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Mechanical Conduct on Banana Fiber Fortified Polymer Composite with the Effect of Fiber Stacking and Length of Fiber on the Properties of Composites

Guruji Ramakrishna, G. R. Selokar

Abstract: ***In view of the growing normal concerns, bio composite delivered out of customary fiber and polymeric tar, is one of the late headways in the business and comprises the present degree of experimental work. The utilization of composite materials field is expanding bit by bit in designing. The composite comprises of fundamentally two stages for example grid and fiber. The availability of trademark fiber and effortlessness of amassing have allured researchers worldwide to endeavour by local benchmarks open cheap fiber and to learning their reachability of fortress judgments and to what degree they satisfy the obliged specifics of extraordinary fortified polymer composite went for basic order. Fiber fortified polymer composites has various inclinations, for instance, by and large negligible exertion of creation, easy to create and preferred quality difference over immaculate polymer tars due with this reason fiber reinforced polymer composite used inside a combination of arrangement as class of structure material. This work depict the mechanical conduct of banana fiber fortified polymer composite with the remarkable references to the effect of fiber stacking and length of fiber on the properties of composites.***

Keywords: Mechanical Tests, Banana Fiber, Groundnut Shell Ash.

I. INTRODUCTION

In the course of the most recent thirty years composite materials, plastics and earthenware production have been the overwhelming developing materials. The volume and number of utilizations of composite materials have developed consistently, entering and vanquishing new advertises tirelessly. Present day composite materials establish a critical extent of the designed materials market running from regular items to refined applications. While composites have officially demonstrated their value as weight-sparing materials, the present test is to make them savvy.

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* Correspondence Author
Guruji Ramakrishna, Research Scholar, Department of Mechanical Engineering, Sri Satya Sai University of Technology and Medical Sciences, Sehore, Madhya Pradesh, India, Email: ggkrishna999@gmail.com
Dr. G.R.Selokar, Registrar and Professor, Department of Mechanical Engineering, Sri Satya Sai University of Technology and Medical Sciences, Sehore, Madhya Pradesh, India. Email: selokar1960dr@gmail.com

Review of fiber and Composites the fascination in using regular fiber, for instance, particular wood fiber and plant fiber as help in plastics has extended definitely all through most recent couple of years. Concerning the biological perspectives if normal filaments may be used as opposed to glass strands as fortress in some basic arrangements it may be amazingly charming.

Normal strands have various focal points stood out from glass fiber, for example they have low thickness, and they are biodegradable and recyclable. Additionally, they are inexhaustible unrefined materials and have commonly extraordinary quality and solidness. A composite material is made from at least two individual materials with various physical and concoction properties. The various properties of materials consolidated to shape new materials which have the huge highlights of individual materials. The individual materials are constantly independent and particular with the new material. The completed or new material has specific attributes, for example, light weight, solidness, quality and ease. The composite material is the blends of grid and strengthening materials or specialists.

II. PROBLEM DEFINITION

In this exploration work the reasonableness of banana fibers as strengthening specialist in three unique sizes to be specific short fiber, full scale and small scale molecule for epoxy framework composite material. The banana fiber small scale, full scale and short fiber reinforced with epoxy grid composites are set up by pressure forming system. The molecule size, substance and scattering of the fiber are the significant capacities in the mechanical properties. The water assimilation qualities of the large scale molecule reinforced with epoxy composites are considered. The machining attributes of the banana smaller scale, large scale molecule and short fiber reinforced with epoxy lattice composites are likewise thinks about in this examination work.

III. RESEARCH METHODOLOGY

The experimental arrangement and the materials are utilized for the investigation of banana fibre smaller scale, large scale and short fibre reinforced epoxy network composites.

The banana fibre are made into small scale molecule at the molecule size went between 1-10 microns.

The epoxy sap (LY 556) and the hardener (HY 951) are utilized in this examination. The consequences for mechanical properties of banana fibre small scale molecule reinforced with epoxy framework composites are assessed. At that point the banana fiber is set up into large scale molecule at the molecule size between 10-100 microns which is likewise assessed on mechanical properties. These small scales and large-scale particles are contrasted and the short fibre reinforced with epoxy lattice composites.

The water assimilation practices are examined in the large scale molecule reinforced epoxy composites. At that point the miniaturized scale, large scale molecule and short fiber reinforced with epoxy network barrel shaped composite of 50 mm length and 30 mm measurement are set up to assess the machining attributes of the composites.

3.1 MATERIALS

Banana fibers are separated from the pseudo-stem of the banana plant (Musa Sepientum) mechanically and they are cleaned physically. At that point, the fibers with the thickness of 1.35 g/cm3, rigidity of 54 MPa, and Young‟s modulus of 3.49 GPa are (Srinivasan et al. 2014) squashed as fine particles by a devastating machine. From that point forward, the fine particles are isolated physically by a sieving machine at a normal size of 1-10 microns and 10-100 microns. 1-10 microns are considered as smaller scale molecule and the 10-100 microns particles are considered as full scale molecule. The short fiber with the length of 10 mm is additionally arranged for this investigation. The epoxy pitch i.e., diglycidyl ether of biphenyl-A (LY 556) with hardener i.e., triethylenetetramine (HY 951) is utilized as polymer framework in this examination. All synthetic substances utilized in this investigation are acquired from the GVR Enterprises, Madurai, Tamilnadu, India. The run of the mill properties of the epoxy gum (C18H21ClO3) utilized in this investigation are given in Table 3.1. (Sapuan et al. 2006 and Suresh Kumar et al. 2014)

3.2 PREPARATION OF BANANA FIBERS IN PARTICLE FORM

The banana fibers are extricated from the pseudo-stem sheath of the banana plant by a mechanical procedure. At that point they are hacked utilizing etch physically, from that point onward, they are squashed utilizing blend processor. At last, the squashed particles are sieved with micron openings to use for the preparation of composites. The miniaturized scale particles with the normal size of 1-10 microns and full scale molecule with the normal size of 10-100 micron and short fiber cut into 10 mm fiber lengths are utilized for this examination.

3.3 PREPARATION OF COMPOSITES

For the creation of composites, the pressure embellishment machine accessible in our composite research center was utilized. The machine has the metal shape with the size of 290 mm × 290 mm × 3 mm, preceding the procedure; a discharging specialist is showered into the form box to guarantee the simple evacuation of the restored composites. Epoxy tar (LY 556) and hardener (HY 951) are blended 10:1 ratio with particulates and afterward it is mixed by a mechanical stirrer. At that point the blend was filled the shape and compacted at 103 bars with 80ºC for 45 minutes. In the wake of restoring, the composites are expelled from the form and slice into example size as indicated by the ASTM standard for mechanical tests.

IV. EXPERIMENTATION

4.1 Tensile Test

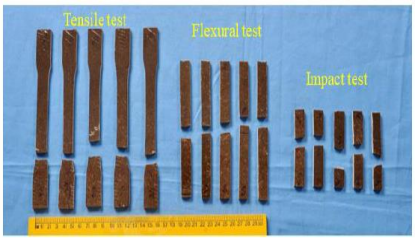
The rigidity of a material is the most extreme measure of elastic pressure that it can take before disappointment. The example was estimated by the ASTM: D3039 standard (American Society for Testing of Materials) (ASTM D 3039 2000). The two parts of the bargains were braced between the jaws. The ductile power was created in the example by the development of the jaws. The power dependent on the measure length was recorded. Tractable test was done in the Universal Tensile Tester (DTRX-30KN DEEPAK POLY PLAST PVT LTD). The examples were tried at a stacking pace of 2mm/min. For each situation, five examples were tried with the elements of 250 mm × 25 mm × 3 mm. The heap was connected and the relating diversions were recorded. Burden was connected until the example got broken. The break burden and extreme elasticity were noted.

4.2 FLEXURAL TEST

Flexural test forced elastic weight on the raised side and compressive weight on the curved side of the example. It caused shear worry along the middle line. This test was done in a three point flexural arrangement in the KALPAUK UNIVERSAL TESTING MACHINE (Model KIC-2-1000-C limit 100KN). The example was bowed and cracked when the heap was connected at the center of the bar. The example was cracked and broke at a pace of 2mm/min. The greatest burden at disappointment was utilized to figure the flexural stress. The examples were set up according to ASTM: D790 (ASTM D 790 2010) standard with the component of 125 mm × 13 mm × 3 mm.

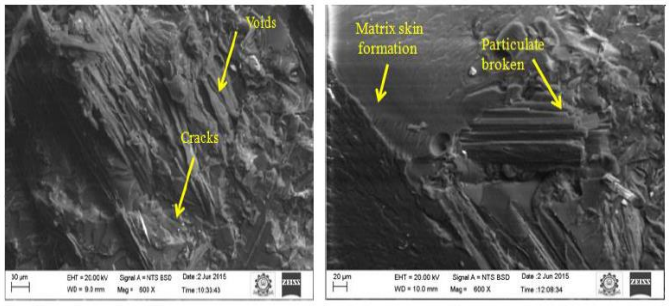
4.3 IMPACT TEST

Impact test decides the ability of material to withstand all of a sudden connected burden. The impact quality of the composite examples was tried in izod impact test rig. The quantitative after effect of impact test estimated the motor vitality expected to start the crack and to proceed until the breakage of the example. The tests were directed according to ASTM: D 256 (ASTM D 256 2005). The test composite example was found vertically in the grippers. The example was broken because of the blow of the pendulum from one side with dynamic vitality. The measure of vitality ingested during the breaking of example was noted. In each test five examples were tried with the components of 65 mm × 13 mm × 3 mm and the normal worth was determined.



4.4 MICRO STRUCTURE ANALYSIS USING SEM

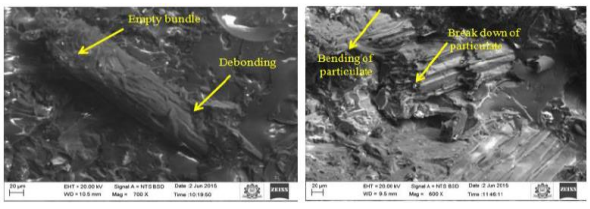
The SEM was utilized to watch the disappointment system on the crack surface of composites. Figure 3.12a demonstrates the SEM picture of a broke surface of 25 wt% composite after the elastic test. It unmistakably demonstrates that the development of splits is because of the poor grip between the molecule and the epoxy pitch. Along these lines, the pressure move between the molecule and the grid is non uniform which prompts the disappointment of the composite. Figure 3.12b demonstrates the SEM picture of a broke surface of 35 wt% composite after the pliable test. It shows that despite the fact that there are some lattices broken in certain spots, the framework skin arrangement is additionally found in different spots. Henceforth, the general holding between the molecule and the epoxy framework is observed to be better.



