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Impact Test on Laminate Composites of Carbon Steel (SAE 1042) Epoxy and Aluminium Alloy (6061- T6) At Room Temperature

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Abstract: This research paper focuses on the laminate composites of carbon steel and aluminium alloy using epoxy resin. For making composite metal laminates, compression molding method is used. Press is used for making sandwiched plates at 90°C for 155 seconds. Izod and Charpy Impact test were performed on the laminated composites and its parent material i.e., Carbon Steel (SAE1042) and Aluminium Alloy (6061-T6) to made a comparison with its composites and to investigate the suitability of the material for a specific application and in predicting its expected service life.

Keywords: Laminate Composite, Carbon Steel (SAE 1042), Aluminium (6061 T6), Impact Test

I. INTRODUCTION

Polymer composite materials have been used for variety of applications like automobile, aerospace and other fields due to its light weight with high strength and stiffness[1]. Now a days thermosetting and thermoplastic polymer composites are widely used as per required applications in different areas[2]. However, composites are susceptible to low velocity impact load because of their weak load-bearing ability in transverse direction. Therefore, study of the low velocity impact behaviours of composite structures have become important and attractive. However, composite structures are normally exposed to complex loading conditions like repeated impacts[3]. The residual strength decreased due to interaction of delamination buckling and extension of the laminated affected [4]. The impact energy absorption capability of composites at room temperature is higher than those of the other temperatures.

Furthermore, perforation thresholds of hybrid composites are affected and generally increased by changing of temperatures according to room temperature [5]. Composite materials provide several benefits compared to the classic materials, in particular, they are capable to provide excellent mechanical performances associated to a lower weight as compared to metallic alloys.[6]

Impact Test (Izod and Charpy) were performed and the results for the different composites are noted. Tests were conducted on specimen at room temperature and average values were reported in results section. The results of impact tests done on the composites and parent material i.e., Carbon Steel (SAE-1042) and Aluminium (6061-T6) have been compared.

II. EXPERIMENTAL METHODS

Carbon Steel plate (SAE-1042) and Aluminium plate (6016-T6) 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

II 1. Izod Test

Impact Testingof 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

Fig 6. Aluminium 6061 T6 after test performed

Fig 7. Carbon Steel SAE 1042 + Epoxy + Aluminium 6061 T6 after test performed

II.2 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 8. Charpy Test Specimen of Carbon Steel SAE 1042

Fig 9. Charpy Test Specimen of Aluminium 6061 T6

Fig 10. Charpy Test Specimen of Carbon Steel SAE 1042 + Epoxy + Aluminium 6061 T6

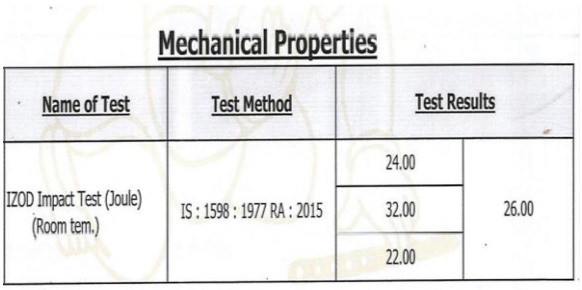
Fig 11. Carbon Steel SAE 1042 after Charpy Test performed

Fig 12. Aluminium 6061 T6 after Charpy Test performed

Fig 13. C.S. SAE 1042 + Epoxy + Aluminium 6061 T6 After Charpy Test Performed

III. Results and Discussions

Table 1: Izod Test result of Carbon Steel SAE 1042



Mechanical Properties

Name of Test	Test Method	Test Results	
IZOD Impact Test (Joule) (Room tem.)	IS : 1598 : 1977 RA : 2015	24.00 32.00 22.00	26.00

