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Experimental Investigation of Fire Proof Plate (Kevlar& E-Glass Fiber)

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Abstract- This investigates the mechanical and thermal properties of hybrid composites made from Kevlar and glass fiber. These materials find applications in various fields including protective gear, aerospace components, and structural elements. By altering the stacking sequence of fibers and using compression molding, seven different hybrid composite plates were created. The tensile, and impact strengths in mechanical properties testing and thermal conductivity, heat deflection temperature and coefficient linear thermal expansion in thermal properties testing of produced samples were evaluated and compared using conventional testing. Mechanical tests revealed that the 8K2G plate exhibited the highest tensile strength and elongation, while the 2K4G plate showed superior impact resistance. Thermal tests revealed that 9K2G plate exhibits lower thermal conductivity, 8K2G,10K2G,7K3G plate have the higher coefficient of linear thermal expansion, 2K5G plate has the highest heat deflection temperature among the plates. These findings highlight the potential of hybridizing Kevlar and glass fiber to create materials with enhanced properties for diverse applications.

Key words – kevlar fibre, e-glass fiber, epoxy ly556, hardner hy951, tensile and impact test.

I. INTRODUCTION

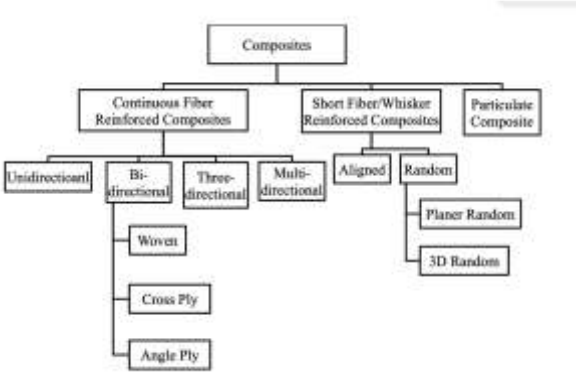
OVERVIEW OF COMPOSITES

A composite material is defined as a material that is composed of two or more materials at a microscopic scale and has chemically dissimilar phases. Consequently, a composite material is heterogeneous at a microscopic scale but statistically homogeneous at a macroscopic scale. There is a difference between composite and alloy or metal with impurities. In an alloy, it is not possible to detect the individual constituents from the cross-section while in the composites component as well as the interface can be physically identified.

According to the ASTM D3878 standard, composite is one substance consisting of two or more materials, insoluble, and collectively form an engineering material useful with certain kinds of properties that are not available in an isolated way.

The following conditions should be satisfied to be called a composite material

- It is manufactured except natural composites.
- The blend of materials should result in considerable property changes when one form should be fibrous.
- The content of the constituents is generally more than 10% by volume.
- It consists of two or more physically and chemically distinct, duly arranged, and distributed phases.
- In general, the property of one constituent should be greater than the corresponding property of others.



Natural fibers like sisal, banana, jute, oil palm, kenaf, recycled jute and coir have been used as a reinforced composite for advanced applications such as aircraft and aerospace structures and for ordinary applications like consumer goods, furniture, low-cost housing and civil structures.

High performance demands on engineering materials have led to extensive research and development of new and improved materials, such as composite materials used for structural purposes. They are often have low densities, resulting in high stiffness to weight and high strength to weight ratios when compared to traditional engineering materials. In addition, the high fatigue strength to weight ratio and fatigue damage tolerance of many composite also makes them an attractive option.

Compared to continuous fiber composites, short fiber composites can easily be processed in a similar manner to the matrix. Short fiber composites with a thermo set matrix can be mass produced by means of compression molding.

HISTORY OF COMPOSITE MATERIALS.

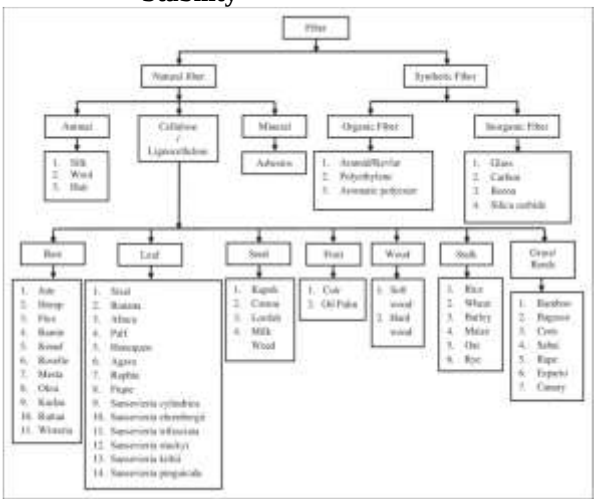
The idea of a composite material is not a new one. In 1500 B.C., early Egyptians and Israelites used a combination of mud and straw to create strong buildings. Nature is another example where the idea of a composite

material can be found. Wood is a naturally occurring composite material which falls under the category of fibrous composites, with cellulose fibers embedded in a lignin matrix.

