e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 6, June 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

International Journal Of Multidisciplinary Research In Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 6, June 2024 |

| DOI:10.15680/IJMRSET.2024.0706008 |

Development and Testing of Agave Fiber Reinforced Polymer Based Composite

Hithesh T L[1], Shayan Pasha[2], Pooja[3], Devaraj M R[4]

UG Students, Department of Mechanical Engineering, ATME College of Engineering, Mysuru, Karnataka, India[1,2,3]

Associate Professor, Department of Mechanical Engineering, ATME College of Engineering, Mysuru, Karnataka, India[4]

ABSTRACT: Natural fibre-reinforced polymer (NFRP) composites are the emerging trend of material used in automotive, building and packaging industries. Natural fibres play a significant role in the development of decomposable green materials which helps to solve ecological and environmental issues. Engineers, scientists, and manufacturers are attracted by natural FRP since they are biodegradable, non-toxic, lightweight and relatively stronger. In addition to that natural fibre composite are cost-effective, have good thermal insulation properties, abundant in nature and better formability. Based on natural fibres origin they are classified into animal-based and plant-based. Animal-based fibres are silk, wool, hair, etc. and plant-based fibres are jute, kenaf, hemp and many more. Further plant-based fibres are subcategorised into six classes namely blast fibres (flax, ramie, and kenaf), leaf fixers (abaca, agave, and sisal), seed fibres (cotton, coir, and kapok), core fibres, grass and reed fibres (corn, wheat, and rice) and all other types (roots and wood). Lignocellulosic fibres are economically reasonable to manufacture since they are lightweight, environment-friendly, high stiffness and specific strength which is a suitable substitute for artificial fibre and they are readily available renewable source of relatively low cost and biodegradable material. The reinforcing capability of fibre depends on various aspects such as mechanical strength, surface appearance, the polarity of fibre and the existence of reactive centres. The property of the natural fibre is governed by several factors namely harvest, maturity, climate, disintegration, fibre modification and textile processing. Despite advantages, some major drawbacks are lack in thermal stability, water absorption, and strength degradation but it can over- come from that by hybridising with either natural or synthetic fiber. Agave americana is a succulent plant of a large botanical genus of name Agave and belongs to family Agavaceae. Among all Agave plants, agave americana is most possibly weather resistant since they are distributed in a wide range of geographical areas. Agave americana produce flowers only after 5–8 years. The leaves have thick and have a spine on their edges. Edge spines are like a fishhook and tip spines are found to be above 25 mm long.

I.INTRODUCTION

The quest for sustainable and environmentally friendly materials has led to the exploration of natural fibers as alternatives to traditional non-biodegradable materials. Among these natural fibers, Agave plants have garnered significant attention due to their remarkable strength and biodegradability. This project is dedicated to the, fabrication, and testing of biodegradable fibers extracted from Agave plants and the evaluation of tensile strength across various compositions. Agave plants, notably the Agave sisalana species, are renowned for their robust and durable fibers. These fibers have been traditionally used in various applications, including textiles, ropes, and handicrafts. However, recent environmental concerns and the shift towards sustainability

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 6, June 2024 |

| DOI:10.15680/IJMRSET.2024.0706008 |

Fig. 1.0 AGAVE PLANT

II. LITERATURE REVIEW

S. Thomas, S.A. Paul, A.L. Pothan, B. Deepa et al Natural fiber: Structure, properties and Application: Cellulose Fibers: Bio and Nano Polymer Composites. Natural fibers have the special advantage of high specific strength and sustainability, which make them ideal candidates for reinforcement in various polymeric matrices. K. Mylsamy, I. Rajendran et al Investigation on physio-chemical and mechanical properties of raw and alkali-treated Agave americana fiber. This paper aims at introducing new natural fibers for use as fillers in a polymeric matrix enabling production of cost-effective, biodegradable, and lightweight composites for load carrying structures. R. Khiari, M.F. Mhenni et al Chemical composition and pulping of date palm rachis and Posidonia oceanica – a comparison with other wood and non-wood fiber sources. The chemical composition of two alternative sources of fibres was established. The obtained results showed that the two raw materials studied contain high amount of cellulose which justifies their valorisation in cellulose derivatives or as a source of fibres for cellulose fibres-reinforced composites or in papermaking applications. N. Saba, M.T. Paridah, M. Jawaid et al Mechanical properties of kenaf fiber reinforced polymer composite. Kenaf bast fibre has excellent tensile strength combined with superior flexural strength verified by several mechanical testing and research work enabling it to utilize in variety of application such as auto- industrial, light weight constructional applications. S.V. Naidu, T.S. Rani, M.C.S. Subha et al Mechanical properties of coir/glass fiber phenolic resin-based composites. Phenolic resin-based coir/glass hybrid composites were developed using compression molding followed by hand lay-up technique.

