COMPRESSIVE STRENGTH OF BRICK
WITH USED COOKING OIL

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SEPTEMBER 2013

ABSTRACT

Nowadays, waste becoming an issue that can contribute to the pollution and can harmful to the people, animal and environment. It has been estimated that the amount of waste in the cities in developing countries is almost about 580 million tons per year. A lot of countries resort to get rid of their waste in many ways in order to reduce the environmental and the health problems. For example, some countries have resorted to bury the waste but they faced problems of groundwater pollution and other problems, therefore it is found that the best way to get rid of the waste is by recycled and re-manufactured it. Oil is one of the most commonly reported as influence to the pollution. Discharge of oil into drainage systems, onto land or to watercourses is not only an offence indeed can be harmful to river birds, fish and other wildlife. Even a small quantity of the oil spreading, it can cause a lot of harmful to the environment and human life. In this study, compressive strength machine is used to measure the strength of the brick that made from two types of oil which are virgin cooking oil and used cooking oil. There are many types of brick in the construction such as fire brick, cement brick, facing brick and so on. A wall or column carrying a compressive load behaves like any other strut, and its loadbearing capacity depends on the compressive strength of the materials, the cross-sectional area and the geometrical properties as expressed by the slenderness ratio. The strength of bricks is affected by the oil percentage inclusion, curing duration and temperature.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Environmental issues gained increasing prominence in the latter half of the 20th century. Global population growth has led to increasing pressure on worldwide waste material. One of the problems in these environmental issues is the problem of oil waste. Actually these wastes have a negative impact on the environment. Many inventors have found that waste material can be used in various industries. In this project, I am going to use used vegetable cooking oil and compare the compressive strength to the virgin oil by testing the both of specimen with 50mm of size.

1.2 Problem Statement

It has been estimated that the amount of waste in the cities in developing countries is almost about 580 million tons per year. A lot of countries resort to get rid of their waste in many ways in order to reduce the environmental and the health problems. For example, some countries have resorted to bury the waste but they faced problems of groundwater pollution and other problems, therefore it is found that the best way to get rid of the waste is by recycled and re-manufactured it. So in this project, used vegetable cooking oil will be used in the making of brick.

Brick are used for building, block paving and pavement. Starting in the 20th century, the use of brickwork declined in many areas due to earthquakes (Wikipedia). In Malaysia, the used of brick is commonly used in construction. Bricks in Malaysia are made from clay, sand and cement. In making of bricks, alternative use of other material in bricks are widely applied.

Vegetable cooking oil has been praticed in many field such as renewable energy. Based on the history, vegetable oil is used as a fuel dates back to 1898, when the German inventor Rudolph Diesel developed a new type of internal combustion engine that used oil derived from peanuts (Varrasi J, 2012). The increasing interest in using vegetable oil as fuel, coupled with worldwide initiatives to reduce carbon dioxide emissions, have spawned a global industry. Large and small companies from the U.S. to Spain and from Germany to China design and manufacture vegetable oil generators and peripheral equipment like diesel conversion kits and oil filtration systems. In the meantime, (Varrasi J, 2012) claimed that vegetable oil enjoys success in the retail power market, where restaurant owners, farmers, and other users are contributing to a clean environment—and saving money in the process.

Having probability of contaminating environmental water, discarding of this waste cooking oil can be challenging (Hubera et al., 2007). Oil wastes are significant into a cause of pollution to the environment and society, for that researchers coming out with alternative to overcome this problems. In this paper, the author are also focusing on decreasing of waste and alternative to use waste as to give the benefits to the construction industry

The purpose of this project is to develop brick made with used vegetable cooking oil. Waste edible oils and fats pose significant disposal problems in many parts of the world. It is noted that the waste problem is increasing day by day as a result of increasing population.

1.3 Objectives

The objective of this project are:

1. To determine the viability of incorporating cooking oil in brick
2. To establish the mixture proportion for brick containing used cooking oil
3. To identify the compressive strength of bricks containing used cooking oil

1.4 Scope of Study

In order to achieve the objective, three scopes have been identified to be studied in this project. They are:

1. Types of oil : Used vegetable cooking oil and virgin cooking oil
2. Oil Percentage Inclusion : 5%, 7%, 9%, 11% and 13% by weight of the brick
3. Test involved : Compressive strength test
    - Dry in Oven at 160 °C.
    - 3 specimens for each age of 24 hours, 48 hours and 72 hours will be tested
    - 90 specimens will be tested to determine the compressive strength of the bricks.

CHAPTER 2

LITERATURE REVIEW

2.1 Global and National Green House Gas Targets

The brick industry has been working for many years to reduce the impact of such emissions. Many researchers are working on it to reduce hydrogen fluoride and particulates emissions and made major capital investment in the latest technology such as filters and scrubbers by handling research development. The main atmospheric emissions resulting from the production process are carbon gases, hydrogen fluoride and particulates.

According to the International Energy Agency (IEA, 2009) the cement industry producing 5% of current global man-made CO_2 emissions. Concrete is the most widely used in construction. On the other hands, it is the essential binder in concrete instead of it is produce CO_2. In the case of Malaysia, the bulk of the emissions come from the cement manufacturing industry. In addition, (Cachim Paulo B, 2009) claimed that concrete industry, in particular, is one of the biggest natural resource consumer as a consequence of being one the most used construction materials.

2.2 Vegetable Oils

Cooking oil consists of edible vegetable oils derived from olives, peanuts, and sunflowers, to name just a few of the many plants that are used. Cooking oil is liquid at room temperature and sometimes added during the preparation of processed foods. About two-thirds are used for foods and one-third for industrial purposes. Several of the cooking oil sources are used for cooking oils, margarine, and salad dressings. In addition, some are incorporated into many food products and animal feeds.

The major industrial uses are for paints, coatings, plasticisers (especially for vinyl), polyamide resins for plastics, and surface-active agents (including soaps and detergents), and as components in linoleums and oilcloths (Zoorob S.E, Forth J.P, and Bailey H.K, 2006). (Zoorob S.E, Forth J.P, & Bailey H.K, 2006) also mentioned that other industrial uses are for synthetic fibers, lecithin, food coatings, cosmetics, medicinals, printing inks, plastic foams, and fatty acid raw materials. Figure 2.1 Shows the World's vegetables oil production, 1975 – 2007.

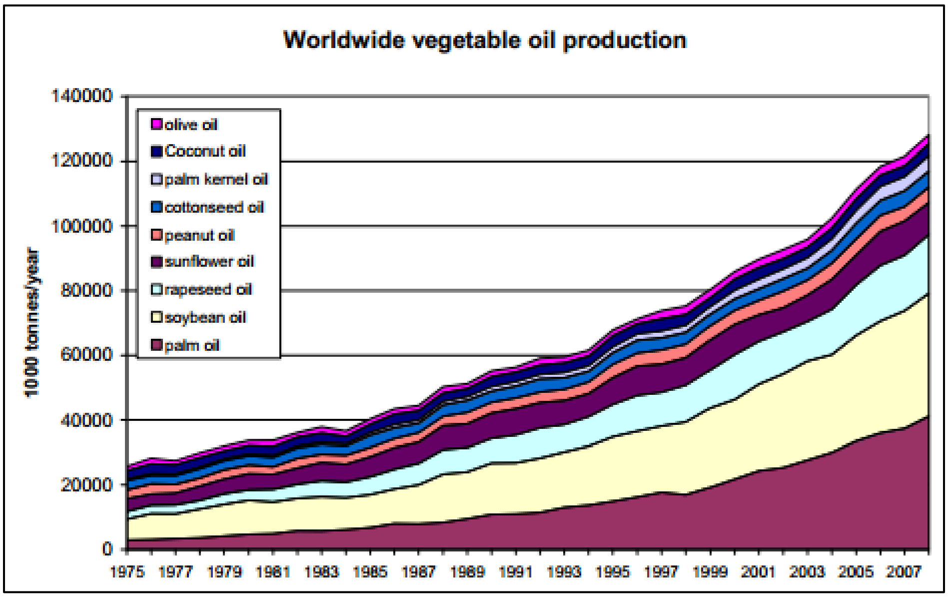

Figure 2.1 World's vegetables oil production, 1975 – 2007

Nowadays, it has become increasingly important to conserve energy and natural resources, and to reduce global pollution and wastage as move forward to sustainable development. Because of that, construction industry need to consider the use of recycled and waste materials as replacements for traditional aggregates in construction materials, in particular cementitious and clay bound materials. By doing so, its helped to improve the sustainability of masonry units which are already considered sustainable. As shown in Figure 2.2, vegetable oil use has high in food use. In addition, the author is focusing on used vegetable cooking oil as a binder in making a brick to reduce environmental problems towards the sustainable development.

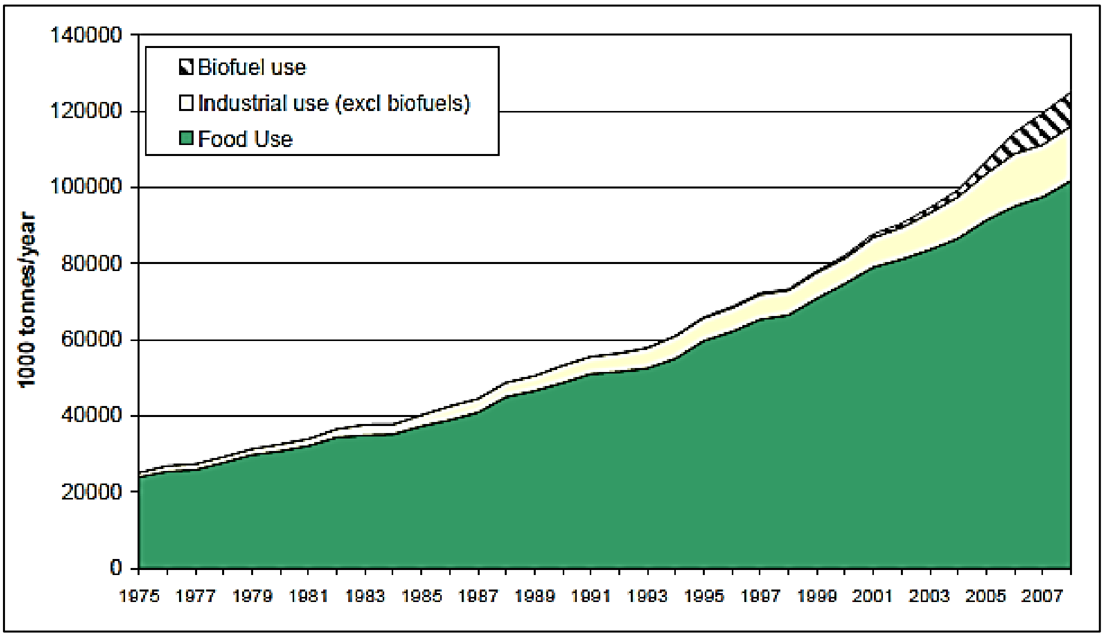

Figure 2.2 Vegetbale Oil Use Worlwide

(Rosillo-Calle . F, Pelkmans. L & Walter. A ,2009) claimed that Malaysia is the world's largest producer and exporter of palm oil and primarily for edible oil. Production of palm oil also generates several by-products, often considered as waste in the past, which offer a significant potential for biodiesel production. By this statement, it can be considered to develop the used cooking oil in construction industry.

2.4 Used Vegetable Oil

Each year, the chowder house produces about 5,000 gallons of used vegetable oil from its kitchen deep fryers (Varrasi J, 2012). Used cooking oil can classified as a domestic waste generated as the result of cooking and frying food with vegetable (Vinyes E ,Oliver-Solà J , Ugaya C , Rieradevall J & Carles M. Gasol 2012).

