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Evaluation on Mechanical Properties of Natural Fiber Based Epoxy Resin Composites

S. Nelson Raja[1], K. Vadivel[2], S. Sabanayagam[3], M. Sakthivel[4]
[1, 3, 4]*Assistant Professor, Department of Mechanical Engineering, Kings College of Engineering, Punalkulam, Tamilnadu, India*
[2]*Lecturer of Mechanical Engineering, Kongu Hi-Tek Polytechnic College, Karur, Tamilnadu, India*

Abstract: ***In this modern world, huge amounts of waste are produced in both natural wastes and human wastes as well. So, recycling and reusing those wastes a lead to a better world in the future, and it will protect the environment. Composite materials have played a vital role because of their adjective properties such as lightweight, lower density, lower corrosion and acceptable mechanical characteristics.***
It has a variety of applications like aerospace, automobiles and marine areas. Moreover, composite materials have been replaced the steel without losing the physical and mechanical properties.
This research paper leads to the desired mechanical and physical properties among the three combinations of natural fibers like neem fiber, raavi fiber and human hair fiber based composites samples along with suitable weight percentages. The composites samples were fabricated by using epoxy resin as a binder.
The desired sized test samples were undergone the various mechanical testing to determine their impact, hardness and tensile characteristics. From the results, clearly indicated that combination of neem-raavi reinforced composites are achieved a superior mechanical properties.
Keywords: Composite materials, Hair fiber, Mechanical characteristics, Natural fiber, Neem fiber, Raavi fiber.

I. INTRODUCTION

Focus on the economic and environmental aspect, composite is replaced by conventional materials without compromising the physical and mechanical characteristics. Mainly fiber composite materials are used instead of heavy materials because of their strength-to-weight ratio.
While using natural composite materials can able to optimize 60 to 80% of weight than aluminium matrix composites. Polymer based fiber composites are achieved a better impact strength compared with epoxy based fiber composites, and epoxy composites have reasonable tensile properties [1].
Adding more fiber content in resin based fiber composites increases the mechanical properties like impact, hardness, tensile and flexural strength [2,3].
Deproteinized natural fibers have improved mechanical characteristics than other natural composite materials [4]. Increasing the weight percentage of fiber content in composite materials that gives the best and most reasonable physical and mechanical properties and elongation ratio [5].
Adding more natural fibers in epoxy resin composites will optimize the voids during the fabrication of composite materials and improves better flexural properties [6,7].
Alkali treated natural fibers comparatively affects both tensile and flexural property [9,10].

II. METHODOLOGY

Neem, raavi and human hair fibers are used in this research to evaluate their mechanical characteristics. Natural fibers like neem, raavi and human hair are readily available in the market. All three fibers were treated with diluted NaOH solution for at least 24 hours, and then treated fibers were allowed to dry at atmospheric temperature. The composite samples were prepared using the hand layup method, and during the fabrication of composite samples, epoxy resin and hardener were added to achieve the desired weight percentage which is shown in fig 1 [1]. The fabricated three composite samples have undergone different mechanical testing such as impact, hardness and tensile as per the ASTM standards. The impact test was conducted using izod testing equipment (KL-300, S.NO 96/1054, Krystal Elmec). The hardness values were measured using vickers hardness tester. The tensile test was conducted using a universal testing machine (UTM 40, S.NO 11/98-2450, FIE).

