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Development and tensile Testing of Composite Sandwich Plate of Al-Carbon Fiber

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Abstract

Sandwich structures play an important role in industries and they are used in varieties of engineering applications because of their weight-saving potential, good fatigue and corrosion resistance properties. In the present investigation, composite sandwich structures of Al-Carbon fiber are fabricated by varying their thickness and their tensile strengths are studied for their use in various engineering application. All the tensile tests for nine samples are carried out on universal testing machine as per ASTM standard. The test results clearly indicate that tensile strength is most important parameter in fabrication of composite sandwich structures of Al-Carbon fiber.

Keywords: Epoxy Resin, Carbon Fiber, Aluminum Alloy, Tensile Strength, UTM.

1 INTRODUCTION:

For design and construction of lightweight structural systems such as satellites, aircraft, high-speed trains and fast ferries, structural strength to weight ratio is one of the major considerations. . To achieve this objective the sandwich structure is used for fabricating the light weight structures instead of using conventional material.

Composite sandwich Structure is frequently used in variety of application where weight saving is important instead of increasing conventional material thickness. High strength to weight ratio, Light in weight, Good fatigue and corrosion resistance ,Low thermal conductivity, Good design and Manufacturing flexibility, Good chemical resistance, High performance at elevated temperature these are the key properties of Composite material which enhance its use in number of applications. Composite materials are brittle, as a result of which hybrid structure of Aluminum and carbon fiber is used to increase the strength of structure [1]. It is necessary to test the Mechanical properties like Tensile strength, Impact Strength. The research found that the mechanical properties are increases to certain extend and then fall down because of metal fiber laminate [2,3].The bonding between the laminate need to be strong otherwise it will leads towards delamination of structure. Mixing of resin with carbon fiber will enhance the ultimate tensile strength also the ductility of carbon fiber is more than other composite material [4]. Use of Continues carbon fiber has more strength as compared to discontinues fiber [5, 6]. In aerospace number of nonlinear forces are acting on to the surface which results in impact force and finally this force leads towards the internal damage of the surface. These aerospace applications body surface is manufactures by laminate to sustain high tensile stress. When bonding between the laminates is not proper it results in premature failure. So, it is necessary to test the carbon fiber laminate for tensile load.

2. EXPERIMENTAL

2.1 Material

In the present investigation we have used carbon fiber as a composite material for fabrication of sandwich structure [7, 8]. The carbon fiber is used as reinforced material in the matrix of Epoxy resin LY230. The epoxy carbon fiber laminate is the core of sandwich structure and Aluminum 6061 is used as sandwich plates. The properties of Al 6061 used in the present investigation are presented in Table 1.The sandwich structure is fabricated by using Hand Lay Up technique at room temperature. For proper bonding of Al plate to core of carbon fiber, inside surfaces of Al plate are made rough.

Table 1: AL 6061 Properties

Density Kg/m^3	**Young's Modulus**	**Poisons Ratio**	**Tensile Strength**
2.7 g/cc	68.9 GPa	0.33	310 MPa

2.2 Design of Experiment

Three parameters and three levels are selected to perform DOE as shown in table 2.L9 array is prepared by using Taguchi method. Total 9 samples of sandwich structure are prepared as per the best solution given by mini tab software. All 9 samples are fabricated by varying the thickness of carbon fiber and Al plates.

Table 2: Design Parameter and Parameters Levels

Parameters	**Parameter Level**		
Composite Plate Thickness	1.5	2	3
Aluminum 6061 Plate Thickness	1	1.2	1.6
Sequence of Plate Lamination	1/1	1/2	1/3

MECHANICAL TENSILE TESTING:

As explain, we have fabricated the 9 laminates as per the ASTM standard. The Aluminum and carbon fiber are cut into required shape. The required thickness of composite structure is achieved by adhesively bonding of Al plate -one layer of carbon fiber with other layer-Al plate by mixture of epoxy resin and hardener. The edges of structure are finished by using emery paper. The tensile test process involves fixing the specimen in Universal testing Machine. The tensile load is applied on to the specimen till fracture occurs. The tensile load at that point is observed and recorded with respect to increase in gauge length. The fabricated laminates and fractured laminates are shown in figure 1.The tensile strength observed for

nine samples are shown in figure 2.

(a)

(b)

Figure 1: (a) Fabricated laminates and (b) Fractured laminate

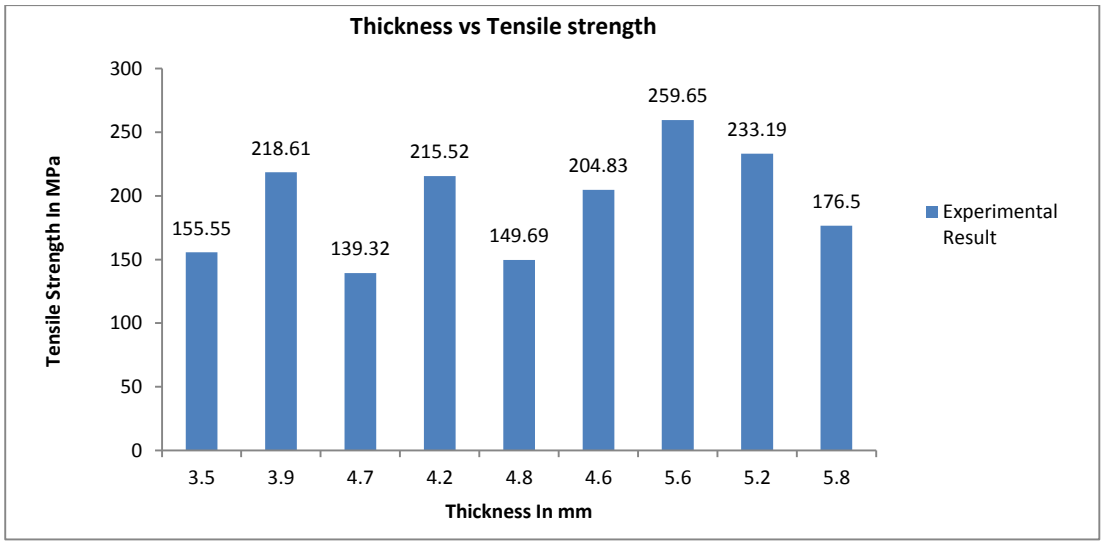

Fig.2 Tensile strength observed over 9 samples

3. RESULT AND DISCUSSION

The fig.2 shows the graph of tensile strength observed over different sandwich structure thickness. It has been observed that the thickness of composite structure plays an important role in defining the strength of the structure. The experiments were conducted by varying the thicknesses of the Structure on Universal testing machine. It

has been observed that increase in the carbon fiber thickness, there is increase in the tensile strength of structure. Change in the aluminum plate thickness also influences the tensile strength of the structure.

CONCLUSION:

1 Carbon fiber plate thickness in sandwich structure has vital importance in strengthening of Al-carbon fiber sandwich structure.
2 Even by placing Al plates of different thicknesses on both side of structure, the strength of the structure found to be increased.
3 In all nine experiments, when the carbon fiber plate thickness is 3mm and Aluminum upper plate thickness is 1mm with lower plate thickness 1.6 mm highest tensile strength is observed experimentally.

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