Load Bearing Simulation Studies of Various Honeycomb Structures for Use as Impact Barriers in Automobiles

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***Abstract*: The present work studied the efficiency of the square shaped honey comb structures under different minute variation of the cells aspect ratios, rib thickness for these different materials Alluminium1060 alloy, E-GLASS & S2-GLASS in with standing the loads that could arise in impact in impact of automobiles collisions. The width of the cells was studied in 3 different variations namely**

a) Equal width in 'x' and 'z' direction
b) Width in 'x' direction >'z' direction
c) Width in 'z' direction >'x' direction

The thickness of the ribs was studied under 2 different conditions

a) Thickness of ribs in 'z' direction > that of in 'x' direction
b) Thickness of ribs in 'x' direction >that of in 'z' direction

All the various conditions in the geometry of square cell honey comb structure are carried out under the condition of contact volume & weights of the structure, thus making that impact resistance comparison relevant. The rib thickness various are adjusted subjected to this important constraints of constant weight of the material in all the impact barriers thus making the comparison of different designs meaningful as it is independent of weight or mass density for a given material.

1.INTRODUCTION

This project gives better shape for textile composite impact barriers by analyzing results using FEM based software COMSOL for impact analysis on

honey comb box type and triangular and hexagonal models, Solid Works software to model 3D models of honeycomb structures. This is going to help in finding out a alternative geometric shape which can be used as a replacement to the traditional hexagonal honeycomb structure and which can help in reducing the delimitation problem of honeycomb structure.

1. Selection of different geometric structures for better

   inner cores

2. Selection of different materials (composite fibers).
3. Use of solid Works to prepare 3D models.
4. Use of COSMOS to perform analysis.
5. Comparison of results of different geometric structures with traditional hexagonal honeycomb structure.
6. To provide a best suitable alternative for traditional hexagonal honeycomb structure.

2. MATERIALS

Composite Material For the specific carbon and glass fiber based composite materials often referred to loosely as 'composites 'Composites are formed by combining materials together to form an overall structure that is better than the individual components.

Composite materials (also called composition materials or shortened to composites) are materials made from two or more constituent materials with significantly different physical or chemical properties that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials. Typical engineered composite materials include:

3. HONEYCOMB STRUCTURES

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. 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 relative high out-of-plane compression properties and out-of plane shear properties.

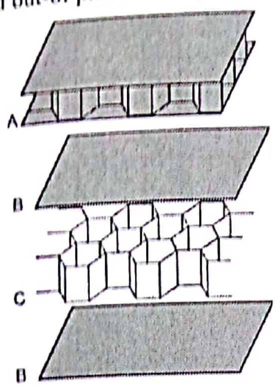


Figure 3.1 A composite sandwich panel (A)

With honeycomb core (C) and face sheets (B)

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 strength-to-weight ratio is valuable. They are widely used in the aerospace industry for this reason, and honeycomb materials in aluminum, fiberglass and advanced composite materials have been featured in aircraft and rockets since the 1950s. They can also be found in many other fields, from packaging materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards.

3.1 Applications

1. They are widely used in the aerospace industry.
2. They are widely used in the aerospace industry.
3. From packaging materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards.
4. Used as front barriers in heavy vehicles.
5. Used in Automobile industries.

3.2 Advantages

1. Very low weight
2. High stiffness
3. Durability
4. Production cost savings

4. RESEARCH METHODOLOGY

Selection of different geometric structures for better inner cores: It is important to understand the stiffness and strength performances of honeycombs when they are used in load-bearing structure. Gibson and Ash-by (1997) specified that generally, if a honeycomb is compressed in-plane that is the plane along X1 and X2 direction in Figure 3, the cell wall at first bend, giving linear elastic deformation. Beyond a critical strain, the cells collapse by elastic buckling, plastic yielding, creep or brittle fracture, depending on the nature of the cell wall material. Cell collapse ends once the opposing cell walls begin to touch each other and as the cells closed up, the stiffness of the structure increases rapidly. When the loading is along out-of-plane direction, which is along X3 direction in Figure 3, the stiffness and strength are much higher because they require extra axial extension or compression of the cell walls.

