3.4.2 RoWiTool

A proven rotor concept

RoWi-Tool is the name of an Exel program for the calculation of wind turbine rotors. It calculates the shape of a rotor blade, which is usually sawn out of a UV-radiation resistant plastic tube. The calculated and on paper can be printed out. This contour is then placed on the tube, traced and then cut out with a jig.

The program for the correct interpretation

The program can be downloaded from the Internet at

https://www.kleinwindanlagen.de/Forum/cf3/topic.php?t=3502or follow this link: RoWiTool

(The construction plans can be found in the section "Construction plans")

Assumptions for the constructive design of the KUKATE34 rotor
Without input it does not work. Here the designer has to decide.

Input area of RoWiToo (*Rotor can also be called repeller*)

Inputs	Air density	ρ	1,225	kg/m³
	High-speed number	λ	3,7	-
	Radius repeller	R_{Rep}	1,7	m
	Tube diameter	D_{Tube}	280	mm
	Blade number	n_{Blade}	6	-
	Target angle of attack	α_{target}	12	°
	Effiency repeller	η_{Rep}	25	%
	Effiency generator	η_{Gen}	80	%
	Wind speed	v_W	7	m/s

The table is the input structure for the rotor calculation program RoWiToo

Assumptions for the design of the KUKATE34 rotor using RoWiTool

Name	Data
Rotor diameter	3,4 [m]
Rotor effiency	Assumption
Generator effiency	0,8
Blade number	6
Angle of attack	11-15[°] at 1/3 of the profile length from the measured from the greater width of the profile.
Theoretical wind performance at 7 m/s	213 [W/m²]
Air density	1,225 [kg/m³]

Design of the rotor blade with the help of RoWiTool

With the technical values defined by us for the KUKATE-RoWiTool rotor from the table, it is possible to implement the dimensioning of the rotor blade with the help of RoWiTool.

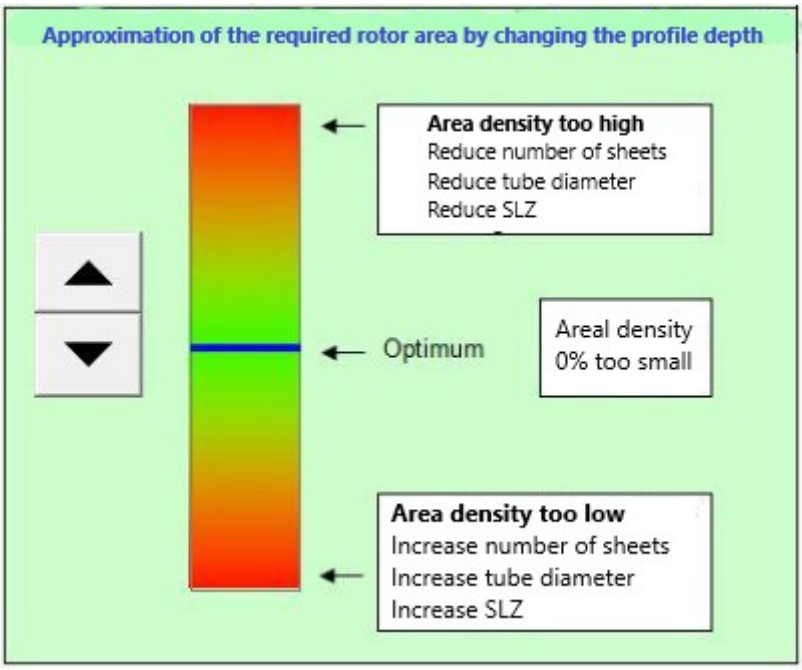
After the input of the assumed values, it is necessary to generate an optimum geometry by trial and error with standardized tube diameters as well as by varying the high-speed number of the rotor to generate an optimum geometry.

Design

For the selection of a suitable pipe, reference is made to the standard DIN 8062, series 3, in which PVC drain pipes are standardized in their geometry.

In this example, we have good results if we insert a pipe of 280mm diameter in the table.

Visually, with the help of a color scale, it is made clear to the user whether the prevailing areal density of the rotor blade is in the optimal range. If the blue bar is exactly in the middle, we have reached the design optimum achieved.

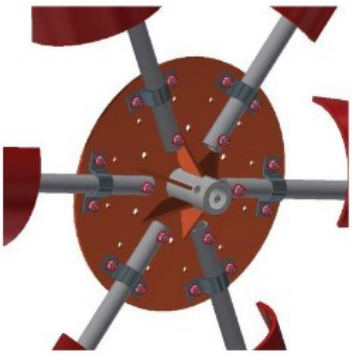


By testing with the individual variables, you have done everything right in the design of the profile cut, you have done everything right, if the beam is close to the optimum.

Constructive considerations

RoWiTool combined with the KUKATE concept

This lift profile is now bolted to the windward side of the KUKATE34 rotor. Hub, home, shaft, bearing can be taken from the KUKATE34K construction plans.



