Available online www.ejaet.com

European Journal of Advances in Engineering and Technology, 2019, 6(9):1-11

Research Article ISSN: 2394 - 658X

Polyethylene Based Jute Reinforced Composite Materials for Radiation Shielding Application by Using Magnetite as Filler

Sony Ahmed[1], Shafiul Islam[*2], Alamgir Hossain[2], Yeasmin Akter[2], Shujit Chandra Paul[2], Ashraful Islam[2], Milon Bhoumik[2] and Saiful Islam[2]

[1]School of Fundamental Science, Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia – 21030.

[2]Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University, Sonapur, Noakhali, Bangladesh-3814

shafiulacce@gmail.com

ABSTRACT

Composite materials have gained much attention due to higher characteristics such as lower density, hardness, lightweight and its improved mechanical properties as well as its widespread applications in aerospace, automobile, sporting industries, and marine. In this research work, polyethylene based (HDPE) jute (fiber length 5-6 mm) reinforced composite materials were prepared by using Magnetite as filler. The composites were prepared at a different weight percentage of magnetite (10-30%), jute (30-40%) and polyethylene (60-30%) by means of compression molding technique. Prepared composites were tested using UTM (Universal testing machine) to study mechanical properties of prepared composite such elongation break, tensile strength, E. modulus, yield, break, load, flexural strength, impact strength. These tests showed better mechanical properties achieved by using 40%polyethylene, 28-30% magnetite as well as 32% jute where average tensile strength 23Mpa, Elongation 133%, E. modulus 385Mpa, Yield 25Mpa, break 6.53, Load 514N. Soil degradation test showed the retention of 80% of the mechanical properties of the composites. Water uptake test was also done to study the impact of water absorption on mechanical properties. Ultimately a significant result anticipated by polyethylene-based jute reinforced composite materials using magnetite as filler than any other polyethylene based heavy mineral composites like ilmenite.

Key words: jute fabric, HDPE, Magnetite, Water uptake test, Impact test

INTRODUCTION

Composites are potent load carrying materials (well prominent as reinforcement) imbedded in weaker material (known as matrix). Reinforcement (jute) helps to increase strength and rigidity, also helping to support structural load. The matrix (polyethylene) is also well established as a binder (Organic or Inorganic) which plays an important role to maintain the position and orientation of the reinforcement. In the present world composites are the wonder material due to its nonentity weight, severe strength to weight ratio and stiffness have come a long way in replacing the conventional material. It is optimistic news for us that day by day using of polymer-based jute composite materials are increasing dramatically due to their unique properties such as light weight, tri-biological responses and good mechanical properties [1]. However, composites encounter various types of problem such as matrix cracking, delaminating as well as fiber fracture. It can be estimated that fiber fracture and matrix cracking play a pivotal contribution in case of lamination under tensile load [2-5]. It can be indicated from the recent research that natural fiber is more auspicious as reinforcement [6-7]. Natural fiber can be used as a replacement of an expensive glass fibers in polymer composites. Natural fiber composites are ambient friendly materials this is because reinforcement comes from renewable resources such as plant fibers or wood [8]. Degradation becomes easier in case of natural fiber reinforced composite materials. When natural fiber is compared with both glass fibers as well as polymer then it can be noted that natural fiber has less environmental impact on their manufacturing portion. This is because it requires less energy and produces fewer emissions [9]. The drizzling performance of natural fiber reinforced composites is lower specific weight and price then synthetic fiber. Durability as well as well dimensional stability against other composites is corners ton of natural fiber [10-13]. Due to environmental and ecological concerns, natural fiber composites have occupied a great position in the world [14]. Among all the natural fibers, jute appears to be a promising material due to its relatively cheap and commercially sufficient in tropical countries [15-18]. It has greater strength, lower density and modulus than plastic. polyethylene based jute reinforced composite materials by using magnetite as a filler have outstanding properties like well surface hardness, scratch resistance, and good mechanical properties. The study of natural fiber reinforcement is essential because of its abundant availability in wide variety [19-26]. Material scientists have given their profound attention on natural reinforced so that its application can be explored in low load condition. Composites are prepared with maintaining desired properties and oriented the fibers according to the application. Manufacturing process of composites are relatively cheaper and there is various manufacturing process available for the composites. The surface finish of the composite is one of them which is comparatively much better. The fabrication of composite is done by using short jute fiber of length 5-6mm with polyethylene and magnetite. Compression molding technique is used to prepare composite considering fiber weight 30-40% and magnetite weight 60-70 % respectively. The mechanical properties were evaluated like flexural strength, tensile strength, impact strength, tensile modulus elongation at break and flexural strength [27]. The mechanical properties of the jute reinforced polyethylene-based composites material by using magnetite as a filler substance at various fibers loading was evaluated. Composite 32% fiber loading showed highest tensile strength (23 MPa). For the improvement of the mechanical property of the composite materials (Jute + Polyethylene + Magnetite) by treating jute fiber with sodium hydroxide (5%) solution for 0,2,4,6 and 8 hours at 30^{o}C was evaluated. After treating 4 hours showed an improvement in the flexural strength by 20%, flexural modulus 23% and 18% for the laminar shear strength. The transverse bending strength and transverse tensile strength increased for NaOH treated jute. The decrease in water uptake with fiber surface treatments and the diffusivity of the composites compared to the untreated jute [28]. Natural fiber reinforced composite was synthesized by using jute reinforced with polyethylene (HDPE) and magnetite were developed. The microstructure of the fiber reinforced was observed by scanning electron microscope. Prepared composite has notable impact on radiation shielding application. From the antediluvian time radiation had occupied as concern matter in the mind of human being because of its noxious impact on human and their surrounding ambience. Therefore, to attenuate radiation, researchers had been tried to develop various types of shielding material from the ancient time. The purpose of this research to develop such kind of composites material on the basis of polyethylene -based jute reinforced composite materials by utilizing magnetite as filler for radiation shielding application. Shielding assuage the intensity of the radiation depending on the thickness. High density materials reduce the intensity of the radiation than the low-density materials. Basically, radiation means emission or transmission of energy [29]. There are two types of radiation as a paradigm we can say that ionizing radiation as well as non-ionizing radiation. Ionizing radiation is not benevolent to us as well as its exposure high energy may result in cell mutation, cancer and death. For this purpose, much research had been devoted to developing shielding materials to attenuate high energy radiation. For complete this mission heavy mineral (magnetite), jute (reinforced), polyethylene (matrix) combined composite materials were consumed. Magnetite is the mineral of iron ore. The specific gravity of the magnetite is 5.17-5.18 and its atomic number is high. Therefore, it could be surmised that magnetite is a good shielding material. Generally biological shielding must be chosen considering both shielding and economy. Natural fiber such as jute fiber due to their reinforcing properties as their biodegradability are good candidates for using new composite materials because economically feasible, have a low density, high mechanical resistance and for their profligate in nature. However, composite that contains natural fiber without modification giving the paucity of mechanical properties [30]. As a result, poor adhesion created between interfaces of the hydrophilic fiber with hydrophobic matrix. To improve properties polyethylene matrix and jute fiber surface had been modified to show improvement in mechanical properties. Polyethylene is another well shielding material because hydrogen content is good, and these high hydrogen atoms are good for absorbing and dispersing radiation.

