© February 2022| IJIRT | Volume 8 Issue 9 | ISSN: 2349-6002

Modelling and structural evaluation of honeycomb structure with frp composites

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***Abstract* - Honeycomb structures are natural or man-made structures that have the geometry of a honeycomb to allow the minimization of the amount of used material to reach minimal weight and minimal material cost. Types of honeycomb structures are depending upon the geometrical shape. There are different types of honeycomb core structures like square, hexagonal, pentagonal, tetrahedral, pyramidal etc. In this project we are comparing the structural analysis for square and hexagonal honeycomb structures and thermal analysis of square and hexagonal honeycomb structures. Structural analysis is the determination of the effects of loads on physical structure. To perform an accurate analysis an engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include deformation, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Thermal analysis calculates the temperature distribution and related thermal quantities in the system or component. Typical thermal quantities of interest are: The temperature distributions:(a) The time to reach steady state, (b) The steady state temperature distribution (using a transient analysis), (c) The temperature distribution after 50 seconds; The amount of heat lost or gained; Thermal gradients; Thermal fluxes.**

***Index Terms* - CATIA modelling of the product, static analysis, Structural Analysis, Thermal analysis, strength etc.**

I.INTRODUCTION

Honeycomb structures are natural or man-made structures that have the geometry of a honeycomb to permit the minimization of the quantity of used material to succeed in minimal weight and minimal material cost. The geometry of honeycomb structures can vary widely but the common feature of all such structures is an array of hollow cells formed between thin vertical walls. The cells are often columnar and hexagonal in shape. A honeycomb shaped structure provides a material with minimal density and relatively high out-of-plane compression properties and out-of-plane shear properties. Man-made honeycomb structural materials are commonly made by layering a honeycomb material between two thin layers that provide strength in tension. This forms a plate-like assembly. Honeycomb materials are widely used where flat or slightly curved surfaces are needed and their high specific strength is effective , they're widely utilized in the aerospace industry for this reason, and honeycomb materials in aluminum, fiber glass and advanced composite materials are featured in aircraft and rockets since the 1950s. they will even be found in many other fields, from packaging materials within the sort of paper-based honeycomb cardboard, to sports equipment like skis and snowboards. Natural honeycomb structures include beehives, honeycomb weathering in rocks, tripe, and bone. Man-made honeycomb structures include sandwich-structured composites with honeycomb cores. Man-made honeycomb structures are manufactured by employing a sort of different materials, counting on the intended application and required characteristics, from paper or thermoplastics, used for low strength and stiffness for low load applications, to high strength and stiffness for top performance applications, from aluminum or fiber reinforced plastics.

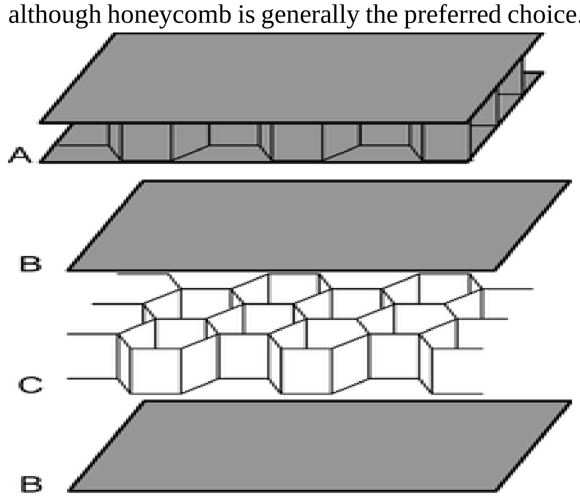
1.2 Manufacture

The three traditional honeycomb production techniques, expansion, corrugation, and Moulding, were all developed by 1901 for non-sandwich applications. For decorative applications the expanded honeycomb production reached a remarkable degree of automation in the first decade of the 20th century. Today honeycomb cores are manufactured via the expansion process and the corrugation process from composite materials such as glass-reinforced plastic (also known as fiberglass), carbon fiber reinforced plastic, Nomex Aramide paper reinforced plastic, or from a metal (usually aluminum). Honeycombs from metals (like aluminum) are today produced by the expansion process. Continuous processes of folding honeycombs from a single aluminum sheet after cutting slits had been developed already around 1920. Continuous in-line production of metal honeycomb can be done from metal rolls by cutting and bending. Thermoplastic honeycomb cores

