The slim rotor

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The story:

It started with a small rotor or bol made from 12 isosceles triangles, called “easy bol”.

This bol has, like most bols a very large surface area compared to its diameter. And as a consequence a relatively small diameter pulls very hard.

Because of the big surface area one also needs a lot of rip-stop to build it. So I started looking for a way to have lower pull and smaller surface area for a larger diameter.

By doubling the number of triangles, 24 instead of 12, it becomes a larger circle for the same surface area. The ratio of surface area/diameter becomes smaller. Thus one can build larger diameters for the same amount of pull.

During the tests a single external bridle proved insufficient. An additional internal bridle helps keep the rotor inflated; the 24P-rotor is proof of this concept.

The picture above shows the prototype: it has a diameter of 1.5meter.

The successor is scaled up to 4 meters diameter, surface area is 6 square meters.

For this rotor I did not use isosceles triangles instead I used right triangles (3 sides have different lengths).

The appearance and behaviour of the rotor is not influenced at all by this change. But it makes the cutting of the panels all that much easier. The rotor is also self starting, one dumps it on the flying field and you let it go. In a strong wind the rotor is pulled out of the bag like a snake.

The first time the big rotor was tested the wind was very low, only a gust from time to time.

In each gust the rotor went like from flat on the beach to full open. This was visible from a great distance on the beach. So if one hears a by passer shouting "look mom I told you now he is flying" it gives you a very good and warm feeling.

24 Panel Rotor:

More information on the 24P-rotor and building instructions is on my website: http://users.pandora.be/claeskites/

With this size of 24P-rotor we have the same problem again, scaling up will also increase the surface area by the square. A bigger 24P-Rotor of about 8 meters diameter will have a surface area of 24 square meters. That's bigger than the sails of a little 2-person sailboat.

A solution was found in a topic on the kite forum: http://www.kitebuilder.com:

Take the 24P rotor and cut all "teeth". We have now a ring about 34cm wide. This width is kept constant while we increase the diameter in such a way that the external diameter is a multiple based on the cut-off triangles.

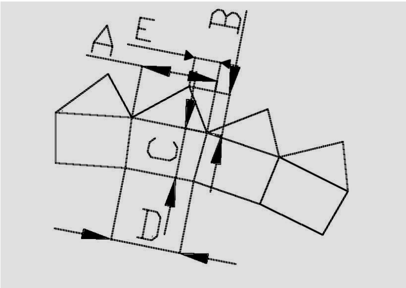
The cut-off triangles have a base of 51 cm. On an external diameter of 782 we can install 48 "teeth". Now we have a rotor with a total diameter of 8.4m (point to point), 48 teeth and a surface area of only 11.7square meter. This is big, really big, as you can see on the photo.

There is a slight catch; this thing has 48 external bridles, 48 internal bridles, 24 secondary bridles, and 12 tertiary bridles. This system can be used to build even bigger rotors. Because of the constant width of the ring, the surface area will increase in a linear fashion with the diameter of the ring.

The only thing to do is to make sure that the outer diameter of the ring can be divided by 51. A rotor of 16 meters will have a surface area of 24 square meters, a scaled up 24P-rotor with the same diameter would have a surface area of 96 square meters! This gives us a lot of possibilities to build gigantic rotors with a lot less pull and a limited amount of rip stop.

Dimensions and Pull:

In the next table the basic dimensions of the rotor are given. Dimensions A, B, C, and E are the same on every size of rotor. Only D is increasing with the increased diameters. One can use the same template for the triangles for different diameters.



