EFFECT OF OLEO CHEMICAL WASTE AS PARTIAL SAND REPLACEMENT IN SAND BRICK

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Thesis submitted in fulfillment of the requirements
for the award of the
B. Eng (Hons.) Civil Engineering

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

Foremost, I would like to thank to Allah SWT for giving me strength and opportunity throughout in completing the research successfully. For my family who have supported me while I have been completing my research in terms of moral and finance. Especially my parents, Jumain bin Rasin and Hayati binti Johari, who always give me a motivation and inspiration during my study and convinced me to complete my research.

Next, I would like to express my sincere gratitude to my supervisor, Dr Sharifah Maszura binti Syed Mohsin for her guidance of my research, for her motivation and immense knowledge. Her effort to advise me in solving the problems either in laboratory works or writing thesis are invaluable. I am very fortunate to have benefited from the convergence of each of her unique expertise.

Then, I would like to thank to the FPG company at Gebeng for provide and supply the waste that used for my research and also the staff of FKASA Laboratory Concrete that have assist in my research analysis in need of materials, guideline and instructions during the laboratory works process of my research.

Last but not least, also not forgetting to mention and thank to my research partner, Aziratul Adawiyah binti Dulkarim who have provided extraordinary moral support, ideas and accompany which important in completing my research to ease my countless episodes of sufferings throughout the journey of the process. I appreciate all the advices and encouragement for everyone during the research.

ABSTRAK

Kajian ini membentangkan penggunaan sisa kimia oleo sebagai pengganti pasir separa dalam bata pasir. Disebabkan pertumbuhan dari segi pembangunan industri pembinaan, permintaan bahan binaan seperti bata dan bahan pasir lebih tinggi. Bata memainkan peranan penting dalam pembinaan sebagai alternatif batu dan dibentuk dalam pelbagai kelas, jenis, bahan dan saiz dalam jumlah besar yang berlainan dalam tempoh masa dan rantau. Penggunaan pasir menjadi tidak terkawal dan menyebabkan peningkatan perlombongan pasir. Aktiviti ini menyebabkan kemusnahan alam sekitar. Oleh itu, mencipta keperluan untuk bahan pembangunan dengan penggunaan sisa yang sesuai. Bata batu adalah salah satu bahan bangunan yang sangat digunakan dalam pembinaan. Penggunaan bahan buangan di dalam batu pasir dapat mengurangkan penggunaan pasir yang berlebihan dan mengurangkan beban alam sekitar. Sisa kimia Oleo yang dikumpulkan ialah dari Industri Kimia Oleo yang memproses minyak sawit. Walau bagaimanapun, ia juga menghasilkan banyak sisa. Apabila sisa dari kilang dikeluarkan, ia akan dibuang dan diletakkan di tempat pembuangan sampah. Untuk mengelakkan tapak pelupusan penuh dengan sisa, ia boleh digunakan untuk penyelesaian yang lebih baik iaitu dengan menggantikan sisa dengan bahan yang digunakan untuk tujuan pembinaan. Selain itu, tiada kajian telah dilakukan mengenai penggantian sisa kimia oleo dalam bata untuk bahan binaan. Kajian ini akan mengkaji kesan sisa kimia oleo sebagai pengganti pasir separa dalam bata pasir. Sisa kimia oleo dibahagikan kepada 0%, 5% dan 10% terhadap peratus berat pasir. Sisa kimia oleo akan dikeringkan dan mengisar dengan lancar sebelum digunakan untuk penggantian pasir. Tiga ujian yang berbeza yang menguji kekuatan mampatan, ujian kekuatan lentur dan ujian penyerapan air dijalankan untuk menguji prestasi bata pasir dengan tingkat penggantian yang berbeza dari sisa kimia oleo pada usia 7 dan 28 hari. Hasil dan perbincangan diperiksa dan direkodkan untuk keputusan analisis.

ABSTRACT

This paper presents about the utilization of oleo chemical waste as a partial sand replacement in sand brick. Due to the growth in terms of development of construction industry, demand of construction material such as brick and material of sand are higher. Brick plays important role in construction as an alternatives of stones and are formed in various classes, types, materials and sizes in large quantity which different in time period and region. The used of sand become uncontrolled and lead to the increasing of sand mining. This activity caused the destruction in environment. Thus created a need for the development material with a suitable utilization of waste. Sand brick is one of building material that highly used in construction. The used of waste materials in sand bricks can lessen the excessive used of sand and reduce the environmental burden. Oleo chemical waste collected from the Oleo Chemical Industry that processing palm oil. However, it also produces a lot of waste. When the waste from factory released, it will be thrown and placed at the landfills. For avoiding landfills full with the waste, it can be used for a better solution which is by replace the waste with material that used for construction purpose. Moreover, no research have done about replacement of oleo chemical waste in bricks for construction materials. This research will investigate the effect of oleo chemical waste as a partial sand replacement in sand brick. The oleo chemical waste are divided into 0%, 5% and 10% of replacement to the percentage weight of the sand. The oleo chemical waste will be dried and grind smoothly before it use for the sand replacement. Three different test which compressive strength test, flexural strength test and water absorption test be conduct to test the performance of the sand brick with different replacement level of oleo chemical waste at age 7^{th} and 28^{th} days. The results and discussions examined and recorded for result of analysis.

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LIST OF ABBREVIATIONS

FAME	Fatty Acids Methyl Ester
JKR	Jabatan Kerja Raya
OPC	Ordinary Portland cement
CaO	Calcium Oxide
SiO_2	Silicon Dioxide
Al_2O_3	Aluminium Trioxide
Fe_2O_3	Iron Trioxide
MgO	Magnesium Oxide
SO_3	Sulphur Trioxide
DPMS	Deinking Paper Mill Sludge
MS	Malaysian Standard
FKASA	Fakulti Kejuruteraan Awam & Sumber Alam
CSH	Calcium Silicate Hydrate

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Brick is small units building material used to make pavements, walls and other elements in construction. Bricks are strong and lasting building material. In Malaysia, generally brick plays important role in construction as an alternatives of stones and are formed in various classes, types, materials and sizes in large quantity which different in time period and region. Highly economical cost, superior finish as well as high compressive strength and durability (Gupta, Attri and Kumar, 2015). Bricks can be composed of sand, cement, water and stick like a bond that secured with mortar to hold the bricks together to make a strong and durable structure.

Sand is natural resources and an important substance that is used in manufactured of concrete and brick. The function sand is to provide bulk and strength to construction materials. Sand mining is the separation of sand from an open pit yet occasionally the sand is mined from beaches, riverbeds and inland dunes from ocean. Sand mining cause to destruction of environment. Environmental problems occur when the rate of extraction of sand, gravel and other materials exceed the rate at which natural processes generate this materials (Ashraf *et al.*, 2011). Until recently, sand has been mined predominantly from land quarries and riverbeds but due to intensive exploitation and because of this practise have been banned in many regions and environmental regulations have become much more strict (Dan Gavriletea, 2017).

