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Design and Analysis of Corrugated Aluminum Sandwich Structures Using Ansys Workbench

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Abstract: Sandwich plates are composed of face plates which are separated by core material. They are usually designed in such a way that the face plates carry the bending and in-plane loads. The core is designed to carry longitudinal loads. The face plates and core can be selected from metals such as structured steel or aluminum alloy but the core can also possess various sandwich structure such as O-core, I-core, Web Core, I-Core, I-Core etc.Sandwich panels with top and bottom plates as well as the core made up of aluminum are called as aluminum sandwich panel .In this paper sandwich structure is made up of aluminum alloy. This construction has often used in lightweight applications such as aircrafts, marine applications and wind turbine blades. Sandwiched panels have advanced High stiffness and strength to weight ratio and in this work various sandwiched structure is applied to optimize the weight of lifting platform. A Sandwich panel of structural steel has more strength but it also has more weight, so our main objective is to optimize the weight with keeping the same strength as structural steel. According to our objective we check the different sandwich structure of aluminum alloy by using the ANSYS software. And based on that finally the best suited sandwich structure is selected for the replacement of Structural steel plate.
Keywords: Sandwich Panels, Ansys, weight optimization, finite element analysis, core

I. INTRODUCTION

In the last several years material handling has become a new, complex, and rapidly evolving science. For moving material in and out of warehouse many types of equipment and system are in use, depending on the type of products and volume to be handled. The equipment is used, in loading and unloading operations, for movement of goods over short distances. The good design of platform will allow us to reduce its self-mass with increase in load carrying capacity. Existing platform used for material handling has more self-mass; hence it is affecting the mass lift capacity. This project aims to design and mass optimization of mass lifting platform.

Mass optimization can be achieved by using sandwiched structures instead of using flat plate as lifting platform. This sandwiched can also find application in various areas as the demand for bigger, faster and lighter moving vehicles, such as ships, trains, trucks and buses has increased the importance of efficient structural arrangements. In principle two approaches exist to develop efficient structures: either application of new materials or the use of new structural design. A proven and well-established solution is the use of composite materials and sandwich structures. In this way high strength to mass ratio and minimum mass can be obtained. The sandwich structures have potential to offer a wide range of attractive design solutions. In addition to the obtained mass reduction, these solutions can often bring space savings, fire resistance, noise control and improved heating and cooling performance.

A sandwich panels typically consists of two thin face sheets and core. This concept mimics an I beam, but in two dimensions, where the face sheets support bending loads and the core transfers shear force between the faces in a sandwich panel under load. Face sheets used in structure are mainly in three forms flat, lightly profiled and profiled. The face sheets of sandwich panels provide structural stiffness and protect the core against damage and weathering. During loading the face sheets take compressive and tensile loads and core transforms shear loads between the faces and provide high bending stiffness. Sandwich structures are used in applications requiring high stiffness to weight ratios because for a given weight, the sandwich structures has a much higher moment of inertia compared to solid or I-beam structures. Sandwich panels with top and bottom plates as well as the core made up of aluminum are called aluminum sandwich panels. The core structures are of different types according to core structures the sandwich structures are divided some of them are I-core, O- core with rectangular beams, Vf/V- core with hat or corrugated sheets as a core, web core, round O-core and X-core with two hats as a core as shown in Fig.1.

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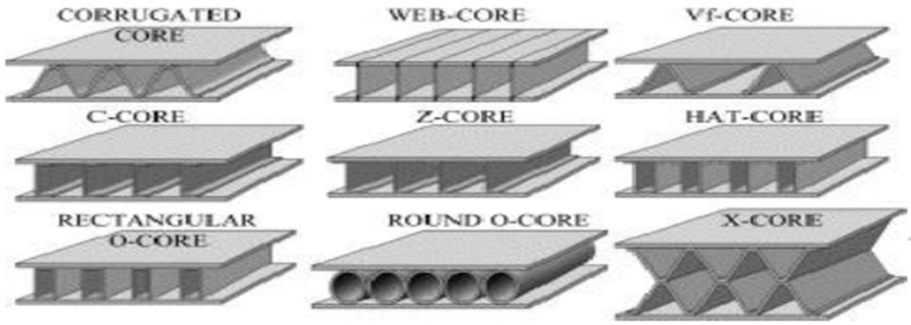