Ydrean, F. Sakli et al Evaluating the fineness of Agave Americana L. fibers show greatly dispersed fineness. In this paper, this dispersion is demonstrated using two approaches: measurement of the gravimetric fineness and evaluation of different aspects of diameter. S. Nunna, P.R. Chandra, S. Shrivastava, A.K. Jalan et al A review on mechanical behavior of natural fiber-based hybrid composites. Hybrid composites are manufactured by combining two or more fibers in a single matrix. Hybrid composites can be made from artificial fibers, natural fibers and with a combination of both artificial and natural fibers. S. Kalia, B.S. Kaith, I. Kaur et al Pretreatments of natural fibers and their application as reinforcing material in polymer composites. Pretreatments of the natural fiber can clean the fiber surace, chemically modify the surface, stop the moisture absorption process, and increase the surface roughness. Among the various pretreatment techniques, graft copolymerization and plasma treatment are the best methods for surface modification of natural fibers.

Relevance to current Research

Synthetic fiber reinforced polymer composites perform credibly well when they were used to replace the conventional materials (metals) for structural and non-structural applications such as in building, aircraft, automobile, sporting, medical, bridge constructions due to the significant advantages offered by these composites. The recent increase in domestic and global population requires for more and better housing for both rural and urban development coupled with environment free from danger to both human and ecological system resulting from the production of petroleum

