span of the battery terminals and used tie-wraps to secure them together. The idea is that, when hooking the cables to one battery, the other ends won't short together and ruin my day.

The other niggling problem with the winch was the method of staking it to the ground so the Sailaire wouldn't pull it down the field. I'd originally used enormous nails about 10 inches long placed through holes in the winch baseboard and pounded into the ground. Many winches use this method and it's tough to get it aligned so the line winds onto the drum smoothly. I finally used a length of rope which was tied onto the nail holes at the rear of the winch. Then I made a loop in the middle of the rope using a tie-wrap that would pass a single nail. Once the winch is aligned so the line winds on straight, I nail the rope into the ground and the winch stays put.

There are many ways to determine the quality of connections in high current applications. I disregarded them all and went flying.

After a typical Sailaire launch I touched the individual terminals on the winch looking for hot spots. There were none. A poor connection with high resistance would have heated up in a hurry but they were all cool to the touch. I do cheat a little by using DEOXIT, a contact enhancer, on them about once a month. It's great stuff and I've mentioned it before for the joints of telescoping antennas on transmitters.

The acid test was to launch the Sailaire and see if the winch bogged down as before. It didn't! The big ship now launches the same as a skinny 3 meter bird and I've taken out the down trim. The Kestrel has similar results. The increase in the available current reserve was the key to great big ship launches. Each battery weighs the same so I can pick them both up and be "balanced." The cable harness stays with the winch in the vehicle and is no bother to use.

The real benefit is the increase in launch height from this arrangement. The Sailaire does seem to bow the wings a little more but the ancient wing rods hold the load and I get higher. The Kestral also goes higher and the launch speed is higher so the ping/zoom is higher as well.

On those days when I want to fly the “small” stuff of only 3+ meters and 3 pounds in weight, I can take a single battery and launch as before. When flying with friends I can leave the second battery in the vehicle for a spare or hook it up if they are flying big hardware. Either way, it makes the chore of dealing with the winch a lot less work.

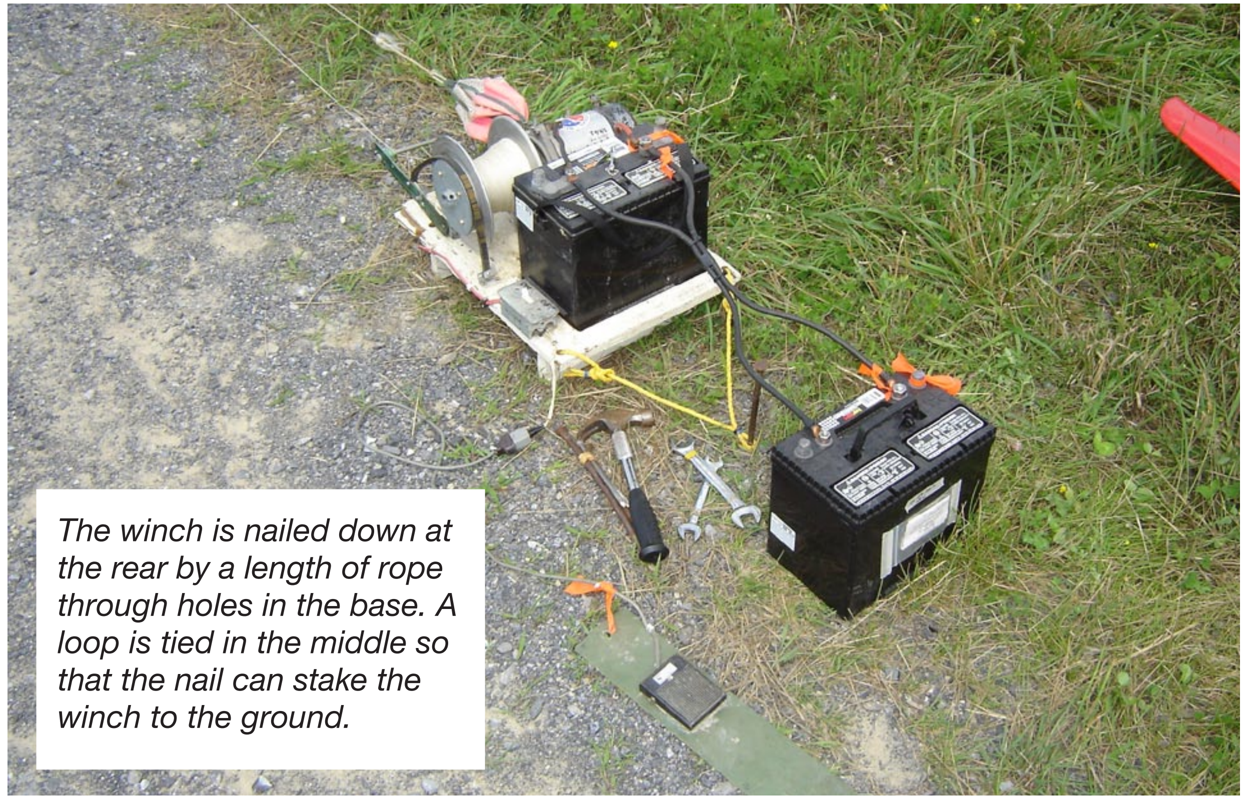
Resources:

<http://theshop.net/store>
winches for sale and accessories.

<http://www.irfmachineworks.com>
home of the Little Big Winch.

<http://www.bayrc.com/mccan_winch.htm>
good info about winches.

<http://www.deoxit.com>
a red liquid that reduces contact resistance.

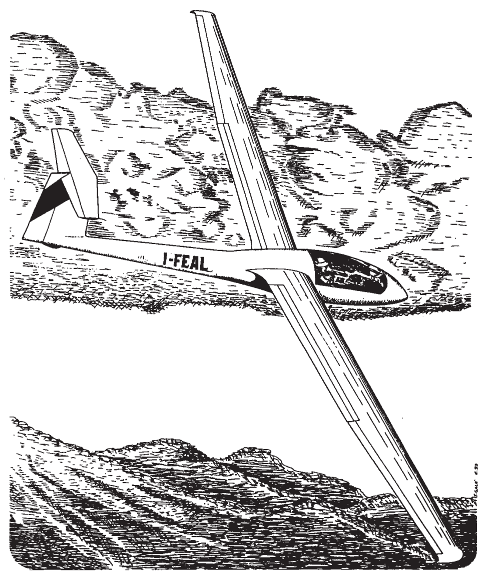


*The winch is nailed down at the rear by a length of rope through holes in the base. A loop is tied in the middle so that the nail can stake the winch to the ground.*

*The winch and two batteries are ready to launch. The cables between the batteries are long enough to allow the rope to stake the winch to the ground. The foot pedal is mounted to a piece of radio fiberglass circuit board which is can also be nailed to the ground.*

Chris Adrian's SG-38 in flight. This is an incredibly realistic model, complete with cabling, pulleys and turnbuckles, linen-like covering, and realistic pilot. Photo courtesy of John Godwin. Nikon D5000, ISO 200, 1/640 sec., f13, 55mm

# SCALING SAILPLANES




Ferdinando Galè

## SCALING SAILPLANES

Aeromodeling, if one defines it as the design, construction and flight of aircraft models, preceded full size aviation in the history of mankind. Many aviation pioneers were builders of model airplanes before becoming builders of full size flying machines.

Once aviation had been born and was being developed, aeromodelling followed its progress, step by step, taking advantage from time to time of anything which could be adapted to the construction of flying models.

Airfoil sections used for airplanes and gliders during the period from 1900 to about 1950 have been used for decades in the construction of model airplanes. Some of them are still used, such as the thin airfoils, with great camber, adopted for use in some free flight models. If one looks at them with a critical eye, one finds that their profiles, often presented as novelties, are either elaborations of sections from World War I aircraft, or derived from the study of bird wing profiles.

Airfoils used for the wings of sailplanes can be referred to as being from one of two grossly different periods. The first period begins with the pioneering times of aviation and extends through World War II, while the latter begins in the early 1950's and continues to the present day.

During the first period, as it appears from TABLE 1 (page 2), airfoils with large camber of the mean line and hefty thickness, up to 20% in some cases, were predominantly used. A well-rounded nose helped in smoothing and delaying the stall. See the photograph on the page 17 for an example of this type of section. Almost all such airfoils were developed at the Göttingen Aeronautical Laboratory in Germany, or were derived from those. Thin airfoils, with thicknesses below 12%, were seldom used. The D-28 Windspiel (1932), Habicht (1936), and SO-P1 (1940) are exceptions to the general rule of the time.

After World War II, laminar airfoils started to be used. Their laminar boundary layer extended up to 40% of the wing chord. Laminar flow airfoils were developed both in the United States by NACA, and in Germany at Göttingen and Stuttgart. The Wortmann FX series serve as examples. See TABLE 2 (page 3).

1

Originally published as part of *Sailplanes!*,
a book by Ferdinando Galè and Aldo Calza

Also available as a standard format downloadable booklet
<http://www.rcsoaringdigest.com/pdfs/ScalingSailplanes.pdf >

TABLE 1

*SAILPLANE AIRFOILS*/PROFILI ALIANTI
[*Before WW II*/Prima della II Guerra mondiale]

| | | |
|---|---|---|
| 1921 | VAMPYR | Goettingen 441 |
| 1922 | DARMSTADT D-9 KONSUL | Goettingen 535 |
| 1923 | DARMSTADT MARGARETE | Goettingen 533 |
| 1926 | DARMSTADT D-1 | Goettingen 535 |
| 1927 | DARMSTADT D-2 | Joukowsky |
| 1928 | PROFESSOR | Goettingen 549 mod. |
| 1929 | WIEN | Goettingen 549 mod. |
| 1930 | FAFNIR 1 | Goett. 652-535, Clark Y |
| 1930 | CW-5 | Goettingen 652 |
| 1930 | TERN | Goettingen 549 |
| 1930 | BOWLUS ALBATROSS | Goettingen 549 |
| 1931 | FALKE | Goettingen 535 mod. |
| 1931 | GRUNAY BABY 1 | Goettingen 535 |
| 1931 | GOLDEN WREN | Goettingen 535 |
| 1931 | AUSTRIA | Goettingen 652 |
| 1931 | SPYR | Goettingen 535 |
| 1931 | M-22 | Goettingen 535 |
| 1932 | STAKHANOVETS | TSAGI R-III [15.6% - 13%] |
| 1932 | FVA-10 B RHEINLAND | Joukowsky 433, Goett.532 |
| 1932 | SG-3 | WARSAW 192 |
| 1932 | SCUD 2 | Goettingen 535 |
| 1932 | RHOENADLER | Goettingen 652 |
| 1932 | CONDOR 2 | Goettingen 532 |
| 1932 | D-28 WINDSPIEL | Goettingen 535 [10% - 8%] |
| 1933 | D-30 CIRRUS | NACA 2414-4412 |
| 1933 | HUETTER H-17 | Goettingen 535, NACA M-6 |
| 1933 | FAFNIR 2 SAO PAULO | DFS Special |
| 1933 | KOMAR | Goettingen 535-549 |
| 1933 | MOAZAGOTL | Goettingen 535 |
| 1933 | RHOENBUSSARD | Goettingen 535 |
| 1934 | MÜ-10 MILAN | Scheibe |
| 1934 | HJORDIS | Goettingen 652, RAF 32 |
| 1934 | GN-7 | Goettingen 549 |
| 1935 | SGS 2-8 TG-2 | NACA 4412 |
| 1935 | SCUD 3 | Baynes |
| 1935 | RHOENSPERBER | Goettingen 535-409 |
| 1935 | WOLF | Goettingen 535 |
| 1935 | GÖ-3 MINIMOA | Goettingen 681-693 |
| 1935 | KIRBY KITE | Goettingen 535 |
| 1935 | KRANICH | Goettingen 535 |
| 1935 | MOSWEY | Goettingen 535 |
| 1935 | MU-13 ATALANTE | Scheibe |
| 1935 | HUETTER H-28 | Joukowsky |
| 1936 | SG-3 bis/36 | Goettingen 549 |
| 1936 | SPERBER SENIOR | Goettingen 757-767 |
| 1936 | SPERBER JUNIOR | Goettingen 535-409 |
| 1936 | MINIMOA 38 | Goettingen 681-693 |
| 1936 | KADET | Goettingen 426 |
| 1936 | HABICHT | Clark Y |
| 1936 | SALAMANDRA | Goettingen 387 |
| 1936 | ZANONIA | NACA 2418-2412 |
| 1936 | REIHER | Goettingen 549-676 |
| 1937 | KING KITE | NACA 23021-4415 |
| 1937 | BABY ALBATROSS | Goettingen 535 |
| 1937 | KIRBY GULL | NACA 4416, RAF 34 |
| 1937 | SPALINGER S-18 | Goettingen 535 |
| 1937 | GOLDEN EAGLE | Goettingen 535, Clark YH |
| 1938 | KIRBY PETREL | Goettingen 652, Clark YH |
| 1938 | SUPER ALBATROSS | Goettingen 549 |
| 1938 | GÖ-4 GOEVIER | Joukowsky |
| 1938 | WEIHE | Goettingen 549, NACA M-12 |
| 1938 | VIKING | Goettingen 535 |
| 1939 | PELLICANO | NACA 24 [Series] |
| 1939 | MEISE | Goettingen 549-676 |
| 1940 | SO-P1 | SNCASO Special |
| 1941 | PRATT-READ G-1 | GS-4, GS-M, GS-1 |
| 1941 | YANKEE DOODLE | NACA 4418-4409 |
| 1942 | LK-10 A | NACA 4413-4409 |

2

TABLE 2

*SAILPLANE AIRFOILS*/PROFILI ALIANTI
[*After WW II*/ Dopo la II Guerra mondiale]

| | | |
|---|---|---|
| 1951 | KRANICH III | Goettingen 549 |
| 1951 | BERGFALKE II | Muenchen 14% |
| 1952 | BOCIAN | NACA 43018A-012A |
| 1952 | LO 100 | CLARK Y |
| 1953 | HKS I | NACA 65 -714 |
| 1955 | HKS III | NACA 65 -1116 |
| 1955 | Ka 6-E | NACA 63 -618,614 mod. |
| 1956 | BLANIK | NACA 63 -615A |
| 1957 | ZUGVOGEL | NACA 63 -616/614 |
| 1957 | PHOENIX T | EC 86(-3)-914 |
| 1957 | Ka 7 | Goettingen 535/549[mixed],532 |
| 1958 | ZEFIR | NACA 65 -515 mod. |
| 1958 | Ka 8-B | Goettingen 533[16,7%]-532 |
| 1958 | AUSTRIA STANDARD | NACA 65 -416 |
| 1959 | SB 5-B | NACA 63 -618 |
| 1960 | FOKA 4 | NACA 63 -618-4415 |
| 1961 | VASAMA | WORTMANN FX 05-188 [14%] |
| 1961 | SB-6 | STE 871-514 |
| 1962 | SB-7B | FX 62-163[over]/E 306 [under] |
| 1962 | BS-1 | EPPLER 348-K |
| 1964 | DARMSTADT D-36 | WORTMANN FX 62-K-31,60-126 |
| 1964 | PHOEBUS B-1 | EPPLER 403 |
| 1964 | LIBELLE H-301 | HUETTER |
| 1965 | ASK 13 | Goettingen 535-539 [mixed] |
| 1965 | SHK | EPPLER 266 |
| 1965 | ELFE STANDARD | WORTMANN FX 61-163,FX 60-126 |
| 1965 | ASW-12 | WORTMANN FX 62-K-131, 60-126 |
| 1966 | B-4 | NACA 64-618 |
| 1967 | CIRRUS B | WORTMANN FX 66-196, FX 66-161 |
| 1967 | PHOEBUS C | EPPLER 403 |
| 1967 | SB-8 | FX 62-K-153/131, FX 60-126 |
| 1967 | DIAMANT 18 | WORTMANN FX 62-K-153 nmod. |
| 1967 | LIBELLE STANDARD | WORTMANN FX 66-17A II-182 |
| 1967 | LS-1C | WORTMANN FX 66S-196 mod. |
| 1968 | FK-3 | WORTMANN FX 62-K-153 |
| 1968 | KESTREL 401 | FX 67-K-176/17, 67-K-150/17 |
| 1968 | ASW 15-B | WORTMANN FX 61-163, 60-126 |
| 1968 | FS-25 | FX-S-196/184/168/147,60-126 |
| 1969 | SB-9 | FX 62-K-153/131, 60-126 |
| 1969 | NIMBUS II | FX 67-K-170/17, 67-K-150/17 |
| 1969 | CIRRUS STANDARD | FX S-02-196, 66-17 A II-182 |
| 1970 | F-101 SALTO | WORTMANN FX 66-17A-182 |
| 1970 | CALIF | FX 67-K-170, 60-126 |
| 1970 | KESTREL 604 | FX 67-K-170/17, 67-K-150/17 |
| 1971 | ASW 17 | FX 62-K-131 [14.4%], 60-126 |
| 1971 | SIGMA | WORTMANN FX 67-VC-170/136 |
| 1972 | DARMSTADT D-38 | WORTMANN FX 61-184, 60-126 |
| 1972 | LSD-ORNITH | WORTMANN FX 66-S-196 mod. |
| 1972 | SB-10 [29 m] | FX 62-K-153/131 |
| 1972 | BS-10 [26 m] | FX 62-K-153/131, 60-126 |
| 1973 | JANTAR STANDARD | NN-8 |
| 1973 | PIK 20-D | WORTMANN FX 67-K-170/150 |
| 1973 | AN 66-C | EPPLER 562/569 |
| 1974 | JANUS | WORTMANN FX 67-K-170/150 |
| 1974 | LS-1F | WORTMANN FX 66-S-196 VI |
| 1974 | DG-100 | WORTMANN FX 61-184, 60-126 |
| 1974 | ASTIR CS | EPPLER 603 |
| 1974 | HORNET | WORTMANN FX 66-17AII-182 |
| 1975 | ASW 19 | FX 61-163, FX 60-126 |
| 1975 | FS-29 | FX 73-170, FX 73-K-170/22 |
| 1976 | LS-3 | WORTMANN FX 67-K-170/150 |
| 1976 | MOSQUITO | WORTMANN FX 67-K-150 |
| 1976 | MINI NIMBUS | WORTMANN FX 67-K-150 |
| 1976 | DG-200 | WORTMANN FX 67-K-170 mod. |
| 1976 | TWIN ASTIR | EPPLER 603 |
| 1977 | GLOBETROTTER | EPPLER 603 |
| 1977 | B-12 | WORTMANN FX 67-K-170/150 |
| 1977 | ASW 20 | WORTMANN FX 62-K-131 [14.4%] |
| 1978 | SPEED ASTIR | EPPLER 662 |
| 1978 | SB-11 | HQ 144-39 F3 |
| 1978 | SFH | WORTMANN FX 61-184, FX 60-126 |
| 1979 | ASK 21 | FX 602-196, FX 60-126 |
| 1979 | MÜ 27 | WORTMANN FX 67-VC-170/130 |

3

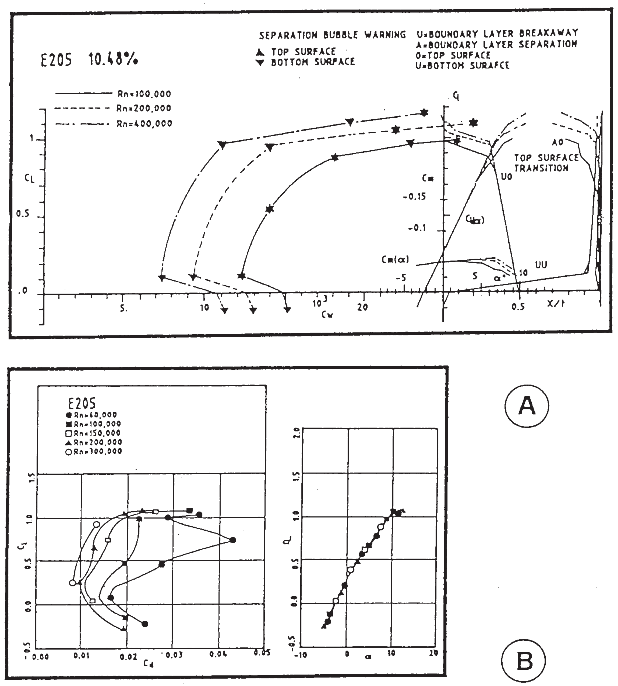



FIGURE 1





(More recently designed laminar sections maintain a laminar boundary layer for nearly the entire chord.)

