POLITEKNIK MALAYSIA
SULTAN HAJI AHMAD SHAH

TITLE: Study of Polymer Concrete for Composite Pre-Cast Plate Material Application

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PLATE MATERIAL

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This report is submitted to the Department of Mechanical Engineering as part of the conditions for the award of the Diploma in Mechanical Engineering.

JABATAN KEJURUTERAAN MEKANIKAL

DISEMBER 2020

AKUAN KEASLIAN DAN HAK MILIK

TAJUK : Study of Polymer Concrete for Composite Pre-Cast Plate Material Application

SESI : DISEMBER 2020

1. Kami,

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1. Adalah pelajar tahun akhir Diploma Kejuruteraan Mekanikal, Jabatan Kejuruteraan Mekanikal (Automotif), Politeknik Sultan Haji Ahmad Shah, yang beralamat di Semambu, 25350 Kuantan, Pahang. (Selepas ini dirujuk sebagai "Politeknik tersebut')

2. Kami mengakui bahawa 'Projek tersebut di atas' dan harta intelek yang ada di dalamnya adalah hasil karya/ reka cipta asli kami tanpa mengambil atau meniru mana-mana harta intelek daripada pihak-pihak lain.

3. Kami bersetuju melepaskan pemilihan harta intelek 'Projek tersebut' kepada Politeknik Sultan Haji Ahmad Shah bagi memenuhi keperluan untuk penganugerahan Diploma Kejuruteraan Mekanikal (Automotif) kepada kami.

Diperbuat dan sebenar benarnya diakui oleh yang tersebut:

	…….
MOHAMAD AKMAL RAFIQ BIN ANUA	AKMAL
	…….
MUHAMMAD SYAHIR FARIS BIN SEPRAN	SYAHIR
	…….
MUHAMMAD IMRAN BIN MOHD NORZAWAKY	IMRAN
	…….
BUKHARI BIN SUKRI	BUKHARI
Di hadapan saya, MOHD SOFFI MANDA	…….
Sebagai penyelia pada tarikh ……	EN SOFFI

APPRECIATION

All praise be to Allah SWT who has allowed me to complete this project proposal successfully. Without Allah SWT permission as well as Allah SWT bounty and grace this project would not have been possible to be successfully completed.

First of all, many thanks to the supervisor of this project, Mr. MOHAMMAD SOFFI MANDA for the guidance and guidance given throughout the project completion period. We will never forget all the instructions given.

This appreciation is also extended to our parents who have helped us a lot in terms of moral support. They are the backbone of this project. Thank you so much for your unwavering encouragement and support in making this project a success. Also don't forget to make your comrades in arms whose involvement in producing this project is undeniable. Without their help, it would not have been possible for this project to succeed like this.

Finally, a big thank you to everyone who has been involved in making this project a success. I will never forget your services. Only God is able to repay your kindness. Thank you for the encouragement and enthusiasm you lent to make this project a success.

ABSTRACT

In this modern era, we can observe around that all types of products available at home or at work are all more sophisticated. This is because, through the development of technology in the 2020 century, various types of products can be obtained easily for example in the business sector and the economic sector through the business conducted by entrepreneurs can develop their business activities through online sales. In addition, they can find customers faster through advertising on television broadcasts as well as on social media and can increase their daily profit rate. There is no denying that technology will evolve with the passage of time. Therefore, we have thought of a project to improve the existing product technology. In this project, there are several objectives that we have focused on, namely to investigate the strength limit of Pre-cast sheet material using Polymer Concrete through experimental. The second is to design and fabricate pre-cast sheet material using polymer concrete material. Last, to test the load bearing capability of the polymer concrete pre-cast sheet material

The project was selected after several studies and analyzes were done. This study and analysis was done after the problems we identified. Therefore, ‘Inventor’ computer software along with hand sketches were used to build the shape of this project. Through this study, we were able to identify the level of durability of our products having a positive impact on society. This experimental process is also related to the formula that we have found in the subject of ‘Engineering Science’. For better innovation, the materials used are taken into account for a manufacturing process that looks neat thus saving costs.

TABLE OF CONTENT

CHAPTER 1

INTRODUCTION

1.1 Background of Project

Polymer concrete is the composite material made by fully replacing the cement hydrate binders of conventional cement concrete with polymer binders or liquid resins, and is a kind of concrete-polymer composite. There are many types of resin typically used in making polymer concrete such as epoxy resin, polyester resin, acrylate resin, vinyl resin and so on. The aggregates in conventional polymer concrete are still using river sands and gravels. Generally, property of polymer concrete is superior to cement concrete in term of curing time, higher strength, bulk modulus, acid or chemical material resistance and so on. The list that are provide in this report shows extensive information on advantageous and common applications of polymer concrete material.

The list below consisting of the advantages of polymer concrete:

i. It has high impact resistance and high compressive strength.
ii. This concrete is highly durable.
iii. Polymer concrete is highly resistant to freezing and thawing.
iv. Highly resistant to chemical attack and abrasion.
v. Permeability is lower than other conventional concrete.

The list below consisting of the common application of polymer concrete material:

- Repair to corrosion damaged concrete.
- Prestressed concrete.
- Nuclear power plants.
- Electrical or industrial construction.
- Marine works.
- Prefabricated structural components like acid tanks, manholes, drains, highway median barriers, and so forth.
- Waterproofing of structures.

Trench drains, in their simplest form, are nothing more than man-made channels that are used to convey excess water from one area of a given property to another area. It is one of the simplest forms of drainage systems that have been around for many years. Generally, it is fabricated using cement concrete material to form precast drain trench.

1.2 PROBLEM STATEMENT

Precast concrete can be challenging with its lack of flexibility once the structure has been built and delivered to the jobsite. Sometimes, precast structures are designed based on as-built drawings of what is expected to be encountered below ground. If a precast structure is built to tie into existing piping, there is the possibility of the existing piping to not be in the location expected, possibly rendering the precast structure useless. To avoid this situation, partial excavations can be performed in advance to confirm the location of utilities prior to manufacturing the precast structure. Structures can also be designed utilizing thin wall knockouts, which are sections of the precast wall specifically designed to be thinner and allowable to break through the area needed. This provides more flexibility in where the location of the pipe penetration occurs in the precast wall.

1.3 OBJECTIVE

Planning to implement this project has several objectives. These objectives have been set to meet the design requirements as described in the problem statement. Among the objectives of this project are as follows:

i. To investigate strength limit of Pre-cast sheet material using Polymer Concrete through experimental.

ii. To design and fabricate pre-cast sheet material using polymer concrete material.

iii. To test the load bearing capability of the polymer concrete pre-cast sheet material

1.4 PROJECT SCOPES

The scope of this project is set as a guide so that this project does not deviate from its track. Project objectives are referred to set these objectives by taking into account the constraints of time, capital and energy. Among the scope of this project are as follows:

i. In this case, 3 prototypes will be made separately with different polymer concrete ratios and one of them is a common product in the market.
ii. Before producing the product. Specimens were made and tested in terms of their durability first.

The material for the prototype tested will be recorded in terms of the strength aspect of the material before making the plate

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

2.1.1 Composite material

Composite material of all and typically consists of loose stones (aggregate) held with a matrix of cement. Concrete is an inexpensive material, and will not compress or shatter even under quite a large compressive force.However, concrete cannot survive tensile loading(i.e., if stretched it will quickly break apart). Therefore, to give concrete the ability to resist being stretched, steel bars, which can resist high stretching (tensile) forces, are often added to concrete to form reinforced concrete.

Composite is light in weight,strength to weight and stiffness to weight are greater than steel or aluminium, fatigue properties are better than common engineering metals.composites cannot corrode like steel and possible to achieve combinations of properties not attainable with metals, ceramics or polymers alone.

2.1.2 Composite Material Manufacturing Process

TCI offers a complete range of composite process molding materials and products for the high-end composite molding industry, including mold release (MR) and vacuum bagging (VB) films, PTFE coated fiberglass bleeder cloth, release fabrics, Edge Breathers, and breather fabrics. Our composite molding films are designed to withstand extreme temperatures while maintaining their release characteristics and are available in various colors to allow for easy identification. TCI's mold release films (MR) for composite molding combine the chemical inertness and universal non-stick properties of PTFE polymers with maximum conformability and heat resistance. Our MR and VB films can withstand the highest temperatures in the composite molding temperature range, making them ideal for use in the aerospace, wind turbine, and automotive industries.

2.1.3 Polymer Concrete as Composite Material

The early research and development of the polymer concrete was done mainly in the Soviet Union (currently, Russia), 1 the United States, 2 Germany 3 and Japan 4 in the late 1950s to the early 1960s. PC is a composite material in which the aggregate is bound together in a polymeric matrix. The polymer modified concrete can be used in the repair and the rehabilitation of old damaged concrete.

2.2 COMPOSITION OF POLYMER CONCRETE

Polymer concrete composed of Binder (material), aggregates, coarse aggregate, admixtures and filler. In a more narrow sense, binders are liquid or dough-like substances that harden by a chemical or physical process and bind fibres, filler powder and other particles added into it. Examples include glue, adhesive and thickening.

Fine aggregates	Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are ¼" or smaller. This product is often referred to as 1/4'" minus as it refers to the size, or grading, of this particular aggregate.
Coarse aggregate	Coarse aggregate is stone which are broken into small sizes and irregular in shape. In construction work the aggregate are used such as limestone and granite or river aggregate.
Admixtures	An admixture is a material other than water, aggregates, cementitious materials, and fiber reinforcement, used as an ingredient of a cementitious mixture to modify its freshly mixed, setting, or hardened properties and that is added to the batch before or during its mixing.
Filler	Fillers are materials whose function in concrete is based mainly on size and shape. They can interact with cement in several ways Polymer concrete consists of a minerals filler, for example, aggregate and a polymer binder, which may be thermoplastic, but more frequently is a thermosetting polymer. Sand is used as filler, and the combination is referred to as a polymer mortar.

