EFFECT OF COCONUT FIBER AND EGG ALBUMEN IN CONCRETE FOR GREENER ENVIRONMENT

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ABSTRACT

This paper is to study the effect of the coconut fiber and egg albumen to the properties of the concrete such as the compressive strength, flexural strength and the drying shrinkage. In this study, a total of 54 cubes (150mm x 150mm x 150 mm) and 54 prisms (100mm x 100mm x 500 mm) were prepared according to three types of mixture and all these samples were cured under two curing conditions which were air and water curing for 7 days, 14 days and 28 days. The three types of concrete mixture were concrete containing 0.1% coconut fiber and 1% egg albumen (mix A), concrete containing 0.5% coconut fiber and 5% egg albumen (mix B) and concrete control sample. From the data analyses showed that both the additives of coconut fiber and egg albumen with concrete in different percentage show improvement in the development of the strength. In water and air curing condition, it shows that the samples in the water curing possess higher strength compare to the air curing samples. But, the strength achieved by the additive in the concrete was still lower than the control concrete. By comparing concrete containing 0.1% coconut fiber and 1% egg albumen with concrete containing 0.5% coconut fiber and 5% egg albumen, the strength of the lower percentage additive was higher than the higher percentage of additive. This can be conclude that, 0.5% coconut fiber and 5% egg albumen was not too capable to be used but there may be some condition that suit or need for such percentage.

ABSTRAK

Kajian ini mengetengahkan tentang kesan serabut kelapa dan telur putih terhadap sifat – sifat konkrit seperti kekuatan mampatan, kekuatan lenturan dan pengecutan kering. Dalam kajian ini, sejumlah 54 kiub (150mm x 150mm x 150 mm) and 54 prisma (100mm x 100mm x 500 mm) disediakan dalam tiga bentuk campuran berbeza dan diawetkan dalam dua keadaan pengawetan iaitu pengawetan udara and pengawetan air untuk 7 hari, 14 hari dan 28 hari sebelum pengujian. Tiga bentuk campuran konkrit tersebut ialah tambahan konkrit dengan 0.1% serabut kelapa dan 1% telur putih (campuran A), tambahan konkrit dengan 0.5% serabut kelapa dan 5% telur putih (campuran B) dan sampel konkrit kawalan. Daripada data yang dianalisis, ia menunjukkan bahawa kedua – dua aditif iaitu serabut kelapa dan telur putih dengan konkrit dalam peratusan berlainan menunjukkan peningkatan dalam kekuatan. Dalam pengawetan udara dan air, sampel dalam pengawetan air menunjukkan kekuatan yang lebih tinggi berbanding dengan sampel dalam pengawetan udara. Tetapi kekuatan yang dicapai oleh aditif dengan konkrit masih rendah daripada konkrit kawalan. Perbandingan antara tambahan konkrit dengan 0.1% serabut kelapa dan 1% telur putih dan tambahan konkrit dengan 0.5% serabut kelapa dan 5% telur putih menunjukkan kekuatan yang dicapai oleh peratusan aditif yang rendah adalah lebih tinggi daripada peratusan aditif yang tinggi. Ini dapat disimpulkan bahawa tambahan konkrit dengan 0.5% serabut kelapa dan 5% telur putih adalah tidak sesuai untuk digunakan tetapi mungkin terdapat beberapa keadaan yang sesuai atau keperluan untuk peratusan tersebut.

