iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3265

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Synthesis and Characterization of Jute Reinforced Composites with Wollastonite Filler

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Abstract: ***Polymers owing their service to the society with their outstanding characteristics Like low density, good corrosion resistance, low coefficient of friction, good mould ability and economical. In the current work epoxy resin in choose as matrix, (jute fiber) fiber, wollastonite as filler are chose as reinforcement. Room temperature cured Epoxy System with fiber and wollastonite filler are synthesized by mechanical shear mixer, and then kept in an Ultrasonicator for better dispersion of wollastonite filler in the matrix. Different weights of wollastonite filler (1, 2,3,4,5 gm wt) has been incorporated into the Epoxy matrix in order to study the variation of mechanical properties.***
Key words: Jute fiber(mate type); wollastonite filler; Epoxy Resin AW106; Stress and strain

I. INTRODUCTION

There is always a demand to develop new materials to match the developing industrial needs. Composite materials are mostly used in different industrial applications due to its lightweight and high-strength properties[1-4]. Polymer Matrix composites (PMC) mostly used in aerospace and automobile applications [2-6] due to its properties like wear resistant, high hardness, corrosive resistance and better form ability. The basic difference between blends and composites is that the two main constituents in the composites remain recognizable while these may not be recognizable in blends[8]. The predominant useful materials used in our day-today life are wood, concrete, ceramics, and so on.

The most important polymeric composites are found in nature and these are known as natural composites. The connective tissues in mammals belong to the most advanced polymer composites known to mankind where the fibrous protein, collagen is the reinforcement [4]. It functions both as soft and hard connective tissue, composites are combination of materials differing in composition, where the individual constituents retain their separate identities.

These separate constituents act together to give the necessary mechanical strength or stiffness to the composite part. Composite material is a material composed of two or more distinct [5] phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents.

Matrix phase is the primary phase having a continuous character and is usually more ductile and less hard phase[6]. It holds the dispersed phase and shares a load with it. Dispersed (reinforcing) phase is embedded in the matrix in a discontinuous form [6-11]. This secondary phase is called the dispersed phase. Dispersed phase is usually stronger than the matrix therefore, it is sometimes called reinforcing phase.

II. EXPERIMENTAL WORK

Polymers owing their service to the society with their outstanding characteristics Like low density, good corrosion resistance, low coefficient of friction, good mould ability and economical [11]. The products produced with polymeric materials have good surface finish, transparent and can be produced with close dimensional tolerance[12-15]. These superior properties of polymers are finding various applications in our life. Even though the polymers have the good characteristics, but their mechanical properties are poor and also they have poor temperature and polymer composites are produced[16]. The fiber reinforced as well as filler added polymers composites have remarkably the mechanical and thermal[17] properties. In the current work epoxy resin[11] AW106 in choose as matrix, (jute fiber) fiber, wollastonite as filler are chose as reinforcement. Room temperature cured Epoxy System with fiber and wollastonite filler are synthesized by mechanical shear mixer, and then kept in an Ultra sonic sonicator for better dispersion of wollastonite filler in the matrix. Different weights of wollastonite filler[19] (1, 2,3,4,5 gm wt) has been incorporated into the Epoxy matrix in order to study the variation of mechanical properties.

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A. Materials

Mechanical properties like Flexural strength, Tensile strength and compression strength of the composites are studied by UTM (Universal Testing Machine) and the change in weight is calculated by chemical treatment process[19]. In the present work, Epoxy resin (AW106) Thermo setting polymer is used as a Matrix, Epoxy is the most common Thermo setting polymer used as matrix in the polymer composites. It is obtained from Araldite (AW106) Huntsman[11], Ciba- Geigy India Ltd Company. Epoxy is a clear liquid with viscosity at 25^0 C. Epoxies are used by the plastic industry in several ways. Epoxy is in combination with glass fiber to produce High- strength composites or reinforced plastics that provide improved Mechanical, Chemical properties and heat resistance. Hardener is used as reaction agent. It acts as catalyst[22]. It is added to the resin in 0.9:0.1 proportions to get harden. In the recent work Araldite (HV953) is used as hardener[23-24] in the Epoxy resin (AW106). It has a shelf pot life 2 years when it is stored in a dry place in a temperature range of 18-25^0C, while for achieving higher pot life, lid should be closed after using the material.

