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Investigating the Designs of Wind Turbine Blades

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ABSTRACT

The performance of a wind turbine is always a matter of discussions and the topic has been a keen interest to be researched and present more efficient solutions to the evident problems. The performance depends on so many factors handful of them are the type of wind blades, the wind speed, the region of installation, power transmission mechanism, material selection and electronics used. This paper tries to cover the first of the mentioned factors the types of wind blades by giving a detailed comprehensive report of how and why certain blades are chosen over others. Wind turbines blades are very crucial for the whole process as optimal aerodynamics and environmental damages are highly dependent on design of blades. The paper gives an abridged knowledge of the wind turbine blades with the help from recent published papers.

KEYWORDS: electronics, blades, wind turbine, transmission

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INTRODUCTION

Renewable energy Is one term which always excited the environmentalist and industrialist for the different reasons yet in a positive way. Wind energy is one of main part of the core sources of renewable energy. The capacity of power generation from this category of sources has always been immense and there has always been a constant competition between solar energy and wind energy for the highest power producing source of energy. The fact of India having 4th largest installed capacity in the world shows its current position of power production from this sole source.

During the last fiscal year of 2019-2020, 2.07GW of wind power capacity was installed in India. Wind Power generation capacity in India has significantly increased in recent years. As of 29 February 2020 the total installed wind power capacity was 37.669GW. The efficient and smooth performance of wind turbine is still a issue and that is why even though the vast potential is there the utilisation part is missing. The various researches in the part of power transmission and blades design are a proof for that. This paper too is in line with the stated problem. We have tried to cover the preliminary aspects of wind turbine blades design.

Literature Review-

1. With a prospective of using wind energy even in small applications a vertical axis Savonius Darrieus investigated the use of wind turbine with a special type of blades on streetlight poles. Important aspects about wind data and street lightings were being discussed by him. The blade geometry which is of Troposkin Shape is being used as the major outcome of this observation and for the Darrieus rotor it is approximated by an iterative method. The entire design is performed for two materials i.e. Aluminium Alloy and E-Glass Fibres. The aerodynamics forces were calculated for Darrieus Blade and Savonius Rotor stress analysis was performed on them with two softwares being majorly used in analysis part as CFD and Ansys were being used for all the analysis part.

2. This paper constitutes the method of improving the design of a wind turbine blade using a shape based on submarine propellers in order to reduce noise. For the experiment perspective they manufactured a miniature version of the blade which was of scale 1:20 and was manufactured from composite materials and being tested over a wind turbine of 350 Watts. Reverse engineering method was used to increase the dimensions and two different scaling methods were used to obtain the blade that was used on a 2.5KW wind turbine. Flow analysis was used for the velocity and flow trajectories to determine for the above two scaled models and compared it to the initial model for the validation of the methods.

Figure 1 (Ref-2)

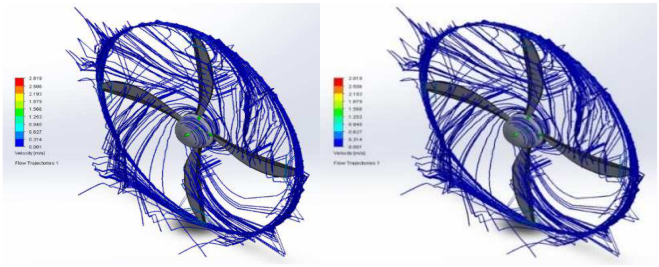
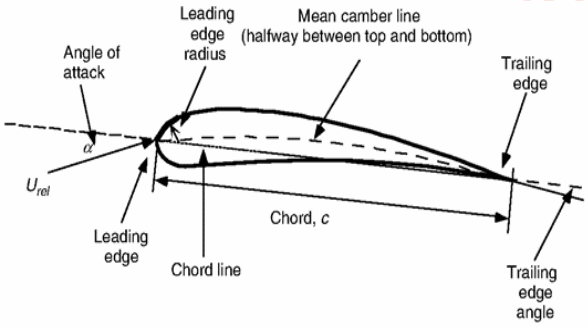
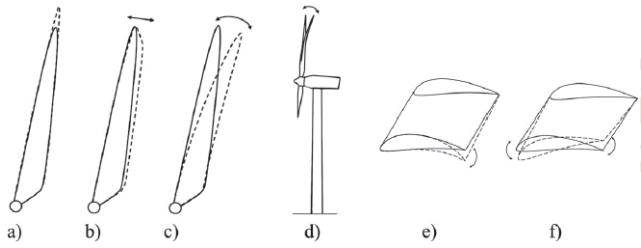


