Investigation Of Polycarbonate Plastic With Composite Material

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I. INTRODUCTION

Composite is a combination of two or more chemically distinct and insoluble phase. Composite material or phases must have significantly different properties for it to combine them. Thus metals and plastics are not considered as composites although they have a lot of fillers and impurities. The properties and performance consist of one or more discontinuous phases (reinforcement) embedded in a continuous phase (matrix).

For example:

- Cemented carbides(Wc with Co binder)
- Rubber mixed with carbon black and
- Wood (a natural composite as distinguished from a synthesized composite)

Composite are one the most advance and adaptable engineering materials known to men. Progresses in the field of materials science and technology have given birth to these fascinating and wonderful materials. Composites are heterogeneous in nature, created by the assembly of two or more components with fillers or reinforced fibre and a compactable matrix. The matrix may be metallic, ceramic or polymeric in the origin. It gives the composite shapes, surface appearance, environmental tolerance and overall durability while the fibrous reinforcement carries most of the structural load thus giving microscopic stiffness and strength. modulus to weight ratio.

Reasons to use composite for application:

- High strength to weight ratio,
- High toughness,
- High creep resistance and
- High tensile strength.

1.1 FIBRE REINFORCED COMPOSITES

Fibre reinforced composites contains reinforcement having length higher than cross sectional dimension. It has been classified as given in the figure. Reinforced fibre in a single layer composite may be short or long based on its overall dimensions. Composites with long fibre are called continuous fibre reinforcement and composite in which short or staple fibre are embedded in the matrix are termed as discontinuous fibre reinforced (short fibre composites).

Fibre Reinforced Composite

- Single layer composites
  Multi -layer composites
- Continuous Laminate
- Unidirectional and Bidirectional

Figure 1.2 Unidirectional laminate

1.4 DISCONTINUOUS FIBRES

1.2 Reinforced in preferred directional:

These fibres are having the discontinuous fibres but they are mostly aligned in the direction of material.

1.3 Randomly oriented reinforcement fibre:

- These fibre are having the discontinuous and randomly arrangement of the short fibre or discontinuous fibre.

1.4POLYCARBONATE PLASTIC:

Polycarbonate (pc) plastics are a natural transparent amorphous thermo plastics. Although they are made commercially available in variety of color, the raw material al for the internal transmission of light nearly in the same capacity as glass. Poly carbonate polymer are used to produce variety of material and are particularly when impact resistance and /or transparency are a product requirement (e.g.in bullet proof glass).pc is commonly use for plastics lens in eyewear, in medical devices, automotive components protective gear, green house/poly carbonate also very good resistance and can be combine with flame retardant material without significant material degradation

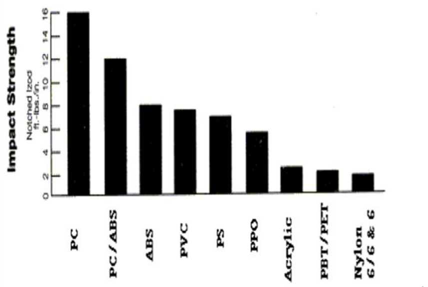


Figure 1.5 Strength ratio

The following diagram shows the relative impact strength of polycarbonate when compare to the impact strength of other commonly used plastic structures ABS, polystyrene, pc or nylon.

II. LITERATURE SURVEY

The composite materials has the evolution of replaced most of the conventional material construction in automobile, aircraft and various aviation industries. The fibre reinforced composite have been widely successfully in hundreds of application where there was a need for high strength materials. There are thousands of custom formulations which offer FRPs a widely variety of tensile and flexural strength.

