International Journal of Advanced Technology in Engineering and Science
Vol. No.5, Issue No. 06, June 2017
www.ijates.com
ijates
ISSN 2348 - 7550

STATIC STRESS ANALYSIS OF DOMESTIC WIND MILL BLADE

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ABSTRACT

There are two primary physical principles by which energy can be extracted from the wind; these are through the creation of either lift or drag force (or through a combination of the two). Drag forces provide the most obvious means of propulsion, these being the forces felt by a person (or object) exposed to the wind. Lift forces are the most efficient means of propulsion but being more subtle than drag forces are not so well understood. So the static stress analysis of domestic wind mill blade. The wind force is developed by the wind on the blade surface .due to this the stresses is developed in the blade

Keywords: blade, E glass epoxy, FEA method , load ,static stress, wind mill.

I. INTRODUCTION

The FE method has been used comprehensive design the past decades. It is a very useful method which captures all the necessary details and allows the designer to determine structure responses for a variety of load case. FE models of wind turbine blades normally use layered shell elements. These elements provide an efficient means of doweling structures composed of laminate composite materials which is used in the wind turbine industry. The orthogonal stiffness properties of the elements are calculated by the use of laminate theory. In this study two different types of 3D shell elements are used; a nonlinear laminated shell element for modeling the sandwich parts and a near laminated shell element for modeling the rest. The types of loading that are applied in the model include an externally applied force due to the wind which is known as aerodynamic load &Inertial forces. Aerodynamic loads are obtained using the Blade Element Momentum (BEM) theory. Lift and drag forces generated in steady wind conditions are analyzed as normal and tangential forces and the blade sections. These forces are applied as boundary loads on some specific nodes on the FE model and along the blade. Providing rotational velocity and gravitational acceleration by the user, inertial forces are applied automatically by ANSYS that is used in this simulation and are combined with the mass matrices to form a body force load vector term. However, inertia loads are effective only if the model has some mass. To do so, density specification is used this research.

II.THEORETICAL ANALYSIS

The wind mill blade is fixed at one end and free at another end that is cantilever type. The load is applied at the centre of the blade. Due to this the bending stresses is developed. They are calculated as follows

Length of the blade = 900mm

Width of the blade (B)= 74mm

Thickness of the blade (T) =13mm

The moment due to applied load at the center of the blade =M=$\frac{WL}{4}$

Where W=applied load

L= length of blade

Section Modulus of blade section (Z) =$\frac{I}{Y}$=$\frac{BT^2}{12}$=$\frac{74\times13^2}{12}$=1042.16mm³

The bending stress developed is calculated by equation $\frac{M}{I}$=$\frac{F}{Y}$ i.e. f = $\frac{M}{z}$

Table 1: Theoretical Static Stress Analysis Of E Glass Epoxy Blade

Sr No	Applied load(N)	Stress in (Mpa)
1	24.5	5.294
2	49.50	10.589
3	73.575	15.884
4	98.1	21.179
5	122.625	26.474
6	147.15	31.769
7	171.675	37.064
8	196.2	42.359
9	220.725	47.654
10	245.25	52.948

III.NUMERICAL ANALYSIS

The Finite Element Method (FEM) is practical application often known as Finite Element Analysis (FEA) is a numerical technique for finding approximate solutions of partial differential equations (PDE) as well as of integral equations. Finite Element Analysis is a simulation technique which evaluates the behavior of components, equipment and structures for various loading conditions including applied forces, pressures and temperatures. Thus, a complex engineering problem with non-standard shape and geometry can be solved using finite element analysis where a closed form solution is not available. The finite element analysis methods result in the stress distribution , displacements and reaction loads at supports etc. for the model.In the finite element analysis 3D model of domestic wind mill blade is developed. After modeling of domestic wind mill blade ,the actual supporting boundary conditions are given i.e. fixed support at one end and free at another end (cantilever type). In fixed support there is no any degree of freedom i.e. there is no displacement at any direction. The gradual load is applied on the blade with different load step.

