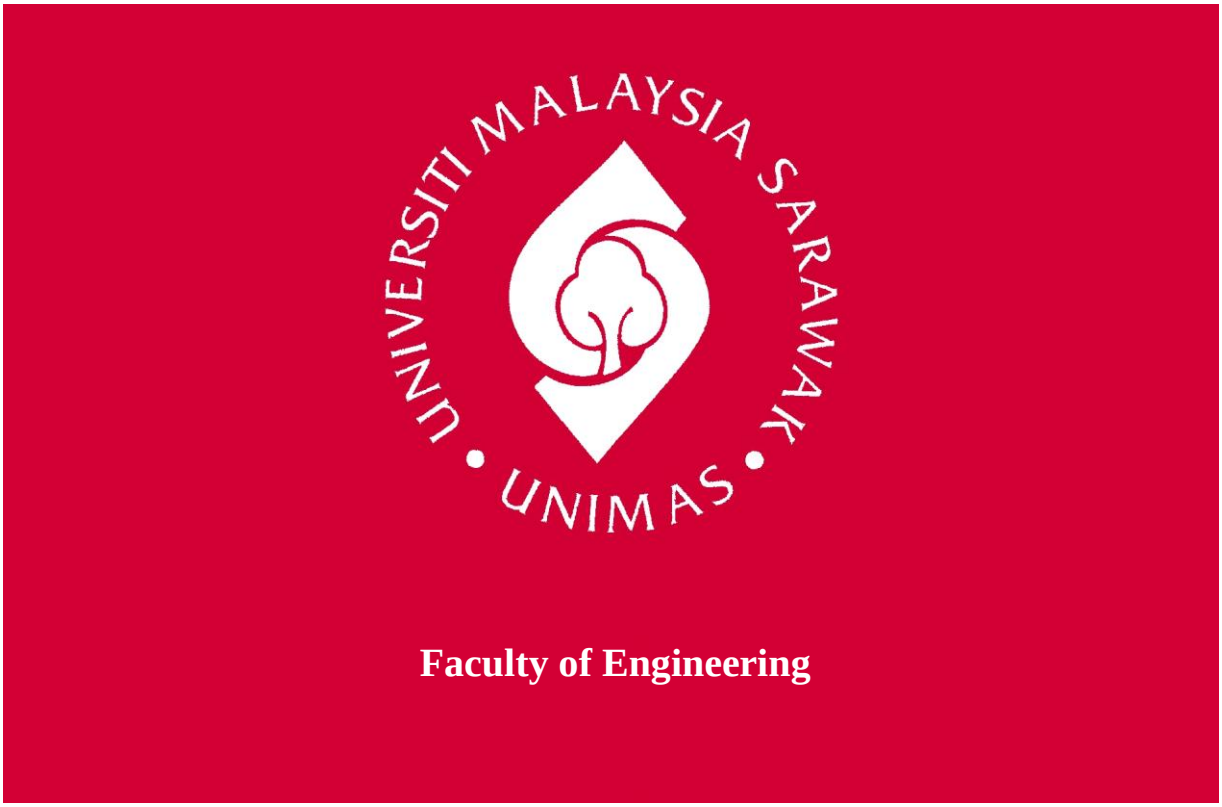

THERMAL CONDUCTIVITY OF LIGHTWEIGHT CONCRETE WITH ADMIXTURES

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THERMAL CONDUCTIVITY OF LIGHTWEIGHT CONCRETE WITH ADMIXTURES

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This project is submitted in partial fulfillment of
the requirements for the Degree of Bachelor of Engineering with
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ABSTRAK

