Kites for Connoisseurs

Thor Nado

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WINDMAN BIEGOLMAI

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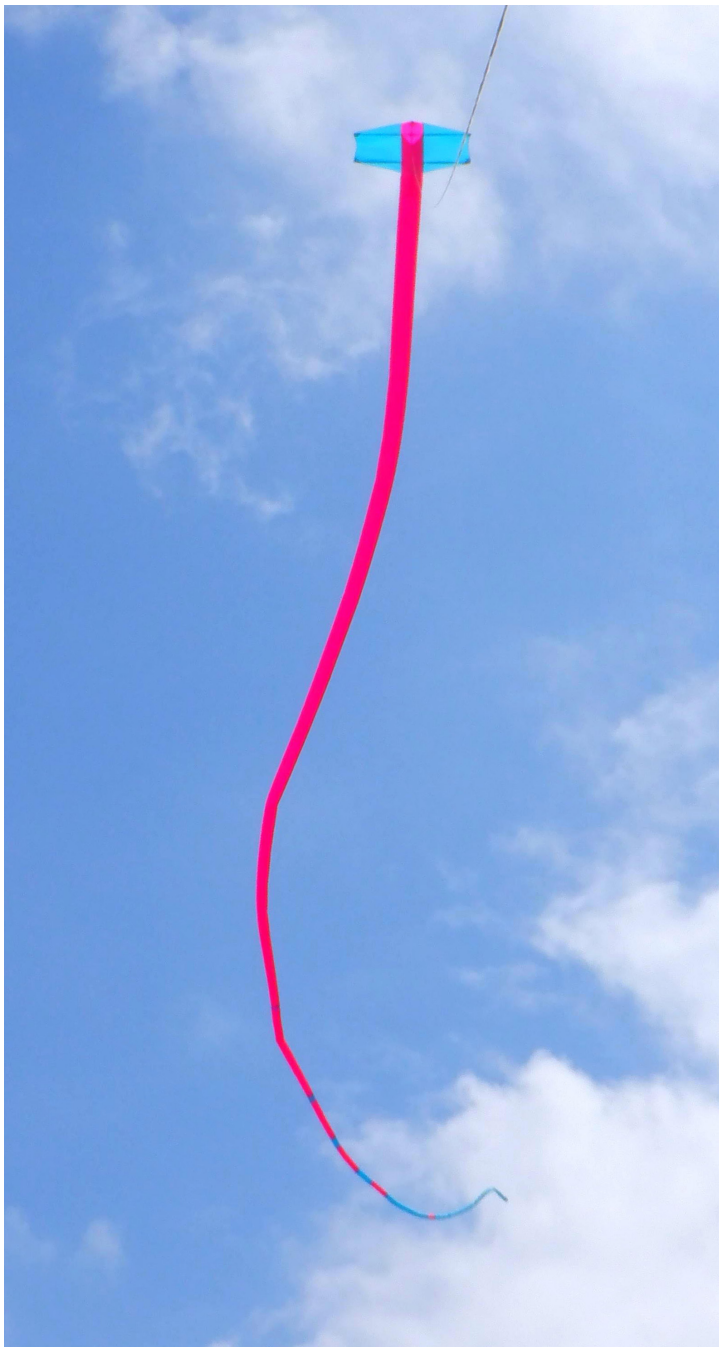


Thor Nado is a high wind kite which basically is a *VFFR - Very Fat Flat Rok* - with a long tapered tube tail that starts inside the VFFR as a tunnel keel.

The width of the VFFR is 1.5 m and the length of the tail is 28 - 30 m.

The purpose of the design was to make a high wind kite where the tail is an integral and prominent part of the complete kite.

The VFFR as such flies well without any tail, but the tapered tube tail adds a great presence in the sky.

See youtube video:
https://youtu.be/0eLacySsQ7g

Wind range 3 - ? ms (So far flown up to 7 ms but should be able to stand a lot more. Maybe the 8 mm carbon tubes need to be replaced with 10 mm carbon tubes for really high winds).

Material

- Ripstop for wings - 1.5 x 1 m
- Ripstop for tunnel keel and tail - 1.5 x13 m
- 1 pcs of 8 mm carbon tube, 82.5 cm
- 4 pcs of 8 mm carbon tube, all 75 cm
- 1 pcs of 6 mm carbon tube, 41 cm
- 2 pcs 8 mm sturdy cross connectors
- 6 pcs 8 mm endcaps
- 2 pcs 6 mm endcaps
- 6 m braided cord, ~100 kg
- dacron for reinforcement and pockets
- velcro, 25 x 240 mm
- webbing for tail end

Making the Thor Nado.
Full size templates (including hems and seam allowances) come as separate documents, but the plan with pure measurements (without hems and seam allowances) come as appendixes in the end of this document.

The templates:

- *Thor Nado VFFR - template*
- *Thor Nado tail 1 - template*
- *Thor Nado tail 2 - template*
- *Thor Nado tail 3 - template*

The lifting part of this kite is a VFFR, Very Fat Flat Rok, with an asymmetrically cut bowtie sail, i.e. the rear wedge is cut deeper.

1. Cut out the ten panels (wing sides, ceiling and tunnel keel) for the VFFR according to the templates or measures. Put a piece of adhesive tape on the bottom edge (with the deeper cut wedge) of the centre wings to easier keep track of which edge is the bottom.
2. Sew the two triangles and the centre wing piece together for one side. The right angle of the triangles should be aligned to the corners of the shortest side of the centre piece. The fold of the plain seam should be inwards to the centre piece.

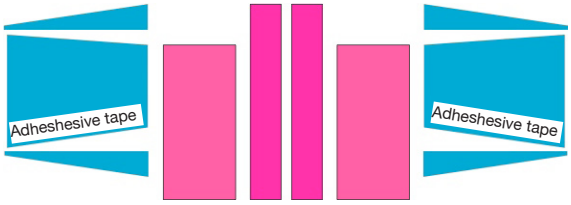
   Trim the triangle tips if they are protruding outside the centre piece edge.

3. Do the same for the other side, making sure that the deeper cut is in the bottom of both sides.

4. Sew 4 x 30 cm long sleeves for the 8 mm cross spars on all four seams joining the triangles and the centre sail, starting 5 cm from the middle edge.

5. Hem the rear edge of the lower triangles.

Panels for the VFFR.

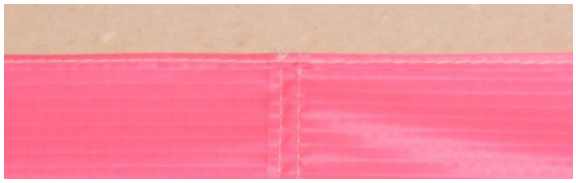


Triangles
Centre wing
Tunnel keel sides
Tunnel keel ceiling

Detail of top triangle sewed to centre wing piece.

