Development of Epoxy-Thermoplastic Based Syntactic Foam for Structural Application

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***Abstract*- The present work is focused on the synthesis and study of the deformation behaviour of epoxy resin/ plastic syntactic foams. Different densities syntactic foams with 0 to 40 volume percentages of plastic were prepared by casting method for the present investigation. The high viscosities of the resin- plastic mixture (putty like consistency) beyond 40 volume percentage prevents processing of higher plastic content syntactic foam. The effects of plastic content on tensile, compression, Flexural and impact properties were studied in detailed. Syntactic Foam means a closed packed cell or matrix. In this project we make a composite material with the help of Epoxy Resin and Adding the Reinforcement is waste Thermoplastic and study the mechanical properties of this composite material.**
Keywords: Epoxy resin, Hardener, Thermoplastic, Syntactic foam

I. INTRODUCTION

Syntactic foam is composite materials. It is closed cell composite material mixed in a resinous matrix. Which have very good mechanical properties, insulation properties, low thermal expansion and low moisture absorption capacity, etc. It is developed for sea application because it is light in weight also its application in ship structure and spacecraft. Syntactic foam are used as core material as a sandwich structure in composite. The advantages of syntactic foam have over conventional open cell structure, honey comb structures. A composite material is a material made from two or more constituent materials with significantly different physical or chemical properties. When combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure, differentiating composites from mixtures and solid solutions.

II. LITERATURE REVIEW

Ho Sung Kim *et.al.* [1] Work on fracture and impact behaviour of hollow microsphere/epoxy resin composite authors observed that the impact strength of composite decrease with increase in volume percentage of glass micro balloon this was due to the breakage of specimen at high volume fraction and strength of glass balloon was less.

UlkuYilmazer *et.al.* [16] studied on tensile, flexural and impact properties of a thermoplastic matrix reinforced by glass fiber and glass bead hybrids on notched and unknotted sample Authors observed that impact energy decrease with increase in volume fraction of glass beads because vacuole growth in impact test is absent and at high speed extensibility of matrix was reduced.

G Raghvendra *et.al.* [2] Studied a Comparative Analysis of Woven Jute/Glass Hybrid Polymer Composite With and Without Reinforcing of Fly Ash Particles authors observed that glass fiber had less bonding nature than jute fiber jute outer layer behaves as brittle because it shows maximum erosion at 90^0. After addition of fly ash composite behaviour was same and it shows maximum at 60^0 which indicate semi brittle behaviour of composite.

III. METHODOLOGY AND EXPERIMENTAL PROCEDURE

Materials: Epoxy resin (Araldite LY556) and hardener (HY951) supply by Herenba Instruments & Engineers Chennai, India was used as a matrix material and curing agent respectively. Araldite (LY556) was highly viscous; having density and viscosity of 1.15g/cc and 10000-12000 mPa-s respectively. Hardener (HY951) was low viscous having density 0.98g/cc was used for room temperature curing. The resin to hardener ratio used was 10:1.

Reinforcement: The reinforcement is used in this project was waste thermoplastic. This is banned in some states because it is not destroy easily. This is major problem of pollution and raises the very dangerous disease.

Specimen processing: The present works is focused on making the composites material by adding the reinforcement and check its mechanical and physical characteristics. In this project we used the (0 to 40%) volume percentage. First of all we make a zero percentage based specimen and perform mechanical characteristic like impact test, hardness test, tensile test and compressive test. The zero percent based specimen make without adding reinforcement. In this type of specimen only epoxy hardener are mixed according to its calculation. After this we make other specimen to use the (10 to 40%) volume percentage of reinforcement and perform the above test measured value is compared with the zero volume percentage measured value. By analysis of the above observed value we plot the graph for the showing the behaviour of composites material. Stir casting method was used, in the present study, to process syntactic foams with varying volume percentage (0-40 volume %) of thermoplastic. Required amount of resin, hardener, and thermoplastic, depending on the volume percentage of the resultant foam were calculated (as shown below).

Preparation of Mold: In the present study the dimension of the mould used to prepare specimen for tensile and flexural testing is 150mm×65mm×8mm. At first wooden bits (of thickness 8.0mm) were cut according to the dimension of 150mm and 65mm respectively. Then these wooden bits were wrapped with plastic tape. A flat wooden board fixed with a transparent plastic sheet was used to form the base of the mold. The wrapped wooden bits were fixed firmly (with the help of nails) in rectangular shape as shown in figure. The purpose of the transparent plastic sheet is to prevent sticking of the mixture and ease removal of the specimen after room temperature curing.

