

# Characterization of Mechanical Behavior of Treatment of Nano Hybrid Kenaf Fibre Composite Material

Parthipan N.

Assistant Professor, Department of Mechanical Engineering, M.Kumarasamy College of Engineering, Karur, Tamil Nadu, India. Email: [parthipann.mech@mkce.ac.in](mailto:parthipann.mech@mkce.ac.in)

**Abstract:** The main objective of our work is to perform and to analyze the mechanical behaviors of kenaf and glass fibre using various mechanical tests such as strength, hardness and many other properties which helps to apply in various industrial and mechanical oriented applications. In this research, Kenaf is separated as treated and untreated composite materials. The kenaf is dipped with the mixture of ethanol and silicon di oxide which is known as treated process and the non-dipped kenaf is known as untreated process. The plates are arranged in the form of 2 kenaf layers and the glass fibre is inserted in the middle, it is molded with the help of epoxy resin. Then each plate are separated with silicon of 0%,1% and 2.5%. Then various tests such as flexural, tensile, impact are being performed and noted as treated and untreated values. The resulting values are plotted in the form of graph which will be easy for the comparison of treated and untreated materials. By finding these ratios, it helps in the replacement with other material properties. So we conclude that our aim is to test and compare both treated and untreated plates to find their properties and applications.

**Keywords:** Kenaf fibre, Glass fibre, Silane, Siline, Epoxy resin

## I. INTRODUCTION

Glass fibre, which is a material with various Mechanical properties. It is also one of the fibre reinforced composite material combined with kenaf. These combination results to show their better than the individual one. Its major role is to achieve more strength and capacity to carry over the load, light weight for the corrosion resistance. Glass fibre normally exists with long life span, under various conditions it ensure itself to high tensile, impact loadings, inter laminar shear strength and acts as low penetration to the hardness. During long time use, it is not easy to obtain critical stresses and minor cracks on the smooth surface. The overall performance of these combinations looks like more inferred. Vishwas M et al. [1] Besides on hybridization of the kenaf/glass fibre composites behaves with impact test, which overcomes the damaged area to be preferred

for increased energy absorption. The fine kenaf and glass fibre contributes to be preserving natural fossil resources. Kishore K Kumar et al. [2], By the way fracture toughness and its vibrational modal analysis, it's to be cleared that there is plenty of vibration capturing capacity is available in glass fibre. Similar to the hybridization; it also performs as high level energy to be absorbed. Jeswin Arputhabalan et al. [3], Influencing with water absorption for these reinforced composite material, it contributes extremely fine fibre compared to the other materials. However, its unique feature that helps to be required conventional composites. Other than its properties, it is considered for the reduction of using alternative glass fibre layers on the composite material. Muhammad F et al. [4], These physical and chemical properties like as stronger, longer, lighter, capable of replacing other materials are considering and evaluated as per the ASTM standards. These polymers are polymerized and obtained tensile and compression testing and analysis with infrared spectroscopy and scanning electron microscopy. Dapeng Wang et al [5], The flexural properties of fibres are comparatively high than the composite material. For structural application these composite materials helps in designing process and other mechanical properties. The tests have been done and evaluated and the following results are plotted in the form of graph. The hybrid of any material such as kenaf or a glass fibre helps in increase in transverse as well as longitudinal strength. H. Fouad et al [6], As the effect of the kenaf fibre plate the fibre material and treatment of chemicals on the tensile response of thermoplastic fibre metal laminates are being investigated. Overall the treated and untreated laminates given show the higher tensile and flexural value of strength and modulus of treated and untreated laminates. The investigation of tensile performance of the laminates gives different orientations and number of fibre layers. N. Parthiban et al [7], Based of scanning electron microscope observation it was found that impregnation significantly helps to enhance the compatibility of kenaf and glass fibre, apart from mechanical properties the advantage is reflected in the reduction of energy consumption and environmental impacts. The SEM observation revealed greatly improved interface compatibility between kenaf and glass fibre. A.M Noor Azammi et al [8], The fibre volume fraction are manufactured by the process of resin

