STUDY THE MECHANICAL PROPERTIES OF LIGHTWEIGHT CONCRETE SLAB USING POLYSTYRENE

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WAN AHMAD HAMIDI BIN WAN MOHD ABD KALAM

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

Faculty of Civil Engineering and Earth Resources
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JUNE 2016

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LIST OF ABBREVIATIONS

OPC	Ordinary Portland Cement
EPS	Expanded Polystyrene Beads
LWC	Lightweight Concrete
SIRIM	Standards and Industrial Research Institute of Malaysia

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ABSTRACT

Nowadays, polystyrene was widely used as food and manufacturing production equipment as packaging tools to absorb vibration during handling and transportation process. It is estimated that it produced large amount of wastes as it abundantly used in the market. Due to its lightweight characteristics, it has potential to serve as aggregates replacement of coarse aggregates. Thus, a study of concrete made of polystyrene beads as aggregates was carried out. Through this study, the mechanical properties of polystyrene can be determined whether it is good or not when replace it as aggregate in the concrete. The main objective of this study is to determine the mechanical properties of the lightweight concrete slab using polystyrene. Several tests were conducted to determine the compressive strength, flexural strength, deformation and also crack pattern of the slabs. There were nine samples of slabs were constructed which consist of three different ratio,1:3:0(Control) ,1:2:1 and 1:1.75:1.25.Each ratio consists of three samples. All the samples were concreted and tested at Heavy Structure Laboratory Universiti Malaysia Pahang (UMP). From the compression test, the strength of the two ratio were lower than strength of the control. That is mean it meet the required characteristic of the study. The average load of control sample is the highest which is 81.84kN.Meanwhile the average load for ratio 1 and ratio 2 were 52.19kN and 51.59kN, respectively. For the deflection, the control sample also got the highest value which is 6.60mm. While ratio 1 and ratio 2 were 3.10mm and 1.90mm, respectively. The load and deflection are decrease due to the increasing amount of polystyrene. Besides, the type of crack and failure such as shear failure, compression failure and also tension failure also determined in this study. In a nutshell, polystyrene beads(EPS) can be used as aggregate replacement in the concrete. Overall of the study showed that the mechanical properties of lightweight concrete mainly influenced by the content of polystyrene beads and the strength decrease with the increase of the polystyrene content.

ABSTRAK

Pada zaman sekarang, polistirena telah digunakan secara meluas dalam makanan dan alatan pembuatan sebagai alat pembungkusan untuk menyerap getaran ketika proses pengurusan dan penghantaran. Ia dianggarkan telah menghasilkan terlampau banyak bahan buangan selepas digunakan di pasaraya. Disebabkan ciri-ciri ringannya, ia mempunyai potensi menjadi pengganti agregat kasar. Setelah itu, satu kajian mengenai konkrit yang diperbuat daripada polistirena sebagai agregat telah dijalankan.. Melalui kajian ini, sifat-sifat mekanik polistirena dapat ditentukan sama ada ia bagus atau tidak apabila ia digantikan sebagai agregat di dalam konkrit. Objektif utama dalam kajian ini ialah untuk mengenalpasti sifat-sifat mekanik lantai konkrit ringan apabila polistirena digunakan. Beberapa ujian telah dijalankan untuk mengenalpasti kekuatan mampatan, kekutan lenturan dan juga bentuk rekahan lantai tersebut. Terdapat sembilan sampel lantai telah dibuat yang mana telah dibahagikan kepada tiga nisbah yang berbeza,1:3:0(Kawalan).1:2:1, dan 1:1.75:1.25. Setiap nisbah ada tiga sampel. Semua sampel telah dibuat dan diuji di Makmal Struktur Berat Universiti Malaysia Pahang (UMP). Daripada ujian mampatan, kekuatan kedua-dua nisbah adalah lebih rendah daripada kekuatan nisbah kawalan. Itu bermaksud ia memenuhi ciri-ciri yang diperlukan dalam kajian. Purata beban sampel kawalan adalah yang paling tinggi iaitu 81.84kN. Sementara itu, purata beban untuk nisbah 1 dan nisbah 2 adalah 52.19kN dan 51.59kN. Untuk pesongan, sampel kawalan juga mempunyai nilai yang paling tinggi iaitu 6.60mm. Sementara itu,nilai nisbah 1 dan nisbah 2 ialah 3.10mm dan 1.90mm. Beban dan pesongan menurun apabila jumlah polistirena meningkat. Selain itu, jenis rekahan dan kegagalan seperti kegagalan ricih, kegagalan mampatan dan juga kegagalan ketegangan juga dikenalpasti dalam kajian ini. Kesimpulannya, polistirena (EPS) boleh digunakan sebagai agregat di dalam konkrit. Kesuluruhan kajian menunjukkan bahawa sifat-sifat mekanik konkrit ringan dipengaruhi oleh kandungan polistirena dan kekuatan menurun dengan meningkatnya kandungan polistirena.