(a) **(b)**

Figure 2. SEM images of micro particle/epoxy composites (a) 25 wt% composite (b) 35 wt% composite after the tensile test

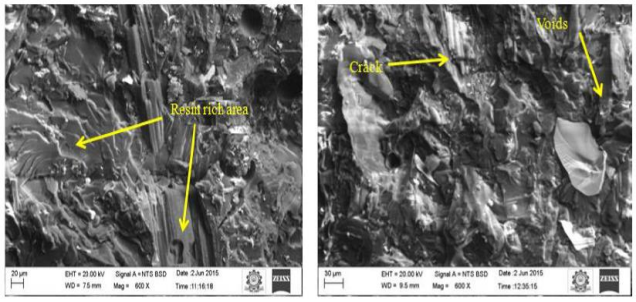
In Figure 2a, the SEM picture of a cracked surface of the flexural test example was appeared and it unmistakably demonstrates that the de-holding of the particles causes the poor interfacial attachment between the particles and the epoxy lattice. Figure 2b likewise demonstrates the vacant molecule, where the gum doesn't infiltrate in the heap of the molecule, which is because of the de-holding. Figure 3a demonstrates the broke surface of the 35 wt% composite examples after the flexural test. It demonstrates a decent holding territory between the molecule and the epoxy network. The pullouts of particles are because of the de-holding from the lattice which is appeared in the Figure 3b.



(a) **(b)**

Figure 3. SEM images of micro particle/epoxy composites (a) 25 wt% composite (b) 35 wt% composite after the flexural test.

In Figure 4a, the SEM examination uncovers that there are no voids and tearing because of the better interfacial quality between the molecule and the grid, which results in increment of impact quality. Figure 4b, demonstrates the broke surface of 35 wt% composite examples after impact test. It displays split and voids. Because of this, the composite examples ingest lower impact vitality.



(a) **(b)**

Figure 4. SEM images of micro particle/epoxy composites (a) 25 wt% composite (b) 35 wt% composite after impact test.

4.5. WATER ABSORPTION PERCENTAGE OF MICRO PARTICLE/EPOXY COMPOSITES

This investigation assesses the water assimilation conduct of miniaturized scale molecule reinforced epoxy grid composites. Figure 13 demonstrates the ocean water submersion of small scale, large scale molecule and short fiber/epoxy composites (25, 30, 35 wt%).

Figure 13. Digital image of the water absorption specimens (micro, macro particle and short fiber composites) immersed in the sea, distilled and tap water.

The small-scale molecule with 25wt% composite example has the underlying load of 0.3249 mg. The example was drenched in ocean water for 24 hours and the heaviness of the example was estimated again and it demonstrates 1.54% higher than the underlying load of the example. A similar method is pursued for 552 hours. The heaviness of the example is expanded to 5.42 %. It unmistakably demonstrates that the molecule brought about the water due to the hydro phallic nature. A similar example drenched into the refined water for 552 hours and the heaviness of the example expanded to 8.5%. The purpose behind the expansion in the water ingestion rate is because of attachment between the molecule and the grid. Again a similar example is plunged into the faucet water for 552 hours and the weight rate is expanded to 7.7%. In this way, the water assimilation conduct of the molecule changed because of the voids and the breaks in composites.

The miniaturized scale molecule with 30wt% composite example has the underlying load of 0.3812 mg. After it was inundated in the ocean water for 24 hours, the heaviness of the example was expanded up to 0.3399 mg. The level of water ingestion following 24 hours is expanded to 2.4%. At that point the example is drenched for 552 hours. The weight directly expanded and the level of water ingestion is 7.4%. A similar example is drenched into the refined water for 552 hours and the rate expanded to 6.3%. Again a similar example is placed into the faucet water for 552 hours the weight expanded to 7.65%. The expansion in water retention rate because of the split and voids present in the composites. The 35wt% of the small scale molecule composite example demonstrates the underlying load of 0.3414 mg and after that the example are drenched in the ocean water for 24 hours. The heaviness of the wet example is estimated and it demonstrates 0.3594 mg. It is 3.4% higher than the underlying load of the example. A similar example is inundated for 552 hours and the heaviness of the example is expanded to 10.1%. It is because of the molecule level of the example. So also, the 35wt% of the example is submerged into the refined water for 552 hours the heaviness of the example is expanded to 10.13%. The expanded in weight level of the refined water drenched example cause for powerless glue between the molecule and the grid. Again, the example is tipped into the faucet water for 552 hours the weight is expanded to10.4%. Here, the heaviness of the example is additionally expanded because of the smaller scale breaks and the voids present in the composite example.

4.6. WATER ABSORPTION PERCENTAGE OF MACRO PARTICLE/EPOXY COMPOSITES

The water assimilation qualities were assessed in the full-scale molecule reinforced epoxy composites. Figure 13 demonstrates the water retention level of small scale, large scale molecule and short fiber/epoxy grid composites (25, 30, 35wt%) in refined water.

The full scale molecule reinforced epoxy composite example with 25wt% composite dry example weight was 0.2819 mg and the example submerged in the faucet water for 24 hours. At that point the heaviness of the example is 0.3378 mg. In this way, the weight rates were expanded up to 19.82% higher than the underlying load of the example. The hour of inundation is expanded as long as 552 hours and the heaviness of the composite is expanded to 25.18%, which is higher than the underlying load of the example. It demonstrates that the water ingestion rate is expanded because of the molecule content. So also, the underlying load of 25wt% composite example is 0.2782 mg and it was dunked in the ocean water for 24 hours. The heaviness of the composite expanded to 0.325 mg that is 16.18% higher than the dry example. A similar example is consistently submerged for 552 hours the weight rate is expanded up to 27.4%. At that point the 25wt% of the example is drenched into the refined water for 552 hours and its weight is expanded up to 26.85%. It is higher than the underlying weight (0.2792 mg) of the composite example.

At that point the 30wt% of the composite example is inundated into the refined water for 24 hours. The heaviness of the composite expanded to 0.391mg that is 26.01% higher than the underlying load of the composites (0.3103 mg). Further, the composites are inundated for 552 hours and the heaviness of the composite is expanded to 32.42%. The expansion in weight rate is because of the level of molecule content. A similar composite example is tipped into the faucet water for 24 hours. The weight rate is expanded to 28.54% than the example tipped into the faucet water for 552 hours. The weight rate is expanded up to 32.42%. Again, the 30wt% composite example is tipped into the ocean water for 24 hours, and the weight rate is expanded to 20.9%. The example is consistently drenched for 552 hours. In this way, the weight rate is expanded up to 27.9%.

The underlying load of 35wt% example is 0.2919 mg. It is drenched into the refined water for 24 hours and the weight is expanded to 0.3532 mg. That is 21% higher than the underlying load of the example. The drenching time is expanded to 552 hours and the weight % is expanded to 23.8%. The composite example is tipped into the faucet water for 24 hours. The weight rate is expanded to 22.5% from the underlying load of the composites. The inundating time is expanded to 552 hours and the composite weight rate is expanded to 26.9%. Again the composite example is tipped into the ocean water for 24 hours and the weight is expanded to 0.3928 mg that is 19.5% higher than the underlying weight (0.3286 mg) of the composites. The composite example is drenched for 552 hours and the weight rate is expanded to 28.3%.

4.7 WATER ABSORPTION PERCENTAGEOF SHORTFIBER/EPOXY COMPOSITES

The figure 13a demonstrates the water assimilation level of smaller scale, large scale molecule and short fiber/epoxy grid composites (25, 30, 35wt%). The underlying load of the banana short fiber reinforced epoxy composite with 25wt% example is 0.298 mg.

It is submerged in the ocean water for 24 hours.

At that point the dissemination rate is expanded and the heaviness of the example is expanded to 0.375mg. It is 25.83% higher than the underlying load of the example. This procedure proceeded for 552 hours. At that point the weight rate is expanded to 42.81%. The underlying load of 30wt% composite example is 0.3001mg. At that point it was submerged into the ocean water for 24 hours. The weight is expanded to 0.382 mg, that is really 27.27% higher than the underlying load of the example. At that point the drenching of example is expanded to 552 hrs the water take-up rate expanded to 42.65%.

At that point the 35wt% composite example is drenched into the seawater. The heaviness of the example is weighted following 24 hours, the weight rate is expanded up to 30.06%. Again the example is inundated into the seawater for 552 hours. The all out weight of the example is expanded to 49.63%. The 35wt% composite example demonstrates the most elevated water admission capacity tantamount to miniaturized scale and full scale molecule reinforced with epoxy composite example. It obviously demonstrates that the qualities of water ingestion are expanded dependent on the fiber content.

Additionally, the hydrophilic idea of cellulose fibers ingests more water particles.

The 25 wt% of the banana short fiber reinforced with epoxy composite example is weighted in wet condition as 0.2764 mg.

At that point the example is submerged in the faucet water for 24 hours and the weight is expanded to 0.355 mg. A similar example is drenched in the faucet water for 552 hours and the weight% of the example is expanded to 35.20%.

The 30wt% of the banana short fiber reinforced with epoxy composite example is inundated in the faucet water for 24 hours. The heaviness of the composite expanded to 0.3754 mg, which is 31.39% higher than the underlying weight (0.2857 mg) of the composite example. At that point the weight level of the example is estimated following 552 hours. It is expanded to 40.01%.

The underlying load of the 35wt% composite example is 0.3034 mg. It is submerged into the faucet water for 24 hours. The heaviness of the composites expanded to 0.3997mg. That is 31.74% higher than the underlying load of the composite example. The example is immerged into 552 hours and the weight rate expanded to 37.54%. Along these lines, It is discovered that the 30 wt% of the composite example demonstrates the high water take-up ability of 40.01%. That is a result of small scale openings present in the composite.