Figure 1 (Ref2)

3. The paper draws attention towards the performance of the aerodynamic system of wind turbine working as a key factor for obtaining maximum torque from the wind power. They stated as wind turbines size increases, designing of optimal wind blades becomes crucial for high lift generation aiming to provide maximum torque to the generator. The factors for optimum wind blades are: speed and density of the wind, surface area, lift coefficient. During designing of aerofoil, the factors like insensitivity to roughness, high drag to lift ratio, stable stall characteristics should be considered. The paper gives brief knowledge about wind turbine aerodynamics, aerofoil design and characteristics, blade structure and control from various publications.



Typical Aerofoil design



Present modified designs
Figure 2 (Ref3)

4. In this paper modification of aerofoil shape and planform of wind turbine blade for the reduction of self-noise from a 10kw wind turbine is being done. For blade design, genetic algorithms techniques is being used. Here the deigned aerofoil was determined over a section of rotor blade, and then considering the above foil design, our design of the blade is taken into consideration . Semi-empirical model is used for predicting self-noise of aerofoil. Numerical analysis provided the fact that the self-noise of aerofoil from this blade was found to be about 2.3 dB lower from the baseline blade. Wind Tunnel experiment gave experimental validation of this design with baseline and rotors was scaled down by a factor of 5.71. This experimental result showed that the aerofoil self-noise falls to 2.6 dB.

5. This paper presents an 800mm long blade of 600W horizontal axis Wind Turbine with its functional and aerodynamic design using NACA4412 profile. Considering the use of electrical home appliances in rural areas for low wind speed its functional design is carried out. Determining the chord and twist angle distributions, the preliminary design doesn't provide the best power performance and requires modifications. They started optimizing with objective of power enhancement and low speed starting behaviour. Optimization of hub regions were carried out and MATLAB programming was developed for the blades. The data were calculated for both normal and the optimized blade design and a table with the stats has been published in the paper. The final designed obtained after all the consideration is shown below.

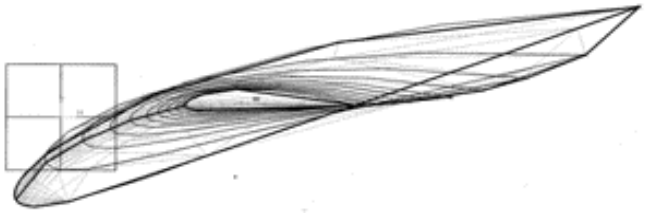


Figure 3 (Ref5)

6. This paper presents a detailed review of current state including theoretical maximum efficiency, propulsion, HAWT blade design and blade loads. It showed us the dominance of modern turbines. Aerodynamics Design Principles with blade shape, aerofoil selection and optimal attack angles. This paper provided a detailed review of design loads over wind turbine blades describing all the operating conditions like centrifugal, gravitational, aerodynamics, all the operating conditions are being reviewed for optimum blade design.

