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Evaluation of Wind Turbine Blade with Stiffeners and without Stiffeners

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Abstract: *For wind energy harnessing a lot of development is carried out. The conversion of kinetic energy into mechanical energy is done with the help of a wind turbine. Mechanical energy is used to produce electricity many researchers have carried out work in order to enhance the performance, life, and cost of blades by increasing the strength and reducing weight. Therefore, the use of composite material for this purpose is increasing. Strength is also an important criterion; it is found that when the blade is subjected to incremental loading fatigue failure takes place. The aim of our work is to evaluate the strength of using stiffeners in wind turbine blades. This will help to reduce deflection which will be caused due to loading and will thereby increase the strength of the blade. In our study, we have considered a GFRP material that is a combination of glass fiber and carbon fiber. A blade of length 1.5m is used to carry out the analysis. A comparative study will be carried out for the deformation of blades without stiffeners and along with stiffeners.*

Keywords: Wind turbine blade, Stiffener, Deformation stress

I. INTRODUCTION

Renewable energy sources are ones whose energy is extracted without causing environmental harm. Technology that captures natural phenomena, such as sunlight, wind, waves, and water flow, as well as biological activities, such as anaerobic digestion, is necessary for human usage of renewable energy. Geothermal heat production and hydrogen production. The technology for harvesting energy from the wind has advanced significantly in comparison to the other sources of energy discussed above. The wind is the movement of air masses brought about by the sun's uneven heating of the earth's surface. As a result, these variations produce forces that move air masses in order to balance the global temperature or, on a much smaller scale, the temperature between land and water or between mountains

1.1 Problem Statement

It is found that when the turbine blade is subjected to incremental loading progressive failure of the turbine blade takes place. Therefore, for this purpose, we are going to evaluate the strength of wind turbine blades. The target of this study is to evaluate strength to weight ratio of wind turbine blades. Therefore, for our study, we have considered a GFRP material. Here glass fiber is used. First strength evaluation will be done without using stiffeners and then by using stiffeners at certain cross sections where deflection will be maximum

II. LITERATURE REVIEW

Shailendra Sao, Mr. Prabhat Ranjan Mishra [1] et.al out of all renewable energy sources wind energy is the most reliable for an extended length of time at a specific time, making it a major source of energy. For a given purpose, such as power or powder grounding,energy can be extracted at a location using various types of wind turbines

N. Saba, M. T. Paridah [2] et.al has reviewed the kenaf fiber reinforced polymer composite's mechanical characteristics. The resultsof this study show that kenaf best fiber possesses high tensile strength and superior flexural strength, which have been confirmed by numerous mechanical tests

Umair Jawaid, Zafar M. Khan [3] et.al in this work, it is examined how glass fiber/vinyl ester composite materials are made and their thermo-mechanical properties for 2.4 m wind turbine rotor blades with 6 m tower heights. Results show

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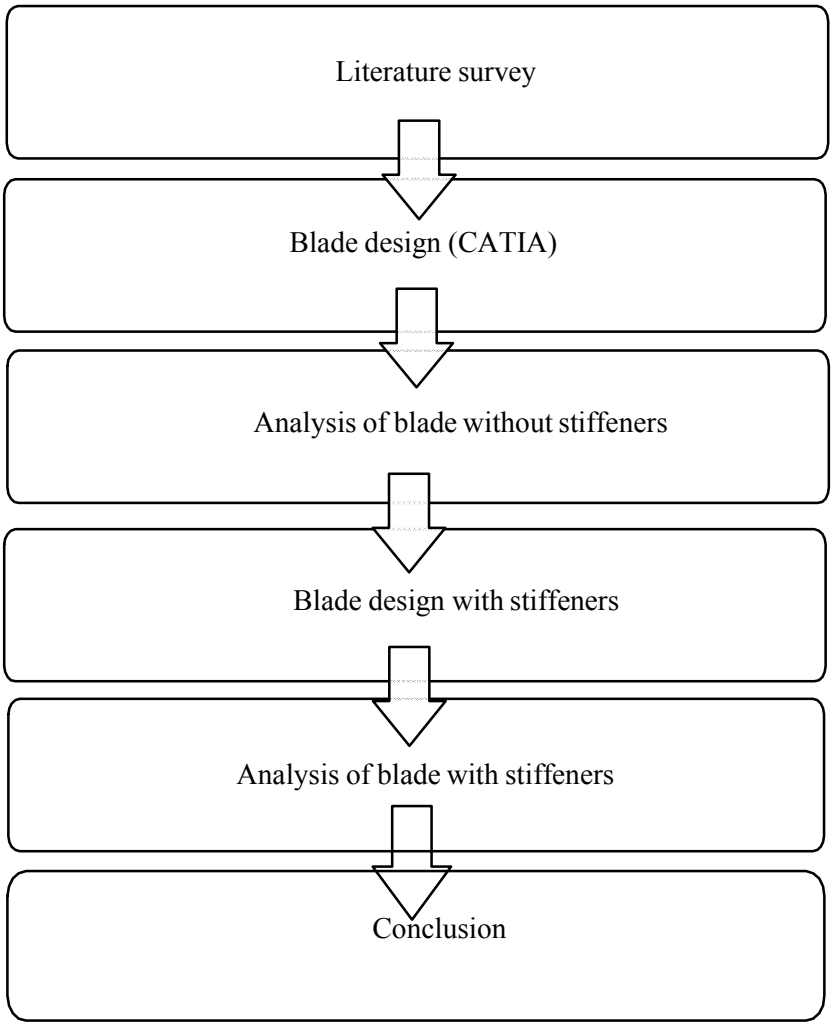
how to produce wind turbine blades with structural integrity using produced composite rotors. Based on the behavior of the loss modulus, the glass transitiontemperature of the glass fiber/vinyl ester composite was determined to be 73.4oC
Rupesh Lokhande, Abhijeet Deshpande [4] et.al conducted research on hemp fiber. based adhesively glued joints. This study's primary goal was to assess the adhesively bonded joints' maximum tensile strength. Such joints' mechanical behavior is influenced by the composite's strength, the adhesive's tensile power, and the adhesion phenomenon between substrate and adhesive.
Tiju T. Thomas, Manish M. Narkhede [5] et.al I section can withstand more high loads than conventional box shaped spar but requires more material and is raiser to design and construct.
Arjun Saxena K S [6] et.al the structure analysis found that I section can withstand more high load than box shaped spar, but it requires more material and is costlier. The modal analysis found that resonance will not occur for both I shaped and box shaped spars, and the value of FR/Fn was less for box shaped spar compared to I shaped spar