Application area	Industry	Company/Product
Racing shells	Sport	Vespoli, Janousek Racing Boats
Aerospace manufacturing	Aerospace	Hexcel, Plascore Incorporated
Gliders	Aerospace	Schleicher ASW 19, Solar Impulse Project
Helicopters	Aerospace	Kamov Ka-25, Bell 533, Westland Lynx
Jet aircraft	Aerospace	General Dynamics/Grumman F-111B, F-111 Aardvark, all commercial airplanes since the Boeing 747
Rocket substructure	Aerospace	Saturn V Instrument Unit, Mars Exploration Rover, S-520
LED technology	Lighting	SmartSlab
Loudspeaker technology	Audio	Loudspeaker #Driver design: dynamic loudspeakers, Woofer
Telescope mirror structure	Aerospace	Hubble Space Telescope
Automobile structure	Automotive	Panther Solo, Jaguar XJ220, Dome F105, Bluebird-Proteus CN7, BMW i3 / i8, Koenigsegg Agera
Snowboards	Sports	Snowboard
Furniture	Woodworking	Furniture

1.3 Aerodynamics

A honeycomb mesh is often used in aerodynamics to reduce or to create wind turbulence. It is also used to obtain a standard profile in a wind tunnel (temperature, flow speed). A major factor in choosing the right mesh is the length ratio (length vs honeycomb cell diameter) *L/d*. Length ratio < 1: Honeycomb meshes of low length ratio can be used on vehicles front grille. Beside the aesthetic reasons, these meshes are used as screens to get a uniform profile and to reduce the intensity of turbulence. Length ratio >> 1: Honeycomb meshes of large length ratio reduce lateral turbulence and eddies of the flow. Early wind tunnels used them with no screens; unfortunately, this method introduced high turbulence intensity in the test section. Most modern tunnels use both honeycomb and screens. While aluminum honeycombs are common use in the industry, other materials are offered for specific applications. People using metal structures should take care of removing burrs as they can introduce additional turbulences. Polycarbonate structures are a low-cost alternative. The honeycombed, screened center of this open-circuit air intake for Langley's first wind tunnel ensured a steady, non-turbulent flow of air. Two mechanics pose near the entrance end of the actual tunnel, where air was pulled into the test section through a honeycomb arrangement to smooth the flow. Honeycomb is not the only cross-section available in order to reduce eddies in an airflow. Square, rectangular, circular and hexagonal cross-sections are other choices available, although honeycomb is generally the preferred choice.



Sandwich pattern using honey homb

A composite sandwich panel (A) with honeycomb core (C) and face sheets (B)

II. FRP COMPOSITES

Rapid growth in manufacturing industries has led to the need for the betterment of materials
in terms of strength, stiffness, density, and lower cost with improved sustainability. Composite
materials have emerged as one of the materials possessing such betterment in properties serving their potential in a variety of applications. Composite materials are an amalgamation of two or more constituents, one of which is present in the matrix phase, and another one could be in particle or fiber form. The utilization of natural or synthetic fibers in the fabrication of composite materials has revealed significant applications in a variety of fields such as construction, mechanical, automobile, aerospace, biomedical, and marine. Research studies from the past two decades have presented composites as an alternative over many conventional materials as there is a significant enhancement in the structural, mechanical, and tribological properties of fiber-reinforced composite (FRC) material. Though composite materials succeeded in increasing the durability of the material, currently a strong concern regarding the accumulation of plastic waste in the environment has arisen.

Fiber-Reinforced Composites

Composites consist of fibers in the matrix structure and can be classified according to fiber length. Composites with long fiber reinforcements are termed as continuous fiber reinforcement composites, while composites with short fiber reinforcements are termed as discontinuous fiber reinforcement composites.

1.Synthetic Fibers

Human-made fibers that are produced by chemical synthesis are called synthetic fibers and further classified as organic or inorganic based on their content. Generally, the strength and stemness of fiber materials are much higher than that of the matrix material, making them a load-bearing element in the composite structure.

