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Experimentation of Jute Fiber Supplemented with E-Glass in Various Layers Alignment

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Abstract: *Composites fiber are moving into the crucial stream of the automobile industry, with manufacturers and suppliers finding different blends of bio composites, glass fibers and places to use them. It has been observed that natural fibers such as flax, hemp, kneaf, jute and sisal help reducing in weight, cost, and CO2, less dependence on other oil sources, and reusability. Also Fibers like flax, hemp or jute are cheap, have better stiffness per unit weight, corrosion resistance, electrical insulation, reduction in tooling and assembly costs, low thermal expansion, higher stiffness and strength, fatigue resistance and have a lower impact on the environment.* ***[1]***

*The present study/research focuses on exploring the possibility of using jute fiber, E-Glass and embedding these in a biopolymer matrix system – epoxy – the task of which is to hold the fibers together. This epoxy stabilizes the shape of the composite structure, transmits the shear forces between the mechanically high-quality fibers, and protects them against radiation and other aggressive media. The component is conditioned and prepared for testing and subjected to tensile, compression, hardness and bending test calculating the element results with ANSYS by using the test results. Promising results have been observed and this study enables for future study in the field of natural fiber composite materials. Main aim of this paper is to reduce the impact on the environment, by using recyclable natural fibers****[6] [7].***

Keywords: *ANSYS,Composites,E-glass,Fibers,Jute*

I. INTRODUCTION

India enriched with huge source of natural fiber such as Jute, Coir, Bamboo, Sisal, Banana, Pineapple etc. has focused on the improvement of natural fiber composites firstly to explore value-added applications in industries. The material scientists all over the world focused their attention on natural composites strengthened with Sisal, Pineapple, Coir, Jute etc. mainly to cut down the cost of raw materials. Reinforced composites are mostly used in industrial applications due to their inherent high specific strength and stiffness. In this type composite the second phase is in the form of fibers dispersed in the matrix which could be either plastic or metal. The volume fraction (Vf) varies from a few percentage to as high as 70%. Usually the fiber reinforcement is done to obtain high strength and high modulus. For that it is necessary for the fibers to have higher modulus than the matrix material, such that the load is passed on to the fiber from the matrix more efficiently .E-Glass was actually developed for standoff insulators for electrical wiring. Later it was found to possess excellent fiber forming abilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fiberglass**[2] [5] [8] [9].**

In this paper four layered and three layered jute glass specimen is compared theoretically using ANSYS and practically on material testing machines. Their properties such as inter laminar shear stresses, bending stresses, Tensile and compressive strength of both specimens are compared.

II. PREPARATION OF SPECIMEN

The manner in which the warp and weft threads are interlaced is known as the weave style. Plain weave is the most basic type of textile weaves. The warp and weft are aligned so they form a simple crisscross pattern. In balanced plain weaves the warp and weft are made of threads of the same weight (size) and the same number of ends per inch. Plain weave with 1/1 layer is selected.

For preparation of composite first a rectangular frame of 250mmx250mm with a height of 25mm is prepared then a GI sheet with same dimension prepared. Fiber mat also prepared with respective dimension.

Wax is applied to frame and as well as to GI sheet. Then GI sheet is placed in the frame and resin is mixed with hardener with required proportions. Have to apply the adhesive to the GI sheet and fiber mat is placed over it and again adhesive is applied with help of brushes. When the adhesive applied properly place another layer of fiber over before one and apply adhesive. Similarly we can do this whenever there is need for more layers. This increases the thickness of the composite material. Now another GI sheet with wax applied is placed over this need to keep small load to avoid voids in the composite material. After the soaking period composite material is obtained. 4 bending and 4 tensile specimens are prepared. Bending with 20mmx140mm and for tensile specimen as per the standards is prepared.