2.2.1 Property compare to cement concrete.

Significantly greater tensile strength than unreinforced Portland concrete (since polymer plastic is 'stickier' than cement and has reasonable tensile strength)

2.2.2 Pre-Cast PC Drain (PCD)/ Pre-Cast PC Grating (PCG)/Pre-Cast PC Sheet Material(PCS)

Purpose of application

Precast Construction Technology consists of various precast elements such as walls, beams, slabs, columns, staircase, landing and some customized elements that are standardized and designed for stability, durability and structural integrity of the building.

Advantage over non-pre-cast product

Durability: Precast Concrete structure has a longer service time period and minimal maintenance. The high-density Precast Concrete is more durable to acid attack, corrosion, impact, reduces surface voids and resists the accumulation of dust.

Example of application

Alternative to precast cement drain

2.3 MANUFACTURING PROCESS OF PCD/PCG/PCS

Hand lay-up is an open molding method suitable for making a wide variety of composites products from very small to very large. Production volume per mold is low; however, it is feasible to produce substantial production quantities using multiple molds. Hand lay-up is the simplest composites molding method, offering low cost tooling, simple processing, and a wide range of part sizes. Design changes are readily made. There is a minimum investment in equipment. With skilled operators, good production rates and consistent quality are obtainable.

2.4 TOOLS FOR WET/ HAND LAYUP PROCESS

Simple, low cost, open mold fabrication process using liquid epoxy resin to position layers of laminations in a mold until desired shape/thickness is achieved. Woven such as plain, twill, plain basket waves, knitted, stitched bonded fabric layers are impregnated with an appropriate epoxy resin system by brush or roller to ensure high quality composite components/parts meet specific end use requirements. Vacuum bagging can be placed over the lay-up to assure no air entrapment or voids during polymorization. Room temperature, heat (oven) and autoclave curing products are available for processing low, medium, high production needs. Heat cure systems should be deliberately ramped up and down in temperature to prevent distortions/warpage from uneven expansion/contraction. Secondary posture process will enhance/maximize composite performance capability. Usage extends from wind turbine blades, auto/bus parts, aircraft components, structural panels, air handling equipment, housing, marine systems. Boat is produced through wet lay up process.

2.5 FLEXURAL PROPERTIES OF COMPOSITE MATERIAL

The flexural test measures the force required to bend a beam under three point loading conditions. The data is often used to select materials for parts that will support loads without flexing. Flexural modulus is used as an indication of a material's stiffness when flexed. Since the physical properties of many materials (especially thermoplastics) can vary depending on ambient temperature, it is sometimes appropriate to test materials at temperatures that simulate the intended end use environment.

2.5.1 ASTM D790

-ASTM D790 is a testing method to determine the flexural (bending) properties of reinforced and unreinforced plastics, high-modulus composites, and electrical insulation materials.

2.5.2 Specimen for ASTM D790

-A variety of specimen shapes can be used for this test, but the most commonly used specimen size for ASTM is 3.2mm x 12.7mm x 125mm (0.125" x 0.5" x 5.0") and for ISO is 10mm x 4mm x 80mm.

2.6 COMPRESSIVE PROPERTIES OF COMPOSITE MATERIAL

In mechanics, compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size. In other words, compressive strength resists compression, whereas tensile strength resists tension.

2.6.1 ASTM C579

ASTM C579 - 18 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

2.6.2 Specimen size for ASTM C579

Test Method A outlines the testing procedure generally used for systems containing aggregate less than 0.0625 in. (1.6 mm) in size. Test Method B covers the testing procedure generally used for systems containing aggregate from 0.0625 to 0.4 in. (1.6 to 10 mm) in size.

2.7 TENSILE PROPERTIES OF COMPOSITE MATERIAL

Tensile properties indicate how the material will react to forces being applied in tension. Tensile tests are used to determine the modulus of elasticity, elastic limit, elongation, proportional limit, reduction in area, tensile strength, yield point, yield strength and other tensile properties.

2.7.1 ASTM C496

ASTM C496 determines the splitting tensile strength of cylindrical concrete specimens, such as molded cylinders and drilled cores. The splitting tensile strength is typically greater than the direct tensile strength and lower than the flexural strength.

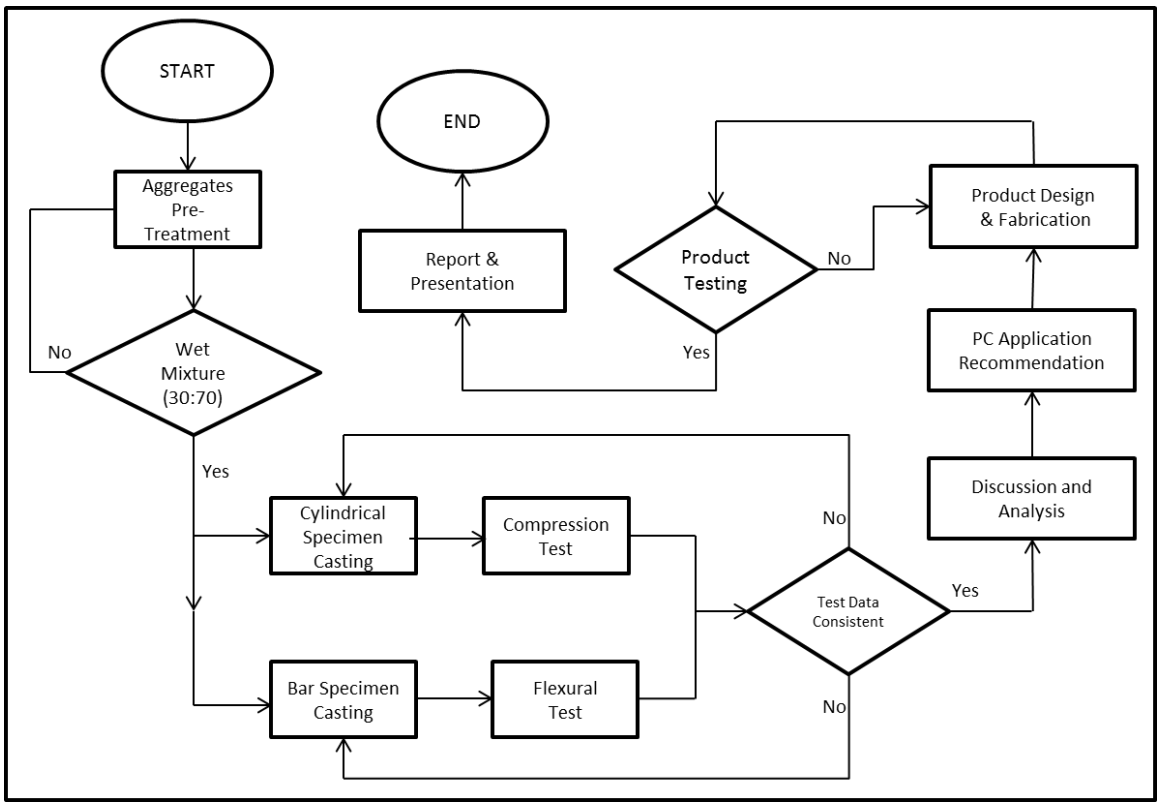
CHAPTER 3

RESEARCH METHODOLOGY

3. 1 INTRODUCTION

Cement concrete material are a brittle material. Pre-cast product made from cement concrete material is usually easily failed. Therefore the use of polymer to replace cement is predicted to reduce the brittleness of cement. In this study, the mechanical properties of polymer concrete under several variations will be investigated. Then a pre-cast product will be made from the polymer concrete material.

This study involves quantitative research. In this study, polymer concrete specimen will be made in several variations namely aggregate grading and resin-aggregate ratio as well as cement concrete for comparison purposes. Figure 3.1 below is a flowchart of research methodology.



3. 2 MATERIALS

a. Polyester Resin

Polyester resin is a matrix binder in polymer concrete. Instead of cement, polymeric materials are used as binder in polymer concrete. Polyester resin will be used with methyl ethyl ketone peroxide (MEKP) as hardener in 2% amount based on resin manufacturer recommendation.

b. River Sand

River sand will become fine aggregates in polymer concrete composition. The sieve size for fine aggregates is <4.75mm (Jaafari, 2018). Fine aggregates are the largest portion of concrete composite material. In this study, variation of 100% fine aggregates (Faidzal, 2018) to 47% (Khalid, 2015) will be applied.

c. Gravels

Gravels will become coarse aggregates in polymer concrete composition. According to Jaafari (2018), coarse aggregates will pass ≥4.75-9.5mm sieve. Coarse aggregates are generally the second largest portion in concrete composite materials after fine aggregates. In this study, up to 48% of coarse aggregates will be used in polymer concrete aggregate grading.

d. Fillers

Fillers is very fine particles that commonly employed to fill in voids among coarse and fine aggregates in concrete composite materials. There are many types of fillers and the most common is fly ash. However in this study, ground coffee husk will be used as fillers. The portion of fillers in this study is up to 18% of polymer concrete composition (Khalid, 2015).

e. Fibers

Fibers are common reinforcement materials in composite material. Fibers may be classify as natural and synthetic fibers. Natural fibers such as bamboo fibers, kenaf and many other are relatively lower strength compared to synthetic fibers. Example of synthetic fibers is glass fibers, carbon fibers, and many others. In this study, chopped glass fibers will be introduced as additional reinforcement in polymer concrete. According to Reis (2015), addition of 2% of 6mm chopped glass fibers into polymer concrete has increased the compressive strength in the range of 27.5% up to 45.4%. In this study, the same specification of fibers will be introduced in the polymer concrete specimen.

f. Moulds

Moulds is a main tools to be used for specimen preparation as well as pre-cast product. In this study, moulds for specimen will be of three variation; cylindrical 25mm diameter x 25mm height (ASTM C579), 25mm x 25mm x 250mm bars (ASTM C580) and disc 50.8mm diameter x 6.35mm height (ASTM D570). Cylindrical and disc mould will be made from PVC pipe and mould for bar specimen will be made from mild steel. Besides testing specimen, the mould for pre-cast product will also be made from mild steel.

