Fabrication and Experimental Characteristics of Aluminum Honeycomb Core Sandwich Panel Compared with Nomex Honeycomb Sandwich Panel

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Abstract:- In this paper mainly discussed about focuses on the aluminum honeycomb structure and Nomex honeycomb structure which are known to be very strong and can be processed easily, As the aerial stems of the honeycomb structure are very strong and which is the core material used in composite panels are used to overcome the present using the composite materials itself the best example for its strength, and from ancient times they use wood, metal and plastic which has the cost and some disadvantages values used to lead many disadvantages , comparatively composite panels is termed as metal, non-metal, e-glass fiber and adhesives like resin/epoxy hardener used for making composite materials used for automobiles body ,marines ,constructions ,aeroplains, domestic applications etc. In the project the laminates of aluminum and Nomex honeycomb core, resin/epoxy, hardener and e-glass fiber composites were made with 500*500*10mm^3 volumes. The laminates are cut into the dimensions for different tests, and tensile test, impact test, water absorption test etc. observation of microstructure is performed. Epoxy resin and hardener which has the excellent mechanical properties is used. Comparison between the aluminum and Nomex composite panels is done and the e-glass fiber in each stage is identified.

Keywords:- *Mechanical Properties.*

I. INTRODUCTION

A composite material is a material 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 composition of a composite. A composite material is composed primarily of a matrix, i.e. a continuous phase, which is armored with a reinforcement (reinforcement is a secondary phase), which is usually the discontinuous phase. Metals and non-metals or particles embedded in matrix of another material are the best example of modern-day composite materials, which are mostly structural. Laminates are composite material where different layers of materials give them the specific character of a composite material having a specific function to perform. Honeycomb structures have matrix, but in the e-glass fibers of different compositions combine to give them a specific character. Reinforcing materials generally withstand maximum load and serve the desirable properties. Further, though composite types are often distinguishable from one another. To facilitate definition, the accent is often shifted to the levels at which differentiation take place viz., microscopic or macroscopic. In matrix-based structural composites, the matrix serves two paramount purposes viz., binding the reinforcement phases in place and deforming to distribute the stresses among the constituent reinforcement materials under an applied force. The demands on matrices are many. They may need to temperature variations, be conductors or resistors of electricity, have moisture sensitivity etc. This may offer weight advantages, ease of handling and other merits which may also become applicable depending on the purpose for which matrices are chosen. Solids that accommodate stress to incorporate other constituents provide strong bonds for the reinforcing phase are potential matrix materials. A few materials, metals and non- metals have found applications as matrix materials in the designing of structural composites, with commendable success. These materials remain elastic till failure occurs and show decreased failure strain, when loaded in tension and compression. Composites cannot be made from constituents with divergent linear expansion characteristics. The interface is the area of contact between the reinforcement and the matrix materials. In some cases, the region is a distinct added phase. Whenever there is inter phase, there has to be two inter phases between each side of the inter phase and its constituent. Some

ISSN No:-2456-2165

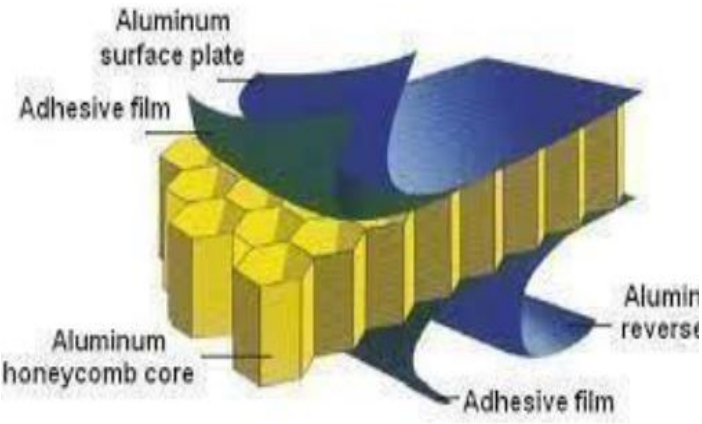

Fig 1 Composite Material

Composites provide inter phases when surfaces dissimilar constituents interact with each other. Choice of fabrication method depend son matrix properties and the effect of matrix on properties of reinforcements. One of the prime considerations in the selection and fabrication of composites is that the constituents should be chemically inert non-reactive.

