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Synthesis and Characterization of Syntacticfoam

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Abstract*— 'syntactic' means 'putting together'. A composite material synthesized by putting a metal or polymer or a ceramic matrix with hollow spheres (microballoons). This composite material known as syntactic foam. It is used in the field where weight is a constrain as well as it is used for the purpose of energy absorption and for the purpose of heat resistant. Submarines, aircrafts where weight is constrained but also energy absorption capability of the material is a necessity factor. Microballoons have a drawback of low mechanical properties, so to overcame this limitation microballoons are filled with filler materials. This project focuses on the study of different syntactic foam and todetermine their behaviour and characteristics. Also find the different mechanical properties (stress,strain,fracture point, yield).

I. INTRODUCTION

Lightweight material is the need of today world, efficiency to cost ratio are always focuses in any design. To increase the cost ratio,efficiency can be increase or decrease the cost, the best way to do this reduce weight of that designed component. It can achieve by using thinner structure of stronger materials, or by reducing the density but strength attained at a high level. Material matrix composition is one of the best options such as metal matrix composition (MMC), ceramic matrix composition (CMC), polymer matrix composition (PMC). By using high density or high strength materials compressivestrength can be improved. This research paper finds the performance and characteristic of syntactic foam by using the UTM (universal testing machine) and noted that there is anappreciable reduction of weight.

II. LITERATURE REVIEW

In today's world everything is kept shrinking means humans are making big things small and compact or "nano", but nano doesn't mean's that they are compromising with quality. Many researchers are researching in the field of syntactic foam, nano particles etc; for achieving or generating new materials which can be moulded into smaller size with high grade qualities.The flow chart given below consist of different types of syntactic foam on which currently the research is going on

Deepika and Roy [1] studied on epoxy/HGM syntactic foam by reinforcing them with fillers of nylon 6 and Polystyrene. In this paper they deal with the compressive and flexural properties of epoxy syntactic foam.

Zhang et al [2]studied on ceramic matrix composition. In this paper they dealt with the topics as mentioned compressive strength, flexural strength, bulk density on the material Fly ash cenosphere syntactic foam.

III. SYNTACTIC FOAM MATERIAL AND COMPOSITION USED

Composite material which is synthesized by filling a polymer, metal or a ceramic matrix withhollowsphere(microballoons). Syntactic foams can be classified in two types: -

1. On the basis of structure
2. On the basis of material

1.1. On the basis of structure: -

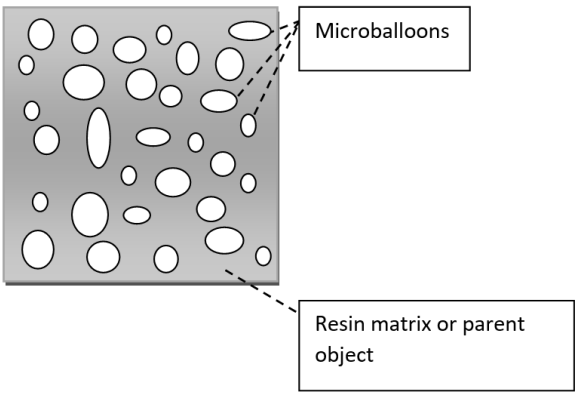

Fig-(a): Two-phase system

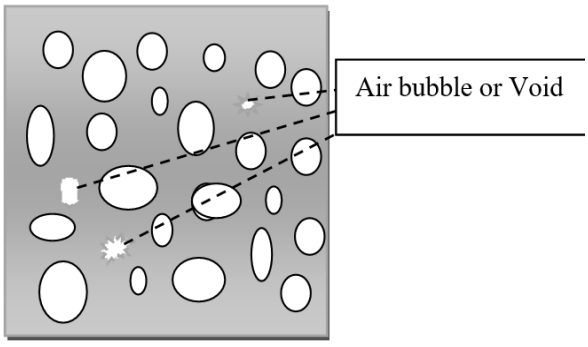

Fig-(b): Three-phase system

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This processis to be done to reduce the weight and increase the strength within the limit. It can be used in the field where weight is a deciding factor like aircrafts, submarines etc.

a) Two-phase syntactic foam

In this only two type of material exists in syntactic foam one is filler material and other is parent object. They are closely packed. Due to closed packed arrangement of microballoons there is no void that exists and no air is entrapped and it leads to minimum impurity to get mixed with the syntactic foam. In this stress concentration is uniformly distributed throughout the syntactic foam.

b) Three-phase syntactic foam

In this type of foam there exist hollow microspheres dispersed in resin with air bubbles in them which leads to create voids and the structure is called three-phase syntactic foam.Stress concentration is not uniformly distributed due to the existence of air bubbles.The existenceof air bubbles leads to form the stress concentration around the air bubble which eventually leads to the result that three-phase system will fail in compare to two phase system.

1.2. On the basis of material: -

a) MMC (Metal Matrix Composition)

When one material in the matrix composition is metal and the other could be a metal or a ceramic polymer is known as metal matrix composition. In metal matrix the main focus is on the following areas: - wear resistance, thermal and electric conductivity, friction coefficient, strength with low density. Forging, rolling or extrusion can also be done by mmc with a standard approach.