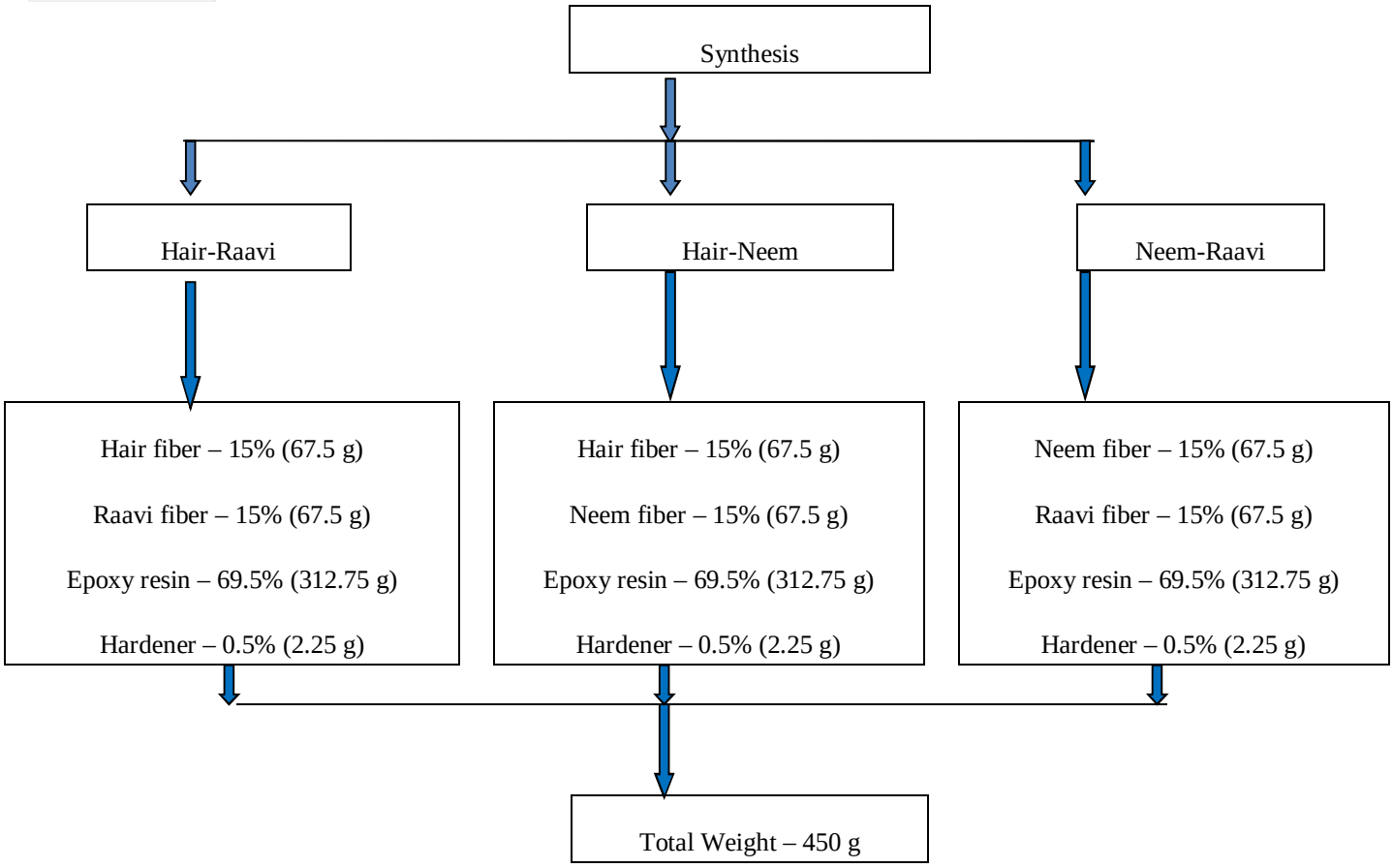

Fig 1. Weight percentage of composite samples

Fig 2. (a) Universal testing machine: (b) Izod testing equipment

III. RESULT AND DISCUSSION

The resized epoxy composite samples were subjected to mechanical testing, and their physical and mechanical properties were studied and characterized. The results observed that neem-raavi-epoxy composite sample has superior hardness and tensile properties, and the hair-neem-epoxy composite sample has excellent impact strength. It found that adding the neem fiber in epoxy composite gave a better mechanical property.

IV. HARDNESS TEST

Vickers hardness test was performed using vickers diamond pyramid along with a load is not more than 1 kgf. From the hardness test neem-raavi-epoxy fiber composite has a better hardness of 21,66667 HV. Similarly, hair-neem-epoxy fiber composite has a hardness value of 21.06667 HV and hair-raavi-epoxy composite has a hardness value of 20.8 HV. Fig 3 clearly shows that adding neem fiber in epoxy resin composite will increase the hardness property.

