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DESIGN AND STRUCTURAL ANALYSIS OF A WIND TURBINE BLADE WITH MICRO TABS AND RIBS USING DIFFERENT MATERIALS

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ABSTRACT
This research is used to investigate the structural analysis of the wind blade to increase the performance of the wind energy. A optimization technique using micro tabs and different materials like Aluminium, Steel Glass and Carbon composites is to reduce weight. The well defined model of blade is created and analysed using ansys software. The results are compared with materials like Aluminium, Steel, Glass and Carbon composites. The Micro tab is attached using CATIA and performed analysis using Ansys for the different materials. The Rib is provided towards the entire length of the wind blade which will reduce the stress and total deformation.

KEYWORDS: Glass and Carbon composites, Stress, Total deformation, Ansys, CATIA

INTRODUCTION
Wind turbines harness the wind to produce electrical power. A turbine consists of generator that is equipped with fan blades and placed at the top of a tall tower. The tower must be tall enough to harness the wind at a greater velocity while avoiding obstacles such as tress, hills and buildings. As the turbine rotates in the wind the generator produces electrical power. A single wind turbine can range in size from a few KW for residential applications to more than 5MW. There are two types of wind turbine, first one is Horizontal Axis Wind Turbine, second one is Vertical Axis Wind Turbine. As part of the certification procedure all wind turbine blade prototypes are subjected to an experimental test procedure in order to ensure that the produced wind turbine blade fulfill the actual design requirements. The most ideal places for wind turbines are areas that have consistent strong winds. Wind turbines are located in areas with strong winds. It is the best for these areas to have an annual capacity factors ranging from 20% to 40%. The life expectancy of a wind turbine is around 20 years. Power generated from farms can be inexpensive when compared to other traditional power production methods. Wind turbine blades are affected by the high velocity winds and are highly prone to damage by other means such as lightning.
This paper describes about the structural analysis of the wind blade to increase the performance of the wind energy. The stress and total deformation were perfomed. Also performed stress and total deformation with tabs.

LITERATURE REVIEW
Different researchers have discussed and tested of the wind turbine blades in numerous ways. They are summarized below

Andrea Toffolo Ernesto Benini describes a multi objective optimization method for the design of stall regulated horizontal axis wind turbines. Two modules are used for this purpose: an aerodynamic model implementing the blade element theory and a multi objective evolutionary algorithm. The former provides a sufficiently accurate solution of the flow field around the rotor disc, latter handles the decision variables of the optimization problem. The scope of the method is to achieve the best trade off performance between two objectives: annual energy production per square meter of wind park and cost of method are described and their performance compared with those of commercial wind turbines.

Pabut O Allikas describes about the structural design and performance analysis of wind turbine blade is an important part of the design theory and application of wind turbines. Manufacturing costs of a small horizontal axis wind turbine blade can reach about 20% of the turbine production cost. Therefore possible profits resulting from a better structural model and use of suitable composite materials refer to a need of multi criteria optimization and refined modelling techniques. These statements are further more reinforced by the fact that for a cost effective wind turbine solution. The blades must achieve a very long operating life of 20-30 years.

Aravind Singh Rathore, Siraj Ahmed describes the optimization model for rotor design of 750 KW horizontal axis wind turbine. The wind turbine blade is a very important part of the rotor. In this work a blade of length 21 m is taken and airfoil for the blade is S809. The airfoil taken is same from root to tip. The model refers to a design method based on type approval provision scheme TAPS-2000. All the loads caused by wind and inertia on the blades are transferred to the hub. The stress and deflection were calculated on blades and hub by finite element analysis method. Result obtained from Ansys is compared with the existing design.

Nitin Tenguria Mittal N.D, Siraj Ahmed describes about the horizontal axis wind turbine blade, this design is based on Glauert's optimal rotor theory. They were focused on the two segments of blade root segment and transition segment. Result obtained from Ansys is compared with the previously done experimental work. In this work they have carried out flap wise loading analysis.

XinCai,JieZhu, Pan and RongrongGu describes the optimization method for structural design of horizontal axis wind turbine blade based on the particle swarm optimization algorithm combined with the finite element method. The main goal is to create an optimization tool and to demonstrate the potential improvements that could be brought to the structural design of horizontal axis wind turbine blades. A multi criteria constrained optimization design model pursed with respect to minimum mass of the blade is developed.

MATERIALS AND METHODS

METHODOLOGY

The 3D modeling of a wind turbine blade is conventionally done using CAD software's like CATIA V5 R20.

1. Problem definition.
2. Generate the 3-dimentional computer model
3. Prepare finite element model of the 3D computer model
4. Preprocess the 3D model for the defined geometry
5. Mesh the geometry model and refine the mesh considering sensitive zones for results accuracy
6. Post process the model for the required evaluation to be carried out
7. Determine the stress and total deformation along the blade.
8. Conclude the results.

