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Review Article

EFFECT OF STRUCTURAL PERFORMANCE OF WIND TURBINE BLADES—A REVIEW

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Wind is the major power source to generate electricity. With the aid of moving air the intermittent source of Wind energy is dependent upon the wind speed, turbulence and wind turbine. Maximum of power produced is based upon the wind turbine resources. The wind turbine is the device that is used to charge the batteries by the conversion of kinetic energy of the moving air into the electrical power. The inefficiencies occurred in the wind turbine due to the mass of air flow through the turbine. The power delivered by the wind turbine is affected by rotor blade friction, blade drag, gearbox losses and generator. So it is necessary to increase the efficiency of the wind turbine by the changes made in the blade design and wind turbine blade design. In this review paper, the several wind turbine blade designs and the effect of blade design modifications on the efficiency of the wind tur-bine is studied.

Keywords: Wind energy, Wind turbine, Blade Design, Blade efficiency

INTRODUCTION

A windmill is a machine that converts the energy of wind into rotational energy by means of vanes called sails or blades. The reason for the name "windmill" is that the devices originally were developed for milling grain for food production; the name stuck when the course of the past, wind mill machinery was personalized to supply power for many industrial and agricultural needs. Most of the modern windmills take the form of wind turbines used to produce electricity or to pump water, neither for land drainages nor to pull out ground water. The wind wheel of the Greek engineer Heron of Alexandria in the first century AD is the earliest known instance of using a wind-driven wheel to power a machine.

LITERATURE REVIEW

Hansena *et al.* (2006) presented the state of the art in wind turbine aerodynamics and aero elasticity, thus the aerodynamic part starts with the simple aerodynamic Blade Element Momentum Method and ends with giving a review of the work done applying CFD on wind

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turbine rotors. Some methods like vortex and panel are explained in the middle. Also the different approaches to structural modeling of wind turbines are addressed.

Jang-Oh Mo and Young-Ho Lee (2012) have developed cfd investigation on the aerodynamic characteristics of a small-sized wind turbine of neural phase VI operates with a stall-regulated method, where Five different inflow velocities, in the range Vin = 7.0-25.1 m/s, are used for the rotor blade calculations. The considered power coefficient is in relation to 0.35 at a TSR of 5.41, equivalent to 7 m/s, and showed significantly fine concord with the new capacity within 0.08%. Therefore, root design approaches were considered the appropriate selection of the angle of attack and the thickness are very important in order to generate the stall on the blade root.

Vendan *et al.* (2010) developed the analysis of a wind turbine blade profile for tapping wind power in the regions of low wind speed. The aerodynamic profiles of wind turbine blades have crucial influence on aerodynamic efficiency of wind turbine. In this paper NACA 63-415 airfoil profile is considered for analysis of wind turbine blade. NACA 63-415 airfoil profile is shaped by using the corresponding file generated in Java Foil.

Naishadh Vasjaliya and Sathya Gangadha-Ran (2011) presented Aero-Structural Design Optimization of Composite Wind Turbine Blade, The objective behind this research is to develop a Fluid-Structural Interface (FSI) system for SERI-8 composite blade to get benefit of aerodynamic efficiency and structural toughness while tumbling blade mass and cost. In the earlier research, a MDO procedure of a composite wind turbine blade has been pioneered as effective process to develop structurally optimized blade design.

Asseff and Mahfuz (2009) developed the Design and Finite Element Analysis of an Ocean Current Turbine Blade, In this study the focus of this work is on the turbine blade design. Much has been learned from the advances in wind turbine blade design, but many differences exist that must be addressed. The medium density in our case is seawater, which is 800 times denser than air, leading to much higher working loads. The ocean is also a very corrosive environment, so materials have to be properly selected. Also, most wind turbine blades are hollow to reduce self weight and cost, but this type of design is not practical for an ocean current turbine.

Pradeep *et al.* (2009) presented the Design and Analysis of Wind Turbine Blade Design System (Aerodynamic), thus The GE 1.5 sle MW wind turbine and NERL NASA Phase VI wind turbine have been used as investigation cases. Particulars of the design system application are described, and the resulting wind turbine geometry and condition are compared to the available results of the GE and NREL wind turbines. A 2D wing investigation code XFLR5, is used for to approximation results from 2D analysis to blade-to-blade assessment and the 3D CFD analysis. This kind of assessment reveals that, from hub to 25% of the span blade to blade effects or the cascade effect has to be calculated, from 25% to 75%, the blade acts as a 2d wing and from 75% to the tip 3D and tip possessions have to be taken into account for design considerations. In addition, the benefits of this approach for wind turbine design and future efforts are discussed.

Kevin Cox and Andreas Echtermeyer (2012) presented Structural design and analysis of 10 MW wind turbine blade, in this project 70 m long blade used in high wind speed location. Such that Glass and carbon fiber used in weight reduction, FEA method is the problem solved. In concluding the Maximum and minimum strain and deflection is identified. For blade tip.

Zafar Hameeda and Jørn Vatn (2012) developed the important challenges for 10 MW reference wind turbine from rams perspective, RAMS Mean Reliability, availability, maintainability And Safety. Here rams analysis has become an active area of research to measure the efficiency of any operational system for evaluating its performance as per its designed features. Thus, finally the areas and problems are easily identified and the optimized design tends to produce better efficiency and effective working condition of the machine.