Figure1: Preparation of mold

Preparation of syntactic foam

The flow chart for preparation of the syntactic foam is shown in figure-

Figure 2: Prepare Sample

IV. MECHANICAL CHARACTERIZATION

Impact Test

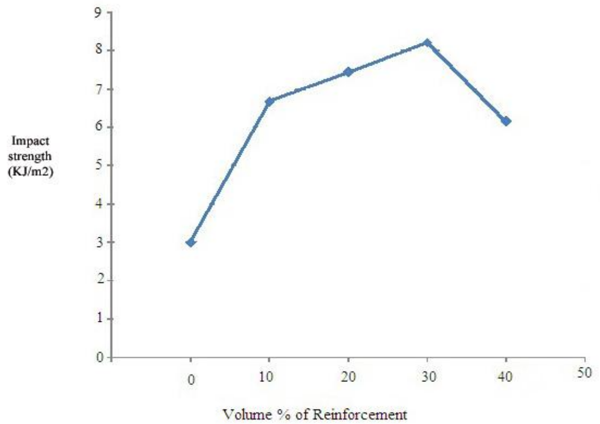
Figure3: Impact testing machine

In this test the components are subjected to Impact (Shock) loads, these loads are applied suddenly. The stresses induced in these are performed to asses shock absorbing capacity of materials subjected to suddenly applied loads. These capabilities are expressed in form of Rapture energy, Impact strength, & Modulus of rapture. Two types of Impact test are commonly used i.e. Charpy test and Izod Test. In presence work only perform Charpy test. In Charpy test, the specimen is placed as cantilever position and specimen have V- shaped notch of $45^{0.}$ The notch is located on tension side of specimen during impact loading. Depth of notch is generally taken as t/5 to t/3 where t is thickness of specimen.

V. RESULTS AND DISCUSSION

Impact testing

Impact strength curve of the syntactic foam with different volume percentage of waste thermoplastic are shown below.



In impact test the impact strength of composite material is varying according to volume of waste thermoplastic. Impact strength of various samples is increases with increasing volume % of Reinforcement up to 30% and then starts decreasing.

Calculation for required amount of casting material for different volume % of syntactic foam

In this subsection, calculation of required amount constituent materials (e.g. epoxy resin, hardener, and thermoplastic) are described for x volume% of epoxy and y volume% of filler.

The calculation for weight estimation for matrix and filler are as follow:-

Calculation for matrix

Density of epoxy =1.15g/cc

Density of hardener =0.98g/cc

Density of thermoplastic =0.95 g/cc

Here epoxy to hardener ratio used was 10:1

Percentage of epoxy in matrix= (10/11) ×100=90.9%

Percentage of hardener in matrix= (1/11)×100=9.09%

By applying rule of mixture for obtaining density of matrix

Density of matrix= density of epoxy × volume fraction of epoxy+ density of hardener × volume fraction of hardener

Density of matrix= (90.9/100)×1.15+ (9.09/100)× 0.98

Density of matrix=1.12g/cc

Volume of mould =150×65×8(mm^3) = 78000 mm^3

Let volume percentage of epoxy and thermoplastic taken was x and y respectively.

Density= mass/volume

1.12×10^{-3}= mass/(x×78000)

Mass of matrix= 87.36x g

Mass of epoxy= (90.9×87.36x)/100

Mass of epoxy= 79.41x g

Mass of hardener = (9.09×87.36)/100

Mass of hardener = 7.94x g

Mass of filler

Density of filler= mass/volume

0.95×10^{-3}= mass/(y×78000)

Mass of filler= 74.1y g

Similar manner it was calculated in respective places for different tests.

VI. CONCLUSIONS

With the increase in thermoplastic content, energy absorption capacity of the syntactic foam increases from 3.1 kJ/m2 (for pure resin) to 8.305 kJ/m2 up to a critical volume fraction (30 vol.%).This is because of the fact that the bond strength between matrix (epoxy hardener) and reinforcement (thermoplastic) start decreasing after 30 vol. %

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