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# Experimental Izod and Charpy Test of Laminate Composites of Carbon Steel and Aluminium

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**ABSTRACT:** - Composite materials are composed of two or more distinct constituent materials that when combined produce a new material with characteristics distinct from those of its individual components. Great properties of composite materials are high solidness and high strength, low thickness, high temperature security, high electrical and warm conductivity, flexible coefficient of warm development, consumption obstruction, further developed wear obstruction and so forth. Izod and Charpy Impact test were performed on the laminated composites and its parent material i.e., Carbon Steel (SAE1042) and Aluminium (6061-T6), Aluminium (6082-T651), (Aluminium 5083-H112) to make a comparison with its different composites results to find the suitable composites having higher mechanical properties with respect to composites made from other base material and to investigate the suitability of the material for a specific application and in predicting its expected service life.

**KEYWORDS:** -Composite Materials, Izod Test, Charpy Test, Laminate Composites

## I. INTRODUCTION

A composite material is a materials framework made out of a blend or mix of at least two full scale constituents varying in structure and additionally material arrangement and that are basically insoluble in one another. Composite materials, frequently abbreviated to composites or called creation materials, are designed or normally happening materials produced using at least two constituent materials with fundamentally unique physical or synthetic properties which stay discrete and unmistakable inside the completed design.

Reinforcement + Matrix = Composite

A typical illustration of a composite would be plate brake cushions, which comprise of hard earthenware particles implanted in delicate metal network. One more model is viewed as in shower slows down and baths which are made of fiber glass. Sinks and countertops made of imitation granite and cultured marble are also widely used. The most exceptional models perform regularly on space apparatus in requesting conditions.

Composites or composite materials are a blend of materials which give unexpected actual qualities in comparison to either material independently. Composite material research inside mechanical designing ordinarily centers on planning (and hence, tracking down applications for) more grounded or more inflexible materials while endeavouring to lessen weight, defenceless ness to consumption, and other unfortunate elements. For instance, carbon fiber reinforced composites have been utilized in a variety of applications, including fishing rods and spacecraft.

Composite materials are among the most seasoned and freshest of underlying materials. The more established idea of composites is basically the blending of at least two materials to correct some inadequacies of a specific helpful part. For instance, early guns, which had barrels made of wood, were bound with metal on the grounds that an honor chamber of wood without any problem blasts under inner strain. In old times, blocks were comprised of earth and straw following this rule. Mix of straw and mud to make cottages is still being used today in towns in our country. Also, normal steel covered with paint to safeguard it from rusting can be viewed as a composite. In the event that this is respected valid, practically all designing materials are composites or the like. In current innovation the idea of consolidating two divergent materials has procured a more extensive importance: the mix has its own particular properties. As far as

strength or protection from intensity or some other helpful quality, a composite material is better than both of the comprising parts taken alone or totally not the same as both of them. The primary fascination of present day composite materials is that they are lighter, stiffer and more grounded than anything made ever previously. At present they are utilized essentially to satisfy extreme needs of very sonic flight, the investigation of room and wanders into the remote ocean water of the seas. There are two significant explanations behind the ongoing interest in composite materials. The first is essentially the need for materials that will outflank the conventional stone monument materials. The second and that's just the beginning significant over the long haul is that composites offer specialists the valuable chance to plan absolutely new materials with the exact mix of properties required for explicit errands.

The term composite can be characterized in different ways. A composite can essentially be characterized as a blend of at least two disparate materials having a particular point of interaction between them with the end goal that the properties of the subsequent materials are better than the person comprising parts. Composite materials can likewise be characterized as at least two divergent materials that are personally attached to frame incorporated structure. A larger part of composites comprise only two stages the network which is nonstop and encompasses the broken second stage, the support. In like manner a high level composite material is characterized as a pitch, metal or earthenware network built up with the high strength what's more, high solidness material in constant fiber or fiber structure. The support may likewise be spasmodic and utilized in structures like chipped strands, bristles, particulates and in situ scattering in metal.

## II. FINITE ELEMENT METHOD

The approximation characteristics characterize the field variable during the assembly of components after the nodal values are known.

The general problems of continuum using the finite element technique typically follow a step-by-step approach.

The following is a step-by-step method for static structural applications:

Step 1:- Explanation of the Design Model (Domain). The partitioning of the final area structure into subdivisions or components is the most important step in the finite element process.

Step 2:- Interpolation of the appropriate kind was employed. Because the explanation of a complex structure (field variable) cannot be anticipated adequately under any particular load circumstances, we assume some appropriate result to estimate an unknown solution in a component. Certain convergence conditions must be met, and the expected outcome must be clear.

Step 3:- Start of the matrices (feature matrices) of the components stiffness and load vectors. The postulated version of the displacement should result in the rigidity matrix  $[K(e)]$  and the vector load  $P(e)$  of the element 'e' utilizing both the balancing scenario and a suitable Variation Precept.

Step 4:- Assembly of element equations to reach equilibrium.

Since there are many finite components in the structure, the individual rigidity matrices and the charging vectors have to be properly constructed and the overall balance equation stated as

$$[K]\phi = P$$

When  $[K]$  is known as the assembled rigidity matrix,  $\phi$  is known as the nodal displacement vector and  $P$  is the vector or nodal pressure for the whole form.

Step 5:- Solve the system equation to get the nodal displacement values (subject variable). The traditional equilibrium equations must be modified to account for the problem's boundary conditions.

In the case of linear problems, the vector  $\phi$  may be very problem-free. However, if there are non-linear problems, the solution must be achieved in phases, which include modifying the stiffness matrix  $[K]$  and the weight vector  $P$ .

