**New Design of Two-Stage Wind Turbine Rotor**

Ulugbek Dekhkonov 1, a), Abdurahmonov Jahongir 1, b), Alijon Yusupov 1, c),   
Dilshod Boltabayev 2, Mansurjon Bustonov 1, Nuriddin Gofurov 1

1 Namangan State Technical University, Namangan, Uzbekistan

2 Urgench State University, Urgench, Uzbekistan

a)[znaniyasila7@yandex.ru](mailto:znaniyasila7@yandex.ru)

b)[Jahongirabdurahmonov09@gmail.com](mailto:Jahongirabdurahmonov09@gmail.com)

c)Corresponding author: alijon.yusupov.ntsi@gmail.com

**Abstract.** The article analyzes the aerodynamic properties of the wind turbine rotor structure. The structural structure is analyzed in detail. This analysis is shown to be the main indicator in the design of the rotor structure, the driving moment that arises under the pressure of the wind flow is the main indicator of the unit, with its help it is possible to determine all the dynamic characteristics of the machine. The relationship between dynamic, kinematic and geometric parameters is reflected in the equation. The rotor blade is in the form of a blade, the central part of which is left open. The main disadvantage of vertical-axis rotors is that the relatively static flow behind the blade resists the free rotation of the rotor. The wind flow passing through this element ensures that this harmful air volume is sucked into itself and gives the unit additional momentum. Controlled horizontal supports on the rotor, if necessary, are folded into the wing section and remove the rotor from the working state, which prevents accidents, creates convenience during repairs, and allows the unit to be installed in any weather conditions. These technical solutions are covered in detail in the article.

# Keywords: rotor, unit, wing, plate, radius of curvature, static air, aerodynamic properties, wind, speed, angular velocity, wind unit, angle of rotation, operating condition, wind pressure, frontal resistance, coefficient, flow, pressure, driving torque, model, wing conditions.

# Introduction

Based on the results of the conducted scientific research, we come to the following conclusions in order to design an effective, independent wind direction vector, large-diameter, small-speed and high-power wind turbine rotor construction suitable for the wind regions of our Republic and our technological capabilities [1-3].

The bottom line is that a rotor producing 6 blades of energy must have the useful efficiency of a 3-blade rotor. Also, the aerodynamic properties of the rotor should be high, i.e., the process of passive air absorption behind the wing should be accelerated and the coefficient of resistance of the nose should be increased, so that the wind flow can be quickly moved away from the rotor by transferring its kinetic energy [4-5].

Let the height of the prototype rotor be h m (Fig. 1). We divide it into two equal parts with a horizontal plane P at a height of *h*/2 m. We turn its separated second - upper tier part 1800 around the *X* axis in the counterclockwise direction. A top view of both of their parts is shown in Figures 2a and 2b. It can be seen from them (Figure 1 shows a 4-bladed rotor) that the proposed design is considered in the case of a 3-bladed rotor. It can be seen that the rotor layer shown in Fig. 2a moves counterclockwise, and the rotor layer shown in Fig. 2b moves clockwise: the active vane 2 of the shaft 1 moves under the wind pressure received by the closed plates 3, vanes 4 and 5 is in a passive position, because the wind pressure affects the plates 6 from the rear and moves them to the vane position [6]. It can be seen from the figure that the asset.

# Statement of the problem

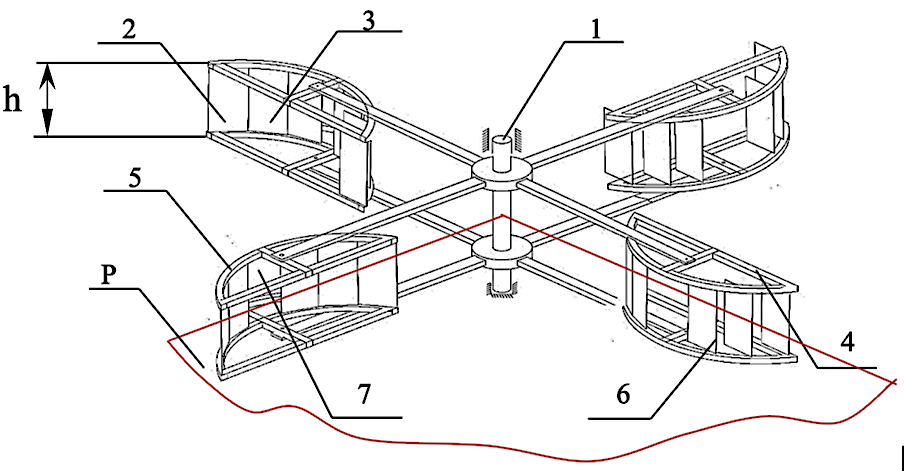
It can be seen from the figure that the center of the active wing 3 has a width of open surface 7 that passes the wind flow. The wings are interconnected by steel ropes 8 at the lower and upper ends of the wings. This allows the wing to operate without jerks in the instantaneously changing wind speed, it isolates the wings [7].

