

FINITE ELEMENT ANALYSIS OF ALUMINIUM SANDWICH COMPOSITE MATERIAL

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ABSTRACT

A sandwich panel is made by aluminum, polypropylene and silicone rubber with the help of vertical injection molding. It showed a greater improvement in its material property. The considerable increase in the energy absorption rate has been noticed, thereby increasing the efficiency of the material. The influence of impregnated aluminum at different concentration on wear and friction behavior of polypropylene is discussed. In present study, report suggests that silicone rubber impregnation can considerably improve the tribological properties of polypropylene. Sandwich composites consist of two thin, stiff and strong skins separated by a thick, light and weaker core. The faces and the core material are bonded together with an adhesive to facilitate the load transfer mechanisms between the components. This particular layered composition creates a structural element with both high bending stiffness – weight and bending strength – weight ratios. Sandwich structures are often used in the marine, aerospace, train and automotive industries. Density measurements indicated that, small reductions in the density of polypropylene incorporating aluminium, even though the aluminium itself has a higher density than the used polypropylene. A possible reason for this is that the addition of silicone rubber causes a decrease in the crystalline of the molded blocks. It can be concluded that, in general, adding aluminium to polypropylene has the effect of reducing the mechanical properties of the polymer. The effect of aluminium concentration on the slope of the steady-state wears per unit load for impregnated polypropylene. It can be seen that small concentrations of silicone rubber have only a slight effect on the steady state wear rate. This effect is attributed to the lubricating effect of the fluid, which migrated to the surface that reduces the coefficient of friction and in turn reduces temperature rise. FEA results are analyzed for deformation and equivalent stress, static stress test conducted, and experimental test also conducted.

KEYWORDS: Composite, Polypropylene, Aluminum, silicone rubber, FEA.

INTRODUCTION

Sandwich composites consist of two thin, stiff and strong skins separated by a thick, light and weaker core. The faces and the core material are bonded together with an adhesive to facilitate the load transfer mechanisms between the components. This particular layered composition creates a structural element with both high bending stiffness – weight and bending strength – weight ratios. Sandwich structures are often used in the marine, aerospace, train and automotive industries. The general concept of sandwich structures has been investigated and developed by many researchers over the past 50 years, see for example. The

structures used in the present work are formed by two high-rigidity glass/polyester thin-facings adhering to a low density polypropylene characterized by less strength and stiffness. Varying the thickness of the core and the walls allows to reach a large range of mechanical properties such as a high strength-to-weight ratio .

The materials of this work are developed in the framework of a comparison with previously studied structures. The evolution of the mechanical properties with some typical sequences is shown in Fig. 3. A particular attention is also applied to the influence of the interfaces that are created in such structures. The final goal is to work out a material of low density well adapted to industrial applications. The mechanical test retained to specify the variations of the multilayer composite is a three-point bending test.

The design principle of a sandwich composite is similar to that of an I-beam, which is an efficient structural shape because as much as possible of the material is placed in the flanges situated farthest from the center of bending and neutral axis. In a sandwich structure, the faces resemble the flanges and the core acts as the web. The basic underlying concept of a sandwich panel is that face sheets carry the bending stresses and the cores carry the shear stresses .

The faces act together to form an efficient stress couple or resisting moment, counteracting the external bending moment. The core resists shear and stabilize the faces against buckling or wrinkling. The selection of the adhesive that bonds the faces to the core is important as it must be strong enough to resist the shear and tensile stresses set up between them. The strength of a beam in bending is a function of many factors including the properties of the materials used and the geometry of the beam. The material properties of main interest are the tensile strength, shear strength and elastic modulus. The geometrical parameters of greatest are the length of the beam (spacing of supports), the width and the height of the beam. For a composite or sandwich beam, the relative thickness of the layers and the shear strength of the bond between the layers are also important.

1.1 SANDWICH PANEL

Sandwich structured composites are a special class of composite materials which have become very popular due to high specific strength and bending stiffness. Low density of these materials makes them especially suitable for use in aeronautical, space and marine applications.

