ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

Experimental investigation on neem fiber/epoxy composites Containing with and without NaoH treatment

T.Seshaiah[1*], D.Sarathkumar[1],*Y.Kalyan Krishna*[1], V.Srinivasa Reddy[1], Maheswararao.R[2]

[1] *Assoc.Professor, Department of Mechanical Engineering, QIS College of Engineering & Technology, Ongole.A.P*
[2]*Asst.Professor, Department of Civil Engineering, QIS College of Engineering & Technology, Ongole.A.P*
qispublications@qiscet.edu.in

ABSTRACT

In this paper investigates the mechanical characteristics of natural (neem) fibers/epoxy composites with and without NaOH treatment. The neem fiber specimens were fabricated by use of wet lay-up method, it's containing a polymer matrix, neem fiber, with and without NaOH treatment. Bending (flexural) strength, impact toughness (strength), and tensile properties were tested on neem fiber reinforced matrix composites with maximum loading and various weights percentage of NaOH (1, 1.5, 2, and 2.5wt%). The results showed that by altering the fiber content, with NaOH (2%). treated neem fibered composite's properties enhanced in comparison to the untreated fibered composite.

Key words: Neem fiber, NaoH, Polyester matrix, Tensile, Flexural and Compressive strength

1. Introduction

Composite materials are used instead of traditional materials because they enhance the strength and optimization of composite structures. A hybrid composite is made up of two or more reinforcing fillers with various characteristics. Shankar ganesh S P et.al [1] the effect of neem fiber as outer layer on the tensile characteristics of neem/almond fruit specimens is investigated. It can be showed flexural and ILSS characteristics of hybrid specimens are enhanced by 6.4% and 5.2%, respectively. Raja T et.al [2] In this study, chopped woven banyan and neem fibers were stacked in seven layers and made-up by using a hand-lay-up method with 70% LY-556 epoxy resin, 25% woven/neem fiber and 5% sawdust filler material. The results reveal that with increased weight fraction of banyan fibers, it has higher impact, flexural, compressive and tensile strength of 17J, 22, and 24,25 MPa respectively Kaliappan et.al [3] investigated three types of composite materials were made-up of using, abaca, neem, glass fiber and LY-556 resin. The type1 is made from abaca /glass fiber, type2 made from glass/neem fiber, and type3 made from abaca/neem/glass fiber with epoxy resin. The results indicate that composites made of type3 with 45^{o} orientations of glass fiber enhanced flexural properties of (abaca /glass and glass/neem) fiber composites. S.Rajesh et.al [4] investigated impact/tensile characteristics of (Neem/Kenaf) specimens were evaluated. The results showed Kevlar with natural Kenaf fiber epoxy composites were strong and high impact properties. J.S.H. Zalifah Rapi et.al [5] studied the hybrid (glass/aramid/neem) fiber composites for boat structures, the result of impact, bending and tensile, strengths increased when addition of the glass fiber content. Colbert B et.al [6] studied the neem fibers reinforced with formaldehyde resin composites the composite with 50wt% neem fiber had a better impact strength of 9.31 KJ/m^2 while other properties such as water absorption, wear resistance and flexural, were increased with 30 wt% neem fiber. Isiaka Oluwole Oladele [7] studied the mechanical characterization of with and without chemical treatment on the neem fiber/epoxy composites can be showed that with modified (chemical) treatment of neem fiber enhanced mechanical properties M.Nagamadhu [8] studied the neem fiber has a good reinforcing material based on the thermoplastic composite materials. It has a

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

low density, high specific and impact characteristics impact on the transportation and automotive industries. V.J. Binu et.al [9] studied the hybrid neem fiber surface treatment with PLA materials can be enhanced the tensile and decreased the impact strength. Vinayagamoorthy R [10], studied about the neem and hemp natural fibers are renewable as compared to conventional glass and carbon fibers. These natural fibers are available quickly for the creation of sophisticated composites. Finally, in this paper investigated. the surface treatment of neem fiber with 10wt% of NaOH enhanced tensile, flexural and impact strength. It is also obvious that the wt% of fiber has a significant impact and toughness of neem fiber specimens. The load is uniformly distributed among all fibers that are well attached to the resin matrix material up to the fiber weight ratio's maximum value.