B. Mould Preparation

Moulds of prepared for different castings that are made from resin as for ASTM standards[12]. A glass mould of 130*130*3 mm^3 is used to prepare specimen for tensile test and Flexural test and 10*10*10 mm^3 glass mould is used to prepare the specimen for compression test. In the present work glass moulds are used to prepare jute fibre reinforced composite with adequate and appropriate amount of epoxy resin with wollastonite[24]. Below figure shows the moulds used in the preparation of jute reinforced composite.

Figure1. Glass Moulds

C. Methodology

The pre-calculated amount of wollastonite and Epoxy is mix together in suitable breaker. Wollastonite is mixed with suitable quantity of resin based on the predetermined ratio and mixed thoroughly with Mechanical shear mixing for about 1 hour at ambient temperature conditions. Then the mixture is carried out a high intensity ultra sonicator for one and half hour with pulse mode (50_s on/ 25_s off). External cooling system is employed avoid system during the sonication process by submerging the beaker containing the mixer in an ice bath[25-26]. Once the irradiation is completed. Hardener is added to modified epoxy in the nature of 0.9: 0.1 parts by weight. A glass mould with required dimensions is use for making sample as per the ASTM standards as it is coated with mould releasing agent enabling easy removal of the sample[27]. Now the mixture is poured into the glass mould and jute fiber with

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required dimensions is placed carefully in the mould on the mixture and again poured the mixture on the jute fiber and place the jute fiber again on the mixture and now pour the remaining amount of mixture on the jute fibre and spread equally on the all sides of the mould by applying pressure against the mould[27-28]. Brush and roller are used to impregnate fiber. The closed mould is kept under the pressure for 24 hours at room temperature. To ensure complete curing the composite samples are post cured at 70^0C for one hour and the test specimens of the required size is cut out from the sheet. The removed castings are cut in to samples in accordance with ASTM standards for further testing. [29].

Table 1 List of raw materials used in the present work

Description	Raw materials
Matrix	Epoxy resin (AW106)
Hardener	Hardener(HV953)
Reinforcing agent	Jute fibre
Mould releasing agent	Polyvinyl alcohol (PVA)/ Wax
Micro filler	Wollastonite
Casting	Glass moulds

Table 2.Combinations of Weights for preparing specimens

Sl. No.	*Epoxy resin*	*wollastonite*	*jute fibre (mat type)*
Specimen 1.	70	1	4
Specimen 2	70	2	4
Specimen 3	70	3	4
Specimen 4	70	4	4
Specimen 5	70	5	4

