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

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ABSTRACT

This study was to investigate the effect of coconut fiber and egg albumen on mortar compressive and flexural strength. The purpose of adding coconut fiber into the mortar was due to coconut fibers had a good performance in controlling cracking in mortar whereas egg albumen act as a foam which rich in protein to strengthen the mortar. In this study, total 108 samples were prepared which were 54 cubes (150mm x 150mm x 150mm) and 54 prisms (100mm x 100mm x 500mm). 3 type of samples were tested to compare the strength development of each others that was mortar control, mortar containing 0.1% coconut fiber + 1% egg albumen (mix A) and mortar containing 0.5% coconut fiber + 5% egg albumen (mix B) . The data show that the strength of mortar added with coconut fiber and egg albumen had improved. The strength of mortar added with additive shows higher strength in water curing conditions compared to the air curing conditions. The strength of mortar containing 0.1% coconut fiber + 1% egg albumen was higher than the mortar control whereas the mortar containing 0.5% coconut fiber + 5% egg albumen was lower strength than the mortar control. Therefore, the mortar containing 0.1% coconut fiber and 1% egg albumen was more suitable added in the mortar and had a better performance in water curing and the mortar containing 0.5% coconut fiber + 5% egg albumen does not encourage to be used as an additive in mortar due to its strength was lower than the mortar control.

ABSTRAK

Kajian ini ialah untuk menyiasat kesan serat kelapa dan telur putih kepada mortar dalam kekuatan mampatan dan kekuatan lenturan. Tujuan menambah serat kelapa ke dalam mortar adalah kerana serat kelapa mempunyai prestasi yang baik untuk mengawal keratakan mortar sedangkan telur putih bertindak sebagai busa yang kaya dengan protein untuk meguatkan mortar. Dalam kajian ini, sejumlah 108 sampel disediakan iaitu 54 kiub(150mm x 150mm x 150mm) dan 54 prisma (100mm x 100mm x 500mm). 3 jenis sampel akan diuji untuk membandingkan pembangunan kekuatan sesama diri iaitu mortar kawalan, mortar yang mengandungi 0.1% serat kelapa + 1% telur putih (campuran A) dan mortar yang mengandungi 0.5% serat kelapa + 5% telur putih (campuran B). Data menunjukkan kekuatan mortar campur dengan serat kelapa dan telur putih telah meningkat. Kekuatan mortar yang ditambah dengan aditif menunjukkan kekuatan yang lebih tinggi dalam keadaan pengawetan air berbanding dengan pengawetan udara. Kekuatan mortar mengandungi 0.1% serat kelapa + 1% telur putih lebih tinggi daripada mortar kawalan sedangkan mortar mengandungi 0.5% serat kelapa + 5% telur putih adalah lebih rendah daripada mortar kawalan. Oleh yang demikian, mortar mengandungi 0.1% serat kelapa + 1% telur putih adalah lebih sesuai ditambah dengan mortar dan mempunyai persembahan yang lebih baik di dalam pengawetan air dan mortar mengandungi 0.5% serat kelapa + 5% telur putih tidak digalakkan untuk diguna sebagai aditif dalam mortar kerana kekuatannya lebih rendah daripada mortar kawalan.

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LIST OF ABBREVIATION

ASTM	-	American Society for Testing and Materials
%	-	percent
BS	-	British Standard
mm	-	millimeter
d	-	days
°C	-	degree Celcius
<	-	less than
cm^3	-	centimeter cube
m^3	-	meter cube
kg	-	kilogram
MPa	-	Mega Pascal

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Mortar was a combination of Portland cement, a clean, well graded aggregate, such as sand, and enough water. Mortar was a workable paste used to bind construction blocks together like stone, brick, cinder blocks and fill the gaps between them. Based on ASTM C270, there were four types of mortar specified for use in the United State which are M, S, N, and O. Mortar types were identified by either proportion or property specifications, but only by one of these, not both. The specification of mortar proportion indicated by the combination Portland cement, masonry cement, hydrated lime and the aggregate. In other way, the mortar types classified under property specifications were based on the compressive strength, durability and workability.