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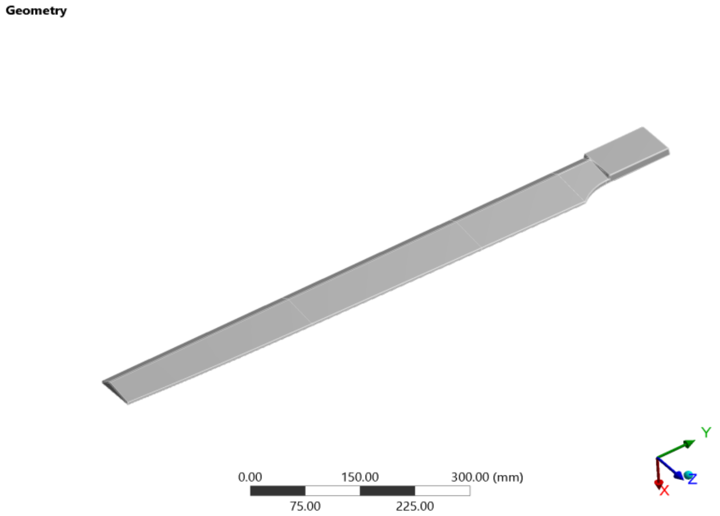

Fig 3.1: 3D Model Of Wind Mill Blade

The meshing of the 3D Model Of Wind Mill Blade having No. of nodes 57566,No. of elements 34146.The load is applied on the blade with different load steps as 24.5N,49.50N,73.575 N,98.1N,122.15 N,147.15 N,171.675 N,196.2 N,220.725 N &245.25 N

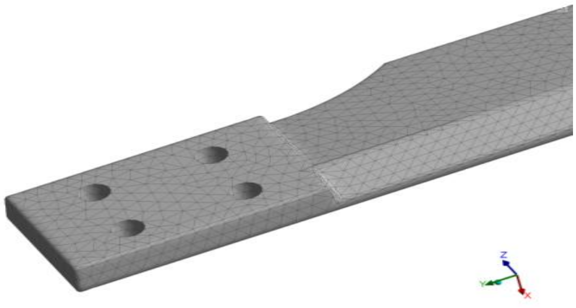

Fig 3.2: Mesh Model Of Wind Mill Blade

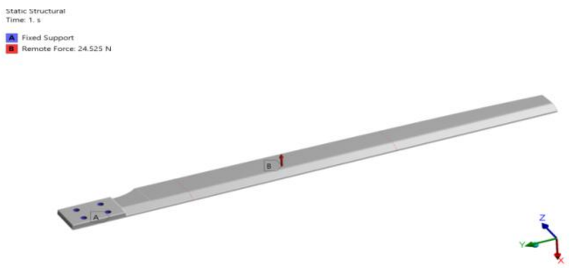

Fig 3.3: Load applied on the wind mill blade

3.1Numerical results

The numerical results are obtained in the ANSYS software as follows

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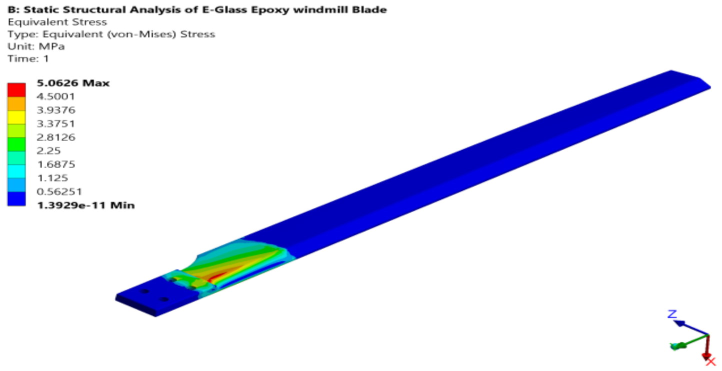

