
PETE ECO
BRICK
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# APPRECIATION

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Lastly, we would like express our gratitude again to our family, seniors and friends for the valuable comments and suggestions, endless love and support, encouragement and helping hands.

Sincerely thanks a lot to all.

# ABSTRAK

Projek ini menggambarkan kesan plastik – High-Density Polyethylene (HDPE) dan Polyethylene Terephthalate (PETE/PET) sebagai bahan pengganti bagi pasir dalam pembuatan bata pasir. Plastik, HDPE dan PETE dicampurkan dan dituang ke dalam acuan 215mm x 100mm x 65mm. Semua sampel telah direndam selama sekurang-kurangnya 7 hari dan maksimum 28 hari sebagai umur pengawetan. Ujian berat, ujian penyerapan air dan ujian kekuatan mampatan dilakukan pada ecobrick dimana HDPE + PETE sebagai bahan pengganti dengan nisbah peratusan yang berbeza, 50%, 30%, 20%, 10%. Keputusan menunjukkan bahawa kadar kekuatan untuk kadar 10% menunjukkan kekuatan mampatan tertinggi berbanding dengan bata pada kadar 30% dan 50%. Kekuatan optimum bata 10% (HDPE + PETE) menghasilkan kekuatan sehingga purata 23.33Pa dibandingkan dengan bata pasir biasa yang mencapai kekuatan mampatan purata 20.23Pa. Dari segi jisim, 20% adalah kadar yang mencukupi untuk ecobrick kerana purata jisimnya ialah 2.145kg/m3. Walau bagaimanapun, 10% adalah peratus optimum untuk menghasilkan kekuatan yang tinggi dengan bata tersebut. Hasil kajian ini, eco-brick dapat disumbangkan untuk menahan beban yang tinggi serta sesuai menggantikan bata pasir biasa terutama dalam pembinaan bangunan bertingkat tinggi.

# ABSTRACT

This project describes the effects of plastics - High-Density Polyethylene (HDPE) and Polyethylene Terephthalate (PETE / PET) as the replacement for sand in the manufacture of sand bricks. The plastic, HDPE and PETE are mixed and poured into 215mm x 100mm x 65mm moulds. All samples were soaked for at least 7 days and a maximum of 28 days as the curing age. Weight tests, water absorption tests and compression strength tests were performed on eco-brick where HDPE + PETE was a replacement with different percentage of ratios which is 50%, 30%, 20%, 10%. The results show that the strength rate of 10% shows the highest compressive strength compared to bricks at 30% and 50%. The optimum strength of 10% brick (HDPE + PETE) yields up to an average strength of 23.33Pa compared to ordinary sand bricks with an average compression strength of 20.23Pa. In terms of density, 20% is an adequate rate for eco-brick as its average density is 2.145kg/$m^3$. However, 10% is the optimal percentage to produce high strength with the brick. As a result of this study, eco-bricks can be applied to withstand high loads and to replace ordinary sand bricks especially in the construction of high rise buildings.

## TABLE OF CONTENT

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Cement bricks are used for masonry construction. Cement brick are a versatile masonry material which can be used in a wide variety of applications. Cement bricks are typically classified into a category by their density or unit weight. Density is determined by the amount of material mixture to produce normal weight cement brick (2240kg/m$^3$ – 2400kg/m$^3$). Cement bricks are also available in decorative and load bearing types.

There are many different type of cement bricks in the market with different compressive strength. These bricks are produced in mass production lines by manufacturers which allow home owners and contractors to purchase them immediately and have them delivered or picked up ready for installation. Cement bricks are an inexpensive building material which can save homeowners hundreds in the pocket. They are a great alternative to natural stone blocks.

The most basic building material for construction of houses is the conventional brick. The rapid growth in today’s construction industry has obliged the civil engineers in searching for more efficient and durable alternatives far beyond the limitations of the conventional brick production. A number of studies had taken serious steps in manufacturing bricks from several of waste materials to reduce the rate.

## 1.2 Problem Statement

This project is carried out because of the increasing of construction cost. From times to times the cost of the material is changing and become increase in future. It was cause of factor of economy, construction site, wastage material and etc. This final year project are made for reduce the cost used in construction. We will see if there any differences between the previous with the current situation.

Significant quantities of cement are required to produce large quantities of cement bricks, but this approach also leads to environmental impacts from increased carbon emission to the atmosphere. The incorporation of more sustainable materials in the production of bricks can partially address this large issue, and the use of waste materials for this purpose can be an attractive option due to their natural availability and the aspect of recycling. Besides that, the significant amount of sand are required to produce brick or in construction. This will make the cost of the material will be expensive and will affected the price that be put in the done project such as residential houses, shopping mall and other project. From that, it will give some burden to the resident especially to the common workers.

On the other hand, approximately 2 million tonnes of resins for the plastics industry are produced locally per annum in Malaysia. However, data on plastic wastes and plastic recycling activities are not known although the wastes constitute the third largest waste tonnage (National Solid Waste Management Department, 2011). Plastics are almost non-biodegradable in the natural environment even after a long period of exposure. Significant efforts have been done by some researchers to create new, reusable, eco-friendly products by recycling plastic waste, and keep millions of pounds of waste from entering the landfills. In 2018, the media had announced about the wastage that go into the sea or river. The aquatic life such as turtles, fish and corals are affected by the wastage. Some of them were died and the rate of extinction will occur.

In a nutshell, this project are held to bring a new idea to decrease the water pollution because of plastic and to decrease the amount of sand used in brick making. All of the responsible party also should find a way to control of this issues.

## 1.3 Objective

1.3.1 To produce an eco-brick by using High-Density Polyethylene (HDPE) and Polyethylene Terepthalate (PETE/PET) as replacement material for sand.

1.3.2 Testing the compressive strength test and water absorption test of the eco-brick.

1.3.3 Compare the data of parameter test between the existing brick and eco-brick.

## 1.4 Scope of work

This project is carry out for a technique of construction where by components are manufactured in a controlled environment, either at site or off site, placed and assembled into construction. Ratios will be choose which has the highest strength between the replacement materials, plastic, which is (50%, 30%, 20% an 10%) PETE + HDPE. The cement ratio is Cement : Coarse sand ( 1 : 6) and the water ratio 500ml.

Each sample are from actual size of brick which is (215mm x 100mm x 65mm). It will be test by using Compressive Strength Test and Water Absorption Test. We will compare with four different replacement ratio. Furthermore, the water absorption test will be carried in the minimum and maximum days between 7 and 28 days. The number of the sample is 6 pieces per person. Lastly, we will provide 3 pieces more for the control brick as our reference.

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 Introduction

Masonry is an assemblage of masonry units and mortar. Its properties and behaviour are controlled by the characteristics of masonry units, mortar as well as the bond between them. For the same type of bricks using same proportions of cement and fine aggregate, the strength obtained may be different due to the variation in quality of water, difference in workmanship and on the arrangement of bricks in masonry.

The construction industry highly demand on conventional material such as cement and sand for the production of brick. The high and increasing cost of these materials has greatly hindered the development of building and other infrastructural facilities in developing countries. These situation need for engineering consideration of the use of cheaper and locally available materials to reduce the construction cost for sustainable development.

Many researchers attempt to reduce the cost of masonry constituents and hence total construction cost by investigating and ascertaining the usefulness of materials which could be classified as agricultural or industrial waste. Some of these waste include sawdust and rice husk which is produced from organic waste factory and wood waste factory.

