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Effect of Stitching on Sandwhich Structures

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***Abstract* - The focus of this research is characterizing a new material system composed of glass fiber woven cloth and H80 foam core which has potential in a wide variety of applications encompassing aerospace, military, offshore, power production another commercial industry. The benefits of this new material include low cost, light weight, fire resistance, good energy absorption, and thermal insulation or conduction as desired. The objective of this research is to explore the bulk material properties and failure modes of the H80 foam through experimental analysis in order to provide a better understanding and assessment of the material for successful design in future application.**

***Keywords* - Sandwich, Structures, composite Materials**

1. INTRODUCTION

The first successful landing of a space on the moon on 20 July 1969 was the result of the successful application of new technologies including rocketry, computers and sandwich construction. Although public interest centered on rocketry and computer technology, it was only with the help of sandwich technology that a shell of the spacecraft could be constructed that was light in weight and yet strong enough to sustain the stresses of acceleration and landing. Figure 1.1 shows the wall construction of the Apollo capsule which consisted of two interconnected sandwich shells. Figure 1.2 shows details of the outer shell, which comprised two thin steel facing and a honeycomb core. The inherent advantage of sandwich construction is immediately apparent, namely, high strength and rigidity at low weight.

1.2 PRINCIPLES OF SANDWICH CONSTRUCTION

The structure of sandwich panels always following the same basic pattern. Two facings, which are relatively thin and high strength, enclose a core which is relatively thick and light and which has adequate stiffness in a direction normal to the faces of panel. A great many alternative forms of sandwich construction may be obtained by combining different facing and core materials. The facings may be steel, aluminum, wood, fiber-reinforced plastic or even concrete. The core may be made of cork, balsa wood, rubber, solid plastic material (polyethylene), regid foam material (polyurethane, polystyrene, phenolics foam) , mineral wool slabs or from honeycombs of metal or even paper. Figure 1.3 shows three examples of structural sandwich elements, namely:

- Panel with a polyurethane or polystyrene core
- Panel with a metal or paper honeycomb core
- Panel with a mineral wool core.

In each case, the faces may be color coated steel, or aluminum, or they may be non-metallic, such as plywood particle board or glass reinforced plastic.

This possibility of combining materials to form composite panels enables optimum designs to be produced for particular applications. In composite panels, the positive properties of the individual materials can be combined and the negative properties eliminated. For example, the good thermal insulating properties of plastic foam materials or mineral wool may only be used if they are protected against moisture by rain tight and diffusion-proof facings: where as the strength and stiffness of thin-walled metal cladding can only be fully utilized if it is stiffened against buckling under compressive force by the presence of the core material.

1.3 LITERATURE REVIEW

Gibson and Ashby have studied cellular solids in great detail . Their work covers honeycomb as well as open and closed cell foams. The focus of this work is on 6. foams characterized by the truss structure in Figure 5, and the equations developed for traditional foams are used extensively in research to predict mechanical properties of carbon foams with a truss configuration.

Sihn and Roy have modeled the three dimensional microstructure in order to obtain an understanding of the performance of open cell foam materials by correlating microstructures properties to bulk properties. They develop a unit cell that consists of truss representation of ligaments in finite elements to predict the bulk behavior of the foam.

Standardization on the steel used in rail construction, ultimately improving railroad safety for the public. As the century progressed and new industrial, governmental and environmental developments created new standardization requirements, ASTM answered the call with consensus standards that have made products and services safer, better and more cost effective. The proud tradition and forward vision that started in 1898 is still the hallmark of ASTM International.

For tensile test

ASTM D3039/D3039M-08 Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials.

For flexural bending test

ASTM C273/C273M-07 a standard test method for shear properties of sandwich core material.

1.4 FABRICATION

The mixture of reinforcement does not really become a composite until the last phase of the fabrication , that is , when the matrix is hardened. After this phases, it would be impossible to modify the material , as in the way one would like modify the structure of a metal alloy using heat treatment , for example. In the case of polymer matrix composites, this has to be polyester resin. During the solidification process, it passes from the liquid state to the solid state by copolymerization with a monomer that is mixed with the resin. The phenomenon leads to hardening. This can be done using either a chemical or heat. The following pages will describe the principle processes for the formulation of composite parts.

1.5 MATERIALS

- Resins: Any, e.g. epoxy, Polyester, Vinyl ester, Phenol.
- Fiber : Any,(although heavy agamid fabrics can be hard to wet-out by hand)
- Cores: Any (H 80, H 45, H 60, H 100, H 130, H 200)

1.6 FABRICATION OF SAMPLE

Sample 1 of our specimen consists of bidirectional plain glass fibre woven mat with epoxy LY556/hardener XY54 as resin. Most widely used, it is a simple but effective process which takes relatively low capital investment but high labor cost. “open” molds are tools that reproduce(or duplicate) only one side of a product, or a component. For the other side another mold has to be used, and another component has to be fabricated. The two components are glued back to back and the outcome is a product with two finished “faces” (and a seem between them). Lay –up is performed in the following steps; pigmented gel coat is first applied by brush or spray. After gel coating, a thin coat of resin(usually polyester) and a thin layer of reinforcement are placed on, and worked by hand with brushes and rollers, so the resin fully impregnates the fabric. other layers follow, until the desired thickness strength are achieved. After cure, the component is pulled out of the mold(or released)and trimmed. Post –curing at elevated temperatures in or out of the mold may also take place.