The underlying load of the 25wt% banana short fiber reinforced with epoxy composite example is 0.2829 mg. It is drenched into the refined water for 24 hours which expands the heaviness of the composite to 0.361 mg. At that point the example is kept on tipping into the refined water for 552 hours, so the level of weight is expanded to 34.46%. The 30wt% of the composite example weight in wet condition is 0.2908 mg. At that point it is inundated into the refined water for 24 hours. The weight is expanded to 0.387 mg. Again the example is tipped into the refined water for 552 hours and the level of weight is expanded up to 40.13%.The beginning load of 35wt% of the composite example is 0.323 mg. It was submerged into the refined water for 24 hours and the weight rate is expanded to 33.74%. At that point the example is tipped into the refined water for 552 hours, which expanded the level of water assimilation rate to 41.67%. The above exchange plainly calls attention to that 35wt% of the banana short fiber reinforced with epoxy composite example has the high water retention capacity than the other two weight rate (25 and 30wt%) composite example. So the water consumption rate is expanded because of the weight level of fiber content.

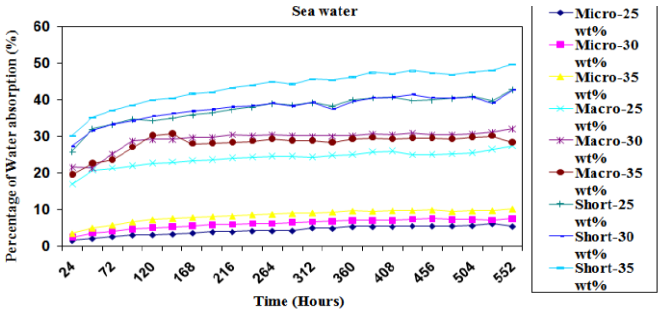


Figure 13a. Water absorption percentage of micro, macro particle and short fiber/epoxy composites (25, 30, 35wt%) in sea water.

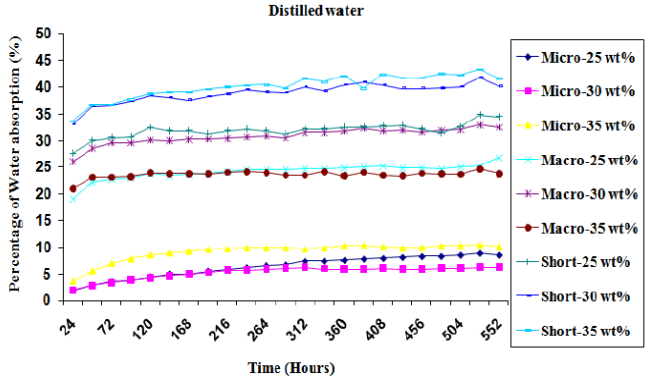


Figure 13b. Water absorption percentage of micro, macro particle and short fiber/epoxy composites (25, 30, 35wt%) in distilled water.

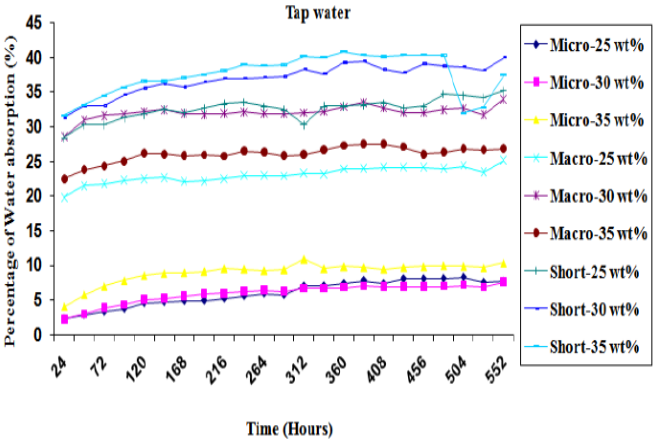


Figure 13c. Water absorption percentage of micro, macro particle and short fiber/epoxy composites (25, 30, 35wt%) in tap water.

V RESULTS:

5.1 TENSILE PROPERTIES

The banana full scale molecule composite ductile test outcomes are appeared in Figure14. From Figure 14, unmistakably the most extreme rigidity is gotten at 35wt% composite.

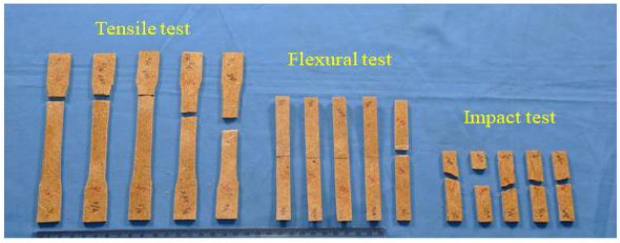


Figure 14. Digital images of macro particle composite specimens (20,25 and 30 wt%) used for the tensile, flexural and impact tests.

That is 14.9% higher than 30wt% of composites. The elasticity of 25wt% composite shows 6.89%, which is lesser than the full scale molecule of 30wt% composite and 19% lesser than the composite of 35wt%. In this way, the composite with 35wt% demonstrates the better elasticity.

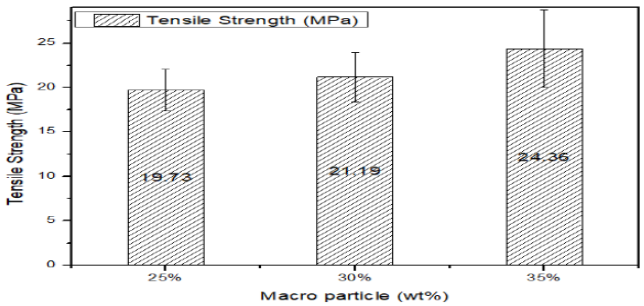


Figure 15. Variation of tensile strength of macro particle/epoxy composites based on the particle loading.

Figure 15. demonstrates the pliable modulus of the composite. The Figure 16 demonstrates the heap versus avoidance chart and the Figure 16 demonstrates the pressure versus strain diagram for the composites that are utilized to discover the elastic modulus of the composites. It is plainly demonstrated that the 35wt% of the composite has the better modulus and the pliable modulus esteems are directly expanded with the molecule wt%. The 35wt% of composite demonstrates the 3.69 GPa, which is 16.77% higher than 30wt% composites and 31.32% higher than 25wt% of composites. From the outcome, it is result called attention to that the expansion of the molecule substance builds the estimation of the durability.

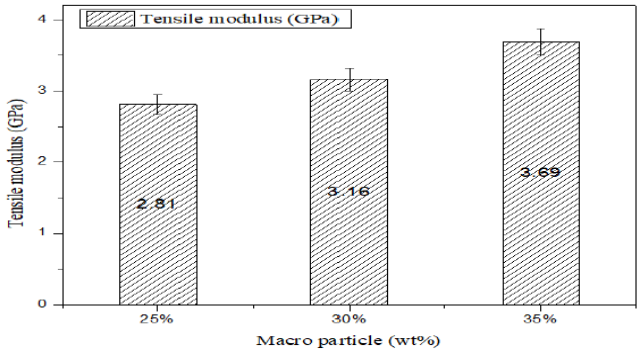


Figure 16, Variation of tensile modulus of macro particle/epoxy composites based on the particle loading.

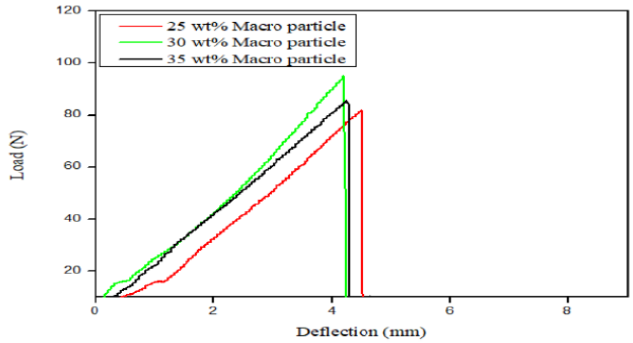


Figure 17, Load vs Deflection graph after the tensile test.

5.2 FLEXURAL PROPERTIES

The flexural quality of the full scale molecule reinforced epoxy composites are appeared in Figure 3.8 to 3.11.Figure 3.8, shows the flexural quality of the composite of 35wt% has the flexural quality of 67.16 MPa which is 29.25% higher than the composite of 30wt% and 55.28% higher than the composite of 25wt%. Along these lines, the flexural quality of the composite increments with the molecule stacking.

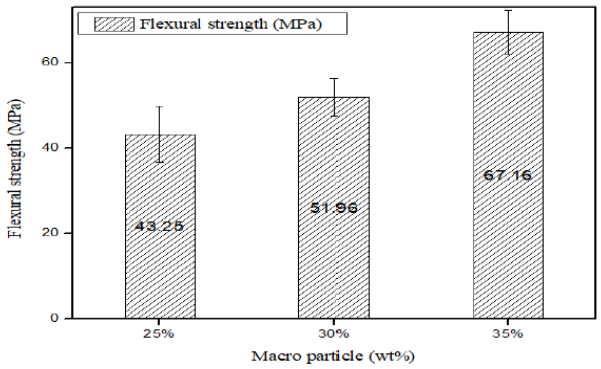


Figure 18. Variation of flexural strength of macro particle/epoxy composite based on the particle loading.

Figure 18 demonstrates the flexural modulus of the composite. Figure 19 demonstrates the heap versus length graph used to ascertain the flexural modulus of the composites. Figure 20 demonstrates the model diagram for the heap versus avoidance for the composites. It unmistakably demonstrates that the composite with 30wt% demonstrates the most noteworthy flexural quality (2.32 GPa) which is 7.91% higher than 25wt% of composites and 37.27% higher than the composite of 35wt%. The 25wt% of composite is 27.21% higher than the composite of 35wt%.

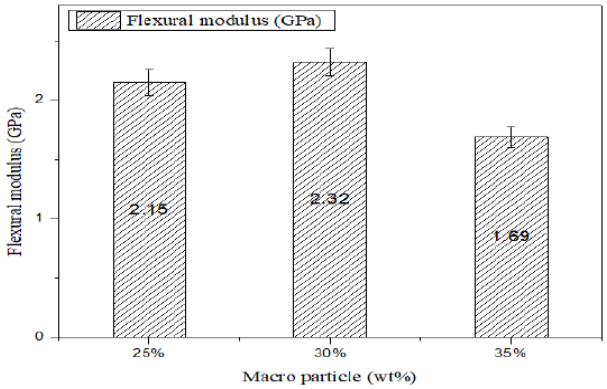


Figure 19 Variation of flexural modulus of macro particle /epoxy composite based on the particle loading.