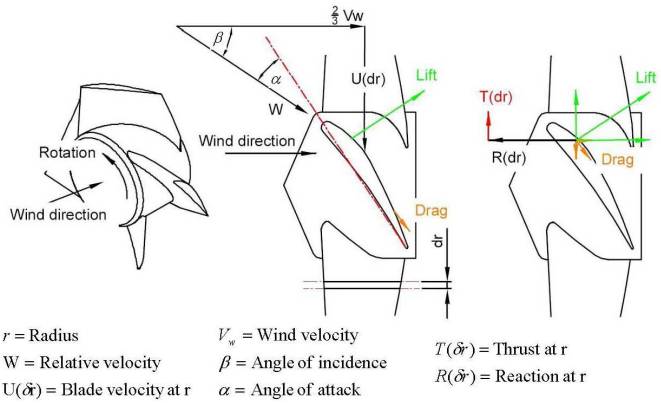


Figure 4 (Ref6)

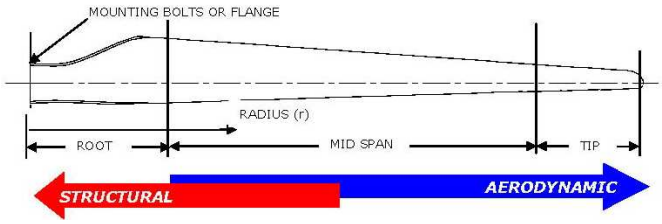


Figure 5 (Ref6)

7. This paper comprises of designing of small wind turbine blades aiming for best improved blade number with selection of tip speed ratio. The power performance was simulated using blade element momentum method(BEM). Tip and hub loss with drag coefficient are the factors that are being taken into account. The design process was selection of Wind turbines and the other selection parameters are

blade aerofoil, twist angle which is being taken along the radius and chord length distribution. The 3-bladed, 5-bladed and 7-bladed rotor achieved maximum values of Cp 0.46, 0.5 and 0.48 at the tip speed ratio 7, 5 and 4 respectively giving observation as per using blade element momentum method theory which also gave a edge that maximum Cp varies weakly with blade number. For blade of number three 4 to 6 percent are the maximum cp and point tip speed ratio is of seven.

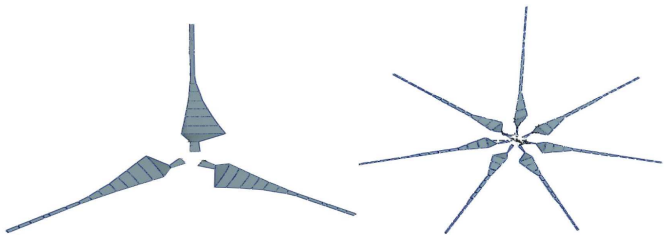


Figure 6 (Ref7)

Conclusions:

The wind blades design play a pivotal role in the performance of wind turbine and ideal optimized version of the blade design is still far from achieved. The two basic types of wind turbines i.e the horizontal and vertical axis wind turbine blades have their own set of advantages and disadvantages. The selection is based on the detailed study of the two sets of the wind turbine. While the design is based highly on the forces and the mathematical approach of the formulated dataset, it is also necessary to control the noise level up to a certain level. The environmental damages are to be considered as well. Amongst all the basic well-established outcome is the fact of curved blades are anyway a better choice for the base structure over the flat structure. Aerofoil version has been at the front end of the design of the blades and several Optimization and research has been done to safeguard it's credibility.

The detailed study of the design procedure and the results obtained till now leaves the message of "still could be improved". The present design are working fine but the scope of further advancements is there. Also for small scale wind turbine aerofoils blades can be considered.

References-

[1] Design and Analysis of Vertical Axis Wind Turbines Blades for Street Lightning (IJETER).

[2] IMPROVING THE DESIGN OF A WIND TURBINE BLADE (R.A. Ghinea , P. Bere , C.Neamtu)

[3] Review of Aerofoil Structures for Wind Turbine Blades (U. M. Mamadaminov, Oregon Institute of Technology, IEEE student member)

[4] Design optimization of wind turbine blades for reduction of aerofoil self-noise (Seunghoon Lee Soogab Lee, Jaeha Ryi and Jong-Soo Cho)

[5] 5. Aerodynamic Deign of a Horizontal Axis Micro Wind Turbine Blade using NACA4412 profile. (Sandeep A Kale, Ravindra N Verma)

[6] Wind Turbine Blade Design (Peter J. Schubel and Richard J. Crossley)

[7] Design & optimization of a small wind turbine blade for operation at low wind speed (Manoj Kumar Chaudhary and Anindita Roy)