CHAPTER 1

INTRODUCTION

1.1 Background of Research

In many countries, due to the increasing cost of raw materials and the continuous reduction of natural resources, the use of waste materials is a potential alternative in the construction industry. Waste materials, when properly processed, have shown to be effective as construction materials and readily meet the design specifications. The continued and expanding extraction of natural aggregate is accompanied by serious environmental problems. Often it leads to irremediable deterioration of rural areas, since quarrying of aggregates alters land topography and causes other potential problems, such as erosion. The artificial aggregates from industrial and post-consumer wastes are not only adding extra aggregate sources, but also reduce environmental pollution.

Therefore, polystyrene beads will be used in this study instead of course aggregates. As we know, polystyrene is a thermoplastic that is designed for applications requiring excellent electrical and mechanical properties together with good process ability. Polystyrenes have well-balanced physical properties and are generally transparent, but available in various colours. Moreover, Polystyrene is lightweight but

extremely strong once rendered and offers high insulation and thermal properties, termite resistance and fire retardant capabilities.

Expanded polystyrene (EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are comprised of about 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water.Therefore, it has a good sound and thermal insulation characteristics as well as impact resistance. Expanded polystyrene beads are often used as the basis for packaging material. This leads to a large amount of waste material which is not biodegradable. This material could be granulated and used as a lightweight aggregate for concrete.

Figure 1.1: Polystyrene beads

Lightweight concrete (LWC) is one of the important materials in construction industry because of the practical and economic advantage of it. The essential characteristic of LWC is its porosity , which results in low apparent specific gravity .In concrete construction self-weight represent a very large portion of the load on the structure , and there are considerable advantages in reducing the density of concrete .

Furthermore, LWC reduces the cost of form work and steel and it also increases productivity. Concrete which has lower density also gives better thermal insulation than ordinary concrete. There are many advantages to be gained from the use of lightweight concrete. These include lighter loads during construction, reduced self-weight in structures, and increased thermal resistance .Lightweight concrete is generally accepted as concrete having a density of about 1800 kg/m3 or less.

Figure 1.2: Lightweight concrete using polystyrene beads (EPS)

1.2 Problem Statement

Nowadays, the raw materials such as aggregates cost are expensive due to lack of sources or hard to produce the aggregates, especially when the request from industries too much. So, this automatically can affect the whole cost of building and it will increase the problem towards owner.

As we know, slab is an important part in a building and it must be strong enough to resist loads from other parts of structures. If the slab is not strong and sturdy, the deflection will occur when loads are applied or landed on the slab. This will collapse the building and risk the others. Concrete is a form when cement, fine aggregate, coarse aggregate and water were mixed together. In addition, concrete commonly used in construction to construct beam, slab, column and other needs like tiling and finishing. Unfortunately, the normal concrete is heavy, rigid and hard to handle during installation and it can cause many problems during the construction.

Moreover, concrete is known as a brittle material with a low capacity for deformation under tensile stress. The development of these tensile stresses may be a result of mechanical loading, harmful reactions and environmental loading. Cracks that can adversely affect the performance of concrete result frequently from these stresses. Cracking is one of the most common defects observed in reinforced concrete structures.

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