Oil is one of the most commonly reported as influence to the pollution. Discharge of oil into drainage systems, onto land or to watercourses is not only an offence indeed can be harmful to river birds, fish and other wildlife. Even a small quantity of the oil spreading, it can cause a lot of harmful to the environment and human life. In United Kingdom, caterers produce between 50 - 90 million litres of waste cooking oil each year and if this is not disposed of correctly the effects of oil pollution on the environment could be quite devastating.

In Malaysia, example of used cooking oil management applied by McDonald's. As stated in their website, more than 12,000 kilograms of used cooking oil is recycled every month by McDonald's Malaysia. Manufacturer will collect the used cooking oil and they will recycle these materials into household items such as soaps and candles. In 2009, two councils in Selangor which are The Subang Jaya Municipal Council (MPSJ) and the Selayang Municipal Council (MPS) announced their Cooking Oil Recycling Project. For every litre of oil collected, the restaurants would be paid 25 cent. This project as to curb the problem of cooking oil being thrown into drains.

2.3 Brick

A brick is a walling unit whose form may be generally defined as a rectangular prism of size that can be handled conveniently with one hand (G.C.Lynch,1994). In brick history, archaeologists have found bricks in the Middle East dating 10,000 years ago. Scientists suggest that these bricks were made from mud left after the rivers in that area flooded. The bricks were moulded by hand and let it dry under the sun. In terms of structure, many ancient structures made of bricks such as the Great Wall of China and remnants of Roman buildings, are still standing today. The Romans further developed kiln-baked bricks and spread the art of brickmaking throughout Europe.

There are many types of brick in the construction such as fire brick, cement brick, facing brick and so on. A wall or column carrying a compressive load behaves like any other strut, and its loadbearing capacity depends on the compressive strength of the materials, the cross-sectional area and the geometrical properties as expressed by the slenderness ratio. The common size of bricks to BS 3921 : 1985 as shown in Table 2.1.

Coordinating size			Work size		
Length	Width	Height	Length	Width	Height
mm	mm	mm	mm	mm	mm
225	112.5	75	215	102.5	65
NOTE The work sizes are derived from the corresponding coordinating sizes by the subtraction of a nominal thickness of 10 mm for the mortar joint.					

Table 2.1 Sizes of Bricks, BS 3921 : 1985

According to (Zoorob S.E, Forth J.P, & Bailey H.K, 2006), In United Kingdom, a compaction pressure of 8 Mpa is typically applied for conventional block manufacturing. In this paper, the author will present the brick made with used vegetable cooking oil. This paper also is more focusing on the compressive strength on the bricks after use the used vegetable cooking oil as a binder.

2.3.1 Types of Brick

2.3.1.1 Common Burnt Clay Bricks

Common burnt clay bricks are formed by pressing in moulds. The bricks are dried and fired in a kiln after that process. The majority of the bricks produced in the US are clay, accounting for an annual production of approximately 8.3billion bricks. Common burnt clay bricks have no special attractive appearances and it was used for a general work. When these bricks are used in walls, they are required for a plastering or rendering job.

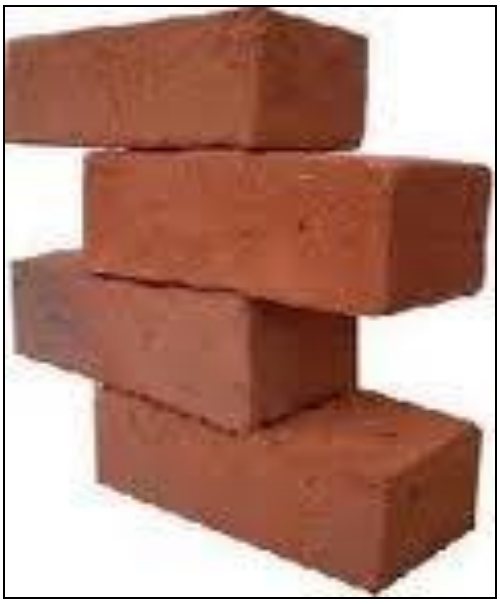

Figure 2.3 Common Burnt Clay Bricks

2.3.1.2 Sand Lime Bricks

Sand lime bricks are made by mixing sand, fly ash and lime followed by a chemical process during wet mixing. The mix is then moulded under pressure forming the brick. These bricks can offer advantages over clay bricks such as:

i. Their colour appearance is grey instead of the regular reddish colour.
ii. Their shape is uniform and presents a smoother finish that doesn't require plastering.
iii. These bricks offer excellent strength as a load-bearing member.

Figure 2.4 Sand Lime Bricks

2.3.1.3 Engineering Bricks

Engineering bricks are bricks manufactured at extremely high temperatures, forming a dense and strong brick, allowing the brick to limit strength and water absorption. Engineering bricks offer excellent load bearing capacity damp-proof characteristics and chemical resisting properties. In BS 3921 Engineering Bricks are classified as A or B based on minimum compressive strength and maximum water absorption not falling below 70 N/mm^2 – 4.5% and 50 N/mm^2 –7% respectively. Engineering bricks are not included in EN 771-1, but are referenced instead in the UK National Annex that appears at the end of the Standard.

		Compressive Strength N/mm2	Water Absorption (%)	Net Dry Density Kg/m^3	Freeze/thaw resistance category	Active Soluble Salts Content Category
BS 3921	CLASS A	≥70	≤4.5	na	na	na
	CLASS B	≥50	≤7	na	na	na
BS ENG 771	CLASS A	≥125	≤4.5	≥2200	F2	S2
	CLASS B	≥75	≤7	≥2100	F2	S2

Table 2.2 Engineering Bricks Classified in BS 3921

2.3.1.4 Concrete Bricks

Concrete is a high-volume building material produced by mixing cement, water, and coarse and fine aggregates. Its use is nearly universal in modern construction as it is an essential component of roads, foundations, high-rises, dams, and other staples of the developed landscape. A concrete masonry unit made from Portland cement, water, and suitable aggregates, with or without the inclusion of other materials. Concrete bricks are usually placed in facades, fences, and provide an excellent aesthetic presence. These bricks can be manufactured to provide different colours as pigmented during its production.

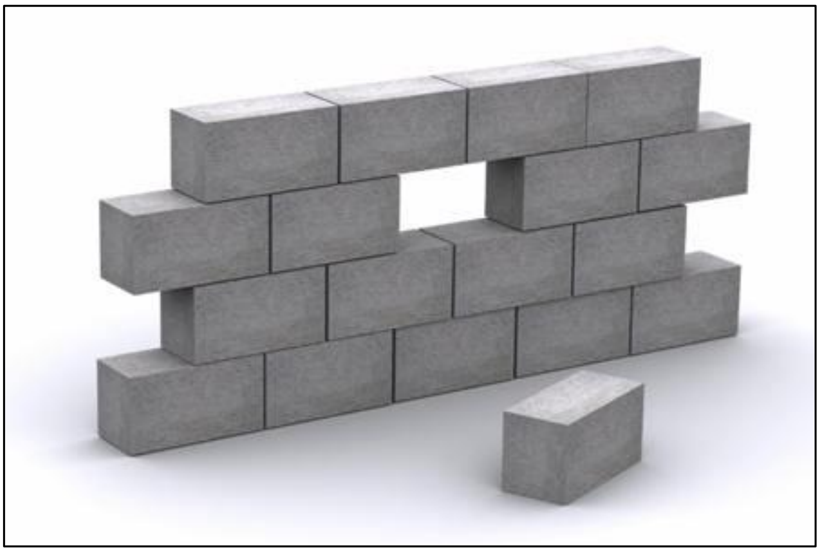

Figure 2.5 Concrete Bricks

2.3.1.5 Fly Ash Bricks

Fly ash brick is defined in Wikipedia as a building material specifically masonry units which containing class C fly ash and water. Fly ash bricks are lighter than clay bricks. Fly ash bricks compressed at 28 MPa of pressure and cured for 24 hours in a 66 °C steam bath, then toughened with an air entrainment agent, the bricks last for more than 100 freeze-thaw cycles. Owing to the high concentration of calcium oxide in class C fly ash, the brick is described as "self-cementing". The manufacturing method saves energy, reduces mercury pollution, and costs 20% less than traditional clay brick manufacturing. The raw materials for fly ash brick is shown in Table 2.3.

Material	Mass
Fly ash	162 kg
Sand/stone dust	280 kg
Lime	39 kg
Gypsum	13 kg
Cement	6 kg
Total formula of material	500 kg

Table 2.3 Raw Materials for Fly Ash Bricks

2.3.2 Compressive Strength of Brick

One of the properties of bricks is compressive strength. The results for compressive strength are recorded in N/mm^2. The test involves grinding the surfaces smooth if they vary in height more than 1mm per 100mm from a level plane. The BS EN 771-1 standard is used to define the compressive strength of brick. Compressive strength test measuring the maximum amount of compressive load a material can bear before fracturing.

The grading, i.e. particle size distribution, of each aggregate is determined using standard sieves in accordance with SANS 197:2006 and 201:2008. A recommended combined grading is as shown in Table 2.4.

Standard sieve size mm	Percentage by mass of aggregate passing
4,75	70 – 85
2,36	50 – 65
1,18	35 – 50
0,60	25 – 40
0,30	10 – 25
0,15	5 – 15
0,075	0 – 10

Table 2.4 Sieve Size Accordance to SANS 197:2006 and 201:2008

CHAPTER 3

METHODOLOGY

3.1 Experimental Details

1. Determination of materials:

Materials that will be used in the experiment are aggregates (fine aggregates), used vegetable cooking oil and virgin cooking oil. The fine sand used in this experiment is sand passing 1.18mm after seiving. The sand will added in a sample with 600g of weight.

2. Determination the proportion of materials:

This is an important step, before mixing the materials all together I have to determine the proportion that is going to be used, in order to get mixture with good properties. After did some research, the oil content used in this experiment is 5%, 7%, 9%, 11% and 13%.

3. Mixing, casting, Compaction and curing:

Figure 3.1 Marshall Machine

Mix the sand and cooking oil (used vegetable cooking oil and virgin cooking oil) then put the mixture into moulds to form the bricks and then put the bricks into oven for some days (24 hours, 48 hours, 72 hours). Before leave it in oven for several days, compaction was done by using marshall machine as shown on figure 3.1. During compaction,75 of blows was applied to the specimen surface. Figure 3.2 shows the specimen after compaction.

Figure 3.2 Specimen

4. Testing:

After curing process, the specimens will be tested using compressive strength machine. The strength reading from the machine in kN unit. The value Mpa can obtain from the formula below.

Figure 3.3 Compressive Strength Machine

5. Comparison:

Determine and analyze the properties of the produced bricks vegebrick and compare it with the brick made with virgin cooking oil and choosen standard bricks.