transfer moulding. The lamination process is being tested for strength and modulus factor under tensile test and modulus under tensile and flexural loading. The similarity between the kenaf and glass fibre lamination process shows as the tensile and flexural modulus is compared with the volume factor of 15%. C. Ramesh et al [9], The major effect of the fibre hybridization and arrangement helps along with the loading axis and helps to know about the flexural dynamics and statically properties. The aim of our process is to analyse the effect of the hybridization and configuration process on the mechanical dynamic factor and static flexural properties of kenaf and glass fibre composite. This implies the reliability and strength of the material. D. Savitha et al [10], Kenaf plants are usually harvested for several times in a particular year which depends upon the source of the plants. The yield and work of these plant components are affected by various factors by both natural and artificial method. It also helps in reducing the wastage of composite material and helps to develop a healthier environment. S. Rassamann et al [11], Epoxy based hybrid Nano composites is prepared by dispersing different Nano particles and composite material. The increase of value in the dynamic mechanical properties and kenaf material of epoxy hybrid composites material are relatively higher than any other material. It shows a high possibility in the rate of advanced light weight structure. N. Saba et al [12], The purpose of this research is to develop more kenaf composites and glass reinforced hybrid composite materials. The damage progression of the two materials is similar. The kenaf and glass hybrid composite materials are fabricated successfully using the combination of two methods namely layup method and cold press method. The polymer matrix may get failed with a whole and cracking sound in initial method. Z. Salleh et al [13], The Mechanical properties of kenaf fibre polypropylene composite material have been elaborated. As for the mechanical and physical testing which are normally performed towards composites material such as high force tension. Explorations on kenaf fibre reinforced composites have created more influence among the research due to some of the ecological factors. Mst. SadiaMahzabin et al [14], The Kenaf material is one of the natural fibre used for reinforcements in case of polymer matrix. Kenaf is one of the important source of fibre which is used as a composites. In overall about 35% of kenaf is known as best fibre which is appropriate for paper textiles and industries. The morphology of bio composites was not an effected material for fibre hybridisation. NurulHidayah D. et al [15], Kenaf and glass composite materials has a good power in recent development of the materials with a high strength and weight factor. The glass fibre which are fabricated by the method of compression moulding process gives good mechanical properties. The comparison charts shows the difference between tensile test, flexural tests and other modes of tests to be performed. N.F Alias et al [16], The coated glass fibre were hybridised with the kenaf fibre to create hierarchical composite laminates by means of hand layup and vacuum bagging method. The kenaf laminated epoxy composite by

spraying process to improve the flexural and thermo mechanical properties, which helps to show the higher values. NabihahSallih et al [17], the kenaf on the bio composite based on the water adsorption and impact properties. Both water adsorption and impact properties are found to be reliant on loading process. The increase of water adsorption percentage on bio composite as loading is been increased. Hence the impact strength of the material is reduced by continuous loading. M. Indra Reddy et al [18], Higher kenaf content with lower barrel temperature result in composite sheets when compared to the high average mechanical properties in various modes and methods of testing process. The average fibre length found in this study results in final composites properties when compared to those with longer fibres which is manufactured using compression moulding machines. W.H. Haniffa et al [19], The variation within the theoretical and experimental values of the tensile modulus are not considerable. The scale ratio among the reinforcement of different aspect ratios acts as control factor in various mechanical properties. The overall mechanical behaviour of the hybrid composite helps in the systematic comparison and used as parameter for optimizing the hybrid properties. Abu Bakarsulong et al [20], this investigation was done hybrid kenaf fiber in tensile and flexural test and other mechanical properties also increased by the reinforcing action of the fibres.

## II. EXPERIMENTAL PROCEDURES

### 2.1 Material Used

The epoxy resin is used as a liquid in the treatment of kenaf fibre. The epoxy resin has a density of 1.2 g/cm<sup>3</sup>. It is blue in colour with a kinematic viscosity of 12,000 Cps. At first two bottle of ethanol is poured in a vessel and stirred for about 10 minutes. Then 25ml of 3-Aminopropyletriethoxysilane is used added with ethanol and then stirred for about 5 minutes. Then the pieces of kenaf fibre is dipped in the mixture of chemical liquid and left for 30 minutes. The ethanol and 3-Aminopropyletriethoxysilane reacts with the kenaf fibre dipped inside. After 30 minutes the kenaf fibre is taken out and dried in sunlight for about 2 days. The kenaf mats pieces dipped are known as treated. And the other kenaf fibre mats are untreated. For SEM test the pieces of kenaf with glass fibre mats are cutted into small pieces and the SEM image of the mats are taken.

