

UTILIZATION OF OIL PALM FROND(OPF) AS
A PARTIAL REPLACEMENT OF SAND IN
CEMENT SAND BRICK FOR NON-LOAD
BEARING STRUCTURE

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRACT

Cement Sand Brick is made from a mixture of cement and sand and widely used in construction industry. Rapid growing towards construction industry in Malaysia lead to high demand of sand in order to fulfil the construction materials required for many projects in one time. Therefore, Inadequate supervision and law enforcement in sand mining activities will increase the number of illegal sand mining activities that may cause water pollution, endangered the aquatic life, erosion of river bank and reducing the national sand reserve due to the uncontrolled amount of sand mining activities. At the same time the price of sand will increase due to the lack of supplies and the cost of imported sand from other country in order to fulfil the construction industry demand in a project. Hereby, some researches have been conducted to reduce the usage of sand in construction industry by replacing partial amount of sand with other suitable and organic materials. As Malaysia is one of the biggest oil palm industry in the world, a lot of agricultural waste are depleted including empty fruit branches(EFB), Oil Palm Shell(OPS), Oil Palm Trunk(OPT), Oil Palm Frond(OPF) and others which may contribute to pollution that can be used as an alternative to replace sand. By replacing sand partially with oil palm frond(OPF) sand mining and agricultural waste problem can be reduced as well as more economical and green friendly cement sand brick can be produced. This research aims to identify the suitability of oil palm frond(OPF) as a partial replacement of sand in brick manufacturing which act as sustainable non-load bearing construction material. The field of studies also cover the important parameters including compressive strength, flexural strength and water absorption. All specimens were subjected to water curing. The compression and flexural strength test has been conducted for 7,14 and 28 days after the bricks undergo water curing process and, water absorption test also conducted for 28 days after undergo water curing process and dried in the oven for 24 hours before it is being soak for another 24 hours. In terms of compressive strength, the higher the percentages of oil palm frond (OPF), the lower the compressive strength. In other hand, regarding to the flexural strength the higher the percentage of oil palm frond(OPF) the lower its flexural strength. In addition, water absorption test was conducted and found out that the higher the percentage of oil palm frond(OPF), the higher the water absorption. However, since the objective of this research is to find out the suitability of oil palm frond mix sand cement bricks to support non-load bearing structure, so it is applicable to use for non-load bearing application.

ABSTRAK

Batu bata pasir dan simen dihasilkan daripada campuran pasir dan simen dan digunakan secara meluas dalam industri pembangunan. Perkembangan pesat dalam industri pembangunan Malaysia menyebabkan permintaan yang tinggi terhadap pasir untuk memastikan bekalan yang cukup kepada permintaan bahan binaan yang diperlukan oleh banyak projek dalam masa yang sama. Oleh itu, kurang pemantauan dan penguatkuasaan dalam aktiviti perlombongan pasir akan mengakibatkan peningkatan jumlah perlombongan haram yang akan menyebabkan pencemaran air, gangguan ekosistem kehidupan akuatik dan kekurangan bekalan pasir negara akibat aktiviti perlombongan yang tidak terkawal. Dalam masa yang sama, harga pasir juga meningkat akibat kekurangan bekalan dan kos import yang tinggi daripada negara lain bagi memastikan bekalan yang mencukupi untuk keperluan sesebuah projek. Hal yang demikian, beberapa kajian telah pun dijalankan bagi mengurangkan penggunaan pasir dalam industri pembangunan dengan menggantikan sebahagian jumlah pasir dengan bahan yang sesuai dan organik. Memandangkan Malaysia merupakan salah sebuah negara yang terbesar dalam industry kelapa sawit, banyak sisa buangan pertanian yang dihasilkan termasuk tandan buah kosong(EFB), tempurung sawit(OPS), batang sawit(OPT), pelepah sawit(OPF) dan lain-lain dimana hal ini akan menyumbang kepada pencemaran walhal bahan ini boleh menjadi alternatif untuk menggantikan pasir. Dengan menggantikan sebahagian pasir dengan OPF, perlombongan pasir dan sisa buangan pertanian dapat dikurangkan serta menghasilkan produk bahan binaan yang lebih mesra alam sekitar. Kajian ini dijalankan bertujuan untuk mengenal pasti kesesuaian penggunaan pelepah sawit sebagai pengganti sebahagian jumlah pasir dalam penghasilan batu bata yang bertujuan tidak menyokong beban. Bidang pengajian juga meliputi beberapa parameter penting termasuk ujian kekuatan mampatan, ujian kekuatan lenturan dan ujian kadar penyerapan air. Semua spesimen akan melalui pengawetan air mengikut umur hari iaitu 7, 14 dan 28 hari untuk kesemua ujian. Dalam konteks ujian kekuatan mampatan, semakin tinggi peratusan OPF dalam sampel, semakin rendah kekuatan mampatan sampel. Manakala dalam konteks ujian kekuatan lenturan pula, semakin tinggi peratusan OPF dalam sampel, semakin rendah kekuatan lenturan sampel. Tambahan pula, dari hasil ujian penyerapan air pula, semakin tinggi peratusan OPF sampel, semakin tinggi penyerapan air sampel. Walaubagaimanapun, memandangkan kajian ini hanya bertujuan untuk memastikan kesesuaian pelepah sawit ke dalam campuran batu bata simen dan pasir yang bertujuan untuk menyokong struktur bahan bukan beban, maka hasil kajian ini sesuai digunakan untuk menyokong struktur bahan bukan beban.