3. Materials and Methods

3.1 Identification, Collection, and Extraction of fibers

Azadirachta indica [11], is a member of the Meliaceae family of mahogany trees. It is one of only two species in the genus Azadirachta and is indigenous to much of Africa and the Indian subcontinent. Tropical and semi-tropical climates are where it is commonly grown. In southern Iran, neem trees are also found on islands. Neem oil is produced from the plant's fruits and seeds. Neem is a fast-growing tree that rarely grows to a height of 35 to 40m. Due of its deciduous nature, it loses a lot of leaves in the arid winter months. The branches reach out and are broad. The somewhat rounded, moderately dense crown can have a diameter of 20–25 m. The Chinaberry (Melia azedarach), a cousin of the neem tree, resembles it in appearance quite a little [12].

Fig 3.1: Neem plant

3.2 Fiber Extraction

During a process of decortication, the fiber is extracted where leaves are wrinkled and crushed by a rotating wheel equipped with blunt knives. After drying, brushing, and baling the fiber for export. The quality of the fibers depends heavily on moisture content, hence proper drying is required. Although artificial drying has been proven to produce fiber with generally better grades than sun drying, it is not always practical in the developing nations where neem is grown; the fiber is then brushed to remove moisture. Dry fibers are mechanically combed and divided into different grades, usually based on the earlier in-field division of leaves into size groups as indicated in Fig. 3.2.

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

Fig 3.2: Neem fibers

3.3 Hand lay-up method

General purpose epoxy resin of LAPOX (L-12), supplied by ECMAS Resins Pvt. Ltd. Hyderabad, is used as the matrix and Neem fibers as reinforcement unsaturated epoxy resin of ortho-pathalic acid grade with transparent colourless is used to fill the produced mould using the hand layup method. Each of these ingredients is added in an amount equal to 10% of the resin's volume. A small layer coating of resin is applied to the surface of the mould, and a known weight of fiber is placed along the specimen's longitudinal axis so that the fibers are oriented (0^0) aligned with its axial direction. The remaining space in the mould is then filled with resin, making sure there are no air gaps in the mould. The rubber mould is then covered with a 0.2 mm thick piece of thin polyethylene paper. For 24 hours, a flat plate of mild steel is left on the mould to cure. The specimen is afterwards taken out and machined to create the final measurements, which are 160mm*12.5mm*3mm. NC thinner is used to clean the specimen, and dirt is then wiped off with a cloth. Sandpaper has been used to make the ends of the specimen's two flat surfaces sufficiently rough to glue the end tabs. For each wt% of fibre, five identical specimens with and without NaOH are fabricated. To compare the effects of NaOH on natural fibre reinforced composites, five simple epoxy and composite specimens are also prepared. For each set, fibre and NaOH content in the specimen are determined. This is determined from the known densities of matrix, NaOH and fibers.

4. Mechanical Properties

4.1 Tensile Testing

The specimen is prepared by hand layup process in the form of a rectangular strip of 160 x 12.5 x 3 mm thick A fixed and moveable grip chuck are accommodated on the tensometer to handle specimens that are 15 mm wide and 7 mm thick. The specimen was held in a fixed grip, and the moveable grip was manually adjusted until the specimen was tightly and firmly grasped. To measure the specimen's load and extension, when the power supply is turned on. The movable chuck is further pushed until the load indicator barely begins to indicate that the specimen is being loaded. When the load on the specimen is zero at that point, the extension meter is set to read zero. The speed reduction pulleys are selected so that the movable grip is subjected to a cross head speed of 2 mm/min. as indicated in Fig. 4.1.

