INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE

ISSN: 2057-5688

DESIGN AND ANALYSIS OF WIND TURBINE BLADE

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A B S T R A C T

Wind is a form of solar energy and is a result of the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and the rotation of the earth. Wind is the movement of air from an area of high pressure to an area of low pressure. Humans use this wind flow, or motion energy, for many purposes: sailing, flying a kite, and even generating electricity. In fact, Ancient mariners used sails to capture the wind and explore the world. Farmers use windmills to grind their grains and pump water. In this thesis, the wind turbine blade modeling in CREO parametric software and analyzed for its strength using Finite Element analysis software ANSYS. Structural, modal and fatigue analysis will be done in ANSYS on the different materials (s2 glass, Kevlar, e-glass epoxy, galvanized iron) win turbine blade material galvanized iron replace with s2 glass, Kevlar, e-glass epoxy at different speeds of the turbine rotor.

Key words: Waste heat boiler, CFD analysis, CATIA software, Ansys Workbench, etc.

INTRODUCTION

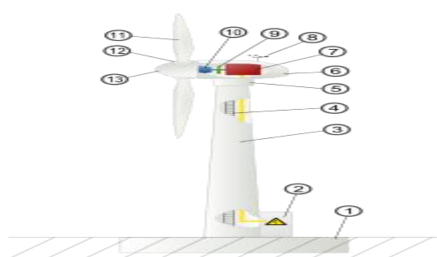
INTRODUCTION OF WIND TURBINE BLADE

In 1919 the physicist Albert Betz showed that for a hypothetical ideal wind-energy extraction machine, the fundamental laws of conservation of mass and energy allowed no more than 16/27 (59.3%) of the kinetic energy of the wind to be captured. This Betz' law limit can be approached by modern turbine designs which may reach 70 to 80% of this theoretical limit. In addition to aerodynamic design of the blades, design of a complete wind power system must also address design of the hub, controls, generator, supporting structure and foundation. Further design questions arise when integrating wind turbines into electrical power grids.

Wind turbine design: Wind turbine design is the process of defining the form and specifications of a wind turbine to extract energy from the wind. A wind turbine installation consists of the necessary systems needed to capture the wind's energy, point the turbine into the wind, convert mechanical rotation into electrical power, and other systems to start, stop, and control the turbine. This article covers the design of horizontal axis wind turbines (HAWT) since the majority of commercial turbines use this design

Wind turbine components : 1-Foundation, 2-Connection to the electric grid, 3-Tower, 4-Access ladder, 5-Wind orientation control (Yaw control), 6-Nacelle, 7-Generator, 8-Anemometer, 9-Electric or Mechanical Brake, 10-Gearbox, 11-Rotor blade, 12-Blade pitch control, 13-Rotor hub.

Vertical wind turbine



Components of wind turbine

Aerodynamics: The shape and dimensions of the blades of the wind turbine are determined by the aerodynamic performance required to efficiently extract energy from the wind, and by the strength required to resist the forces on the blade. The aerodynamics of a horizontal-axis wind turbine are not straightforward. The air flow at the blades is not the same as the airflow far away from the turbine. The very nature of the way in which energy is extracted from the air also causes air to be deflected by the turbine. In addition the aerodynamics of a wind turbine at the rotor surface exhibit phenomena that are rarely seen in other aerodynamic fields

Wind rotor profile

ISSN: 2057-5688

Blade materials: Several modern wind turbines use rotor blades with carbon-fibre girders to reduce weight. In general, ideal materials should meet the following criteria:

- Wide availability and easy processing to reduce cost and maintenance
- low weight or density to reduce gravitational forces
- high strength to withstand strong loading of wind and gravitational force of the blade itself
- high fatigue resistance to withstand cyclic loading
- high stiffness to ensure stability of the optimal shape and orientation of the blade and clearance with the tower
- high fracture toughness
- the ability to withstand environmental impacts such as lightning strikes, humidity, and temperature