Table 1. Hardness test

Micro Hardness Test (Vickers Hardness Value In HV)				
Description	Trial 1	Trial 2	Trial 3	Average
Sample 1 (Hair-Raavi-Epoxy)	20.8	20.9	20.7	20.8
Sample 2 (Hair-Neem-Epoxy)	21	20.9	21.3	21.066667
Sample 3 (Neem-Raavi-Epoxy)	21.5	21.8	21.7	21.66666667

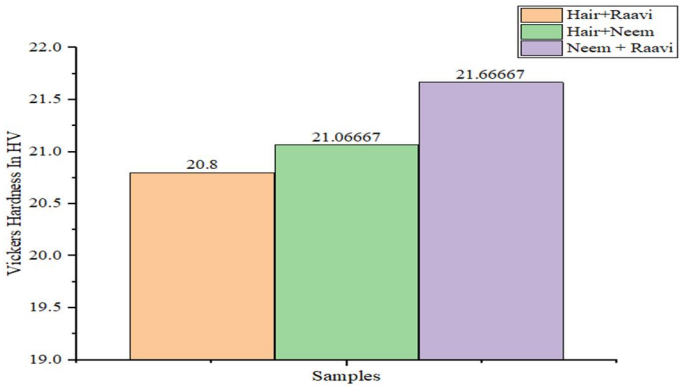

Fig 3. Hardness test

V. IMPACT TEST

Impact test was performed using izod test apparatus along with desired dimensions of 3 mm thickness. Generally, epoxy composites are having low impact properties than metal composites. Impact test values are recorded and shown in fig 3. The test results found that neem-raavi-epoxy resin fiber composites have lower impact strength, but hair-neem-epoxy resin fiber composite has shown better impact strength. It shows that adding neem fiber in epoxy resin composites will increase the impact property.

Table 2. Impact test

Impact Test (Izod Value In J For 3mm Thickness)				
Description	Trial 1	Trial 2	Trial 3	Average
Sample 1 (Hair-Raavi-Epoxy)	0.4	0.6	0.4	0.466667
Sample 2 (Hair-Neem-Epoxy)	0.6	0.9	0.55	0.683333
Sample 3 (Neem-Raavi-Epoxy)	0.45	0.25	0.65	0.45

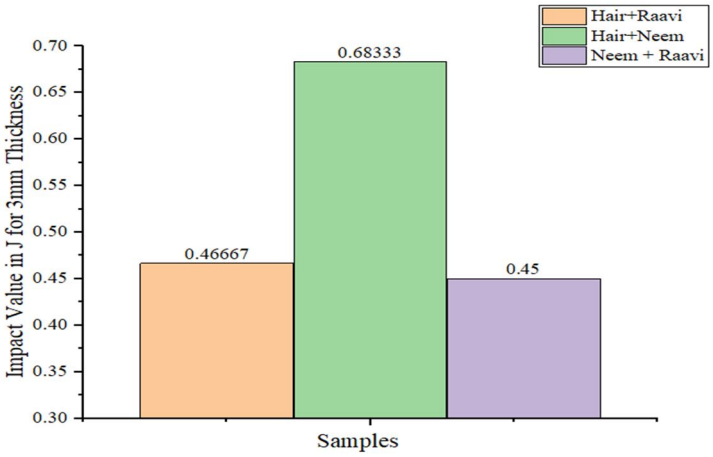

Fig 4. Impact test

VI. TENSILE TEST

Fig 5 shows the tensile property variations of the epoxy resin composite samples. The test was conducted by using universal testing machine. The graph noted that NaOH treated neem-raavi-epoxy resin fiber composite achieves a better ultimate tensile strength value of 21.21867 N/mm2. Likewise neem-raavi-epoxy resin fiber composite samples have undergone the least elongation value of 1.92667% (fig 6). Among three samples neem-raavi-epoxy resin fiber composite withstands a maximum load value of 1591.57 N (fig 7). The addition of neem fiber in the epoxy composite will also increase the ultimate tensile strength and maximum load carrying capacity. Simultaneously it consists of fewer elongation characteristics. Finally, found from the mechanical testing conducted, samples neem-raavi-epoxy resin fiber composite have superior mechanical properties.