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

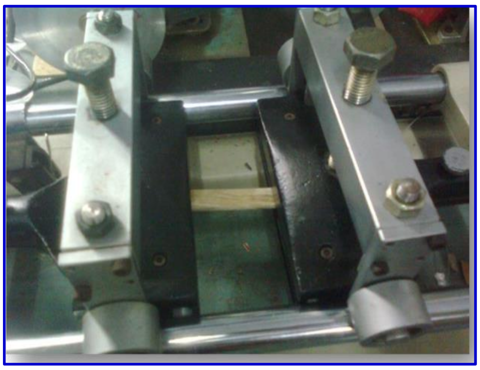


Fig 4.1: Composite under tensile test

4.2 Flexural Testing

The speed reduction pulleys are selected so that the movable grip is subjected to a machine loading speed of 1.5 mm/min as shown in Fig 4.2. Then, the tensometer's and load values are fitted zero position, at each 0.3 mm extension the load values are noted until the specimen(100×25×3mm) failure. Each specimen's failure type and any further failure-observations also reported. The tests are carried out in a lab environment with a relative humidity of 50% and a temperature of 24^{0}C. The rate of loading and testing time chosen for each specimen varied between 2 and 5 minutes. Neem fibre composites before and after flexural testing as shown in Fig.4.3

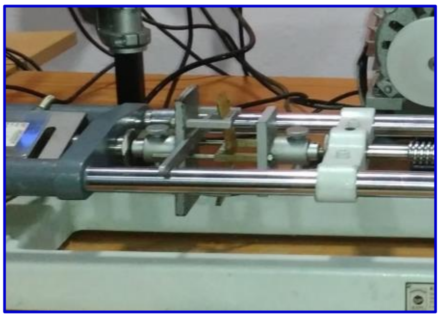
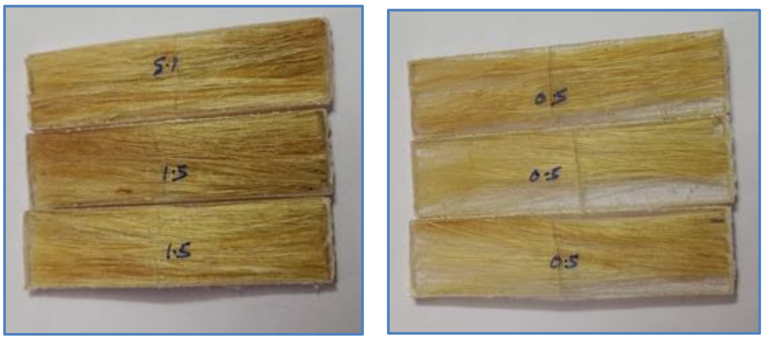


Fig 4.2: Composite under flexural test



(a) **(b)**

Fig 4.3 (a): NaOH treated Neem fiber (b) Without NaOH treated Neem fiber epoxy composites

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

4.3. Impact Testing:

As per ASTM the specimen size (63.5x12.36x10mm) is considered for impact properties. The load and extension meters on the impact machine have a minimum count of 0.01 J. A fixed and moveable grip chuck are both fitted on the impact machine. The specimen was held in a fixed grip, and the moveable grip was manually adjusted until the specimen was tightly and firmly grasped. The sudden force to measure the specimen's energy absorption occurs when the lever is released. When the load on the specimen and extension meter is adjusted to zero as shown in Fig.4.4. Then the lever is released the impact machine started. Starting from zero, the energy absorbed values are noted until the specimen failure. The total energy absorbed is shown on the indicator display at the end of the test. Additionally, it has been concluded the specimen failure within length of the specimens. Five identical neem/fiber epoxy composites are tested for with and without NaoH as shown in Fig.4.5

