Fabrication and 3 Point Bending Analysis of Nomex Composite Sandwich Panel

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Abstract : This study presents the Experimental characterizations of composite sandwich structures needed to optimize structure design. We fabricated composite sandwich structures; one is having a Nomex Honeycomb Core of 5mm thickness and another having a Nomex Honeycomb Core of 8 mm thickness. Honeycomb sandwich panels had Carbon and fiber face sheets (3 layers of Carbon of .2 mm each). The mechanical properties of the constituent materials were discovered experimentally using ASTM/ISO standards. After testing a comparison is made of the different properties achieved from the two different specimen having core thickness of 5 mm and 8 mm. By analysis it was observed with the core height (5 mm) when span length is increased the flexural strength increases and with the core height (8 mm) when span length is increased the flexural strength decreases.

***Keyword* – Composites, Nomex Honeycomb, Mechanical properties, Flexural Test.**

I. INTRODUCTION

Composite fibers are also known as the composition fibers. In composite fibers there are various kinds of material is to be combined to make the composite fibers. Generally, these fibers are made up of two or more constituents that have their different properties individual and when they are combined together, they will create combined properties that are different from the individual constituent properties.

Types of Composites

1) Polymer Matrix Composite reinforced polymer-based on macromolecular substance- PMC

2) Metal Matrix Composites (reinforced metals, cermet's, alloys)- MMC

3) Ceramic Matrix Composites (ceramic and other inorganic composites: ceramics, glass, carbon)

Methods of Composite Fabrication

1) Open Mold Processes-In the open mold processes technique, the laminates have come in the contact with the atmosphere. Open mold processes have further types which are -:
Wet Lay-up Process-In the wet lay-up process mold cavity present in this process is covered with polyvinyl alcohol or a non-silicon wax.
Spray-up Process-In the spray-up process mold tool is used and in mold tool, the gel coat is applied and cured in an oven at 120-degree Celsius.
Filament Winding Process-In the Filament winding rotating mandrel is used as a fully automatic mold.

2) Close Mold Process-Close mold process is used for production of composites for the industries. Close mold process generally used to make the complex parts for the industries. Closed mold process has many types -:

Resin Transfer Molding-RTM which is known as Resin Transfer Molding is used for mass production of composites in industries.

Vacuum Assisted Resin Transfer Molding-This method is the successor of the RTM process. With the help of this process, the cost of production becomes less as compared to RTM and it can build the material of larger size also.

Compression Molding-For the production of high strength glass fiber reinforcement compression molding is suitable in this scenario.

Pultrusion -This process is used for manufacturing the material which is having the constant cross-section.

Injection Molding-In the Injection Molding process, the material is heated with the help of an external heat source in the hopper.

Litrature Review

Mr. Vishal S. Jagadale , Prof. Laukik B. Raut (1)in order to how the mechanical properties of glass fiber we mix the different volume of fiber in the composite. To making the composite we used two method which are hand layup and compression molding. In this process volume of fiber used is 40%, 50% & 60% in the total composition.

Choon Chiang Foo *, Gin Boay Chai, Leong KeeySeah (2) in this experiment we seen the Nomex paper and Nomex honeycomb linear elastic mechanical properties. So, Nomex paper mechanical properties were used in modeling and for the analysis of structure of Nomex honeycomb structure.

L. Gornet, S. Marguet, and G. Marckmann (3) our first work is to develop a software which is useful to detect the effective elastic properties of Nomex honeycomb such as geometry cell, density and thickness. This software based on the strain periodic homogenization technique and give better results as compare to the manufacturer data.

RaghulKrishni Narasimhan, DaivaZeleniakiene (4) in our experimental setup we obtain specific material properties which are honeycomb comb structure and another was FRP composite. Structure was designed and experimentally verified.

LamineRebhi, Mirko Dinulović, PredragAndrić, MarjanDodić, BranimirKrstić (5) in this experiment we discuss about the shear properties of the honeycomb. For this purpose, we used different types of composites. In case of hexagonal structure, it is difficult to find out the predication. In this we use numerical values to determine the stress and strain displacement fields using honeycomb true scale.

Laurent Wahl, Stefan Maas, DanièleWaldmann(6) When clamped sandwich panel is loaded by transverse forces than we can calculate core shear stresses by using direct formulas in honeycomb structure. In this study the calculations of the forces have the results and the results shows that the stresses are mainly target the core orientation of the honeycomb sandwich panel between L and W directions.