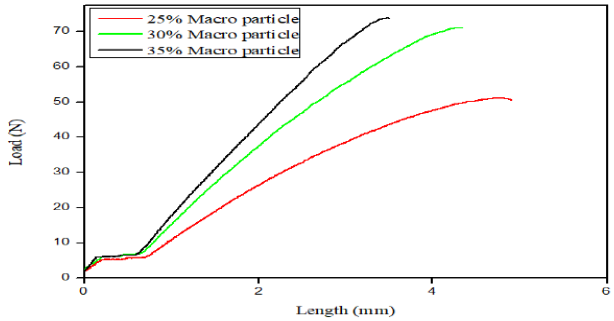


Figure 20. Load Vs Length graph for after the Flexural Test.

5.3 IMPACT PROPERTIES

The energy assimilated, while an example is impacted by an overwhelming blow. The composite of 35wt% retains more vitality (39.13%) which is higher than the composite of 25wt% and is (28%) more than the composite of 30wt% as appeared in Figure 21. It demonstrates that the composite with 35wt% is higher than the other two composites.

The expanding molecule substance and size of the molecule additionally impact the vitality retention. Consequently, the composite of 35wt% doesn't start split effectively.

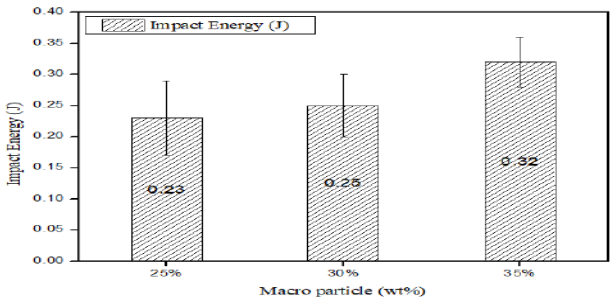


Figure 21. Variation of Impact Strength of Macro Particle/Epoxy Composite Based on Particle Loading.

5.4 EFFECT OF WATER ABSORPTION ON THE TENSILE PROPERTIES OF MACRO PARTICLES REINFORCED COMPOSITES

The tensile quality and modulus versus full scale molecule weight rate for the composite examples at dry and wet conditions are appeared in Figures 22 and 23. For dry composites both tensile quality and modulus are observed to be expanded altogether as the full scale molecule weight rate expanded to 35 wt%. The most extreme tensile quality and modulus of dry composites are 24.36 MPa and 3.69 GPa, separately. The tensile properties of the composites diminished radically on introduction to ocean water inundation, with the expansion in molecule content. At 35 wt% the tensile quality and modulus are 22.4MPa and 2.31 GPa at wet condition as appeared in Figures 21 and 23. The diminishing in tensile properties after ocean water inundation might be because of the development of hydrogen holding between the water atoms and cellulose particles (Arib et al. 2004 and Acha et al. 2005). The arrangement of hydrogen holding prompts the variety in dimensional dependability and poor interfacial grip between the molecule and framework, which diminishes the tensile properties.

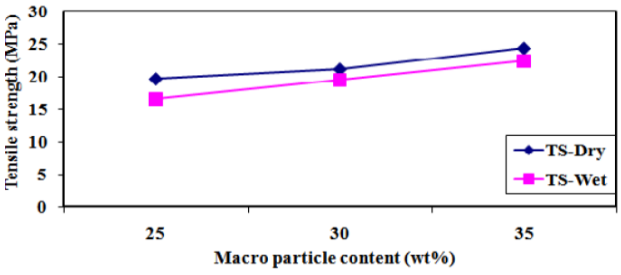


Figure 22 Tensile strength of macro particle/epoxy composite in dry and wet conditions.

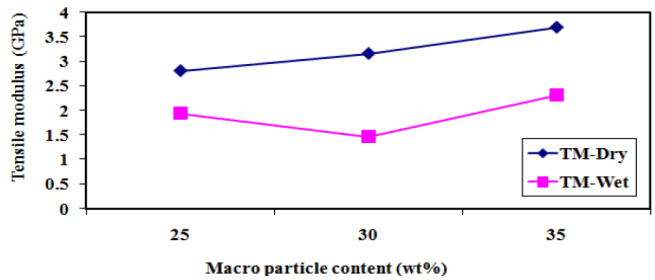


Figure 23. Tensile modulus of macro particle/epoxy composite in dry and wet conditions.

5.5 EFFECT OF WATER ABSORPTION ON THE FLEXURAL PROPERTIES MACRO PARTICLES REINFORCED COMPOSITES

The diverse weight rates of the flexural properties of full scale molecule composites after water ingestion were investigated. Figures 24 and 25 demonstrate the tensile flexural properties of the full scale molecule/epoxy composites. It was seen that the flexural quality was higher for dry composite examples not at all like the ocean water submerged examples, where the flexural quality was observed to be diminished. The dry composite example at 35 wt% without water ingestion had a flexural quality of 67.16 MPa, though the composite example at 35 wt% with water assimilation had a flexural quality of 55.18 MPa. The flexural quality was diminished at wet composite examples when contrasted with dry composite example. Correspondingly, the flexural modulus of wet composite examples diminished when contrasted with dry example because of the ocean water take-up. The full scale molecule/epoxy composites at wet condition diminished in flexural quality almost by 17.8%. This is because of the harm of interracial holding between the molecule and the lattice in the composites.

It is additionally might be expected to the swelling of the grid in ocean water. Because of the swelling of large scale molecule, the ingestion of ocean water prompts the decrease in the fiber-grid interface and a reduction in flexural properties.

The inorganic polymers will retain dampness from the different situations somewhat bringing about dissolving and swelling which can bring about loss of physical and mechanical properties of the composites (Dhakal et al. 2007). Characteristic cellulose fibers and particles can ingest more water particles or dampness than polymer lattice. Additionally, because of the inappropriate interfacial grip between the fiber and grid in the polymer composites, the dampness or water particles can without much of a stretch enter and wet the fibers and particles totally through that interfacial bond and afterward, the properties of that composite are diminished.

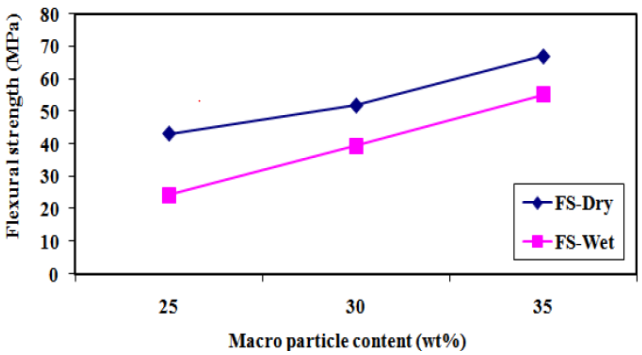


Figure 24. Flexural strength of macro particle/epoxy composite in dry and wet conditions.

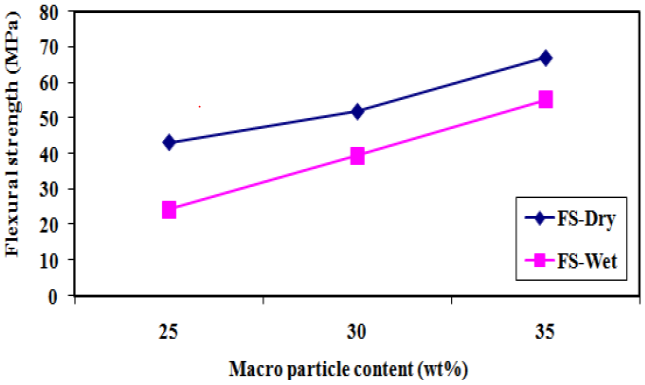


Figure 25. Flexural modulus of macro particle/epoxy composite in dry and wet conditions.

5.6 EFFECT OF WATER ABSORPTION ON THE IMPACT STRENGTH

The impact of water retention on the mechanical properties of full scale molecule/epoxy composites at various times of ocean water inundation is appeared in Figure 26. The outcomes demonstrate that impact property of the full scale molecule composites are changed essentially in wet condition. Full scale molecule composites (35 wt%) at dry condition demonstrated 14.29% more noteworthy impact quality than the 35 wt% of composite at wet condition. 30 wt% of composite is influenced by water atoms take-up and indicates 8% of decrease when contrasted and 30% of dry composite example. 25 wt% of composites had an impact quality of 0.23 J at dry condition and extensively diminished in quality at wet condition.

During the water submersion, the polymer lattice composites may plasticize (Dhakal et al. 2007) which may harm the molecule and the interface of the composites. This harm may cause the corruption of composite‟s properties and diminished the physical and mechanical properties of the composites. The thickness swelling of the 30 wt% composite was higher than that of 35 and 25 wt% composites. This might be because of the feeble interfacial holding between the molecule and lattice.

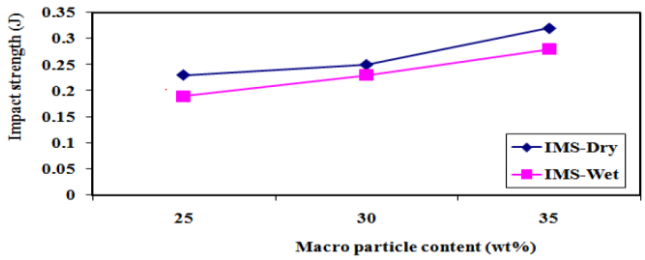


Figure 26. Impact strength of macro particle/epoxy composite in dry and wet conditions.

5.7 EFFECT OF MACHINING PARAMETERS ON THE SURFACE ROUGHNESS DURING TURNING PROCESS OF COMPOSITES

Composite pole materials utilized for the tests are produced using distinctive banana fiber reinforcements, for example, short fiber-reinforced epoxy composite, large scale molecule reinforced epoxy composite and smaller scale molecule reinforced epoxy composite as appeared in Figure 27. The composite pole tests are set up by utilizing PVC pipe form of 50 mm length and 30 mm measurement. The one of the end is shut with end cup, inside the pipe encompassed by the plastic sheet which is utilized for simple evacuation of the composite example. The smaller scale molecule, large scale molecule and short fiber are estimated (120 gms) and afterward it is blended with the epoxy pitch (100 ml) and hardener (10 ml) at a ratio of 10:1. The blend containing reinforcements and tar framework is mixed by physically and after that filled the form. The form is kept for 24 hours in the sunlight for restoring. From that point forward, the composites are expelled from the shape.

Figure 27. Digital image of the composite rod for micro, macro particle and short fiber reinforced with epoxy composites

Figure 28. Digital image of composite specimen during surface roughness measurement.

