Experimental and FEA analysis of natural fibre composite sandwich panel

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Abstract : Composite sandwich structures are usually utilized in aviation application, transport building, connect, and so on because of their low weight and superb solidarity to weight proportion. In the most recent decades, light-weight center materials, for example, honeycomb, wood, foam center have been utilized in make sandwich structures dependent on required. For this situation, sandwich structure with jute epoxy composite honeycomb center and carbon fiber face sheet is to be displayed, created, manufactured. The composite sandwich structures were made utilizing hand lay-up and vacuum sacking producing process. Design of honeycomb structure is performed in CATIA and analysis in ANSYS software. The practices of these structures under three-point bending is to be explored. Flexural conduct of these structures has been tentatively and limited component researched.

***IndexTerms* - FEA, Sandwich composite Panel, UTM.**

I.INTRODUCTION

A composite material is mix of reinforcement fibers, molecule and fillers inserted in a restored sap otherwise called a lattice polymer. The network holds the support together to make the necessary shape while the reinforcement builds the general mechanical conduct of the lattice. Fiber glass composite sandwich beam with foam and honeycomb center development are reasonable for building light-weight structures, particularly for aviation and marine businesses. Sandwich structures are popular as acceptable protection from weight proportions contrasted with unsurprising materials. Sandwich panels comprise of two in number and solid meager sheets, indicated skins, isolated by a low-thickness center. They are broadly utilized as intend to fabricate superior lightweight structures. The division of two slender skin layers by a lightweight center prompts a remarkable weight-explicit twisting firmness contrasted with solid structures. Subsequently, this development rule has progressively been embraced in the most recent decades in various airplane, train and space vehicles, where the weight decrease can be utilized to build the payload, to speed up or just to lessen the vitality utilization with kept up stacking ability and top speed. At that point expanding prerequisite for greater, quicker and lighter vehicles has expanded the significance of productive basic courses of action, making sandwich developments an entrenched strategy in lightweight segment structure. At the point when a sandwich structure is stacked in twisting mode, the center augmentations the flexural solidness of the sandwich by expanding the snapshot of latency of the segment and isolates the appearances from the unbiased line. Moreover, the center gives the out-of-plane shear and compressive quality of the board. A sandwich is acquired when the heaviness of the center is generally equivalent to the joined load of the appearances. Sandwich panels are utilized not just in light of their focal points as far as weight sparing and auxiliary execution, yet in addition as a powerful mean to diminish costs. In this manner, plan and improvement of new materials for minimal effort superior centers have consistently been on the focal point of producers and applied enterprises, for example, car, aviation and transport aluminum honeycombs by more earth cordial materials. A low-thickness center can play out these capacities sufficiently, and thus a significant bit of leeway of a sandwich structure is its high solidness and solidarity to weight proportion. Polymer foams, metal foams, balsa wood, and different honeycomb structures are ordinarily utilized as center materials. Carbon fiber-strengthened polymer (CFRP) composites and glass fiber-reinforced polymer (GFRP) composites are the most generally utilized skin materials for sandwich panels. The normal fiber mats used to make skin material in these sandwich panels are in tangle structure with the exception of for the situation for the reused paper.

II. LITERATURE REVIEW

Zhimin Wua et al. [1] In this paper it presents a basic and inventive foam filled cross section composite board to update the peak load and energy absorption capacity. Test outcomes show that contrasted with the foam center composite panels, a limit of a roughly 1600% expansion in the pinnacle quality can be accomplished because of the utilization of cross section networks. These panels had the attributes of high compressive firmness and quality, and solid vitality engrossing limit. The exploratory outcomes show that contrasted with the foam filled composite panels, a limit of a roughly 1600% expansion in the pinnacle load of panels can be accomplished because of the utilization of grid networks. The thicker grid web and littler cross section web separating can improve the pinnacle heap of panels altogether, however the impacts of foam thickness on the pinnacle heap of panels are little. The vitality assimilation of panels is influenced by cross section web thickness, grid web dispersing and foam thickness. Bigger vitality assimilation can be accomplished by expanding the cross-section web thickness and foam thickness and diminishing the web dividing. Generally, it has been shown that the foam filled cross section composite panels displayed preferred execution over the typical foam center sandwich panels. It is normal that the foam filled cross section composite panels can be generally utilized as extension decks, formworks and partition sheets.