Fig.1.Various Sandwich Structures. [2]

II. LITERATURE REVIEW

Noor, Burton and Bert state that the concept of sandwich construction dates back to Fairbairn in England in 1849. Also in England, sandwich construction was first used in the Mosquito night bomber of World War II which employed plywood sandwich construction. Feichtinger states also that during World War II, the concept of sandwich construction in the United States originated with the faces made of reinforced plastic and low density core. In 1951, Bijlaard studied sandwich optimization for the case of a given ratio between core depth and face thickness as well as for a given thickness[1].Analysis of sandwich structure is done by A.Gopichand,Dr.G.Krishnaiah,B.Mahesh Krishana,Dr.Divakar Reddy.V,A.V.N.L.Sharma in paper named Design and analysis of corrugated steel sandwich structure using ANSYS workbench.[2] Various analyses on sandwich structure are Kevin J. Doherty investigate sandwich panels of metallic face sheets and a pyramidal truss core subjected to panel bending and in plane compression testing to explore the effects of relative core density and process parameters.[3]. Aydıncak, İlke made a design and analysis of honeycomb structures to develop an equivalent orthotropic material model that is substitute for the actual honeycomb core.[4] . Jukka Säynäjäkangas make a review in design and manufacturing of stainless steel sandwich panels and conclude an efficient sandwich is obtained when the weight of the core is close to the combined weight of the both faces[5]. Tomas Nordstrand made an analysis on corrugated board in three-point bending and evaluation of the bending stiffness and the transverse shear stiffness [6]. Pentti Kujala discussed that steel sandwich panels that are welded by laser can save 30-50% weight compared to conventional steel structures[7]. Jani Romanoff presents a theory of bending of laser welded web core sandwich panels by considering factors that affect the total bending response of laser welded web core sandwich plates [8]. Pentti Kujala made analysis on metallic sandwich panels which are laser welded have excellent properties with light weight having more applications[9]. Narayan Pokharel determined local buckling behavior of fully profiled sandwich panels which are based on polyurstyrene foam and thinner and high strength steels[10]. Pentti kujala determined ultimate strength of all steel sandwich panels and numerical FEM analysis and development of design formulations for these panels.[11]

III. DESIGN AND ANALYSIS OF SANDWICH STRUCTURES.

Sandwich panels are modeled in ANSYS 16.2 Design Modular. The top and bottom plates are modeled by using extrude command and the core part is modeled by using pattern command. Materials properties are given to the Sandwich structure . Now mesh the geometry as free mapped mesh and structural analysis is done by fixing the plate at four corners and pressure is applied at top face of the plate as shown in fig.6 now by solving the structure the deflection and von misses stress are noted. By changing the corrugated core and same is modeled and analyzed at a constant pressure the variation in deflection and von misses are compared for various sandwich structures.

IV. BENDING TEST

Aluminum sandwich structure with faces and core are joined by Locktight324 and bending test is conducted on Universal testing machine (UTM) and ultimate stress and deflection are studied. The in-plane bending testing of sandwich structure was performed on universal testing machine (UTM)having capacity 400KN. The samples were simply supported and the load is applied by circular jaw in order to cover the maximum core under bending load condition Load is applied uniformly and deflection and bending strength are noted.

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V. ANALYSIS STEPS

A. Pre-processors

1) Step I - Choosing the discipline from the tool box of the Ansys such as structural, thermal, fluid electromagnetic etc.For our project purpose we choose static structura
2) Step II – Choose the suitable element from library as per national agency for finite element methods and standards (NAFEMS).As per our project requirement we choose aluminum alloy static structural et
3) Step III - Assigning the material and geometric properties as standard data available in the engineering data source so no need to assign the material and geometric properties of material so leave as it is
4) Step IV - Construction of geometric model and importing so we construct the plate of dimension 100*100*15 in Ansys design
5) Step V -Discretization of meshing and mesh refinement now after construction of geometry go to the model tab below the geometry tab and double click on it the very imp work after that meshing of the plate select the face meshing of the plate and generate it so we have structured mesh plate
6) Step VI - Application of boundary condition and loading There after fix the plate at four corners with round fix support now applying the load on the load the fix side of the plate as the loading on the plate is uniformly Distributed hence we apply pressure of 9.81*e-2 MPA equivalent to 100 kg load on the fix side of the plate

B. Processor

Step VII - After giving all the required information for problem solving now the time to call the main step that is solving the above problem The governing equation are assembled into matrix form and solved numerically The required for process depends upon the type analysis element type material properties and boundary condition As per our input given to the programmed moderate time is required for solution.