Backside of wings with the adhesive tape indicating the rear of the sail.

6. Join the two halves of the tunnel keel with a seam along one of the long edges and hem the front edge.

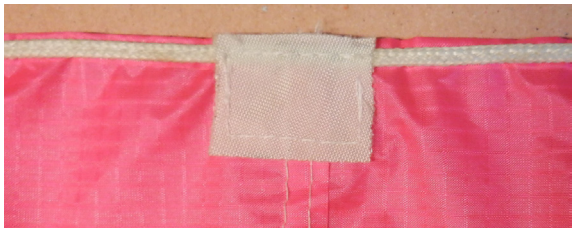


7. Sew a 150 cm long braided cord (100 kg) line along the entire front edge except the last 5 cm on each side. The ends of the cord, ~35 cm, should be hanging loose symmetrically outside the edges for the time being.

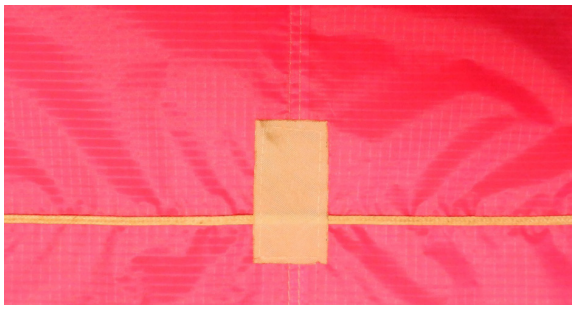
Choose a flat cord where you later can make a Brummel splice, see step 43.

8. Measure 40 cm from the front edge and sew a rear cord in the same way and in parallel with the front cord..

9. Sew a 4 x 3 cm dacron reinforcement on the joining seam of the tunnel keel, on top of the front cord.



10. Sew a larger dacron reinforcement, 4 x 6 cm, on the joining seam of the keel tunnel on top of the rear cord. Let the dacron protrude 2 cm over the cord towards the rear edge.



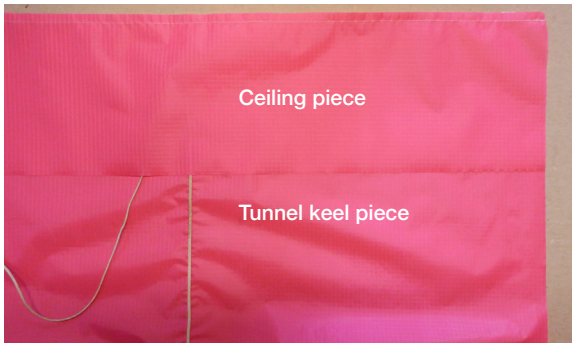
11. Fold the keel parts double along the joining seam and create a long pocket for the tunnel keel rod by sewing a seam 2 cm from the joining (bottom) edge of the tunnel keel. Sew from the right side (outside) of the material and from the front of the keel, but stop where the dacron reinforcemenet begins in the rear end (so a rod can be inserted from inside the keel).

End pocket seam where dacron starts.

12. Close <u>both</u> ends of the rod pocket with triple seams.

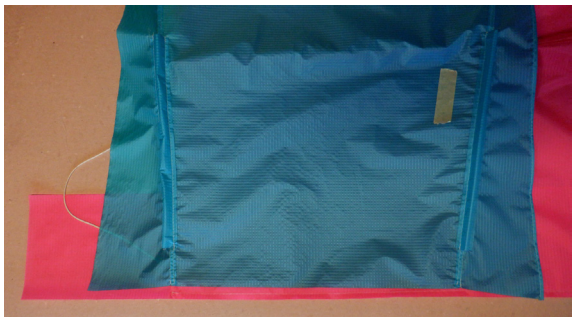
Closing seam at rear end of the rod pocket. Sew a similar seam at the front end.

13. Put a tunnel keel ceiling piece on top of the tunnel keel with the cord side of the tunnel keel facing the ceiling piece. The rear edges should be aligned and one long edge of the ceiling piece should be aligned with a side edge of the keel. Sew with only a single seam. (The ceiling panels are a bit longer then necessary in the top to allow sewing discrepancies.)



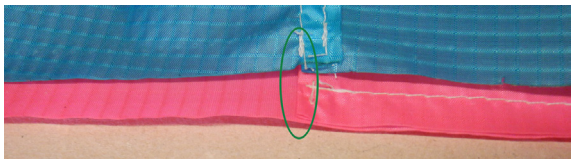
One side of the rear end of keel; ceiling piece on top of the keel piece. Joining seam in top of the picture.

14. Sew the FFR wing onto the joined tunnel keel parts.
    a. Flip the joined tunnel keel parts over vertically so the ceiling part comes in the bottom, and then place the wing part on top of the tunnel keel part. (The three layers from top are thus wing, keel side and in the bottom the keel ceiling.)



Previous seam in picture bottom. Wing part on top of keel, then keel and then keel ceiling in the bottom.

    b. Align the top edge of the centre piece with the hemmed edge of the tunnel keel.

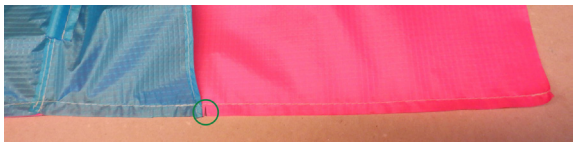


The top edge of the centre piece aligned with the hemmed side of the tunnel keel. The ceiling part is in the bottom.

    c. Align the edges of the wing part and the keel/ceiling part and sew a single seam. It might be best to do that in two steps, both starting at the point where centre wing and tunnel front edge are aligned.

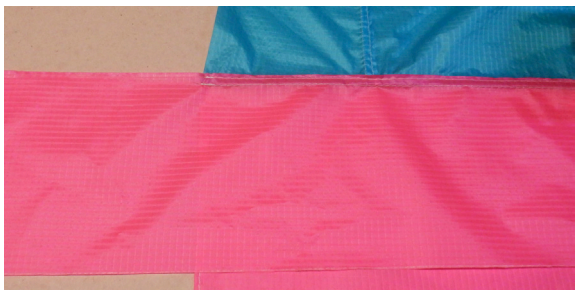
The first joining seam starts at the top of the wing.

15. Cut a short slit in the tunnel keel part just where the rear edge of the wing ends.



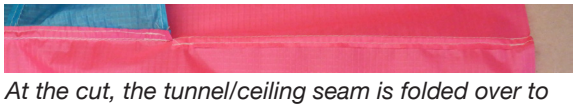
16. For the second plain seam:
    a. Bring out the tunnel/ceiling parts from under the wing.
    b. Fold the top part of the seam over to the wing side.
    c. Sew the second seam all the way to the rear edge of the wing.

    d. At the slit fold the remaining tunnel/ceiling seam over to the ceiling part and continue the second seam there.



