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Design and Fabricaton of Wind Turbine Blade By Using Composite Material

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ABSTRACT
The wind turbine blade is a main part of the rotor. The Production of energy from wind depends on themodel of the blade. At modern days, the majority of wind turbine blades are fabricated with glass fiber reinforced plastic (GFRP). Utilization of composite materials eventually has solved some of the trouble associated with efficient operation of horizontal axis wind turbines (HAWTs) such as gravitational forces due to weight but there are other unresolvedissues such as long-term material property degradation, local shape deformation of the profile of the wind turbine blades etc. The objective of this project is to address the adverse structural response of the blade profile with the change of operational parameters such as wind velocity and material properties on blade's performances. For this reason, the shape memory alloy (SMA), which is Nitinol (NiTi) has been embedded in the blade to alleviate the load.
A parametric blade model has design by utilizing the ANSYS fluent finite element program has been created to efficiently predict the deflection of the blade. The objective is to address the adverse structural response of the blade profile with thechange of operational parameters such as material properties on blades. A parametric blade model utilising the ANSYS finite element program has been created to efficiently determine the deflection of the blade.
Keywords: windturbine, reinforcedfiber, composite material.

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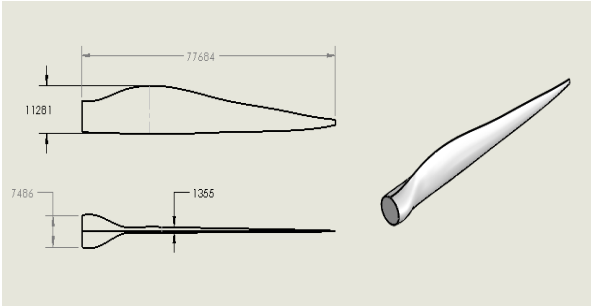
I. INTRODUCTION

Energy is a major necessity and with the ever-rising demand of it and the high and fluctuating prices of oil, researchers are continuously coming up with modern and more sophisticated alternative resources of energy. However, energy has it worth , as it is either precious or it ends with major health issues. Renewable energy resources are a good solution to tap energy crisis. Wind is called a renewable energy source because wind will continuously be produced as long as the sun shines on the earth. The sun'sgift to wind energy deals with converting air into heat or cool wind. Wind is generated by the irregular heating of the earth's surface by the sun. On land, the warm air disperses andmoves up in the sky, in the water, heavier and cooler air moves in to take the warm air's place, thus providing local

winds. This power source should be utilized more often in the United States for its safer standards regarding the environment and finance.Extraction of energy from wind depends on the design of wind mill and the blade. Therefore, wind turbine blade is a significant part of the rotor. At modern days, the majority of wind turbine blades are fabricated with glass fiber reinforced plastic (GFRP). The use of composite materials eventually will solve some of the problems associated with efficient operation of horizontal axis wind turbines (HAWTs) such as gravitational forces due to weight and problems such as long-term material property degradation, local shape deformation of the profile of the wind turbine blades etc. This paper objective is to introduce the adverse structural response of the blade profile with the change of operational parameters such as wind velocity and material properties on blade's performances. The composite materials such as CFRP and Kevlar RFP are made using long fibers compared to the short fibers used in the fiberglass. By incorporating few layers of CFRP and Kevlar not only introduce the structural problems, but it also helps to minimize the weight and gives more flexibility and impact resistance, which is an additional benefit.