Step 6:- The tensions and stresses are computed in great detail. If required, the detail lines and stresses may be computed from the nodal displacements using the basic equations of stability or structural mechanics. The words in parentheses in the steps above impose the FEM step by step.

## III. EXPERIMENTATION

Carbon Steel plate (SAE-1042) and Aluminium plate (6016-T6)/ (6082-T651)/ (5083- H112) were chosen for impact test of the laminates. The dimensions for Izod test specimen are 75x10x10 mm and for Charpy test, it is 55x10x10 mm. One side of both plates are knurled to a depth of 1mm and are sandwiched with the help of epoxy. Epoxy Resin X (M-544) is a clear uniform paste of colour yellow while Hardener Y(H-209) clear uniform paste of colour beige [7]. The ratio of this cold setting is 60:40 with resin and hardener respectively. This mixture was kept at room temperature for

20 to 25 minutes. For making laminate metal composites, the sandwiched plates were pressed with 400 Ton upsetting press for 155 second at 90° C. After removing from press, the composite laminate plate was cooled under room temperature [8].



**Fig 1: Laminated Metal Composite (LMC) of Carbon Steel / Epoxy /Aluminium**

#### Izod Test

Impact testing of metals is used basically for calculating the amount of energy absorbed during fracture.. This test determines the impact resistance or toughness of materials. In this test, a specimen is machined to a square section, Izod samples are normally (75 × 10 × 10 mm) in size, with the notch machined across the 28 mm face and into the 2 mm depth. The load given by pendulum is approximately 1000N for Izod test at the end of its arm swinging down. The pendulum strikes the specimen while it is held securely in a vertical position or 90°. The pendulum is left and it strike the specimen which are placed vertically and the impact result is noted. We apply break to stop the pendulum and before doing another test safety lock is applied on pendulum so that it can't come in action until it is removed.



**Fig. 2: Izod Specimen of Carbon Steel SAE 1042**



**Fig 3: Izod Specimen of Aluminium 6061 T6**



Fig 4: Izod Specimen of Carbon Steel SAE 1042 + Epoxy + Aluminium 6061 T6



Fig 5: Carbon Steel SAE 1042 Specimen after test was performed

### Charpy Test

Charpy V notch test specimens are used. The standard Charpy impact test specimen is of dimension 55 mm × 10 mm × 10 mm. Specimen has a notch machined across one of the larger dimensions. In Charpy impact test, the specimen held in vertical position. Pendulum strike the specimen and break it. The pendulum is left and it strike the specimen which are placed horizontally and the impact result is noted. Break were applied to stop the pendulum and set a safety lock to stop any unfair incident.



Fig 6: Charpy Test Specimen of Carbon Steel SAE 1042



Fig 7: Charpy Test Specimen of Aluminium 6061 T6



Fig 8: Charpy Test Specimen of CS + Epoxy + Aluminium 5083 H112



Fig 9: Charpy Test Specimen of Carbon Steel SAE 1042 + Epoxy + Aluminium 6061 T6



IV. SIMULATION RESULTS

Izod Test result of Carbon Steel SAE 1042

S. No	Name of Test	Test Method	Test Results	
1	Izod Impact Test (Joule)	IS:1598:1977RA:2015	24	26
			32	
			22	

Izod Test result of Aluminium 6061 T6

S. No	Name of Test	Test Method	Test Results	
1	Izod Impact Test (Joule)	IS:1598:1977RA:2015	46	51.33
			40	
			68	

Izod Test result of Carbon Steel SAE 1042 + Epoxy + Aluminium 5083 H112

S.No	Name of Test	Test Method	Test Results	
1	Izod Impact Test (Joule)	IS:1598:1977RA:2015	18	20
			22	

Here we perform Izod Test on different materials i.e., Carbon Steel SAE 1042, Aluminium 6061 T6 / 6082 T651/ 5083 H112 and composites of

- C.S SAE 1042 + Epoxy + Aluminium 6061 T6
- C.S SAE 1042 + Epoxy + Aluminium 6082 T651
- C.S SAE 1042 + Epoxy + Aluminium 5083 H112

Charpy Test result of Carbon Steel SAE 1042

S.No	Name of Test	Test Method	Test Results	
1	Charpy Impact Test (Joule)	IS:1757Part1 1988RA-2014	34	30
			28	
			28	

Charpy Test result of Aluminium 6061 T6

S.No	Name of Test	Test Method	Test Results	
1	Charpy Impact Test (Joule)	IS:1757Part1 1988RA-2014	54	58
			68	
			52	



**Charpy Test result of Aluminium 6082 T651**

S.No	Name of Test	Test Method	Test Results	
1	Charpy Impact Test (Joule)	IS:1757Part1 1988RA-2014	60	42.67
			30	
			38	

Here we perform Charpy Test on different materials i.e., Carbon Steel SAE 1042, Aluminium 6061 T6 / 6082 T651/ 5083 H112 and composites of

- C.S SAE 1042 + Epoxy + Aluminium 6061T6
- C.S SAE 1042 + Epoxy + Aluminium 6082 T651
- C.S SAE 1042 + Epoxy + Aluminium 5083 H112

**V. CONCLUSION**

- i. This de-lamination happen may be because of their irregular chemical or mechanical properties, as both the material have different properties and when the pendulum hit the specimen one component is separated from the laminate composites.
- ii. If composite were prepared by moulding both the material and then making a new composite from them apart from laminating them by epoxy than its results will be more effective.
- iii. Here composites of laminates are effective as per weight cost and it can be used in machines where less impact is needed
- iv. Further FEM analysis was also done on composite plate using drop test.

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