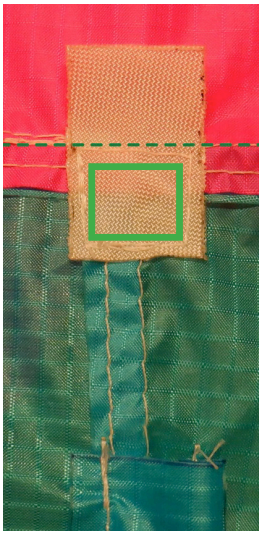
Wing part on upper side of first seam and tunnel/ceiling on lower side of seam with ceiling part on top. The top part of the seam folded over onto the wing part and the second seam sewn.

17. Repeat steps 13 - 16 for the other half. Now the entire sail is joint by the keel but the ceiling is still open.



At the cut, the tunnel/ceiling seam is folded over to ceiling.

18. Cut 4 pcs of dacron, 2 x 3 cm as reinforcement for the tunnel cord holes.
19. Sew one piece of that dacron: half of it onto the ceiling and half of it onto the wing on the seam between the wing triangle and the wing centre.
    a. Put the dacron piece on the inner wing edge and align the middle of the dacron piece with the primary seam. Sew half the piece with stiches on four sides, up to the primary seam, while making sure the tunnel material is out of way.
    b. Sew the other half of the dacron onto the tunnel ceiling with stitches on only three sides, also while making sure the tunnel material is out of way.

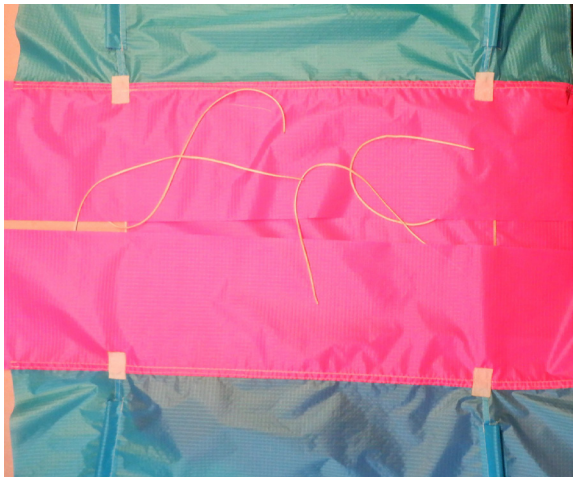


The middle of the dacron aligned with the primary seam (dashed green line) of the ceiling. Stiches on four sides as indicated by the green rectangle.

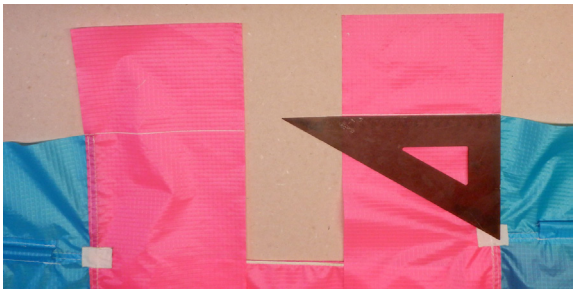
On the ceiling part there are stiches only on three sides as indicated by the green 'goal posts'.

Inside the 'goal' a hole will be made for the tunnel keel cord (step 35).

20. Repeat for the other three dacron pieces.

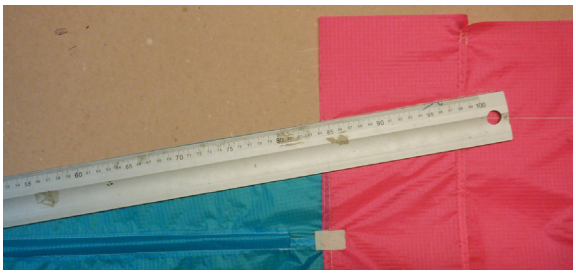


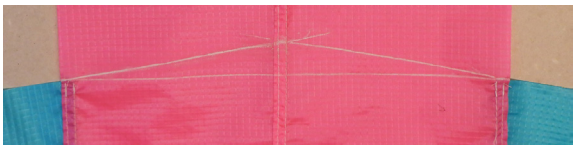
21. Sew together the two ceiling halves.
    c. Due to the multiple seams on both sides the level of the front of the wing edge should be checked against the ceiling parts before sewing the halves together. Using a right-angle bracket draw a line across each ceiling half from the front edge of the wing.



    d. Sew the halves together with the drawn lines aligned.

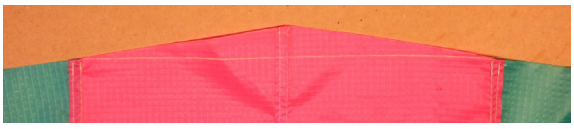
22. Create the pointed top:
    a. Create the pointed top in the ceiling by extrapolating the slanted sides if the top triangles.

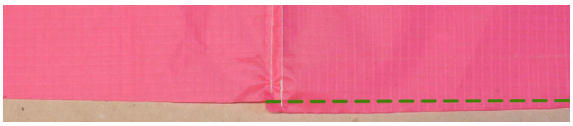




Check that the extrapolated lines meet in the exact middle.

    b. Cut the pointed top.



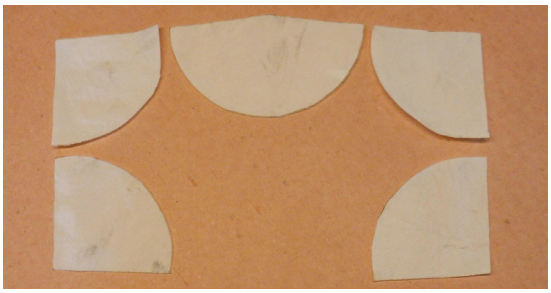


Trim uneven rear edge of tunnel keel ceiling.

23. Check that the rear edges of the ceiling halves are aligned and trim if not.
24. Hem the leading edges.
25. Hem the side edge of the wings.

Pockets for spars.

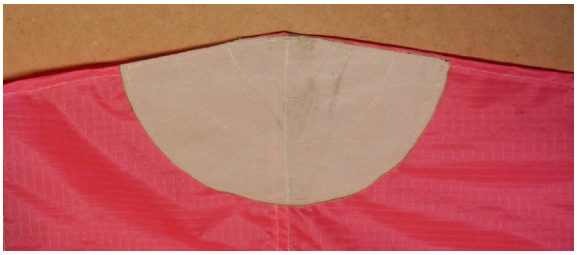
26. Prepare dacron circle sectors for the five corners of the VFFR.