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LIST OF ABBREVIATION

Mix A	-	Concrete added with 0.1% coconut fiber and 1% egg albumen
Mix B	-	Concrete added with 0.5% coconut fiber and 5% egg albumen
FKASA	-	Fakulti Kejuruteraan Awam dan Sumber Alam
kg/m^3	-	kilogram per meter cube
N/mm^2	-	Newton per millimeter square
BS	-	British Standard
ASTM	-	American Society for Testing and Materials
7d	-	7 days
mm	-	millimeter
UMP	-	Universiti Malaysia Pahang
BSI	-	British Standard Institution
^oC	-	Celsius
kg	-	kilogram
MR	-	Modulus of Rupture
MPa	-	Mega Pascal

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Concrete is a mixture of four materials which are Portland cement, water, fine aggregate (sand) and coarse aggregate (gravel or crushed stone). Concrete hardening is not caused by evaporation or drying but as results from a chemical reaction which is hydration between Portland cement and water. The history of the concrete can be traced back as early as the third century B.C. where the Romans used it to construct temples and other buildings where the concrete was made from lime, broken stones and sand. In this study, the coconut fiber was added into the concrete to observe the effect of the coconut fiber on the concrete's flexural strength, compressive strength and drying shrinkage. According to M. Brahmakumar *et al.* (2005), there are many advantages by using plant fiber. Some of the advantages are low cost, low density, acceptable specific strength, good thermal insulation properties, reduced tool wear, renewable resource and recycling possible without affecting the environment.

Beside coconut fiber, egg albumen also added into the concrete to test its strength and performance. Egg albumen contains high percentage of protein composition which influenced the cement properties when both were added together. For this study, the egg albumen was blended to make it become foam before added into the concrete mixing process which increased the strength of the concrete. According to Chandra S. And Aavik J. (1987), proteins inside the egg albumen acted as the air entraining agents in the cement.

1.2 Problem Statement

A large amount of agricultural waste was disposed in most of tropical countries especially in Asia for countries like Thailand, Philippine and Malaysia. According to a survey conducted by the *Agricultural Ministry of Malaysia*, there are about 156,000 hectares of coconut plantation in Peninsular Malaysia alone. If the waste cannot be disposed properly it would lead to social and environmental problem. Utilized these disposed material was one method of treating the agricultural waste from waste to wealth. The used of coconut fiber from the dispose of coconut shell could be a useful material in the formation of an admixture for housing construction. In Malaysia, egg albumen also was a waste material from the bakery factory where most of the bakery just used egg yolk for their product. Egg albumen that discarded from the bakery really was a waste because it can increase the strength and reduced the density of the concrete. But this waste is not fully utilised by the construction company for their project because the lack of research using egg albumen. Besides that, in all over the world, concrete is a major materials used because the materials needed by the concrete are available in most part of the world and it does not required any complex or expensive equipment to make it. Concrete is used all over the world to make pavement, architectural structure, pipe, foundations, roads, bridges, parking structures, brick/block wall and many more. By comparing concrete with other man-made materials in the world, it had shown that concrete is used more

and about 7.5 cubic kilometres of the concrete are made each year according to Bjorn Lomborg.

1.3 Objective

The objectives of this study are as listed below:

i. To investigate the effect of coconut fiber and egg albumen in concrete under flexural and compressive strength.
ii. To investigate the cracking pattern.
iii. To study the curing condition of coconut fiber and egg albumen in concrete.

1.4 Scope of Work

For the flexural test, it is using prism mould with the dimension of 500mm x 100mm x 100mm and for compressive test, the size of the cube is 150mm x 150mm x 150mm. The number of samples that needed for the use of this study was shown in Table 1.1. There were three types of samples that been prepared for this study, Sample I was concrete added with 0.1% of the coconut fiber and 1% of egg albumen (Mix A), Sample II was concrete added with 0.5% coconut fiber and 5% of egg albumen (Mix B) and the Sample III was just concrete as the control sample. The tests that were carried out for this study were flexural test, compressive test and drying shrinkage test which would be performed at the Concrete Laboratory of Civil Engineering (FKASA Lab). The mix ratio for this study was 2:3:0.6 (sand: cement: water) and the density of the concrete used was 2400 kg/m^3 with the concrete strength of 25 N/mm^2. The materials used in this study were coconut fiber, egg albumen, sand, cement, coarse aggregate, water, and plywood. The standards used for this study were BS1881-5:1970, BS 4551: Part 1:1998 for flexural test, ASTM C 293 for centre-point loading, BS 812-120:1989 for testing aggregates, method for testing and classifying drying shrinkage of aggregates in concrete, BS 1881-

116:1983 for determination of compressive strength of concrete cubes and ASTM C1148 - 92a(2008) Standard Test Method for Measuring the Drying Shrinkage.

