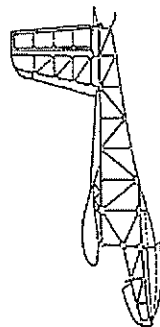


ENTWICKLUNG UND ERPROBUNG VON LEICHTFLUGZEUGEN

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Construction Manual
for the Ultra Light Sailplane



ULF-1

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IMPORTANT NOTE:

- o Study the plans carefully and plan your work in small increments
- o Contact experienced aircraft constructors or appropriate associations if you are not an expert yourself
- o Use best quality aircraft material
- o If you are in doubt with anything you do or with anything you use, make tests to gain confidence.

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FOREWORD

This plane is only permitted as a glider* if the empty weight stays below 50 kg. To stay within this limit it is essential to build as light as possible.

Spruce* with a low specific density should be chosen. Only if $\rho \leq 0.55 \text{ g/cm}^3$ the given weights for spars etc. can be reached. Use high quality spruce for all parts! Naturally the wood should be straight and grown clean.

Plywood: Only birch-wood class I is being used.

Balsa-wood: On the fuselage stiffeners use hard balsa. End-ledge, ribstiffeners etc. use medium.

Glues: On spar caps, ribs, fuelage, tailspars Aerodux can be used. For plankings, sparwebs, torsion noses for wing and tails, endledges definitely use Epoxy-resin, thickened with cottonflakes. (Epoxy/Laromin 100:38) Watch out for the exact mixing ratio when preparing the glue. During gluing the room temperature should not go below 20° C.

* German Authority requirement. * * or equivalent material

CONSTRUCTION OF WING

Main spar:

It is advisable to start the construction of the wing at the spar. After cutting the caps there are enough left-overs to cut the rib caps. Start putting up a rig during fabrication of spar caps so that it can be used later to glue the spars and to assemble the torsion nose.

Since the spar caps are very thin and pliable, a stiff support over the whole length is necessary. The best way is to build a structure (rig) of wooden boards or out of steel profiles which are screwed together. On top of this structure screw pressboard measuring 5 mm in length, 300 mm width at one end and 200 mm width at the other. This pressboard has to be leveled with the help of a water balance. It should be lying firm so that it does not bend during planing of the spar caps.

The lamellas for the spar caps are cut out of a well grown board of spruce. Watch out for right position of timber rings. The grain should run parallel to the edge and is allowed to cut the surface at an angle up to 1:20.

Start cutting the lamellas to a thickness of 10 mm. Do not use a planing machine because the roller pressure causes damage. The width of the lamellas is to be taken off the drawing. Plan an additional 5 mm in the width. Before gluing the lamellas are roughened up with a fine plane. Just one lamella runs over the full length, the others stop earlier according to the drawing. The gluing is done on the rig-board.

It is important to use even pressure. As shim plates to distribute the pressure use strips of 20 mm press-board. The thinner the glued joints are made the better will the bond hold. Besides, the caps will be lighter because glue weighs more than wood.

After all the caps have been glued together they are roughly cut to size with a disc saw or strap saw. From the drawing transfer cap height and width to the caps, spaced at least every 0,5 m apart. Then the caps are planed to final size. For this work experience and care is necessary. The tolerance for the spar caps is $\pm 0,2 \text{ mm}$.

The cap height is planed (within the tolerance) to size. For the time being the cap width is planed to $\pm 0,5 \text{ mm}$.

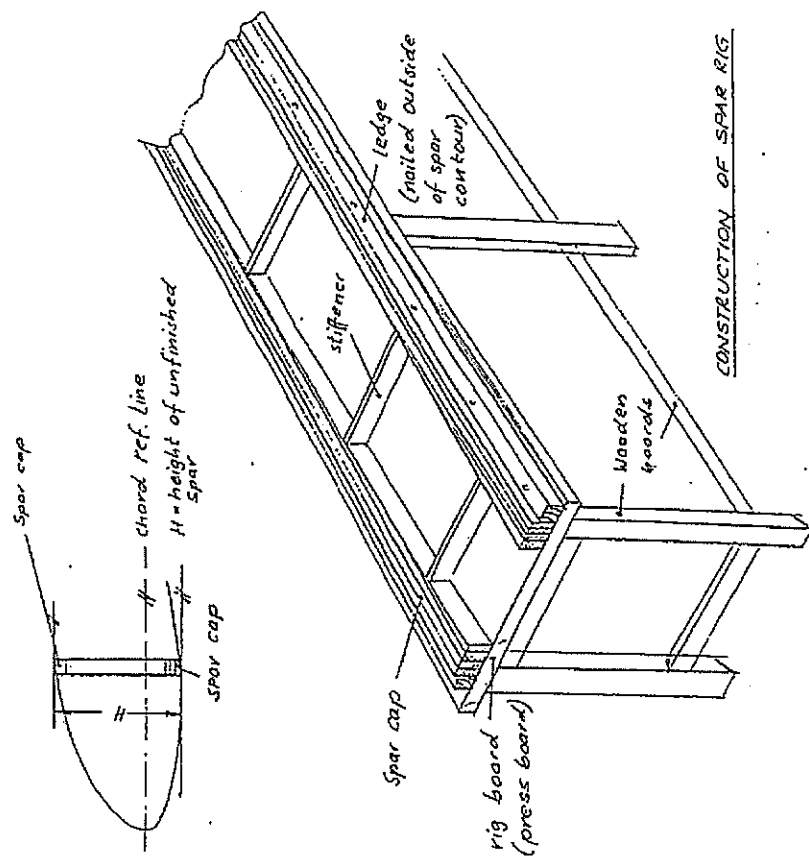
Before the stiffeners are glued in and before the spar web is glued on, the spar is trimmed. After that the cap width should be within the tolerance.