Victor Birmana et al. [2] In this paper it audits on the scientific models and strategies for investigation of sandwich structures just as delegate issues using or looking at these models. The significant determinations the creators make from the evaluated investigations are displaying of sandwich structures requires continuously refined strategies representing the three-dimensional impacts, physical and geometric nonlinearities and constitutive relations for the recently evolved materials. Such highlights as warmth move the executives, radar wave assimilation, commotion and fire protection are considered in assorted modern settings. Instances of materials fused into new sandwich plans incorporate, yet not restricted to, nanotubes, shape memory combination and piezoelectric, while the points may fluctuate from improved quality, solidness and durability to detecting interior damage. Natural impacts, including fire, have been seriously concentrated because of their criticalness in various applications. While sandwich structures can be embraced to consolidate warm assurance layers, inside harm brought about by such wonders isn't in every case effectively identified.

Craig A. Steeves et al. [3] In this paper it presents on the contending breakdown components for basically upheld sandwich beams with composite countenances and a PVC froth center exposed to three-point twisting. The countenances include Hexcel Fib revival 7781-914G woven glass 9bre-epoxy prepreg, while the center involves shut cell Divinycell PVC froth of relative thickness 6.6% and 13.3%. The expository appearances for top burden are satisfactory straightforward shaft hypothesis gets wrong and the systematic models are incorrect for squat pillars with thick faces comparative with the center thickness. A failure system map is built to uncover the reliance of the predominant breakdown component upon the geometry of the shaft. Breakdown is by center shear, face miniaturized scale clasping, face sheet space or by center pounding, contingent on the sandwich pillar geometry and the decision of thickness of the froth center. A failure system map, with tomahawks given by the slimness proportion of the beam and the general thickness of face sheet to center, is helpful for indicating the prevailing systems of each breakdown mode, and for arranging sets of tests on the impact of shaft geometry upon breakdown quality.

Yicheng Dua et al. [4], In this paper it makes reference to some utilization of biofiber based paper-reinforced polymer (PRP) composites as skin materials for lightweight sandwich board developments. Different sandwich panels with PRP composite skins and a business gum impregnated aramid paper honeycomb center of various cell sizes and center statures were manufactured in the lab. The flexural moduli and qualities of the lab-made panels were contrasted with the announced qualities for three existing business items utilized for car load floor applications. The manufacture procedure is like the two-phase process frequently used to make sandwich panels with GFRP-skins. The flexural modulus and qualities of the lab-made sandwich panels were deeply subject tallness and center cell size. The deliberate load redirection relationship for the lab-made sandwich panels corresponded well with the forecasts got utilizing the Timoshenko model underneath as far as possible. PRP composite skins/honeycomb center sandwich panels had practically identical bowing rigidities yet lower areal loads than the qualities detailed for some business items for car inside applications.

R. A. Staal et. al [5] This paper portrays to predict failure stacks precisely in undamaged sandwich panels subject to twisting. The direct wrinkling models over-gauge wrinkling failure stacks in flawless panels by 100%. This examination utilizes these Finite Element models to discover failure worries in unharmed panels and to follow the failure mode and decide the failure component. The outcomes show that the panels breakdown because of restricted center smashing as a result of face sheet wrinkling. In contrast to conventional solid materials, sandwich panels and composites display countless complex failure modes. Under bowing or in-plane pressure, sandwich structures can bomb because of any of three principle failure modes; wrinkling, dimpling, and face sheet yield or crack. Wrinkling is a short frequency clasping mode constrained by the general solidness of the face sheet and the basic center. It prompts lost solidness in the structure and is one of the most widely recognized failure modes in sandwich structures with flimsy countenances. There are two face sheet wrinkling types in straight pressure: symmetric, where the faces clasp evenly about the center surface of the sandwich and hostile to symmetric, where the clasping mode is lopsided as for the center surface of the sandwich. Zenkert indicated that symmetric wrinkling happens all the more promptly when the center to confront sheet thickness proportion is more noteworthy than 17 and antisymmetric when this proportion is under 17. For panels with slender face sheets and thick centers or panels under unadulterated twisting, symmetric wrinkling models ought to be utilized.

