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Experimental Study of Pressure Deformation on Honeycomb Structures With Variations in Hexagonal Size Tested Static

Study Of Pressure deformation Experiments On Beehive Structure With Hexagonal Size Variations Tested Static

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ABSTRACT

Since ancient times, humans have tried to create new materials that are strong, rigid, lightweight and inexpensive. The honeycomb structure is a man-made material that has a honeycomb geometry to minimize the amount of material used, to achieve a minimum weight so that a light mass is obtained for the construction. This honeycomb structure is commonly used in aerospace applications, transportation, F1 racing and many other industries. In general, the purpose of this research is to determine the level of deformation, stress-strain that occurs in the honeycomb structure which is tested statically in compression. The honeycomb is made using aluminum material with a thickness of 0.4 mm and then formed with varying hexagonal sizes, namely 2 mm, 4 mm and 6 mm. This compression test is carried out using a Universal Testing Machine with 2 positions, namely horizontal and vertical. The specimen is pressed until it finds a broken point that is visible on the graph. The results obtained from this compressive test are in the form of deformation values and the maximum force acting on the specimen. From the results of the comparison of hexagonal size variations, it can be concluded that the larger the size of the honeycomb hexagon, the greater the deformation that occurs

Keywords : Aluminum, Honeycomb, Deformation, Universal Testing Machine

INTRODUCTION

Developing new things and improving quality has become a necessity for the industry to exist, develop and advance which is of more value according to today's times. The advantages obtained will be useful, economical, practical, and efficient. Especially those related to the field of manufacturing construction with these advantages will encourage people to create new materials to meet industrial needs, one of the industries that requires new innovation is aircraft. Airframe construction is a necessary thing a new innovation, the honeycomb structure is a natural or man-made structure (material) that has a honeycomb-shaped geometry. From the shape of this structure, it is used to minimize the amount of material used which aims to achieve a light mass weight and relatively low cost for the construction of the fuselage.

In addition to focusing on the light mass of the material, a large degree of flexibility is also obtained from the selection of composite materials. Every material that is given a load will experience a change (deformation), the magnitude of the deformation value can be known because of the stress and strain values that occur in the material that is given a load, deformation in certain parts is very undesirable, Aluminum is a metal that has a relatively low strength, soft but has good corrosion resistance and electrical conductivity. Aluminum was discovered in 1825 by*Hans Christian Oersted.* Just confirmed for sure by*F. Wohler*in 1827.

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The source of this element is not free, the main ore is Bauxite. Other uses of Aluminum are for the manufacture of cables, aircraft frames, automobiles and various household products. Its compounds can be used as medicine, water purifier, photography as well as as a paint ingredient, coloring agent, sandpaper and synthetic gems1.

Aluminum is one of group III A which is a metallic element that has a shiny silver white color. Aluminum is also 10 grams electropositive and in the air aluminum is a metal that is resistant to rust. Modern technology applications generally require materials with unusual combinations of properties that are not found in conventional materials, ceramics or polymers. Therefore, a new type of material has emerged that is combined with aluminum, because it has the necessary properties and fulfills its use, with a combination of macro-scale properties and is growing rapidly at this time called composite materials.2.

The general properties of aluminum are superior when compared to other metals so that the use of aluminum is widely used in everyday life, while the general properties of aluminum are as follows:

1. Light
2. Strong
3. Corrosion Resistance
4. Good Electrical Conductivity
5. Anti-Magnetic
6. Toxicity
7. Ease of processing (forging)

Aluminum has the physical properties shown in the table below:

Table 1. Physical Properties of Aluminum

No	Sifat	Nilai
1	Jari-jari atom	Empiris :143 pm
2	Volume atom	10 cm/gr.atm
3	Density (660^{o} C)	2,368 gr/.atm
4	Density (20^{o}C)	2,698 gr/ atm
5	Potensial elektroda (25^{o} C)	-1,67 volt
6	Kapasitasa panas (25^{o} C)	5,38 cal/mol ^{o}C
7	Panas pembakaran	399 cal/gr mol
8	Tensile strength	700 Mpa
9	Kekasaran brinnel	12-16 skala mehs
10	Hantaran panas (25^{o}C)	0,49 cal/det ^{o}C
11	Valensi	3
12	Kekentalan	0,0127 poise
13	Panas peleburan	94,6 cal/gr
14	Panas uap	200 cal/gr
15	Massa atom	26,98
16	Titik lebur	660 ^{o}C
17	Titik didih	2452 ^{o}C
18	Tegangan permukaan	900 dyne/cm
19	Tegangan tarik	4,76 kg/mm