II. TYPES OF FIBER MATERIALS AND CORE MATERIALS

- *Boron Fibers.*
- *E-Glass Fibers*
- *Carbon Fibers*
- *Ceramic Fibers*
- *Natural Fibers.*
- *Metal Fibers*

- *Core Materials*

- *Thermoplastic,*
- *Stainless Steel,*
- *Nomex,*
- *Aluminum*

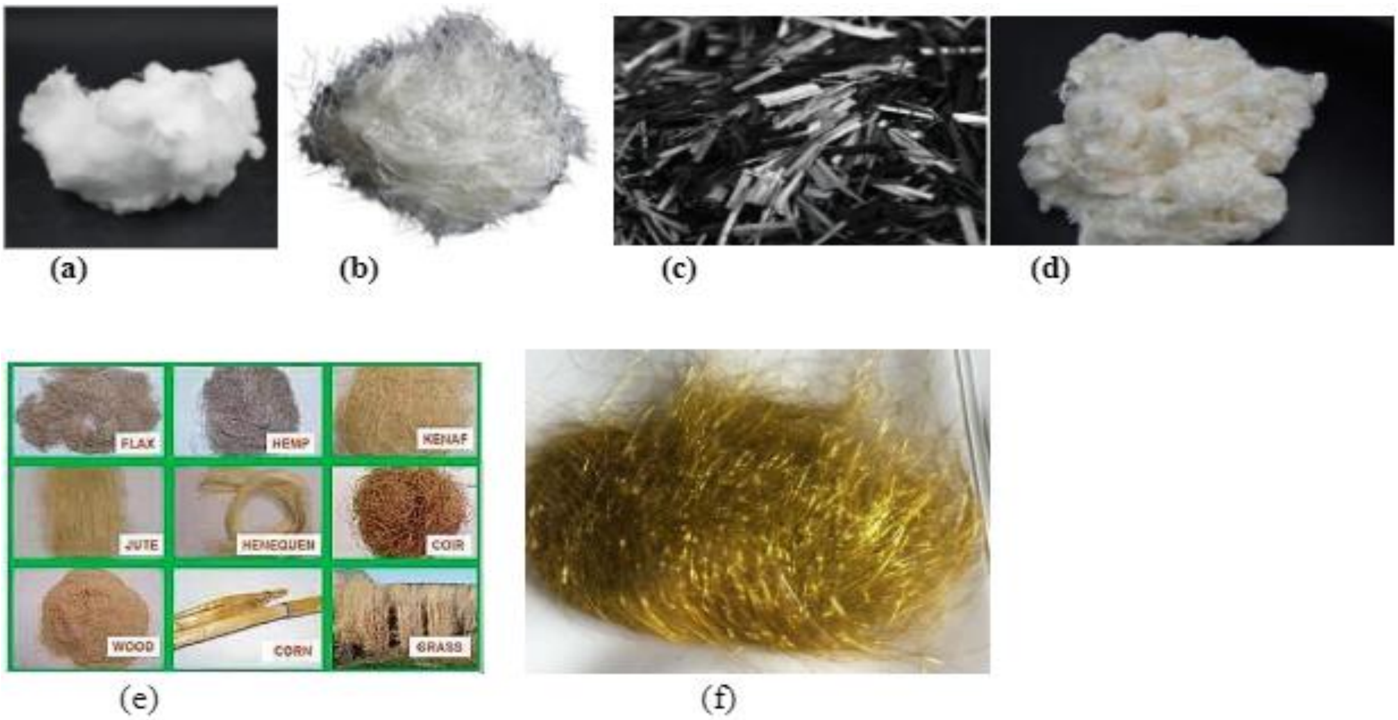

Fig 2 Fiber Materials

- *Types of Core Materials*

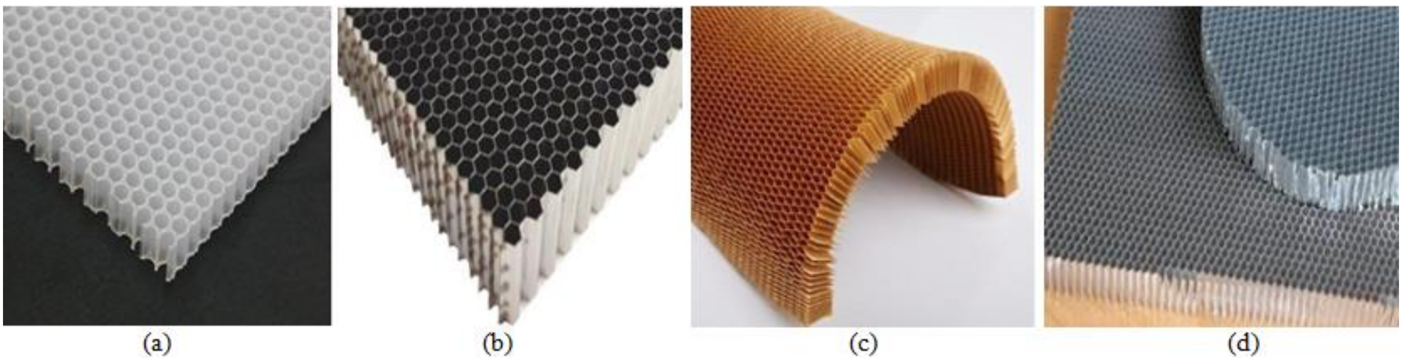

Fig 3 Types of Core Materials

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III. MATERIALS AND METHODS

Composite materials are commonly used in many applications and uses. There are many materials like wood, plastic, ceramic, metals and non-metals. So, this composite materials application reduces cost and increase advantages for the users. Nowadays composite materials are getting in advanced technologies like nano particles and honeycomb cored composite panels. Aluminum and Nomex honeycomb core panels are composite materials used in a variety of applications such as aerospace, marine, automotive, and construction industries. The construction of these panels involves the use of a honeycomb core sandwiched between two face sheets made of aluminum and Nomex. The honeycomb core is made of a series of hexagonal cells that are filled with air, which creates a lightweight yet rigid structure. Aluminum and Nomex honeycomb core panels are commonly used in many applications. The following are the general materials and methods used in the production of aluminum and Nomex honeycomb core panels.