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

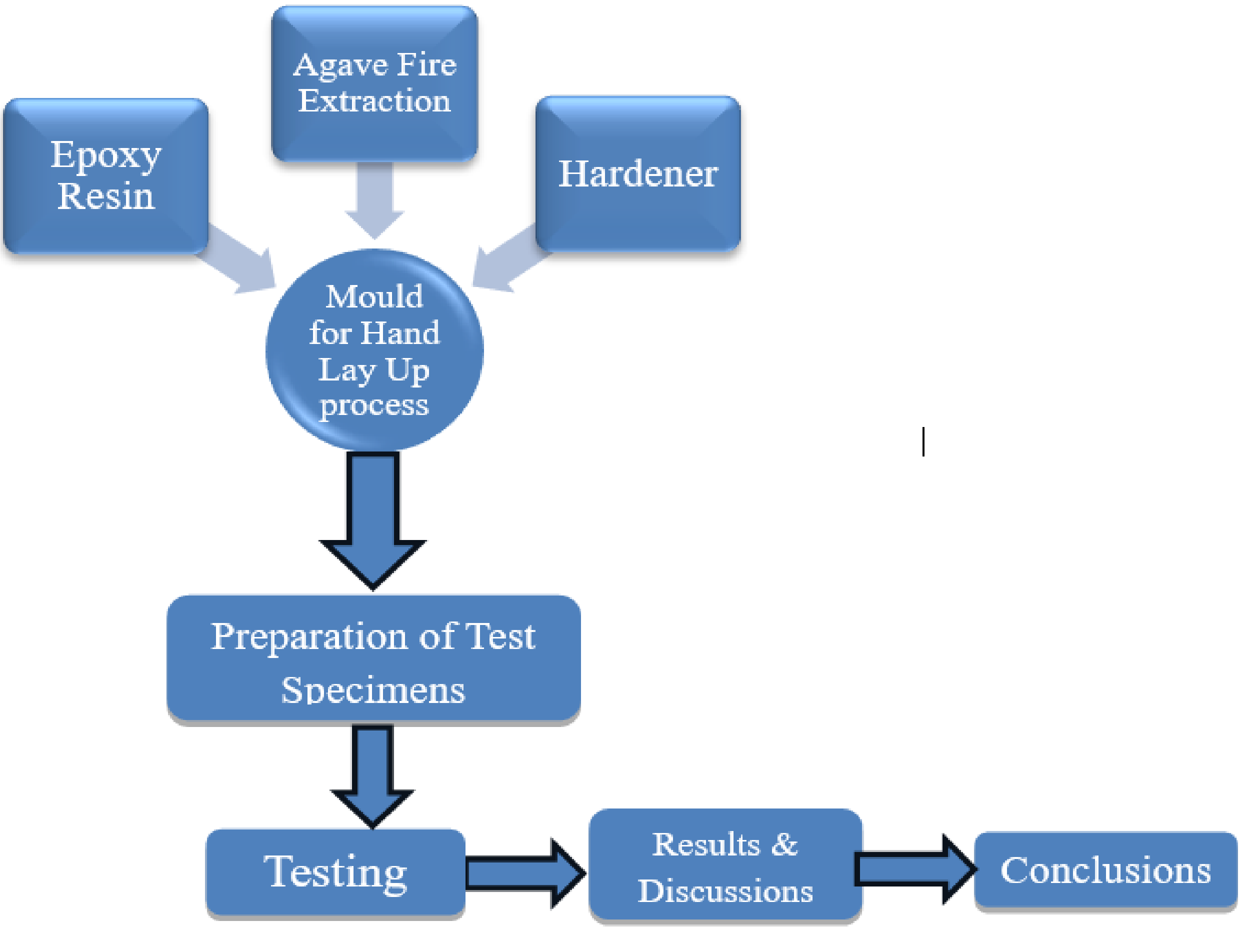
| Volume 7, Issue 6, June 2024 |

| DOI:10.15680/IJMRSET.2024.0706008 |

and its by-products (synthetic fibers). This is one of the major reasons for further researches and development on natural fiber reinforced composites to reduce dependency on petroleum and reduce carbon dioxide emission. Hence, using materials that are recyclable, biodegradable, low cost, low weight, high tensile and stiffness, non-toxic with specific tensile and modulus properties that can compete favorably with synthetic composites in both structural and non- structural areas of applications (PTRPC). Jute and sisal fibers which are second and third to the largest natural fibers produced after cotton, has presently been used to replace synthetic fiber reinforced composites in the automobile, building, aircraft, bridges with limitation to interior and non-structural applications due to their drawback of poor mechanical properties and poor moisture resistance since structural composites must resist loads due to tension, compression, impact, fatigue, blast and creep. Recent studies, researchers and publications have shown
that if sisal and jute fibers are well treated chemically before use, their mechanical and adhesion properties with non-polar matrix would be improved enough to rival glass composites in structural applications. Other properties of sisal and jute fibers that have been confirmed through researchers are:

1] Their chemical, physical and mechanical properties are reliable to some extent than glass fiber.
2] They are continuous fibers; hence their properties can be tailored due to their anisotropic properties similar to glass fibers.
3]They can be grown easily hence, providing economic opportunity to the agricultural sector and employment opportunity.
4]Since human existence is basically on: food, clothing and shelter, low cost of building and easy accessibility of the rural communities to the urban city for sales of their agricultural goods to promote good standard of living, sisal and jute with low cost, low density with reliable economic and mechanical properties should be developed to meet these needs.

III. METHODOLOGY OF PROPOSED WORK



| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 6, June 2024 |

| DOI:10.15680/IJMRSET.2024.0706008 |

1. Agave Fibre Extraction: A systematic approach is developed to extract fibres from Agave leaves. This includes the process of decorticating the leaves, retting, and mechanical extraction to obtain long, continuous fibres. The objective is to minimise waste and optimise the quality of the fibres.
2. Fibre Composition Variations: The study explores the influence of various factors on the quality and strength of the extracted Agave fibres. These factors include retting duration, fibres alignment, and chemical treatments. The goal is to identify the most suitable composition for different applications.
3. Fibre Strength Testing: The strength of Agave fires is assessed using standard mechanical testing methods, including tensile testing. Different compositions are tested to evaluate their tensile strength, modulus of elasticity, and elongation at break. This will provide valuable data for understanding the material's mechanical properties.
4. Applications and Sustainability: The study aims to identify potential applications for Agave fibres, such as in textiles, composite materials, and sustainable packaging. The research will also assess the environmental benefits of using biodegradable materials.

