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Fabrication and Study of Mechanical Property Fly Ash and Jute Fiber Bio Composite

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Abstract
With increase in population the market demand of the articles or the items were also increased. To feed the population different polymeric items or non biodegradable material are manufactured by industries, which decade the environment slowly-slowly. To over-come this problem the present study was done with the use of thermal waste i.e. fly ash and bio composite fiber as reinforced material with epoxy resin as matrix materials. In this study the mechanical properties such as flexural and compression of reinforced and matrix are discussed. Fabrications of different specimens of bio composite fibers are done by using hand layout method Different specimens are developed with different composition of constituent i.e. fly ash and jute fiber with resin matrix. 40 to 60% (wt % of the composite) of fly ash and 2% to 5% (wt % of the composite) of jute with matrix material for different specimen i.e. E1, E2, and E3. The mechanical properties were analysis after the testing of specimen on UTM (universal testing machine) servo hydraulic machine for compressive, tensile and flexural strength.
Keywords: fly ash, epoxy resin, hand layout technique and mechanical properties.

1. INTRODUCTION

This is finding from central electricity authority in the year 2013-2014 - 172.87 million tons of fly ash produced In India; most of fly ash produced from power plant is deposited of in the vicinity of the plant as a waste material covering several hectares of valuable land. When thermal waste (fly ash) combined with calcium hydroxide exhibit cementations property. Fly ash hydrate in the presence of water in the similar fashion as Portland cements but do not generate the strength that the pc bond do and generally gain strength slowly over much greater period of time. However it has been seen that fly ash can use by without affecting various long strength parameters of concrete.

Table 1. The Chemical composition of fly-ash on the basis of type of coal burnt.

COMPONENT	BITUMINOUS	SUB-BITUMINOUS	LIGNITE
$SiO_{2(\%)}$	20-60	40-60	15-45
$Al_2O_{3\,(\%)}$	5-35	20-30	20-25
$Fe_2O_{3(\%)}$	10-40	4-10	4-15
CaO(%)	1-12	5-30	15-40
LiO(%)	0-5	0-3	0-5

Natural/Biofiber composites are emerging as a viable alternative to glass fiber composites, particularly in automotive, packaging, building, and consumer product industries, and becoming one of the fastest growing additives for thermoplastics. An investigation is carried out on jute fiber. Jute fiber has gained interest in the composite field due to its superior specific properties compared to manmade synthetic fibers like glass, Kevlar, asbestos, etc. ([10]Prasada et al. 2014)

1.1 Composite

When two or more material is combining together to form a single discrete property material called composite material. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics. Composites consist of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the reinforcement or reinforcing materials whereas the continuous phase is termed as the matrix.

The strength of the composite material depends on their mechanical behavior. The mechanical properties of tensile, compressive and bending strength of the 12%, 24% and 36% of hybrid fibers like (Natural fiber-Sisal; Jute and Hemp) polymer composite material is used as bio composite materials. Characterization of 12%, 24% & 36% hybrid natural fiber composites material with the low density; economical for prosthetic bone with respect to biocompatibility the mechanical behavior of long human bones such as Femur bone ([3]Gouda et al., 2014). The study fly ash and epoxy resin is used for making the cores of materials woven glass fabric as reinforcing skin materials, epoxy resin worked as adhesive this is used for construction of solid material with strength. Analysis is carried out on different proportions of epoxy and fly ash composites of solid materials for determining the flexural strength and compressive strength and three different proportions of epoxy and fly ash is used for determination of their properties ([9]Kumar et al., 2014).

2. METHODOLOGY

This section describes the material and methods used to fabricate the bio- composite fiber by using fly ash (thermal waste) and jute as reinforcement and resin as matrix material.