MATERIALS AND METHODS

Materials

Jute fiber (Hessian cloth) was collected from Bangladesh Jute Research Institute (BJRI), Dhaka. The color of hessian cloth is natural or full bright. Country of origin is Bangladesh. Polyethylene is obtained by the polymerization of ethylene. Polyethylene is a rigid, waxy, white, translucent non-polar material exhibiting considerable chemical resistance to strong acid, alkalis and salt solutions at room temperature. Polyethylene is most common plastic. The annual production of polyethylene is approximately 80 million metric tons. The physical and chemical properties are polyethylene is a thermoplastic polymer consisting of hydrocarbon chain. Common commercial classes of medium and high-density polyethylene usually contain melting point 120 to 130^{o}C (248 to 266 F). Low density polyethylene melting point 105 to 115^{o}C (221 to 239 v). Polyethylene (high density polyethylene) is used as a matrix, which is loaded by iron. HDPE was purchased from MITSUIPET Company, Thailand and polyolefin company Limited from Singapore respectively. Heavy minerals such as magnetite is used as filler material. Filling composite material has a significant role accompanying the pores. One of the main iron ore with magnetite is a rock mineral and chemical formula Fe_3O_4. The color of the magnetite is dark, gray with brown color in the reflected sun. The hardness of magnetite 5.5-6.5 on the Mohs scale.

Surface pre-treatment of fiber

Fiber processing technology plays an important contribution to the quality improvement. To obtain the desired standards, maintaining super molecular structure of fiber is more important. Untreated jute shows poor mechanical properties therefore pretreatment is very necessary. Various pretreatments for jute such as Alkali treatment, Treatment with stearic acid, Benzylation, TDI treatment.

Alkali treatment

The collected jute (Hessain cloth) was cleaned and unwanted materials were removed. The jute fiber is treated with distilled water at room temperature for 30 minutes and dried. Jute fibers were treated with 5%, 10%, 15% sodium hydroxide solution at room temperature for 30 minutes. Treated sample was again washed with cold water neutralized with acetic acid and finally washed and dried at 100^0C. The jute fiber filler material (Magnetite) and matrices were mixed properly.

Preparation procedure of composite materials by compression molding technique

To develop variety of composite materials, compression molding is most kudos technique. It is a closed molding process with high pressure application.

Compression molding technique

The compression welding base plate is stable when the high plate is running. Reinforcement and matrix are placed in metallic mold and the assembly is kept in compression molder. The heat is applied according to the composite requirement for a specific time period. The material placed in the molding plates flows due to the heat application because the shape of the mold hole is high accuracy, depending on the molding. Composite healing is also important in compression molding. The composite is performed at the healing temperature of the room or at some higher temperatures. After healing, the mold is open, and composite products are removed for further processing. Basically, a compression molding machine is a type of press that is vertically oriented with two modes semi-circular (upper and bottom lower). Generally, the hydraulic process is used for pressure compression molding pressure. Compression molding method improves the combination parameters to enhance superior and customized features. It should be optimally optimized for three levels of the model (pressure, temperature and time-application) to achieve critical and appropriate logical products because each level of the model is equally important to others.