2.1 STUDIES RELATED TO POLYCARBONATE

Peng He , Yong Gao and Jie Lian (2005)

The plasma surface has the effect of modification and ultrasonic time on the mechanical properties and multi-wall carbon nano fiber polycarbonate composites were investigated. The study is showed that the mechanical properties of the nano composite depended on the ultrasonic dispersion time. Long term dispersion damaged the surfaces of both untreated and plasma polymerized carbon nano fibers. Carbon nanotubes have demonstrated great potential in many practical

Sodden and syzhang (1986)

They studied the inter laminar shear fracture of chopped strand mat glass fibre reinforced polyester laminates and reported that cracking mechanism and shear strength depends on the surface of the composite material.

2.2 STUDEID RELATED TO GLASS FIBRE INVESTICATION

Manjunath et la (2010)

In their study on the fatigue behavior of a glass fibre reinforced plastic composites in the hybrid toughened epoxy matrix have reported that the cyclic fatigue life of an epoxy polymer modified with 9% weight carboxy terminated butadiene acryl nitrite rubber micro particle and 10% of weight silica nano particle is about6 to 10 times higher than that of the neat epoxy polymer.

III. SELECTION OF MATERIALS

Thus the materials and additives which has been used in composite will be follows as.

- Fibre
- Resin
- polycarbonate plastic and
- Other additives.

3.1 Selection of fibre

Ancient Egyptian use glass fibre for decorative items in the 16th and 17th century. But the use of glass fibre as a reinforced material in a new ideas. Glass fibres are therefore used as a reinforcing agent for many polymer products to form a very strong and relatively light weight fibre reinforced polymer composite material called glass reinforced plastic also popularly known as “fibre glass “.

Figure 3.1 Glass fibre

sensitivity to abrasion and low fatigue strength. Glass fibre is often used for secondary structure on aircraft such as fairing, radomes and wing tip. Glass fibre is also used for helicopter rotor blades. There are several type of glass fibre used in the aviation industry.

3.1.1 SELECTION OF POLYCARBONATE PLASTIC

Polycarbonate (pc) plastics are a natural transparent amorphous thermo plastics. Although they are made commercially available in variety of color, the raw material al for the internal transmission of light nearly in the same capacity as glass. Poly carbonate polymer are used to produce variety of material and are particularly when impact resistance and /or transparency are a product requirement (e.g.in bullet proof glass).pc is commonly used for plastics lens in eyewear combine with flame retardant material without significant material degradation.

3.1.2 TYPES OF GLASS FIBRE

- A -GLASS – Soda lime silicate glasses used where the strength, durability, and good electrical resistivity of E Glass are not required.
- C -GLASS – Calcium borosilicate glasses used for their chemical stability in corrosive acid environments.

3.1.3 ADVANTAGE OF GLASS FIBRES

- High strength
- Light weight
- Increases life
- Low maintenance.

3.1.4 ADVANTAGE OF PC PLASTIC

- UV production
- Impact resistance
- It is also less weight.

3.1.5 ADVANTAGE OF E-GLASS FIBRE

- High strength
- Light weight
- Low maintenance
- Chemical resistant
- Low cost.

3.1.6 APPLICATION OF GLASS FBIRE

Glass fibre can be used for both interior and exterior fixture in a variety of shape, style and textures.

- Transportation
- Electrical/Electronics
- Aerospace/Defense

USES OF POLYCARBONATE PLASTIC

- Windsurfing
- Gliding wing spar
- Hockey sticks
- Aircraft wing
- Aircraft fuselage

There are variety of fibre are there with two main types and synthetic forms. From the

From the performance of the fibre listed above we chosen the glass fibre for the reason of low cost and performance higher, today almost any specialization for structure material can be met by combination of glass fibre and plastic resin, which are characterized by many outstanding properties.

3.2 SELECTION OF OTHER ADITIVES

3.2.1 HARDNER

- Ii is mainly used for the bond formation between the fibre and the resin.
- A substance or mixture added to a composition to promote or control curing by taking part in it.

IV. WEIGHT ESTIMATION

4.1 VOLUME FRACTION:

Consider a composite material that composite of fibre and matrix material. The volume of the composite material is equal to the sum of the volume of the fibre and the volume of the matrix.