2.1 Materials

a) Jute fiber
b) Fly ash
c) Resin (CY 230)
d) Hardener (HY 951)

Jute fiber: In India, China, Bangladesh, Indonesia and Thailand Jute is abundantly grown. This is removed from woody type of plant, after cutting the tree they are submerged into water for 20 to 30 days then washed in water &dried under the sun light. Jute fiber is strong and cheap and durable. The fibers are 1 to 4 meters (3-12 feet) long. Jute is comprised mostly of cellulosic fiber partially a textile fiber and partially wood.
Fly ash: For the present study the fly ash is collected from NTPC (National thermal power corporation limited) Feroze Gandhi Unchahar Thermal Power Plant is located at Unchahar in Raebareli district in Indian state of Uttar Pradesh.
***Epoxy Resin*:** Epoxy resin (araldite) CY-230 is a liquid solvent free epoxy resin. It has versatile applications in technical and industrial application. It can be coloured easily. It can be odorless, tasteless and completely non toxic. Curing take place at room temperature and atmospheric pressure after addition of hardener.
Hardener: Hardener (HY-951) it is act as catalyst for resin. Hardener is a yellowish-green liquid which is resistant from chemical attack. Hardener has been used as curing agent in the industries. Hardener HY 951 purchased from Shahgal Fibers Pvt. Ltd., Rudrapur industrial area, Uttar Khand.

2.2 Preparation of Specimen for mechanical test

All the specimens are prepared by simply hand layout technique in which an open mould is used to fabricate a composite material. The specimens are prepared according to ASTM and ISO standard for compressive, tensile and flexural test, respectively.

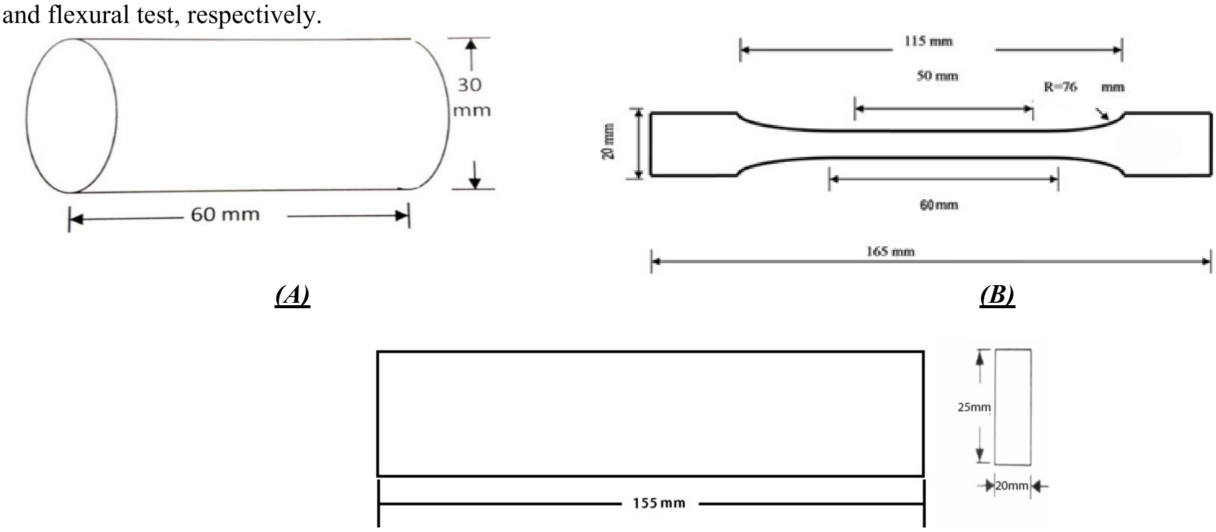


Figure 1. Specimen (A) for compressive test according to ISO-1708, specification (B) for tensile test according ASTM D 638 type I and specimen (C) for flexural test according to D790-09

Three point bending flexural tests are usually used in the composite material tests, because the sample preparation and fixtures are very simple *(Chang 1995).*According to ASTM D790, the flexural strength in a three-point flexural testing is given by:

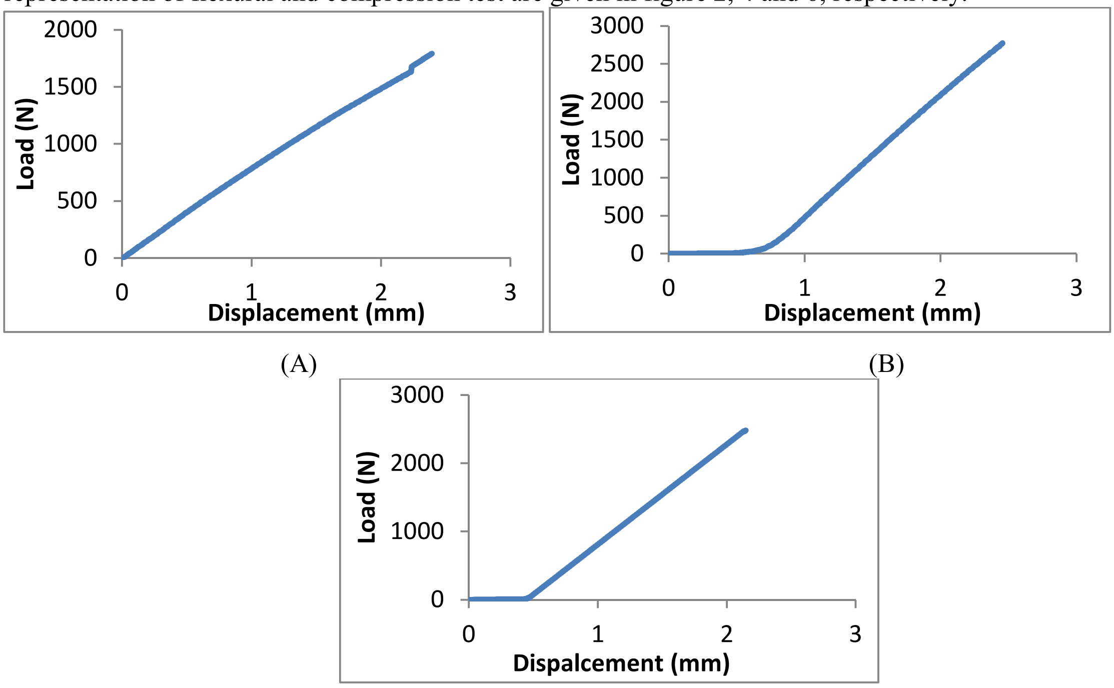
$$\sigma = \frac{3PL}{2bt^2}$$

Table 2. Reinforcement and matrix composition for different model of flexural, tensile compression and test

Experiment		% of Epoxy resin (by weight)	% of Hardener (by weight)	% of Fly ash (by weight)	% of Jute fiber(by weight)
E 1	Flexural	64	4	30	2
	Tensile	64	4	30	2
	Compressive	64	4	30	2
E 2	Flexural	48	4	45	3
	Tensile	48	4	45	3
	Compressive	48	4	45	3
E 3	Flexural	31	4	60	5
	Tensile	31	4	60	5
	Compressive	31	4	60	5

2. RESULT AND DISCUSSION

In this section the compatibility of composite material models (E1, E2 and E3) which to be fabricated for mechanical test i.e. compression, tensile and flexural are discussed. The load verses displacement graphical representation of flexural and compression test are given in figure 2, 4 and 6, respectively.



