UTILIZATION OF LOW-DENSITY POLYETHYLENE (LDPE) PLASTIC IN PRODUCTION OF CEMENT BRICK

FINAL YEAR PROJECT

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ABSTRACT

The rapid industrialization and urbanization of today's construction sector in the country requires high amount of building material which leads to several problems like shortage of construction materials, increased productivity of wastes and other products. In the meantime, brick known as a material that have solid properties and easy to handle, which leads to the variety of materials added or replaced in its mixture. In this study, low-density polyethylene (LDPE) was selected as the replacement of materials which is sand in the making of bricks. Its recyclable properties that can minimize the used of natural material was the main reasons behind the use of LPDE. Other than that, the use of LDPE will help reducing the source of pollution by avoiding the millions of accumulated plastic waste in the disposal sites. Furthermore, the material has high endurance level and is weatherproof. This study was carried out on experimenting the replacement of sand to LDPE in the mixture of cement bricks, a components of building materials which is commonly manufactured using the mixture of cement, sand and water, following to a certain ratio, and left to dried to produce block of bricks. A series of four different percentages of LDPE were used, which were 0% (controlled brick), 5%, 10% and 15%. Tests were done on all the different percentage of displacement sand of bricks, to study its compressive strength and the initial water absorption rate. Both tests were conducted on the 7^{th} and 14^{th} day. Based on the results acquired, for compressive strength tests on the 14^{th} day, the use of 0% of LDPE shown values of 12.95N/mm² while the replacement of 5% of LDPE shown values of 13.10N/mm². Onto the next percentage, 10% replacement of LDPE shown values of 11.28 N/mm² while the replacement of 15% of LDPE shown values of 8.72N/mm². Based on the experimental investigation conducted, maximum strength was shown by cement brick on having 5% replacement of LDPE. On overall basis, this is supposed to be the best combination with respect to compressive strength.

ABSTRAK

Perindustrian dan perbandaran pesat sektor pembinaan hari ini memerlukan bahan binaan yang tinggi yang membawa kepada beberapa masalah seperti kekurangan bahan binaan, peningkatan produktiviti sisa dan produk lain. Sementara itu, bata dikenali sebagai bahan yang mempunyai sifat padat dan mudah dikendalikan, yang membawa kepada pelbagai bahan yang boleh ditambah atau diganti dalam campurannya. Dalam kajian ini, polietilena ketumpatan rendah (LDPE) dipilih sebagai penggantian bahan iaitu pasir halus dalam pembuatan batu bata. Ciri-ciri kitar semula yang dapat mengurangkan kos bahan adalah alasan utama penggunaan LPDE tersebut. Selain itu, penggunaan LDPE akan membantu mengurangkan punca pencemaran dengan mengelakkan berjuta-juta sisa plastik terkumpul di tapak pelupusan. Selain itu, bahan ini mempunyai tahap ketahanan yang tinggi dan tahan rintangan cuaca. Kajian ini dijalankan untuk menguji penggantian pasir kepada LDPE dalam campuran bata simen, komponen bahan binaan yang biasa dihasilkan menggunakan campuran simen, pasir dan air, mengikut nisbah tertentu dan dibiarkan kering dan menghasilkan batu bata. Satu siri empat peratusan LDPE yang berbeza digunakan, iaitu 0% (bata kawalan), 5%, 10% dan 15%. Ujian dilakukan pada semua peratusan yang berlainan daripada pasir anjakan batu bata, untuk mengkaji kekuatan mampatan dan kadar penyerapan air. Kedua-dua ujian dijalankan pada hari ketujuh dan ke-14. Berdasarkan keputusan yang diambil, untuk ujian kekuatan mampatan pada hari ke-14, penggunaan 0% daripada LDPE menunjukkan nilai 12.95N/mm^2 sementara penggantian 5% daripada LDPE menunjukkan nilai 13.10N/mm^2. Ke peratusan berikutnya, penggantian LDPE 10% yang ditunjukkan pada 11.28 N/mm^2 manakala penggantian 15% daripada LDPE menunjukkan nilai 8.72N/mm^2. Berdasarkan penyelidikan eksperimen yang dijalankan, kekuatan maksima dapat dicapai pada penggantian LDPE sebanyak 5%. Secara keseluruhannya, ini sepatutnya menjadi kombinasi campuran terbaik berkenaan dengan kekuatan mampatan.

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LDPE	Low-Density Polyethylene
HDPE	High-Density Polyethylene
PET	Polyethylene Terephthalate
RCA	Recycled Concrete Aggregate
PSF	Polystyrene Foam
PC	Portland Cement Composite
PCC	Portland Cement
PSA	Politeknik Sultan Salahuddin Abdul Aziz Shah
MS	Malaysian Standard
BS	British Standard

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, infrastructure development across the world created the demand for construction materials. Cement brick is the premier civil engineering construction material. Cement brick contains ingredients like cement, fine sand, and water. Building materials needed more quantity to develop the country is due to the ongoing infrastructure as well as the amount of plastic waste and demolition waste generated each year. The disposal of this plastic waste is a very serious problem because on one side it requires huge space for its disposal while on the other side it pollutes the environment.

Sustainable concepts have been created in the construction industry due to growing concern about the future of our planet. With this method of recycling, it will be more beneficial, and environmentally friendly to reduce the impact of the environment in the future. This has created what we call the biggest problem in the world and plastic waste accumulation. Research into new and innovative use of waste materials being undertaken world-wide and innovative ideas that are expressed are worthy of this important subject. To achieve this, major emphasis must be laid on the use of waste plastic from various industries.

The production of plastics in a factory sometimes increases and decreases, this cannot be maintained. plastics are a widely used material in many applications and are expected to increase as more products and plastics are developed to meet consumer demand. Waste plastic is unwanted or unusable and any substance. It is also discarded after primary use or is worthless, defective and of no use. It can be solid, liquid, or gas, or it can be waste heat.

In additional, plastic recycling can help preserve natural materials and reduce the cost of waste treatment before disposal. Civil engineers need to give new ideas and methods to the problem of adding new materials to the brick and its economic use. Larger reuse of waste is considered the best environmental alternative to discuss waste disposal issues.

1.2 Problem Statement

The global fossil-based plastics production capacity has increase and grown more than 20 fold since 1964 which is 322 million tonnes in 2015 (Ellen MacArthur Foundation and World Economic Forum, 2014; PlasticsEurope, 2017). The statistics presented in the Science journal 2015, estimated that about 8.3 million tonnes had become plastic waste where 9% recycled well, 12% incinerated, and 79% accumulated on the ground. Science magazine published an article warning that by 2050, we'll have produced 26 billion tonnes of plastic waste, half of it will be dumped in landfills and the environment (Guglielmi, 2017). From that amount found, Malaysia produces almost one million tonnes of plastic waste that is not recycled or disposed of properly and the worst part is that plastic waste is harmful because as it is believed to contain highly toxic elements and will take hundreds of years to degrade (Huysman et al, 2017).