Specimen type : Flat

- Specimen width mm : 15.11
- Specimen thickness mm : 5.44
- C/S Area mm^2 : 82.198
- Original Gauge Length mm : 50
- Final Gau**g**e Length mm : 51.72

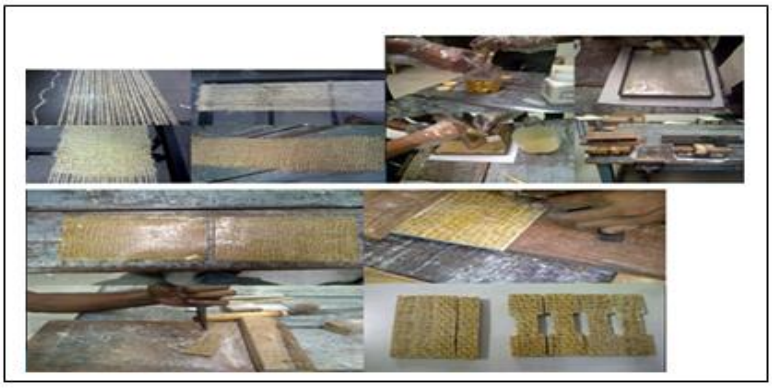

Fig1: Preparation of Specimen

Material Properties of Natural Fiber Jute **[4]**

- Density gm/cm^3 : 1.45
- Youngs Modulus GPa : 55
- Poissons ratio : 0.38
- Shear Modulus GPa :7.24
- E glass and k12 epoxy resin used

III. FINITE ELEMENT METHOD

The analysis in Ansys is done using the shell 99 element which is used for layered applications. Shell99 element lacks nonlinear capabilities of shell 91 and has shorter formulation time. It allows up to 250 layers. For an analysis requiring more than 250 layers a user input constitutive matrix is shown available. It has six degrees of freedom at each node i.e. 3 translations and rotations at each node. [10] [11].

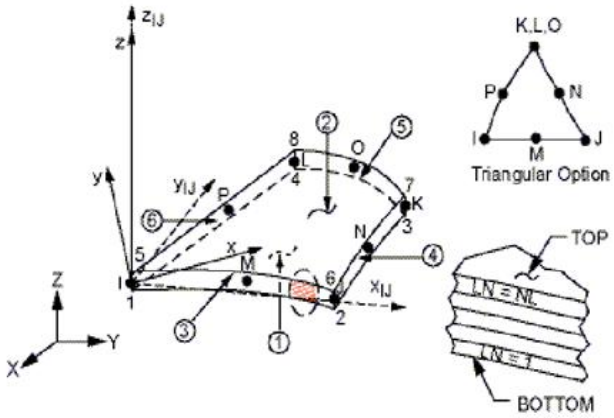

Fig2: SHELL99 element Geometry [3]

x_{IJ} = Element x-axis if ESYS is not supplied.
x = Element x-axis if ESYS is supplied.
LN = Layer Number
NL = Total Number of Layers

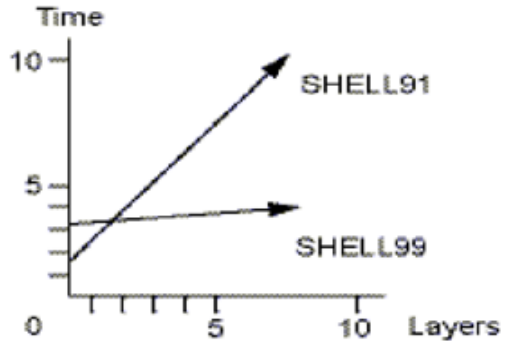

Fig3: Stress recovery time as a function of the number of layers [3]

IV. EXPERIMENTATION RESULTS

The specimen is considered in the form of three layers and four layers. In three layered specimen has two categories. In the first, layers are made in the series of "**Jute-Glass-Jute**" and other in series "**Glass-Jute-Glass**" similarly in the four layered specimen has two categories. In the first, layers are made in the series of "**Jute-Glass-Glass-Jute**" and other in series "**Glass-Jute-Jute-Glass**". Results are obtained both practically and through Finite Element Method. In practical method by using universal testing machine all the four kinds of specimens are considered and load versus deformation graphs are obtained in the machine. In Finite Element Method also all four cases are considered. Von-Mises stresses in bending and Tensile Tests are obtained.