3. 3 SPECIMEN/ SAMPLE PREPARATION

Specimen will be prepared for three standard testing; compression, flexural and water absorption test. The following table provides the variation of specimen preparation Table 1. Aggregate grading. Table 2. Resin/ cement: aggregate ratio and Table 3. Specimen shape and size.

Aggregate grading	
AG1	1:1 sands and gravels (Jaafari 2018)
AG2	Sands only (Faidzal 2018)
AG3	18% filler, 34% coarse and 48% fine (Khalid 2015)
AG4	17.6% filler, 33.4% coarse, 47% fine and 2% fibers -chopped 6mm (Khalid 2015 and Reis 2005)

Aggregate grading is divided into four groups to compare the performance of PC based on aggregate grading. The group is named AG1, AG2, AG3 and AG4.

Resin/ Cement:Aggregate Ratio	
RT1/C1	20%:80% (Leonardi 2019)
RT2/C2	30%:70% (Faidzal 2018)
RT3/C3	12%:88% (Khalid 2015)

Resin to aggregate ratio is divided into three groups to compare the performance of PC under different resin to aggregate ratio. In addition to that, cement is also introduced to present the comparison between cement and polymer concrete. Resin ratios are named as RT1, RT2 and RT3. Cement ratio are named as C1, C2 and C3.

Specimen Shape and Size	
S1	25mm diameter x 25mm height (ASTM C579) -Compression
S2	25mm x 25mm x 250mm bars (ASTM C580) -Flexural
S3	50.8mm diameter x 6.35mm height (ASTM D570) -Water absorption

Specimens are prepared by mixing the predetermined aggregate grading with predetermined resin/ cement to aggregate ratio. The wet mixture of specimen is then casted into specimen mould. Specimen mould will be of three variations each according to their own ASTM standard. For compression test, ASTM C579, the specimen is a cylindrical shape. For flexural test, ASTM C580, the specimen is a bar and for ASTM D570 water absorption test, the specimen is disc. Detail of specimen shape and size are as Table 3. and named as S1, S2 and S3. Table 4. summarized all of the specimens.

PC and cement concrete comparison study		
	Cylinder (S1)	Bar (S2)
AG2RT2	3	3
AG2C2	3	3
Optimum PC aggregate resin-ratio study		
	Cylinder (S1)	Bar (S2)
AG2RT1	3	3
AG2RT2	3	3
AG2RT3	3	3
Optimum PC aggregate grading study		
	Cylinder (S1)	Bar (S2)
AG1RT2	3	3
AG2RT2	3	3
AG3RT2	3	3
AG4RT2	3	3
Water absorption		
	Disc (S3)	
AG1RT2	3	
AG2RT2	3	
AG1C2	3	
AG2C2	3	

3. 4 TESTING

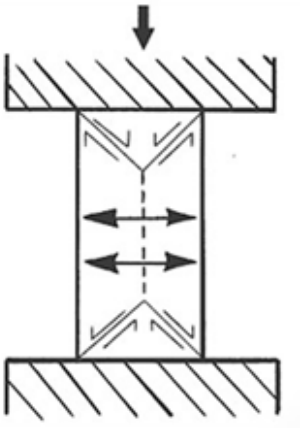
Main mechanical testing will be performed by using Shimazu AG-50kN Universal Testing Machine. Figure 2. below show the machine. Except for water absorption test, compression and flexural test will be perform using this machine.

a. Compression Test

Compression testing is perform according to ASTM C579 Test Method A. Set the testing machine to a crosshead speed of 0.1 to 0.125 in./min times the specimen height in inches (0.1 to 0.125 cm/min times the specimen height in centimetres) when the machine is running without load. Load the test specimen to failure and record the maximum load (W). Compressive strength is calculated using formula below:

$$\sigma = \frac{4W}{\pi D^2}$$

$\boldsymbol{\sigma}$ is compressive strength (Pa), W is maximum load (N) and D is specimen diameter (mm).



b. Flexural Test

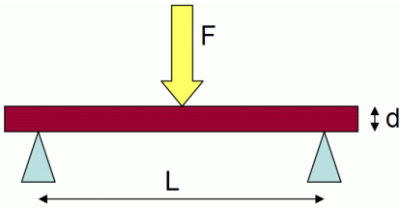
Flexural test is performed using 3 point testing apparatus. The standard for 3 point flexural test used is ASTM C580 Test Method A. Load will be applied in the middle of the specimen and the span length shall be 230mm. In order to achieve a strain rate of 0.01 6 0.001 per minute at the top and bottom of the beam, set the testing machine to produce a cross head speed as determined by the following formula:

$$Speed = \frac{0.00167xL^2}{d}$$

The flexural strength, σ_f (Pa) is equal to the stress calculated at maximum load. It is calculated as follows:

$$\sigma_f = \frac{3PL}{2bd^2}$$

Where σ_f is flexural strength at mid span, P is maximum load (N), L is span length (mm), b is width of the specimen (mm) and d is depth of the specimen (mm). In this experiment, b=d=25mm.



c. Water Absorption Test.

Water absorption is used to determine the amount of water absorbed under specified conditions. Factors affecting water absorption include: type of plastic, additives used, temperature and length of exposure. The data sheds light on the performance of the materials in water or humid environments. Water absorption test is performed based on ASTM D570 standard.

Specimen used is two inch diameter disks, 0.125" or 0.250" thick. The specimen is then emerged in water at agreed upon conditions, often 23°C for 24 hours or until equilibrium. Specimens are removed, patted dry with a lint free cloth, and weighed. Water absorption is expressed as increase in weight percent. The following is equation to obtain the percentage.

$$Percent\ Water\ Absorption = \frac{(Wet\ weight - Dry\ Weight)}{(Dry\ Weight)} x100$$

3. 5 PRE-CAST PRODUCT

a. Sketch the mould and product

b. Explain fabrication process

c. Explain Field Testing on Finished Product

3. 6 CONCLUSION

a. Provide a summary of research methodology section.

b. May also write researchers expectation.

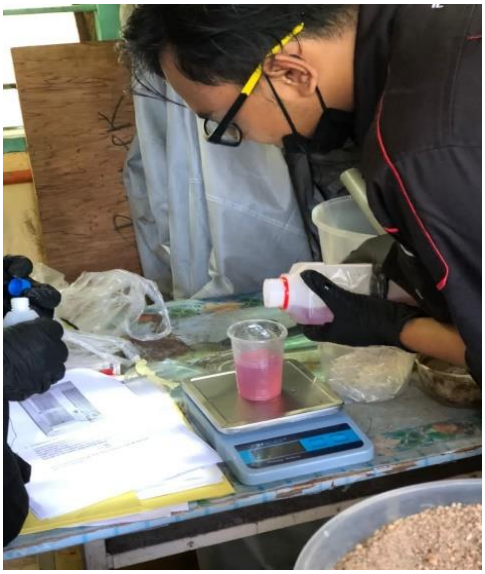
CHAPTER 4

4.1 PERFORMANCE TEST

Hollow iron was cut using a grinder.

PVC pipes have been cut using a pipe saw

Next, the pipe that has been cut is also stated at the top



The resin is poured into a container

The material and the resin that has been mixed until complete

Chopped fiber filler sand and resin

resin are added once until complete

The aggregart compound is put

into the iron bar.

The same steps are continued

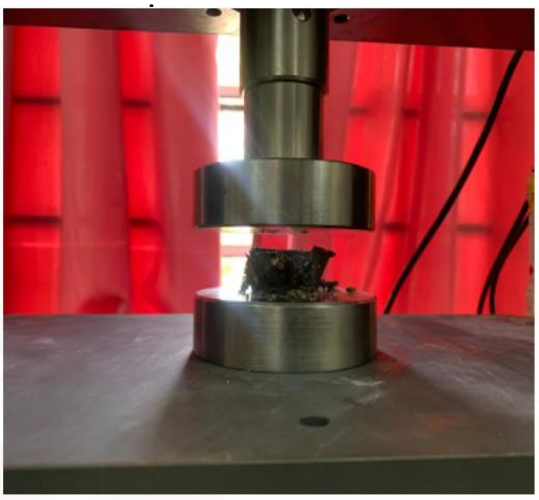
continued on the other iron bar

Iron bars that has been

dry out

4.2 MECHANICAL TESTING

4.2.1 COMPRESSION TEST

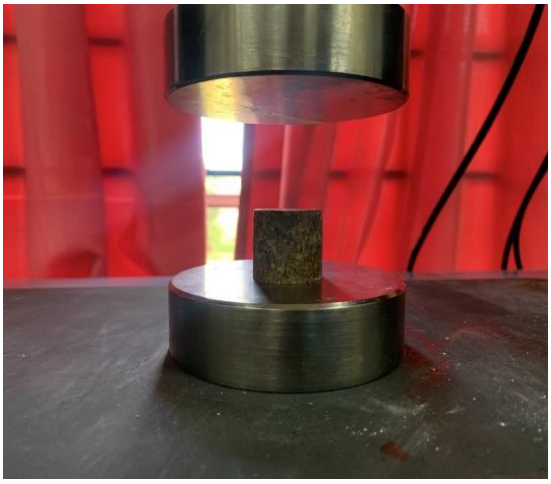


Change the appropriate tool for bending test testing

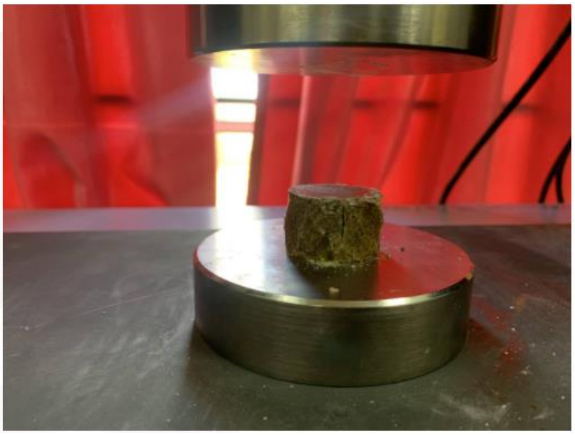
Open and turn on the universal test machine

Start the bending test on the specimen AG4RT2

Bending test were performed on AG4RT2. After the bending test is performed. Specimen changes were recorded.