## 2.2 Cement Brick

According to Deodhar and Patel (1997) presented that under compression; mortar deformed more than brick and expanded laterally causing failure of masonry. With the strength of brick and mortar, the compressive strength of brick masonry was evaluated with the constants given. It was found that rich mortar does not improved the strength of masonry but for low strength bricks a mortar ratio 1:4 or 1:5 gave considerably high strength.

Dayal (1995) described that the fly ash has good shear strength properties and relatively less compressibility. He suggested the usage of fly ash in various modes. With respect to the fly ash bricks, there are two types of bricks which are manufactured from fly ash, non-calcinite bricks (fly ash mixed with bonding agent) and calcinite bricks (fly ash clay brick). The use of fly ash offered a considerable saving of coal consumption which had been found to vary in the range of 3t – 7t of grade I coal per 105 bricks. The percentage of fly ash mixed varied from 10% to 80% and tested for their suitability and 40% by weight of local silty soil found as the optimum percentage of fly ash.

Brick is the oldest manufactured building material. The earliest brick, made from mud (sometimes with added straw), was invented almost 10,000 years ago. Clay brick started to appear about 5,000 years ago, when builders borrowed pottery manufacturing techniques to improve its strength and durability. From some of the oldest known structures to modern buildings clay brick has a history of providing shelter that is durable, comfortable, safe, and attractive.

Primary raw materials for modern clay bricks include surface clays, fire clays, shales or combinations of these. Units are formed by extrusion, moulding or dry-pressing and are fired in a kiln at high temperatures to produce units with a wide range of colors, textures, sizes and physical properties. Clay and shale masonry units are most frequently selected as a construction material for their aesthetics and long-term performance. While brick and structural clay tile are both visually appealing and durable, they are also well-suited for many structural applications. This is primarily due to their variety of sizes and very high compressive strength.

Cement brick is a very effective way to make a strong first impression. When people walk up or drive by a home with cement brick, second glances are common reactions. Cement brick has more benefits than its striking visual qualities. They deaden exterior noise, providing a buffer from traffic noise, airplanes flying overhead and other various disruptions. Fire protection is another benefit as is reduced maintenance. Finally, cement brick walls can improve the thermal mass qualities of exterior walls, thus reducing energy bills.

## 2.3 PLASTIC BOTTLE

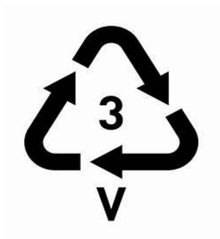
Plastic bottle is a bottle constructed from plastic. Plastic bottles are typically used to store liquids such as water, soft drinks, motor oil, cooking oil, medicine, shampoo, milk and ink. The size ranges from very small sample bottles to large carboys. Plastic bottles are formed using a variety of techniques such as High-Density Polyethylene, Low-Density Polyethylene, Polyethylene Terephthalate (PETE) and etc. The choice material varies depending upon application.

### 2.3.1 PROPERTIES OF PLASTIC

The Society of the Plastics Industry (SPI) established a classification system in 1988 to allow consumer and recyclers to identify different types of plastic. Manufacturers place an SPI code, or number, on each plastic product, usually moulded into the bottom. This guide provides a basic outline of the different plastic categories associated with each code number.

**Table 2.1 Categories of plastic and their general properties.**

| PLASTIC TYPES | GENERAL PROPERTIES | COMMON HOUSEHOLD USES |
|---|---|---|
|  <br>Polyethylene Terephthalate | - Good gas & moisture barrier properties.<br>- High heat resistance.<br>- Clear<br>- Hard<br>- Tough<br>- Microwave transparency<br>- Solvent resistant | - Mineral water, fizzy drink and beer bottles.<br>- Pre-prepared food trays and roasting bags.<br>- Boil in the bag food pouches.<br>- Soft drinks and water bottle.<br>- Fibre for clothing and carpets. |
| | | |

| | | |
|---|---|---|
| <br>High-Density Polyethylene | - Excellent moisture barrier properties<br>- Excellent chemical resistance<br>- Hard to semi-flexible and strong<br>- Permeable to gas<br>- HDPE films crinkle to the touch<br>- Pigmented bottles stress resistant | - Detergent, bleach and fabric conditioner bottles.<br>- Snack food boxes and cereal box liner.<br>- Milk and non-carbonated drink bottle.<br>- Plastic woods, garden furniture. |
| <br>Polyvinyl Chloride | - Excellent transparency<br>- Hard, rigid (flexible when plasticised)<br>- Good chemical resistance<br>- Long term stability<br>- Good weathering ability<br>- Stable electrical properties<br>- Low gas permeability | - Credit cards<br>- Carpet backing and other floor covering.<br>- Window and door frames, guttering.<br>- Pipes and fittings, wire and cable sheathing. |
| <br>Light-Density Polyethylene | - Tough and flexible<br>- Waxy surface<br>- Soft – scratches easily<br>- Good transparency<br>- Low melting point<br>- Stable electrical properties<br>- Good moisture barrier properties | - Films, fertiliser bags, refuse sacks.<br>- Packaging films, bubble wrap<br>- Flexible bottles<br>- Irrigation pipes<br>- Wire and cable applications.<br>- Some bottles top. |

| | | |
|---|---|---|
| <br>Polypropylene | - Excellent chemical resistance<br>- High melting point<br>- Hard but flexible<br>- Waxy surface<br>- Translucent<br>- Strong | - Most bottle tops.<br>- Ketchup and syrup bottles.<br>- Yoghurt and some margarine containers.<br>- Potato crisp bags, biscuit wrappers.<br>- Crates, plants pots, drinking straws. |
| <br>Polystyrene | - Clear to opaque<br>- Glassy surface<br>- Rigid or foamed<br>- Hard<br>- Brittle<br>- High clarity<br>- Affected by fats and solvents | - Fast food trays.<br>- Video cases.<br>- Yoghurt containers, egg boxes.<br>- Seed trays<br>- Coat hangers<br>- Low cost brittle toys |
|  | - There are other polymers that have a wide range of uses, particularly in<br>- Engineering sectors. They are identified with number 7 and OTHER (or a triangle with numbers from 7 to 19) | - Nylon (PA)<br>- Acrylonitrile Butadiene Styrene (ABS)<br>- Polycarbonate (PC)<br>- Layered or multi-material mixed polymers. |

### 2.3.2 Research of High-density Polyethylene Brick

Chowdhury et al. (Chowdhury, Maniar, & Suganya, 2013) studied the effect of Polyethylene Terephthalate (PET) as reinforcement in concrete and observed a lower compression strength and flexural rigidity but higher ductility in the concrete. The materials produced are light weight due to the reduction of density. For an increase from 0% to 15% of PET replacement to concrete, Rai B et al.(Rai, Rushad, Kr, & Duggal, 2012) observed a decreasing rate of reduction in compressive strengths in which the maximum reduction was only 15%.

While the workability reduced significantly with the increase of PET in the concrete, the flexural strengths also decreased accordingly. Zerdi et al. (Zerdi, Minhajudin, Waseem, Yusuf, & Zerdi, 2016), when reused the HDPE waste plastics as partial replacement to coarse aggregate in M20 lightweight concrete, observed that the compressive strength is highest at the replacement of 20% but still lower than the normal concrete. Kathe et al. (Kathe, 2015) used the plastic waste mixture of polyvinyl chloride (PVC), Polypropylene (PP), Polyethylene (PE) to produce green concrete. The replacement of sand with plastic waste by 10 to 20% is recommended for green concrete while a replacement of 30% is suitable for members of building which do not carry high load.