### 2.2 Treatment of Reinforcements

The composites of kenaf and glass fibre are fabricated into 270mm square shape plates and are cutted into the required size for tensile test, flexural test impact test and Inter laminar shear stress (ILSS). The Nano particles and kenaf fibre are treated in an oven at a temperature of 100 degree Celsius which helps to eliminate the bound moisture. Ethanol and water with the value of 95/5% are initially taken and treated for about 10 minutes. The necessary quantum of silane substance of 2wt% are in

general added as drop by drop to form an uniform blend and then it is stirred for 5 to 10 minutes. The silicon dioxide and kenaf fibre are absorbed in the ethanol and water solution for about 10 to 15 minutes. Then they are taken out and washed with the help of ethanol to eliminate the excess of silane and are dried in the oven with the temperature of 100 degree Celsius to remove the moisture content in the material.

2.3 Composite Fabrication

The quantity of fibre at 50% of volume and silicon dioxide at different values of 1.0, 2.0, 2.5 and 3.0 were mixed with epoxy resin at a room temperature and stimulated continuously until the process gets completed. Then the epoxy and hardener with the ratio of 10:1 is taken and stirred until it forms as a homogeneous solution. Then the compression moulding is done by applying wax over it which helps to separate the plating after the moulding process. At first two kenaf fibre are placed and the glass fibre is placed in the between the two kenaf fibres. Then using compression moulding the process takes places for about 30 to 40 minutes with the temperature of 92 to 96 degree Celsius. After the fabrication process is done the plates are left to cool down for about 10 minutes and taken out.

2.4 Specimen Preparation Process

The epoxy kenaf and glass fibre silane 4 oxide particle is prepared and reinforced as shown. These composite material sheets are cutted by moulded sheets by shearing process. The abrasive water absorption is prepared by the test specimens on ASTM standards. Many test such as Tensile test, Impact test, Flexural test and Inter laminar shear stress (ILSS). The further more tabulations and its properties are briefly explained below.

III. GENERAL CHARACTERIZATION

3.1 Mechanical Testing

These testing are obtains properties like Tensile, Bending, water absorption, Impact, Interlinear shear strength, Hardness were carried out fully by pure ASTM standards. The ASTM standards for the tensile is ASTM D-3039 and for the flexural is ASTM D-790, and for the impact is ASTM D-256, and for the water absorption is ASTM D-5229, and for the inter laminar shear strength is ASTM D-2344, and atlast for the hardness is ASTM D-2240. Tensile test is performed using a machine called as Universal testing machine with maximum capacity load of 100KN(SR.NO. 121101) then follows by impact test which it is carried out by mini impact testing machine with maximum capacity load of 30J. Then finally all the samples are here to undergone various testing's and preferred for results. According to various ranges of silicon, the results will be changed. In terms of its properties, it will shows its capacity and its withstands.

Table 1 Material composition

S.No.	Material	Epoxy%	Kenaf & Glass%	Silicon%
1	EKG	50	50	0
2	EKGS1	49	50	1
3	EKGS2	48	50	2
4	EKGS3	47.5	50	2.5

3.2 Morphological analysis

The SEM is the process of scanning the plates to make a magnifies image consisting with the electron beam and its analysis. It is also called as a effective micro analysis. Although the solid of inorganic and organic materials and composite materials are also included to get magnified image. The two dimensional image is also fully examined. The SEM image test and magnified images are successfully carried out by the TESCAN VEGA3 machines.