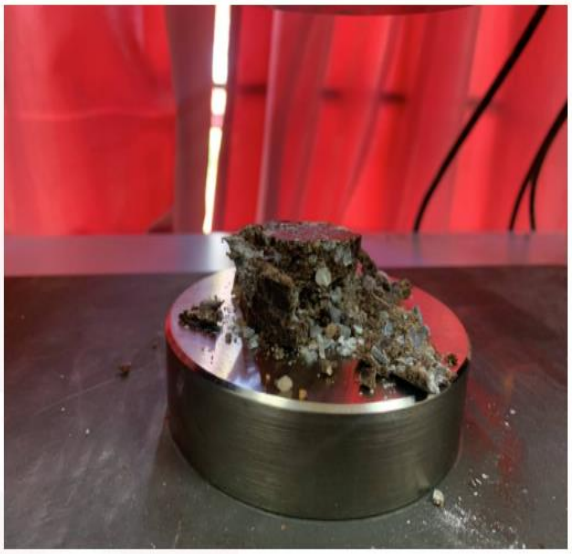
Bending tests were carried out on the AG1RT2 bar specimen. Following the completion of the bending test. Changes in the specimen were noted.



Bending test on AG2RT2

Bending test were performed on specimen bar AG2RT2.

After the bending test is performed. Specimen changes were recorde

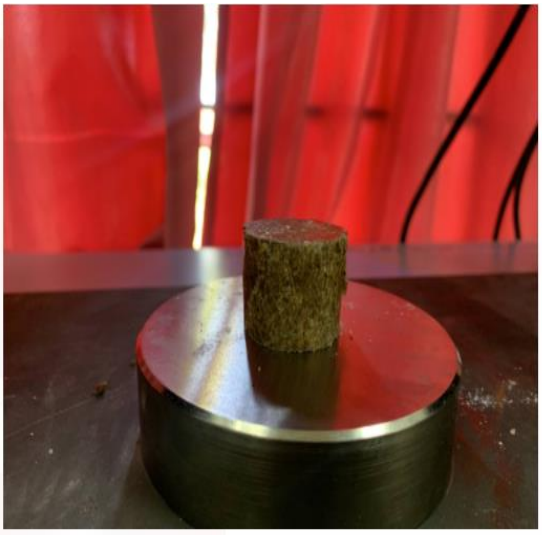


AG3 RT2

Bending test on AG3RT2

Bending test were performed on specimen bar AG3RT2.

After the bending test is performed. Specimen changes were recorded



AG1 RT1

AG1RT1 bending test

Bending tests were carried out on a AG1RT1 specimen bar.

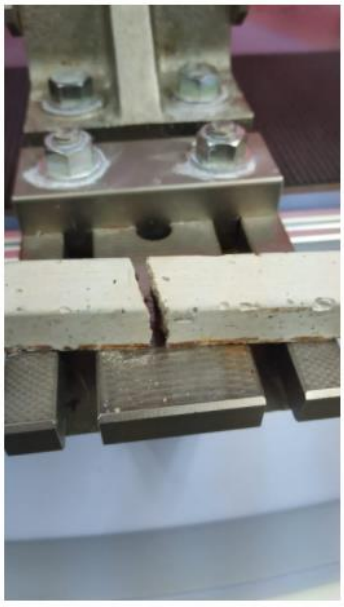
Following the completion of the bending test. Changes in the specimen were noted.

4.2.2 BENDING TEST

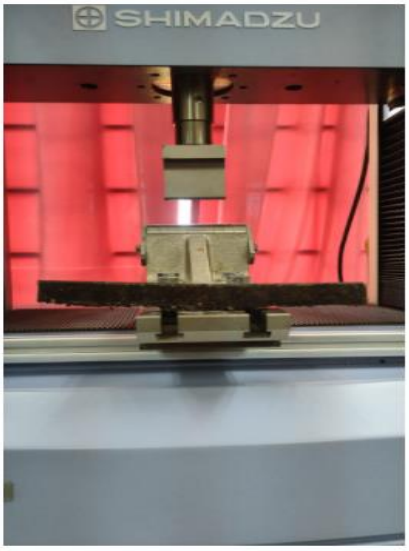
AG2RT2 compression test.After the bending test has been completed. Clean the universal testing machine's surface. To do the compression test, replace the tool on the universal testing machine. Begin the compression test on the AG2RT2 specimen rod.

AG1 RT2

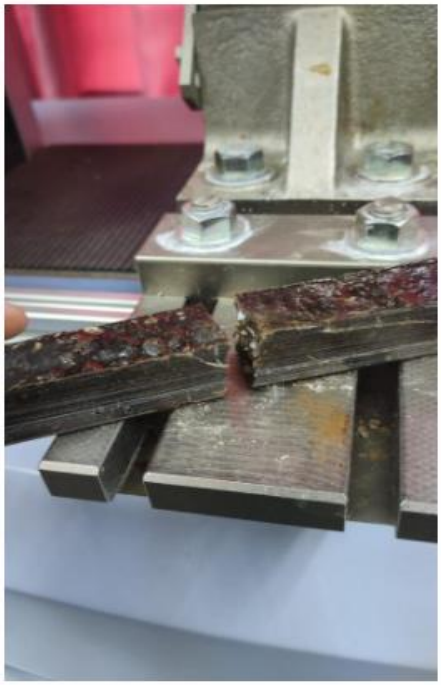
AG1RT2 compression test The specimen rod AG1RT2 was put through a compression test. After you've completed the compression test. Changes in the specimen were noted.



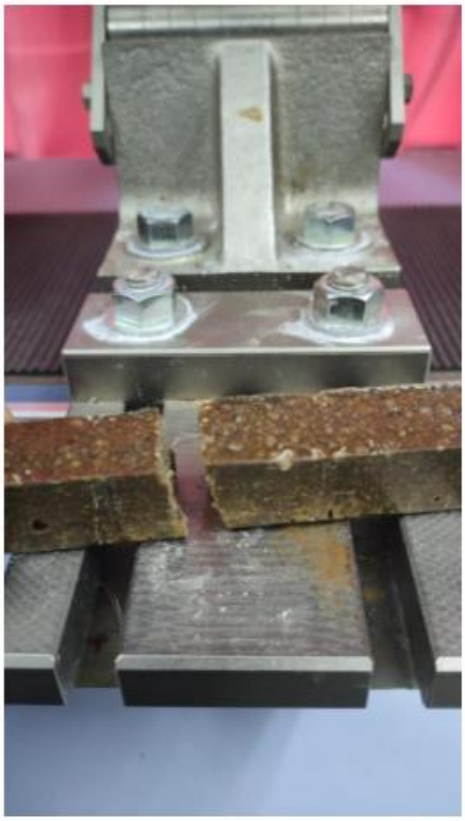
Compression test on AG2C2
Compression test was performed on specimen rod AG2C2. After the compression test is performed. Specimen changes were recorded



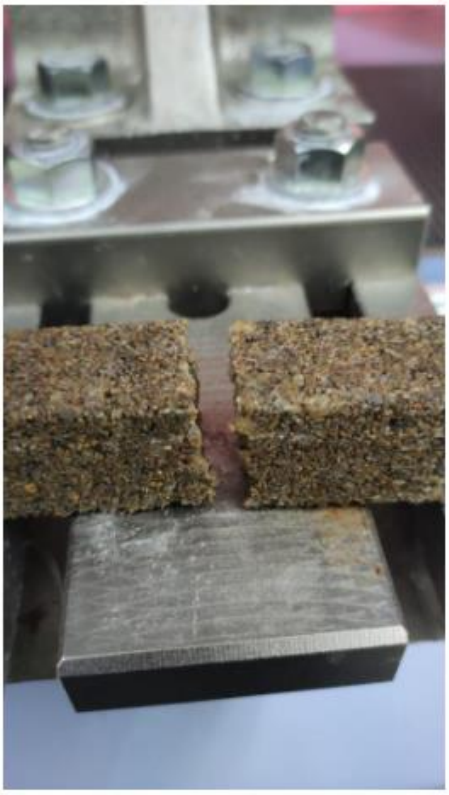
AG4RT2 compression test The specimen rod AG4RT2 was put through a compression test. After you've completed the compression test. Changes in the specimen were noted.



AG3RT2 compression test. The specimen rod AG3RT2 was put through a compression test. After you've completed the compression test. Changes in the specimen were noted.



AG2RT1 compression test The specimen rod AG1RT1 was subjected to a compression test. After you've completed the compression test. Changes in the specimen were noted.



G2RT3 compression test

The specimen rod AG2RT3 was put through a compression test. After you've completed the compression test. Changes in the specimen were noted.