In aeromodelling, airfoils are often used which have been developed by the builders themselves, according to their own personal empirical rules. Sometimes the Joukowsky graphical method is used, or existing airfoils are modified.

Nowadays several computer programs are available which allow one to quickly produce a myriad of airfoils which are often dubbed laminar. Their superiority over the traditional ones, as evidenced by the computer derived characteristics, is quite far from being confirmed by scarce wind tunnel tests.

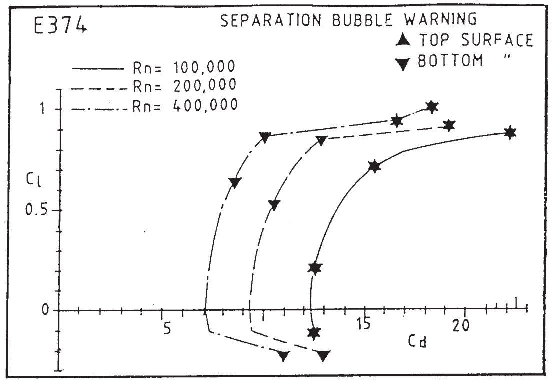
The reason for this is rather simple and well defined, even if this subject is seldom debated in specialized publications. At low Reynolds Numbers, such as those prevailing in aeromodelling, the formation of the so called laminar bubble is relevant and easy to detect by various means, visual and acoustic being the most commonly used methods.

Unfortunately, a mathematical model has not yet been found which can accurately represent the laminar bubble and its evolution. As a consequence, nobody knows how to program a computer to properly calculate real performance. As a matter of fact, the laminar bubble is completely neglected in all but the most very recent of the aforementioned programs. The consequence is an anomalous drag increase, as appears in the typical example of FIGURE 1 (page 4).

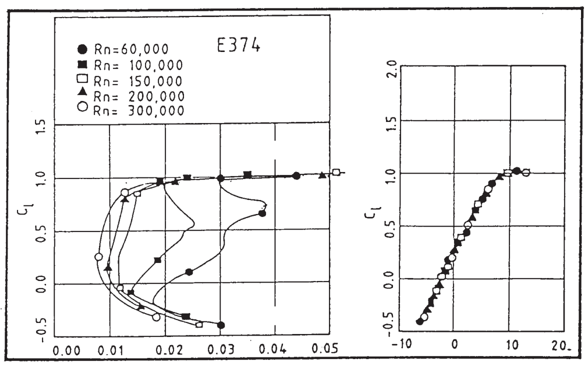
EXAMPLE: Let's assume that we intend to adopt the airfoil E 205 at an incidence equivalent to $C_L$ = O.5, at a Reynolds Number Re = 100,000.

In FIGURE 1 the polar diagram A (theoretical, computer derived) shows an aerodynamic efficiency

$$E = \frac{C_L}{C_D} = \frac{0.5}{0.0137} = 36.5$$




A




B

FIGURE 2



On the contrary, the polar diagram B of FIGURE 1 (derived from wind tunnel testing) gives this much lower value

$$E = \frac{C_L}{C_D} = \frac{0.5}{0.02} = 25.0$$

If the Reynolds Number becomes smaller, for instance Re = 60,000, which is a typical value for many radioguided sailplanes of medium size, the end result would become even worse.

$$E = \frac{C_L}{C_D} = \frac{0.5}{0.028} = 17.85$$

Should we decide to increase the working angle of incidence so that $C_L = 0.74$, the aerodynamic efficiency will worsen even more.

$$E = \frac{C_L}{C_D} = \frac{0.74}{0.044} = 16.81$$

Another example is shown in FIGURE 2 (page 6). The difference between the theoretical polar (A) and the one derived from wind tunnel testing (B) is macroscopic and cannot be neglected.

By the same token, there is another empirical rule which cannot be ignored. The aerodynamic efficiency of a flying model is halved with respect to the airfoil $E = C_L/C_D$ as measured in the wind tunnel. From a practical point of view, this means that the flying model will hardly attain a glide ratio of 1:12 even though its wing airfoil shows a 1:24 ratio when tested in the wind tunnel.

Sometimes airfoils for flying models are "invented" by taking the upper contour from one airfoil and the bottom contour from another one. A common case is a concave bottom section which has been flattened, *a la* the Clark Y, for ease of construction, thus spoiling the aerodynamic performance. Something like this has been done also with full size sailplanes. For instance, the wing of the BS-1 (1962) has the top

TABLE 3

| | 1938 | 1960 | 1980 |
|---|---|---|---|
| *Max. Wing loading*<br>Carico alare max.<br>Kg/m | 12 - 20 | 18 - 32 | 42 - 50 |
| *Max. speed*<br>Velocita' max.<br>Km/h | 150 - 180 | 200 - 250 | 250 - 300 |
| *Wing airfoils*<br>Profili alari | Goettingen<br>Joukowsky | NACA<br>Eppler | Wortmann<br>DFVLR<br>HQ |
| *Wing planform*<br>Pianta alre<br>[FIG.6-A] | RT | RT<br>DT | RT<br>DT<br>PT |
| *Examples*<br>Esempi | FAFNIR II<br>MOAZAGOTL<br>MINIMOA<br>SPYR III<br>MU 13<br>REIHER | ZEFIR<br>SKYLARK<br>PHOENIX<br>ELFE M<br>Ka 6<br>FOKA | NIMBUS 3<br>ASW 20<br>DG 202<br>LS-4<br>JANTAR<br>DISCUS |
| *Construction*<br>Costruzione | *Wood*/Legno<br>*Steel*/Acciaio | *GRP*/Vetrores<br>*Light* alloy<br>Lega legg. | *CRP*/Vetro-carbonio |
| *Water ballast*<br>Zavorra [acqua]<br>Kg | 50 - 80 | 100 | 350 |



TABLE 4

| *Sailplane* / Aliante | *Minimum Sink Speed*<br>Velocita' Minima di Caduta | *At* / a | *With Wing Loading*<br>Con Carico Alare | *Best Glide Ratio*<br>Miglior Rapporto di Planata | *At* / A | *With Wing Loading*<br>Con Carico Alare | *Max. Speed [VNE]*<br>Velocita' Max. |
|---|---|---|---|---|---|---|---|
| | m/s | Km/h | Kg/m² | E | Km/h | Kg/m² | Km/h |
| DG-101/100 [Glaser Dirks]... | 0.59 | 74 | 28.0 | 39.0 | 105 | 38.0 | 260 |
| ASW 19 B [Schleicher]........ | 0.62 | 72 | 30.0 | 38.5 | 112 | 41.0 | 255 |
| LS-4 [Schneider]............. | 0.60 | 82 | 33.0 | 40.5 | 118 | 45.0 | 270 |
| JANTAR 2 STANDARD 48-1[SZD].. | 0.65 | 77 | 34.7 | 39.5 | 130 | 48.8 | 280 |
| DG-202 [Glaser Dirks]........ | 0.59 | 80 | 32.0 | 42.5 | 110 | 45.0 | 270 |
| 304 [Glasflugel]............. | 0.57 | 77 | 31.0 | 43.0 | 116 | 45.5 | 250 |
| Mini-Nimbus [Schempp-Hirth].. | 0.60 | 85 | 34.5 | 41.6 | 112 | 45.0 | 250 |
| Mini-Nimbus C [Schempp-Hirth] | 0.53 | 80 | 33.0 | 42.0 | 120 | 51.0 | 250 |
| Ventus a [Schempp-Hirth]..... | 0.55 | 80 | 33.0 | 44.0 | 120 | 45.0 | 250 |
| ASW 20 [Schleicher].......... | 0.59 | 84 | 32.0 | 42.0 | 115 | 43.0 | 265 |
| LS 3a [Schneider]............ | 0.60 | 80 | 33.0 | 41.8 | 100 | 33.0 | 270 |
| Nimbus 2 B [Schempp-Hirth]... | 0.48 | 80 | 30.0 | 49.0 | 110 | 40.0 | 270 |
| Nimbus 2 C [Schempp-Hirth]... | 0.47 | 80 | 30.0 | 49.0 | 115 | 45.0 | 270 |
| Nimbus 3 [Schempp-Hirth]..... | 0.44 | 62 | 30.0 | 55.0 | 125 | 46.0 | 270 |
| ASW 17 [Schleicher].......... | 0.56 | 77 | 33.0 | 49.0 | 105 | 33.0 | 270 |
| JANTAR 2 B- 42-2 [SZD]....... | 0.46 | 75 | 32.0 | 50.3 | 102 | 45.0 | 250 |
| ASW 22 [Schleicher].......... | 0.41 | 80 | 32.0 | 60.0 | 115 | 45.9 | 270 |
| LAK 12 Lietuva [LAK]......... | 0.48 | 79 | 31.0 | 48.0 | 95 | 43.0 | 250 |
| Diamant 18 [FFA]............. | 0.52 | 69 | 30.5 | 45.0 | 95 | 28.0 | 270 |
| G 102 [Grob]................. | 0.60 | 75 | 30.6 | 37.5 | 85 | 36.0 | 250 |
| G 103 [Grob]................. | 0.64 | 80 | 26.0 | 36.0 | 105 | 33.0 | 250 |
| G 103 Twin III [Grob]........ | 0.64 | 73 | 27.0 | 38.0 | 109 | 35.0 | 280 |
| SZD-42 Jantar 2 "AMBER".[SZD] | 0.46 | 75 | 32.5 | 47.0 | 102 | 41.6 | 250 |
| SB-9.[Akaflieg Braunschweig]. | 0.44 | 75 | 27.7 | 48.0 | 110 | 28.6 | 180 |
| SB-11.[Akaflieg Braunschweig] | 0.67 | 85 | 27.5 | 48.0 | 104 | 44.5 | 265 |
| SZD-55-1.[SZD]............... | 0.54 | 79 | 31.0 | 44.1 | 119 | 50.0 | 180 |
| Discus.[Schempp-Hirth]....... | 0.59 | 80 | 29.5 | 42.4 | 105 | 50.0 | 180 |
| SF-26.[Scheibe].............. | 0.70 | 70 | 22.1 | 30.0 | 80 | 25.1 | - |
| SB-12.[Glasflugel]........... | 0.59 | 80 | 31.0 | 41.0 | 98 | 45.0 | - |
| Phoebus C.[Bolkow-Laupheim].. | 0.63 | 83 | 23.0 | 39.0 | 93 | 32.6 | - |
| LS 7.[Rolladen-Schneider].... | 0.58 | 80 | 32.0 | 43.0 | 105 | 50.0 | - |
| Mistral.[Strauber-Frommhold]. | 0.59 | 83 | 32.9 | 39.0 | 98 | 32.9 | - |
| L-10 Libelle.[Bitz-Linner-Z.] | 0.65 | 65 | 22.4 | 28.0 | 70 | 24.0 | - |
| Glasflugel 304.[Glasflugel].. | 0.57 | 77 | 33.9 | 42.7 | 96 | 45.6 | - |
| fs-32.[Akaflieg Stuttgart]... | 0.60 | 85 | 35.7 | 43.0 | 105 | 50.3 | - |
| Elfe S 4.[Oerlinghausen]..... | 0.59 | 79 | 27.1 | 37.0 | 90 | 29.7 | - |
| AK-5.[Akaflieg Karlsruhe].... | 0.58 | 85 | 30.0 | 39.0 | 105 | 28.4 | - |
| Lo 150.[Wolf Hirth]......... | 0.68 | 86 | 28.4 | 34.0 | 105 | 28.4 | 200 |
| Janus.[Schempp-Hirth]....... | 0.58 | 83 | 30.0 | 43.5 | 95 | 36.5 | 250 |
| Cirrus 75 [16 m].[Schempp-H.] | 0.60 | 78 | 29.8 | 38.0 | 88 | 30.0 | 200 |

contour of the Wortmann FX 62-163 airfoil and the bottom contour of the Eppler 306.

In full size gliding, duration contests have been abandoned a long time ago and duration flights are no longer recorded by the Federation Aeronautique Internationale. As a matter of fact, a remarkable improvement in glider performance has been achieved in the few last decades, as depicted in FIGURE 9-B (page 35), so that the duration potential is far beyond human endurance under certain meteorological conditions.

Once the proper correction for scale effect has been made, the design requirements of modern sailplanes appear to be comparable with those of radioguided gliders, for both thermal and slope soaring, according to class rules established by the Federation Aeronautique Internationale and other ruling bodies. As a consequence, many aeromodelers keep looking rather closely at 3-view plans and characteristics of vintage and contemporary sailplanes, not only for possible scale reproduction, but also for design and construction hints.

The comparison between full size gliders and model gliders, which every reader can make using information available in this digest, concerns only basic geometrical proportioning. Some simple considerations can be made by examining the plans of hundreds of sailplanes. To this effect, let's focus our attention at three cutoff dates which characterize the development of gliding, namely 1938, 1960, and 1980. TABLE 3 (page 8) synthesizes the essential parameters and information.

Other lessons can be learned from TABLE 4 (page 9), which summarizes the performance of some contemporary sailplanes.

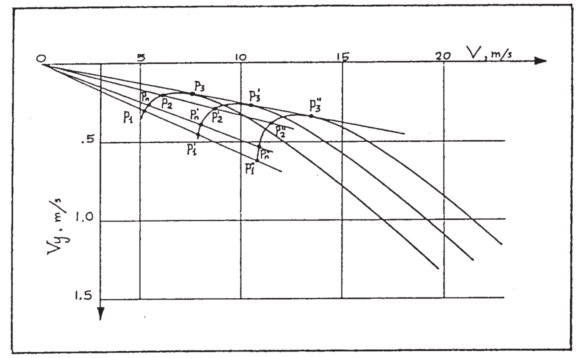
It appears clear that the minimum sink speed, $V_y$, is achieved at a translation speed, V, and with a wing loading, W/S, which are lower than those required to obtain the maximum aerodynamic efficiency,

$$E = \frac{C_L}{C_D} = \frac{L}{W} = \frac{D}{H}$$

See also FIGURE 4 (page 16).








*Speed polars*
Polari odografiche

FIGURE 3

This confirms what one learns when studying the speed polar of any sailplane. See for instance FIGURE 3, above, taken from Reference 3.

Points P, P', and P" correspond to the minimum sink speed, $V_y$. By tracing a tangent line to the curves from the point 0 (pole), one finds the points P, P', P" which indicate the maximum aerodynamic efficiency, $E = C_L/C_D$, for three different wing loading, W/S. The aerodynamic efficiency, E, simply shows the length of the glide path for a given tow release altitude.

By increasing the wing loading, both the translation speed, V, and the sink speed, $V_y$, increase. Also, the smaller the latter becomes, the better the thermaling performance.

EXAMPLE: A scale RC glider, having an efficiency E = 20, released at 100 m altitude, may glide straight for 2000 m, if there is no wind and control surfaces (ailerons, elevator, rudder, flaps) are not actuated.

If the sink speed of such a sailplane is 0.5 m/s, it will climb at 1.5 m/s when entering a rising thermal which has a vertical velocity of 2 m/s.

The lesson to be learned here is that for radioguided sailplanes which are supposed to soar in thermals, the wing loading must be reduced to the minimum required by the necessary structural strength (Reference 18).

As far as aerodynamic design is concerned, that is, the selection of airfoils for wings and tails, one must remember the specific operating conditions of flying models, as characterized by a relatively low Reynolds number.

Let's now complete some considerations for airfoils which are perfect scale reproductions of those used on full scale sailplanes, to be adopted for radioguided sailplanes.

First of all, the concept "scale" must be properly clarified.

Since radioguided gliders fly in the air, exactly as their full size counterparts, it appears to be quite logical to follow the "dynamic similitude" principle.

Let's avoid complicated reasonings by means of a practical example. If a flying model is built on a 1:5 scale, any one of its linear dimensions is equal to 1/5 of the equivalent dimension of the full size aircraft.

EXAMPLE: If a full size aircraft has a wingspan of 15 m, the span of its 1:5 scale reproduction is equivalent to 15:5 = 3 m.

The number 5 represents the "scale factor," usually indicated with the letter F.

So far, so good!

Let us now consider any flat surface, for instance a square, having sides of 10 dm. Its area measures 10 dm • 10 dm = 100 $dm^2$ = 1 $m^2$.

If one wants to reduce it to 1:10 scale, its side becomes 10/1 = 1 dm.

Now the fun!

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The area of a 1:10 scale square measures 1 dm • 1 dm = 1 $dm^2$, which is 100 times smaller (1/100) than the full scale square.

If the same reasoning is repeated for a cube having an edge of 10 dm, the volume of the 1:10 scale model becomes 1000 times smaller (1/1000)!

Similar reasonings, which are here omitted since they are beyond the scope of this work, allow one to establish some simple rules which are required for the perfect scale realization of dynamic models, such as radioguided scale sailplanes. These rules are to be followed when a scale model of a dynamic full scale vehicle has to be built, no matter whether the scale is reduced or enlarged. The latter is the case of some flying machines which are first built as reduced scale radioguided models, then as full scale versions with human pilots at the control column. Actually, reduced scale radioguided models replace time consuming wind tunnel testing, since some aeronautical builders cannot afford expensive aeronautical laboratories. TABLE 5 (page 14) summarizes these simple rules.