➢ *Materials*:

- Aluminum and Nomex honeycomb core with hexagonal cells about 500*500*10mm and 1mm foil thickness.
- Resin/epoxy and hardener.
- Hand layup technique materials like paint roller, paint brush, gloves.
- Plastic paper of 2mm thickness of 1squre meter to cover the laminated protect from surrounding.

➢ *Methods*:

- Preparing the honeycomb core material can be either aluminum or Nomex. In case of aluminum-glass fiber and aluminum are corrugated with resin/epoxy and hardener then bonded together to form a honeycomb panel. In case of Nomex, the honeycomb structure is made by Nomex paper same as aluminum the e-glass fiber and adhesive resin/epoxy and hardener is bonded together to form a sandwich panel.
- Preparing the aluminum and Nomex panel by using hand layup technique. The resin /epoxy serves as the adhesivesto bond the honeycomb core.
- Bonding the honeycomb core the honeycomb core is placed on the top of the e-glass fiber sheet and the epoxy – coated sheet on bottom of the core, layer by layer the e-glass fiber is laminated both side of the honeycomb core with adhesive by using hand layup technique.
- Applying pressure on the laminated panel to get bonded together. This process causes the materials to cure for 2 days for bonding the honeycomb core panel.
- After curing the excess material is trimmed from the edges of the panel and the panel is sanded and finished to the desired testing.