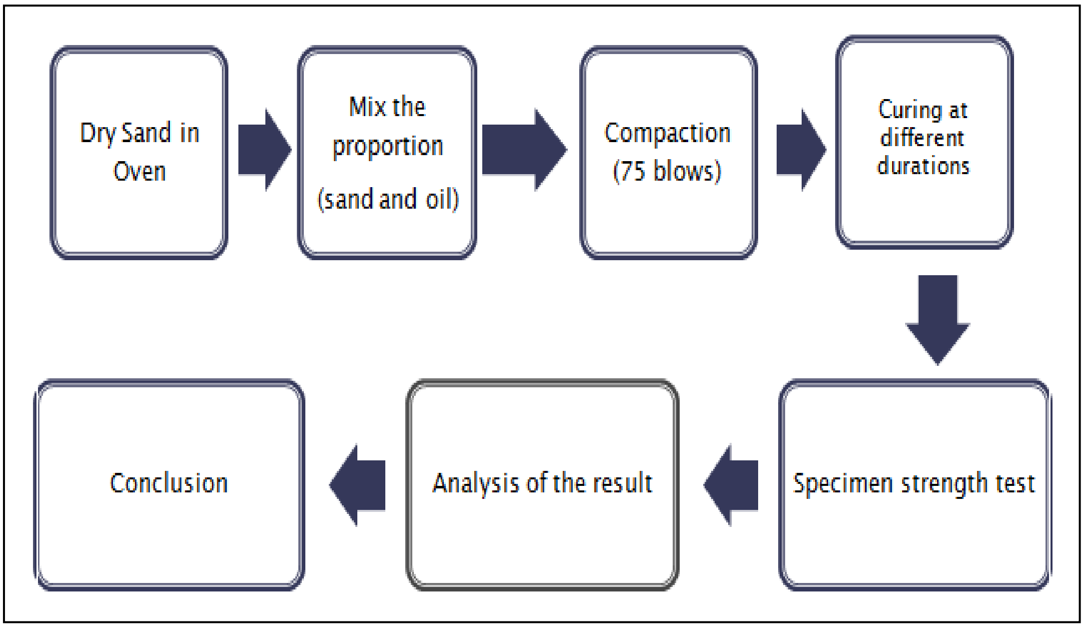

Figure 3.1 The Experimentation Process of Making Bricks Made from Used Vegetable Cooking Oil

3.2 Hardware/Tools and Software

Hardware tools and their function:

* **Mixer:** to mix all the ingredients.
* **Bricks moulds:** to form the bricks.
* **Hand tools:** To construct the brick mould.
* **Compressive test machine:** to test the produced bricks.

Software programs:

* **Microsoft office word:** for documentation.
* **Microsoft office power point:** for slide presentation.

CHAPTER 4

RESULT AND DISCUSSION

From the experiment, 90 cylinders specimen with 100mm of diameter was tested at concrete technology laboratory. The controller in this experiment is oil content (5%, 7% and 9%), temperature at 160 °C and curing duration at 24 hours, 48 hours and 72 hours. Before curing process, the specimen is compacted using marshall machine with 75 number of blows. Table 4.1 shows the results.

TYPES OF OIL	OIL PERCENTAGE (%)	CURING DURATION (HOURS)		
		24	48	72
		COMPRESSIVE STRENGTH (MPa)	COMPRESSIVE STRENGTH (MPa)	COMPRESSIVE STRENGTH (MPa)
VCO5	5	12.40	14.8	19.6
VCO7	7	15.3	15.3	21.8
VCO9	9	12.2	15.8	27.4
VCO11	11	10.3	14.3	29.94
VCO13	13	8.42	13.42	17.85
UCO5	5	12.70	14.80	13.96
UCO7	7	13.96	19.00	20.94
UCO9	9	9.10	23.26	25.32
UCO11	11	8.21	21.90	26.59
UCO13	13	7.74	19.56	17.81

Table 4.1 Results for Compressive Strength of Brick

4.1 Compressive Strength of Brick with Virgin Cooking Oil

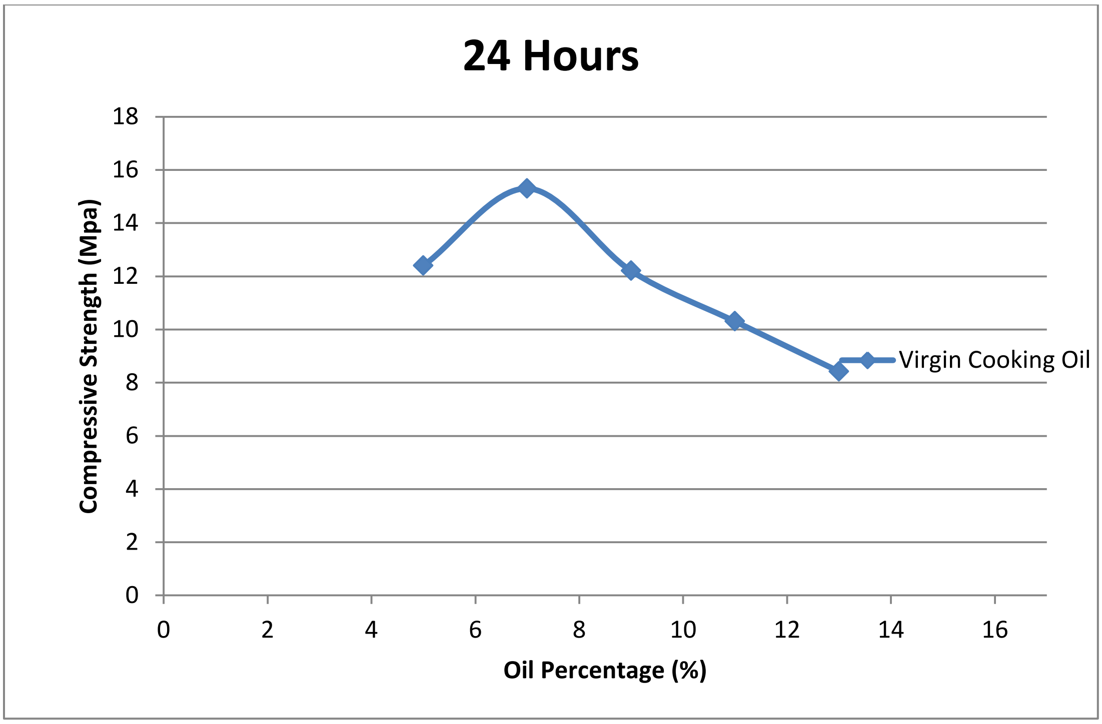

Figure 4.1 Compressive Strength of Virgin Cooking Oil Brick with 24 Hours of Curing

Figure 4.1 shows the compressive strength of brick which virgin cooking oil was added into the specimen. After cured at 24 hours, the brick that have the highest strength is brick made from 7% of virgin cooking oil and sand where the optimum value is 15.3 Mpa. The strength of brick is decreasing after 9%, 11% and 13% of virgin cooking oil was added into the brick.

From the graph shown aboved, the more oil added the lower strength will get because of the brick needs time to cure and to become harden eventhough the curing process was involved high temperature which is 160°C.

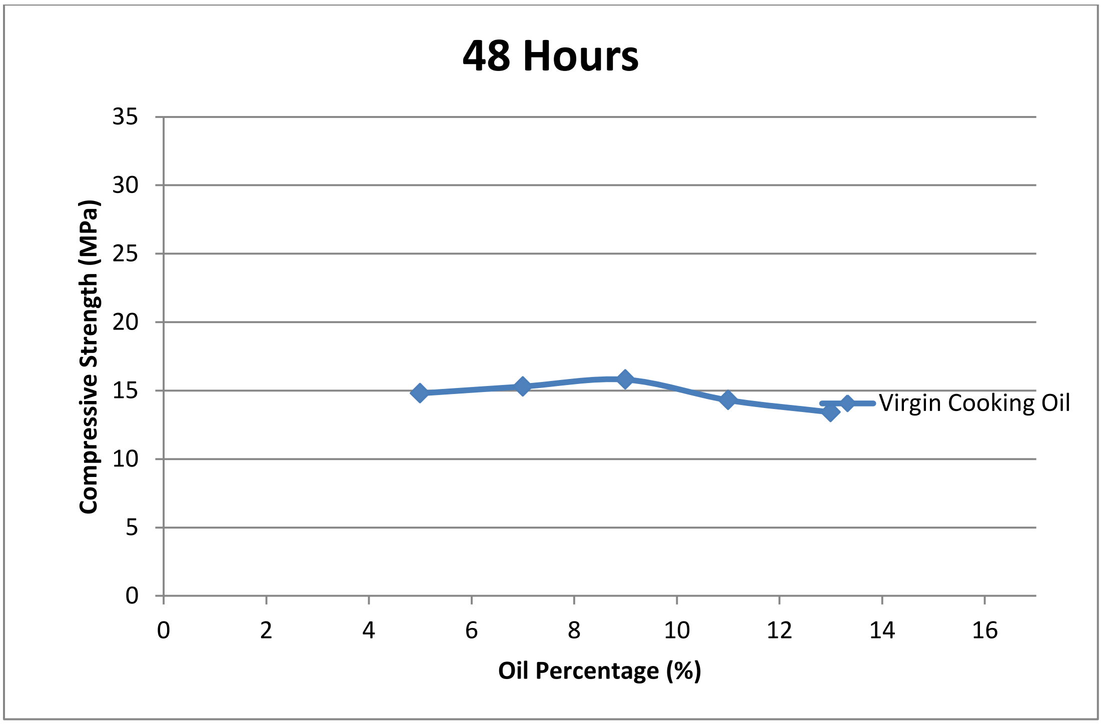

Figure 4.2 Compressive Strength of Virgin Cooking Oil Brick with 48 Hours of Curing

Figure 4.2 shows the compressive strength of brick which virgin cooking oil was added into the specimen. After cured at 48 hours, the brick that have the highest strength is brick made from 9% of virgin cooking oil and sand where the optimum value is 15.8 Mpa. The strength of brick is decreasing after 11% and 13% of virgin cooking oil was added into the brick.

From the graph shown aboved, the more oil added the lower strength will get because of the brick needs time to cure and to become harden eventhough the curing process was involved high temperature which is 160°C.

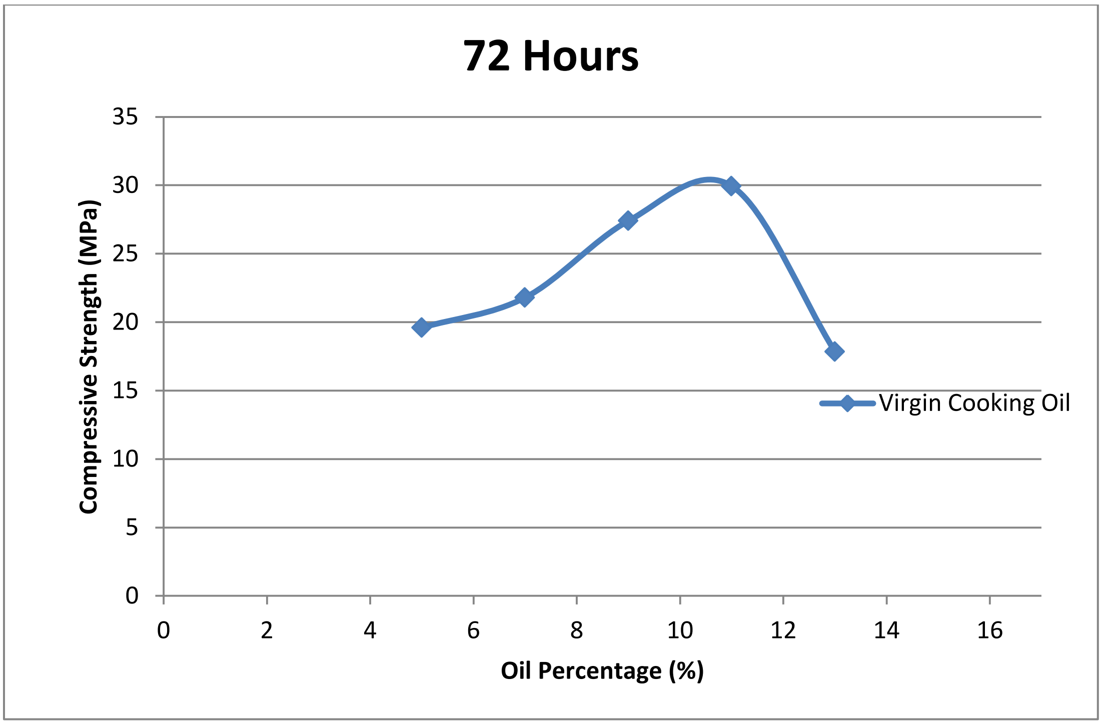

Figure 4.3 Compressive Strength of Virgin Cooking Oil Brick with 72 Hours of Curing

Figure 4.3 shows the compressive strength of brick which virgin cooking oil was added into the specimen. After cured at 72 hours, the brick that have the highest strength is brick made from 11% of virgin cooking oil and sand where the optimum value is 29.94 Mpa. The strength of brick is decreasing after 13% of virgin cooking oil was added into the brick.

