

KITES FOR CONNOISSEURS

AKKA

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Kites for Connoisseurs is a collection of plans for kites designed by Andreas Ågren. These kites often have a unique technical twist. The plans can be found at <http://windman.se/kite-plans> and they may not be used for commercial purpose without written consent.



akka is a single point high aspect ratio kite in shape of a stylized bird. The design has two special features that make it stable and self correcting, see the theory behind that in the end of this document. The kite might look fairly simple, but it does require a certain level of accuracy to build, especially regarding the frame.

The frame also requires special 3D printed cross connectors for the cross spar/battens.

akka is a kite to play; not to anchor down. It is best enjoyed when actively flown from hand.

The name **akka** is derived from the leader goose in the novel *Nils Holgersson's Wonderful Journey Across Sweden* by *Selma Lagerlöf*. It is spelled with lowercase initial **a** so as to not cause imbalance.

Material

- Ripstop, colour A: appr. 0,3 m², non stretchy
- Ripstop, colour B: appr. 0,9 m², non stretchy
- White dacron
 - 25 mm wide, 25 cm
 - 20 mm wide, 50 cm
 - 15 mm wide, 60 cm
 - 10 mm wide, 12 cm (or 60 mm wide, 2 cm)
- 25 mm wide velcro, 7 cm
- 10 mm wide double sided velcro, 30 cm
- 2 or 3 mm bungee cord, 25 cm
- Thin string, ~20 kg, 1.5 m
- 2 pcs Skyshark P2X/P200
- 1 pcs Skyshark P4X/P400
- 6 mm carbon tube, 1 cm (for stepdown to 4 mm)
- 4 mm carbon tube, 25 cm
- 2 mm carbon rod, 95 cm
- 1.5 mm carbon rod, 210 cm (8 x 26 cm)
- 4 mm fibre glass rod, 65 cm
- 3D printed connectors, 8 pcs (see STL files)
- 4 mm T-connector, 1 pcs
- 8 mm cross connector (see #59 for alternatives)
- 1.5 mm nails, 15 mm, 2 pcs
- 4 mm plastic tube, 5 cm
- 6 mm (or 7 mm) endcaps, 2 pcs
- 2 mm endcaps, 8 pcs
- 1.5 mm endcaps, 16 pcs

The frame structure.

The **akka** is optimized for a wingspan of three Skyshark tubes, where the one in the middle should if possible be a bit stiffer. Recommended is 2PX/P200 on the sides and 4PX/P400 in the middle.

The battens across the crossspar are all in different angles to the crossspar which requires special 3D printed connectors. These 3D printed connectors should, in addition to the different angles for the battens, have a cross spar hole optimized for the used Skyshark tubes. The STL file for the 3D printed connectors is included in the plan download, courtesy of *Roman Skrzek*. These connectors are optimized for Skyshark P200 (7.2 mm). See the theory behind the different angles at the end of this document.

Templates.

The templates consist of five parts:

- front outer wing
- rear outer wing
- inner wing
- body
- beak

All templates include a joining seam allowance and a 5 mm hem allowance where applicable.

The templates come in two versions: one JPEG for plotting out on plotter/big printer, one PDF for printing out on A4 sheets to be glued together, facilitated by blue criss cross lines.

Seams.

Throughout this description folding-over double straight seams (plain seam with a single stitch) are being used.

The skin.

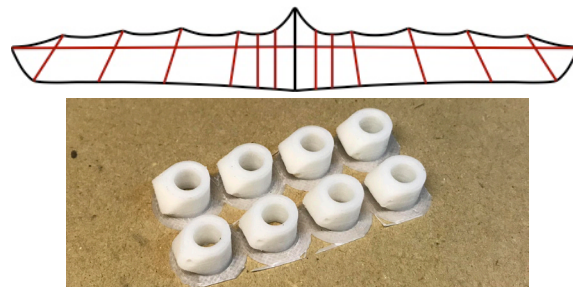
The sail area of the **akka** is quite small, just a little bit more than 1m² in total (see figure of templates to the right). In this manual two colours of ripstop have been used but other colour schemes may of course be used:

- Colour A for front of outer wing plus inner wing.
- Colour B for rear of outer wing plus body.
- (A small piece of red or orange ripstop is used as accent colour for the beak.)

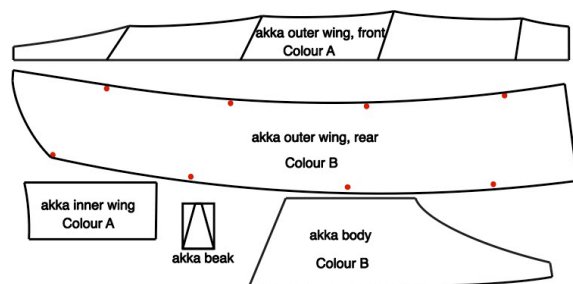
The ripstop must be of good, non stretchy quality. Crisp/stiff is better than soft.

Follow the grain indication marked in the templates.

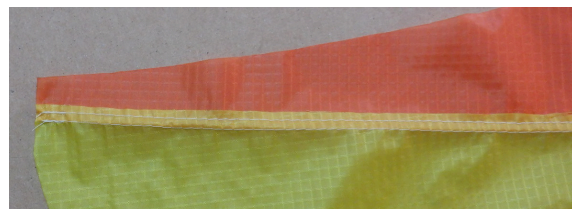
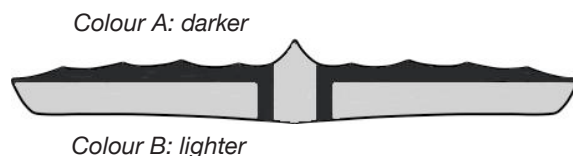
1. Sew front and rear of the outer wing parts together for both sides starting from wing tip. Fold the seam allowance material onto front wing part for the second seam.
2. Trim the inner edges.



3D printed connectors.



The actual size of the template sheet is 56.4 x 111.7 cm.

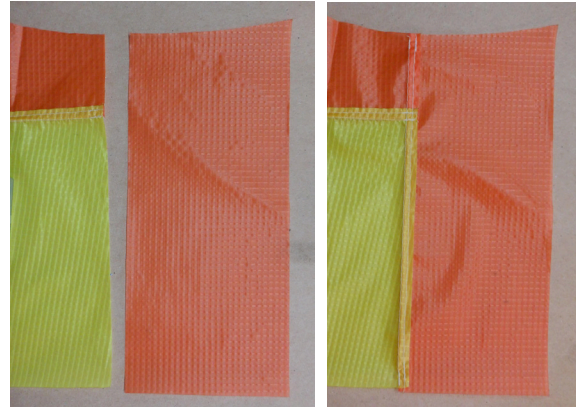


3. Sew the inner wing parts to both outer wing parts, starting from the leading edge. The leading edge of the inner wing part is curved, and the whole part is intentionally a little bit too long at the rear edge to facilitate perfect alignment/trimming, see step #7.