During machining process, the normal estimations of three preliminaries of surface unpleasantness (Ra) were recorded as procedure reaction. Table 4.1 presents the registered estimations of surface harshness (Ra) of the three unique composites. Figure 28 demonstrates the example computerized picture for the surface unpleasantness estimation. Figures 29 to 31, watch the development of the surface unpleasantness (Ra) with the diverse feed rate, cutting velocity and profundity of cut qualities.

Table 1 Experimental results of the L_9 orthogonal array experiments.

Experiment No	Speed (rpm)	Feed (mm/min)	Depth of cut (mm)	Micro - surface roughness	Macro - surface roughness	Short - surface roughness
1	300	0.1	1	3.972	2.514	2.577
2	300	0.2	2	3.527	3.172	3.276
3	300	0.3	3	3.393	3.233	3.328
4	450	0.1	2	3.282	2.658	2.721
5	450	0.2	3	3.438	3.261	3.482
6	450	0.3	1	3.655	3.469	3.529
7	600	0.1	3	4.885	2.795	2.808
8	600	0.2	1	4.876	2.864	3.795
9	600	0.3	2	3.808	4.004	4.243

From the Table 1, it is seen that the surface harshness esteems at smaller scale molecule epoxy composites are high as for feed rate and profundity of cut at a cutting rate of 600 rpm pursued by 300 rpm and 450 rpm. If there should be an occurrence of large scale molecule epoxy composites, the surface harshness esteems expanded with an expansion in the slicing speed as for the feed rate and profundity of cut.

At short fiber epoxy composites, the surface harshness esteems expanded with an expansion in the slicing speed from 300 rpm to 600 rpm as for the feed rate and profundity of cut. From the outcomes, it is recognized that the large scale molecule epoxy composites demonstrate the low surface harshness esteems contrasted with the miniaturized scale molecule and short fiber epoxy composites. It might be because of the better association between the particles and the epoxy sap framework. The better holding inside the composite examples demonstrates the better surface completion. After the instrument is contact on the surface of the composite examples during machining process, the machined surface ought to have the required or low surface unpleasantness. It relies on the interfacial attachment between the reinforcement and the pitch framework.

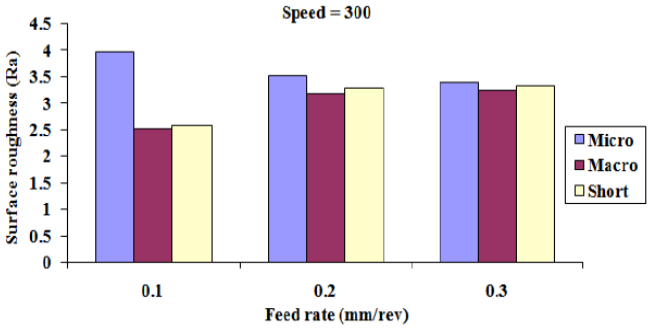


Figure 29. Variations of surface roughness based on the feed rate with a cutting speed of 300 rpm.

The surface unpleasantness esteems expanded with an expansion in the feed rate at a wide range of epoxy composites with the cutting rate of 450 rpm. Here, the large-scale molecule epoxy composites give the lower surface unpleasantness esteems contrasted with the miniaturized scale molecule and short fiber epoxy composites.

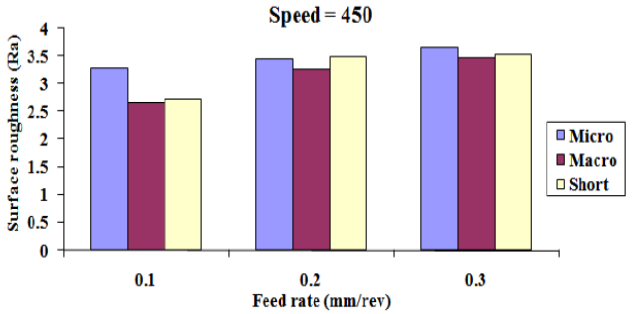


Figure 30. Variations of surface roughness based on the feed rate with a cutting speed of 450 rpm.

During machining at a cutting velocity of 600 rpm, the surface unpleasantness esteems diminished with an expansion in the feed pace of smaller scale molecule epoxy composite. However, the surface harshness esteems expanded at large scale molecule and short fiber epoxy composites with an expansion in the feed rate. The large scale molecule epoxy composites demonstrate the lower estimations of surface unpleasantness, when contrasted with the other epoxy composites.

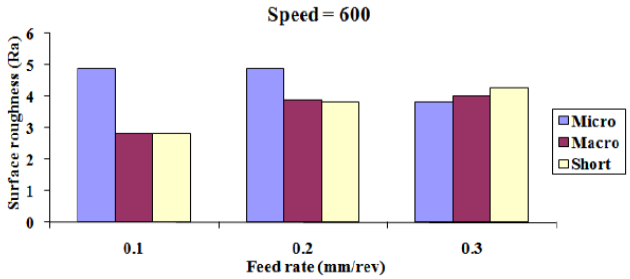


Figure 31. Variations of surface roughness based on the feed rate with a cutting speed of 600 rpm.

The varieties of surface harshness dependent on the profundity of slice concerning the cutting rate are given in Figures 32 to 34. When machining procedure is led at a cutting rate of 300 rpm, the surface unpleasantness esteems diminished with an expansion in the profundity of cut qualities at smaller scale molecule epoxy composite. In any case, on account of large scale molecule and short fiber epoxy composites, the surface unpleasantness esteems expanded with an expansion in the profundity of cut qualities. At the point when contrasted with the small scale molecule and short fiber epoxy composites, the large scale molecule epoxy composites demonstrate the lower surface unpleasantness esteems for all estimation of profundity of cut.

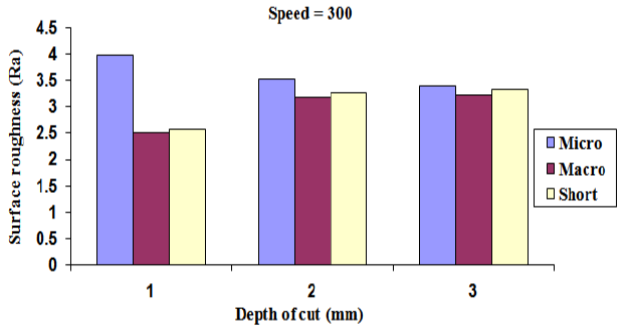


Figure 32. Variations of surface roughness based on the depth of cut with a cutting speed of 300 rpm.

During machining at a cutting velocity of 450 and 600 rpm, dissipate estimations of the surface unpleasantness were gotten. Be that as it may, the large-scale molecule epoxy composites demonstrate the lower estimations of surface unpleasantness, when contrasted and the miniaturized scale molecule and short fiber epoxy composites, as appeared in Figures 33 and 34.

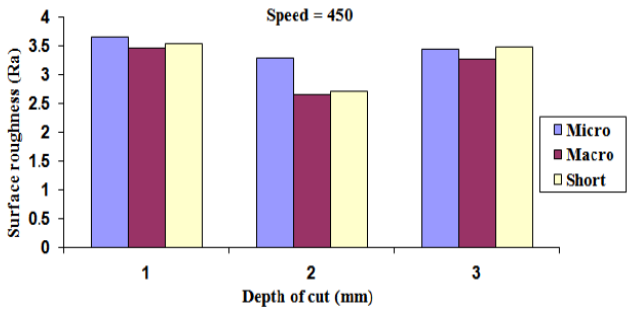


Figure 33. Variations of surface roughness based on the depth of cut with a cutting speed of 450 rpm.

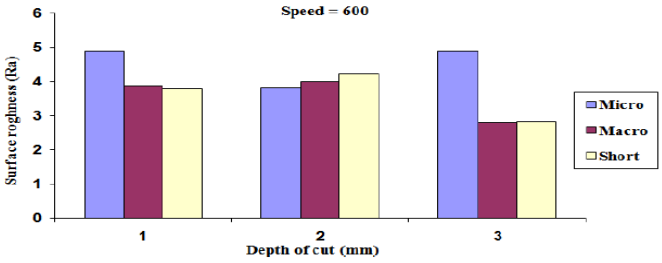


Figure 34. Variations of surface roughness based on the depth of cut with a cutting speed of 600 rpm.

5.8 REGRESSION MODEL

A few forecast techniques have been utilized to model the machinability practices of fiber and molecule reinforced polymer composite material as far as various machining parameters. The relapse model is observed to be valuable in deciding the machinability practices of fiber-reinforced polymer composites. The surface harshness esteems are recorded during turning of epoxy composites reinforced with the banana fibers at three distinct structures (short, large scale and smaller scale). In this way, we are taking surface harshness data for factual expectation utilizing RM. The data gathered from the test was utilized to assemble a scientific model utilizing relapse examination. Relapse conditions were found to get the connection between reaction variable (surface unpleasantness) and the info parameters (cutting rate, feed rate, and profundity of cut) utilizing MINI TAB 17 programming.

5.9 DEVELOPMENT OF REGRESSION EQUATIONS

The linear regression Equations 8.1 to 8.3 for surface roughness of micro particle, macro particle and short fiber reinforced epoxy composites were developed as:

- Micro - Surface roughness

(Ra) = 4.22 - 0.000159 S - 2.10 F - 0.0445 DC (4.1)

- Macro - Surface roughness

(Ra) = 1.62 + 0.00194 S + 4.57 F - 0.0930 DC (4.2)

- Short - Surface roughness

(Ra) = 1.57 + 0.00185 S + 4.99 F - 0.047 DC (4.3)

The squared remaining qualities (R2) for surface unpleasantness of small scale molecule, large scale molecule and short fiber composites are observed to be 0.850, 0.865 and 0.849 separately in the Regression model. The term "R2 " is a measurement esteem which gives some data about the decency of attack of a created model. In relapse technique, the assurance of "R2" coefficient is a measurable figure of how well the relapse line in the investigation approximates the genuine estimation of data focuses. In the event that R2 = 1.0, the created relapse line impeccably fits the data esteems. The typical likelihood plots for miniaturized scale molecule, full scale molecule and short fiber composite are appeared in Figures 35 to 37. Tables 2, 4, and 6 give the coefficients esteems for three kinds of epoxy composites. The investigation of change for surface unpleasantness recorded during turning of composites was given from as tabulated.