4.2.3 WATER ABSORTION TEST

All specimen bars were prepared

Tested on ag1c2, ag2c2, ag1rt2, ag2rt2.

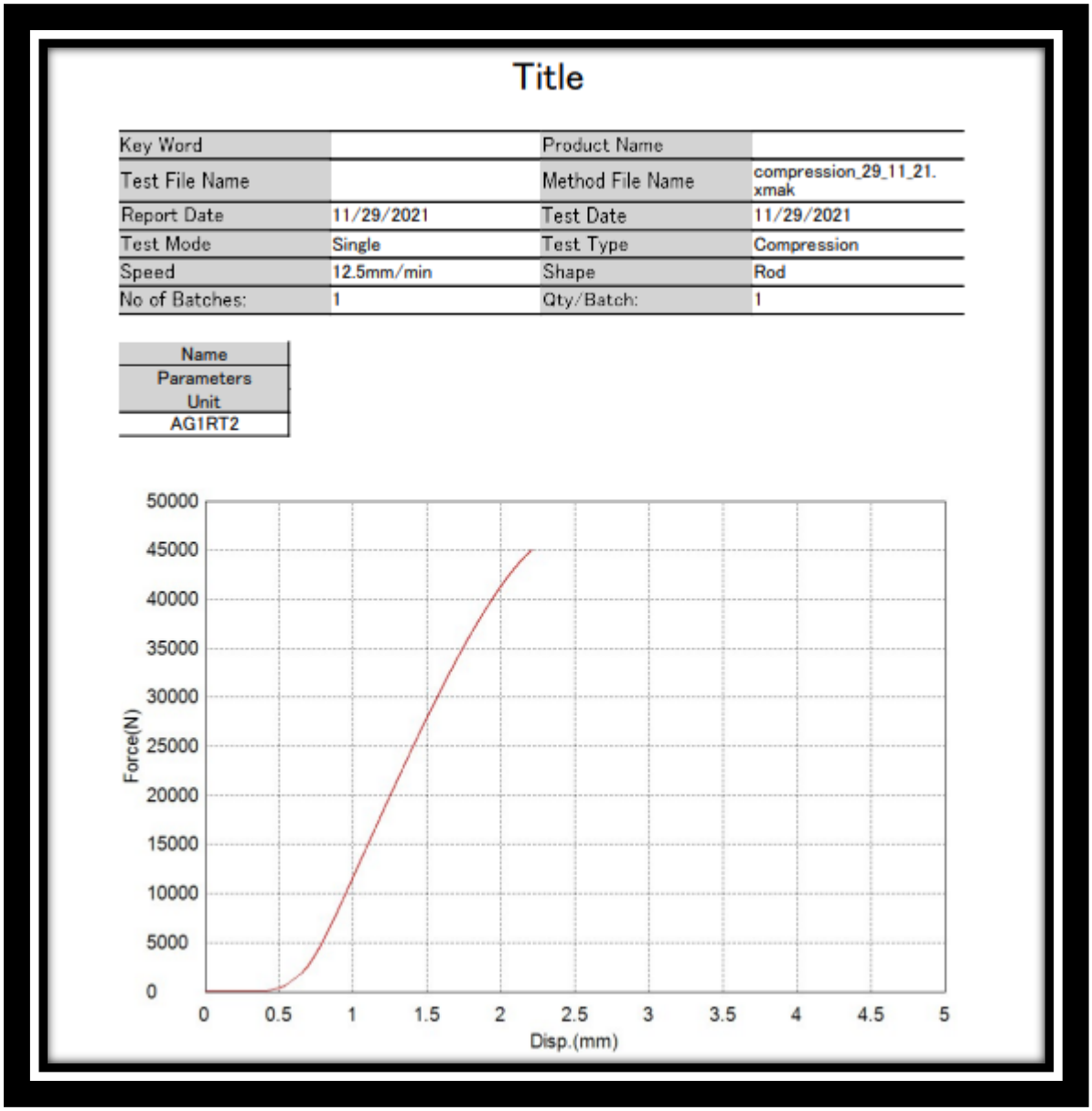
Soaked specimen ag1c2 in water for 7 days. After after 7 days, the s pecimens were removed and the mass the mass changes were recorded.

Soaked specimen ag2c2 in water for 7 days. After 7 days, the specimens were removed and the mass changes were recorded.

Soaked specimen ag1rt2 in water for 7 days. After 7 days, the specimens were removed and the mass changes were recorded.

Soaked specimen ag1rt2 in water for 7 days. After 7 days, the specimens were removed and the mass changes were recorded.

4.3 RESULT



Title

Key Word		Product Name	
Test File Name		Method File Name	compression_29_11_21.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	Compression
Speed	12.5mm/min	Shape	Rod
No of Batches:	1	Qty/Batch:	1

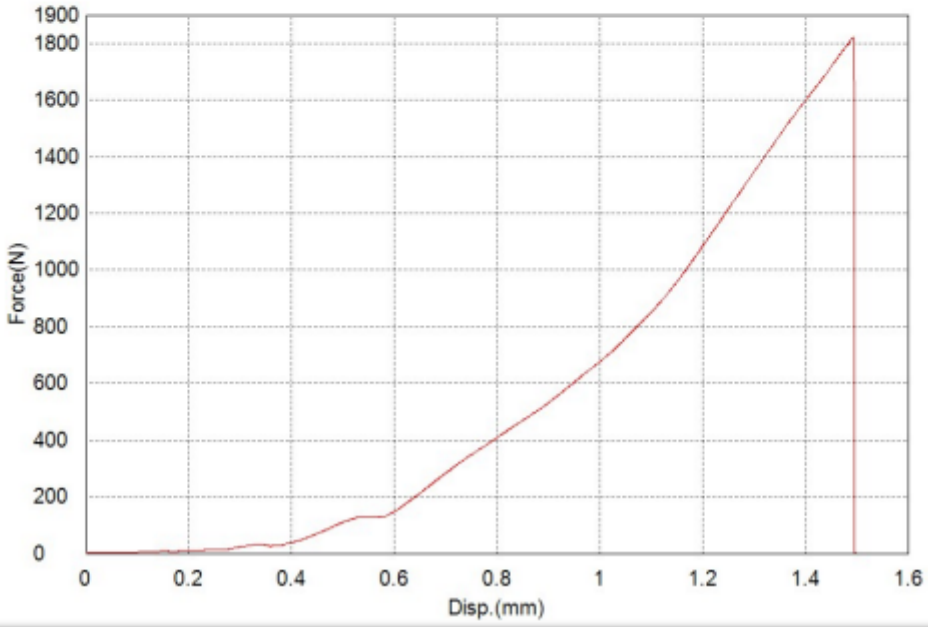
Name
Parameters
Unit
AG1RT2

AG1RT2

Title

Key Word		Product Name	
Test File Name	AG1RT2S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1 _ 1

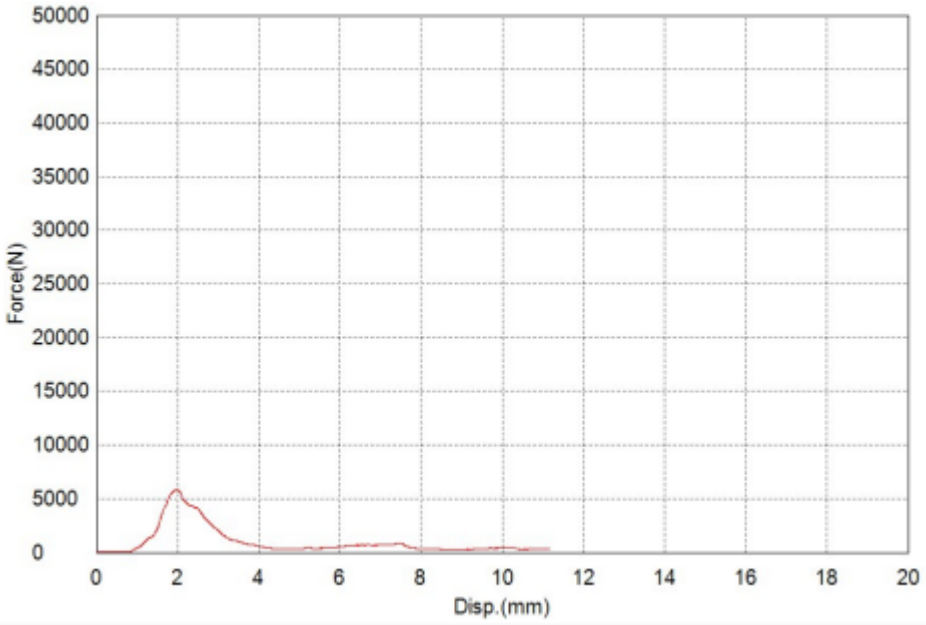


AG1RT2S2

Title

Key Word		Product Name	
Test File Name		Method File Name	compression_29_11_21.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	Compression
Speed	12.5mm/min	Shape	Rod
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
AG1RT2 _ 1

