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EFFECTIVE PERFORMANCE OF WINDMILL TURBINE BLADE USING COIR AND E-GLASS FIBER

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ABSTRACT

Environmental awareness today motivates the researchers, worldwide on the studies of natural fibre reinforced polymer composite and cost effective option to synthetic fibre reinforced composites. The trend toward ever larger offshore wind farms continues unabated. Wind turbines with rotor blades measuring up to 80 meters in length and a rotor diameter of over 160 meters are designed to maximize energy yields. Since the length of the blades is limited by their weight, it is essential to develop lightweight systems with high material strength.

The lower weight makes the wind turbines easier to assemble and disassemble, and also improves their stability at sea. With low cost and high specific mechanical properties, natural fibre represents a good renewable and biodegradable alternative to the most common synthetic reinforcement, i.e. glass fibre. By improving the design and materials used, we hope to reduce the weight of the blades and thus increase their service life. Despite the interest and environmental appeal of natural fibres, there use is limited to nonbearing applications, due to their lower strength compared with synthetic fibre reinforced polymer composite

INTRODUCTION

A wide variety of sources including wood, coal, coke, oil, natural gas and nuclear materials have been used to generate energy. Over the years, the consumption of energy has increased due to the increasing population and civilization. At the same time, the ecological awareness has become the major environmental issue in the global marketplace. In today's scenario the major threat for the environment is the imbalance in the ecological system which is increasing due to the disposal of toxic waste. This issue has led to the increased interest on renewable and sustainable energy sources.

The only concern for the sustainable development is minimum pollution and reduction in energy consumption. The increasing interest in the direction of using renewable energy has led to the development of the concept of wind energy. The wind energy is a prominent renewable energy source and is a solution of global energy problem. To convert the kinetic energy of the wind into mechanical or electrical energy, wind turbines or mills have been established. Most of the wind turbines basically consist of three rotor blades that rotate around a horizontal hub and convert the wind energy into the mechanical energy. The development of wind turbines for the generation of power is an emerging area.

The rotor blades of wind turbines are considered as one of the key component of the wind turbine. The efficiency of the wind turbine majorly depends on the aerodynamic shape and length/angle of the blades as well as the materials used to manufacture the blades. Further, the wind turbines generate power according to the speed of the wind, not according to the demand. The basic criterion for the selection of materials for the wind turbine blades is that the material should possess high strength and stiffness, low density and adequate fatigue strength.

METHODOLOGY

Reinforcement

The objective of the reinforcement in a composite material is to enhance the mechanical properties of the resin system. All of the distinct fibers that are used in composites have distinct properties and so affect the properties of the composite in different ways. For most of the applications, the fibers need to be arranged into some form of sheet, known as a fabric, to make handling possible.

Machining Behaviour of Natural Fiber Reinforced Composites

The joining through adhesive bonding is not always possible for obtaining the ultimate structural integrity. Mechanical fastening such as riveting and bolting are the important methods of joining of natural fiber reinforced composite parts. The mechanical fastening demands the making of good quality holes of the desired size in composite parts. The making of holes is mostly done through conventional drilling. Various novel techniques have been developed for making of holes in polymer composites, but the conventional drilling is one of the most common methods .

The fundamental concept of drilling of natural fiber reinforced composites is similar when compared with the drilling of traditional polymer matrix composites. But, the fact is that, the drilling behaviour of natural fiber reinforced composites is different from the drilling of traditional polymer matrix composites.Drilling of natural fiber reinforced composites is a tedious task, because several factors are involved that control the quality of the drilled hole. The optimization of the operating variables such as cutting speed and feed rate, selection of compatible tool material, designing of optimum tool point geometry and the evaluation and characterization of machining induced damage are some of the research areas that need substantial attention in order to enlarge the applications of the natural fiber reinforced composites.

EXPERIMENTAL DETAILS

Composite material

Composite material (also called a composition material or shortened to composite) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials. More recently, researchers have also begun to actively include sensing, actuation, computation and communication into composites, which are known as Robotic Materials.

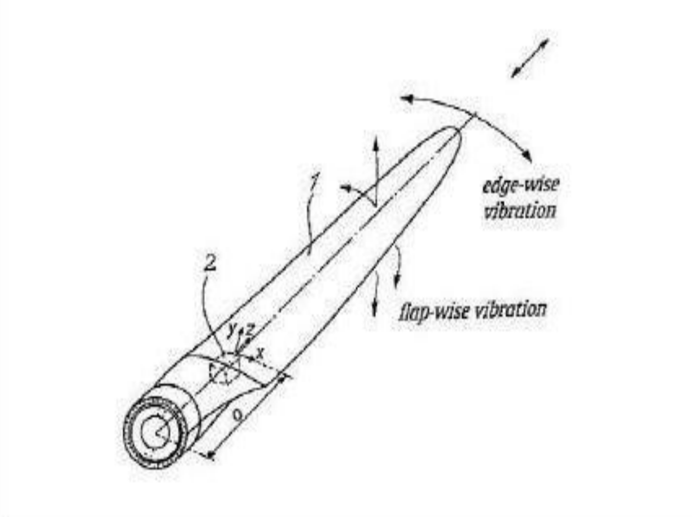
Typical engineered composite materials include:

- Composite building materials, such as cements, concrete
- Reinforced plastics, such as fiber
- Metal composites
- Ceramic composites (composite ceramic and metal matrices)

Composites are made up of individual materials referred to as constituent materials. There are two main categories of constituent materials: matrix and reinforcement. At least one portion of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination.