Another example is gluing wood strips along different orientations to produce plywood. Concrete can also be considered a composite since it consists of a mixture of stones held together by cement. Ancient Mongolians used composite bows made from wood, bone, and bamboo bonded with a naturally occurring pine resin. These bows are said to be very powerful and accurate.

ADVANTAGES OF COMPOSITES

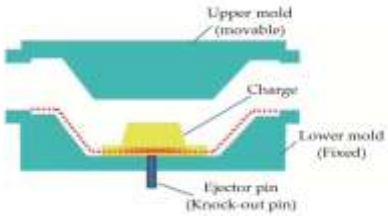
- **Lightweight**
- **High Strength**
- **High Strength-to-Weight ratio**
- **Corrosion Resistance.**
- **High Impact Strength**
- **Design Flexibility and Dimensional Stability**



COMPRESSION MOULDING;

Compression molding is the fastest close molding process in which the part is made into the cavity of a die. The molding charge which is placed in the die can be bulk molding compound or sheet molding compound.

This process can be used by hot pressing or cold pressing. This process gives dimensional accuracy with a good surface finish but having large curing time.



The part and mold can often be designed in such a way that no successive trimming or machining processes are required. This method is normally applied for mass production and development of a low-cost component.

The shortcoming of the method is that it is limited to very short fiber lengths and restricted fiber volume. Also, since there is a large amount of material flow throughout the process, it may cause fiber damage into the barrel.

II.LITERATURE SURVEY

1. NUMERICAL AND EXPERIMENTAL EVALUATION OF THE MECHANICAL BEHAVIOR OF KEVLAR/GLASS FIBER REINFORCED EPOXY HYBRID COMPOSITES
   Muhammad Nabeel etl., 2020

Flexural, tensile, and impact strength of hybrid Kevlar/glass reinforced epoxy composite is studied. Six different types of hybrid composite material were manufactured by hand layup process using different compositions of Kevlar and glass fiber. Tensile, flexural and impact strengths of manufactured samples were investigated using standard tests and com- pared. It is observed that tensile strength is greater for combinations with higher percentage (%) of Kevlar fabric and decreases with an increase in the glass fabric %age. Flexural strength is higher for combinations with greater %age of glass fabric and decreases with an increase in the Kevlar fabric %age. From drop weight test, it is found from visual inspection that damaged area is increased with an increase in the glass fabric percentage. Numerical simulation model incorporated with elastoplastic material data successfully predicts tensile and flexural experimental results.

2. CHARACTERIZATION ON THERMAL PROPERTIES OF GLASS FIBER AND KEVLARFIBER WITH MODIFIED EPOXY HYBRID COMPOSITES
   Vivekanandha chinnasamy,etl.,2020

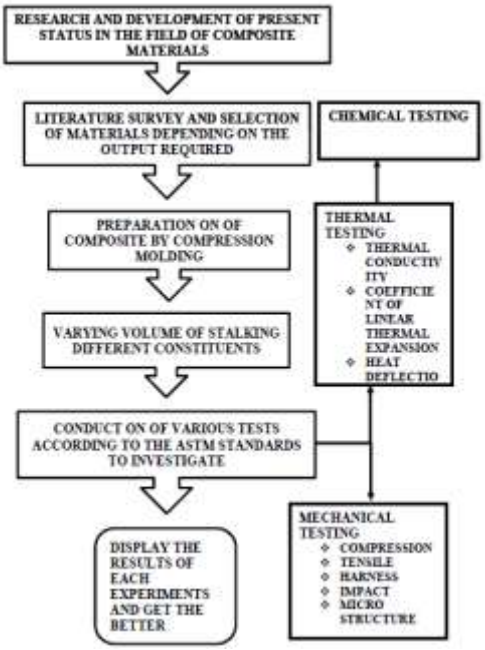
Scores of modern applications have the presence of composite materials. As such, scientists worldwide started considering fabrication of a new composite and attempting to have more applications using these materials. Fabricating composite materials newly has become the genuine considerations of scientific community worldwide and hence, serious attempts are continuously being taken in-order to improve the application of these materials.