Plastic takes almost 500 to 1,000 years to decay and decompose and a large number of plastics will be brought into the tourist area to be removed or burned that leads to environmental pollution and air. Burning is also not an answer for a solution to plastic waste. Plastic combustion can liberate gases and harmful substances such as heavy metals, toxins and chemical compounds that take a very long time to biodegradable, so it will remain in the environment and can pose a hazard to health.

Therefore, the existing mixing material requires a lot of workforce as it has a heavily weighted and stressed mass that makes the work less smooth. Water absorption due to the use of cement in the mix also contributes to the decline in product quality. Moisture continuously destroys the structure and causes increased costs in the repair and maintenance work. Besides, river sand was generally used as a fine aggregate for construction. Due to the continuous mining of sand from riverbed led to the depletion of river sand and it became a scarce material. Also, sand mining from river bed caused a lot of environmental issues.

Hence, this study is aimed at reducing the plastic to the environment, the sea and the lake and to reduce toxic gas that can pollute the environment. All of these give an important value to the option of recycling waste plastics through cement brick, which is the most consumed material in our planet, about 25 giga tonnes per year around 3.5 ton per capita (Hossain et al., 2018). The use of recycled plastics in eco-efficient cement brick can be done mainly by replacing natural sand with recycled plastic. Allowing for improvements in the ductility of cement brick composites.

1.3 Objective of Study

To implement and complete this project there are several objectives that we have set up which is:

i. Producing brick using LDPE (Low-Density Polyethylene) plastic granular.

ii. Compare the compressive strength and water absorption of different quantity of plastic granular.

iii. Compare the compressive strength and water absorption between control brick and Plastic Brick.

1.4 Scope of Study

The project will be conducted at Sultan Salahuddin Abdul Aziz Shah Polytechnic concrete workshop. The scope of this study involved the collection of data and information related to cement brick with different percentage of replacement of sand. Information such as the quantity of plastic granules used is also taken into account in determining the strength and effectiveness of cement brick. Parameters such as maximum strength data to accommodate one load at a time, the amount of water absorption and the amount of plastic granular needed to produce a cement brick. Subsequently, the project uses plastic granular that have been processed from a plastic processing plant. Secondly, the use of cement is maintained but the quantity of fine aggregate is reduced and mix with the plastic granular. The material ratio used was (1:5) and the replacement of partially sand were 5%, 10%, 15% of granular plastic. The size of mould is 215mm x 103mm x 65mm (MS 7.6 : 1972 / BS 3921 : 1985).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Bricks are building materials used in construction which is used in structures, walls, pavements, gates, and other masonry construction. Bricks commonly used in construction are cement bricks, clay bricks and cement blocks. Each one has their own way of producing it. The biggest difference is how they are prepared to be used. Cement bricks are made from a mixture of cement, sand and water. It is also known as an unfired brick where it does not need to be heated by fire, but is only compressed in a mold and left to dry under the sunlight. The production of cement bricks helps prevent the cost of burning with fire and reduces air pollution. Bricks are molded and left to curing until it reaches to a minimum of 7 N/mm^2 or 10 N/mm^2 in strength. The Standard sizes of cement brick are 215mm x 103mm x 65mm according to BS EN 771-3 and BS 476-2. Cement bricks are very durable for use in buildings construction. In addition, Clay bricks need to be fired in tonne to burn hard bricks and cement blocks should be allowed to be set. Each brick is made for different uses in terms of shape, strength and capacity. The properties of the bricks themselves are not known by its supporting loads, so elements that contribute to sustainable construction today include the use of other materials to replace sand. Cement bricks are perfect for use on building projects, either for residential or industrial facilities. They are ideal for single and double storey laying. They can be used for building and retaining walls, as well as in paving. There are many methods of brick making nowday that allow the use of recycled materials in brick construction such as fly ash, eggshell, or plastic.

2.2 Literature Review

This chapter presents literature review as a guide in determining the quality of this study. There are stated from others researcher around the world about study related to plastic brick topics.

Noorwirdawati Ali (2017) and her group research conducted a study of using high density polyethylene (HDPE) as the substitute materials in the making of bricks. The reason they use HDPE is because of its recyclable properties and the recycling process that do not emit hazardous gases to the atmosphere. The use of HDPE also will help reducing the source of pollution by avoiding the millions of accumulated plastic waste in the disposal sites and the material has high endurance level and is weatherproof. This study was conducted to test substitutes materials in cement brick mixtures, components of building materials commonly manufactured using cement, sand and water mixtures, to a certain ratio, and left dried to produce blocks of bricks. A series of three different percentages of HDPE were used, which were 2.5%, 3.0% and 3.5%. Tests were conducted to study its compressive strength and the initial water absorption rate. Both tests were conducted on the 7^{th} and 28^{th} day. Based on the results acquired, the higher amount of HDPE used will cause higher compressive strength obtained up to a certain amount. However, this study found that 3.0% use of HDPE gives higher value of compressive strength than the controlled bricks, and at the same time reduce the use of sand in the production of bricks, as well as reducing pollution to the environment caused by plastics.

According to N B Azmi (2018) present the study of the performance of composite sand cement brick containing recycle concrete aggregate and waste polyethylene terephthalate with different mix design ratio. The objective is to determine the compressive strength, water absorption and the optimum mix ratio of bricks containing recycled concrete aggregate and polyethylene terephthalate waste. The bricks specimens were prepared by using 100% natural sand, then replaced by RCA at 25%, 50% and 75% with proportions of PET consists of 1.0%, 1.5%, 2.0% and 2.5% by weight of natural sand. Based on the results of compressive strength, the replacement of RCA shows an increasingg strength that starts to increase from 25% to 50% for both mix design ratio. strength for RCA 75% volume of replacement began to decrease as the amount of PET increased. However, the result of water absorption with 50% RCA and 1.0% PET showed less permeable compared to control bricks at both mixed design ratios. The overall result based on two different mix design ratio shows instability in compressive strength of bricks when RCA and PET were added. When the compressive strength of the mixtures values were compared at different mix design ratio (1:4,1:5), it showed that the compressive strength for control brick at mix design ratio 1:4 was higher than mix design ratio 1:5 at ages 7th days and 28th days. Overall result of different percentages of RCA and PET compared at different mix design ratio, the lowest value of compressive strength were obtained for a mix design ratio 1:5.