A	B	C	E
Cm	cm	cm	cm
51,2	29,5	34,2	177

Number of Δ	surface area	external diameter	internal diameter	dimension D	drag at 12m/sec 6 Beaufort	drag at 12m/sec 6 Beaufort
	M2	m	m	cm	N	kg
32	7,7	5,8	4,5	44,5	926	94
40	9,7	7,1	5,8	45,8	1169	119
48	11,7	8,4	7,1	46,8	1412	144
56	13,7	9,7	8,4	47,4	1654	169
64	15,7	11,0	9,8	47,8	1897	193
72	17,7	12,3	11,1	48,2	2139	218
80	19,7	13,6	12,4	48,5	2382	243
88	21,7	14,9	13,7	48,8	2625	268
96	23,7	16,2	15,0	49,0	2867	292
104	25,7	17,5	16,3	49,1	3110	317
112	27,7	18,8	17,6	49,3	3353	342

For all sizes the drag or theoretical pull on the swivel has been calculated at a wind speed of 12m/sec or 6 Beaufort. I use Dacron bridle lines of 30kg (0.75mm diameter); 12m/sec is the maximum load these lines can take in this bridle configuration.

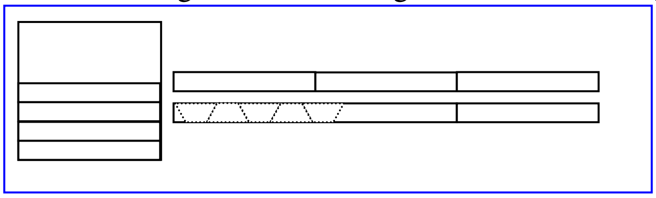
Personally I will not fly the 11.7m2 rotor (yellow) above wind speeds of 6m/sec. Wind speeds of 6m/sec will induce a force of 75 kg on the swivel.

Warning: the calculated values are theoretical values. The author is not responsible for these values. The construction of the anchor point, and the way the anchor is used is not the responsibility of the author. For your own safety and the safety of others: test your anchor point thoroughly. Ask for the advice of experienced rotor users. Use of this data is at your own risk.

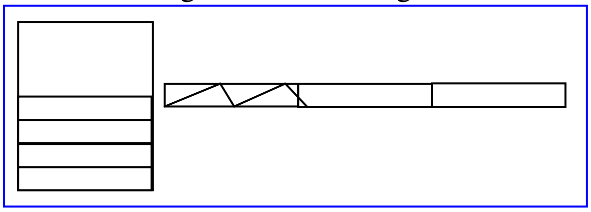
Construction:

The slim(mer) rotor is not only small in surface area; the design allows you to cut the rip-stop without losses.

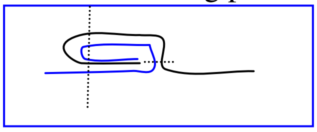
1. Ring parts:
    - Cut the rip stop in ribbons 34.2 cm wide add seam allowance (or don't). Sew the ribbons together in one long ribbon. Cut the ring parts as in the drawing.



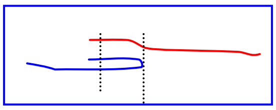
2. The triangles :
    - Cut the rip stop in ribbons 29.3 cm wide add seam allowance (or don't). Sew the ribbons together in one long ribbon. Cut the triangles as in the drawing.



3. montage:
    - First sew all ring parts together. Use a double folded seam.



    - Close the Ring. Make sure the ring is not inverted.
    - Hem the inside of the ring
    - Hem in advance both short sides of the triangles. The long side is connected to the ring.
    - Use for the hem's a double folded seam.
    - Connect the triangles to the ring with a sail seam. A double fold seam stacks too much material at the intersection between two ring parts.



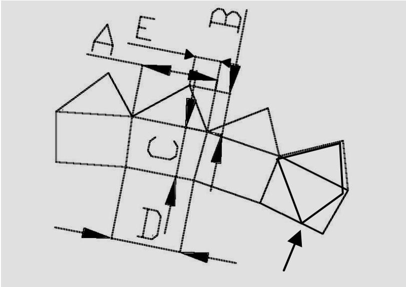
The bridle:

The bridle is divided into 3 stages:

- Internal and external primary bridle lines (made out of one piece of Dacron!)
- Secondary bridle lines: 1 per pair of internal + 1 pair of external bridle lines
- Tertiary bridle line: 1 per pair of secondary bridle lines

