International Journal of Engineering Research And Advanced Technology (IJERAT)
ISSN:2454-6135 [Volume. 03 Issue.3, March– 2017]
www.ijerat.com

Experimental Investigation of Mechanical Properties for Tamarind Shell Particles as Filler in Epoxy Composite

Srinivas K. R.[1], Tariku Achamyeleh[2], Somanath B.[3], Murali K. B[4].
[1]Dept. of Mechanical Engineering.Debre Tabor University, Ethiopia, P.O-27
[2]Dept. of Mechanical Engineering.Debre Tabor University, Ethiopia, P.O-272
[3]Dept. of Mechanical Engineering.Madawalabu University, Ethiopia.
[4]Dept. of Mechanical Engineering, SIT, Mangalore, India

ABSTRACT:

This paper explores the potential of tamarind shell particles as a filler in epoxy composites. The tamarind shell particles reinforced epoxy composites plates were prepared by varying both tamarind shell particle and epoxy volume percentage. The mechanical properties such as tensile strength, deflection, impact, hardness and specific gravity are evaluated for different composition of composite plates.

KeyWords: *Tamarind shell, Polymer composite.*

1. INTRODUCTION

Generally Composite materials can be defined that are formed by the combination more materials to achieve better properties that are superior to those of their constituents. Polymer composites consist of a resin as the matrix, with filler particles as the reinforcement material. Considerable interest has been generated in the manufacture of polymer composites due to their unique properties, including their good mechanical properties, their thermal stability, and a reduced product cost. Due to the combination of more than one material, the properties of composites are influenced by many factors such as percentage of reinforcement, type of reinforcing particles,….etc. But the increase in concentration levels of heavy metals in the environment particularly in water is a cause for concern. The major contributor for this rise in the concentration level is in the extensive development of heavy & manufacturing industries that use metals & related compounds [3].Many fiber-reinforced polymers offer a combination of strength and modulus that are either comparable to orbetter than many traditional metallic materials. Becauseof their low density, the strength–weight ratios andmodulus–weight ratios of these composite materials aresuperior to those of metallic materials. In addition,fatigue strength as well as fatigue damage tolerance ofmany composite laminates are excellent. For thesereasons, fiber reinforced polymers have emerged as amajor class of structural materials and are either used orbeing considered for use as substitution for metals in many weight-critical components in aerospace, automotive, and other industries[1]. In recent years there is a perceived shortage of wood fibre for composite products due to competition for fibre by pulp mills, reduced harvesting and manufacturing and diminished log quality. Also, there is pressure from environmentalists to reduce forest use and regulatory legislation pending on disposal of agri-fibres [2]. Polymer matrix composites with bio-fillers have the potential to replace traditional materials. One of the advantages of use of fillers is that it can reduce the overall cost involved in development of composites because of reduced resin requirement. It also helps in improving toughness, mechanical and tribological properties [4]. For hybrid composites we can combine the fillers and fibers with the matrix material to get better properties [5].Hybrid composites gives the better tensile strength, flexural load carrying capacity [6]. The reinforcement materials in the polymer matrix composites increases the mechanical properties[7][8] and the geometry of the components also affect the mechanical strength[9].

2. COMPOSITE PREPARATION

Naturally and abundantly available material Tamarind fruit shell is used as a filler particle with the epoxy resin in the present work to prepare a composite material. The flow chart of preparation of Tamarind fruit shell Particles shown in figure 1.

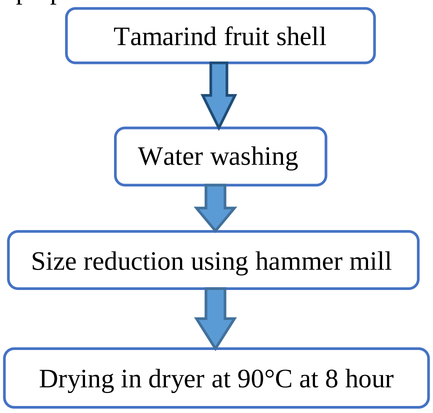

Fig. 1:Preparation of Tamarind fruit shell particles

Tamarind fruit shell is washed repeatedly with water to remove dust and soluble impurities. The contents are sun dried followed by oven drying at 90^0C. The dried tamarind fruit shell is converted into powder using a hammer mill, and sieved to obtain powder with average size of 100µ.