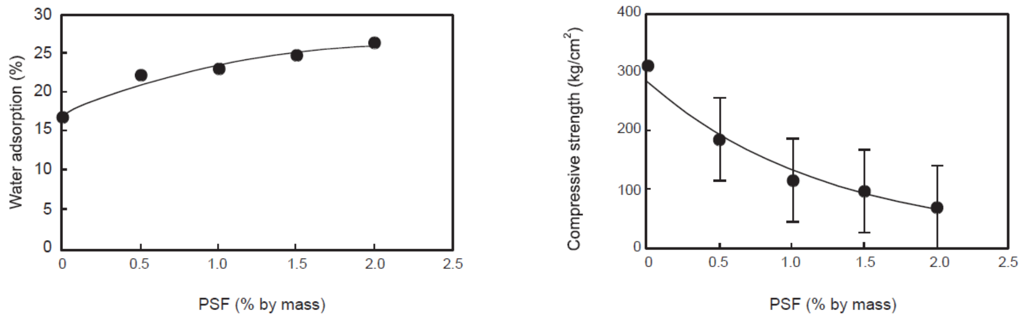

Figure 2.1 Water Absorption and Compressive Strength (Sohrab Veiseh, 2003)

Figure 2.1 shows a result from an experiment conducted by Sohrab Veiseh and Ali A. Yousefi (2003) about The Use of Polystyrene in Lightweight Brick Production. In this study, some results of the research project “production of lightweight bricks using polymeric materials”, carried out at the Building and Housing Research Center is represented. Tests showed that by increasing the polystyrene foam additive, the compressive strength and density of the bricks decreases while the water absorption increases. Adding 2% of recycled polystyrene foam keeps the compressive strength of the bricks are suitable for ordinary loadbearing bricks according to the Iranian standard. Higher firing temperatures lead to higher compressive strengths and less water absorption. It is due to formation of new minerals such as mullite and glass phase, and consequently stronger bondings in the produced bricks. Thermal conductivity of lightweight polymeric bricks made of 1.5% recycled PSF is ¼ of ordinary bricks, so it causes a considerable effect on energy saving in building. In conclusion, the increasing percentage of PSF in lightweight brick make the strength decreased.

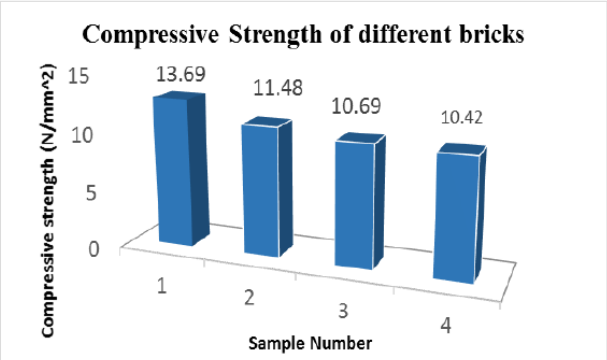

Figure 2.2 Compressive strength of different bricks (Ronak Shah,2017)

Figure 2.2 shows the data from Ronak Shah (2017) study. The main aim of their study is to overcome the large plastic waste produced worldwide. Using only plastic waste or add other materials such as powders, fly ash, plastics and other materials into useful building materials such as pavers, building blocks, and bricks. Some of sample with different combinations have been performed to efficiently convert waste plastic into bricks. The result shows that the maximum compressive load of LDPE plastic bricks could sustain was 13.69 N/mm². This is followed by the LDPE fly ash composite bricks with a strength of 11.48 - 10.42 N/mm², which is higher than the conventional compressive strength of bricks available on the market consisting of clay with a compressive strength of 3-5 N/mm².

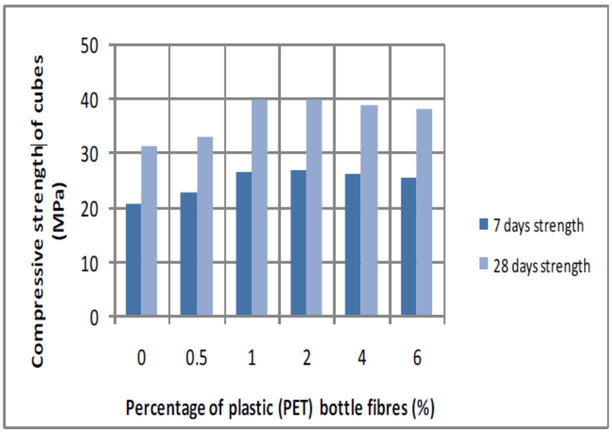

Figure 2.3 Compressive StrengthVS Plastic Fibres (%) (K.Ramadevi,2012)

Figure 2.3 shows compressive strength and plastic fibres according to K.Ramadevi (2012) experiments that discussed the possibility of using a waste PET bottle as the partial replacement of fine aggregates. Concrete with 1%, 2%, 4% and 6% PET bottles fibre for fine aggregates were produced and compared with control samples without replacement. Cube specimens, cylinder specimens and prism specimens were cast, cured and tested for 7^{th} and 28^{th} days of strength. The results show an increase in compressive strength and tensile strength with the increasing of fine aggregates. The replacement of fine aggregates reducing the quantity of river sand for use in concrete and even plastic fibers has proven to be more economical. It has been observed that compressive strength increases up to 2% in replacement of fine aggregates with PET bottle fibers and gradually decreases for 4% and 6% replacements. Therefore, replacement of fine aggregates with 2% replacement is perfect.

According to the Unung Suwarno (2015) which presents the study of the use of plastic waste bags as a mixture of fine aggregates in concrete production of (1:2:3) variation in plastic mixture plus mortar 0, 1, 1.5, 2, 2.5, 3, 4, and 5%. All variations were tested for compressive strength and tensile strength. From their test results showed that the addition of 5% plastics increased the tensile strength of about 50% compared with no plastic additives, compared with the addition of the same plastic reduce the compressive strength of 47%. From this result it can be stated that the addition of plastics will increase the tensile strength so that the inner structure of the fiber stress crack will not occur and with the addition of plastics can reduce the density of concrete so that the structure is lighter.

Pratikto (2010) conducted a study of lightweight concrete using aggregates of PET (Polyethylene Terephthalate) plastic bottle waste. PET can be used as a substitute for coarse aggregates in lightweight concrete through the process of heating, cooling and solving. The stirring process is different with stirring in normal concrete. Stirring starts with adding sand aggregate, cement and 50% water to the mixer, then additive 50% and stirring for 5 minutes. The remaining water and additives are put into the mixer and stirred for the next 5 minutes. The PET aggregate is inserted last little by little. From this study, the ratio of the mixture for each m^3 of lightweight structural concrete was cement 263 kg, sand 420 kg, water 279 kg and aggregate PET as much as 559 kg for additive use of 50 ml. The resulting compressive strength is 17.49 MPa with a split tensile strength of 1.15 MPa. So that this lightweight concrete can be categorized as structural concrete. The split tensile strength produced is not more than 10% compressive strength, which is 1.15 MPa.

