STIFFNESS ANALYSIS ON ALUMINIUM BASED SANDWICH COMPOSITE

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Abstract— **Automotive industry is on the verge of development and more comforts are being incorporated in a vehicle. On other hand customers have stringent demand of fuel economy, high performance at low cost. In order to have high fuel economy the automotive manufacturers are induced to reduce weight. In this project car body panel is selected as a target weight reduction component and to improve the strength and mechanical properties. This can be achieved either using high strength low weight material or by using low weight composite sandwich panel. Aluminum composite (Aluminum skin, polypropylene core and epoxy resin) material being light and strong, it is thought as an alternative material. Stiffness is analyzed with varying load applied on the specimen. Stiffness analyzed were done on the panel was carried out using Finite Element Solution.**

Index Terms—**composite material, Aluminium sheet, polypropylene sheet, sandwich panel composite, stiffness**

I. INTRODUCTION

Aluminum-foam sandwich structures have been increasingly used in a wide range of applications, including automotive, marine, aerospace, and other transportation applications [1–4] due to their high specific stiffness and strength. Through appropriate composite designs and material property selections of the face sheets and aluminum-foam core, structural properties such as the thermal conductivity [3] and stiffness can all be tailored during the sandwich manufacturing process to meet the needs of specific requirements? The combination of aluminum skin, polypropylene core and epoxy offers a promising option for the sandwich structure design. Sandwich structures are often utilized in the marine, aerospace and automotive industries, where low weight is a critical design factor [4–5]. The purpose of this study has been to explore whether the component weight can be reduced. Body panel can decrease fuel economy through weight reduction. This report describes an analytical method to predict the performance of a body panel based on shape and material properties. Sandwich panels are layered structural components composed of thin strong face sheets or skins separated and bonded to light weight core materials. This particular layered composition creates a structural element with a very high bending stiffness to weight ratio as well as bending strength to weight ratio.

A. Stiffness

Stiffness is the rigidity of an object, the extent to which it resists deformation in response to an applied force. The complementary concept is flexibility or pliability.

II. MATERIAL SELECTION FOR SANDWICH PANEL

A. Aluminum

Pure Aluminium is a silvery-white metal with many desirable characteristics. Aluminium is the third most abundant element (after oxygen and silicon), and the most abundant metal, in the Earth's crust. It makes up about 8% by weight of the Earth's solid surface. Aluminium metal is too reactive chemically to occur natively. Instead, it is found combined in over 270 different minerals.[4] The chief ore of Aluminium is bauxite. Aluminium is remarkable for the metal's low density and for its ability to resist corrosion due to the phenomenon of passivation. Structural components made from aluminum and its alloys are vital to the aerospace industry and are important in other areas of transportation and structural materials. The most useful compounds of Aluminium, at least on a weight basis, are the oxides and sulfates. Despite its prevalence in the environment, aluminum salts are not known to be used by any form of life.

B. Polypropylene Sheet

During the past thirty years polypropylene has gained wide acceptance for use in corrosive applications where previously steel vessels with a rubber & brick lined interior and coated exterior were used. Polypropylene has also been the material of choice to replace tanks and other vessels fabricated from specialty metals such as stainless steel because of reduced original cost and long term cost savings benefits over the life of the equipment. Polypropylene is a low cost, chemically resistant plastic material with excellent aesthetic qualities. Polypropylene is easy to weld using thermoplastic welding equipment and is often fabricated into water and chemical tanks. Polypropylene is available in both homo polymer and copolymer grades. Homo polymer polypropylene is stronger and stiffer than copolymer. Copolymer polypropylene is a bit softer, but it is tougher and more durable than homo polymer polypropylene. Copolymer polypropylene tends to have better stress crack resistance and low temperature toughness than homo polymer.

III. EXPERIMENTAL PROCEDURE

Both aluminum foam core surfaces were cleaned thoroughly using acetone, and were then impregnated by the same epoxy. The specimen is created by placing aluminum sheets as the face materials and polypropylene foam as the core materials with resin has been used for the binding purposes and made to a specimen by applying a load of about 250 tons to make the specimen. Compressive molding was used to cure the sandwich panel under a constant curing pressure of 0.6 MPa after the sandwich assembly in the mold. The specimen dimension are verified and tested. Aluminum sheets are placed on the top and bottom with polypropylene core sheets are placed between them, resin is applied between the core and the aluminum would be of 2mm. the specimen would be of 3mm sheet.