Due to this vast development and research in this field, conscious attempt has been made in this present work that studies the effect of nano clay content with reference to structural and morphological behavior of epoxy composites. In this process, epoxy materials get reinforced with different particulate fractions of chosen nanoclay and investigations were carried out on the specimens. Composite laminate with varied layers of glass fiber and Kevlar fiber and modified epoxy with 2 wt.% of Cloisite 30B and hardener are used, and strips are fabricated and tested for their mechanical properties. Also, sheets with 14 layers of glass without and with nanoclay and likewise sheets with 14 layers of kevlar without and with nanoclay were fabricated. The fabricated kevlar/glass fiber reinforced composites were subjected to various tests to evaluate the thermal properties.

III. MATERIALS USED

- Epoxy resin (LY-556)
- Hardener(HY-951)
- Synthetic fiber (Kevlar and Glass fiber)

IV. METHODOLOGY



OVERALL OBJECTIVES OF MECHANICAL TESTING

Humanity's utilization of materials has always been supported by testing activities, which have developed over the centuries from crude tests of the fitness-for-purpose of service items to the modern science-based procedures that support all aspects of the science and technology of materials and their utilization. There is now a mutual dependency between advances in scientific knowledge and test method development, with first one and then the other providing an enabling facility for further progress in the development of versatile evaluation programmes capable of supporting various essential industrial operations. In the particular case of mechanical tests those operations include:

- quality control
- quality assurance
- comparisons between materials and selection
- design calculations
- predictions of performance under conditions other than those of the test
- indicators in materials development programmers
- Starting points in the formulation of theories.

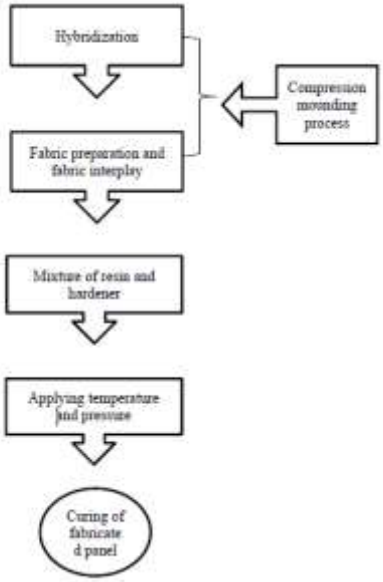
EXPERIMENTAL STUDIES PRODUCTION OF COMPOSITE PLATES AND DETERMINATION OF MECHANICAL PROPERTIES

MATERIALS:

In the production of composite plates, plain woven E-Glass fibers (300g/m2) and plain woven Kevlar fibers (200g/m2) have been used. LY556 epoxy resin and HY951 hardener are used at a ratio of (10/1) in the production of composite plates.

LY556 epoxy resin and HY951 hardener

PROCESS FLOW CHART USED IN THE FABRICATION OF HYBRID COMPOSITES



CONFIGURATIONS OF KG HYBRID COMPOSITE LAMINATES.

NUMBER	NAME	Laminate stacking Laminate configurations
1	12K1G	
2	2K5G	
3	8K2G	
4	10K2G	
5	9K2G	
6	7K3G	
7	2K4G	
TOTAL	KEVLAR E-GLASS	50 19

E-GLASS FIBRE + KEVLAR FIBRE + EPOXY LAMINATED PLATES

PLATE 1 (12K.1G)

PLATE 2 (2K.5G)

PLATE 3 (8K.2G)

PLATE 4 (10K.2G)

PLATE 5 (9K.2G)

PLATE 6 (7K.3G)

PLATE 7 (2K.4G)

V. RESULTS

SPECIMEN PREPARATION AS PER ASTM STANDARDS

The samples are cut to the following dimensions as per ASTM standards for testing shown in table

SI.No	ASTM code	Mechanical Test	Sample dimensions(mm)
1	ASTM-D3039	Tensile	250 × 25 × thickness
2	ASTM-D256	Impact	65 × 13 × thickness

