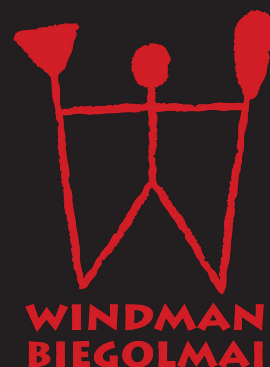


KITES FOR CONNOISSEURS

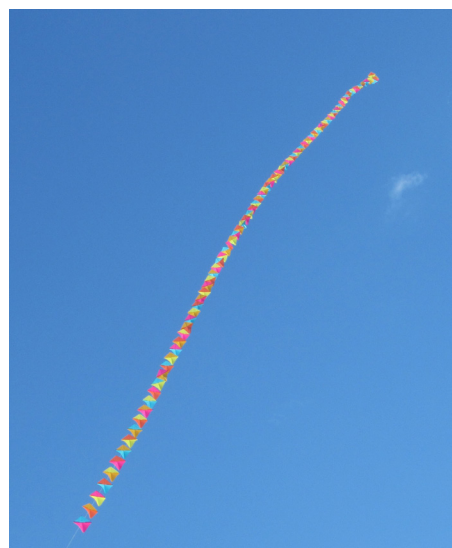
NYOMAN

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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.



Single Point, Tail Free and Dancing.

The **Nyoman** [*Nee-oh-man*] kite is designed for hassle free trains: The single point allows for easy stacking, and not having any tails reduces considerably the tangling risks. In a train the top kite may have a tail for cosmetic reasons. The wind range is 2.5 - 6 ms.

In-sail dihedral.

The Nyoman kite has no dihedral in the cross spar. Instead it has an in-sail dihedral on the rear part of the sail. This is achieved by cutting a wedge out of the front edge of rear sail part. It is this in-sail dihedral that eliminates the need of tail.

The straight cross spar runs inside pockets created by the overlap of the front part of the sail and the rear part of the sail. These pockets are not firmly closed at the outer edges: there is an overlapping gap between the two sail layers where the cross spar can be inserted. The spine is a double stick spine where the line passes through.

Shimmying.

A third, in the air more visible feature of a train of Nyoman kites, a **Nyoman Shimmy**, is that the kites are dancing in the air. *Shimmy* is a dance that was popular 100 years ago (often banned due to its 'obscene' appearance).

The name **Nyoman** is a homage to pak *Nyoman Adnyana*, the Grand Seigneur of Bali kiting.

Two sizes of Nyoman.

The Nyoman kite can be made in two sizes. The difference in size of sail area is only about 20 %, but the larger one, *Nyoman Besar*, needs carbon fibre rods for all spars, while the smaller one, *Nyoman Kecil*, can have either carbon fibre or fibreglass rods. Measures within square brackets below indicate carbon fibre.

Nyoman Kecil is optimized for those who prefer imperial units: the spars are exactly half a yard (18"). *Nyoman Besar* is optimized for using 1 meter rods.

Material per kite.

Nyoman Kecil, 45.7 cm rods (18")

- Rear part: ripstop 49.5 x 34 cm
- Top part: ripstop 51 x 19.5 cm
- 2 mm fibreglass rod or 1.5 mm carbon fibre rod, 91.4 cm (36")
- 3 mm fibreglass rod or 2 mm carbon fibre rod, 45.7 cm (18")
- 3 mm [2 mm] end caps, 4 pcs
- Dacron, 1.5 x 7.0 cm
- 3 mm [2 mm] plastic tube, 5 cm
- 2 mm abrasion resistant sleeve, 12 cm
(For suitable sleeve see discussion at the end of the document.)
- Optional: 2 mm teflon tube, 6 cm.

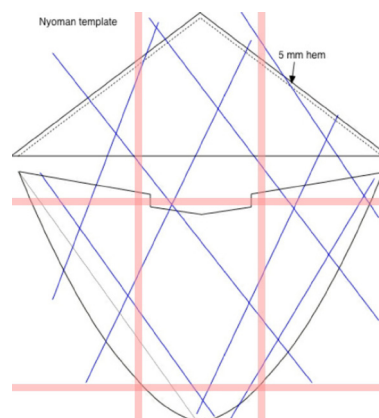
Nyoman Besar, 50 cm rods

- Rear part: ripstop 53 x 37 cm
- Top part: ripstop 55 x 21.5 cm
- 2 mm carbon fibre rod, 100 cm
- 3 mm carbon fibre rod, 50 cm
- 2 mm end caps, 2 pcs
- 3 mm end caps, 2 pcs
- Dacron, 1.5 x 7.0 cm
- 3 mm plastic tube, 5 cm
- 2 mm abrasion resistant sleeve, 12 cm (see above)
- Optional: 2 mm teflon tube, 6 cm.