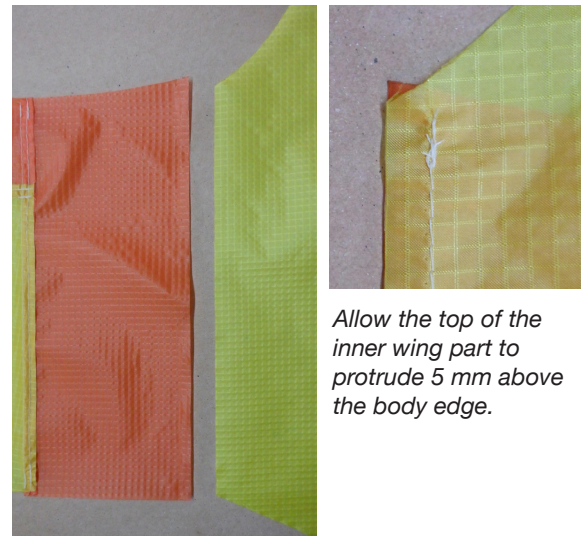
4. Fold the seam allowance material onto the inner wing part.

5. Sew the wing parts onto the body part.

Allow the top of the inner wing part to protrude 5 mm above the body edge.

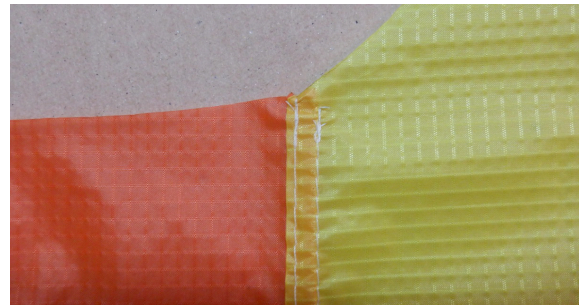


The inner wing part: the curved edge on top, the shorter side towards the outer wing part.



Allow the top of the inner wing part to protrude 5 mm above the body edge.

6. Fold the seam allowance material onto the wing part.



7. Trim the trailing edge of the inner wing parts.



8. Sew the two complete wing/body parts (kite halves) together.
 - Fold the seam allowance material onto any side and trim the rear end.



- Check that the edges of two halves of the top of the “neck” are completely aligned and also in absolute right angle with the main joining seam of the two halves. Trim if not.

The “beak” part is at start a rectangular piece, 6 x 9 cm. This is only since it might be a bit difficult to sew a ready cut trapezoid shape onto the neck in the precise way that is required. Therefore the correct shape is cut only when the beak part is already sewn onto the neck.

9. Sew the rectangular “beak” part onto the “neck”.



10. Extrapolate the line of the main joining seam, i.e. the middle of the body, up onto the top of the beak.



11. At the top end of the beak part make marks 15 mm on each side of the drawn line (the middle).



12. Cut away the surplus of the beak from where the beak starts at the neck unto the marks.



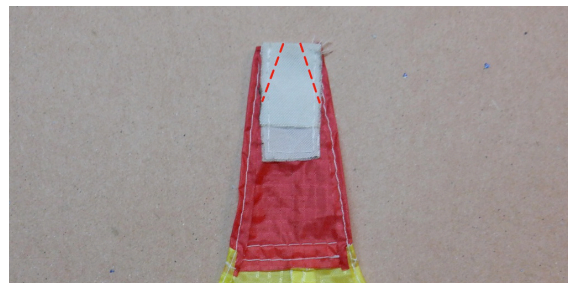
13. Hem the entire leading edge (wings, body and beak) with a 5 mm hem.
14. Hem the entire trailing edge (wings and body) with a 5 mm hem.

Sleeves, pockets and reinforcements.

The body will have a 4 mm fibre glass rod from beak point till tail end. The rod cannot be called a spine since it is running in the bottom of the body, maybe rather a *belly stick*. It is secured in place by a pocket at the beak and an adjustable velcro pocket at the tail end plus one short sleeve. While sewing the pockets, sleeves and tow points reinforcement make sure that the centre line of them are perfectly aligned with the centre line of the body.

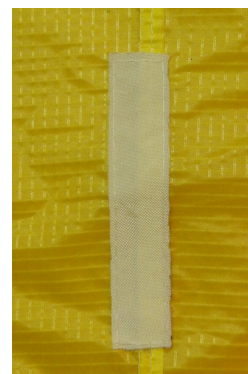
15. Sew a 20 x 70 mm dacron piece as a pocket on the beak point.

Sew extra guiding stiches slanted to the top centre so the body belly stick always comes in the exact middle.



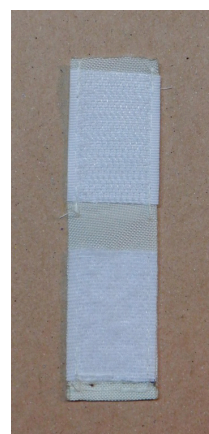
Slanted guiding stiches indicated with dashed red.

16. Sew a 20 x 110 mm dacron piece as tow points reinforcement centered on the central seam, starting 30 cm from the beak point.



30 cm to beak point.

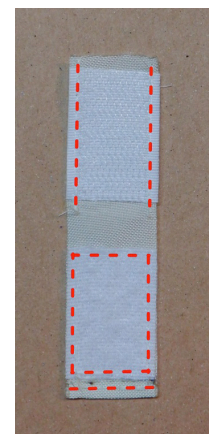
17. Sew an adjustable velcro end pocket for the belly stick at the rear edge.
 - a. Cut 50 mm of the hook (hard) part of a 25 mm wide velcro strip.
 - b. Sew this as a sleeve onto a 25 x 130 mm dacron piece, starting 5 mm from one end. The width between the side stitches should allow the belly stick to go inside.
 - c. Fold over 5 mm at the other end of the dacron piece and fasten it with a seam as a strap.
 - d. Cut 50 mm of the loop (soft) part of 25 mm velcro.
 - e. Sew the soft velcro loop part onto the dacron piece starting just at the strap.
 - f. Sew a little less than half (60 mm) of the dacron piece with the velcro hook (the sleeve) onto the rear end of the body.



