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Study of Statically Tested Honeycomb Structure

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ABSTRACT
Honeycomb structure is a natural or man-made structure (material) that has the geometry of the honeycomb, in addition to being directed to the mass of light construction material, also obtained a degree of flexibility from the selection of such materials. The purpose of this study is to analyze the ability of energy absorption in static press testing. Energy absorption is a method of how an object attenuated due to external pressure. Energy absorption testing is conducted with static press tests, aluminum plate test objects in the form of honeycomb structures with different hexagonal size variations. This test will compare the results of voltage data – strain and energy suppression in each specimen that has been tested to see which is more efficient among three specimens of different hexagonal sizes. The final results of this test will be displayed using a voltage graph – horizontal and vertical position strain and energy absorption capability with horizontal and vertical testing positions. Therefore, the largest energy absorption result is in the horizontal testing position with a hexagonal size of 2 mm, and the smallest energy absorption is found in the vertical testing position with a hexagonal size of 6 mm

Keywords : ***honeycomb, energy absorption, static test***

INTRODUCTION

The development of technology today is growing very rapidly as time goes by and the development of human thinking patterns. This is due to the human need for ease and efficiency in the field of industry. In the development of the industrial world, especially related to the research of materials and their use. Utilization of honeycomb structures in the industry has grown rapidly. Some industries that require light, rigid and robust construction have utilized this structure. Industries that have utilized this structure include the aircraft, shipping, automotive and building industries. Honeycomb structure is a natural or man-made structure (material) that has the geometry of the honeycomb minimizes the amount of material used to achieve a minimal weight and relatively low cost, so that a light mass is obtained against the construction. In addition to being aimed at the light mass of construction materials, there is also a considerable degree of flexibility from the selection of such materials.

Research conducted by A. Atiqah et al. (2020), Higher filler honeycomb content reduces the impact and hardness of property. Morphology of surface impact of surface shards of playable fibers pulled out, cavities, and matrix cracks. the existingsifat of any addition of fillers will affect the adhesion of fibersand composite matrices. Thus, natural honeycomb fibers are biased to be potential candidates to replace synthetic fibers as reinforcement binders in polymer composites. A composite

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is a material formed from a combination of two or more materials so that composite materials are produced that have mechanical properties and different characteristics of the forming material. Composites have better mechanical properties than metals, type rigidity (Modulus Young/density) and higher density of metals. Some composite lamina can be stacked in different direction of fiber orientation, this compound lamina is referred to as laminate. So that the composite can be concluded as two or more kinds of material combined or combined in a macroscopic scale (can be seen directly by the eye) so that it becomes a new material that is more useful [2].

LITERATURE REVIEW

Sandwitch Composite

This sandwich composite is a type of structural composite that has the potential to be developed in manufacturing applications. The composite structure of the sandwich consists of two thin, stiff and strong surfaces (skins) tied with thick cores, light weight and weak adhesive materials. The core of a sandwich composite is made lightweight, low cost, must be able to guarantee supported and separated surfaces, can work as a single unit and must withstand transverse and normal transverse shear loads. Core materials that are often used in research include wood (sea sengon, balsa), Foam (PVC, PU), honeycomb structure and others. The part of the sandwich composite are: [3].

a. Skin
   Is a part that serves to withstand tensile and compresive stress, skin usually has rigid or low rigidity. Conventional materials such as aluminum, steel, stainles steel can be used for this part. Plastic materials reinforced with glass fibers and fibers are a good choice because these materials have advantages such as easy to combine, design can be designed according to needs, as well as good surface shape.
b. Core
   It is a very important part of the sandwitch, where the core must have enough rigid parts so that the distance between the surface is maintained and the rigidity possessed by the core must be able to withstand the slide so that there is no slide between the surfaces. Materials with low rigidity are not good for the core, because the stiffness in the sandwitch will be reduced or lost. Not only strong and has a low density, cores usually have other conditions, such as moisture content level, buckling, long life and so on.
c. Adhesive
   Is an ingredient that will glue between the skin and cores, in addition to glue adhesive must also transfer the shear force between the skin and cores in order to maintain the strength of the sandwicth. Adhesive should also be able to maintain strain and shear force. Sandwitch Honeycomb as Figure 1 below [4].