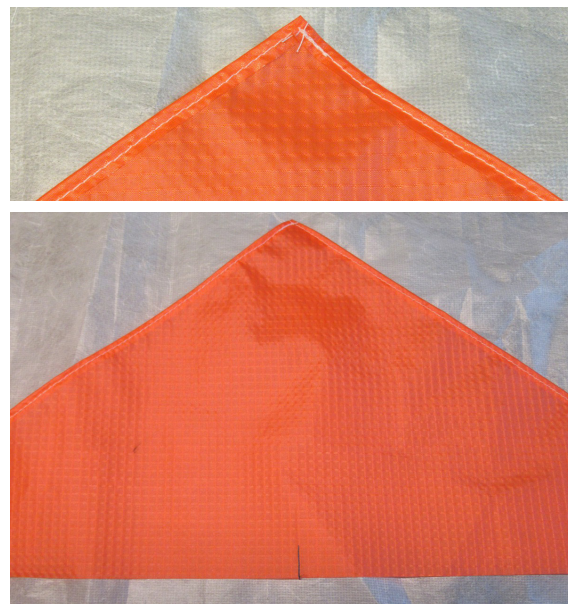
Using carbon fibre rods instead of fibreglass rods extends the wind range slightly in both ends.

How to make a Nyoman kite.

1. Print out the template PDF for the desired size (*Besar* or *Kecil*) and glue the pages together. The blue lines are just help lines to make it easier to align the pages properly. Alternatively plot out the JPEG file which is in full scale.
2. Cut out the templates on cardboard or mat board.
3. Cut out the top and the bottom parts for the kite on ripstop using the templates.
4. Hem the leading edges of the top triangular part.
5. On the front side (hem on the other side) of the top triangle: at the exact middle of the base draw a short line.



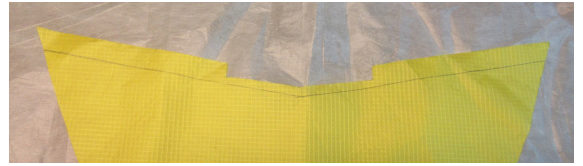
Template on multi paged PDF (6 or 9 pages) to be glued together with a 5 mm overlap.



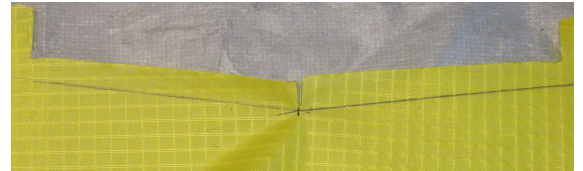
6. On the bottom part draw a line 20 mm from the top edges using a pencil. To get the line perfectly on 20 mm distance on both sides it is probably best to use a 20 mm wide ruler (or piece of wood) and align it with the top edges.



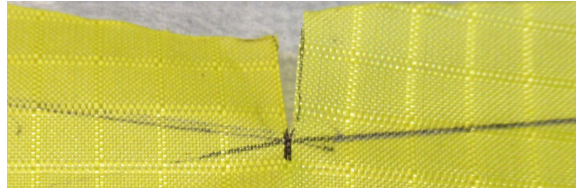
7. Draw a 15 mm line at the exact middle of the bottom part from the top edge and crossing the drawn line.



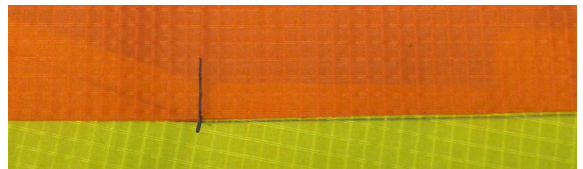
8. Cut a slit on that line until the crossing line, leaving a 5 mm long mark on the other side of the line.



9. Put the top triangle with front side up (i.e. the hem on the down side) on the bottom part so the centre of the base coincides with the extension mark of the slit and the base is aligned with the pencil line of one side of the bottom part.



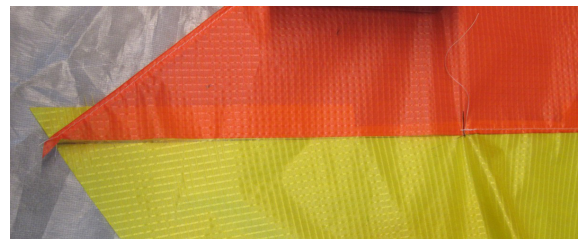
10. Sew a seam from the centre to the edge.



11. Align the other half of the triangle base with the pencil line on the other side of the bottom part.



12. Sew a seam from the centre to the edge making sure the edge of the triangle is aligned with the pencil line.



13. Flip the material over so the back side is up.



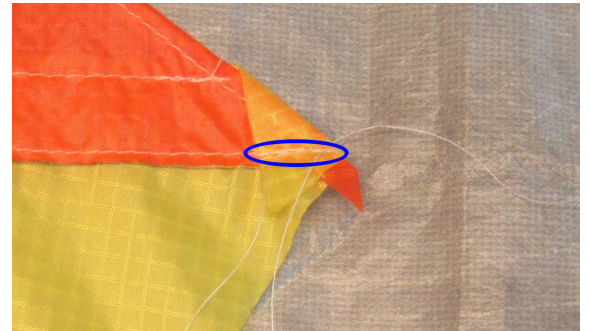
14. Sew a seam to create a pocket for the cross spar, starting at the edge (left edge in this example).