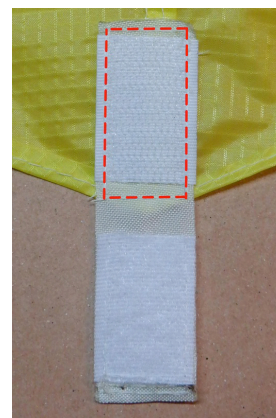
Velcro hook part.

Velcro loop part

"Strap"



Velcro pocket with stitches indicated.



18. Sew a short front sleeve, 15 x 50 mm of ripstop for the belly stick, with the rear edge starting at the top of the 11 cm tow point reinforcement. The centre of the sleeve must be exactly aligned with the centre seam/line of the body.

This sleeve will also act as a stopper for the T-connector on the belly stick.

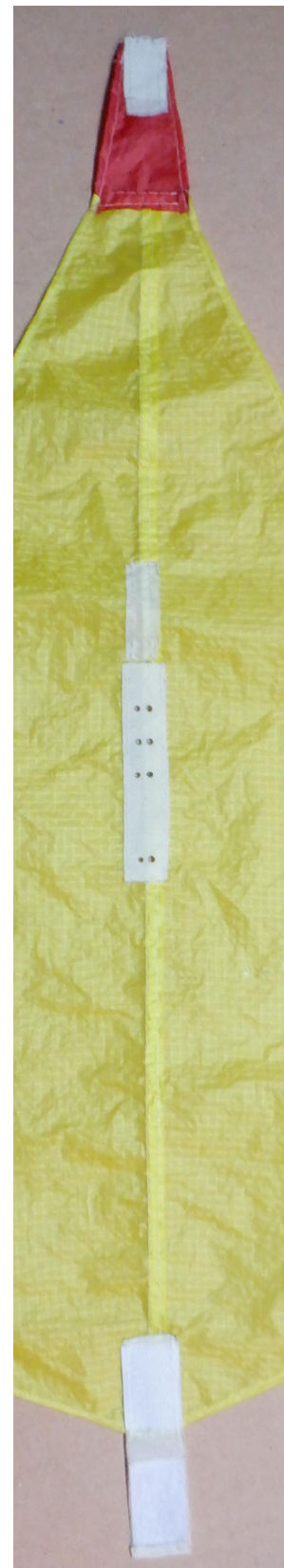


T connector stopper sleeve.

19. Burn or punch three pair of holes in the long reinforcement for alternative towing points. First make small holes through the dacron and ripstop, then enlarge the holes from the ripstop side pairwise to get them absolutely symmetrical around the centre seam/line of the body. The foremost pair of holes are 20 mm from the front edge of the dacron and then with a 15 mm gap between each pair of holes.



20. Burn or punch a fourth pair of holes in the same way 10 mm from the rear end of the dacron. These holes will be used to tie a string around the belly stick to secure it in the centre.



Pockets, sleeves and reinforcements for the body belly stick.

21. Sew 25 x 70 mm pieces of dacron as end pockets on both wing tips for the cross spar, centered on the overlapping part.
22. Prepare 16 pieces of dacron 15 x 35 mm for 12 front batten pockets and 4 rear batten pockets.
23. Burn small (1 mm) holes in all four #1 pockets for tensioning strings.
24. Sew the pockets for battens #1 over the seams of the inner wing part and orient them straight along the seams.
25. Sew the pockets for battens #2 over the seam on both wing sides, same as for battens #1.

As mentioned earlier the battens #3 - 6 across the crossspar are in different angles to the crossspar. The batten pockets should therefore be oriented in these different angles.

26. At the leading edge of the wings: use the template for the front outer wing to mark with a tailor's chalk the positions and the **angle** for each batten front end pocket for battens #3 - #6.

Remember 5 mm of the wing tip has been hemmed. so the the sail is 5 mm shorter than the template at the wing tip.

27. Sew the 15 x 35 mm pieces of dacron as pockets for the battens #3 - 6 at the leading edge for both wing sides, each oriented in the angle of the batten.

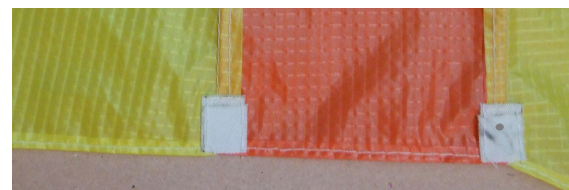
For pockets #4 - 6 one corner of the pocket can be folded in to make it possible to sew the pocket closer to the edge.

The rest of the rear pockets #3 - 6 need more preparation.

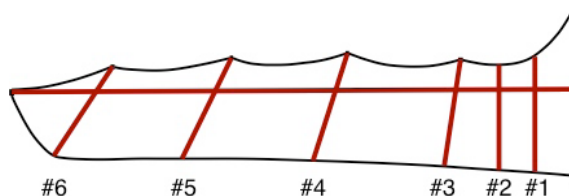
28. Sew one short sleeve over the seam of batten #2; 15 x 70 mm, the front edge starting 60 mm from the front edge of the wing.



Hole in #1 front pocket.



Hole in #1 rear pocket.



29. In a narrow piece of double sided (self gripping; hook on one side and loop on the other) velcro, 10 x 55 mm, punch two 2 mm holes, the first about 20 mm from one end and next with a gap of 10 mm. This is for keeping the cross spar in place.
30. Sew this velcro piece at the position of batten #2, over the overlapping part joining the front and rear part of the wing with a single seam between the punched holes and with the soft side (loop side) of the velcro facing the ripstop. The longer part should face the front batten pocket and the lower hole should be just above the sleeve.
31. Repeat steps #28 to #30 for the other wing side.
32. Make marks for the positions of rear edge pockets for battens #6 - 3 from the outer corner on the rear edge. The mark for batten #6 should be in the bend,
 - for batten #5 at 29.5 cm
 - for batten #4 at 60 cm
 - for batten #3 90 cm
 all measured from the mark for batten pocket #6.
33. Check that the marks are absolutely symmetrical on both wing sides.
34. Sew 20 x 35 mm pieces of dacron as rear pockets for the battens on the marks. The centre of the pockets should be on the marks and each of the pockets should be oriented towards[/aimed at] the corresponding pocket in the leading edge.
35. Fold the sail double and check that all pockets are symmetrical positioned on both sail halves.



Position marks for rear pockets for battens #6, #5 and #4. (#3 not shown in picture.)



The rear pockets for battens #3 - 6 are a little bit wider than the front pockets to allow some sideways play from the batten connectors.