Four circle sectors with an angle of ~95° for the side corners.
One circle sector with an angle of ~165° for the top corner.
A radius of 7 - 8 cm is suitable for the circle sectors.

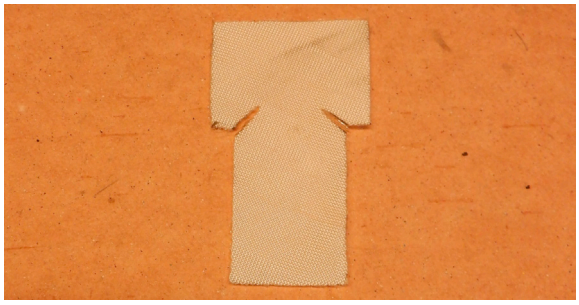
27. Reinforce the four wing corners with a dacron circle sector.

28. Reinforce the top corner with the fifth dacron circle sector.

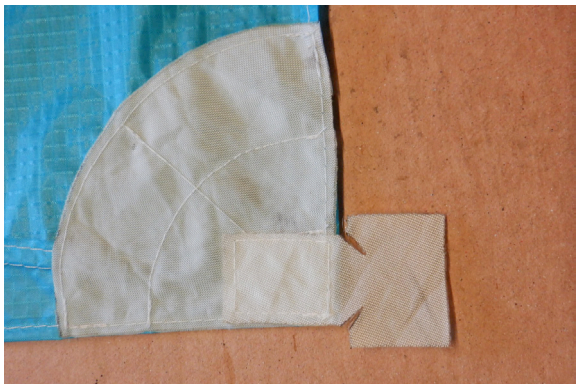


Cross spar pockets.

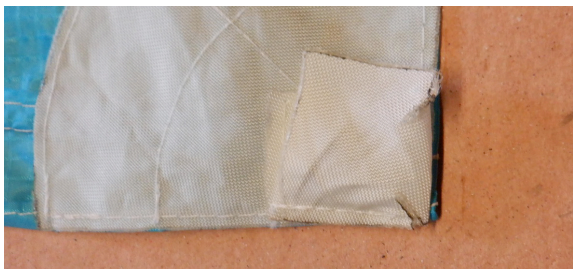
29. Prepare two pieces of dacron for cross spar pockets: 35 x 60 mm. Cut out at the 60 mm edges strips of 5 x 35 on both sides so the rest is a T shape. Cut a small slit in the inner corners of the T shape. The T shape is to make it easier to create the valve for an 8 mm spar.



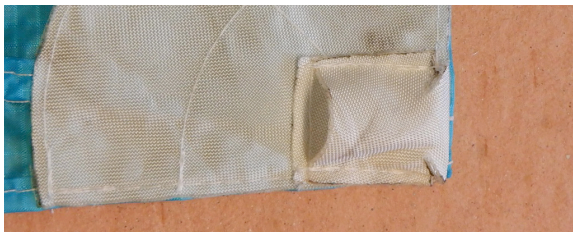
    a. Sew the vertical part of the T onto the dacron reinforcement, on the seam joining the triangle panel and the centre panel, with the top of the T base aligned with the sail edge.



    b. Fold over the horizontal T top bar and align one of its edges with the dacron on the sail and sew it there.

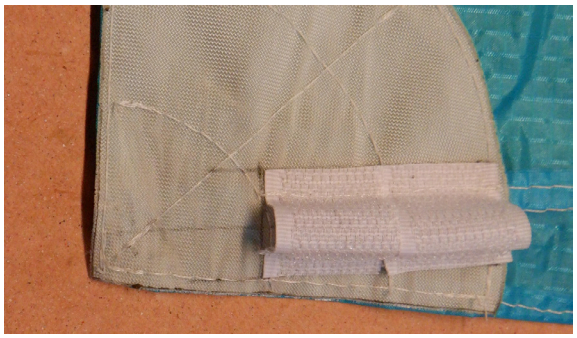


    c. Sew the other side of top bar aligned with the other edge with the dacron.

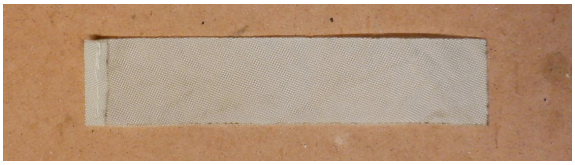


Sew these dacron pockets only on <u>one</u> wing side. (The opposite side will have adjustable velcro pockets.)

30. On the other side of the wing sew velcro closing pockets on the corner dacron reinforcements, on the seam joining a triangle with the centre sail.
    a. Cut 2 pieces of 35 mm of the hook part (hard part) of 25 mm wide velcro.
    b. Draw two guide lines on the corner dacron: Parallel with the mentioned seam and 20 mm apart with the main seam in the middle.
    c. Sew the velcro pieces as sleeves, side by side onto the dacron reinforcement, with the short edges aligned to the guide lines and starting 30 mm from the outer edge of the same dacron piece. The sleeves should be wide enough for the 8 mm cross spars.



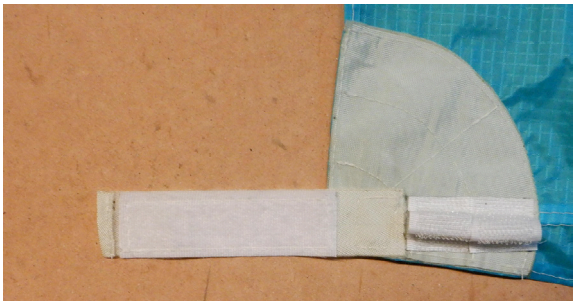
    d. Cut a strip of dacron 25 x 120 mm.
    e. Fold one end 5 mm and fixate it with a seam.



    f. Cut a piece of 25 x 80 mm of the loop part (soft part) of velcro.
    g. Starting from the fold sew the 80 mm soft velcro part onto the dacron strip.

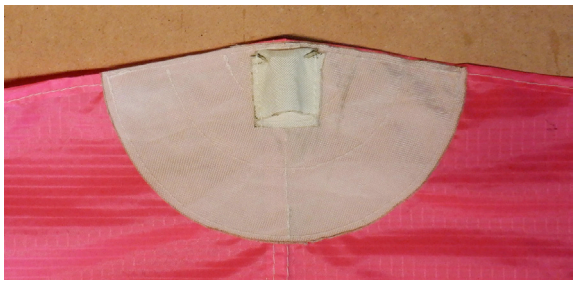
    h. Sew only the first 15 mm of the velcro + dacron strip onto the corner dacron reinforcement, starting directly at the hard velcro sleeve.

    Repeat for the other wing corner.