15. Sew a corresponding seam to create the right side pocket.



16. Flip the material over so the front side is up. Close the end of the cross spar pocket by folding over the corner of the bottom part and sew a seam on top of the existing seam along the pencil line.



17. Trim the protruding material from the top part.

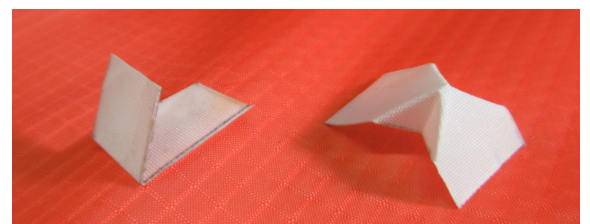
18. Repeat steps 16 - 17 for the other side.



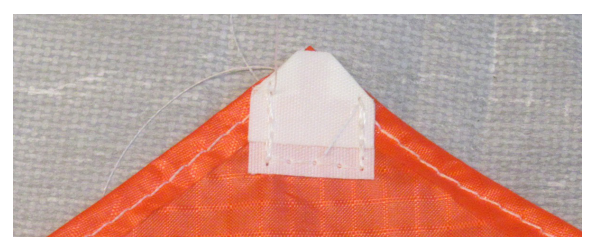
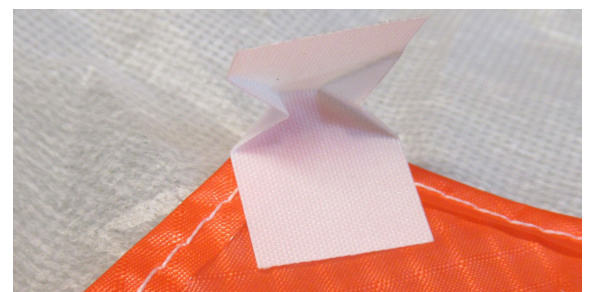
19. Flip the material over again so the back side is up. Prepare two pieces of dacron, 15 x 35 mm, for spine pockets.

20. Fold the pieces so one end is a bit shorter.

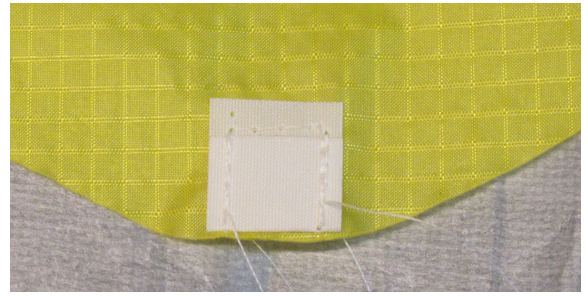
21. On one of the pieces fold in the corners to create a shape suitable for the pointed top.



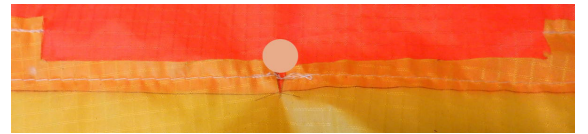
22. Sew this piece onto the very top.



23. Sew the other dacron piece in the exact middle of the trailing edge.



24. Punch a 10 - 15 mm hole nudging the seam at the V split.



The skin of the kite is complete.

Frame and train line.

The spine in a Nyoman kite consists of two equivalent rods, and the train line passes between these rods. The material for the frame of a Nyoman Kecil could be either fibre glass or carbon fibre, while for Nyoman Besar it must be carbon fibre.

(The lengths might have to be adjusted [shortened] depending of the accuracy of sewing).

Fibreglass rods for *Nyoman Kecil*:

- 2 pcs of 2 mm rod, 46.7 cm long for the spine.
- 1 pcs of 3 mm rod, 45.7 cm for the cross spar.

Carbon fibre rod

- 2 pcs of 1.5 mm rod, 46.7 cm long for the spine.
- 1 pcs of 2 mm rod, 45.7 cm for the cross spar.

Carbon fibre rods for *Nyoman Besar*:

- 2 pcs of 2 mm rod, 50 cm long for the spine.
- 1 pcs of 3 mm rod, 50 cm for the cross spar.

Making the frame.

Measures within square brackets are for when carbon fibre rods are used for Nyoman Kecil.

25. Cut off the bottom half of 4 pcs of 3 [or 2] mm end caps, just to make them shorter. Save two of the bottoms for future use (step 34 and 36) as “squeezers”.

