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Design Optimization of Wind Turbine Blade Using Composite and Natural Fiber Materials

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***Abstract*-The prime objective of the proposed work is to introduce a most predictive model to diagnose the Diabetic retinopathy and Glaucoma. India's new focus on multi-dimensional growth of non-conventional energy is an open economy. This is because the country's population of one billion people is expected to continue expanding, which may accelerate quick use of existing non-conventional sources of energy. In the aftermath of the energy crisis that has gripped the rural sector, it has become increasingly important to investigate potential new sources of energy as well as technologies that may one day make it possible to extract energy from resources that were previously unused. There are still 80,000 villages in India that do not have access to power; therefore, these communities are in perpetual darkness. In addition, the isolated position makes it difficult for them to connect to a grid. There are many different techniques for the generation of energy, but the only one of them or a hybrid system that can be adopted by rural communities at an investment that is cheap is only one of those methods. The efficiency of energy capture for the creation of electricity may be improved by utilising turbines that rotate in opposite directions. i.e. Electricity can be produced even with wind speeds as low as 3 metres per second. An attempt has been made to build a low-cost wind turbine with a power output of 0.80 kilowatts for use in residential settings, as well as 3 kilowatts for use in the management of agricultural operations and the pumping of water for irrigation. In this study, the methods that are used to make cost-effective turbine blades utilising materials such as wood, natural fibres, and glass fibres, as well as inexpensive labour in distant locations, are described. In addition to this, it advises using locally sourced materials for the construction of towers and turbines in order to stimulate the local economy and provide work opportunities to the people who live in rural areas. As the results of the studies indicated in further detail, this is a technology that can build wind turbines at an affordable price for rural areas.**

Keywords: Natural Fiber, Composite materials, FEM, Wind Turbine, Power Generation.

I. INTRODUCTION

1.1 WIND TURBINE

In recent years, there has been a sharp increase in consumer awareness of new renewable-energy products. Green marketing, new recycling directives, social influence, and a shift in cognitive values have all influenced consumers to seek out environmentally friendly products. Composite materials, in particular, are being developed and redesigned with the goal of improving and adapting traditional products while also introducing new products in a sustainable and responsible manner. This paper examines and discusses recent trends in fiber-reinforced bio-composite materials, as well as providing information on natural fibers for bio-composites, with a focus on properties and applications. Natural fibers are mostly derived from plants or animals. The first is mostly made of cellulose, while the later is made of protein. Natural fibers are often referred to as vegetable fibers in the composites business. One of the problems with natural fibers is the lack of consistent information and claimed variances in mechanical characteristics. Furthermore, the lack of standards for both producers and users of these materials in terms of how to collect, treat, process, and post-process natural fibers complicates the selection process. These concerns are, in fact, major deterrents to the widespread use of natural fibers in a variety of applications. To fill this need, this study presents a review of various mechanical characteristics of natural fibers and their applications. Natural fibers are divided into three categories depending on their origin: animal, mineral, and plant. Plant fibers are the most widely recognized fibers in the industry, as well as the most studied by researchers. This is owing to the short growth time, renewable resources, and increased availability. Cellulose, hemicelluloses, and lignin are the components of vegetable fibers, which can be extracted from bast, leaf, seed, fruit, wood, stalk, and grass/reed

1.1.1 COMPONNETS

- Blades: These are the most important parts of the windmill, since they are the ones that regulate how fast the rotors spin.
- Rotor: A rotor is sometimes referred to as a propeller.
- Anemometer: This component is utilised for determining the velocity of the wind.
- Towel: This is the support mechanism that keeps the blades and the propeller from coming apart.

1.1.2 MATERIALS USED

Currently used material in windmill
blade

- Carbon fiber
- Aramid fiber
- E-glass fiber

Carbon fiber- Carbon fibers, also known as CF, graphite fiber, or graphite fiber, are carbon-based fibers with a diameter ranging from 5 to 10 micrometers (0.00020–0.00039 in). [needs a reference] Carbon fibers have several advantages, including high stiffness, strong tensile strength, low weight to strength ratio, great chemical resistance, high temperature tolerance, and little thermal expansion. [1] Due to its unique properties, carbon fiber is extensively employed in aviation, civil engineering, military, and racing, as well as other competitive sports. They are, however, relatively expensive when compared to equivalent fibers such as glass fiber, basalt fibers, or plastic fibers.