Kajian ini memaparkan satu kajian mengenai konkrit berjisim rendah yang diguna pakai sebagai bahan binaan yang mengandungi simen, pasir, *expanded polystyrene,* dan sisa bahan buangan contohnya seperti *fly ash, silica fume, rice husk* dan *sawdust*, dimana bahan ini bertindak sebagai campuran tambahan di dalam nisbah campuran konkrit. Konduktiviti haba dan ketumpatan sampel-sampel telah dikaji. Konduktivity haba ialah unit ukuran untuk mengenal pasti ke-berkesanan sesuatu bahan membenarkan haba mengalir melaluinya. Berdasarkan keputusan yang diperolehi, ia menunjukkan bahawa nilai konduktiviti haba akan berkurangan dengan penambahan bahan sisa buangan ke dalam ratio campuran konkrit berjisim rendah. Bahan buangan tersebut memenuhi keperluan asas untuk penghasilan bahan penebat untuk bahan binaan, ia boleh digunakan sebagai dinding, lantai dan atap. Maka, dengan penemuan ini, ia menunjukkan bahan buangan tersebut mempunyai potensi yang baik dalam pembinaan kos rendah. Akhir sekali, selain menjadi bahan penebat yang baik, ia juga merupakan bahan yang dapat menjimatkan penggunaan tenaga untuk sesebuah bangunan dan merupakan salah satu cara alternatif untuk mengguna pakai bahan buangan daripada industri bagi mengurangkan pencemaran.

ABSTRACT

This research presents an investigation of a new lightweight concrete for construction materials which composed of cement, sand, expanded polystyrene, and wastage materials such as fly ash, silica fume, rice husk and sawdust which react as admixtures in the mix proportion. Thermal conductivity and density of the samples will be investigated. Thermal conductivity is a measure of the effectivity of the material in transmitting heat through it. The result obtained shows that the thermal conductivity value reduces with the increment addition of wastage materials in the lightweight concrete mix proportion. The wastages satisfy the basic requirement of insulation for construction materials and could be used for wall, slab and roof. Hence, with this finding it shows that it has good potential for development progress for low cost construction. Finally, apart of being a good insulation materials which save energy consumption for the building, this research also has provide an alternative to reused the wastage from the industries in order to reduce the rate of pollution.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Malaysia is one of the developing countries which are still depending on the usage of concrete materials on their building constructions. Several reasons on choosing concrete as the main construction materials are due to the cost of concrete materials which is more economical and affordable compare to the steel materials. Unlike steel structures, concrete structures can be designed with a fire resistance factor. Besides that, Malaysia generates its own sources of cements and aggregates. By taking the construction cost, concrete characteristic and its availability in Malaysia into consideration, it shows that Malaysia is a country which still depending on the concrete materials in their building constructions.

The constituent materials in producing concrete are cement, coarse aggregates, fine aggregates, water and admixtures. All these ingredients are mixed well together and molded into the desired shapes and sizes. The mixture will harden with respect to time. The hardening process is caused by the reaction between the water and cement (Somayaji, 1995).

In order to obtain a good quality of concrete, several properties of concrete need to be achieved. Important properties that need to be reached are; concrete are much stronger in compressive strength compare to tensile strength where the compressive strength is not less than 15.5N/mm^2, to enable it to resist tensile stresses the concrete are reinforced with steel bars or wire netting (Mosley *et al*, 2007), minimum shrinkage take place during the hardening process, density of the concrete are adequately about 24kN/m^3, sufficiently hard and provide enough resistance to abrasion, adequately durable to resist environmental attacks, have a minimum thermal expansion as to provide good resistance to fire, sufficient impermeability or water tightness to avoid the steel inside the concrete corrode and cause structure failure, and finally the concrete should have minimum creep effect (Rajput, 2000).

In this research, four different admixtures gain from wastage such as fly-ash, silica fume, sawdust, and rice husk will be added into the concrete. An admixture is a material added to batch immediately before or during its mixing and used to improve or gives special properties to fresh concrete or hardened concrete and should only be

considered for use when the admixtures can produce the required effects more economically or required effects cannot be made by varying the mix proportion and composition of the basic constituent materials (Jackson and Ravindra, 1996). The admixture is generally added in a relatively quantity from time to time to ensure that no excessive quantity of admixture that may be detrimental to the properties of concrete (Rajput, 2000).