Table 1.1: Number of Samples and Test

Percentage		0.1% Coconut Fiber + 1% Egg Albumen + Concrete (Mix A)			0.5% Coconut Fiber + 5% Egg Albumen + Concrete (Mix B)			Concrete (Control)		
Test	**Curing**	7d	14d	28d	7d	14d	28d	7d	14d	28d
Flexural Test	Air	3	3	3	3	3	3	3	3	3
	Water	3	3	3	3	3	3	3	3	3
Drying Shrinkage	Air	3	3	3	3	3	3	3	3	3
	Water	3	3	3	3	3	3	3	3	3
Total Samples		**108 Samples**								

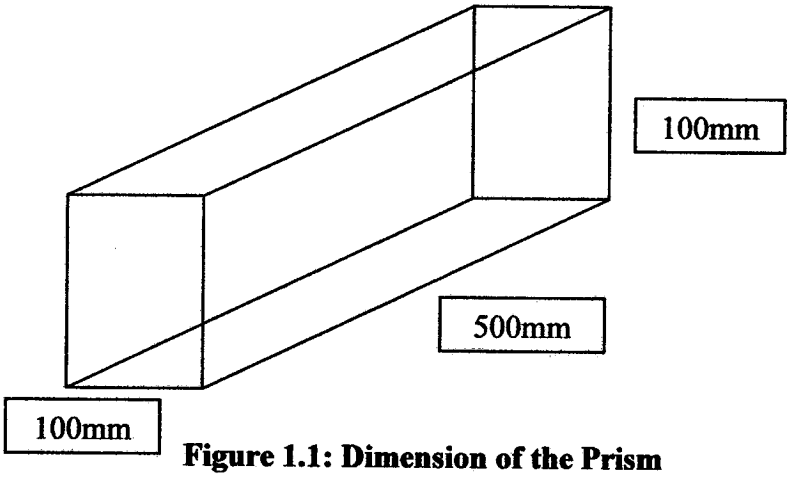

Figure 1.1: Dimension of the Prism

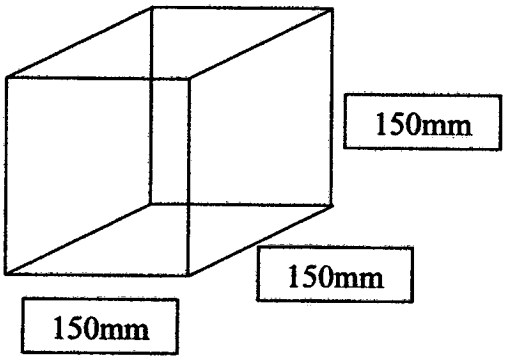

Figure 1.2: Dimension of the Cube

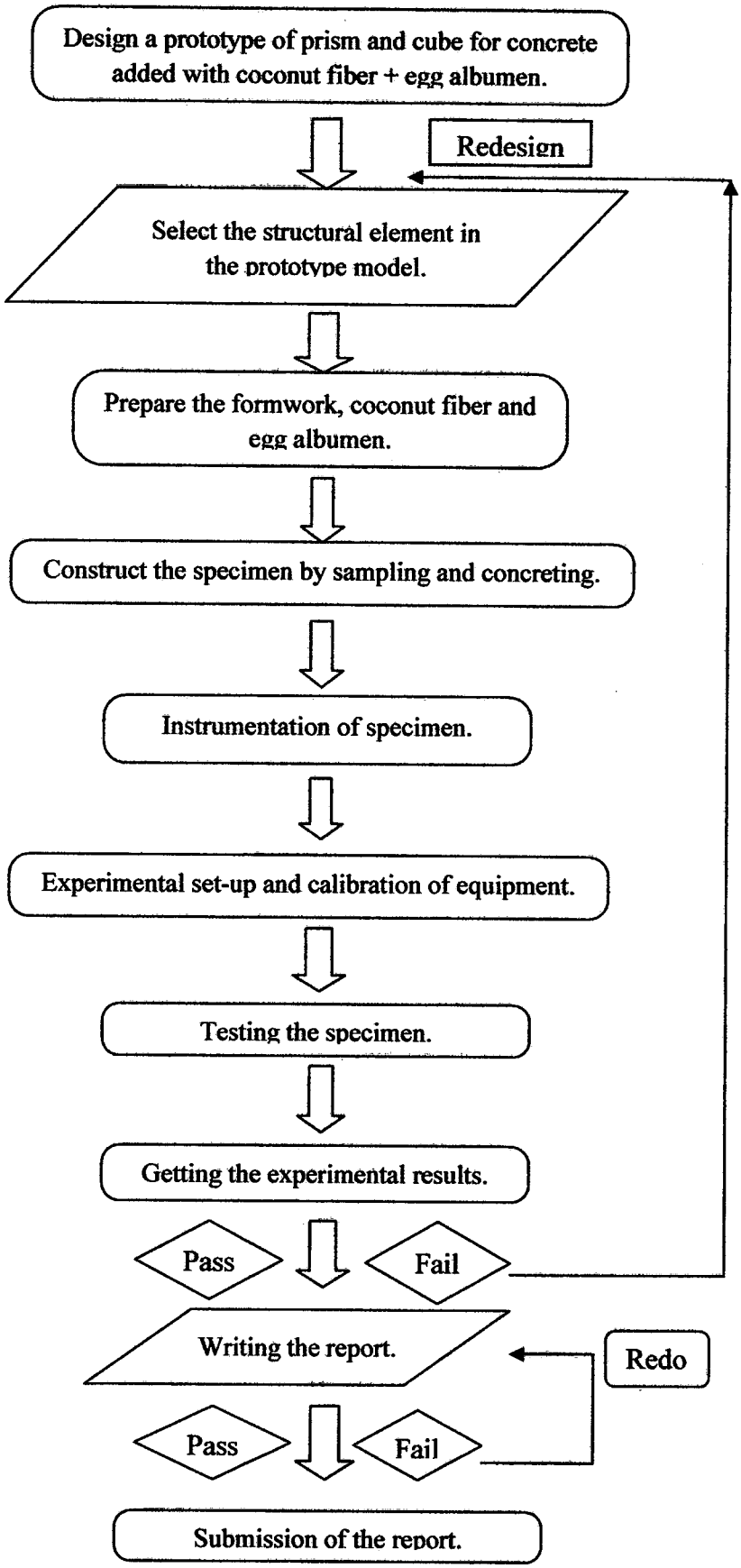

Figure 1.3: Flow Chart of Study

1.5 Significant of Study

The main purpose of this study was to utilise waste to wealth where coconut fiber and egg albumen were added into the concrete so that it increase the strength of the concrete. The advantages of using waste material like coconut fiber and egg albumen were that they can be reused without affecting the environment. By reusing, that mean the waste would be less and it improve the environment of the earth. Beside strength, coconut fiber also can help in reducing the cracking in the concrete and egg albumen can reduced the density of the concrete. Moreover, the curing also affects the strength of the concrete and this point was investigated.

1.6 Summary

This study was carry out to investigate the effect of 0.1% coconut fiber + 1% egg albumen and 0.5% coconut fiber + 5% egg albumen on concrete flexural and compressive strength and drying shrinkage. Besides that, this study was also to identify the effectiveness of the coconut fiber and egg albumen in the concrete to achieve high strength, high durability, high quality and performance. And lastly, by using coconut fiber and egg albumen to utilise them from waste to wealth which mean reusing, this can reduce the waste produced from industry and then improved the environment of the earth.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discussed previous study related to the effect of the coconut fiber and egg albumen on concrete in term of the engineering properties of the concrete, egg albumen and coconut fiber. Besides that, this chapter also reviews the performance of the concrete, egg albumen and coconut fiber in the existing application.