T.Johnbabu, M.KhajaGulam Hussain (7) studied that most of the engineering equipment are replaced by composite materials .Composites material arewidely used in many industries such as marine, aircraft and automobiles applications because theyhave less weight and the capacity of bearing the load is more, composite material have high strength toweight ratio, high corrosion resistance flexibility in the composite materialand have high impact strength .

2. OBJECTIVES

To determine the deflection in composite structure, bending stress in faceplates and shear stress in the core material

To analyse and find out the effect on varying core thickness of composite sandwich structure using honeycomb core structure.

3. COMPOSITE FABRICATIONS

We fabricated 2 composite structures having; one having a Nomex Honeycomb Core of 5 mm thickness and another having a Nomex Honeycomb Core of 8 mm thickness. The face sheet and the epoxy in both the structures will remain same and consists of Carbon fibers (.6 mm Thick).

3.1 Manufacturing Route and Procedure

Technical Datasheet – Carbon Woven Reinforcement Fabric

200 GSM – 2X2 Twill Woven Carbon Fabric

Table 6.1

Fiber Properties	
Density Pgpcm^{3}o	g58
Filament Diameter Pμmo	7
Tensile Strength P MPa	345y
Tensile Modulus P GPa	–3y
Elongation P%o	g55
Sizing	Epoxy Compatible

PN2 aerospace grade Meta-Aramid fiber honeycomb is specified as follows:

Material - Cell Size - Density - Cell Configuration

Designates aerospace grade Meta-Aramid fiber — The nominal density in pounds per cubic foot

Example: PN2 - 3/16 - 3.0 - OV

Cell size in inches — Over expanded cells

PN2 Meta-Aramid Mechanical Properties

CELL SIZE		NOMINAL DENSITY		COMPRESSIVE STRENGTH (BARE)				PLATE SHEAR STRENGTH "L" DIRECTION				PLATE SHEAR MODULUS "L" DIRECTION		PLATE SHEAR STRENGTH "W" DIRECTION				PLATE SHEAR MODULUS "W" DIRECTION	
				Typical		Minimum		Typical		Minimum		Typical		Typical		Minimum		Typical	
in	mm	lb/Ft³	Kg/m³	psi	Mpa	psi	Mpa	psi	Mpa	psi	Mpa	ksi	Gpa	psi	Mpa	psi	Mpa	ksi	Gpa
1/8	3.2	3.0	48	303	2.09	180	1.24	196	1.35	162	1.12	6.7	0.05	100	0.69	85	0.59	3.8	0.03

3.2 STEPS USED IN FABRICATION OF COMPOSITE SANDWICH –

The entire procedure involves the cutting of fibre sheets in required dimensions and then using these sheets for fabrication. Fabrication involves saturating the reinforcement and then allowing the matrix to form a rigid structure via a chemical reaction. Here we are using **Wet Lay-up Method followed by (VARTM)**Method for even spreading and mixing of the resin with the composite.

Step 1: Cutting of Fibre Sheets.
Step 2: Preparation of Epoxy Resin- Hardener Mixture.
Step 3: Preparation of Mould/Work Surface.
Step 4: Layer Reinforcement onto the Surface.
Step 5: Tape the Reinforcement.
Step 6: Cut and position the Peel Ply over the Reinforcement.
Step 7: Cut and position the Infusion Mesh.
Step 8: Cut the bagging film oversize of the sealant area.
Step 9: Connect the pump with the hoses and connector to the bagging film.
Step 10: Remove the Pump and the Bagging film and all infusion mesh.
Step 11: Cure the reinforcement and remove the plies.
Step 12: Trim the edges and clean the plate.

4. RESULTS AND DISCUSSION

The flexural test has been performed to find the effects of varying thickness on different properties of the composite structure as per ISO/ASTM standard.

Flexural Test

For Core HT of 5mm
(100*54.13*6.5mm),
(150*55.15*6.5mm),
For Core HT of 8mm
(100*54.13*9.5mm),
(150*56.57*9.5mm) were used.

All the dimensions of the specimens of the Nomex composite honeycomb sandwich panel were ensured with the digital Vernier caliper. For testing these specimens UTM machine was used which has a load capacity of 500kg.The specimen used for the flexural test was designed according to ASTM standard.