Table I. Show the properties of carbon fiber

Phase at STP	Solid
Density	2000 kg/m3
Ultimate Tensile Strength	4000 MPa
Yield Strength	2500 MPa
Young's Modulus of Elasticity	500 GPa
Brinell Hardness	N/A
Melting Point	3657 °C
Thermal Conductivity	100 W/mK
Heat Capacity	800 J/g K
Price	22 $/kg

1. Disadvantages

- Conductivity-This can be used both as an advantage in carbon fiber composites and as a drawback in practical applications. Carbon fibers are extremely conductive, while glass fibers are insulated. Many products use fiberglass instead of carbon fiber or metal because they require strict insulation. In the production of utilities, many products require the use of fiberglass. For example, the production of ladders uses fiberglass as a ladder because the possibility of electric shock is much reduced when the fiberglass ladder is in contact with the power line.
- **Fragile-** Carbon fiber relates material used for the manufacture of components exposed to repeated stress and impact. Any strong impact. g. hitting with a hammer may result in carbon fiber composite cracking Therefore aramid has been developed and its layers placed additionally improve significantly impact resistance of carbon fiber Interestingly aramid is not visible as it is placed inside carbon fiber composite.

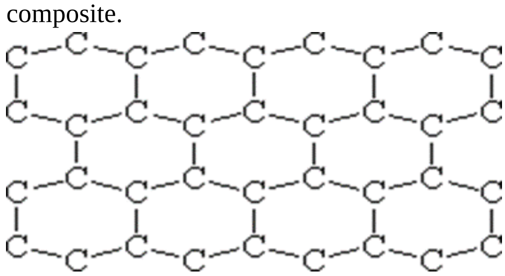


Fig.1 Structure of carbon fiber

2. Aramid fiber - High-performance fibers created from man-made molecules with moderately rigid polymer chains are known as aramid fibers. Strong hydrogen bonds connect these molecules, effectively transmitting mechanical stress and permitting the use of chains with low molecular weight.

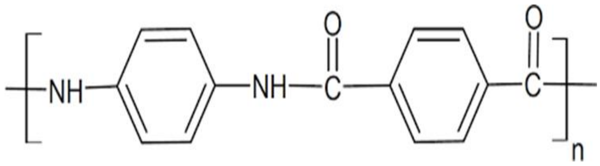


Fig.2 Aramid fiber structure

Properties

- High strength
- Good resistance to abrasion
- Good resistance to organic solvents
- Non-conductive
- No melting point
- Low flammability
- Good fabric integrity at elevated temperatures

Disadvantages of aramid fibers

- The fibers absorb moisture so aramid

composites are more sensitive to the environment than glass or graphite composites.

- For this reason, it must be combined with moisture resistant materials like epoxy systems.
- Compressive properties are relatively poor too.
- Consequently, aramid fiber is not used in bridge building or whenever this kind of resistance is needed. Also, aramid fibers are difficult to cut and to grind without special equipment (e.g special scissors for cutting, special drill bits).
- Finally, aramid suffer some corrosion and are degraded by UV light. For this reason, they must be properly coated.

3. E-glass- E-glass fibers, the first major synthetic composite reinforcement, were originally developed for electrical insulation applications (that is the origin of the "E"). E-glass fibers are, by many orders of magnitude, the most widely used of all fibrous reinforcements. The primary reasons for this are their low cost and early development compared to other fibers. Glass fibers are produced as multifilament bundles.

