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Experimental Bending Behaviour of Sandwich Panel with Numerical Simulation

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Abstract— ***In this study, an experimental investigation, an analytical analysis and a numerical model of a typical 3-point bending test on copper honeycomb multi-layer sandwich panel are proposed. The copper honeycomb core is modelled as a single solid and multi-layer of equivalent material properties. Analytical and numerical (finite element) homogenization approaches are used to compute the effective properties of the single honeycomb core and analytical homogenization of the multi-layer one. The results obtained by numerical simulation (finite element) of 3-point bending are compared with the experimental results of a copper honeycomb core a stainless steel chosen a face sheet and copper is a core material. Honeycombs are most often an array of hollow hexagonal cells with thin vertical walls Copper Honeycomb is low density permeable material with numerous applications.***
Keywords— **copper honeycomb sandwich structure, FEA,3-point bending test,.**

I. Introduction

Sandwich construction is commonly used in structures where strength, stiffness, and weight efficiency are required. Most commonly, Sandwich Panels are used in Aircraft; Space craft, Satellites, Automobiles, Trains, Trucks, Boatsetc.Low-density,[3]hexagonal honeycombs are preferred as the core material on performance basis. The Sandwich Panel" which is composition of a "weak" core material with "strong and stiff" faces bonded on the upper and lower side. The facings provide practically all of the over-all bending and in plane extensional rigidity to the sandwich. . In principle, the basic concept of a sandwich panel is that the faceplates carry the bending stresses whereas the core carries the shear stresses. The core plays a role which is analogous to that of the I beam web while the sandwich facings perform a function very much like that of the I beam flanges. The sandwich is an attractive structural design concept since, by the proper choice of materials and geometry, constructions having high ratios of stiffness- to-weight can be achieved. Since rigidity is required to prevent structural instability, the sandwich is particularly well suited to applications where the loading conditions are conducive to buckling. Ceramic Honeycomb is often used for thermal insulation, acoustic insulation, adsorption of environmental pollutants, filtration of molten metal alloys, and as substrate for catalysts requiring large internal surface area. The geometric structure of copper honeycomb allows for the minimization of material used thus lowering weight and cost. The honeycomb pattern has a high strength-to-weight ratio. Copper Honeycomb is generally immediately available in most volumes.

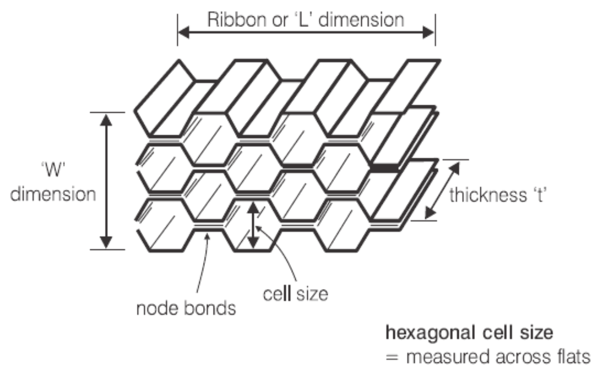

Fig .1 Honey comb structure

Sandwich panels with honeycomb cores have been studied by many researchers. [2]Yang and Qiao (2008) have performed a quasi-static indentation behavior of honeycomb sandwich materials which behavior of honeycomb sandwich materials which will be applied in impact simulations and found that the corresponding global stiffness changes in the load versus displacement curve clearly depict the three loading stages of failure process (i.e., initial core yielding load, global transition load, and ultimate failure load). [3] Crupi and Montaini (2007) performed static and dynamic three-point bending on aluminum foam sandwich to determine the collapse modes of the panels. From their study, different collapse modes (Modes I, IIA and IIB) can be obtained depending on the support span distance and on the own properties of Aluminum Foam Sandwich (AFS) panels.[4] Paik et. al. (1999) have studied the strength characteristics of aluminum honeycomb sandwich panels using a series of strength tests, namely three-point bending tests, buckling/collapse tests and lateral crushing tests. They also carried out a theoretical study to analyze the elastic-plastic bending behavior, buckling/ultimate strength and crushing strength of sandwich panels subject to the corresponding load component. Foo et. al. (2006)

II. Material and Methodology

B.Specimen preparation As mentioned earlier, the test specimen consisted copper core with hexagonal cells and stainless steel facing. 2mm thick used for making the sandwich panel faces as well as core. Three core heights, 5mm, 10mm and 15mm are selected for study. The core is spot welded to the face plates. Figures 3 (a) & 3(b) show the spot weld locations (dark spots).Top and bottom face sheets are 133mm X 96mm in dimensions. The cell size of the honeycomb is 28mm. 3-point bending tests are carried out on the specimen. Figure 3 shows the image of the copper honeycomb core fabricated.