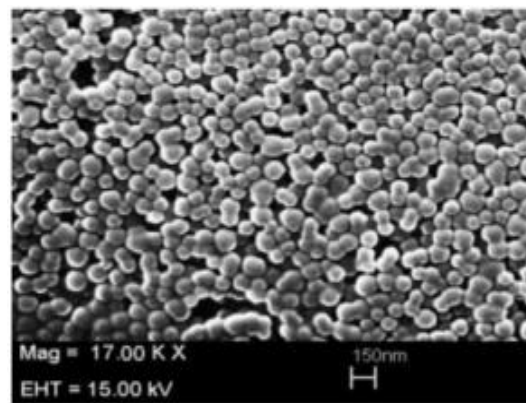


Fig.1 SEM image of kenaf fiber

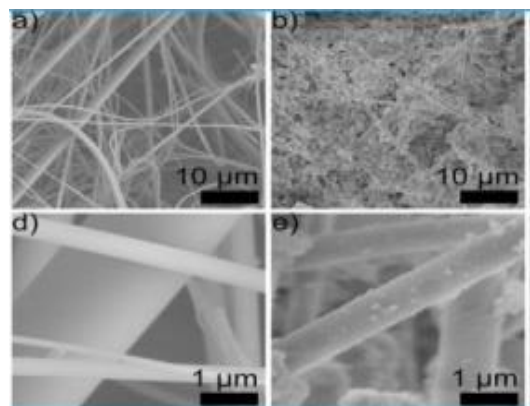


Fig. 2 SEM image of nano

IV RESULT AND DISCUSSION

4.1 Identification of properties

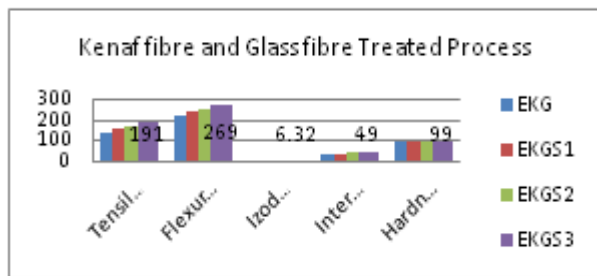


Fig.3 Kenaf Fibre and Glass Fibre Treated Process

The tensile, flexural, impact, hardness test are received and silane-treated with silicon (IV) oxide dispersed kenaf and glass fibre-reinforced epoxy hybrid composite materials are used presented in the table 2 and 3. It is used that addition of the include and surface-modified silicon (IV) oxide. The mechanical properties are improved in the epoxy resin fetched and kenaf and glass fibre resultant. The tensile material percentage are improvement of 53-60 above are found as a tensile strength and modulus of EKG, EKGS1, EKGS2 and composite designed. The kenaf fibre material and dispersed silicon (IV) oxide particles are improvement of the load sharing ability are composite material. It acquired moisture particle are absorbs in the creating bonding with matrix. And other mechanical properties are improved in the epoxy resin fetched and kenaf and glass fibre resultant. The flexural material percentage are improvement of 55-62 above were observe flexural strength and modulus are EKG, EKGS1, EKGS2 and composite designed. It silicon (IV) oxide particle are continuous load sharing and long kenaf and glass fibre are improvement and highly compacted tested. The impact test were absorbed in silicon (IV) oxide are kenaf and glass fibre into a epoxy resin of mechanical properties. The impact percentage and improvement of 57-65 above were observed impact strength and modulus are EKG, EKGS1, EKGS2 and composite material. It acquired moisture particle are flexural test is greater than impact test load sharing with bond matrix are kenaf and glass fibre are improvement and highly compacted test.

The results for each and every tests are shown below.

Table. 2 Kenaf and glass fibre of untreated process

Material	Tensile strength (MPa)	Tensile modulus (MPa)	Flexural strength (MPa)	Flexural modulus (MPa)	Izod Impact (J)	Inter laminar shear strength (MPa)	Hardness (HRC)
EKG	139	6192	213	5820	4.82	33	92
EKGS1	147	6254	234	5891	4.98	37	93
EKGS2	162	6463	247	5942	5.43	42	95
EKGS3	184	6684	262	6084	6.21	48	98

