A Review of Composite Wind Turbine

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Abstract- In the wake of extraordinary consumption of customary vitality sources, there is popularity for the non-regular choices. Wind turbines give an elective method for producing vitality from the intensity of wind. Wind vitality is made when the air is warmed unevenly by the Sun; a few patches of air end up hotter than others. These warm fixes of air raise other air surges in to supplant them – therefore, wind blows. A wind turbine extricates vitality from moving air by backing the wind off, and moving this vitality into a turning shaft, which as a rule turns a generator to create power. The power in the wind that is accessible for reap relies upon both the wind speed and the region that is cleared by the turbine edges. With the improvement of wind control age innovation, the wind turbine sharp edge is ending up increasingly imperative. Demonstrating and stress examination of the wind turbine cutting edge are exceptionally basic for the further outline and the utilization of wind turbine edge
Keywords: FEA, Wind Turbine Blade, Deformation, Directional Deformation.

1. INTRODUCTION

In this day and age of vitality situation, sun-powered, wind, biomass and hydro control have turned into the major inexhaustible portions that are assuming an essential job in endeavouring to locate a correct harmony between developing vitality requests and making it as 'green' as could reasonably be expected. No big surprise, they have so much consideration and push over the previous years that nations are attempting to move their vitality profile from customary assets to renewables.

Power has been extracted from the wind over hundreds of years with historic designs, known as windmills, constructed from wood, cloth and stone for the purpose of pumping water or grinding corn.

A. Wind Turbine

Wind Turbine "rotary engine in which the kinetic energy of a moving fluid is converted into mechanical energy by causing a bladed rotor to rotate". Wind turbine blades spin opposite of a fan from the wind and make energy, instead of using energy to make wind.

The wind rotates the turbine blades, spins a shaft connected to a generator and the spinning of the shaft in the generator makes electricity. Wind turbines, like windmills, are mounted on a tower to capture the most wind energy, wind speed varies by height, wind current 100m above the ground dropped in speed by 10% when its height declined to 50m. This property is known as wind shear in which wind speed increases in speed with height, due to friction at the Earth's surface.

B. Classification of Wind Turbine

Wind turbines can be grouped into Horizontal Axis Wind Turbines (HAWT), and Vertical Axis Wind Turbines (VAWT). Level compose turbines have the sharp edges turning in a plane which is opposite to the pivot of revolution. The HAWTs are the most generally utilized sort of wind turbine and come in different sizes and shapes. The essential kind of power following up on the cutting edges of HAWT is the drag powers.

The Horizontal kind is financially relevant to composition because of its changed sizes and capacity limits. In Vertical Axis Wind Turbine's sharp edges, the turning pivot concurs with the hub of the age of intensity. Points of interest of Vertical Axis wind turbine is the arrangement of the generator at the base of the turbine. In any case, these sorts are closer to the ground which makes it hard to catch the power at higher heights. While the HAWTs require a yaw component to arrange them toward wind, the VAWTs don't have such an issue. In any case, the drawback with VAWTs is the low beginning torque, lesser establishment tallness and dynamic solidness issues.

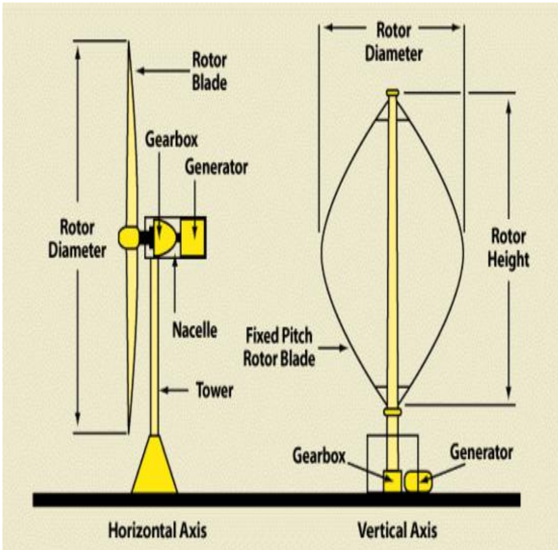

Figure 1: Basic model of Horizontal and vertical axis wind turbine.

2. LITERATURE SURVEY

One of the main global engineering challenges for the wind energy sector is to develop efficient wind turbine blades with high fatigue life. Large wind turbine blades are made out of polymer composites to deliver high specific stiffness and strength, and good fatigue performance. The arbitrary nature of wind flow and extreme weather conditions render wind turbine blades as fatigue critical elements. Therefore, reliable fatigue damage models need to be developed. Numerous studies were carried out in the past to identify the effect of various materials and loading conditions for the fatigue life of wind turbine blades. However, these models do not consider the effect of manufacturing defects and in-service damages on the fatigue life of wind turbine blades. In the area of wind turbine blade design and analysis, several works are available in the literature. These are summarized in this section.

Jack P. Salameh et. al.[2018] worked on Gearbox condition monitoring in wind turbines: A review. a review on different methods and techniques for gearbox condition monitoring in wind turbines. Furthermore, various methods and techniques in the literature will be presented in order to get an insight into the most used methods in wind turbine gearbox condition monitoring.

Chen-Hsu Wang et. al. [2017] worked on Stress analysis of composite wind turbine blades by the finite-element method. The finite element analysis software ANSYS was used to analyze the composite wind turbine blade. The wind turbine blade model used is adopted from the 5 MW model of US National Renewable Energy Laboratory (NREL).

Chong-wei Zheng,et. al.[2017] worked on Rezoning global offshore wind energy resources. In this study, a new wind energy classification scheme that incorporates a comprehensive consideration of wind energy factors, environmental risk factors and cost factors is proposed to rezone the potential offshore wind energy resources worldwide.