Basically, study in concrete is more concentrate on the strength and characteristic properties of the materials. As the global energy issues become one of the main agenda, the thermal conductivity factors should be taken into the considerations. The study on thermal conductivity of lightweight concrete and mortar will be carried out in this project. Generally lightweight concrete can be defined as concrete which the density is less than 2000kg/m^3 and made in densities down to about 160kg/m^3 (Everett, 1994). Constituent materials used for producing lightweight concrete are water, cement, lightweight aggregates and, admixtures. As for mortar, constituent materials used are water, cement, and fine aggregate which is sand and lime (Somayaji, 1995). The different between mortar and lightweight concrete is on the constituent material used where the mortar only used sand as its fine aggregates in the mix. This will make the strength of lightweight concrete is greater than the mortar, but both materials possess a good insulating property to provide the thermal comfort to the occupants in the building. These two materials normally used to produce bricks and blocks for construction.

A material such as brick is the most commonly material used in building constructions. Normally it will be used as walls, columns, under-floors, roofs, etc. The procedure of installing the bricks is very simple, so that the brickwork can be carried out by the non-skill labourers and it does not require finishing work. Bricks are made by suitable clay and used to replace stones at the construction area if the stones are limited. The advantages of bricks are; it is lighter than stone, absorbs less heat comparatively to stone and overall cost of manufacture less than stone materials (Rajput, 2000). As for blocks, the sizes are bigger and can be laid more quickly than bricks. Usually blocks are intended to be rendered or plastered but concrete blocks are sufficiently regular in shapes and sizes and otherwise of good appearance without plaster for walling. Both bricks and blocks possess high insulating property and good resistance to fire (Everett, 1994).

According to (Hilton, 1994), heats from the environment which transferred into the building will cause discomfort to the user. As an engineer, it is important to have knowledge on thermal conductivity and thermal resistance. For instant, engineer must know the thermal conductivity for each material they use in the structure in order to specified the heating and cooling equipment to avoid thermal bridging. A thermal bridge can be defined as a portion of the building envelope that has the lowest of overall thermal resistance and has a higher thermal conductivity than the surrounding materials of the building envelope.

1.2 BACKGROUND OF STUDY

Nowadays, the world temperature is increasing gradually due to global warming and green gas effects. Malaysia also affected by this phenomenon so called climate change. Malaysia's climate can be classified as tropical with high temperatures, high humidity and heavy rainfall. Air temperatures are uniformly high throughout the year with a mean maximum of 29˚ to 32˚C in the day and a mean minimum of 22˚ to 24˚C at night in the coastal areas. Average annual rainfall is between 250cm to 300cm (Lim, 1987).

With the global warming issues rising up as a continuing problem, energy efficiency is becoming a higher priority for many areas of industry. Study on low thermal conductivity materials is significant to improve the insulation of the buildings structures and can be the mode to reduce the energy efficiency problems. To overcome this problem, study on various lightweight concrete mix proportions with admixtures will be carried out.

Since thermal conductivity is a study to determine the heat transfer in a material, this aspect is crucial in construction industries. By considering this factor, the thermal bridge in a building can be avoided and bring comfort to the users. There are three methods of thermal conductivity measurement; steady state method, transient method and heat flow meter method.

Heat flow meter (HFM) method is the main focus in this project. Heat flow meter method is a comparative technique which has advantages over the two other method mentioned. Advantages of using this method is considerably faster than steady state method, no guarding and estimation of heat loss is necessary as the heat flow through the specimen is measured directly. This method also is suitable for a wide range of materials and specimen thickness as it not requires sophisticated control or measurement equipment as transient method (Hilton, 1994).