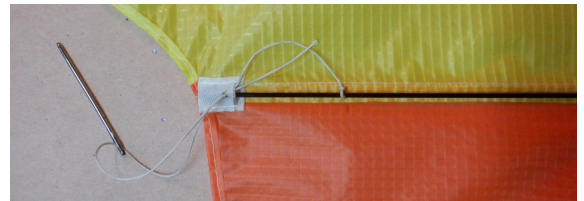
Entire wing sail complete with pockets and reinforcements.

When the straight cross spar is applied to the sail the curved wing will be straightened, see picture on page 18. The leading edge will tighten and the trailing edge will slacken and thus there will be small in-sail dihedrals at every batten.

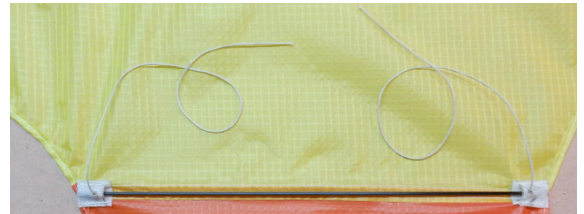
Body sticks and battens.

36. Cut four pieces of 2 mm carbon rod (check the length before cutting):
 - Batten #1: two pieces 24.5 cm long.
 - Batten #2: two pieces 23.0 cm long.
37. Put short (not longer than 5 mm) endcaps on battens #1 and insert them into the pockets on both sides.
38. Tie thin strings, ~20 kg and 30 cm long around the batten and pull them through the 1 mm hole (made in step #23) in all four batten #1 pockets.

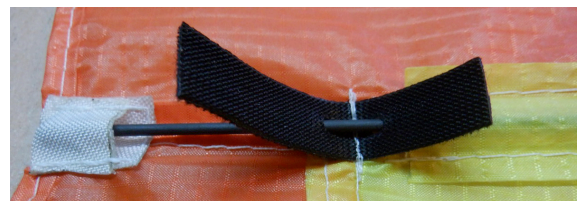
The strings will be used for creating a suitable shape of the body.



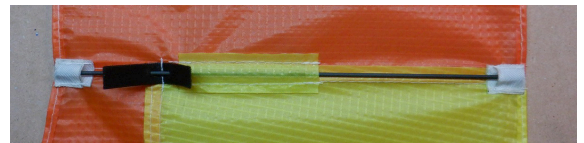
Use a needle to pull the string through the holes in the pockets.



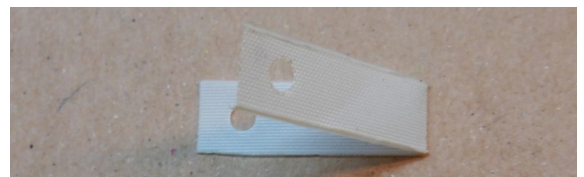
39. Insert batten #2 through the sleeve from rear.
40. Insert the front of this batten through the holes in the velcro strip.



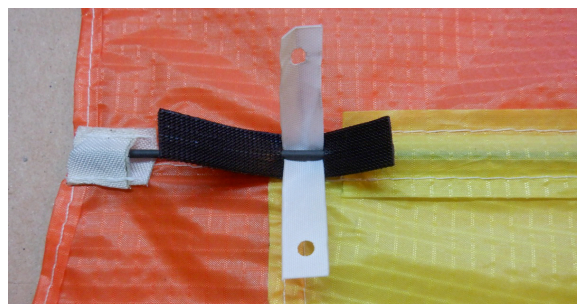
41. Put endcaps in both ends and fix the batten in the pockets.
42. Repeat steps #39 - 41 for the other side.



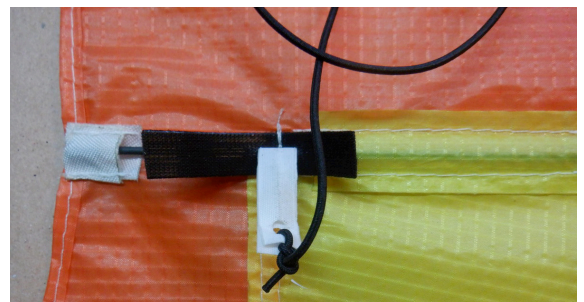
43. Cut two pieces of dacron, both 10 x 60 mm. Fold them double and punch a 3 mm hole at the open ends.



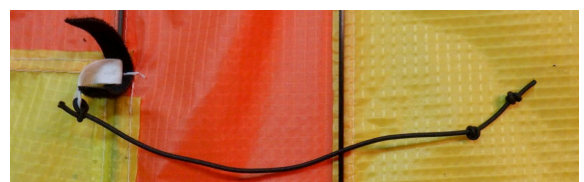
44. Insert one dacron strip between batten #2 and the velcro strip and fold it over the batten.



45. Tie a 3 mm bungee cord, 25 cm long, through the holes in the dacron strip.

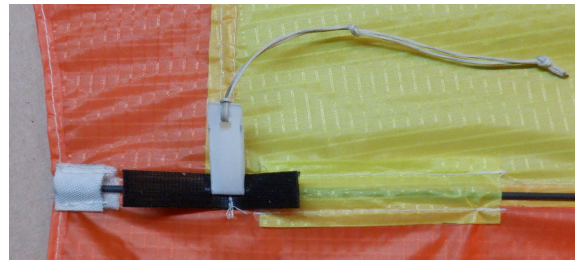
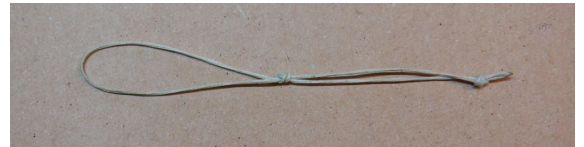


46. Tie two double overhand knots (or figure-of-eight-knots) at the free end of the bungee cord: one 1 cm from the end and one 3 cm inside the first knot.



47. Insert the other dacron strip in the same manner at the other batten #2 (see step #44).
48. Cut a thin string, ~20 kg and 30 cm long, fold it double and tie two overhand knots: one at the outer end of the loop, the second approximately 5 cm inside the first.
49. Tie the loop through the holes in the second dacron strap.

The purpose of the bungee cord and the string loop is to tension/tauten the two wing halves once the frame is in place.

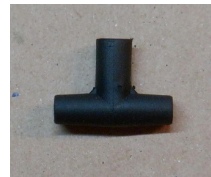


Body belly stick.