(C)

Figure 2. Graphical representation of load verses displacement for different specimen for flexural test E1 (A), E2 (B) and E3 (C)

Table 3. Experimental analysis of different composition of fly ash for flexural strength

Experiment	Gauge length (mm)	Width (mm)	Thickness (mm)	Max load N	Flexural strength (N/mm^2)
E1	110	25	20	1791.78	29.56
E2	110	25	20	2773.75	45.76
E3	110	25	20	2480.42	40.92

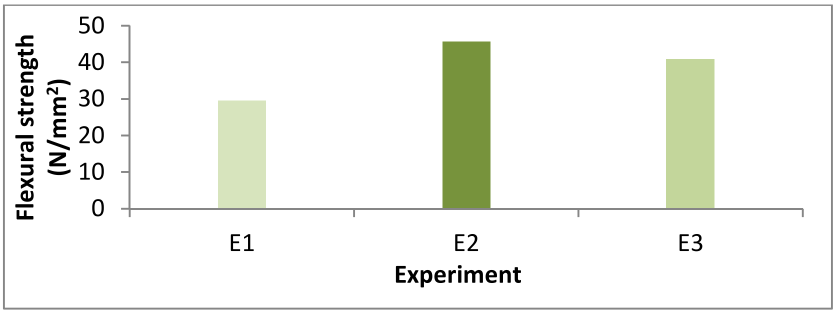
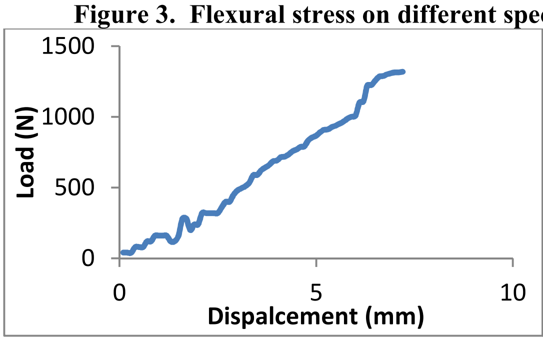
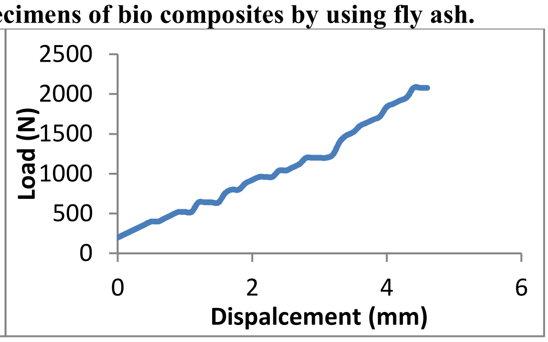
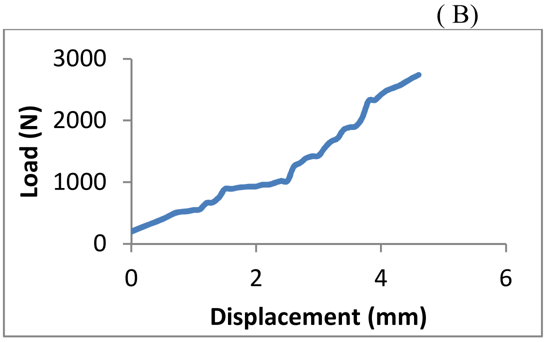


Figure 3. Flexural stress on different specimens of bio composites by using fly ash.





(A) (B)



(C)

Figure 2. Graphical representation of load verses displacement for different specimen for tensile test E1 (A), E2 (B) and E3 (C)

Table 3. Experimental analysis of different composition of fly ash for tensile strength

Experiment	Gauge length (mm)	Width (mm)	Thickness (mm)	Max load N	Tensile strength (N/mm^2)
E1	90	10	10	1319	13.19
E2	90	10	10	2080	20.8
E3	90	10	10	2740	27.4