III. PROBLEM STATEMENT

.After survey of literature review it is observed that use of composite material in day by day life is extensively used to replace existing solid body structure. Due to honeycomb structure load distribution and sustainability is greater. So, in present investigation jute composite material is used to understand the stress concentration and load carrying capacity along with low weight application e.g. space, aerospace and automobile.

IV. OBJECTIVES

To investigate the effects of thicknesses and materials, manufacturing processes and length of span of honeycomb structure panel.
To perform static structural analysis of composite sandwich panel with the help of ANSYS 19 software.
To determine reaction force for application of load on honeycomb structure panel.
Manufacturing of honeycomb composite panel to perform three-point bend test.
Validation of experimental results of three-point bending test with FEM simulation.

V. METHODOLOGY

Step 1:- Initially research paper are studied to find out research gap for project then necessary parameters are studied in detail. After going through these papers, we learnt about composite sandwich panel.
Step2:- Research gap is studied to understand new objectives for project.

Step 3: - After deciding the components, the 3 D Model and drafting will be done with the help of software.
Step 4: - The components will be manufactured and then assembled together for three-point bend test.
Step 5: -The testing will be carried out and then the result and conclusion will be drawn.

5.1 CATIA MODEL

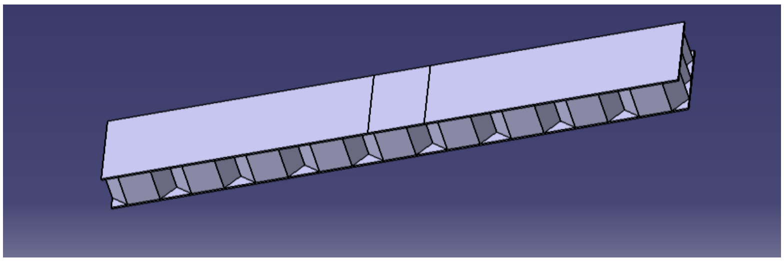


Fig 1 CATIA model of sandwich panel

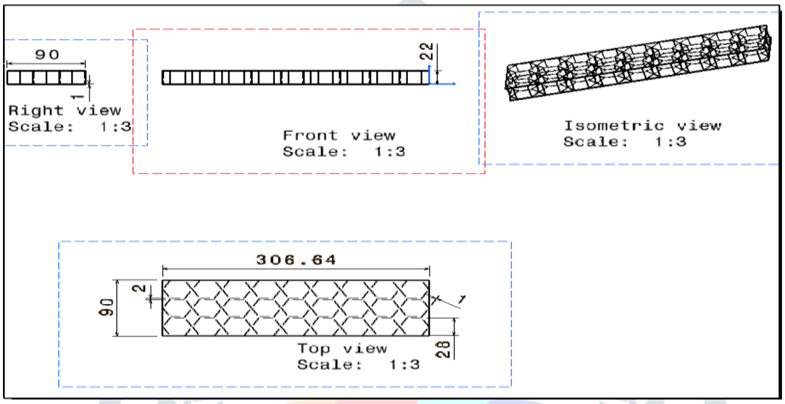
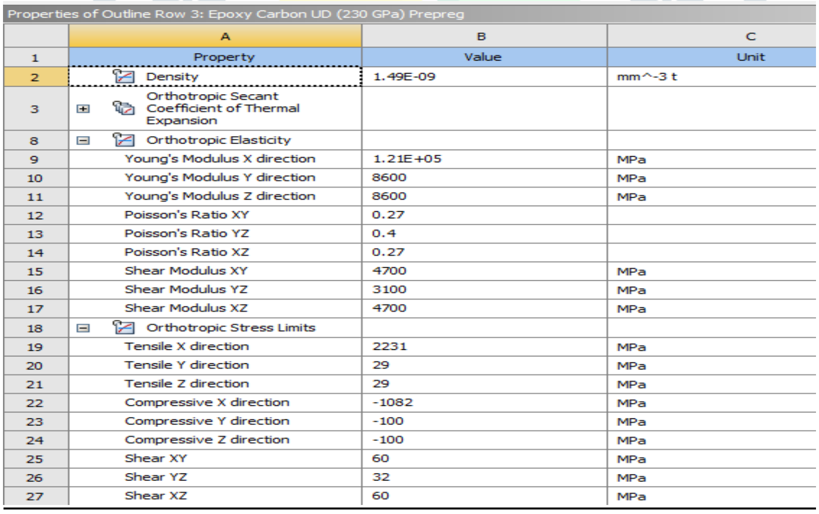