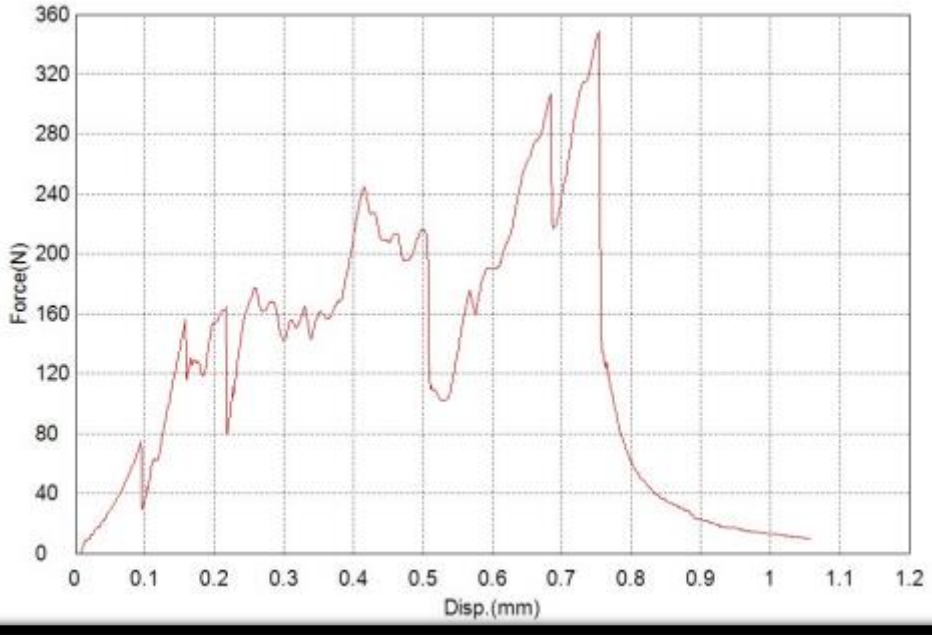


AG2C2

Title

Key Word		Product Name	
Test File Name	AG2C2S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1_1

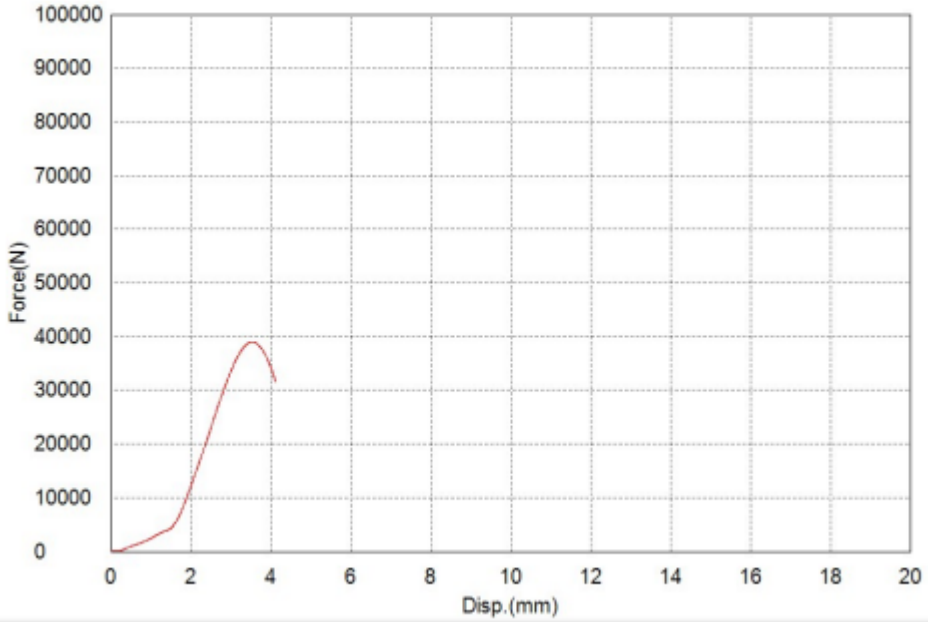


AG2C2S2

Title

Key Word		Product Name	
Test File Name		Method File Name	compression_29_11_21.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	Compression
Speed	12.5mm/min	Shape	Rod
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
AG1RT2 _ 1

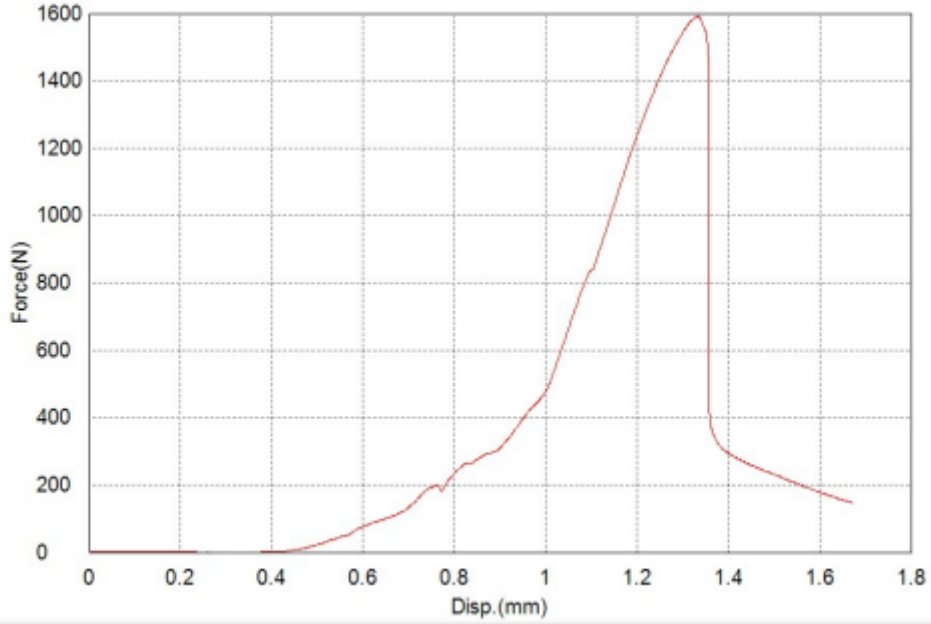


AG2RT1

Title

Key Word		Product Name	
Test File Name	AG2RT1S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1 _ 1

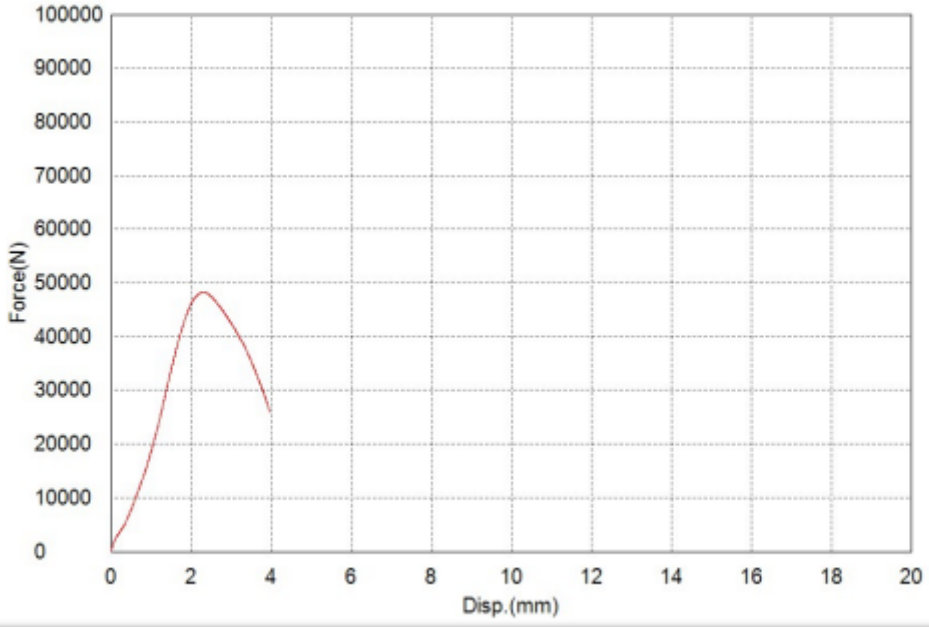


AG2RT1S2

Title

Key Word		Product Name	
Test File Name		Method File Name	compression_29_11_21.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	Compression
Speed	12.5mm/min	Shape	Rod
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
AG1RT2 _ 1

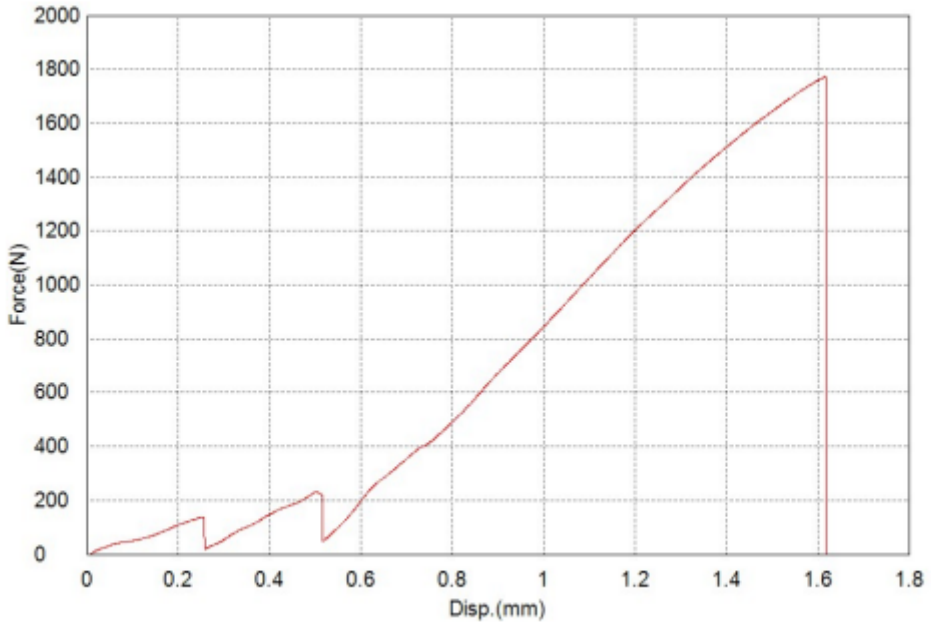


AG2RT2

Title

Key Word		Product Name	
Test File Name	AG2RT2S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1 _ 1