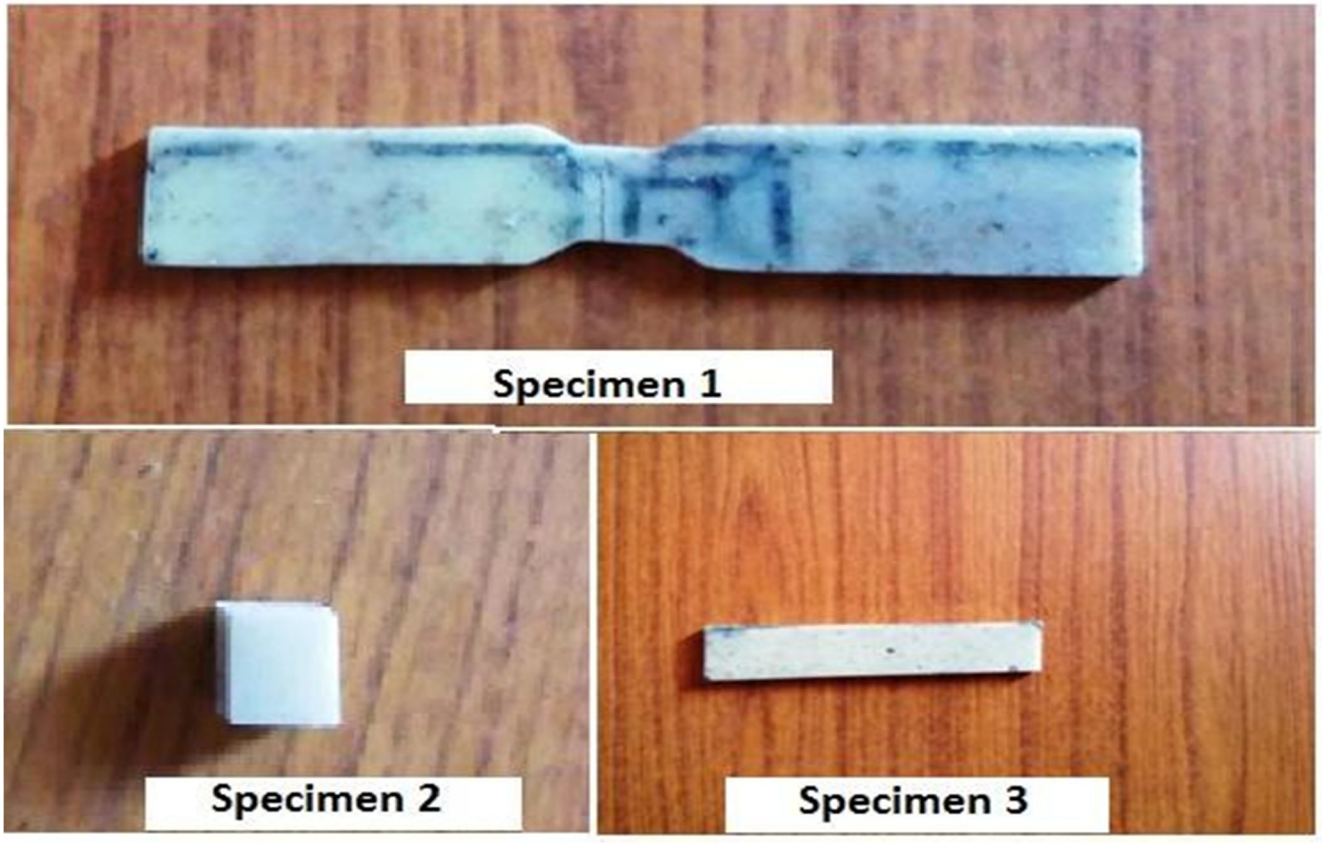

Fig 2. Specimens for Tensile, Compression, Flexural' Tests

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Table 3 specimen specification

Name of the Test	ASTM Standard	Specimen size (mm^3)
Tensile Test	ASTM D638	120*20*3
Compression Test	ASTMD642	10*10*10
Flexural Test	ASTMD618	120*20*3