2.2 Introduction to Concrete

Nowadays, the concrete was the most widely used man-made construction material in mostly every type and size of engineering and architectural structure all around the world. Concrete major used were for buildings, columns, beams, roofs, floor slabs, foundation walls, footings, staircases, sidewalks, paving, highways, bridges and the list go on. Concrete was widely used all around the world because of its advantages which are fireproof, watertight, economical and easy to make. Besides

that, it also offers surface continuity and solidity which it was bond with other materials.

2.2.1 Historical of Concrete

According to H.L.Simmons (2007), the usage of concrete can trace back as early as third century B.C. where the Romans were using concrete made with lime, broken stones and sand to built temples and other buildings. First, the surface of the concrete was left rough and finished it with a form of stucco. Later on, they began to produce a decorative finish by embed small stones in the concrete surface. Finally, they incorporated broken terra cotta roof tiles by embedding it at the outer surface of the concrete and this led to the manufacture of the clay bricks.

After the collapse of the Roman Empire, the concrete technology was fall into disuse and was remained unknown until the time of Renaissance. Around 15th century, '*De architectura*', the book series written by Roman architect and engineer Marcus Vitruvius Pollio became a famous object to be study. But it was until the end of 18th century where the research of the concrete technology was resumed and by the year of 1824, the essential ingredient in the modern concrete was just discovered.

2.3 Limitation of Concrete

According to U.S. Department of Army (1999), there were some limitations of the concrete where the concrete causes cracking and other weaknesses in the structural that detract from the appearance, serviceability, and useful life of the concrete structure.

2.3.1 Low Tensile Strength

Concrete is good at compressive strength but not in tensile strength. So, concrete members which subjected to the tensile stress must be reinforced with the steel bars to prevent cracking and failure during construction.

2.3.2 Thermal Movements

When the concrete was setting and hardening, the heat of hydration would raises the concrete temperature and then it gradually cools. The changes in the temperature can cause early cracking and severe thermal strains. Besides that, concrete that hardened would be expands and contracts when there were changes in the temperature. So, to prevent this kind of failure, expansion and contraction joints must be provided in the concrete structures.

2.3.3 Dying Shrinkage and Moisture Movements

When concrete was dry and harden, it would shrinks and when concrete getting wet and dry, it would be expands and contracts. These kinds of movements would cause unsightly cracks and control joints must be provided. For preventing drying shrinkage, the surface of the newly lay concrete must be kept moist continuously during the curing process. Meanwhile, when the concrete was hard enough, moisture was applied so that it would not damage the concrete's surface.

2.4 Fresh Concrete

A fresh concrete was a concrete in the relatively fluid state and readily to be molded but the shape of the fresh concrete would slowly change if the mold was immediately removed. The fresh concrete mixed would kept all the grains of the sand and gravel encased and held in place where it was called homogeneous. The quality and characteristic of the finish product normally influence by the degree of the plasticity and significant changes in the mix proportions would affect the plasticity of the concrete. Below here were the properties of the fresh concrete according to T.W.Love and U.S. Department of Army (1999):

2.4.1 Workability

Workability stands for the relative ease or difficulty when placing and consolidating the concrete in the formwork. By using slump test, the consistency of the mixture can be measured and can be maintained as necessary for us to obtain the required workability that we needed for the specific condition and method of placement. To have a low slump, a very stiff mixed was required and it was desirable for many uses. The workability was controlled by the amounts and proportion of the fine to course aggregate used with a given quantity of the paste.

2.4.2 Non Segregation

A fresh concrete should be handle with care when mixing and compacting so that there would be minimum of segregation and the mixture would be remain homogeneous. Besides that, care must also be taken in handling so that it can prevent bleeding of the concrete. For example, fresh concrete should not be drop or free fall from more than 3 to 5 feet high to prevent the segregation to occur and cannot be transported over a very long distances without a proper agitation.