Design ideas

At higher wind speeds, control vanes have to regulate the power downwards. We recommend to adjust the vane control of the KUKATE34 adequately.
A mast should be quickly erected and lowered with a jib boom. be able to be lowered.

12 or 6 wings?

Our KUKATE construction principle basically leaves a lot of room for variations. That is why this rotor is also flexible with regard to the design possibilities. 6 or 12 blades can be accommodated on the disk of the hub. For power generation, 6 blades and a high-speed factor of 3.7 are well suited. At 5m/s wind speed this would be 105U/min, at 10m/s wind this would be 210U/min.

The results of the rotor blade design are calculated by RoWiTool.
At a wind speed (design speed) the rotor should produce 380W generator power at 145 rpm. As you can see in the input table, we have calculated the aerodynamic efficiency with (only) 0.25 and the generator efficiency with 0.8.

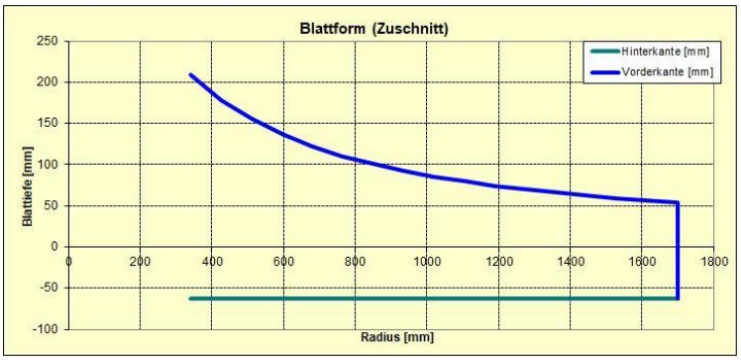
Results	Repeller area	A_{Rep}	**9,08**	m²
	Opt. Area density		**13,56**	%
	Opt. blade area	A_{Opt}	**1,2312**	m²
	Current blade area	A_{cur}	**1,2282**	m²
	Start torque	M_{start}	**5235,3**	Nmm
	Speed at SLZ	n_{SLZ}	**145,5**	U/mm
	Mech. performance	P_{mech}	**476,86**	W
	Elec. performance	P_{elec}	**381,49**	W

Calculated values within RoWiTool
We have designed here for OPEN WINDMILL a 6 blade rotor, which achieves a generator power of 380W at 7m/s wind speed.

The most important thing of RoWiTool: The template for the tube to cut out the rotor blade profiles.

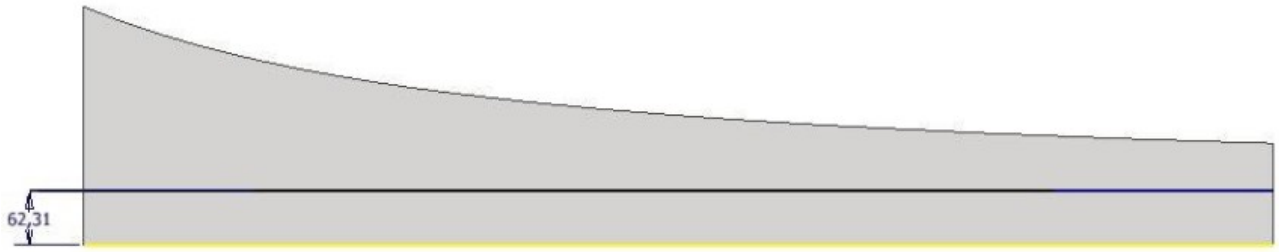
By entering values into the EXEL program RoWiTool, a template is also generated for cutting the 280mm tube is generated.

Calculated template for cutting out



In order to generate the final sheet profile with the template with the template, it is necessary to draw the contour of the template the tube.

Rotor blade contour



Construction and assembly of the rotor

After fixing the spar with the profile, the positions of the holes are transferred to the rotor blade.
After drilling, profiles and tubes are screwed together.

Front View

Back view

Fixing the rotor blades between the two discs of the hub.

The blades of the KUKATE34RoWiTool are clamped between a 10mm thick and a 4mm thick steel disk.
From the bullet point "4.4.3 KUKATE34 Rotor" we can use the content and apply it to the RoWiTool hub (hyperlink to 4.4.3 KUKATE34 Rotor)

Even with a weak wind, a significant yield - in the winter half-year twice as much as in the summer.
The year has 8760 hours. Let's assume not 7m/s, but on average only 5m/s wind. Then we have to calculate the average generator power of the RoWiTool-KUKATE34 rotor of 140W multiplied by 8760h/year. We would then get over 1200kWh of valuable electrical energy per year! **Regenerative**!
If the wind blows with 7m/s in winter and with 5m/s in summer, we can even gain about 3000kWh per year.

We from OPEN-WINDMILL urgently ask you for experience reports with this rotor concept. We have a 3.4m rotor in this size ourselves yet.

This program is very well suited to build small wind turbines with pupils in a project week, which can drive a bicycle generator. There are some suggestions on the Internet under the search term RoWiTool.