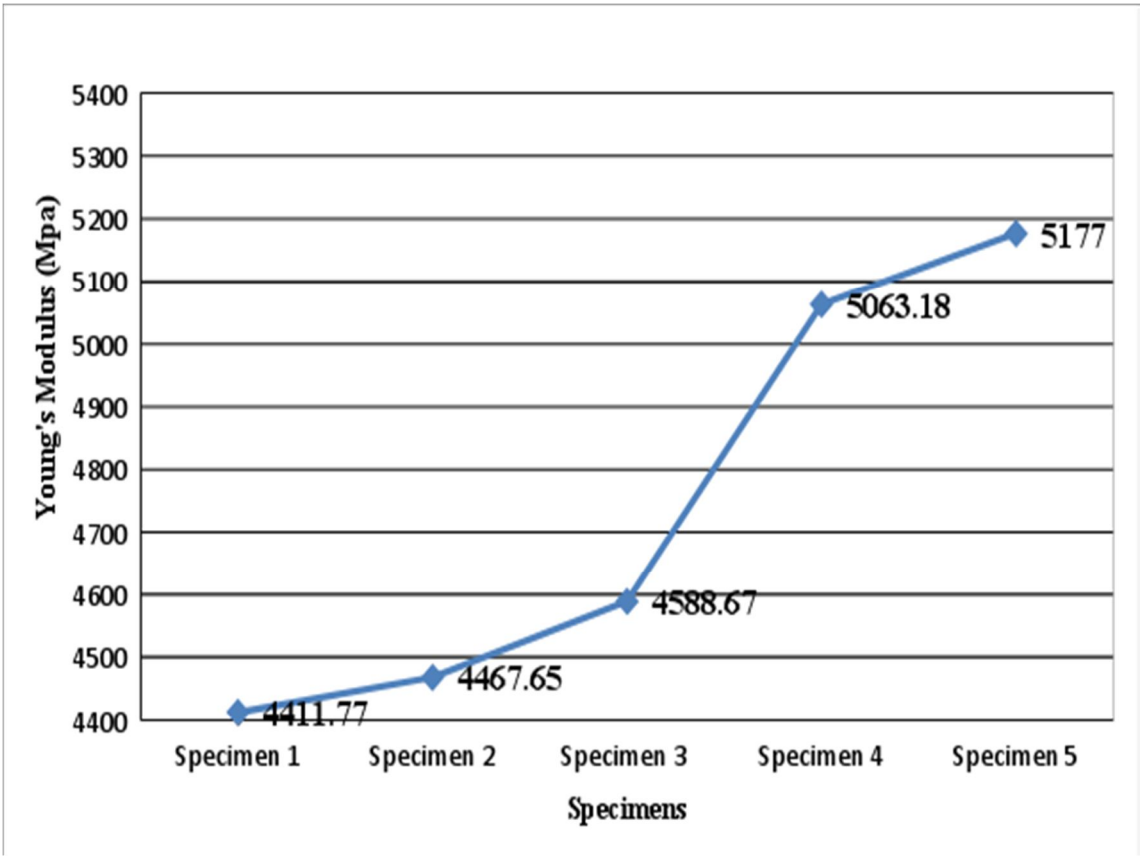
III. RESULTS AND DISCUSSION

A. Tensile Test Results

In the present work the tensile strength for the different specimen of system epoxy resin filled with wollastonite with jute fiber were checked in Universal Testing machine and the variations of tensile load (or) load at break, maximum tensile[15] at maximum Load, young's modulus, tensile strain at break were tabulated in the table 4. And the graphs for tensile load (or) Load at break, Maximum tensile at maximum Load, young's modulus, tensile strain at break is shown separately. [16]

Table 4. Variations In Tensile Test Results

Max. load or load at break (N)	Specimen	Max. tensile stress at maximum load (Mpa)	Young's modulus (Mpa)	Tensile strain at break (mm/mm)
Specimen 1	1029.28	34.31	4411.77	0.00917
Specimen 2	1430.09	47.67	4467.65	0.01400
Specimen 3	1760.48	58.68	4588.67	0.01500
Specimen 4	1958.90	65.30	5063.18	0.02017
Specimen 5	2338.72	77.96	5177.00	0.02067



Graph 1. Variation of Young's Modulus for different specimens at Maximum Load

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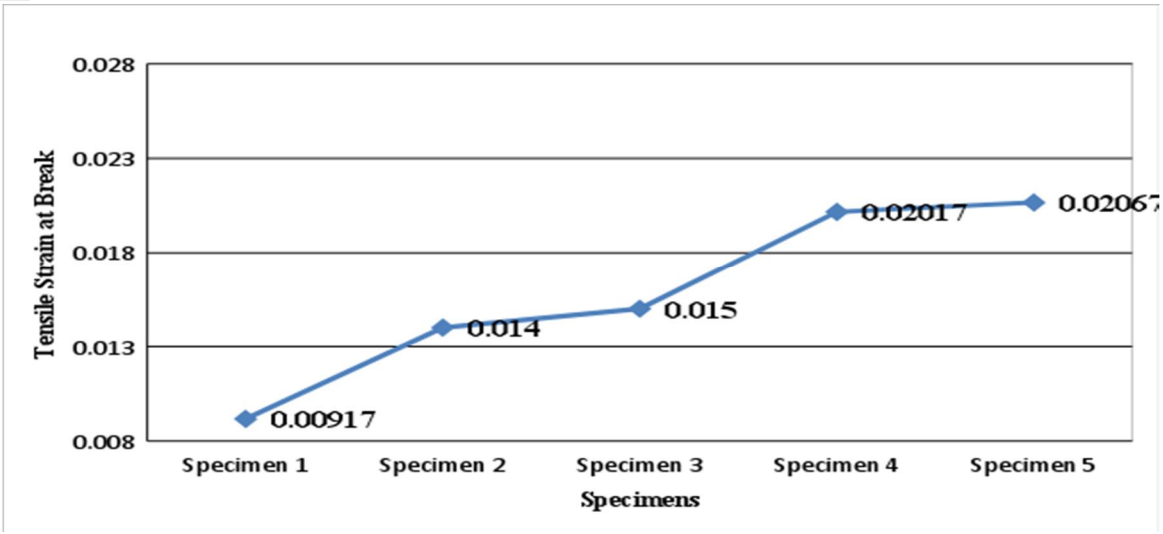