III. METHODOLOGY



IV. MATERIAL SELECTION

We have selected GRPF the properties are as follows

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Table 1

Sr. No	PROPERTIES	VALUE
1	Density (kg/m^3)	2000
2	Young's modulus (Pa)	4.5E+10
3	Poisson ratio	0.3

FEA ANALYSIS

Table 2

Sr. NO	PARAMETERS	WITHOUT STIFFENER	WITH STIFFENER	SPECIFIC REGION
1	Total Deformation (mm)	15.794	2.0688	6.9976
2	Permissible Stress (MPa)	125.44	153.6	77.74

WITHOUT STIFFENER

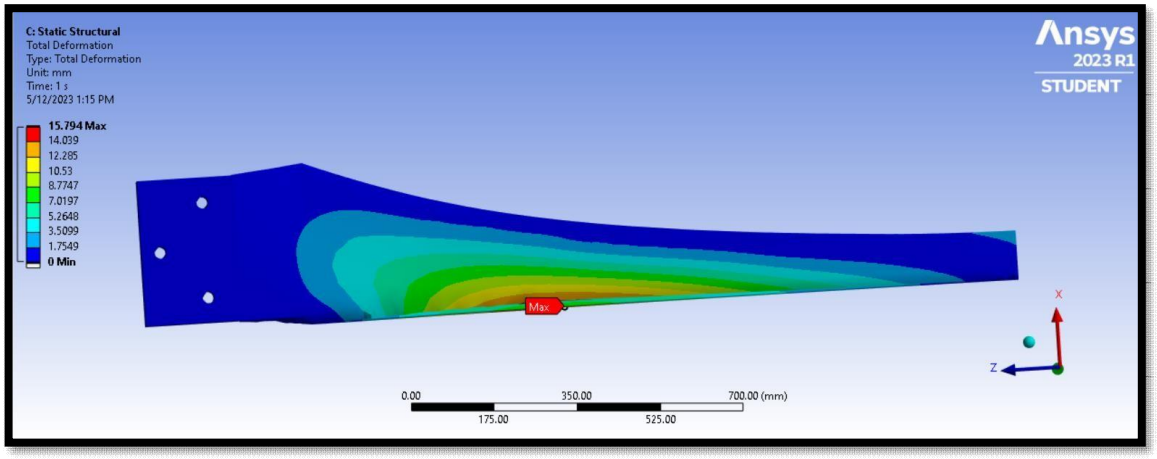

Fig. 1. TOTAL DEFORMATION

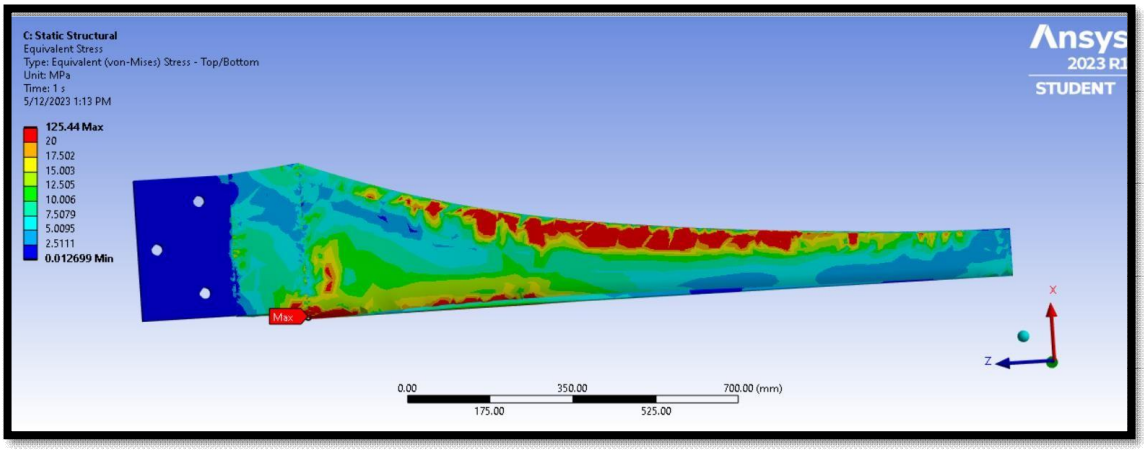