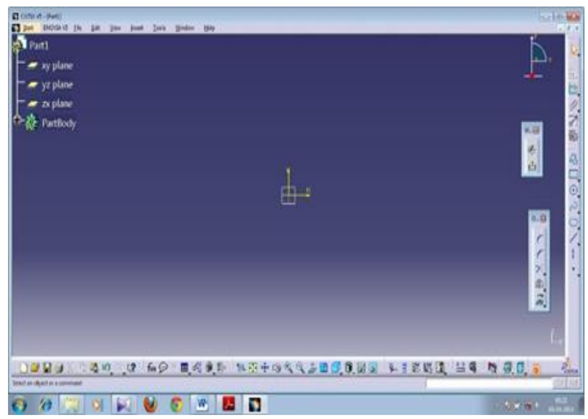
2.Natural Fibers

Natural fibers (NFs) are a very easy to obtain, extensively available material in nature. They reveal some outstanding material properties like biodegradability, low cost per unit volume, high strength, and specific stiffness. Composites made of NF reinforcements seem to carry some diverse properties over synthetic fibers, such as reduced weight, cost, toxicity, environmental pollution, and recyclability.

3. Hybrid Fibers

Thermoplastic composites reinforced with natural fiber, in general, show poor strength
performance when compared to thermoset composites. Therefore, to acquire benefits of design flexibility and recycling possibilities, these natural fiber composites are hybridized with small amounts of synthetic fibers to make them more desirable for technical applications.

III. INTRODUCTION TO CATIA



French organization Dassault Systems created multi-stage CAD/CAM/CAE business programming CATIA (Computer Aided Three-dimensional Interactive Application). This is composed in the C++ programming language, CATIA is the primary result of the Dassault Systems item lifecycle administration programming suite.

CATIA competes with Siemens NX, Pro/E, Autodesk Inventor, and Solid Edge as well as many others in the CAD/CAM/CAE market.

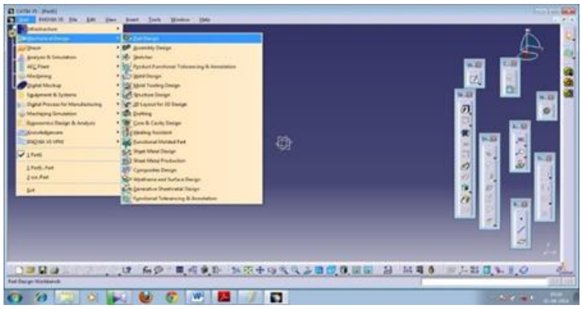
Developer(s)	Dassault Systems
Stable release	V6R2011x / November 23, 2010
Operating system	Unix / Windows
Type	CAD software
License	Proprietary
Website	WWW.3ds.com

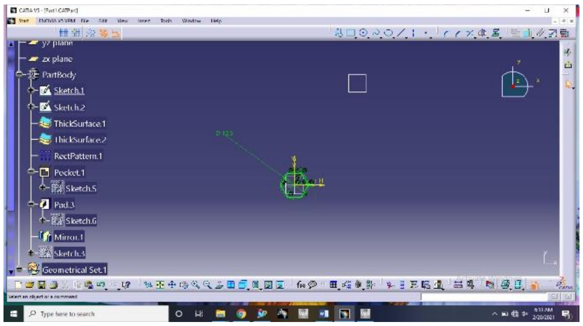
MODELING OF HONEYCOMB STRUCTURE

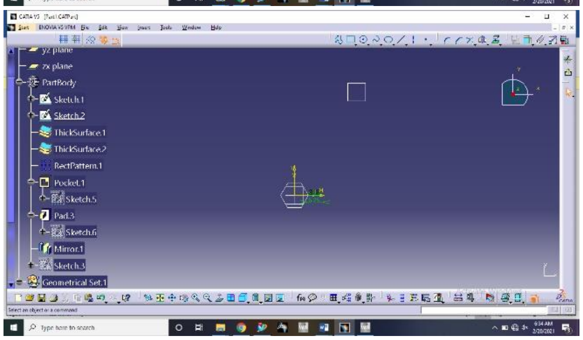
Procedure

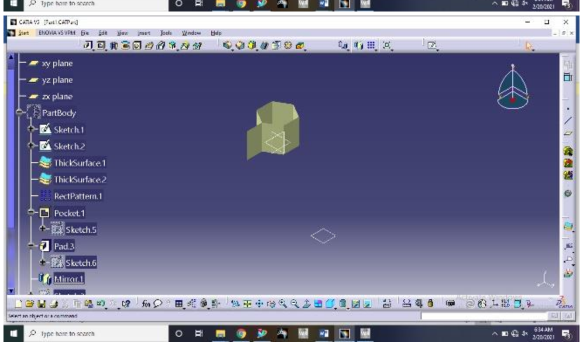
1) Modeling of honeycomb structure using CATIA V5R16 by considering all

