Modelling of Hexagonal Cell Structure using ANSYS Analysis

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Abstract

Honeycomb structures are natural or man-made assemblies that have the geometry of a honeycomb is used to minimize the amount of used material and reduce the weight and cost of the materials. The honeycomb structures are classified based on the geometrical shape. There are various types of honeycomb core structures like square, hexagonal, pentagonal, tetrahedral, pyramidal etc. In this paperwe did two types analysis such as structural analysis and thermal analysis ofpentagonal and hexagonal honeycomb arrangements. Structural analysis is the determination of the effects of loads on physical structure. To makeperfect analysis an engineer must control such statistics as structural loads, geometry, support conditions, and materials properties.The effects of such an analysis are used to find outthedistortion, internalpressures and movements. This information is then linked to standards that indicate the conditions of failure. Thermal enquiry is a group of techniques which is used to calculate the temperature distribution and related thermal quantities in the given system or component. There are different form of thermal quantities are: The temperature circulations:(1)the steady state time (2) The steady state temperature circulation (using a transient analysis) (3) The temperature circulation after 50 seconds, The amount of heat lost or gained; Thermal ramps; Thermal fluctuations.

Keywords -Honeycomb structures, Structural Analysis, Thermal analysis, strength, CATIA modelling of the product.

I. INRODUCTION

A. *Definition of Honeycomb Structure*

Honeycomb structures are natural or man-made assemblies that have the geometry of a honeycomb to permit the minimization of the amount of used material to reach nominal weight and negligible material cost. The geometrical figure of honeycombassemblies can be differentlargely but the collective feature of complete assemblies is an array of hollow cells formed between thin vertical walls. The cells are usually columnar and hexagonalforms. A honeycomb shaped arrangementdelivers a material with minimal density and relative high out-of-plane compression properties and out-of-plane shear properties.

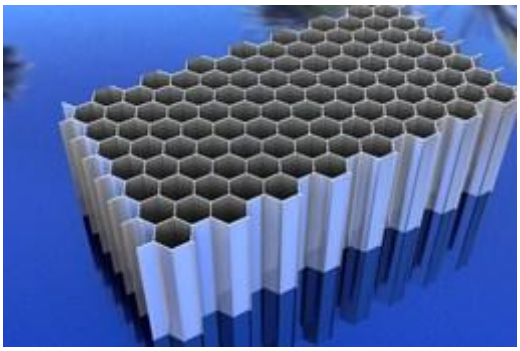

Fig. 1 Honeycomb Structure

Man-made honey comb assembly materials are manufactured by two thin layers it reduce the strength in tension. These arrangements are a plate-like assembly. Honeycomb materials are made of flat or slightly arched surfaces and their high strong point is treasured. Honeycomb materials are widely used in the aerospace industry for this reason, and honeycomb materials are made up of aluminium, fibre glass and advanced composite materials are mostly used in aircraft and rockets since the 1950s. They can also be used in many other fields, such as wrapping materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards. The honeycomb is mainly used in structural applications. The standard hexagonal honeycomb is the basic and most common cellular honeycomb configuration.

B. *Honeycomb Composites*

Natural honeycomb structures occur in various environments, from beehives to honeycomb weathering in rocks. Followed by Natural honeycomb structures, man-made honeycomb structures have been constructed with similar geometry with reduction of the quantity of material used, and thereby recognizing minimal weight and material cost. Man-made honeycomb structures consist ofsandwich-structured composites with honeycomb cores. Man-made honeycomb structures are generated by using a variety of different materials, depending 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 high performance applications, from aluminum or fiber reinforced plastics.

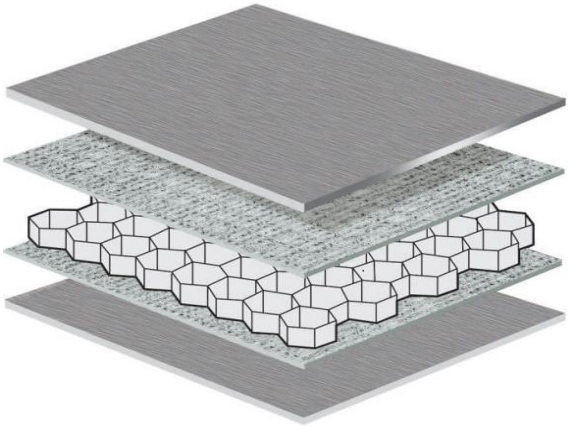

Fig.2 Honeycomb Structure with Panels

Artificial honeycomb structures have been established by agroup of hollow cells made between thin perpendicular walls, so for the material has nominalcompactness, strength in tension and high out-of-plane compression properties.