Known quantities of tamarind shell powder, B11 epoxy resin and hardener 140 were mixed thoroughly. Figure 2 shows the mould made of mild steel of dimension of 310×310×4 mm^3 of board, two frames of same dimensions were placed adjacently on the mould. Thoroughly mixed mixture of tamarind shell powder, hardener and epoxy resin was taken and placed in the mould uniformly. A layer of mould removal agent was placed both at the top and bottom of the board can be easily taken from the mould.

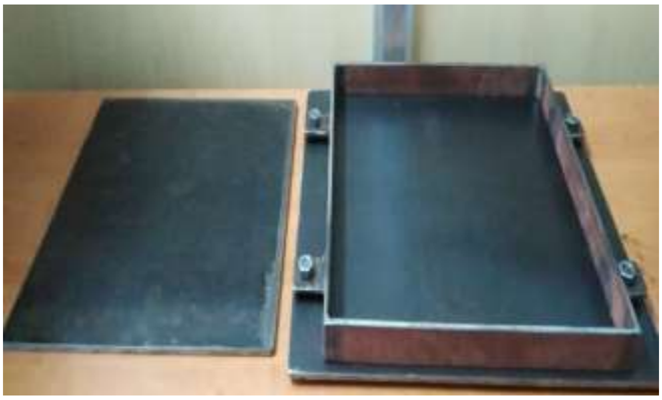

Fig. 2: Mould box

Table 1 represents the different composition of tamarind shell particle, epoxy and hardener by volume referred for the preparation composite plates used for this work.

Table 1: Composition of composite plate

Plate name	Percentage of Tamarind shell particle by volume	Percentage of epoxy and hardener by volume
A	80	20
B	70	30
C	60	40
D	50	50

Figure 3 shows the hydraulic cold press which is used to prepare the boards. The mould with the mixture of materials is placed in hydraulic press, which is maintained at room temperature, and then a pressure of 2bar is applied .The setup is maintained undisturbed about 24 hrs. Later, the mould is taken out and remove the composite plate from the mould.

Fig. 3: Cold press

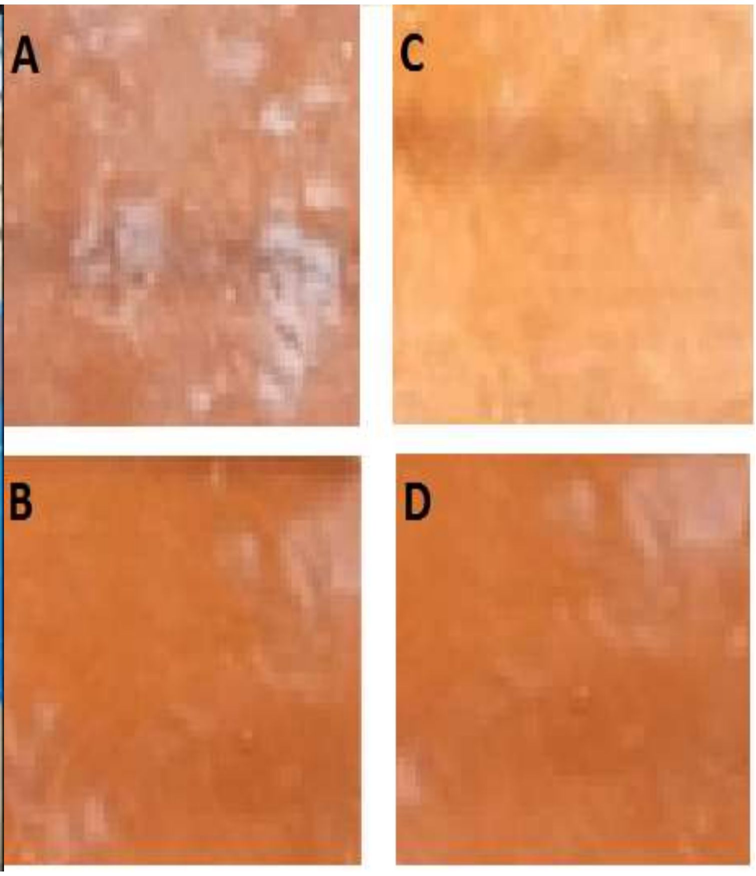

Fig. 4: Prepared composite plates

Figure 4 shows the prepared composite plates, this plates were used to prepare the test specimen according to ASTM standards.