C. Postprocessor

Step VIII - Now it is time for getting the results in graphical or tabular form as we required equivalent von mises stresses ,safety factor rector and total deformation of the plate so we got that required results from the above procedure create the report above process in report preparation it to the Microsoft word office Comparing the results with actual solid plate if the result are satisfactory then choose the plate for best of try another plate for test. As per the results obtain the plate performance under loading is very good so we select following are the various plates analysis out of which we choose round core. .

D. Plate geometry

Dimensions

Face Plates =100*100*2.5 mm

Vertical Cylinder=.Height-10mm,Diameter-10mm

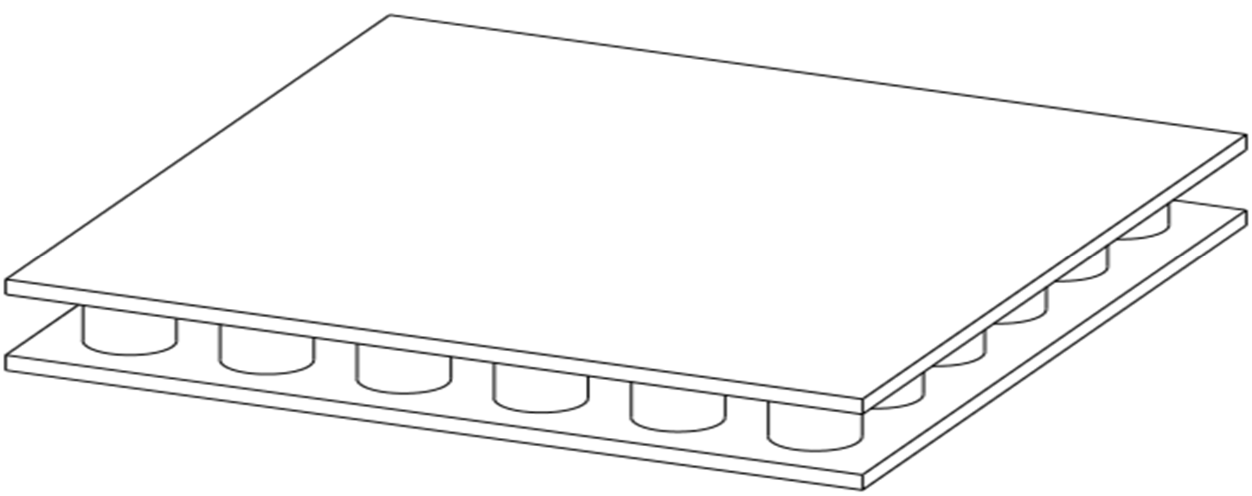

Fig.2-Vertical Cylinder Sandwich Structure

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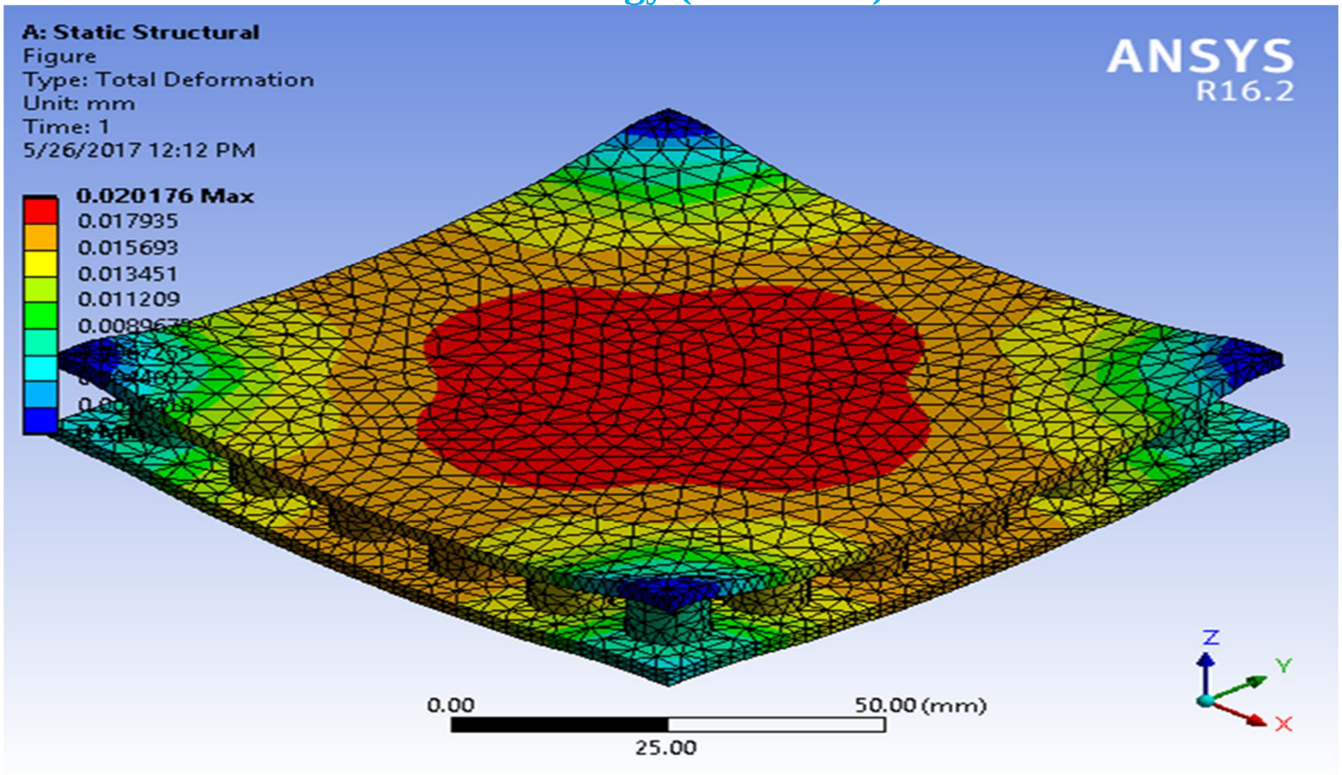