MATERIAL PROPERTIES

In this paper we used the glass fiber composites because of the strength to weight ratio is high.

	Symbols	Glass fiber	Units
Young's modulus 0^0	E1	16.2	GPa
Young's modulus 90^0	E2	12.17	GPa
Inplane shear modulus	G12	2.43	GPa
Major poisson's ratio	Y12	0.3	-
Density	ρ	1.60	g/cc

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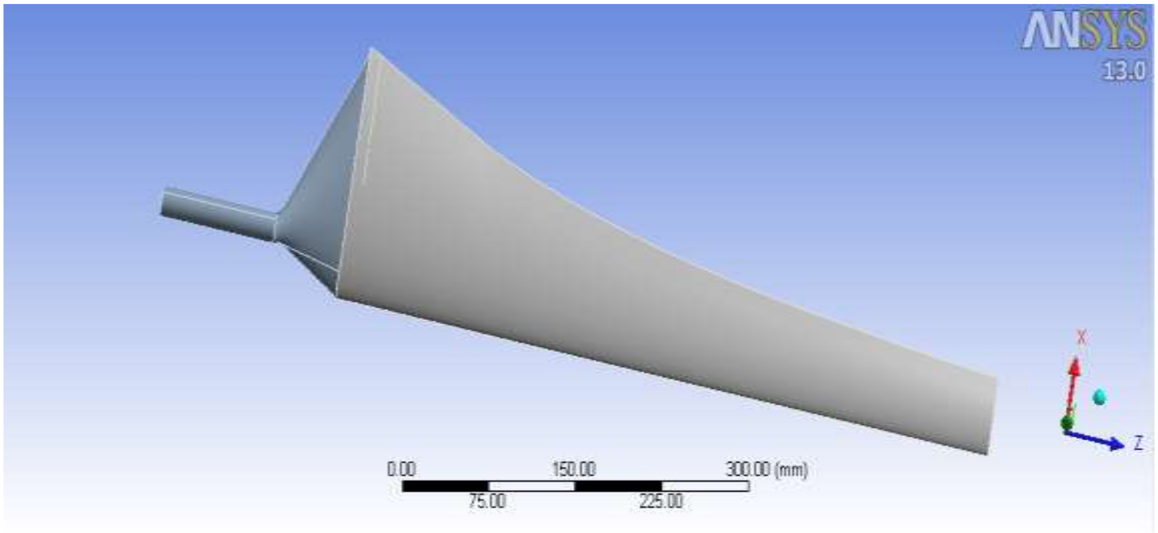
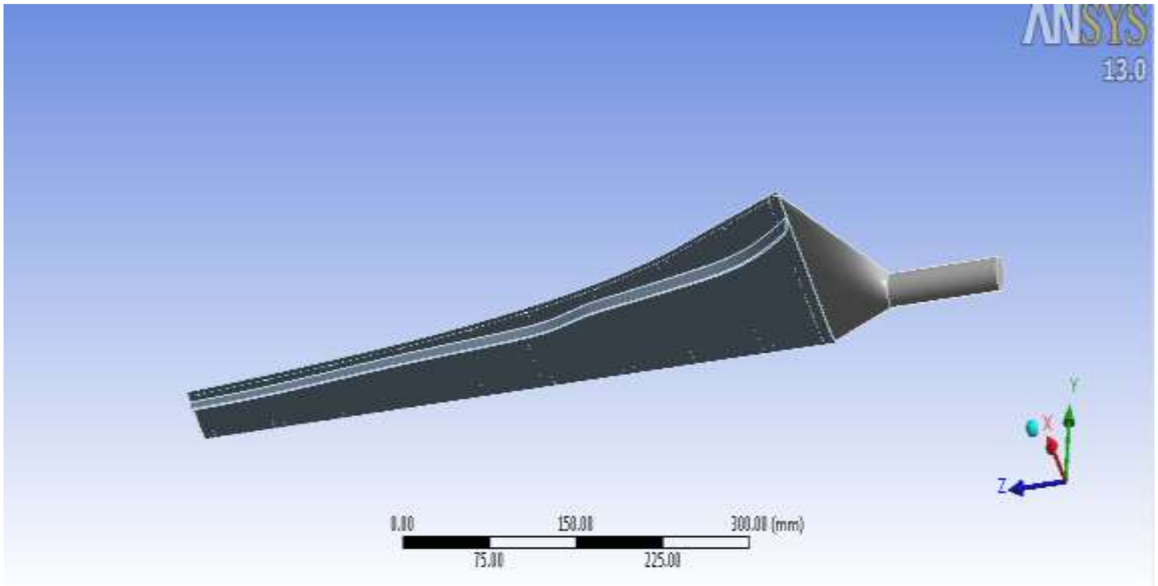
Existing Model