A study on 100% plastic bricks using low-density polyethylene (LDPE) revealed that the compressive strength is 1.5 times higher than clay brick. Likewise, a combination of PP, rubber powder and calcium carbonate with a proportion of 70:20:10 in the plastic brick gave a compressive strength of 1.74 times higher than clay brick. Further study on concrete and masonry poly blocks indicated that a mixture of waste polymer materials decreases density, porosity and water absorption of the blocks significantly. HDPE-based concrete exhibited higher density when compared to Polyurethane formaldehyde (PUF) based block, both in which are recommended for used in non-load bearing structures, floating structures and lightweight materials (Rahman et al., 2012).

**Table 2.3.1 Average value of 3 sets of brick in different percentage**

| Data | Average value<br>0% plastic<br>(6 bricks) | <br>10% plastic<br>(6 bricks) | <br>20% plastic<br>(6 bricks) |
|---|---|---|---|
| Mass (kg) | 2.9 | 2.4 | 2.4 |
| Maximum load (kN) | 207.8 | 135.8 | 110.2 |
| Compressive strength (N/m$^3$) | 9.5 | 6.3 | 5.0 |
| Density (kg/m$^3$) | 1972.0 | 1716.4 | 1660.8 |
| Dimension | 215 x 100 x 65 | 215 x 100 x 65 | 215 x 100 x 65 |

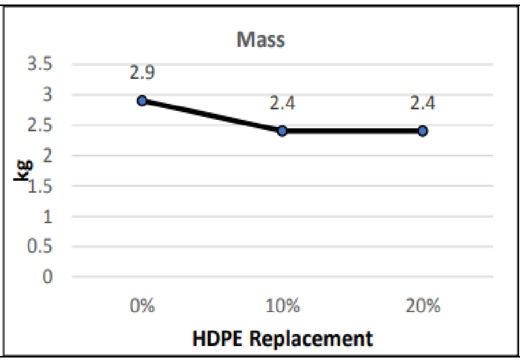


Figure 1 Mass

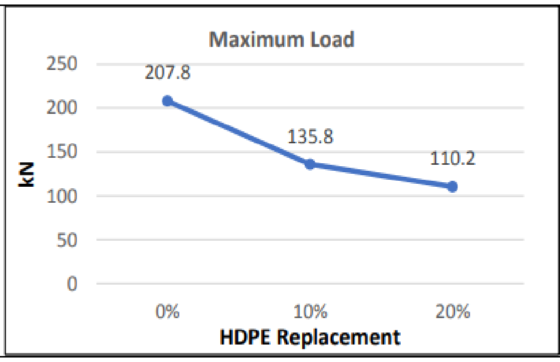


Figure 2 Maximum Load

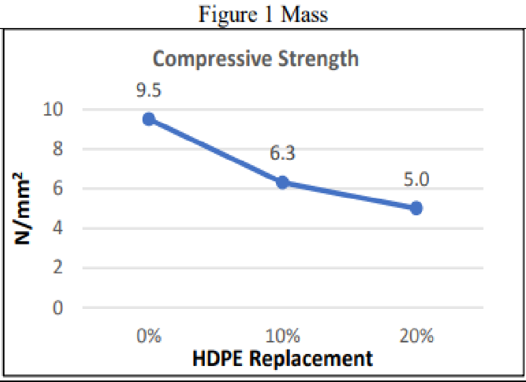


Figure 3 Compressive Strength

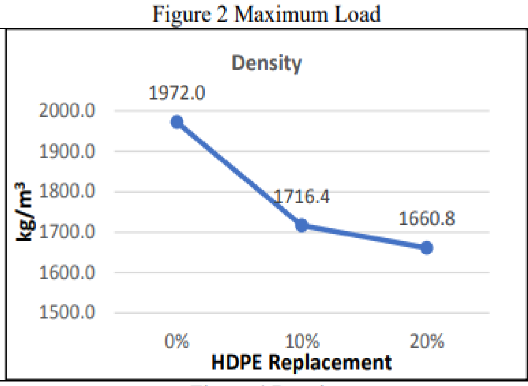


Figure 4 Density

**Figure 2.3.2 Properties of HDPE cement Brick**

Based on the result and analysis data obtained from the laboratory testing, a few conclusions can be made from this research. Concrete brick added with HDPE plastic is suitable to be use in building construction industry in Malaysia for non-load bearing members of building. The maximum substitution of HDPE plastic replacing sand is at 20% and from the compression testing results, the strength is in accordance to BS5628-3:1985. Reuse of plastic waste into useful construction materials can help reduce the environmental issues and further decreases the problem of plastic waste disposal. In addition to the environmental benefits, using plastic waste can minimise pollution from sand mining activities.

# CHAPTER 3

# METHODOLOGY REVIEW

## 3.1 INTRODUCTION

This chapter will cover the details explanation of methodology that is being used to make this project complete and working well. Many methodology finding from this field mainly generated into journal to others to take advantages and improve as upcoming studies. The method is use to achieve the objective of the project that will accomplish a perfect result. Generally, the major step are planning, design, testing and analysis.

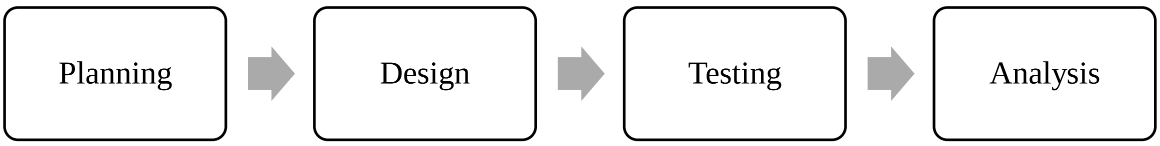



**Figure 3.1.1 Product processing flow chart.**

This final year project used three major steps to implement project starting from planning, design, testing and analysing. All the method used for finding and analysing data regarding the project related.

| | |
|---|---|
| Planning | • Research review<br>• Collection of previous data |
| Design | • Eco-brick with different ratio of replacement material which is plastic (HDPE and PETE).<br>• Ratio of plastic: (50%, 30%, 20% and 10%) HDPE + PETE. |
| Testing | • Compressive Strength Test<br>• Water Absorption Test (7 and 28 days) |
| Analysis | • Analysis the data<br>• Identify the data |

**Figure 3.1.2 Scopes of Methodology**

## 3.2 MATERIAL USED

**Table 3.2.1 Material**

| MATERIAL | DESCRIPTION |
|---|---|
| **Ordinary Portland Cement (OPC)**<br> | • Ordinary Portland Cement (OPC) is the most common cement used in general concrete construction when there is no exposure to sulphates in the soil or groundwater. |
| **Coarse Sand**<br> | • Coarse grained soils are divided into two groups, Sand and Gravel and particles having diameter in between 4.75mm to 75 micron is called sand.<br>• Maximum size of coarse sand which are 5 mm are use as the original material in the eco brick. |
| **Plastic Bottle :**<br>**High-Density Polyethylene (HDPE)**<br> | • It was known as number ‘2’ as its identification code.<br>• HDPE is a polyethylene thermoplastic made from petroleum<br>• Used in the production of plastic bottles, corrosion-resistant piping, and plastic lumber<br>• Use as the replacement materials in the lightweight brick. |

| | |
|---|---|
| **Plastic Bottle :**<br>**Polyethylene Terephthalate (PETE)**<br> | • It known as number ‘1’ as its resin identification code.<br>• PETE is the most common thermoplastic polymer resin of the polyester family.<br>• It is used in fibres for clothing, containers for liquids and foods |
| **Masonry Trowel**<br> | • A hand trowel used in brick work or stonework for levelling, spreading and shaping mortar or concrete.<br>• Use to mix and put the ingredients. |
| **Cement Bucket**<br> | • Use to gather and mix the material |
| **Electronic Weighing Scale**<br> | • Use to measure weight or calculate mass of brick |

| | |
|---|---|
| **Brick Mould**  | • Use as a frame for shaping brick |
| **Sieve Machine**  | • Use to sieve the coarse sand with minimum 4.75mm size. |
| **Compressin Testing Machine**  | • Use to determine the compressive strength of bricks. |