Fig4: Experimentation showing UTM with Specimen

Tensile Results:

S. No	No.of layers	Specimen	Ultimate Load(N)	Ultimate Tensile Strength (N/mm^2)	Elongation %
1	3	Glass-Jute-Glass	1960	23.844	3.440
2	3	Jute-Glass-Jute	1880	20.678	3.380
3	4	Glass-Jute-Jute-Glass	2840	28.434	5.680
4	4	Jute-Glass-Glass-Jute	1520	13.006	1.800

The below graphs depict the variation of load with respect to deformation in all above four cases obtained from the Universal Testing Machine

Case 1(3 layered GJG):

Fig5: variation of load with respect to deformation in 3 layered Glass-Jute-Glass specimen

Case 2 (3 layered JGJ):

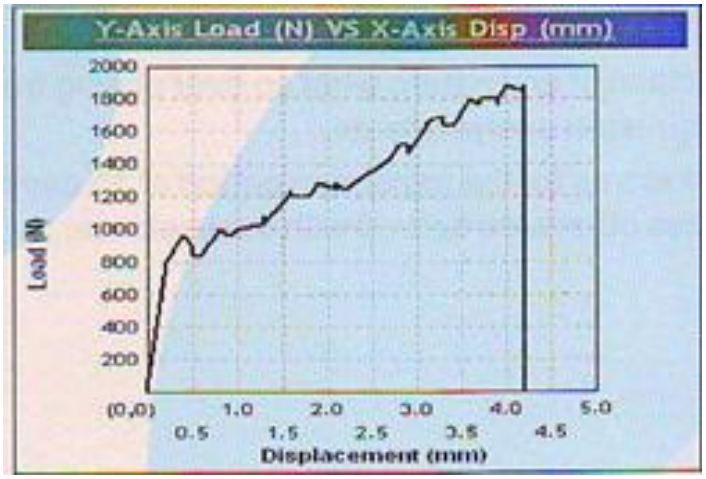

Fig6: Variation of load with respect to deformation in 3 layered Jute-Glass-Jute specimen.

Case 3 (4 layered G2JG):

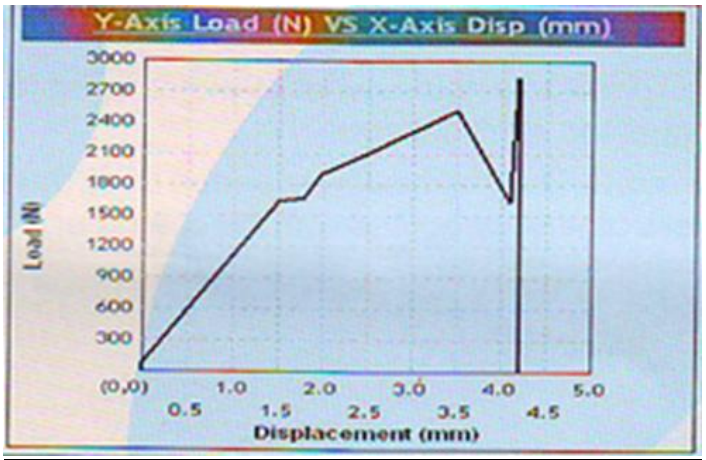

Fig7: variation of load with respect to deformation in4 layered Glass-Jute-Jute-Glass specimen

Case 4 (4 layered J2GJ):