Table 3. Ultimate tensile strength

Ultimate Tensile Strenth (N/mm^2)				
Description	Trial 1	Trial 2	Trial 3	Average
Sample 1 (Hair-Raavi-Epoxy)	19.797	16.402	12.635	16.278
Sample 2 (Hair-Neem-Epoxy)	15.804	19.041	14.215	16.35333333
Sample 3 (Neem-Raavi-Epoxy)	17.383	22.288	23.985	21.21867

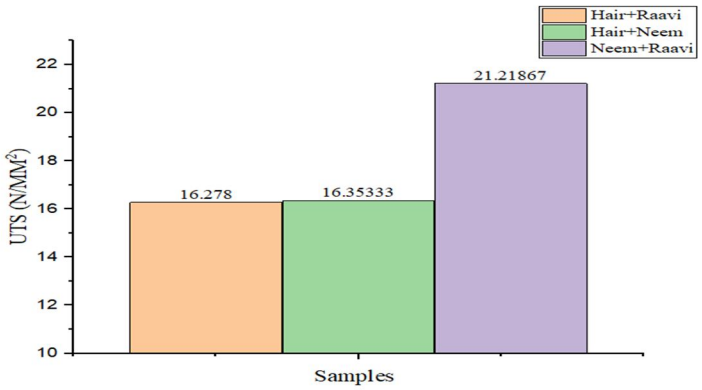

Fig 5. Ultimate tensile strength

Table 4. Percentage of elongation

Percentage of Elongation				
Description	Trial 1	Trial 2	Trial 3	Average
Sample 1 (Hair-Raavi-Epoxy)	2.79	2.63	4.79	3.403333333
Sample 2 (Hair-Neem-Epoxy)	2.27	2.53	2.88	2.56
Sample 3 (Neem-Raavi-Epoxy)	1.87	1.82	2.09	1.926666667

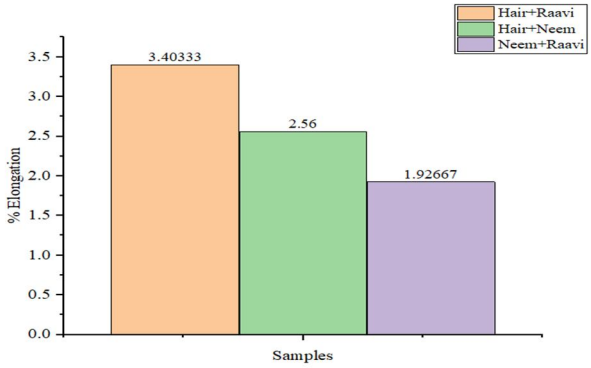

Fig 6. Percentage of elongation

Table 5. Peak Load

Peak Load (N)				
Description	Trial 1	Trial 2	Trial 3	Average
Sample 1 (Hair-Raavi-Epoxy)	1484.92	1230.213	947.568	1220.91
Sample 2 (Hair-Neem-Epoxy)	1185.009	1428.258	1066.298	1226.53
Sample 3 (Neem-Raavi-Epoxy)	1304.122	1671.575	1798.997	1591.57

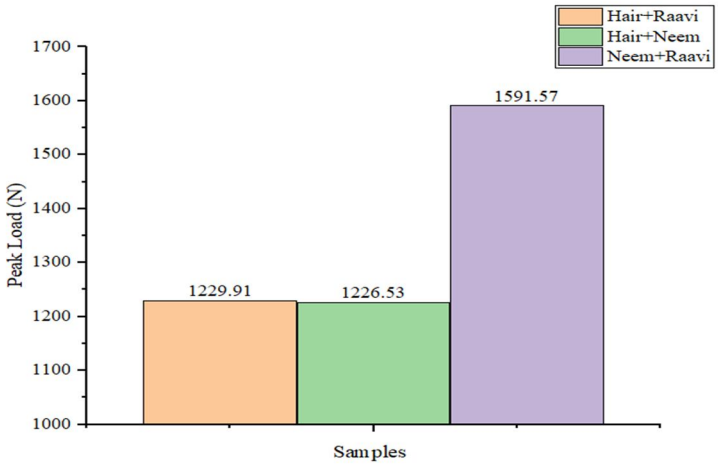

Fig 7. Peak load

VII. CONCLUSION

Hair-raavi, hair-neem and neem raavi composites sample was prepared according to ASTM standards. They were subjected mechanical characteristics testing, and their results were validated. NaOH chemically treated neem-raavi-epoxy resin fiber composite has a maximum hardness value of 21.66666667 HV, tensile strength of 21.21867 N/mm2 and minimum impact strength of 0.45 J. From the results revealed that the addition of neem fiber increases the mechanical characteristics of epoxy composites.