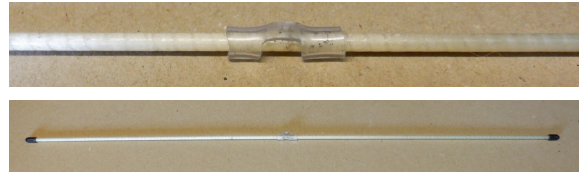


26. Cut 1 piece, 2 cm long from a 3 [2] mm (same diameter as the cross spar) plastic tube for the cross connector.



27. Cut out about 5 mm in the middle, half way through. If the optional teflon tubing will be used the cut-out in the middle should be 7 - 8 mm to give room for the teflon tubes.

28. Slide the 3 mm [2 mm] plastic tube with the cut-out onto the crossspar (45.7 cm for Nyoman Kecil and 50 cm for Nyoman Besar) and put end caps on both ends of the cross spar.

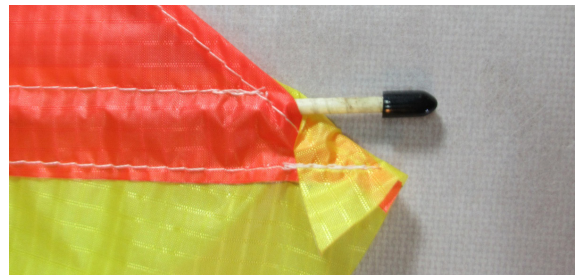


29. Insert the cross spar in the cross spar pocket opening at the centre (of the back side).



30. Wiggle the spar end out of the semi closed pocket end.

The picture shows the front side: the kite having been flipped over.

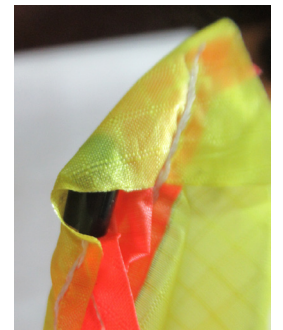
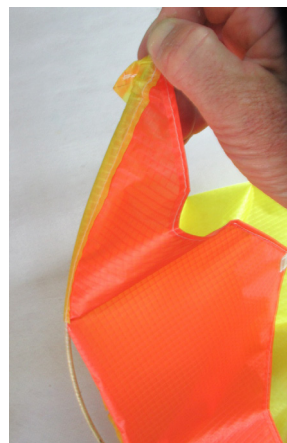


31. Pull the spar out enough to be able to insert the other end in the other pocket opening in the centre.

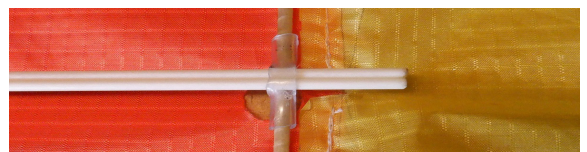


32. Push the cross spar fully back into the pocket and wiggle the first end back inside the pocket end.

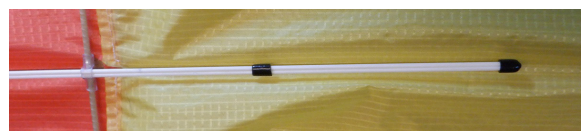
To make this easier bend the rod: Press the rod from the top and bend it at the opening in the middle so it gets extra flex in the end. The sail should be taut but not overly taut over the rod: better cut off a few mm of the rod if it gives too much tension. However, it should not be possible to slide the spar back and forth inside the sleeve.



33. Insert the double spine spars in the cut-out of the tube, between the plastic and the cross spar. It should be very tight. The cross spar should be nearest to the sail.

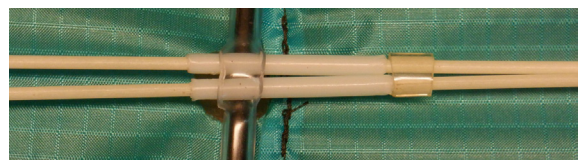


34. Slide one of the "squeezers" (cut-off pieces of the end caps from step 25) onto the double spine part that goes through the plastic connector, put an end cap on the bottom end and insert that end in the bottom pocket of the kite.



"Squeezer" and end cap on bottom part of the double spine. The bottom part of the sail is to the right.

35. If the optional teflon tubing is used cut two pieces of 30 mm of 2 mm teflon tube and slide down on both of the spine rods on the top side of the kite, through the plastic tube, leaving 5 mm on the top side.



Double spine with 30 mm of teflon tubes, leaving 5 mm on the top side (left).

36. Repeat step 34 for the top part of the double spine.

Training Nyoman kites (making a Nyoman Shimmy).

Train line type, sleeve, line strength and sectioning.

- There are two (at least) ways to implement a line for a kite train:
 - A. Every kite has an individual piece of line that is tied to a stopper on the kite below.
 - B. One single line that goes through each kite with a stopper on each side of the kite.

Both have their advantages. With A it is easy to replace broken kites.

With B it is a bit more work to replace a broken kite but less line to handle.

This manual will describe how to make both individual line and through-going line.

- The "shimmying" (roll) of the Nyoman kites makes the spine turn back and forth, which causes a substantial wear on the line and the line will eventually break. Therefore the part of the line that passes through the spine must be sleeved with a sleeve of abrasion resistant material, see discussion on suitable sleeve at the end of this document.