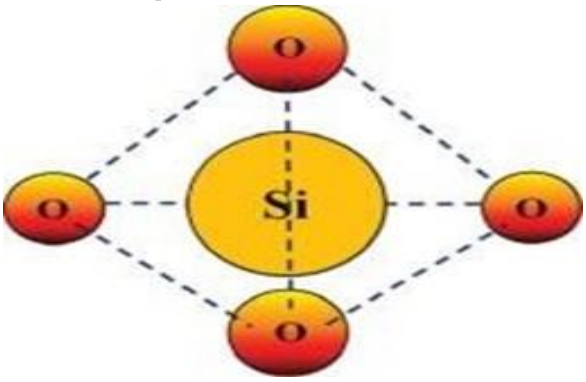


Fig.3 Structure of glass fiber

Table II. shows the properties of E-glass fiber

Mechanical property	Glass fiber
Youngs modulus	73
Tensile strength	3400
Weight	350
Density	2.6
Thickness	0.067
Ultimate strain	4.5
Colour	White

Disadvantages of E-glass fiber

- Moisture Issues-Fiberglass insulation is particularly prone to moisture. Unlike other materials such as sprayed foam insulation or foam board, wet fiberglass insulation loses all R-value and has almost no insulating properties until it dries out. Moisture can harm insulation in attics as the primary location for fiberglass batts due to roof leaks or from simple condensation.
- Mould Issues- Mould growth will occur when moisture is present in fiberglass insulation. It is more common in fiberglass as compared to other insulation materials such as loose-filled cellulose as cellulose does not permit free air movement that carries molds pores and delivers moisture.
- Air Exchange Issues- In addition to conduction directly through walls and ceilings, heat energy also moves through direct air exchange, such as air leaks through a ceiling into an attic. Other insulation materials such as sprayed foam or loose-fill cellulose are denser and give more effective protection against air leaks than glass fiber.

1.2 COMPOSITE MATERILAS USED FOR WIND TURBINE BLADE

1.3 NATURAL FIBER USED FOR WIND TURBINE BLADE

Natural fibers are substances that are biodegradable over time and are derived from plants, animals, minerals, or geological processes. They may be woven, knitted, matted, or tied after being spun into filaments, threads, or ropes. Natural fibers do not need any formation or reformation since they are derived from natural sources. Cellulosic fibers derived from plant seed hairs, stems, and leaves; protein fibers derived from animal hair, fur, or cocoons; and the crystalline mineral asbestos are the most economically significant natural fibers.

- Hemp fiber
- Jute fiber
- Amplitex fiber

1.2.1Hemp fiber

Hemp fibers are a strong member of the bast natural fibers family, obtained from the hemp plant, which belongs to the Cannabis species. Because of their biodegradability and low density compared to artificial fibers, these fibers are now widely used as reinforcements in composite materials. Mechanical, thermal, and acoustic qualities are also inherent in these materials.

Hemp fiber, like many other natural fibers, is seeing a resurgence in the building industry. This is due to its intrinsic qualities as well as the environmental advantages of energy conservation during building stages. The following are some of the main reasons that will make this possible:

- cost-effective
- effective replacement for glass fiber
- high tensile strength and stiffness
- easy to process and recycle
- weight reduction in finished part

Fig.4 Hemp Plant

Table III. shows the Properties Hemp fiber

Density (g/cm^3)	1.4–1.6
Tensile Strength(MPa)	200–1040
Stiffness (GPA)	17.6-66
Tensile modulus (GPa)	23.5–90
Specific tensile strength (MPa)	210–510
Young's modulus (GPa)	30–60
Specific Young's modulus (GPa × cm^3/g)	20–41
Diameter(µm)	270–900
Length(mm)	8.3–14
Aspect ratio (length / diameter)	549
Percentage of elongation (%)	1–3.5
Failure strain (%)	2-5

1.2.2Jute fiber

Plants of the genus Corchorus, family Malvaceae, generate jute fiber. Jute is a lignocellulosic fiber that is both a textile fiber and a wood fiber. It's classified as a bast fiber (fiber collected from bast or skin of the plant). cellulose (64.4 percent), hemicellulose (12 percent), pectin (0.2 percent), lignin (11.8 percent), water soluble (1.1 percent), wax (0.5 percent), and water make up the chemical makeup of jute fiber (10 percent). Jute fiber is made up of many cells. These cells are made up of cellulose-based crystalline microfibrils that are joined to a full layer by amorphous lignin and hemicellulose.