Applications: -

- Automobile sector uses mmc as their raw material in building their specific automotive parts likedrive shaft, disc brake, cylinder liner etc.
- It can also be used in power electronics module.
- It can be used in building structure of different kinds.

b) **PMC (Polymer Matrix Composition)**

Continuous or short fibres which are bound together by a polymer matrix are known as polymer matrix composition.

c) CMC(Ceramic Matrix Composition)

If theinteratomic bonding in the compound is ionic that type of compound is called ceramic material.

Ceramic fibres embedded in ceramic matrix are known as ceramic matrix composition. Author tries to improve the following properties: -

- To increase fracture toughness
- To improvise thermal shock resistance
- To set new limits of stress bearingcapacity

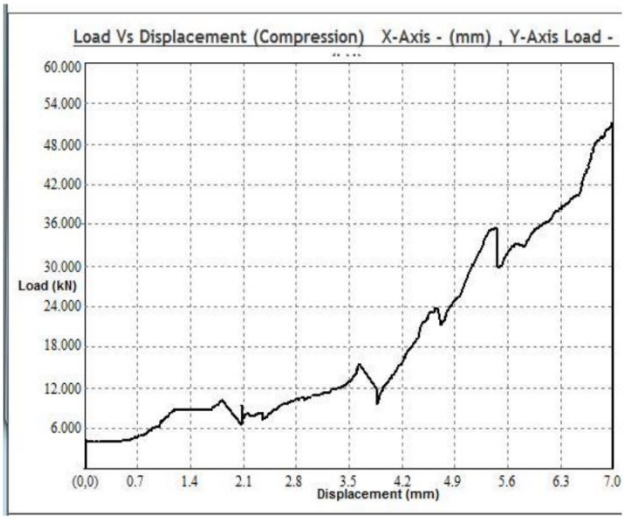
IV. MATRIX SYNTHETIC FIBRE (POLYPROPYLENE FOAM)

Polypropylene can also be moulded into porous like structures which is naturally suitable for syntactic foam because microballoons are already present in it. For creating syntactic foam there is no need of making new microballoons just fill the material in it. Filler material could be Plaster of Paris, cement etc. For this research author takes Plaster of Paris as a filler material.

For comparing syntactic foam with data of Red Brick

Table(a): Red Brickinput parameters and result

Input Parameters		Result	
Specimen width(mm)	110.00	Peak Load	51.110
Specimen thickness (mm)	16.00	Compressive strength (kg/mm^2)	0.677
Cross section area	7700.0	Elongation at break (mm)	6.99
		Breaking load (KN)	39.49
		Breaking stress (KN/mm^2)	0.523



Fig(c): Load Vs displacement of red brick

For making syntactic foam, authormakes semifluid like paste of Plaster of Paris then submerged the Matrix into the semifluid and all the pores of the matrix gets filled with semifluid. Then syntactic foam is dried,after the solidification of semifluid. It is then baked for 1.5 hour at 220ºc. Then perform test on UTM (universal testing machine) and tries to find or tries to study the behaviour of syntactic foam in compression load. Following data comes by testing on UTM.

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Table(b): Syntactic foam input parameters and result

Input Parameters		Result	
Specimen width(mm)	45.00	Peak Load	5.130
Specimen thickness (mm)	40	Compressive strength (kg/mm^2)	0.194
Cross section area	2700.0	Elongation at break (mm)	6.99
		Breaking load (KN)	39.49
		Breaking stress (KN/mm^2)	0.523

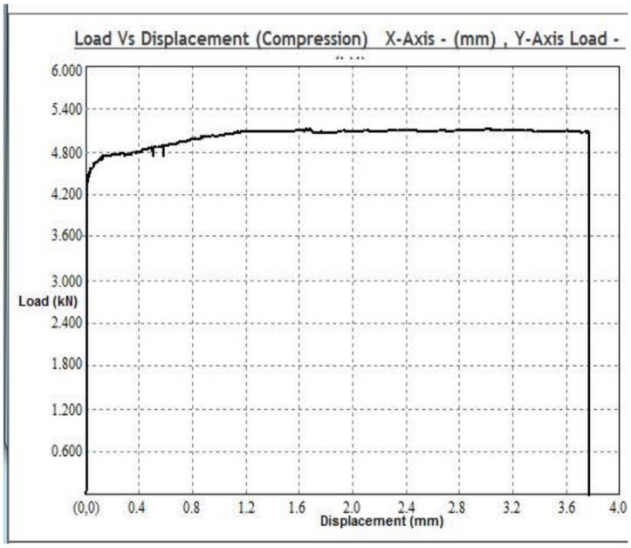

Fig (d): Load Vs displacement of Syntactic foam

V. RESULT AND DISCUSSION

Table(c): Comparison between Red brick and Syntactic foam

Specimen	Average Specimen density	Yield stress	Breaking Stress
Red brick	1922 kg/m^3	0.610KN/ mm^2	0.523kg/m m^2
Syntactic foam	1239.90 kg/m^3	0.165 KN/mm^2	0.192 kg/mm^2

As lightweight material is in demand, this research tries to reduce density but yield strength kept in a limit. As per the result of experiment density reduces 35.35% and breaking stress is reduced upto 63%.

VI. CONCLUSION

From the above experiments the conclusion is that there is a reduction in density by 35.35% and breaking stress by 63%.Then ceramic syntactic foam which is made up of Plaster of Paris as a filler material and polypropylene syntheticfoam as matrix, can be used in a field where weight is a constrain but strength is not the necessity factor like in decorations, walking platforms, concrete almirahs in households. This will not only meetup with the requirement of the material but it will also be economical.

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