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LIST OF SYMBOLS

%	Percentages
Mm	Millimeter
Kg	Kilogram
N	Newton
kN	Kilo Newton
Pa	Pascal
Mpa	Mega Pascal
mm²	Millimetre Square
W/C	Water Cement Ratio
°C	Celsius
µm	Micro Metre
±	Plus Minus
≤	Less or Equal Than

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
OPF	Oil Palm Frond
EFB	Empty Fruit Brunch
OPT	Oil Palm Trunk
OPS	Oil Palm Shell
RM	Ringgit Malaysia
GSG	Greenhouse Gas
OPC	Ordinary Portland Cement
MS	Malaysian Standard
OPFB	Oil Palm Frond Brick

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

One of the most highly increasing global demand is oil palm product whereas the oil palm industries keep expanding in the past decade. Oil palm is an alternative for bio-fuel and become one of the main economy boost to many countries around the world. Malaysia and Indonesia is both dominate the global palm oil market and give impact to the global oil palm industries market (Ping & Publishing, 2011). According to Malaysia Oil Palm Council(MOPC), Malaysia is one of the largest producer and exporter in the world whereas 11% of world's oils and fats production and 27% of export trade of oils and fats. Therefore, Malaysia is currently focus more on oil palm industries until every state around Malaysia have oil palm plantation to ensure the production of oil palm is sufficient to supply the global market. However, the most usage in oil palm industries is the fruit and its bunch meanwhile the oil palm frond still not widely use as much as its fruit and its bunch. In Malaysia, oil palm frond mostly used in agriculture field where it is utilise to feed ruminant animals(Wan Zahari, Abu Hassan, Wong, & Liang, 2003). It contains a lot sugar to make it suitable to feed the animals. The only oil palm frond factory exist in Malaysia is at Bukit Sagu Felda Kuantan. Malaysia does not focus much on oil palm frond since it does not bring much market to the country economy therefore a lot of oil palm frond will be a waste and some farmer use it as a composition for composed fertilizer to the oil palm tree. Hence, to support the development toward green technology in our country, oil palm frond we should innovate its uses to another fields as it is an organic material same as natural fibre. This can help to maximise the usage of

oil palm to the market of oil palm industries to the country as Malaysia is one of the largest oil palm producer and exporter of oil palm in world.