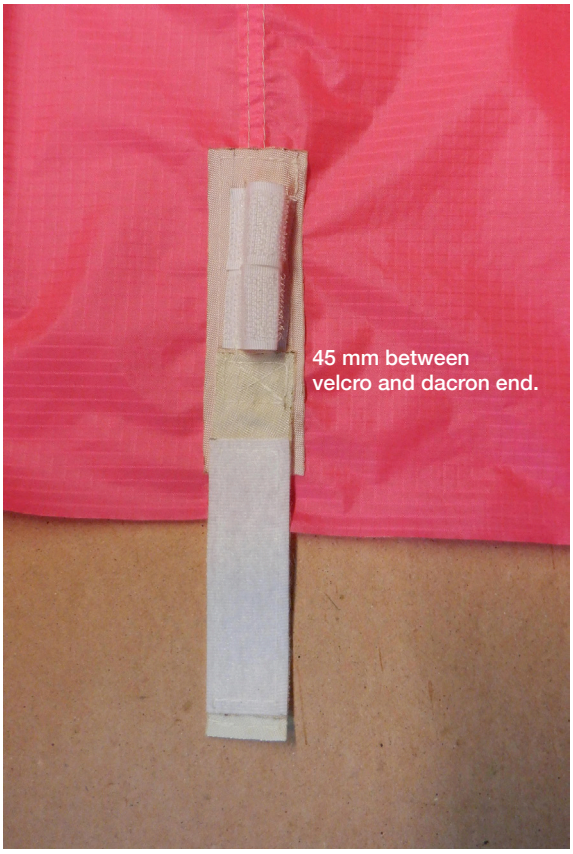
Spine pockets.

31. Sew a dacron pocket onto the top corner dacron reinforcement on the centre seam in the same way as described in step 29.

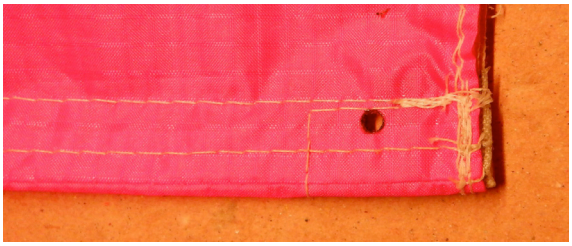


32. Sew a dacron reinforcement, 30 x 100 cm, starting 75 cm down from the top corner in the exact middle line of the tunnel ceiling (on the main seam in the middle).

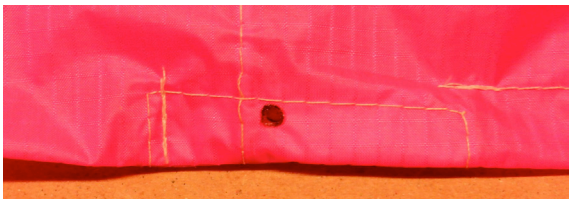
33. Sew a velcro closing pocket onto that dacron reinforcement, same as for one wing side.
    a. Cut 2 pieces of 35 mm of the hook part (hard part) of 25 mm wide velcro.
    b. Draw two guide lines on the dacron strip: Parallel with the main seam and 20 mm apart.
    c. Sew these velcro pieces as sleeves, side by side onto the dacron piece with the short edges aligned with the guide lines and starting 45 mm from the rear end of the same dacron.
    d. Cut a strip of dacron 25 x 120 mm (see above [30 d-h] for following steps).
    e. Fold one end 5 mm and fixate it with a seam.
    f. Cut a piece of 20 x 80 of the loop part (soft part) of velcro.
    g. Starting from the fold sew the 80 mm soft velcro part onto the dacron strip.
    h. Sew only the first 15 mm of the velcro + dacron strip onto the corner dacron reinforcement, starting directly at the hard velcro sleeve.



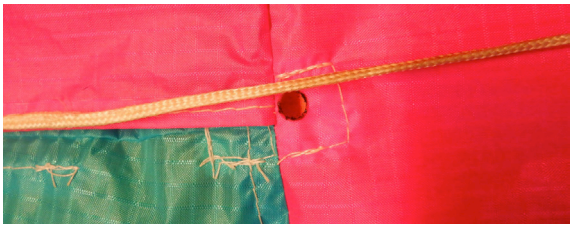
34. Punch or burn holes for the bridle in the tunnel keel rod pocket, 15 mm from the bottom edge:
    a. at the front 15 mm behind the cord.



    b. in the rear end of the pocket just in front of the cord (which will be 20 mm from the pocket end; by this the bridle will prevent the keel rod from popping out).



35. Punch or burn a 5 mm hole in the ceiling, at the tunnel cord reinforcements (steps 18 - 20) just above the cord as near the inside of the tunnel keel panels as possible.


Cord hole seen from under side.

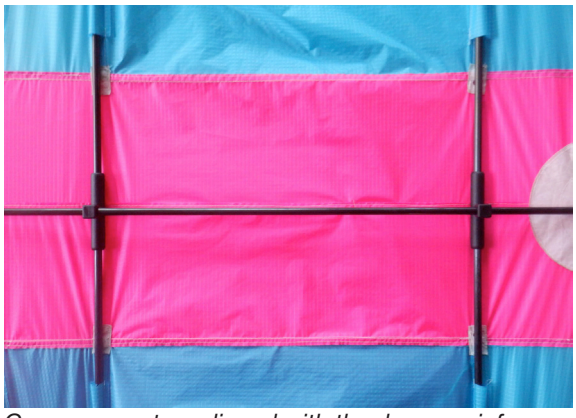
36. Pull the cords through these holes.


Cord hole seen from back side.

Prepare the frame.
The frame consists of 1 pcs of 8 mm carbon tube 82.5 cm long for the spine and 4 pcs of 8 mm carbon tube 75 cm long for the cross spars. The spine piece has two sturdy cross connectors and end caps in both ends. The four cross spar tubes have an end cap in one end only. For the velcro pockets the end caps can be of the T type.

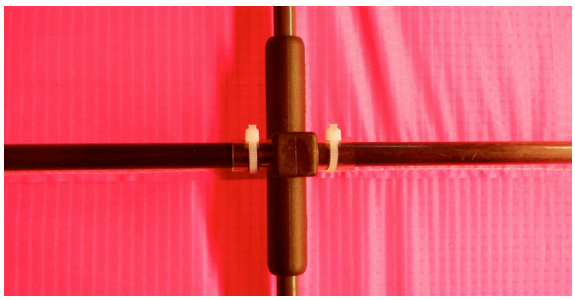
37. Put the frame onto the sail and check that both leading edge and rear edge is taut.
    - Suggested working order: spine (without tightening the velcro pocket), cross spars in closed pockets, cross spars in velcro pockets, then tighten all velcro pockets. The cross spars should be closest to the skin.