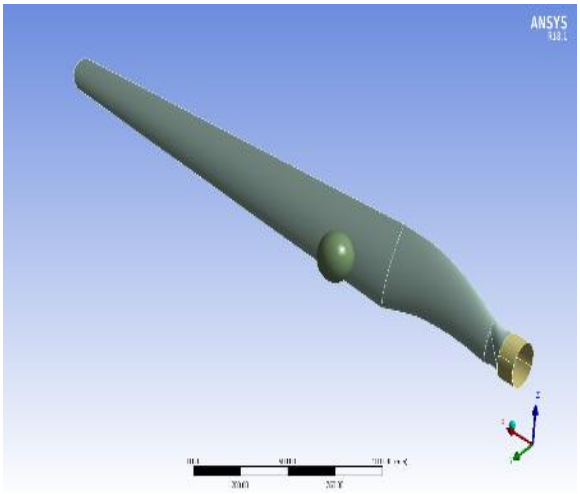
II. DESIGN AND MODELLING

Design Data

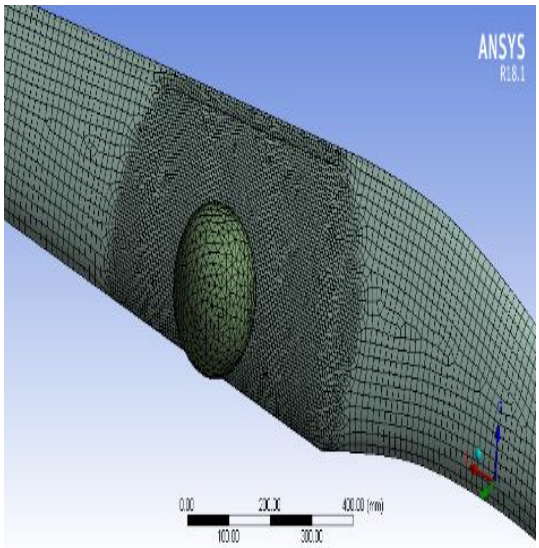


Design Data

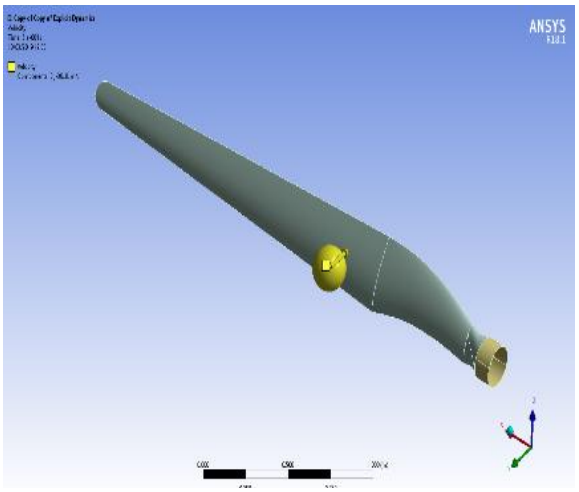
1. Thickness of GFRP base layer : 20 mm
2. Thickness of each additional layer : 0.5 mm
3. Diameter of the projectile : 50 mm
4. Material of the projectile : Steel
5. Projectile velocity : 30 m/s



Geometric Model



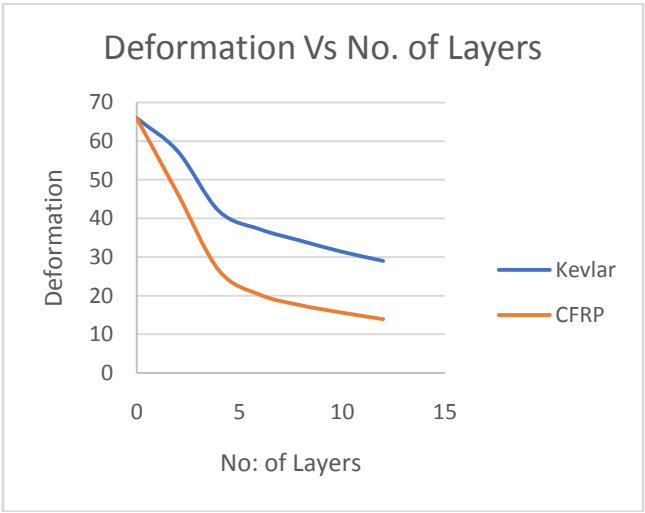
Meshing



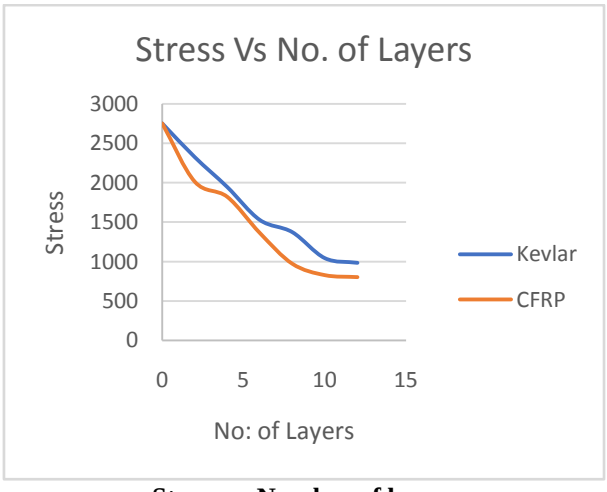
Boundary Conditions

III. RESULTS AND DISCUSSION

The analysis has been carried in 6 steps changing the GFRP layers with CFRP layers in steps of 2 layers at a time up to 12 layers. The same procedure repeated with Kevlar as the replacement material. Both the CFRP and Kevlar are found to increase the impact strength of the blade, with higher stiffness CFRP is proved to be better material suitable for strengthening the blade.