Bai *et al.* (2013) designed 10 KW Horizontal-Axis Wind Turbine (HAWT) blade and aerodynamics investigation using numerical simulation, in this system the horizontal axis wind turbine blade with 10000 watt power output has been designed. The BEM theory is very successful in HAWT blade design. Wind speed 10 m/s tip speed ratio 6 and angle design 6 deg, Turbine blade performed by the CFD numerical simulation.The simulation result compared BEM theory wind speed of 10 m/s. Finally author concludes CFD is good method of aerodynamic.

Fangfang Song *et al.* (2011) presented Optimization Design, Modeling and Dynamic Analysis for Composite Wind Turbine Blade, The performance analysis of wind turbine blades are important parts of the design and also he has been solved this paper using MATLAB tools in Wilson method. FEM method is analysis for the composite material modeling method of combining of solid work with ANSYS.

Waleed Ahmed (2013) modelling of Wind Turbine: Relative Study this paper discovers the modelling of gear train of the wind turbine and extricates the difference in the approaches usually used to found the mathematical model which is later has a significant influence on the design, characteristic and presentation of the modelled system. Mainly two commonly used advanced for the gear train systems are analyzed and deliberated. The main well known mechanisms are examined in term of the most proposed expectations to contract with the damping, shaft stiffness and inactivity effect of the gear. In general, the concept of using the wind energy to find the electricity power can be characterized by the following diagram. wind turbine gear box consists of two main shafts, the low speed shaft which is fundamentally connected with the wind turbine blades, and the second one is high speed shaft linked directly to the manufacturer.

Jihoon Jeong *et al.* (2012) design optimization of a wind turbine blade to reduce the changing unsteady aerodynamic load in turbulent wind Design optimization of the wind turbine of a NREL 1.5-MW HAWT blade was deliberate to reduce the fluctuation of the bending moment of the blade in turbulent wind. In order to examine the unsteady aerodynamic weight of a wind turbine, FAST code was used as the examination code. To study turbulent wind as the wind input model in FAST, TurbSim was used as a turbulent wind simulant. Accordingly, the result of the design optimization is comparedwith the baseline for variation in the out of plane bending moment at the blade root and for the required generated power. In addition, the section services for the radial station around the out of plane and in plane were investigated to deliberate the load appearances of the optimized blade. Next, the local angles of occurrence of the optimized blade in each airfoil section are associated to that of the baseline blade. Finally, the robustness of the optimized blade was authorized according to various wind speeds with off design examination.

Khelladi *et al.* (2014) analysis and learning of the aerodynamic turbulent flow arounda blade of wind turbine the flow around a wind turbine is a set of forces practical by the wind on the blades distinct by the most momentous parameters from a dimensional analysis describing the power of wind turbine. This later is criss spanned by changes of turbulent strength unlike the Reynolds number essential parameter and not unique for the change in turbulent flow. Thus the presentation of the wind turbine depends on the specific speed that allows to get the most power constant by managerial the speed. The option of regulating power of the current high-speed wind turbine by changing the blade angle and or speed of rotation of the blades, unlike the older generation in active stall control of the blade, will lead to a study of the stress of the blade by the occurrence wind aerodynamic forces and therefore of the flow around a wind turbine and the identification of the most see-through parameters for dimensional study of the power.

Maryam Refan and Horia Hangan (2012) Aerodynamic Presentation of a Small Horizontal Axis Wind Turbine The aerodynamic presentation three-bladed, minute Horizontal Axis Wind Turbine (HAWT) rotor of 2.2 m in diameter was examined experimentally and theoretically in order to measure the applicability of the Blade Element Method (BEM) theory for screening the rotor presentation for the case of small HAWTs. The wind turbine has been experienced in the little and high speed pieces of the Boundary Layer Wind Tunnel 2 (BLWT2) at the University of Western Ontario (UWO) in order to regulate the power curve over a wide range of wind speeds. Furthermore, the rationality of wind tunnel testing and new systems, counting full scale HAWT windtunnel tests and impasse improvements were lectured. The overall choice of the present work is, therefore, twofold: (i) evaluating the probability of wind tunnel testing for small HAWT to determine resolute power arcs even for high solid blockageratios, and (ii) appraising the possible limitations of the BEM theory to forecast small HAWT performance.

Herbert Sutherl and John (2004) effect of mean stress on the damage of wind turbine blades in many studies of composite wind turbine blades, the effects of mean stress on the resolution of injury are either overlooked totally or they are considered ineffectively. An modernized Goodman diagram for the fiberglass resources that are classically used in wind turbine blades has been unconfined lately. This diagram, which is based on the MSU/DOE Fatigue Database, comprises thorough material at thirteen R-values. This diagram is the most complete to date, and it contains any loading conditions that have been unwell embodied in earlier studies. Also, the EFL is a more consistent constraint for comparing fatigue studies because it is not subject to the risky variations noted in typical guesses of service lifetimes, For the statement sets used here, the results illustrate a momentous over estimate of the EFL and an underestimate of the service lifetime when the main stress is not measured. And, the results from the modernized Goodman diagram prove the status of counting material on the changeover between compressive and tensile failure modes in the fatigue account of composites with filament glass.

CONCLUSION

In wind turbine there was a strong coupling between aerodynamic loads, the time dependent structural behaviour of construction. Through a clear understanding an aerodynamic characteristics of the small-sized NREL Phase VI wind turbine, it is so expected that useful aerodynamic data will be made available to designers as guidance in designing stall-regulated wind turbine blades in the development phase of small-sized wind turbine systems in the future. This complex MDO presented here is applied to the design of wind turbine blades to obtain a structurally optimized blade design with optimal blade thickness distribution and maximum power output without compromising its aerodynamic performance.

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