3. EXPERIMENTATIONS

Following are the types of test conducted on the specmens

a. Tensile test
b. Three-point bending test
c. Charpy impact testing
d. Hardness
e. Specific gravity

3.1 Tensile test: The specimen prepared as per the Type 1 ASTM D638 standard is placed in the UTM with the arrangements of the jigs, as the setup is clear, a constant state of loading is applied on the either side of the specimens which are equal and opposite direction. The dimensions are shown in figure 5.

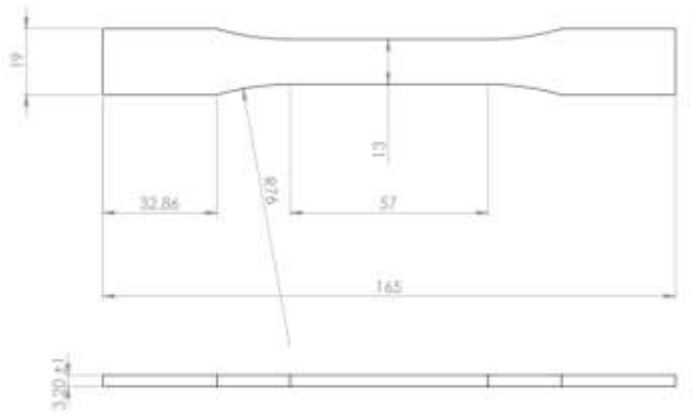

Fig. 5:Type 1 ASTM D638 Tensile specimen

3.2 Three-Point Bending: According to ASTM D790 standard the composite specimens were prepared for bending test. Each test specimen of 12.7mm width, length 125mm and thickness 3.2mm as shown in figure 6 were prepared. The specimen is loaded at the center of the span through a loading cell. The test is carried until the specimen completely fails.

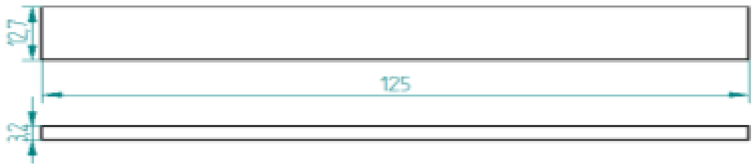

Fig. 6:ASTM D790 Bending specimen

3.3 Charpy impact testing: Impact testing is an ASTM standard method of determining impact resistance of materials. An arm held at a specific height (constant potential energy) is released. The arm hits the sample. The specimen either breaks or the weight rest on the specimen. From the energy absorbed by the sample, its impact energy is determined. A notched sample is generally used to determine impact energy and notch sensitivity. Figure 7 shows the ASTM D256 standard for impact test.

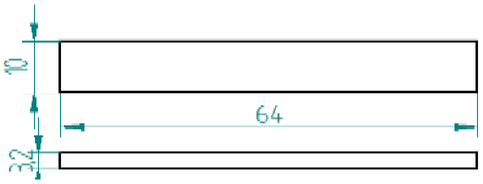

Fig. 7:ASTM D256 Impact test specimen

3.4 Hardness testing:A standard specimen is placed on the surface of the Rockwell Hardness tester. A minor load is applied and the gauge is set to zero. The major load is applied by tripping a lever. After 15 seconds the major load is removed. The specimen is allowed to recover for 15 seconds and then the hardness is read off the dial with the minor load still applied. The standard specimen for ASTM D785 is shown in figure 8.