In sand replacement, industrial waste used to be a partial replacement in production of brick. The waste which is oleo chemical waste are used to replace the sand partially in the mix proportion. The oleo chemicals are chemicals that been produced from the palm oil. The processed of the palm oil is obtained by extracting the pulp of the palm fruit. Palm oil is reacting in form of triglycerides with vary composition of the alky chains. Fatty acids, fatty acid methyl esters (FAME), fatty alcohols, fatty amines and glycerol are the basic formation of oleo chemical substances. The production of oleo chemical used for making soaps, detergents, lubricants, solvents, bioplastics and biodiesel (Rupilius and Ahmad, 2005). In oleo chemical industry, the industrial process waste need to be treated before discharged even the material are considered to be environment friendly. When the waste from factory released, it will be thrown and placed at the landfills. For avoiding landfills full with the waste, it can be used for a better solution which is by replace the waste with material that used for construction purpose.

1.2 Problem Statement

Sand brick are widely used in construction in Malaysia because it is easy to make it and not expensive to be produced. However, the use of natural sources such as sand are difficult to find especially for the manufactures to locate the suitable places for the natural aggregate supply. Due to the shortage of the natural sources, it is affect the pricing of the sand brick and the price of the sand. Next, the more excessive used of sand also causes the activities of sand mining continued. Sand mining will cause to destruction of environment and give impacts to the wildlife. Besides, the extraction of sand can cause the disturbance of underwater and coastal sand which can causes the turbidity in the water. The ecosystems of aquatic life will be disrupted and the flow of river become deeper due to the sand mining.

1.3 Objectives of the Study

The aim of this research is to test the potential of using oleo chemical waste as partial sand replacement in sand brick. The objectives of this study are:

I. To investigate the compressive strength of sand brick with the effect of oleo chemical waste as partial sand replacement.
II. To determine the flexural strength of sand brick with the effect of oleo chemical waste as partial sand replacement.
III. To study the water absorption of sand brick with the effect of oleo chemical waste as partial sand replacement.

1.4 Scope of the Study

The scope of this research are:

I. The sample of sludge is taken from FPG Oleo chemical industry at Gebeng, Pahang.
II. For the mix design, the sludge divided into 0%, 5% and 10% to replace the percentage weight of sand.
III. For the testing, compressive strength test, flexural strength test and water absorption test will be conducted to check the effect of sample with sand replacement.
IV. The testing will be handled at laboratory at Universiti Malaysia Pahang (UMP).
V. For the compressive and flexural, the test will be conducted on 7^{th} and 28^{th} days and will be according to ASTM.
VI. The water absorption test will according to JKR standard 2014.
VII. The size of mould for a brick is 113mm x 225mm x 75mm (W x L x H) according to JKR standard 2014.
VIII. The mix design and non-load bearing for a brick will be according to JKR standard 2014.

1.5 Significance of Study

The used of oleo chemical waste as a partial sand replacement can reduce the use of natural sources in producing the sand brick. The sludge that used are easily to find and not be a burden to the manufactures to find the adequate natural sources. Besides, the replacement also can decrease the price of the sand which it will affected the price of the sand brick simultaneously. For the cost for any kind of project that are involved will be not exceed the limit because it can reduce more benefit in term of budget. Other than that, our biological resources like flora and fauna will not affected and wildlife can survive freely without any interruption by extraction of sand. The turbidity of water also can be restored and ecosystem of aquatic life will be not disrupted so the life of nature and the natural sources can be take care.

1.6 Thesis Layout

Thesis layout will summarize the details of the thesis and organized into five chapters as detailed below:

Chapter 1 - Introduction: This chapter present the background and the problem of this research. This chapter contain the objectives, scope of research and the significance throughout the research.

Chapter 2 – Literature Review: This chapter explain the utilization of waste as replacement in production of brick from the others research. This chapter investigate the effect of waste to the performance of brick from the previous research.

Chapter 3 - Research Methodology: This chapter describes the methods used to achieve the objective of this research. The materials and type of testing used in this research based on JKR Standard (2014) and ASTM C618 (1994).

Chapter 4 - Result and Discussion: The chapter present and discuss the data that have be examined and recorded throughout the research from the flow of process and testing that have done. In this chapter, the data analysis will present the effect of the waste in brick used and show the result of the experiment take place including testing process.

Chapter 5 - Conclusion: In this chapter, conclusion made based on the result from the chapter 4. The conclusion will refer to the result and objective of this research. The suggestions are made for an improvements to new research in utilization of waste in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are many researchers (Kumar and Gomathi, 2017) (Chiang *et al.*, 2009) (Rahman *et al.*, 2018) (Amira *et al.*, 2018) have done the investigations and experiments that related with the production of cement sand brick by using waste materials or sludge as a replacement. There also researcher that optimize the industrial applications of granite and kaolinite rock tailings in ceramics industry in the manufacture of clay bricks (Monem *et al.*, 2016). Next, the arsenic-iron sludge in making bricks and to analyze the corresponding effects on brick properties (Mahbub *et al.*, 2014). But, there are none researchers that have investigate and analyse the composition and properties of oleo chemical waste towards the performances of the sand brick. Thus, this research are to investigate the compressive strength, flexural strength and water absorption of the sand brick with the effect of oleo chemical waste as partial sand replacement.

In this chapter discuss the various type of topics and reading material which can help to study the properties of sand brick containing waste material which is oleo chemical waste as partial sand replacement on sand brick. Besides, this chapter describes about the brick, material used in mixing proportion including the waste material, oleo chemical waste and its properties. Lastly, the review explained about the lab testing that been handled in this research which are compressive strength test, flexural strength test and water absorption test. All the test conducted in order to determine the performances of sand brick with the presence of oleo chemical waste as partial sand replacement.

2.2 Type of Bricks

A brick is a building unit material which have various types that being used in the construction industry. Due to its flexible properties, brick has become one of the most common building materials (Kadir *et al.*, 2013). The commonly used bricks types are clay bricks, sand lime bricks and sand cement bricks. Bricks are most often used for wall construction especially in outer wall surface of building. Brick belongs to the wide family of construction materials since it is mainly used for the construction of outer and inner walls in buildings (Shakir *et al.*, 2017).

2.2.1 Clay Bricks

As shown in Figure 2.1, clay bricks are the oldest building materials that come usually in reddish colour. Fired clay bricks are one of the oldest construction material used in the construction of partition and load carrying walls in the buildings (Kazmi *et al.*, 2016). The clay bricks are commonly used for wall construction and brickwork layer of outer surface of building. In term of properties of the clay bricks, the clay building materials are natural, versatile and durable which the clay bricks can be used for a variety of application and it also consist of the natural raw materials. The clay bricks have good fire resistant, higher durability of building material and a dense material which can be strong walls and structure to any building. Due to their strength, reliability, weather resistance, simplicity and durability, bricks have been extensively used and given a leading place in history in conjunction with stone (Ukwatta *et al.*, 2015). The manufacturing of the clay bricks followed the specification that have a small variation in size during manufacturing process.