Graph 2. Variation of Tensile Strain at Break for different specimens

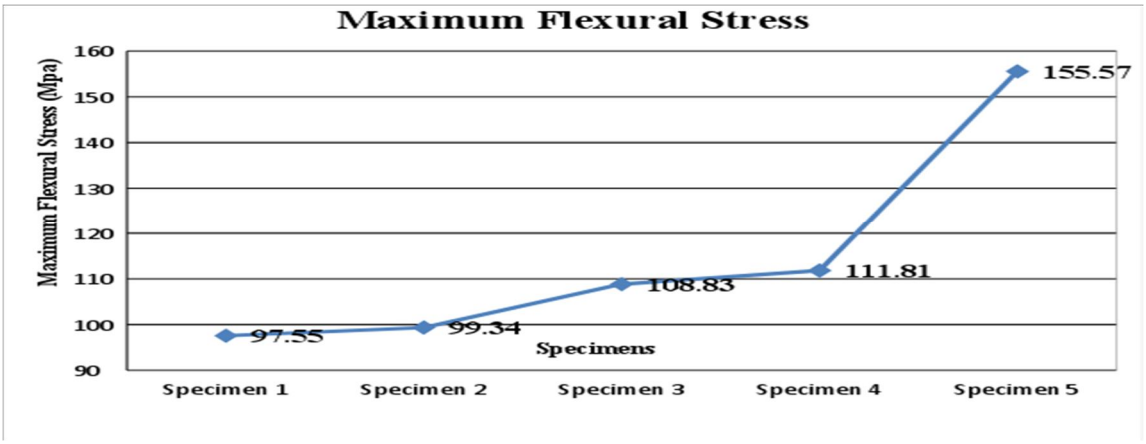
From the above Tensile test graphs it is observed that specimen 5 (epoxy resin filled with five grams of wollastonite and 4grams of jute fiber) have highest tensile load (or) Load at break and highest Maximum tensile at maximum Load and highest young's modulus, and highest tensile strain remaining than all the specimens.

B. Flexural Test Results

In the present work the flexural strength for the different specimen of system epoxy resin filled with wollastonite and jute fibre were checked in Universal Testing machine and the variation of flexural load and flexural stress and flexural modulus is tabulated in the table 5. And the graphs for flexural load and flexural stress and flexural modulus are also shown below separately.

Table 5: variations in Flexural Test results

Specimen	Max. Flexural Load (KN)	Flexural Stress (Mpa)	Flexural Modulus (Mpa)
Specimen 1	0.18	97.55	3932.36
Specimen 2	0.2	99.34	7526.72
Specimen 3	0.2076	108.83	8531.146
Specimen 4	0.28	111.81	9027.83
Specimen 5	0.49	155.57	9167.6



Graph 3. Variation of Maximum Flexural stress for different specimens at Maximum flexural Load