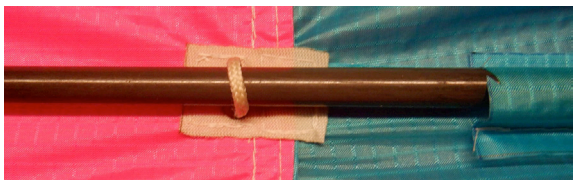
38. Adjust the position of the cross connectors so the cross spars are aligned with the cord dacron reinforcements and sleeves on both sides.



Cross connectors aligned with the dacron reinforcements and sleeves on both sides.

39. Lock the position of the cross connectors with stopper clips or a piece of plastic tube and a cable tie.





40. Pull the tunnel cord over the cross spars and back through the hole again. The cords are to take the pull instead of the seams in the tunnel keel, therefore a loop (or eye) must be tied around the cross spar and the cords must be made taut.

41. While tensioning the tunnel keel also tension the return cord so the sail is touching the cross spar.
42. At the under side of the sail make a mark with a colored pen on the up-going part of the cord just below the spot where it goes through the hole.

Mark on up-going cord (which is sewn to keel front) The splice will be made within the encircled area to the left of the mark..

With the down-going cord part make a variation of the ‘Brummel Splice Loop’ (Google it!) using only the down-going part to make the pass-throughs. Best is to use a proper splice needle, but also an ordinary needle will work (maybe with the help of a plier to pull the needle through the cord).

43. Push the down-coming part through the mark of the up-going part using a needle.

Pull down the up-going cord a bit so there is some working space and push the needle through the mark.

44. After pulling the down-coming part through the up-going cord at the mark, pull the down-coming part in a zig-zag 4-5 times through the up-going part below the first pass through so there are 4 - 5 loops of the down-coming part.

Pull the down-going cord through the mark.

Push the needle through the up-going cord again, this time some 5 mm below the mark to create a small loop.

Continue making loops in the same way, each time approximately 5 mm below the previous loop, until there are four or five loops.

45. Tighten the first loop so the cord is taut around the cross spar, then tighten the other loops one by one.

Starting at the mark: tighten all loops.

46. Stretch the entire splice and fixate the end with an overhand knot after the last through-pass so the end can't slip out.

    Don't tie the overhand knot too tight because the cord might need to be losened to tune the kite for a straight flight. The excess part outside the knot can however for the time being be trimmed to 5 cm.

When all loops are thoroughly tightened, secure the down-going cord part with an overhand knot.

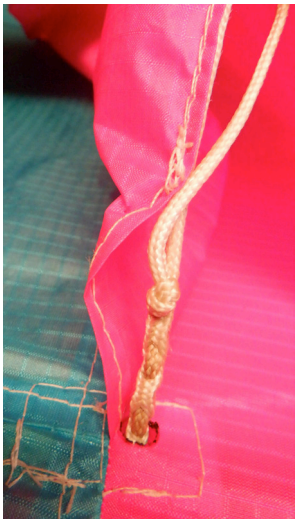
47. The result should be a firm loop (or eye) for the cross spar.

48. For the rear tunnel cords it might be easier to work from the top side of the ceiling by first pulling the up-going part up as much as possible. Then of course the whole splice should be pushed back through the hole again and steps 45 and 46 carried out while the cross spar is inserted in the eye.

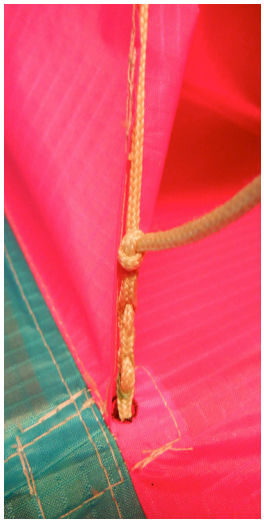
Splicing done on the top side of the tunnel ceiling.

49. With the wings upside down check the tension of the cords by lifting the wings holding the keel front. Adjust the splicing if necessary. The wall of the keel should follow the splice without bulging.

    Do the same check on the rear cords.



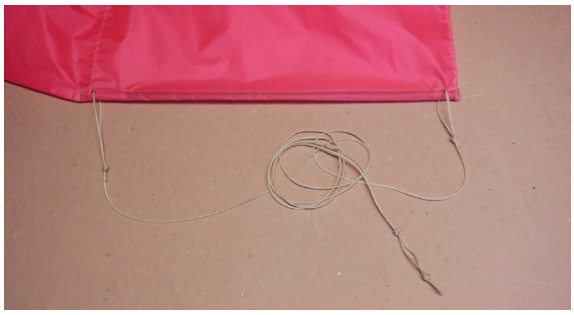
Wrong: The wall of the keel is bulging when the cord is under tension. The knot on the splice should be moved up a little bit and the loops beneath it adjusted.



Corrected:The splice has been adjusted so the cord and the wall of the keel have the same tension.

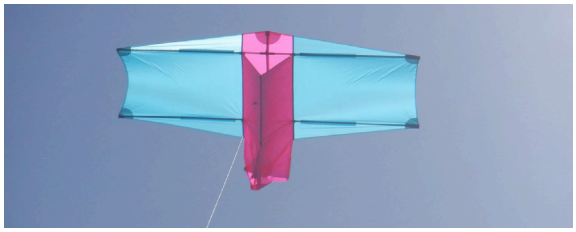
Bridle and tow point.

50. Cut 41 cm of a 6 mm carbon tube for the tunnel keel rod and put end caps in both ends.
51. Insert the tube in the pocket in the tunnel keel (from the rear end) and adjust the length if it is too long.
52. When the correct length has been found cut 230 cm of a cord of the same type that has been used for the tunnel keel.
53. Tie the cord with loose loops in the front and rear of the tunnel keel, through the holes made in step 34 and around the carbon tube.
54. Cut a 20 cm long piece of the same cord and tie it to a loop with a figure-of-eight knot.
55. Tie this loop as a towing point with a Prusik knot on the bridle. If the effective bridle lenght is 200 cm, the towing point is approximately 94 cm from the front knot.



The bridle tied with loose loops in both ends and the tow point loop tied with a Prusik knot. The rear bridle loop knot will prevent the keel tube to jump out of the pocket.

56. Test fly the wings without the tail to check that the kite is balanced. Required windspeed ~3ms.



Tail

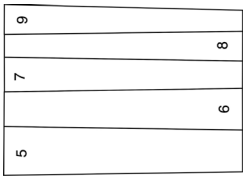
The Thor Nado tail is a tapered tube tail with a total length of 28 - 30 m. It can of course be made shorter and with some graphics added. The front diameter is ~30 cm; i.e. a circumference of 93 cm (the template is 95 cm including seam allowance).