From the graph shown aboved, the more oil added the lower strength will get because of the brick needs time to cure and to become harden eventhough the curing process was involved high temperature which is 160°C.

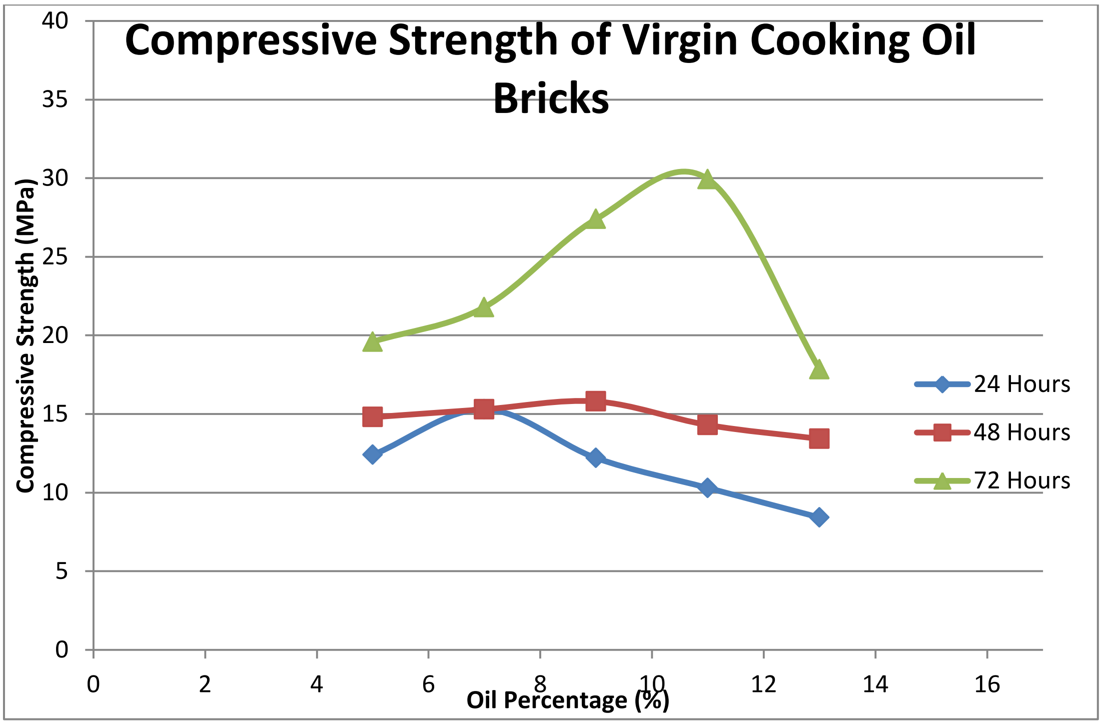

Figure 4.4 Compressive Strength of Virgin Cooking Oil Brick with 24, 48 and 72 Hours of Curing

Figure 4.4 shows the compressive strength of brick which 5%, 7%, 9 %, 11% and 13% of virgin cooking oil was added into the specimen. After cured at 24 hours, 48 hours and 72 hours, the bricks that have the highest strength is brick cured at 72 hours and 11% of cooking oil was added. From the three of results above, it has the highest strength of 29.94 MPa. The lowest strength comes from brick that 13% cooking oil was added and cured at 24 hours.

4.2 Compressive Strength of Brick with Used Cooking Oil

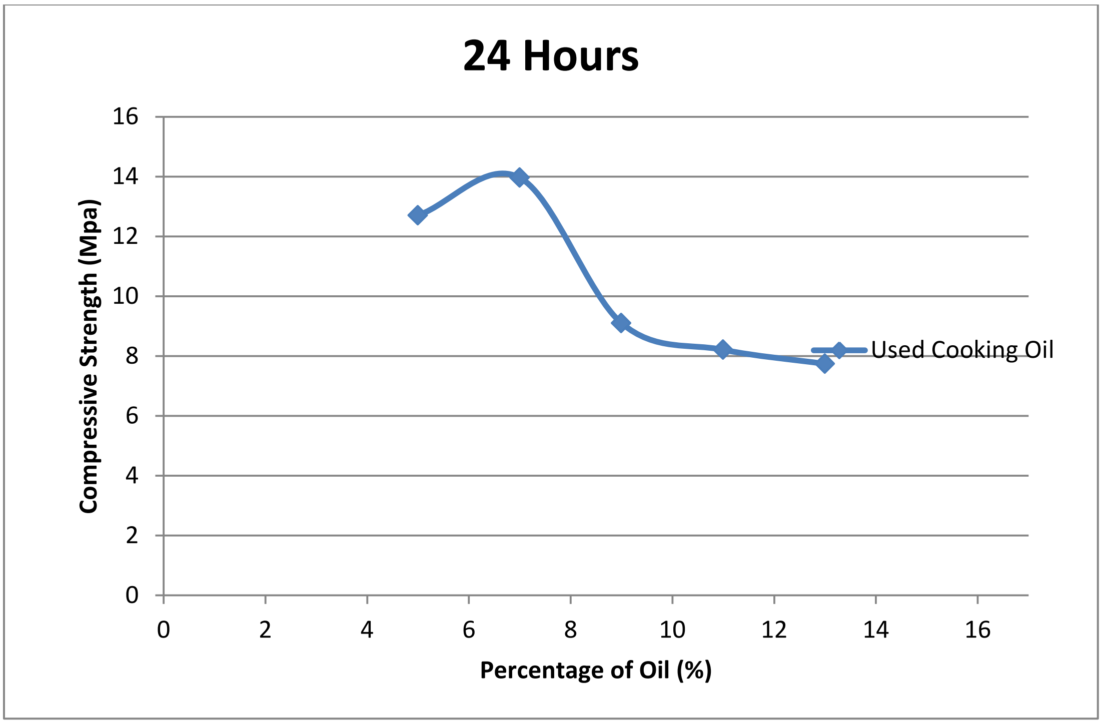

Figure 4.5 Compressive Strength of Used Cooking Oil Brick with 24 Hours of Curing

Figure 4.5 shows the compressive strength of brick which used cooking oil was added into the specimen. After cured at 24 hours, the brick that have the highest strength is brick made from 7% of virgin cooking oil and sand where the optimum value is 13.96 Mpa. The strength of brick is decreasing after 9%, 11% and 13% of used cooking oil was added into the brick.

From the graph shown aboved, the more oil added the lower strength will get because of the brick needs time to cure and to become harden eventhough the curing process was involved high temperature which is 160°C.

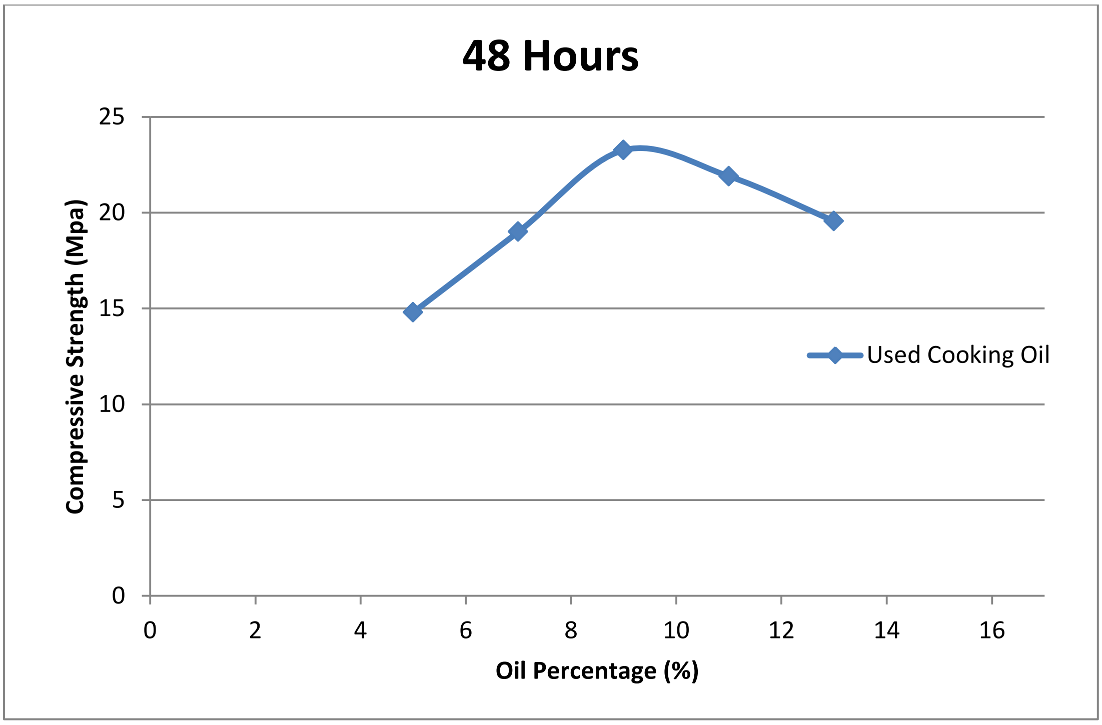

Figure 4.6 Compressive Strength of Used Cooking Oil Brick with 48 Hours of Curing

Figure 4.6 shows the compressive strength of brick which used cooking oil was added into the specimen. After cured at 48 hours, the brick that have the highest strength is brick made from 9% of used cooking oil and sand where the optimum value is 23.26 Mpa. The strength of brick is decreasing after 9%, 11% and 13% of used cooking oil was added into the brick.

From the graph shown aboved, the more oil added the lower strength will get because of the brick needs time to cure and to become harden eventhough the curing process was involved high temperature which is 160°C.