During planing of the caps observe the following:

- the surfaces are not to bulge
- the caps have to stay at right angle
- the dimensions must stay within the tolerances also between the stations shown in the drawing
- edges are not to be chambered

After finishing the caps, the spar template is build on the rig. The spar height is taken out of the loftline drawing of the ribs. The dimensions have to be kept exactly. How to find spar height see drawing.

The spar height and the position of the stiffeners are transferred to the rig-board. Cover board with foil to prevent sticking during gluing. Nail ledges along the contours. Keep them approx. 5 mm lower than the width of the caps.



After that the caps are put in and the stiffeners are fitted. Between the stiffeners (made of spruce) where the ribs are later attached, put stiffeners made of balsa to reduce the field length. When the stiffeners are glued in they are a bit wider. They will later be planed to the size of the caps.

Before the spar web is glued on, the whole spar is planed (watch for tolerances) and roughened up with a fine plane.

If enough clamps are available (appr. 40) the spar web can be spliced first and then glued together in one working process. Otherwise it is to be glued in sections. A distance block with the exact height has to be placed under the splicing area. To prevent the spar web from slipping it must be fixed with pins every 0,5 m. Again use shim plates to achieve even pressure. Before the spar is closed at slightly wider than the spar height. The best is to use pressboard the root area the cavities have to be treated with stained wood preservative because they cannot be reached afterwards. Be careful not to get preservative on areas that still have to be glued. To glue on the spar web use thickened Epoxid resin. Take care that glue squeezes out of the whole joint length evenly. Always apply glue to both surfaces.

INSTALLATION OF MAIN FITTINGS

The spar caps are reinforced with plywood strips according to drawing. Take notice that the fittings on the upper caps match. The spars are adjusted.

V-position: upper side of spar is straight.

The spars are not allowed to be twisted against each other. Secure the fittings with clamps. If all measurements and the positions of the fittings are correct they are bolted together in all holes with 6 mm bolts. Hereby both fittings of the upper caps have to be joint with a 6 mm assembly bolt.

On the fittings at the lower cap the distance of the assembly lugs is taken off the drawing. Later the main bulkhead with the fittings is adjusted. Now the fittings are removed, carefully cleaned of all grease and glued to the spar with UHU Plus. To apply pressure they are again screwed together with the 6 mm bolts. \$\$\$

Subsequently the fittings together with the spar are drilled up to 11,8 mm. For this the spar have to be aligned carefully under a column type drilling machine to ensure that the drill hits the hole of the fitting on the other side. The bore has to be reamed to 12 H7. One after another a 6 mm bolt is replaced by a rivet. The lug of the main fitting is drilled up to 11,5 mm and reamed to 12 H7 later during assembly of frame.

The rivets are made of 12 x 1,5 mm galvanized steel tubing. We shall not go further into production of rivets or the method of rivetting. If somebody has done this type of work before, he knows the technique and owns the necessary tools. Otherwise it is advisable to ask an experienced aircraft builder for assistance. (see APPENDIX)

When rivetting the main fittings to the spars, be careful not to damage the glue!