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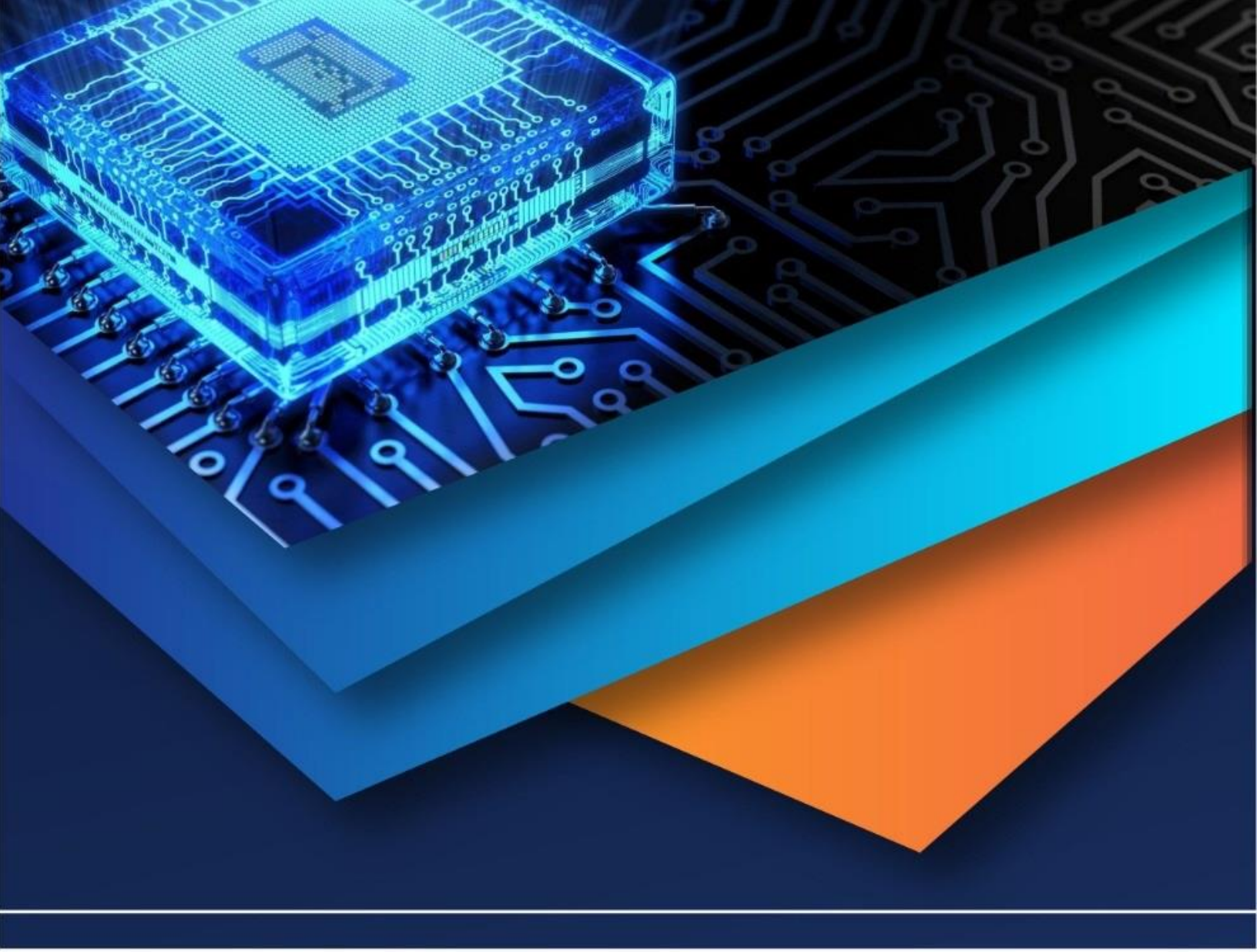

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