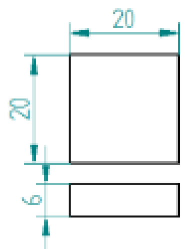

Fig. 8: ASTM D785 Hardness test specimen

3.5 Specific gravity: The broken samples of impact test can be utilized for specific gravity.

4. RESULTS AND DISCUSSION

4.1 Tensile test: Tensile test is conducted for all the 4 composite plates, results are discussed below.

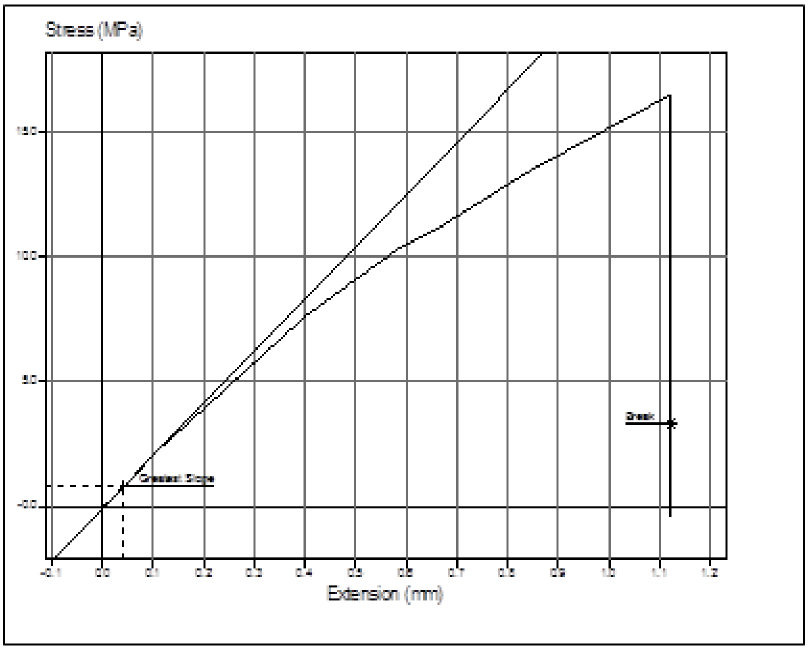

Fig. 9: Stress-strain curve for composite plate-A

Figure 9 represents the plot of tensile test on composite plate-A and it is found that the maximum load carrying capacity is 0.46kN for the deflection of 0.67mm and stress at maximum load is 10.16MPa and the young's modulus is 2658.093MPa.

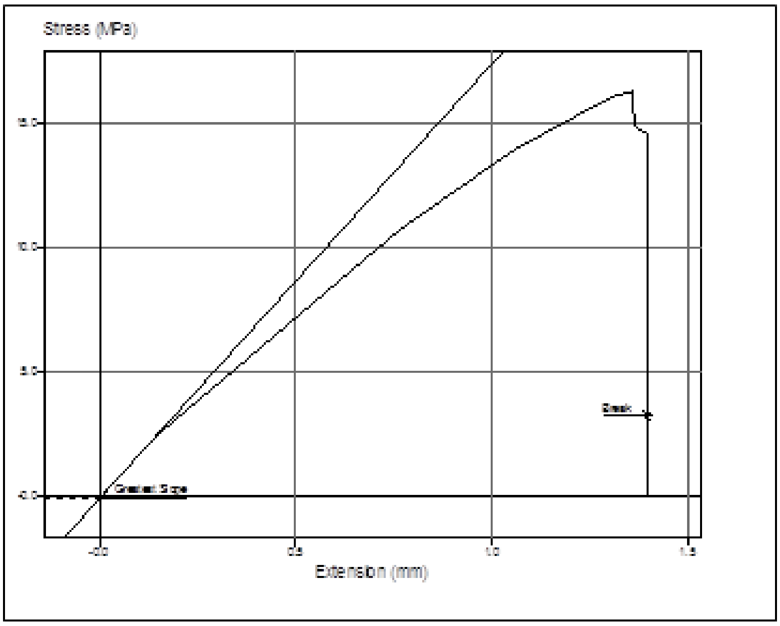

Fig. 10: Stress-strain curve for composite plate-B

Figure 10 represents the plot of tensile test on composite plate-B and it is found that the maximum load carrying capacity is 0.78kN for the deflection of 1.35mm and stress at maximum load is 16.3MPa and the young's modulus is 2011.986MPa