Deformation Vs Materials

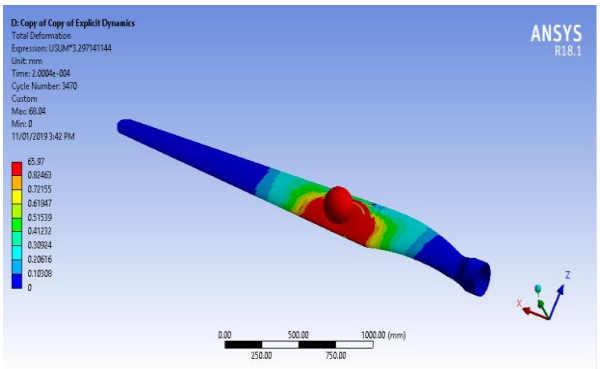


Stress vs Number of layers

	Deformation		Stress	
No of Layers	**Kevlar**	**CFRP**	**Kevlar**	**CFRP**
0	**65.9692**	**65.9692**	**2753**	**2753**
2	**57.3696**	**46.3677**	**2325**	**2014**
4	**41.9239**	**26.5561**	**1945**	**1821**
6	**37.1957**	**20.2332**	**1527**	**1363**
8	**34.2011**	**17.4933**	**1372**	**972**
10	**31.3641**	**15.5964**	**1042**	**828**
12	**29**	**13.9103**	**983**	**803**