Fig.3-Total Deformation of Sandwich Structure

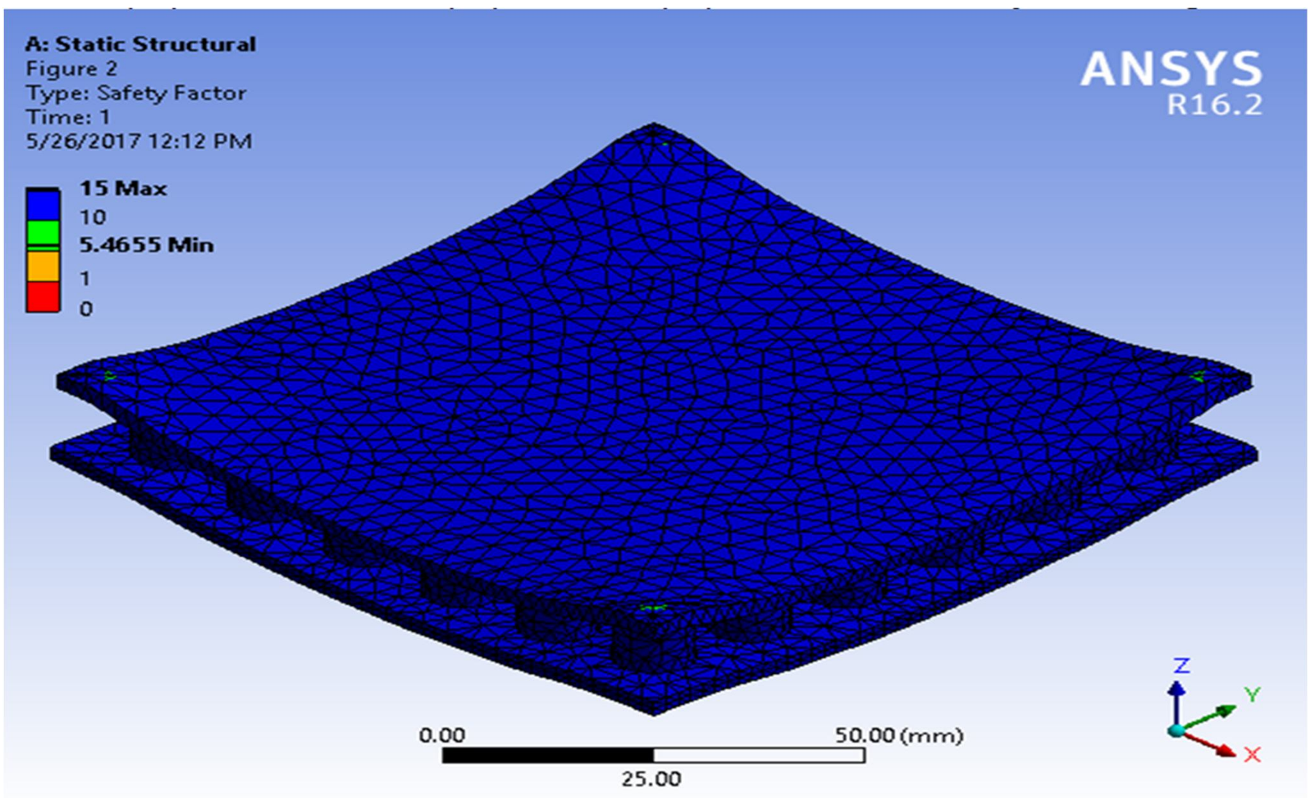

Fig.4-Factor of Safety for