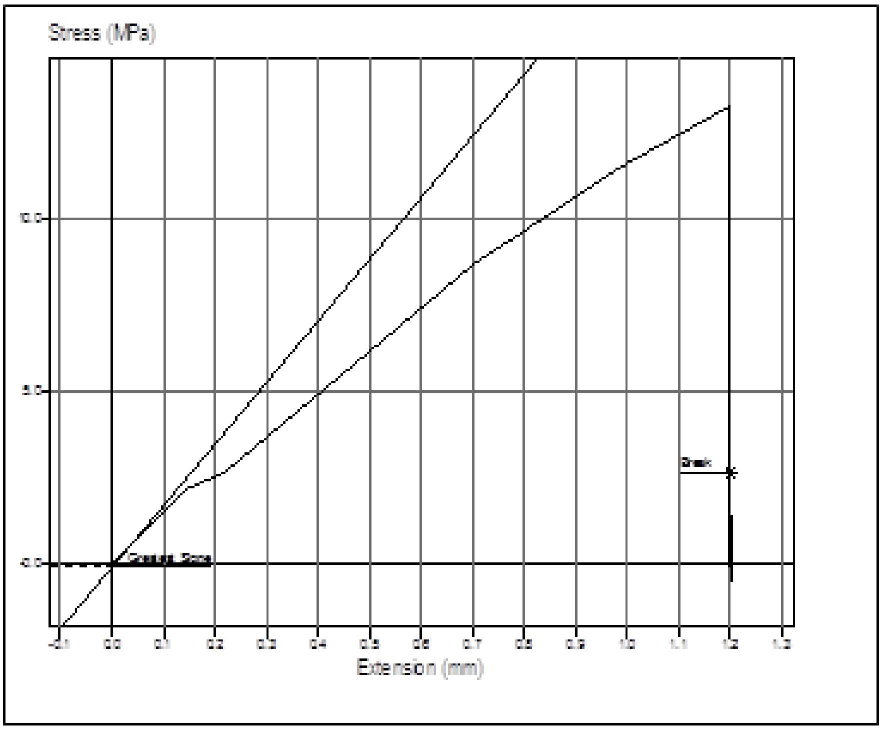

Fig. 11: Stress-strain curve for composite plate-C

Figure 11 represents the plot of tensile test on composite plate-C and it is found that the maximum load carrying capacity is 0.517kN for the deflection of 1.12mm and stress at maximum load is 13.2MPa and the young's modulus is 2049.477 MPa.

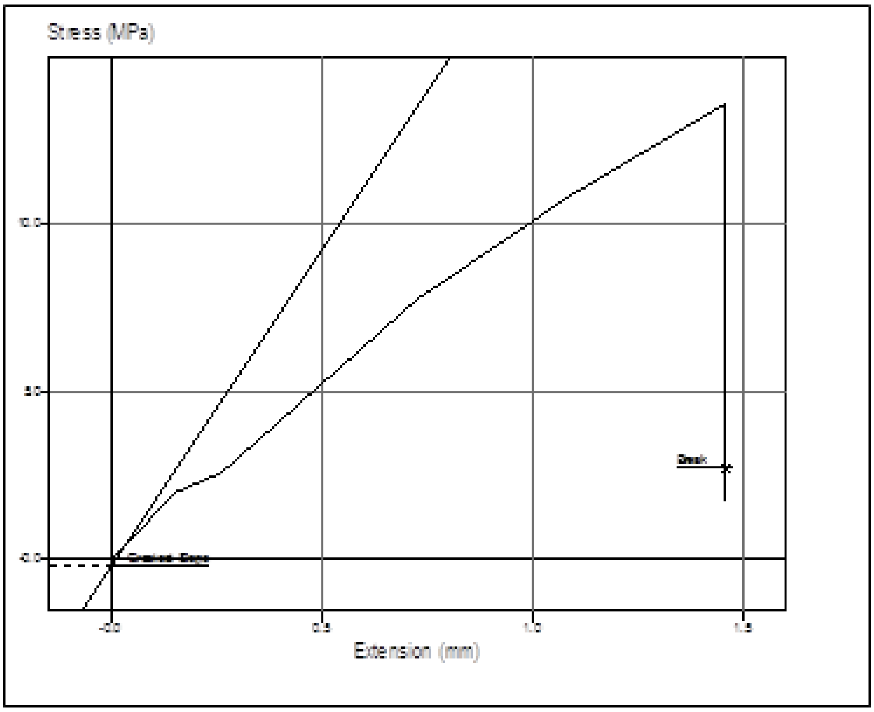

Fig. 12: Stress-strain curve for composite plate-D

Figure 12 represents the plot of tensile test on composite plate-D and it is found that the maximum load carrying capacity is 0.51kN for the deflection of 1.45mm and stress at maximum load is 13.6MPa and the young's modulus is 2175.111 MPa.