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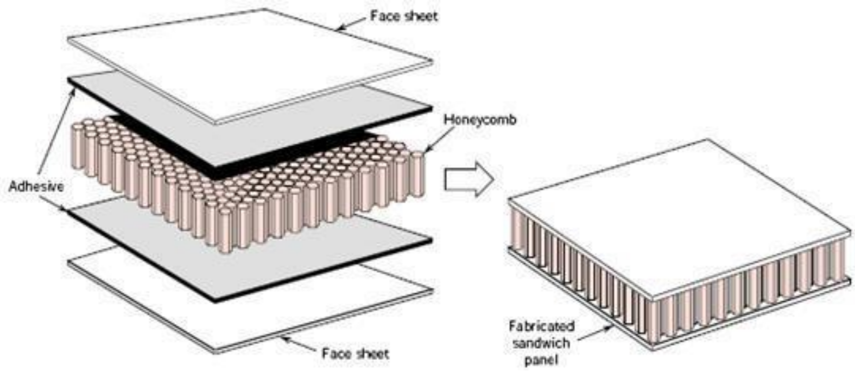

Figure 1. Sandwitch Honeycomb

Honeycomb

Honeycomb's structure consists of an unlimited variety of materials and configurations. Honeycomb structures are generally made of composite material, so a light mass is obtained against the construction. In addition to being aimed at the light mass of construction materials, there is also a considerable degree of flexibility from the selection of composite materials. Structural considerations on honeycomb sandwiches are:

1. Power
   The core of this Honeycomb Sandwich structure and coating materials that have good mechanical properties can result in an increase in material to its strength. In addition, the treatment of damage or defects in materials should always be checked for futures to ensure that no deformities or other abnormalities can make the construction of the Honeycomb Sandwich reduced in strength.
2. Stiffness
   Honeycomb Sandwich structure is often used to get high rigidity and also light weight. The shear force that works on the core is relatively low, but the selection of the right material must be precise to allow the shear voltage to occur. In addition, the gluing factor of the top and bottom material layers to the core also affects these structural considerations.
3. Temperature
   The right material selection of Honeycomb Sandwich to be able to work properly generally ranges from -55°C to 170°C.
4. Flammabillity
   Flammabillity consists of 3 namely:
   - No burn (burn resistant)
   - Can reduce the cause of increased fire when burning
   - Can separate the occurrence of increased burn in the material

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5. Heat Transfer
Heat transfer such as conduction, convection and radiation depend on the selection of the material. However, honeycomb sandwich structure is better for these three heat transfer compared to other conventional structures. Generally the cell shape in the structure of Honeycomb Sandwich is hexagon-shaped with different sizes as needed and allows there to be further development that varies special forms to obtain certain characteristics of the use of this Honeycomb Sandwich.

Press Test

Objects have a strength that can not be guessed or predicted, sometimes there are objects that have strong strength and also light. After the development of technology in the world at this time the strength of the object can be measured or known with a press test tool. A press test is a mechanical test tool that is useful for measuring and knowing the strength of objects against compressive forces. This press test has good performance and quality to know the strength of the object. Generally this press test is used on metals that are vibrating, because this press test tool has a point of destruction that is clearly visible when testing the object.

Static Press Testing

The press voltage is opposite to the tensile voltage. If at the tensile voltage, the direction of both forces knows the tip of the object (the two forces are far apart), then at the compressive voltage, the direction of the two forces approaches each other. In other words the object is not drawn but pressed (the styles work inside the object). The compressive strength of the material is the uniaxial press voltage value that has a failure mode when testing. Changes in the shape of objects caused by compressive voltage are called clogging. For example, on poles that support the load, such as building poles are subjected to press voltage. Compressive strength is usually obtained from experiments with press testing tools. When in later testing, specimens (usually cylinders) will become smaller as they spread. Changes in objects caused by compressed voltage can be seen in Figure 2.