CONSTRUCTION OF RIBS

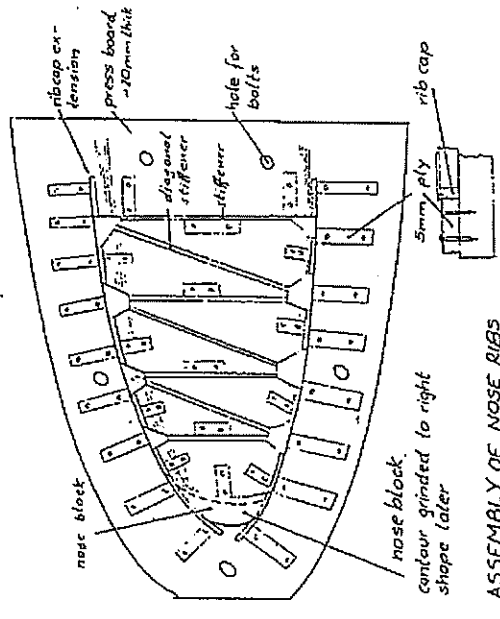
Construction of the ribs demands a lot of care, because the flight performance and flight characteristic is influenced by the accuracy during construction.

A later working over of the glued on ribs is not planned in order not to weaken the already very thin caps. Nose and end ribs are constructed separately. The contour of the ribs is transferred to non-

* toothed plane iron \$\$\$ Before drilling, wait until glue is set.

**Two component epoxy glue

warping transparent paper an exact is possible using a curve template. The position of the stiffeners is also marked. The transparent paper is placed on a pressboard and is covered with foil. Now little plywood blocks are nailed along the contour, spaced at 30 mm. These blocks should not be thicker than 5 mm. The caps can be bent into position in a dry state. After fitting the nose block, the stiffeners and the diagonals and the plywood corners (gussets) are glued in on one side in one working process. To press use board of same size. Template and pressing-board can be bored together.



ASSEMBLY OF NOSE RIBS

Instead of using clamps to press, some bolts with supporting disc and nuts can be used. This saves clamps and the template, at least for the nose ribs, will fit into a normal oven. Aerodux can be cured within 13 Min. at a temperature of 90° C.

After the rib for the second wing half is built on the template. transfer the plywood blocks inwards to the next rib contour. To grind the nose area of the ribs to fit the contours make a template. All nose ribs are again transferred to 0,8 mm plywood. Also transfer the wing reference chord exactly. Cut out each rib one after another with a pair of scissors. The template is put on to the matching rib and the nose contour is marked. Also transfer to the rib the position of the wing reference chord. After that the nose contour is smoothed with a wood grinder (do not use grater). The rib edges have to be rectangular. On all ribs it is advisable to let the upper and lower caps extend 30 mm beyond the last stiffener (see drawing) This helps to keep the angle in which the caps reach the spar more exact.

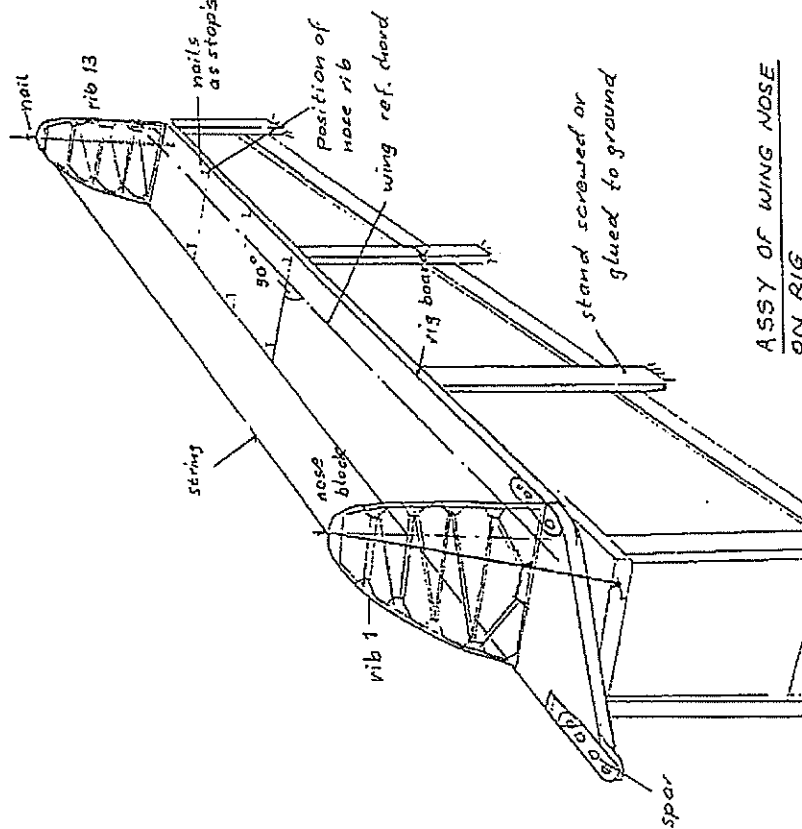
ASSEMBLY OF WING

The upper and lower caps of the main spar are planed to match profile contours. The contour is taken out of the loftlines at each rib-station. The slant can be measured with an adjustable evaluation angle! The dimension should be checked by fitting the endrib and the nose ribs to the according stations. The next step is to glue the ribs to the spar.