In the picture at the first page the tail is in one main colour with some segments in an accent colour (same colour as the wings), but the template describes it as continuous tail. The template is split in a number of segments for the sake of optimizing the use of ripstop material. To also reduce the number of joints the first four segments are each 5 m long, and when placed on 150 cm wide ripstop (as 1 + 4 and 2 + 3) there is not much ripstop waste. The following segments from tail length 20 m and downwards are split in 5 panels that fit on a piece of 150 cm wide ripstop of 2 m length.

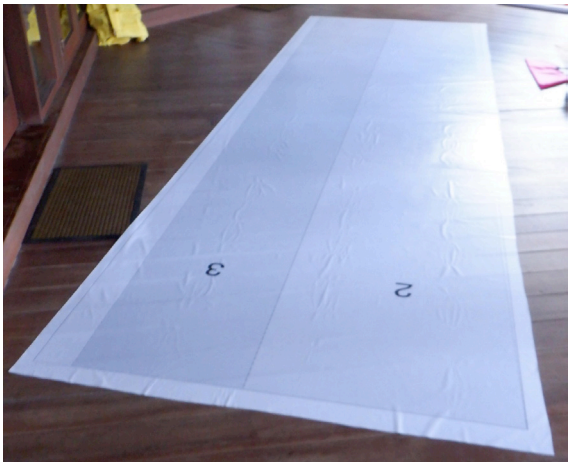
The width of the top edge (=upper circumference) of the tail template is 95 cm and the width at the end (30 m) is 18 cm, meaning the width of a segments is decreasing by approximately 2.5 cm per meter.

Template 1 with tail segments 1 and 4 in 5 m length.

Template 2 with tail segments 2 and 3 in 5 m length.



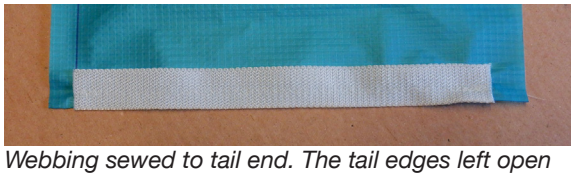
Template 3 with tail segments 5 to 9 in 2 m length.



A 5 m long printout of template (no 2).

A roll of 150 cm wide ripstop is put on the template. The ripstop is thin enough so the panel contours on the template are visible through the ripstop and can be copied onto the ripstop.

57. Sew together all tail parts to a long flat piece.
58. Reinforce the tail end with a webbing.
    - Sew the webbing onto the very end with a single seam. The length of the webbing should be a little bit smaller than the width of the tail end to make it easier to sew the tubing seam.



Webbing sewed to tail end. The tail edges left open for the joining seam in step 51.

- Fold over the webbing twice and secure it with two or three seams.

The webbing folded over twice and secured with two - three seams.

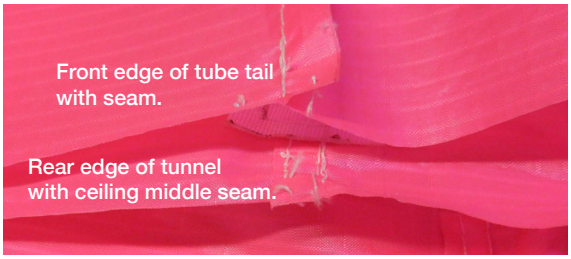
59. Sew the entire tube together and keep it in and out for the time being. When sewing the tube together the webbing should be on the outside of the tube (so it comes on the inside when the tube is turned inside out).

The front and the end of the long tapered tube, still inside out.

60. Remove all spars from the wing and tunnel keel.

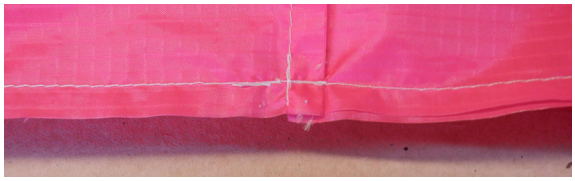
61. Shove the entire wing and keel part inside the tube from the tube front with the tunnel front going in first.

62. Align the front edge of the tail with the rear edge of the tunnel, and the joining seam of the tube with the middle seam of the tunnel ceiling.



63. Sew the front end of the tail and the rear end of the keel tunnel together. If any of these two happens to have a slightly larger diameter just make a dart at the top middle where necessary.

    Since the long tail will cause a lot of drag a second seam should be sewn.



64. Pull the wing and keel out from the tube <u>through the keel tunnel</u>, thereby putting the keel tunnel inside out.
65. Push the in and out keel tunnel over the free arm of the sewing machine and sew the second plain seam.

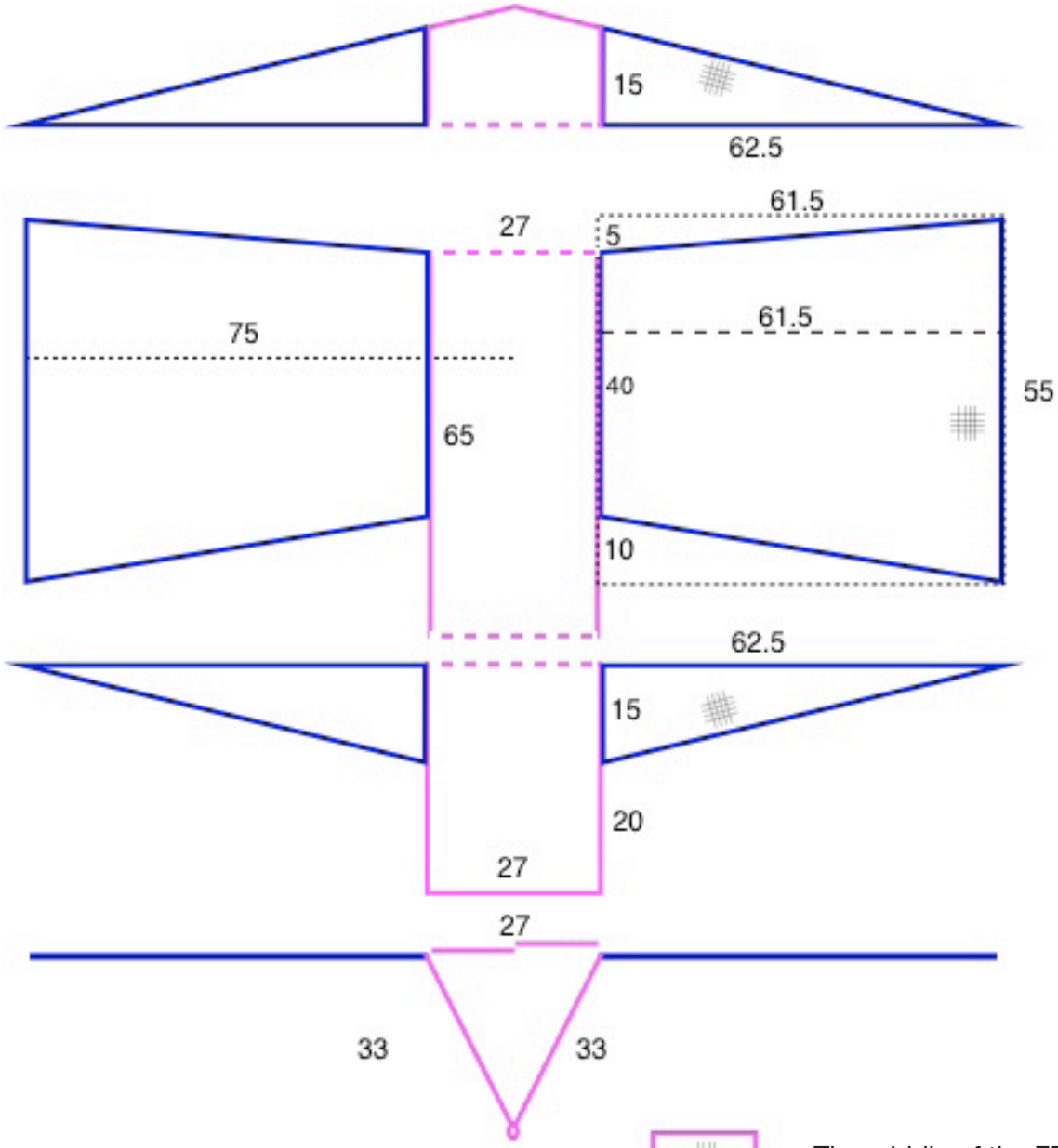
66. Turn the tunnel keel and tail tube back inside out to so the real outside is on the outside. The joining seam for tunnel and keel should look nice and clean.