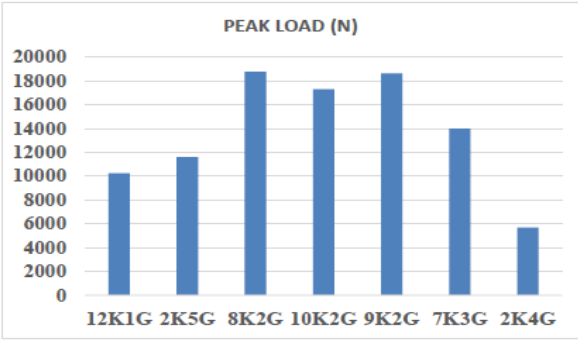
Tensile Testing:

Mechanical properties such as Tensile strength (TS), Impact strength of synthetic and glass fiber reinforced epoxy resin system composites are computed from the test conducted using universal testing machine (UTM) in accordance to ASTM standards for specimen preparation. The 10 ton capacity UTM machine is supplied by Kalpak instruments and controls, Pune, India.

TEST RESULTS FOR (EPOXY RESIN SYSTEM + E-GLASS FIBER+KEVLAR FIBRE)

- **TENSILE TEST RESULTS**

COMPOSITES	PEAK LOAD (N)	%ELONGATION
12K1G	10253.824	3.525
2K5G	11585.0215	3.855
8K2G	18763.543	6.36
10K2G	17295.565	4.69
9K2G	18621.509	5.362
7K3G	13980.7265	4.055
2K4G	5681.913	2.26

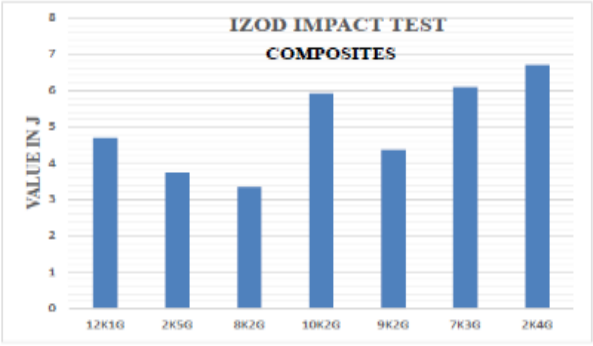


IMPACT STRENGTH TESTING OF COMPOSITES

ASTM D 256: Standard test method for impact properties of polymer matrix composites. charpy impact strength of composite samples is evaluated as per ASTM D256, using Impact Testing Machine.

The test specimen geometry as specified in the above standard for balance symmetric glass and kevlar fiber composites are 65 mm long × 13mm wide × 5mm thick. The charpy test specimens are clamped in an horizontal position so that the end of the specimen faced its striking edge and impact energy absorbed for breaking the specimen is directly obtained.

COMPOSITES	IZOD IMPACT VALUE IN JOULE
12K1G	4.7
2K5G	3.75
8K2G	3.35
10K2G	5.92
9K2G	4.37
7K3G	6.1
2K4G	6.7



VI. CONCLUSION

This investigated the performance of Kevlar and E-glass fiber polyester composites. Different parameters which affect the mechanical properties were studied. Most of the investigations included experiments. From all these investigations, it can be seen that there are several common conclusions besides those remarks at the end of each chapter for tensile test 8K2G plate have higher peak load(N) and %elongation than the other six plates and 2K4G plate have the lesser peak load and %elongation than the other six plates. In impact test 2K4G plate have higher impact value than the other six plates and 8K4G have lesser impact value the other six plates.

The new hybrid composite produced with synthetic fibers as reinforcements gives good mechanical properties as compared with pure matrix material. These hybrid composite can be used in Aerospace and automobile and fire protection application.

In the present work, composite with multiple fibers such as synthetic fibre and glass fibre have been successfully reinforced with the epoxy resin by simple and inexpensive compression. The synthetic fibers Kevlar and e-glass have been successfully reinforced with the epoxy resin by compression moulding technique. The aim of this project is to find the tensile and impact strength of hybrid synthetic fiber/glass fibre reinforced composites.

FUTURE SCOPE OF PROJECT

In future we are going to conduct thermal and chemical properties test in our hybrid composite Kevlar and E-glass fibre.

Most materials change their dimensions as the temperature is changed. Thermal expansion is defined as the change of dimensions of a body or material as a result of a temperature change. Such a property is very important in the application of composite materials in structures that undergo temperature changes, such as engine parts and space structures. The material property constant describing this phenomenon is the coefficient of thermal expansion (CTE).

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