TENSILE TEST

The specimen for tensile testing is prepared according to ASTM D638 standard and the test was carried on Universal Testing Machine (UTM) at room temperature. The crosshead speed of the machine for testing the samples was 2 mm/min with a load cell of 30 kN. The dimension of the specimen is 165, 12.7 3 mm3 and its gauge length is 50 mm. The tensile fracture developed during to test. The load and elongation at the breaking point of the composite were obtained as an output from the machine which was used to calculate the tensile stress, tensile strain, and tensile modulus.

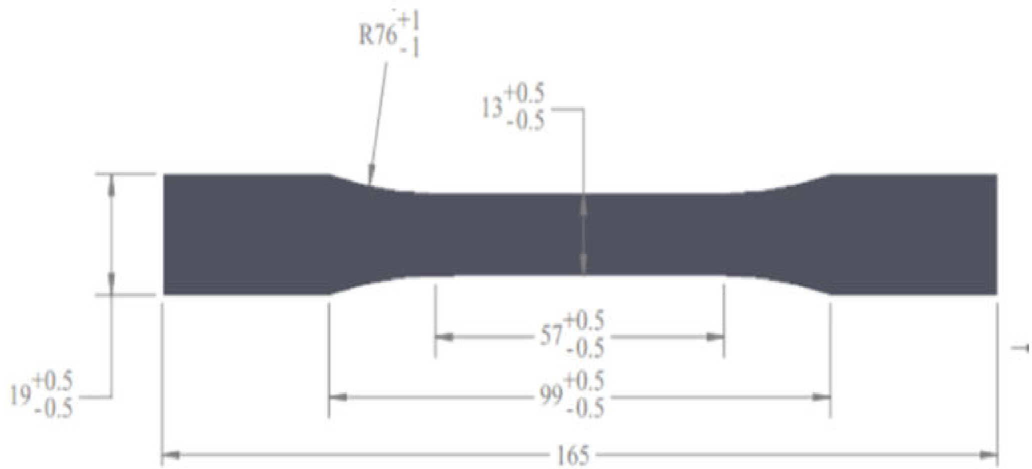


Fig. 1.1 Tensile Test specimen as per ASTM dimensions

FLEXURAL TEST

According to ASTM D790-10, the flexural test was performed by three points bending method with the aid of the electronic Univer- sal Testing Machine with a cross-head speed of 1.5 mm/min at room temperature. The dimension of the specimen is 60.8 12.7 3 mm3 and five specimens were tested. The specimen was freely supported by two supports at the span of 48 mm. The load was applied in the middle of the top surface of the specimen which develops crack and specimen deforms. The obtained load versus displacement curves were used to calculate the flexural strength and modulus.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 6, June 2024 |

| DOI:10.15680/IJMRSET.2024.0706008 |

RESULTS AND DISCUSSIONS

TENSILE TEST:

Table 1.0 shows Tensile strength of test specimens.

S.No	Sample ID	Tensile Strength (N/mm^2)
1	A1-1	17.73
2	A1-2	22.93
3	A1-3	27.09
4	A1-4	27.09
5	B1-1	15.74
6	B1-2	26.04
7	B1-3	31.09
8	B1-4	47.60

Table 1.1 Test Specimens with varying Percentage of Fiber reinforcement:

A1-1- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(1CM)+FIBER WEIGHT(10%)
A1-2- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(1CM)+FIBER WEIGHT(15%)
A1-3- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(1CM)+FIBER WEIGHT(20%)
A1-4- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(1CM)+FIBER WEIGHT(25%)
B1-1- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(4CM)+FIBER WEIGHT(10%)
B1-2- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(4CM)+FIBER WEIGHT(15%)
B1-3- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(4CM)+FIBER WEIGHT(20%)
B1-4- EPOXY RESIN+AGAVE FIBER+FIBER LENGTH(4CM)+FIBER WEIGHT(25%)

FLEXURAL TEST:

Table 1.2 shows Flexural strength of test specimens.