### 3.3 PROCEDURE TO PRODUCE AN ECOBRICK

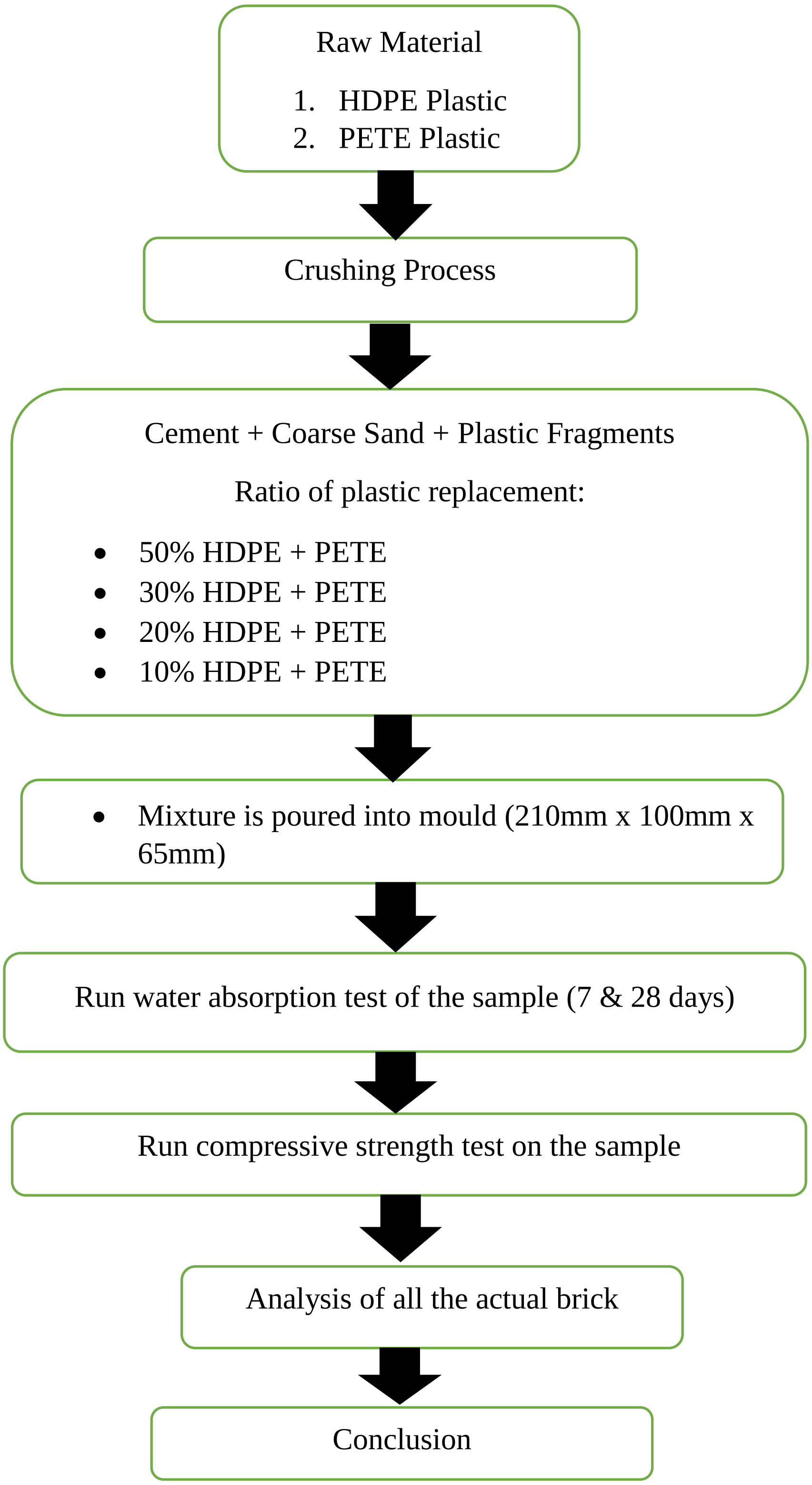



**Figure 3.3.1 Flow chart of the eco-brick making process.**

### 3.3.1 Process to get raw material (plastic)

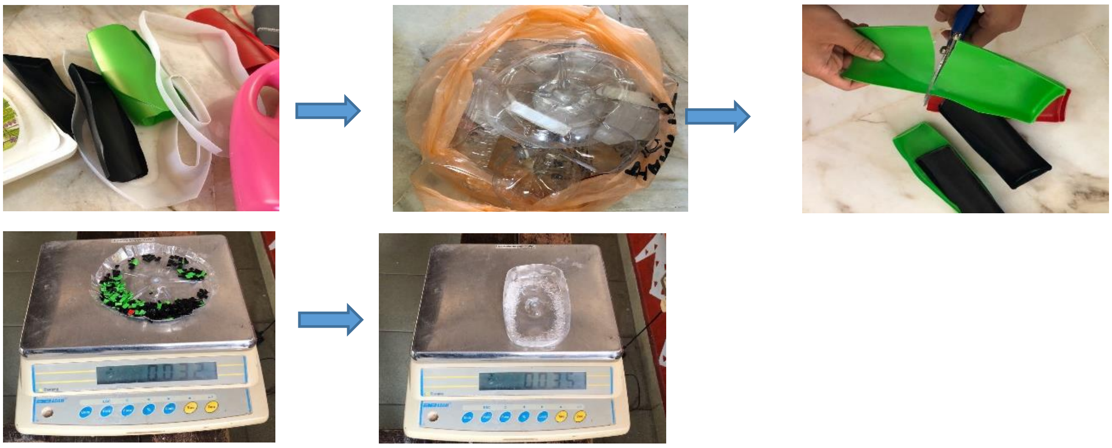


**Figure 3.3.2**

i. High-density polyethylene (HDPE) and Polyethylene terephthalate (PETE) has been collected.
ii. Cut the bottles into small fragments.
iii. Blend the small fragment until achieve desired size.

### 3.3.2 Preparing and weighing the raw material

**Figure 3.3.3**

i. The raw material – cement, plastic (HDPE & PETE) and sand has been weigh according to design ratio.
ii. Design ratio (plastic) is 50%, 30%, 20% and 10% (HDPE + PETE).
iii. Control of brick ratio are used by 1:6.