Fig. Drafting of sandwich panel

Table. Material Properties



Properties of Outline Row 3: Epoxy Carbon UD (230 GPa) Prepreg

	A	B	C
1	Property	Value	Unit
2	Density	1.49E-09	mm^-3 t
3	⊞ Orthotropic Secant Coefficient of Thermal Expansion		
8	⊟ Orthotropic Elasticity		
9	Young's Modulus X direction	1.21E+05	MPa
10	Young's Modulus Y direction	8600	MPa
11	Young's Modulus Z direction	8600	MPa
12	Poisson's Ratio XY	0.27	
13	Poisson's Ratio YZ	0.4	
14	Poisson's Ratio XZ	0.27	
15	Shear Modulus XY	4700	MPa
16	Shear Modulus YZ	3100	MPa
17	Shear Modulus XZ	4700	MPa
18	⊟ Orthotropic Stress Limits		
19	Tensile X direction	2231	MPa
20	Tensile Y direction	29	MPa
21	Tensile Z direction	29	MPa
22	Compressive X direction	-1082	MPa
23	Compressive Y direction	-100	MPa
24	Compressive Z direction	-100	MPa
25	Shear XY	60	MPa
26	Shear YZ	32	MPa
27	Shear XZ	60	MPa

Table. Material Properties of jute

5.2. Finite Element Analysis:

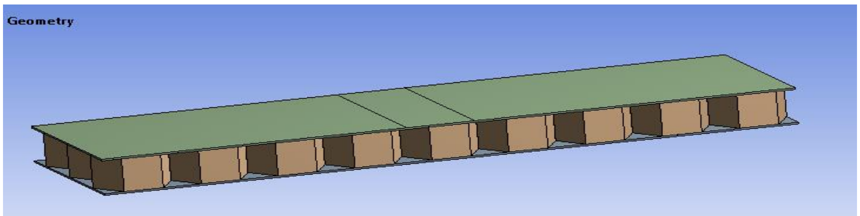
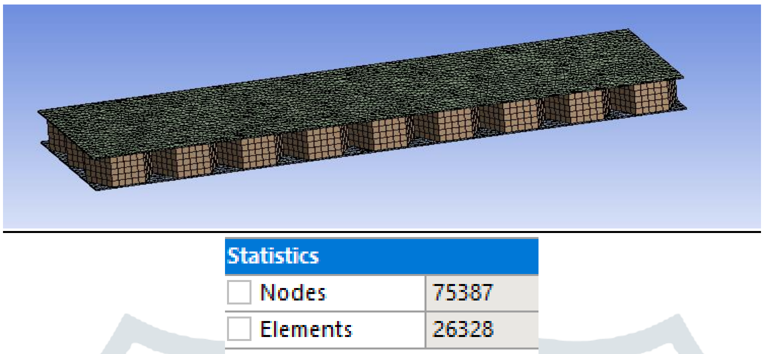


Fig. CATIA model imported in ANSYS

5.3. Mesh

In ANSYS meshing is performed as similar to discretization process in FEA procedure in which it breaks whole components in small elements and nodes. So, in analysis boundary condition equation are solved at this elements and nodes. ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multiphysics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it.