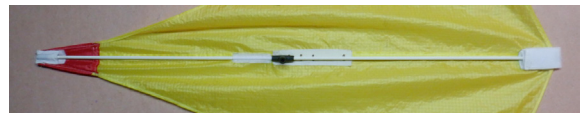
50. Prepare the T connector for the belly stick:
 - 4/4 mm T connector (stand off bracket)



51. Cut the vertical part of the T connector to half.



52. For the body belly stick cut a 4 mm fibre glass rod, 65 cm. (measure the length of the "belly" first).
53. Push the belly stick through the velcro pocket from the rear.
54. Slide the T connector over the belly stick.
55. Proceed to push the stick through the connector stopper sleeve, put an endcap on the end and insert it in the beak pocket.
56. Push the belly stick hard into the beak end pocket and close the velcro pocket tight to check the proper length of the stick.
57. Trim the length of the stick if necessary before gluing an endcap on the end of the stick.
58. Tie with a thin string a tight knot through the hintermost pair of holes to secure the body stick in the middle.



The body stick may remain in place even when the kite is dismantled.

The spreader.

The spreader consists of three Skyshark tubes, where the one in the middle should, if possible, be a bit stiffer. Recommended is 2PX/P200 on the sides and 4PX/P400 in the middle.

There are four alternatives for the connector that should hold the stand-off rod to the belly stick, see text box to the right. Best is probably the Skyshark "T connector" (alternative B) because it is made of rubber and thus somewhat flexible.

Here is described the use of a 6/8 mm cross connector (alternative A: 6 mm spine, 8 mm spreader).

59. Open the spreader separator in the 8 mm hole by drilling a hole straight through with a diameter same as the centre Skyshark tube (for a P400 7.6 mm). The hole should be just big enough to let the spar barely go through. It should stay in a position on the spar and need some power to be slid on the spar.
60. The 6 mm spine hole needs to be stepped down to 4 mm for the stand-off rod, so insert a 6 mm carbon tube in that hole, glue it and cut it to precise length.
61. Put this cross connector in the middle of the centre Skyshark tube but do not glue it in place: for tuning at flight it needs to be sideways slideable.

There are four alternatives for the connector that should hold the stand-off rod to the body belly stick:

- A. Cross connector - preferably 6/8 mm
- B. Skyshark "T connector" (actually a cross connector)
- C. 8 mm T connector
- D. 8 mm stand-off connector

The difference in use is that with a cross connector the active length of the stand-off rod to the body belly stick can be regulated, while with a T connector or a stand-off connector the stand-off rod needs to be cut in the exact length.



A. Cross connector.



B. Skyshark T connector.



C. T connector.



D. Stand-off connector.



Spreader separator of cross connector A drilled through with diameter for centre Skyshark tube.



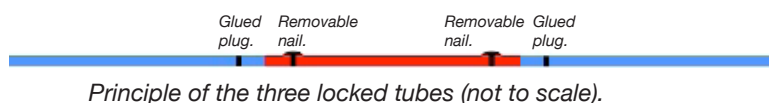
The spine hole/stand-off rod hole stepped down from 6 mm to 4 mm.

This step-down needs to be done for any of the four alternatives that is used.

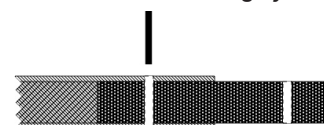
Anti rotating system.

The three Skyshark tubes must be joined together such they not can rotate in relation to each other; the three tubes must act like a single continuous tube when the anti-rotation nails are insered. Thus the internal ferrules for joining the three tubes must be fixed with a 1.5 carbon rod plug through the tube where the internal ferrule is glued plus a removable 1.5 mm nail through both tube and ferrule at the centre tube.

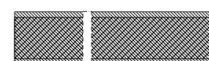
Principle of anti rotating system, length section.



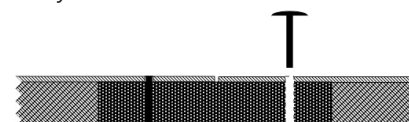
Details of anti rotating system, length section.



End of side tube with glued ferrule and drilled holes. Plug ready.



End of centre tube with drilled hole.



Side and centre tubes joined and anti-rotation plug glued in side tube. Nail ready.



Cross section of hole.

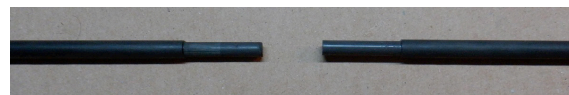


The removable anti-rotation nail inserted in the centre tube.



Cross section with nail.

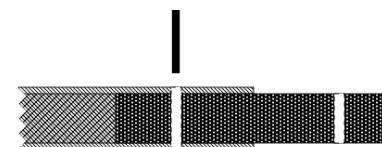
62. Glue (instant glue/cyanoacrylate) internal ferrules in one end of each of the Skyshark tubes that are going to be used as side spars.
63. Connect the three tubes together and drill 1.5 mm holes straight through the tube plus ferrule, 20 mm from the meeting ends of the tubes. Drill the 2 holes around either side of the two tube joints (2 cm from the joint). All four holes must be in line.
64. Cut two pieces 10 mm of a 1.5 mm carbon rod and glue them into the holes drilled through the side tubes (where the ferrule is glued) and ferrules.
65. Trim the ends of the carbon rod so they protrude as little as possible from the surface of the tube.



The two side tubes with ferrules.



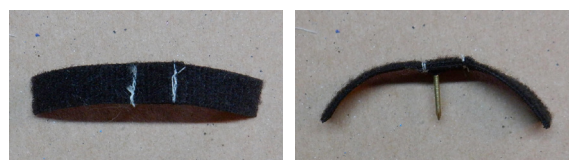
The centre tube joined to one side-tube and the holes drilled on either side of the joint.



Insert a 1.5 mm carbon rod in the hole drilled in the side tube with a ferrule glued inside.

Prepare two holders for the removable 1.5 mm anti-rotation nails for the centre tube:

66. Cut 2 pcs of 10 mm wide double sided velcro, 30 and 50 mm long.
67. Sew the longer velcro piece on top of the shorter, overlapping it with 15 mm, hook side to loop side.
68. Inside the overlap push a 15 mm long 1.5 mm nail (stainless steel or brass) with a fairly large head through the shorter velcro piece from the loop (soft) side as close as possible to the seam.
69. Sew the free end of the overlapping piece to the shorter velcro piece, covering the nail head. Thus the nail is secured in place and won't easily disappear.
70. Make the second holder by repeating steps #66 - 69.



71. Insert the nails in the drilled holes in the centre tube and trim what is protruding on the other side of the tube, leaving 1 mm of the nail outside. The protruding piece is left to make it easier to push the nail out if it gets stuck.



Nail protruding 1 mm.