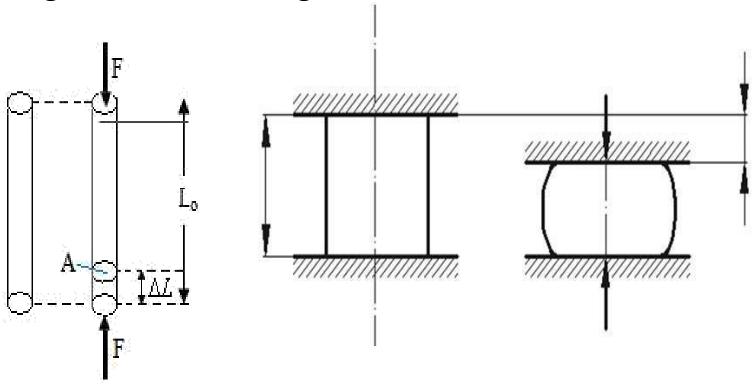

Figure 2. Changes in objects caused by axial press voltage

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Voltage Equation – Strain

A rod or selinder that is subject to press load will undergo a change in length accompanied by a reduction in the cross-sectional area of the elastic area of the material. The tension curve of the strain due to compressive load can be shown in Figure 3. In this study there are materials that undergo plastic deformation if continuously given voltage and this material will not change its original form. Usually technical materials occur in elastic areas that are almost narrowed to the maximum limit.

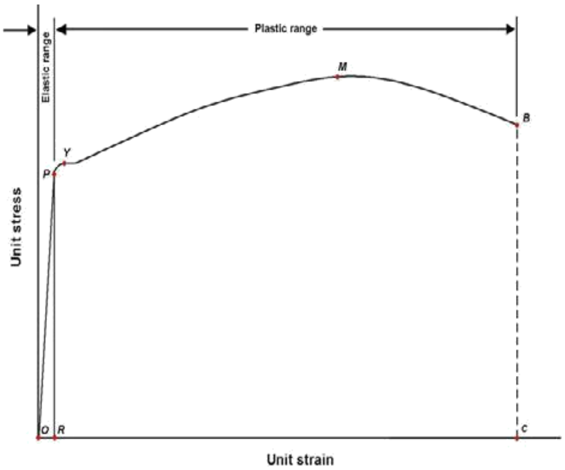

Figure 3. Strain Voltage Curve

Tensile Test

A tensile test is a retraction or tensile voltage to a material to determine the strength of a material. Tensile testing is performed by providing continuous tensile force to the material, so that the material undergoes an increased and regular extension until it breaks, with the aim of determining the tensile value of the material. To know the tensile strength of a material in tensile loading, the force line must be squeezed with the material axis line so that the loading that occurs the pull load is straight. But if the angle pull force is squeezed then what happens is the flexible force. The results of the tensile test recorded a voltage-strain relationship during the tensile test process. Tensile test is often used in engineering activities to know the mechanical properties of a material. Tensile tests are often performed to complete the basic design information of a material's strength and as additional material specification data. In the tensile test the object tested was given a cosy tensile force that increased significantly, along with observations of the extension experienced by the test object.

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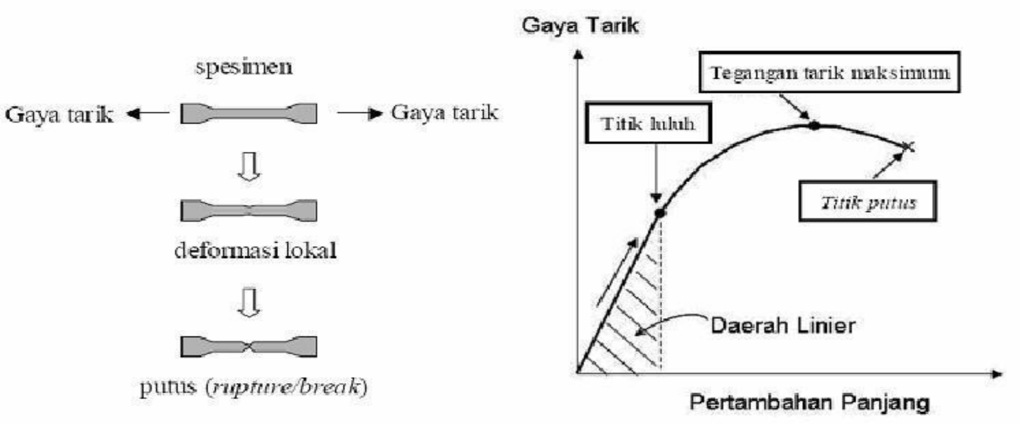