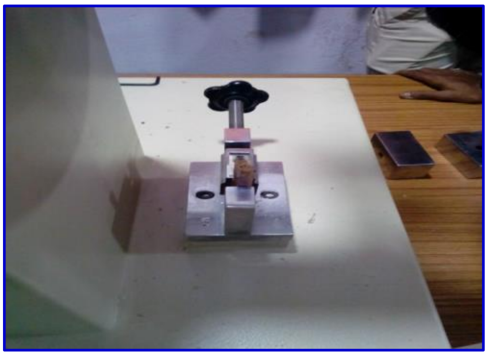
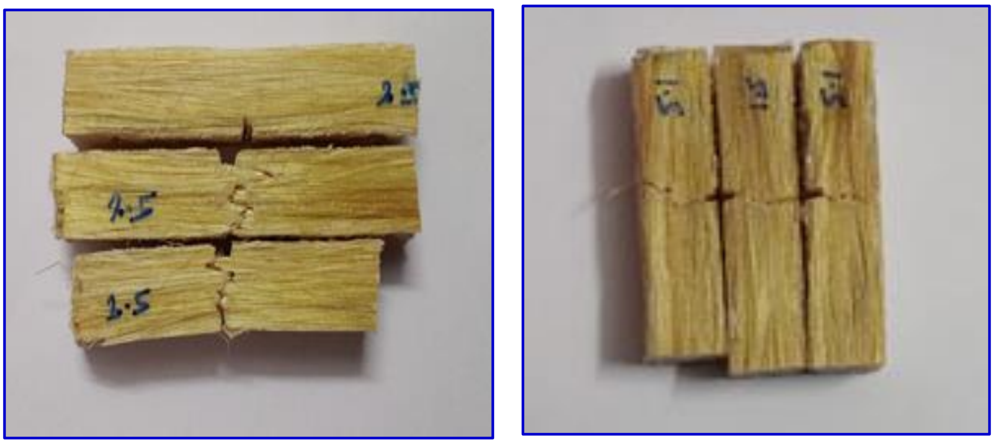


Fig 4.4: Composite under impact test



(a) **(b)**

Fig 4.5 (a): NaOH treated Neem fiber (b) Without NaOH treated Neem fiber epoxy composites

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

5. Results and Discussions

5.1 Mechanical properties Neem fiber/epoxy composites

5.5.1 Tensile test

The tensile characteristics of neem (natural) fiber/epoxy specimens have been tested using as per the ASTM, D638M-89.

Table 5.1: Fiber vol%. on tensile strength of composites made of neem fibre and epoxy with and without NaOH treatment.

Composition	Bending1		Bending2		Bending3	
	Load (N)	Elongation (mm)	Load (N)	Elongation (mm)	Load (N)	Elongation (mm)
1	1810	3.8	1930	3.9	1970	3.1
2	1880	1.9	3490	4.0	3610	4.0
3	5320	4.3	4200	3.2	4908	3.8

In Fig 5.1, the mean tensile strength for Neem fiber composites with and without NaOH treatment is plotted against the volume fraction of fiber. It has been found that for composites treated with NaOH, the mean tensile value of Neem fiber epoxy composites increases linearly as a function of the volume fraction of the fiber. At a 23% vol. fraction of fiber, the average tensile value of NaOH-treated neem fiber epoxy specimen is enhanced to 200 MPa. Epoxy composites treated with NaOH have increased tensile strength even further and exhibit intercalated morphology.

In Fig. 5.2, the effect of fiber vol. fraction on the mean tensile modulus of specimen made of epoxy and neem fiber with and without NaOH treatment is depicted. From 9% volume of fiber, the tensile modulus rises steadily and continues to rise continuously until it reaches 23% volume of fiber. At 23% volume fraction of fiber, the tensile modulus of NaOH-treated Neem fiber epoxy composites is raised to 10.66GPa. It can be shown tensile modulus of neem/fiber composites can be increased by fiber that has undergone NaOH treatment. The shape of composites affects the modulus increment.

The results for the specific tensile and modulus follow same curve as the mean tensile and modulus, which are depicted in Figs. 5.2 and 5.3, respectively. The particular characteristics are calculated as the mass density of the composites expressed in kg/m^3 divided by the relevant strength/modulus in MPa. With respect to volume fraction of fiber at 23%, the exact tensile and modulus of NaOH-treated Neem fiber epoxy composites are likewise raised to 0.119&6.39MPa/(kg/m^3), respectively.

