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INVESTIGATIVE STUDY ON IMPACT STRENGTH VARIATION IN DIFFERENT COMBINATION OF POLYMER COMPOSITES

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Abstract - The present work describes the development of impact strength of different types of polymer composites with glass fiber reinforcement, epoxy resin and different filler ranging from fibers, particulates and flakes. The results shows that out all other type of reinforcement the epoxy resin with glass fiber reinforcement and filler materials shows the better results than epoxy resin with any other type of reinforcement . The experiments were conducted for different mechanical characteristics of polymer composites but in the present study are fully concentrated on the impact strength of the composites. This study is only restricted to the glass epoxy composites with different filler the composites polymer composites consisting of glass fiber reinforcement, epoxy resin and filler materials

Keyword: Composite material, aircraft, Woven glass/epoxy, aspect ratio, impact strength, fiber orientation, filler, flakes, hybrid composites

Introduction

Composites materials have found wide range of application in modern day engineering and day to day life. In composite material polymer composites play a vital role in aeronautical field applications. Among that impact strength of the composites materials also play a vital role in automobile and aeronautical field. Among the polymer composites there are two types one is thermoset polymer and other is thermosetting polymer composites. Epoxy resin is in one of the thermosetting polymer resin and it has higher durability strength and most commonly used resin. Glass fibers of different grade are available for the fabrication of composites as a fiber reinforcement generally E glass fiber used for hand layup fabrication technique.Sic carbide has very good thermal statbility and mecahniacl strength and hence it can be used to enhance the mechanical property of the composites. Generally hybrid composites show higher strength than single fiber reinforced composite. Higher composites are of two two they can be either multiple type of fiber reinforcement or fiber reinforcement along with filler can be used The impact strength is defined as the ability of a material to absorb impact energy or shock without breaking. The impact energy is calculated as the ratio impact energy absorbed to cross-section area of the specimen. Impact energy of the composite plates is calculated using Charpy or Izod impact test.

Literature survey

1.glass fiber reinforced polymer composites are frequently used now a days for engineering applications such as aerospace, automotive and marine application where mechanical and tribological properties are of primary concern. [3]

2.The performance of the composites can further be improved by adding particulate fillers to them. In the present investigation, physio-mechnical, two-body abrasive wear and analysis of glass-fiber reinforced epoxy composites filled with different proportion of graphite powder / alumina oxide are studied. [2]

3.As comparison, physio-mechanical ,two-body abrasive wear and fem analysis of unfilled G-E composites are evaluated under identical test conditions. Physio-mechanical properties such as density, hardness, tensile properties are investigated accordance with ASTM standards. [1]

4.Two-body abrasive wear test with different loads and abrading distance should be performed at room temperature by using a pin on a disc apparatus. The experiments must be evaluated by using Taguchi's experimental design approach to make a parametric analysis of wear behavior of selected composited must be studied. [1]

Specimen preparation

Al the materials in the present study are prepared by hand layup technique which is the oldest method used to fabricate the laminated composites. The materials used are epoxy as the resin and the glass fiber as the reinforcement with different filer material combination. The resin material used was (Lapox L-12) matrix material with medium viscosity. The glass fiber reinforcement are used in the form of woven fabric as it has higher strength than other form of glass fiber. Different hardener are used according the requirement of the filer material. This matrix is chooosen because it provide good resistance to alakali 's and has good adhesive properties.

Experimental setup

The materials are cut according to astm standards for particular test specimen. There two different method for measuring impact strength of the materials Charpy impact test and Izod impact test. These two methods have different way of testing according to Charpy the test specimen is supported at both ends, according to Izod the specimen is clamped only on one side like a cantilever.the dimension of the testing component is done as per ASTM standard

Results and discussion:

Comparing the results of impact strength of the different material combination of following data have been collected. On comparing all the data obtained for different material combination material with particulate and flakes reinforcement shown lower impact strength than the material with hybrid composites. Materials with lower impact strength are neglected (matrix material other than epoxy resin are neglected)