Fig.5 Jute fiber

Table IV. shows the properties of Jute fiber

Density	1.35 gm/cc
Youngs modulus	20GPa
Tensile strength	393MPa
Poisson's ratio	.38
Shear Modulus	7.24GPa

Amplitex fiber-

AmpliTex power Ribs are high-performing grid textiles manufactured from flax yarn that are based on proprietary power Ribs technology. The flax yarn location is adjusted throughout manufacture to provide an application-specific mesh structure. To get the best mechanical qualities in the final composite material, flax fiber quality, yarn thickness, and twist are all tuned. This material increases the flexural stiffness of flat and curved surfaces by more than three times, as well as the buckling resistance of hollow structures.

Fig.6 Amplitex fiber

Table V show the properties of Amplitex fiber

Young's Modules	32.1 GPA
Strength Palleral	394 MPA
Strength perpendicular	20.9MPA
Strain failure pallar	1.72
Strain failure perpendicular	0.54
Density	1515kg/m3

II. LITERATURE REVIEW

This section presents the contributions given by the various scholars in the subject are of Pressure vessel design and analysis work. The major contributors with their contributions in the regards are mentioned below.

2.1 NOTEWORTHY CONTRIBUTIONS

MEM Microtabs were used by D. T. Yen Nakafuji, C. P. Van Dam, R. L. Smith, and S. D. Collins [1] to improve aerodynamic characteristics, resulting in an increase in section lift coefficient with minimal drag penalty. The results of computational and experimental wind tunnel tests using fixed and remotely actuated tabs for a representative airfoil are compared. The findings show that Microtabs have a lot of potential when it comes to active load control. ChalothornThumthae and TawitChitsomboon [2] investigated the condition for the optimal pitch that produces the highest power output by numerical simulation of horizontal axis wind turbines with untwisted blades in steady-state conditions. The blades were fixed around the rotating frame using the rotating frame technique. The computed results were in good agreement with the experimental findings. Ferhat Kurtulmus, Ali Vardar, and NazmiIzli [3] investigated the angle of attacks for four different blade profiles, as well as Re Numbers and lift-drag rate correlations. Lift, drag, moment, and minimum pressure coefficients were calculated using Snack 2.0 computer software. The most convenient angle of attack was determined in the range of 3o and 9o for all evaluated blade profiles and all Re rates in the provided highest sliding rates. The highest drag rates are found in the Re 20000 range, according to the results. Using the snack 2.0 computer programme, NazmiIzli, Ali Vardar, and Ferhat Kurtulmu [4] conducted various simulation programmes to find lifting and drifting coefficients for 14 different Reynold numbers and four different NACA profiles. Out of all correlations the most convent angle of attack and 14 different Reynold Numbers, lifting numbers, and angle of attack have been revealed and depicted in chart form. A correlation between the lifting and drifting rates has also been discovered for the 14 different Reynold numbers.

SHEN Zhen-Guo-Liang-W3-211 airfoil in the blade model development and conducted a small low-speed tunnel, and varied the installation angles between 6-14oC and a wind velocity ranges from 8-15 m/s. The results showed that under all conditions the wind power utilization factors of the tested wind turbines are more acceptable when a gurney flap is added. F. Wang, L. Bai, J. Fletcher, J. Whiteford, and D. Cullen[6] investigated wind energy capture improvements at low wind speeds using physical methods such as boundary layer theories and wind tunnel experiments, as well as computer modelling using CFD. Validation of a CFD model and optimization of a scoop design The scoop's final design increases airflow speed and, as a result, wind turbine power output. Experimenting with power curves, a good agreement with the CFD model was discovered. To better understand the physical and numerical attributes that determined modal performance, Scott J Schreck and Michael C. Robinson [7] looked at full-scale turbine blade aerodynamic blades and current modelling methodologies. By selecting the appropriate orientation and size of the airfoil cross-sections based on low oncoming wind speed and given constant rotation rate, RS Amano and R.J Malloy [8] investigated the possibility of increasing turbine blade efficiency at higher wind speeds while maintaining efficiency at lower wind speeds. To achieve efficiency at higher wind speeds, a swept blade profile was implemented. CFD was used to investigate performance. The results of wind tunnel testing were described by P. Migliore [9]. In the open-jet test section, aeroacoustics tests were conducted on a typical small wind turbine blade. Tim Fischer [10] investigated the impact of the rotor-nacelle-integrated assembly's design on obtaining the optimal structure at a lower cost. The characteristics and control of the turbine are used in an integrated approach to simultaneously reduce aerodynamic and hydrodynamic loads, which is especially important in terms of fatigue.