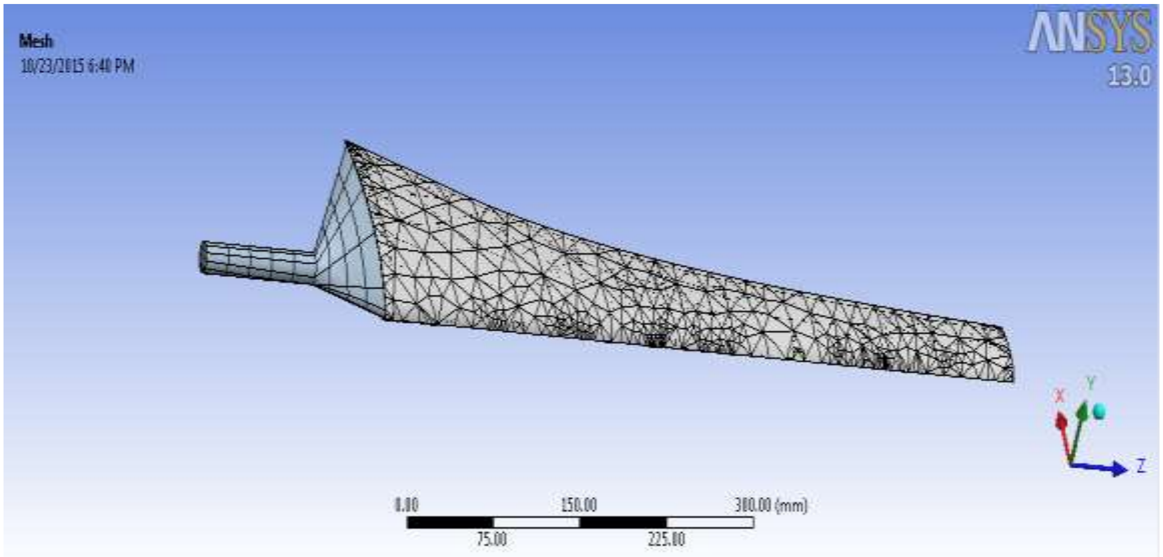


Altered Model



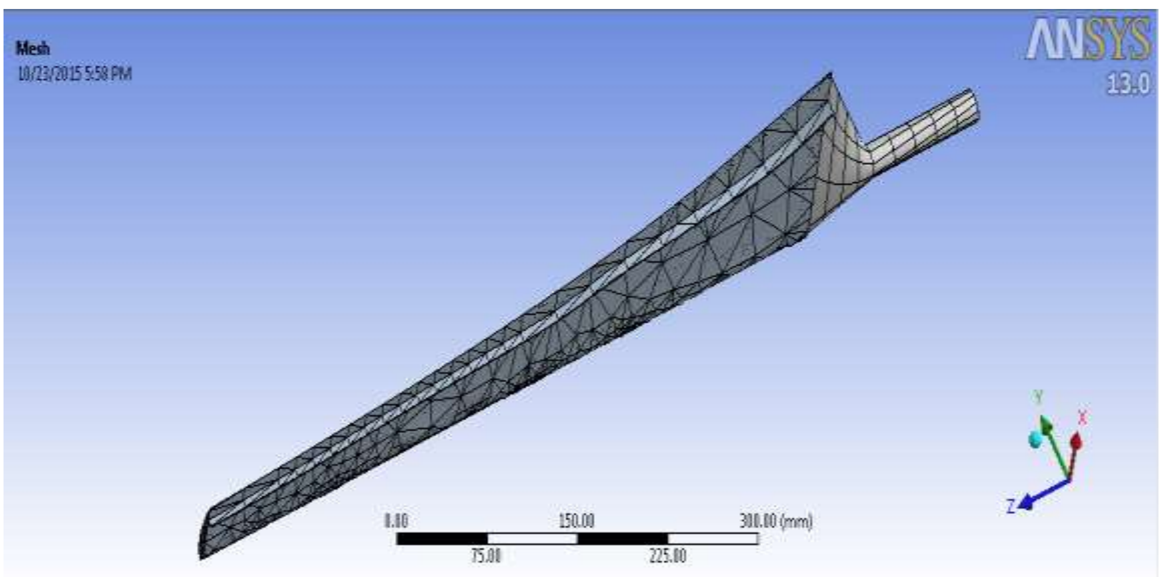
Design Parameter:
Blade profile NACA - 4412
Root chord length - 335 mm
Tip chord length – 136 mm
Total length of the blade – 2500 mm

Meshing (Existing model)



No of Nodes - 141117
No of Elements – 138139

Meshing (Altered Model)