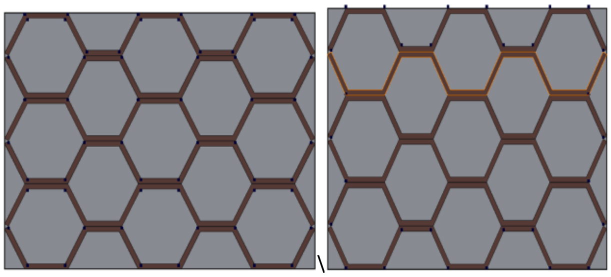

Figure 3: (a) Spot weld location (dark spots) between core and top panel **(b)** Spot weld location (dark spots) between core and bottom panel.

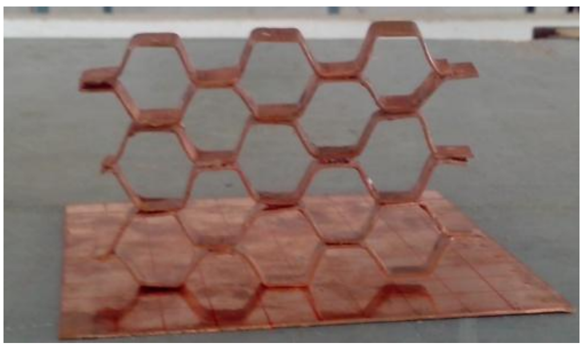

Figure 4: Copper Honeycomb core fabricated

Figure 4 shows the image of the copper honeycomb core fabricated.Figure 5 shows the meshed model used for simulation. s. The bottom two cylindrical models in the model shown are the supports. Each support axis is 15mm from the edge. The top cylinder is the load applying member. All the three cylinders are modeled with high young's modulus material. The face sheets are modeled using shell elements while the core is modeled using solid elements. No penetration contact is simulated between each member. The results of the tests and simulation are presented in the next section.

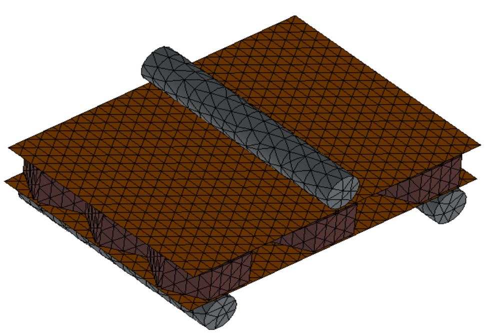

Figure 5: Meshed model,

III. Results and Tables

That the increase in deflection with increase in load is quite high when the core height is 5mm when compared to that of 15mm. Figure 5 show the variation in deflection for various core heights.

Figure 6: Specimen loaded and tested using UTM

Static analysis was performed to obtain the response of the hexagonal honeycomb sandwich panel with three different loads, i.e. 2kN, 5kN, 7kN for three different core heights i.e. 5mm, 10mm and 15mm. It is observed during the analysis that the increase in deflection with increase in load is quite high when the core height is 5mm when compared to that of 15mm. Figure 5 show the variation in deflection for various core heights.

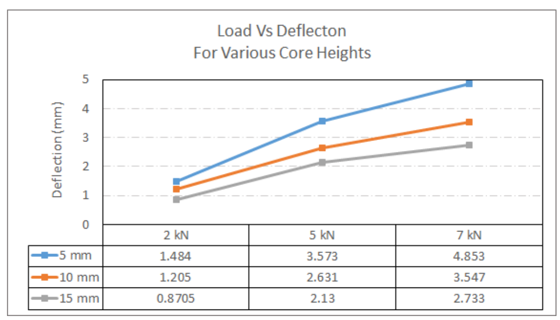

Figure 7: Variation of deflection with core height

Deflection and stress plots all loads for core height of 5mm are only presented in this paper. These plots are shown in figures 7&8 Graph showing the variation of stresses with loading for various core heights is shown in figure 10. From the graph it can be observed that lower stress values are observed for larger core heights.