sandwich structure

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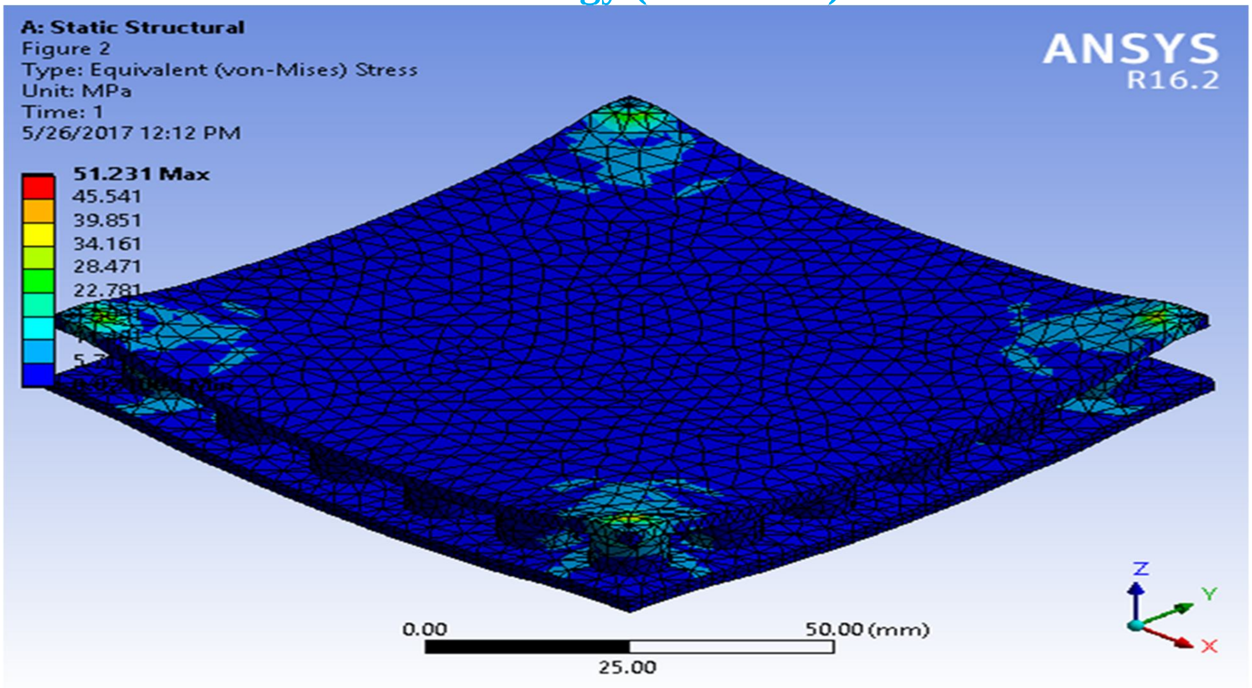