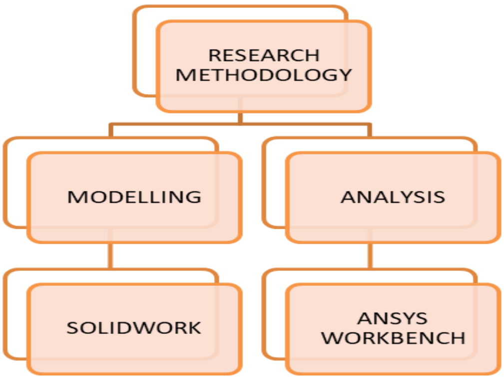
The research of T K Barlas and G A M Van Kuik [11] focused on active rotor control and smart structures for load reduction. The goal of the work is to provide a perspective on the current state and future directions of the specific research area, which includes unsteady load specifications, modern load reduction control, and detailed active aerodynamic control. Preliminary performance evaluation and novel computational and experimental research approaches are reviewed as feasibility improves. The study was conducted out by W. Devenport, R.A. Burdisso, H. Camargo, E. Crede, M. Remillieux, M. Rasnick, and P. Van Setters [12] to increase the knowledge of wind turbine aeroacoustics. According to Indian wind conditions, Nitin Tenguria [13] devised an optimization approach for a HAWT blade of a VESTAS 1.65 MW horizontal axis wind turbine. The optimization approach was created using BEM theory. The NACA 634221 airfoil was employed, and the data was analysed using the airfoil's characteristics. Using a computer software, create a power coefficient curve using different factors such as tip speed ratio, lift and drag coefficient, chord distribution, and twist distribution. The results were compared to the reference data from the literature and determined to be satisfactory. S. Lan, B. Quintero, and Y. Lopez [14] investigated the aeromechanical evaluation of HAWT Blades using a strategy based on the combination of an aerodynamic module that provides the three-dimensional distribution on the blades and a strategy based on the combination of an aerodynamic module that provides the three-dimensional distribution on the blades. For determining blade deformation, strain and stress distributions across the blade, pressure forces are used as input data. The three-dimensional non-linear lifting surface theory techniques are combined in the aerodynamic module.

Juan Mendez and David Greiner [15] demonstrated a technique for calculating the chord and twist distributions in wind turbine blades. Depending on the Weibull wind distribution at a certain location, the distributions are estimated to maximize the mean predicted power. Chord and twist distributions are optimized using BEM theory. The implementation is confirmed by comparing power predictions to Riso test turbine experimental data. The performance test on the new set of planned, built blades employing NREL S822, NREL S823 airfoils was carried out by Donny R. Cagle, Anthony D. May, Brian D. Vick, and Adam J. Holman [16]. For the new blades, the system's maximum power coefficient was 0.41. When the turbine was turned with new blades instead of Bergey blades, the water pumping capacity was doubled. The natural frequencies of the rotor blades of the NACA 4415 and NASA / Langley LS (1) 421 MOD series of wind power plants were researched by K. Turgut Gursel, Tufan Coban, and AydoganOzdamar [17]. To discover the natural frequencies, Rayleigh's approach was utilised, followed by the finite element method. The stimulation of external forces is also used to perform resonance studies on both rotor blades.