72. Wrap the velcro straps around the tube and trim the lengths of these if necessary.

Now the three tubes should be connected in such a way that the can't rotate in relation to each other.



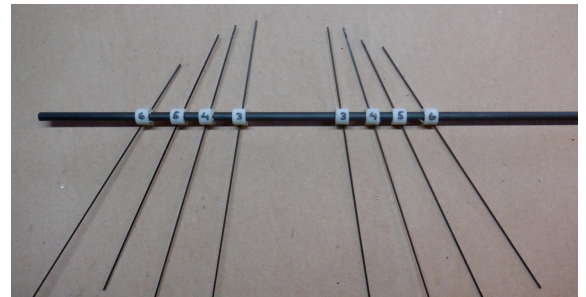
73. Separate the tubes again for the next steps and keep track of which ends joined together.

3D printed batten connectors.

All Skyshark tubes have different outer diameters. The connectors in the STL files for 3D printing are optimized for P200 with a diameter of 7.2 mm. However, 3D printers print with varying accuracy, so the holes printed from the attached files might be smaller. Local companies that can print out from the STL files, using white (no pigment) PTEG or ABS, should be easy to find. Have drills with the same diameters as the used the Skyshark tubes (e.g. 7.6 mm for P400) at hand to drill up holes if necessary. Also have a 1.5 mm drill at hand.

It is of utmost importance that the 3D printed connectors are placed and glued in a correct order and at correct positions on the tubes as well as that the battens are absolutely horizontally aligned.

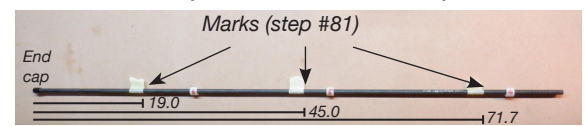
74. Check that a 1.5 mm carbon rod can precisely go through the connectors. It should go through rather sluggishly so it stays in place once positioned.
75. Check that the connectors precisely can slide onto the Skyshark tubes.
 - Connectors for batten #3 on the centre tube.
 - Connectors for battens #4 - #6 on the side tubes.
76. Cut 8 pieces of 1.5 mm carbon rod, all 26 cm long, or according to the below approximate lengths:
 - Batten #3 - 24 cm
 - Batten #4 - 25.5 cm
 - Batten #5 - 24 cm
 - Batten #6 - 23 cmEach individual length will be trimmed later.
77. Prepare all batten connectors by putting the 1.5 carbon rods through the batten holes.
78. Organize the batten connectors in the correct order according to decreasing angle from centre for both sides on one Skyshark tube.
79. Mark the batten connectors with a number (3 - 6) corresponding to their position on the wing spars. Note that half of the connectors are for the left side and half are for the right side. Preferably use different colours on the two sides to keep track of which tube ends should meet.
80. Remove the connectors from the tube and put end-caps on the outer end (opposite ferrule) of the side spars.



The batten connectors organized on the same spar for order marking only, starting with #3 from centre.

81. Mark with a pencil the position of the outer edge (as seen from the ferrule end) of the batten connectors #6 - #4 on the side spars: measure from the outer end of the spar with and including the endcap: 19.0 cm, 45.0 cm and 71.7 cm respectively.
82. Slide the batten connectors #6, #5 and #4 onto the side spars from the ferrule end (connector #6 should be closest to the endcap). Leave a gap between the position mark and the connector for the drop of instant glue (step #97).
83. Put a piece of thick tape (like masking tape or textile tape) on the outside (towards the endcap) of each position mark with the edge of the tape aligned with the position mark. The purpose of the tape is to act as a stopper when sliding and gluing the batten connector in position.
84. Do the same on the other side tube and then stand the two side tubes upright next to each other and check that the stopper tapes are pair wise at exactly the same level and the battens are the same angle.
85. Check that the cross connector is near the middle of the centre cross spar tube.
86. Mark the position of the outer edge (as seen from the centre/cross connector) of the batten connectors #3 on the centre spar: measure from each end: 15.8 cm.
87. Slide the batten connectors #3 onto the centre spar from each side, with a gap (towards centre) between the position mark and the connector.
88. Put a piece of thick tape (like masking tape or textile tape) on the outside (towards the tube end) of each position mark with the edge of the tape aligned with the position mark.
89. Connect the three tubes again as they now have the batten connectors more or less in location.
90. Insert the anti-rotation nails and secure the nail with the velcro around the tube.
91. Insert the battens in the corresponding connectors again if they were removed in a previous step.
92. Swing all batten connectors so the battens are approximately in parallel with the anti-rotation plugs and nails and horizontally aligned and in decreasing angles from the middle (as seen in step #78). The front part of the battens should be 5 - 7 cm long.
93. As an extra precaution before gluing the connectors to the spars a check of the connectors position can be done: put the three spars onto the wings, with the battens ends inserted in the front pockets, and check that the batten connectors come in the correct position when adjacent to the side of the corresponding tapes.

The result of steps #81 - 83 for a side spar.

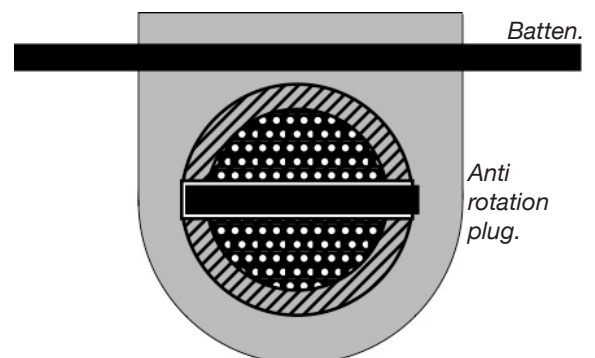


Side spar with masking tape and batten connectors. The rightmost edge of the masking tapes are at 19.0 cm for batten #6, at 45.0 cm for batten #5 and 71.7 cm for batten #4, measured from the outer end of the spar, including the endcap.

The battens might be temporarily removed during this and the next steps.

The ferrule is to the right.

The result of steps #86 - 88 for centre spar.



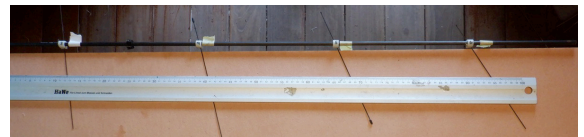
Cross section of the Skyshark tube with connectors swung around the battens so they are more or less in parallel with the anti-rotation plugs and velcro nails.

Now comes the most crucial part of the making of the akka: it is extremely important that all battens are perfectly aligned. For this a flat surface (table) of minimum 180 cm length is required.