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Aluminum Honeycomb is an artificial material structure that has many shapes such as square, triangle, rhombus or kagome and different cell shapes, each shape has different advantages, for example a square honeycomb would be better to be the core of a sandwich panel for impulsive loads intense, due to good crushing resistance, large transverse strength and strong in stretching3. (xiong zhang. 2014).

Aluminum honeycomb is widely used in the material industry for making trains, aircraft and automotive because it has good physical and mechanical properties4(B.Hou et al. 2012) The honeycomb shape has advantages compared to other conventional materials, including:

1. Light
2. Have good strength
3. Durable
4. Reduce production costs

This honeycomb construction is a layered construction on a thin sheet high modulus (strong skin) and light core. The surface bears the load, the core constrains the surface and transfers shear forces, among other things, to be effective around a common axis. During World War II honeycomb construction based on skinned panels *plywood*honeycomb core, now polymer is more widely used in the wings and tail of airplanes5(Buitrago Brenda L, et al. 2009)

In addition to applications in the aerospace industry, currently honeycomb construction has also been widely used for parts of transportation, one of which is F1 car bodies, sports equipment, ship structures and the oil and gas industry (Xiuhui et al 2016). The honeycomb structure consists of an unlimited variety of materials and configurations. Honeycomb Sandwich structures are generally made of composite materials, so that a light mass is obtained for the construction. In addition to being aimed at the mass of lightweight construction materials, a large degree of flexibility is also obtained from the selection of these composite materials6(YanTing Ren, 2014) The selection of honeycomb as the construction material to be used, has received various considerations based on needs, so that the use of this material is the right choice and meets the desired criteria. There are several structural considerations of honeycomb, namely:

A. Structural Considerations
   1. Strength
      The essence of this Honeycomb Sandwich structure and the coating material which has good mechanical properties can result in an increase in the material's strength (Muzamil husain 2018).
   2. Stiffness
      Honeycomb Sandwich structures are often used to obtain high rigidity and light weight. The shear force acting on the core is relatively low, but the selection of the right material must be appropriate to allow the shear stress to occur.

B. Environment.
   1. Temperature
      Selection of the right material for Honeycomb Sandwich applications to work well generally ranges from -55°C to 170°C.
   2. Flammability

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This category of environmental considerations for Flammability consists of

a. Non-flammable (resistance to fire)
b. Can reduce the cause of the increase in fire when burning
c. Can separate the occurrence of increased burning of the material

3. Heat transfer

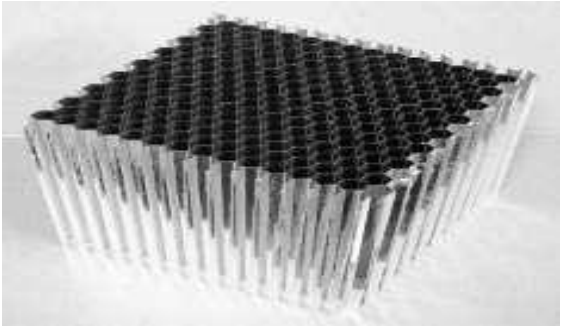

Figure 1.Aluminum Honeycomb

This sandwich composite is a type of structural composite that has the potential to be developed in manufacturing applications. Composite structure*sandwich*consists of two surfaces*(skins)*thin, rigid and strong bound with a core*(cores)*thick, light and weak using adhesive materials*(adhesives)*.Core/*core*a composite*sandwich*made of light weight, low cost, must be able to guarantee the supported and separated surfaces, can work as a unit and must withstand transverse shear loads and transverse normal. Material*core* which are often used in research include wood (sea sengon, balsa),*Foam (PVC, PU)*, structure *honeycomb* and others9(Buitrago Brenda L).