Figure 4. Tensile Test

Energy Absorption

Energy absorbtion materials (EAMs) are optimally designed to absorb kinetic energy, static, plastic deformation, and other mechanisms. Energy-absorbing materials are used in everyday life such as samples in aircraft bodies, automobiles, electronic devices, personal protective equipment, shock wave reliever, vibration reduction, or to distribute pressure on an object. The rapid advancement of this technology has sparked interest (EAMs) with a larger absorption capacity that is energy absorbtion capacity (EAC). Due to the high static deformation of metals, excellent toughness in composites, and so on. These materials are already widely used in energy absorption structures, because the voltage-strain response is very high in the objects used. In terms of energy absorption in objects as well as materials can be affected by the area of the cross-section. The cross-sectional area on the surface of the workpiece is very influential on the process of energy absorption when at the time of static press test because the greater the surface area on the object, the greater the ability to absorb energy produced in objects and vice versa [6].

METHODS

Specimen Testing Procedure

Aluminum sheet used with a thickness of 0.4 mm to make the core of the honeycomb structure formed using a core printer, as for the physical properties of the aluminum plate is in following table 1:

Table 1. Physical Properties of The Aluminum Plate

No	Nature	Description
1.	Densitas Yield	2.8 g/cm^2 (170 lb/ft^2)
2.	Strenght	47 to 220 MPa (6.8 to 32 x 10^3 psi) 69 GPa
3.	Modulus Young	($10x10^6$ psi)
4.	Poison Ratio	0,33

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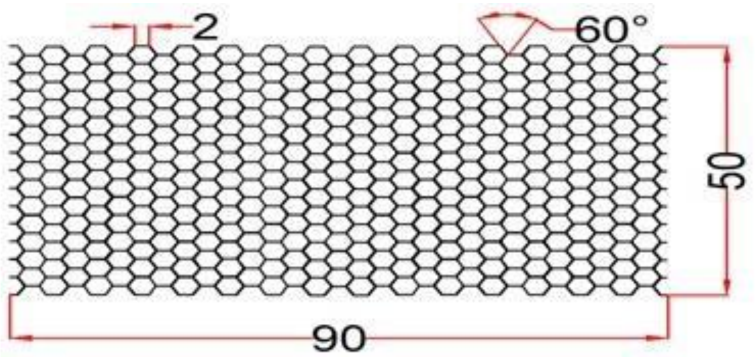