As an example, let's apply them to the elegant Minimoa (1935) sailplane, since we intend to build a 1:5 scale reproduction of it.

The following is thus obtained:

| Dimension | Symbol | Unit of measurement | Full scale | 1:5 scale |
|---|---|---|---|---|
| Wing span | b | m | 17 | 3.4 |
| Wing area | S | $m^2$ | 19 | $19/5^2 = 19/25 = 0.76$ |
| Mean chord | c | m | 1.12 | 0.224 |
| Weight | W | Kg | 350 | 2.8 |
| Wing loading | W/S | Kg/$m^2$ | 18.42 | 3.73 |
| Speed | V | Km/h (m/s) | 100 (27.7) | 44.72 (12.4) |

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TABLE 5

*To convert full scale values to apply to a model constructed to a scale ratio of F to 1, divide by the factors shown:*

Per convertire valori in scala reale per applicarli a modelli costruiti secondo un rapporto di scala di F:1, dividere per i fattori qui elencati:

| *Type of units*/ Tipo di unita' | | Factor/Fattore |
|---|---|---|
| *Linear dimension*/Dimensione lineare | | F |
| *Area*/Area | F*F= | $F^2$ |
| *Volume*/Volume | F*F*F= | $F^3$ |
| *Weight*/Peso | F*F*F= | $F^3$ |
| *Force*/Force | F*F*F= | $F^3$ |
| *Work or Energy*/Lavoro o Energia | F*F*F*F= | $F^4$ |
| *Torque*/Coppia | F*F*F*F= | $F^4$ |
| *Moment (static)*/Momento (statico) | F*F*F*F= | $F^4$ |
| *Moment of inertia*/Momento d'inerzia | F*F*F*F*F= | $F^5$ |
| *Strength of materials*/Resistenza materiali | | 1/F |
| *Time*/Tempo | | $\sqrt{F}$ |
| *Speed*/Velocita' | | $\sqrt{F}$ |
| *Linear accelleration*/Accellerazione lineare | | 1 |
| *Angular accelleration*/Accellerazione angolare | | 1/F |
| *Horsepower*/Potenza | $F*F*F*\sqrt{F}$= | $F^3*\sqrt{F}$ |
| *Power loading*/Potenza unitaria | | $1/\sqrt{F}$ |
| *RPM*/Giri/minuto | | $1/\sqrt{F}$ |
| *Angles and revolutions*/Angoli e rotazioni | | 1 |
| *Wing loading*/Carico alare | $F^3/F^2$= | F |

*To convert observed or measured values of the model to full scale values, multiply by the factors above.*

Per convertire in scala reale i valori osservati o misurati relativi al modello, moltiplicare per i suddetti valori.

TABLE 6

| | METRIC SYSTEM<br>SISTEMA METRICO<br>Kg - m - sec | BRITISH SYSTEM<br>SISTEMA INGLESE<br>Lb - ft - sec |
|---|---|---|
| ρ | 0.125 $Kg \cdot m^2/s$ ▲ | 0.0002378 $lb \cdot ft^2/s$ ▲ |
| V | m/s | ft/s |
| ℓ | m | ft |
| μ | $1.81 \cdot 10^{-6}$ $Kg \cdot s/m^2$ * | $0.3728 \cdot 10^{-6}$ $lb \cdot s/ft^2$ * |

* = TEMP: 15 °C PRESS: 760 mm Hg ▲ = AT 0 ALTITUDE A QUOTA 0

| ρ/μ | SPEED<br>VELOCITA' | CHORD<br>CORDA |
|---|---|---|
| 69'000 | m/s | m |
| 690 | m/s | cm |
| 192 | Km/h | cm |
| 6378 | ft/s | ft |
| 9354 | miles/h | ft |

1 mile = 1609.32 m 1 ft = 30.48 cm





First remark: It will be very difficult to keep the total weight within the limit established by the "true scale" rule. Most likely the weight will turn out to be very close to about 4 Kg. As a consequence, the wing loading will increase to about 53 $g/dm^2$

As far as the choice of the airfoil is concerned, the Reynolds number must be taken into consideration. It is given by the following formula, which appears in any textbook of applied aerodynamics

$$Re = V \cdot c \cdot \left(\frac{\rho}{\mu}\right)$$

where

V = speed, m/s
c = wing chord, m
ρ = (rho) air density, 0.125
μ = (mu) air viscosity

From a practical point of view, speed V, chord c, and ρ/μ (rho/mu) are multiplied by each other. The value of the ratio ρ/μ (rho/mu) depends upon the units of measurement, as indicated in TABLE 6 (page 14).

In our case one gets

FULL SIZE SAILPLANE: 27.7 • 1.12 • 69,000 = 2,140,656

MODEL SAILPLANE: 12.4 • 0.224 • 69,000 = 191,654

Second remark: Under these circumstances, it becomes obvious that the airfoils used on the full scale sailplane cannot be adopted for scale models because they are too thick. Drag would be magnified and the glide ratio would be highly penalized.

From a practical point of view, the efficiency, E, indicates the horizontal distance flown for a given tow release altitude. See FIGURE 4 below.

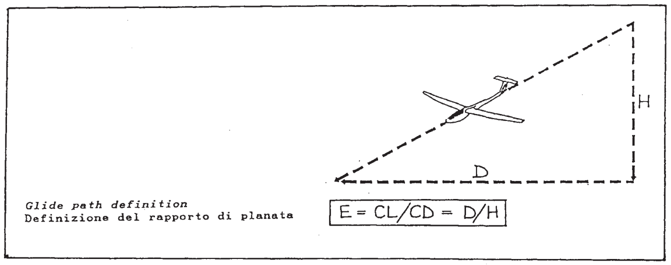



FIGURE 4

Characteristic data of a significant number of vintage and contemporary sailplanes are listed in TABLE 7 (pages 18 to 27). The definitions of the various terms are summarized in FIGURES 5, 6, 7-A and 7-B, and 8 (pages 28 to 32).

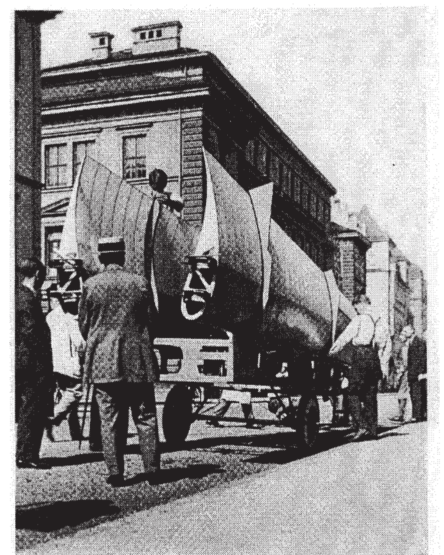
FIGURE 9-A (page 34) shows the trend of the aerodynamic efficiency, $E = C_L/C_D$ versus the wing aspect ratio, AR. This confirms what one learns at any aeromodeling course: At comparable Reynolds Numbers the lift/drag ratio, that is the glide angle, improves when the aspect ratio, AR, increases, since the induced drag is reduced.

FIGURE 9-B (page 35) shows the increase of the sailplanes efficiency, E, through the years, from the pioneering days up to now.

In aeromodelling, the increase of the aspect ratio must be adopted with caution, because an excessive reduction of both the mean aerodynamic chord and the tip chord causes a deterioration of characteristics, mainly due to the decrease of the Reynolds Number and to less precise reproduction of the airfoil contour.







Photograph from Howard Siepen

A GLIDER, MADE BY MUNICH COLLEGE STUDENTS, READY FOR SHIPMENT TO THE WASSERKUPPE FLYING GROUND

NATIONAL GEOGRAPHIC, JUNE 1929

TABLE 7.1.2

✱ = FLEXIBLE FLAPS
FLAPS ELASTICI

W&C = WOOD AND CALICO CONSTRUCTION
= COSTRUZIONE IN LEGNO E TELA

W&C-15 = WOOD AND CALICO CONSTRUCTION 15 m CLASS
= COSTRUZIONE IN LEGNO E TELA CLASSE 15 m

| | | ㉑ AILERON SPAN / APERT. ALETT. | ㉒ AIL. MEAN CHORD / CORDA MEDIA AL. | ㉓ EMPENN. ARRAN. / SIST. IMPENN. | ㉔ STABILATOR SPAN / APERT. STABIL. | ㉕ STABILATOR AREA / SUP. STABILIZZ. | ㉖ STABILATOR AR / ALLUNG. STAB | ㉗ STAB. MEAN CHORD / CORDA MEDIA STA. | ㉘ ELEVATOR CHORD / CORDA ELEVATORE | ㉙ ELEV. LEVER ARM / BRACCIO ELEV. | ㉚ TAIL VOL. COEFF. / RAPP. VOLUMETR. | ㉛ FIN HEIGHT / ALTEZZA DERIVA | ㉜ TOTAL FIN AREA / SUP. TOT. DERIVA | ㉝ FIN ASPEC. R. / ALLUNG. DERIVA | ㉞ FIN MEAN CH. / CORDA M. DERIVA | ㉟ RUDDER CHORD / CORDA DIREZ. | ㊱ RUDDER L. ARM / BRACCIO DIR. | ㊲ TAIL VOL. COEF. / RAPP. VOLUM. | ㊳ SPOILERS ARR. / SIST. DIRUTT. | ㊴ AIR BRAKE SPAN / APERT. DIRUTT. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | sa | ca | FIG.7 | bt | st | ARt | ct | ht | A | TVC | y | sv | ARv | cv | hv | B | VVC | FIG.15 | sb |
| | | [%s] | [m] | | [m] | [m²] | [–] | [m] | [% ct] | [m] | [–] | [m] | [m²] | [–] | [m] | [% cv] | [m] | [–] | | [m] |
| W&C | VAMPYR | 32 | 0.46 | A | 2.50 | 1.88 | 3.33 | 0.75 | 100 | 3.40 | 0.31 | 0.90 | 1.28 | 0.63 | 1.42 | 38 | 2.50 | 0.016 | | |
| W&C | FAFNIR | | | A | 3.50 | | | | | | | 1.66 | | | | | | | | |
| W&C | GRUNAU BABY II b | 52 | 0.32 | A | 2.90 | 2.32 | 3.63 | 0.80 | 47 | 3.45 | 0.40 | 1.20 | 0.81 | 1.78 | 0.68 | 91 | 3.90 | 0.016 | C | 0.72 |
| W&C | MINIMOA | 58 | 0.40 | A | 3.00 | 1.98 | 4.55 | 0.66 | 41 | 4.13 | 0.38 | 1.94 | 1.20 | 3.14 | 0.62 | 1 00 | 4.50 | 0.017 | | |
| W&C | WEIHE 50 | 64 | 0.33 | A | 3.50 | 2.25 | 5.44 | 0.64 | 55 | 4.70 | 0.56 | 1.15 | 1.27 | 1.04 | 1.10 | 69 | 5.00 | 0.019 | C | 0.89 |
| W&C | HKS I | ✱ | ✱ | D | 2.70 | 1.97 | 3.70 | 0.73 | 44 | 4.72 | 0.56 | 1.13 | 1.65 | 3.10 | 0.73 | 44 | 4.72 | 0.023 | A | 1.30 |
| W&C | HKS III | ✱ | ✱ | D | 2.45 | 1.39 | 4.32 | 0.57 | 44 | 4.00 | 0.47 | 1.03 | 1.17 | 3.63 | 0.57 | 44 | 4.00 | 0.019 | A | 1.30 |
| W&C | ZUGVOGEL III | 32 | 0.23 | A | 2.60 | 1.81 | 3.73 | 0.70 | 46 | 4.28 | 0.63 | 1.50 | 1.37 | 1.64 | 0.91 | 59 | 4.66 | 0.026 | C | 1.11 |
| W&C | ZEFIR | 42 | 0.17 | A | 2.40 | 1.28 | 4.50 | 0.53 | 44 | 4.45 | 0.50 | 1.34 | 0.99 | 1.81 | 0.74 | 44 | 4.10 | 0.017 | A | |
| W&C | SHK | 38 | 0.18 | D | 2.73 | 1.94 | 3.84 | 0.71 | 100 | 3.73 | 0.57 | 1.32 | 1.87 | 3.73 | 0.71 | 1 00 | 3.73 | 0.028 | C | 1.79 |
| W&C | FK 3 | 32 | 0.14 | B | 2.80 | 1.28 | 6.13 | 0.46 | 45 | 3.95 | 0.46 | 1.68 | 1.35 | 2.09 | 0.80 | 51 | 4.20 | 0.023 | C | 1.50 |
| W&C - 15 m | MEISE | 30 | 0.20 | A | 2.90 | 2.35 | 3.58 | 0.81 | 40 | 4.13 | 0.65 | 1.40 | 1.07 | 1.83 | 0.76 | 67 | 4.53 | 0.022 | C | 0.88 |
| W&C - 15 m | Ka 6E | 29 | 0.20 | A | 2.80 | 1.61 | 4.87 | 0.58 | 100 | 3.75 | 0.59 | 1.43 | 1.15 | 1.78 | 0.80 | 55 | 3.95 | 0.024 | C | 1.01 |
| W&C - 15 m | Ka 8B | 32 | 0.23 | A | 2.80 | 1.95 | 4.02 | 0.70 | 49 | 3.82 | 0.53 | 1.50 | 1.40 | 1.61 | 0.93 | 54 | 4.18 | 0.027 | C | 1.01 |
| W&C - 15 m | STANDARD AUSTRIA | 28 | 0.20 | D | 2.60 | 2.00 | 3.38 | 0.77 | 100 | 3.80 | 0.62 | 1.30 | 2.00 | 3.38 | 0.77 | 1 00 | 3.80 | 0.037 | C | 1.76 |
| W&C - 15 m | SB 5B | 36 | 0.25 | D | 2.80 | 1.70 | 4.61 | 0.61 | 41 | 3.96 | 0.60 | 0.98 | 1.20 | 3.20 | 0.61 | 41 | 3.96 | 0.024 | C | 0.98 |
| W&C - 15 m | FOKA 4 | 40 | 0.15 | A | 2.70 | 1.40 | 5.21 | 0.52 | 40 | 4.00 | 0.55 | 1.20 | 0.98 | 1.47 | 0.82 | 45 | 3.80 | 0.020 | C | 1.06 |
| W&C - 15 m | VASAMA | 32 | 0.18 | B | 2.20 | 1.27 | 3.81 | 0.58 | 50 | 3.65 | 0.50 | 1.35 | 1.10 | 1.66 | 0.81 | 50 | 3.80 | 0.024 | C | 0.95 |

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TABLE 7.1.1

REMARKS NOTE

✱✱ = FUSELAGE PLUS VERTICAL TAIL
FUSOLIERA PIU' CODA VERTICALE

✱ = EMPTY WEIGHT PLUS 90 KG
PESO A VUOTO PIU' 90 KG

✸ = METAL CONSTR.
COSTRUZ. METALLICA

| | | ❶ FIRST FLIGHT / PRIMO VOLO | ❷ TAKE OFF WEIGHT ✱ / PESO AL DECOLLO | ❸ MAX. TAKE OFF W. / PESO MAX. DECOLLO | ❹ WING WEIGHT / PESO ALA | ❺ FUSELAGE WEIGHT ✱✱ / PESO FUSOLIERA | ❻ STABILATOR WEIGHT / PESO STABILIZZATORE | ❼ BALLAST WATER / ZAVORRA ACQUA | ❽ OVERALL LENGTH / LUNGHEZZA F. T. | ❾ WING SPAN / APERTURA ALARE | ❿ ASPECT RATIO / ALLUNGAMENTO | ⓫ WING AREA / SUPERFICIE ALARE | ⓬ MIN. WING LOADING / CARICO ALARE MIN. | ⓭ MAX. WING LOADING / CARICO ALARE MAX. | ⓮ MEAN WING CHORD / CORDA MEDIA ALARE | ⓯ ROOT WING CHORD / CORDA ALARE: RADICE | ⓰ TIP WING CHORD / CORDA ALARE: ESTR. | ⓱ WING PLANFORM / PIANTA ALARE | ⓲ TAPER RATIO / RAPP. RASTREMAZ. | ⓳ TAPER POINT / INIZIO RASTREM. | ⓴ WING TWIST / SVERGOLAM. ALA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | YEAR | W | W' | Ww | Wf | Wt | Wb | L | b=2s | AR | S | W/S | W'/S | c | cr | ce | FIG.6 | TR | yi | αw |
| | | ANNO | [Kg] | [Kg] | [Kg] | [Kg] | [Kg] | [Kg] | [m] | [m] | [–] | [m²] | [Kg/m²] | [Kg/m²] | [m] | [m] | [m] | | [ce/cr] | [%s] | [°] |
| W&C | VAMPYR | 1921 | 210 | 210 | – | – | – | – | 5.00 | 12.6 | 10.0 | 16.0 | 13.1 | 13.1 | 1.27 | 1.35 | 0.76 | RT | 0.56 | 0.54 | – |
| W&C | FAFNIR | 1930 | 290 | 315 | – | – | – | – | 7.76 | 19.0 | 20.0 | 18.6 | 15.6 | 16.9 | 0.98 | 1.63 | 0.41 | T | 0.27 | – | 0 |
| W&C | GRUNAU BABY II b | 1933 | 239 | 250 | 85 | 57 | 7 | – | 6.05 | 13.6 | 13.0 | 14.2 | 16.8 | 17.6 | 1.04 | 1.18 | 0.49 | RT | 0.42 | 0.53 | -9.5 |
| W&C | MINIMOA | 1935 | 340 | 350 | 145 | 95 | 10 | – | 7.00 | 17.0 | 15.2 | 19.0 | 17.9 | 18.4 | 1.12 | 1.30 | 0.75 | RT | 0.58 | 0.58 | -2 |
| W&C | WEIHE 50 | 1938 | 335 | 335 | 140 | 93 | 12 | – | 8.14 | 18.0 | 17.7 | 18.34 | 18.3 | 18.3 | 1.02 | 1.56 | 0.43 | T | 0.28 | – | -6.5 |
| W&C | HKS I | 1953 | 540 | 588 | 250 | 183 | 17 | – | 8.30 | 19.0 | 20.3 | 17.79 | 30.4 | 33.1 | 0.94 | 1.27 | 0.59 | T | 0.47 | – | 0 |
| W&C | HKS III | 1955 | 389 | 410 | 173 | 109 | 17 | 75 | 7.16 | 17.2 | 20.8 | 14.23 | 27.3 | 28.8 | 0.83 | 1.23 | 0.54 | T | 0.44 | – | 0 |
| W&C | ZUGVOGEL III | 1957 | 335 | 365 | 150 | 88 | 7 | – | 7.10 | 17.0 | 20.1 | 14.37 | 23.3 | 25.4 | 0.85 | 1.16 | 0.38 | DT | 0.33 | 0.52 | 0 |
| W&C | ZEFIR | 1958 | 385 | 415 | 185 | 103 | 7 | – | 7.07 | 17.0 | 20.6 | 14.0 | 27.5 | 29.6 | 0.82 | 0.96 | 0.34 | RT | 0.36 | 0.56 | 0 |
| W&C | SHK | 1965 | 350 | 370 | 164 | 87 | 11 | – | 6.30 | 17.0 | 19.7 | 14.65 | 23.9 | 25.3 | 0.86 | 1.20 | 0.51 | T | 0.43 | – | 0 |
| W&C | FK 3 ✸ | 1968 | 364 | 400 | 152 | 113 | 9 | 50 | 7.22 | 17.4 | 21.9 | 13.8 | 26.4 | 29.0 | 0.79 | 0.87 | 0.30 | T | 0.34 | – | 0 |
| W&C - 15 m | MEISE | 1939 | 250 | 255 | 82 | 71 | 7 | – | 7.27 | 15.0 | 15.0 | 15.0 | 16.7 | 17.0 | 1.00 | 1.45 | 0.55 | T | 0.38 | – | 0 |
| W&C - 15 m | Ka 6E | 1955 | 281 | 300 | 116 | 69 | 6 | – | 6.70 | 15.0 | 18.1 | 12.4 | 22.7 | 24.2 | 0.83 | 1.17 | 0.37 | DT | 0.32 | 0.61 | -2 |
| W&C - 15 m | Ka 8B | 1958 | 281 | 310 | 110 | 74 | 7 | – | 7.00 | 15.0 | 15.5 | 14.5 | 19.4 | 21.4 | 0.97 | 1.30 | 0.49 | DT | 0.38 | 0.60 | -4 |
| W&C - 15 m | STANDARD AUSTRIA | 1958 | 298 | 323 | 122 | 78 | 8 | – | 6.20 | 15.0 | 16.7 | 13.5 | 22.1 | 23.9 | 0.90 | 1.20 | 0.60 | T | 0.50 | – | -1.5 |
| W&C - 15 m | SB 5B | 1959 | 293 | 300 | 122 | 69 | 12 | – | 6.50 | 15.0 | 17.3 | 13.0 | 22.5 | 23.1 | 0.87 | 1.00 | 0.56 | RT | 0.56 | 0.54 | 0 |
| W&C - 15 m | FOKA 4 | 1960 | 335 | 385 | 130 | 107 | 8 | – | 7.00 | 15.0 | 18.5 | 12.16 | 27.5 | 31.7 | 0.81 | 1.22 | 0.38 | T | 0.31 | – | 0 |
| W&C - 15 m | VASAMA | 1961 | 303 | 300 | 124 | 83 | 6 | – | 5.97 | 15.0 | 19.1 | 11.75 | 25.8 | 26.5 | 0.78 | 1.08 | 0.40 | DT | 0.37 | 0.62 | 0 |