According to Nursyamsi Nursyamsi (2019), the study on the influence of using LDPE plastic waste as a fine aggregate in lightweight concrete bricks. In this study, the use of sand in brick was reduced with LDPE plastic pellets. The reason for the use of LDPE plastic pellets as replacement materials is that LDPE plastic pellets have a smaller density than fine sand, so it is expected that the brick becomes more lighter although consists of the same composition. It can also reduce environmental problems as LDPE plastic waste is difficult to decomposed by nature. The samples in this study consisted of cylinders of 15 cm in diameter and 30 cm in height as a test specimen, a concrete brick measuring 40 cm x 20 cm x 10 cm, a cube measuring 5 cm x 5 cm x 5 cm. the trial mixed samples will be treated 7^{th} and 28^{th} days. In addition, the sample will be tested with visual, weight content, water absorption, and compressive strength. This study uses a mixture of cement, sand and water with a ratio of 1: 6: 0.24, the composition obtained from experiments on certain compositions. The results showed that replacement of LDPE plastic pellets to sand reduced the weight of the bricks as well as the compressive strength of the test material when the addition of LDPE plastic pellets decreased by 57.02%. In the tensile strength test, specimen with the addition of 20% of LDPE plastic pellets decreased by 45.15%, the absorption test also decreased by 23.09%, meaning that if it were added with plastic pellets, the concrete bricks would have less cavity than ordinary bricks. Absorption tests do not reflect porosity, but interconnectivity of voids.

With the evidence and sources of researches ever mentioned above, this study will be more organized and believed to have been referenced by a validated reference and can move to the next step.

2.3 Materials

i. Plastic

A plastic material is any of a wide range of synthetic or semi synthetic organic solids used in the manufactureof industrial products and requires a long time to decompose. However, plastic is still used for a variety of purposes and its use is very widespread throughout the world. The use of plastics in a wide range of fields is that plastic has its own superiority compared with other materials, for example not easy to rust, strong, not fragile, light and elastic. In this project, Low Density Polyethylene (LDPE) as a replacement of partially sand of cement brick wil be produces. With the presence of plastic, the strength of the brick will increase as the plastic properties are more durable and difficult to decompose.

Plastic material is the excellent choice of chemical resistance. Chemical resistance to the climate is another of the advantages to the use of plastic. Aside from the moisture resistance, chemical resistance to the weather is also useful for resisting the effect of associated phenomena making plastic ideal for hot and rainy weather in Malaysia.

Furthermore, another of the engineering considerations of the use of plastic materials is the electrical conductivity of the materials that are useful because they do not conduct electricity. For construction, plastic that do not conduct to electricity are very useful to enclosures the other component that will contact the electrically active items that can avoid the accident to the user. Perhaps the greatest advantage of plastic is their ease of manufacture. Plastic molding can eliminate the need for investment in molds even operations such as tapping and core the mold is screwed out. Plastic molding is typically done in very rapid cycles.

Figure 2.4 LDPE Plastic Granule

LDPE (Low-Density Polyethylene) is defined by density 0.917-0.930 g/cm3. It is not active at room temperature, except by strong oxidizing agents, and some solvents. Its widespread use is used as food wrap. In accordance with its sequence, the plastic symbolizes a triangular number 4. From CY Intertrade SDN BHD data, each of the granule plastics is 4-5mm in sized which can hold up to 90 newtons and the strength is 14.5 N/mm². The temperature resistance for LDPE granule is up to 190°C which means suitable to use in production of cement brick in Malaysia. The maximum temperature in Malaysia can reach up to 40°C. Therefore, LDPE is suitable for use in the manufacture of cement brick and is use in construction in malaysia.

In the nutshell, the used of granule LDPE plastic as a replacement of natural sand in the mix to increase the strength of the brick. Plastic is a material that can resist water and moisture absorption from a mixture of materials where moisture is the major source of building materials estatist damage. Plastics also reduce the load on the bricks and prevent the termite and anti-corrosion attacks. The plastic as the additive is believed to be able to provide maximum strength without reducing the durability of existing cement bricks.

ii. Cement

Cement is a major component of industrial construction. Cement is a type of dust that when mixed with air it will harden. This hardening process occurs because of chemical reactions that convert dust cement into a bonding bond until the liquid is hardened. The type of cement commonly used in industry Malaysia is Portland cement. In this study, the type of cement used is Portland cement. The main content of Portland is chalk (CaO), silica oxide (SiO_2), alumina silica (Al_2O_3) and Oxide fission (Fe_2O_3) at a certain percentage.

Based on the research that written by Yusuf Amran (2015), Cement is hidraulic binder which means that the compounds contained in the cement can react with water and form new substances that are adhesive to aggregates. This reaction is influenced by the fineness of the cement, the amount of cement, and temperature.

Cement Portland (PC) and Composite Portland Cement (PCC) are cement obtained by mixing lime and clay materials, burning them at temperatures that result in the formation of clinkers and smoothing the clinker with plaster as an additive.

iii. Fine Sand

Sand is the second most important component in the manufacture of concrete. Fine sand is a fine-grained aggregate having minerals that serve as a filler in a concrete mixture. The fine sand used in this mixing need to be less than 5mm and obtained from quarries, mines and rivers. This aggregate compound is more than filler. It plays an important part in the brick composition. The presence of sand fines in concrete is likely to affect the workability, strength and long-term performance of brick. The amount of sand in bricks determines the mixture's strength and texture. Fine sand as a bond that ensures the mix is really solid.

iv. Water

Water is a fluid that descends from the clouds as rain, forming rivers, lakes, and seas, and is the main source of all living things. Water is a compound of oxygen and hydrogen (H_2O) with its unique physical and chemical properties. Water that used for mixing and curing shall be clean and free from injurious amounts of oils, acids, salts, akalis and others organis materials. Water used in this study was free from any substain and the water cement ratio is 0.6.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Research methodology is something important in a project. This is because to ensure that the research is conducted systematically and can be completed within a specified time frame. With this, the final outcome of the study will reach the needs of the problems to be resolved and to achieve the objectives of the study. In this chapter we also list materials and equipment as well as regulations of project implementation procedures to be followed. In this chapter will also state the appropriate tests conducted on cement bricks and procedure to conducted the testing.

3.2 Project Equipments and Materials

i. Equipments

Before starting the mixing process, all the equipment needs to be prepared and cleaned so that the implementation process runs smoothly. When carrying out the process, appropriate clothing and safety boots should be wear for safety in brick workshop. Below is the list of equipment:

Table 3.1: list of equipment

No	Equipments
1	Bucket
2	Trowel
3	Hoe
4	Weight scale
5	Metal rod
6	Oil
7	Brick mould (215mm x 103mm x 65mm)

i. Materials

Materials used for mixed process were Ordinary Cement Portland, fine aggregate, clean water with water cement ratio 0.6, and LDPE granule with 5%,10% and 15%. The ratio for this study was cement : sand (1:5) and a replacement of LDPE with certain percentage.

Specimen A is a control brick with 0% of LDPE granule. For this mixing, about 4kg cement, 20kg fine sand and 0.6 water cement factor were used to produced 6 bricks control with 0% replacement of LDPE plastic granule.