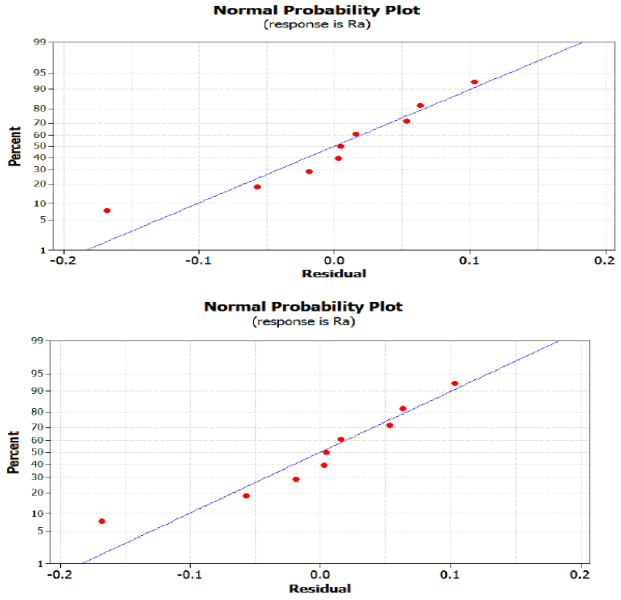


Figure 35. Normal probability plot for micro particle reinforced with epoxy composites.

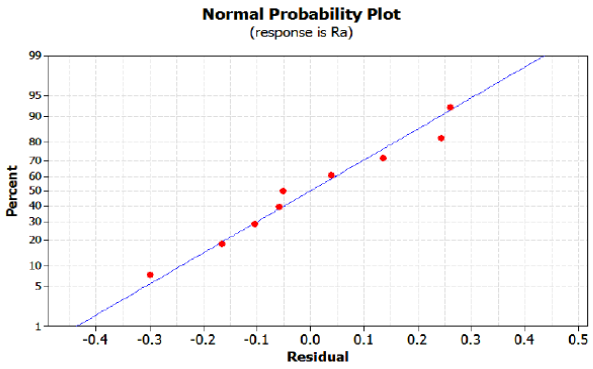


Figure 36. Normal probability plot for macro particle reinforced with epoxy composites.

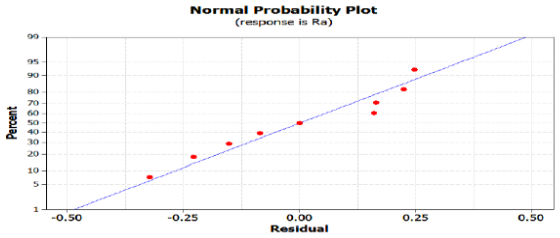


Figure 37. Normal probability plot for short fiber reinforced with epoxy composites.

From the Table 4.2, it is seen that the p-esteem for feed rate is 0.004, which shows that during machining of smaller scale molecule reinforced epoxy composites; the levels of surface harshness are related with feed rate. The Analysis of Variance (ANOVA) for surface unpleasantness got during machining of miniaturized scale molecule reinforced epoxy composite is given in Table 4.3.

In view of the p-values and a criticalness level of 0.05, the anticipated surface unpleasantness esteems (p = 0.017) are related with experimental surface harshness esteems.

Table 2. Response table for surface roughness (Micro particle reinforced epoxy composite).

Predictor	Coefficient	SE Coefficient	T	P
Constant	4.2211	0.1711	24.67	0.000
S	-0.0001589	0.0002714	-0.59	0.584
F	-2.1050	0.4071	-5.17	0.004
DC	-0.04450	0.04071	-1.09	0.324

Table 3 Analysis of Variance for surface roughness (Micro particle reinforced epoxy composite).

Source	DF	SS	MS	F	P
Regression	3	0.281151	0.093717	9.43	0.017
Residual Error	5	0.049707	0.009941		
Total	8	0.330858			

The reaction table for surface unpleasantness (full scale molecule reinforced epoxy composite) is exhibited, as given in Table 4. It is distinguished that the p-esteem for cutting velocity and feed rate are 0.030 and 0.005, separately, which shows that the levels of surface harshness for full scale molecule reinforced epoxy composites are related with cutting rate and feed rate. Table 3 gives the ANOVA to surface harshness for large scale molecule reinforced epoxy composite. From Table 5, it is seen that the anticipated surface unpleasantness esteems (p = 0.013) are related with experimental surface harshness esteems.

Table 4 Response table for surface roughness (Macro particle reinforced epoxy composite).

Predictor	Coefficient	SE Coefficient	T	P
Constant	1.6199	0.4070	3.98	0.011
S	0.0019378	0.0006455	3.00	0.030
F	4.5650	0.9683	4.71	0.005
DC	-0.09300	0.09683	-0.96	0.381

Table 5 Analysis of Variance for surface roughness (Macro particle reinforced epoxy composite).

Source	DF	SS	MS	F	P
Regression	3	1.80917	0.60306	10.72	0.013
Residual Error	5	0.28127	0.05625		
Total	8	2.09044			

From the Table 6, it can seen that the p-esteem for cutting pace and feed rate are 0.050 and 0.006, individually, which demonstrates that during machining of short fiber reinforced epoxy composites; the levels of surface unpleasantness are related with cutting velocity and feed rate. The ANOVA to surface harshness for short fiber reinforced epoxy composite is given in Table 6. In view of the p-values and an importance level of 0.05, the anticipated surface unpleasantness esteems (p = 0.017) are related with experimental surface harshness esteems.

Table 6. Response table for surface roughness (Short fiber reinforced epoxy composite)

Predictor	Coefficient	SE Coefficient	T	P
Constant	1.5704	0.4549	3.45	0.018
S	0.0018500	0.0007216	2.56	0.050
F	4.990	1.082	4.61	0.006
DC	-0.0472	0.1082	-0.44	0.681

Table 7. Analysis of Variance for surface roughness (Short fiber reinforced epoxy composite).

Source	DF	SS	MS	F	P
Regression	3	1.96939	0.65646	9.34	0.017
Residual Error	5	0.35145	0.07029		
Total	8	2.32085			

The correlation made between another arrangement of qualities acquired by experimental estimations and anticipated qualities by direct relapse model. The mistake rates for three kinds composites were acquired by the Equation. (4.4) (Narayanasamy and Padmanabhan 2008). The deliberate and anticipated values of surface unpleasant ness with process parameters for threedifferent composites are given in Tables 4 to 6.

$$Error(\%) = \frac{V_m - V_{exp}}{V_{exp}} \times 100 \quad (4.4)$$

where Vm is the estimation of the model and Vexp the experimental worth measured.From the tables, the acquired normal supreme rate blunders to the surface harshness for small scale molecule, large scale molecule, and short fiber epoxy composites are 3.83%, 3.92% and 4.02% separately. From the estimations of normal outright rate mistakes and R2, it is seen that while thinking about the surface harshness during turning of miniaturized scale molecule, large scale molecule and short fiber composites, the direct relapse model is observed to be in great concurrence with experimental surface unpleasantness esteems. Figures 32 to 33 demonstrate the examination between the experimental and anticipated surface harshness esteems.

Table 8. Comparison of experimental and predicted value for surface roughness (Micro particle reinforced epoxy composite).

S.No	Speed (rev/min)	Feed (mm/rev)	Depth of cut (mm)	Measured value (µm)	Predicted value (µm)	Error (%)
1.	350	0.15	1.5	3.636	3.782	4.02
2.	400	0.25	2.5	3.394	3.52	3.71
3.	500	0.27	2.75	3.318	3.451	4.01
4.	550	0.28	2.8	3.295	3.42	3.79
5.	575	0.29	2.9	3.271	3.39	3.64
Average absolute percentage error						3.83

Table 9. Comparison of experimental and predicted value for surface roughness (Macro particle reinforced epoxy composite).

S.No	Speed (rev/min)	Feed (mm/rev)	Depth of cut (mm)	Measured value (µm)	Predicted value (µm)	Error (%)
1.	350	0.15	1.5	2.256	2.345	3.95
2.	400	0.25	2.5	3.175	3.306	4.13
3.	500	0.27	2.75	3.447	3.568	3.51
4.	550	0.28	2.8	3.549	3.706	4.42
5.	575	0.29	2.9	3.659	3.791	3.61
Average absolute percentage error						3.92

Table 10. Comparison of experimental and predicted value for surface roughness (Short fiber reinforced epoxy matrix composites).

S.No	Speed (rev/min)	Feed (mm/rev)	Depth of cut (mm)	Measured value (µm)	Predicted value (µm)	Error (%)
1.	350	0.15	1.5	2.784	2.895	3.99
2.	400	0.25	2.5	3.304	3.44	4.12
3.	500	0.27	2.75	3.587	3.713	3.51
4.	550	0.28	2.8	3.697	3.853	4.22
5.	575	0.29	2.9	3.781	3.944	4.31
Average absolute percentage error						4.02

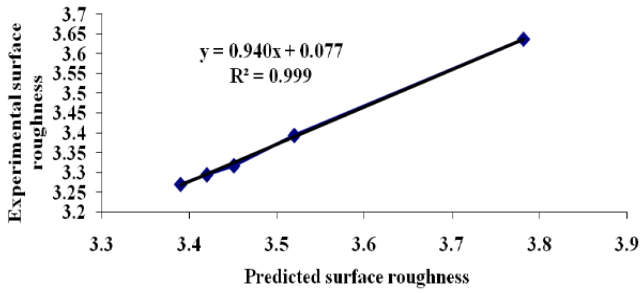


Figure 32. Comparison between the experimental and predicted surface roughness during turning of macro particle reinforced epoxy composite.

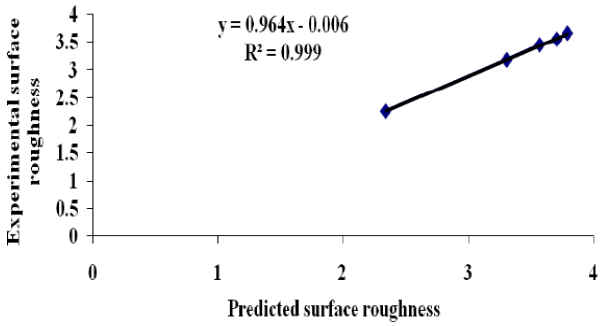


Figure 33. Comparison between the experimental and predicted surface roughness during turning of short fiber reinforced epoxy composite.