No of Nodes - 159639
No of Elements - 143987

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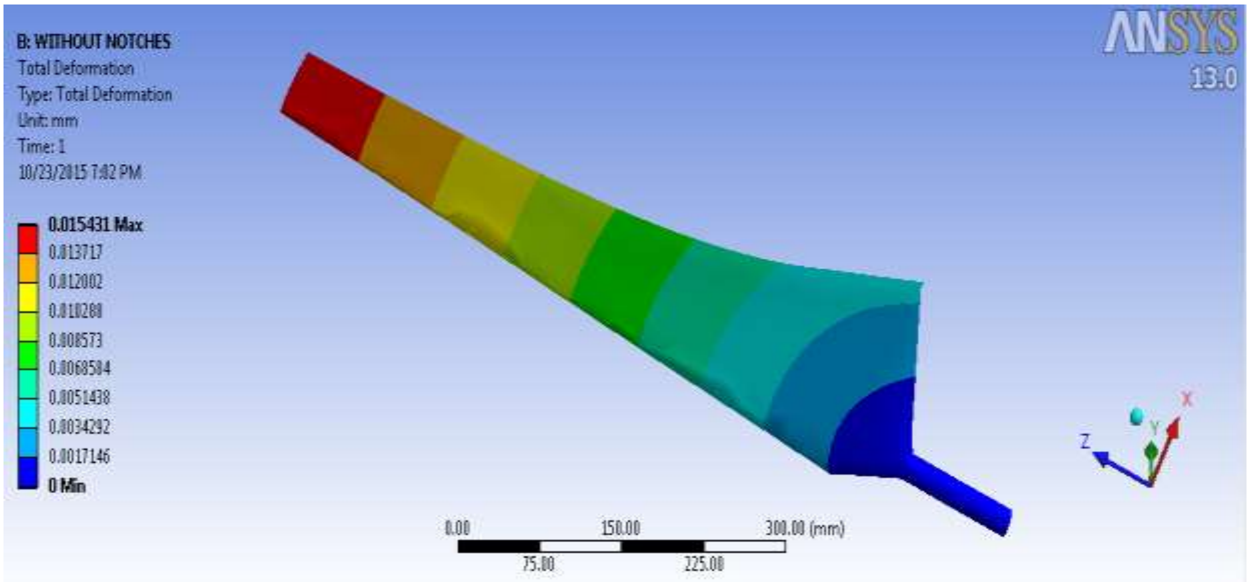
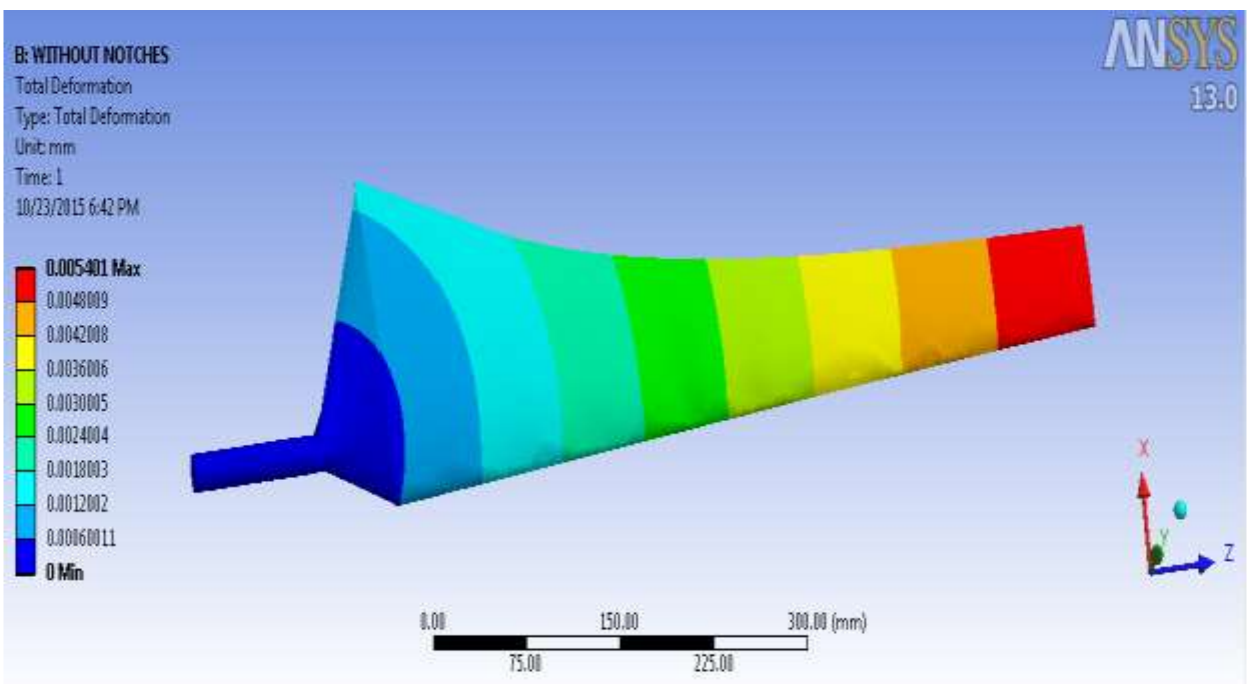
Analysis Results