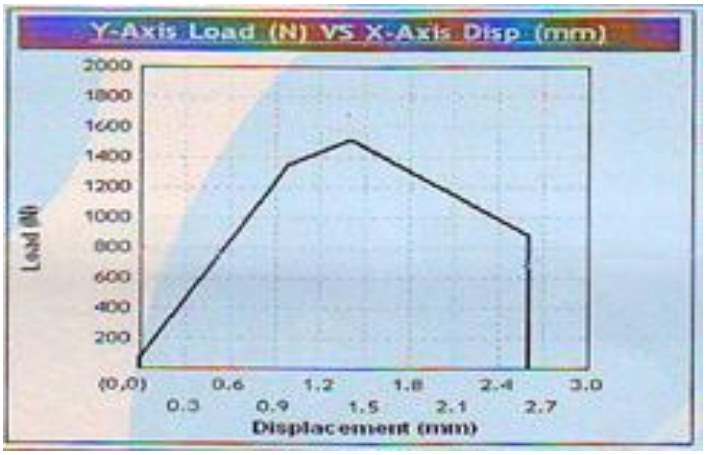

Fig8: variation of load with respect to deformation in 4 layered Jute-Glass-Glass-Jute specimen

Von Mises Stresses In Tensile Test:

Nodal stress distribution of the object in von mises direction. The below images shows the displacement of all layer composite tensile specimens.