Figure 2.1 Clay Brick

2.2.2 Sand Lime Bricks

Sand lime brick also known as calcium silicate bricks are made of lime, sand and water. Figure 2.2 illustrated an example of sand lime bricks that commonly used for masonry works and ornamental uses in buildings. The materials are mix together and the mixture moulded under pressure to press the bricks. The bricks are placed in autoclaved with tightly sealed ends and the materials bond together by a chemical reaction when the bricks dry under heat and pressure condition which the process done for 6 to 12 hours then transported to work place. These bricks have good heat and humidity accumulation as well as good fire resistance. The compressive strength of the sand lime bricks is about 10 N/mm^2 so it be suitable to be used for multi storey building.

Figure 2.2 Sand Lime Brick

2.2.3 Sand Cement Bricks

Sand cement brick is a kind commonly used in low- and medium-cost housing development and other commercial constructions in Malaysia (Khalid *et al.*, 2017). The production of sand cement brick is easy and not expensive to be produce. The material needed in order to produce the sand cement brick are sand, cement and water. The sand cement bricks are usually used for internal brickwork and fences.

Figure 2.3 Sand Cement Brick

2.3 Application of Bricks

Development of bricks have many used in construction industry because it been viewed as one of the longest enduring material utilized all through history. Nowadays, brick plays very important role in civil engineering construction purpose. There are many sorts of brick with various utilize such as load bearing wall and non-load bearing wall, covering wall and insulation. The uses of bricks including structural uses such as for construction of walls of any kind of size, brick retaining wall, floors and also construction arches and cornices. Thus, as we know the brick commonly used because its properties lightweight materials, very resistant and material and provide a structure with reduced life cycle cost. Such products have high density, compressive strength, resistance to freeze-thaw cycles and low water absoprtion values (Kizinievi *et al.*, 2018).

2.2.5 Material of Sand Brick

In this research, in order to used sludge as a partial sand replacement, sand brick is produced. The production of sand bricks required the materials of sand, cement, water and also sludge that undergo the treatment process before used in the mix design. Brick properties depend of the composition of raw materials and method of production (Kazmi *et al.*, 2016).

2.4.1 Sand

Sand is important material as aggregate that used in production of brick. Sand is a granular material made up of rock and mineral particles. It is categorized as smaller aggregates as the size of the sand is normally smaller than 4.75mm. Sand is one of the important ingredients that provide bulk and strength to the production of brick. Different types of sand will affect different strength of brick and different sand to cement ratio will produce brick with different strength too. Recently due to the difficulty in the availability of natural sand its cost is quite high (N *et al.*, 2018). Other than that, the sand can be used as a partially replacement to investigate the properties of the brick. The quarry waste from dolomite production had been used to replace sand in order to study the performance of modified brick sand (Isa *et al.*, 2016) is one of research about sand replacement in bricks.

2.4.2 Portland cement

Generally, Portland cement is one of the most common type of cement used for production of concrete in construction industry. Ordinary Portland cement (OPC) is the most common used which is in grey colour. Portland cement is a fine powder that produced by heating of limestone with clay minerals that form clinker. The magnesium oxide content (MgO) shall not exceeed 5.0% by mass (Mansoor, 2017). Then, the clinker will be grinded and added with 2 to 3 percent of gypsum. Cement act as binder that harden the mixes through hydration process to produce brick. Normally, OPC used for general construction purposes such as reinforced concrete buildings, bridges, pavements and concrete masonry units.

2.4.3 Chemical Composition of Portland cement

The chemical composition of Portland cement is shown in Table 2.1 which made up from several materials such as lime, silica, alumina and iron oxide.

Table 2.1 Chemical Composition of Portland cement

Parameters	OPC (%)
CaO	55.49
SiO_2	26.49
Al_2O_3	9.81
Fe_2O_3	3.90
MgO	0.80
SO_3	4.72

2.4.4 Water

In construction area, water is important element in whole construction process. The good quality of water is necessarily needed in order to produce good performance of brick during the hydration process. Furthermore, without water the hydration process cannot be take place and production of brick cannot be formed. Since it helps to bind all the raw materials for giving proper mix (Mansoor, 2017). Water can be find easily but water with a good quality is a little bit harder to be find. Normally, mixture of 100 kilograms of cement will only consume around 40-45 litres of water. Lower amount of water will cause the workability decreasing. However, if the amount of water that used for casting a brick is higher, the amount of air voids produced will be greater and can affect the strength and performance of the brick itself. For construction purpose, clean water is utilized. Other than that, water must be free from any amount of deleterious material and polluting influences that also can affect the strength and durability of the brick. The typical normal water provided in blending the materials. Water used for making brick should be free from impurities (Mansoor, 2017).

2.4.5 Sludge

Nowadays, many researchers have done the investigation to perform the research about the effect of sludge as a replacement to the performance of brick. Sludge is the treatment process that come in various type of industry of processing such as manufacturing, kitchen wastes, factory processes and others. Thus, sludge is solids, liquid or semisolids residuals (concentrated contaminants) generated as by product of waste water treatment (Mahajan and Husain, 2016). The deinking paper mill sludge (DPMS) was collected from M/s Khanna Paper Mills Limited, Punjab, India (Singh *et al.*, 2018). This research about the sludge from paper that utilized to the percentage of replacement and alluvial soil that used in production bricks to determine the density, firing, shrinkage, water absorption, efflorescence, apparent porosity, compressive strength and thermal conductivity. From the research, results showed that the sludge can be used as alternative to the conventional bricks and towards the sustainable, economical and energy efficient construction. Waste glass also be used in burnt clay bricks. By using waste glass, bricks with improved compressive strength and water absoprtion can be produced (Abbas *et al.*, 2017).

Other than that, research about the sludge from water treatment plant also be used in manufacturing of brick. The aim of this study is the utilization of the sludge wasted during wastewater treatment to manufactured improved building bricks through some nano mineral powder addition (Algamal, Khalil and Saleem, 2018). Furthermore, because of the higher disposal sewage waste also encourage to use as replacement in manufacturing of brick. The construction of treatment plants has caused problems with huge content of dry sludge (Tanpure *et al.*, 2017).

However, there is none of researcher that do an experiment and investigation about effect of using oleo chemical waste as a partial sand replacement to produce brick. The oleo chemical waste is by product of oleo chemical that processing palm oil. This oleo chemical have glycerine and fatty acid methyl ester (FAME) as main content. In order to investigate the performances of bricks with the effect of oleo chemical waste as partial replacement, research be conducted.