Fig.5-Equivalent (von-mises) stresses of sandwich structure

Fig.6-Bending Test on Sandwich Structure

VI. RESULTS AND DISCUSSION

CORE	Weight	FOS	Stress	Deformation
I -core	0.307	1.085	247.3	0.03992
Ho – core	0.302	9.370	29.88	0.00976
V - core	0.2548	1.52	183.89	0.0175
Z-core	0.194	2.06	135.85	0.1033
Vo- core	*0.21*	*5.46*	*51.23*	*0.020176*

Above table shows different observations of the plates. So we required the plate having f.o.s. more than 1.5 and the weight of the plate is less .so the plate vertical cylinder core has less weight and more fos so on the basis of that we select the vertical core plate.

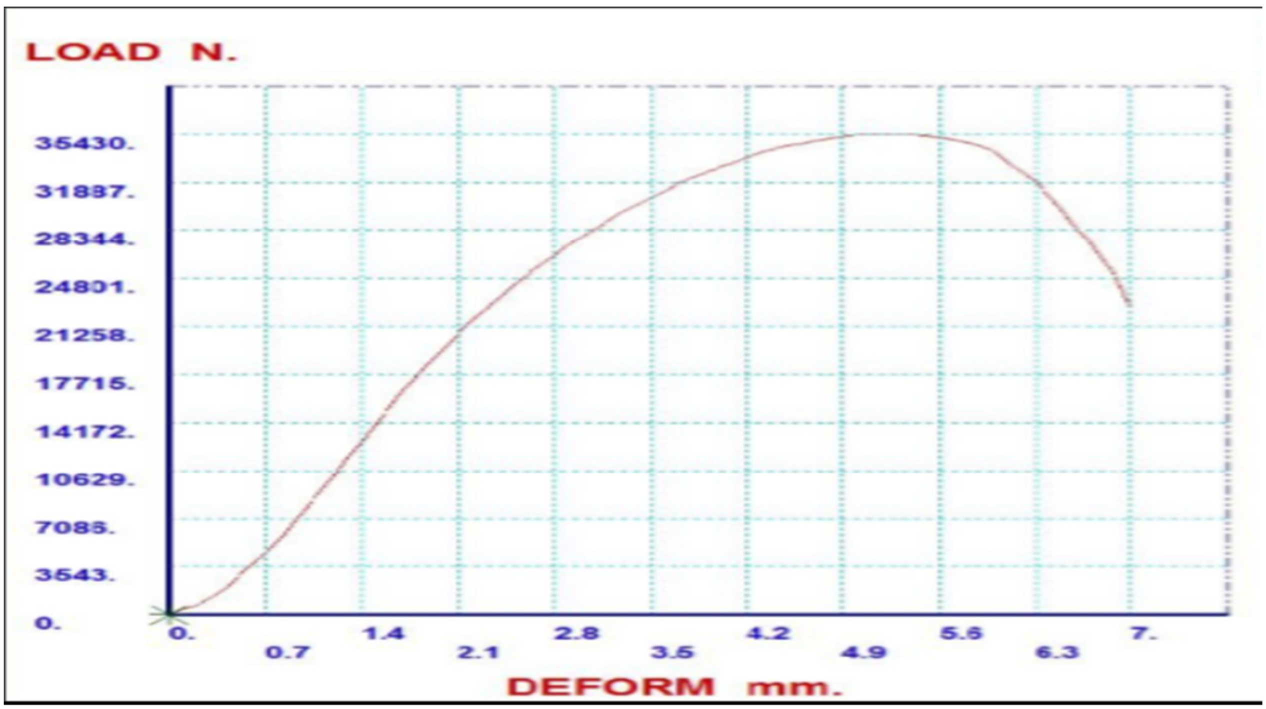

Fig.7-Load Vs Deformation Curve

VII. CONCLUSION

The sandwich panel model into Ansys workbench structural analysis. We analyses various sandwich structure made of aluminum alloy out of which we found that the vertical cylinder core structure panel has best optimized weight comparatively better strength. So we come to conclusion that the above vertical cylinder core structure is best suited for the replacement of structural sandwich plates.