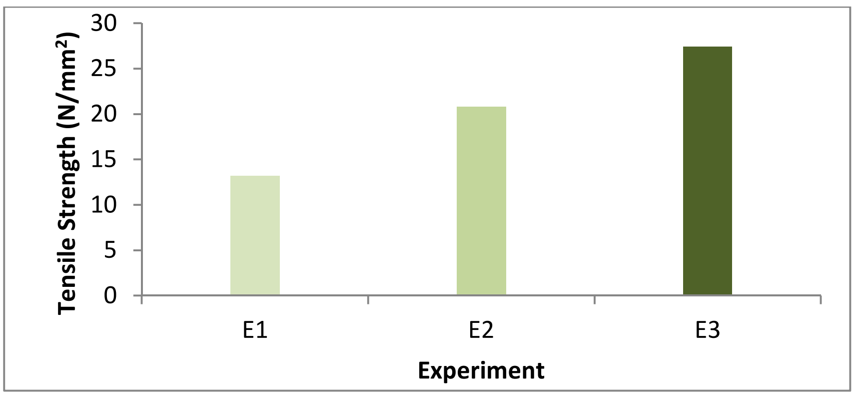


Figure 3. Tensile stress (N/mm^2) on different specimens of bio composites by using fly ash.

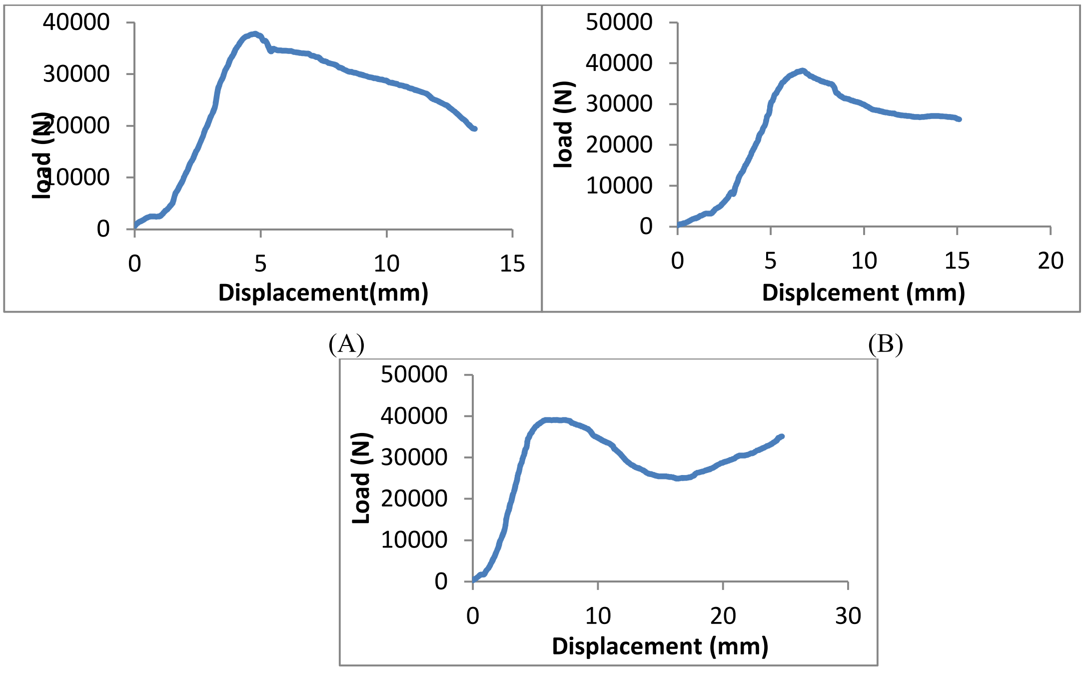


Figure 4. Graphical representation of load verses displacement for different specimen for compression test E1 (A), E2 (B) and E3 (c)

Table 4. Experimental analysis of different composition of fly ash for compressive strength

Experiment	Height (mm)	Diameter(mm)	Area (mm^2)	Load (N)	Compressive Strength (N/mm^2)
E1	60	30	707.14	37800	53.45
E2	60	30	707.14	38200	54.02
E3	60	30	707.14	39100	55.29