Statistics	
☐ Nodes	75387
☐ Elements	26328

Fig. Details of meshing of sandwich panel

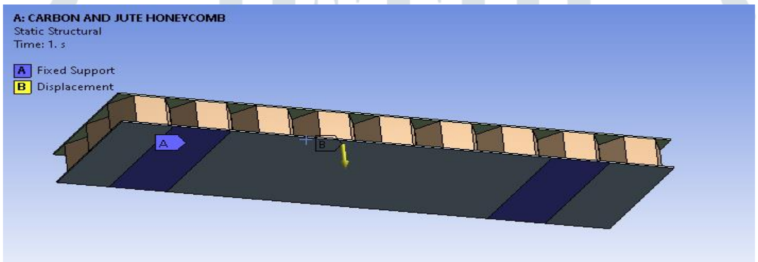


Fig. Boundary conditions

Fixed support is applied at base indicated in blue region and displacement of 1 mm is applied at top indicated in yellow color to determine reaction force.

5.4 Deformation result

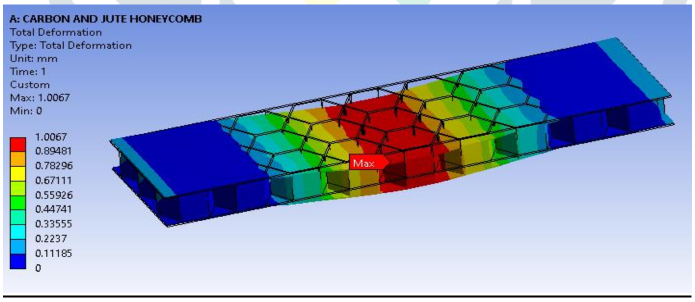


Fig. Deformation of sandwich panel

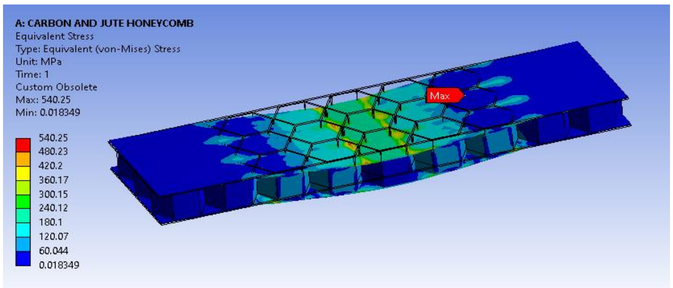


Fig. Equivalent stress results

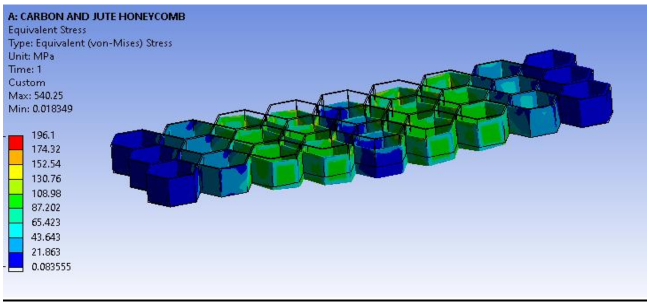
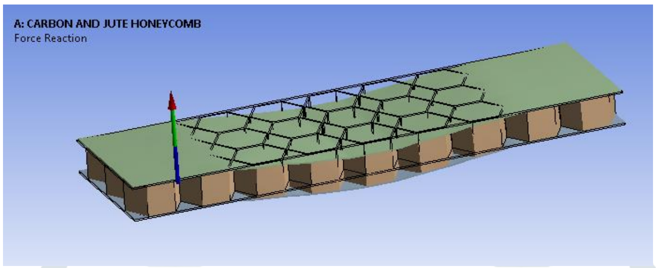
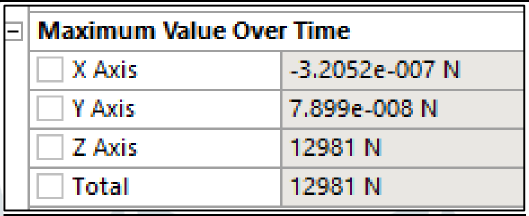