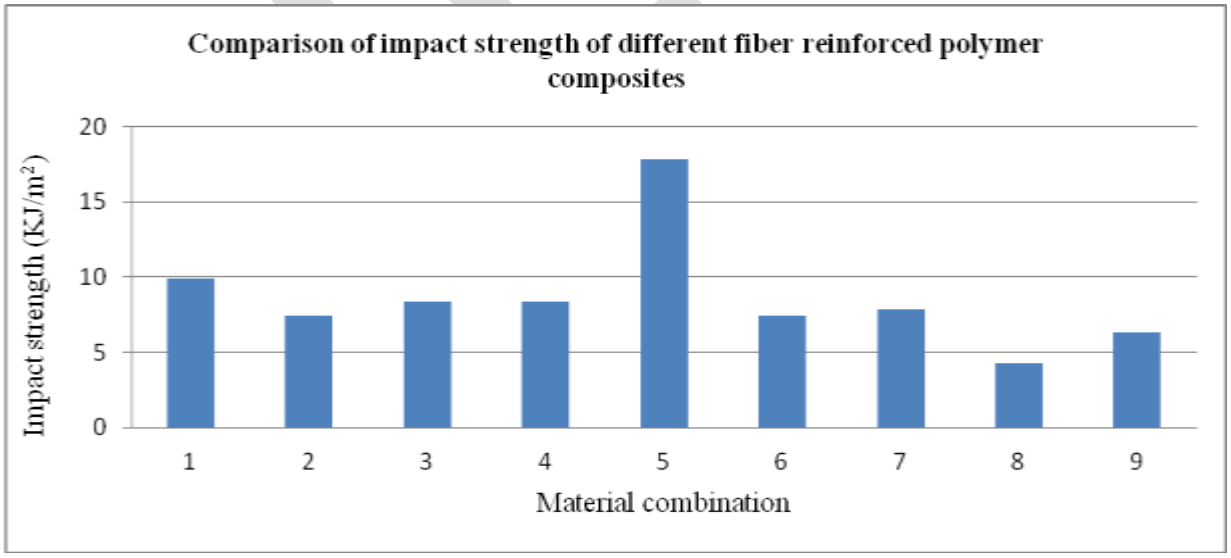
Impact strength of fiber reinforced polymer composites

Sl. No	Materials	Impact strength KJ/m2)
1	Ukamfibre Lamina	9.89
2	Banana fibre laminate	7.47
3	Sisal fibre laminate	8.36
4	Coconut fibre laminate	8.37
5	E-glass laminate	17.82
6	Hemp fibre laminate	7.41
7	Kevlar Fiber Reinforced Polymer Matrix Composites	7.89
8	Polyester resin with basalt fiber	4.32
9	Epoxy resin with palymra fibers	6.32

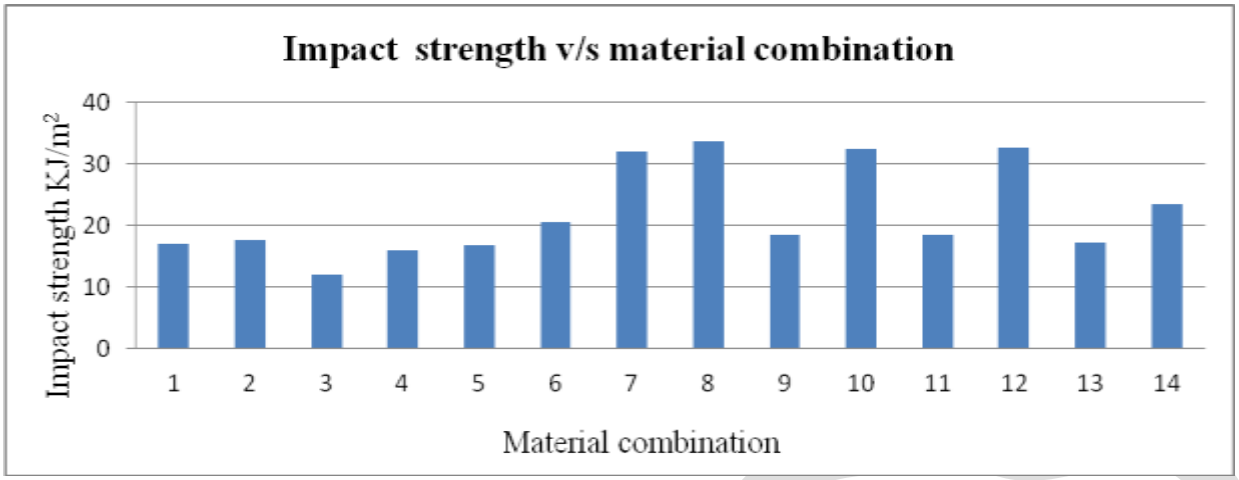
Impact strength of hybrid polymer composites