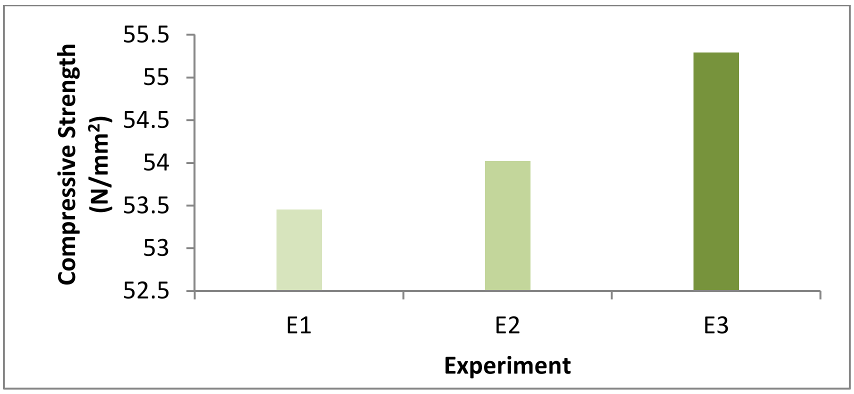


Figure 3. Compressive stress (N/mm^2) on different specimens of bio composites by using fly ash.

4. CONCLUSION

From the above result following conclusion can be drawn,

1. The maximum flexural strength was found to be 45.76 N/mm^2 for 45 % (wt% of composite) of fly ash with 3% of jute fiber for specimen E2 and minimum was 29.56 N/mm^2 for 30 % fly ash with 2% of jute fiber for specimen E1.
2. The maximum tensile strength was found to be 27.4 N/mm^2 for 60 % (wt% of composite) of fly ash with 5% of jute for specimen E3 and minimum 13.19 N/mm^2 was for 30 % fly ash with 2% of jute for specimen E1.
3. The maximum compressive strength was found to be 55.29 N/mm^2 for 60 % (wt% of composite) of fly ash with 5% of jute for specimen E3 and minimum was 53.45 N/mm^2 for 30 % fly ash with 2% of jute for specimen E1.
4. The mechanical properties of bio composite i.e. compression and tensile have found to be increase with

increase in percent of fly ash with epoxy resin matrix.

5. RECOMMENDATIONS

Engineers and manufacturer are always preferred and look for new material for their work. They improved processes to use in the manufacturing of better products, at better price to gain profit. The developed composites are a good substitute for a number of petroleum based products and non bio- gradable material. They have lot of advantages like low density, low price, recyclable, biodegradable, low abrasive wear, and environment friendly. Natural fiber composites are being used in a large number of applications in automotive, constructions, marine, electronic and aerospace. It was also used in agricultural implement. Fly ash epoxy composites form a new class of bio-fiber reinforced composites, which may find potential applications in:

- Passenger seat frames (replacing wood/steel) in railway coaches / automobiles
- Pipes carrying pulverized coal in power plants
- Household furniture and also as low cost housing materials.
- Trim parts in dashboards
- Door panels and Seat Cushions
- Backrests and Cabin linings
- Agriculture equipment

6. FUTURE SCOPE

Fly ash used bio composites have a lot of research potential, considering the present day environmental concerns. The present work can be extensive by a number of different ways. Considering the raw materials, fly ash and jute fiber as reinforcement has been used for fabrication of the composites with resin matrix in the present work. However bi-directional jute fiber can also be used as reinforcement in the composites. Fiber length can be one of the variables in the composite fabrication and their effect can be studied on the mechanical, chemical and erosive properties. As far as method used in fabrication, the hand up layout method has been used for fabrication of composites in the present work. It is recommended that the use of injection moulding to fabricate composites samples for testing is more precise, which reduces much of human errors and consume less time. The mechanical properties of composites have been studied in the present work; however the effect of temperature, wall thickness during emersion in water and water absorption can be explored as future work. Effect of chemicals on the mechanical properties of the composites can also be a good problem to study.

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