This process, which happened around the shaft 1 of the lower tier, takes place in the second tier of the rotor around the shaft 9, with only the opposite movement.

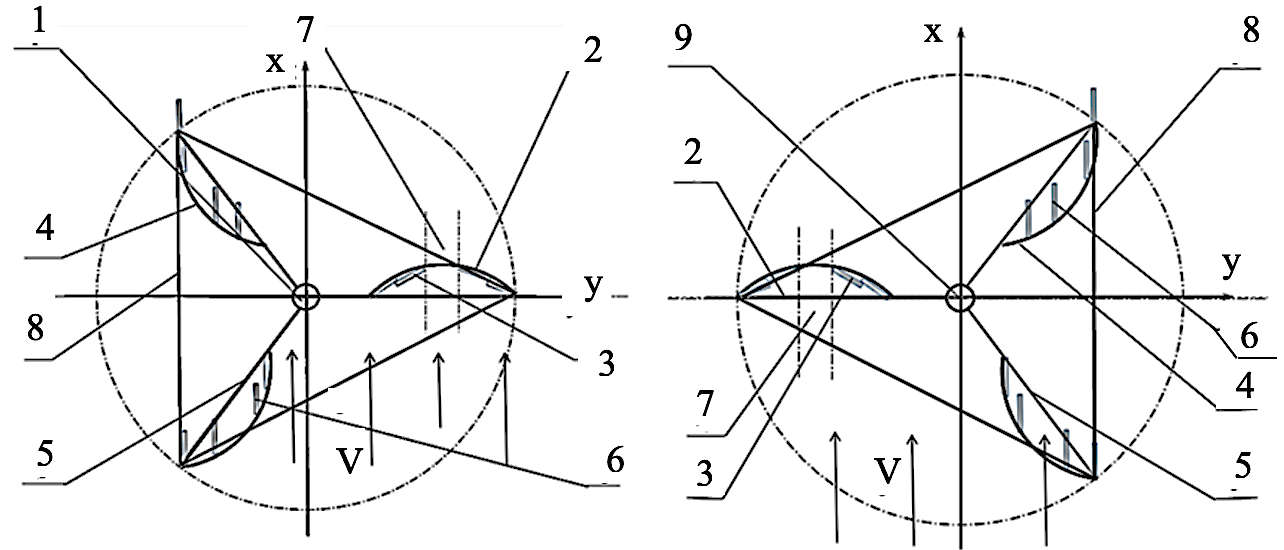
If we put the second layer of the rotor on top of the first layer of the rotor, the rotor shown in Figure 3a is formed.

In this case, the assembly process is as follows: the shaft 9 is passed through the shaft 1, and with the help of links with a joint (radial bearing), the upper and lower tiers of the rotor are ensured to rotate in opposite directions (Fig. 3b). The vertical position of the shafts is ensured as follows: the shaft 9 is mounted on the radial-support bearing 10 in the lower part, and the shaft 1 forms a hinged joint with the help of the radial bearings 11 and 12.

In turn, the shaft 1 is fixed to the frame 13 with the help of radial bearing 14 and support bearing 15.