Methodology

1. At the beginning part 50 to 90 PE and 10% Magnetite was taken by weight.
2. After than in metal sheet Magnetite and polyethylene uniformly distributed on silicon paper. Other silicon paper was kept on magnetite as well as polyethylene sample. In the next step another metal sheet is kept on the sample.
3. Total sample by means of two metal sheets was placed at heat press molding machine at 350^oC for three minutes. After then pressure is increased from 0 to 3 bars. If in this moment pressure falls pressure returns to the previous pressure.
4. After passing two minutes the sample was removed from heat press molding machine by means of heavy cloth gloves as it is very cold.
5. Then it was sent to the cooling machine. Here 5 minutes is eagerly waiting and collected two metal sheets from cooling machine by cloth gloves.
6. Two metal sheets removed and such a way composite material by the combination of polyethylene as well as filler magnetite material developed.
7. By adopting similar procedure four films of Magnetite and polyethylene were made. The shape of composite material seemed like a circle and cut same shape of three jutes roundly.
8. At the last stage combined film of Polyethylene, Magnetite and jute is again kept consecutively on silicon paper in the middle position of two metal sheets and again kept heat press molding machine at 350^oC for 3 to 4 minutes and cooled by cooling machine. As a result, the combined composite film of Magnetite, Polyethylene, and jute achieved.

Composition of the composite materials

Various compounds are made by altering the weight fractions of jute, polyethylene and magnetite. The next step is to cut the composite for our required tests such as ASTM standards, tensile test, impact test, water uptake test, hardness, soil degradation test etc.

Tensile tests

The standard used is ASTEM D5638-03 the gauge length distance is 20cm. The test is performed by the dint of the Universal Testing Machine (UTM) at room temperature. Generally, the environmental condition is about 28^OC and relative humidity is about 65%. The testing involves the application of tension in the work piece until it cracks. The tensile stress recorded depending on strain. The ultimate tensile strength is recorded in a digital computer connected with UTM.

Flexural test

The compound sample performs three-point flexible flexural test ASTM D790 test standard. Flexural test is applied through both ends of a uniaxial load. Reinforced polyethylene-based magnetite composite with bipedal jute fiber flexural test sample

Impact test

Standard ASTM D256-05 is followed as the impact test is performed and shown in figure. The middle of the sample is made in the form of a wall design (shape of V notch) and it is loaded for testing purpose. Pendulum is present in an inactive position and it is release and it is made to hit V notch repeatedly until it is fractured. Strain rates on factor and material flexibility can be determined through the effects of impact.

Micro-hardness test

Micro-hardness: Micro-hardness tester composite sample is used to measure the fabric hardness. An angle 136° under an iron p. A square base of the opposite face is forced into a diamond indent sample in the form of a right pyramid. When the load is removed two triangles of the remnant of the sample surface is measured and its arithmetic mean L is calculated. The current study is being loaded with P = 412 N as well as hardness number calculated by using the following equation:

$H=0.1889P/L^2$ Where $L=D_1+D_2/2$

Here

P= Applied load

L= Diagonal of square impression (mm)

D1= Horizontal length (mm)

D2= Vertical length (mm)

Water absorption

Water absorption is most widely used to determine the amount of water absorbed under certain conditions. Temperature and length exposure, there are some reasons to influence water absorption such as additives. To test water exploitation, strengthening the composites using polyethylene-based jute magnetite, fillers are accepted and for a variety of periods, sunlight in the normal water at a cone flask at room temperature. In some time, the composite sample is taken out of the unemployed and easily removed with tissue paper or lint-free clothes and then weighs. Water absorption is calculated using percentage sources. ASTM D750-98 test standard of compound sample water absorption test is completed.

The water absorption test of polyethylene-based jute reinforced composite material by means of magnetite using filler is calculated by the following formula.

W_{UP} (%) = W_F- W_I/W_I

Where

W_{UP} (%) = % of water uptake of the sample

W_F= Final weight before immersion in water

W_I = Initial weight before immersion in water

Soil degradation test

Composite materials were buried in soil where the amount of moisture at least 25 % for different time interval. After then for testing purposes 4 weeks were eagerly waiting. After finishing this certain period samples were withdrawn carefully as well as washed with the help of distilled water and dried at 105^{o}C for 6 hours and kept at room temperature (20 to 25^{O}C) for 24 hours and mechanical properties were measured by means of Universal Testing Machine (UTM).

RESULT AND DISCUSSION

Mechanical properties of polyethylene: Mechanical properties of polyethylene by means of UTM shown Table 1 & Figure 1

Table-1 Mechanical Property of Polyethylene

Number of specimens	Tensile strength (MPa)	Elongation (%)	Elastic modulus (MPa)	Break (mm)	Load (N)
Polyethylene (27 gm)	13.42	195	168	59	133.5
Polyethylene (27 gm)	13.07	190	170	62	130
Polyethylene (27 gm)	13.25	192	169	61	132

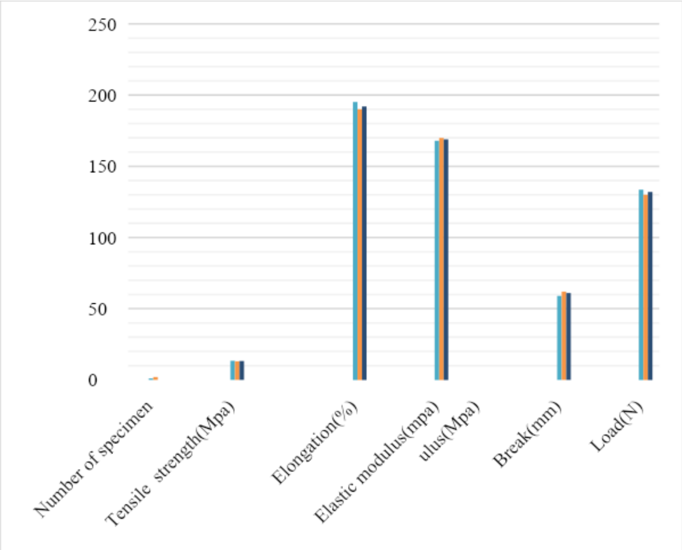

Fig. 1 Mechanical Properties of Polyethylene

Mechanical properties of polyethylene and jute

Mechanical test of jut and polyethylene composite & Mechanical properties of polyethylene are shown in Table 2 & Figure 2.