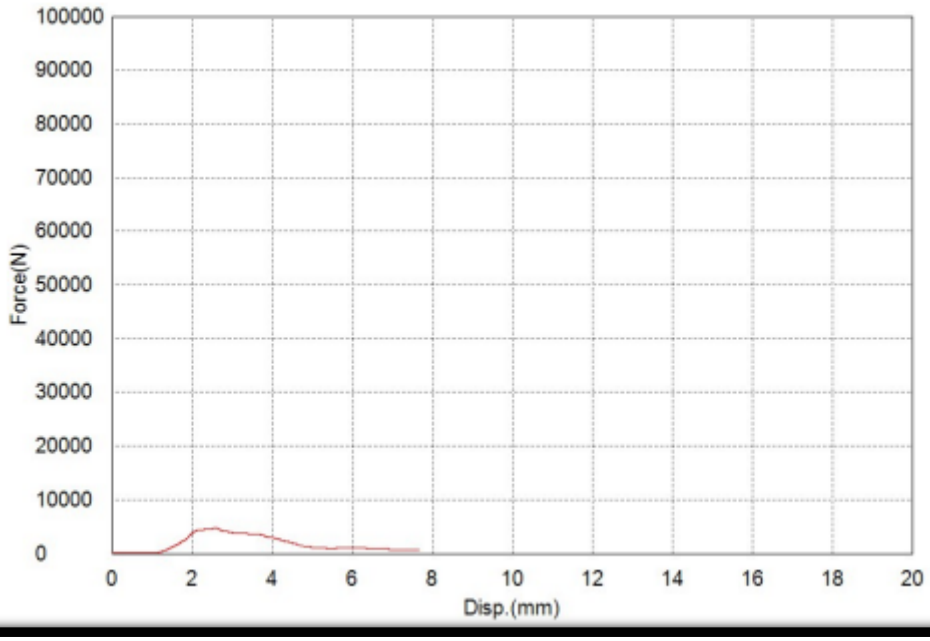


AG2RT2S2

Title

Key Word		Product Name	
Test File Name		Method File Name	compression_29_11_21.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	Compression
Speed	12.5mm/min	Shape	Rod
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
AG1RT2 _ 1

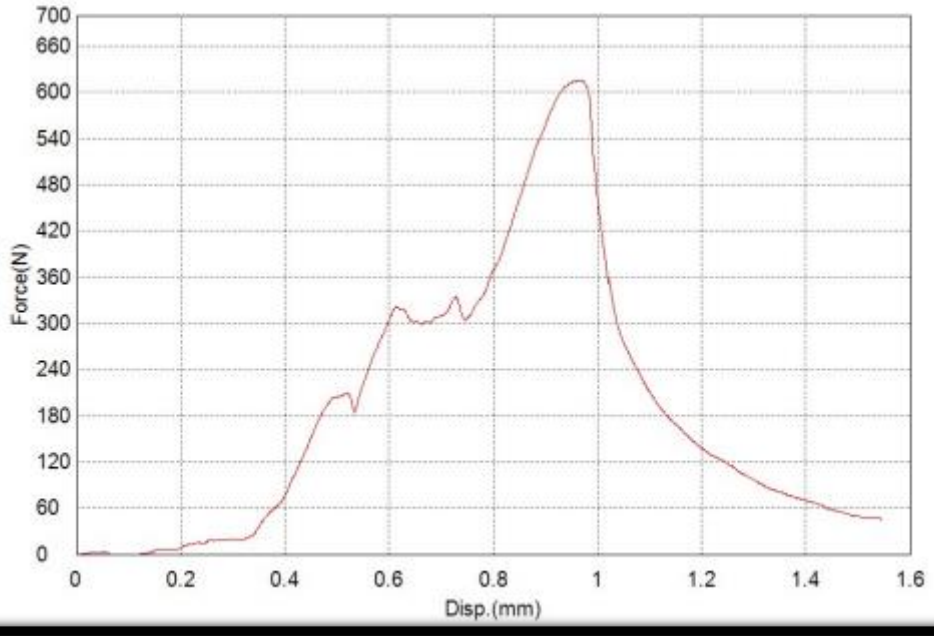


AG2RT3

Title

Key Word		Product Name	
Test File Name	AG2RT3S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1 _ 1

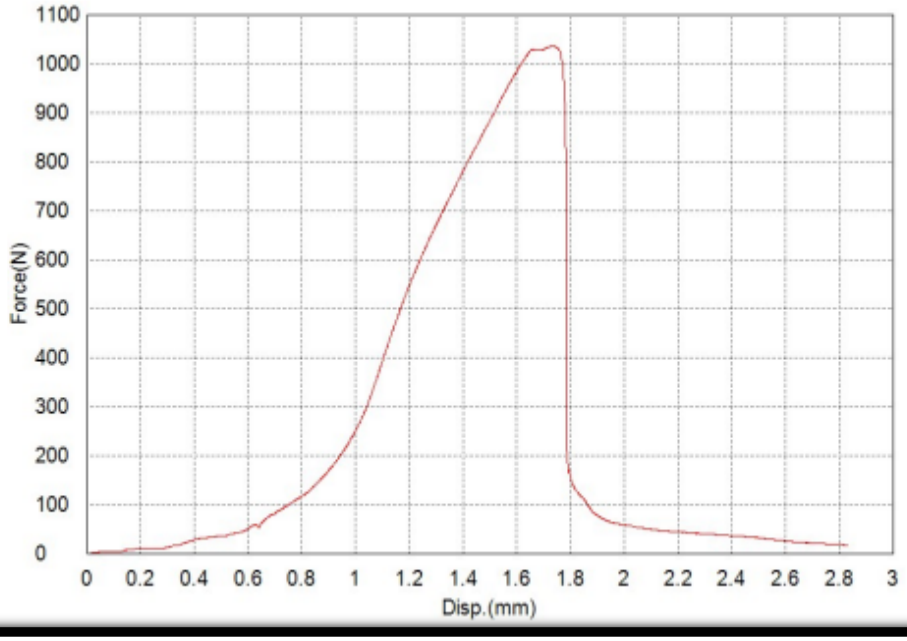


AG2RT3S2

Title

Key Word		Product Name	
Test File Name	AG3RT2S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1 _ 1

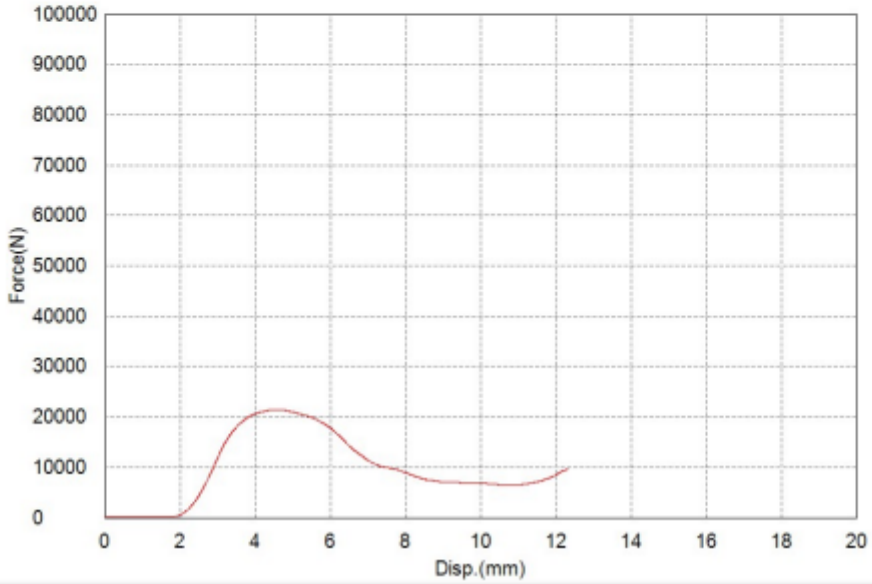


AG3RT2S2

Title

Key Word		Product Name	
Test File Name		Method File Name	compression_29_11_21.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	Compression
Speed	12.5mm/min	Shape	Rod
No of Batches:	1	Qty/Batch:	1

Name Parameters Unit
AG1RT2 _ 1

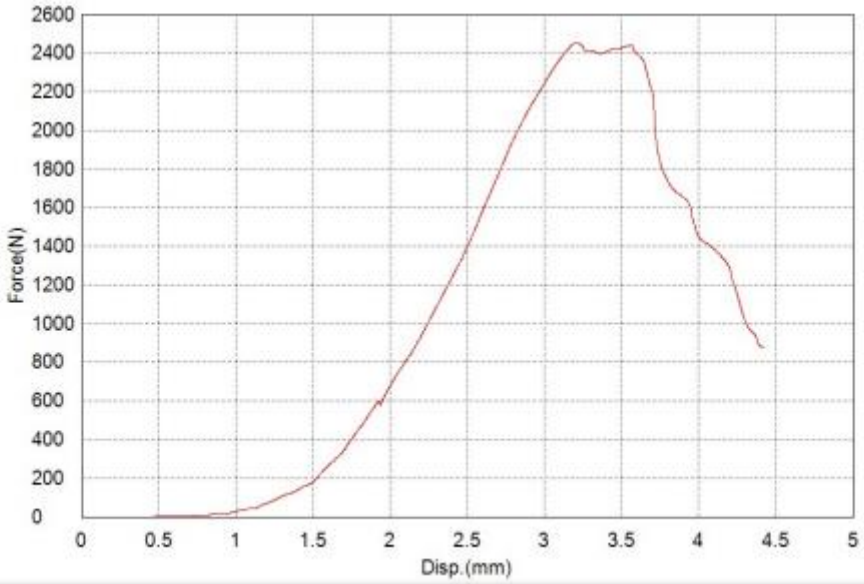


AG4RT2S2

Title

Key Word		Product Name	
Test File Name	AG4RT2S2.xtak	Method File Name	3 POINT.xmak
Report Date	11/29/2021	Test Date	11/29/2021
Test Mode	Single	Test Type	3 Point Bend
Speed	5mm/min	Shape	Plate
No of Batches:	1	Qty/Batch:	1