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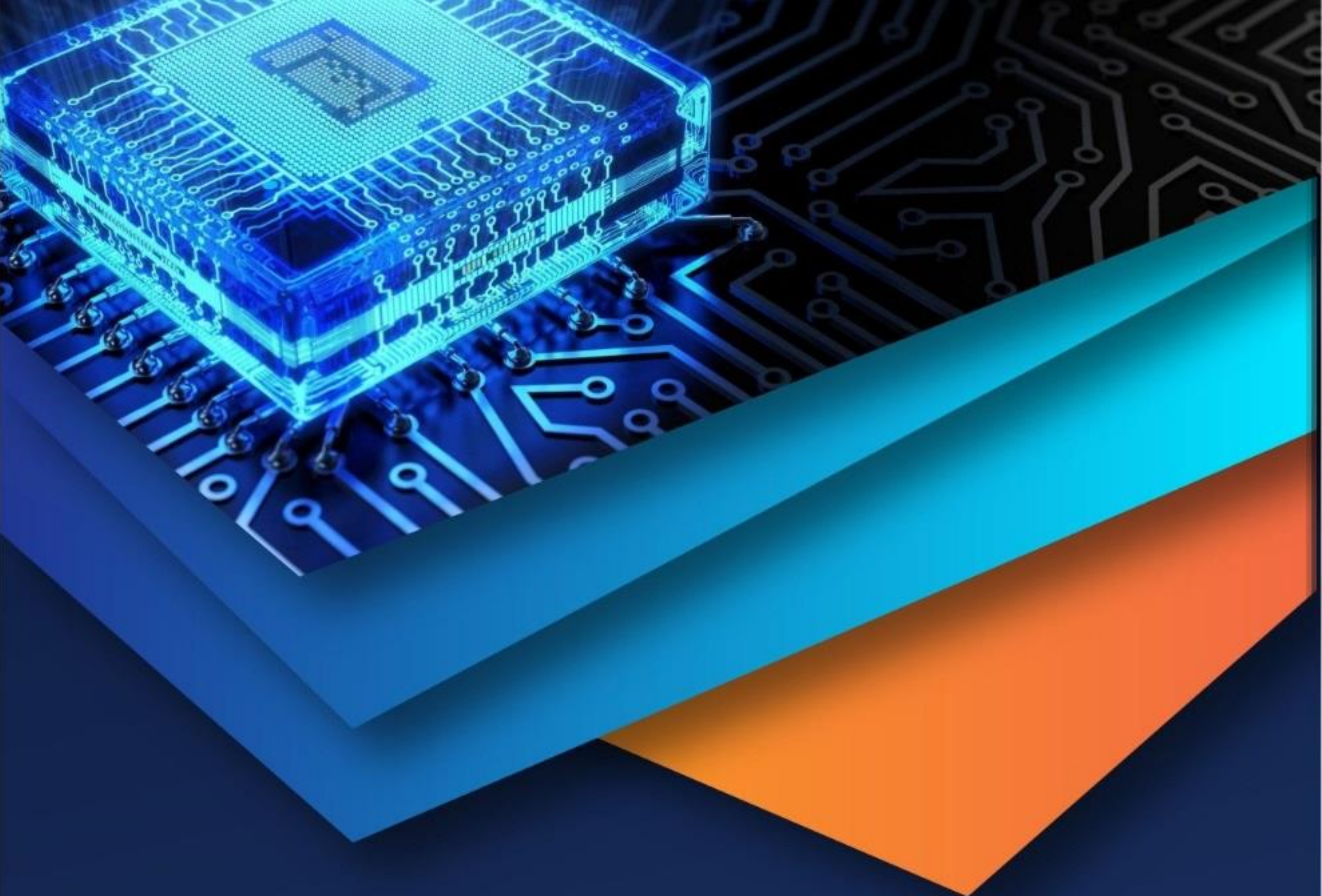

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