As an option, to further decrease the wear, teflon tubing can be used on the spine spars.

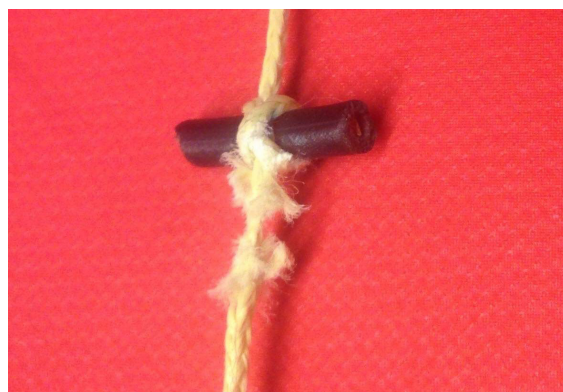
- The strength of the train line should be changing throughout the length of the train with a thinner line (~30 kg) for the top 10 kites, then stronger (~100 kg) for next 40 and then even stronger (~250 kg) for more than 50 kites.
- For maintenance reason it is recommended to define sections of 5 kites. Then the sleeve on the top kite of each section should have an identifying stopper knot in different colour.

Train line of individual strings.

The train line consists of individual strings that are tied to the next kite below. Here is described how to make a section of five kites.

37. Cut 4 pieces of string, each 120 cm long.
38. Cut 1 piece of string of 125 cm length for the kite in the bottom of a section (to allow an extra strap).
39. Cut 5 pieces of 2 mm abrasion resistant sleeve each one 12 cm. One piece, for the top kite, should preferably be in a different colour, just to distinguish it as the start of another section.

PET sleeve can also be hot cut which makes it less prone to fraying.

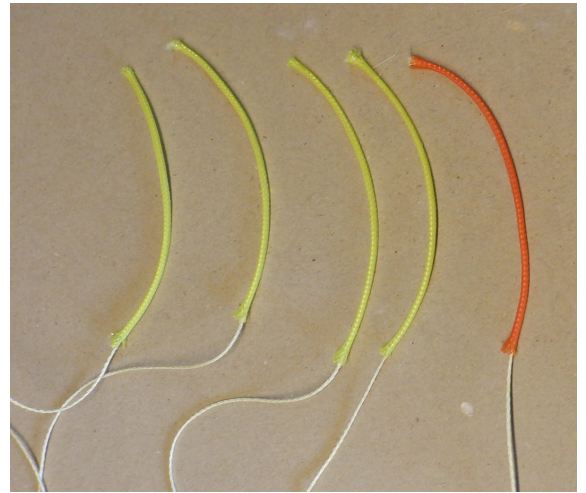
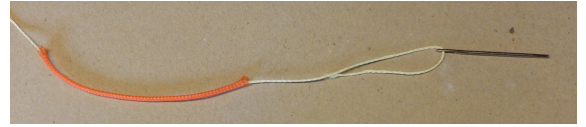


With the original training solution using a grommet in the kite element and a constrictor stopper knot (see Background - Making a train at the end of this document) even a kevlar line would be worn till it broke. This happened many times during the first three years before the real cause and solution was found.



For each pair of string piece and sleeve piece:

40. Use a needle to pull the string through the sleeve. Pull the string so some 15 cm of the string end is free.
41. Put some glue on the 12 cm end of the string and pull the sleeve gently over. Let the glue dry.



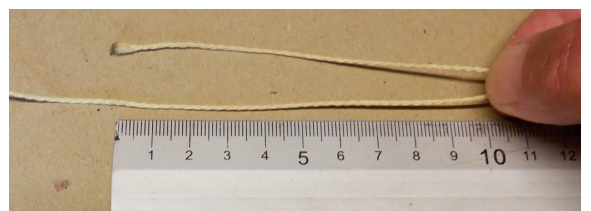
The five pieces of sleeve glued to the end of its line.

42. At the inner end of the sleeve tie a figure-of-eight knot and tighten it.
43. Tie another figure-of-eight knot at the outer end of the sleeve and tighten it. The gap between the knots should be 1-2 cm.
44. Trim the excess part of the sleeve on the outer end.
45. Put a drop of glue on the ends of the sleeve to keep it from fraying (if the sleeve is not hot cut).



The five pieces of sleeve with two figure-of-eight knots acting as stoppers.

46. At the other end of the string pinch 10 cm and loop back.
47. Tie a figure-of-eight knot on the loop to make a long loop for tying to next kite.



48. For the bottom kite of each section pinch instead 15 cm and loop back and make a strap on the long loop by tying a second figure-of-eight knot 1 cm from the loop end.

49. Take out the spine top from the top pocket and temporarily remove the end cap and the “squeezer” and keep them in a safe place for a minute.

50. Pull the string part with the loop through the hole in the kite from the back and then slide the sleeved part (between the knots) of the string between the two parts of the top of the spine all the way down to the cross spar.

If the optional teflon tubing is being used make sure there is 5 mm of the teflon tubing on the top side of the cross spar, where the sleeved part can slide in between.