2.5 Waste Treatment

Before the waste material can be used as partial replacement in manufacturing of brick, a treatment been conducted. The industrial wastewater sludge resulting from the treatment process has a variable physico-chemical composition, depending on the composition of treated wastewater and the nature of the chemicals used for the treatment (Series and Science, 2018). Other than that, converting agricultural waste (soy beans, cotton, sawdust, etc) into high density and energy concentrated fuel briquettes (Sakhare and Ralegaonkar, 2016) is the process of bio briquetting. The bio briquette ash used for development of bricks. However, sludge treatment/disposal represents 50% of the capital and operational costs of wastewater treatment plant (Mahajan and Husain, 2016). Hence, there is several research not required the waste treatment for the replacement process such as agricultural waste. Rice husk, sawdust and peanut shell are used as raw without any pre-preparation or treatment (Sathiparan and Zoysa, 2018).

2.6 Strength of Brick

Strength of bricks can be investigate depending to the type of material used, replacement of material that take place in the mix proportion and type of curing. For the strength of bricks can be determined by testing the compressive strength, flexural strength and also the water absorption. All the testing can be conducted in the laboratory and referred to the standards requirement. The strength of brick is important purpose to ensure the durability and performance of bricks while used in the construction industry.

2.6.1 Compression Strength

Compression test is one of the most important laboratory testing that test the compressive properties of a brick. Theoretically, compressive strength is the ability of the brick to sustain the compressive load applied without any fracture. Normally, compressive strength test is conducted right after the curing process took place. The compressive strength of a brick is depending on the mix design and the types of curing that took place on that brick. The durability of the brick is perpendicular to the strength of brick. The higher strength of brick, the higher the durability of the brick. The compressive strength is at least 24% better than the very best of the standard clay bricks that are available (Kayali, 2005). Other than that, the compressive strength of brick increase when firing the brick in temperature from 900^{o}C to 1000^{o}C (Singh *et al.*, 2018). Utilization of waste glass sludge in clay bricks can improve the compressive strength. Other than that, type of material replacement used also can lower the compression strength (Minhaj *et al.*, 2018). For instance, for brick specimen having 5% of sugarcane bagasse ash by clay weight, 14% decreases in compressive strength compared to specimen without sugarcane bagasse ash (Kazmi *et al.*, 2016).

Figure 2.4 Compressive strength machine

2.6.2 Flexural Strength

Flexural strength is a modulus of bending brick strength and ability of brick to withstand that flexural load. The testing is conducted at laboratory by added a stress on the brick until it yields in flexural test. The compressive strength result is parallel with flexural strength. When the compressive strength is increase, the flexural strength also increase. The flexural strength increases as the additives increases. The use of waste marble dust when calcite and quartz as an additive, compressive strengths were found 97 Mpa and 120 Mpa respectively in cultured marble (Bilgin *et al.*, 2012). Other than that, the flexural strength of sand cement brick containing recycled fine aggregate exhibited an increase of 17.9% (Khalid *et al.*, 2017). The flexural strength seen to be increased from 0.6 (900^{o} C) to 7.1 Mpa (1050^{o} C) in bricks containing up to 30% of treated calamine processing mine tailings (Taha *et al.*, 2016). There are researchers that conducted the flexural strength test but did not achieved their objective. Porous structures as a result of rice husk ash and sugarcane bagasse ash incorporation in burnt clay bricks reduced the flexural strength (Kazmi *et al.*, 2016). The strength decreases when the replacement of the material take place.

Figure 2.5 Flexural strength machine

2.6.3 Water Absorption

Water absorption is important parameter for durability bricks. The lower water infiltrates into bricks, the higher is the durability (Algamal, Khalil and Saleem, 2018). Brick become denser and durable when the water absorption is lower. The bricks having lower water absorptions were usually found denser and durable against external weathering conditions (Singh *et al.*, 2018). Some of researcher done an experiment of water absorption by using different firing temperature. To increase density and decrease water absoprtion of clay bricks, the firing temperature must be raised (Phonphuak, Kanyakam and Chindaprasirt, 2016). As a result, at higher temperature the water absorption is lesser compare to lower temperature. However, after immersed in cold water for a period of 24 hours, water absorption shall not be more than 20% (Kumar and Gomathi, 2017). The more increase of water absoprtion, the less strength achieved. There are several waste that increase the water absoprtion in manufacturing of brick. With further increasing of the waste rice husk ash, water absoprtion increases (Silva and Perera, 2018). Wastewater from olive stage and olive oil stage both incorporation decreased slightly the values of water absorption and hardly increased behaviour under compression (Eliche-quesada *et al.*, 2014).

CHAPTER 3

METHODOLOGY

3.1 Introduction

Methodology is a set of procedures or methods used to conduct research. This chapter describes on the methodologies used main intention of doing this research.

An experiments are conducted to determine the effect of oleo chemical waste as a partial sand replacement in sand brick. The sludge is used for 0%, 5% and 10% from weight of sand as partial sand replacement. The materials, casting of the specimen and testing method are explained specifically. All the specimens are needed to be tested in order to analyze and present the data. The testing are compressive strength test, flexural strength test and water absoprtion test. Both compressive strength test and flexural strength test are done for 7 and 28 days while for the water absorption test are take place at 28 days.

3.2 Flowchart of Experimental work

The flow of process for the experiments for the preparation and testing method are showed in Figure 3.1.