### 3.3.3 Mixing sample process.

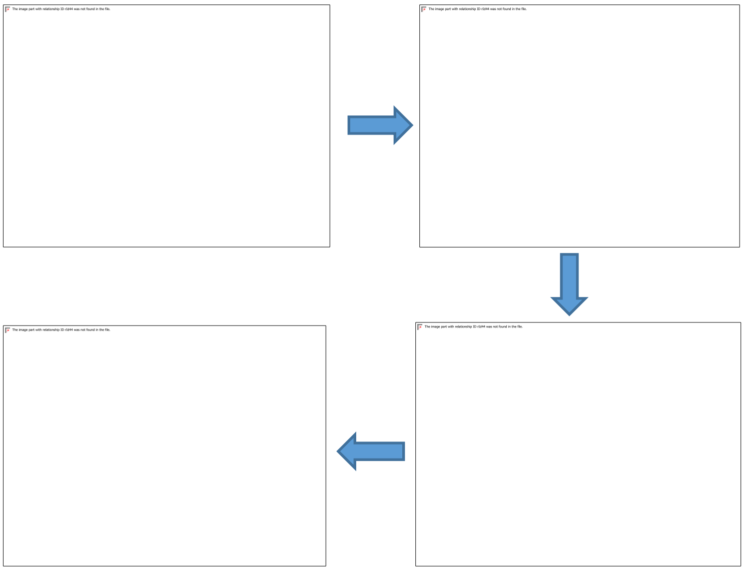


**Figure 3.3.4**

i. Mix the material according to ratio.

ii. The admixture is poured into the sample mould (215mm x 100mm x 65mm).

iii. 30 pieces total are made.

iv. Then, the samples has been test in water absorption and compression test.

v. The best testing data according to ratio has been recorded.

### 3.3.4 Water absorption test for actual brick.

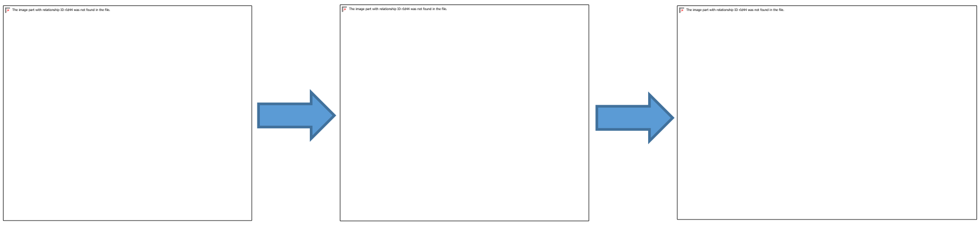


**Figure 3.3.5**

i. After the brick dry, all the samples were put into a curing tank.
ii. Curing age has been set for 7 days minimum and 28 days for maximum.
iii. The weight has been recorded after the sample reached the curing age.
iv. Then, the sample will be dry by natural for the following test.

### 3.3.5 Compression test for actual brick.

Compressive test is done in order to determine the compressive strength of the ecobrick against vertical loading. The procedures for testing for each samples was done according to BS 812: Pat 1:1981 as following.

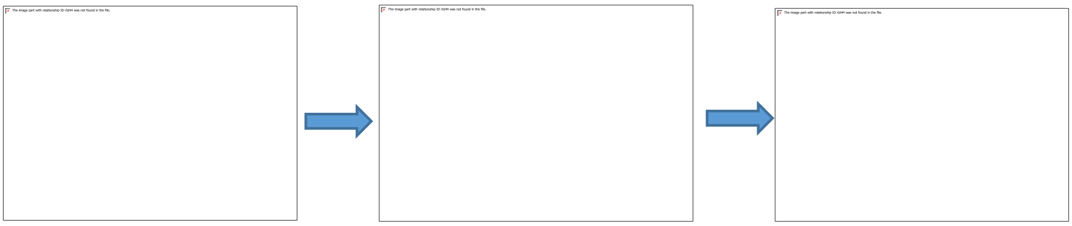


**Figure 3.3.6**

i. The unit and specification of the sample has been set on the machine.
ii. The sample has been put between the compressive plate.
iii. All of the brick run compressive test.
iv. The data has been recorded

## 3.4 GANTT CHART

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**Figure 3.4.1 Planning of activities in semester** 4

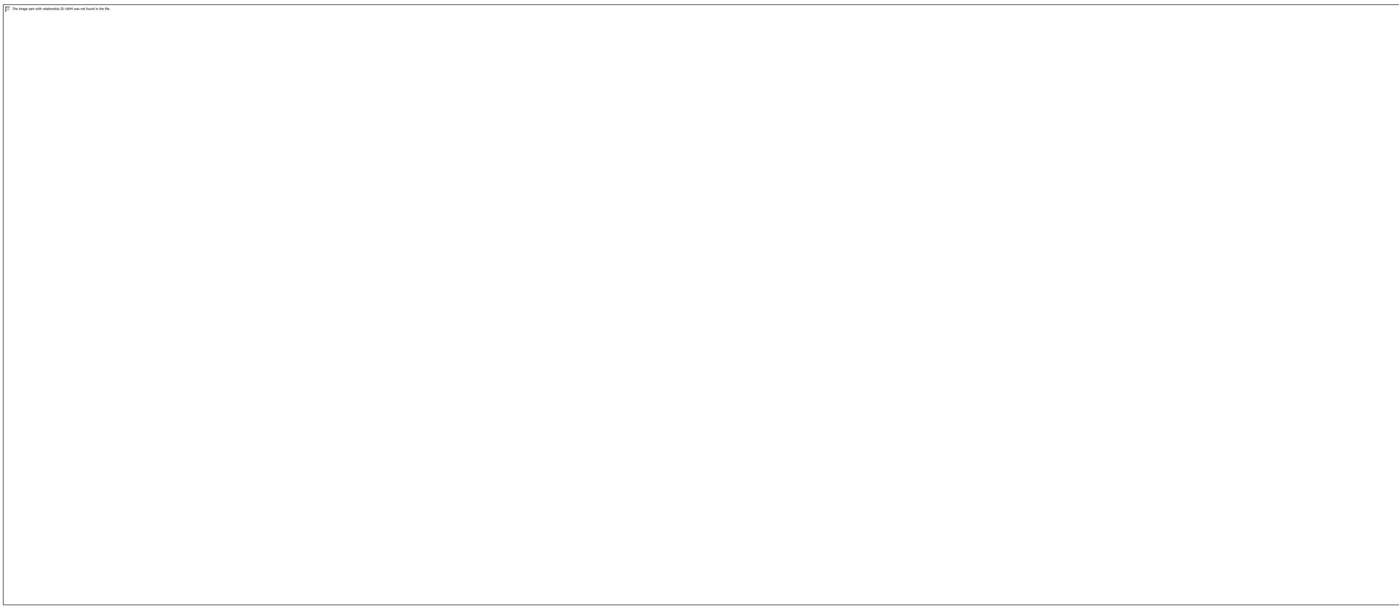

**Figure 3.4.2 Planning of activities in semester 5**

## 3.5 Summary

As a conclusion, from this chapter, the procedure to make lightweight brick, procedure of compressive strength test and comparison between existing normal brick and lightweight brick are clearly explained. From the compressive strength test, the strength of the brick can be determined. Besides, the strength of lightweight brick can be compared with the existing or control brick. Furthermore, the data of weight and mass can be obtain and the weight and mass of lightweight brick can be compare with the existing normal brick from the weighing test.

In addition, the materials and equipment are clearly descript in this chapter. Moreover, the Gantt Chart and Timetable are managed. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of the project. Gantt chart are most commonly used for tracking project schedules. For this it is useful to be able to show additional information about the various task or phases of the project, for example how the tasks related to each other, how far each task has progressed, what resources are being used for each task and so on. The work of project is able done on time and the sequence of wok is more systematic with the Gantt Chart and Timetable.