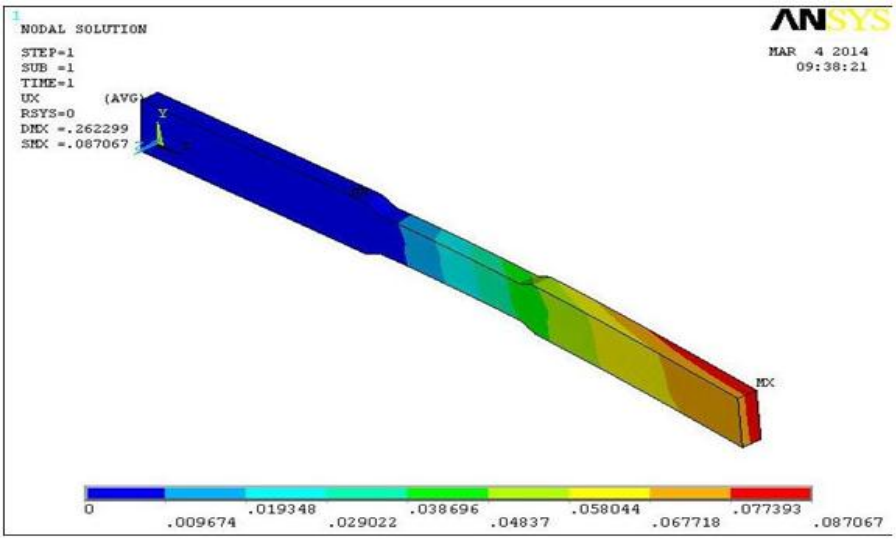

Fig9: Von mises stress of Glas-jute-jute-Glass layer specimen

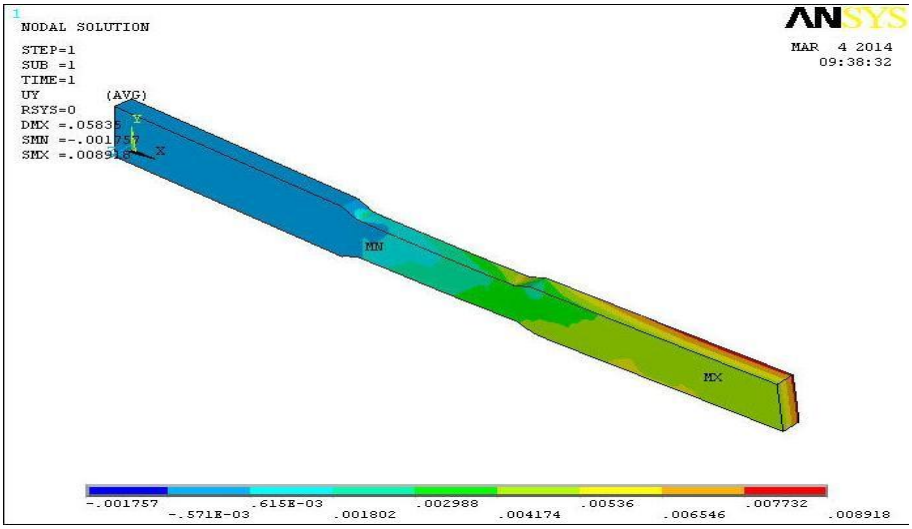

Fig10: Von mises stress of jute- Glas- Glas-jute layer specimen

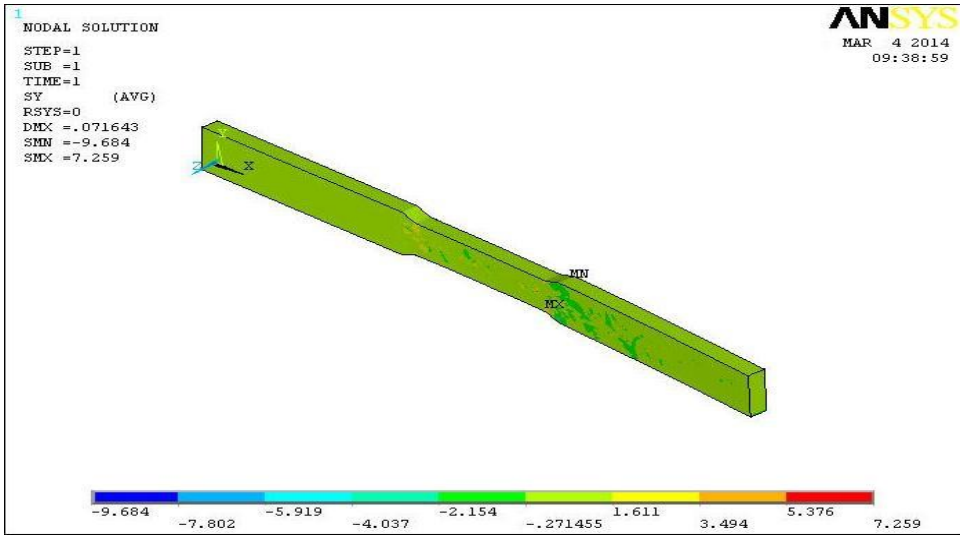

Fig11: Von mises stress of Glas- jute-Glas layer specimen

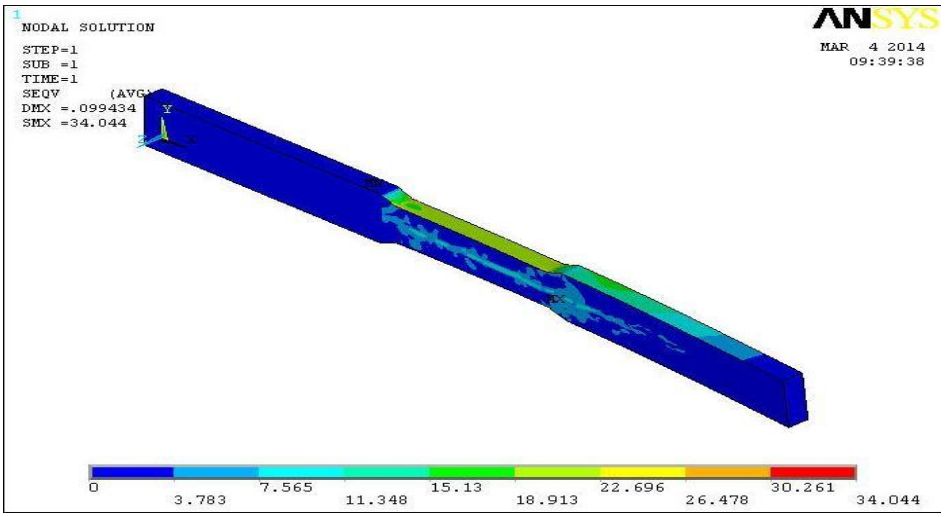

Fig12: Von mises stress of jute-Glas-jute layer specimen

Von Mises Stresses In Bending Test:

Now we get nodal stress of the object in von mises conditions. The below images shows the von mises stress of all layers Bending specimen.