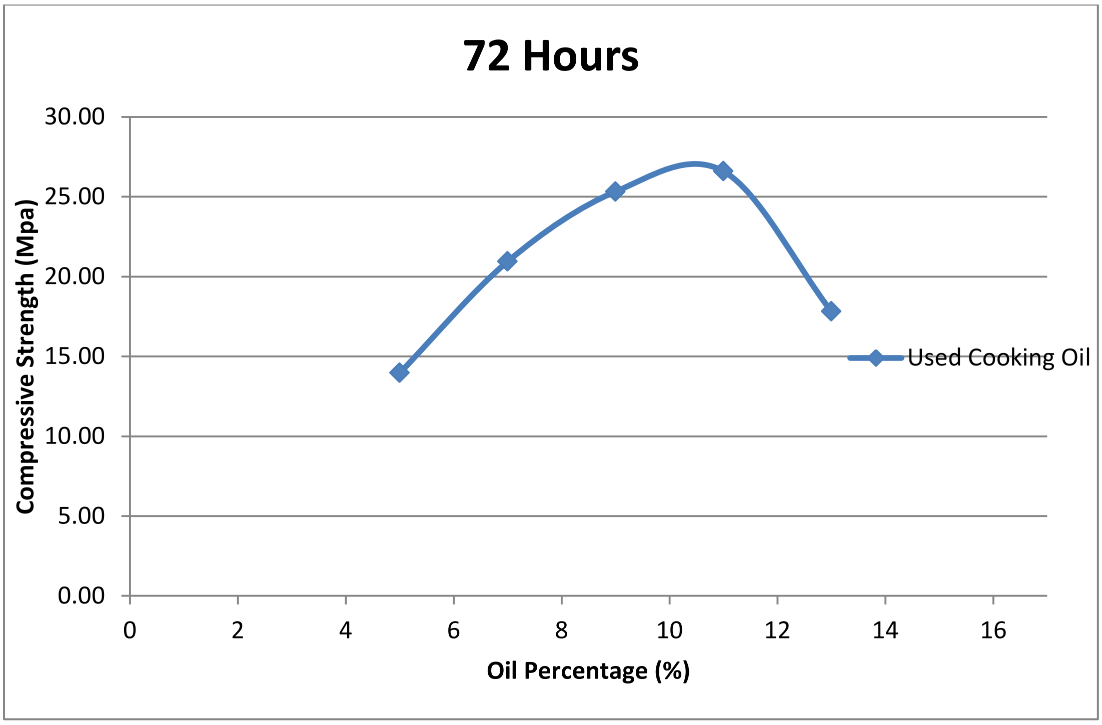

Figure 4.7 Compressive Strength of Used Cooking Oil Brick with 72 Hours of Curing

Figure 4.7 shows the compressive strength of brick which used cooking oil was added into the specimen. After cured at 48 hours, the brick that have the highest strength is brick made from 11% of used cooking oil and sand where the optimum value is 26.59 Mpa. The strength of brick is decreasing after 13% of used cooking oil was added into the brick.

From the graph shown aboved, the more oil added the lower strength will get because of the brick needs time to cure and to become harden eventhough the curing process was involved high temperature which is 160°C.

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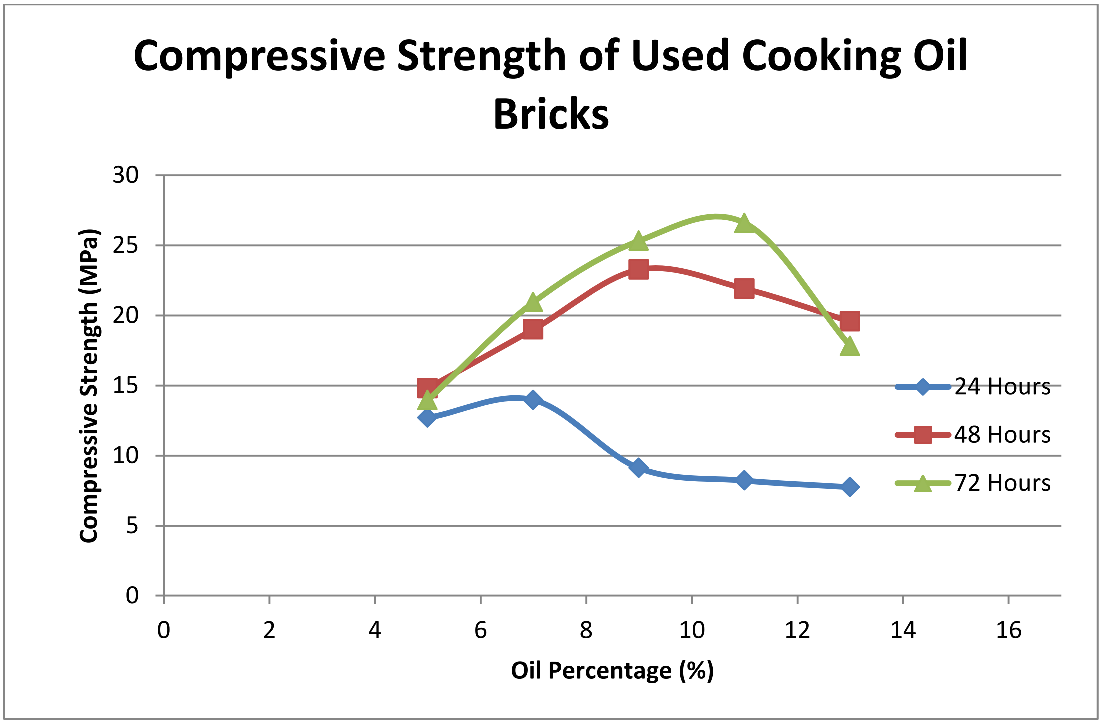

Figure 4.8 Compressive Strength of Used Cooking Oil Brick with 24, 48 and 72 Hours of Curing

Figure 4.8 shows the compressive strength of brick which 5%, 7%, 9 %, 11% and 13 % of used cooking oil was added into the specimen. After cured at 24 hours, 48 hours and 72 hours, the bricks that have the highest strength is brick cured at 72 hours and 11% of cooking oil was added. From the three of results above, it has the highest strength which is 26.59 Mpa. The lowest strength comes from brick that 13% used cooking oil was added into the brick.

4.3 Density of Brick with Cooking Oil

TYPES OF OIL	OIL PERCENTAGE (%)	CURING DURATION (HOURS)		
		24	48	72
		DENSITY (g/cm³)	DENSITY (g/cm³)	DENSITY (g/cm³)
VCO5	5	1.54	1.57	1.56
VCO7	7	1.57	1.58	1.59
VCO9	9	1.58	1.55	1.57
VCO11	11	1.59	1.62	1.58
VCO13	13	1.68	1.68	1.66
UCO5	5	1.52	1.51	1.5
UCO7	7	1.55	1.54	1.54
UCO9	9	1.58	1.58	1.56
UCO11	11	1.6	1.63	1.62
UCO13	13	1.7	1.66	1.67

Table 4.2 Results for Compressive Strength of Virgin Cooking Oil Brick

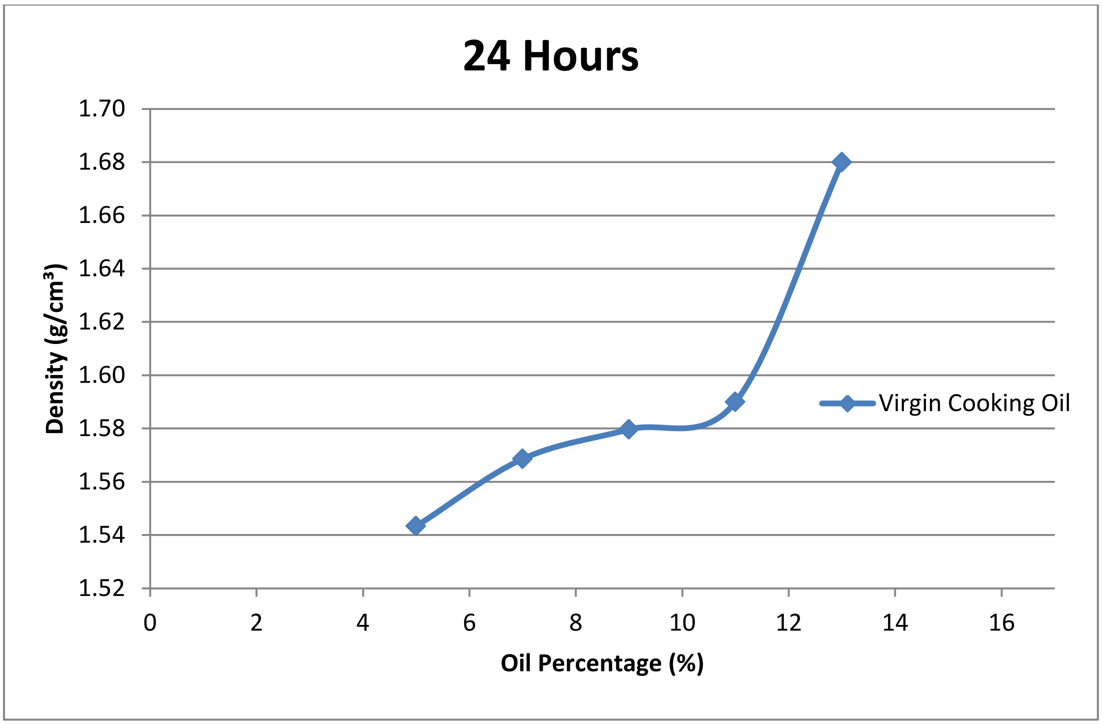

Figure 4.9 Density of Virgin Cooking Oil Brick with 24 Hours of Curing

Figure 4.9 shows the density of brick which virgin cooking oil was added into the specimen. After cured at 24 hours, the brick that have the highest density is brick that 13% of virgin cooking oil was added into the specimen. After cured at 24 hours with 13% of virgin cooking oil content, the density of brick is 1.68 g/cm^3. Based on the graph above, the lowest density comes from brick cured at 24 hours with 5% of virgin cooking oil was added into the specimen and the density is 1.54 g/cm^3.

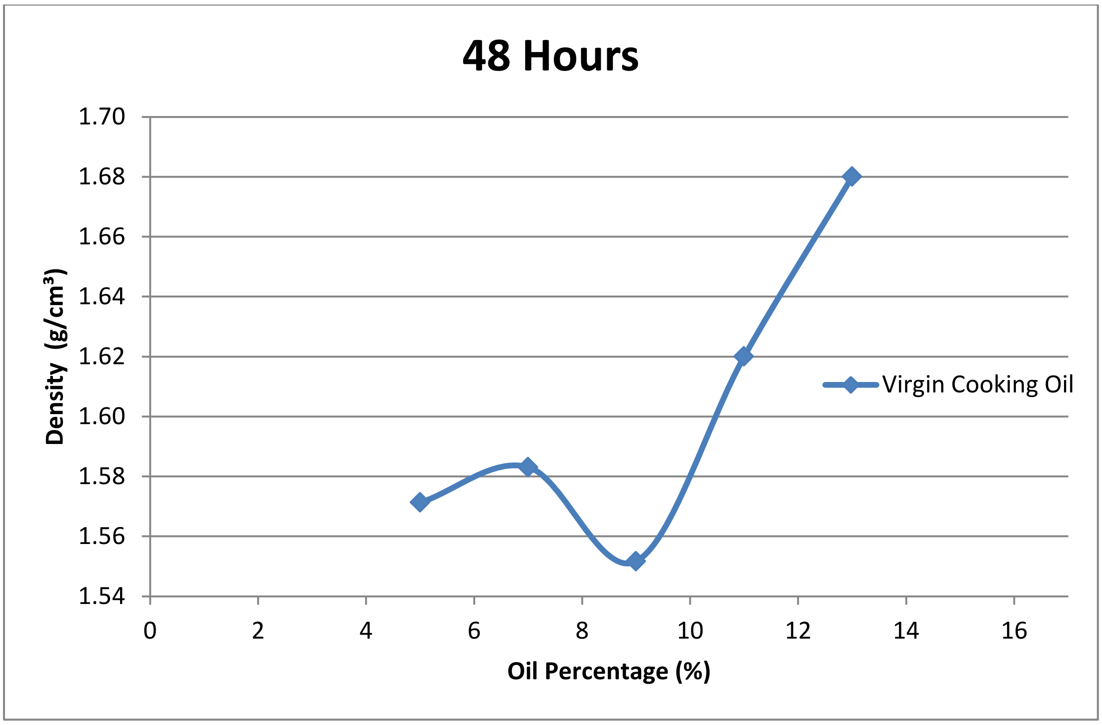

Figure 4.10 Density of Virgin Cooking Oil Brick with 48 Hours of Curing

Figure 4.10 shows the density of brick which virgin cooking oil was added into the specimen. After cured at 24 hours, the brick that have the highest density is brick that 13% of virgin cooking oil was added into the specimen. After cured at 48 hours with 13% of virgin cooking oil content, the density of brick is 1.68 g/cm³. Based on the graph above, the lowest density comes from brick cured at 24 hours with 9% of virgin cooking oil was added into the specimen and the density is 1.55g/cm³.