# CHAPTER 4

# RESULT & ANALYSIS

## 4.1 Introduction

The eco brick was test by two method which are compressive strength test and water absorption test. The purpose of this tests were to determine of the eco-brick and compare the rate of water absorption with the normal standard brick.

The test was carried out at the private laboratory. The specimen is delivered to the laboratory after 7 days and 28 days of curing. Data was taken during the test carried according to the compressive strength test machine. After the experiments carried, we are able to compare and identify the optimum ratio of the replacement material in the sand brick.

## 4.2 RESULT

The result obtained were recorded in a typical brick check sheet and the summary shown in table below. It was noticed that the brick produced with four differences ratio of the replacement material. Each ratio of eco-brick are present in three specimen.

**Table 4.2.1 Weight comparison**

| RATIO | 50% HDPE + PETE | | | 30% HDPE + PETE | | | 20% HDPE + PETE | | | 10% HDPE + PETE | | | CONTROL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIMEN | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| DENSITY, kg | 2.132 | 2.152 | 2.157 | 2.203 | 2.139 | 2.124 | 2.127 | 2.176 | 2.132 | 2.194 | 2.158 | 2.170 | 2.177 | 2.102 | 2.120 |
| AVERAGE, $kg/m^3$ | 1.536 | | | 1.541 | | | 1.534 | | | 1.556 | | | 1.526 | | |

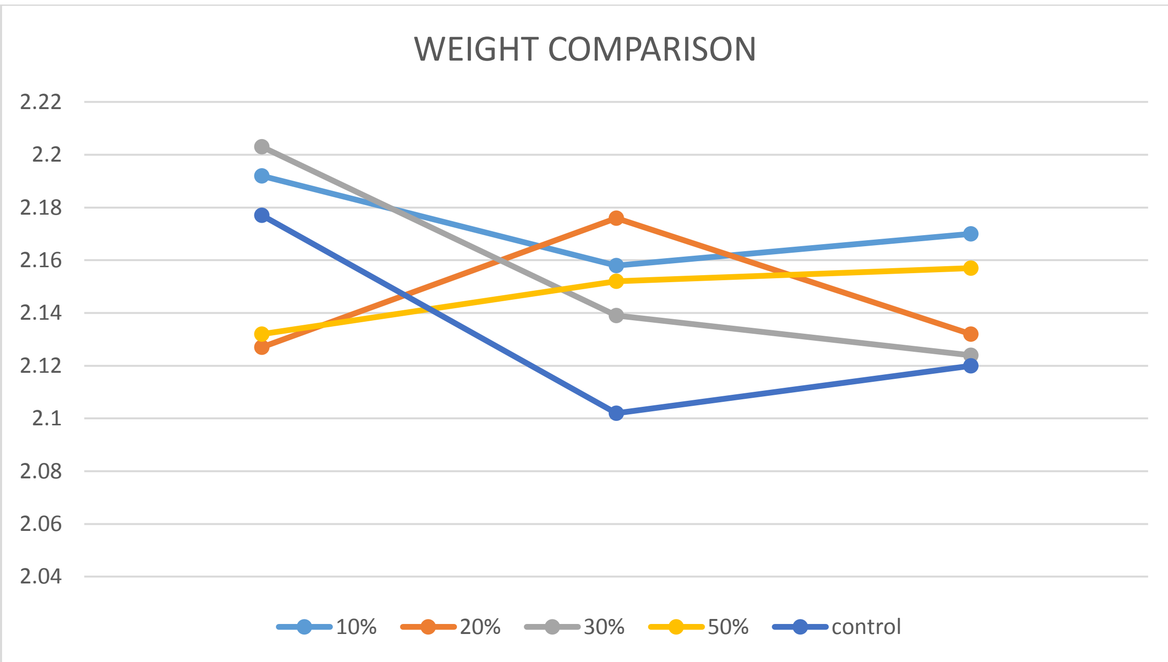


**Figure 4.2.1 Weight Comparison**

**Table 4.3.1 Water absorption test**

| Ratio | Days | | | | | |
|---|---|---|---|---|---|---|
| | 7 Days | | | 28 Days | | |
| Specimen | 1 | 2 | 3 | 1 | 2 | 3 |
| 10 % | 2.225 | 2.240 | 2.217 | 2.320 | 2.294 | 2.302 |
| | 1.594kg/m$^3$ | | | 1.650 kg/m$^3$ | | |
| 20% | 2.243 | 2.237 | 2.256 | 2.298 | 2.263 | 2.289 |
| | 1.607 kg/m$^3$ | | | 1.634 kg/m$^3$ | | |
| 30% | 2.267 | 2.254 | 2.237 | 2.305 | 2.251 | 2.285 |
| | 1.613 kg/m$^3$ | | | 1.632 kg/m$^3$ | | |
| 50% | 2.248 | 2.229 | 2.236 | 2.284 | 2.264 | 2.319 |
| | 1.602 kg/m$^3$ | | | 1.639 kg/m$^3$ | | |
| control | 2.190 | 2.115 | 2.150 | 2.220 | 2.148 | 2.169 |
| | 1.540 kg/m$^3$ | | | 1.560 kg/m$^3$ | | |