Figure 5. Dimensions of hexagonal specimen 2 mm

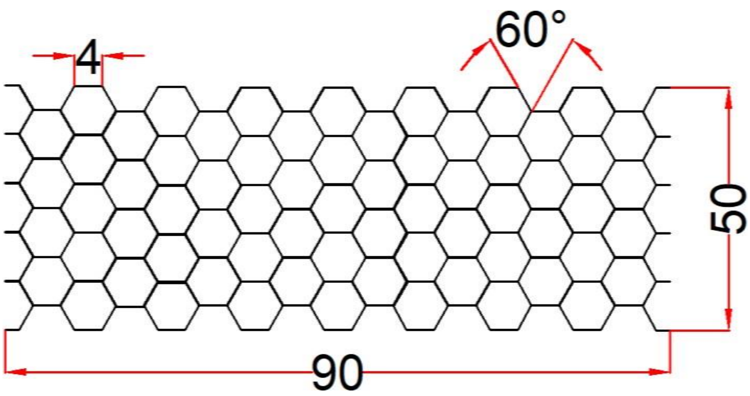

Figure 6. Dimensions of hexagonal specimen 4 mm

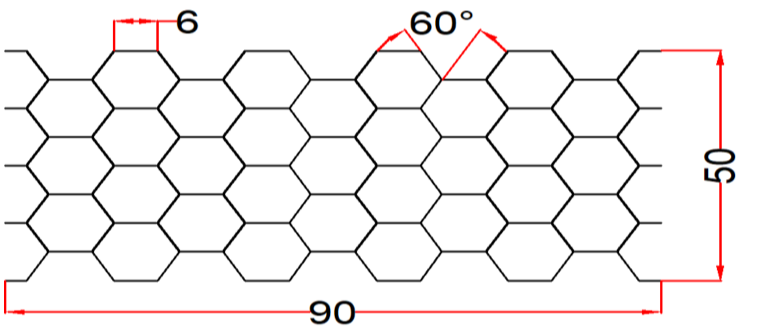

Figure 7. Dimensions of hexagonal specimen 6 mm

The specimen testing procedure using static press test equipment can be seen as follows**:**

1. Set up your CPU and PC
2. Connect sensor to CPU
3. Turn on the machine by pressing the ON button on the
4. Measuring the dimensions of the workpiece

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5. Enter the dimensions data of the workpiece on the computer
6. Installing the workpiece (specimen) so that it has no space at the time of testing and tightening the locking bolt
7. Turn the setting switch > testing
8. Press the start button
9. After the workpiece has changed shape, save the data on the computer
10. Press the OFF button as in the
11. Move data using disk
12. Turn off the test equipment and clean the tool used.

This press test machine runs manually, so even if the press test specimen reaches the optimal limit until it changes shape, it will continue to run. Therefore, operators are always on the side of the machine to control the static press testing process.

RESULT AND DISCUSSION

Graph strain voltage specimen 1 size (hexagonal 2 mm)

From the calculation above, the voltage strain graph is obtained as follows:

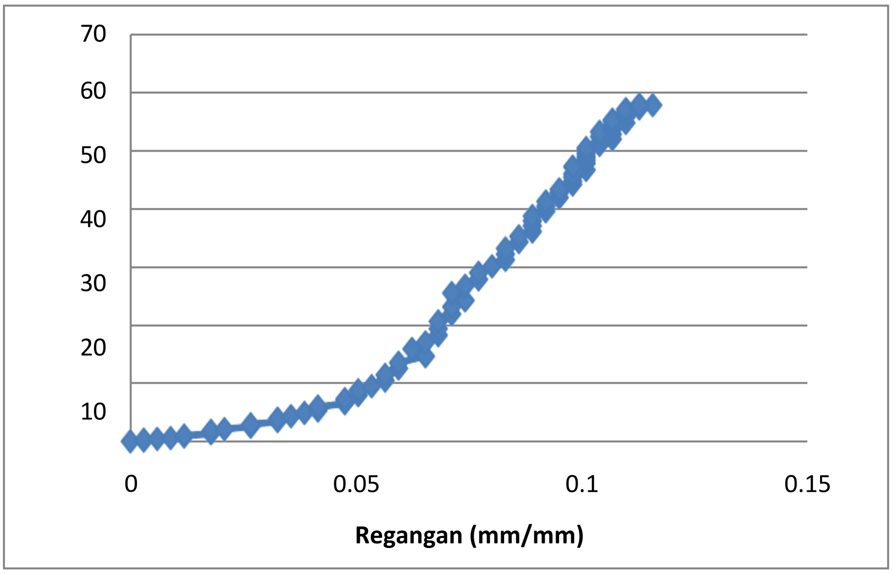

Figure 7. Graph Strain voltage 2 mm.

From the graph above we can see that the peak voltage value is 57.71408 Mpa, and the strain value is 0.11275 mm/mm.