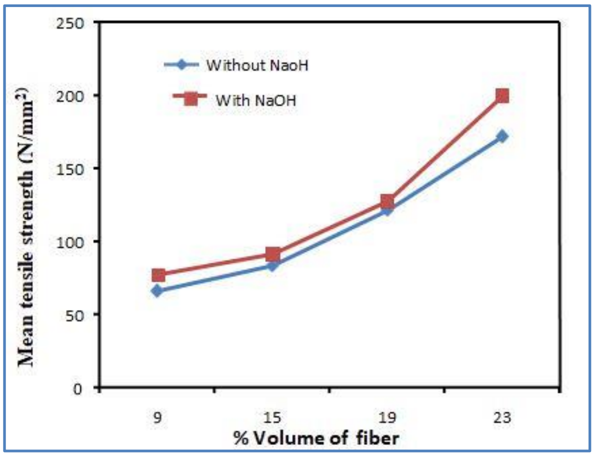


Fig 5.1: Fiber Vol%. Vs the tensile strength of composites made of epoxy and neem fiber with and without NaOH treatment

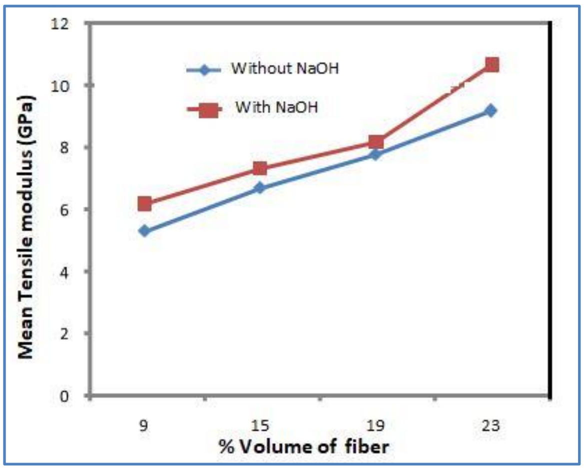


Fig.5.2 Fiber Vol%. Vs tensile modulus of composites made of epoxy and neem fibre with and without NaOH treatment.

5.5.2 Flexural test

The flexural test as per ASTM, D790M is used for testing the of natural(neem) fiber epoxy specimens.

Table 5.2: Fiber vol%. on bending characteristics of neem fibre

Composition	Bending1		Bending2		Bending3	
	Load (N)	Elongation (mm)	Load (N)	Elongation (mm)	Load (N)	Elongation (mm)
1	220	6.4	160	5.0	140	4.8
2	220	6.4	280	5.7	250	5.6
3	240	5.6	370	7.3	400	6.2

In Fig. 5.3 shows the average flexural strength Vs fiber volume fraction for composites made of natural fibers from Neem, both with and without NaOH treatment. It has been found that for composites treated with NaOH, the mean bending (flexural) strength of Neem fiber epoxy specimens rises with fiber vol.%. At a volume percentage of fiber of 24%, the mean bending (flexural) strength of Neem fiber specimen is sharply raised to 280MPa. The flexural results follow the same curve as a mean tensile value result, as

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

illustrated in Fig. 5.4. The particular characteristics are calculated as the mass density of the composites expressed in kg/m3 divided by the relevant strength/modulus in MPa. The particular flexural strength of treated