Specimen B is sample that contain 5% of LDPE granule. For this mixing, 4kg cement, 19kg fine sand and 0.6 water cement factor used to produce 6 brick with the replacement 1kg (5%) of LDPE plastic granule.

Specimen C is sample contain of 10% of LDPE plastic Granule. For this mixes, 4kg cement, 18kg fine sand with 0.6 water cement factore were use to produce 6 brick with the replacement 2kg (10%) of LDPE plastic granule.

Last sample is specimen D that contain 15% of LDPE plastic granule. This mixes use 4kg cement, 17kg fine sand and 0.6 water cement factor to produce 6 brick with the replacement 3kg (15%) of LDPE plastic granule.

3.3 Procedures

i. Preparation Process.

After the equipments and materials already prepared, the next step is to started mix the material to produce a sample of each specimen. A suitable place are founded which is Brick Workshop Politeknik Sultan Salahuddin Abdul Aziz Shah, Department Civil Engineering.

Figure 3.1: Weighing the material

As the Figure 3.1 shows, the material is weighed in a dry bucket in a certain ratio for the first mixture.

ii. Implementation process

Figure 3.2: The mixing

Figure 3.2 show after the material has been weighed, all material is placed on a metal plate for the purpose of mixing.

Figure 3.3: Mixed the material

Figure 3.3 shows the mixing of materials which is cement, sand and plastic until it well mixed. Then a hole is made in the middle of the mixture to mix the water so that the water does not spill out of the mixture. Then slowly mixed the materials using hoe until the mixture turn grey.

Figure 3.4: Oil is rubbed into mould

Figure 3.4 shows oil were applied to the inside of the mould to make it easier to remove the mould.

Figure 3.5: Pouring the mixture

As the Figure 3.5 shows, the mould that are made from plywood planks and nails were prepared before the mixture is poured into the mould. The mould is placed on a board and the mixture is poured into the mould. The mixture in the mould is compressed by using a compacting rod.

Figure 3.6: Flattened the brick surface

The top of the brick is flattened using a trowel. After that, the mould is left for 5 to 10 minutes before the mould is removed. Then, the specimen are left to dry at room temperature for 7th to 14th days.

iii. Process of labelling

Figure 3.7: Process of labelling

Figure 3.7 show the specimen after 24 hour left to dry at room temperature and the specimen be marked as the sample A, B, C, and D.

3.4 Test Methods

To know the quality of the specimen, several test was conducted. All the specimen were placed at temperature room for a period of 7th and 14th days. The specimens were taken for testing which is compression test and water absorption test. Three numbers of specimens in each sample were tested and the average value is calculated. The results were compared and analysed with the control specimens.

i. Water Absoprtion Test

Water absorption test was conducted based on MS 76: 1972 to determine the percentage of water absorption of the specimen. The method of the test is by 24-hour cold immersion test. First, the dry specimen at room temperature is weighed in a dry condition. Then, the specimens were completely immersed in water at room temperature. After immersion for 24 hours, the specimens were removed from water and wiped with cloth and weighted the wet specimens. Then the difference between the percentage of dry and wet bricks is calculated. Following is the formula to calculate the percentage of water absorption:

$$\text{Water absorption (\%)} = \frac{\text{Wet brick} - \text{Dry brick}}{\text{Dry brick}} \times 100$$

The procedure for testing water absorption is stated as below:

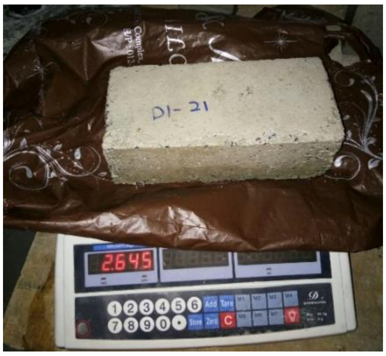

Figure 3.8: Dry brick weighed

Figure 3.8 show all the specimen are weighed in dry condition in room temperature.

Figure 3.9: Curing process

Figure 3.9 show the specimen being totally immersed for 24 hour.

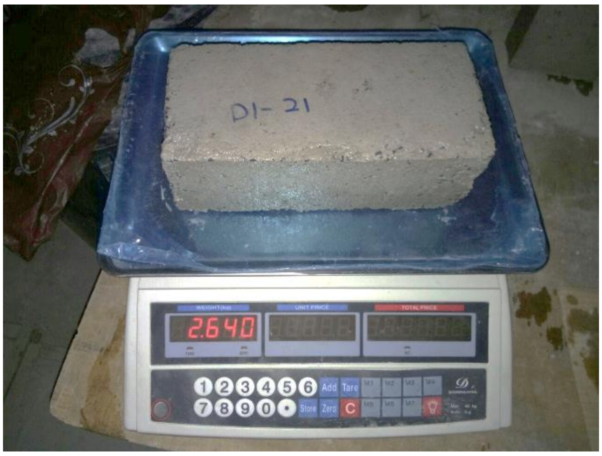

Figure 3.10 : Wet brick weighed

Figure 3.10 show after removed the specimen from water and being wiped with cloth, the specimen are wighed at a wet condition to record the water absorption data. Using the water absorption formula, data was obtained.

ii. Compressive Strength Test

This test is done to study the compressive strength of bricks that contains a certain percentage of LDPE Granule as a replacement of sand. The test is conducted based on BS EN 772-1: 2011. Generally, the specimen brick was taken to the laboratory for testing and tested one by one. In this test, control brick and the specimen are placed on compressive strength machines and subjected to pressure until they break. The final pressure in which the brick is destroyed is taken into account. All 3 brick specimens were tested one by one and the average result was taken as compressive strength.

Figure 3.11: Compressive strength test

Figure 3.11 show the specimen were placed on the compressive strength machines and subjected to the maximum pressure until it break. Average for all 4 sample which is 0%, 5%,10% and 15% was taken as the final result compressive strength.

Calculation of the compressive strength is done by dividing the maximum strength obtained with the area which loads are forced to. Following is the formula of compressive strength:

$$\text{Compressive strength} = \frac{\text{Force}}{\text{Surface Area}}$$

After that, high compression is obtained and comparisons are made between the bricks and the data analysis was conducted from the information obtained.