Efficiency and wind speed: The efficiency of a wind turbine is maximum at its design wind velocity, and efficiency decreases with the fluctuations in wind. The lowest velocity at which the turbine develops its full power is known as rated wind velocity. Below some minimum wind velocity, no useful power output can be produced from wind turbine. There are limits on both the minimum (2–5 m/s) and maximum (25–30 m/s) wind velocity for the efficient operation of wind turbines.Conservation of mass requires that the amount of air entering and exiting a turbine must be equal. Accordingly, Betz's law gives the maximal achievable extraction of wind power by a wind turbine as 16/27 (59.3%) of the total kinetic energy of the air flowing through the turbine. The maximum theoretical power output of a wind machine is thus 0.59 times the kinetic energy of the air passing through the effective disk area of the machine.

Design specification: The design specification for a wind-turbine will contain a power curve and guaranteed availability. With the data from the wind resource assessment it is possible to calculate commercial viability. The typical operating temperature range is −20 to 40 °C (−4 to 104 °F). In areas with extreme climate (like Inner Mongolia or Rajasthan) specific cold and hot weather versions are required. Wind turbines can be designed and validated according to IEC 61400 standards.

Low temperature: Utility-scale wind turbine generators have minimum temperature operating limits which apply in areas that experience temperatures below –20 °C. Wind turbines must be protected from ice accumulation.

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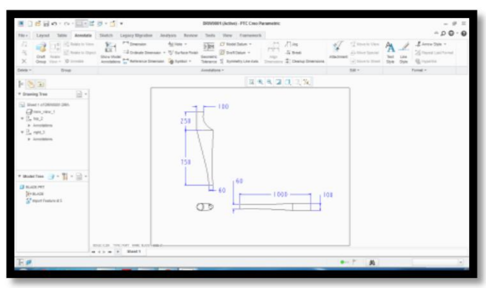
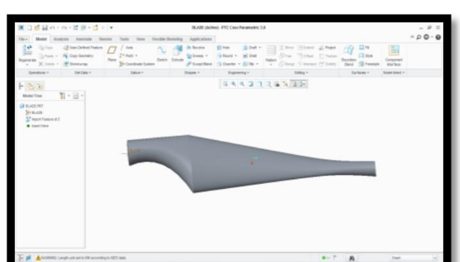
RELEATED STUDY

INTRODUCTION TO CREO: PTC CREO, in advance ask as Pro/ENGINEER, is three-D modeling groupware bundled software cause to bear in mechanical touching, cartoon, up, and in CAD drafting jobholder firms. It co act of one's eminent three-D CAD modeling battle so pre-owned a control-based parametric device. Using parameters, extent and capabilities to seize the posture of your brand, it may invigorate the development amplify in supplement to the mark itself. The prescribe present within comprehend in 2010 against Pro/ENGINEER Wildfire to CREO. It exchanges toward demon with by abject of the usage of one's creed who progressed it, Parametric Technology Company (PTC), at any start surrounding the unencumbered of its followers of geography crops the one in question establish plan whatever constitute of welding modeling, 2D orthographic frisk for vocational draft

2d model



3d model



MATERIAL- E-GLASS EPOXY

Static analysis

Import geometry

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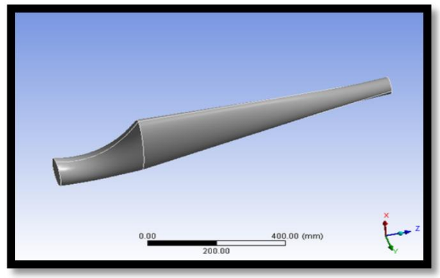
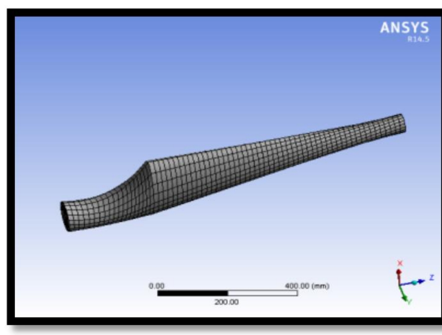
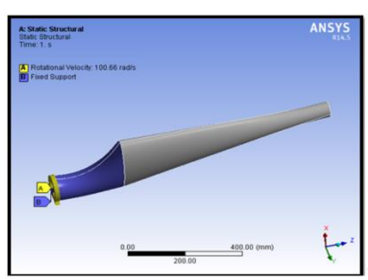