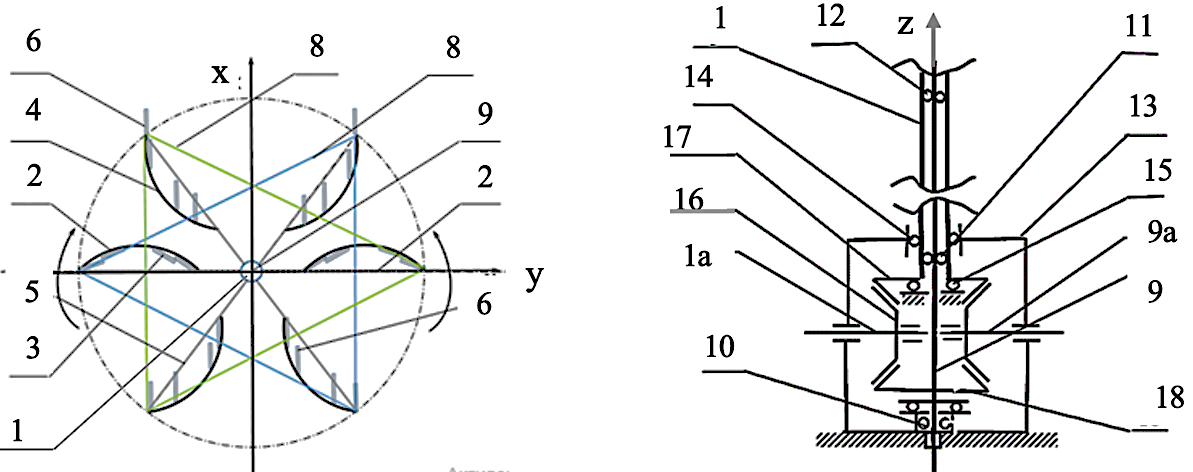
**FIGURE 1.** A single-stage rotor with an open center of the blade . Patent Uz 2118



a) Upper wing position b) Lower wing condition

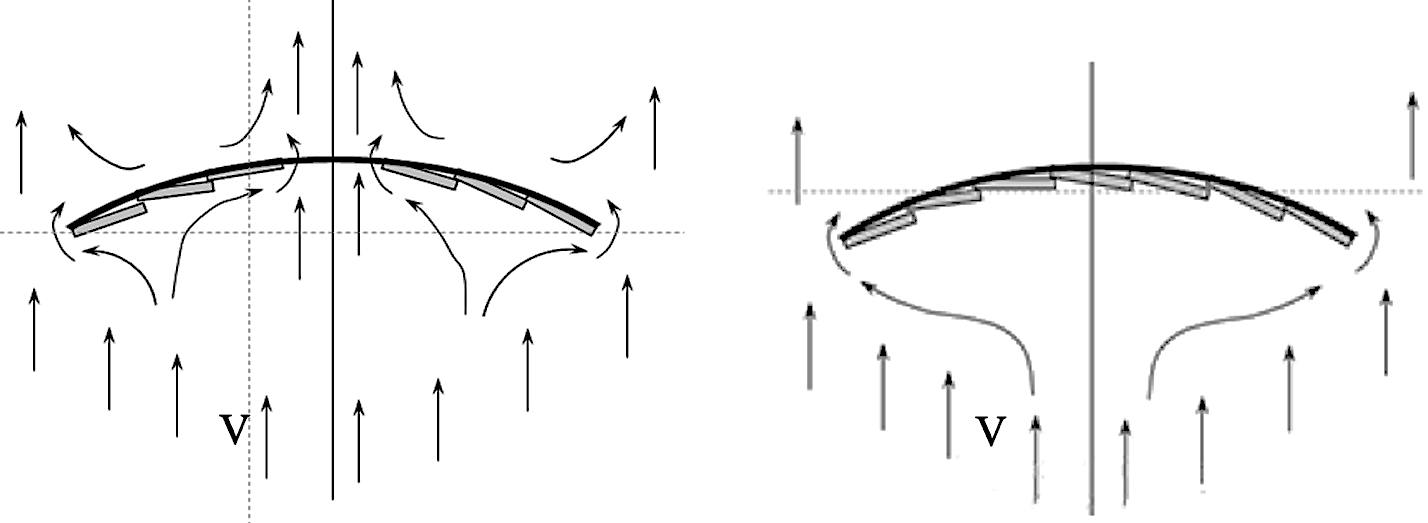
**FIGURE 2.** Horizontal of the two layers of the rotor

Another important aspect of the design is that the center of each wing is left open to let the wind flow through (Figure 4). If we pay attention to the figures, we can estimate that the aerodynamic processes of the wind flow are different in rotor constructions with a wing consisting of a central open part of the working surface 7 and a wing with a fully closed working surface [8-9].