4.2 Three-point bending test: 3-point bending is conducted for all the 4 composite plates, results are discussed below.

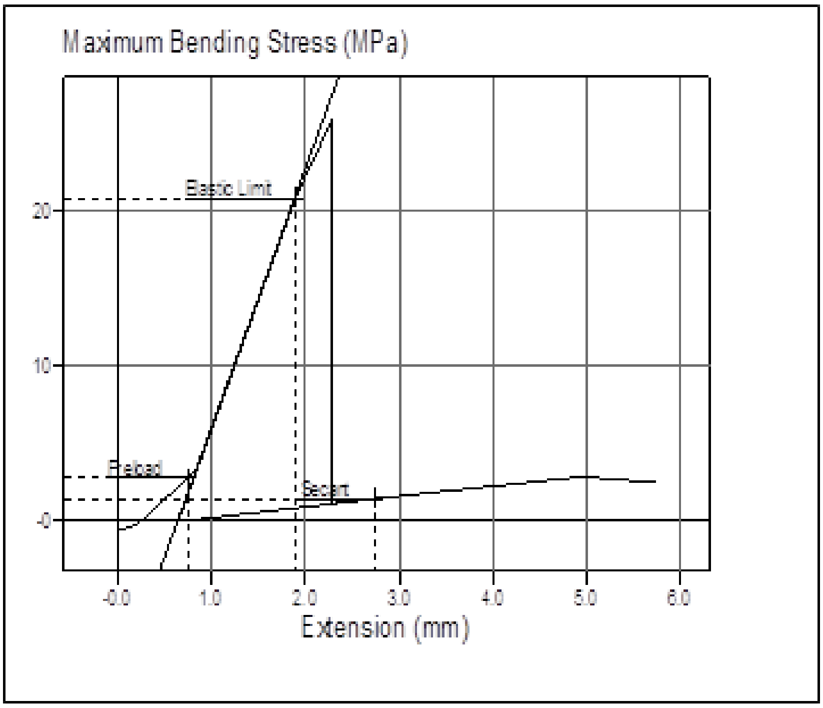

Fig. 13: Stress- strain curve for composite plate-A

Figure 13 represents the plot of bending test on composite plate-A and it is found that the maximum load carrying capacity is 61.38N for the deflection of 5mm and bending stress at maximum load is 25.86MPa and the young's modulus is 1874.39 MPa.

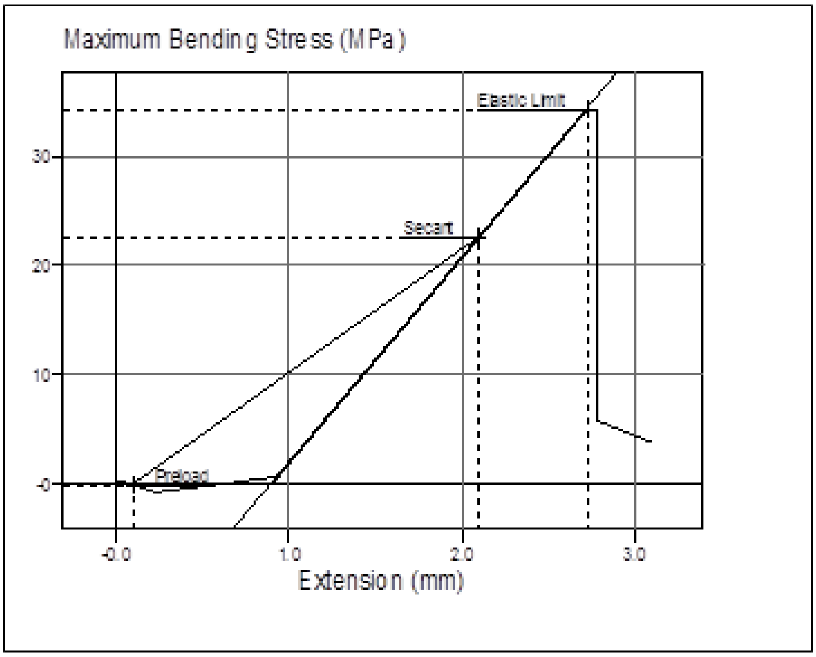

Fig. 14: Stress- strain curve for composite plate-B

Figure 14 represents the plot of bending test on composite plate-B and it is found that the maximum load carrying capacity is 68.15N for the deflection of 2.99mm and bending stress at maximum load is 34.26MPa and the young's modulus is 2371.26 MPa.