51. Slide back the “squeezer” as a locker over the double spine spar to lock the sleeved string in position. The sleeve should be tightly squeezed between the cross spar and the locking squeezer.

If the optional teflon tubing pieces have been put on the spine rods, make sure that the sleeved line is between the teflon tubings.

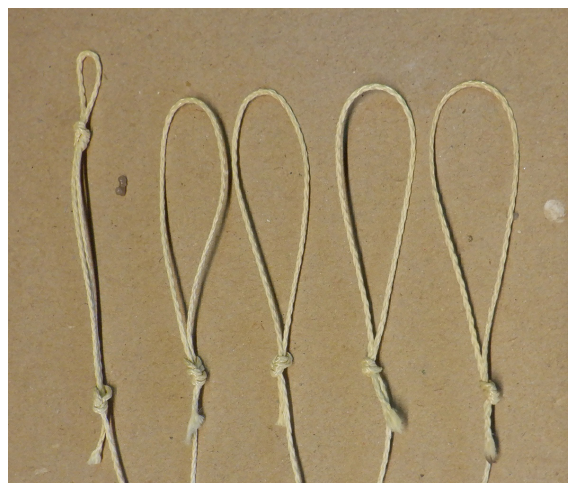
52. Put back the end cap on the top end of the spine and put the spine back into the top pocket.

53. Adjust the location of the cross spar plus sleeved line plus the locker (squeezer) downwards so the leading edges of the kites are taut.

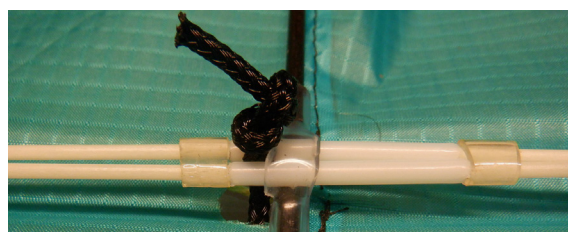
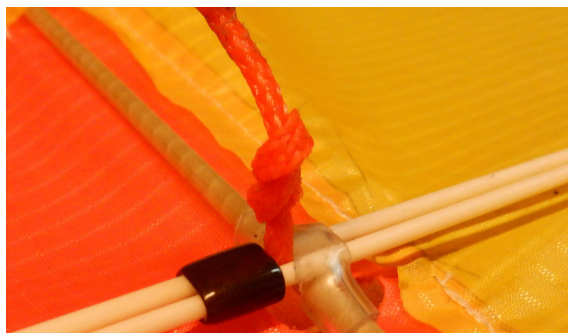
54. Adjust the plastic cross connector sideways so the spine is exactly over the middle of the hole. (It might be needed to adjust if the kite doesn't fly straight.

55. Secure the locking “squeezer” (plastic tube) on the upside of the sleeved line with a cable tie.

56. Slide the “squeezer” (cut-off end cap piece) on the downside of the sleeved line as far up as possible.



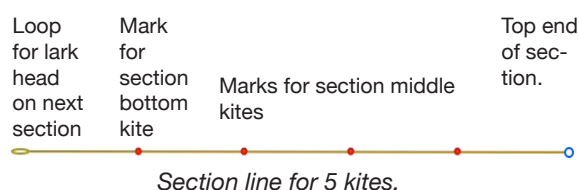
Loop with extra strap for the bottom kite to the left.



Teflon sleeved spin rods with plastic tube squeezers. locking the teflon tubes in place.



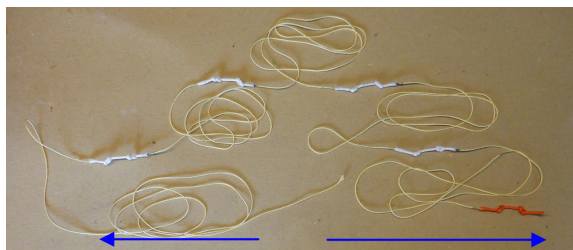
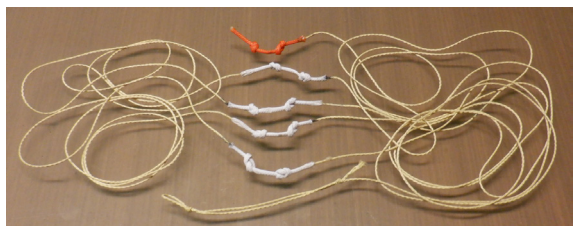
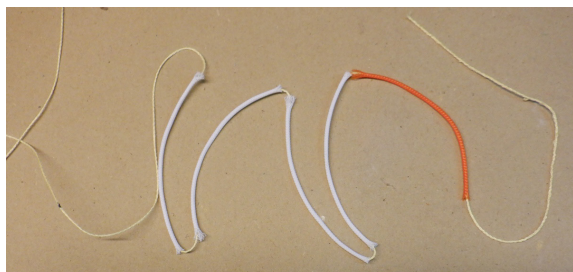
57. Repeat for the other four kites in the section.
58. Train the kites by tying an upper kite to a lower kite by tying a simple lark's head below the stopper knot on the sleeve.