$V_c= V_f+V_m$
$V_f = V_f/V_c$
$V_m = V_m/V_c$
Such that the sum of volume fraction is
$V_f +V_m =1$

4.2 WEIGHT FRACTIONS:

Assuming that the composite material consist of fibre and matrix material, the weight of the composite material is equal to the sum weight of the fibre and the weight of the matrix.
$W_c = W_f + W_m$, $W_f +W_m = 1$

4.3 DENSITY FRACTION:

Density of the composite material can be defined as the ratio of weight of composite material to the volume of the composite material and is expressed.

$\rho_c =Wc/Vc$

but, Vc = Vf +Vm, and V = W/ρ, therefore the above equation can be rewritten as.
$W_c/\rho_c = W_f/\rho_f + W_m/\rho_m$
$1/\rho_c = 1/\rho_f \; W_f/W_c + 1/\rho_m \; W_m/W_c$
By writing in term o weight fraction.
$1/\rho_c = W_f/\rho_f + W_m/\rho_m$
$\rho_c = 1/ W_f/\rho_f + W_m/\rho_m$
The equation $W_c = W_f + W_m$, can be rewritten as.
$\rho_c V_c = \rho_f V_f + \rho_m V_m$
ρc = ρf vf/vc +ρm vm/vc
Writing term of volume fraction, the density of the composite material is written as.
ρc = ρfVf + ρmVm

4.4 CALCULATIONS:

We know that the following values,
Density of the glass fibre = 2.5 Kg/m3
Density of the epoxy resin = 1.5 Kg/m3
Weight of the fibre = 500gms
Weight of the resin 1000gms
From the composites as shown that in figure.
Length of the fibre (l) =210 mm
Breadth of the fibre (b) = 150 mm
Thickness of the fibre (t) = 3mm
Volume of the composite = l*b*t
= 210*150*3
Volume of the composite=$9*10^{-5}$ m^3

Weight fraction:

$W_c = W_f + W_m$
$W_c = 500+1000$
$W_c = 1500$ gms
$W_f = W_f/W_c = 500/1000$
$\mathbf{W_f = 0.33}$ **or 33.3%**
$W_m = W_m/W_c$

Density and volume fraction:

$1/\rho_c = W_f/\rho_f + W_m/\rho_m$
$\rho_c = 1.732$ Kg/m_3
$\rho_c = \rho_f V_f + \rho_m V_m$
$1.732 = \rho_f V_f + \rho_m V_m$
$1.732\ 2.5\ V_f + 1.5\ V_m$
Solving the above two equation we get,
$V_f = 0.232$
$V_m = 1.768$
Volume fraction will be given as,
$V_f = 0.232*9.10^{-5}$
$V_f = 1.392*\ 10^{-5}\ m^3$
$V_m = 0.768*9*10^{-5}$
$V_m = 4.608*10^{-5}\ m^3$

V. TESTING OF COMPOSITE

5.1 COMPONENTS of UTM

Load frame: Usualconsisting of two strong support for the machine.Some small machines have single support.

Load cell: A force transducer or other means of measuring the load is required. Periodic calibration is usually required by governing regulations or quality system.

Uses

- Elastic limit
- Proportionality limit
- Elastic limit

The following test are conducting for laminates.

1. Tensile Test
2. Flexural Test
3. Impact Test

The laminate will be tested should have the ASTM standards as per the test specimen dimensions

5.2 TENSILE TEST

Tensile test is a measurement of the ability of material that reacts to force that are applied in the form of tension on different material such as plastic, textile, rubber etc

Figure 5.1Tensile test of the specimen.

Thus the American Standard for Testing Material (ASTM)
Length will be 165 mm
Breadth will be 20 mm.

Figure 5.2 Test specimen for tensile test

Under ASTM standard the specimen are used to fabrication as given in the 6.3.