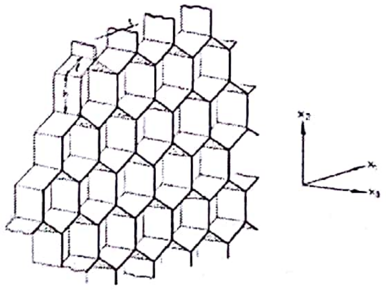
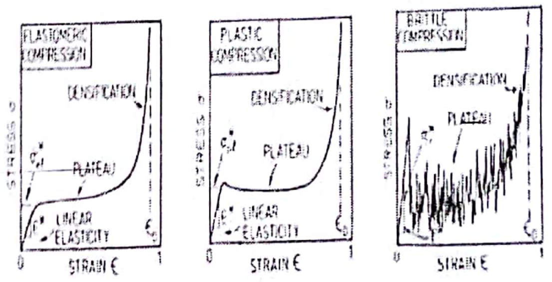


Figure 4.1: Honeycomb structure with hexagonal cells



Graph 4.2 Stress-Strain Curves for Cellular Solid

5. RESULTS

5.1. Various geometric configurations analyzed by using solid works

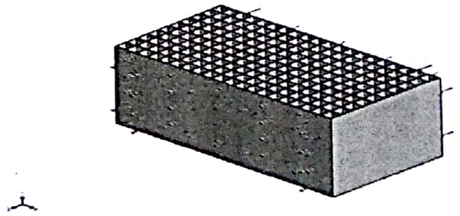


Fig.5. Basic Geometry of square type honeycomb structure Case-I (t_x=t_y) [Al 1060 alloy, E-glass&S2-glass)

5.1.1 Various geometric configurations analyzed by using solid works works Case-I (t_x=t_y) [Al 1060 alloy, E-glass&S2-glass)

Case-I	L_x	L_Y =l_y	L_z	l_x	l_z	t_x	t_z	T_x	T_z	nc_x	nc_z
t_x=t_z	442	22 2	222	20	20	2	2	42	22	20	10

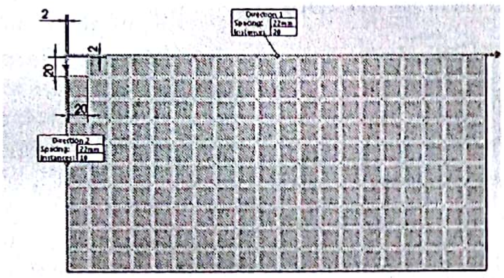


Fig. 5.1.1 Geometric configuration of case-I

5.1.2 Various geometric configurations analyzed by using solid works Case-II (t_x>t_y) [Al 1060 alloy, E-glass&S2-glass)

Case-II	L_x	L_Y=l_y	L_z	l_x	l_z	t_x	t_z	T_x	T_z	nc_x	nc_z
t_x>t_z	442	222	222	20	20	3	1	63	11	20	10

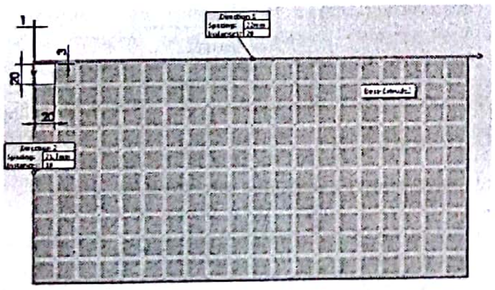


Fig. 5.1.2 Geometric configuration of case –II

5.1.3 Various geometric configurations analyzed by using solid works: CASE-III (t_z >t_x) [Al 1060 alloy, E-glass&S2-glass)

Case-III	L_x	L_Y=l_y	L_z	l_x	l_z	t_x	t_z	T_x	T_z	nc_x	nc_z
t_z >t_x	442	222	222	21.164	18.9	0.89141	3	18.79	33	20	10