K.R. Ajao and I.K. Adegun [18] used Blade Element and Momentum Theory to examine the rotor aerodynamics of a wind turbine. The focus of the study is on the mechanics of wind turbine power extraction in both close and distant wake zones. In order to describe turbine power, the extended Fokker-Planck equation, which is a partial differential equation fulfilled by the probability density function, is used. The aerodynamics of horizontal axis wind turbine waves were examined by L.J. Vermeer, J.N. Sorensenb, and A. Crespo [19]. The experimental and numerical efforts linked to the physics of power extraction by wind turbines are reviewed, with a focus on observations under controlled situations. Dr. S. P. Vendan, S. Aravind Lovely, M. Manibharathi, and C. Rajkumar [20] developed a low-speed wind turbine for use in urban areas. For wind turbine blade analysis, the NACA 63415 Airfoil is used. The CFD study is performed using STAR-CCM+ at different angles of attack ranging from 00 to 160 degrees. For low Reynolds numbers, the coefficients of lift and drag are determined, and the pressure distributions are displayed. The findings suggest that NACA 63415 is suitable for use on wind turbine blades.

Franck Bertagnolio, Niels S rensen, Jeppe Johansen, and Peter Fuglsang [21] confirmed the findings of tests using the 2D Navier-Stokes solver EllipSys2D on a variety of airfoil data. The results of a research comparing the available data and categorization suggest that the transition modelling is to a significant degree responsible for the low quality. Finally, some suggestions are made for developing future airfoil design methods including the EllipSys2D numerical code and transition modelling. Richard E. Wirz and Perry M. Johnson [22] devised a multiplane inboard design for wind turbine blades that provides favorable aero-structural performance. The cross-sectional characteristics of a thick monoplane are compared using a biplane method. The lift to drag ratio of a biplane is determined to be much larger than the lift to drag ratio of a thick monoplane, according to numerical simulations. Finally, the biplane blade method is an appealing design for the next portion of wind turbine blades, according to these findings.

III. RESEARCH METHOLOGY



3.1 FINITE ELEMENT ANALYSIS (FEA)

Ansys is a computer aided engineering tool, which is used for the structural analysis tool and is based on Finite Element Method, Finite Element Method (FEM), firstly breaks the domain, which is object here into several smaller element, which is called Discretization and then equations for all the smaller element are done and get it calculated, it is done for the accurate result.

3.1.1 Pre-Process

- Selection of structure –

The very first step what need to be done is selection of the structure to analysis for, here in this research work it wind mill blades is a structure.

Open> Ansys>static structure>>.

- Material selection –

In Ansys workbench 16.0 normally structural carbon fiber, E-glass shown in the material section but here for the Material of choice of the designer has to be created by feeding the properties equivalent to that material, so there is a section called Engineering Data, where all those required properties are fed to create the material need to analysis for in Ansys.

Open Ansys>static structure>> engineering Data>> add new material> material name.

- Material properties-

To get the same material on which the analysis supposed to be done , the same properties like density, ultimate tensile strength, yield strength, Poisson ratio Young's modulus and few other need to be added to get that material activated in the Ansys material library.

Ansys>staticstructure>>EngineeringData>>MaterialName(Natural Fibers)>Add properties from left table> Density> Insert value>adjust unit.

- Geometry creation –

The model or the geometry on which work to be done can be created in the Ansys itself under the Geometry section but here the model is imported from the external source ,which is a CATIA cad model, only analysis was performed here in Ansys Workbench 16.0.

Ansys> static structure>> Geometry> file> import file form external source> computer.

- Model-

Once the model is imported into the Ansys workbench and generated the meshing has to be performed in order to break the whole part (domain) into smaller element which is called Discretization. The smaller section is called element and the point where these entire edged meet are known as nodes.

Ansys> static structure>>Model> Mesh> Generate mesh> Right click> Mesh size/On Curvature/Mesh element type.

Solution

- Boundary condition –

In the solution section, which is second phase of the analysis the structure has to be bounded by somewhere to hold the entire structure by fixing the structure at some point, this is called boundary condition. This may an edge support, point support or may be a plane support but it has to be somewhere in the structure.

Ansys> static structure>> Static structure >Right click> insert> fixed support> select plane/edge/point-(ctrl for multiple).

- Define load-

Defining a load of a system is under is the key process what gives the actual real condition to the system, which comes under the solution section, the second phase of analysis.

Ansys>staticstructure>>Model>Staticstructure>Rightclick>insert>force>apply>add magnitude.

- Solver-

This is the solution steps of the Ansys analysis which seems to be mathematical mind of the software. Software creates mathematical equation for each domain to find the exact value through numerical approach and get the value calculated, the representation of this is done in the form of matrix but Ansys screen print is in image format can be seen only under the result section which is third phase of Ansys analysis.