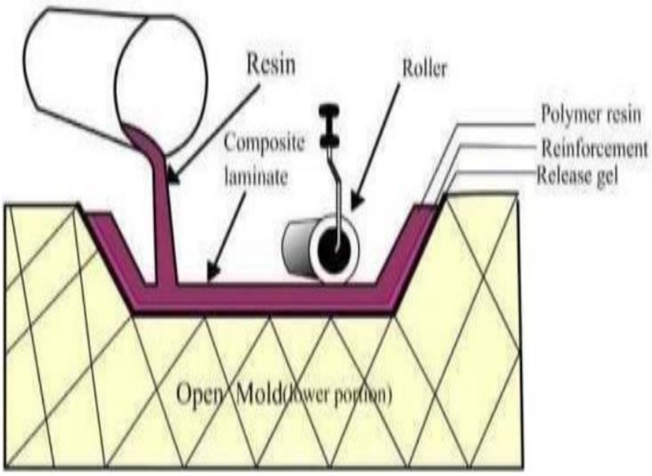

Fig 4 Hand Layup Technique

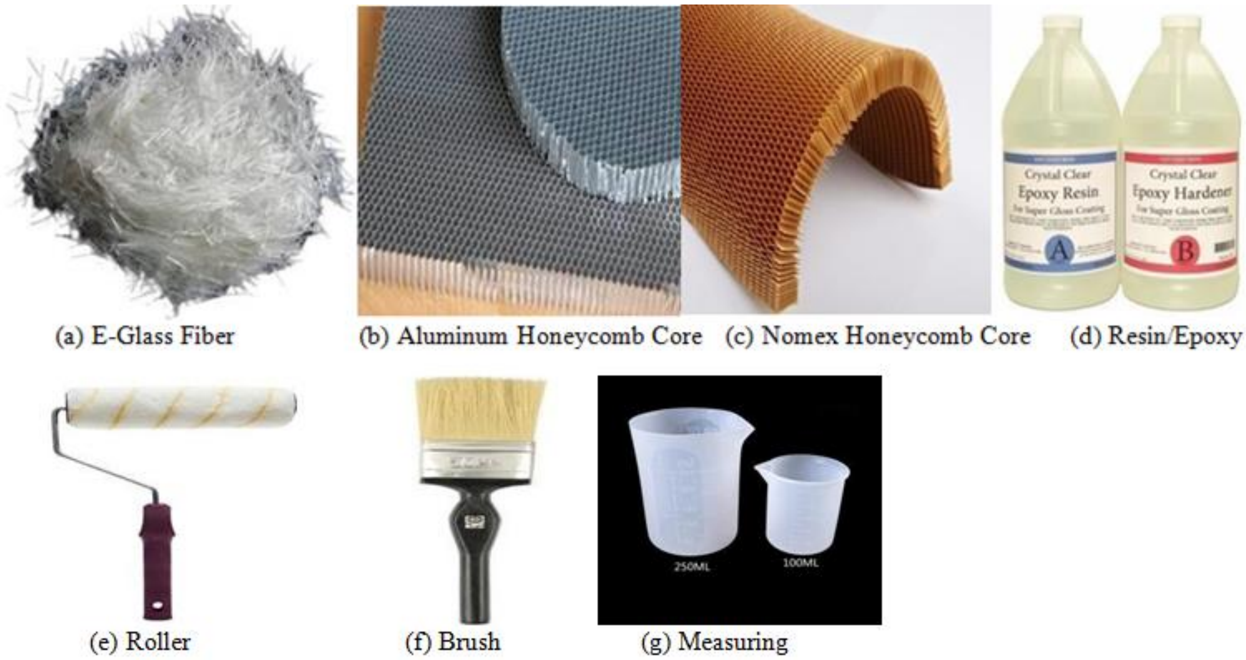

Fig 5 Materials Required

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- The figure 3 indicates that the raw material and equipments which is taken for fabrication of the Aluminum and Nomex honeycomb core sandwich panel.
- The raw materials like honeycomb core is taken as per the design which we desired to fabricate, we can modify the cell size, foil thickness, length and width as per the reference of previous journals.
- We modified the core thickness, cell size and length of the core material.
- We can take e-glass fiber as per our requirement in the form of sheet with 2mm thickness.
- Resin/epoxy and hardener are the adhesives used for the bonding for the core material and fiber sheet.
- After laminating the materials together it is cured at room temperature for 2-3 days for perfect bonding between the materials which is laminated together, because we have choose the Hand layup technique for fabrication.
- It is a simple and basic technique which is never used previously. This technique is completely depending on manual measuring and fabrication without machine, it is easy method and low cost method which can be used for moderate manufacturing.

IV. RESULTS AND DISCUSSION

Flexural test on aluminum and Nomex honeycomb panels:

➢ *Specimen Specifications for Different Tests :(in mm):*

- *Flexural test :500*500*10 mm ASTM D 790*

1. Nomex panel 2. Aluminum panel
Fig 6 Flexural Test Specimens Aluminum and Nomex panels

Table 1 Flexural Test Result

Sl. No	Material	Flexural load
1.	Nomex	2407N
2	Aluminum	1930N

➢ *Compression Test*

Fig 7 Tensile Test Specimens

Table 2 Compression Test Results

Sl. No	Material	Peak load(N)	UCS(Mpa)
1	Nomex	7.840kN	15.682
2.	Aluminum	3.740kN	14.960

Fig 8 Fabrication Process

➢ *Since*

- *W_2 is the Weight of the Sample after Test*
- *W_1 is the Weight of the Sample before Test*

Table 3 Weight Compressions

Sl.No	Material	Weight of Specimen before Test(w1)	Weight of Specimen after Test(w2)
1.	Nomex	50gms	250gms
2.	Aluminum	85gms	275gms