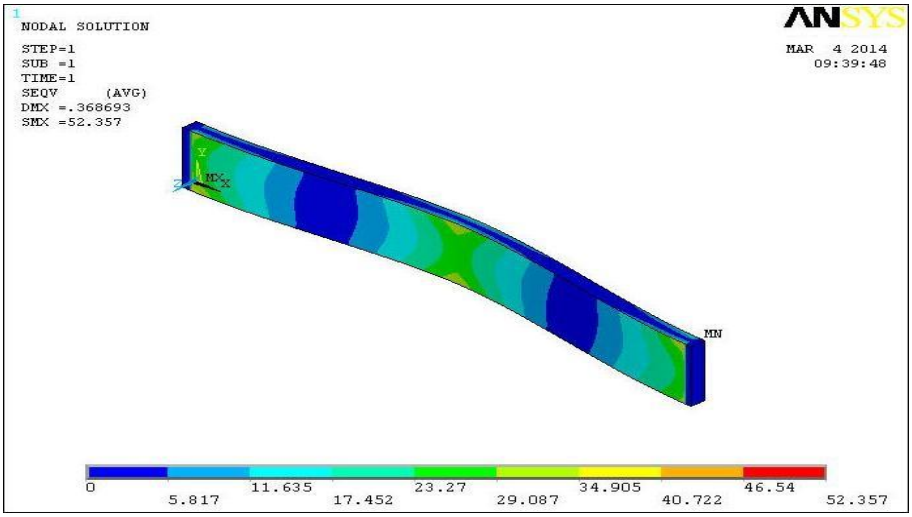

Fig13: Von mises stress of Glas-jute-jute-Glass layer specimen

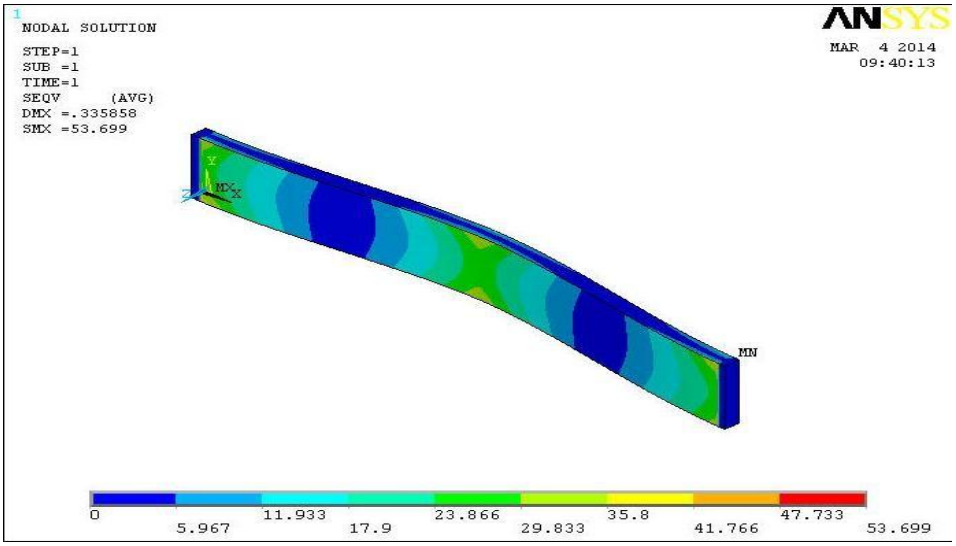

Fig14: Von mises stress of jute- Glas-Glas-jute layer specimen

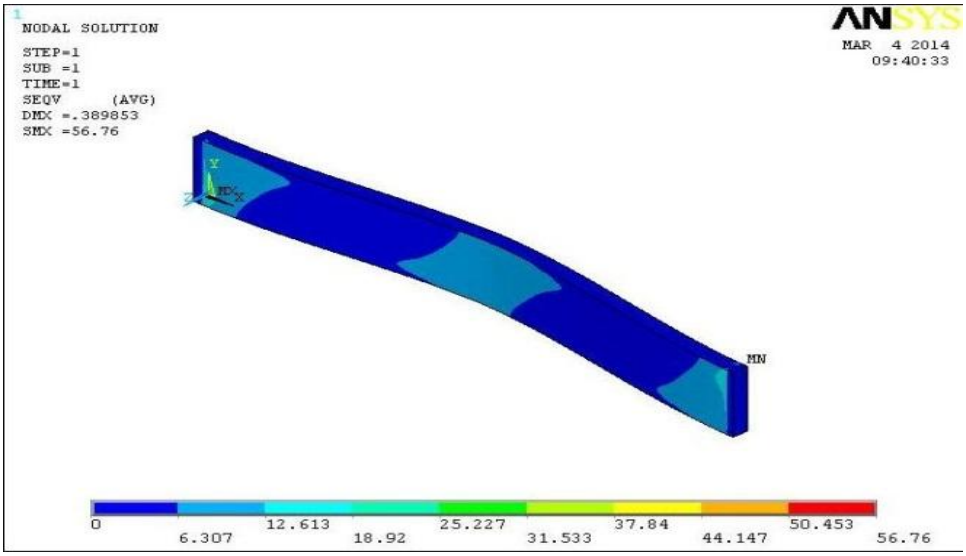

Fig15: Von mises stress of Glas-jute-Glass layer specimen

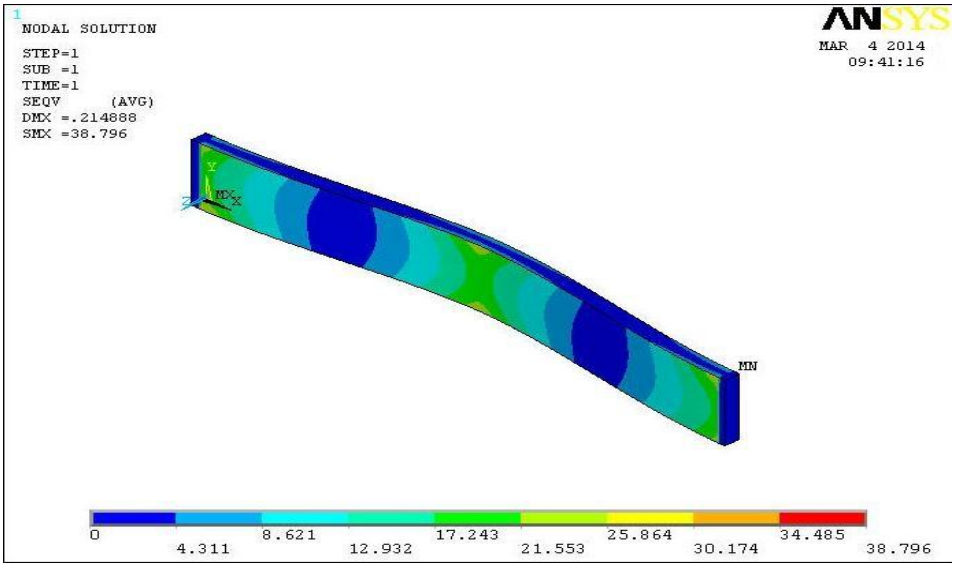

Fig16: Von mises stress of jute-Glas-jute layer specimen

V. CONCLUSION

The following conclusions are drawn from the present work

- The 4 layered Glass-jute-jute-Glass specimen is more stiffer than 3 layered Glass-Jute- Glass specimen because the variation of percentage in deflection is 39.43, and also it is 19.25% more hard enough than 3 layered one.
- The Bending shear stresses are 8.40% more in 3 layered one than the 4 layered Glass-Jute-Glass specimen.
- The 3 layered Jute-Glass-Jute specimen is more stiffer than 4 layered Jute-Glass-Glass-Jute specimen because then variation of percentage in deflection is 65.08, and also it is 58.98% more hard enough than 4 layered one.
- The Bending shear stresses in 38.41% more in 4 layered one than the 3 layered jute glass jute specimen.

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