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1. *The condition of the upper and lower wings b) Mechanism for transmitting driving torque to the working shaft*

**FIGURE 3.** 3-assembled view of the rotor



1. *A wing with an open middle b) A wing with a closed middle*

**FIGURE 4.** a) open and b) closed surface wings,

In the following, we define the mathematical expression of the driving moment for the rotor design

It is known that the rotor may operate in four distinct positions, each associated with a corresponding change in the driving force applied to the wings during one cycle of operation. In this paper, we will analyze the second and third positions and derive their respective expressions.

An active cathode with the center plate relay open. According to it, the wind flow enters along the concave surface of the wing and flows along the central zone. While the central opening helps to suck the static air behind the wing in its direction, the wind stream flowing through the peripheral zones sucks the trailing static air close to it. In this way, the value of the air mass flowing over the wing surface increases [10-14].

# Numerical results and their analysis

The aerodynamic process on the surface of the rotor with the central plate open can be analyzed as follows: according to Bernoulli's equation,

 (1)

Here,  and  are the static pressure on the surfaces, /2 is the aerodynamic pressure, and *z* is the height of the surfaces through which the wind flows. Since in our conditions the wind current flows over a surface of uniform height, we can write equation (1) as follows:

 (2)

Therefore, the pressure difference, which is the main indicator of energy production, will be equal to equation (3).

 (3)

The essence of this equation is that in the zone of increased kinetic pressure, the static pressure decreases, and vice versa, the static pressure increases. Due to the almost motionless air behind the wing, the static pressure increases, and it tends to the areas of the wing that pass the wind flow, creating a relative vacuum behind the wing - that is, this process leads to the equation of non-self (continuity of the environment) of the flow () according to the fact that the wind speed in the open part of the center of the wing increases slightly.

Based on the above-mentioned scientific research and certain technical laws, the proposed new design of the rotor of the wind turbine is shown in Figure 5.

The second position occurs when the second wing is restricted from moving in the direction of the wind at point B of the first wing, in shape 1. The third position is when the second wing travels from point A of the first wing relative to the direction of the wind, in shape 2.



**FIGURE 5.** Rotor of wind turbine "Samarkand", Uz FAP 2774

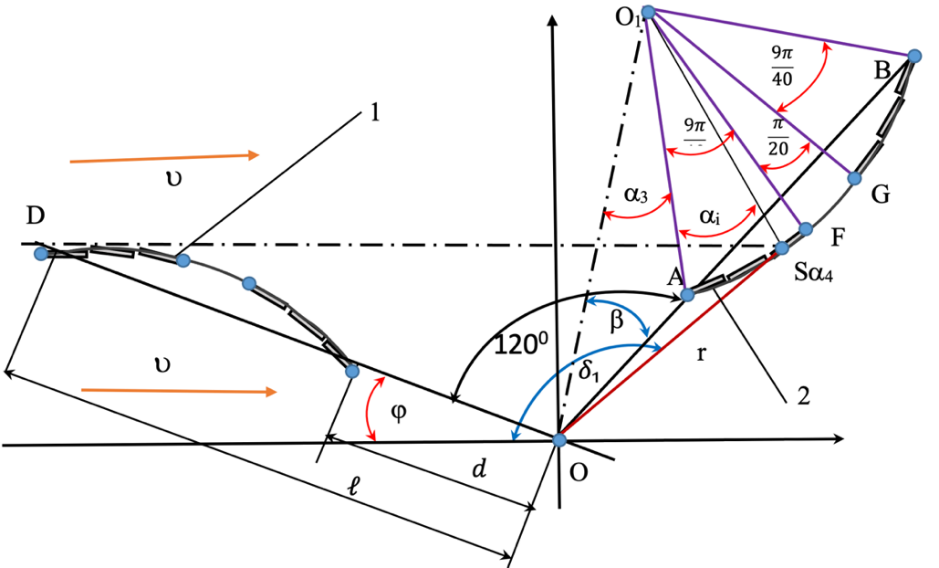
The thrust moment they are generated by the rotor when in position 2 is influenced by the angle at which the wings are oriented relative to the oncoming wind. This angle significantly impacts the thrust generated, which is determined by how the operating surface of the second wing varies. The first wing is always fully operational. This is the statement of the second wing:

 (4)

Equality begins with finding a solution. Precisely,

 (5)

when equals the value, the angle of inclination of the first wing in the starting position begins with angles at the corners of the first and second wings. As a result, the forming surface of the second wing at a  angle generates no driving torque. In this case,  increases as  increases, and its value can reach 90 degrees. Consequently, it is completely blocked by the second wing. In Form 1,  represents an angle. The challenge lies in determining how  varies when the angle of inclination changes.