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TABLE 7.2.2

| Group | Sailplane | 21 AILERON SPAN / APERT. ALETT. (sa) [%s] | 22 AIL. MEAN CHORD / CORDA MEDIA AL. (ca) [m] | 23 EMPENN. ARRAN. / SIST. IMPENN. (FIG.7) | 24 STABILATOR SPAN / APERT. STABIL. (bt) [m] | 25 STABILATOR AREA / SUP. STABILIZZ. (st) [m²] | 26 STABILATOR AR / ALLUNG. STAB (ARt) [–] | 27 STAB. MEAN CHORD / CORDA MEDIA STA. (ct) [m] | 28 ELEVATOR CHORD / CORDA ELEVATORE (ht) [%ct] | 29 ELEV. LEVER ARM / BRACCIO ELEV. (A) [m] | 30 TAIL VOL. COEFF. / RAPP. VOLUMETR. (TVC) [–] | 31 FIN HEIGHT / ALTEZZA DERIVA (y) [m] | 32 TOTAL FIN AREA / SUP. TOT. DERIVA (sv) [m²] | 33 FIN ASPEC. R. / ALLUNG. DERIVA (ARv) [–] | 34 FIN MEAN CH. / CORDA M. DERIVA (cv) [m] | 35 RUDDER CHORD / CORDA DIREZ. (hv) [%cv] | 36 RUDDER L. ARM / BRACCIO DIR. (B) [m] | 37 TAIL VOL. COEF. / RAPP. VOLUM. (VVC) [–] | 38 SPOILERS ARR. / SIST. DIRUTT. (FIG.15) | 39 AIR BRAKE SPAN / APERT. DIRUTT. (sb) [m] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W&C-15 m | STANDARD ELFE | 32 | 0.18 | A | 2.90 | 1.45 | 5.80 | 0.50 | 100 | 4.27 | 0.66 | 1.43 | 1.05 | 1.94 | 0.74 | 40 | 4.33 | 0.025 | C | 1.11 |
| GRP-F | PHÖNIX T | 29 | 0.12 | C | 3.20 | 1.55 | 6.61 | 0.48 | 35 | 4.04 | 0.54 | 0.95 | 1.21 | 0.75 | 1.27 | 58 | 4.33 | 0.022 | | |
| GRP-F | SB 6 | 28 | 0.13 | B | 2.60 | 1.20 | 5.63 | 0.46 | 100 | 4.47 | 0.57 | 1.50 | 1.27 | 1.77 | 0.85 | 40 | 4.51 | 0.024 | A | |
| GRP-F | SB 7B | 35 | 0.12 | C | 2.50 | 1.05 | 5.95 | 0.42 | 100 | 4.10 | 0.46 | 1.35 | 1.00 | 1.82 | 0.74 | 37 | 4.12 | 0.019 | C | |
| GRP-F | BS 1 | 39 | 0.14 | C | 3.00 | 1.33 | 6.77 | 0.44 | 100 | 4.53 | 0.54 | 1.35 | 1.33 | 1.37 | 0.99 | 40 | 4.66 | 0.024 | C | |
| GRP-F | D 36 | 38 | 0.14 | C | 2.30 | 1.00 | 5.29 | 0.43 | 21 | 3.89 | 0.42 | 1.57 | 1.27 | 1.94 | 0.81 | 52 | 4.02 | 0.022 | C | |
| GRP-F | ASW 12 | 37 | 0.15 | C | 2.50 | 1.00 | 6.25 | 0.40 | 35 | 4.17 | 0.45 | 1.50 | 1.20 | 1.88 | 0.80 | 50 | 4.30 | 0.022 | A | |
| GRP-F | CIRRUS B | 37 | 0.15 | B | 2.50 | 1.05 | 5.95 | 0.42 | 28 | 4.16 | 0.49 | 1.48 | 1.15 | 1.90 | 0.78 | 45 | 4.30 | 0.022 | C | |
| GRP-F | PHOEBUS C | 32 | 0.16 | C | 3.20 | 1.56 | 6.56 | 0.49 | 100 | 4.24 | 0.57 | 1.20 | 1.16 | 1.24 | 0.97 | 49 | 4.28 | 0.020 | C | |
| GRP-F | SB 8 | 34 | 0.15 | C | 2.70 | 1.30 | 5.61 | 0.48 | 30 | 4.65 | 0.55 | 1.45 | 1.30 | 1.62 | 0.90 | 35 | 4.72 | 0.024 | C | |
| GRP-F | DIAMANT 18 | 41 | 0.16 | C | 2.80 | 1.19 | 6.59 | 0.43 | 100 | 4.67 | 0.49 | 1.32 | 1.01 | 1.73 | 0.77 | 59 | 4.63 | 0.018 | C | |
| GRP-F | KESTREL 401 | 39 | 0.09 | C | 2.85 | 1.28 | 6.35 | 0.45 | 19 | 3.76 | 0.61 | 1.30 | 1.00 | 1.69 | 0.77 | 35 | 3.85 | 0.020 | C | |
| GRP-F | SB 9 | 43 | 0.15 | C | 2.70 | 1.30 | 5.61 | 0.48 | 30 | 4.40 | 0.53 | 1.40 | 1.30 | 1.51 | 0.93 | 43 | 4.65 | 0.018 | C | |
| GRP-F | NIMBUS II | 38 | 0.12 | C | 2.40 | 1.02 | 5.65 | 0.43 | 100 | 4.60 | 0.46 | 1.27 | 1.24 | 1.30 | 0.98 | 38 | 4.46 | 0.019 | σ FIG.15 | |
| GRP-F | KESTREL 604 | 30 | 0.09 | C | 3.55 | 1.50 | 8.40 | 0.42 | 50 | 4.40 | 0.55 | 1.35 | 1.29 | 1.42 | 0.95 | 30 | 4.45 | 0.016 | | |
| GRP-F | ASW 17 | 37 | 0.12 | B | 2.90 | 1.43 | 5.88 | 0.49 | 30 | 4.22 | 0.55 | 1.70 | 1.44 | 2.01 | 0.84 | 51 | 4.43 | 0.021 | σ FIG.15 | |
| GRP-F | SB 10 [29 m] | 68 | 0.16 | B | 3.30 | 1.47 | 7.41 | 0.45 | 41 | 5.74 | 0.47 | 2.40 | 2.61 | 2.20 | 1.09 | 49 | 6.14 | 0.024 | B σ u | |
| GRP-F | FS 29 [13 m] [19 m] | 46 32 | 0.24 | C | 2.40 | 1.03 | 5.59 | 0.43 | 100 | 4.64 4.63 | 1.41 0.94 | 1.27 | 1.24 | 1.30 | 0.98 | 38 | 4.50 4.49 | 0.048 0.023 | σ A | |

W&C-15 = WOOD AND CALICO CONSTR. 15 m CLASS = COSTR. LEGNO E TELA, CLASSE 15 m

GRP-F = GLASS REINFOR. PLASTIC CONSTR. FREE CLASS = COSTRUZIONE IN VETRORESINA CLASSE LIBERA

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TABLE 7.2.1

| Group | Sailplane | 1 FIRST FLIGHT / PRIMO VOLO (YEAR) [ANNO] | 2 TAKE OFF WEIGHT* / PESO AL DECOLLO (W) [Kg] | 3 MAX. TAKE OFF W. / PESO MAX. DECOLLO (W') [Kg] | 4 WING WEIGHT / PESO ALA (Ww) [Kg] | 5 FUSELAGE WEIGHT** / PESO FUSOLIERA (Wf) [Kg] | 6 STABILATOR WEIGHT / PESO STABILIZZATORE (Wt) [Kg] | 7 BALLAST WATER / ZAVORRA ACQUA (Wb) [Kg] | 8 OVERALL LENGTH / LUNGHEZZA F.T. (L) [m] | 9 WING SPAN / APERTURA ALARE (b=2s) [m] | 10 ASPECT RATIO / ALLUNGAMENTO (AR) [–] | 11 WING AREA / SUPERFICIE ALARE (S) [m²] | 12 MIN. WING LOADING / CARICO ALARE MIN. (W/S) [Kg/m²] | 13 MAX. WING LOADING / CARICO ALARE MAX. (W'/S) [Kg/m²] | 14 MEAN WING CHORD / CORDA MEDIA ALARE (c) [m] | 15 ROOT WING CHORD / CORDA ALARE: RADICE (cr) [m] | 16 TIP WING CHORD / CORDA ALARE: ESTR. (ce) [m] | 17 WING PLANFORM / PIANTA ALARE (FIG.6) | 18 TAPER RATIO / RAPP. RASTRENAZ. (TR) [ce/cr] | 19 TAPER POINT / INIZIO RASTREM. (yi) [%s] | 20 WING TWIST / SVERGOLAM. ALA (αw) [°] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W&C-15 m | STANDARD ELFE | 1965 | 234 | 350 | 147 | 89 | 8 | - | 7.30 | 15.0 | 19.0 | 11.86 | 23.2 | 29.5 | 0.79 | 0.90 | 0.37 | RT | 0.41 | 0.57 | 0 |
| GRP-F | PHÖNIX T | 1957 | 269 | 300 | 96 | 75 | 8 | - | 6.90 | 16.0 | 17.8 | 14.36 | 18.7 | 20.9 | 0.81 | 1.25 | 0.53 | T | 0.42 | - | -2 |
| GRP-F | SB 6 | 1961 | 350 | 350 | 145 | 119 | 6 | - | 7.50 | 18.0 | 24.9 | 13.00 | 26.9 | 26.9 | 0.72 | 0.90 | 0.48 | DT | 0.53 | 0.66 | 0 |
| GRP-F | SB 7B | 1962 | 390 | 390 | 181 | 112 | 7 | - | 7.08 | 17.0 | 22.8 | 12.66 | 30.8 | 30.8 | 0.74 | 0.92 | 0.37 | RT | 0.36 | 0.41 | |
| GRP-F | BS 1 | 1962 | 425 | 500 | 192 | 134 | 9 | - | 7.58 | 18.0 | 22.8 | 14.20 | 29.9 | 35.2 | 0.79 | 0.99 | 0.40 | DT | 0.41 | 0.56 | 0 |
| GRP-F | D 36 | 1964 | 375 | 401 | 166 | 110 | 9 | - | 7.35 | 17.8 | 24.8 | 12.80 | 29.3 | 31.3 | 0.72 | 0.95 | 0.34 | DT | 0.36 | 0.60 | -3 |
| GRP-F | ASW 12 | 1965 | 409 | 430 | 194 | 117 | 8 | - | 7.35 | 18.3 | 25.8 | 13.00 | 31.5 | 33.1 | 0.71 | 0.76 | 0.26 | DT | 0.34 | 0.59 | -3 |
| GRP-F | CIRRUS B | 1967 | 366 | 400 | 165 | 104 | 7 | 100 | 7.20 | 17.7 | 24.9 | 12.60 | 29.0 | 31.7 | 0.71 | 0.87 | 0.35 | DT | 0.40 | 0.58 | -2 |
| GRP-F | PHOEBUS C | 1967 | 333 | 459 | 176 | 85 | 9 | - | 6.98 | 17.0 | 20.6 | 14.06 | 23.7 | 32.6 | 0.83 | 1.21 | 0.37 | T | 0.31 | - | |
| GRP-F | SB 8 | 1967 | 301 | 334 | 129 | 76 | 6 | - | 7.70 | 18.0 | 23.0 | 14.10 | 21.3 | 23.7 | 0.78 | 0.97 | 0.45 | DT | 0.46 | 0.62 | -3 |
| GRP-F | DIAMANT 18 | 1967 | 385 | 440 | 182 | 105 | 8 | - | 7.72 | 18.0 | 22.7 | 14.28 | 27.0 | 30.8 | 0.79 | 0.93 | 0.36 | RT | 0.39 | 0.56 | |
| GRP-F | KESTREL 401 | 1968 | 362 | 400 | 149 | 115 | 8 | 50 | 6.72 | 17.0 | 25.0 | 11.58 | 32.3 | 34.5 | 0.68 | 0.71 | 0.32 | DT | 0.45 | 0.59 | 0 |
| GRP-F | SB 9 | 1969 | 415 | 421 | 218 | 100 | 7 | 100 | 7.50 | 22.0 | 31.3 | 15.48 | 26.8 | 27.2 | 0.70 | 0.97 | 0.25 | DT | 0.26 | 0.51 | -1.5 |
| GRP-F | NIMBUS II | 1969 | 446 | 580 | 230 | 120 | 6 | 150 | 7.28 | 20.3 | 28.6 | 14.41 | 31.0 | 40.2 | 0.71 | 0.76 | 0.27 | DT | 0.36 | 0.57 | 0 |
| GRP-F | KESTREL 604 | 1970 | 551 | 650 | 294 | 159 | 8 | 100 | 7.56 | 22.0 | 29.8 | 16.23 | 33.9 | 40.0 | 0.74 | 0.98 | 0.40 | DT | 0.41 | 0.68 | |
| GRP-F | ASW 17 | 1971 | 495 | 570 | 266 | 127 | 11 | 180 | 7.55 | 20.0 | 27.0 | 14.84 | 33.4 | 38.4 | 0.74 | 0.94 | 0.40 | DT | 0.43 | 0.61 | 0 |
| GRP-F | SB 10 [29 m] | 1972 | 647 | 897 | 419 | 127 | 11 | 100 | 10.36 | 29.0 | 36.7 | 22.90 | 28.3 | 39.0 | 0.79 | 0.97 | 0.77 0.29 | DT | 0.80 0.30 | 0.30 0.67 | -1.5 |
| GRP-F | FS 29 [13 m] [19 m] | 1975 | 458 | 461 | 241 | 121 | 6 | (70) | 7.16 | 13.3 19.0 | 20.7 28.5 | 8.67 12.65 | 52.8 36.2 | 53.2 36.4 | 0.65 0.67 | 0.76 0.73 | 0.41 0.49 | RT | 0.40 | 0.54 0.68 | -1.5 |