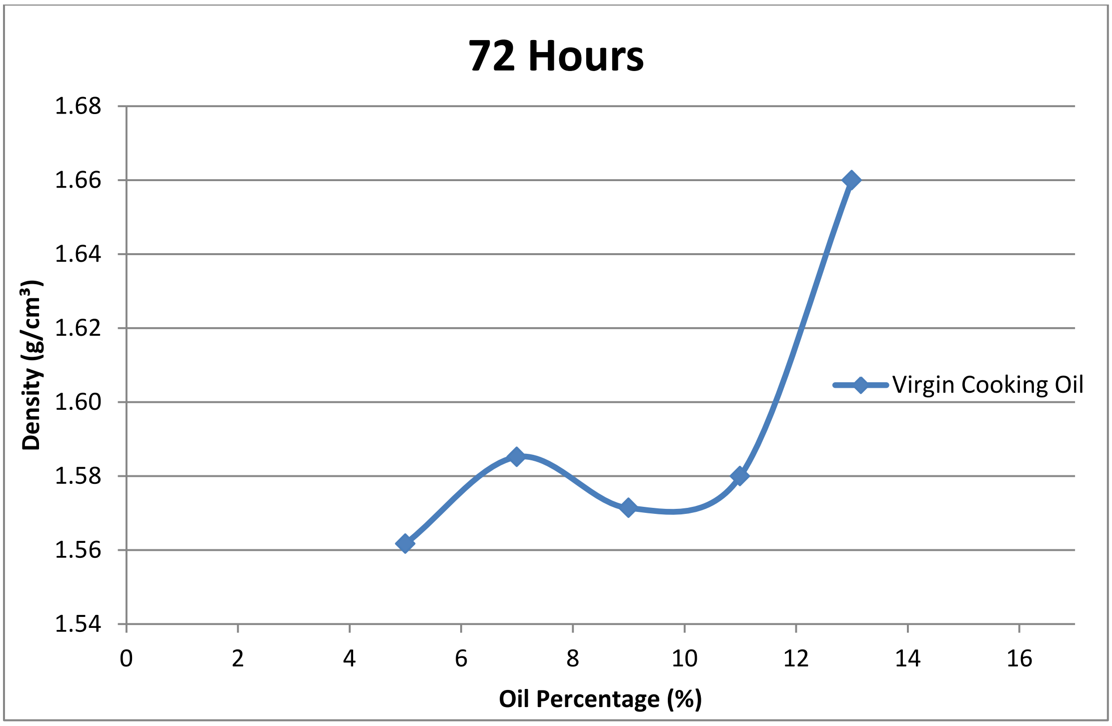

Figure 4.11 Density of Virgin Cooking Oil Brick with 72 Hours of Curing

Figure 4.11 shows the density of brick which virgin cooking oil was added into the specimen. After cured at 72 hours, the brick that have the highest density is brick that 13% of virgin cooking oil was added into the specimen. After cured at 72 hours with 13% of virgin cooking oil content, the density of brick is 1.66 g/cm³. Based on the graph above, the lowest density comes from brick cured at 24 hours with 5% of virgin cooking oil was added into the specimen and the density is 1.56g/cm³.

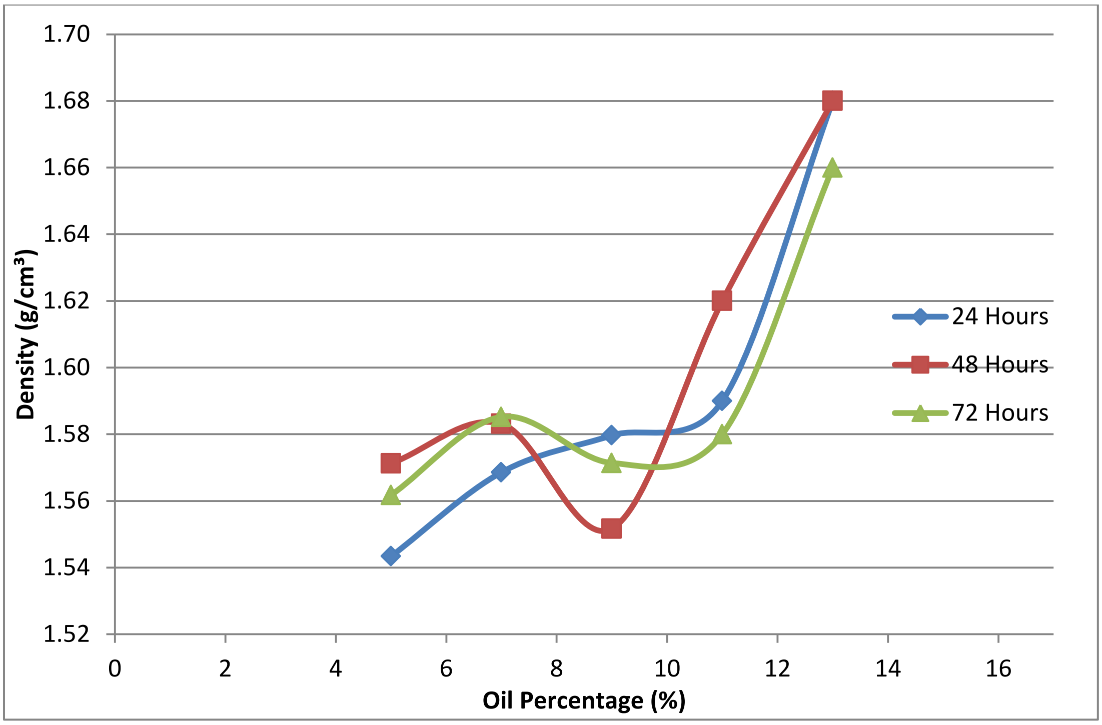

Figure 4.12 Density of Virgin Cooking Oil Brick with 24, 48 and 72 Hours of Curing

Figure 4.12 shows the density of brick which 5%, 7%, 9 %, 11% and 13% of virgin cooking oil was added into the specimen. After cured at 24 hours, 48 hours and 72 hours, the bricks that have the highest density is brick cured at 24 and 48 hours and 13% of cooking oil was added. From the three of results above, it has the highest density which is 1.68 g/cm^3. The lowest density comes from brick that 5% cooking oil was added and cured at 24 hours which is 1.54 g/cm^3.

4.4 Density of Brick with Used Cooking Oil

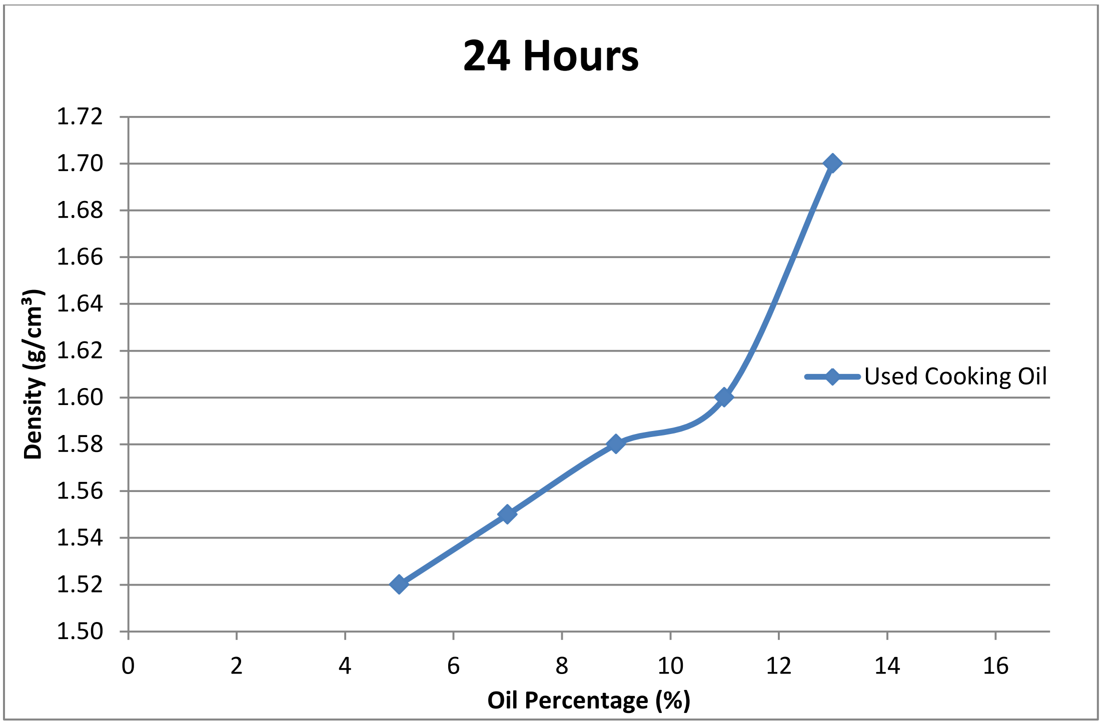

Figure 4.13 Density of Used Cooking Oil Brick with 24 Hours of Curing

Figure 4.13 shows the density of brick which used cooking oil was added into the specimen. After cured at 72 hours, the brick that have the highest density is brick that 13% of used cooking oil was added into the specimen. After cured at 24 hours with 13% of used cooking oil content, the density of brick is 1.67 g/cm³. Based on the graph above, the lowest density comes from brick cured at 24 hours with 5% of virgin cooking oil was added into the specimen and the density is 1.52g/cm³.

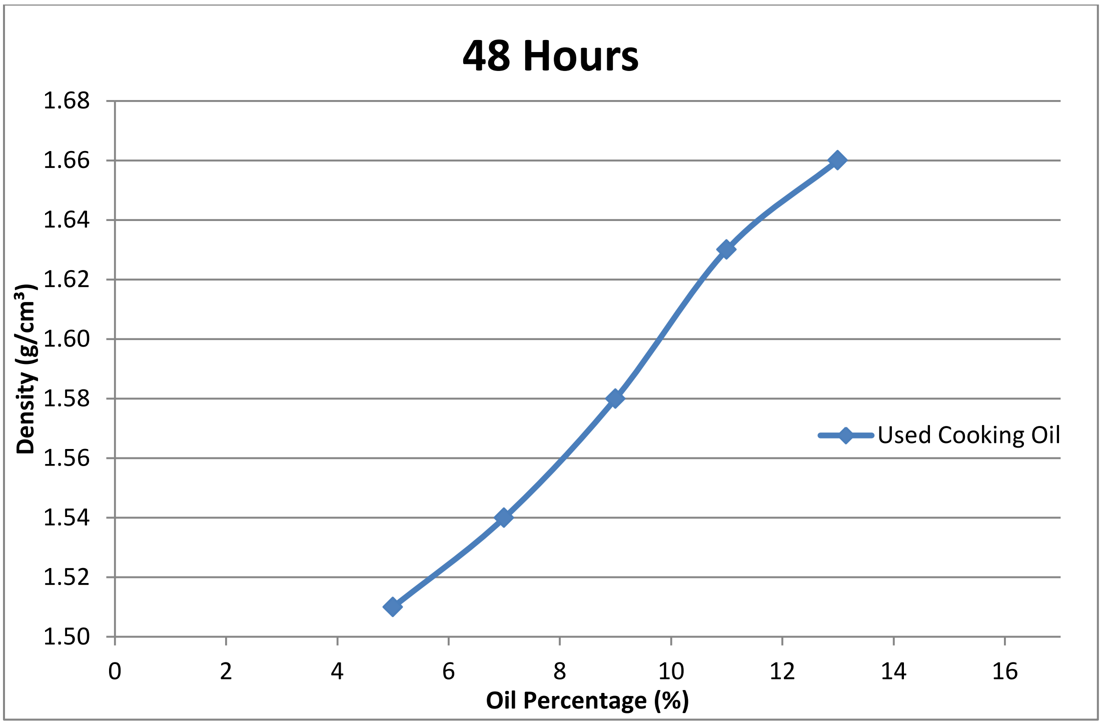

Figure 4.14 Density of Used Cooking Oil Brick with 48 Hours of Curing

Figure 4.14 shows the density of brick which used cooking oil was added into the specimen. After cured at 48 hours, the brick that have the highest density is brick that 13% of used cooking oil was added into the specimen. After cured at 24 hours with 13% of used cooking oil content, the density of brick is 1.66 g/cm³. Based on the graph above, the lowest density comes from brick cured at 24 hours with 5% of virgin cooking oil was added into the specimen and the density is 1.51g/cm³.