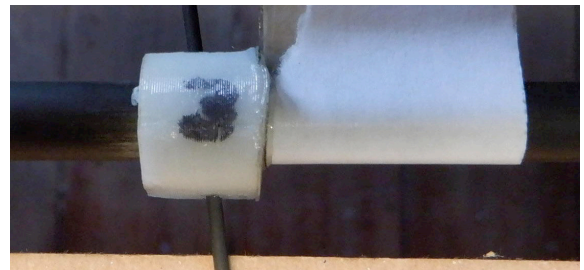
94. Put the three tubes along the side of the table with the long part of the battens resting on top of the table and the tubes just outside the table edge.

At least one side tube and the whole centre tube, i.e. all three battens on one side tube plus both battens on the centre tube, should rest on the table, preferably in parallel with the anti-rotating nails through the tubes.

95. Adjust the battens so they are all absolutely flat and aligned on the table top.
96. Put a long ruler or a metal bar with some weight over the five battens to keep the battens in place.
97. Starting from the centre spar; put a drop or two of instant glue/cyanoacrylate just next to the stopping tape and slide the connector towards the tape till it stops at the tape while making sure the tube is not rotating: hold the tube in a firm grip while making a quick slide of the conector.



Half of the centre spar plus one complete side spar just outside the edge of the table with battens #3 - 6 resting flat and aligned on the table, held in place by a heavy ruler.



98. Proceed with the other connector on the centre tube in the same way and then the three connectors on side tube.
99. Check from the side that all five glued battens are perfectly aligned.
100. Proceed with the connectors on the other side tube in the same way.
101. Check again from both ends of the connected tubes that all battens are perfectly aligned.
102. Remove the stopper tapes.

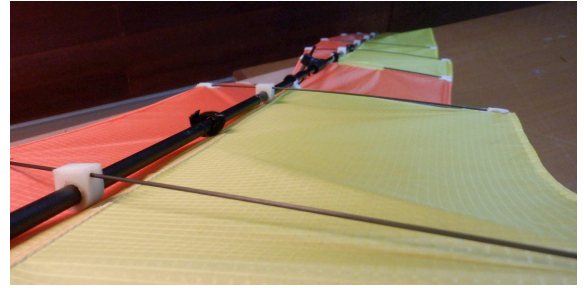


Visual check that all battens are aligned.

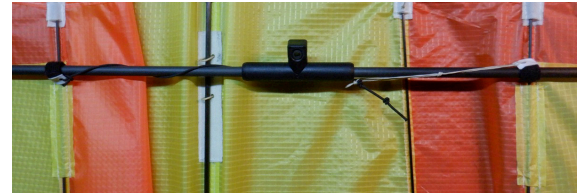
Frame on sail.

With the three tubes joined together the entire cross spar is just placed over the wings. The battens should be on the top side of the cross spar (i.e. not the sail side).

103. Insert the tube ends in the wing tip pockets and align the tubes with the seam joining the front and rear parts of the wing.
104. Fixate the tubes over the seam with the two velcro straps at batten #2. The dacron loops with the bungee should be on the outside of the battens (away from the body).
105. Tension the bungee between battens #2.

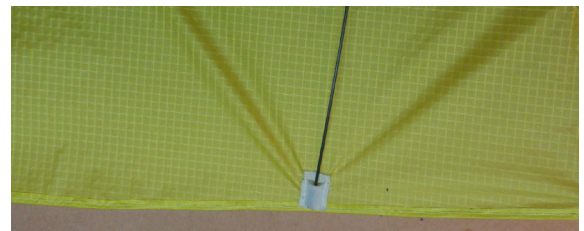


Battens up! The battens are in top of the cross spar and not on the sail side.



The cross spar aligned with the seam between front and rear wing parts. The length of the front part of the battens adjusted so they fit into the front pockets.

106. Put endcaps on the shorter, front part of the battens.
107. Insert the battens in the front edge pockets, while adjusting the batten length to the front pocket and simultaneously keeping the tube aligned with the seam.
108. Trim the length of the battens at the rear edge so the sail is tensioned without being too taut (see fig. below right), and put endcaps on the rear battens ends.
109. Carefully bend one batten at a time and insert the free end in the rear batten pocket.
110. Repeat for the other wing side.



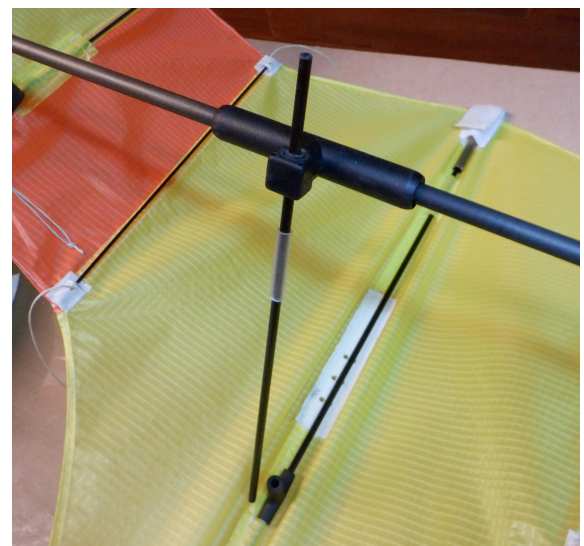
The sail at this batten is too taut; shorten it 1 - 2 mm.

For transport reasons (disassembly) the battens might be marked with their number and side.

Stand-off rod.

For stand-off connectors alternatives C and D on page 11 the following steps should be done a bit differently regarding use of plastic tube.

111. Cut 23 cm of a 4 mm carbon tube.
112. Cut 3 cm of a 4 mm plastic tube and slide this onto the carbon tube.
113. Swing the cross connector on the centre cross spar so the hole for the "spine" is in front, towards the beak.
114. Insert the 4 mm carbon tube from underneath in the "spine" hole as stand-off.
115. Make sure the cross connector is turned so the stand-off points towards the T-connector. If it doesn't and the cross connector turns very sluggishly around the cross spar this might affect the angles of the battens.



