© March 2019 | IJIRT | Volume 5 Issue 10 | ISSN: 2349-6002

A Review on Stress Analysis of Composite Wind Turbine Blade by Finite Element Method

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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. In this work the investigation center around the Finite component examination of 5 MW wind turbine edge by utilizing diverse sort of composite fibre material. The anxieties happen in the wind turbine cutting edge and distortion is the biggest issue in the wind turbine and which results in substantial harms and miscreant of turbine edges.**

INTRODUCTION

Wind power devices are now used to produce electricity, and commonly termed wind turbines. Wind control is developing at the rate of 30 % every year and, thus with this advancement, the outline of a wind turbine and its suggestions should be surely knew. Yearly vitality creation (AEP) and cost are the two significant drivers administering the general outline of a wind turbine. The plan ought to be sufficiently dependable to keep any undesirable upkeep or downtime and fundamentally stable enough to manage every one of the heaps following up on it through its normal lifetime of around 20 years.

Wind power gained remarkable attention in the past decade since worldwide policies are fighting climate change through the support and investment into renewable energy sources. Recent investments into renewable energy-based power plants increased to a level of 3–1 compared with fossil fuel and nuclear power plants. Therefore one of the main global engineering challenges for wind energy sector is to develop efficient wind turbine blades with high fatigue life.

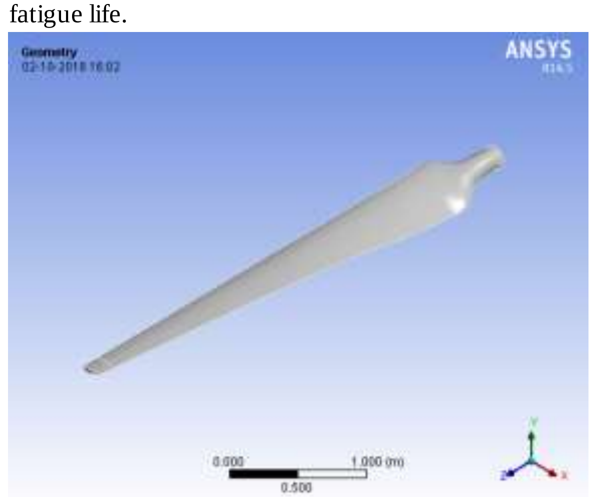

Figure 1.1: Geometrical model of wind turbine blade

LITERATURE REVIEW

Designing a blade by using well known Blade Element Momentum (BEM) Theory is a fascination to many researchers who are interested to get better geometrical parameters to maximize the power output of the blades.

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 onto the most used methods in wind turbine gearbox condition monitoring.

Chen-Hsu Wang et. al. [2017] worked on Stress analysis of composite wind turbine blade by finite element method. The finite element analysis software ANSYS was used to analyse 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-weiZheng,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 asLillgrund in Sweden.

Sami et al. [2014] extracted fundamental flapwise and edgewise modal frequency of a 5KW GFRP wind turbine blade by using 3d shell elements. It is to understand better the dynamic behaviour that he conducted experiments using electrodynamics shaker system to predict the resonant frequencies. He observed that flapwise frequencies are found to be in agreement to each other while % of error is more in 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 Comparison of the pressure distribution of a wind turbine blade based on field experiment and CFD.The distribution of pressure is gathered by disposed 191 taped pressure sensors span-ward on seven particular sections of a blade. And the parameters of 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 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 if 16.8% occurred during load Case 6, damaging the blade due to value of obtained stress being greater than yield strength of the skin element of blade.

Gursel et al. [2012] studied the vibration characteristics of rotor blades using approximation method such as Rayleigh to calculate the natural frequency of each blade. They have validated the results of vibration analysis by using Finite element analysis.

John McCosker [2012], developed an optimized code for a discretized 9 element wind turbine blade having a length of 0.95 m. He obtained optimal speed ratio, angle of wind, the pitch angle and relative chord lengths for each element. After convergence, the power extracted from wind is found to be 0.81 KW. The air foil shape is varied from NACA 4412 to NACA 23012 where the angle of attack of the blade to get maximum glide ratio is found different for each profile.

Keerthana et al. [2012] introduced a step wise procedure to develop the blade's geometrical properties by using optimization techniques and taking input parameters as the tip speed ratio, wind speed and the aerofoil properties, the chord, twist distributions are calculated. Then a CFD analysis for obtaining the lift & drag a coefficient (CL and CD) is done to calculate the lift and drag forces acting on the blade.

Peter J.Schubel[2012] worked on Wind Turbine Blade Design. review of the current state-of-art for wind turbine blade design is presented, including theoretical maximum efficiency, propulsion, practical efficiency, HAWT blade design, and blade loads. The review provides a complete picture of windturbine blade design and shows the dominance of modern turbines almost exclusive use of horizontal axis rotors.

Fangfang song [2011] worked on optimization of design of the blade, having NACA 63415 profiles and then modelled the surface model of blade using Solid works software. Then the finite element model is considered to find out the modal analysis of the blade. The excited frequency from wind speed of

10m/s is calculated as 7.16 Hz which is found to be more than the fundamental frequency obtained from the modal analysis therefore no resonance will occur when the blades run at rated wind speed.

CONCLUSION

The main objective of project is to protect the turbine blade from various hazards like deformation and directional deformation. The FEA simulation of E Glass Fibre and S glass fibre Turbine blade have been done and make a compression on deformation , Directional deformation and Von misses stress occurs on the turbine blade. The structural model of wind turbine blade will be design on ANSYS 14.5. The design model of ANSYS will be meshed on the ICEM. The meshed model will be analysed and the results will be discussed in the further research work.

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. Ravindra, "Meta Heuristic 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.

[12] K. TurgutGursel, TufanCoban, AydoganOzdamar, "Vibration Analysis of rotor blades of a farm wind power plant", Mathematical and Computational applications, Vol. 17, No. 2, 2012, pp. 164-175.

[13] Gunner C. Larsen, Morten H. Hansen, Andreas Baumgart, Ingemar Carlen, "Modal Analysis of Wind Turbine Blades", Risφ National Laboratory, Roskilde, Denmark February 2002, pp 1-72.

[14] Chao Liu, Dongxiang Jiang and Jie Chen, "Vibration Characteristics on a Wind Turbine Rotor using Modal and Harmonic Analysis of FEM", 978-1-4244-8921-3/10 IEEE 2010, pp 1-5.

[15] O Pabut, G Allikas, H Herranen, R Talalaev, K Vene, "Model Validation and structural analysis of a small wind turbine blade", 8th International DAAAM Baltic Conference, Industrial Engineering, 19-21 April 2012, pp 1-10.

[16] Saad Sami, Behzad Ahmed Zai, M. Amir Khan,"Dynamic Analysis of a 5KW Wind Turbine Blade with experimental Validation", Journal of Space Technology, Vol. 4, No-1, July 2014, pp 82-87.

[17] Fangfang Song, Yihua Ni, Zhiqiag Tan, "Optimization Design, Modelling and Dynamic Analysis for Composite Wind Turbine Blade", International Workshop of Automobile, Power and Energy Engineering, Procedia Engineering, 16 (2011) 369-375.
[18] Zhu Jie, CaiXin, Pan Pan, "Static and Dynamic Characteristics Study of Wind Turbine blades", Advanced Materials Research Vols 433-440 (2012) pp 438-443.