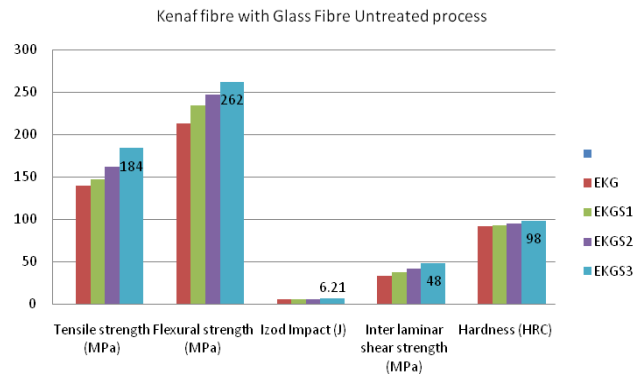


Fig.4 Kenaf and glass fibre of untreated process

Table. 3 Kenaf and glass fibre of treated process

Material	Tensile strength (MPa)	Tensile modulus (MPa)	Flexural strength (MPa)	Flexural modulus (MPa)	Izod Impact (Joules)	Inter laminar shear strength (Mpa)	Hardness (HRC)
EKG	142	6198	219	5829	4.91	34	92
EKGS1	153	6262	241	5897	4.99	38	96
EKGS2	171	6472	253	5958	5.58	44	97
EKGS3	191	6691	269	6091	6.32	49	99

4.1.1 Tensile test

During tensile test, the natural glass fibre and kenaf fibre reinforced to shows the breaking load values for each and every testings. Addition with the silicon to the all the plates which will considerably increases the breakeven point. It also obtains yield stresses and also leads to the ultimate stresses. There exists their sudden elongation on the pulling up in the each of the end. The remarkable values which to shows better than the other composites. The final resultant values are obtained morphologically. For the untreated process the percentage elongation values are 1.440, 1.430 and 1.930 for each EGK, EGKS1 and EGKS2. Then its universal testing values are 39.171 N/mm<sup>2</sup>, 36.307 N/mm<sup>2</sup> and 40.957 N/mm<sup>2</sup> for EGK, EGKS1 and EGKS2 respectively. The same like in treated plates are also tabulated as on the percentage elongation and its universal testing values. Which in percentage elongation value 2.430, 1.600 and 1.190 which is totally differ from untreated process. Then for the universal testing values it obtains 46.911N/mm<sup>2</sup>, 37.916N/mm<sup>2</sup> and 30.882N/mm<sup>2</sup> for each EKG, EKGS1 and EKGS2. It comparisons shows the treated process as much more capable property. It completely defines there is percentage increase in the treated process. Comparing to this plates, there is 0.8%, 0.3% and 0.2% increases in the plates. The below graphs are shows each plates behaviour in its treated and untreated plates.



Fig. 5 a) Tensile Untreated b) Tensile Treated

The delaying factor can be identified by due to Skill set of labour, Labour personal problem, misunderstanding among labours, Overtime, Material transportation, Lack of housekeeping, Drinking water problem, Climatic condition, Time constrain in hoist, Communication. Remedial measures to increase the productivity are the Stream line production, invest in capital equipment, invest in employeetraining, providing hoist material and labour transportation, provide drinking water facility in alternative floors, Safety training, Scheduling of material and labour transportation in hoist. Then tensile values depend on its universal values are tabulated below. Here it is clear that's the breaking load occurs on either on the both the treated and untreated plates depend upon the pulling force, which been surface has to recover to withstand its properties.

#### 4.1.2 Impact test

The impact test that is used in determining the behaviour of the material by subjecting the material into a sudden shock. This test is used to determine to know how the material will respond to a sudden applied stress. At first the material EKG, EKGS1, EKGS2 of untreated plates are used for the impact test and the point of sudden shock were the plates are broken are noted and tabulated. In the same way the EKG, EKGS1, EKGS2 of treated plates are used in the impact test and the values are tabulated. For the impact tests, untreated process and treated process as thickness along with in the range of about to 1-2mm. For the untreated plates of EKG, EKGS1 and EKGS2 obtains the value of 1.15mm, 1.70mm and 1.55mm. Then on the treated plates, the obtained values are 1.10mm, 0.90mm and 2.00mm respectively



Fig. 6 Impact Untreated



Fig. 7 Impact Treated

#### 4.1.3 Flexural test

The Flexural test is employed which helps to measure the bending of the material. It helps to refer to the material resistance and permanent indentation. At first the EKG, EKGS1, EKGS2 and EKGS3 of untreated plates are taken. The force is applied at a particular point with a certain pressure. After that the point where the force is applied is marked with the help of chalk. Then the EKG, EKGS1, EKGS2, EKGS3 of treated plates are taken and the same procedure is followed. Then the plates are taken and the marked area is zoomed by micro hardness test and result is noted down.