* try square

Since the spar is very thin and flexible it should rest firmly in full length. Use the rig on which the spar was prepared. Narrow the resting board so that the spar extends at the sides for appr. 5 mm. This will make it possible to pull the nose planking beyond the spar.

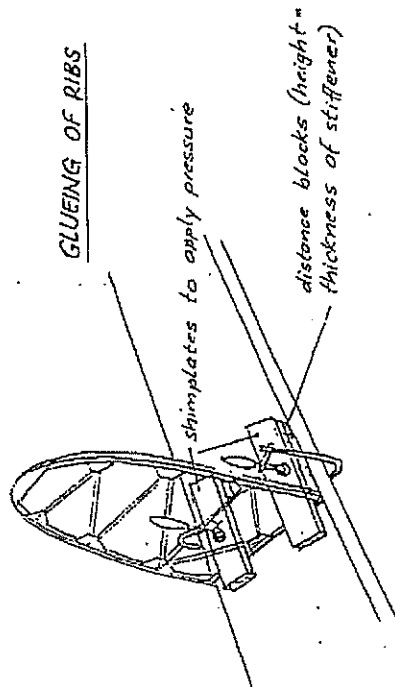
The rig-board should be in a horizontal position. Span a string over the full length of rig-board. At each end place blocks of 2 mm thickness under string so that string hangs free over full length of board. Pad rig-board until space between rib-board and string is 2mm. Normal to the string measure with water balance if rig-board stays leveled. Using a leveling instrument is naturally a lot faster and more exact. The board is screwed to the rig and covered with foil.



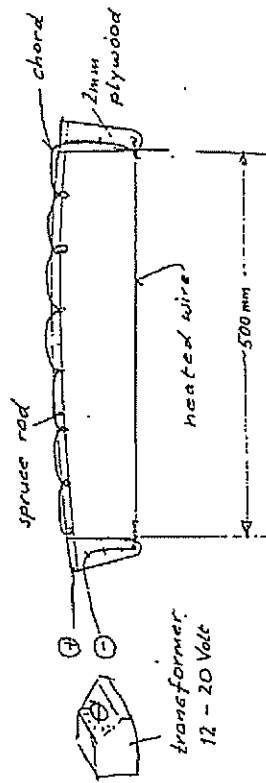
ASSY OF WING NOSE ON RIG

Now the spar is placed on and fastened with small clamps. Mark positions of ribs with pencil. Put two nails next to markings as a fixing. First rib 1 and 13 are fitted, adjusted to vertical position and then glued. At the position of the wing reference chord put nails into noseblock of each rib. Then a thin string is spanned tightly between the nails of rib 1 and 13 (see drawing). All other ribs are now fitted until string touches noseblock at the mark of the reference chord. Now glue on ribs. After the glue has set remove all nails used for fixing.

GLUEING OF RIBS



Centered between the ribs glue 20 mm bead foam pieces. These polystyrene ribs are cut to dimension with a heated wire. Guide the cutting tool along the wooden rib situated next to the polystyrene rib. Take care that wire runs exactly on the surface line. Heating wire can be bought in modelshops. To heat up the wire use a transformer as used on electrical model railroad sets. (See drawing)



CUTTING TOOL FOR BEAD-FOAM (STYROFOAM)

ASSEMBLY OF TORSION NOSE

Before the nose is assembled the ribs and the web is impregnated. After that the connections between ribs and spar caps are cleaned and all glued areas are slightly roughened with a plane. The plywood for the nose can be put on in dry condition without any difficulties. To tighten use ordinary clamps. When cutting the plywood watch for grain direction. Let enough material extend beyond spar to apply clamps. To assemble the proto-type 8 Ulmin clamps were used.

The nose is pressed to the spar caps with nailing strips. Towards the wing tip the caps become very thin. Nailing is difficult because the caps are elastic and will spring. Therefore it is recommended to squeeze several wooden strips between upper and lower cap before the spar is placed on. (parallel to the stiffeners). After plywood is roughly cut, it is tacked to nose block of both splice ribs in the you are working. (use 2 nails). One side is lifted up. Now mark on opposite side position of spar and ribs. Remove plywood and impregnate areas not to be glued. Don't get closer than 5 mm to glueing surfaces.