Train line of through-going line.

The through-going train line consists of a single line that goes through each kite with stoppers on each side of the kite. For maintenance reason it is recommended to define sections of 5 kites. Then the top kite of each section should preferably have an identifying stopper knot in different colour.

59. Cut 5 pieces of 2 mm abrasion resistant sleeve each one 12 cm. One piece, for the top kite, should preferably be in a different colour, just to distinguish it as the start of a another section.
- PET sleeve can also be hot cut which makes it less prone to fraying.
60. Cut a 5.7 m long piece of string.
61. From one end make 4 marks with 110 cm gaps.
62. Use a needle to pull the string through all the sleeves. The sleeve with different colour should go on last.
63. Pull the sleeves so they are some 15 cm below each mark/end of the line.
64. Put some glue on the 12 cm piece of the string below the end/each mark and pull the sleeve gently over the glued string part.
65. Do the same for the four other sleeves.
66. Put a drop of glue on each sleeve end (if not hot cut) and let the glue dry to prevent fraying.
67. Tie a figure-of-eight knot in each end of the sleeves, with a gap of 1-2 cm between the knots.



Through-going line for a section of five kites with stopper knots on sleeves. The blue arrows indicate the probably best directions when tying the knots, starting from approximately the middle of the line and working towards the ends.

68. Pull the line with the sleeves through all kite skins, starting from top, keeping it on the top side of the cross spars and leaving the knots of each sleeve on the backside of the kite.
69. For inserting the line into the spine:
Follow steps 49 - 57 above for all kites.
70. For the train line from the bottom kite of the section:
pinch 15 cm and loop back, tie a figure-of-eight knot and then make a strap on the long loop by tying another figure-of-eight knot 1 cm from the loop end.

Keeping train sections in order.

If you have a carefully designed order of the elements and the sections in the train you might want to mark the top kite of each section to be able to retain this order after maintenance. This can be done by putting a piece of hot shrink tube on the spine and write the sequence number on it with a permanent pen.



Examples of element order.

Each element can be made in a single colour or with different colours in top and bottom.

With different colours at top and bottom a minimum of four different colours are required to create a train where no element has adjacent elements with one colour the same as its own. Certainly, with four different colours 12 combinations are possible top/bottom, but only four can be used to meet the challenge of not the same colour on two adjacent kites: Each second element would have the same colours: 1/2 - 3/4 - 2/1 - 4/3 - 1/2 etc. making a repetitive sequence of four.

With five colours, using different colours on top and bottom, 20 different combinations are possible. All can be used, and a more elaborate sequence can be created: a sequence of 20 elements which can be repetitive without any changes.

Test flying.

Test fly one section (of 5 elements) at a time. Then it is easier to correct any kite that is not flying straight by moving the plastic connector sideways: to the right if the kite is leaning to the right and v.v. Or the other way around. Also check that the leading edge is taut.

Pull.

A Nyoman Shimmy gives quite some pull. A train of 40 elements has to be walked down at a wind speed of 5 m/s.

	Top	Bottom
1	2	3
2	5	1
3	3	4
4	1	2
5	4	5
6	1	3
7	2	4
8	5	3
9	4	2
10	3	5
11	1	4
12	2	5
13	3	1
14	5	2
15	4	1
16	3	2
17	5	4
18	2	1
19	4	3
20	1	5

Section of 20 elements (numbered 1 - 20) using five colours, numbered 1 - 5, with top and bottom of each element in different colours where no two adjacent elements use the same colour.

Sleeves.

To solve the line wear problem of the Nyoman Shimmy train several types of sleeves have been tested:

- a. Sleeve from kite shop (1.5 mm from Metropolis).
- b. PET Braided sleeve, 2 mm (white)
- c. PET Braided sleeve, 2 mm (orange)
- d. Flexo PET from Techflex, 1.6 mm (black)

Each type of sleeve has been tested with and without teflon tubing on the spine pair. After a 30 hours durability test in wind speed ranging from 2.5 to 6 m/s there was no visible wear on any of the sleeves. All sleeves of course had quite visible squeeze marks after being squeezed between the spine rods, and some even had some miscolouring from the rod.

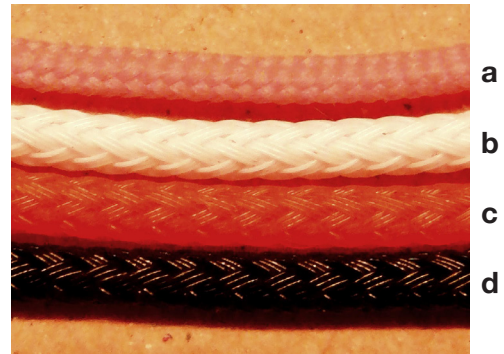
For a couple of sleeves the string inside had become visible through the braid, but the string as such was not affected.