REMARKS NOTE

** = FUSELAGE PLUS VERTICAL TAIL / FUSOLIERA PIU' CODA VERTICALE

* = EMPTY WEIGHT PLUS 90 KG / PESO A VUOTO PIU' 90 KG

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TABLE 7.3.2

TWS = TWIN SEAT SAILPLANES
= ALIANTI BIPOSTO

✱ = METAL CONSTRUCTION
= COSTRUZ. METALLICA

| | 21 AILERON SPAN / APERT. ALETT. sa [%s] | 22 AIL. MEAN CHORD / CORDA MEDIA AL. ca [m] | 23 EMPENN. ARRAN. / SIST. IMPENN. FIG.7 | 24 STABILATOR SPAN / APERT. STABIL. bt [m] | 25 STABILATOR AREA / SUP. STABILIZZ. st [m²] | 26 STABILATOR AR / ALLUNG. STAB ARt [–] | 27 STAB. MEAN CHORD / CORDA MEDIA STA. ct [m] | 28 ELEVATOR CHORD / CORDA ELEVATORE ht [%ct] | 29 ELEV. LEVER ARM / BRACCIO ELEV. A [m] | 30 TAIL VOL. COEFF. / RAPP. VOLUMETR. TVC [–] | 31 FIN HEIGHT / ALTEZZA DERIVA y [m] | 32 TOTAL FIN AREA / SUP. TOT. DERIVA sv [m²] | 33 FIN ASPEC. R. / ALLUNG. DERIVA ARv [–] | 34 FIN MEAN CH. / CORDA M. DERIVA cv [m] | 35 RUDDER CHORD / CORDA DIREZ. hv [%cv] | 36 RUDDER L. ARM / BRACCIO DIR. B [m] | 37 TAIL VOL. COEF. / RAPP. VOLUM. VVC [–] | 38 SPOILERS ARR. / SIST. DIRUTT. FIG.15 | 39 AIR BRAKE SPAN / APERT. DIRUTT. sb [m] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KRANICH II | 69 | 0.40 | A | 3.00 | 2.20 | 4.09 | 0.73 | 45 | 4.35 | 0.33 | 1.58 | 1.36 | 1.82 | 0.86 | 73 | 4.78 | 0.016 | C | 1.67 |
| GOEVIER | 61 | 0.34 | A | 3.18 | 2.64 | 3.83 | 0.83 | 42 | 4.26 | 0.46 | 1.74 | 1.72 | 1.76 | 0.99 | 64 | 4.64 | 0.028 | C | 0.90 |
| KRANICH III | 46 | 0.37 | A | 3.50 | 2.32 | 5.28 | 0.66 | 41 | 4.70 | 0.45 | 1.26 | 1.68 | 0.95 | 1.33 | 82 | 5.00 | 0.022 | C | 1.21 |
| BERGFALKE II/55 | 46 | 0.26 | A | 2.80 | 2.00 | 3.92 | 0.71 | 46 | 4.11 | 0.43 | 1.27 | 1.09 | 1.48 | 0.86 | 77 | 4.87 | 0.018 | C | 1.10 |
| BOCIAN | 48 | 0.34 | A | 3.85 | 2.80 | 5.29 | 0.73 | 45 | 4.35 | 0.52 | 1.63 | 1.51 | 1.76 | 0.93 | 60 | 4.85 | 0.020 | C | 1.18 |
| BLANIK ✱ | 42 | 0.34 | A | 3.45 | 2.66 | 4.47 | 0.77 | 42 | 4.76 | 0.56 | 1.53 | 1.61 | 1.46 | 1.05 | 56 | 4.74 | 0.024 | C | |
| Ka 7 | 37 | 0.27 | A | 3.00 | 2.55 | 3.53 | 0.85 | 42 | 4.43 | 0.59 | 1.45 | 1.34 | 1.57 | 0.92 | 58 | 4.95 | 0.024 | C | 1.47 |
| ASK 13 | 37 | 0.27 | A | 3.00 | 2.55 | 3.53 | 0.85 | 42 | 4.40 | 0.58 | 1.45 | 1.21 | 1.74 | 0.83 | 57 | 5.05 | 0.022 | C | 1.47 |
| CALIF | 28 | 0.18 | C | 3.15 | 1.70 | 5.84 | 0.54 | 20 | 5.08 | 0.68 | 1.95 | 1.34 | 2.84 | 0.69 | 47 | 4.92 | 0.020 | B | 3.50 |
| SB 10 [26 m] | 64 | 0.16 | B | 3.30 | 1.47 | 7.43 | 0.44 | 41 | 5.74 | 0.46 | 2.40 | 2.61 | 2.20 | 1.09 | 49 | 6.14 | 0.028 | °Bu | 1.20 |
| LSD-ORNITH | | | C | 2.30 | 0.84 | 6.30 | 0.37 | 100 | | | 1.30 | 1.20 | 1.41 | 0.92 | | | | | |
| JANUS | 37 | 0.15 | C | 2.70 | 1.24 | 5.88 | 0.46 | 100 | 5.39 | 0.44 | 1.30 | 1.24 | 1.36 | 0.95 | 30 | 5.25 | 0.021 | °C | 1.21 |
| TWIN ASTIR | 36 | 0.18 | C | 3.30 | 2.05 | 5.31 | 0.62 | 27 | 4.81 | 0.52 | 1.60 | 1.43 | 1.79 | 0.89 | 38 | 4.68 | 0.021 | °C | 1.40 |
| GLOBETROTTER | | | C | 2.75 | 1.47 | 5.14 | 0.53 | | | | 1.20 | 1.00 | 1.44 | 0.83 | | | | °C | |
| B-12 | 37 | 0.15 | B | 3.28 | 1.44 | 7.47 | 0.44 | | | | 1.79 | 1.46 | 2.19 | 0.82 | | | | °C | 1.21 |
| SFH 34 | | | C | | | | | 25 | | | | | | | 40 | | | °C | 1.40 |
| ASK 21 | | | C | | | | | | | | | | | | | | | °C | |
| PHOEBUS B1 | 32 | 0.17 | C | 3.20 | 1.56 | 6.56 | 0.49 | 100 | 4.24 | | 1.20 | 1.16 | 1.24 | 0.97 | 49 | 4.28 | 0.045 | °C | 1.51 |

TWS: KRANICH II – ASK 21





TABLE 7.3.1

REMARKS NOTE

** = FUSELAGE PLUS VERTICAL TAIL
FUSOLIERA PIU' CODA VERTICALE

* = EMPTY WEIGHT PLUS 90 KG
PESO A VUOTO PIU' 90 KG

✱ = METAL CONSTRUCTION
= COSTRUZ. METALLICA

| | 1 FIRST FLIGHT / PRIMO VOLO YEAR ANNO | 2 TAKE OFF WEIGHT* / PESO AL DECOLLO W [Kg] | 3 MAX. TAKE OFF W. / PESO MAX. DECOLLO W' [Kg] | 4 WING WEIGHT / PESO ALA Ww [Kg] | 5 FUSELAGE WEIGHT** / PESO FUSOLIERA Wf [Kg] | 6 STABILATOR WEIGHT / PESO STABILIZZATORE Wt [Kg] | 7 BALLAST WATER / ZAVORRA ACQUA Wb [Kg] | 8 OVERALL LENGTH / LUNGHEZZA F.T. L [m] | 9 WING SPAN / APERTURA ALARE b=2s [m] | 10 ASPECT RATIO / ALLUNGAMENTO AR [–] | 11 WING AREA / SUPERFICIE ALARE S [m²] | 12 MIN. WING LOADING / CARICO ALARE MIN. W/S [Kg/m²] | 13 MAX. WING LOADING / CARICO ALARE MAX. W'/S [Kg/m²] | 14 MEAN WING CHORD / CORDA MEDIA ALARE c [m] | 15 ROOT WING CHORD / CORDA ALARE: RADICE cr [m] | 16 TIP WING CHORD / CORDA ALARE: ESTR. ce [m] | 17 WING PLANFORM / PIANTA ALARE FIG.6 | 18 TAPER RATIO / RAPP. RASTRENAZ. TR [ce/cr] | 19 TAPER POINT / INIZIO RASTREM. yi [%s] | 20 WING TWIST / SVERGOLAM. ALA αw [°] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KRANICH II | 1935 | 380 | 465 | 163 | 117 | 10 | – | 7.70 | 18.00 | 14.3 | 22.70 | 16.7 | 20.5 | 1.26 | 1.60 | 0.61 | RT | 0.38 | 0.33 | – |
| GOEVIER | 1938 | 325 | 410 | 122 | 102 | 11 | – | 6.24 | 14.84 | 11.6 | 19.00 | 17.1 | 21.6 | 1.28 | 1.45 | 0.56 | RT | 0.39 | 0.37 | 0 |
| KRANICH III | 1951 | 410 | 520 | 204 | 105 | 11 | – | 9.10 | 18.10 | 15.6 | 21.06 | 19.5 | 24.7 | 1.16 | 1.75 | 0.58 | T | 0.33 | – | -8 |
| BERGFALKE II/55 | 1951 | 349 | 440 | 152 | 97 | 10 | – | 7.88 | 16.60 | 15.6 | 17.70 | 19.7 | 24.9 | 1.07 | 1.51 | 0.91 | T | 0.40 | – | 0 |
| BOCIAN | 1952 | 423 | 510 | 166 | 155 | 12 | – | 8.00 | 18.11 | 16.4 | 20.00 | 21.2 | 25.5 | 1.10 | 1.60 | 0.53 | T | 0.33 | – | -2 |
| BLANIK ✱ | 1956 | 382 | 500 | 172 | 106 | 14 | – | 8.40 | 16.20 | 13.7 | 19.15 | 19.9 | 26.1 | 1.18 | 1.67 | 0.70 | T | 0.42 | – | -3 |
| Ka 7 | 1957 | 382 | 480 | 162 | 120 | 10 | – | 8.10 | 16.00 | 14.6 | 17.50 | 21.8 | 27.4 | 1.09 | 1.50 | 0.61 | T | 0.41 | – | -4 |
| ASK 13 | 1965 | 408 | 480 | 161 | 147 | 10 | – | 8.18 | 15.95 | 14.5 | 17.50 | 23.3 | 27.4 | 1.10 | 1.50 | 0.61 | T | 0.41 | – | -4 |
| CALIF | 1970 | 532 | 644 | 257 | 169 | 16 | – | 7.74 | 20.38 | 25.7 | 16.19 | 32.9 | 39.8 | 0.79 | 0.90 | 0.68 | RT | 0.36 | 0.63 | 0 |
| SB 10 [26 m] | 1972 | 708 | 889 | 397 | 211 | 10 | 100 | 10.36 | 26.00 | 31.0 | 21.80 | 32.4 | 40.8 | 0.84 | 0.97 | 0.77 / 0.45 | RT | 0.80 / 0.46 | 0.34 / 0.82 | -.5 |
| LSD-ORNITH | 1972 | 377 | 450 | | | | | 7.50 | 18.00 | 26.1 | 12.40 | 29.0 | 36.3 | | 0.96 | | | | | |
| JANUS | 1974 | 472 | 620 | 220 | 154 | 8 | – | 8.57 | 18.20 | 20.0 | 16.60 | 28.4 | 37.3 | 0.91 | 1.20 | 0.48 | DT | 0.40 | 0.59 | 0 |
| TWIN ASTIR | 1976 | 495 | 650 | 194 | 196 | 15 | 100 | 8.10 | 17.50 | 17.1 | 17.90 | 27.7 | 36.3 | 1.05 | 1.30 | 0.66 | DT | 0.51 | 0.58 | 0 |
| GLOBETROTTER | 1977 | 498 | 600 | | | | | 7.66 | 17.00 | 18.1 | 15.72 | 31.7 | 35.2 | | 1.30 | | DT | | | 0 |
| B-12 | 1977 | 492 | 582 | | | | | 8.67 | 18.20 | 20.0 | 16.60 | 29.6 | 35.1 | 0.91 | 1.20 | 0.48 | DT | 0.40 | 0.59 | 0 |
| SFH 34 | 1978 | 390 | 490 | | | | | 7.50 | 15.80 | 17.0 | 14.80 | 26.4 | 33.1 | 1.07 | | | T | | | |
| ASK 21 | 1979 | 440 | 550 | | | | | 8.35 | 17.00 | 16.1 | 17.95 | 24.5 | 30.6 | 1.06 | | | T | | | |
| PHOEBUS B1 | 1964 | 314 | 350 | | | | | 6.98 | 15.0 | 17.2 | 13.11 | 24.0 | 26.7 | 0.87 | 1.21 | | DT | | | |

TWS: KRANICH II – ASK 21

TABLE 7.4.2

GRP-S = GLASS REINFORC. CONSTRUCTION, STANDARD CLASS = COSTRUZIONE IN VETRORESINA, CLASSE STANDARD

GRP-15 = GLASS REINFORCED CONSTRUCTION, 15 m CLASS = COSTRUZIONE IN VETRORESINA, CLASSE 15 m

| Group | | 21 AILERON SPAN / APERT. ALETT. | 22 AIL. MEAN CHORD / CORDA MEDIA AL. | 23 EMPENN. ARRAN. / SIST. IMPENN. | 24 STABILATOR SPAN / APERT. STABIL. | 25 STABILATOR AREA / SUP. STABILIZZ. | 26 STABILATOR AR / ALLUNG. STAB | 27 STAB. MEAN CHORD / CORDA MEDIA STA. | 28 ELEVATOR CHORD / CORDA ELEVATORE | 29 ELEV. LEVER ARM / BRACCIO ELEV. | 30 TAIL VOL. COEFF. / RAPP. VOLUMETR. | 31 FIN HEIGHT / ALTEZZA DERIVA | 32 TOTAL FIN AREA / SUP. TOT. DERIVA | 33 FIN ASPEC. R. / ALLUNG. DERIVA | 34 FIN MEAN CH. / CORDA M. DERIVA | 35 RUDDER CHORD / CORDA DIREZ. | 36 RUDDER L. ARM / BRACCIO DIR. | 37 TAIL VOL. COEF. / RAPP. VOLUM. | 38 SPOILERS ARR. / SIST. DIRUTT. | 39 AIR BRAKE SPAN / APERT. DIRUTT. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | sa | ca | FIG. 7 | bt | st | ARt | ct | ht | A | TVC | y | sv | ARv | cv | hv | B | VVC | FIG. 15 | sb |
| | | [%s] | [m] | | [m] | [m²] | [–] | [m] | [%ct] | [m] | [–] | [m] | [m²] | [–] | [m] | [%cv] | [m] | [–] | | [m] |
| GRP-S | LS 1 C | 35 | 0.14 | C | 2.30 | 0.84 | 6.30 | 0.37 | 100 | 4.05 | 0.54 | 1.30 | 1.00 | 1.69 | 0.77 | 35 | 4.10 | 0.028 | °C | 0.93 |
| GRP-S | STANDARD LIBELLE | 39 | 0.10 | B | 2.50 | 1.16 | 5.39 | 0.46 | 21 | 3.65 | 0.66 | 1.19 | 0.78 | 1.82 | 0.66 | 40 | 3.59 | 0.019 | C | 1.20 |
| GRP-S | FS 25 | 36 | 0.11 | C | 2.00 | 0.72 | 5.56 | 0.36 | 100 | 4.05 | 0.60 | 1.20 | 0.72 | 2.00 | 0.60 | 40 | 4.05 | 0.023 | B | 1.20 |
| GRP-S | ASW 15 B | 33 | 0.17 | B | 2.62 | 1.15 | 5.97 | 0.44 | 100 | 3.45 | 0.49 | 1.48 | 1.13 | 1.94 | 0.76 | 47 | 3.66 | 0.025 | C | 1.00 |
| GRP-S | STANDARD CIRRUS | 33 | 0.12 | C | 2.40 | 1.02 | 5.65 | 0.43 | 100 | 3.85 | 0.58 | 1.20 | 0.95 | 1.52 | 0.79 | 35 | 3.79 | 0.024 | °C | 1.20 |
| GRP-S | D 38 | 35 | 0.17 | C | 2.30 | 1.00 | 5.29 | 0.43 | 100 | 4.27 | 0.53 | 1.25 | 0.92 | 1.98 | 0.63 | 40 | 4.29 | 0.021 | °C | 1.35 |
| GRP-S | STANDARD JANTAR | 32 | 0.11 | C | 2.60 | 1.35 | 5.01 | 0.52 | 29 | 3.92 | 0.45 | 1.35 | 1.10 | 1.66 | 0.81 | 42 | 3.98 | 0.027 | C | 1.33 |
| GRP-S | LS 1f | 35 | 0.14 | C | 2.20 | 0.98 | 4.94 | 0.45 | 25 | 3.95 | 0.61 | 1.15 | 0.90 | 1.47 | 0.78 | 35 | 3.99 | 0.025 | °C | 1.35 |
| GRP-S | DG 100 | 35 | 0.17 | C | 2.30 | 1.00 | 5.29 | 0.43 | 100 | 4.29 | 0.53 | 1.24 | 0.92 | 1.67 | 0.74 | 50 | 4.29 | 0.024 | °C | 1.34 |
| GRP-S | ASTIR CS | 33 | 0.18 | C | 2.80 | 1.50 | 5.23 | 0.54 | 25 | 4.05 | 0.59 | 1.22 | 0.96 | 1.55 | 0.79 | 30 | 4.04 | 0.021 | °C | 1.21 |
| GRP-S | HORNET | 39 | 0.10 | C | 2.50 | 1.15 | 5.43 | 0.46 | 25 | 3.74 | 0.68 | 1.15 | 0.89 | 1.49 | 0.77 | 30 | 3.73 | 0.023 | B | 3.72 |
| GRP-S | ASW 19 | 33 | 0.15 | C | 2.50 | 1.10 | 5.68 | 0.44 | 30 | 3.82 | 0.52 | 1.25 | 1.00 | 1.56 | 0.80 | 30 | 3.84 | 0.023 | °C | 1.20 |
| GRP-15m | LIBELLE H-301 | 44 | 0.12 | B | 2.50 | 1.00 | 6.25 | 0.40 | 25 | 3.62 | 0.60 | 1.19 | 0.78 | 1.82 | 0.66 | 40 | 3.50 | 0.019 | C | 1.20 |
| GRP-15m | PIK 20D | 94 | 0.13 | C | 2.00 | 1.00 | 4.00 | 0.50 | 23 | 3.66 | 0.55 | 1.20 | 0.93 | 1.55 | 0.78 | 31 | 3.60 | 0.022 | °C | 1.20 |
| GRP-15m | LS 3 | 95 | 0.16 | C | 2.20 | 0.89 | 5.44 | 0.40 | 25 | 3.95 | 0.48 | 1.32 | 1.00 | 1.74 | 0.76 | 35 | 3.90 | 0.025 | °C | 1.38 |
| GRP-15m | MOSQUITO | 45 | 0.11 | C | 2.50 | 1.15 | 5.43 | 0.46 | 25 | 3.88 | 0.70 | 1.40 | 0.90 | 2.18 | 0.64 | 30 | 3.90 | 0.024 | B | 3.20 |
| GRP-15m | MINI NIMBUS | 45 | 0.11 | C | 2.40 | 1.02 | 5.65 | 0.43 | 100 | 3.91 | 0.61 | 1.15 | 0.95 | 1.39 | 0.83 | 30 | 3.76 | 0.024 | B | 3.20 |
| GRP-15m | DG 200 | 40 | 0.09 | C | 2.24 | 0.95 | 5.30 | 0.42 | 27 | 4.23 | 0.60 | 1.21 | 0.88 | 1.66 | 0.73 | 50 | 4.24 | 0.025 | °C | 1.46 |