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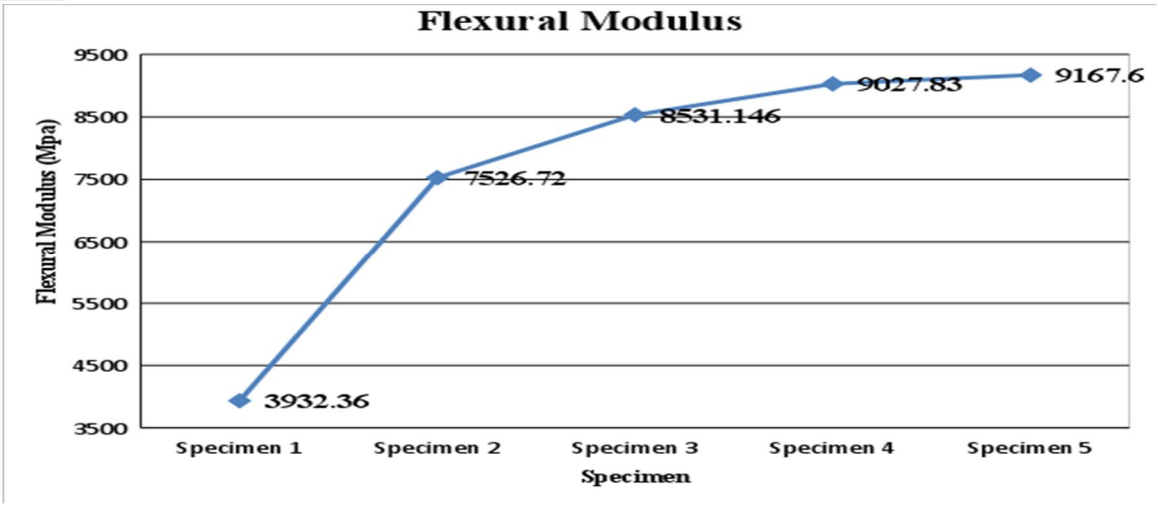


Graph 4. Variation of Flexural Modulus for different specimens at maximum Flexural Load

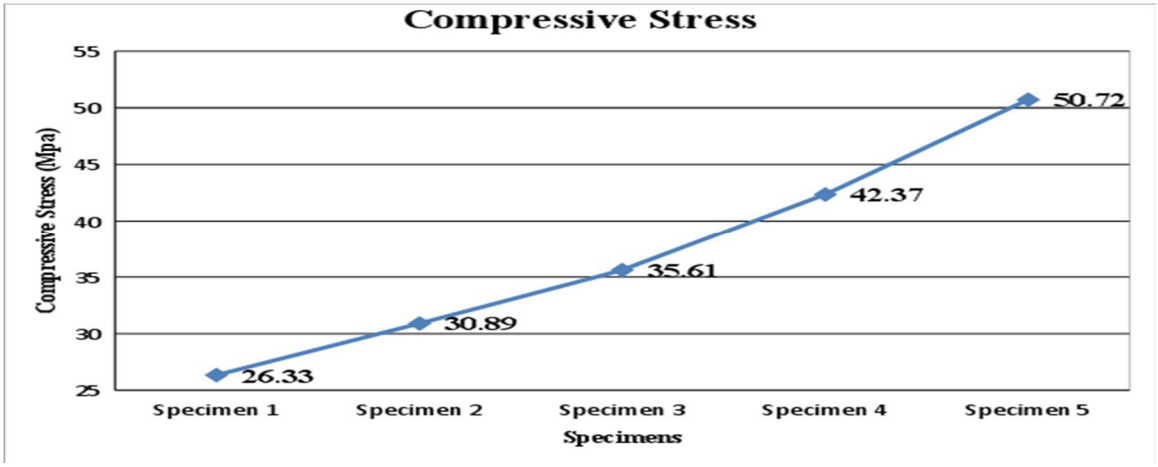
From the above flexural test graphs it is observed that specimen 5 i.e., epoxy resin filled with five grams of wollastonite and 4grams of jute fiber have highest flexural strength and highest flexural stress and highest flexural modulus than the remaining all the specimens.

C. Compressive Test Results

In the present work the compressive strength for the different specimen of system epoxy resin filled with wollastonite and jute fibre were checked in Universal Testing machine and the variation of compressive load and compressive stress and compressive modulus is tabulated in the table 3.3. And the graphs for compressive load and compressive stress and compressive modulus are also shown below separately.