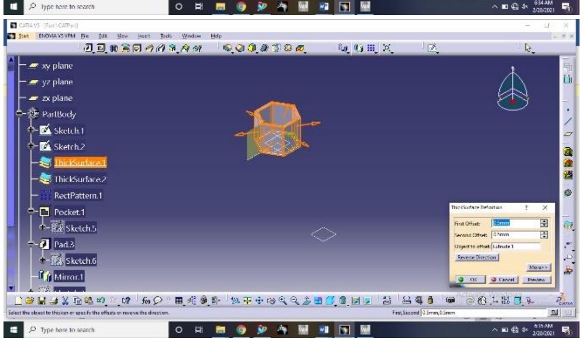
Open CATIA and from start menu selec the mechanical design and then

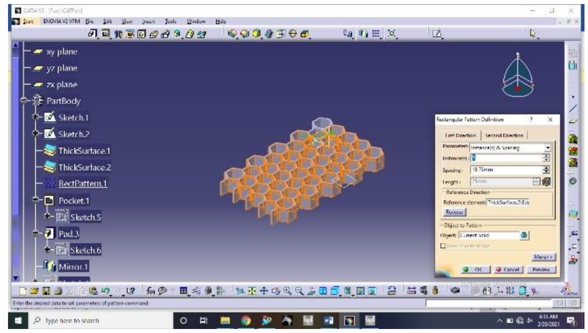


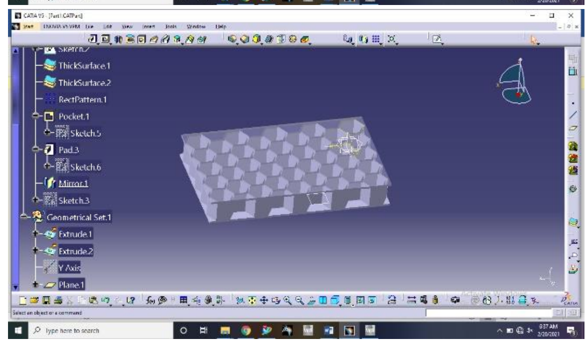










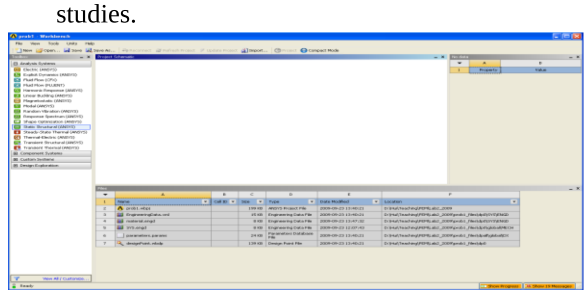


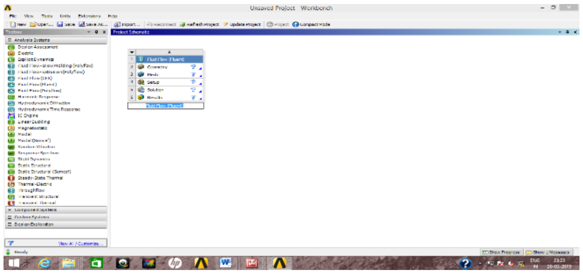
IV. ANALYSIS

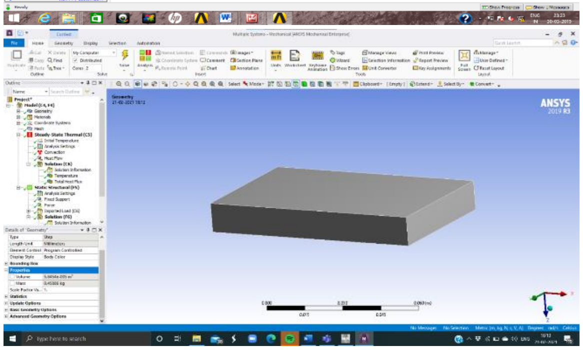
Analysis Steps:

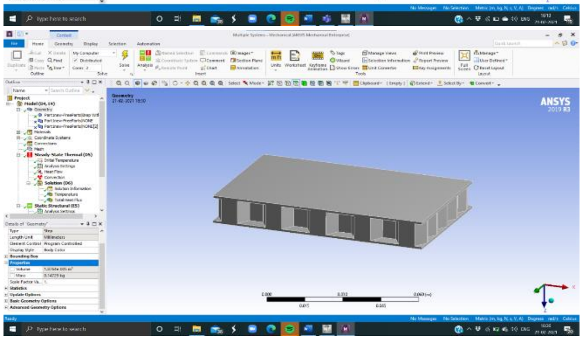
The steps needed to perform an analysis depend on the study type. You complete a study by performing the following steps:

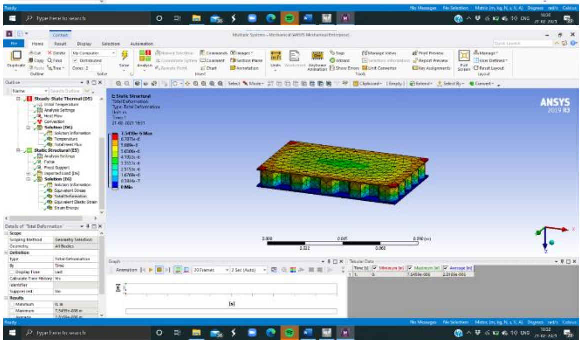
- Create a study defining its analysis type and options.
- If needed, define parameters of your study. A parameter can be a model dimension, material property, force value, or any other input.
- Define material properties.
- Specify restraints and loads.
- The program automatically creates a mixed mesh when different geometries (solid, shell, structural members etc.) exist in the model.
- Define component contact and contact sets.
- Mesh the model to divide the model into many small pieces called elements. Fatigue and optimization studies use the meshes in referenced studies.

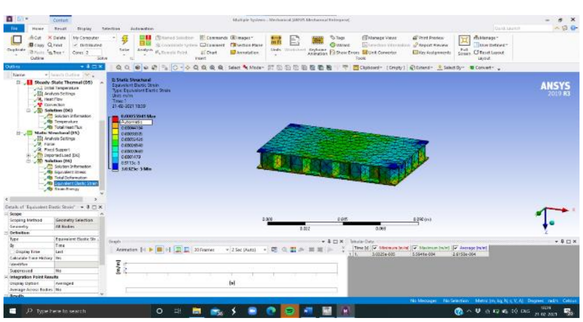












V. RESULTS AND COMPARISON

From the above analysis of honey comb structure in ansys 14.5 the results are collected in tabular form for different materials. We have noticed a change in structural analysis

Comparison Table For static structure analysis for SOLID BODY

	Stainless Steel	ALUMINIUM ALLOY	EPOXY CARBON
total deformation, (M)	2.52*10^-5	4.91*10^-5	2.31*10^-5
equivalent elastic strain, (M/M)	0.0039	0.0077	0.0037
equivalent stress, (pa)	7.91*10^8	5.50*10^8	2.47*10^8
strain energy, (j)	0.033054	0.044028	0.010366

	Stainless Steel	ALUMINIUM ALLOY	EPOXY CARBON
total deformation, (M)	7.54*10^-6	1.45*10^-6	9.68*10^-6
equivalent elastic strain, (M/M)	0.00064138	0.0012884	0.00055941
equivalent stress, (pa)	1.25*10^8	8.95*10^7	3.49*10^7
strain energy, (j)	0.00011402	0.00015652	3.37*10^-5

VI. CONCLUSIONS

Our project is to design and analysis of honey comb structure on different material namely steel, aluminum alloy and frp composites i.e. epoxy carbon materials.

We have designed solid using CAD software namely CATIA V5 and analysis is done using ANSYS 14.5 and the static analysis is done under required boundary conditions.

we have observed that frp shows good results when compared to other material and regular using material i.e., cast iron. In static analysis fiber glass reinforced plastic shows lower deformation and less affected to stress and strain factors when compared different materials

even steel shows nearly equal results as fiber glass reinforced plastic which can be encouraged after fiber glass reinforced plastic.

By this project we want to conclude that by using fiber glass reinforced plastic in place of cast iron shows good physical bearable properties. We even conclude that steel is also comparatively good material

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