C. Geometric Types of Honeycomb Structures

Based on geometry, a space filling process or higher-dimensional cells that is no gap between two cells are create honeycomb structure. It is an illustration of the more collective mathematical slating or tessellation in any number of dimensions.Honeycombs are classicallybuilt in ordinary Euclidean ("flat") space and alsobuilt in non-Euclidean spaces, such as hyperbolic honeycombs. Any finite uniform polytope can be projected to its circumsphere to form a uniform honeycomb in spherical space.

II. EXPERIMENTAL ASPECTS

A. Design Procedure

First stage of design procedure uses tools that have to be simple to design the Hexagonal cell structure and then extrude. After that gather of group of Hexagonal cells to form honeycomb structure used for analysis. Second stage of design to create panel of the rectangle and create Computer codes are based on finite difference methods or finite element methods, with 1D, 2D or 3D models of physical phenomena (internal ballistics, fluid dynamics, continuum mechanics structural analysis). They allow precise calculations, or optimization up to defining final geometry.

B. Assessment

Engineer need to find the information like structural loads, geometry, support conditions, and materials properties to give perfect analysis. The properties of such a scrutiny are used to catches the deformation, internal stresses and displacements. This information is then linked to standards that indicate the conditions of failure.

C. Material Selection

For the given properties of materials we choose different materials from the library like Aluminum, Titanium.

D. Design phase

The CATIAdescribed as (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite established by the French company Dassault Systems'. It is a very convenient to modelling and drafting the tool.Inventive designers must be equipped with software tools that permit them to definitely craft and adjust the product's emotional content through their designs CATIA is mush useful to modelling and drafting the product. It has more than 60 segmentsstretching from simple sketcher, part design, drafting, sheet metal design, 2D and 3D design, and design to gather many ceaseless features that are helpful in some phases depends onrequirements, from generative shape design used to analysis of the tool.

CATIA software usage

Aerospace:

- The CATIA V3 used byBoeing Company to cultivate 777 airliner and used CATIA V5 for the 787 series aircraft. They have laboring the full variety of DassaultSystem's' 3D PLM harvests — CATIA, DELMIA, and ENOVIA LCA — augmented by Boeing-developed applications. The CATIA V5 used to build Indian Light Combat Aircraft.
- The first aircraft established as Chinese Xian JH-7A designed by CATIA V5.
- CATIA used for designing Canadian aircraft architect Bombardier Aerospace.
    - The EMBRAER is the Brazilian aircraft company which use Catia V4 and V5 to shape all airplanes.
    - Vought Aircraft Industries to products its parts by using CATIA V4 and V5.
    - The Augusta Westland Company designs their Anglo/Italian Helicopter using CATIA V4 and V5.
    - The CATIA V4 and V5 used to design Eurofighter Typhoon.
    - The foremostcontractor of helicopters to the U.S Military forces, Sikorsky Aircraft Corp., uses CATIA as well.
    - Bell Helicopter designer create the Bell Boeing V-22 Osprey, using CATIA V4, V5, and now V6.

Automotive:

- Various automotive factoriesdesign their products by using CATIA tool to fluctuating degrees, including BMW, Porsche, McLaren

Automotive, Chrysler, Honda, Audi, Jaguar Land Rover, Volkswagen, SEATBentley Motors Limited, Volvo, Fiat, Benteler International, PSA Peugeot Citroën, Renault, Toyota, Ford, Scania, Hyundai, Tesla Motors, Rolls-Royce Motors, Valmet Automotive, Proton, Elba, Tata motorsand Mahindra & Mahindra Limited.

III. MODELLING

Required hexagonal cell structure can be designed using this tool with very small in size, depth, length and thickness.