Table-2 Mechanical Test of Jute and Polyethylene Composite

Number of specimens	Tensile strength (MPa	Elastic-modulus (MPa)	Load (N)
Polyethylene (27 gm), Jute (13 gm)	15	255	535
Polyethylene (27 gm), jute (13 gm	17	270	446
Average	16	263	496

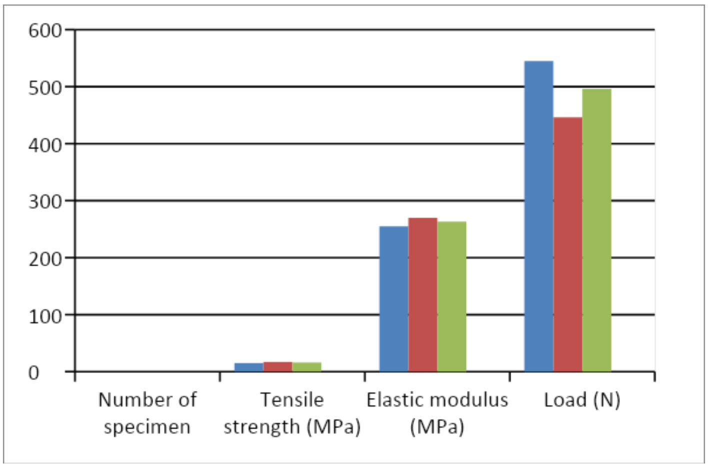

Fig. 2 Mechanical Property of Polyethylene

From the table 1 it can be observed that the mechanical properties of polyethylene such as tensile strength, elastic modulus is dramatically starting to increase when jute is used as reinforcement with polyethylene matrix. The load withstanding capacity of polyethylene (Table 1) equal to three times of jute, polyethylene composite (Table 2). The graph indicates that the value of tensile strength of jute, polyethylene combined composite is 16 MPa which is higher than tensile strength of polyethylene.

Composition of jute, polyethylene and magnetite

Composition of jute polyethylene and magnetite are shown in table 3.

Table-3 Composition of Jute Polyethylene and Magnetite

Composite material	Polyethylene (%)	Magnetite (%)	Jute (%)
D1	54	13	32
D2	59	7	34
D3	38	26	36
D4	40	28	32

Mechanical properties of combined composite of jute, Polyethylene and magnetite

Mechanical properties of combined composite of jute, polyethylene and magnetite & Tensile result of components are shown in table 4, figure 3.

Table-4 Mechanical Properties of Combined Composite of Jute, Polyethylene and Magnetite

Composite combination	Tensile strength (MPa)	Elongation (%)	Elastic modulus (MPa)	Load (N)
D1	19.28	96	371	770
D2	19.08	75	335	750
D3	21.52	45	441	637
D4	23	133	405	545

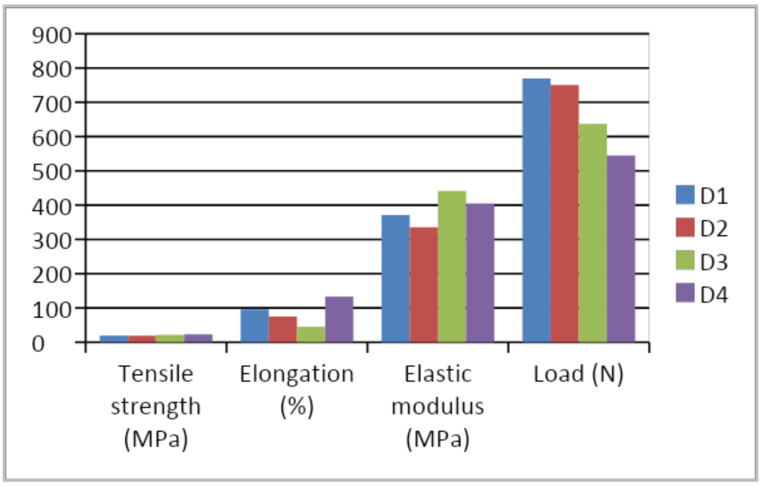

Fig. 3 Tensile Result of Components

This chapter is related to Treatment of mechanical and water absorption of polyethylene-based jute reinforced composite material by using magnetite as a filler. The percentage of elongation (%) D4 is higher than the composite D1, D2, D3 but D4 load withstanding capacity is lower than D1, D2, D3 which is shown in the Table 4. The universal testing equipment is tested to four different composite specimens such as D1, D2, D3, and D4 polyethylene-magnetite- jute fiber composites to find out mechanical properties. Graph indicates that the material D4 is ultimate tensile strength is more than the other components such as tensile strength of D4 is 23MPa where the tensile strength of D1, D2, D3 are 19.28MPa ,19.02MPa, 21.5MPa respectively.

Water uptake test

Weight of composite in different time interval during water uptake test are shown in table 5.