Composite parts *sandwich* that is:

A. Skins

Is the part that serves to hold*tensile*and*compressive stress*, *skin*usually have a rigid or low level of rigidity. Conventional materials such as aluminum, steel, stainless steel can be used for this section

B. Core

It is a very important part of*sandwich*,where*core* must have sufficient parts that are sufficiently rigid so that the distance between the surfaces is maintained with the stiffness possessed by*core*must be able to withstand shear so that there is no slide between surfaces (wen yea jang 2014). Materials with low stiffness are not good for*cores*,because of the rigidity of *sandwich* will reduced or lost. Not only strong and has a low density,*core* usually have other conditions, such as the level of water content,*buckling*, long life and so on10.(F. Lopez et al, 2013)

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Figure 2.Honeycomb sandwich structure (A. Abbadi, 2010)

Deformation is a change in the shape of an object due to receiving a force or when the object is working. Deformation in quantum mechanics is the change in an object from its original state to its current state. The meaning of "condition" can be interpreted as a series of positions of all particles in the object. The cause of deformation can be caused by external forces, internal forces (such as gravity or electromagnetic forces) or changes in temperature inside the object (expansion).(Ines Ivanes 2017). The formula for deformation/increase in length is:

$$\mathbf{1} = \frac{\mathbf{1}}{\boldsymbol{E}} = \frac{\boldsymbol{P}.\mathbf{1}}{\boldsymbol{A}.\boldsymbol{E}}$$

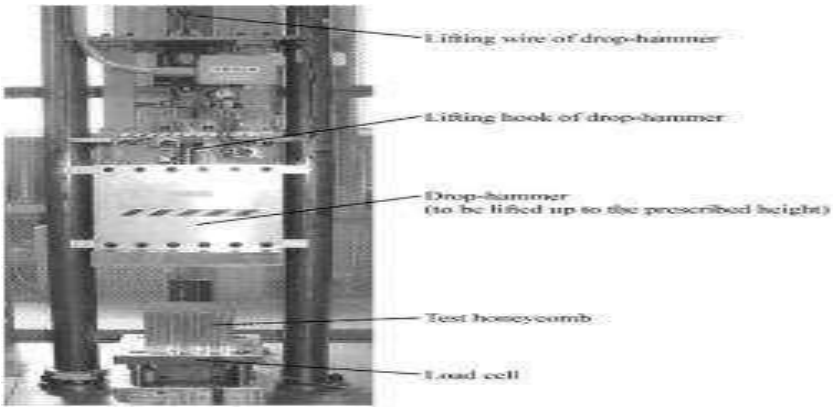

Figure 3.Universal Testing Machine (yamashita, 2005)

METHODS

The method used in this research is starting from data collection, design and manufacture of aluminum honeycomb with various sizes*hexagonal*and tested by *Static*. The test uses a static compression test tool to determine the deformation, so as to obtain the strength and durability of the honeycomb structure with variations in hexagonal size.