Ansys> static structure>> Static structure >Right click>solve.

3.1.2 Post Process

- Solution-

To get the result of the analysis performed after applying the boundary conditions and the load being acted on the structure, the rewired result like stress, strain and deformation in the system has to be evaluated under solution section. The result for the stress may be Principle or von Mises and many more similarly for the strain it may be Principle and von Mises strain along with the deformation or total deformation may be evaluated under solution.

Ansys>staticstructure>>Solution>Rightclick>Insert >Rightclick>Deformation/Strain/Stress? Evaluate all result.

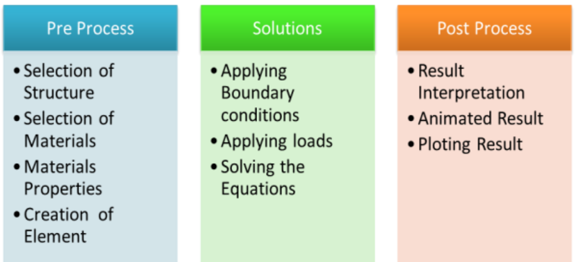


Fig. 4.5 Finite Element Method Steps

3.2 MODELLING

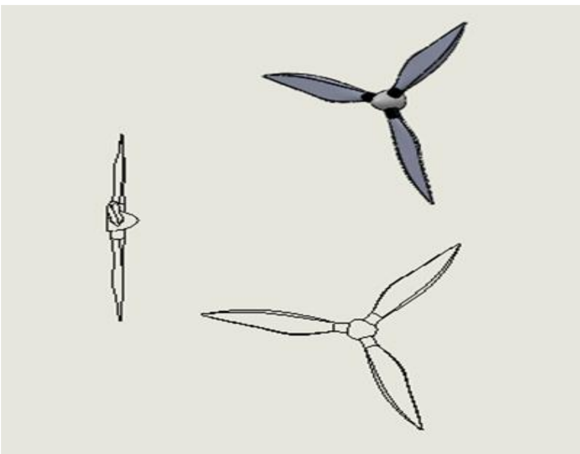


Fig.7 Dimensions of turbine blade

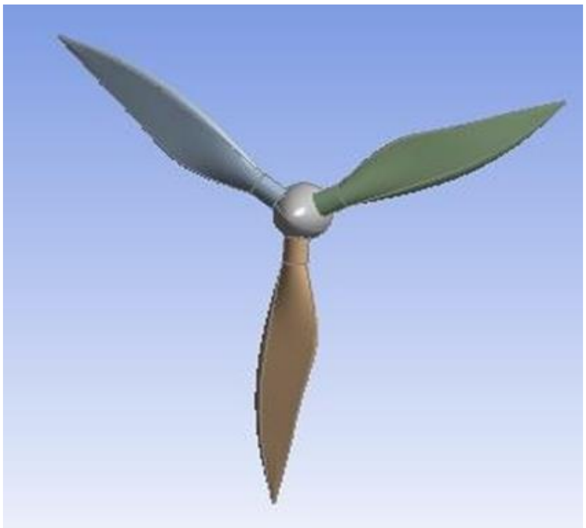


Fig.8 Geometry

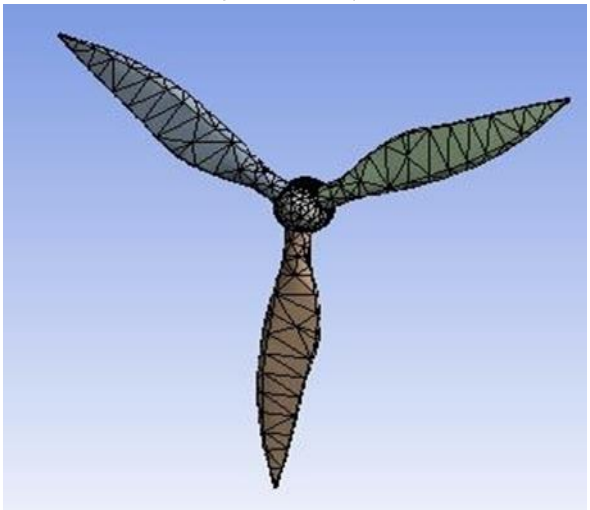


Fig.9 Meshing

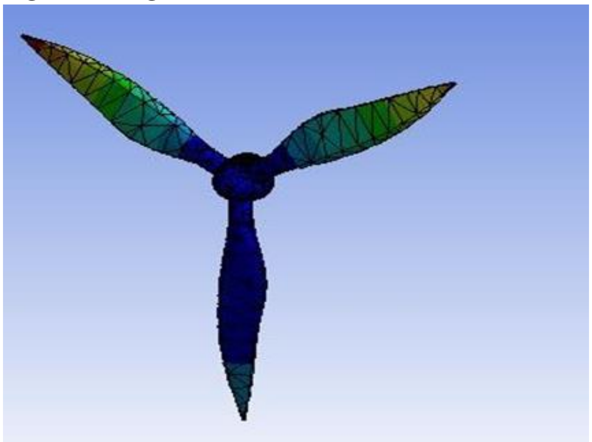


Fig.10 Analyzing

3.3 ANALYSIS

To execute the Design by Analysis (DBA), according to the alternative material design method, Ansys software was proposed to used, here Model made in the CATIA was imported and then, after taking the standard engineering data analysis was performed. Ansys workbench 16. Was used for the analysis work on the models, for natural fibers material was selected initially and all the design parameters was fed as per the standard design.

IV. RESULT AND DISCUSSSION

Table VI. Shows Comparison Between Carbon & AmpliTex5031-2

S. No	Result	Carbon Fibre	AmpliTex
1	Total Deformation (mm)	0.048228	0.014038
2	Stress (N/mm2)	1.777	1.3008
3	Strain (mm/mm)	0.00010046	2.1836e-5

Table VII. Comparison Between E Glass, Hemp & Jute Fibre

S. No	Result	E Glass	Hemp Fibre	Jute Fibre
1.	Total Deformation (mm)	0.12226	0.26809	0.19256
2.	Stress (N/mm^2)	1.9442	1.8729	1.3451
3.	Strain (m/m)	0.00023484	0.00061501	0.00030087

4.1 MAJOR FINDINGS

As all the values of stress are shown in above table is below the value which is given for material so our design is safe.

V. CONCLUSION