The keel tunnel and tail tube plain seam seen from tunnel ceiling.

The Thor Nado is ready to fly.

See note on bridle adjustments after appendix 2.

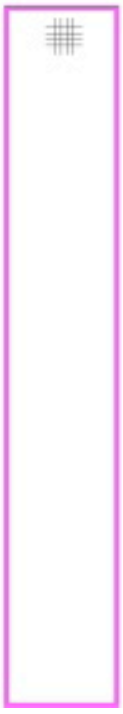
Measurements (without hems and sewing allowances) for the Thor Nado FFR part with tunnel keel.



The Bowtie trapezium is cut out from a rectangle, which is 61.5 x 55 cm without hems and sewing allowances.

Tunnel Keel side
33 x 77

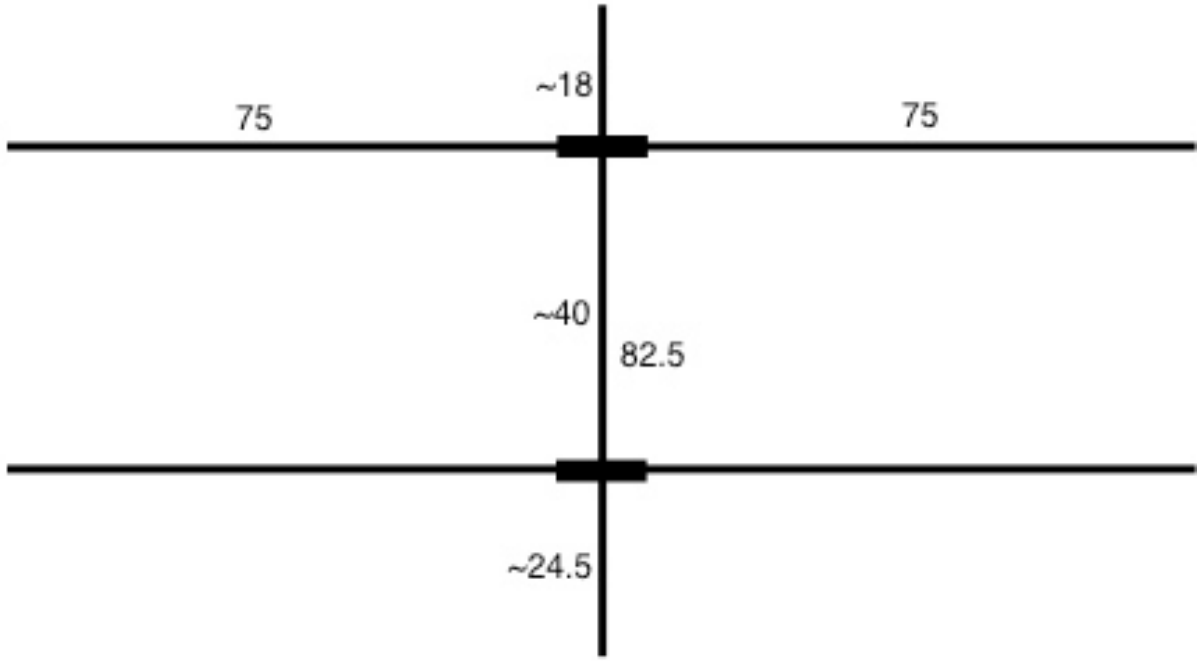
2 pcs



The middle of the FFR (ceiling of the tunnel) goes from the ponted top all the way till the start of the tail. It is split in two longitudinal halves to make it easier to sew all parts together.

FFR centre piece
and tunnel keel ceiling
13.5 x 97

2 pcs



Note on bridle adjustments.

If the effective bridle lenght is 200 cm, the towing point is approximately 94 cm from the front knot. When looking at the kite in the air from the side the wings part and the tail should practically form a straight line with no visible angle between the wings and the tail.

If the complete Thor Nado tends to pull to one side, one of the splices have to be adjusted. To determine if the error is in the front pair of the splices or in the rear pair, adjust the towing point so it is only the front of the bridle that is under tension. The bridle part to the rear of the tunnel keel should be totally slack. If the kite still pulls to the same side the error is in the front splice pair. If the Thor Nado however flies straight it means the error is in the rear splice pair.

Note that although the kite will fly with only the front under tension it will not fly very stable, but it will fly stable enough to determine where the error is located.

- If the kite pulls e.g. to the left with only the front of the tunnel keel under tension, the left of the front splices should be shortened.
- If the kite pulled to the left with tow point in normal position but flied straight with only front of tunnel keel under tension, then the right of the rear splices should be shortened.

To be able to work comfortably with the rear splices inside the keel tunnel it is best to remove all spars, including the tunnel keel rod.

Flying kites with very long tails.

Flying a kite with a very long tail entails (sic!) a special responsibility:

- At launch make sure there are no spectators near the tail who might get caught in the tail.
- When flying take special care not to disturb other kites. Kites with long tails should preferably fly higher up so the tail is out of the way for lower flying kites.