Graph strain voltage specimen 2 size (hexagonal 4 mm)

From the calculation above, the voltage strain graph is obtained as follows:

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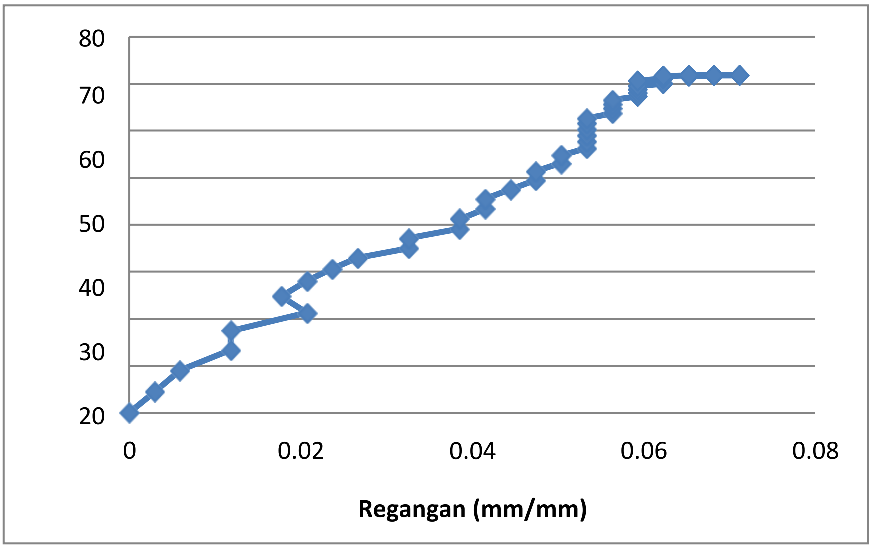

Figure 8. Graph Strain voltage 4 mm.

From the graph above we can see that the peak voltage value is 71.84913 Mpa, and the strain value is 0.0682 mm/mm

Graph strain voltage specimen 3 size (hexagonal 6 mm)

From the calculation above, the voltage strain graph is obtained as follows:

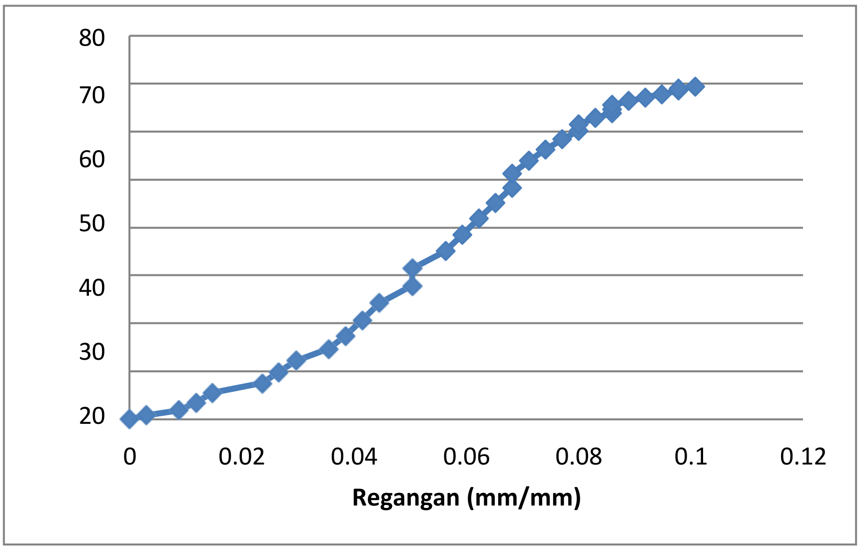

Figure 9. Graph Strain voltage 6 mm.

From the chart above we can see that the peak voltage value is 69.06004 Mpa, and the strain value is 0.10085 mm/mm.

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Voltage and Strain Chart Comparison