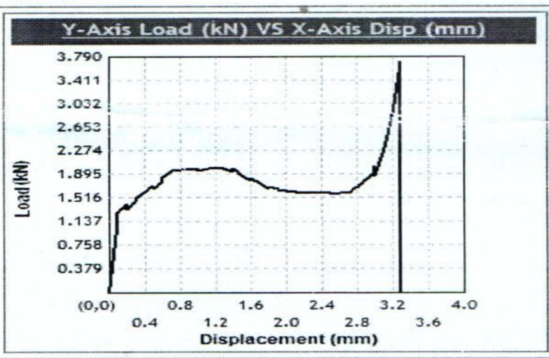
➢ *Graphs*

Identification: ALUMINIUM HONEY COMB CORE PANEL
SIZE: 400 X 400 X 5MM

Sample No : 4
Test Procedure : --
Material Specification : --

Stamped As:

Input Data			Results			Specified Values
Specimen Type	:	Flat	Ultimate Load	kN :	3.740	
Specimen Width	mm :	50	Compressive Strength	MPa :	14.960	
Specimen Thickness	mm :	5				
C/S Area	mm² :	250				
Original Gauge Length	mm :	0				
Final Gauge Length	mm :	0				



Remarks : --

Fig 9 Compression Test on Aluminum Honeycomb Core Sandwich Panel

Identification: NOMEX HONEY COMB CORE SANDWICH PANEL
SIZE: 300 X 300 X 10MM

Sample No : 3
Test Procedure : --
Material Specification : --

Stamped As:

Input Data			Results			Specified Values
Specimen Type	:	Flat	Ultimate Load	kN :	7.840	
Specimen Width	mm :	50	Compressive Strength	MPa :	15.680	
Specimen Thickness	mm :	10				
C/S Area	mm² :	500				
Original Gauge Length	mm :	0				
Final Gauge Length	mm :	0				

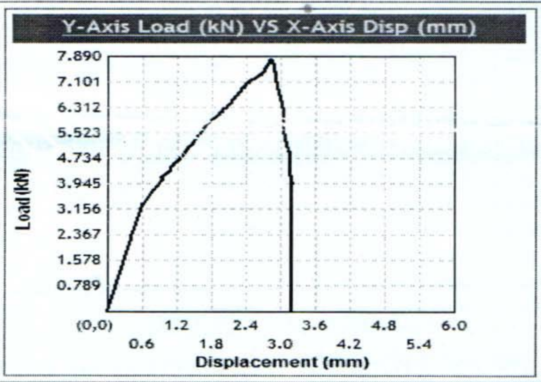


Fig 10 Compression Test on Nomex Honeycomb Core Sandwich Panel

Identification: ALUMINIUM HONEY COMB CORE PANEL
SIZE: 400 X 400 X 5MM

Sample No : 2
Test Procedure : ASTM D 790
Material Specification : --

Stamped As:

Input Data			Results			Specified Values
TC No	:	M-I23-0050-2	Ultimate Load	N :	193	
Specimen Type	:	Flat	Flexural Strength	MPa :	11.58	
Specimen Width	mm :	300.00				
Specimen Thickness	mm :	5.00				
C/S Area	mm² :	1500.00				
Span Length	mm :	300				

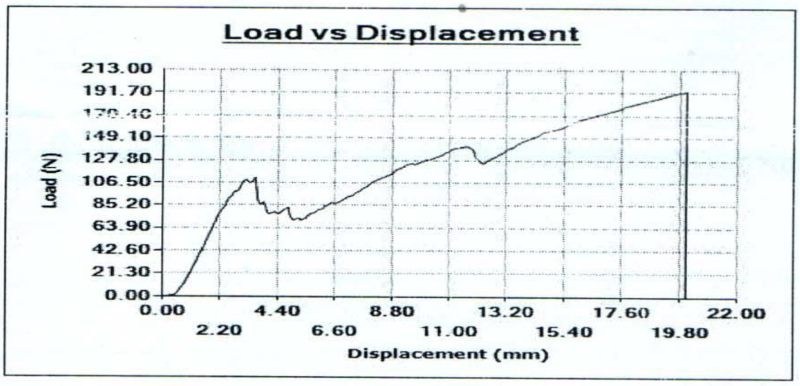


Fig 11 Flexural test on Aluminum Honeycomb Core Sandwich Panel

Identification: NOMEX HONEY COMB CORE SANDWICH PANEL
SIZE: 300 X 300 X 10MM

Sample No : 1
Test Procedure : ASTM D 790
Material Specification : --

Stamped As:

Input Data			Results			Specified Values
TC No	:	M-I23-0050-1	Ultimate Load	N :	2407	
Specimen Type	:	Flat	Flexural Strength	MPa :	36.11	
Specimen Width	mm :	300.00				
Specimen Thickness	mm :	10.00				
C/S Area	mm² :	3000.00				
Span Length	mm :	300				

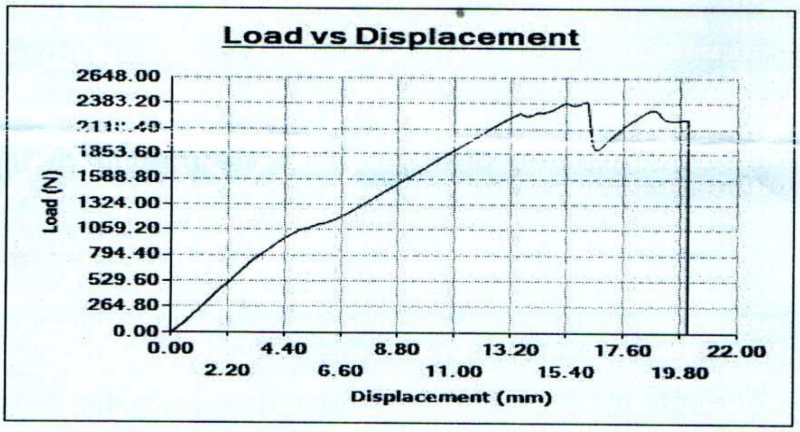


Fig 12 Flexural Test on Nomex Honeycomb Core Sandwich Panel

V. FUTURE SCOPE OF HONEYCOMB SANDWICH PANELS

Aluminum and Nomex honeycomb sandwich panels have a wide range of potential applications in industries such as aerospace, transportation, construction, marine and defense. The combination of aluminum and Nomex honeycomb provides an ideal balance of strength, stiffness and weight, making it an attractive material for lightweight structures that require high strength and rigidity. Some of the potential future applications of aluminum and Nomex honeycomb sandwich panels include. Aerospace, Constructions, Medical industry, Renewable energy testing of aluminum and Nomex honeycomb sandwich panels is essential to ensure their performance anddurability in various applications. Some of the commonly used tests for these panels include tensile test, Shear test, fatigue test, Thermal analysis etc. We can change the cell size, thickness, foil thickness, length and width of the panel as per our desired design and specifications. We can choose cell in form of circular, triangular, square and are explained in the above mentioned types of fiber and same as adhesives also overall, the future looks promising for honeycomb panels as they offer a unique combination of strength, lightweight, and versatility, making them suitable for a wide range of applications hexagonal as per applications and design. We can choose different reinforcement fiber materials which is suitable for our panel the name of fiber. As technology advances the use of honeycomb panels is likely to grow in various industries comparison test result.

VI. CONCLUSION

Therefore, the test performed on both the panel's aluminum honeycomb matrix sandwich panel and Nomex honeycomb matrix sandwich panel. Nomex honeycomb panel has good bonding between adhesive and matrix material which as good mechanical properties compared with aluminum honeycomb sandwich panel which is fabricated by Hand layup technique. Hand layup technique is not mushsuitable for metal oriented composite panel, due to improper bonding between core and face sheet takes place. It takes more adhesive material and bonding time. Hand layup technique is a good method for fabrication of non - metal composite panels which give good output with low cost in less time duration. There are many techniques to fabricate the composite panels automatically by using machines, which is costly. Hand layup method reduces cost and gives good output with our desire accuracy. From the above literaturesit is find out that, honeycomb sandwich panel are used in many civil structures such as bridge and pedestrian decks, roof panels, railway sleepers, bridge beam etc. Their properties like high stiffness to weight ratio, high thermal insulation property, and high impact and vibration absorption rates are very useful for civil structures. The structural behavior of honeycomb sandwich panel depends upon theparameters such as core height, face sheet thickness, cell size, cell thickness, cell geometry.

➢ *Mechanical Test Results Comparison:*

Table 4 Comparison Results of Aluminum and Nomex Honeycomb Panel

Sl. No	Material	Flexuralstrength Mpa	Compression Strength(KN)	SpecimenType	Specimen Area
1.	Nomex honeycomb sandwich panel	36.11 Mpa	15.680 KN	flat	500*500*10mm
2.	Aluminum honeycomb sandwich panel	11.58Mpa	14.960 KN	flat	500*500*10mm

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