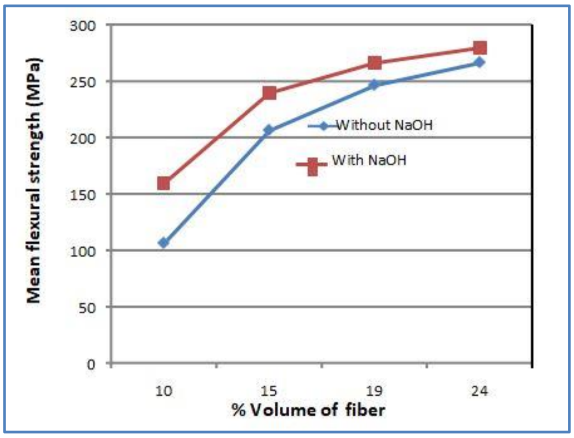


Fig 5.3: Fiber Vol%. Vs Neem fiber/epoxy both with and without NaOH treatment

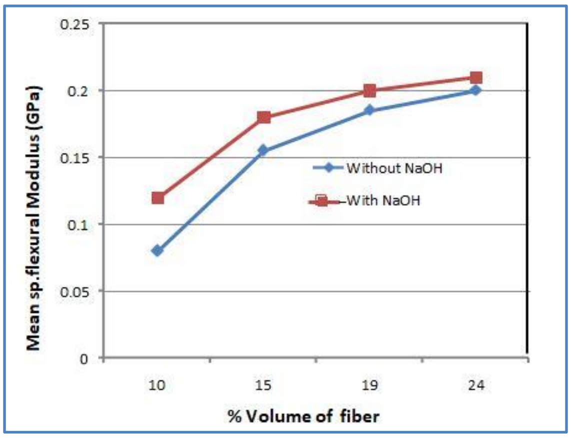


Fig 5.4: Fiber Vol%. Vs Neem fiber/epoxy both with and without NaOH treatment.

5.5.3 Impact Test:

The impact test method ASTM-D256M has been used for testing the impact toughness (strength) of Neem (natural) fiber/epoxy specimens

Table 5.3 Fiber vol%. on neem fibre impact test treatment

Composition	Impact -1 (J)	Impact –2 (J)	Impact -3 (J)
1	1.6	1.8	2.2
2	3.0	4.6	3.8
3	7.0	3.4	5.0

In Fig. 5.5 shows the average impact strength Vs fibre volume fraction for composites made of natural fibers from Neem, both with and without NaOH treatment. It has been found that for composites treated with NaOH, the mean impact strength of neem specimens rises linearly with fiber vol%. fraction. At 20% a volume fraction of fiber, toughness(impact) strength of neem composites is enhanced to 1.12 Joules/mm.

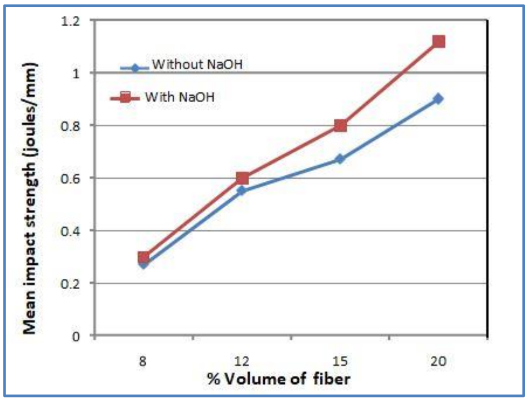


Fig 5.5: Fiber Vol%. Vs Neem fiber/epoxy both with and without NaOH treatment.

Conclusions

The following conclusions are taken from the experimental findings.

- Compared to without NaOH treatment (171.73MPa), the mean tensile strength of NaOH-treated neem fiber epoxy composites is 200MPa at a 23% volume fraction of fiber.
- The mean tensile modulus of NaOH-treated neem fiber epoxy composites increased from 9.16GPa to 10.66GPa at a 23% volume percentage of fiber.
- Additionally, the specific tensile strength of NaOH-treated neem fiber epoxy composites is increased to 0.119 MPa/ (kg/m^3), which is 23% higher than the untreated composites value of 0.103 MPa/kg/m^3.
- Neem fiber epoxy composites treated with NaOH have a specific tensile modulus that is also 23% higher 6.39 MPa/(kg/m3) than composites untreated with NaOH, which had a specific tensile modulus of 5.49 MPa/(kg/m^3).
- Compared to without NaOH treatment(266.67MPa), the mean flexural strength of NaOH-treated neem fiber epoxy composites is raised to 280MPa at a volume percentage of fiber 24%.

- At a volume fraction of 24% more fiber, the specific flexural strength of NaOH-treated neem fiber epoxy composites is raised from 0.200MPa/(kg/m^3) to 0.210MPa/(kg/m^3).
- In addition, the impact strength of the NaOH-treated neem fiber epoxy composite is improved from 0.90 joules/mm without NaOH treatment to 1.12 joules/mm at a volume fraction of fiber 20%.