5.10 SUMMARY

The mechanical properties of epoxy composites reinforced with the three unique types of banana fiber-reinforced epoxy composites (short fiber/epoxy composite, full scale molecule/epoxy composite, and smaller scale molecule/epoxy composite) were examined in this part. The short fiber-reinforced epoxy composites demonstrate the more noteworthy estimations of tensile quality when contrasted with different composites. The tensile quality qualities expanded with the expansion in the fiber content from 25 wt% to 35 wt%. The most extreme tensile quality of 35.59 MPa was watched for the composite with 35 wt% short fibers. The flexural quality estimations of the composites are higher at full scale molecule reinforced epoxy composites. The flexural quality qualities expanded with the ceaseless expansion of the particles from 25 wt% to 35 wt%. Composite with the large scale molecule substance of 35 wt% invigorates the most extreme estimation of flexural. The short fiber and full scale molecule reinforced epoxy composites demonstrate the expanding pattern with the expansion of the fibers and particles from 25 wt% to 35 wt%. Then again, the smaller scale molecule reinforced epoxy composites demonstrate the diminishing pattern with the expansion of the particles. The short fiber and large scale molecule reinforced epoxy composites give nearly a similar impact vitality at 35 wt%,

which is higher than that of miniaturized scale molecule reinforced epoxy composite. The SEM examination uncovered that the tensile, flexural, and impact exhibitions were influenced by a factor, for example, poor bond among fiber and network, development of smaller scale splits, nearness of voids, and fiber haul out.

The water retention practices of the epoxy composites reinforced with the banana smaller scale molecule, full scale molecule, and short fibers, were examined at three distinctive water situations, for example, ocean water, refined water, and faucet water for 23 days at room temperature. The impacts of water retention on the mechanical properties of full scale molecule/epoxy composites were additionally contemplated. It was seen that the composites demonstrate the abnormal state of the water ingestion rate adrift water drenching when contrasted with the other water conditions. Because of the water assimilation, the mechanical properties of large scale molecule/epoxy composites were diminished at all weight rates. The composites reinforced with 35 wt% of full scale particles demonstrate the most extreme degree of mechanical properties at wet condition. The impacts of machining parameters (cutting rate, feed rate and profundity of cut) on the surface harshness during turning of epoxy composites reinforced with the banana fibers in three unique structures are considered. In view of the design of tests of small scale molecule, full scale molecule and short fiber composites demonstrates the normal surface harshness esteems were 3.92, 3.11 and 3.31 separately. For large scale molecule investigation feed impact was noteworthy than speed and profundity of cut.

In short fiber feed impact was huge than speed and profundity of cut. To accomplish the base surface unpleasantness the ideal qualities are acquired for shaft speed, feed rate and profundity of cut were individually 300 rpm, 0.1 mm/rev and 1 mm. In view of the T esteem in the ANOVA table speed puts a critical role than other two parameters, for example, profundity of cut and feed. The correlation among experimental and anticipated (Regression model) values is directed to be solid by the high R2 and low normal supreme rate mistake esteems acquired, i.e., desire for a superior straight relationship. The examination among experimental and anticipated surface unpleasantness esteems demonstrated that they were in great understanding.

IV. CONCLUSION

As of late, the plant based regular cellulose fiber-reinforced polymer composites have pulled in the consideration of numerous scientists and material specialists because of their advantages of explicit properties over engineered fibers. The best possible choice of the materials and creation techniques for the preparation of characteristic fiber polymer composites is important to accomplish the utilization of composites. This gives the quality items to the assembling condition. In the present work the appropriateness of banana fibers as fortifying operator in three unique sizes to be specific short fiber, large scale and small scale molecule for epoxy network composite material. The banana fiber miniaturized scale, full scale and short fiber reinforced with epoxy lattice composites are set up by pressure shaping system. The molecule size, substance and scattering of the fiber are the significant capacities in the mechanical properties. The water retention qualities of the large scale molecule reinforced with epoxy composites are examined. The machining qualities of the banana small scale, large scale molecule and short fiber reinforced with epoxy lattice composites are likewise considered. The accompanying ends are acquired from the present research work:

The subtleties of materials and approach utilized for preparation and portrayal of epoxy composites reinforced with the banana fiber in three distinct structures or sizes (smaller scale molecule, full scale molecule and short fiber) were displayed. Composite examples were described by static mechanical properties, for example, tensile, flexural and impact.

The mechanical properties of epoxy composite reinforced with the miniaturized scale particles produced using the banana fiber were assessed dependent on the molecule stacking and their outcomes were finished up here. Composite with the molecule stacking of 35wt% demonstrates the most astounding tensile and flexural properties when contrasted with the other molecule stacking composites. Composite with the molecule stacking of 25wt% ingests the impact vitality of 0.26 J which is higher than different composites. The impact results demonstrate that the expansion of small scale particles has not affected the impact quality of epoxy composite. Further, the nearness of voids, area of de-holding of the molecule from the network, and framework splits, and so on were distinguished through the investigation of SEM.

Epoxy composites reinforced with the banana fiber large scale molecule are set up with three distinctive wt% in pressure trim machine. The tensile quality increments with an expansion in the ratio of large scale molecule wt%. As the weight % of full scale molecule increments in the composite of 35wt%, it can withstand more burden which results in better tensile properties of the composites. The composite of 35wt% is predominant in flexural properties. The impact quality of the composite with 35wt% has a most astounding estimation of 0.32 J since it retains more vitality than composite of 25wt% and 30wt%. Fractrography studies demonstrate the break conduct of the composite which shows better bond between the full scale molecule and the grid.

The mechanical properties of epoxy composites reinforced with the three unique types of banana fiber-reinforced epoxy composites (short fiber/epoxy composite, large scale molecule/epoxy composite, and small scale molecule/epoxy composite) were considered. The short fiber-reinforced epoxy composites demonstrate the more prominent estimations of tensile quality when contrasted with different composites.

The greatest tensile quality of 35.59 MPa was watched for the composite with 35 wt% short fibers. The flexural quality estimations of the composites are higher at full scale molecule reinforced epoxy composites. Composite with the large scale molecule substance of 35 wt% invigorates the most extreme estimation of flexural. The short fiber and full scale molecule reinforced epoxy composites give nearly a similar impact vitality at 35 wt%, which is higher than that of miniaturized scale molecule reinforced epoxy composite. The SEM investigation uncovered that the tensile, flexural, and impact exhibitions were influenced by factor, for example, poor bond among fiber and grid, development of miniaturized scale splits, nearness of voids, and fiber haul out.

The water retention practices of the composites were examined at three distinctive water situations, to be specific, ocean water, refined water, and faucet water, for 23 days at room temperature. The impacts of water assimilation on the mechanical properties of large scale molecule/epoxy composites were additionally contemplated. Composites demonstrate the abnormal state of the water assimilation rate adrift water drenching when contrasted with the other water situations. Mechanical properties of full scale molecule reinforced epoxy composites were diminished at all weight rates. The full scale molecule reinforced epoxy composites having 35 wt% of large scale particles demonstrate the most extreme degree of mechanical properties at wet condition.

The impacts of turning process parameters (cutting pace, feed rate and profundity of cut) on the surface unpleasantness during turning of composites were examined. The procedure parameters (feed rate and cutting pace) have critical impact on the surface harshness of epoxy composites reinforced with the banana fibers in three distinct sizes. The full scale molecule epoxy composites demonstrate the lower surface harshness esteems for all estimation of profundity of slice when contrasted with the small scale molecule and short fiber epoxy composites.

The examination among experimental and anticipated qualities was led to be solid by the high R2 and low normal outright rate mistake esteems acquired. The examination among experimental and anticipated surface harshness esteems demonstrated that they were in great understanding.