Table-5 Weight of Composite in Different Time Interval during Water Uptake Test

Composite	Initial weight	Weight after 20 minutes	Weight after 40 minutes	Weight after 60 minutes
C1	0.587	0.592		
	0.588		0.593	
	0.665			0.663
C2	0.879	0.882		
	0.421		0.427	
	0.685			0.698
C3	0.646	0.649		
	0.518		0.625	
	0.594			0.615

Composite was planned to push 60 minutes of lifting water. The results indicated in composite C1 (90% PE, 10% magnetite) high absorption characteristics. After 60 minutes composite C1, the water absorbs 2.7%. Composite C2 as well as C3, water absorption capacity is relatively less than C1. Percentage of composite water absorption as shown in figure 4

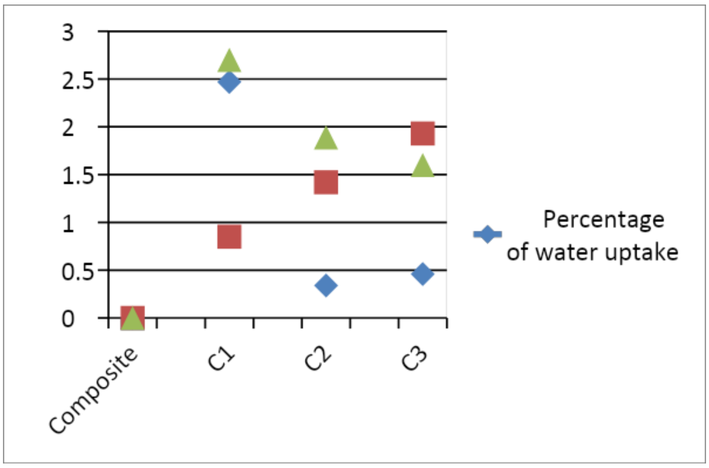

Fig. 4 Percentage of Composite Water Absorption

Percentage of water uptake

Water uptake of C1, C2 as well as C3 composite in percentage are shown in table 6**.**

Table-6 Water Uptake of C1, C2 as Well as C3 Composite in Percentage

Composite	**Percentage of water uptake**		
	After passing 30 minutes	**After passing 40 minutes**	**After passing 60 minutes**
C1	2.47	0.85	2.70
C2	0.34	1.42	1.89
C3	0.46	1.93	3.5

Water uptake test of combined composite of polyethylene-based jute reinforced composite by using magnetite as filler

Weight of composite (PE+ Magnetite+ Jute) in different time interval are shown in table 7.

Table-7 Weight of Composite (PE+ Magnetite+ Jute) in Different Time Interval

Composite	**Initial weight (gm)**	**Weight after 20 minutes**	**Weight after 40 minutes**	**Weight after 60 minutes**
D1	1.080	1.091		
	1.278		1.308	
	1.442			1.467
D2	1.768	1.820		
	1.216		1.259	
	1.915			1.956
D3	1.273	1.290		
	1.637		1.6889	
	1.45			1.50

Percentage of water uptake in different composites: After water uptake test of different composites, the result indicated that the percentage of water uptake of D2 composite is higher than D1 and D3 composite. The percentage of water uptake test of D2 composite is 45%, D1 composite is 25% AND D3 composite is 18%. It can be understood that the water absorption capacity of D2 composite is 20% and 27% more than D1 and D3. The result indicates that the absorption of water of this composition is mainly due to presence of jute fibers. The main reason is that lumen, the cell and gaps between fibers & polyethylene matrix and magnetite as a filler material create weak interface. Percentages of water uptake show in Table 8 & Percentage of water uptake of D1, D2 and D3 composite are shown in figure 5.

Table-8 Percentage of Water Uptake in Different Times

Composite	**Percentage of water uptake**		
	After passing 30 minutes	**After passing 40 minutes**	**After passing 60 minutes**
D1	1.01	1.34	1.73
D2	2.94	3.53	2.61
D3	1.33	3.11	3.44

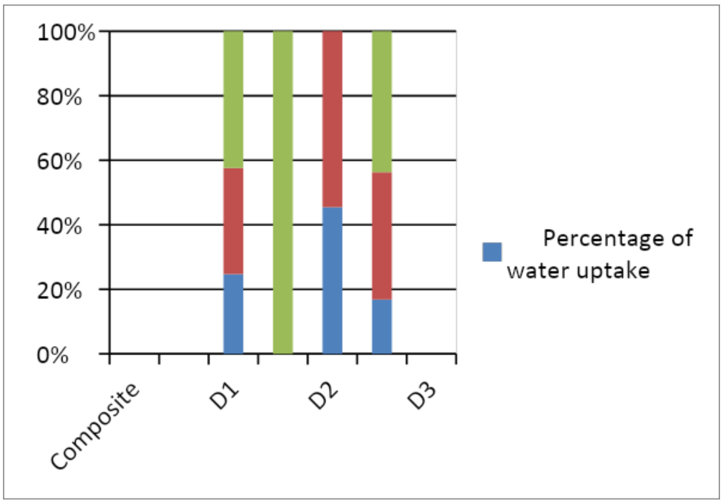

Fig. 5 Percentage of Water Uptake of D1, D2 and D3 Composite

Impact test

Impact analysis is done by the analysis of various composite samples, due to high impact strength due to the current of jute fiber. The result shows that high impact strength is attained in case of C1 composite than C2 and C3 composite. The maximum impact strength of C1 composite is 5.84 Kg/m^2.