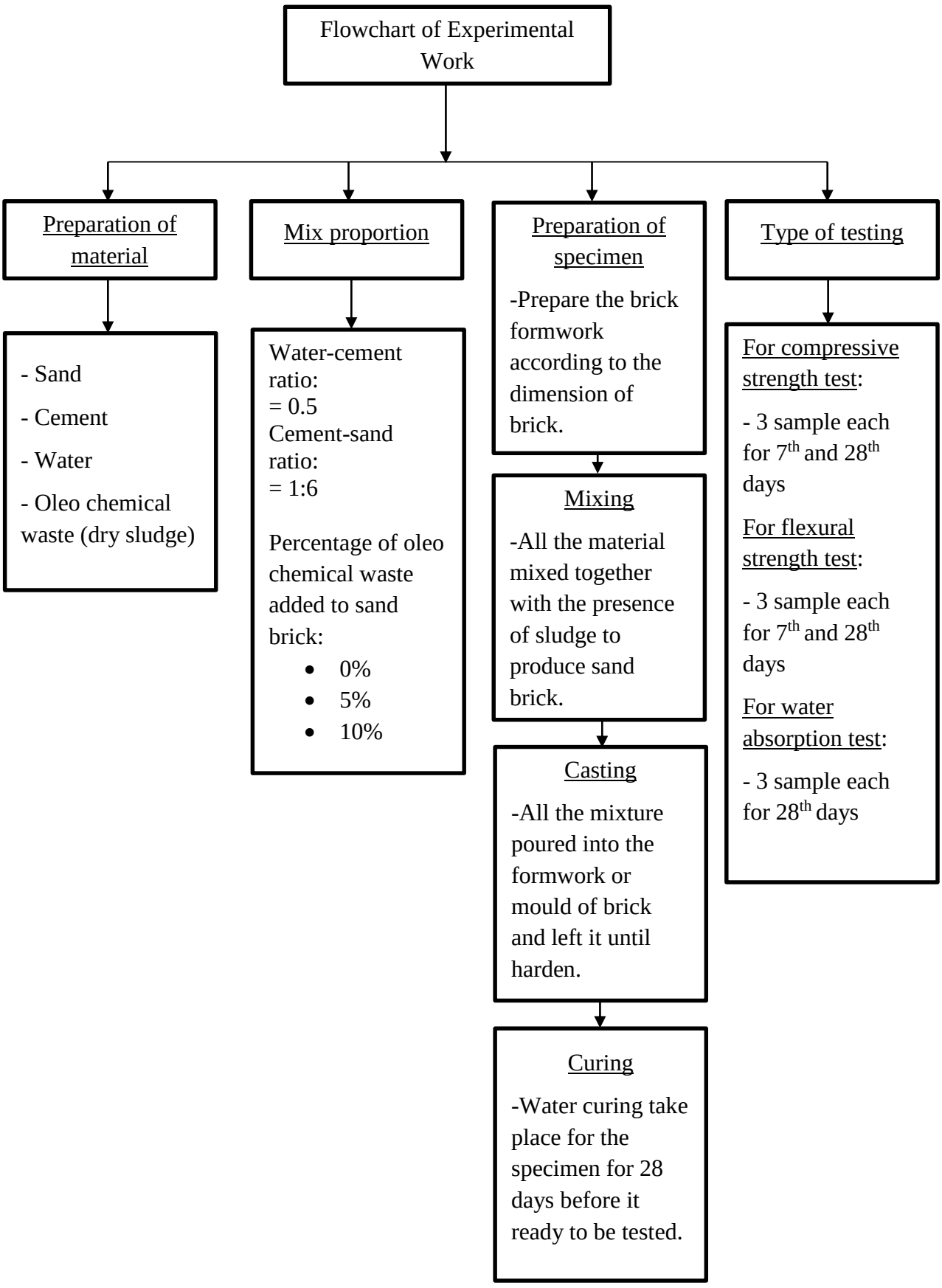

Figure 3.1 Flowchart of experimental work

3.3 Materials

In order to investigate the effect of oleo chemical waste, sand brick be produced. The materials that used for making sand bricks are sand, cement, water and sludge from oleo chemical waste in dry sludge condition.

3.3.1 Sand

Sand is a natural consolidated granular material. Sand are either mineral particles, rock fragments or biogenic in origin. Sand by size is finer than gravel and coarser than silt. Majority of sand is composed of silicate minerals and silicate rock fragments. Sand provides bulk, strength and others to construction materials like concrete. Sand are mixed along with the cement and water for making the sand brick. The sand sieve referred to JKR Standard MS 29 that passing 4.75mm to 0.07mm which used to produce the sand brick.

Figure 3.2 Air dry river sand

3.3.2 Cement

Cement is a fine mineral powder which a material with adhesive and cohesive properties. The type of cement that used is Ordinary Portland cement which follows the Malaysian Standard MS 522: Part 1: 2007 for specification of Portland cement. Cement is one of the most important building materials. The function of cement is cement act as a binding agent that bind the others material like sand and coarse aggregate to form a compact mass. The cement mixed with water to cause chemical reaction and then forms a paste that hardens to bind the building materials. In order to make the bricks in this research, the cement bind together with oleo chemical waste as partial sand replacement and sand in presence of water.

Figure 3.3 Ordinary Portland cement

3.3.3 Water

Water is an important ingredient for the construction of various construction materials in construction industry. Water are used either in mixing cement concrete, preparation of cement mortar or for curing work. The water distributes evenly and react chemically with cement that gives strength to the concrete. The quality and quantity of water is important because it has much effect on the strength of brick, mortar and cement concrete. The water should be potable, in other words the water should be clean and clear that generally suitable for mixing. For both mixing and curing, water must be free from injurious amounts of deleterious materials that can affect the strength and durability of brick and concrete. The pH value of water that used must be not less than value 6. The amount of water used in this experiment are depends on the mix design and follows the requirement in JKR Standard MS 28.

Figure 3.4 Tap water

3.3.4 Oleo chemical waste

Oleo chemical waste is a waste product from plant oil from palm oil industry. In this experiment, the oleo chemical waste will be partial replacement of sand. The sand brick is casted with different percentage of oleo chemical waste and sand in the mixture. The process preparation of oleo chemical waste used for sand replacement are in three stages, oven, grind and sieve. This oleo chemical waste collected from FPG Oleo Chemical Sdn Bhd located at Gebeng, Pahang.

Figure 3.5 Sludge from oleo chemical waste

3.3.5 Processing of Oleo chemical waste

The oleo chemical waste transferred from the company of FPG itself to FKASA laboratory at UMP. Early step the sludge dried outside the laboratory. After that, the sludge transferred into a small tray then put in the oven for oven dried for 24 hours. The step repeated until all the oleo chemical waste are in oven dried condition and ready to grind. The sludge grind smoothly to get the amount that need and passing the sieve size 600 micron metre before ready to use in mixing ingredient.

Figure 3.6 Sludge after oven dried

Figure 3.7 Dry sludge after grind before sieve

3.4 Mix Proportion

The mix design for making the sand brick are following the standard brick making procedures. Oleo chemical waste are used as a partial sand replacement in this research. The amount of replacement consists of 0%, 5% and 10%. The water-cement ratio is 0.5 while the cement-sand ratio is 1:6. The size of the sand brick is 113mm x 225mm x 75mm (W x H x L). The volume of one brick specimen is 1.907×10^{-3} m^3 and the normal weight of brick is 2.7 kg. Table 3.1 shows the mix proportion of the specimen used in this research.

Table 3.1 Mix Proportion by weight per volume

Samples	Cement (kg/m^3)	Sand (kg/m^3)	Oleo chemical waste (%)	Oleo chemical waste (kg/m^3)	Water (kg/m^3)
A	320	1920	0	0	160
B	320	1824	5	96	160
C	320	1728	10	192	160

Table 3.2 Total sample for each test

Type of testing	Percentage of replacement (%)	No of samples		Total sample
		7^{th} days	28^{th} days	
Compressive Strength	0	3	3	18
	5	3	3	
	10	3	3	
Flexural strength	0	3	3	18
	5	3	3	
	10	3	3	
Water Absorption	0	-	3	9
	5	-	3	
	10	-	3	

3.5 Preparation of Brick

The process for making the brick are determined by ensure the dimension of brick that are used in this research before preparing the mould. All the materials are mixed together with the sludge and process of casting can be conducted. The curing take place before the specimens can be tested for the strength of brick.