Fig. 2. EQUIVALENT STRESS

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WITH STIFFENER

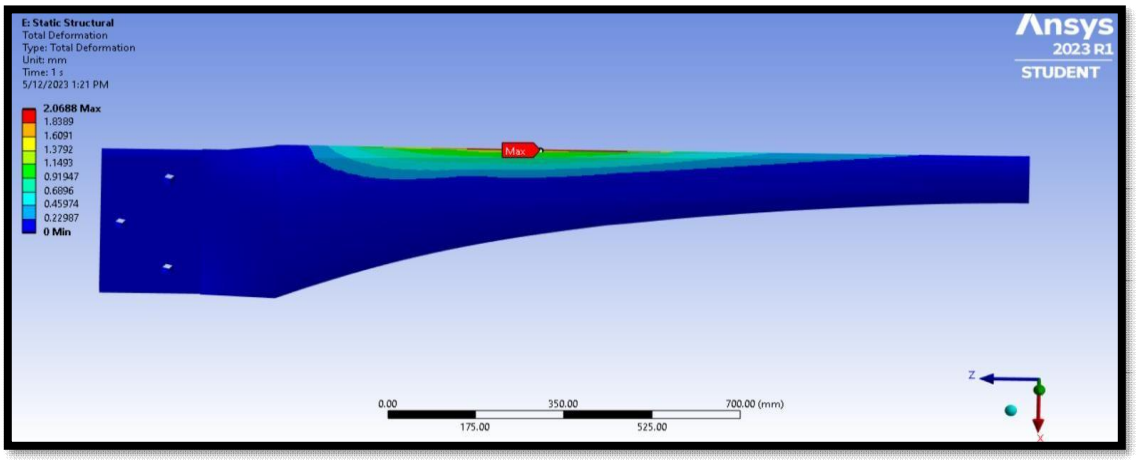

Fig. 3. TOTAL DEFORMATION

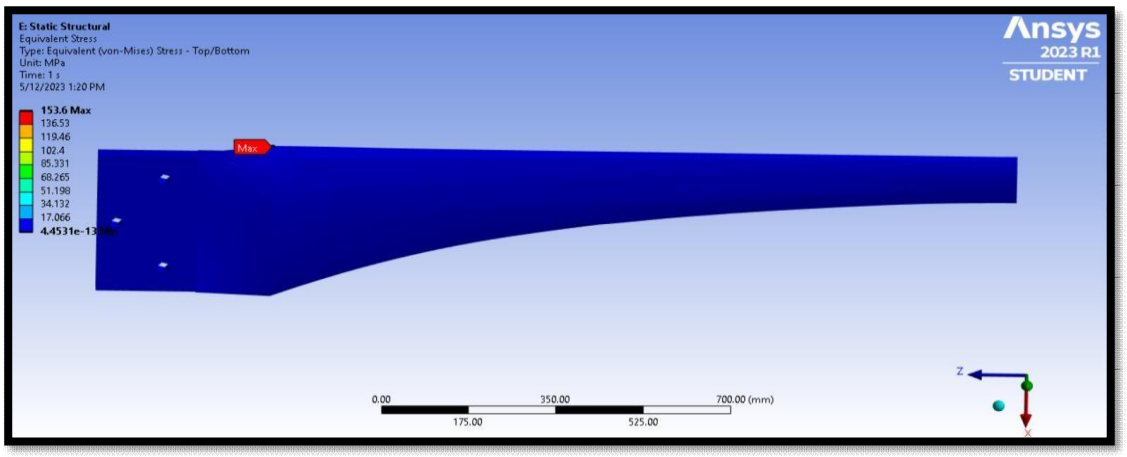

Fig 4. EQUIVALENT STRESS

IV. CONCLUSION

After doing the analysis it is found that deformation in wind turbine blades with stiffeners also the stress generated are within permissible limits. Therefore, wind turbines blade with stiffeners gives better results when subjected to incremental load as well as the deformation is less.

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