A. Modelling in the Catia Software

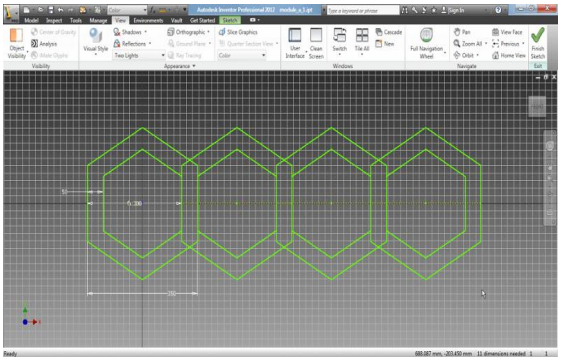

Fig. 3 Hexagonal Cell Structure

Dimensions of hexagonal cell:

- Edge length = 0.0040m,
- Radius = 0.02m,
- Depth 0.017m,
- Thickness=0.000065m.

B. Modelling of Hexagonal Cell

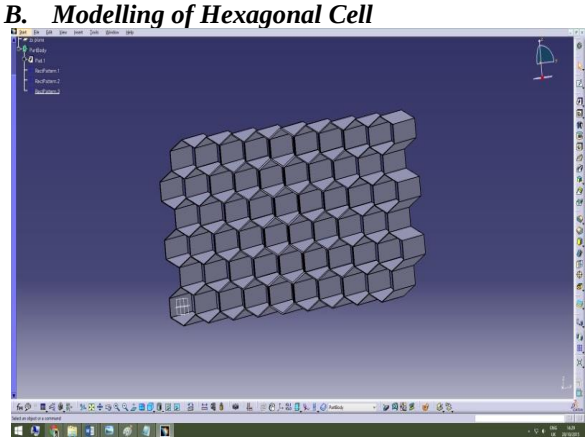

Fig.4 Hexagonal cell extrude

In fig. 3 shows 2D hexagon shape it is extrude in x, y and z directions obtain 3D view of hexagon cylinder as shows in fig.4 Create another hexagon with thickness is 0.000068m, using constraint. In the same way form array of hexagon shapes using extrude option.

C. Assembly of Hexagonal cells

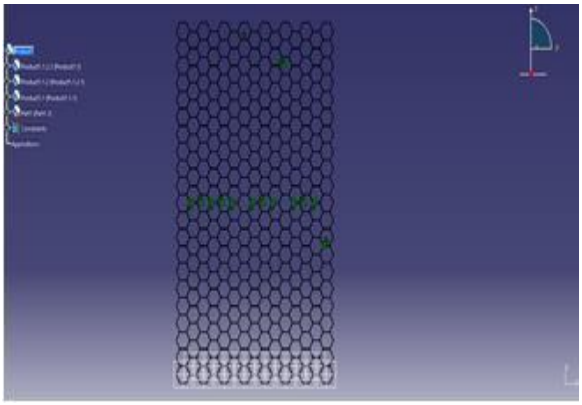

Fig. 5 Assembly of Hexagonal Cell

D. Modelling of Panel

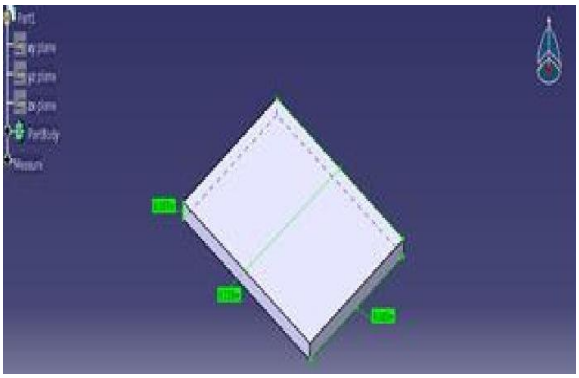

Fig. 6 Rectangle plate

Dimensions of panel

- Length= 0.082m
- Width = 0.120m and Thickness= 0.0008m

IV. ANSYS Analysis

ANSYS is engineering simulation software. Dr.John A. Swanson has been developed Swanson Analysis Systems, Inc.(SASI) in 1970. Its main was to improve and advertisefixedcomponent analysis software for essentialbehaviorof structure that could simulate static (stationary), dynamic (moving) and thermal (heat transfer) problems.

A. Honeycomb Structural Analysis

The structural analysis done by following cases, in each case consider deformation, stress and strain.