Fig 3.3.1: Numerical Result for Load of 24.5 N

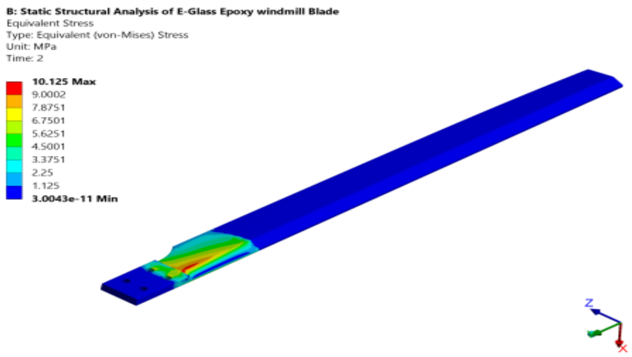

Fig3.3.2: Numerical Result for Load of 49.50 N

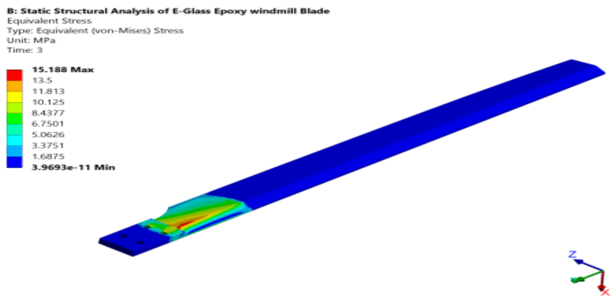

Fig 3.3.3 : Numerical Result for Load of 73.575N

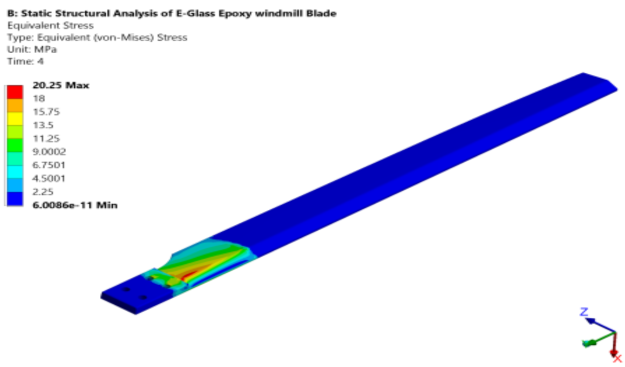

Fig 3.3.4:Numerical Result for Load of 98.1 N

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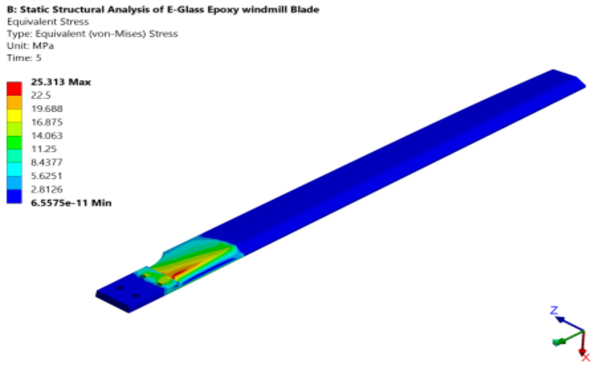

Fig 3.3.5: Numerical Result for Load of 122.15N

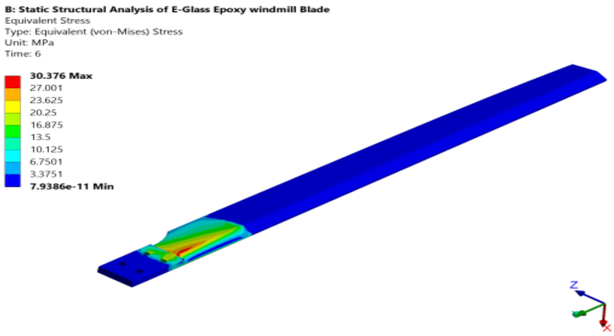

Fig 3.3.6: Numerical Result for Load of 147.15N

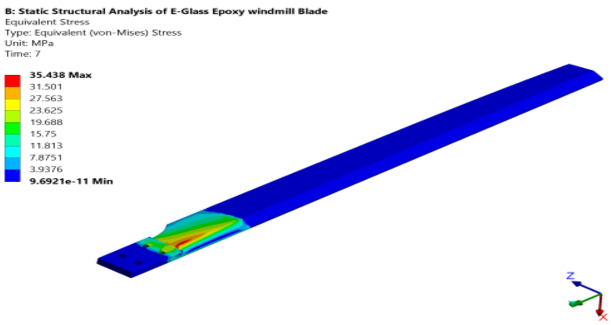

Fig 3.3.7: Numerical Result for Load of 171.675N

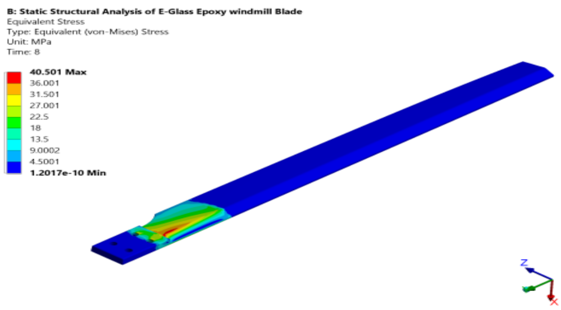

Fig 3.3.8: Numerical Result for Load of 196.2N

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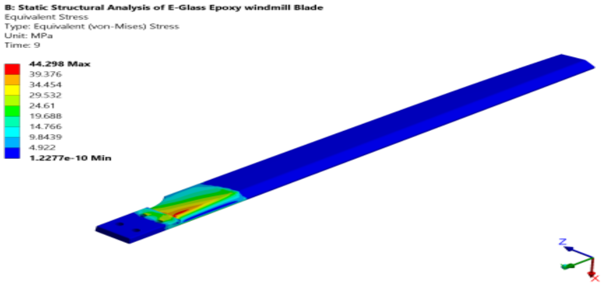