Impact test of polyethylene and magnetite composite

Impact test of polyethylene and magnetite & Impact strength of different composites are shown in table 9 & figure 6

Table-9 Impact Strength of C1, C2 and C3 Composite

Composite	Thickness (mm)	Degree	Impact strength (kg/m^2)
HDPE + Jute	2.25	140	8.99
C1	1.1	148	5.84
C2	1.3	144	4.80
C3	1.1	140	4.60

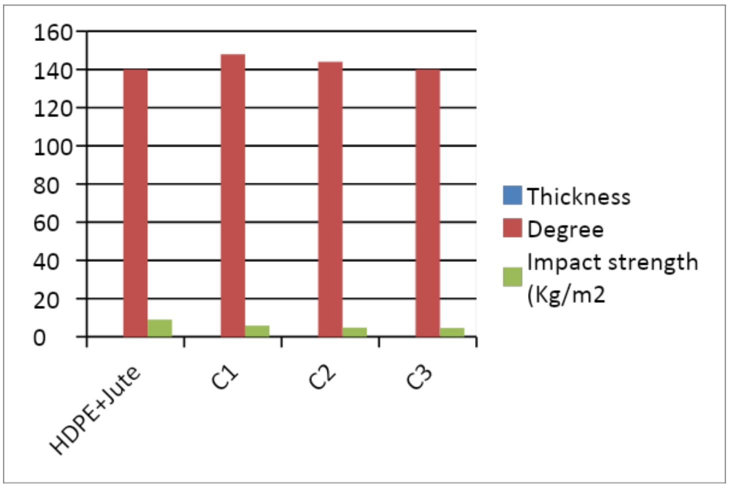

Fig. 6 Impact Strength of Different Composites

Impact test of polyethylene-based jute reinforced composite using magnetite as a filler

From impact strength analysis of different D1, D2 and D3 composite, it can be observed that the impact test of D1 composite is relatively higher than D2 and D3 composite. The result indicates that maximum impact strength of D1 composite is 10.28Kg/m^2 table 10 and Impact test of various composite with thickness are shown in figure 7

Table-10 Impact Strength of D1, D2 and D3 Composites

Composite	Thickness (mm)	Degree	Impact strength (kg/m^2)
D1	2.98	338	10.28
D2	2.72	144	8.080
D3	2.30	140	8.996

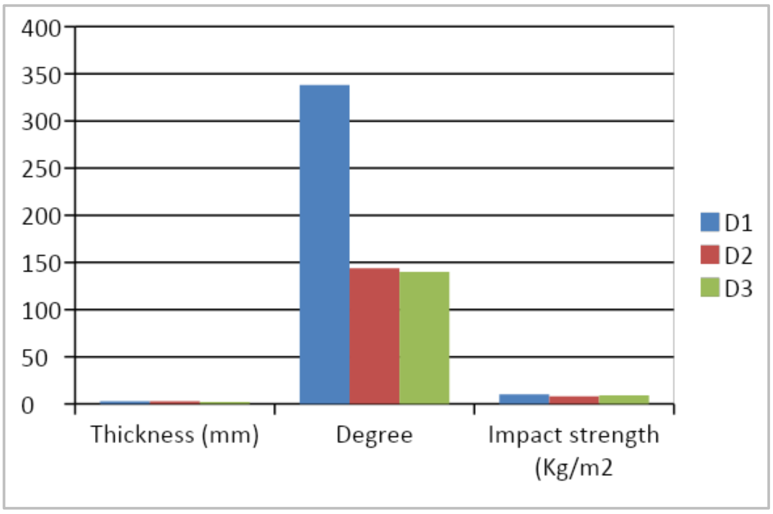

Fig. 7 Impact Test of Various Composite with Thickness

Micro-hardness test

Micro hardness measured by means of Vickers method. With increasing load micro hardness is increased. On the same way, with decreasing load micro hardness start to decrease. The results indicate that micro hardness of D1 composite is greater than D2 and D3 composite. The micro hardness of D1 composite is 18Hv.Micro hardness of D3 composite is higher than D2 composite but lower than D1 composite are shown in table 11 & figure 8

Table-11 Micro Hardness of D1, D2, and D3 Composite

Composite	**Horizontal length (mm); D1**	**Vertical length(mm); D2**	**Diagonal of square impression (mm); L=D1+D2/2**	**Applied load (N)**	**Micro-hardness; $H=0.1889P/L^2$ (Hv)**
D1	40	17.56	28.78	770	18
D2	44	18.77	31.38	750	14
D3	40	15.08	27.54	637	16

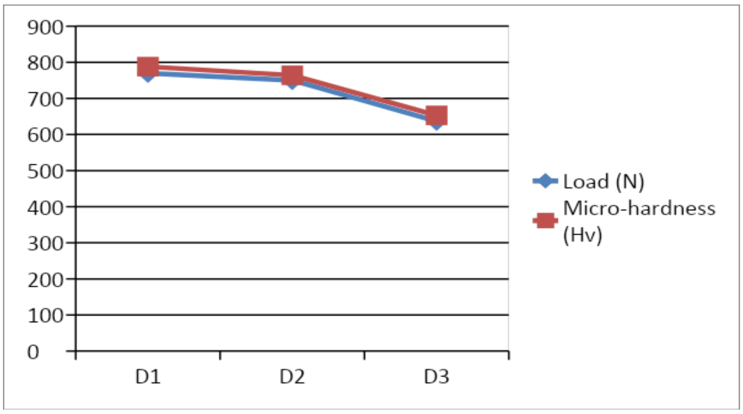

Fig. 8 Micro Hardness of Various Composites with Applied Load

Soil degradation test

D1, D2, and D3 composite were buried in soil for 4 weeks where the amount of moisture in soil is at least 25%. After 4 weeks mechanical test was done by dint of UTM (Universal Testing Machine). The result showed that the mechanical properties of D1, D2 and D3 composite are started to reduce gradually with increasing buried time of composites in the soil (table 12) (figure 9). From this soil degradation test of D1, D2 and D3 composite, we can ensure that prepared composite of polyethylene-based jute reinforced composite using magnetite as a filler material is biodegradable.