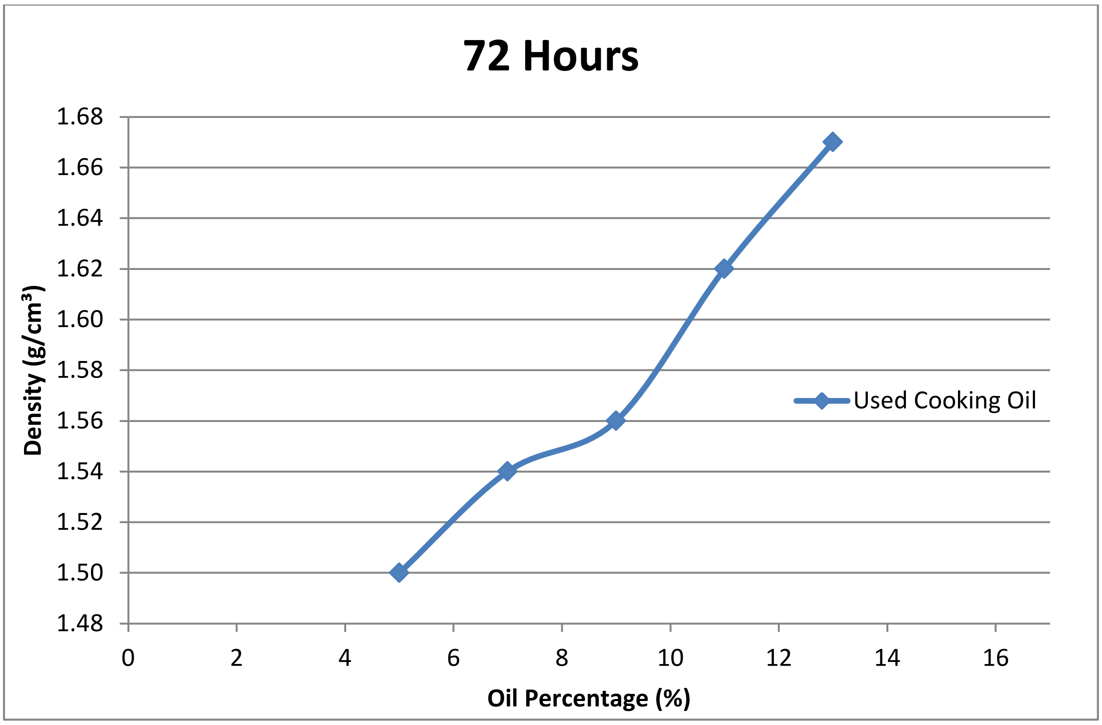

Figure 4.15 Density of Used Cooking Oil Brick with 72 Hours of Curing

Figure 4.15 shows the density of brick which used cooking oil was added into the specimen. After cured at 48 hours, the brick that have the highest density is brick that 13% of used cooking oil was added into the specimen. After cured at 72 hours with 13% of used cooking oil content, the density of brick is 1.67 g/cm³. Based on the graph above, the lowest density comes from brick cured at 24 hours with 5% of virgin cooking oil was added into the specimen and the density is 1.50g/cm³.

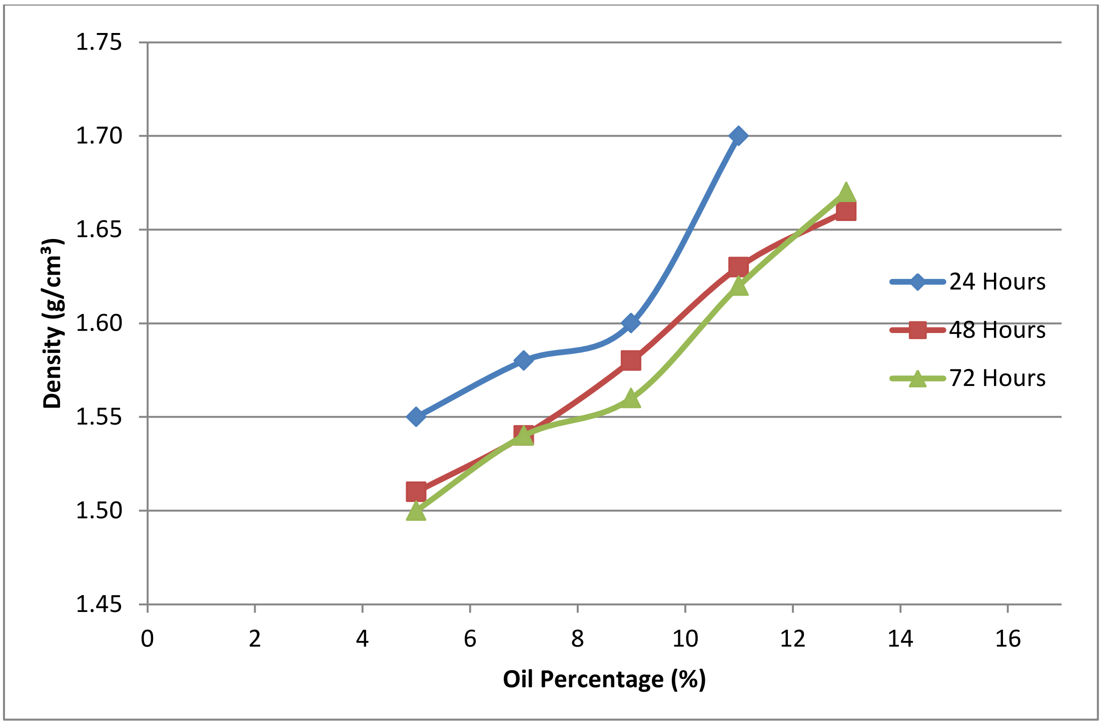

Figure 4.16 Density of Used Cooking Oil Brick with 24, 48 and 72 Hours of Curing

Figure 4.16 shows the density of brick which 5%, 7%, 9 %, 11% and 13% of virgin cooking oil was added into the specimen. After cured at 24 hours, 48 hours and 72 hours, the bricks that have the highest density is brick cured at 24 hours and 11% of cooking oil was added. From the three of results above, it has the highest density which is 1.70 g/cm^3. The lowest density comes from brick that 5% cooking oil was added and cured at 72 hours which is 1.50 g/cm^3.

From the all results, what can be concluded is duration of curing and oil percentage will affect the strength of brick. However, the resul shows that the strength will decrease after 13% of oil added into the specimen and with the short period of curing, specimen cannot be binded properly.

4.5 Comparison of Virgin Cooking Oil Bricks and Used Cooking Oil Bricks Strength

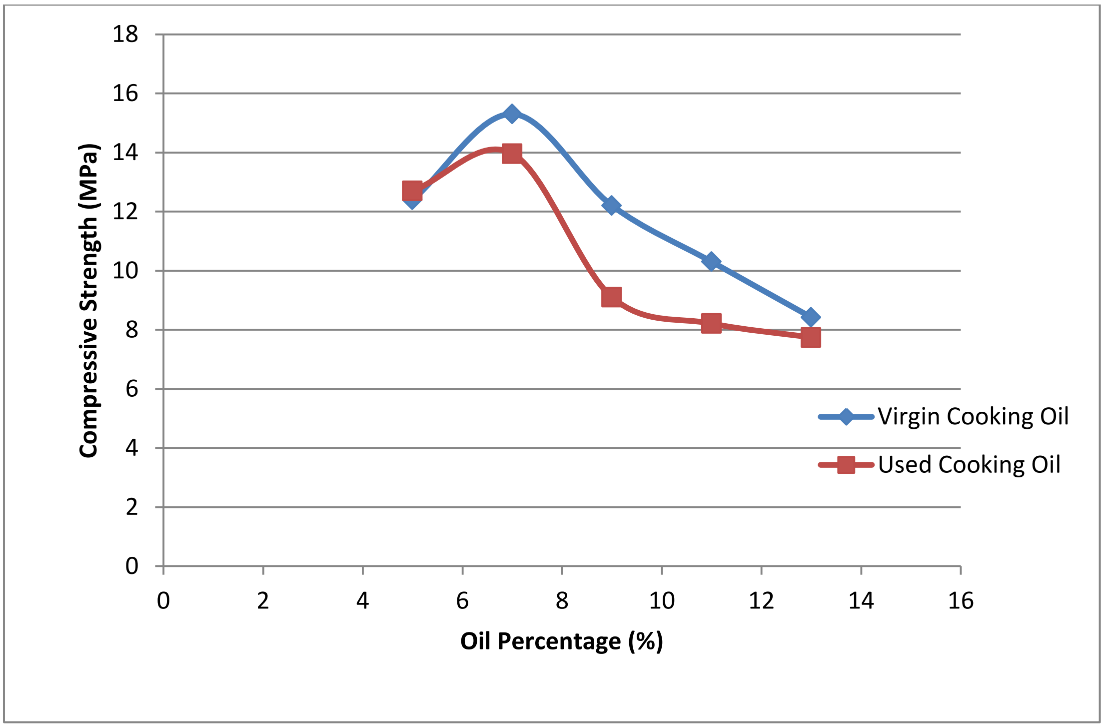

Figure 4.17 Strength of Virgin Cooking Oil Bricks and Used Cooking Oil Bricks at 24 Hours of Curing

Figure 4.17 shows the compressive strength of brick which 5%, 7%, 9 %, 11% and 13 % of virgin cooking oil and used cooking oil was added into the specimen. From the results obtained, it shows that the trend of strength is same where the strength is started to decrease at percentage of oil is 9%. In addition the graph shows that the virgin cooking oil has the highest strength at all the level of the oil percentage except at 5% of oil inclusion.

At 5% of oil inclusion, virgin cooking oil brick has the lower strength because the bricks need more time to bind properly instead of curing duration affect the strength of the brick.