3.5 Flowchart Of Project

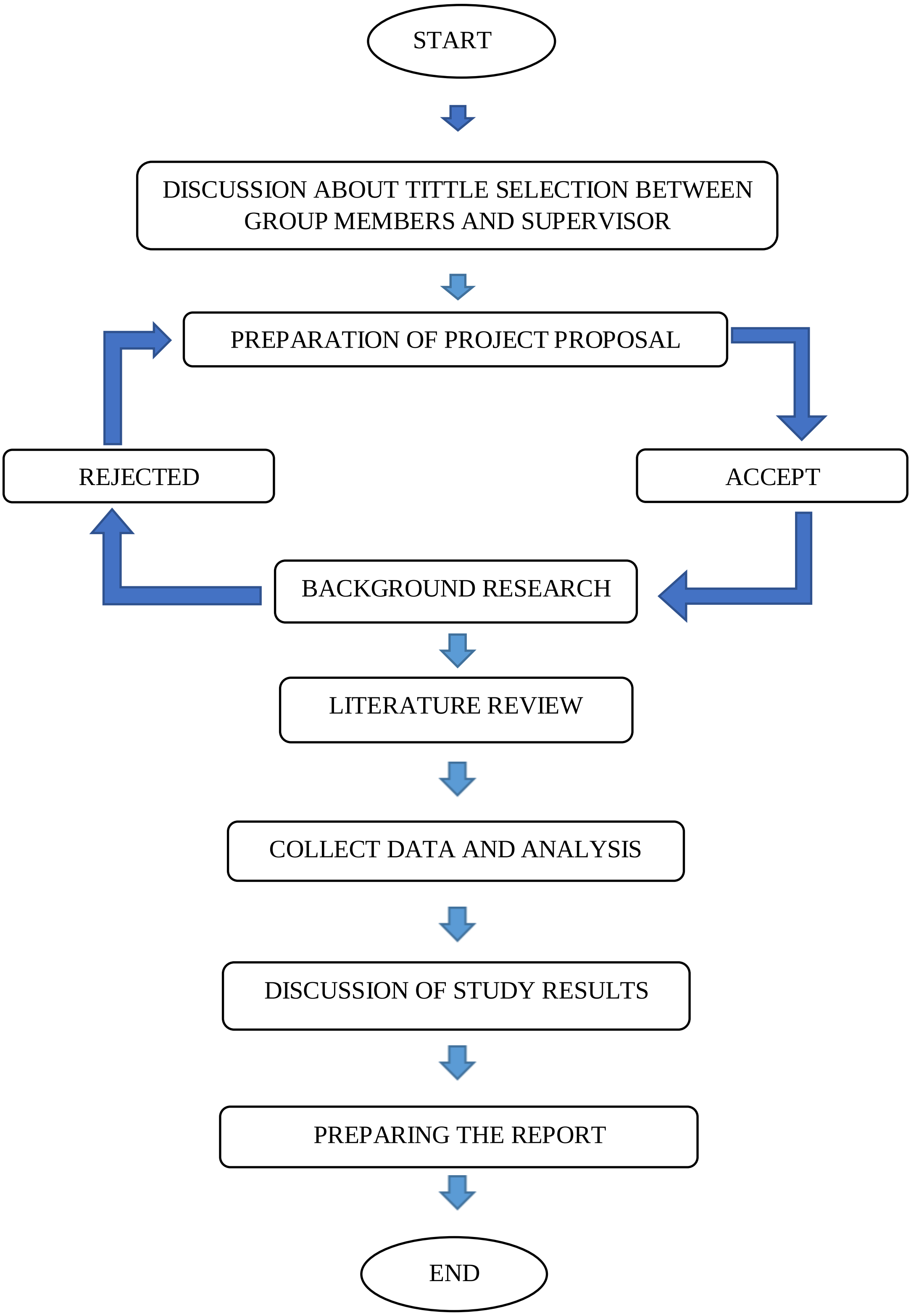

Figure 3.12 Flowchart

CHAPTER 4

RESULTS

4.1 Introduction

After completion of the implementation process and all data obtained, analysis was performed to see the effectiveness and quality of the specimen. The results obtained from this chapter are the results of testing conducted in brick workshops PSA on water absorption test and in engineering laboratories on compressive strength testing. The data obtained from this testing were analyzed in more detail to draw the conclusions based on the objectives of the study.

4.2 Results and Discussion

The specimen were store for 14 days and be tested before 14 days based on BS 772-1 : 2000. This testing was performed on specimens on the 7 th and 14 th day. The sum of bricks used in both test were 24 specimens of brick. Every specimen mixture use the same ratios of water and different percentages of Low Density Polyethylene (LDPE) Granule which are 0% (controlled), 5%, 10% and 15%

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4.2.2 Compressive Strength Test Data

The compressive strength of the specimens is to determines its load bearing capacity before the failure. Compressive strength of bricks was tested at age of 7^{th} and 14^{th} days. The specimens are being tested with different percentages replacement of LDPE granule plastics.

A series of four different percentages of LDPE granule were used, which were 0%, 5%, 10% and 15%.

Table 4.1 : Average of Compressive Strength Test

DAY \ ITEM	SPECIMEN	% OF LDPE	AVERAGE COMPRESSIVE STRENGTH (MN/m²)
7	A(CONTROL)	0	12.63
	B	5	13.49
	C	10	10.25
	D	15	8.35
14	A (CONTROL)	0	12.95
	B	5	13.10
	C	10	11.28
	D	15	8.72

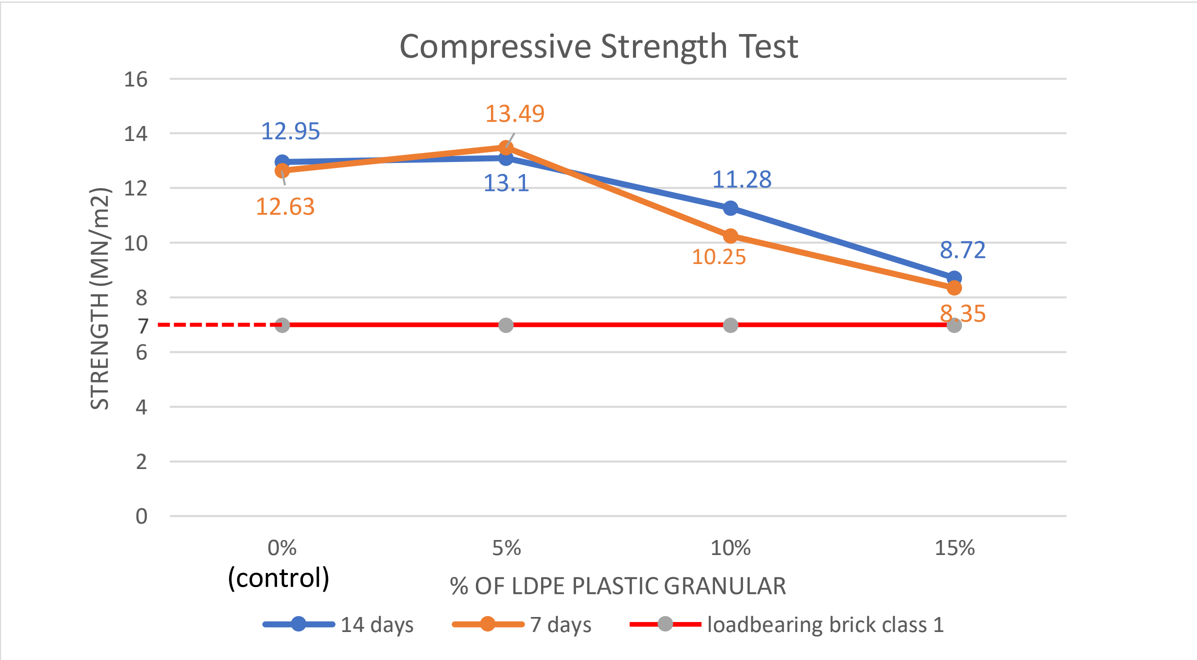

Figure 4.1 : Compressive Strength Test Result

Based on the results obtained, for compressive strength tests on the 7th day, with the 0% LDPE replacement shows the value of 12.63 MN/m². Next, the use of 5% of LDPE granule plastics shows values of 13.49 MN/m², while the use of 10% of LDPE granule plastics shows values of 10.25 MN/m². Over the next percentage, 15% of LDPE granule shows values of 8.35 MN/m².