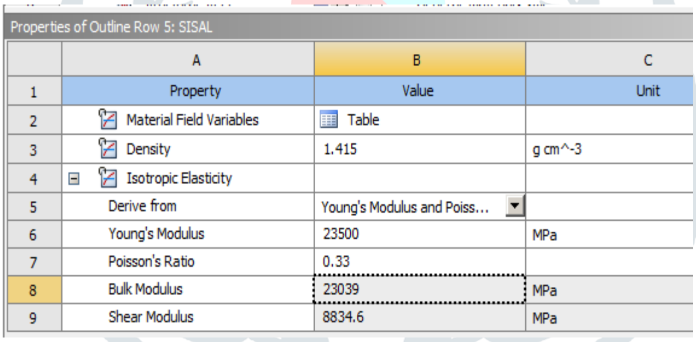
Fig. Von misses stress at each layer (jute)





Maximum Value Over Time	
☐ X Axis	-3.2052e-007 N
☐ Y Axis	7.899e-008 N
☐ Z Axis	12981 N
☐ Total	12981 N

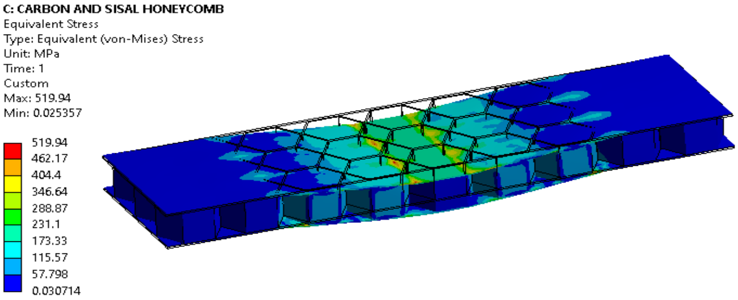
Fig. Force reaction results

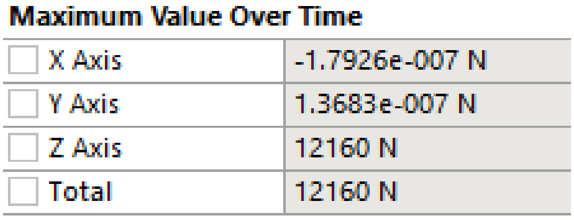


Properties of Outline Row 5: SISAL

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	1.415	g cm^-3
4	⊟ Isotropic Elasticity		
5	Derive from	Young's Modulus and Poiss...	
6	Young's Modulus	23500	MPa
7	Poisson's Ratio	0.33	
8	Bulk Modulus	23039	MPa
9	Shear Modulus	8834.6	MPa

Table. Material Properties of sisal





Maximum Value Over Time	
☐ X Axis	-1.7926e-007 N
☐ Y Axis	1.3683e-007 N
☐ Z Axis	12160 N
☐ Total	12160 N

Fig. Force reaction results

VI. CONCLUSION

1. In present research honeycomb panel structure with both layers upper and lower plate with carbon epoxy fibre and honey comb structure is of jute is analyzed to determine stiffness.
2. It is observed from existing result that 12.9 kN force stiffness.
3. It is observed from reaction force that while using sisal material reaction force is less compared to jute composite.

VII. REFERENCE

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