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ASH AS PARTIAL CEMENT REPLACEMENT IN
MORTAR BRICK

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THE POTENTIAL OF CALCIUM CARBONATE AS ADDITIVE AND
MICROWAVED SEWAGE SLUDGE ASH AS CEMENT REPLACEMENT IN
MORTAR BRICK

MUHAMMAD AIZAT BIN AZED

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

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JUNE 2016

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LIST OF SYMBOLS

%	Percent
mm	Millimetre
mm ²	Millimetre square
m ³	Cubic metre
µm	Micro metre
g	Gram
kg	Kilogram
kg/m ³	Kilogram per cubic metre
N/mm ²	Newton per square millimetre
kN	Kilo newton
°C	Degree Celsius
°	Degree
kN/sec	Kilo newton per second
W _{SA}	Weight of saturated samples measured in the air
W _{SW}	Weight of saturated samples measured in water
W _d	Weight of oven dry samples measured in the air
θ	Theta
cps	Count per second
x	Times

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
BS	British Standard
MS	Malaysian Standards
IWK	Indah Water Konsortium
MSSA	Microwaved Sewage Sludge Ash
ESP	Egg Shell Powder
i.e.	That is
e.g.	For example

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ABSTRACT

The production of sewage sludge from waste water treatment plant is also increasing every year. Its high content of heavy metal were harmful and must be dump in proper way in land fill to prevent pollution that will affect the soil condition surroundings. Furthermore, eggshell in Malaysia has founded as one of the valuable wastage that not being utilized usefully. Research found that Calcium Carbonate (CaCO_3) found in eggshells giving hardness and strength to things. Approximately 94% of a dry eggshell is calcium carbonate. Nowadays, as the construction industries develop rapidly, the demand of cement sand brick has also increased. This will lead to increased cement production and emission of carbon dioxide because the cement industry one of the major contributor of carbon dioxide emission in the world. Hence, this research is helping in reducing the pollution and usage of cement with replacing cement partially with the sewage sludge ash (SSA), and also helping reducing the waste to environment by using eggshell powder as additive to increase the strength of the brick mortar. The sewage sludge is incinerated in the microwave with medium high temperature for 30 minutes and grind into powder form while the dry eggshell is only grind into the powder form after 24hour of drying process under the sun. Four different percentages of eggshell powder and 10% fixed of SSA are used to test the brick mortar in term of compressive strength, flexural strength and also water absorption. The XRD test was also carried out to investigate the composition of eggshell powder and also microwaved SSA (MSSA). Results shows that the eggshell powder with 5% and 10% MSSA is the most optimum percentage with highest flexural and compressive strength, with lowest water absorption compared to control samples

ABSTRAK

Pengeluaran enapcemar kumbahan dari loji rawatan air sisa meningkat setiap tahun. Kandungan logam berat yang tinggi adalah berbahaya dan mesti dilupus dengan cara yang betul dalam mengisi tanah untuk mengelakkan pencemaran yang akan menjejaskan persekitaran keadaan tanah. Tambahan pula, kulit telur di Malaysia telah terbukti sebagai satu pembaziran yang berharga yang tidak digunakan. Penyelidikan mendapati bahawa Kalsium Karbonat (CaCO_3) yang terdapat di kulit telur memberi kekerasan dan kekuatan untuk sesuatu. Kira-kira 94% daripada kulit telur yang kering adalah kalsium karbonat. Pada masa kini, kerana industri pembinaan berkembang dengan pesat, permintaan bata campuran simen juga turut meningkat. Ini akan membawa kepada peningkatan pengeluaran simen dan pelepasan karbon dioksida kerana industri simen salah satu penyumbang utama pelepasan karbon dioksida di dunia. Oleh itu, kajian ini membantu dalam mengurangkan pencemaran dan penggunaan simen dengan menggantikan simen sebahagiannya dengan ketuhar gelombang mikro abu enapcemar kumbahan, dan juga membantu mengurangkan pembaziran kepada alam sekitar dengan menggunakan serbuk kulit telur sebagai bahan tambahan untuk meningkatkan kekuatan mortar bata. Enapcemar kumbahan dibakar dalam ketuhar gelombang mikro dengan suhu yang tinggi sederhana selama 30 minit. Manakala kulit telur yang kering dikisar menjadi serbuk selepas 24jam proses pengeringan di bawah matahari. Empat peratusan yang berbeza serbuk kulit telur dan 10% tetap SSA digunakan untuk menguji mortar bata dari segi kekuatan mampatan, kekuatan lenturan dan juga penyerapan air. Ujian XRD juga telah dijalankan untuk menyiasat komposisi serbuk kulit telur dan juga abu enap cemar gelombang mikro. Keputusan menunjukkan bahawa serbuk kulit telur dengan 5% dan 10% MSSA adalah peratusan yang paling optimum dengan lenturan yang tinggi dan kekuatan mampatan, penyerapan air rendah berbanding sampel kawalan