#### 4.2 Morphology Analysis

Morphological analysis scanning electron microscope helps to perform a focused beam of high energy electron which helps to generate a multiple signals on the surface of solid specimens. The plates of EKG, EKGS1, EKGS2 and EKGS3 is undergone SEM test and the result is noted as images. The signals that are derived from the electron-sample interaction that reveal the information of the sample of external morphology and chemical composites that helps in developing the image result. The SEM is also able of performing various analyses in the selected point location on the plates for the images. The accelerated electrons present in the SEM helps in carrying significant amount of kinetic energy which helps in developing the SEM image. The SEM test is usually used to generate the high resolution in order to develop spatial variation in chemical compositions.

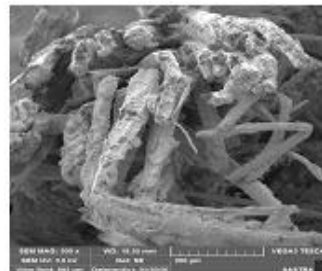


Figure. 8 a) Un Treated Tensile

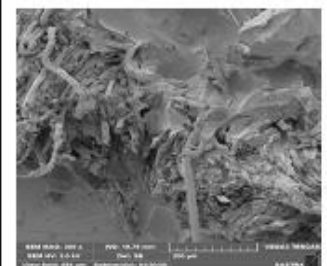


Figure. 8 b) Untreated Tensile

#### 4.3 Image Damage Analysis

The impact damage of various fabricated composite plating is shown. The drop load of impact is separated into 3 layers such as side damage mid surface damage and penetration damage at the end of untreated composites of E and EKS3. The surface damage found on the composite EK is more than composite EKS3 this is due to the absence of load in micro mechanism. The least amount damage of the impactor receiving side of composites takes place in EKS3. The mixing of 2.5% silicon in composite matrix were it absorb high load and transfers to matrix due to the no stress intensity factor.

It shows the impact damage between E and EKS3 of the penetration side damage. It shows the impact damage of treated composite designation of EKS3 in side receives damage and penetration side also undergoes impact damage. Thus the silane treated process improve the impact load phenomenon of absorbed layer composites.

## V. CONCLUSION

Materials and composites of a mixture of quantity and kenaf fibre and silicon oxide reinforced epoxy composites are prepared. The tests such as impact, tensile and hardness help in developing the mechanical properties of the kenaf and glass fibre in many ways. The fibre helps in civilizing the mechanical properties and also in addition of epoxy composites helps in improving the thermal stability and drilling parameters. The treated plates of kenaf and glass fibre silane particle helps in increase of adhesion as it was poor in the earlier stage. The morphology of drilled holes in the hardness test helps in improving dimensional stability on the silane treated kenaf and glass fibre composite material. These tests helps to be a mechanically strengthened material in various ways and methods.