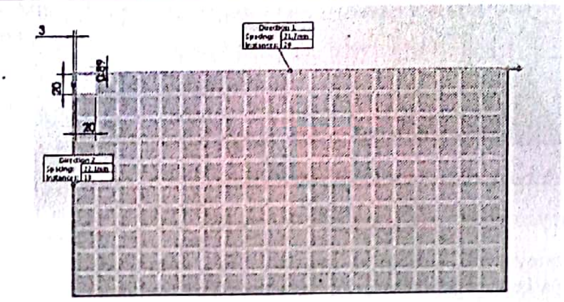


fig. 5.1.3 Geometric configuration of case -III

5.1.4 Various geometric configurations analyzed by using solid works: CASE-IV (Tz>Tx) [Al 1060 alloy, E-Glass&S2-Glass)

Case-IV	L_x	L_Y=l_y	L_z	l_x	l_z	t_x	t_z	T_x	T_z	nc_x	nc_z
T_z >T_x	442	222	222	40	20	3.818	2	18.79	33	20	10

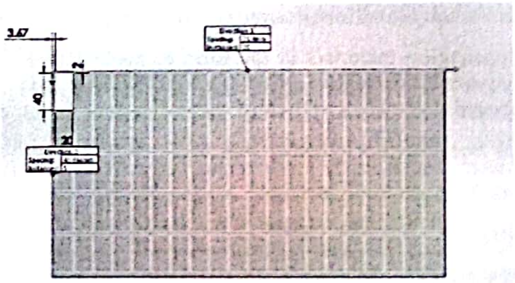


Fig. 5.1.4 Geometric configuration of case-IV

5.1.5 Various geometric configurations analyzed by using solid works: CASE-V (Tx>Tz) [Al 1060 alloy, E-Glass&S2-Glass)

Case-V	Lx	L_y=ly	Lz	lx	lz	tx	tz	Tx	Tz	ncx	ncz
Tz>Tx	442	222	222	21.164	18.9	0.89141	3	18.79	33	20	10

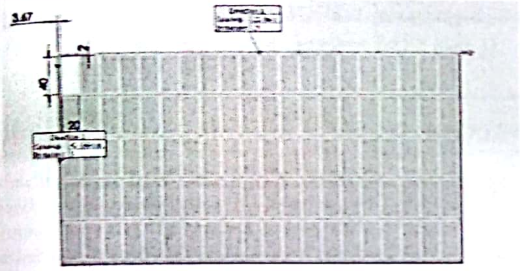


Fig. 5.1.5 Geometric configuration of case-V

5.2 Simulation analysis of CASE-I (t_x=t_z): ALLUMINIUM-1060 ALLOY

5.2.1:VON-MISES STRESS

Figure 5.2.1 shows von-mises stress value of square type Al 1060 alloy fiber honeycomb impact barrier. Analysis was done at constant volume as well as const force 15000Kgf using cosmos software which are a part of solid works. Von-mises stresses obtained in simulation of Max = 1.86E+07 N/mm^2 (Mpa).

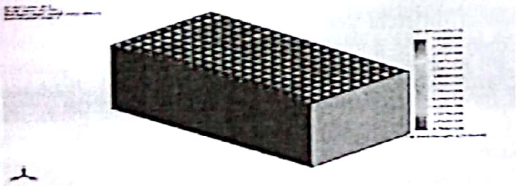


Fig. 5.2.1 VON-MISES STRESS FOR Al 1060 ALLOY IN CASE-I

5.2.2DISPLACEMENT

Figure 5.2.2 shows displacement value of square type Al 1060 alloy fiber honeycomb impact barrier. Analysis was done at constant volume as well as const force 15000Kgf using cosmos software which are a part of solid works. Displacement obtained in simulation of Max = 0.047413 mm.

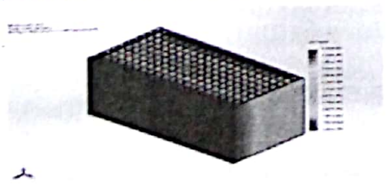


Fig 5.2.2 DISPLACEMENT FOR Al 1060 ALLOY IN CASE-I

5.2.3. E-STRAIN

Al 1060 alloy fiber honeycomb impact barrier. Analysis was done at constant volume as well as const force 15000Kgf using cosmos software which are a part of solid works. Estrain Obtained in simulation of Max =.0.000229

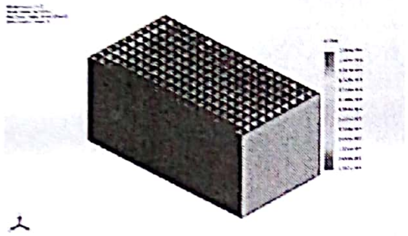


Fig5.2.3 ESTRAIN FOR Al 1060 ALLOY IN CASE-I

5.3 DISCUSSIONS

The results obtained by using analysis done on square honeycomb structure are as fallows table shows the strain, stress and displacement values of different materials used for different cases of honeycomb barrier.