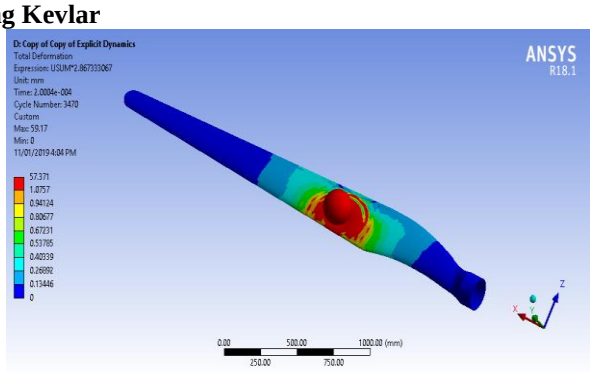
Analysis Result

Total Deformation of GFRP

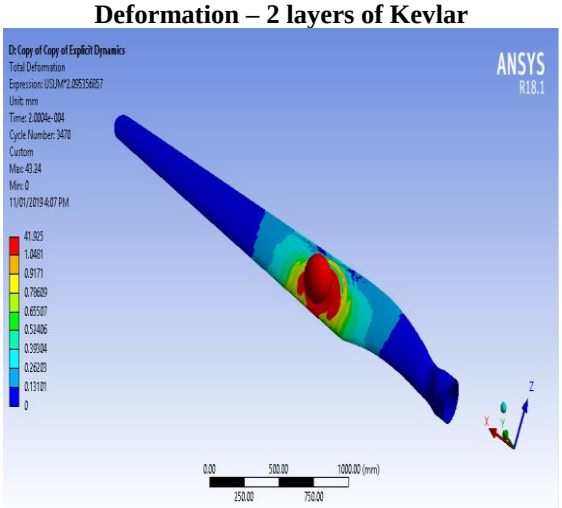


Deformation of GFRP

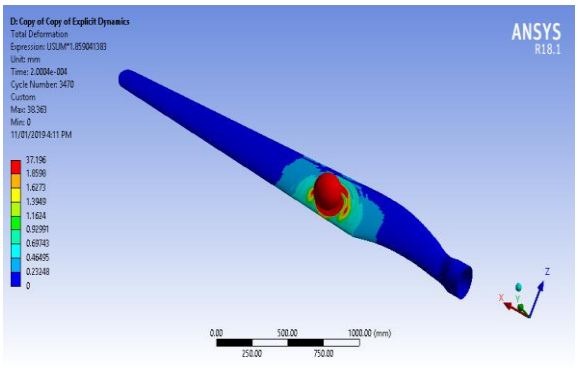
Deformation of after adding Kevlar



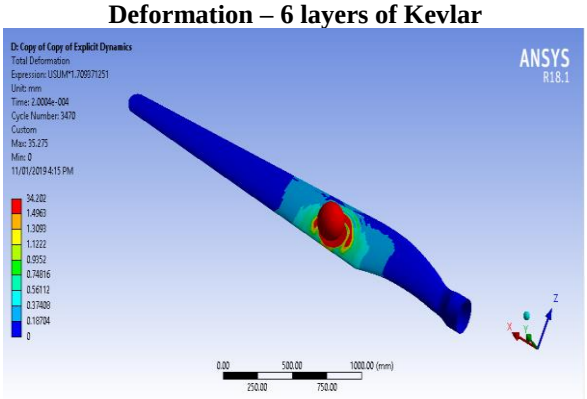
Deformation – 2 layers of Kevlar



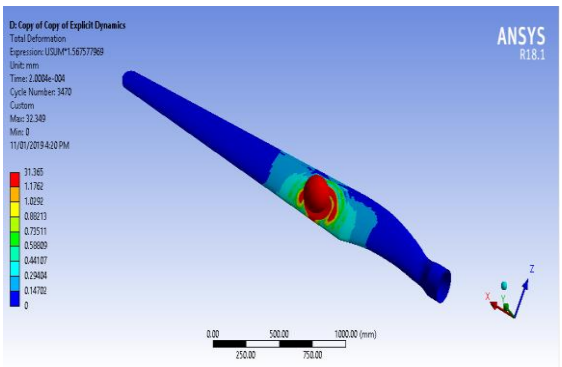
Deformation – 4 layers of Kevlar



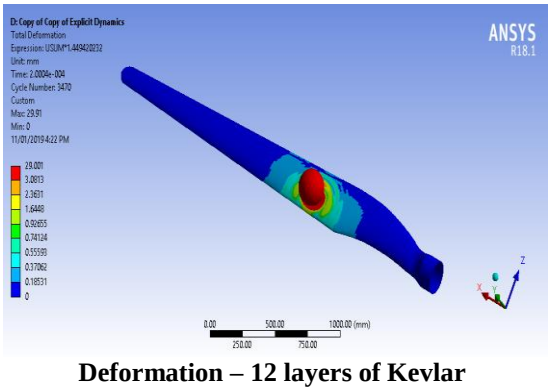
Deformation – 6 layers of Kevlar



Deformation – 8 layers of Kevlar

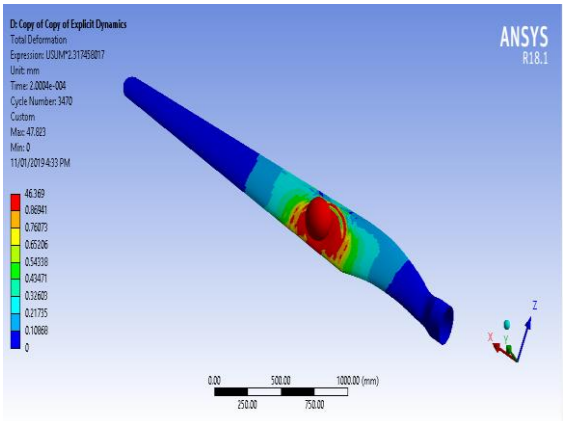


Deformation – 10 layers of Kevlar

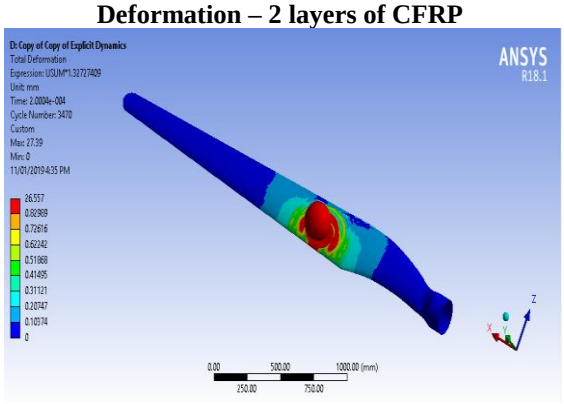


Deformation – 12 layers of Kevlar

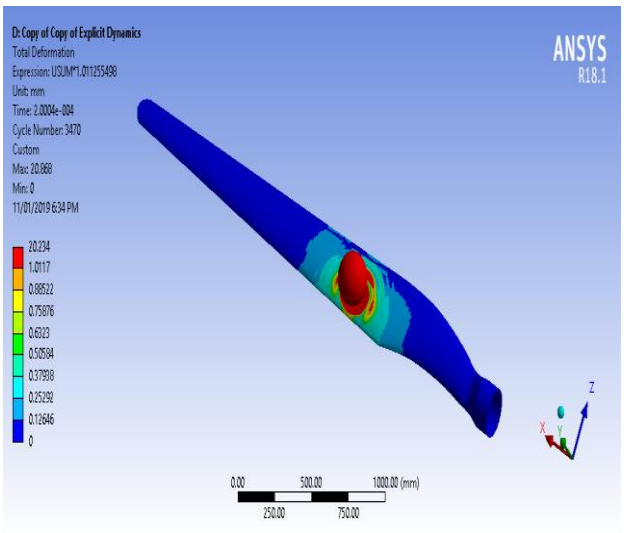
Deformation of after adding CFRP



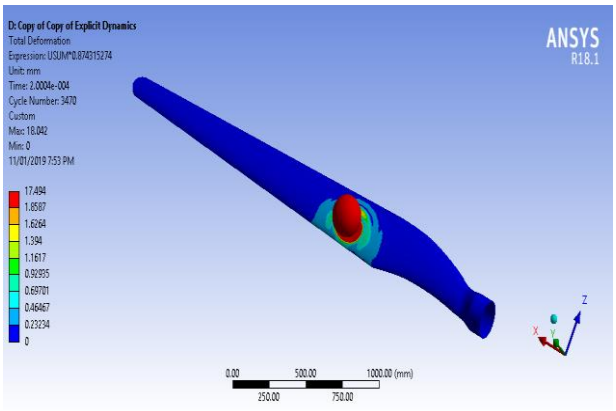
Deformation – 2 layers of CFRP



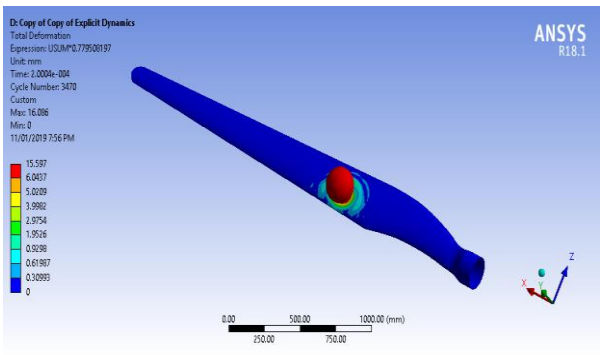