TABLE 7.4.1

REMARKS NOTE

** = FUSELAGE PLUS VERTICAL TAIL / FUSOLIERA PIU' CODA VERTICALE

* = EMPTY WEIGHT PLUS 90 KG / PESO A VUOTO PIU' 90 KG

| Group | | 1 FIRST FLIGHT / PRIMO VOLO | 2 TAKE OFF WEIGHT* / PESO AL DECOLLO | 3 MAX. TAKE OFF W. / PESO MAX. DECOLLO | 4 WING WEIGHT / PESO ALA | 5 FUSELAGE WEIGHT** / PESO FUSOLIERA | 6 STABILATOR WEIGHT / PESO STABILIZZATORE | 7 BALLAST WATER / ZAVORRA ACQUA | 8 OVERALL LENGTH / LUNGHEZZA F.T. | 9 WING SPAN / APERTURA ALARE | 10 ASPECT RATIO / ALLUNGAMENTO | 11 WING AREA / SUPERFICIE ALARE | 12 MIN. WING LOADING / CARICO ALARE MIN. | 13 MAX. WING LOADING / CARICO ALARE MAX. | 14 MEAN WING CHORD / CORDA MEDIA ALARE | 15 ROOT WING CHORD / CORDA ALARE: RADICE | 16 TIP WING CHORD / CORDA ALARE: ESTR. | 17 WING PLANFORM / PIANTA ALARE | 18 TAPER RATIO / RAPP. RASTREMAZ. | 19 TAPER POINT / INIZIO RASTREM. | 20 WING TWIST / SVERGOLAM. ALA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | YEAR | W | W' | Ww | Wf | Wt | Wb | L | b=2s | AR | S | W/S | W'/S | c | cr | ce | FIG. 6 | TR | yi | αw |
| | | ANNO | [Kg] | [Kg] | [Kg] | [Kg] | [Kg] | [Kg] | [m] | [m] | [–] | [m²] | [Kg/m²] | [Kg/m²] | [m] | [m] | [m] | | [ce/cr] | [%s] | [°] |
| GRP-S | LS 1 c | 1967 | 293 | 312 | 107 | 91 | 5 | - | 7.20 | 15.0 | 23.1 | 9.74 | 30.1 | 32.0 | 0.65 | 0.85 | 0.32 | DT | 0.38 | 60 | -2 |
| GRP-S | STANDARD LIBELLE | 1967 | 289 | 350 | 108 | 84 | 7 | 50 | 6.20 | 15.0 | 23.0 | 9.80 | 29.5 | 35.7 | 0.65 | 0.88 | 0.35 | DT | 0.40 | 58 | -2.5 |
| GRP-S | FS 25 | 1968 | 238 | 250 | 78 | 66 | 4 | - | 6.48 | 15.0 | 26.3 | 8.54 | 27.9 | 29.3 | 0.57 | 0.76 | 0.24 | DT | 0.32 | 74 | 0 |
| GRP-S | ASW 15 B | 1968 | 324 | 408 | 135 | 90 | 9 | 82 | 6.48 | 15.0 | 20.5 | 11.00 | 29.5 | 37.1 | 0.73 | 0.91 | 0.38 | DT | 0.42 | 59 | -2 |
| GRP-S | STANDARD CIRRUS | 1969 | 302 | 390 | 110 | 95 | 7 | 60 | 6.35 | 15.0 | 22.4 | 10.04 | 30.1 | 38.8 | 0.67 | 0.92 | 0.35 | DT | 0.38 | 60 | -0.75 |
| GRP-S | D 38 | 1972 | 306 | 360 | 118 | 91 | 7 | 40 | 6.92 | 15.0 | 20.5 | 11.0 | 27.8 | 32.7 | 0.73 | 0.94 | 0.37 | DT | 0.40 | 60 | -2.6 |
| GRP-S | STANDARD JANTAR | 1973 | 340 | 440 | 136 | 106 | 8 | 100 | 7.11 | 15.0 | 21.1 | 10.66 | 31.9 | 41.3 | 0.71 | 0.95 | 0.45 | T | 0.47 | - | -3 |
| GRP-S | LS 1f | 1974 | 317 | 390 | 119 | 102 | 6 | 90 | 6.70 | 15.0 | 23.1 | 9.75 | 32.5 | 40.0 | 0.65 | 0.84 | 0.32 | DT | 0.38 | 60 | -2 |
| GRP-S | DG 100 | 1974 | 316 | 418 | 120 | 98 | 8 | 100 | 7.00 | 15.0 | 20.5 | 11.0 | 28.7 | 38.0 | 0.73 | 0.94 | 0.38 | DT | 0.40 | 60 | -1.8 |
| GRP-S | ASTIR CS | 1974 | 342 | 450 | 138 | 105 | 9 | 100 | 6.47 | 15.0 | 18.1 | 12.4 | 27.6 | 36.3 | 0.83 | 1.00 | 0.45 | DT | 0.45 | 60 | 0 |
| GRP-S | HORNET | 1974 | 334 | 420 | 124 | 112 | 8 | 100 | 6.40 | 15.0 | 23.0 | 9.8 | 34.1 | 42.9 | 0.65 | 0.88 | 0.35 | DT | 0.40 | 58 | -2.5 |
| GRP-S | ASW 19 | 1975 | 344 | 408 | 140 | 104 | 10 | 120 | 6.80 | 15.0 | 20.5 | 11.0 | 31.3 | 37.1 | 0.73 | 0.91 | 0.38 | DT | 0.42 | 59 | -2 |
| GRP-15 m | LIBELLE H-301 | 1964 | 275 | 300 | 105 | 75 | 5 | – | 6.18 | 15.0 | 23.7 | 9.5 | 28.9 | 31.6 | 0.63 | 0.94 | 0.33 | T | 0.35 | – | 0 |
| GRP-15 m | PIK 20 D | 1973 | 338 | 450 | 140 | 102 | 6 | 140 | 6.45 | 15.0 | 22.5 | 10.0 | 33.8 | 45.0 | 0.67 | 0.90 | 0.36 | DT | 0.40 | 60 | |
| GRP-15 m | LS 3 | 1976 | 370 | 472 | 158 | 115 | 7 | 150 | 6.86 | 15.0 | 21.4 | 10.5 | 35.2 | 45.0 | 0.70 | 0.97 | 0.46 | T | 0.47 | - | - |
| GRP-15 m | MOSQUITO | 1976 | 332 | 450 | 134 | 102 | 6 | 125 | 6.40 | 15.0 | 23.0 | 9.8 | 33.9 | 45.9 | 0.65 | 0.84 | 0.40 | DT | 0.48 | 47 | 0 |
| GRP-15 m | MINI NIMBUS | 1976 | 326 | 450 | 130 | 99 | 7 | 140 | 6.41 | 15.0 | 22.7 | 9.9 | 32.9 | 45.5 | 0.66 | 0.87 | 0.42 | DT | 0.48 | 47 | 0 |
| GRP-15 m | DG 200 | 1976 | 331 | 450 | 126 | 108 | 7 | 110 | 7.00 | 15.0 | 22.5 | 10.0 | 33.1 | 45.0 | 0.67 | 0.84 | 0.33 | DT | 0.40 | 68 | 0 |

TABLE 7.5.2

| Class | Sailplane | 21 AILERON SPAN / APERT. ALETT. | 22 AIL. MEAN CHORD / CORDA MEDIA AL. | 23 EMPENN. ARRAN. / SIST. IMPENN. | 24 STABILATOR SPAN / APERT. STABIL. | 25 STABILATOR AREA / SUP. STABILIZZ. | 26 STABILATOR AR / ALLUNG. STAB | 27 STAB. MEAN CHORD / CORDA MEDIA STA. | 28 ELEVATOR CHORD / CORDA ELEVATORE | 29 ELEV. LEVER ARM / BRACCIO ELEV. | 30 TAIL VOL. COEFF. / RAPP. VOLUMETR. | 31 FIN HEIGHT / ALTEZZA DERIVA | 32 TOTAL FIN AREA / SUP. TOT. DERIVA | 33 FIN ASPEC. R. / ALLUNG. DERIVA | 34 FIN MEAN CH. / CORDA M. DERIVA | 35 RUDDER CHORD / CORDA DIREZ. | 36 RUDDER L. ARM / BRACCIO DIR. | 37 TAIL VOL. COEF. / RAPP. VOLUM. | 38 SPOILERS ARR. / SIST. DIRUTT. | 39 AIR BRAKE SPAN / APERT. DIRUTT. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | sa | ca | FIG. 7 | bt | st | ARt | ct | ht | A | TVC | y | sv | ARv | cv | hv | B | VVC | FIG. 15 | sb |
| | | [%s] | [m] | | [m] | [m²] | [–] | [m] | [%ct] | [m] | [–] | [m] | [m²] | [–] | [m] | [%cv] | [m] | [–] | | [m] |
| GRP - 15 m | ASW 20 | 36 | 0.09 | C | 2.20 | 1.00 | 4.85 | 0.45 | 32 | 3.89 | 0.53 | 1.25 | 1.00 | 1.57 | 0.80 | 30 | 3.88 | 0.024 | σC | 1.40 |
| GRP - 15 m | SPEED ASTIR | 47 | 0.13 | C | 3.00 | 1.44 | 6.25 | 0.48 | 28 | 3.87 | 0.64 | 1.09 | 0.98 | 1.21 | 0.90 | 30 | 3.75 | 0.022 | σC | 1.50 |
| VGW | AN 66 C | | | B | | | | | | | | | | | | | | | | |
| VGW | SIGMA | | | C | 2.59 | 1.12 | 5.99 | 0.43 | | | | 1.83 | 1.44 | 2.33 | 0.79 | | | | | |
| VGW | SB 11 | 41 | 0.14 | C | 2.70 | 1.24 | 5.88 | 0.46 | 100 | 4.55 / 4.50 | 0.76 / 0.51 | 1.27 | 1.17 | 1.38 | 0.92 | 40 | 4.45 / 4.40 | 0.033 / 0.028 | σC | 1.20 |
| VGW | MÜ 27 | | | | | | | | | | | | | | | | | | | |
| AS | Lo 100 | 56 | 0.24 | B | 2.70 | 1.00 | 7.29 | 0.37 | 42 | 3.24 | 0.27 | 1.10 | 0.78 | 1.55 | 0.71 | 63 | 3.74 | 0.027 | B | 2.30 |
| AS | B 4 | 37 | 0.19 | C | 3.08 | 1.71 | 5.56 | 0.55 | 33 | 3.83 | 0.50 | 1.32 | 1.22 | 1.70 | 0.85 | 34 | 3.38 | 0.020 | C | 1.31 |
| AS | SALTO | 43 | 0.10 | D | 2.14 | 1.09 | 4.20 | 0.51 | 38 | 3.61 | 0.73 | 0.91 | 0.46 | 3.60 | 0.51 | 38 | 3.61 | 0.028 | B | 1.30 |

GRP-15 = GLASS REINFORCED CONSTRUCTION 15 m CLASS
= COSTRUZIONE IN VETRORESINA CLASSE 15 m

WGV = VARIABLE GEOMETRY WING
= ALA A GEOMETRIA VARIAB.

AS = AEROBATIC SAILPLANES
= ALIANTI ACROBATICI





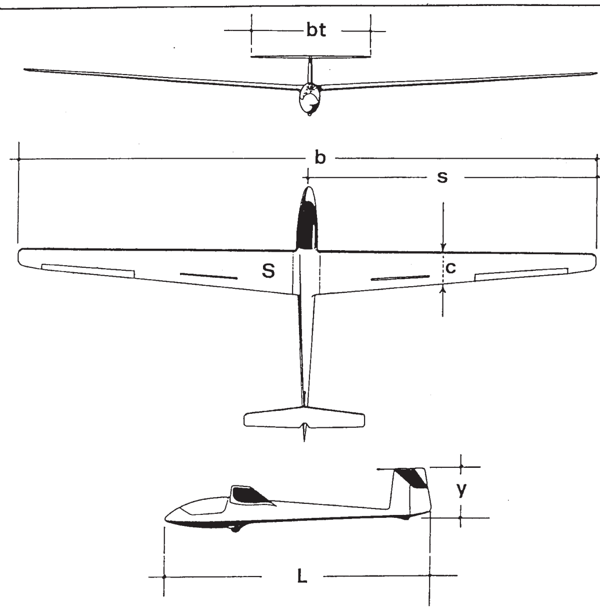
TABLE 7.5.1

| Class | Sailplane | 1 FIRST FLIGHT / PRIMO VOLO | 2 TAKE OFF WEIGHT* / PESO AL DECOLLO | 3 MAX. TAKE OFF W. / PESO MAX. DECOLLO | 4 WING WEIGHT / PESO ALA | 5 FUSELAGE WEIGHT** / PESO FUSOLIERA | 6 STABILATOR WEIGHT / PESO STABILIZZATORE | 7 BALLAST WATER / ZAVORRA ACQUA | 8 OVERALL LENGTH / LUNGHEZZA F.T. | 9 WING SPAN / APERTURA ALARE | 10 ASPECT RATIO / ALLUNGAMENTO | 11 WING AREA / SUPERFICIE ALARE | 12 MIN. WING LOADING / CARICO ALARE MIN. | 13 MAX. WING LOADING / CARICO ALARE MAX. | 14 MEAN WING CHORD / CORDA MEDIA ALARE | 15 ROOT WING CHORD / CORDA ALARE: RADICE | 16 TIP WING CHORD / CORDA ALARE: ESTR. | 17 WING PLANFORM / PIANTA ALARE | 18 TAPER RATIO / RAPP. RASTREMAZ. | 19 TAPER POINT / INIZIO RASTREM. | 20 WING TWIST / SVERGOLAM. ALA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | YEAR | W | W' | Ww | Wf | Wt | Wb | L | b=2s | AR | S | W/S | W'/S | c | cr | ce | FIG. 6 | TR | yi | αw |
| | | ANNO | [Kg] | [Kg] | [Kg] | [Kg] | [Kg] | [Kg] | [m] | [m] | [–] | [m²] | [Kg/m²] | [Kg/m²] | [m] | [m] | [m] | | [ce/cr] | [%s] | [°] |
| GRP - 15 m | ASW 20 | 1977 | 335 | 454 | 134 | 102 | 9 | 120 | 6.82 | 15.0 | 21.4 | 10.5 | 31.9 | 43.3 | 0.70 | 0.70 | 0.30 | DT | 0.43 | 63 | 0 |
| GRP - 15 m | SPEED ASTIR | 1978 | 365 | 515 | 134 | 119 | 11 | 140 | 6.68 | 15.0 | 19.6 | 11.47 | 31.8 | 44.9 | 0.76 | 1.03 | 0.50 | T | 0.49 | – | 0 |
| VGW | AN 66 C | 1973 | 510 | 650 | 300 | | | 120 | 8.10 | 23.0 | 33.8 / 27.6 | 16.0 / 19.2 | 31.9 / 26.2 | 40.6 / 33.9 | 0.74 / 0.84 | | | RT | | | |
| VGW | SIGMA | 1971 | 697 | 703 | | | | | 8.81 | 21.0 | 36.2 / 26.8 | 12.2 / 16.5 | 57.1 / 42.2 | 57.6 / 42.6 | 0.58 / 0.79 | | | RT | | 35 | |
| VGW | SB 11 | 1978 | 360 | 470 | 169 | 95 | 6 | 100 | 7.40 | 15.0 | 21.3 / 17.0 | 10.36 / 13.2 | 34.1 / 27.3 | 44.5 / 35.0 | 0.70 / 0.88 | 0.80 / 1.00 | 0.32 / 0.40 | RT | 0.40 | 60 | 0 |
| VGW | MÜ 27 | 1979 | | | | | | | 10.30 | 22.0 | 27.5 / 20.2 | 17.6 / 23.9 | | | | | | | | | |
| AS | Lo 100 | 1952 | 258 | 265 | 80 | 80 | 8 | – | 6.15 | 10.0 | 9.2 | 10.9 | 23.7 | 24.3 | 1.09 | 1.30 | 0.56 | RT | 0.43 | 30 | -3 |
| AS | B 4 | 1966 | 314 | 350 | 121 | 93 | 10 | | 6.57 | 15.0 | 16.1 | 14.0 | 22.4 | 25.0 | 0.93 | 1.07 | 0.43 | RT | 0.40 | 59 | 0 |
| AS | SALTO | 1970 | 259 | 270 | 86 | 75 | 8 | | 5.90 | 13.6 | 21.5 | 8.6 | 30.1 | 31.4 | 0.63 | 0.86 | 0.36 | DT | 0.42 | | -2 |

REMARKS NOTE

** = FUSELAGE PLUS VERTICAL TAIL
FUSOLIERA PIU' CODA VERTICALE

* = EMPTY WEIGHT PLUS 90 KG
PESO A VUOTO PIU' 90 KG



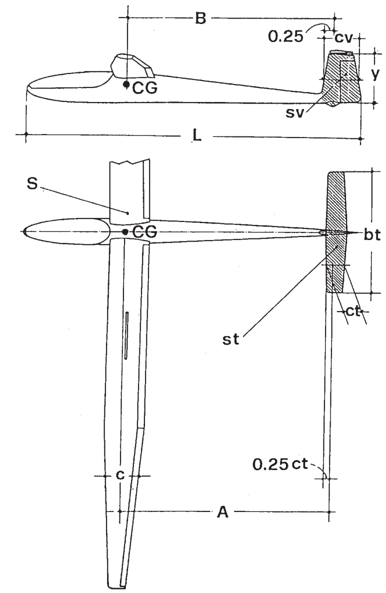

$$S = b*c \qquad AR = b/c = b^2/S$$

*Basic sailplane's parameters*
Parametri basilari dell'aliante

S = b*c = *Wing area* / Superficie alare
b = *2s = Wing span* / Apertura alare
L = *Overall length* / Lunghezza totale
*bt= Stabilator span* / Apertura stabilizzatore
c = *Wing mean chord* / Corda media alare
*y = Fin height* / Altezza deriva
AR= *b/c = B^2/S = Aspect ratio* / Allungamento

FIGURE 5



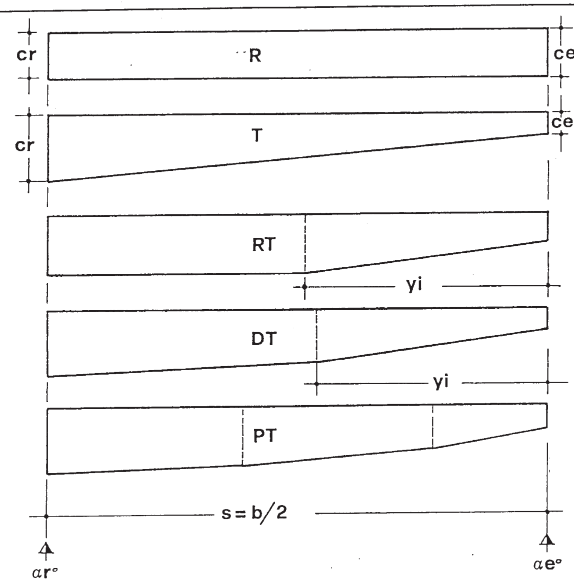



$$TVC = \frac{st*A}{S*c} \qquad VVC = \frac{B*sv}{S*b}$$

*Tail volume coefficients*
Rapporti volumetrici di coda

S = *Wing area* / Superficie alare
A = *Stabilator* arm / Braccio di leva stabilizzatore
B = *Rudder arm* / Braccio di leva direzionale
st= *Stabilator area* / Superficie stabilizzatore
sv= *Vertical tail area* / Superficie deriva
ct= *Stabilator mean chord* / Corda media stabilizzatore
cv= *Vertical tail mean chord* /Corda media deriva