References

1. S P Shankarganesh, R Muralikannan, R Selvabharathi[2] and R Karuppasamy (2019) Investigation of tensile, flexural and impact properties of Neem-Indian almond hybrid fiber based epoxy composites, Materials Research Express, Volume 6, Number 8. Mater. Res. Express 6 (2019) 085322, https://doi.org/10.1088/2053-1591/ab20f7.
2. Raja T, Anand P,Karthik K &Udaya Prakash J,(2021) Mechanical properties and moisture behaviour of neem/banyan fibres reinforced with polymer matrix hybrid composite, Advances in Materials and Processing Technologies, Volume 7, Issue 2 (2021)https://doi.org/10.1080/2374068X.2021.1912530.

ISSN- 2394-5125 VOL 6, ISSUE 02, 2019

3. P Kaliappan ,R Kesavan and B Vijaya Ramnath, Investigation on effect of fibre hybridization and orientation on mechanical behaviour of natural fibre epoxy composite, Bull. Mater. Sci., Vol. 40, No. 4, August 2017, pp. 773–782, DOI 10.1007/s12034-017-1420-2.
4. S.Rajesh B.Vijayaramnath C.Elanchezhian S.Vivek M. Hari Prasadh M.Kesavan, Experimental Investigation of Tensile and Impact Behavior of Aramid-Natural Fiber Composite, Materials Today: Proceedings, Volume 16, Part 2, 2019, Pages 699-705.
5. M. J. Suriani Hannah Zalifah Rapi , R. A. Ilyas, Michal Petr u and S. M. Sapuan , Delamination and Manufacturing Defects in Natural Fiber-Reinforced Hybrid Composite: A Review, Polymers 2021, 13, 1323. https://doi.org/10.3390/polym 13081323.
6. Colbert B, D K Kidmoa A Tomb RRN Mvondocd et.al Effect of neem (Azadirachta Indica) fibers on mechanical, thermal and durability properties of adobe bricks, Energy Reports, Vol 7, (5), Nov 2021, Pp 686-698. https://doi.org/10.1016/j.egyr.2021.07.085.
7. Isiaka Oluwole Oladel, Oluwagbenga Adelania et.al Sustainable Naturally Derived Plantain Fibers/Epoxy Based Composites for Structural Applications. Journal of Natural Fibers 27 Oct 2022. https://doi.org/10.1080/15440478.2022.2134264.
8. M.Nagamadhu S.Vijay Kumar S.Ravi Kumar R.Suraj G.C.Mohan Kumar Dynamic Mechanical Analysis and Thermal Stability of Neem Wood Veneer Plastic Composites, Vol.24, Part 4, 2020, Pp 2265-2273. https://doi.org/10.1016/j.matpr.2020.03.754.
9. V. J. Binu Kumar J. Bensam Raj R. Karuppasamy, R. Thanigaivelan, Influence of Chemical Treatment and Moisture Absorption on Tensile Behavior of Neem/banana Fibers Reinforced Hybrid Composites: An Experimental Investigation. Journal of Natural Fibers Volume 19, 2022 - Issue 8. https://doi.org/10.1080/15440478.2020.1838995.
10. Vinayagamoorthy R. Trends and Challenges on the Development of Hybridized Natural Fiber Composites, Journal of Natural Fibers, Volume 17, 2020 - Issue 12. http://dx.doi.org/10.1080/15440478.2019.1598916.
11. E.M.El.Khatib N.F.AliR.S.R.El-Mohamedy, Influence of Neem oil pretreatment on the dyeing and antimicrobial properties of wool and silk fibers with some natural dyes, Arabian Journal of Chemistry Volume 13, Issue 1, January 2020, Pages 1094-1104. https://doi.org/10.1016/j.arabjc.2017.09.012.
12. E L Scudelera A S G Garciaa, PFF Pinheiro, D C d Santosa, Neem oil (Azadirachta indica A. Juss) affects the ultrastructure of the midgut muscle of Ceraeochrysa claveri (Navás, 1911) (Neuroptera: Chrysopidae), Acta Histochemica Volume 119, Issue 1, January 2017, Pages 84-91. https://doi.org/10.1016/j.acthis.2016.11.012.