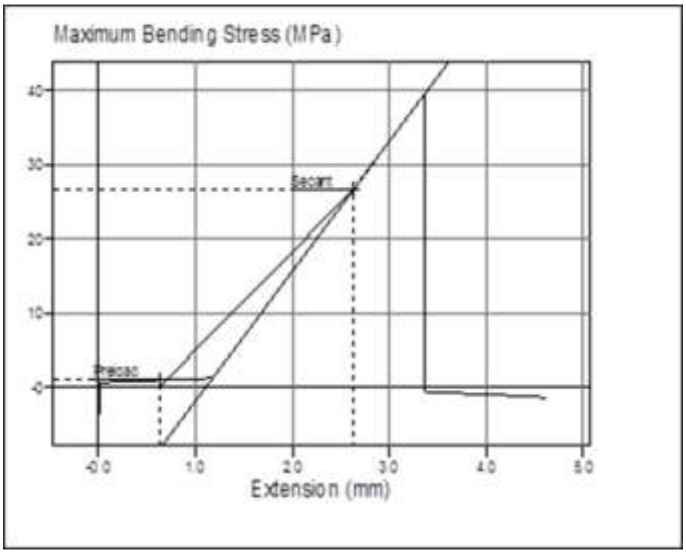

Fig. 15: Stress- strain curve for composite plate-C

Figure 15 represents the plot of bending test on composite plate-C and it is found that the maximum load carrying capacity is 56.76N for the deflection of 4mm and bending stress at maximum load is 39.63MPa and the young's modulus is 2609.53 MPa.

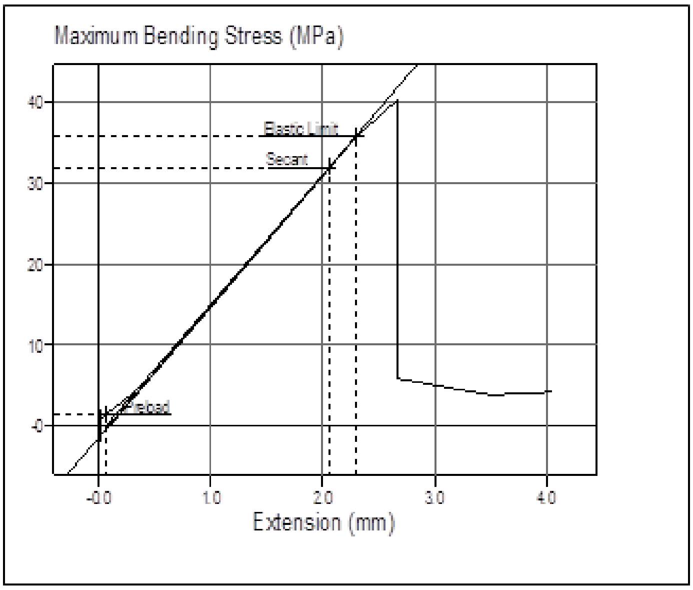

Fig. 16: Stress- strain curve for composite plate-D

Figure 16 represents the plot of bending test on composite plate-D and it is found that the maximum load carrying capacity is 62.44N for the deflection of 4mm and bending stress at maximum load is 40.35MPa and we found young's modulus as 2326.35 MPa.

4.3 Charpy impact testing: Table 2 represents the impact test results on various composite plates of varying composition, it is found that the composite plates 1 and 3 of composition 80% of tamarind and 20% of epoxy resin and 60% of tamarind and 40% of epoxy has the highest impact strength of 4.9J/m.