5.3 COMPRESSION TEST

A compression test can be performed on (UTM) by keeping the test piece on base block and moving down the central grip to apply load. It can also be performed on a compressive testing machine. A compressivetesting machine. Thus the ASTM Standard for the compressive test (ASTM D3410) will be given below.

Length will be 155 mm.
Breadth will be 30mm.

5.4 FLEXURAL TEST:

The three point bending flexural test provides value for the modulus of elasticity in bending. Flexural stress, flexural strain and the flexural stress strain response of the material. The main advantage of the three point flexural test is the ease of the specimen preparation testingThus the ASTM Standard for compression test (ASTM D790) will be given below.

Length will be 64 mm.
Breadth will be 13mm.

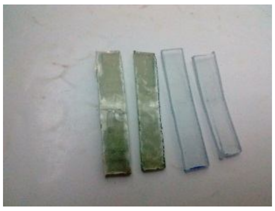


Figure 5.3 Test specimen for flexural test

Under ASTM Standard the specimen are used to fabricate as given in the figure.

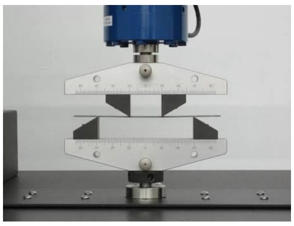


Figure 5.4 Flexural test of the specimen

VI. EXPERIMENATAL RESULT

Tensile load is the load as the material is being pulled, we will find its strength. Tensile load is shown in figure.

6.1.2 COMPRESSIVE LOAD

Compressive load is the capacity of the ot withstand loads tending to reduce size. Compressive load on the laminate will be given.

Thus the all specimens of each laminate are used to have the test over the universal testing machine and strength values are determined. Thus the laminates to be analyzed of each loading will be mention below.

6.2 FELUXURAL TEST RESULT

Table 6.1 Testing values for flexural strength

S NO	LAMINATES	FLEXURAL STRENGTH
1	Glass fibre(A)	10.26
2	Glass fibre(B)	9.61
3	PC Plastic(A)	14.96
4	PC Plastic	15.10

6.3 IMPACT STRENGTH RESULT

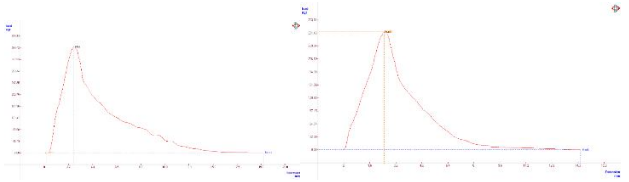
Thus the impact strength value for laminate specimen will be mention in the table 8.3

Table 6.2 Testing values for impact strength

S NO	LAMINATES	IMPACT STRENGTH
1	Glass fibre(A)	10.26
2	Glass fibre(B)	11.54
3	PC Plastic(A)	13.548
4	PC Plastic	12.548

VII. CONCLUSION

Thus the strength value (tensile strength, flexural strength, impact strength) of each laminates by the experimental and computational ANSYS result are given in the above chapters.



Graph 9.2 Tensile test for glass fibre composite

The comparison of glass fibre to other fibre and polycarbonate plastic,

Table 9.4 Comparison of the result.

Test	Glass fibres(A)	Glass fibres(B)	PC plastic(A)	PC Plastic(B)
Tensile	292.4	364.4	182.1	192.2
Flexural	10.36	9.61	14.96	15.10
Impact	10.26	11.2	13.25	12.568

VIII. FUTURE WORK

We investigated polycarbonate plastic and glass fibre such as tensile strength, flexural strength, impact strength and compressive strength by both experimental and computational analysis from the result the concluded that the laminate having the more strength properties compared to E-glass. The work can be extended by the addition of carbon fibre and natural fibre to form the orientation of hybrid laminate. Thus the hybrid laminate will be used to fabricate with different orientation and high strength laminate orientation will be defined with thermaleffect.

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