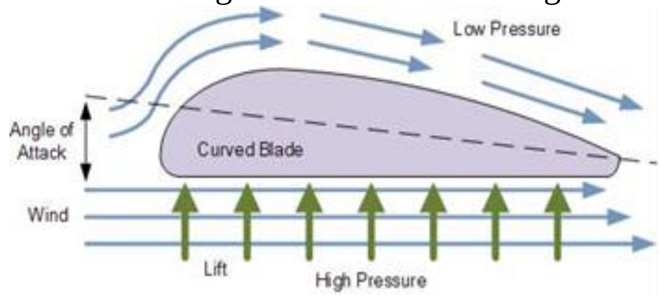
Blade design

The ratio between the speed of the blade tips and the speed of the wind is called tip speed ratio. High efficiency 3-blade-turbines have tip speed/wind speed ratios of 6 to 7. Modern wind turbines are designed to spin at varying speeds (a consequence of their generator design, Use of aluminum and composite materials in their blades has contributed to low rotational inertia, which means that newer wind turbines can accelerate quickly if the winds pick up, keeping the tip speed ratio more nearly constant. Operating closer to their optimal tip speed ratio during energetic gusts of wind allows wind turbines to improve energy capture from sudden gusts that are typical in urban settings.And in contrast, older style wind turbines were designed with heavier steel blades, which have higher inertia, and rotated at speeds governed by the AC frequency of the power lines. The high inertia buffered the changes in rotation speed and thus made power output more stable.



Curved Blade Air Flow and Performance

But curved blades also suffer from drag along its length which tries to stop the motion of the blade. Drag is essentially the friction of air against the blade surface. Drag is perpendicular to Lift and is in the same direction as the air flow along the blade surface. But we can reduce this drag-force by bending or twisting the blade and also tapering it along its length producing the most efficient wind turbine blade design.The angle between the direction of the oncoming wind and the pitch of the blade with respect to the oncoming wind is called the "angle of attack".

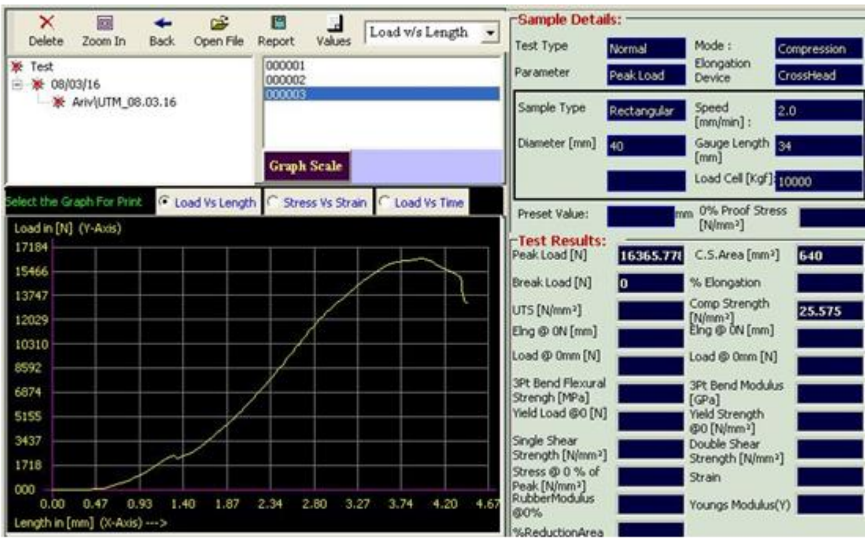


RESULTS AND DISCUSSION

A 100m blade made entirely out of glass fiber could weigh up to 50 metric tonnes [110,231 lb], he notes. "When you consider achieving a 20 to 30 percent weight savings by incorporating carbon fiber, that's a weight savings of 15 metric tonnes [33,069 lb]. Multiply that by three and it can make a significant difference,

Although the calculation of wind power illustrates important features about wind turbines, the best measure of wind turbine performance is annual energy output. The difference between power and energy is that power (kilowatts [kW]) is the rate at which electricity is consumed, while energy (kilowatt-hours [kWh]) is the quantity consumed. An estimate of the annual energy output from your wind turbine, kWh/year, is the best way to determine whether a particular wind turbine and tower will produce enough electricity to meet your needs.

A wind turbine manufacturer can help you estimate the energy production you can expect. They will use a calculation based on the particular wind turbine power curve, the average annual wind speed at your site, the height of the tower that you plan to use, and the frequency distribution of the wind–an estimate of the number of hours that the wind will blow at each speed during an average year. They should also adjust this calculation for the elevation of your site. Contact a wind turbine manufacturer or dealer for assistance with this calculation.



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