Table 2: Impact strength of various composite plates

Composite plate	**Impact results in J/m**
A	4.90
B	4.30
C	4.90
D	3.68

4.4 Hardness: Table 3 shows the results of hardness test on various composite plates of varying composition, it is found that the composite plate 2 of composition 70% of tamarind and 30% of epoxy resin has the highest hardness of 94 and composite plate 4 of composition 50% of tamarind and 50% of epoxy resin has a least hardness of 66.25.

Table 3: Hardness of various composite plates

Composite plate	Hardness in M-scale
A	70.50
B	94.00
C	82.25
D	66.25

4.5 Specific gravity: Table 4 represents the specific gravity of various composite plates of varying composition, it is found that the composite plate 2 of composition 70% of tamarind and 30% of epoxy resin has the highest value of 1.1180 and composite plate 4 of composition 50% of tamarind and 50% of epoxy resin has a least value of 1.0272.

Table 4: Specific gravity of various composite plates

Composite plate	Specific gravity
A	1.0690
B	1.1180
C	1.0673
D	1.0272

5. CONCLUSION:

By comparing the tensile strength, bending strength, hardness, impact, specific gravity for composite plates, it is found that:

1. The tensile strength of composite plate-A of composition 80% of tamarind shell particle and 20% of epoxy resin has better load carrying capability compared to other three configurations.
2. In bending, the composite plate-C of composition 60% of tamarind shell particle and 40% of epoxy resin has better load carrying capability compared to other three configurations.
3. From the impact test, it is found that the composite plates-A of composition 80% of tamarind shellparticle and 20% of epoxy resin has better impact strength compared to other two plates.
4. For hardness test, the composite plate-B of composition 70% of tamarind shell particle and 30% of epoxy resin has the better hardness.
5. The specific gravity test of the composite plate-B of composition 70% of tamarind shell particle and 30% of epoxy resin has more specific gravity compared to other three configurations.

REFERENCES

1. Senthil J, MadanRaj.P, "Preparation and Characterization of Reinforced Egg Shell PolymerComposites" International Journal on Mechanical Engineering and Robotics (IJMER), ISSN (Print) : 2321-5747, Volume-3, Issue-3,2015
2. S.B. Hassan, V.S. Aigbodion, S.N. Patrick, "Development of Polyester/Eggshell Particulate Composites" *Tribology in Industry Vol. 34, No. 4 (2012) 217-225*
3. S. L. Pandharipande, Rohit P. Kalnake, "Tamarind Fruit Shell Adsorbent Synthesis, Characterization And Adsorption Studies For Removal Of Cr(Vi) & Ni(Ii) Ions From Aqueous Solution" International Journal of Engineering Sciences & Emerging Technologies, Feb. 2013.ISSN: 2231 – 6604, Volume 4, Issue 2, pp: 83-89 ©IJESET
4. Suhas Y. Nayak, SrinivasShenoy H., Pratul Sharma, IqbalAman, SukantaDey, "Use Of Egg Shell Particulate As Fillers In E-Glass/Epoxy Composites", *Proceedings of International Conference on Mechanical Engineering and Industrial Automation Held on 21-22, Nov, 2015, in Dubai, ISBN:97881931373 21*
5. K.Kannapiran, K.Rajchander, K.Nirmalkumar, "Analysing Mechanical Properties of Natural Fibers Reinforced With Egg Shell" International Conference on Engineering Trends and Science & Humanities (ICETSH-2015)
6. Kiran R. Garadimani, G. U. Raju, K. G. Kodancha, "Study on Mechanical Properties of Corn Cob Particle and E-Glass Fiber Reinforced Hybrid Polymer Composites" American Journal of Materials Science 2015, 5(3C): 86-91
7. Srinivas, K. R., PremkumarNaik, and B. Somanath. "Experimental Comparison of E-Glass Fiber Reinforced Thermosetting and Thermoplastic Composites for Tensile Strength." International Journal for Scientific Research and Development. Volume-3 Issue-9, Nov. 2015
8. Shantharaja, M., &Srinivas, K. R. Comparison of Riveted Panel and Integral Panel for Damage Tolerance by Using FEA. International Journal for Science and Research, Volume 3 Issue 9, September 2014: 426-431.
9. Naik, Premkumar, et al. "A Study of Short Areca Fiber and Wood Powder Reinforced Phenol Formaldehyde Composites." *American Journal of Materials Science* 5.3C (2015): 140-145.