Total deformation (Existing model)



Aluminium



Steel

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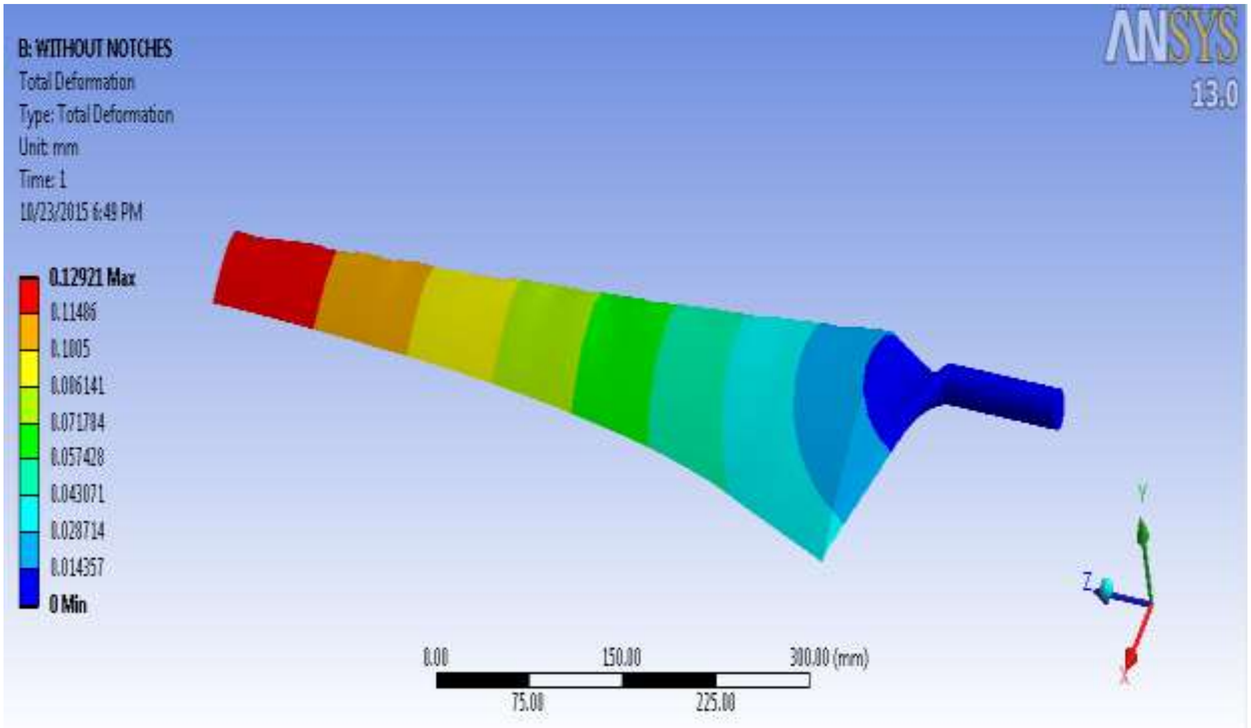
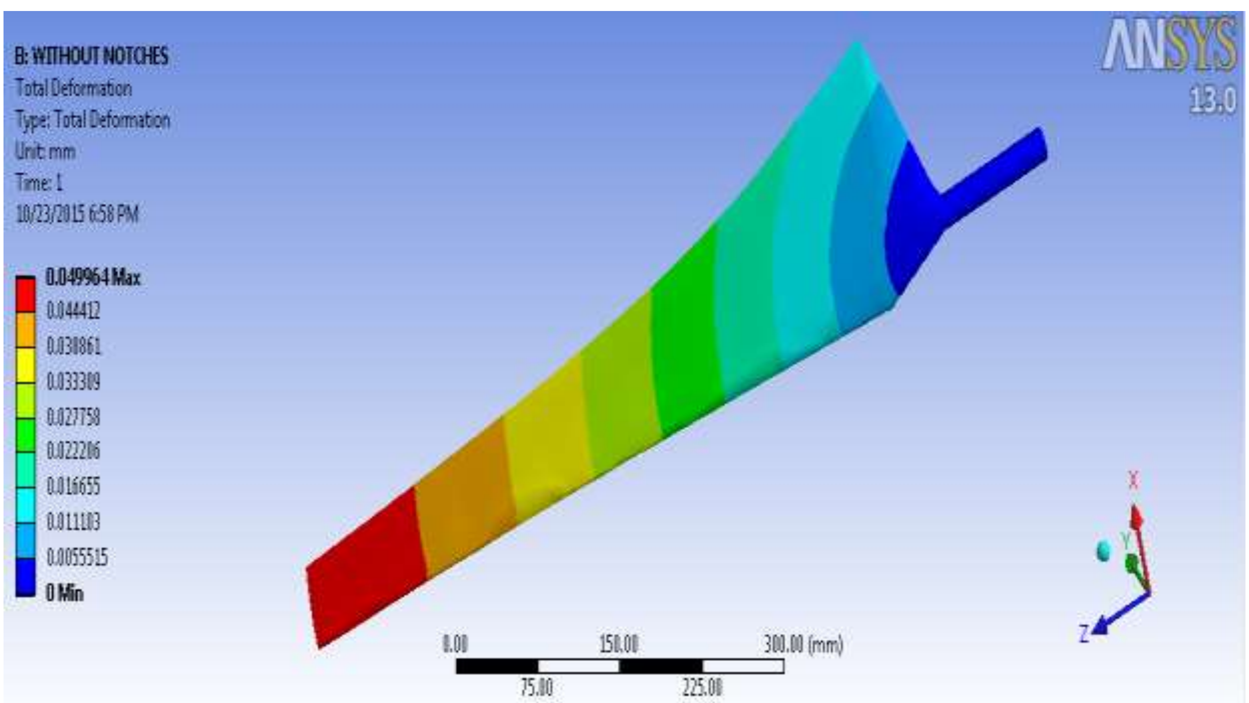