The teflon tubing on the spine rods did not seem to make any difference.

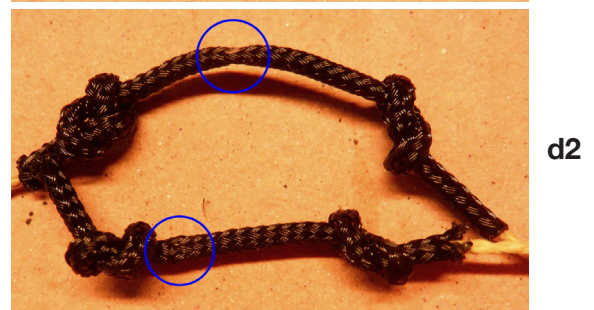
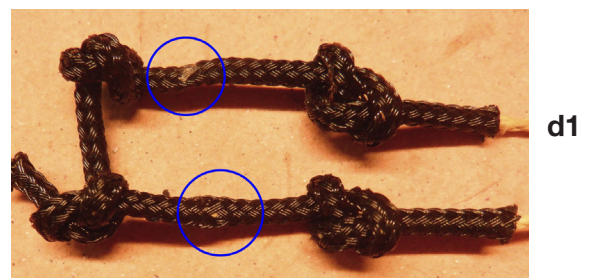
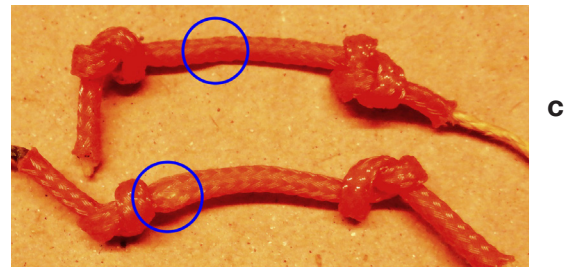
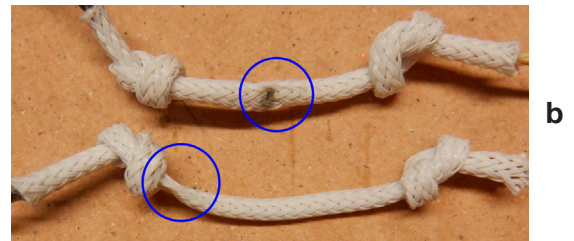
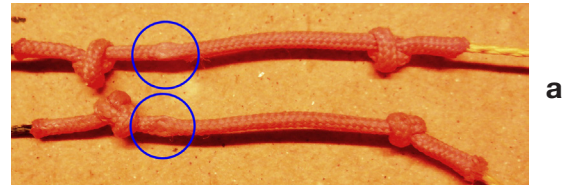
The pictures to the right show the used sleeves and encircled in blue is the “squeeze” from the spine rods. The lower sleeve in each picture was inside rods with teflon sleeving.

The **d1** tefloned sleeve shows the string through the braid at the squeeze mark.

Conclusion: All PET sleeves will do the job. However, it is recommended that from time to time inspect all kite elements for line wear.



The braid density seems to be the same for the three PET sleeves.



Close-up of the “squeeze”.

Background.

The kite

- I have often on kite festivals seen workshop diamond kites (with tails) that "fly" like a propeller. I set out to make a diamond kite on single point that needs no tail and no dihedral at the cross spar without resorting to the fighter kite type with a horizontally bowed cross spar.

The name

- Mr **Nyoman Adnyana** was my first Balinese friend, whom I met already in 1995 on my first kite tour to Indonesia. He is a very dear friend, and he visited my villa in Klungkung, Bali, on July 26, 2016. In the afternoon the same day, after he had left, I started experimenting with a tail-less, single point diamond kite with straight cross spar. The first idea was crap, but I got the second version flying at sunset and have then optimized it so it flies good in a wind speeds of 2.5 - 6 m/s. In honour of my good friend I decided to name the kite **Nyoman**.

- Kecil is the Indonesian word for small.

- Besar is the Indonesian word for big.

When the wind is perfect the kites in the train have a dancing movement in the sky, much like the many times forbidden dance **Shimmy** in the 1920's. Hence the train name **Nyoman Shimmy**.

Making a train

My philosophy when making kite trains is that each kite; each train element should fly freely and independent of the other train elements. Each kite should also be able to move freely around the line, so that if one kite rotates around the line, the line will stay straight without being twisted. Both these conditions are met by using a grommet. A line can then be pulled freely through any number of kites. A stopper is required at the backside of each grommet to fix the kite in a top position. My favourite stopper has always been a Constrictor knot around a short piece of single core cable. An additional stopper may be used below the kite element.

However, the "shimmying" (roll) of the Nyoman kites makes the spine turn back and forth, which causes a substantial wear on the line and inevitably cuts it. This has forced me to abandon my favourite kite train line solution (with grommet and constrictor knot) and find another solution: **Sleeve and Squeeze**, i.e. sleeved sections with figure-of-eight knots as stoppers, a solution that took three years to find.