Table 2: Izod Test result of Aluminium 6061 T6

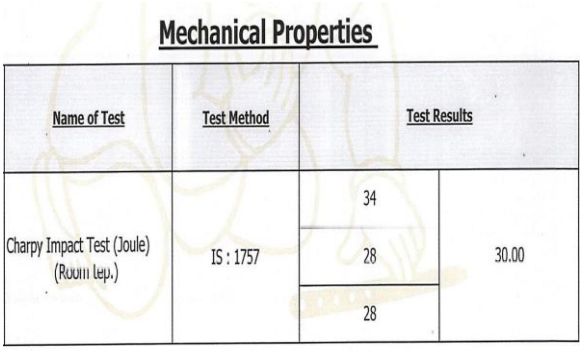
Name of Test	Test Method	Test Result	Result
Izod Impact Test(Joule) (Room Temperature)	IS:1598:1977RA:2015	48.00 44.00 44.00	45.33

Table 3: Izod Test result of 7 Carbon Steel SAE 1042 + Epoxy + Aluminium 6061 T6

Name of Test	Test Method	Test Result	Result
Izod Impact Test(Joule) (Room Temperature)	IS:1598:1977RA:2015	22.00 30.00	26.00

Here we perform Izod Test on 3 different materials i.e., Carbon Steel SAE 1042, Aluminium 6061 T6 and C.S. SAE 1042 + Epoxy + Aluminium 6061 T6 i.e., Composite material. We get the value of **26 J** when impact is done on the Carbon Steel at room temperature, value of **45.33 J** when impact is done on the Aluminium 6061 T6 and **26 J** when done on the composite. The value of Composites should come between 26 J to 45.33 J but due to delaminate it can't bear that much stress. The value of Aluminium is greater than Carbon Steel because of its mechanical properties, and we can notice that Aluminium specimen doesn't break completely while Carbon Steel break into two parts.

Table 4 Charpy Test Result of Carbon Steel SAE 1042 Specimen



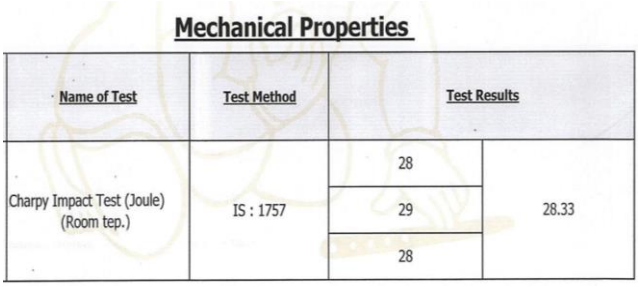
Mechanical Properties

Name of Test	Test Method	Test Results	
Charpy Impact Test (Joule) (Room tep.)	IS : 1757	34 28 28	30.00

Table 5 Charpy Test Result of Aluminium 6061 T6 Specimen

Name of Test	Test Method	Test Result	Result
Charpy Impact Test(Joule) (Room Temperature)	IS:1757 part 1:1988 RA: 2014	23 35 35	31.00

Table 6 Charpy Test Result of C.S SAE 1042 + Epoxy + Aluminium 6061 T6



Mechanical Properties

Name of Test	Test Method	Test Results	
Charpy Impact Test (Joule) (Room tep.)	IS : 1757	28 29 28	28.33

Here we perform Charpy Test on 3 different materials i.e., Carbon Steel SAE 1042, Aluminium 6061 T6 and C.S SAE 1042 + Epoxy + Aluminium 6061 T6 i.e., Composite material. We get the value of **30 J** when impact is done on the Carbon Steel at room temperature, value of **42.67 J** when impact is done on the Aluminium 6061 T6 and **28.33 J** when done on the composite. The value of Composites should come between 30 J to 42.67 J but due to delaminate it can't bear that much stress as happened during Izod test.

IV. CONCLUSIONS

In the present research it is found that the composite material undergo delamination and didn't absorb much amount of impact. In general, they are light weighted and can be cost competitive and are flexible for many applications, but in this research, it is found that it is delaminated at very beginning and couldn't bear much impact.

1. This delamination 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.

2. The knurling done between two different materials to add epoxy so that it can hold firmly is less i.e., 1mm and so during the impact test done on the composite material it can't hold both the alloys plates and got delaminated.
3. 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 effectives.

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