Figure Specimen (100*54.13*9.37mm) Before UTM test & After UTM test

Figure 7.2 Specimen (100*54.13*6.72mm) Before UTM test &After UTM test

Figure 7.3 Specimen (150*56.57*9.43mm) Before UTM test & After UTM test

Figure : Specimen (150*55.15*6.72mm) Before UTM test & After UTM test

Result

Speed – 10mm/sec

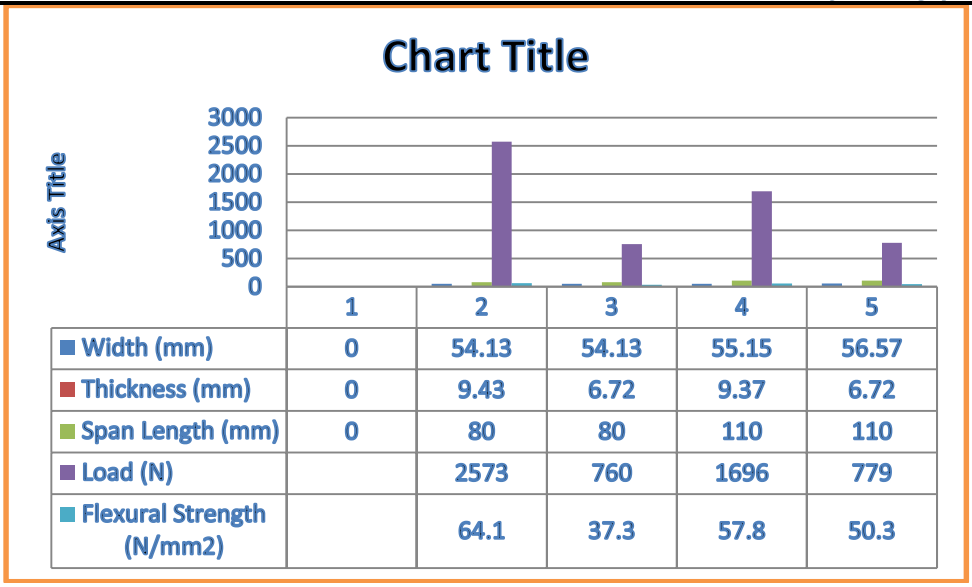
Table 7.1

S.No.	Width (mm) Of Sample	Thickness (mm) Of Sample	Span Length (mm) Of Sample	Load (N)	Flexural Strength (N/mm^2)
1	54.13	9.43	80	2573	64.1
2	54.13	6.72	80	760	37.3
3	55.15	9.37	110	1696	57.8
4	56.57	6.72	110	779	50.3

5. CONCLUSIONS

It is found that by using the honeycomb core structure we can make panel lighter. For making the composite face sheet Nomex composite material is used which was further glued at the upper face sheet and below face sheet of the honeycomb structure. By glued up the face sheet, a complete Nomex honeycomb sandwich panel was made. After the fabrication of the Nomex honeycomb sandwich panel, 3 points bending test was performed to find out the load-bearing capacity on different width of the Nomex composite honeycomb sandwich panel.

Table Comparison of results of two specimens



Result figure

Table 8.1

S. N.	Test Performed	Standard Used	Span Length (mm) Of Sample	SPECIMEN 1 (Core Ht. 5mm)	SPECIMEN 2 (Core Ht. 8mm)	Conclusion
1	Flexural Strength (N/mm2)	ISO-11721996	80	37.3	64.1^	The Flexural strength of the specimen increases with the increase the thickness of the core.
2			110	50.3	57.8^	

It is found that more width of the Nomex composite honeycomb sandwich panel has more load-bearing capacity after testing all the specimens in the UTM machine. (N/mm2)
The Flexural strength of the specimen increases as we increase the thickness of the core i.e. Nomex Honeycomb core. So, it was observed from these tests that the flexural strength of the composite increases as we increase the thickness of the core.

Also, after having a look on the values of table it was also observed that-
1. With the core height (5 mm) when span length is increased the flexural strength increases i.e. from 37.3 N/mm^2 to 50.3N/mm^2.
2. With the core height (8 mm) when span length is increased the flexural strength decreases i.e. from 64.1 N/mm^2 to 57.8N/mm^2.This is due to the fact that more the span length the deflection will be more and ultimately the flexural strength decreases.

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