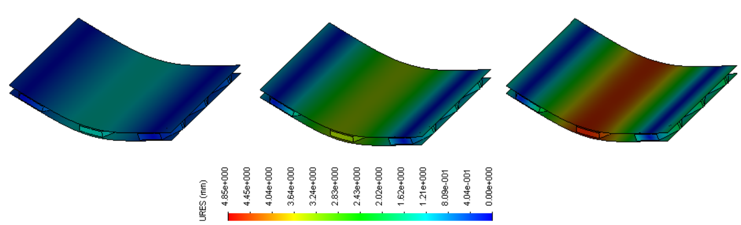

Figure 8: Deflection plots for various loads with core height of 5mm

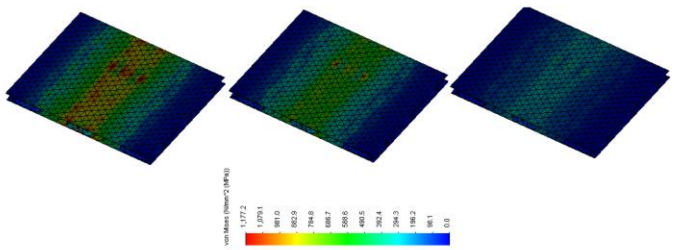

Figure 9: Stress distribution for various loads with core height of 5mm

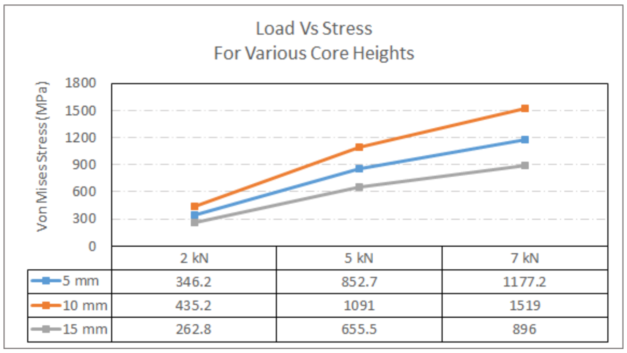

Figure 10: Variation of Von Mises Stress with core height

		Deflections			
Core Height(mm)	**Load (KN)**	**Theoretical (mm)**	**Experimental (mm)**	**Simulation (mm)**	**Vonmises stress**
5	2	1.4365	1.9	1.484	519.3
	5	3.591	3.8	3.573	1279
	7	5.0280	5.2	4.853	1765.7
10	2	1.781	1.9	1.205	652.9
	5	2.845	2.9	2.631	1637.6
	7	3.568	3.8	3.547	2278.8
15	2	1.58	1.1	.8705	394.9
	5	2.154	2.6	2.130	963.2
	7	3.12	3.0	2.733	1343.9

Table1. Comparing The Experimental Value With Theoretical And Simulation Values

III. Conclusion

Copper Honeycomb is generally immediately available in most volumes. Copper honeycomb is used in numerous engineering and scientific applications in industry for both porosity and strength. In the current work, bending behaviour of copper core honeycomb sandwich panel with stainless steel facing under 3-point bending was studied experimentally for various core heights and loads. Numerical simulation was used to predict the deflection. The predicted values and experimental values were compared. Based on the results it is found that the gradient of deflection curve is high for lower core height and stress is low for higher value of core height. These results can be used as input when designing sandwich panels.

References

i.A.Gpoichand, R.Mohanrao, N.V.S Sankar, G.RaBalaji P.Sandeep Kumar,"Design and Analysis of Copper Honey SandwiStructure", International Journal of Engg and Advanced Technology, 2(4), pp. 635-638, 2013

ii.K.KanthaRao,K. Jayathirtha RaoA.G.Sarwade,B.Madhava Varma , 2012, Bending Behavior of Aluminum Honey Com b Sandwich Panels, International Journal of Engineering & Advanced Technology, 1(4), 268-272

iii.K.Kantha Rao, K. Jayathirtha Rao, 201Thermostructural analysis of honeycomb sandwich panels, International Journalof Engineering, Science & Advanced Technology, 2(5), 1402-1409

iv.Anupam Chakrabarti, H.D.Chalaka, Mohd. Ashraf Iqbal, Abdul Hamid Sheikh, 2012, Buckling analysis of laminated sandwich beam with soft core, Latin American Journal of Solids and Structures, 9(3), 367-381 v.Md Radzai Said, Mohd Khairir Ismail, Syed Ammar bin SyedPutr 2011, Paper Honeycomb Sandwiches Panels under Static3Point Bending, nternational Conference and Exhibition on Sustainable Energy and Advanced Materials (ICE SEAM 2011) Solo-Indonesia, 271-278

vi.Frank A. Leone, John G. Bakuckas, Peter Shyprykevich, Curtis Davies, 2008, Structural Testing and Analysis of Honeycomb Sandwich Composite Fuselage Panels, U.S. Department of Transportation: Federal Aviation Administration www.tc.faa.gov/its/worldpac/techrpt/ar0851.pdf

vii.M K Khan, 2006, Compressive and lamination strength of honeycomb sandwich panels with strain energy calculation from ASTM standards, Proc. IMechE Vol. 220 Part G: Journal of Aerospace Engineering, 220(5), 375-386

viii.Jeom Kee Paika, Anil K. Thayamballi, Gyu Sung Kim, 1999, The strength characteristics of aluminum honeycomb sandwich panels, Thin-Walled Structures, 35(3), 205-231

ix.Achelles Petras, 1998, Design of sandwich structures, Cambridge University Engineering Department, PhD Thesis

x.I. G. Masters, K. E. Evans, 1996, Models for elastic deformations of honeycombs, Composite structures, 35, 403-422

xi.Chyanbin Hwu, Jian S. Hu, 1995, Delamination buckling of honeycomb sandwich panels with laminated faces, Journal of Composite Materials, 29(15), 1962-1987

xii.Ijsbrand J. Van Straalen, Comprehensive overview of theories for sandwich panels, The DOGMA Project, www.dogma.org.uk/vtt/modelling/workshop/straalen2.pdf

xiii.HexWeb^{TM} Honeycomb sandwich design technologies, HexelComposites,URL: http://www.hexcel.com/Resources/DataSheets/Brochure-Data-Sheets/Honeycomb_Sandwich_Design_Technology.pdf

xivHoneycombstructure,URL: http://en.wikipedia.org/wiki/Honeycomb_structureCopper honeycomb, URL: http://www.americanelements.com/copper-honeycomb.html