CASE-1:

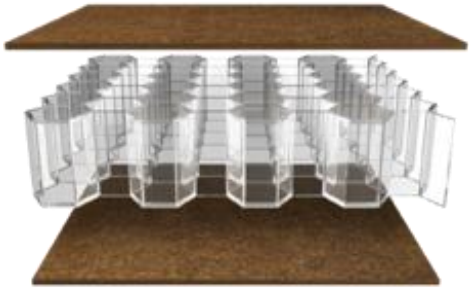

Fig.7 Pressure Applying on the Panel

In case-1, pressure can be applied on top of panel by protectback side DOF as zero. Analysis the result of deformation of aluminium and titanium, Von misses stresses, strains for aluminium and titanium.

A founding operation is one in which the shape and size of an aluminium is reformed by plastic deformation. Forming processes comprise stamping, rolling, extrusion and forging, where deformation is induced by external compressive forces or stresses exceeding the yield stress of the material. There is a growing demand to decrease the weight of vehicles in order to diminish energy consumption and air pollution.

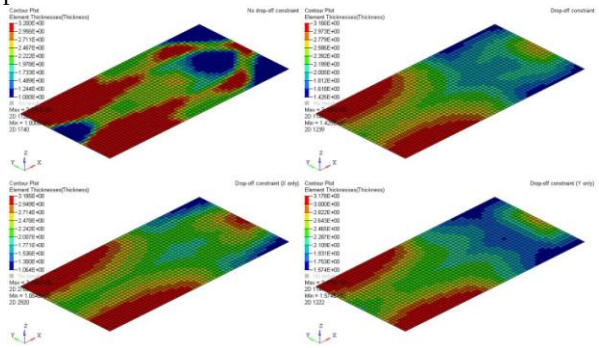

Fig. 10 Deflection and Stress Values of Aluminium and Titanium

CASE-2

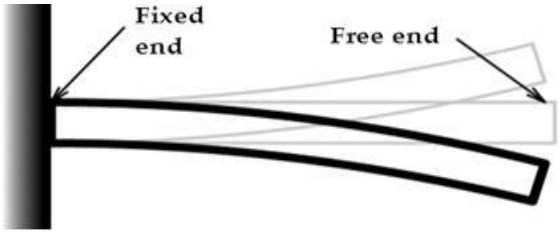

Fig. 11 Cantilever Beam with Point Load

In second case, consider cantilever beam structure one end is fixed alternative end is free. Now spread overthe force at free end, in downwards.The use of the cantilever is in immovable- annex aircraft project, initiated by Hugo Junkers. Primary aircraft annexes typically bore their loads by using two (or more) wings in a biplane configuration braced with wires and struts.

V. THERMAL ANALYSIS

A thermal analysis computes the heat distribution and interrelated thermal quantities in a scheme or component. Typical thermal quantities of interest are:

- The temperature distributions
- The amount of heat mislaid or gained
- Thermal gradients
- Thermal fluxes.

Thermal simulations is an significant role in the design of various engineering applications, including internal ignition engines, turbines, warm exchangers, piping systems, and electronic components. In many cases, engineers follow a thermal analysis with a stress analysis to compute thermal stresses (that is, stresses caused by thermal expansions or contractions).

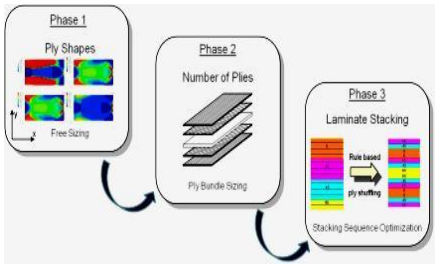

Fig. 13 Panel laminated Stacking

VI. CONCLUSION

Honeycomb structure used to minimize the amount of used products and reduce the weight and cost of the materials. Based on the ANSYS analysis results we conclude that titanium is the appropriate material for design, owing to less deflection and high thermal stability. But titanium has some drawbacks such as more weight compared to aluminum and expensive material. To overcome these problems, compare with aluminium and titanium. In that aluminium has less deflection values, less weight, and fewer in cost. These properties are suitable for aerospace industries. In aircraft industries need to fit a lesser amount of deflection materials. According to this case, titanium is suitable. For this confused situations we go for using composite materials. These materials are compositions of aluminium and titanium, which have less deflection as well as less amount of the weight.As a consequence of above session honeycomb is a preferred core material has advantageous because of:

- High strength to weight ratio
- Good compressive strength

- Lightweight

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