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

For sustainable development, wastes should be recycled, reused, and channeled towards the production of value added products. This is to protect the environment on one side and on the other side to obtain value added products. The utilization of the waste is a priority today in order to achieve sustainable development.

Eggshell in Malaysia has founded as one of the valuable wastage that not being utilized usefully. Through many research found that Calcium Carbonate (CaCO_3) found in eggshells giving hardness and strength to things. Approximately 94% of a dry eggshell is calcium carbonate and has a typical mass of 5.5 grams. The chemical composition (by weight) of by product eggshell has been reported as follows: calcium carbonate (94%), magnesium carbonate (1%), calcium phosphate (1%) and organic matter (4%) (Stadelman, 2000).

Otherwise, sewage sludge plant industries in Malaysia also facing the same problem as they produce 5 million m^3 of sewerage sludge waste per year. The main problem is that this sewage waste can pollute the environment. In recent years sewage waste production has increased alarmingly. One of the most common solid waste disposal means is in controlled landfills. However, space limitations on existing landfill sites and problems of waste stabilization (Andac and Glasser, 1998, Lombardi et al., 1998 and Diet et al., 1998) have prompted investigation into alternative disposal routes.

In other experimental work, it is reported that Sewage Sludge Ash (SSA) behaves as an active material, producing and increase of compressive strength compared to control mortar, probably due to pozzolanic properties of SSA. It should be noted that high sulfur content of SSA ($\%SO_3 > 10$) seems to have little influence on compressive strength of mortars containing SSA. Thus, this is the right time in transforming the wastes into high value product and also finding the cheapest and strongest brick have ever been invented. This situation will contributes to the decreases of solid waste generates and could led to production of economical building materials. The present research is about the use of eggshells and sewage sludge in production of brick.

1.2 PROBLEM STATEMENT

During this period of time in Malaysia, The food industry generates huge amount of eggshell waste every year. Eggshell is an agricultural waste largely considered as useless and is discarded mostly because it contributes to pollution (Abdulrahman et al., 2014). Eggshell which is a byproduct of the aviculture industry has been highlighted recently because of its reclamation potential. Unfortunately, most eggshell waste is discarded in landfills without further processing. It is known that eggshell waste contains valuable organic and inorganic components which can be utilized in commercial products by creating new value in these waste materials. This study presents a useful eggshell powder as cement replacement in brick production for construction used.

Furthermore, sewage plant industry also facing the same wastage problem as bakery and food industry in Malaysia. The exceeded amount of wastage gives a huge problem in dumping the waste without effecting the environment and polluted to nature. Of the constituents removed by effluent treatment, sludge is by far the largest

in volume, therefore its handling methods and disposal techniques are a matter of great concern. Without a reliable disposal method for the sludge the actual concept of water protection will fail. Utilization of sludge as an addition to construction and building material including building bricks, lightweight artificial aggregates, and cement-like materials is a win-win strategy because it not only converts the wastes into useful materials but it also alleviates the disposal problems (Weng et al. 2003).

1.3 OBJECTIVES

This study was conducted to achieve the following objectives:

- i) To investigate the compressive strength of bricks containing various percentage of calcium carbonate and fixed percentage of sewage sludge as cement replacement.
- ii) To investigate flexural strength of the brick containing various percentage of calcium carbonate and fixed percentage of sewage sludge as cement replacement.
- iii) To investigate water absorption of the brick containing various percentage of calcium carbonate and fixed percentage of sewage sludge as cement replacement.
- iv) To study the characterization of the chemical composition in the Microwaved Sewage Sludge Ash (MSSA) and Egg shell powder (ESP).

1.4 SCOPE OF STUDY

This research will study the properties of the brick mixture when it contains various percentage of calcium carbonate containing fixed percentage of sewage sludge as partial cement replacement. The percentage of the calcium carbonate (CaCO_3) varies from 0%, 5%, 10%, 15% by weight. The sludge used was 10% weight, fixed for every sample and sieved before mix with another component.