Number of Δ	surf ace area	primaries length	Number of primaries	primaries length	Number of primaries	secondary bridle length	Number of secondary bridles	tertiary bridle length	Number of tertiary bridle length
		external	external	internal	internal				
	m2	cm		cm		cm		cm	
32	7,7	183	32	210	32	340	16	333	8
40	9,7	183	40	210	40	340	20	417	10
48	11,7	183	48	210	48	340	24	500	12
56	13,7	183	56	210	56	340	28	583	14
64	15,7	183	64	210	64	340	32	667	16
72	17,7	183	72	210	72	340	36	750	18
80	19,7	183	80	210	80	340	40	833	20
88	21,7	183	88	210	88	340	44	917	22
96	23,7	183	96	210	96	340	48	1000	24
104	25,7	183	104	210	104	340	52	1083	26
112	27,7	183	112	210	112	340	56	1167	28

In the table above the losses in the connection points and knots are not included.



An additional 15 cm is needed for the knots and connection type described in the following text. The length of the primary and secondary bridle does not change with the size of the rotor only their number. The length and number of the tertiary bridle changes with the size of the rotor. The connection points are the points of the rotor and a point on edge of the inner ring given by flipping over the triangle.

Bridle Construction (As an example the 48 point rotor is used):

The internal and external primary bridle is made out of one piece of Dacron: cut 48 pieces of 183+210=393cm long. Add to this length the connection Point losses.

Place a marker at 183 cm, this is where the secondary bridle is connected.

The internal and external bridles are made out of one piece this makes it easy to trim the rotor: just slide the knot along the primary bridle.

The bridle can be sewn directly on the hem, or tied into sewn-on loops.

When you use the sewn on method, make a test piece first, sew the bridle on the test piece with the same hem as your rotor; then pull and see what happens. If it rips it is better to use loops. Do not overestimate the force on the bridle connection points: this is fairly low because there are so many connection points. I estimate the force at about +- 3 kg per bridle at 12m/sec. This force is the same for all rotor sizes.

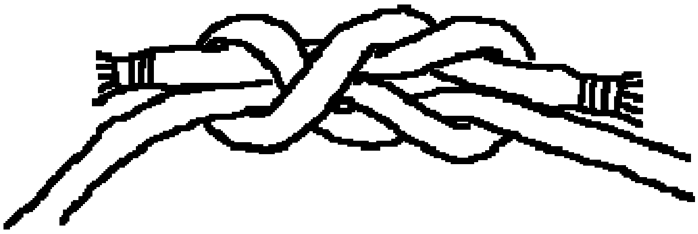
The secondary bridle is also cut in pairs:

Cut 12 pieces of: 2*340=680cm plus connection Point losses.

Mark the 340 cm point this is the connection point of the tertiary bridle.

The tertiary bridle is also cut in pairs:

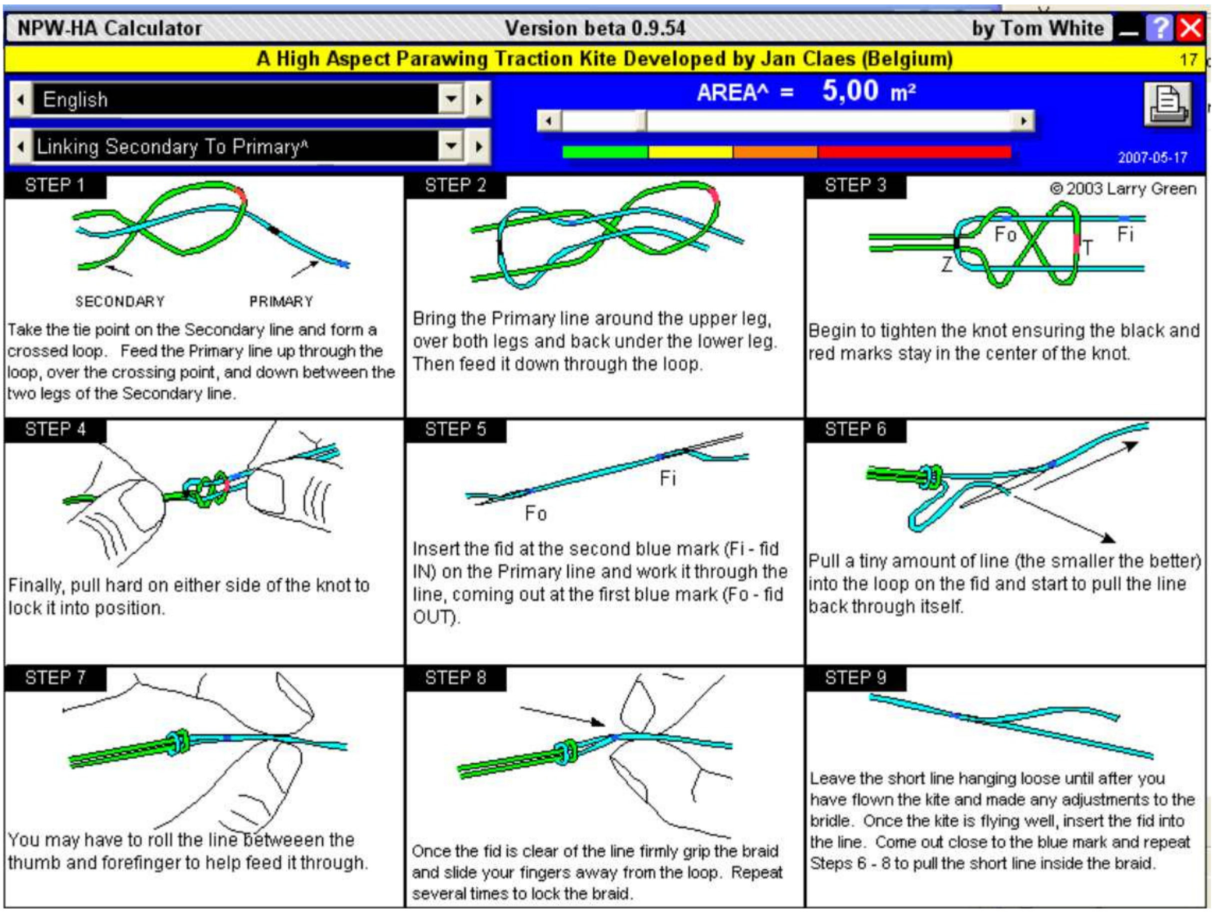
Cut 6 pieces of: 2*500=1000cm plus connection Point losses.
Mark the 500 cm point this is the connection point of the line to the swivel.
At the 500cm mark a double 4mm polypropylene line is used to knot all tertiary together.
This line is connected to the swivel. (For bigger rotors use a stronger line.)



The bridles are connected with: "simple simon over"

For more details see the copy of NPW9-HA calculation programme.

(In the program primary and secondary are used differently)



The swivel can be bought or home made using an old inline skate wheel.

Flying the rotor:

The slim rotor is best flown with a 15meters line between the swivel and the anchor point.

Do test the ground anchor thoroughly. It can be very dangerous if the anchor pops out of the ground. This can injure you or any spectator standing to close.

In a constant breeze the rotor will have a nice circular shape and rotate fast; occasionally a point will flap to the inside. When the wind is changing or gusty the rotor takes any shape from oval, square triangle to circular.

To take the rotor down in a hard wind it is very easy to put a carabineer or hook around the bridle line just in front of the swivel, slide the hook forward over the bridle line towards the rotor. Leave the carabineer in place and Bag the whole lot.

Sources:

NPW-HA calculation program: Tom White, drawings: Larry Green

English language assistance: Dazzz

Have fun, take care!

Veel plezier, en wees voorzichtig!

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