Table 6. variation in Compressive Test Results

Specimens	Max. Compressive Load (KN)	Compressive Stress (Mpa)	Compressive Modulus (Mpa)
Specimen 1	3.33	```26.33	1836.62
Specimen 2	3.90	30.89	1999.650
Specimen 3	4.52	35.61	2576.92
Specimen 4	4.62	42.37	2976.34
Specimen 5	6.41	50.72	3919.71



Graph 5. Variations of Compressive Stress for different specimens at Maximum Compressive Load

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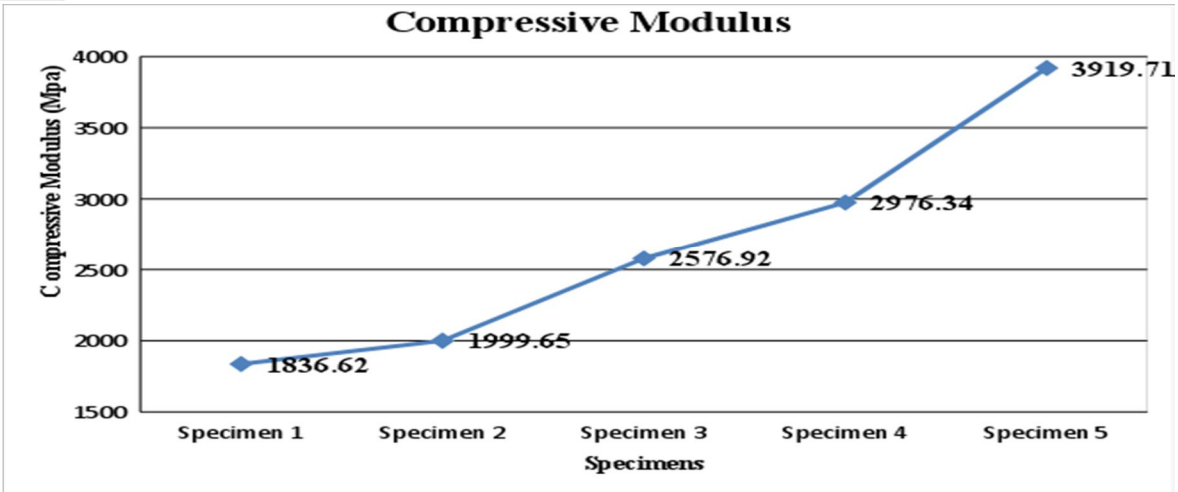

Graph 6: Variations of Compressive Modulus for different specimens at Young's Modulus

From the Graph 6 compression test graphs it is observed that specimen 5 i.e., epoxy resin filled with five grams of wollastonite and 4grams of jute fiber have highest compression strength and highest compression stress and highest compression modulus than the remaining all the specimens.

D. Chemical Treatment Test results

In the present work weights of the specimens are calculated before, after chemical treatment and change in percentage of weight is also calculated for each specimen by chemical treatment process. Chemical used in this treatment [30]process is Hydrochloric Acid (HCL). Following table shows the difference in weights for a chemical treatment for 24 hours

Table 7. Change in weight and change in percentage of weight for all the specimens

Specimen	*Weight Before Treatment (Gms)*	*Weight After Treatment (Gms)*	*Change In Percentage of weight (% change)*
Specimen 1	36.390	36.830	1.20
Specimen 2	32.330	32.680	1.08
Specimen 3	34.40	34.780	1.10
Specimen 4	42.930	43.270	0.79
Specimen 5	42.030	42.270	0.808

From the Table 7. we can observe that weight for each specimen is increased and increase in percentage of weight is calculated for all the specimens.

IV. CONCLUSION

A. The Tensile Strength for Specimen 5 (Epoxy filled with 5grams of wollastonite and 4grams of jute fibre) have more Tensile Strength while compared to all the specimens.

B. The Flexural Strength for Specimen 5(Epoxy filled with 5grams of wollastonite and 4grams of jute fibre) have more Flexural Strength while compared to all the specimens.

C. The Compressive Strength for Specimen 5(Epoxy filled with 5grams of wollastonite and 4grams of jute fibre) have more Compressive strength while compared to all the specimens.