116. Insert the other end of the stand-off in the T-connector on the body belly stick.

117. Press the stand-off tube firmly down through the cross connector so the walls of the body are properly tensioned.

118. Slide the plastic tube upwards so it locks the stand-off in position.

119. Secure the plastic tube with a small cable tie and trim the protruding part of the stand-off tube.

120. Finalize the tensioning string, split in two parts, between the front pockets of batten #1:

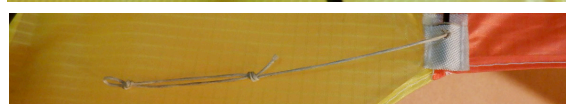
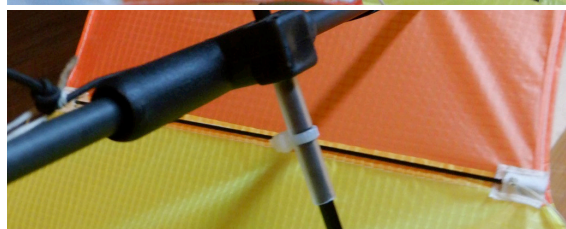
- a. In the end of one of the strings tie a loop with a lark's tail; two overhand knots with a distance of 5 cm in between. The loop should end in line with the stand-off rod.
- b. Insert the string from the other side in the main loop and tighten the string slightly.
- c. When the distance between the front ends of the battens is about 19 cm, tie a stopper knot at that string.

121. Do the same for the strings at the rear ends of batten #1. The distance between the rear ends of the battens should be about 15 cm.

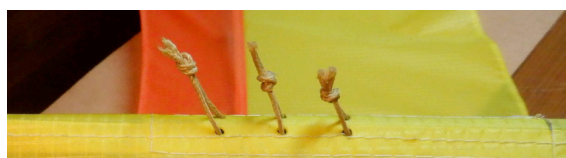
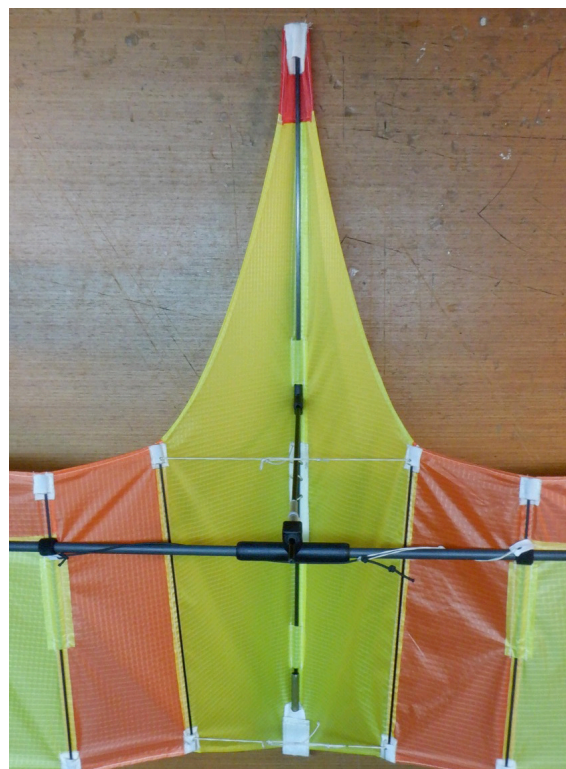
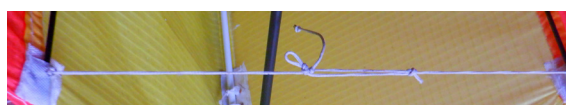
122. Trim the excess ends of the strings.

The purpose of these tensioning strings is to create a suitable body shape; a little bit wider in the front and more narrow in the rear.

123. Tie the three alternative tow points through the three front holes (made at step #19) and around the belly stick.



Loop with a lark's tail: Main loop with short loop outside.





The completed kite with tensioned leading edge and bulging trailing edge.

Theory of self correcting single point wing.

There are two special features for self correcting incorporated in the design of the **akka** kite:

- I. Multiple in-sail dihedrals that come from the 'Wipe' sail shape.
- II. Fanned out wing battens.

The 'Wipe' sail has a trailing edge that is longer than the leading edge. Both are curved, and when a straight spar is applied to the front edge of a 'wiped' sail, the trailing edge will bulge and create small dihedrals around every batten.

The 'fanned out wing battens' means that the battens across the cross spar has an angle to the cross spar that decreases the further the batten is from the centre. This means the battens on the extreme left and right have a larger angle towards the wind and produce more drag than the ones in the center; the wind hits a larger sail area at the extreme left and right battens.

If the kite turns e.g. clockwise (as in the figure) the battens to the left of the single point (green pivot point) will get an increased angle to the wind and receive more wind pressure, while the battens to the right of the single point will get a decreased angle to the wind: letting the wind pass through more easily. The theory is that the kite should then automatically turn back to straight flying again.

Flying akka.

akka needs a mild breeze of 2.5 - 4 m/s. If the kite tends to go slightly to one side (e.g. right) there are two ways to adjust this:

- Slide the cross/stand-off connector on the cross spar slightly towards the other side (left).
- Push the cross spar on the other side (left wing) 1 mm to the rear. The battens might need to be locked in the new position using e.g. cut off endcaps.

The kite is best enjoyed when flying from hand, preferably with a large spool like a Pan Ying spool.

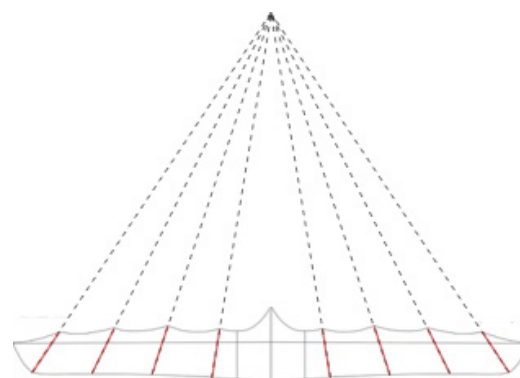


I. 'Wipe' sail.

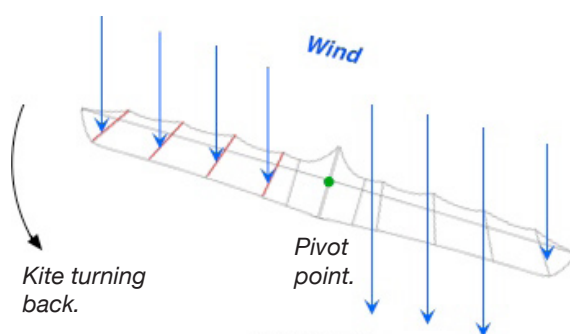
The rear part of the wing has the 'wipe' shape and there will be small dihedrals at every batten. See the effect in the picture below.



Side view: The trailing edge is bulging upwards in the air and create dihedrals around every batten.



II. Fanned out wing battens.



If the kite has turned (clockwise as in the figure), the battens on the left will produce more drag (since they will take up more of the wind pressure) and the kite will turn back anti clockwise.