Table-12 Mechanical Test of D1, D2 and D3 Composite after Soil Degradation

Composite combination	Tensile strength (MPa)	Elongation (%)	Elastic modulus (MPa)	Load (N)
D1	15.53	77	296	620
D2	15.20	60	255	600
D3	16.5	36	332	503
D4	18.2	104	316	425

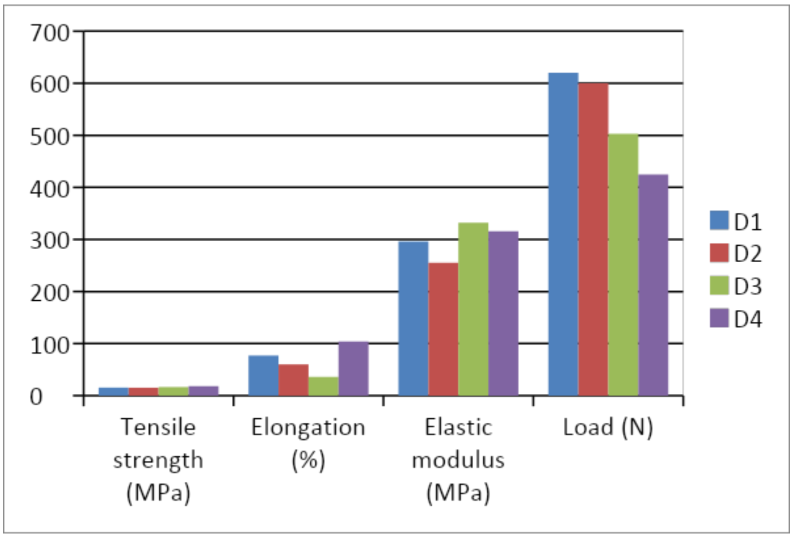

Fig. 9 Mechanical Properties after Soil Degradation

CONCLUSION

It can observe that when polyethylene is used with hessian cloth, mechanical properties are developed. Highest mechanical property is obtained for D4 composite than D1, D2 and D3composite. C1 and D1 have high impact strength than other composites. It can also be noted that D3 composite has low water absorption capacity and D1 have good micro-hardness than other composite material.

Acknowledgements

This research work was done with laboratory facilities of School of Fundamental Science, University Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia-21030 and the department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University, Sonapur, Noakhali, Bangladesh-3814.

Conflict of Interest Statement

The author declares no conflict of interest

REFERENCES

[1]. Ramesh Chandra Yadaw, and Sachin Chaturvedi, An Investigation of Mechanical and Sliding Wear Behevior of Glass \ Fiber Reinforced Polymer Composite with or Without Addition of Silica (SiO2), *International Conference on PFAM XXI, IIT Guwahati,* 2012.

[2]. Mukul Kant Paliwal and Sachin Kumar Chaturvedi, An Experimental Investigation of Tensile Strength of glass composite Calcium carbonate ($CaCO_3$) Filler, *Int. J. Emerg. trends in Eng. and Dev*, 2012, 6(2):303-309.

[3]. Cantwell WJ and Morton j, The impact resistance of composite materials-A review'. Composites part, 1991, 22: 347-362.

[4]. Richardson MOW and Wisheart Mj, Review of low-velocity impact properties of composite materials, Composites Part, 1996, 27:1123-1131.

[5]. Bibo GA and Hogg PJ, Review- The role of reinforcement architecture on impact damage mechanisms and post-impact compression behavior, *J. Mater. Sci*, 1996, 31: 1115-1137.

[6]. Shaikh and S AChanniwala, To Study the Characteristics of Jute Polyester Composite for randomly Distributed Fibre Reinforcement, *Proceedings of the World Congress on Engineering, London*, 2010, Vol 2

[7]. Dieter H Mueller and Andreas Kaobjilowski, New discovery in the Properties of Composite Reinforced with Natural Fibres, *J. Ind. Textiles*, 2003, 33(2):111-130.

[8]. Mohanty, A.K., Khan, M.A. and Hinrichen, G, Surface Modification of Jute and its Influence on performance of Biodegradable Jute Fabrics/Biopol Composites, *Composites Science and Technology*, 2000, 60:1115-1124.

[9]. Khan, M.A., Hossain, M. and Ali, K.M.I, Jute Composite with MMA by Gamma and UV Radiation in the Presence of Additives, *Journal of Applied Polymer Science*, 1999, 74: 900-906.

[10]. Vazguez, A., Riccieri, J. and Carvalho, L, Interfacial Properties and Initial Step of Water Sorption in Unidirectional Unsaturated Polyester/Vegetable Fiber Composites, *Journal of Polymer Composites*, 1991, 20(1): 29-37.