3.5.1 Brick Design

The dimension of the specimen is 113mm x 225mm x 75mm (L x W x H) referred to JKR standard 2014.

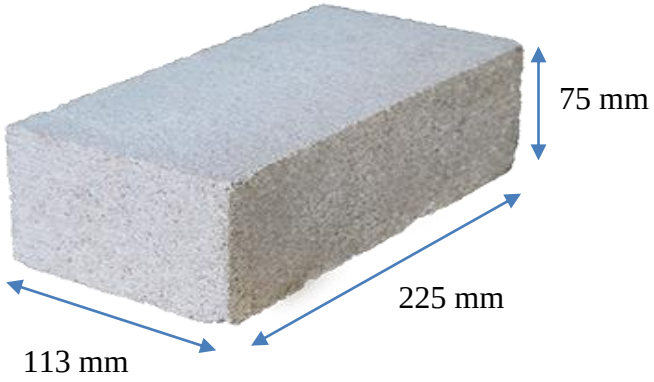

Figure 3.8 Dimension of Brick

3.5.2 Preparation of Brick Formwork

Timber used as the material to prepare the formwork of brick. The material of timber used because it easy to handle, easy to form in any dimension of brick and can be reused again for another specimen.

Figure 3.9 Preparation for the brick mould

3.5.3 Mixing and Casting

For mixing process, the mixer machine used to ensure all the materials such as sand, cement, water and the dry sludge that had already sieve mixed together properly. Then, the mixture are poured into the mould and compacted manually by hand. Oil are used on the surface of the mould to make it easier when removing it and avoid the mould absorb the water from the specimens. Before casting process, the mould need to check by it condition. The specimens left out for 24 hour to be harden after casting. Next, the specimens need to be properly unmould by taking out the brick each before the process of curing method.

Figure 3.10 Mixer machine

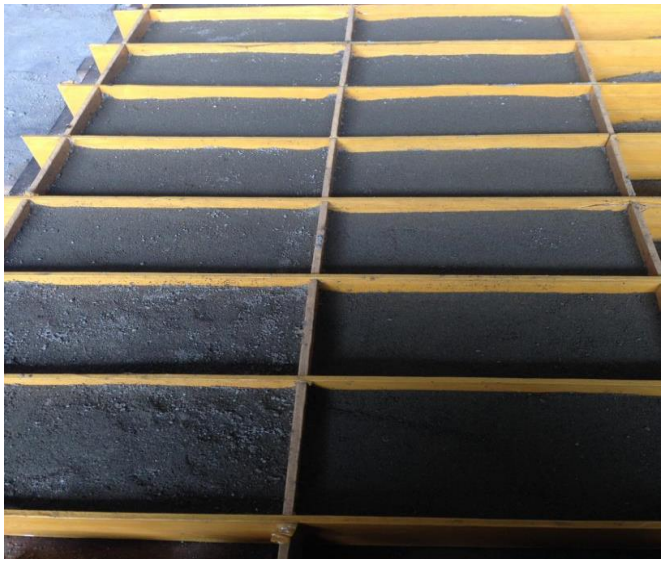

Figure 3.11 Casting process

3.5.4 Curing Method

The type of curing method that used in this research is water curing. All the specimens are curing in the pond that prepared in the laboratory for 28 days before it conducted to be testing. The testing that include for compressive strength, flexural strength and water absorption are conduct when the specimen cured in the water at age 7^{th} and 28^{th} days.

Figure 3.12 Water curing

3.6 Testing of Brick

There are 3 types of test that focus in this research which are compressive strength test, flexural strength test and water absorption test. For the compressive strength test and flexural strength test, the specimens are undergo the test by age 7^{th} and 28^{th} days. For water absorption test, the specimens run the test at age 28^{th} days.

3.6.1 Compressive Strength Test

Compressive strength test is carried out by using compressive machine. The test is carried out in UMP concrete laboratory, Faculty of Civil Engineering & Earth Resources. The compressive strength of brick are measured at 7^{th} and 28^{th} days. Three samples are prepared for the test. The sample are placed so the load applied is perpendicular to the surface of brick. The test are required to determine the strength of brick. Next, apply load axially at uniform rate till failure occurs and take note the maximum load at failure. The failure load of the specimen is then recorded. Load at the failure divided by area of samples gives the compressive strength of concrete. The load at failure is the maximum load at which sample fails to produce any further increase. The last reading will be taken. The calculation is as follows:

$$C = W / A \qquad 3.1$$

Where;

C = compressive strength, MPa

W = maximum load, N indicated by compression test machine

A = area of upper and lower bearing surfaces of sample

3.6.2 Flexural Strength Test

Flexural strength test is to determine the bending properties of a material which the ability of the specimen to resist the stress. The breaking load of the brick are obtained at 7^{th} and 28^{th} days. The specimen will be supported with solid steel rods at underside and centre load is applied at the middle point of brick. Next, the load is applied to the brick through steel bearing plate until failure of specimen. The failure load for the sample is recorded. The loading must be applied without any shock happens to ensure accurate result. The calculation as follows:

$$p = P / w \qquad 3.2$$

Where;

p = breaking load per width

P = transverse breaking load obtained from machine

w = width of brick

3.6.3 Water Absorption Test

Water absorption test is used to determine the amount of water absorbed under specified condition. The bricks are weighed and be recorded as W_i. The samples are dried for at least 24 hours in an oven. Then, the weight are recorded as $W_{d.}$ After drying, the samples are cooled in drying room at with relative humidity around 70%. Next, the samples are stored free from air draft and separately placed for 4 hours until the surface temperature approximately 28^o C. For 24 hours, the samples then submerged in clean water at 30^o C. After removed the samples from submerged, the samples will be weighed again and recorded as $W_{s.}$ The calculation as follows:

$$\text{Absorption, percentage (\%)} = 100 (W_s – W_d) / W_d \qquad 3.3$$

Where;

W_d = dry weight of samples

W_s = saturated weight of samples after submersion in cold water

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the result for the effect of using oleo chemical waste as partial sand replacement in sand brick are examined. The result that obtained by using the oleo chemical waste in dry condition as partial sand replacement was reviewed for the performance and mechanical properties of the sand brick. The result obtained from the experimental testing had been presented according to the method that has been discussed in the previous chapter. Compressive strength test, flexural strength test and water absorption test were subjected to the all specimens of brick for the outcomes of the test and the impact of using oleo chemical waste as partial sand replacement.