FIGURE 6




$TR = ce/cr$

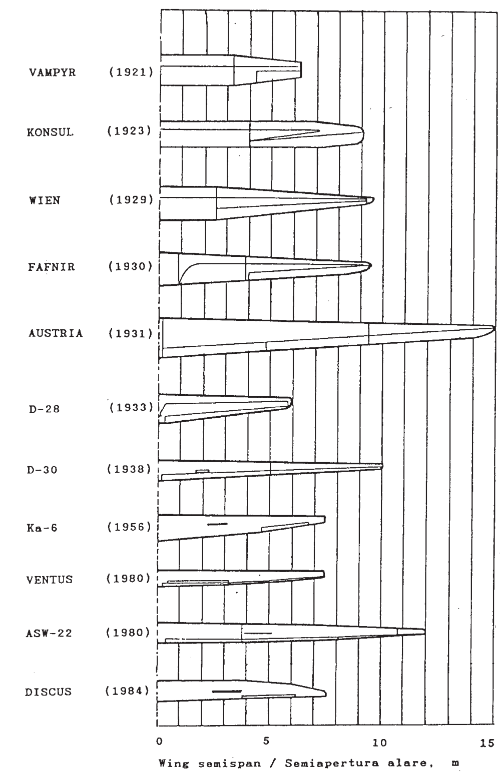
$\alpha w° = \alpha r° - \alpha e°$

*Wing planforms: style PT is just the "Schuemann" or TNT (Dornier) wing, if turned upside down*
Piante alari: PT, capovolta, e' la cosiddetta ala "Schuemann" o TNT (Dornier)

R = *Rectangular* / Rettangolare
T = *Tapered* / Rastremata
Rt= *Rectangular-tapered* / Rettangolare rastremata
TT= *Double tapered* / Doppia rastremazione
PT= *Multi-tapered* / Rastremazione multipla

FIGURE 7-A






*Evolution of sailplane wing planforms*
Evoluzione della pianta alare degli alianti

FIG.6-B

FIGURE 7-B

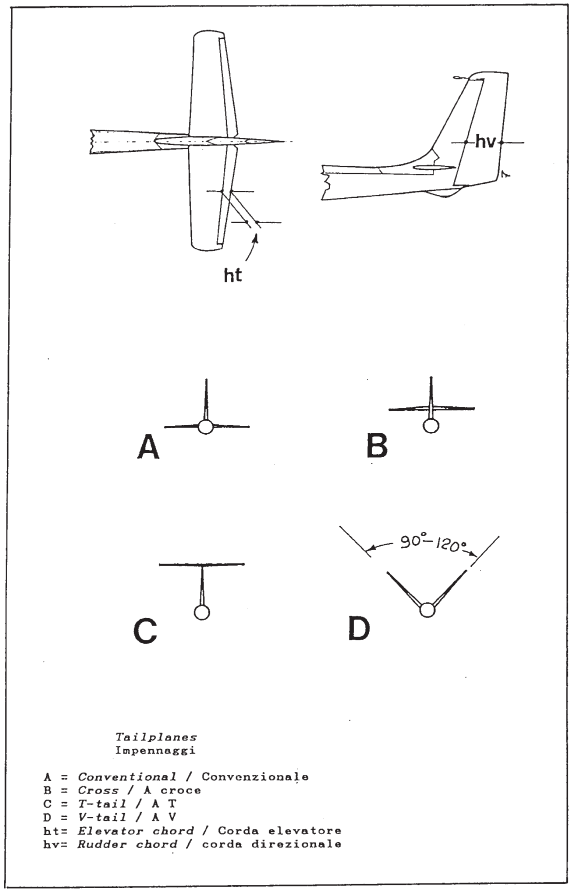



FIGURE 8





The ratio TVC — as it appears in any aerodynamics textbook — is one the fundamental parameters which define the static longitudinal stability. The ratio TVC is given by the relation

$$TVC = \left[\frac{st}{S}\right] \bullet \left[\frac{A}{c}\right]$$

where

st = stabilator area
A = wing-stabilator lever arm
S = wing area
c = wing mean chord

Similarly, the tail volume coefficient, VVC (vertical), is one of the parameters which define the static directional stability of any aerodyne, whether flying model or aeroplane.

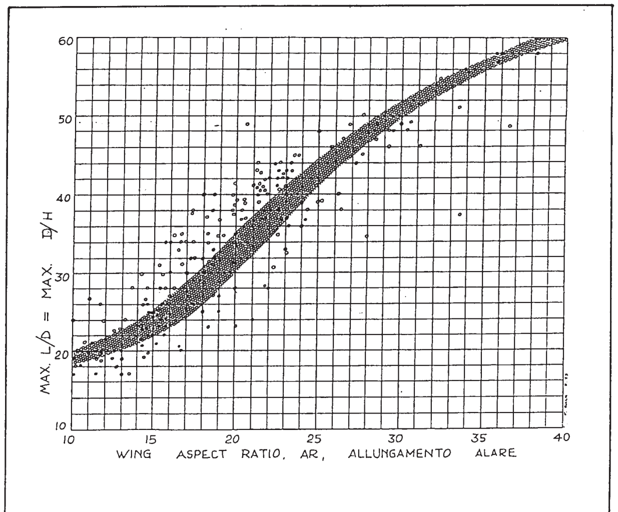
The ratio VVC is given by the relation

$$VVC = \left[\frac{sv}{S}\right] \bullet \left[\frac{B}{b}\right]$$

where

B = wing-vertical tail lever arm
sv = vertical tail area
S = wing area
b = wing span

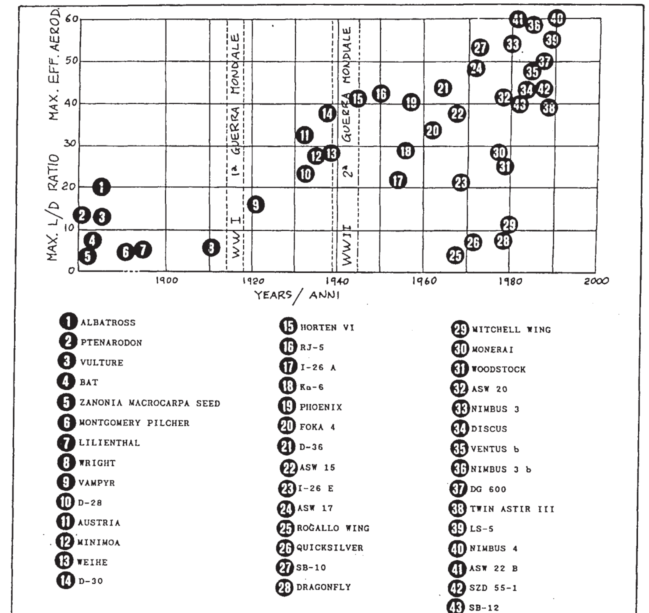
These ratios, or tail volume coefficients as they are also named, TVC (horizontal) and VVC (vertical), are often referred to as indices of static stability in aeromodeling publications. As a matter of fact, they are part of the formulae which define the pitching moment coefficient and the yawing moment coefficient, respectively. See, for instance, Reference 2.




*Lift/drag ratios vs. Aspect Ratio, AR*
Efficienza secondo l'allungamento, AR

FIGURE 9-A






*Efficiency improvement over the years*
Miglioramento dell'efficienza nel corso degli anni

FIGURE 9-B

The construction technique of some vintage and contemporary soarers may offer interesting hints for aeromodelling applications. However, a detailed analysis, aimed at locating specific details for potential use in flying models, is beyond the scope and the limits of this simple digest.

In order to realize an intrinsically "good" radioguided sailplane, an old golden rule suggests the ballast added in the nose so the center of gravity, CG, is at the right point, must not exceed 10% of the total weight. If this does not happen, there is something wrong, either in the design or in the construction.

For instance, if the ballast is more than 200 g in a radioguided glider having a total weight of 2000 g, the fuselage might be too short ahead of the wing, or the lever arm between the wing and the empennages is too long, or the empennages are too heavy.

In the case of scale reproductions of full size sailplanes, the above problem is magnified because of the different percentage bearing of the "payload." While the pilot is the sailplane's payload, the radio gear (receiver, servos, and battery) is the payload of a radioguided sailplane.

As a rule, the payload is situated ahead of the wing on both full size gliders and model gliders. It easily represents 20% to 30% of the total sailplane weight; in well designed and well built model gliders, thanks to the use of miniaturized receivers and servos, it seldom exceeds 10% of the all-up weight.

Let's examine again the Minimoa sailplane which we are supposing is to be reproduced in 1:5 scale. Realistically we assume the scale model will weigh 4 Kg, instead of the theoretical 2.8 Kg given by the "true scale" formula in FIGURE 10 (page 38). We assume also that the following conditions are verified on both the full size aircraft and the scale model:

1) The center of gravity, CG, is situated at 30% of the wing chord;

2) The weight of the discrete components (wing, fuselage, plus vertical tail) have the same percentage bearing;

3) The center of gravity of each discrete component is situated at the same point.





By applying the "true scale" rules of TABLE 5 (page 14), the following partial weights are obtained.

| Component | Symbol | % of total weight | Original | Model |
|---|---|---|---|---|
| Wing | GI | 58 | 145 | 2.118 |
| Fuselage plus vertical tail | G2 | 38 | 95 | 1.392 |
| Stabilator | G3 | 4 | 10 | 0.140 |
| Total empty weight | W — G4 | 100 | 250 | 3.650 |
| Payload | G4 | | 100 | 0.350 |
| Total take-off weight | W | | 350 | 4.000 |

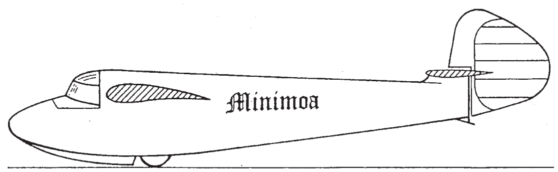
At this point, let's calculate the moment of every partial weight about a vertical line. For ease of reasoning, we choose the vertical straight line y-y on which the center of gravity, CG, is located. See FIGURE 11 (page 39).

On the right side of such a line the following moments can be computed:

G2 • b2 = 95 • 0.8 = 74.1
G3 • b3 = 4 • 4.25 = <u>17.0</u>
Total = 91.1 Kg • m

On the left side, the following moments are found:

G1 • b1 = 145 • 0.18 = 26.1
G4 • b4 = 100 • 0.65 = <u>65.0</u>
Total = 91.1 Kg • m



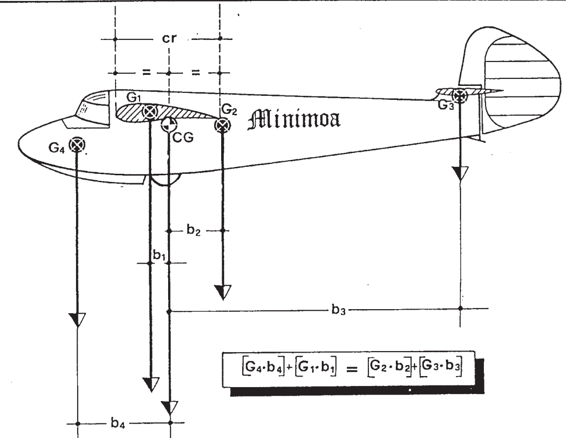

| | | FULL SIZE ORIGINALE | 1:5 SCALE MODEL MODELLO IN SCALA 1:5 |
|---|---|---|---|
| b | [m] | 17.00 | 3.40 |
| S | [m²] | 19.00 | 0.76 |
| st | [m²] | 1.98 | 0.079 |
| A | [m] | 4.13 | 0.82 |
| sv | [m²] | 1.20 | 0.048 |
| B | [m] | 5.40 | 1.08 |
| c | [m] | 1.12 | 0.224 |
| W | [Kg] | 350 | 4.00 → 5.65 * |
| TVC | [ - ] | 0.38 | 0.38 |
| VVC | [ - ] | 0.02 | 0.02 |
| W/S | [Kg/m²] | 18.42 | 5.26 → 7.43 * |

* = BALLAST ADDED / AGGIUNTA ZAVORRA

*A scale reduction example*
Esempio di riduzione in scala

FIGURE 10






$$[G_4 \cdot b_4] + [G_1 \cdot b_1] = [G_2 \cdot b_2] + [G_3 \cdot b_3]$$

G1 = Ww, G2 = Wf, G3 = Wt — SEE TABULATION 7 / VEDERE TABELLA 7

| | | | FULL SCALE ORIGINALE | MODEL MODELLO |
|---|---|---|---|---|
| | | WEIGHTS / PESI, Kg | | |
| G1 | WING / ALA | | 145 | 2.118 |
| G2 | FUSELAGE + VERT. TAIL / FUSOLIERA + IMPENNAGGIO | | 95 | 1.392 |
| G3 | STABILATOR / STABILIZZATORE | | 10 | 0.140 |
| W-90 Kg = | EMPTY WEIGHT / PESO A VUOTO | | 250 | 3.650 |
| | | LEVER ARMS / BRACCI DI LEVA m | | |
| b1 | G1 LEVER ARM / BRACCIO DI LEVA DI G1 | | 0.18 | 0.036 |
| b2 | G2 LEVER ARM / BRACCIO DI LEVA DI G2 | | 0.79 | 0.246 |
| b3 | G3 LEVER ARM / BRACCIO DI LEVA DI G3 | | 4.05 | 0.810 |
| G4 | PAYLOAD / "CARICO PAGANTE" | KG | 100 | 0.350 |
| b4 | G4 LEVER ARM / BRACCIO DI LEVA DI G4 | m | 0.65 | 0.13 → 0.28 |

*Examplo of balance calculations*
Esempio di calcolo per bilanciamento

FIGURE 11

As a result, the Minimoa sailplane is perfectly balanced with the pilot on board. The situation is quite different in the case of the 1:5 scale reproduction. On the right side of the y-y line the following moments are acting:

G2 • b2 = 1.392 • 0.246 = 0.472
G3 • b3 = 0.140 • 0.81 = 0.113
Total = 0.585 Kg • m

On the left side the following is found:

G1 • b1 = 2.118 • 0.036 = 0.0762
G4 • b4 = 0.350 • 0.13 = 0.0455
Total = 0.1217 Kg • m

As a consequence, the scale reproduction of the Minimoa is totally unbalanced. Some ballast must be added in the nose in order to bring the center of gravity, CG, to the right location.

Question: How much ballast? If the additional ballast is placed at the point G4, where the radio gear is installed, the required quantity would be

ballast = [0.5850 — 0.1217] / 0.13 = 0.4633 / 0.13 = 3.56 Kg

This almost doubles the weight of the model! Therefore (in order to maximize the moment about such a point), one tries to place the ballast ahead of the center of gravity, CG, as far as possible. In our example, placing the ballast at about 0.28 m ahead of the center of gravity seems to be a possible solution. By doing so, the quantity required becomes

[0.5850 — 0.1217] / 0.28 = 1.65 Kg

Luckily, as far as flying models are concerned, keen builders do much better than the above theoretical example. For instance, Nunzio Pompele, an aeromodeler hailing from Milan Italy, has built a 1:3.95 scale Minimoa, obtaining the following characteristics:

b = 4.30, S = 1.18 m, c = 0.28 m, W = 5.10 kg, W/S = 4.32 Kg/m$^2$





Discrete weights are as follows:

| | |
|---|---|
| wing | 2.000 |
| stabilator | 0.124 |
| fuselage with vertical empennage | 2.178 |
| radio gear | 0.400 |
| ballast | 0.400 |

It can be seen that the distribution of the partial weights of the scale model is quite different than the original Minimoa. Most probably the positions of the discrete centers of gravity G1, G2, G3, and G4 are different, allowing the model to be balanced by adding only 400 g of lead. In this R/C scale model by Nunzio Pompele the center of gravity, CG, is situated at 50% of the root chord, cr. This corresponds to about 33% of the mean wing chord, c, exactly as for the original Minimoa sailplane.

This model, which has been mentioned here as a good example of scale reproduction, also fulfils the previously mentioned golden rule, according to which ballast should not exceed 10% of the total weight. Additionally, the wing loading is lower than the value assessed with the "true scale" rule. A fundamental lesson is to be learned from this simple arithmetical exercise: The weight of the rear part of the fuselage, behind the centre of gravity, must be as low as possible.

Needless to say, such a requirement determines the choice of the construction technique, since every gram of extra weight in the tail requires roughly five grams of additional ballast in the nose.
Ideally, the traditional wood (balsa and ply) construction with ribs, formers, stringers, and light covering, is to be preferred for scale models of vintage sailplanes.

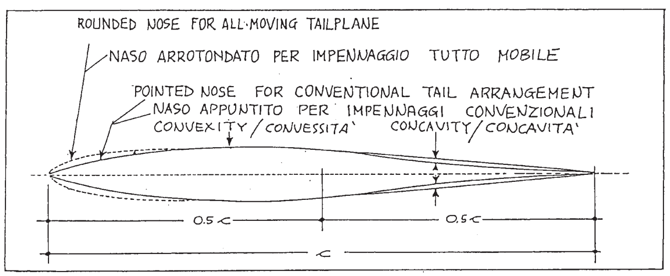
Often, a fiberglass monocoque construction is preferred as far as the fuselage is concerned, due to its higher impact resistance, since landings of flying models are sometimes rather hectic. However, monocoque fuselages of flying models are usually too heavy in the tail because of the fiberglass thickness.

In the best case, such thickness is constant along the whole length, while, according to the science of structures, it should be larger where the fuselage exhibits the largest cross section. Let's not forget that any extra material at the tail must be balanced by added ballast in the nose!

The logical suggestion that can be derived from the above reasonings is to realize a fuselage with a long nose ahead of the wing in order to minimize the addition of ballast. Of course, this suggestion can be followed only for radioguided gliders which are not true scale reproductions of full size sailplanes.

As logically expected, the previously mentioned tail volume coefficients don't change when the aircraft is scaled down, as appears from the example of FIGURE 10 (page 38). However, sometimes it may happen that the horizontal tail coefficient, TVC, is too small. Therefore the static longitudinal stability is inadequate, particularly at low speed.

The simplest remedy is to increase by 10% to 15% the area of the horizontal tail, st, but this bends the competition rules for radioguided scale sailplanes. Alternatively, one can use a "biconcave" airfoil, such as the example of FIGURE 12 (below). Airfoils of this type are quite common in contemporary competition sailplanes, but practically unknown among model builders.




*Example of "bi-concave" airfoil*
Esempio di profilo "biconcavo"

FIGURE 12





These airfoils are characterized by a substantial moment coefficient, even with small angles of deflection. Their stabilizing action is substantially larger than that produced by conventional symmetrical airfoils, such as the well known and used NACA 0009, NACA 0006, etc.

Variable geometry wings have been the subject of experimentation in full size sailplanes — this in order to fulfil various requirements related to thermal flight, turns, and speed. The same requirements apply also to radioguided sailplanes.

There are various solutions to the variable geometry problem of increasing the lifting area and reducing the wing loading:

A) Increase the wing span. The airfoil and the maximum lift coefficient do not change. Only the aspect ratio, AR, and the wing area, S, increase.