## REFERENCES

- [1] Vishwas M, SharnappaJoladarshi, "Behaviour of natural rubber in comparison with steel, aluminium and glass epoxy composite under low velocity impact loading". *Materials today proceedings* (2016) (5): 10721-10728.
- [2] Kishor K Kumar, Ch. Karunakar, "Development and characterization of hybrid fibres reinforced composites based on glass and kenaf fibres". *Materials Today: Proceedings, 2018 - Elsevier* (6): 14539-14544.
- [3] JeswinArputhabalan, Palanikumar K, "Investigation of glass fiber influence on mechanical characteristics and resistance to water absorption of natural fiber reinforced polyester composites". *Materials today Proceedings, Volume 16, Part 2, 2019, Pages 843-852*.
- [4] Muhammad F. Ismail, Mohamed T.H. Sulthan (2019), "Low velocity impact behaviour and post impact characteristics of kenaf/glass hybrid composites with various weight ratios". *Materials Today: Proceedings* (2019)(6): 2662-2673.
- [5] Dapeng Wang, Qinzhaoh Wang, "Study of long term behaviour of glass fibre in the tensile stress field". *Ceramics International Volume 45, Issue 9, 15 June 2019, Pages 11578-11583*.
- [6] H. Fouad, Abdel-Hamid I. Mourad, "Fracture toughness, vibration modal analysis and viscoelastic behaviour of kelvar, glass and carbon fiber/epoxy composites for dental-post applications". *Journal of the Mechanical Behavior of Biomedical Materials Volume 101, January 2020, 103456*.
- [7] N. Parthiban, T.Maidurai, "Effect of silane treated silicon (IV) oxide nanoparticle addition on mechanical, impact damage and drilling characteristics of kenaf fiber-Reinforced epoxy composites", *Silicon volume 12, pages459-467(2020)*
- [8] A.M. Noor Azammi, S.M Sapuan, "Physical and damping properties of kenaf filled natural rubber/thermoplastic polyurethane composites". *Defence Technology 6 June 2019* (15): 2214-2219.
- [9] C. Ramesh, Manickam, "Dry sliding wear characteristics of heat treated and modified hematite particle- epoxy particulate composite". *evista Română de Materiale / Romanian Journal of Materials 2017, 47 (3), 401 - 405*.
- [10] D. Savitha, R. Goel, "Natural fibre Reinforced polymer composite materials". *Sage (2017) Volume: 8 issue: 2, page(s): 71-78*.
- [11] S. Rassamann, R. Pasakaramoorthy, "Effect of resin system on the mechanical properties and water absorption of kenaf fibre reinforced laminates". *Materials & Design Volume 32, Issue 3, March 2011, Pages 1399-1406*
- [12] N. Saba, M.T Paridah, "Dynamic mechanical properties of oil palm nano filler/kenaf/epoxy hybrid nano composites". *Construction and Building Materials Volume 124, 15 October 2016, Pages 133-138*
- [13] Z. Salleh, M.N. Berhan, "Open hole tensile properties of kenaf composites and kenaf/fibreglass hybrid composites". *Procedia Engineering Volume 68, 2013, Pages 399-404*
- [14] Mst. SadiaMahzabin, Lim Jee Hock, "The influence of addition of treated kenaf fibre in the production properties of fibre reinforced foamed composite". *Construction and Building Materials Volume 178, 30 July 2018, Pages 518-528*.
- [15] NurulHidayah, D. NurSyuhada, "Enhanced performance of lightweight kenaf-based hierarchical composite laminates with embedded carbon nanotubes". *Materials & Design Volume 171, 5 June 2019, 107710*.
- [16] N.F Alias, H. Ismail, "The effect of kenaf loading on water absorption and impact properties of polylactic acid/ Natural rubber/ Kenaf core powder biocomposite". *Material Proceedings Volume 17, Part 3, 2019, Pages 584-589*.

- [17] Nabihah Sallih, Peter Lescher, "Factorial study of material and process parameters on the mechanical properties of extruded kenaf fibre/polypropylene composite sheets". *Composites Part A: Applied Science and Manufacturing* Volume 61, June 2014, Pages 91-10.
- [18] M. Indrareddy, M. Anil kumar, "Tensile and flexural properties of jute, Pinapple leaf and glass fiber reinforced polymer matrix hybrid composites". *Materials today Proceedings*, Volume 5, Issue 1, Part 1, 2018, Pages 458-462.
- [19] W.H. Haniffah, S.M. Sapunan, "Kenaf fibre reinforced polypropylene composites: Effect of cyclic immersion on tensile properties". *International Journal of Polymer Science* Volume 2015, Article ID 872387, 6 pages.
- [20] Abu Bakar Sulong, Norhamidi Muhamad, "Kenaf fiber composites: A Review on Synthetic and biodegradable polymer matrix". *Jurnal Kejuruteraan* 31(1) 2019: 65-76.