DESIGN AND ANALYSIS OF VERTICAL AXIS WIND TURBINE

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Abstract

The aim of this research work is to find the optimized efficiency of Vertical Axis Wind Turbine with different types of rotor blade profiles. A scaled down model has been designed and analysis is done to determine the performance of Vertical Axis Wind Turbine based on different series of blade profile sections, solidity ratio, wind speed and the number of blades. Experimental testing of these blades is done using low speed wind tunnel .The experimental results will be validated with theoretical results obtained from simulation software i.e.,ANSYS. Based upon the results obtained the performance characteristics of VAWT based on various parameters will be formulated.

Keywords: wind energy, vertical axis wind turbine, renewable energy, Savonius Turbine

1.INTRODUCTION : Vertical-axis wind turbines (VAWTs) are a type of wind turbine where the main rotor shaft is set transverse to the wind (but not necessarily vertically) while the main components are located at the base of the turbine. This arrangement allows the generator and gearbox to be located close to the ground, facilitating service and repair. VAWTs do not need to be pointed into the wind,[1] which removes the need for wind-sensing and orientation mechanisms. Major drawbacks for the early designs (Savonius, Darrieus and giromill) included the significant torque variation or "ripple" during each revolution, and the large bending moments on the blades. Later designs addressed the torque ripple issue by sweeping the blades helically.

A VAWT tipped sideways, with the axis perpendicular to the wind streamlines, functions similarly. A more general term that includes this option is "transverse axis wind turbine" or "cross-flow wind turbine." For example, the original Darrieus patent, US Patent 1835018, includes both options.

Drag-type VAWTs such as the Savonius rotor typically operate at lower tipspeed ratios than lift-based VAWTs such as Darrieus rotors and cycloturbines.

II METHODOLOGY

The idea of this project was to create two different models of vertical axis wind turbines that convert wind energy to electrical power. The first type of windmill built, the Darrieus model, involves three airfoil blades made of poster board. Figure 1 shows the complete model of the Darrieus with the three air foils connected to the windmill**.**

Fig 1. The Darrieus Model

To change the angle of the blades, one would simply need to change the holes through which brass pins fastened the airfoils to the spokes of the turbine. Figure 2 shows the top view of the Darrieus windmill, where the connecting pins can be seen at the edges of the wooden plate.

Figure 2. The Darrieus Model (top view)

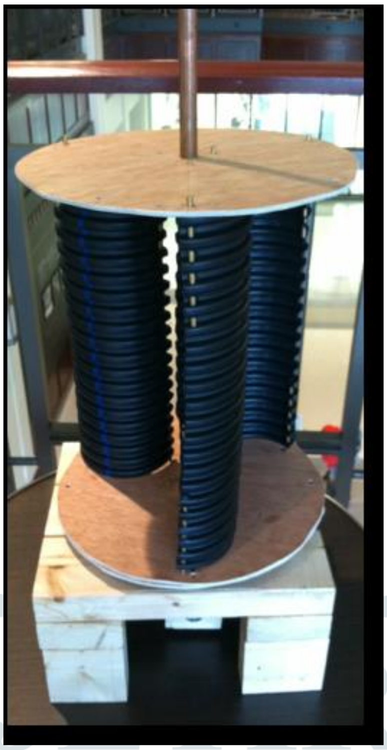

Figure 3. The Savonius Model

The second type of windmill built, the Savonius model, uses semi-circular blades made of corrugated pipe also known as “scoops.” Figure 3 shows the full view of the Savonius model of the turbine**.**

For this model, the number of scoops can vary by using metal pins. The turbine has the option of using two, three, or four blades. Figure 4 shows the connecting pins at the edges of the plate and near the axis of the circular wooden plate. A hollow copper axis connects the two wooden plates in both models. This axis fits easily over a steel rod, which connects to the wooden base. This set up allowed for not only a reduction of materials and expenses, but also an easy transfer from one windmill to the other.

Originally, the angles of the airfoils were chosen to be 0° (perpendicular from the center of the air foil to the axis), positive 30o and 60o (turning the tail toward the axis), and negative 30o and 60o (turning the tail away from the axis). However, the 60o variations did not spin during testing. Therefore, the project no longer contains these two variations in the results.

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Table 1 (below) includes a full summary of all expenses for the project as well as all parts used to build the windmill.