1.7 PREPARATION OF THE RESIN MIXTURE

The resin for sample 1 is epoxy LY556 with hardener XY 54. First the reinforcement used for the fabrication of the sample 1 is weight and the required amount of resin is taken such that the fibre to resin ratio 1:1 in this case, the weight of the reinforcement we get 120gms. Hence we took the resin 120gms of resin beaker. The amount of hardener is take such that the resin to hardener ratio is 100:50. Hence we took 60gms of hardener and mixed to the resin using stirrer thoroughly.

1.8 SANDWICH STITCHING FABRICATION PROCEDURE

1.8.1 Core and Face Sheet Prepration

Initially the glass fiber woven cloth and H80 form core cut into as size according to ASTM code 50X35cm. Preparation of glass-fiber yarn include the following

(a) Applications of wax as the yarn so that it dose not break during stretching.

(b) Then the applied wax as the yarn are dried at room temperature.

(c) Yarn is being cut in to required length according to the need.

1.8.2 Stitching

(a) An needle setup is boughs’ such that the length between two needle 1.5cm .

(b) An H 80 form core care is sandwich in between fiber woven cloth. The pitch is being marked with pencil as the sandwich according to the pitch size ,so that it is ready to be stitched.

(c) The thread is being hooked in to the needle . Once the thread are arranged into the needle setup stitching is done according to the required pitch 10,15,20mm.

(d) The entire prepared needle setup is punched an to the prepared sandwich .So that the thread passes an to the end of the sandwich.

(e) The slightly the needle setup is pulled up a distance such that a gap of 0.5cm is obtained.

(f) Through the gap so obtained another thread is passed through it. And after that the entire needle setup is pulled aback.

(g) This procedure is carried out for all other pitch similarly. After that using hand layup process applying resign over stitching sandwich.

1.8.3 Properties of E-Glass Fiber

Fiber Diameter d(mm)	**16**
Density p(kg/m3)	**2600**
Modules of Elasticity E (MPa)	**74,000**
Shear Modulus G(MPa)	**30,000**
Poisson Ratio	**0.25**
Tensile Strength Ult (MPa)	**2500**
Elongation E (%)	**3.5**
Heat Capacity c(J/kg^{0}C)	**800**
Useful Temperature Limit Temp.max (^{0}C)	**7.00**

1.8.4 (b) Properties of Epoxy Resin LY556

Density at 25^{0}C p (g/cm^3)	**1.20**
Elastic Modulus E(MPa)	**3500-4000**
Viscosity at 25^{0}C (mPa.s)	**7-15**
Shear Modulus G(M Pa)	**1600**
Poisson Ratio	**0.4**
Tensile Strength 6, Ult (MPa)	**56**
Impact strength (unnotched) (kJ/m^3)	**5.2**
Compressive strength (MPa)	**97**
Heat distortion temperature (^{0}C)	**82**
Water absorption (mg)	**20**
Hardness (shore D)	**81-82**
Useful Temperature Limit Temp.max (^{0}C)	**90-200**
Price in rupees	**417**

1.8.5 Properties H 80 foam core

Nominal density (kg/m3)	**80**
Compressive strength (Mpa)	**1.4**
Compressive Modules (MPa)	**90**
Shear Modulus G(MPa)	**27**
Tensile Strength (MPa)	**2.5**
Shear Strength (MPa)	**1.15**
Tensile modules (Mpa)	**95**
Shear strain (%)	**30**
Operating temperature(^{0}C)	**-200,+70**

1.9 FOR TENSILE TEST

ASTM code D 3039 / D 3039 M-08 standard test method for tensile properties of polymer matrix composite materials.

1.10 FOR FLEXURAL BENDING TEST IN SANDWICH

ASTM standard C273 / C 273 M -07 a standard test method for shear properties of sandwich core material.

1.11 FLEXURAL BENDING TEST

The procedure for flexural bending test is done according to ASTM standards. The ASTM code for tensile test of composite laminate is **C 273**

1.12 TENSILE TEST

Test Specimen:-

Depth of sandwich	=	2 mm
Thickness of the care	=	10mm
Base pleat	=	1mm
Bottom plate	=	1mm
Width of the specimen	=	25mm

Flexural bending test

Specimen	Maximum load (KN)	Maximum displacement (mm)	Maximum strength (KN / mm²)	Stiffness (N/mm)
10 mm pitch	1.0.580 2.0.560	1.37.70 2.35.20	1.0.002 2.0.006	15.38 15.90
20 mm pitch	1.0.340 2.0.300	1.33.60 2.31.50	0.001 0.001	10.11 9.52
Without stitching	1.0.290 2.0.320	1.39.50 2.32.20	0.001 0.003	7.34 9.93

CONCLUSION

As an emerging material system, glass fiber and H80 foams have great potential in various industries encompassing aerospace, military, offshore, power production and other commercial industries for applications like radiators, advanced power electronic heat sinks, fireproof containers, "elevator" floor for aircraft carriers, lightweight ship hulls, EMI and radar-selective shielding.

In the present study, overall flexure response and material properties are explored through an integrated experimental and computational approach. Specifically, mechanical properties and failure modes of sandwich beams with glass fiber /epoxy laminate face sheets and H80 foam core are characterized.

The ASTM C 273 flexure tests reveal that the dominant failure mode is shear in the80 foam core. Even though delamination is observed in the experiments, it did not occur at the face sheet/core interface, and subsequent computational studies support this fact. The beam bending stiffness is found as 15.33 N/mm core thickness.

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