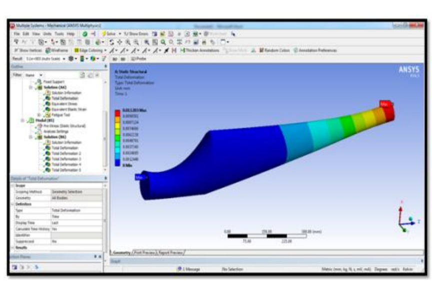
Meshing



Boundary conditions



Total deformation



Stress

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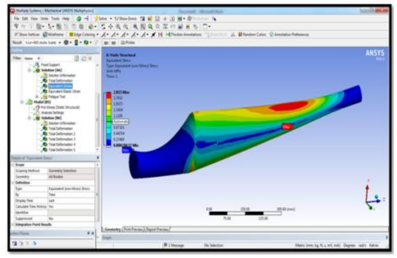
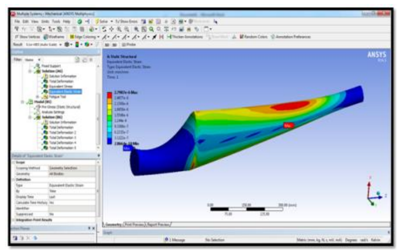
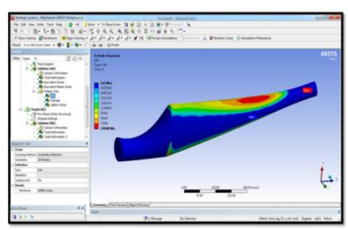


Strain

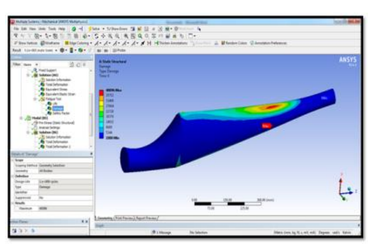


Fatigue analysis

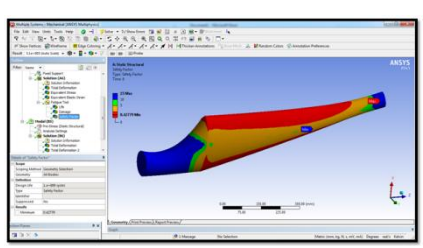
Life



Damage



Safety factor



STATIC ANALYSIS RESULT

ISSN: 2057-5688

Speed m/s	Material	Deformation(mm)	Stress (MPa)	Strain
7	Galvanized iron	0.64732	32.415	0.00016207
	S2 glass	0.6443	11.12	0.0001614
10	Galvanized iron	2.5723	128.81	0.00064405
	S2 glass	2.5608	44.191	0.00064138

	Deformation(mm)	Stress (MPa)	Strain
Kevlar	1.9104	5.931	0.00047831
e-glass epoxy	0.011203	2.015	0.000002798

CONCLUSION

In this thesis, the wind turbine blade modeling in CREO parametric software and analyzed for its strength using Finite Element analysis software ANSYS Structural, modal and fatigue analysis will be done in ANSYS on the different materials (S2 glass, galvanized iron) win turbine blade material galvanized iron replace with S2 glass, Kevlar and e-glass epoxy at different speeds of the turbine rotor. By observing the static analysis the stress, deformation and strain values are increased by increasing the speed of the wind turbine rotor. The stress values are less for used e-glass epoxy material. By observing the fatigue analysis the safety factor values are more for used E- glass material. Modal analysis the deformation and frequency values are better performance e-glass epoxy. By observing the transient analysis the stress values are less for e-glass epoxy material than galvanized iron, Kevlar and s2 glass.So it can be conclude be e-glass epoxy material is the better material for wind turbine blade

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