2.1 VAWT Blade Model in Solid Works Software.

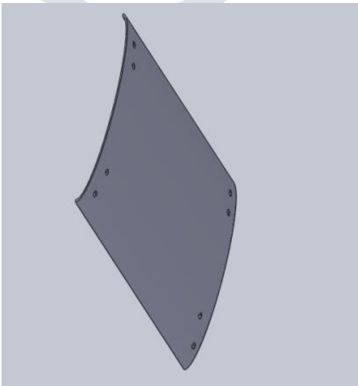

Fig 5.VAWT 3D Model

III.Results

3.1 Analysis of VAWT Blade using ANSYS

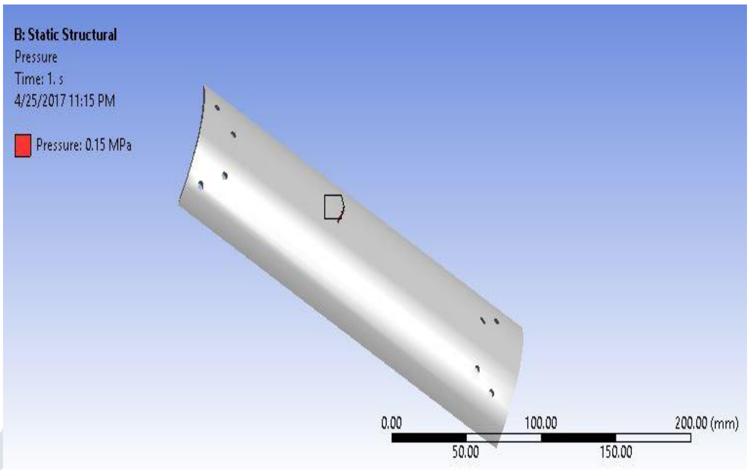

Fig6.Application of a pressure of magnitude 0.15mpa upon the blade

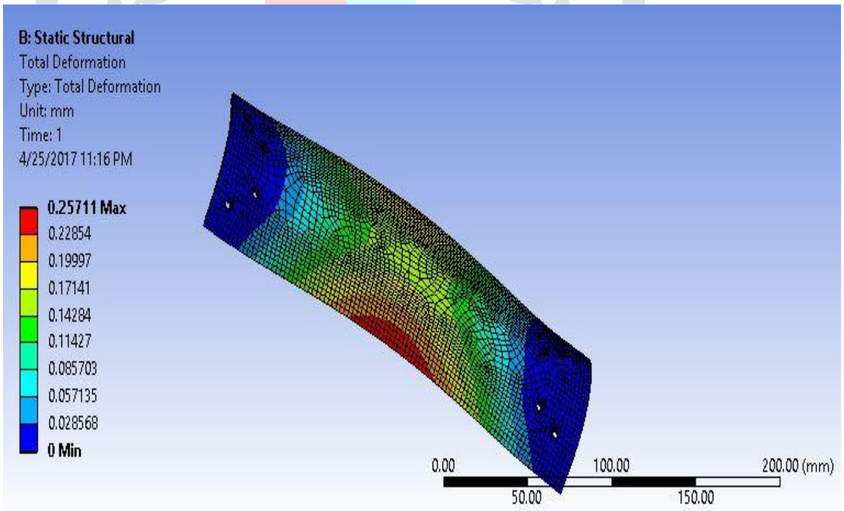

Fig 6.Deformation Model Nodal Displacement Plot

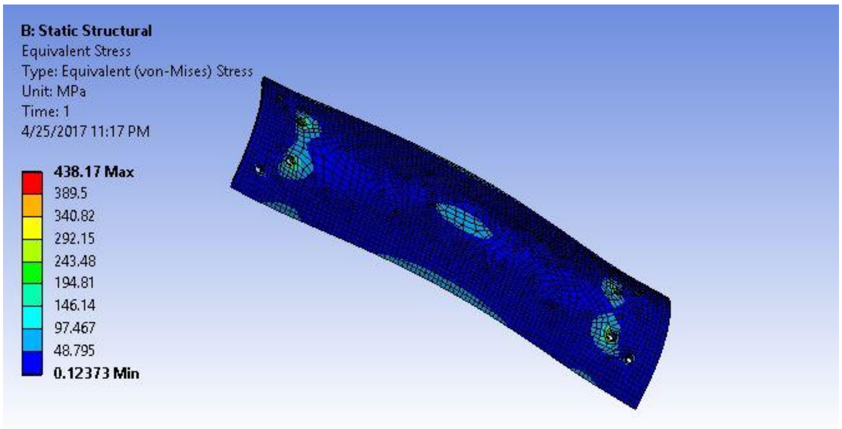

Fig 6.Deformation Model Equivalent Stress

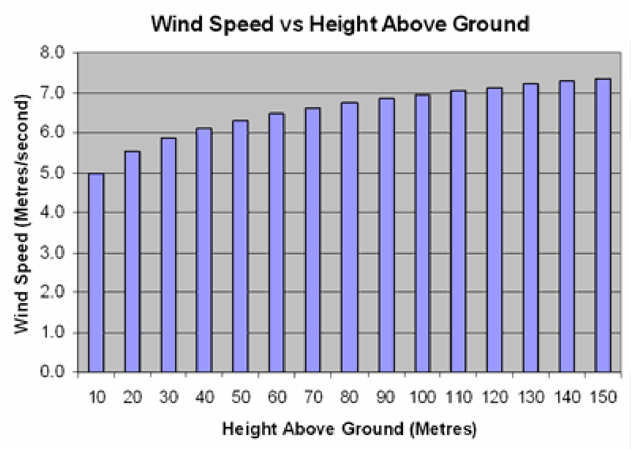

Fig 7: Variation of Wind with Altitudes

The above bar graph shows the variation of wind speeds along with changing altitudes. As is specified from the bar-chart, as the altitude increases, the wind gradually increases to a higher value. From this it could be understood that higher the altitude, higher is the wind power. So, it is clear that turbines installed at higher altitudes are capable of generating more power when compared to those situated at lower altitudes.

References

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