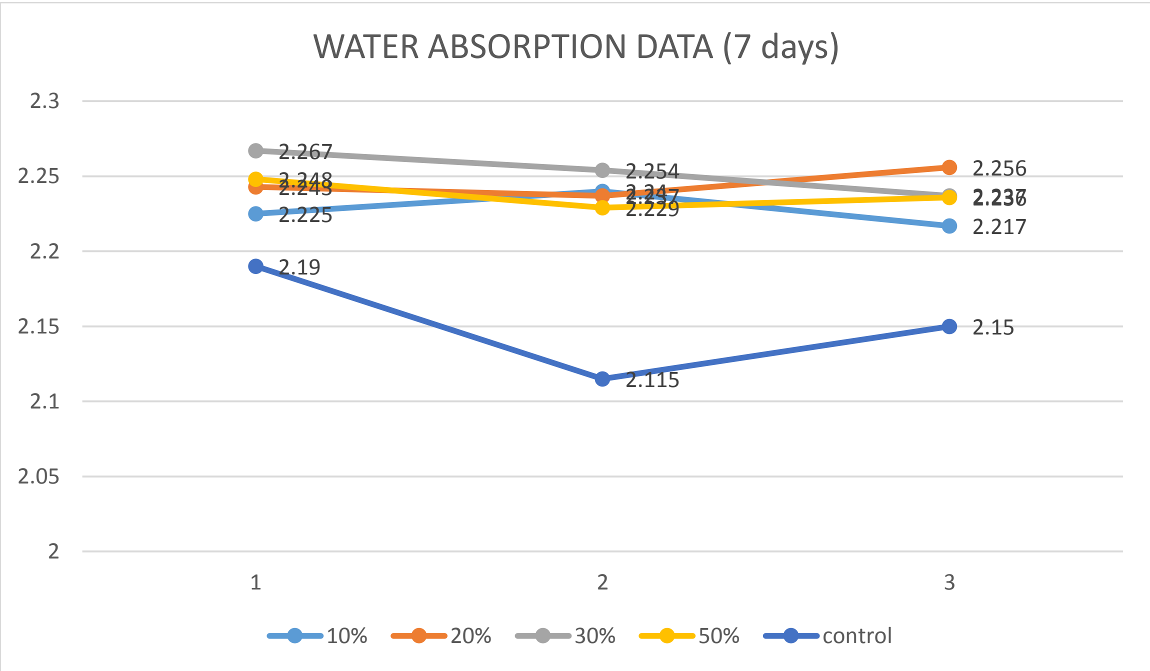


**Figure 4.3.1 Water Absorption Test (7 days)**

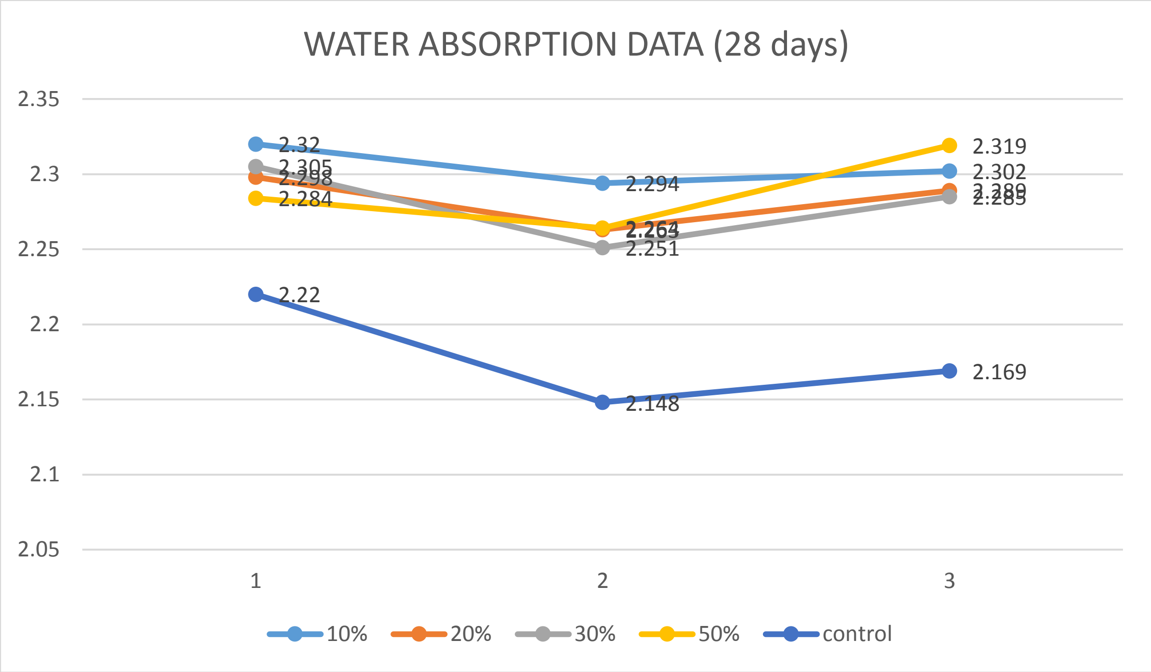


**Figure 4.3.2 Water Absorption Test (28 days)**

The ecobrick is curing in water minimum 7 days. After 7 days, the brick is taken out and dried for the following test. Then, continue with the following 28 days and the data were recorded. The density of the control brick is become smaller while the ratio of the replacement brick increased.

**Table 4.4.1 Compressive strength test**

| Ratio | Days | | | | | |
|---|---|---|---|---|---|---|
| | 7 Days | | | 28 Days | | |
| Specimen | 1 | 2 | 3 | 1 | 2 | 3 |
| 10% | 14.07 | 14.37 | 14.27 | 22.77 | 22.45 | 21.76 |
| | 14.24Pa | | | 23.33Pa | | |
| 20% | 18.65 | 19.04 | 18.56 | 20.83 | 21.44 | 21.30 |
| | 18.75Pa | | | 21.19Pa | | |
| 30% | 13.71 | 13.89 | 13.39 | 17.09 | 17.31 | 16.61 |
| | 13.66Pa | | | 17.00Pa | | |
| 50% | 17.06 | 16.67 | 16.39 | 17.98 | 18.13 | 17.59 |
| | 16.71Pa | | | 17.9Pa | | |
| Control | 18.22 | 18.01 | 18.15 | 20. 25 | 20.44 | 20.30 |
| | 18.13Pa | | | 20.33Pa | | |