Sl. No	Material combination	Impact strength (KJ/m^2)
1	Glass epoxy with 10% $Mg(OH)_2$	16.87
2	Glass epoxy with 5.1% fly ash	17.6
3	Glass epoxy with 3.9% CaCO3	12
4	Glass epoxy with 15% Hematite Powder	15.83
5	Glass epoxy with 10% Al2O3	16.81
6	Glass epoxy with 10 % fly ash	20.41
7	Epoxy glass & sisal fiber	32.02
8	Epoxy glass & sisal fiber with Sic filler	33.71
9	Glass epoxy with coal ash	18.5
10	Glass epoxy with silicon carbide	32 .3
11	Glass epoxy with titanium oxide (across)	18.5
12	Glass epoxy with ZnS (across)	32.5
13	Glass epoxy with titanium oxide (along)	17.2
14	Glass epoxy with ZnS (along)	23.5

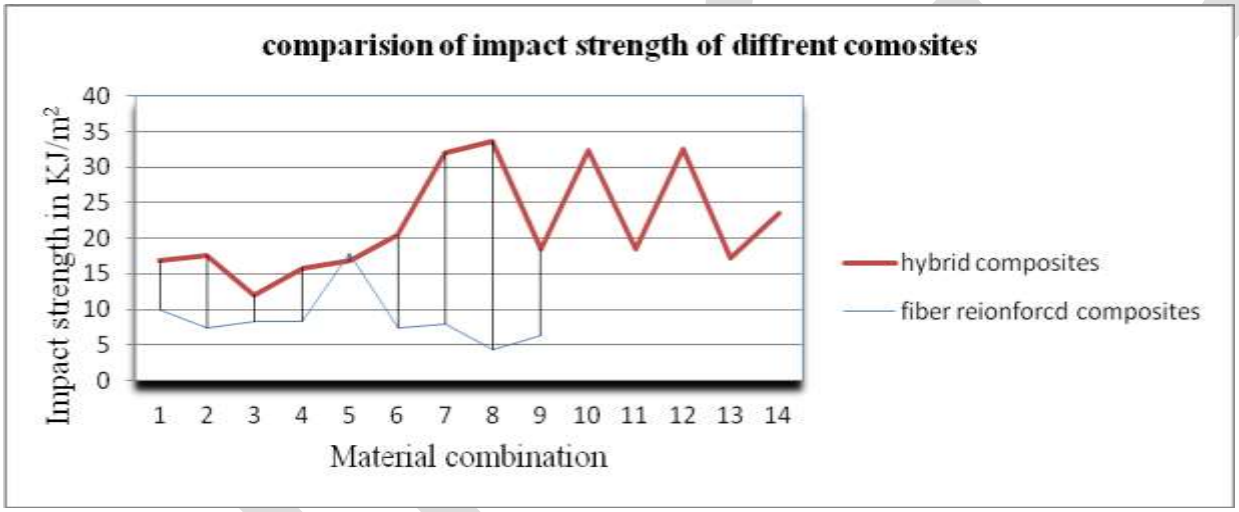
Impact strength comparison of fiber reinforced polymer



Impact strength comparison of hybrid composites



Impact strength comparison of different material combination



When compared to impact strength all other material combination fiber reinforced polymer composites show higher strength than other individual reinforced polymer composites such as flakes and particulate reinforcement. Natural fiber reinforced polymer composites shows lower strength because of loose bonding with matrix material due to the presence of hemicellouse this can be improved to certain extent by treating those natural fiber with acidic and alkali solutions. Fiber other than glass does not bond with epoxy resin so easily because of difference in interphase. Following data shows that out of all other fiber reinforcement glass fiber reinforced epoxy resin shows higher strength hence in the present paper detailed study of glass epoxy with other combination are studied and some material combination of glass epoxy composites with other filler materials are neglected because of their lower strength. Explanation of the higher strength of hybrid composites is given below.

GE composites filled with fly ash

These composite has shown 3 times higher impact strength than the unfilled composites of the same material. When the small particles are reinforced as a filler material in the matrix the crack length considerably increases during the process of facture. For same volume smaller the size of the particle larger will be the surface area. This increase is observed up to certain limit of the filler material and further increase in the filler material may lead to deterioration of the impact strength.

GE composites filled with $CaCo_3$ (calcium carbonate)

When impact strength of the above mentioned composites were done it was absorbed that the impact strength was increased by 1.5 times when compared to the unfilled composites. Calcium carbonate is as crystalline material hence the size the particles will be higher when compared to fly ash. So impact strength of these composites is found increased by half of that when compared to same composites filled with fly ash.