4.2 Result of Compressive Strength for Sand Brick

The result for compressive strength test for the sand brick obtained after all the specimens undergo water curing at 7^{th} and 28^{th} days of curing period. Under this test, the uniform load was connected to the sand brick until the sand brick begins to crack. The result for performance of sand brick with the effect of oleochemical waste in dry condition were appeared in Figure 4.1. The value of compessive strength for 0% sand replacement was recorded and tabulated in Table 4.1. The outcomes demonstrates that the compressive strength.

Table 4.1 Result of Compressive Strength Test

Curing period		7^{th} days	
Sample	1	2	3
Compressive Strength (MPa)	6.107	7.252	8.792
Average (MPa)		7.384	

Curing period		28^{th} days	
Sample	1	2	3
Compressive Strength (MPa)	6.173	7.556	10.560
Average (MPa)		8.096	

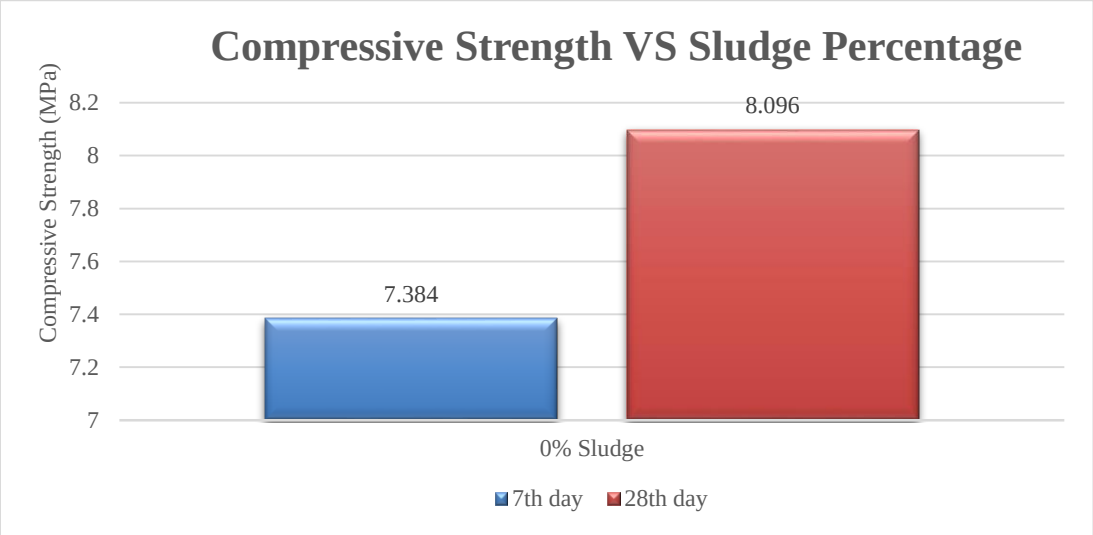

Figure 4.1 Compressive Strength to Oleo chemical waste (sludge) percentage

Figure 4.1 shows results for compressive strength in brick with 0% and 5% percentage of oleochemical waste as partially sand replacement. The graph shown for the brick with 0% replacement achieved 7.38 MPa and 8.09 MPa at day 7 and day 28. However, the strength become 0 MPa at 5% partial sand replacement because no testing be conducted for the specimen. During taking out the brick of 5% replacement level from the mould after 24 hours, the brick itself fragile and crack easily and cannot be done for the curing process. It is because the behaviour of the dry sludge that have been sieved cannot be used as sand replacement. The dry sludge cannot bond with other materials to form brick and complete the hydration process.

Hydration process occurred when the cement react with water to produce a calcium-silicate-hydrate (C-S-H) gel and calcium hydroxide. The more C-S-H gel produced, the higher strength can be obtained. For 5% replacement, the bonding process in the sand brick itself weak and the strength of the brick become totally zero. Thus, the curing process cannot be done and the testing cannot be conducted. No testing with different percentage of replacement can be proceed after.

Figure 4.2 Compressive strength test for 0% replacement

Figure 4.3 Condition of sand brick with 5% replacement after taking out from the mould

4.3 Result of Flexural Strength for Sand Brick

The result of flexural strength test was acquired after the 7th and 28th days of water curing period. Under this test, the uniform load was connected to the sand brick until the sand brick begins to split to two. The result for performance of sand brick with the effect of oleochemical waste in dry condition were appeared in Figure 4.4. The Table 4.2 recorded the flexural strength for the 0% replacement in sand brick. The outcomes demonstrates that the flexural strength.

Table 4.2 Result of Flexural Strength Test

Curing period	7th days		
Sample	1	2	3
Flexural Strength (MPa)	0.107	0.172	0.207
Average (MPa)		0.183	

Curing period	28th days		
Sample	1	2	3
Flexural Strength (MPa)	0.265	0.238	0.311
Average (MPa)		0.271	

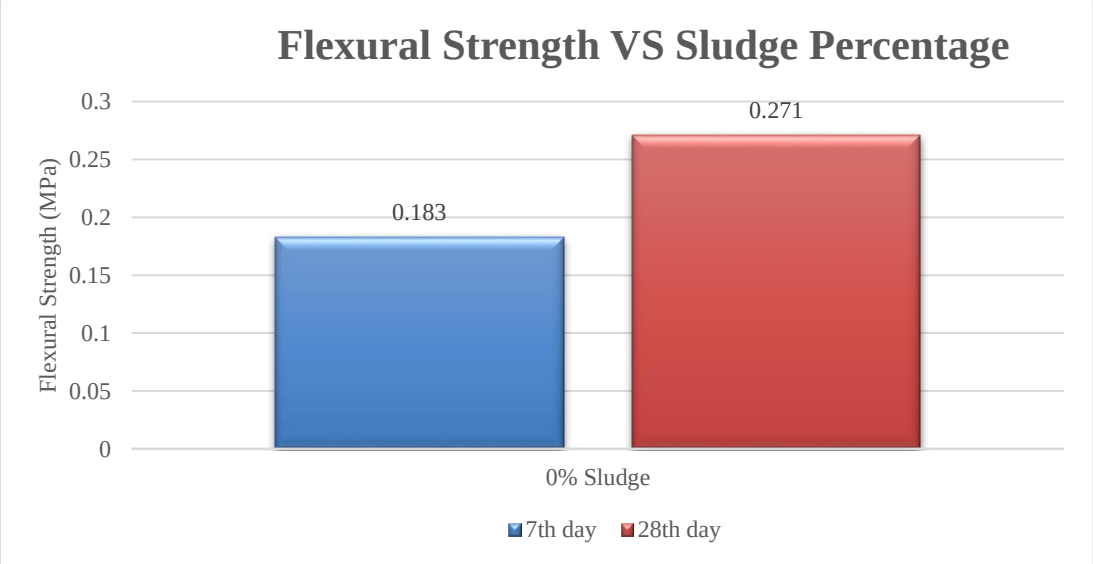

Figure 4.4 Flexural Strength to Oleo chemical waste (sludge) percentage

From the Table 4.2 and Figure 4.4 shows the results for flexural strength in sand brick with 0% and 5% percentage of oleochemical waste as partially sand replacement. The result for flexural strength were similar pattern of graph as compressive strength result. No strength recorderd as no testing be conducted to test the strength of the sand brick when 5% replacement level take place. For the flexural strength of control brick achieved 0.183 MPa and 0.271 MPa at 7^{th} and 28^{th} days while for 5% replacement of dry sludge did not showed any change for the brick as the brick itself fragile after casting. The curing process cannot be done and no testing be conducted.