Fig 3.3.9.: Numerical Result for Load of 220.725N

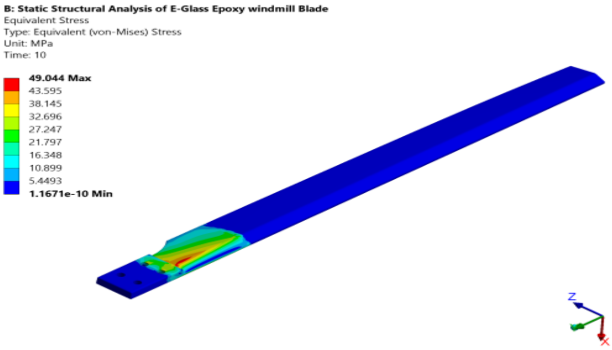

Fig 3.3.10.: Numerical Result for Load of 245.25N

TABLE 2 : Numerical Static Stress Analysis Of Blade

Sr No	Applied load (N)	Numerical stress (Mpa)
1	24.5	5.062
2	49.50	10.125
3	73.575	15.188
4	98.1	20.25
5	122.625	25.313
6	147.15	30.376
7	171.675	35.438
8	196.2	40.501
9	220.725	44.298
10	245.25	49.044

IV.RESULTS AND DISCUSSIONS

TABLE 3: Comparison between theoretical static stresses and numerical static stresses

Sr No	Applied load (N)	Theoretical stress(Mpa)	Numerical stress (Mpa)
1	24.5	5.294	5.062
2	49.50	10.589	10.125
3	73.575	15.884	15.188
4	98.1	21.179	20.25
5	122.625	26.474	25.313
6	147.15	31.769	30.376
7	171.675	37.064	35.438
8	196.2	42.359	40.501
9	220.725	47.654	44.298
10	245.25	52.948	49.044

From the above results it is seen that there is good conformity between theoretical and simulated static stress of E glass epoxy material domestic wind mill blade. The theoretical calculated stress is compared with numerically obtained values.

V.CONCLUSION

The theoretical static stress is calculated acted on domestic wind mill blade. Also numerically static stress is calculated. The numerical results from finite element analysis show a good conformity between theoretical values.

VII. ACKNOWLDGEMENT

The authors are grateful to Dr J.J. Magdum Collage of Engineering, Jaysingpur for supporting this work.

REFERENCES

[1] Chen C. P. And Kam T. Y., " Failure Analysis Of Small Composite Sandwich Turbine Blade Subjected To Extreme Wind Load", The Twelfth East Asia-Pacific Conference On Structural Engineering And Construction, Procedia Engineering 14, 2011, Pp 1973-1981

[2] Wu J. H. And Lai F. M., "Fatigue Analysis Of Small Composite Sandwich Wind Turbine Blades" The Twelfth East Asia-Pacific Conference On Structural Engineering And Construction, Procedia Engineering 14, 2011, Pp 2014-2020

[3] Ji Yao, Weibin Yuan, Jianliang Wang, Jianbin Xie , Haipeng Zhou, Mingjunpeng And Yong Sun, "Numerical Simulation Of Aerodynamic Performance For Two Dimensional Wind Turbine Airfoils",

International Conference On Advances In Computational Modeling And Simulation, Procedia Engineering 31, 2012 Pp 80 -86

[4] Cox Kevin Cox And Echtermeyer Andreas, “Structural Design And Analysis Of A 10MW Wind Turbine Blade”, Deepwind, 19-20 January 2012, Trondheim, Norway, Energy Procedia 24, 2012 Pp 194- 201

[5] Peeters J. , Vandepitte D., Sas P., “Structural Analysis Of A Wind Turbine And Its Drive Trainusing The Flexible Multibody Simulation Technique”, Proceedings Of ISMA 2006, Pp 3665-3680

[6] Zhang Lanting, “Research On Structural Lay-Up Optimum Design Of Composite Wind Turbine Blade”, Energy Procedia 14, 2012 Pp637-642

[7] Tenguria Nitin, Mittal. N. D, Ahmed Siraj, “Design And Finite Element Analysis Of Horizontal Axis Wind Turbine Blade”, International Journal Of Applied Engineering Research, Dindigul, Volume 1, No 3, 2010, Pp 500-507