2.4.3 Uniformity

The uniformity was determined by how accurate the ingredients were proportioned and mixed according to the specifications. Each batch of the concrete used must be proportioned and mixed exactly the same way so that to ensure the total structural mass had uniform structural properties. Besides that, the uniformity of the fresh concrete was important because it would affect the economy and strength considerations.

2.5 Hardened Concrete

Hardened concrete was the end product for any concrete design. By referring to the book with the title of 'Concrete Technology' written by M.L.Gambhir, the most important properties of the hardened concrete were its strength, stress-strain characteristic, shrinkage and creep deformation, permeability and durability. The concrete strength was the greater significance because it was related to the structure of the hardened cement paste and given the overall picture for the quality of the concrete. The strength of the hardened concrete at a given age and under a given curing condition was mainly depending on the water-cement ration and the degree of the compaction.

2.5.1 Strengths of Concrete

According to the book by T.W.Love and U.S. Department of Army (1999), the strength of the concrete is where the concrete ability to resist the load in the compression, flexural or shear. The strength of the concrete was mainly determined by the water-cement ratio. By allowing additional water into the mixing process means to thin the paste and to allow it to coat more particles. But, if the water was too much, then it would affect the concrete's strength by reducing it due to the dilution of the paste.

2.5.1.1 Compressive Strength

There were various strengths of concrete but the determination of the compressive strength was the most important because the primary meant of the concrete is to withstand the compressive stresses. The strength of the concrete was influenced by the specimen size and shape, the method of the pore formation, water content, characteristics of the ingredients used, direction of the loading and the method of curing (Valore RC, 1954). Jones MR and McCarthy A (2006) reported that small changes in the water-cement ratio would not affect the strength of the foam concrete if compare to the normal weight concrete. Meanwhile, when the water-cement ratio become higher, it would increase the strength of the foam concrete just opposite to the conventional concrete where entrapped air content is just only a few percentage by volume.

2.5.1.2 Flexural and Tensile Strength

The use of flexural tensile strength was to estimate the load where the concrete members maybe crack (M.L.Gambhir). As mention by Valore RC (1954), the ratio of the flexural strength to the compressive strength of the concrete is in the range of 0.25-0.35. By comparing normal foam concrete with normal aggregate concrete, the splitting tensile strengths of the normal concrete is higher than the foam concrete. The flexural tensile strength at the failure or in the other word, modulus of rupture was useful in the design of the pavement slabs and also airfield runway. According to M.L.Gambhir, the result of the flexural strength were mainly affected by the size of the specimens, the casting methods, curing and moisture conditions, manner of loading and the rate of the loading. The strength estimated by the flexural test was higher than the tensile strength of the concrete.

2.5.2 Creep of Concrete

As mentioned by M.L.Gambhir, the creep was cause by the increased of the strain in the concrete with the time under sustained stress. Creep and shrinkage were occurring simultaneously and it was assumed to be the additive for the simplicity. The relaxation of the creep takes place when a loaded concrete specimen was being subjected to a constant strain and the creep decreases the stress progressively with the time. The rate of the creep was decreases with the time. There are many factors that influencing the creep which were the types of aggregate, admixtures, cement, mix proportions, mixing time and consolidation, age of the concrete, level of the sustained stress, temperature and the size of the specimen.

2.5.3 Durability of Concrete

Durability in the concrete was meant that the ability of the hardened mass to withstand the effects of the natural and chemical elements such as the action of the wind, snow, frost and ice, and the chemical reaction of the soils, or the effects of the salts and abrasion. The durability of the concrete would decrease when the water-cement ratio was increased correspondingly (T.W.Love). When the concrete structures were expected to last longer than five years and above the durability of the concrete should be a very strong consideration. According to M.L.Gambhir, there was one characteristic that would influenced the durability of the concrete which was its permeability to the ingress of water, oxygen, carbon dioxide, chloride, sulphate and other potentially deleterious substances.