However, for compressive strength tests on the 14th day, with the 0% of LDPE replacement shows the value of 12.95 MN/m². Meanwhile, the use of 5% of LDPE granule shows values of 13.1MN/m², while the use of 10% of LDPE granule shows values of 11.28MN/m². In the next percentage, 15% of LDPE granule shows values of 8.72MN/m².

Based on the experiment, it is found that used 5% of LDPE granule reached 13.49MN/m² of compressive strength on the 7th day, and decreased by a small portion on the 14th day to 13.1MN/m². For the specimen with 10% of LDPE granule, it showed increased in value of compressive strength which was 10.24MN/m² on the 7th day and 11.28MN/m² on the 14th day. Meanwhile, specimen with 15% of LDPE granule shows the increased value of compressive strength for both day which were 8.35MN/m² on the 7th day and 8.72MN/m² on the14th day.

According to the study, the compressive strength data for 5% LDPE granule at 7th days was 13.49 MN/m² stronger than 14th days at 13.10 MN/m², but in comparison between all specimens showed brick with 5% LDPE much stronger than the others.

From the data collected, it is confirmed that specimen with 5% replacement of LDPE granule has good interlocking well graduation between coarse and cement portland. LDPE granule of 5% replacement is within reasonable range to incorporate into sand cement brick. Therefore, 5% LDPE granule content was selected as the optimum value for fine sand replacement regarding from compressive strength test.

4.2.3 Water Absorption Test Data

Water absorption was carried out to determine the percentage of water absorption of the specimen. The results of water absorption against ages for each percentage of LDPE granule was given in Figure. It shows the evolution of water absorption from 7th days to 14th days for all specimen. The results illustrated that the water absorption decrease, and dramatically increased with the replacement percentage of fine aggregate by the LDPE granule for all mixtures.

Table 4.2 : Average of Water Absorption Test

ITEM / DAY	SPECIMEN	% OF LDPE	AVERAGE WATER ABSORPTION (%)
7	A(CONTROL)	0	4.9
	B	5	4.12
	C	10	5.06
	D	15	5.92
14	A (CONTROL)	0	5.22
	B	5	4.92
	C	10	5.74
	D	15	6.83

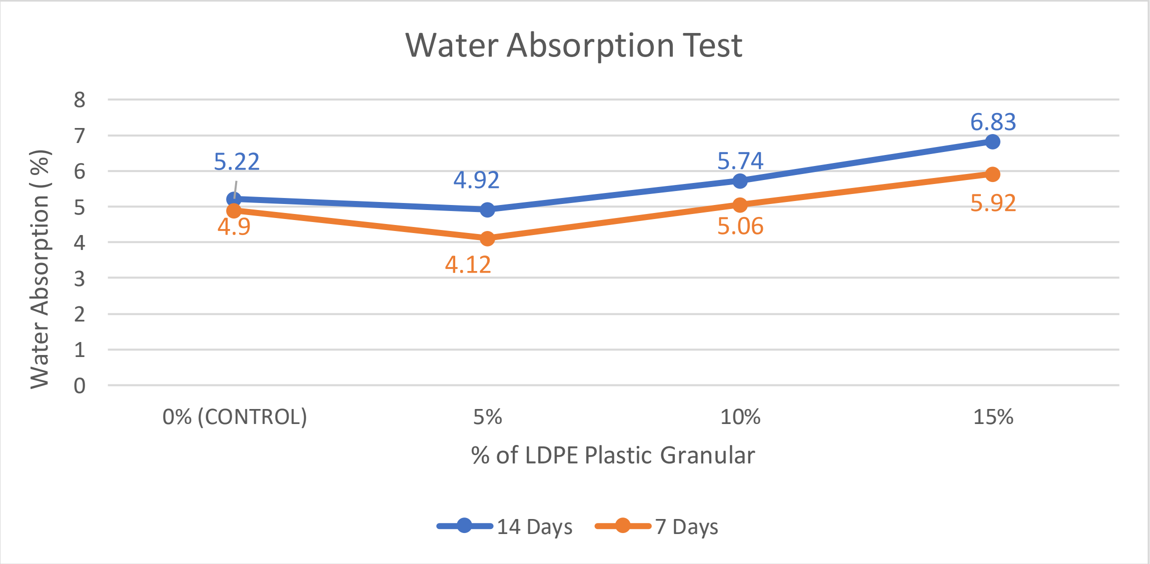

Figure 4.2 Water Absorption Test Result

Figure 4.2 shows a percentage graph of water absorption rate on the 7th and 14th day with the percentage of LDPE usage. Based on the data obtained, the highest rate recorded on 7th day is specimen 15% of LDPE which is the value of water absorption is 5.92%, meanwhile on 14th day its reach 6.83% of water absorption. Specimen with 5% of LDPE recorded the lowest value of water absorption on the 7th day with 4.12%. On the 7th day, the water absorption rate recorded for all specimen are lower than their 14th day. The results indicate that the specimen with 5% LDPE granule was less permeable when compared to others specimen. Then, the percentages of water absorption decrease below control brick and start to increase from 5% LDPE granule to 15% LDPE granular.

It can be concluded that the density of specimen decrease and the water absorption increase as the LDPE granule content is increased. The sand cement brick containing with high percentage of LDPE granule was more porously than the natural sand. The water absorption of bricks increased with increase in pores. The physical size, shape and random distribution of LDPE granule are more coarse than natural sand which is make the packing of mortar matrix becomes less efficient as the LDPE granule content is increased.

The good rate of water absorption is between 0% to 7% because it provides better resistance to damage by freezing. This value can be referred to evaluate the performance of water absorption rate on the specimen brick. As shown in Figure 4.2, it is found that each brick showed a different values of water absorption. The degree of compactness of bricks can be obtained by water absorption test, as water is absorbed by pores in bricks.

4.3 Conclusion

From the results that have been obtained, replacement of LDPE granule with the fine sand can reduce the content weight of the specimen and the compressive strength increase from 0% replacement of LDPE to 5% replacement. The water absorption test shows the decreased value when the specimen is added 5% of LDPE, which means that the 5% specimen have better water absorption value than control specimen (0%). Overall, the optimum value of both test is obtained at the 5% LDPE which means this specimen have a good strength from the standard brick and the others specimen and may be use as a construction material.