Cristina L. Archer [2016] worked on Wind farms with counter-rotating wind turbines. The objective of this study is to assess the effects of using counter-rotating wind turbines on the performance of a wind farm. Large-eddy simulations, coupled with the actuator line model, were conducted to investigate flow through a test wind farm with 48 large-scale wind turbines with the same layout as Lillgrund in Sweden.

Sami et al. [2014] extracted the fundamental flatwise and edgewise modal frequency of a 5KW GFRP wind turbine blade by using 3d shell elements. It is to understand better the dynamic behaviour he conducted experiments using an electrodynamics shaker system to predict the resonant frequencies. He observed that flaps frequencies are found to be in agreement with each other while the % of error is more in the case of edgewise frequency.

Yangfeng Wang [2014] considered two cases of turbine blades having 1m and 5m in length and conducted damage detection technique by comparing the dynamic response analysis and mode shape curvature methods using composite multi-layer materials. The dynamic analysis method is used to understand the damage severity of wind turbine blades.

X Y Wang [2013] worked on a Comparison of the pressure distribution of a wind turbine blade based on field experiments and CFD. The distribution of pressure is gathered by disposed of 191 taped pressure sensors span-ward on seven particular sections of a blade. And the parameters of the experimental condition of inflow and operation condition of the wind turbine are obtained at the same time.

Allikas et al. [2012] validated a full-scale single layer layup small horizontal axis wind turbine blade through an experimental bending test and modal analysis. They have taken Glass fibre reinforced composite plastics to get the stiffness and strength analysis acted by 7848 N load. A difference of 16.8% occurred during load Case 6, damaging the blade due to the value of obtained stress being greater than the yield strength of the skin element of the blade.

3. SUMMARY OF LITERATURE REVIEW

Most of the literature deals with the investigation of various airfoils design, aerodynamic evaluations by simulation tools, and the analysis of complex composite web section blades using various techniques including FE modelling, analytical approaches as well as experimental works. The main objective of the project is to protect the turbine blade from various hazards like deformation and directional deformation.

One of the most important drawbacks of the current fatigue life investigations phenomena is that it is based on estimations and does not cover the whole possible outcomes (deterministic approach). The real governing situation is a stochastic behavior as a result of random variation of wind patterns. The wind turbine blade will experience each load case randomly. While deterministic analysis of fatigue damage progression is limited to investigating the failure associated with the most critical load pattern, stochastic implementation captures the whole events that a wind turbine will encounter. Deterministic approaches capture just one load pattern as a compromise, which is not necessarily representative of the real conditions imposed on a wind turbine. In stochastic simulation of fatigue phenomena, both the frequency of load occurrence and their sequence play a significant role.

The problems identified from the study of literature review are as follows:

- The design of the Turbine blade plays an important role in the power generation of the wind turbine.
- The Stresses occurs on the turbine blade is the major problem in blade design.
- The deformation that occurs in the turbine blade is the beginning of damage to the turbine blade.

4. SCOPE OF FUTURE WORK

Wind turbines are subjected to very specific loads and stresses. Due to the nature of wind, loads are highly variable. Varying loads are more difficult to handle than static loads because the material becomes fatigued. Moreover, as a working medium, the air is of low density so the surface required for capturing energy must be large. When designing a wind turbine, the aim is to attain the highest possible power output under particular atmospheric conditions.

REFERENCES

1. Nitin Tenguria, N.D. Mittal, Siraj Ahmed, “Aerodynamic Design of a HAWT Blade for Indian Wind Condition”, International Journal of Advances in Engineering, Science & Technology (IJAEST), Vol. 1 No.7, September – November 2011, pp 37-41.

2. John McCosker, “Design and optimization of a small wind turbine”, Rensselaer Polytechnic Institute, Hartford, Connecticut, December 2012, pp 1-56.

3. M. Anjali, C. Tara Sasanka, Ch. Deva Raj, K. Ravind Meta-Heuristicistic Method for the Design Optimization of a Wind Turbine Blade”, International Journal of Current Engineering and Technology, ISSN 2277 – 4106, Special Issue -3, April 2014, pp 175-179.

4. ChalothornThumthae, TawitChitsomboon, “Optimal Pitch for untwisted blade horizontal axis wind turbine”, 2nd Joint International Conference on “Sustainable energy and environment SEE, November 2006, pp 1-6.

5. Juan Mendez, David Greiner, “Wind blade chord and twist angle optimization by using genetic

algorithms", Intelligent systems & Numerical Applications in Engineering, Spain 2011, pp 4-19.

6. Wang Yongzhi, Li Feng, Zhang Xu, Zhang Weimin, "Composite Wind Turbine Blade aerodynamic and structural integrated design optimization based on RBF meta-model", China Academy of Aerospace Aerodynamics, May 2007, 830: 10-18.

7. K. Dykes, A. Platt, Y. Guo, et al. "Effect of Tip speed constraints on the optimized design of a wind turbine", National renewable energy laboratory, NREL/TP-5000-61726, October 2014, pp 1-77.

8. Grant Ingram, "Wind Turbine Blade Analysis using the Blade Element Momentum Method, Version 1.1", October 18, 2011, pp 1-21.

9. Naishadh G. Vasjailiya, Sathya N. Gangadharan, "Aero-structural design optimization of composite Wind Turbine Blade", 10th World Congress, 2013, pp 201-217.

10. Ahmad Sedaghat, M. El Haj Assad, Mohamed Gaith, "Aerodynamics Performance of continuously variable speed horizontal axis wind turbine with optimal blades", Energy Vol 77, December 2014 752-769.

11. Scott Larwood, C.P. Van Dam, Daniel Schow, "Design Studies of swept wind turbine blades", Renewable Energy 71 (2014) 563 – 571.