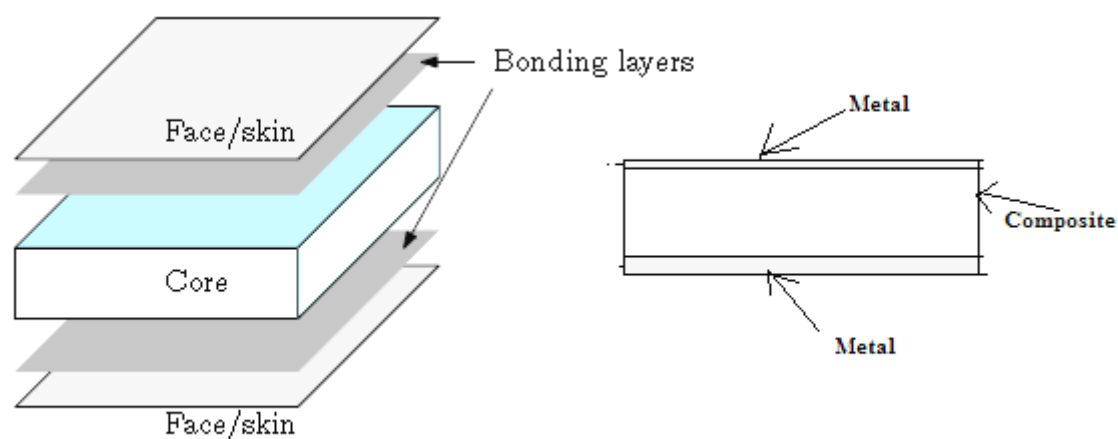


Fig. 1 Structure of a sandwich composite

Sandwich composites primarily have two components namely, skin and core as shown in Figure 1.1. If an adhesive is used to bind skins with the core, the adhesive layer can also be considered as an additional component in the structure.

The thickness of the adhesive layer is generally neglected because it is much smaller than the thickness of skins or the core. The properties of sandwich composites depend upon properties of the core and skins, their relative thickness and the bonding characteristics between them.

Properties/materials	Aluminum	Steel
Stiffness(N/m)	$22.9 e^3$	$22.65e^3$
Density(kg/m ³)	2700	7800
Weight	Low	High
Young modulus(N/m ²)	$70000 e^6$	$210000 e^6$
Shear modulus	$27000 e^6$	$81000 e^6$
Poisson ratio	0.33	0.3
Thermal expansion	$23 e^3$	$12 e^3$
Corrosion resistance	High	Low

Table-1: properties of aluminum and polypropylene

1.2 POLYPROPYLENE

Polypropylene is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.

Most commercial polypropylene is isotactic and has an intermediate level of crystallinity between that of low-density-polypropylene, is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.

1.2.1 Characteristics of polypropylene

- High chemical and corrosion resistances
- Light weight and rigid
- High tensile strength
- Low moisture absorption
- Easily machined and cut

1.2.2 Application of polypropylene

- Chemical tanks
- Plating tanks
- Fire truck water tanks

RESULT AND DISCUSSION

Finite element analysis

In prepared the modal for analysis, Ansys subdivide the model into many small tetrahedral pieces called elements that share common points called nodes.

Thus the finite element analysis of the material modeled in CATIA is done using ANSYS software and the deformation and equivalent stress are found for that material.

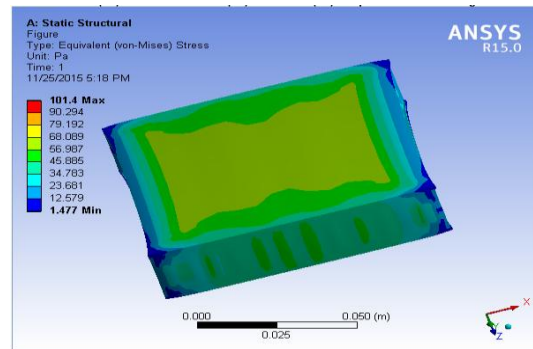


Fig 2 Equivalent Stresses

The above fig 6.4 shows the result of equivalent stress values that is at corners the value is 1.477 pa and at the center 56.987 pa.

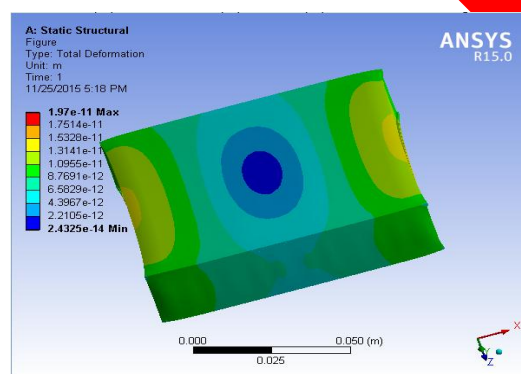


Fig 3 Total Deformation

The above fig 6.5 shows the total deformation of sandwich panel which is analyzed by using ansys. The values at the corner is 2.4325 e -14 and at the corners the deformation value is 8.7691 e -12

From the FEM analysis by using ansys, we had found the total deformation and equivalent stress of the honey comb sandwich material. Thus, the deformation and equivalent stress values are shown in table 7.1.

	At corners	At center
Total Deformation [m]	$8.769e^{-12}$	$2.4325e^{-12}$
Equivalent(von-miss)stress[Pa]	1.477	56.987

Table2 .Analysis results

CONCLUSION

In this work more than twenty journals related to sandwich composite materials were collected. Aluminium based sandwich panel specimen was created with polypropylene and silicone rubber has been used on the sandwich material. The size of 2mm length, 2mm breadth and 2mm thickness of specimen was prepared. By using pressing machine 100 tons

load was applied on the aluminium sandwich panel specimen. By using ANSYS software, stress and deflection were analyzed.

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