The final result reveals overall natural fiber give favorable result for replace plastic and carbon fiber, natural fiber analysis shows that it may use in the form of alternate of e-glass and carbon fiber. The analyzing simulation of natural fibers in the form of wind mill blade design giving very good and similar result which make this fiber material is proper alternate of glass and carbon fiber, this simulation is also provide that it is suitable for any product where glass and carbon fiber have used. Next step this material is suitable for composition and for mechanical testing. The production of energy is vitally important for human existence and the growth of society; nevertheless, the production of energy that does not pollute the environment is the greatest problem of the twenty-first century. Using renewable energy sources is one way to address this issue, which may then be considered solved. Wind power is the best example of a form of energy that is environmentally friendly. W and energy is clean, ecologically friendly, and exhaustible; it also has the potential to serve as an alternative to fossil fuels. The use of renewable sources of energy is predicated on the idea that this strategy will help cut down on emissions of greenhouse gases and other forms of pollution. Although it is true that wind power is the alternative energy source that is increasing at the quickest rate, the materials that are utilized for the components of wind turbines are not particularly kind to the environment.

In light of the fact that contemporary wind turbines are constructed with an expected lifetime of twenty years in mind, a sizeable construction will have to be removed from the natural environment at some point in the future after the completion of their useful lives. Wind turbines are made of materials that cannot be broken down by nature and are thus non-biodegradable. For this reason, scientists and engineers are continually focusing their attention on the material system of wind turbines that already use biodegradable materials. Natural fiber reinforced composites are one kind of material that belongs to this category. These composites not only have exceptional mechanical or other properties, but they also break down naturally and are considered biodegradable. Natural fiber reinforced composites have the potential to be a strong option in situations where they can successfully replace the current material systems used in the wind industry. These materials may be used in the process.

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