A. Stiffness Measurement

Plywood sheet fixture with nut and bolt arrangement has been made for constraining sandwich panels. Over these wooden weed dead weights has been applied as a force. Dial gauges and probe indicators, are instruments used to accurately measure small linear distances, and are frequently used in industrial and mechanical processes. They are named so because the measurement results are displayed in a magnified way by means of a dial. Here accuracy of this dial gauge is 0.01mm.

Fig 1.stiffness set up

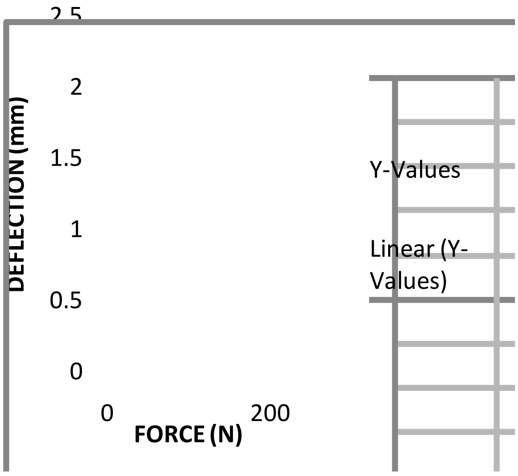
IV. RESULT AND DISCUSSION

A. Experimental Stiffness Analysis

Table1.Deflection of panel at load 10 to 120 N

Applied load (N)	Deflection of composite panel(mm)	Deflection of Al panel (mm)
10	0.1776	0.156
30	0.5328	0.468
60	1.0656	0.936
90	1.5984	1.404
120	2.1312	1.872

B. Experimental Stiffness For Sandwich



PANEL:

Fig 2. Force vs. Deflection Graph

C. Stiffness Analysis Of Sandwich Panel (FEA)

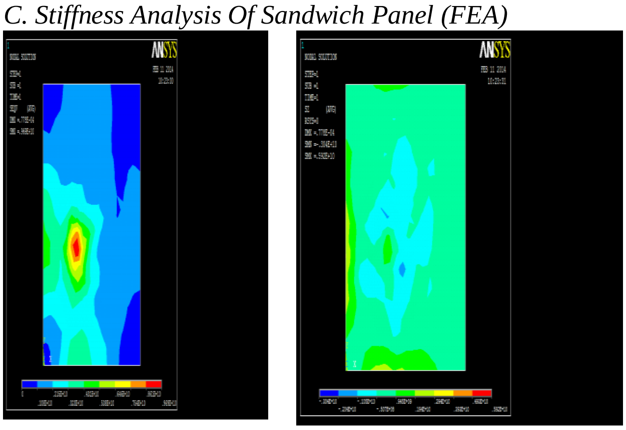


Fig 3.Stress and Displacement of Sandwich Panel

Table 2. Simulated panel Deflection and Stiffness

Total panel thickness (mm)	Deflection (simulation) in mm	Stiffness (N/mm)
0.5	16.835	8.745
0.8	5.059	40.905
1.0	2.308	61.846
1.20	1.455	92.972
1.35	1.026	115.267
1.50	0.915	130.543

COMPARISON OF SANDWICH PANEL AND ALUMINUM PANELS:

Table 3.comparison of sandwich and aluminum panel

panels	Stiffness(FEA) N/mm	Stiffness(exp) N/mm	Weight in gm
Aluminum panel	66.09	70.36	204.93
Sandwich panel	61.84	52.81	145.54

Above table shows comparison of stiffness and weight of both panels. For same stiffness of aluminum panel and sandwich panel weight has been reduce 29.12%.

V. CONCLUSION

1. Aluminum based composite sandwich panel was prepared
2. Experimental and analytical stiffness analysis has been performed for sandwich panel and it is found that the weight obtained for sandwich panel is lower than pure aluminum panel for same stiffness with 29.12% weight reduction.

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