**FIGURE 6.** Regarding the calculation of the torque of the Rotor 2nd wing in position 2

Occurs when the value is. When the values of the  and +1200 angles on the second wing increase, the angle of inclination of the first wing at the initial position begins to move toward the second wing. As a result, the surface formed at the base of the corners of the second wing doesn't create driving torque. In this case, the  angles increase by  and their value reaches 900. This is fully covered by the second wing when in form 1. In form 1, the  angles are represented as number , where the question of determining the change in value from to  when the angle moves from answered.

From the drawing or and in this  considering that  and and from it we find the final equation:

It is known that the expressions r, ,  and  are represented by the following equations:

|  |  |
| --- | --- |
| ,  , | (6) |

To this equation and Fig balanid 2-wing for holding events based on the conditions of:

|  |  |
| --- | --- |
|  | (7) |

# The driving moment of the rotor tier wing in position 3:

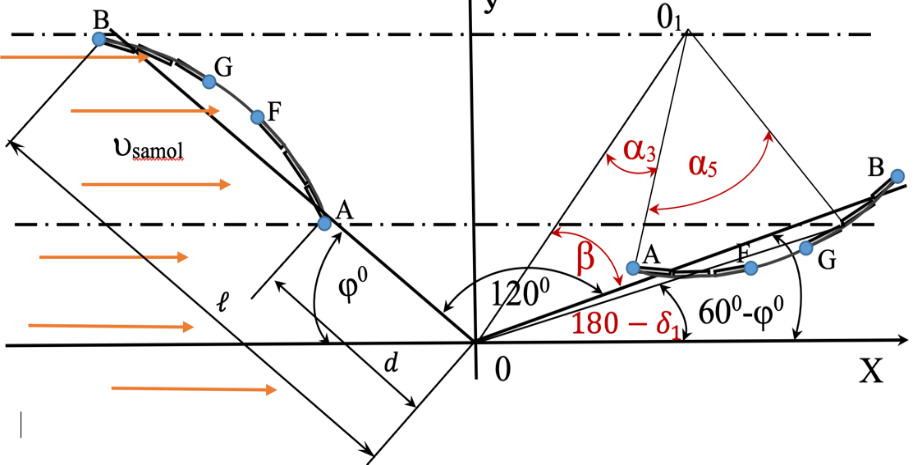
Here are the values derived from rotor design ,  and : Based on the number of equations, it can be concluded that the second-stage wing undergoes three homogeneous dynamic transformations during its second position.

Once the tier 2 fan advances behind wing 1, modification  transfers it to position 3. At the same moment, wing 2 begins to expand again in the direction of the wind from point A, which is its bottom section.

 marks the start of state 3 of the limitations. Even in this instance, it will seem homogenous with the following equation:

 (8)

The arc-shaped surface formed on the angular base enters an active functioning state, whereas the surface built on the angular basis  remains passive. This is critical for determining the limit of the integral.



**FIGURE 7.** We calculate the torque of rotor wing 2 in position 3 using the following conditions:



|  |  |
| --- | --- |
| in the past  And in the range, | (9) |

The equations will be suitable. It is worth noting that in scenario 2, angle will represent the integral's beginning coordinate,  as well as its end coordinate. However, in the  range, the surface moment caused by the wing autofocus arc will be relatively tiny, because the surface is nearly parallel to the wind direction.

The result is that the second wing undergoes two homogenous dynamic changes at the third position of the tier. The term "tier" indicates that the rotor is divided into two tiers. We studied the second wing of one tier here. The second wing of the second tier will have the same characteristics, but with a 600 delay.

These equations do not require answers in engineering calculations; instead, they allow you to calculate with the required precision utilizing computer-based approximate solution methods.

# Сonclusion

The rotor operates unchanged in the direction of rotation, regardless of changes in the direction of the wind vector.

The pressure of the wind molasses on the wing area is controlled by changing the angular speed of the rotor, while ensuring safety from breakage.

The rotor drag coefficient reaches up to 1.4.

The open part of the wing allows the relatively static air to be sucked out behind the wing.

The rotor generates energy like a six-wing rotor, the efficiency is like a three-wing rotor.

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