Name
Parameters
Unit
1 _ 1



AG4RT2S2

FINAL RESULT FLEXURAL TEST – 3 POINT BENDING

Specimens	Maximum Load (N)	Flexural Strength (Mpa)
AG2RT2-S2	1770	9.3456
AG2C2-S2	340	1.7952
AG2RT1-S2	1590	8.3952
AG2RT3-S2	620	3.2736
AG1RT2-S2	1820	9.6096
AG3RT2-S2	1040	5.4912
AG4RT2-S2	2450	12.936

3. Water Absorption Test

FINAL RESULT WATER ABSORPTION TEST

Specimens	Dry Weight (g)	Wet Weight (g)	Water Absorption (%)
AG1RT2-S3	51	55	7.84
AG2RT2-S3	45	45	0
AG1C2-S3	72	78	8.33
AG2C2-S3	46	52	13.04

4.4 DISCUSSION

Tests are performed on all types of experimental materials so that we can find out which materials are suitable for use on the product. The tests performed on the test material are compression test and bending test and water absorption test. This test successfully showed the appropriate test material to be used on the product

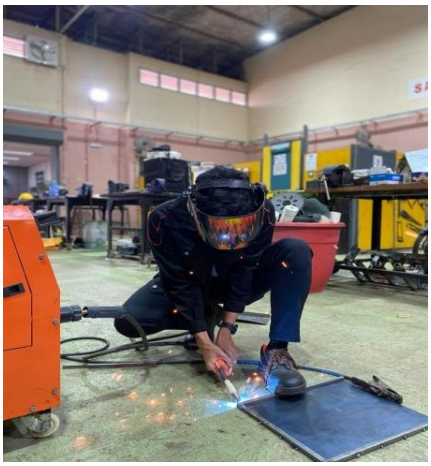
Compression tests are used to determine the behavior of a material under an applied crushing load, and are usually carried out by applying compression pressure on a test specimen (usually either cuboid or cylindrical geometry) using special plates or fixtures on a universal test machine. Next, the Bending Test is a simple and inexpensive qualitative test that can be used to assess both the ductility and stiffness of a material. Water absorption is used to determine the amount of water absorbed under a given condition.

The first test performed is the compression test. It was found that the AG2RT2 test material was stronger and stronger than the AG2C2 test material, this was because the AG2RT2 test material had obtained a suitable mixture. The next attempt, followed by a bending test. It was found that AG4RT2 was stronger than AG2C2, this was due to the type of material used in accordance with the mixture and counts tested. Finally, the test was continued with water absorption. The experimental material was soaked for 7 days. It was found that AG2RT2 absorbs less water than AG2C2, because the material used is suitable for the mixture and also the correct calculation.

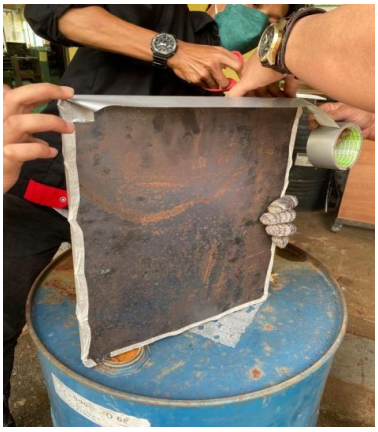
4.5 INNOVATION

Step Explanation

- We have cut the iron rod into 3 parts

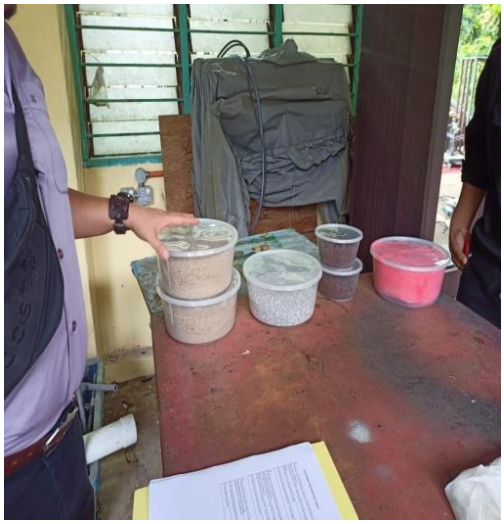


- Then we weld the rod to a plate in the form of a compartment.



- After we weld the rod, we place sellotape on the empty part so that it is easy to remove the specimen when it has hardened.

- Then, we placed the wex on the surface of the plate so that the specimen did not stick to the plate



- After that, we collected the materials that should be used to make the specimen.

- After that, we collected the materials that should be used to make the specimen.

- Resin is placed as much as 293 grams.

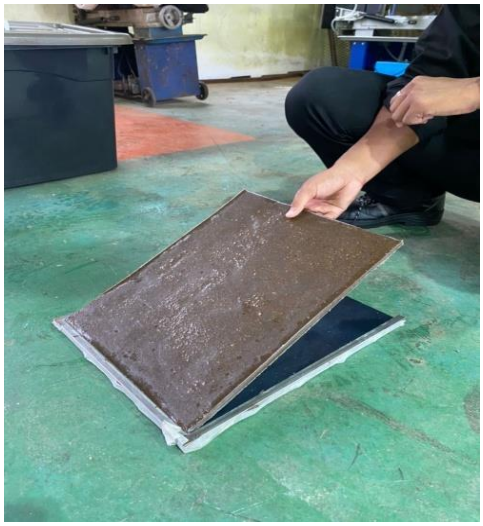
- Then, we put a small amount of catalyst liquid of 5 grams.

- After that, we put river sand into a container of 700 grams.

- Then, we mix the two ingredients it is a mixture of resin and catalyst into the sand.

- After that, we stir the dough until well blended.

- Wait up to 7 days for the material to harden.



- After 7 days, the material has hardened completely.

4.6 DATA ANALYSIS

Data to prove that PC has better performance than cement concrete may be present. Then, the result of testing will be analyzed by comparing the parameters to recommend the optimum aggregate grading and resin to aggregate ratio. For water absorption test, the data is expected to shows that PC has less water absorption compared to cement concrete. Besides compressive strength and flexural strength, stress-strain curve may also be analyzed which will provide more results in term of elastic and plastic behavior of PC under multiple variation of aggregate grading and resin ratio. Table 5. Table 6. and Table 7 shows the data presentation for each testing.

Compression Test

Specimens	Maximum Load (N)	Compressive Strength (Mpa)
AG2RT2-S1	48000	94.73
AG2C2-S1	5900	11.64
AG2RT1-S1	39600	78.15
AG2RT3-S1	4800	9.47
AG1RT2-S1	45000	88.80
AG4RT2-S1	20600	40.65

Flexural Test – 3 Point Bending

Specimens	Maximum Load (N)	Flexural Strength (Mpa)
AG2RT2-S2	1770	9.3456
AG2C2-S2	340	1.7952
AG2RT1-S2	1590	8.3952
AG2RT3-S2	620	3.2736
AG1RT2-S2	1820	9.6096
AG3RT2-S2	1040	5.4912
AG4RT2-S2	2450	12.936

Water Absorption Test

Specimens	Dry Weight (g)	Wet Weight (g)	Water Absorption (%)
AG1RT2-S3	51	55	7.84
AG2RT2-S3	45	45	0
AG1C2-S3	72	78	8.33
AG2C2-S3	46	52	13.04

BAB 5

(DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS)

5.1 INTRODUCTION

In this chapter 5, all the data and studies that we have done will be discussed in this chapter. This chapter also includes additional suggestions and conclusions. composite material is a tool that meets the requirements nowadays consumers, This is because this mixed material has user-friendly features in terms of durability. With the improvement properties on this material can increase the durability more than existing products.

The mold of the material in this plate uses easy -to -find materials allowing it to be made easily. In addition, it can also be obtained at a cheap price.

The hope is that this plate can achieve the objectives of the study and beyond potential to be competitive in the global market.

5.2 DISCUSSION

The discussion we can conclude is that the process of making this plate is not as complicated as we initially imagined. because when we have already found the results of the search to make a strong composite material. It becomes easy

In addition, if using this plate. We do not need to maintain the floor regularly because of its higher durability properties compared to existing products thus saving maintenance costs.

Static Loading Test	
Weight	**Effect**
50 KG	No Effect
70 KG	No Effect
90 KG	No Effect
110 KG	No Effect

Free Falling Test	
Height	**Effect**
1m	No Effect
2m	No Effect
3m	No Effect
4m	No Effect

Static Loading Test

Free Falling Test

5.3 CONCLUSIONS

In conclusion the materials used in our plate products are very suitable for use in various other products such as mosaics and walls. The strength of the material in our products has also been proven by our partners where the plate is able to withstand loads up to 110 KG

The products we make have also gone through various tests such as endurance test in strength tester using compression machine, Static loading test and free falling test so that the specimen we selected is strong enough to go through various obstacles.

Overall, with this plate product, we can further diversify the types of materials available in Malaysia and can also be sold locally or abroad.

5.4 RECOMMENDATION

This plate is a product that has many uses such as mosaic, drain cover and many more. many improvements that we have thought of including:-

1. Thicken the plate again so that the stiffness of the plate is more guaranteed.

2. Add other materials to make the plate stronger like fiber.

5.5 REFFERENCES

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6) Yeon. K.S. (2010). Polymer Concrete as Construction Materials. International Journal of the Society of Materials Engineering for Resources. Vol.17, No.2.

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