Figure 4.5 Flexural strength test for 0% replacement

Figure 4.6 Specimen of 0% replacement after flexural strength test

4.4 Result of Water Absorption for Sand Brick

The water absoprtion test was conducted at 28th days after water curing period. The result for the sand brick with 0% and 5% replacement were obtained and apperared in Figure 4.6. Table 4.3 shows the value obtained from water absorption test for 0% replacement.

Table 4.3 Result of Water Absorption Test

Sample	Weight of sample (g)			Rate of Water Absorption (%)	Average Rate of Water Absorption (%)
	Original	Dry Oven	Saturated Water		
1	3429.2	2966.4	3402	14.684	14.966
2	3645.6	3088.5	3593	16.335	
3	3748.3	3246.4	3697	13.880	

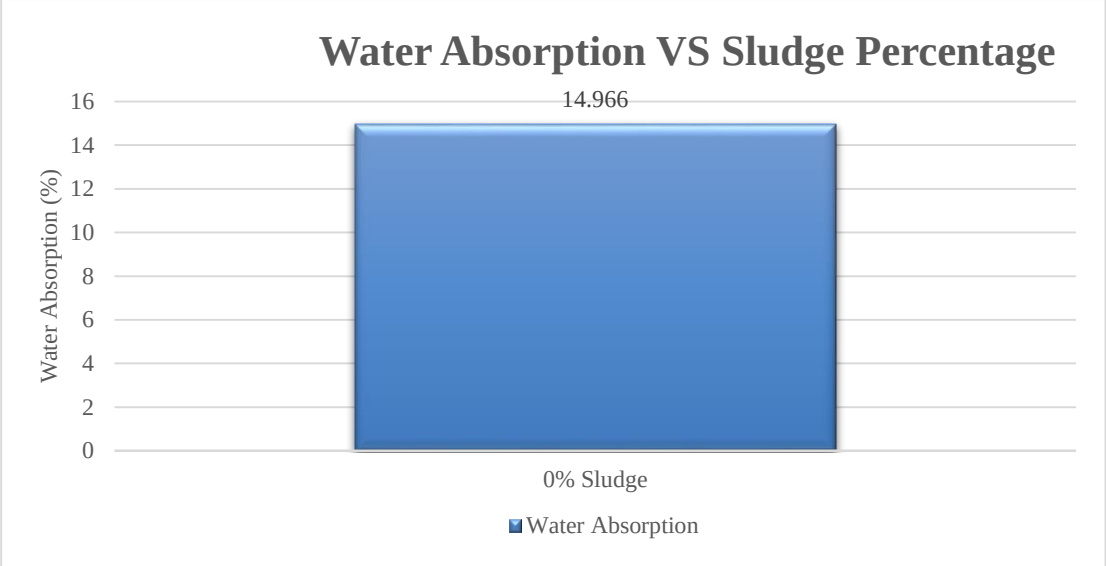

Figure 4.7 Water Absorption to Oleo chemical waste (sludge) percentage

Figure 4.7 shows the results of water absorption test of sand brick. The results shown that the percentage of water absorption for control brick which 0% replacement achieved the value of 14.966% then due the failed 5% replacement of brick, no value recorded for the percentage of water absorption. The water absorption test for brick with 5% replacement of dry sludge cannot be conducted because the brick itself failed and crack after 24 hour casting process.

Figure 4.8 Specimens dried in the oven before water absorption test

Figure 4.9 Specimen weighed after water absoprtion test

4.5 Discussion

Based on result from all the testing that have been conducted which compressive strength, flexural strength and water absoprtion test. The oleochemical waste cannot be used as the sand replacement for the sand brick. No strength recorded since the 5% replacement level of brick failed after 24 hours casting process. All the testing for 5% replacement cannot be conducted so it conclude that the dry sludge cannot be used as sand replacement. The bonding process between the dry sludge and others material when mixed together not occurred completely thus the caused the sand brick fragile and crack easily after cast. From the result, the objective for this research cannot be achieved. The performance of the sand brick decreased after the replacement take place.

Figure 4.10 Condition of sand brick with 5% replacement after casting process

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter presents the conclusion of this research based on the objective which have been set at the beginning stage of research. The main objective of this research is to determine the compressive strength, flexural strength and water absorption with the effect of oleo chemical waste as partial sand replacement in sand brick. This chapter will conclude the result.

5.2 Conclusion

This research had demonstrated the effect of oleo chemical waste as partial sand replacement in the sand brick. This research was an explore research to investigate whether the oleo chemical waste can be used as sand replacement in the future. From the results and discussion that had been made, the objectives of this research were not achieved. Based on the results and analysis in Chapter 4, there have several conclusions can be drawn.

5.2.1 Effect of Oleo chemical waste to Compressive and Flexural Strength

From the result of compressive strength test, no value of strength had been obtained after 5% replacement take place with no sand brick produced completely. This probably due to the behaviour and the material inside the dry sludge cannot be used as replacement and also weak bonding between dry sludge and others material. The strength for control brick only have been recorded. For flexural strength test, the results showed similar result with the compressive strength test. No strength recorded with 5% replacement in sand brick.

5.2.2 Effect of Oleo chemical waste to Water Absorption Test

In term of water absorption test, the test for the 5% replacement level cannot be conducted. There was no sand brick produced with the effect of the dry sludge. Thus, no value can be obtained and as comparison with the value that obtained for control brick.

5.3 Recommendations

There are several recommendations that can be identified to develop the oleo chemical waste as replacement material.

I. Wet sludge can be used as partial sand replacement rather than dry sludge because the failed result obtained. By adding hardened and carbon to reduce the odour of the oleo chemical waste.

II. No polymer content in the sludge to prevent formation of plastic which cover the surface of the sludge after drying process.

III. Change the type of curing method such as air curing to investigate the potential of the sand brick with the effect of oleo chemical waste.

IV. Increase the water-cement ratio in mix proportion to avoid less of water content during mixing process to produce the sand brick.

V. Replace the percentage of the sludge by the volume of the sand rather by weight of the sand as partial sand replacement in the sand brick.

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