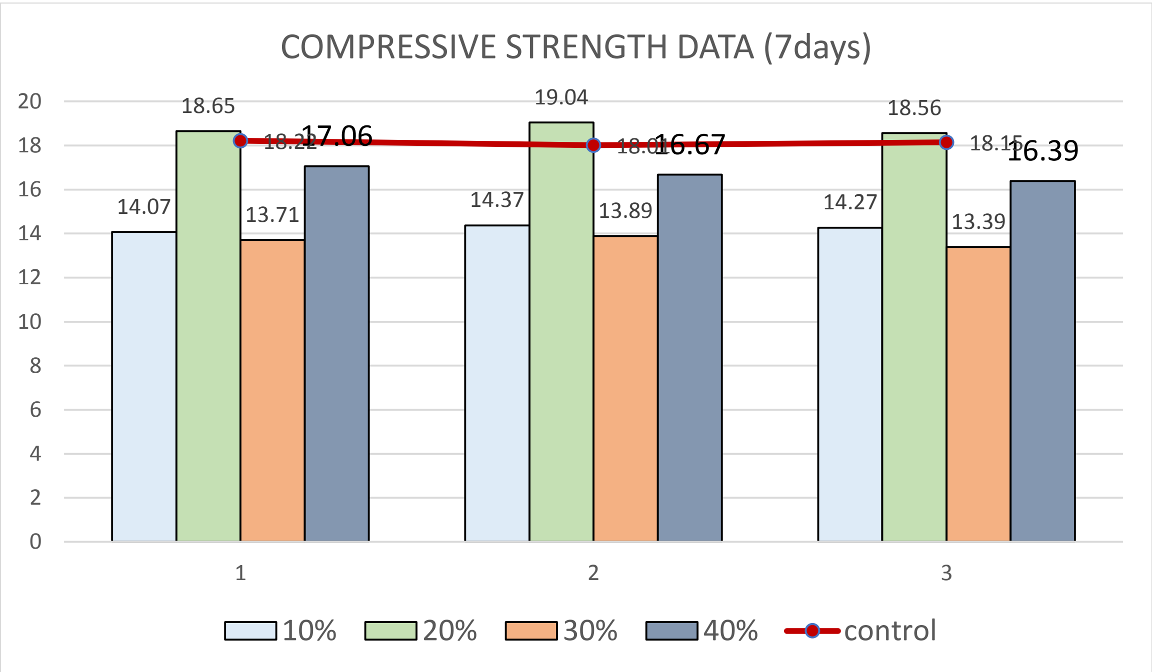


**Figure 4.4.1 Compressive Strength Test**

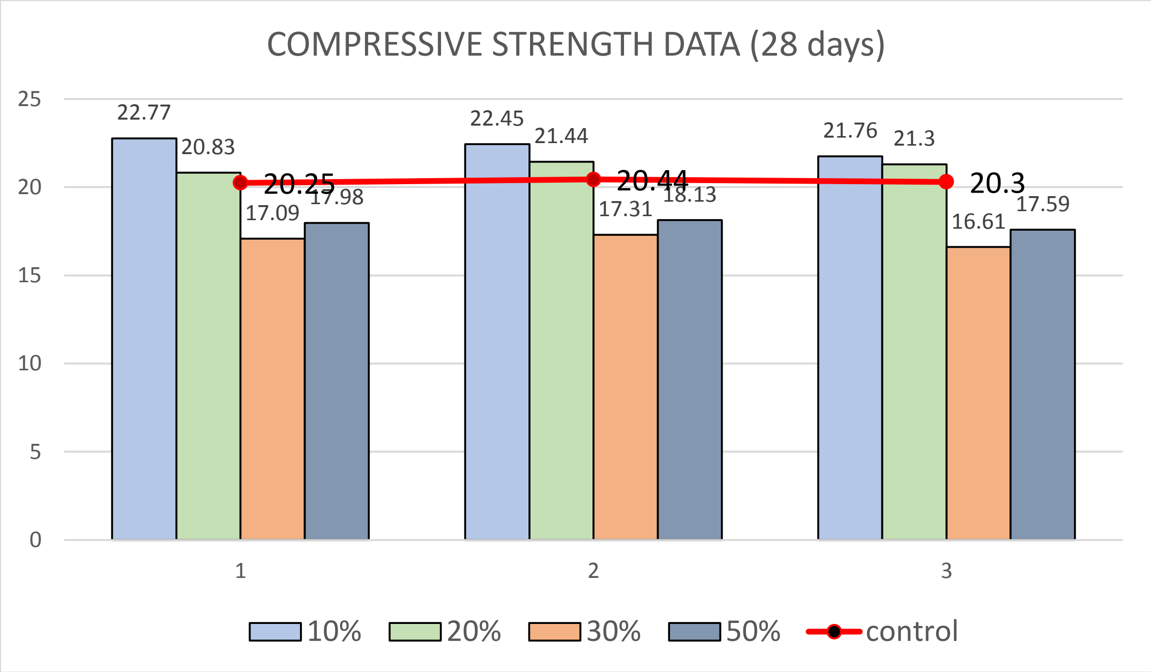


**Figure 4.4.2 Compressive Strength Test (28 days)**

The compressive strength of the ecobrick, a few of it is lower and some of it is higher than the normal sand brick (control). However, the best data were recorded on 28 days and the optimum ratio to maintain the strength of the sand brick is 10% (HDPE + PETE).

# CHAPTER 5

## DISCUSSION

### 5.1 DISCUSSION

Compared to the normal weight brick of 1.526kg/m$^3$, some of HDPE and PETE a bit heavier. This happened because of the presence of the plastics. We presume that the density should be lighter than the control brick but we got heavier instead. It may be due to the error of scaling the material for the making of eco-brick. Table 4.4.1 shows the strength of different type of brick with different ratio of plastic (HDPE and PETE). The result show that the greatest compressive strength was obtained at 10% of HDPE + PETE as sand replacement on the maximum days.

When the 30% of the replacement material added to the brick, the strength is became weaker compare to the normal brick. While 10%, the brick achieve an optimum average strength (23.33Pa) compared to 30% (17.00Pa) and 50% (17.9Pa). The application of 10% of plastic as in sand led to about 30% increase in strength of sand brick. However, some of them led to the strength reduction of the brick. The reduction in strength could be due to many factors such as flaky shape and the density. In conclusion, brick with plastic (HDPE and PETE) could be used for construction.

As could be observed, from table 4.2.1, ratio 20% (sand replacement) resulted as the nearest density as control brick. From the result, we can conclude that the 20% plastic (HDPE and PETE) can be applied into construction because of the density error does not to far from the control brick. So, it is a suitable material as the replacement for sand for the brick.

# CHAPTER 6

# RECOMMENDATION AND CONCLUSION

## 6.1 RECOMMENDATION

According to the test result, High-Density Polyethylene and Polyethylene Terephthalate (PETE/PET) can be used to replace fine aggregate in the sand brick. We recommend to produce more fine or tiny plastic (HDPE and PETE) fragment to improve the quality of the brick and its strength at the same time. Small and fine size will bind the brick between cement and sand more efficiently. Furthermore, we recommend that the procedure to make this eco brick should do in detail and proper ways to form a lightweight brick. We suggest to modify the percentage of the replacement ratio to produce better eco-brick which can be applied in the future and bringing benefit to the environment.

## 6.2 CONCLUSION

The compressive strength of the eco-brick with different percentage ratio of replacement material are tabulated in table and illustrated in graph. By using the different percentage, High-Density Polyethylene (HDPE) and Polyethylene Terephthalate (PETE/PET), 10% of replacement materials complied thw Malaysia Standard while 30% and 50% are not. Malaysia standard stated that the compressive strength of sand brick should be at least $5N/mm^2$ or 24Pa.

However, for 30% and 50% percentage of replacement material gain the average compressive strength below the control which is 17.9Pa and 17.0Pa. The natural characteristic of plastic also affected the compressive strength of sand brick which has smooth surface and reduce the skin resistance between cement. While for the weight of the brick, 20% of replacement material achieve the nearest weight with the control brick.

Between all of the percentages of replacement material, we can conclude that the optimum percentage is 10%. While the efficient density of the brick is 20% of replacement material.

# REFERENCES


Rafiq Ahmad, Mohammad Iqbal Malik, Mohammad Umar Jan, Parve Ahmad, Himanshu Seth, Javaid Ahmad. (October 2013 – March 2014) Brick Masonry – A Comparative Study. International Journal of Civil and Structural Engineering Research (IJCSER) Vol.1, Issue 1, pp: (14-21).

Cement & Concrete Institute, Midrand. (1996). How to Make Concrete Bricks & Blocks.

Dina M. Sadek. (10 September 2011). Physico-Mechanical Properties of Solid Cement Bricks Containing Recycled Aggregates. Journal of Advanced Research (2012)3, 253-260.

Hannah Ritchie, Max Roser. (September 2018). Article of Plastic Pollution to Environment, Our World in Data Organization.

ProSciTech Pty Lt. (1 July 2019). Plastic Properties Table. Extensive plastic properties and compatibilities information. Laboratory Resource.

Aditya Raut, Mohammad Salman Patel, Nilesh B. Jadhwar, Uzair Khan, Prof. Sagar W. Dhengare. (March 2015). Investigating the Application of Waste Plastic Bottle as a Construction Material – A Review.

MojtabaValinejadShoubi, MasoudValinejadShoubi, AzinShakilaBarough. (January 2013). Investigating the Application of Plastic Bottle as a Sustainable Material in the Building Construction, 28-34.

Laura Parker, Jason Treat. (20 December 2018). Plastics Facts Infographics Ocean Pollution. Fast Facts About Plastic Pollution. National Geographic.

P.C Varghese. (February 2012). Building Materials. Plastics, 185-197.

P.C Varghese. (August 2011). Building Construction. Brick Masonry, 38-58.

Bjorn Berge. (2000). The Ecology of Building Materials. Plastics Materials, pp.276.

Shan Somayaji. (1995). Civil Engineering Materials. Masonry Units, 140-158.

A.Brent Strong. (2006). Plastics Material and Processing. Thermoplastic Materials (commodity Plastics), 223-257.

Raghatate Atul M. (April-June, 2012). Use of Plastic in a Concrete to Improve Its Properties. IJAERS/Vol. I/ Issue III/April-June, 2012/109-111.

Tanveer Asif Zerdi. (2016). Investigation of Compressive Strength in Recycled Plastics Granules (HDPE) Concrete by Replacement with Course Aggregate.

PHYS Organization, University of Bath. (13 September 2018). Waste plastic in concrete could support sustainable construction in India – A review.

The Constructor, Civil Engineering Home. (2019). Compressive Strength Test on Bricks.

# APPENDIX

I) BRICK TEST REPORT (7 DAYS)

II) BRICK TEST REPORT (28 DAYS)