CHAPTER 5
CONCLUSION AND DISCUSSION

5.1 Conclusion

The use of LDPE in making cement bricks can affect the physical properties of the bricks in various ways. Among the visible effect was the sign of the presence of LDPE in the form of small black beads. Other than that, it is concluded that the values obtained for compressive strength recorded the highest at 5% replacement of LDPE (13.5 N/mm^2) on 7^{th} day while on the 14^{th} day the highest values of compressive strength recorded was 13.1 N/mm^2 at 5% replacement of LDPE. Moreover, the initial water absorption rate shows decreased slightly from 0% of LDPE used (controlled brick) to 5% of LDPE used for both 7^{th} day and 14^{th} day which is represents replacement of LDPE partially on 5% is the lowest value of the water absorption rate. Beyond that, from 5% replacement to 15% replacement of LDPE values on both 7^{th} and 14^{th} day recorded a gradually increased initial water absorption rate. Overall, we can see a clear upward trend in the percentage of water absorption values from 5% to 15% replacement of LDPE in cement brick.

In other words, the higher amount of LDPE used will affect the values of compressive strength. Based on the experimental investigation conducted, it's found that LDPE can be used as a replacement for sand but achieve the manimum strength value, the replacement should not exceed 5%. However, this study found that 5.0% use of LDPE gives lower value of water absorption and higher value of compressive strength than the controlled bricks, and at the same time reduce the use of sand in the production of bricks, as well as reducing pollution to the environment caused by plastics. Meanwhile, the presence of LPDE as a replacement of sand causes the weight of the bricks to decrease.

5.2 Suggestion

As to improve the study carried out, some considerations and suggestion can be applied in future studies. Among the suggestions for future studies are:

i. This study was performed with a consistent ratio of water on all samples. A variety of water cement ratios can be used for future studies, to evaluate the optimum brick strength using different water ratios and different percentages of LDPE.

ii. Substitution of sand with LDPE into other kind of bricks or concrete mixture in future studies, as LDPE has high potential to be used as a substitute for sand, and not specifically for cement.

iii. Different types of plastic granule may be used such as LDPE, HDPE and PET. In addition, may be used the smallest size of plastic granule. Theoretically, the smallest size used, can increase the values of compressive strength of the bricks.

REFERENCE

1. *Anung Suwarno, Sudarmono (2015), Kajian Penggunaan Limbah Plastik Sebagai Campuran Agregat Beton, Jurnal Ilmiah Teknik Kimia UNPAM, Vol. 20 No. 1 Jun 2015 1-10.*

2. *Bagus Soebandono, As'at Pujianto, Danar Kurniawan, "Compressive and Tensile Strength Behavior Of Concrete Filled With Hdpe Waste"., Jurnal Ilmiah Semesta Teknika Vol. 16, No. 1, 76-82, Mei 2013.*

3. *Ellen MacArthur Foundation and World Economic Forum (2014) "The New Plastics Economy - Rethinking the future of plastics". https://www.ellenmacarthurfoundation.org/publications/the-new-plastics-economy-rethinking-the-future-of-plastics*

4. *Guglielmi G(2017). "In the next 30 years, we'll make four times more plastic waste th at we ever have". http://www.sciencemag.org/news/2017/07/next-30-years-we-ll-make-four-times-more-plastic-waste-we-ever-have.*

5. *Huysman S, De Schaepmeester J, Ragaert K, Dewulf J, De Meester S (2017). "Performance indicators for a circular econ omy: a case study on post- industrial plastic waste" Resources, Conservation and Recycling. 2017;120:46–54.*

6. *Hossain M.U, Poon C.S, Dong Y.H, Xuan D. "Evaluation of environmental impact distribution methods for supplementary cementitious materials. Renewable and Sustainable Energy Reviews". 2018;82:597–608.*

7. *Itsna Fauziah Royani, Achmad Basuki, Sunarmasto (2014), "Kajian Kuat Tekan, Kuat Tarik, Kuat Lentur Dan Redaman Bunyi Pada Panel Dinding Beton Ringan Dengan Agregat Limbah Plastik Pet Dan Limbah Serbuk Kayu", Desember 2014*

8. *Ms. K.Ramadevi, Ms. R. Manju (2012), Experimental Investigation on the Properties of Concrete With Plastic PET (Bottle) Fibres as Fine Aggregates, International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 6, June 2012*

9. *N B Azmi, F S Khalid, J M Irwan, P N Mazenan, Z Zahir and S Shahidan (2018), "Performance of composite sand cement brick containing recycle concrete aggregate and waste polyethylene terephthalate with different mix design ratio", OP Conf. Series: Earth and Environmental Science 140 (2018) 012129*

10. *Noorwirdawati Ali, Norhasmiza Din, Faisal Sheikh Khalid, Shahiron Shahidan, Siti Radziah Abdullah, Abdul Aziz Abdul Samad, Noridah Mohamad (2017). "Compressive strength and initial water absorption rate for cement brick containing high-density polyethylene (HDPE) as a substitutional material for sand". IOP Conference Series: Materials Science and Engineering. Vol 271, No 1*

11. *Nursyamsi Nursyamsi, Ivan Indrawan, Prasetyo Ramadhan (2019), "The influence of the usage of ldpe plastic waste as fine aggregate in light concrete bricks, MATEC Web of Conferences" 258, 01006 (2019)*

12. *Plastics. Plastics - the Facts. PlasticsEurope. Brussels: Brussels– Association of Plastics Manufacturers; 2017. https://www.plasticseurope.org/download_file/force/1055/181*

13. *Pratikto (2010). "Beton Ringan Ber-Agregat LIMBAH BOTOL PLASTIK JENIS PET (Polyethylene Terephthalate)", Jurnal Poli-Teknologi , Politeknik Negeri Jakarta.*

14. *Ronak Shah ,Himanshu Garg ,Parth Gandhi ,Rashmi Patel ,Anand Daftardar , (2017) " Study of Plastic Dust Brick Made from Waste Plastic " , International Journal of Mechanical and Production Engineering (IJMPE) , pp. 120-123, Volume-5,Issue-10*

15. *Science. 2017. http://www.sciencemag.org/news/2017/07/next-30-years-we-ll-make-four-times-more-plastic-waste-we-ever-have.*

16. *Sohrab Veiseh and Ali A. Yousefi (2003), "The Use of Polystyrene in Lightweight BrickProduction, Iranian Polymer Journal", 12 (4), 2003, 323-32*

17. *Yusuf Amran (2015), "Pemanfaatan Limbah Plastik Untuk Bahan Tambahan Pembuatan Paving Block Sebagai Alternatif Perkerasan Pada Lahan Parkir Di Universitas Muhammadiyah Metro", 2 Mei 2015.*