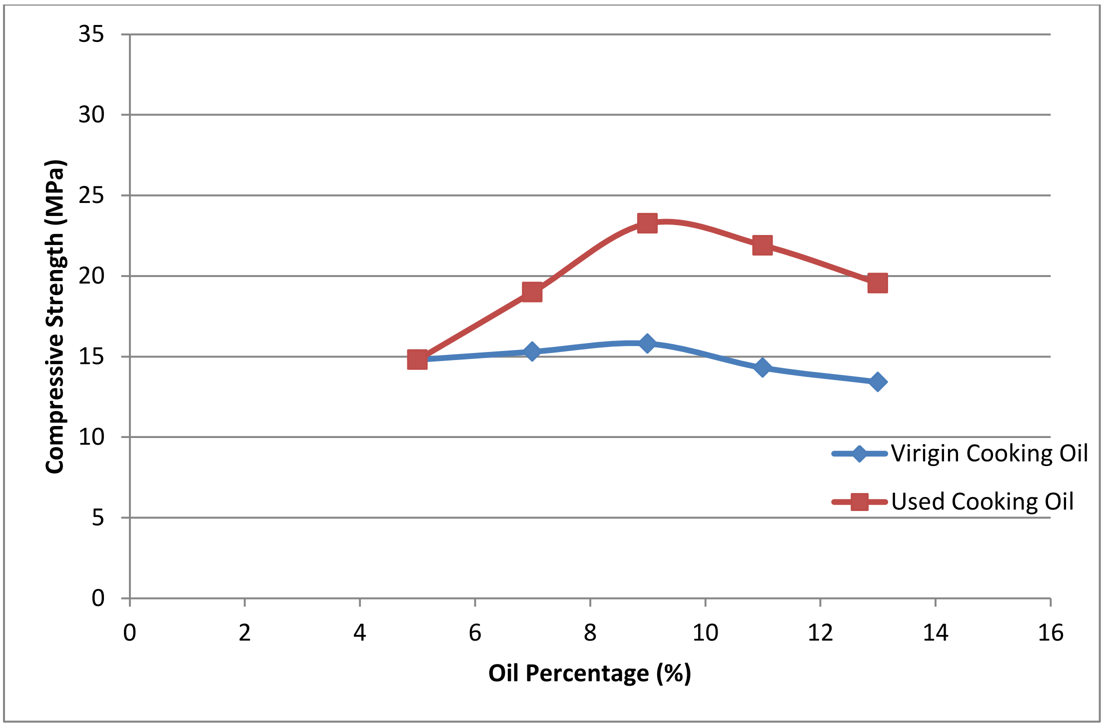

Figure 4.18 Strength of Virgin Cooking Oil Bricks and Used Cooking Oil Bricks at 48 Hours of Curing

Figure 4.18 shows the compressive strength of brick which 5%, 7%, 9 %, 11% and 13 % of virgin cooking oil and used cooking oil was added into the specimen. From the results obtained, it shows that the trend of strength is same where the strength is started to decrease at percentage of oil is 11%. In addition the graph shows that the virgin cooking oil has the highest strength at all the level of the oil percentage except at 5% of oil inclusion the strength is same which is 14.80 MPa.

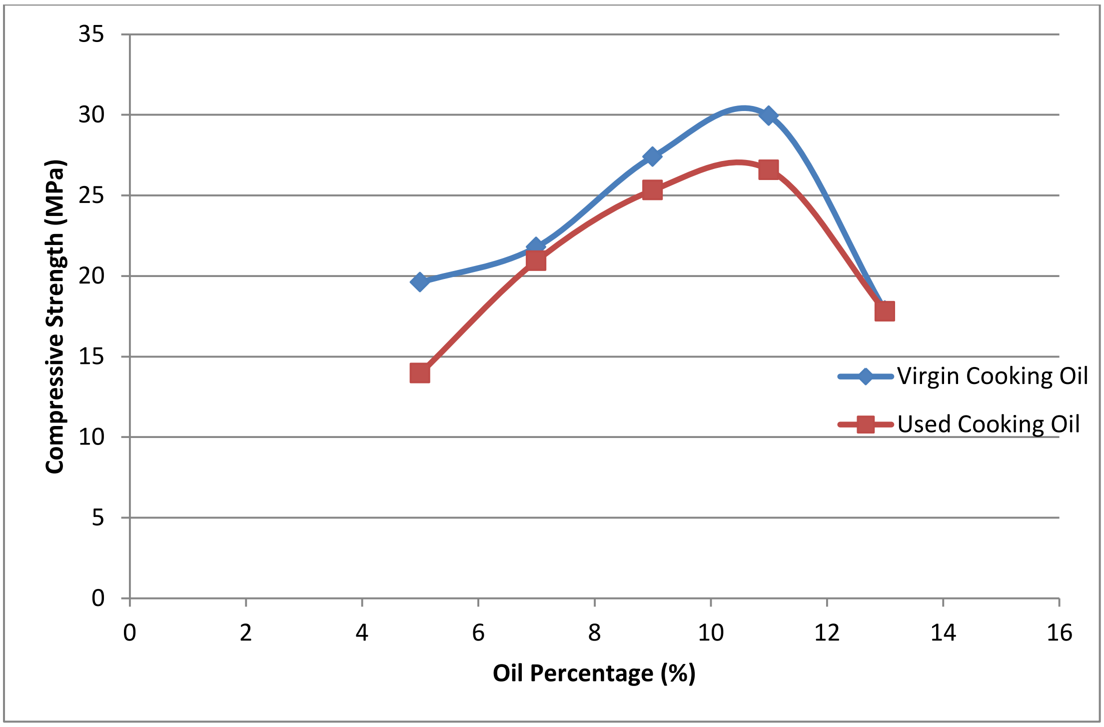

Figure 4.19 Strength of Virgin Cooking Oil Bricks and Used Cooking Oil Bricks at 72 Hours of Curing

Figure 4.19 shows the compressive strength of brick which 5%, 7%, 9 %, 11% and 13 % of virgin cooking oil and used cooking oil was added into the specimen. From the results obtained, it shows that the trend of strength is same where the strength is started to decrease at percentage of oil is 13%. In addition the graph shows that the virgin cooking oil has the highest strength at all the level of the oil percentage except at 5% of oil inclusion the strength is same which is 14.80 Mpa.

From the results, it shows that the strength of bricks is high when the curing duration is long while the strength become lower when the curing duration is short.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

As a conclusion, the target is achieved where the highest strength of brick obtained from the experiment is 26.59 Mpa for the brick made from usedcooking oil and sand. Although the highest strength comes from the brick made from cooking oil and sand, the project is to get the strength from the brick that made from used cooking oil as to sustain the environment. As the results, the brick made from used cooking oil can be introduced in the construction industry.

5.2 Recommendations

1. Vary the parameters of the coilbricks such as water absorption and initial rate of suction, bulk density and porosity.
2. Use more samples as to get the accurate data.
3. Further study on vegetable cooking oil composition

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APPENDICES

24 Hours Curing

Oil Percentage (%)	Compressive Strength (Mpa)			
	1	2	3	Data Selected
5	13.49	11.48	12.7	12.7
7	13.96	12.5	11.9	13.96
9	7.1	9.1	8.4	9.1
11	8.5	7.9	8.21	8.21
13	7.53	6.96	7.74	7.74

48 Hours Curing

Oil Percentage (%)	Compressive Strength (Mpa)			
	1	2	3	Data Selected
5	14.8	15.3	17.4	14.8
7	19	21.86	21.5	19
9	23.26	22.42	17.86	23.26
11	22.45	21.9	20.49	21.9
13	19.56	21.22	20.06	19.56

72 Hours Curing

Oil Percentage (%)	Compressive Strength (Mpa)			
	1	2	3	Data Selected
5	13.96	17.03	15.25	13.96
7	20.94	22.88	21.32	20.94
9	25.32	25.51	26.05	25.32
11	23.61	24.25	26.59	26.59
13	17.81	18.34	20.36	17.81

Compressive Strength of Used Cooking Oil Brick (Raw Datas)

24 Hours Curing

Oil Percentage (%)	Compressive Strength (Mpa)			
	1	2	3	Data Selected
5	14.2	12.4	13.7	12.4
7	15.3	14.9	15.1	15.3
9	11.8	11.3	12.2	12.2
11	9.2	10.3	9.86	10.3
13	8.42	6.56	7.98	8.42

48 Hours Curing

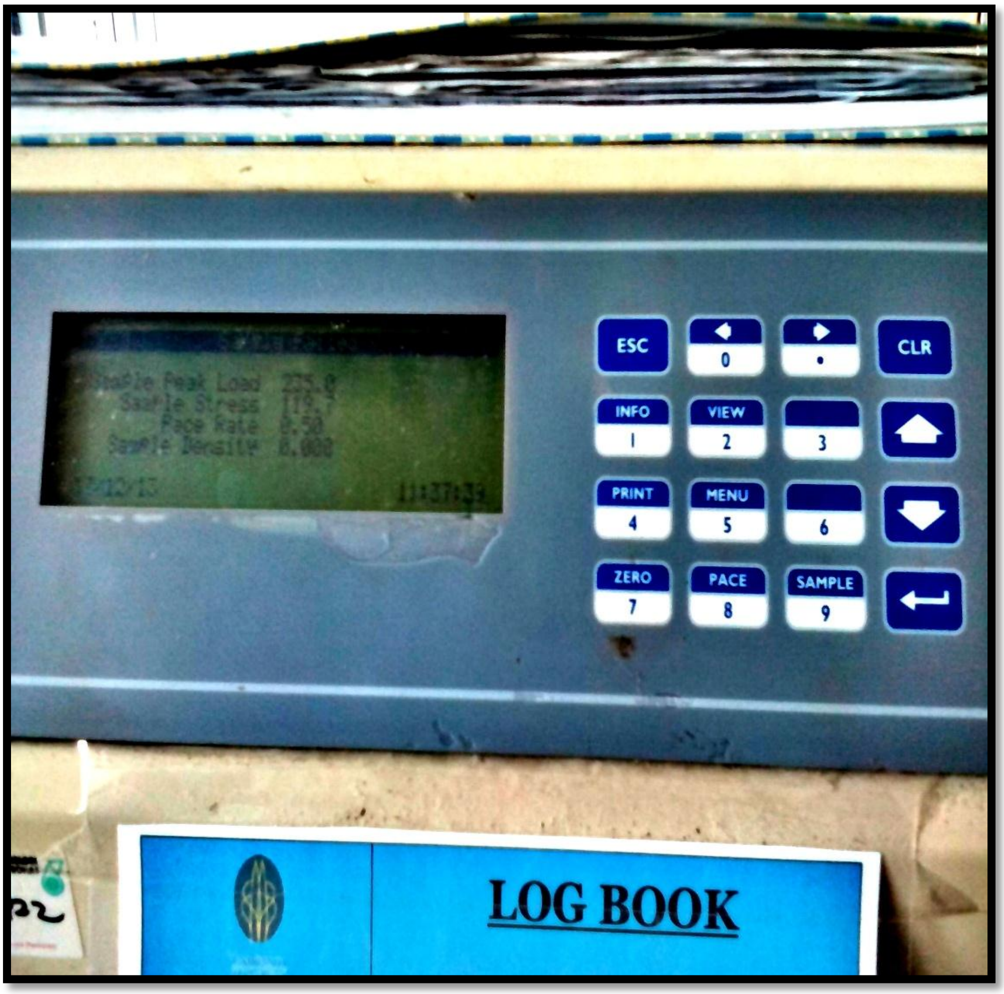
Oil Percentage (%)	Compressive Strength (Mpa)			
	1	2	3	Data Selected
5	15.9	15.2	14.8	14.8
7	16	15.9	15.3	15.3
9	15.6	14.9	15.8	15.8
11	14.3	14.27	13.96	14.3
13	13.42	13.25	12.43	13.42

72 Hours Curing

Oil Percentage (%)	Compressive Strength (Mpa)			
	1	2	3	Data Selected
5	18.5	19.6	21.2	19.6
7	21.4	22.3	21.8	21.8
9	25.6	27.4	26.9	27.4
11	26.98	28.8	29.94	29.94
13	15.46	16.88	17.85	17.85

Compressive Strength of Virgin Cooking Oil Brick (Raw Datas)

Specimen Compressive Strength Test



Example of Reading From Compressive Strength Machine