Glass fiber



Carbon fiber

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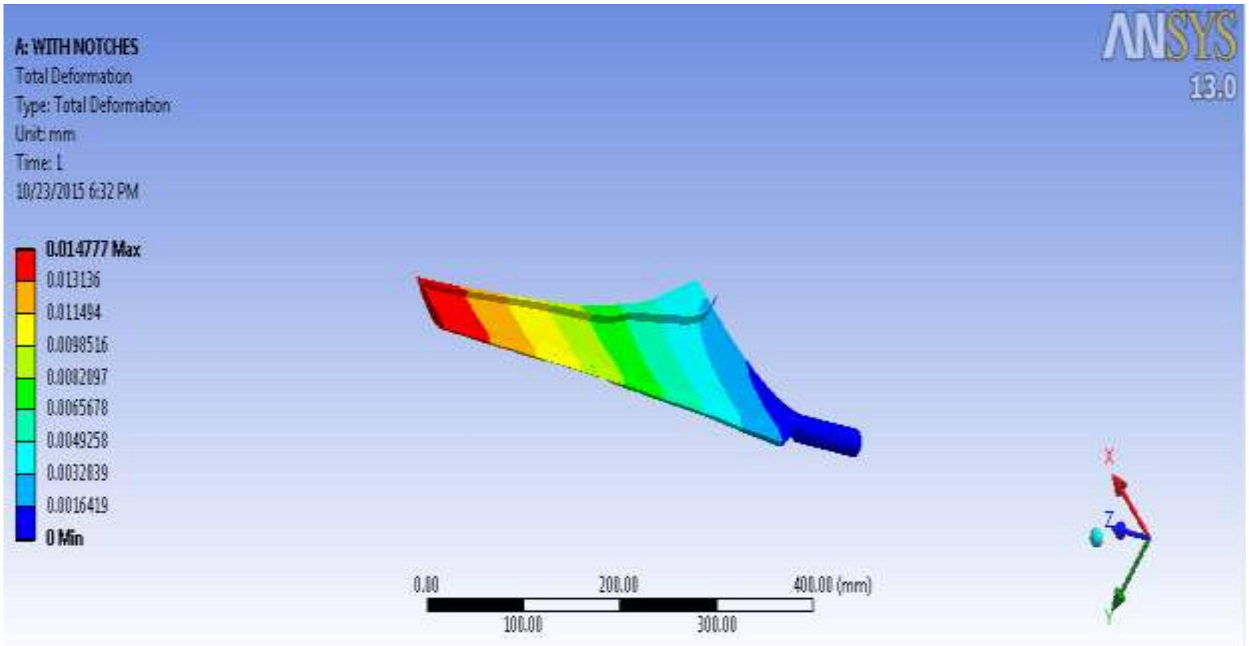
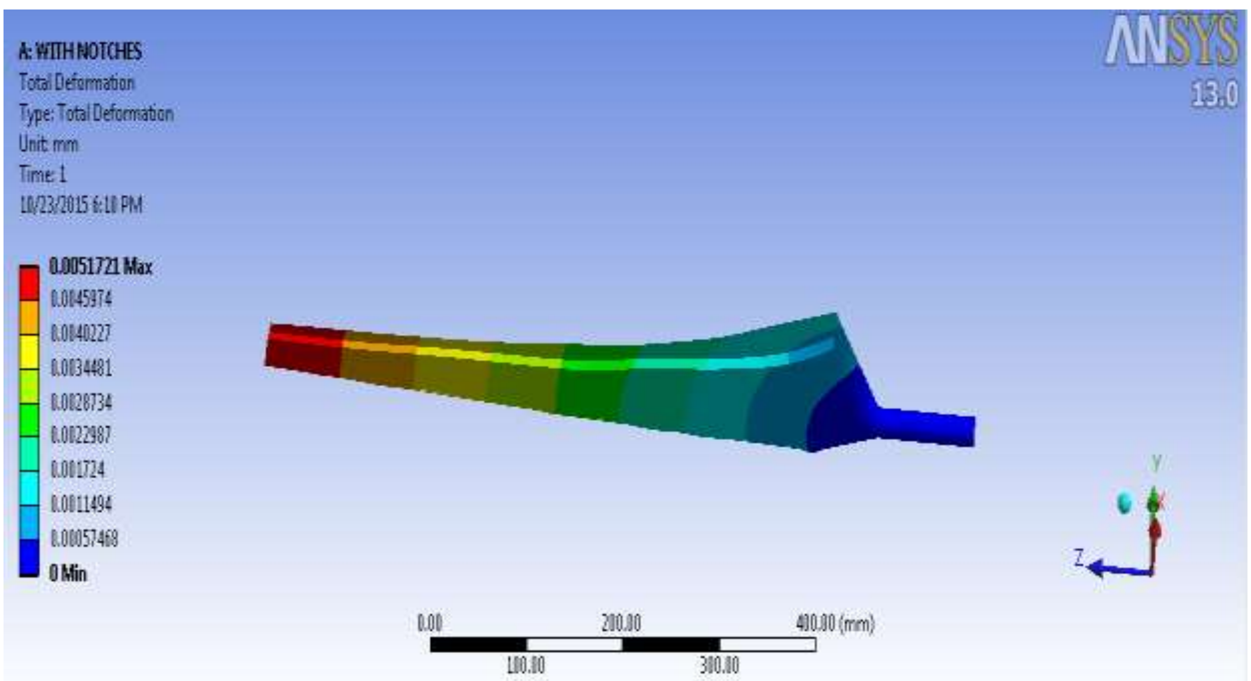
Total deformation (Altered model)