V. ACKNOWLEDGEMENT

I thankful to Dr. Chandra Mohana Reddy. B Assistant Professor, Department of Mechanical Engineering, JNTUACE, Ananthapuramu, Andhra Pradesh for giving their valuable time to do this research guidance. And also Thanking you for JNTUA Library staff for which they permitted us to use their Digital library and Referring various project Thesis and Text books.

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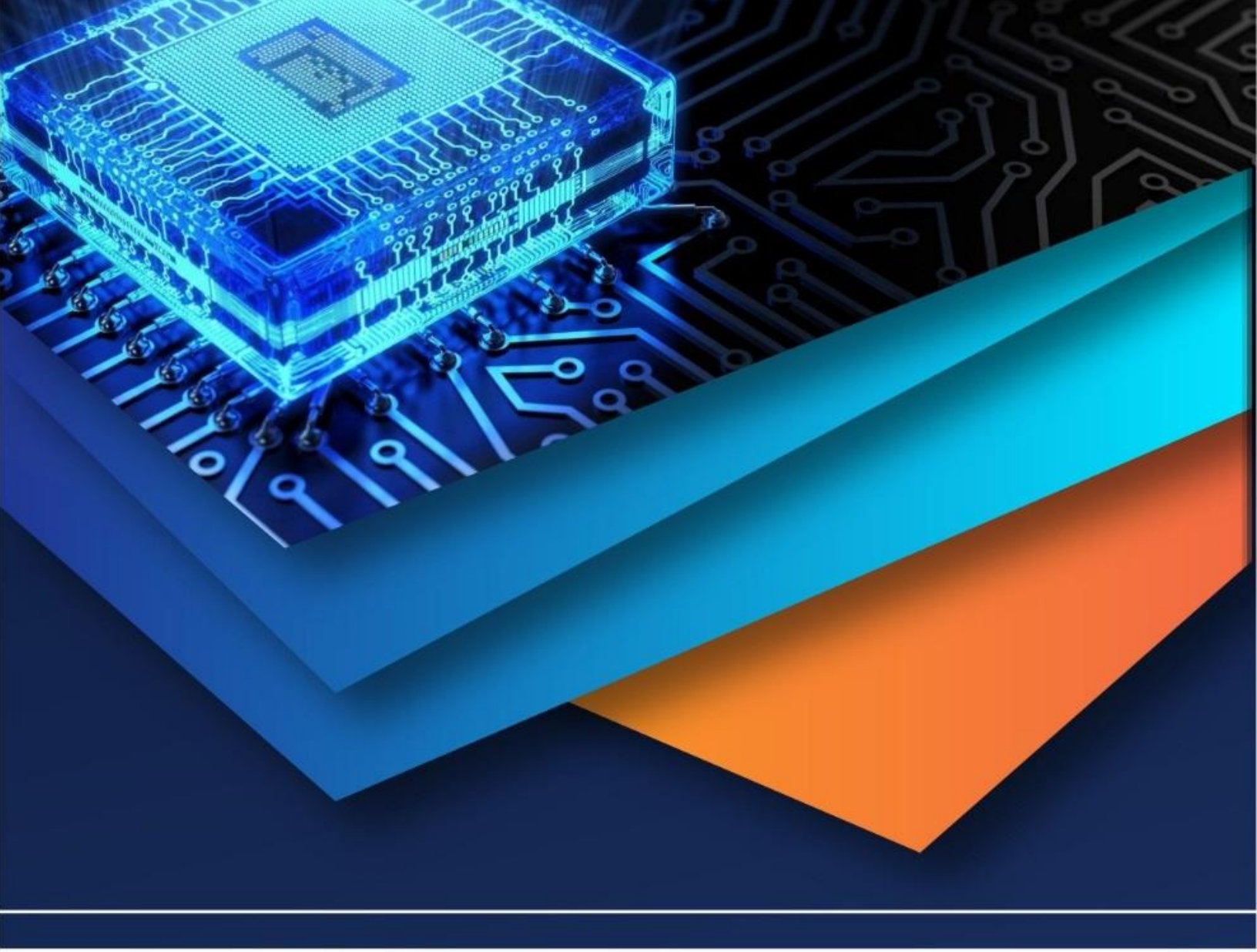

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