Deformation – 4 layers of CFRP



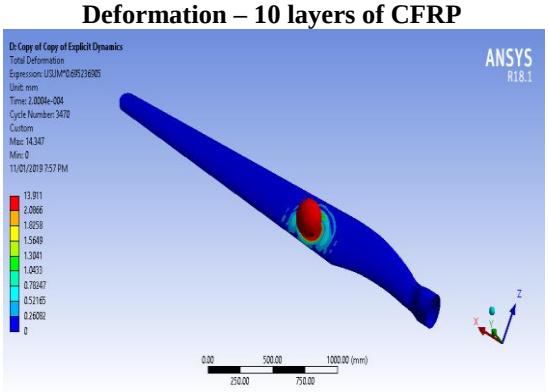
Deformation – 6 layers of CFRP



Deformation – 8 layers of CFRP



Deformation – 10 layers of CFRP



Deformation – 12 layers of CFRP

IV. CONCLUSION

1. The following conclusions may be drawn based on the present work,
2. By replacing a few layers of GFRP with Kevlar or CFRP is found to increase the strength of the wind mill blade significantly
3. With higher tensile strength and stiffness CFRP is proved to be better material
4. As the Kevlar is cheaper compared to the CFRP, it is also a good alternative to GFRP, those blades are better suited where impacts may be lesser
5. Replacing GFRP with Kevlar and CFRP not only improves the strength, but does that a reduced weight, since the Kevlar and CFRP have lower density than that of GFRP

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