Name	Material	Von -misses Stress In (N/mm2)	Displacement in (mm)	Strain
SQUARE (CASE-I)	E-Glass	18765800	4.72984E-08	2.02834E-10
	S_2-Glass	18234700	0.3921	0.0017
	Aluminium	18603900	0.0474	0.0002
SQUARE (CASE-II)	E-Glass	26795600	4.76602E-08	3.00884E-10
	S_2-Glass	26628800	0.3938	0.0026
	Aluminium	26404300	0.048	0.0003
SQUARE (CASE-III)	E-Glass	25606800	5.47116E-08	2.77741E-10
	S_2-Glass	25412900	0.4527	0.0024
	Aluminium	24736600	0.0552	0.0003
SQUARE (CASE-IV)	E-Glass	21229500	5.17769E-08	2.39538E-10
	S_2-Glass	21263100	0.4286	0.002
	Aluminium	21263100	0.0524	0.0003
SQUARE (CASE-V)	E-Glass	21229500	5.17769E-08	2.39538E-10
	S_2-Glass	21229500	5E-08	2E-10
	Aluminium	23359600	0.0555	0.0002

Table: Comparison of Results for different cases.

5.4 GRAPHS

5.4.1. Von-misses stress vs geometric configuration

Fig 5.4..1 shows the graphical representation of Von-mises stress values for different materials like E-Glass, S2-Glass and Aluminium types of materials assigned to different geometries. This graph helps to compare the material stress values.

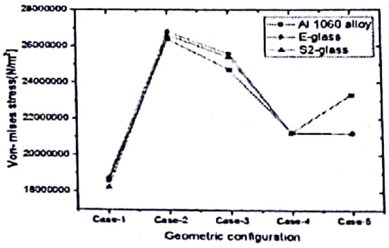


Fig.5.4.1 VON-MISES STRENGTH GRAPH

5.4.2. Displacement vs geometric configuration

Fig 5.4.2 shows the graphical representation of Displacement values for different materials like E-Glass, S2-Glass and Aluminium types of materials assigned to different geometries. This graph helps to compare the material stress values.

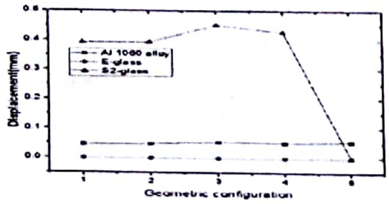


Fig 5.4.2 DISPLACEMENT GRAPH

5.4.3. E-Strain vs geometric configuration

Fig 5.4.3 shows the graphical representation of Von-mises stress values for different materials like E-Glass, S2-Glass and Aluminium types of materials assigned to different geometries. This graph helps to compare the material stress values.

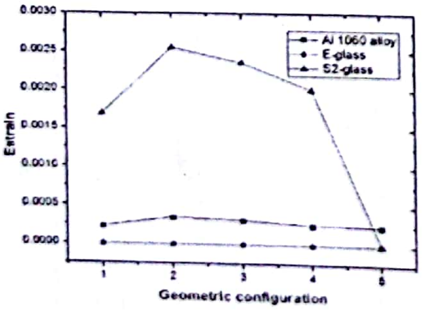


Fig.5.4.3 STRAIN GRAPH

6. CONCLUSION:

By the analysis of above results find out these values and materials should be optimized for CASE-I type.

MATERIAL	VON-MISES STRESS (N/m²)	YIELD STRENGTH (N/m²)
S2-LASS	1.82e+07	4.89e+009
AL 1060	2.56e+07	2.75742e+007
E-GLASS	2.47e+07	1.725e+009

Table 6. RESULTS ANALYSIS

FUTURE SCOPE OF WORK: 1. Number of different works are possible to be investigated to extend the current findings in higher level of discovery.

2. Analysis has conducted in 2D, and more 3D models can analyzed to validate experiment results or for more deep investigation

3. Manufacturing procedure has to be established to get more accurate angles, to produce from thickness of walls of impact Barrier.

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