In order to measure the thermal conductivity of the lightweight concrete, Hilton B480 will be used to provide an accurate and easy technique to determine the thermal conductivity value (k) of a wide range of materials used in the buildings for insulation purposes. This machine unit is based on ISO8301 and incorporates a heat transfer.

In this study, the lightweight concrete samples which consist of waste admixtures react as insulation materials such as sawdust, rice husk, fly ash and silica fume will be tested using this machine in order to determine the thermal conductivity value (k) of the materials. It is expected to give a low thermal conductivity value and can be used as significant insulation materials in the future construction.

1.3 PROBLEM STATEMENT

This project aims is to study on the thermal conductivity on the lightweight concrete which contain waste admixtures in different mix proportion which possess high insulating property. By supporting the government scheme which encourages the public to recycle their waste, it will bring improvement on the environmental and economical condition.

In this project, the thermal conductivity of lightweight concrete materials will be determined by varying the mix proportion of the concrete which consist of different admixtures. Besides that, the thickness of the lightweight concrete samples in this study will be cast into the size of 300mm x 300mm x 60mm in order to measure the thermal conductivity value (*k*).

a. Heat transfer in different mix proportion of lightweight concrete

In this study, six different types of mix proportion will be used to determine the thermal conductivity value of the concrete.

b. Heat transfer in different admixtures of concrete

To carried out this project, there are four admixtures will be added in the mixture to determine the thermal conductivity value of the materials. The admixtures that will be used are stated below:

i. **Fly ash**
ii. **Silica fume**
iii. **Rice husk**
iv. **Saw dusk**

c. Heat transfer in different densities of lightweight concrete

Besides testing on the different mix proportions and admixtures, the value of thermal conductivity of concrete will be obtained by testing the lightweight concrete samples with the different densities using the heat flow meter machine.

1.4 AIM AND OBJECTIVES

Aim of the study;

This project aims is to study on the thermal conductivity on the lightweight concrete which contain waste admixtures in different mix proportion which possess high insulating property.

The objectives of this project are;

a. To determine the thermal conductivity value (*k*) of lightweight concrete which containing waste admixtures and mortar.

b. To compare the thermal conductivity value (*k*) of the samples based on the ratio of mix proportions.

c. To compare the thermal conductivity value (*k*) of the samples based on the admixture used.

d. To suggest the most suitable mix design and admixtures for concrete usage in Malaysian climate.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this literature review chapter was to investigate on the thermal conductivity value of a lightweight concrete samples which consist of waste materials that are used to reduce the cement ratio in the mix design. Research on the properties of waste materials used as admixtures in the lightweight concrete such as fly-ash, silica fume, rice husk and sawdust will be included in this chapter. Study on the previous research need to be carried out and make an effort to relate the studies to the objectives that have been mention from the previous chapter.

2.2 THERMAL CONDUCTIVITY

Thermal conductivity can be defined as a fundamental property of a material that gives the rate of thermal conduction when the heat is transmitted through the materials. Experimentally, thermal conductivity is measured by placing the material in contact between two conducting plates and measuring the energy flux based on temperature gradient. Normally, heat is being transferred by all three mechanisms which are conduction, radiation and convection (Binay, 2001).The thermal conductivity value is denoted by the symbol (*k*), it is a measure of ability of material to conduct heat. For the materials with good conductors it will give a higher value of thermal conductivity (Cengel and Boles, 2002). The value of thermal conductivity of a material can be obtain from the reference books, internet, or by the manufacturer's of the material itself. It has been observed, in general, materials of low density provide a better thermal insulation compare to those with higher density.

According to Cengel and Boles (2002), conduction can be defined as the transfer of energy from the more energetic particles of a substance to the adjacent less energetic particles as a result of interaction between the particles. This process can take place either in solid, liquid or gas. In liquids and gases, conduction is due to collision of molecules occurs in random motion. Meanwhile, conduction in solid is due to the combination of vibrations of molecules in a lattice and the energy transport by free