[11]. Khan, M. A. and Hasan, M.M., Surface Modification of Natural Fibers by Photo-grafting and Photo-curing, In: Mital, K. L. (ed), Polymer Surface Modification: Relevance to Adhesion, Proceedings of the International Symposium on Polymer Surface Modification: *Relevance to Adhesion, Orlando, FL*, 2004, 9-11 June, Vol. 3, pp.263-283.

[12]. Kafi, A. A., Abedin, M. Z., Beg, M. D. H., Pickering, K. L. and Khan, M. A, Study on the Mechanical Properties of jute/Glass Fiber-reinforced Unsaturated Polyester Hybrid Composites: Effect of Surface Modification by Ultraviolet Radiation, *Journal of Reinforced plastics and Composites*, 2006, 25: 575-588.

[13]. Wambua, P., Ivan, J. and Verport, I, Natural Fibers: Can They Replace Glass in Fiber Reinforced Plastics, *Composite Science and Technology*, 2003, 63: 1259-1264.

[14]. Ali, K.M.I., Khan, M.A. and Husain, M.M., Study of Wood Plastic Composites in Presence of Nitrogen Containing Additives, *Radiation physics and Chemistry*, 1994, 44(4): 427-429.

[15]. Rowell, R.M., Sanadi, A.R., Caulfield, D.F. and Jacobson, R.E, Utilization of Natural Fibers in plastic composites: Problems and Opportunities, *In: Leao, A,L. Carvalho, F.X. and Frollini, E. (eds), Lignocellulosic plastics composites*, 1997, pp. 23-51.

[16]. Mohanty, A. K., Misra, M and Hinrichsen, G, Biofibers, Biodegradable Polymers and Bio composites: An Overview, *Macromolecular Materials and Engineering*,2000, 276/277: 1-24.

[17]. Li, X.H., Meng, Y.Z., Wang, S.J., Rajulu, A.V. and Tjong, S.C, Completely Biodegradable Composites OF Poly (Propylene Carbonate) and Short Lignocellulose Fabrics HildegardiaPopulifidia, *Journal of polymer Science Part B*, 2004, 42: 666-675.

[18]. Gassan, J. and Bledzki, A.K., Possibilities for Improving the mechanical Properties of jute /epoxy Composites by Alkali Treatment of Fibers, *Composites Science and Technology*, 1999, 59: 1303-1309

[19]. Shah, A.N. and Lakkad, S.C, Mechanical properties of Jute Reinforced Composite, *Fiber Science and Technology*, 1981, 15: 41-46.

[20]. U.Z. Hayder,Khan A H, Hossain M A, Mubarak A khan and Ruhul A Khan, Mechanical and Electrical Properties of Jute Fabrics Reinforced Polyethylene/ Polypropylene composites.: Role of Gamma Radiation, *Polymer Plast. Technol. Eng*, 2009, 48: 760-766.

[21]. Khan M A, Khan R A, Haydaruzzaman, Sushanta G, Siddiky M N A and Saha M, Study on the Physico-mechanical Properties Starch Treated Jute Yarn Reinforced Polypropylene composites. Effect of Gamma Radiation, *J Polym. Plast. Technol. Eng, 2009,* 48: 542-548.

[22]. Ramakrishna M, Vivek Kumar, and Yuvraj N S, Recent Development in Natural Fiber Reinforced Polypropylene Composites. *J. Reinf. Plast. Compos*, 2009, 28: 1169-1189.

[23]. Yang H S, Kim H J, Lee B J and Hwang T S, Water Absorption Behavior and Mechanical properties of Lignocellulosic Filler-Polyolefin Bio-Composites. *Compos. Struct*., 2006, 72: 429-437.

[24]. Vilaseca F, Mendez J A, Pelach A, Llop M, Canigueral N, Girones, J, Composite Materials Derived from Biodegradable Starch Polymer and Jute Strands. *Process Biochemistry*, 2007, 42: 329-334.

[25]. Jamil M S, Ahmed I and Abdullah I, Effect of Rice Husk Filler on the Mechanical and Thermal properties of liquid Natural Rubber Compatibilizer High Density Polyethylene, *J. Polymer*, 2006, 13: 315-321.

[26]. Scarponi C and Pizzinelli C S, Interface and Mechanical Properties of Natural Fiber Reinforced Composites: a review. Int. *J. Mat. Prod. Tecnol*, 2009, 36: 278-303.

[27]. Li X, Panigrahi S and Tabil L G, A Study on Flax Fiber-Reinforced Polyethylene Bio-composites, *Am. Soc Agric. Biol. Eng*, 2009, 25(4): 525-531.

[28]. Md Nuruzzaman Khan, Juganta K . Roy,Nousin Akter ,Hayder U. Zaman. Tuhidul Islam and Ruhul, A. Khan, Production and properties of Short Jute and e-Glass Fiber Reinforced Polypropylene-Based Composites, *J. Compos. Mater*, 2012, 2: 40-47.

[29]. Gassan J, Bledzki A K, Influence of Fiber Surface Treatment on the Mechanical Properties of Jute Propylene Composites- Part A, *Applied Science and Manufacturing*, 1997, Vol-28 No. 12 pp. 1001-1005.

[30]. Ramesh M, Palani Kumar K. and Reddy K H, Mechanical property Evolution of Sisal-Jute-Glass Fiber Reinforced Polyester Composite, Composite: Part B, 2013, Vol. 48, pp. 1-9.