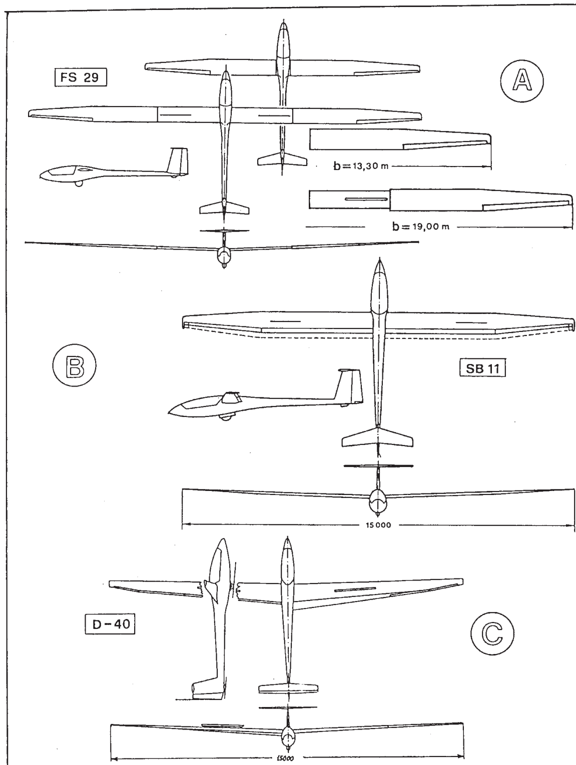
This has been done with the fs-29, a sailplane built by Akaflieg Stuttgart. It has a telescopic wing, as shown in FIGURE 13-A (page 44). Apart from the extreme complication of this construction, which cannot be easily duplicated in aeromodeling, the major problem of this solution is the quantity of energy required to slide in and out the telescopic wing. The resulting operation is too slow to be practicable.

B) Increase the wing chord. In this respect, two systems have been tried:

1) a sliding flap at the trailing edge, which extends along the full wing span, as in the case of the SB-1, Milomei M-2, and Sigma sailplane. See FIGURE 13-B (page 44) and FIGURE 14-D (page 45).

2) a triangular flap, which extends out of a great portion of the trailing edge. This system has been tried out on the D-40 sailplane built by Akaflieg Darmstadt. See FIGURE I3-C (page 44).

This system increases the lifting area and the induced drag as well, since the aspect ratio, AR, is reduced. Eventually the aerodynamic efficiency, $E = C_L/C_D$, is slightly spoiled, while both the wing loading W/S and the sink speed, $V_y$, are reduced.

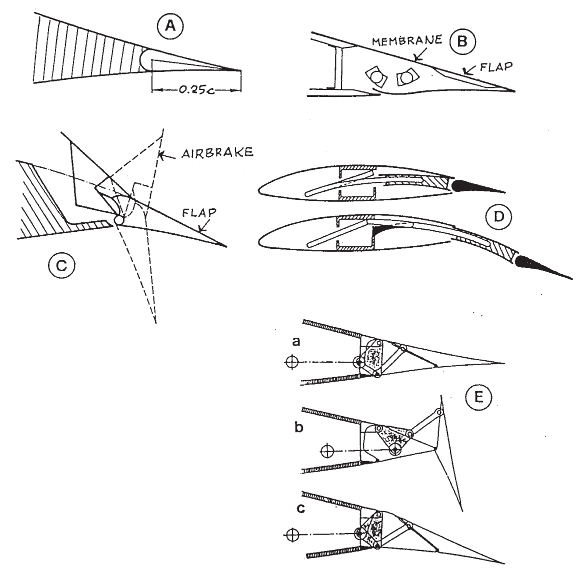



*Variable geometry wings*
Ali a geometria variabile

A = *Telescopic wing* / Ala telescopica
B = *Extensible flap* / Flap estensibile
C = *Triangular extensible flap* / Flap triangolare estensibile

FIGURE 13






*Airbrakes, spoilers, flaps*
Aerofreni, diruttori, flaps

A = *Plain flap* / Flap normale
B = *Elastic flap* / Flap elastico [Speed Astir]
C = *Flap-airbrake* / Flap-aerofreno [Mini Nimbus]
D = *Extensible flap* / Flap estensibile [SB 11]
E = *Flap-airbrake* / Flap-aerofreno [Windex 1200]

a = *Zero flap, airbrake closed* / Zero flap, freno chiuso
b = *Zero flap, max. airbrake* / Zero flap, freno tutto aperto
c = *15° flap, airbrake closed* / Flap 15°, freno chiuso

FIGURE 14

In this respect, there is no point in repeating here detailed considerations and reasonings which appear in every textbook of aerodynamics. Let's only remember that the sink speed, $V_y$, of every glider, whether flying model or full size, is determined by the relation

$$V_y = 4 \bullet \sqrt{\left[\frac{W}{S}\right] \bullet \left[\frac{C_D^2}{C_L^3}\right]}$$

where

$V_y$ = sink speed, m/s
W = weight, Kg
S = lifting area, $m^2$
$C_D$ = drag coefficient of the complete sailplane,
$C_L$ = lift coefficient of the complete sailplane.

It is worth noting that the coefficients $C_D$ and $C_L$ are referring to the complete sailplane and not to the wing airfoil.

EXAMPLE: $S = 0.76\ m^2$, $W = 2.8$ Kg, $C_D = 0.06$, $C_L = 0.8$

The sink speed, in m/s, becomes

$$V_y = 4 \bullet \sqrt{\left[\frac{2.8}{0.76}\right] \bullet \left[\frac{0.06}{0.8}\right]} = 0.64$$

If one adds some ballast, in order to trim the craft, both the wing loading, W/S, and the sink speed, $V_y$, increase. In this respect, the following formula applies:

$$V_y' = V_y \bullet \left[\frac{W'}{W}\right]$$

The tighter the turn radius, while soaring in a thermal, the stronger is the requirement for an increased wing area.





The above mentioned variable geometry systems, apart from the complexity of construction, show also some operational drawbacks. For instance, when flaps are fully deployed, ailerons are no more effective.

As a matter of fact, the yaw moment coefficient and the roll moment coefficient are proportional to the lift coefficient squared, so the yaw moment coefficient is magnified when flaps are deployed. As a consequence, a larger rudder must be installed to compensate for the inadequate response of the ailerons.

Additionally, the increased lift coefficient, $C_L$, due to the deflection of the trailing edge flaps, has a negative side effect. The point of maximum camber is moved rearwards, thus requiring a stronger correction by means of the elevator. This notwithstanding, the system with a triangular trailing edge flap, shown in FIGURE 13-C (page 44) can be easily adapted to flying models.

Air brakes are commonly used in order not to exceed the ultimate velocity ($V_{NE}$). Beyond this limit, structures can deform beyond the possibility of recovery. Several types of air brakes are described in the aeronautical literature. See, for instance, those described in Reference 19.

As far as sailplanes are concerned, whether full size or flying model, air brakes can be placed into one of two types:

(a) those mounted on the top and/or on the bottom of the wing, usually near the point of maximum thickness;

(b) those mounted at the wing trailing edge.

Spoilers of the type (a) were the first to be mounted on sailplanes. See FIGURE 15 (page 48). Air brakes of this type spoil the air flow over the wing surfaces, thus causing a great drag which hinders the speed. However, their most remarkable effect is the steepening of the glide path. Generally speaking, the speed reduction which these air brakes can produce on flying models is marginal. The only sizing criterium available to model builders is their span, sb, as shown in FIGURE 15 (page 48).

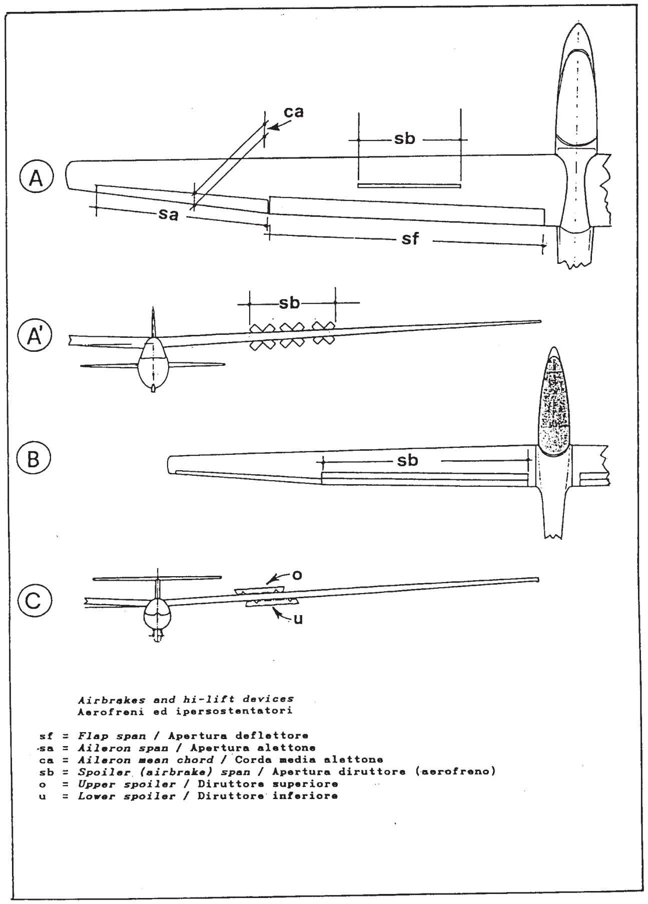



FIGURE 15



A plain flap and a spoiler are incorporated in air brakes of the (b) type. FIGURE 14-C (page 45) and FIGURE 14-E (page 45) depict two such systems installed on full size gliders.

This air braking system effectively reduces the flying speed, since it increases both drag and lift. Systems of this type, adequately simplified, have been successfully installed on radioguided gliders, although their construction complexity prevents a wider usage.

TABLE 8 (page 50) lists the complete technical specifications of the Polish glider SZD-42 Jantar 2 "Amber" This information can be used as a guide when sizing air brakes and flaps.

Two items, which could be related to the "dynamic similitude" principle, are seldom taken into consideration, when it comes to flying models: speed and strength of materials. Even for the so called "speed classes" (for both radioguided and control line models), scoring is based on the time spent to cover a given course or a number of laps, never on the relative (even approximate) speed. As a result, aeromodelers are usually in almost complete darkness when it comes to reasonings about the real speed of their models.

The only exception to this generalized practice is the Schneider Trophy Re-enactment, held at Lake Havasu, Arizona (USA), every year. Here scale reproductions of the floatplane racers, which competed for the full scale Schneider Trophy Races (1912 - 1931) are required to cover a given course at "scale speed."

As far as radioguided sailplanes are concerned, there are four speed values of interest to the keen model builder:

(a) Speed at the best glide angle, $V_e$, that is, when the maximum aerodynamic efficiency ($C_L/C_D$) is achieved;

(b) Lowest sink speed, $V_y$;

(c) Stalling speed, $V_s$,

(d) Maximum speed, never to be exceeded, $V_{NE}$.

TABLE 8

**SZD-42 JANTAR 2 - "AMBER"**
*Complete Specifications* / Specifiche Complete

| | | | |
|---|---|---|---|
| *Wing span* / Apertura alare | b | m | 20.5 |
| *Wing root chord* / Corda alare alla radice | cr | m | 0.90 |
| *Wing tip chord* / Corda alare alla radice | ce | m | 0.395 |
| *Wing mean chord* / Corda media alare | c | m | 0.731 |
| *Wing aspect ratio* / Allungamento alare | AR | - | 29.2 |
| *Length overall* / Lunghezza fuori tutto | L | m | 7.11 |
| *Stabilator span* / Apertura stabilizzatore | bt | m | 2.60 |
| *Height over tail* / Altezza alla deriva | y | m | 1.76 |
| *Wing area* / Superficie alare | S | m | 14.25 |
| *Ailerons area* (total) / Superficie alettoni (totale). | aa | m | 1.15 |
| *T.E. flaps area (total)* / Superficie flaps B.U. | fa | m | 1.38 |
| *Spoilers area (total)* / Superficie diruttori (totale) | ba | m | 0.69 |
| *Fin area* / Superficie deriva fissa | | m | 0.72 |
| *Rudder area* / Superficie direzionale | | m | 0.48 |
| *Tailplane area* / Superficie piano orizzontale | st | m | 1.35 |
| *Elevator area* / Superficie elevatore | | m | 0.38 |
| *Empty weight* / Peso a vuoto | We | Kg | 343 |
| *Max. take off weight* / Peso massimo al decollo [**] | W' | Kg | 593 |
| *Max. take off weight* / Peso massimo al decollo [*] | W | Kg | 463 |
| *Max. wing loading* / Carico alare massimo [**] | W'/S | Kg/m | 41.6 |
| Max. wing loading / Carico alare massimo [*] | W/S | Kg/m | 32.5 |
| *Best glide ratio* / Miglior rapp. di planata.[**] | | | 1:47 @ 102 Km/h |
| *Best glide ratio* / Miglior rapp. di planata.[*] | | | 1:46 @ 88 Km/h |
| *Min. sink speed* / Minima vel. di caduta .[**] | | m/s | 0.54 @ 87 Km/h |
| *Min. sink speed* / Minima vel. di caduta .[*] | | m/s | 0.46 @ 75 Km/h |
| *Stalling speed* / Velocita' di stallo .[**] | | | 80 Km/h |
| *Stalling speed* / Velocita' di stallo .[*] | | | 65 Km/h |
| *Max.speed (smooth air)* / Vel.max. (aria calma).[**] | | | 165 Km/h |
| *Max.speed (rough air)* / Vel.max. (aria pertur.).[**] | | | 140 Km/h |
| *Max.speed (smooth air)* / Vel.max. (aria calma).[*] | | | 250 Km/h |
| *Max.speed (rough air)* / Vel.max. (aria pertur.).[*] | | | 160 Km/h |
| *Max.aero-tow speed* / Vel.max. di traino | | | 140 Km/h |
| *G-limits* / Limiti di carico .[**] | g | | +4 -1.5 |
| *G-limits* / limiti di carico .[*] | g | | +5.3 -2.65 |

[**] = *With (water) ballast* / Con zavorra (acqua)
[*] = *Without (water) ballast* / Senza zavorra (acqua)

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A look at the speed polar of any sailplane, no matter whether full size or scale model, tells us immediately that $V_e$ (best glide ratio velocity) and V (at which $V_y$ is minimum) are well apart. The former is always larger than the latter. For instance, in the case of the SZD-42 Jantar 2 "Amber," the best glide angle is achieved at 88 Km/h, while the minimum sink speed is obtained at 75 Km/h. See TABLE 8 (page 50).

From time to time, aeromodeling literature has shown examples of builders who embarked themselves in simple or sophisticated endeavors to measure glide angles and flight speeds of their models. Unfortunately, this practice is far from being widespread. Anyhow, let's proceed with a hypothetical example of "scale speed" calculations. Our guinea pig is again the Minimoa sailplane of FIGURE 10 (page 38). By applying the "true scale" rules of TABLE 5 (page 14), one gets:

| Symbol | Explanation | Unit | Full scale | 1:5 model |
|---|---|---|---|---|
| $V_e$ | (best glide) | Km/h | 70 | 31.3 |
| $V_y$ | (best sink) | m/s | 0.70 | 0.31 |
| V at $V_y$ | (for best $V_y$) | Km/h | 60 | 26.8 |
| $V_{NE}$ | ($V_{NE}$) | Km/h | 200 | 89.5 |

The only speed which is not realistically attainable is the sink speed, $V_y$, 0.31 m/s (1 ft/s). This value has been and still is the midsummer night's dream of every serious free-flighter. Chances are extremely slim for any radioguided sailplane to achieve this performance.

In our quest to achieve complete "dynamic similitude," we find another area where Mother Nature refuses to cooperate with us. This is the strength of materials, which is related to internal forces (molecular forces) which are not reduced at all on scaled down components of any kind. As a result, the material is relatively much stronger with respect to the stresses it must withstand.

Although surprising at first glance, this result can be easily explained with a working example. A large steel cube weighing 60,000 pounds is suspended, like a stationary pendulum, by means of a steel bar with

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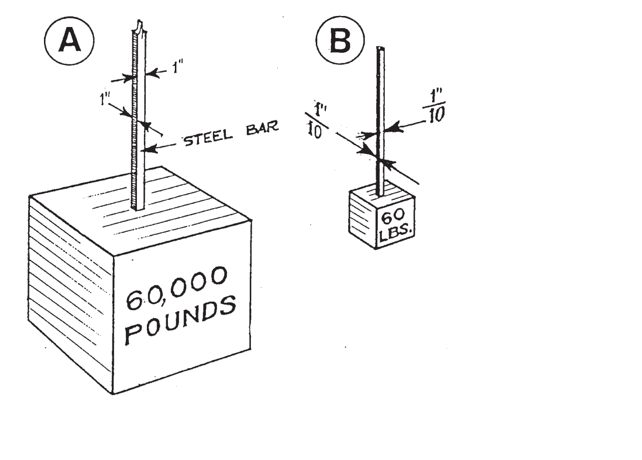
one inch square cross section. Let's assume that the breaking strength of the steel bar is just one ounce more than 60,000 pounds per square inch. In other words, it is stressed right up to within one ounce of its ultimate (breaking) load. See FIGURE 16-A (below). The additional weight of even a small slice of pizza, placed on the cube, would cause the bar to break and the cube to fall.

Now look at the model of the cube-bar system in FIGURE 16-B (below), which has been constructed to 1/10 scale. The sketch has not been




Scale effect on strength of materials / Effetto scala sulla resistenza dei materiali

FIGURE 16





drawn to such a high scale ratio. The model bar, of course, has a cross section of 1/10" by 1/10", that is 1/100 square inches. The unit tensile strength of the steel bar of the model is still 60,000 pounds per square inch. Therefore the ultimate breaking strength of the model bar is 1/100 of 60,000 pounds, that is, 600 pounds. However, the weight of the model cube is 1/10 x 1/10 x 1/10 x 60,000 lbs., that is 60 pounds! The bar in the model could therefore support ten times the weight of the cube.

This is equivalent to a relative increase in the strength of the bar by a 10 to 1 ratio — the same scale ratio to which the model was constructed. Lesson to be learned here: The strength of materials in any scaled down model always undergoes a relative increase by the ratio of the scale factor, indicated by F in TABLE 5 (page 14).

This explains why it is possible to build flying models of balsa wood, which would be totally unsuitable for a full scale aerodyne. This is also the reason for the apparent herculean strength of some insects, ants for instance, which easily carry many times their own weight and can withstand severe mistreatment. An ant can fall from a tall building without any damage at all! Its "F" value is enormously high compared to the structural strength of a human!

All of the above may sound like a kind of academic exercise, but it could be food for thought for keen modelers, particularly for those who claim the structures of their R/C sailplane are built to scale.

Ferdinando Galè