Clay brick is one of the oldest building material to make walls, pavements and other masonry construction. Nowadays, many types of brick have been invented with some modification to its characteristic according to the desired function of the brick by fulfil the requirement of the strength of the brick to carry load. Brick can be categorised by manufacture method, its use and specialised use of brick. In this industrialisation global era, a lot of country started to develop and some are already developed competing each other to build skyscraper building. Most of the building required a lot of brick consumption due to its cost and abundant in volume rather than build with other materials such as steel and timber. This will result the increment production of bricks due to the high demand in construction market. The ingredient to make a brick are 50%-60% silica (sand), 20%-30% by weight of alumina (clay) , 2%-5% by weight of lime, $\leq 7\%$ by weight of iron oxide and less than 1% of magnesia (Punmia & Jain, 2003). Bricks manufacturing from clay or fly ash will contribute to greenhouse gas emission as the manufacturing utilise cement and coal. Alternative way to overcome this problem by using natural and agro waste material as it is sustainable and economically friendly material (Joglekar, Kharkar, Mandavgane, & Kulkarni, 2018).

Rapid grow development of a country means a lot of construction progress in one time. Therefore, the demand of sand increase to prepare concrete, manufacturing of brick and other need that use sand as one of the material for the construction. As sand is non-sustainable material so it can be shortage and limited resources in future. There is a statement stated that Vietnam domestic demand for sand exceeds their total reserve for sand and it is predicted that the resources will run out by 2020 (Aurora Torres, 2017). Meanwhile, in Malaysia an environmentalist group of *Sahabat Alam Malaysia* (SAM) from Georgetown, Pulau Pinang claiming that continuous sand mining contribute to the soil degradation, erosion and reduction in water quality in the nation (The Star , 2017). Thus, to avoid this limitation of resources, sand should be replaced with any other materials that are sustainable and low cost to reduce the usage of sand as the materials of a construction.

Alternatively, in order to reduce the usage of sand in brick manufacturing oil palm frond may be suitable as a replacement because it its low density, low cost and environmental friendly which able to help to boost the economy of construction and oil palm industries in

Malaysia. However, since oil palm frond is an organic material it may decay at one time which will contribute to the failure of the structure.

There is not much research has been conducted to use oil palm frond as a replacement of sand in brick or any construction materials however some research has been conducted to enhance the decay protection of the oil palm frond(OPF). Pultrusion process introduced by Van de Velde and Kiekens by sandwiching layers of the fibre with composited fabricated and found that dimensionally stable and able to retained its mechanical properties under all aging conditions(Akil et al., 2011). The ability to prevent the oil palm frond(OPF) from decay may reduce the cost of a construction materials either its production or usage and sustainable without increasing the risk of failure in a structure. Thus, using oil palm frond(OPF) as a replacement of sand in construction materials such as bricks may be an alternative solution to replace sand which is non-sustainable material that is widely use nowadays with more economical and environmental friendly.

1.2 PROBLEM STATEMENT

Department of Mineral and Geoscience Malaysia reported that in 2011-2015 there are obvious increment to the production and consumption of sand and gravel in Malaysia whereas in 2015 stated the highest amount of production and consumption which are 40.58% and 40.69% respectively (Report & Report, 2017). The statistic shows that increase demand of sand in Malaysia every year due to the rapid development of the country. In 2015, it was estimated around 7544 projects awarded in Malaysia worth RM 142 billion and 7244 of it done in 3 years and approximately 300 projects left to complete in 2018 (Malaysia, 2016). Example of high impact projects that are currently on going which are believe can be a booster to the future Malaysia economy growth, the 2300km of Pan Borneo Highway Project located in Sabah and Sarawak, the 300km Central Spine Road in Pahang, East Coast Rail Line (ECRL), Mass Rapid Transit 2 (MRT 2) and High Speed Rail Kuala Lumpur-Singapore. Within this mega projects in our country still on going and many more upcoming projects may contribute to the increasing demand of sand and construction material such as brick. Increasing number of sand mining and conventional bricks manufacturing may lead to the limitation and lack of resources of sand in future.

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