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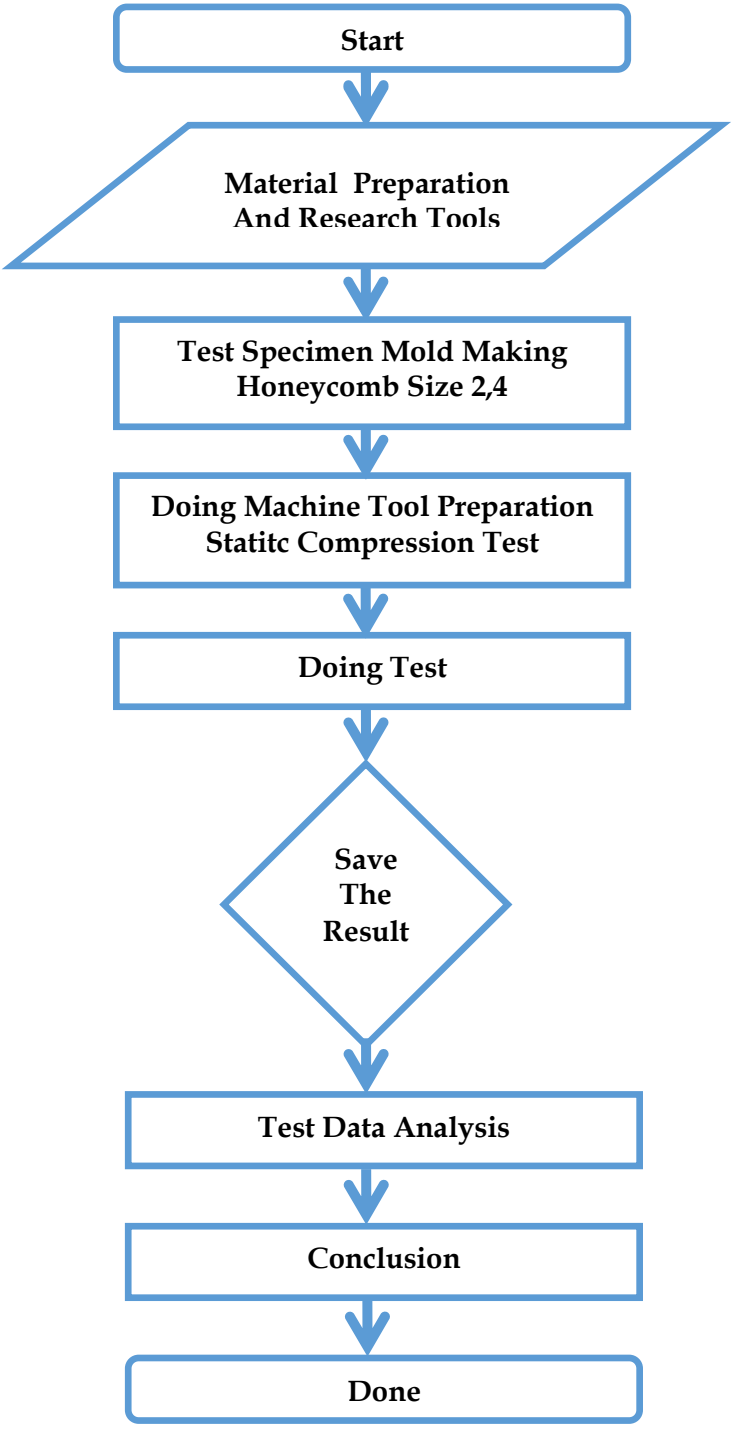

Figure 4. Research Flowchart

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RESULTS AND DISCUSSION

Specimens measuring 2 mm experienced a change in shape after undergoing the test press the deformation can be calculated the existing method. The change in shape can be seen as in the picture:

a. Before testing b. After being tested

Figure 8.specimen (a) before testing (b) after testing

A. Deformation

$$\Delta l = \frac{F.l}{A.E}$$

$$\Delta l = \frac{25.864{,}16}{384.873{,}6003} = 1{,}542 mm$$

B. Voltage

$$\sigma = \frac{F}{A}$$

$$\sigma = \frac{F}{A} = \frac{25864{,}16N}{384} = 67{,}355\ Mpa$$

C. Strain

$$\varepsilon = \frac{\Delta I}{1} = 0{,}077\ mm$$

CONCLUSION

1. The specimens used are made of aluminum with a thickness of 0.4 mm which is formed hexagonally with various sizes, 2 mm, 4 mm and 6 mm
2. Static compression test is carried out to determine the deformation value of the specimen
3. Testing using a Universal Testing Machine which has a maximum compressive/ tensile force of 5000 kg or 49000 N

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4. The maximum strength and resistance of the specimen is known from the value/ highest point of
5. Deformation, force, stress and strain on the specimen
6. From the results of the test data, it can be concluded that the larger the hexagonal size, the greater the deformation value obtained. If the larger the hexagonal size, the smaller the working force.
7. From the comparison of the horizontal and vertical tests, it can be concluded that the deformation value in the horizontal test is lower than the vertical test, the force value in the horizontal test is higher than in the vertical test, and the stress value in the horizontal test is higher than the vertical test, the strain value on the horizontal test is lower than the test.

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