GE composites filled with cOAL ASH

When impact strength of these composites was conducted there was no much significant changes occur in the impact strength of the composites with up to 20 % wt of the filler composites. The use coal ash as a filler material does not bring any change in the bonding of the composites

GE composites filled with sic (silicon carbide)

Experimental results indicated that SiC filled composites having high impact strength when compared with other filled composites this due to that good bonding strength between filler, matrix and fiber and flexibility of the interface molecular chain resulting in absorbs and disperses the more energy, and prevents the cracks initiator effectively.

GE composites filled with alumina (AL_2O_3)

These composites show slight increase in the impact strength in comparison with unfilled composites as partially dispersion of the filler material in the composite.

Epoxy composite with sisal and glass fiber

The hybrid composite shows higher impact strength on comparison with GE composites or epoxy sisal composites. They show higher strength when sisal and glass fibers are used in 1:1 ratio. The composite with sisal and glass fiber combination has almost 1.9 times higher impact strength as the composites with the glass and epoxy composites.

GE composite with Hematite

When hematite is used as a filler material for glass epoxy composites the impact strength of the composites increased till 10% wt of the filler used. Any further increase in filler content has harmful effect on impact strength of the composites due to improper bonding between the matrix and the filler, material and increased embrittlement of the composite

GE composite with titanium oxide (Tio_2)

Impact strength of composite were done in two ways along the notch of the specimen and across the notch of the specimen for same Wt% of the filler the impact strength across the notch is higher as compared to the impact strength of the of the composites tested along the notch. N both the tested it shoes that TiO2 filled compsites have higher strength than GE composites due close bonding of composites.

GE composite with zinc sulphate zns

Impact strength of the ZnS filled composites is higher than TiO_2 filled composites for both tests that were conducted across the notch and along the notch. The ZnS filled composites shows almost 3 times higher impact strength when tested across the notch. The ZnS filler will easily dispersed along the matrix material and increases the strength of the composites till optimum wt % of the filler used and further any increase in wt % of the filler the strength decreases.

Epoxy RESIN WITH treated and untreate natural fibers(pseudo stem of banana)

Impact test were conducted for different % of natural fibers with both treated and untreated fiber. The fiber that are chemically treated shows higher impact strength as compared to untreated fibers for all three % of fiber because alkali treatment not cleans surface it also removes the impurities and hemicelluloses from the fiber. These cause fiber surface to better interface between fiber and blend with the matrix. This results in obtaining the enhanced Impact properties

Epoxy composite with jute and glass fiber

These hybrid composites show slightly higher impact strength when compared to both unfilled GE composites and epoxy jute composites.

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Conclusion

1. Present investigation gives information of the impact strength of glass composites with different material combination.
2. Use of silicon carbide as a filler gives higher impact strength to glass epoxy componensts as compared to all the combination.
3. These materials can be used in car bumpers and dash boards as they have higher impact strength.
4. Glass epoxy composites with sic carbide can be used as casing for cold and hot storage boxes as SiC has less Thermal expansion.
5. Future work can be done for using these composites in break disc by performing necessary alteration

Appendix

Table 1

1. Effect of Alkali Treatment on Impact Behavior of Areca Fibers Reinforced Polymer Composites Srinivasa CV et al.,

2. Assessing Mechanical Properties of Natural Fibre Reinforced Composites for Engineering Applications. Olusegun David Samuel1 et al.,

3. Investigation of Low velocity Impact Properties of Kevlar Fiber Reinforced Polymer Matrix Composites. S. Channabasavaraju et al.,

4. Mechanical Properties of Natural Fibre (Banana, Coir, Sisal) Polymer Composite M.SAKTHIVE et al.,

Table 2.

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2. An Investigation of Mechanical Properties of Hybrid Polymer Composites S. Bhargavi Devi et al .,

3. Characterization of Ceramic Filled Polymer Matrix Composite Used for Biomedical Applications. WaleedAsim Hanna et al .,

4.Determination Of Mechanical Properties Of Al2O3, Mg (OH)2 And Sic Filled E-Glass/ Epoxy Composites K.Devendra et al.,

5.Mechanical Properties of Bamboo Fibre filled with Fly Ash filler R einforced Hybrid Composite sVenkateswaraRao T et al.,

6.Mechanical and Electrical Behavior of Polymer Matrix Composite and their Hybrids Reinforced with (Carbon Black–Boron) Particles. R. S. Al-Khafaji

7.A Review on Potentiality of Nano Filler/Natural Fiber Filled Polymer Hybrid Composites Naheed Saba et al.,

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