REFERENCES

1. Abrao, AM, Faria, PE, Campos Rubio, JC, Reis, P &Davim, J 2007, „Drilling of fiber reinforced plastics: Areview", Journal of Materials Processing Technology, vol.186, no. 1-3, pp. 1-7.
2. Acha, BA, Marcovich, NE & Reboredo, MM 2005,Physical and mechanical characterization of jute fabric composites", Applied Polymer Science, vol. 98, pp.639-650.
3. Adam Khan, M & Senthil Kumar,A2011, Machinability of glass fibre reinforced plastic (GFRP) composite using alumina-based ceramic cutting tools", Journal of Manufacturing Processes, vol.13, pp. 67-73.
4. Agunsoye, JO, Bello, SA, & Adetola, LO 2017, Experimental investigation and theoretical prediction of tensile properties of delonix regia seed particle reinforced polymeric composites", Journal of King Saud University – Engineering Sciences. Available from: <https://doi.org/ 10.1016/j.jksues.2017.01.005>. [2 February 2017].
5. Akindapo Jacob Olaitan, Agov Emmanuel Terhemen, Garba Danladi King & Ogabi Rapheal Oluwatoyin 2017, Comparative assessment of mechanical properties of Ground nut shell and rice husk reinforced epoxy composites", American Journal of Mechanical Engineering,vol. 5, no. 3, pp. 76-86.
6. Alamri, H & Low, IM 2012, „Mechanical properties and water absorption behaviour of recycled cellulose fibre reinforced epoxy composites", Polymer Testing, vol. 31,no. 5, pp. 620-628.
7. Ali, MS, French, TA, Hastings, GW, Rae, T, Rushton, N, Ross, NERS & Wynn-Jones, CH 1990, „Carbon fiber composite bone plates for fixation of forearm fractures", Journal of Bone and Joint Surgery, vol. 72, no. 4, pp. 586-591.
8. Alomayri, T, Assaedi, H, Shaikh, FUA & Low, IM 2014, Effect of water absorption on the mechanical properties of cotton fabric-reinforced geopolymer composites", Journal of Asian Ceramic Societies, vol. 2, no. 3, pp. 223-230.
9. Athijayamani, A, Thiruchitramblam, M, Natarajan, U & Pazhanivel, B 2009, „Effect of moisture absorption on the mechanical properties of randomly oriented natural fibers/ polyester hybrid composite", Materials Science and Engineering: A, vol. 517, no. 1-2, pp. 344-353. Atiqah, , 10.Jawaid, M, Ishak, MR, & Sapuan, SM 2017,„Moisture absorption and thickness swelling behaviour of sugar palm fibre reinforced thermoplastic polyurethane", Procedia Engineering, vol. 184, pp. 581-586.
10. Azmir, MA, Praveena Nair Sivasankaran, Hamedon, Z & Azmir, MA 2010, „Experimental study on drilling process of CFRP composite laminate", Materials Science Forum, vol. 638-642, pp. 927-932.
11. Barbosa, AQ, da Silva, LFM, Abenojar, J, Figueiredo M & Ochsner, A 2017, „Toughness of a brittle epoxy resin reinforced with micro cork particles: Effect of size, amount and surface treatment", Composite Part: B Engineering, vol. 114, pp. 299-310.
12. Bashar Dan-asabe 2016, „Thermo-mechanical characterization of banana particulate reinforced PVC composite as piping material", Journal of King Saud University – Engineering Sciences. Available from < . . https://doi.org/ 10.1016/j.jksues.2016.11.001>. mber 2016].
13. Babur Ozcelik & Mahmut Bayramoglu 2006, „The statistical modeling of surface roughness in high-speed flat end milling", International Journal of Machine Tools and Manufacture, vol. 46, pp. 1395-1402.
14. Bhoopathi, R, Ramesh, M & Deepa, C 2014, „Fabrication and property evaluation of banana-hemp-glass fiber reinforced composites", Procedia Engineering, vol. 97, pp. 2032-3041.
15. Boopalan, M, Niranjanaa, M & Umapathy, MJ 2013, „Study on the mechanical properties and thermal properties of jute and banana fiber reinforced epoxy hybrid composites", Composites Part B: Engineering, vol. pp. 54-57. 27.
16. Bos, HL, Van den oever, MJA & Peters, O 2002, „Tensile and compressive properties of flax fibres for natural fibre reinforced composites", Journal of Materials Science, vol. 37, no. 8, pp. 1683-1692.
17. Chandramohan, D & John Presin Kumar, A 2017, „Experimental data on the properties of natural fiber particle reinnforced polymer composite material", Data in Brief, vol. 13, pp. 460-468.
18. Chen, T, Liu, W & Qiu, R 2013, „Mechanical properties and water absorption of hemp fibers-reinforced unsaturated polyester composites", Effect of fiber surface treatment with heterofunctional monomer, BioResources, vol. 8, pp. 2780-2791.
19. Clemons, CM & Caulfield, DF 1994, „Natural fibers", Journal of Reinforced Plastics Composites, pp. 1354-1366. 31. Crosky, A, Soatthiyanon, N, Ruys, D, Meatherall, S & Potter, S 2014, „9 – Thermoset matrix natural fibre-reinforced composites', Available from: <https://doi.org/10.1533/9780857099228.2.233> [25 February 2014].
20. Dhakal, HN, Zhang, ZY & Richardson, MOW 2007, „Effect of water absorption on the mechanical properties of hemp fibre reinforced unsaturated polyester composites", Composites Science and Technology, vol. 67, pp. 1674-1683.
21. Dilli Babu, G, Sivaji Babu, K & Uma Maheswar Gowd, B 2013, „Effect of machining parameters on milled natural fiber reinforced plastic composites", Journal of Advanced Mechanical Engineering, vol. 1, pp. 1- 12.
22. Dilli Babu, G, Sivaji Babu, K & Uma maheswar Gowd, B 2013, „Optimization of machining parameters in drilling hemp fiber reinforced composites to maximize the tensile strength using design of experiments", Indian Journal of Engineering & Materials Sciences, vol. 20, pp. 385-390.
23. Dimo Hristozov, Laura Wroblewski & Pedram Sadeghian, 2016, „Longterm tensile properties of natural fibre-reinforced polymer composites: Comparison of flax and glass fibres", Composites Part B: Engineering, vol. 95, pp. 82-95.
24. Durowaye, SI, Lawal, GI, Akande, MA & Durowaye, VO 2014, „Mechanical properties of particulate coconut shell and palm fruit polyester composites", International Journal of Materials Engineering, vol. 4, no. 4, pp. 141-147.
25. Essabir, H, Nekhlaoui, S, Malha, M, Bensalah, MO, Arrakhiz, FZ, Qaiss, A & Bouhfid, R 2013, „Bio-composites based on polypropylene reinforced with Almond Shells particles: Mechanical and thermal properties", Materials & Design, vol. 51, pp. 225-230.
26. Farid Bajuri, Norkhairunnisa Mazlan, Mohamad Ridzwan Ishak & Junichiro Imatomi 2016, „Flexural and compressive properties of hybrid kenaf/silica nanoparticles in epoxy composite", Proceedings of the fifth International Conference on Recent Advances in Materials, Minerals and Environment, Procedia Chemistry, vol. 19, pp. 955-960.
27. Faruk Hossain, M, Shoumya Nandy Shuvo & Islam, MA 2014, „Effect of types of wood on the thermal conductivities of wood saw dust particle reinforced composites", Procedia Engineering, vol. 90, pp. 46-51. 40. Fenner, R 1996, „High strength partially absorbable composites produced by sintering method for internal bone fixation", Proceedings of the Transaction of 5th World Biomaterials Congress, pp. 440-440.
28. Gu Huang & Hongxia Sun 2007, „Effect of water absorption on the mechanical properties of glass/polyester composites", Materials and Design, vol. 28, pp. 1647-1650.
29. Gupta, MK & Srivastava, RK 2015, „Effect of sisal fibre loading on dynamic mechanical analysis and water absorption behaviour of jute fibre epoxy composite", Materialstoday: Proceedings, vol. 2, no. 4-5, pp. 2909- 2917.
30. Haameem, JAM, Abdul Majid, MS, Afendi, M, Marzuki, HFA, Ahmad Hilmi, E, Fahmi, I & Gibson, AG 2016, „Effects of water absorption on Napier grass fibre/polyester composites", Composite Structures, vol. 144, pp. 138-146.
31. Hari Om Maurya, Gupta, MK, Srivastava, RK & Singh, H 2015, „Study on the mechanical properties of epoxy composite using short sisal fibre", Materials today: Proceedings, vol. 2, no. 4-5, pp. 1347-1355.
32. Ismail Mahamad Hakimi, Sharif, S, Denni Kurniawan & Hakimi, IM 2013, „Laminate Orientation Effect on Drilling of Carbon Fiber Reinforced Plastic Composites", Applied Mechanics and Materials, vol. 315, pp. 768- 772.
33. Jacob Olaitan Akindapo, Umar Alhaji Binni & Olawale Monsur Sanusi 2015, „Development of roofing sheet material using groundnut shell particles and epoxy resin as composite material", American Journal of Engineering Research, vol. 4, no. 6, pp. 165-173.
34. Li, X, Tabil, LG, Panigrahi, S & Crerar, WJ 2009, „The influence of fiber content on properties of injection molded flax fiber-HDPE biocomposites", Can Biosyst Eng. vol. 148, pp.1-10.
35. Mamun, AA, Heim, HP, Faruk, O & Bledzki, AK 2015, „8 – The use of banana and abaca fibres as reinforcements in composites", Biofiber Reinforcements in COMPOSITE MATERIALS.

36. Manjunatha Chary, GH & Sabeel Ahmed, K 2017, „ Experimental characterization of coconut shell particle reinforced epoxy composites", Journal of Materials and Environmental Sciences, vol. 8, no. 5, pp. 1661- 1667.
37. Manpreet Singh Bahra, Gupta, VK & Lakshya Aggarwal, 2017, „Effect of fibre content on mechanical properties and water absorption behaviour of pineapple/HDPE composite", Materialstoday: PROCEEDINGS, vol. 4, no. 2, pp. 3207-3214.
38. Maslinda, AB, Abdul Majid, MS, Ridzuan, MJM, Afendi, M & Gibson, AG 2017, „Effect of water absorption on the mechanical properties of hybrid interwoven cellulosic-cellulosic fibre reinforced epoxy composites", Composite Structures, vol. 167, pp. 227-237.
39. Mohamed Konneh, Muataz Hazza Faizi Al Hazza, Atiah Abdullah Sidek, Ruhaki Huda Samsul Bahri & Konneh, M 2015, „Evaluating delamination at entry of drilled Carbon Fiber Reinforced Polymer (CFRP) composite with diamond coated ball nose drills", Advanced Materials Research, vol. 1115, pp. 64-69.
40. Mohd Zurayyen Abdul Mutalib & Mohamad Juraidi Jamal 2017, „Effect of machining parameters on delamination during milled banana fiber reinforced polyester composites", Journal of Engineering and Science Research, vol. 1, no. 1 pp. 9-13.
41. Muthukumar, S & Lingadurai, K 2014, „Investigating the mechanical behaviour of coconut shell and groundnut shell reinforced polymer composite", Global Journal of Engineering Science and Researches, vol. 1, no. 3, pp. 19-23.
42. Narayanasamy, R & Padmanabhan, P 2009, „Modeling of springback on air bending process of interstitial free steel sheet using multiple regression analysis", Int J Interact Des Manuf, vol. 3, pp. 25-33.
43. Nongman, AF, Baharin, A & Abu Bakar, A 2016, „The Effect of banana leaves lamination on the mechanical properties of particle board panel", Procedia Chemistry, vol. 19, pp. 943-948.
44. Orefice, RL, Hench, LL & Brennan, AB 2001, „Effect of particle morphology on the mechanical and thermo-mechanical behavior of polymer composites", Journal of the Brazilan society of Mechanical Sciences, vol. 23, no.1, pp.1-8. 71. Panneerdhass, R, Gnanavelbabu, A & Rajkumar, K 2014, „Mechanical properties of luffa fiber and ground nut reinforced epoxy polymer hybrid composites", Procedia Engineering, vol. 97, pp. 2042-2051

AUTHORS PROFILE

Guruji Ramakrishna Pursuing PhD. in, Department of Mechanical Engineering, Sri Satya Sai University of Technology and Medical Sciences, Sehore, Madhya Pradesh, India. I completed my M.Tech in CAD/CAM from GMRIT, Rajam and BTech in Mechanical Engineering from Gokula Krishna College of Engineering, Sullurupeta, He published 2 papers in Scopus, 17 International Journal Papers, 16 International Conference Papers,15 Workshops attended and Associate Member in The Institution of Engineers(India) and also received Active Young Researcher Award.

Dr. G. R.Selokar, Registrar and Professor, Department of Mechanical Engineering, Sri Satya Sai University of Technology and Medical Sciences, Sehore, Madhya Pradesh, India. He was completed his Ph.D, M.Tech and BE from Mechanical Engineering Department at Visvesvaraya National Institute of Technology, Nagpur and also Alumni of VNIT, Nagpur. His total Experience is 38years. He was Published 105 International Journal Papers, 40 National journals Papers and guided Ph.D's of 9 and 6 was under process and also having professional membership of ISTE, IIPE & IIIE.