Aluminium



Steel

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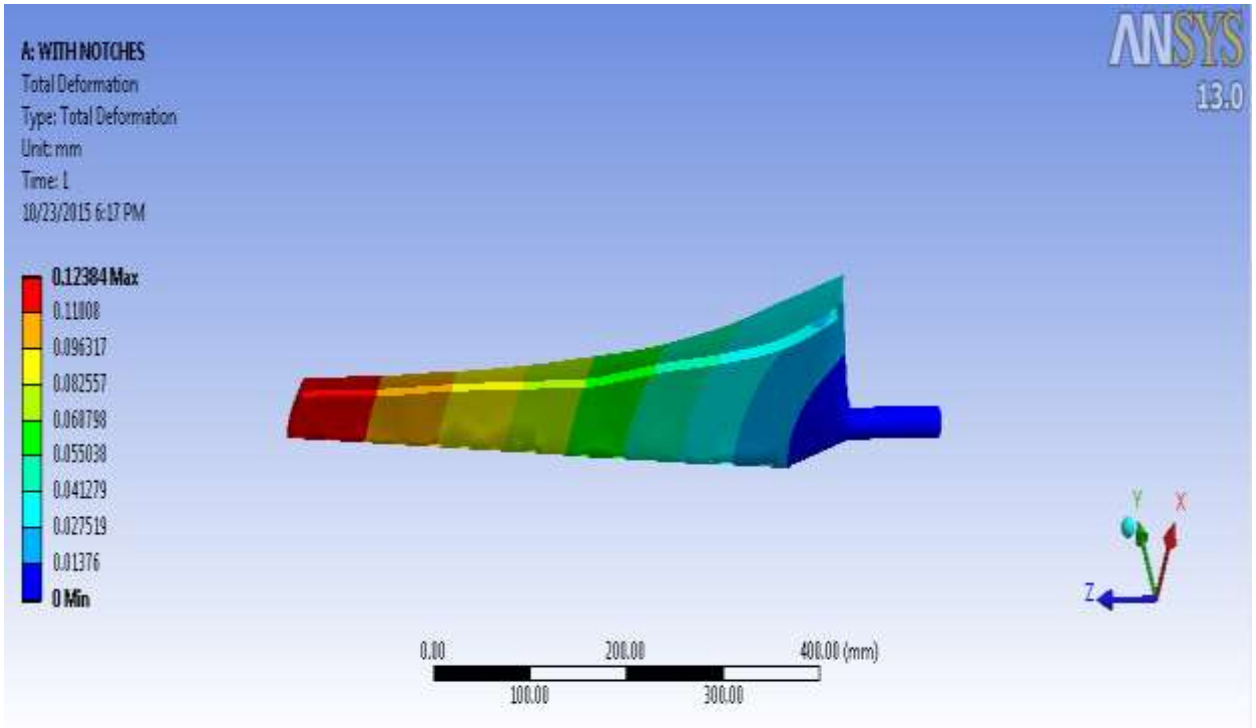
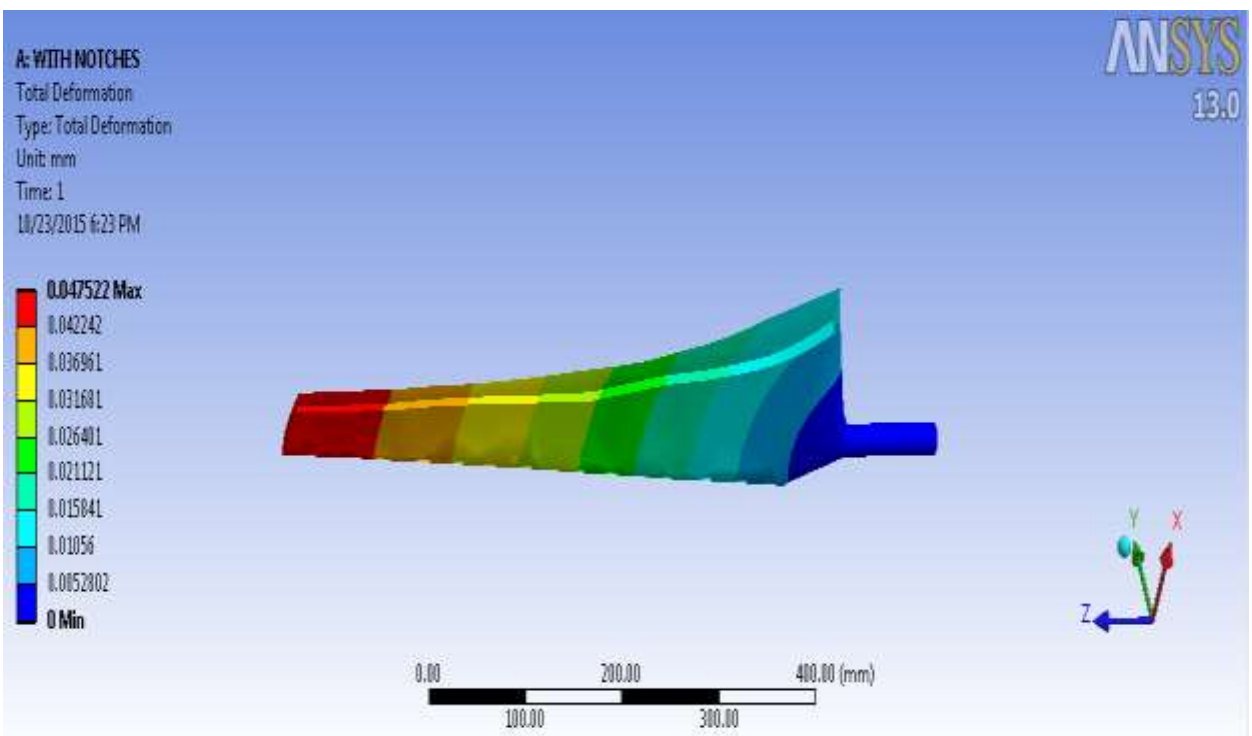


Glass fiber



Carbon fiber

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RESULT AND DISCUSSION

Results for Total Deformation

Material	Existing model	Altered model	Unit
Aluminium	0.015431	0.01477	Mm
Steel	0.005401	0.005172	Mm
Glass fiber	0.12921	0.12384	Mm
Carbon Fiber	0.04996	0.04752	Mm

CONCLUSION

From the obtained results, the following conclusion was made. The wind turbine blade designed with side rib, the strength of the wind blade is more. Also this wind blade provides more torque and it will rotate the motor speedy. The blade could not damage due to strengthening of the wind blade by rib, because of more wind velocity. Fro the obtained analysis results the total deformation of altered wind blade is less comparatively existing wind blade. The same will be continuing for stress also in all direction. This would be the reason, the altered wind blade is providing better results.

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