S.No	Sample ID	Flexural Strength (N/mm^2)
1	A1-1	122.56
2	A1-2	174.03
3	A1-3	186.06
4	A1-4	180.68
5	B1-1	68.89
6	B1-2	256.62
7	B1-3	155.29
8	B1-4	174.86

IV.CONCLUSION AND FUTURE WORK

The exploration of agave fibre as reinforcement in polymer composites, particularly when combined with epoxy resin and a suitable hardener, presents a promising avenue for developing sustainable and high-performance materials. The following conclusions can be drawn based on the study of agave fibre reinforced polymer composites:

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 6, June 2024 |

| DOI:10.15680/IJMRSET.2024.0706008 |

1.Mechanical Properties: Agave fibre reinforced epoxy composites exhibit enhanced mechanical properties such as improved tensile strength, flexural strength, and impact resistance compared to the neat epoxy resin. The natural fibre's intrinsic properties contribute significantly to these enhancements, making the composite suitable for various structural applications.

2.Environmental Benefits: Agave fibres are biodegradable and renewable, offering an eco-friendly alternative to synthetic fibres like glass or carbon. The use of agave fibres reduces the overall environmental impact of the composite material, aligning with the growing demand for sustainable and green materials in various industries.

3.Interfacial Adhesion: The effectiveness of the composite largely depends on the interfacial adhesion between the agave fibres and the epoxy matrix. Surface treatments of agave fibres, such as alkaline treatment, can significantly enhance this adhesion, leading to better stress transfer and overall composite performance.

4.Cost-Effectiveness: Agave fibres are relatively inexpensive and abundantly available, particularly in regions where agave plants are cultivated for other purposes such as tequila production. This makes the material cost-effective for large-scale production, potentially lowering the overall cost of composite manufacturing.

5.Application Potential: The combination of agave fibres with epoxy resin is particularly suitable for applications in automotive, construction, and consumer goods, where high strength-to-weight ratios and environmental considerations are paramount. The versatility of these composites allows for their use in a wide range of products, from automotive panels to sports equipment.

In conclusion, agave fibre reinforced polymer composites with epoxy resin and hardener represent a viable and attractive option for industries seeking sustainable, high-performance materials.

V. SCOPE OF FUTURE WORK

Mechanical Properties Enhancement:
Fiber Treatment: Investigate various chemical and physical treatments of agave fibers to improve interfacial bonding with the epoxy matrix. Treatments such as alkali treatment, silane coupling agents, and plasma treatments can be explored.
Hybrid Composites: Combine agave fibers with other natural or synthetic fibers (e.g., glass, carbon) to create hybrid composites, aiming to optimize mechanical properties such as tensile strength, flexural strength, and impact resistance.

REFERENCES

1. Zwane, P.E. Degumming of sisal fibres. UNISWA Research Journal of Agriculture Science and Technology 6(1), 37-44, 2002.
2. Boguslavsky, A., Barkhuysen, F., Timme, E. and Matsane, R.N. (2007). Establishing of Agave Americana industry in South Africa. 5th International Conference on New Crops,Southampton, September, 2007.
3. Zwane, P.E. (1997). Softening of sisal fibers to improve hand characteristics for the production of textiles. Unpublished doctoral dissertation, Florida State University, Tallahassee, Florida, USA
4. Dutta, A.K. Ghosh, B.L. and Aditya, The enzymatic softening and yarn upgrading of lignocellulosic fibres. Part III: Pretreatment of jute with enzymes for fine spinning. Journal of Textile Institute, Part 1(1), 28-34, 2000.
5. Y. Chaabouni, J. Drean, S. Msahli and F. Sakli, Morphological characterisation of individual fibre of Agave Americana L., Textile Res. J. 76, 367–374, 2006.
6. Slah Msahli , Faouzi Sakli and Jean-Yves Drean, Laboratory of Textile Physics and Mechanics ENSITM, 11
7. S. Thomas, S.A. Paul, A.L. Pothan, B. Deepa, Natural fiber: Structure, properties and Application: Cellulose Fibers: Bio and Nano Polymer Composites, Springer (2011) 3–42,
8. W.H. Zhu, B.C. Tobias, R.S.P. Coutts, G. Langfors, Air-cured banana-fiberreinforced cement composites, Cem. Concr. Compos. 16 (1) (1994) 3–8.
9. R. Khiari, M.F. Mhenni, M.N. Belgacem, E. Mauret, Chemical composition and pulping of date palm rachis and Posidonia oceanica – a comparison with other wood and non-wood fiber sources, Bioresour. Technol. 101 (2010) 775–780.
10. A. Belaadi, A. Bezazi, M. Bourchak, F. Scarpa, Tensile static and fatigue behavior of sisal fibers, Mater. Design 46 (2013) 76–83.

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com