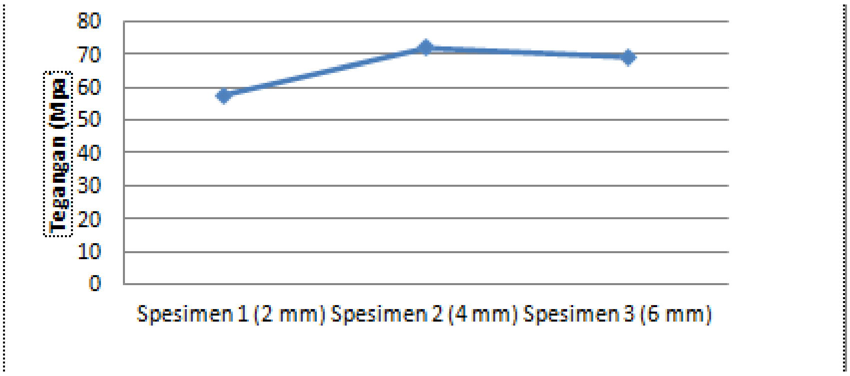

Figure 10. Voltage comparison graph

Energy Absorption Graph Comparison

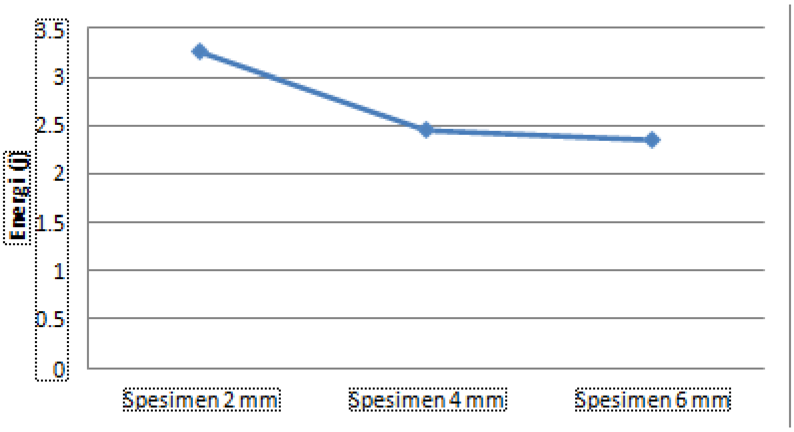

Figure 10. Absorption comparison graph

From the graph above can be concluded that the largest energy absorption is found in specimen 1 with a size (hexagonal 2 mm) of 2.25363 joules, and the lowest energy absorption is found in specimen 3 with a size (hexagonal 6 mm) of 2.35494 joules. This can be caused by several factors, one of which is because of the difference in the cross-sectional area on the surface of the workpiece, the larger the surface of the object, the greater the absorption of energy that occurs in objects such as in this study where the cross-sectional area in the first specimen is 691.2 mm, while in the third specimen the cross-sectional area is 384 mm. So it can be concluded that the larger the cross-sectional area on the object, the greater the ability to absorb energy in objects due to static load.

CONCLUSION

Based on the results of the research and discussion in the previous chapter, the author can draw the conclusion that:

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1. From the results of static press testing at the horizontal position obtained maximum voltage in each - each specimen is specimen 1 (hexagonal size 2 mm) is 57.71408 Mpa, specimen 2 (hexagonal size 4 mm) is 71.84913 Mpa, specimen 3 (size 6 mm) is 69.06004 Mpa. And the results of static press testing at the vertical position obtained maximum voltage in each specimen ie specimen 1 (hexagonal size 2 mm) is 4.7787 Mpa, specimen 2 (hexagonal size 4 mm) is 0.84577 Mpa, specimen 3 (size 6 mm) is 0.63781 Mpa.
2. In static press testing at the horizontal position obtained the maximum strain of specimen 1 (size 2 mm) is 0.11275 mm, specimen 2 (size 4 mm) is 0.0682 mm, and specimen 3 (size 6 mm) is 0.10085 mm. And in static press testing at the vertical position obtained the maximum strain of specimen 1 (size 2 mm) is 0.1504 mm, specimen 2 (size 4 mm) is 0.18396 mm, and specimen 3 (size 6 mm) is 0.18752 mm.
3. The largest energy absorption result in the horizontal position is in specimen 1 (hexagonal size 2 mm) of 3.25363 joules, while the smallest energy absorption is found in specimen 3 (hexagonal size 6 mm) of 2.35494 joules. And the largest energy absorption result in the vertical position is in specimen 1 (hexagonal size 2 mm) of 0.38 joules, while the smallest energy absorption is found in specimen 3 (hexagonal size 6 mm) of 0.0598 joules.
4. The greater the cross-sectional area of an object, the greater the ability to apply energy to an object, and vice versa.
5. The strength of the adhesive or matrix on the core plays an important role in the shear voltage strength of the specimen.

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