According to a survey conducted by the Agricultural Ministry of Malaysia, there were about 156,000 hectares of coconut plantation in Peninsular Malaysia alone. There was an enormous potential waste of coconut fibers that can be utilized for construction industry especially in the production of new material. Coconut fibers can be considered

as waste materials and it can bring the waste to wealth where it can become an additive in mortar to increase the physical strength of mortar. In this study, the coconut fiber was added into the mortar to observe the effect of the mortar compressive and flexural strength. The type of failure and pattern of cracking were observed after the compression test. Egg white was the common name for the clear liquid and it also called the albumen. The egg white contains approximately 40 different proteins, the main components of the egg white in addition to water. The egg white can create a foam by physically stress of beating the egg white. In this study, the egg white protein in foam formation was added into the mortar to increase the strength of mortar and decrease the density of mortar. In addition, the cement properties would be influenced by the egg albumen which contains high protein composition when biopolymer- added cement composition with egg albumen. Based on the S. Chandra and J. Aavik (1987), proteins used work as air entraining agents in cement mortar.

1.2 Problem Statements

Mortar was used extensively in construction today and it was an important part of any masonry project because mortars have some strength, to resist weathering and ensure long-term durability. Masonry was commonly used for the walls of buildings, retaining walls and monuments. Most of tropical countries in Asia such as Malaysia, Philippine, and Thailand disposed a large amount of agricultural waste. In this condition, if the waste did not disposed properly, it would lead to social and environmental problem. As a solution, utilized those of the disposed material was one of the effective methods of treating the agricultural waste. In this study, the used of coconut fiber can be an additive in the mortar to increase its strength and control its cracking appearance. From the bakery factory, egg albumen was a waste material; they usually discarded the egg albumen since the bakery mostly used egg yolk for their bakery. In this case, the egg

albumen which considered as waste materials was useful for our research that we need to add the foam of egg albumen inside mortar to increase its strength and thus decreasing its density. But the construction company would not use this kind of method due to the lack of research using this egg albumen.

1.3 Objective

The objectives of this study were:

i. To investigate the effect of coconut fiber and egg albumen in mortar under flexural and compressive strength.
ii. To observe the type of cracking on mortar.
iii. To study the curing condition of coconut fiber and egg albumen in mortar.

1.4 Scope of Work

During the laboratory work, the 0.1% coconut fiber + 1% egg albumen and 0.5% coconut fiber + 5% egg albumen added into mortar. Total 108 samples were prepared for testing and compared, 36 samples for 0.1% coconut fiber + 1% egg albumen added with mortar (Mix A), 36 samples for 0.5% coconut fiber + 5% egg albumen added with mortar (Mix B) and 36 samples for normal mortar. The compression test and flexural test were tested on the samples for 7, 14 and 28 days after the curing process. The drying shrinkage test was tested on samples every day. The materials used during the experiment were cement, water, fine sand, formwork, egg albumen and coconut fiber. The mix ratio for these specimens were 5:1:0.6 (sand, cement, water) and the 0.1% coconut fiber + 1% egg albumen and 0.5% coconut fiber + 5% egg albumen were added into the mix. The standards used for this study were ASTM C270, Standard

Specification for Mortar for Unit Mansory, and BS EN 1015-11:1999, Determination of Flexural and Compressive strength of hardened mortar. For the compressive test, it was using cube mould with the dimension of 150mm x 150mm x 150mm which was shown by Figure 1.1 whereas the dimension for prism was 100mm x 100mm x 500mm which was shown by Figure 1.2. The number of samples that needed for the use of this study was shown in the Table 1.1. Figure 1.3 shows the flow chart of this study.

Table 1.1: Number of Samples and Tests

Samples		**0.1% Coconut Fibre + 1% egg albumen + mortar (Mix A)**			**0.5% Coconut Fibre + 5% egg albumen + Mortar (Mix B)**			**Mortar (Control)**		
Test	**Curing**	7d	14d	28d	7d	14d	28d	7d	14d	28d
Compression Test	Air	3	3	3	3	3	3	3	3	3
	Water	3	3	3	3	3	3	3	3	3
Flexural test	Air	3	3	3	3	3	3	3	3	3
	Water	3	3	3	3	3	3	3	3	3
Total Samples		**108 Samples**								

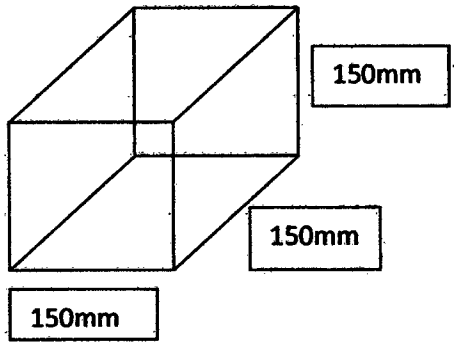

Figure 1.1: Dimension of the Cube

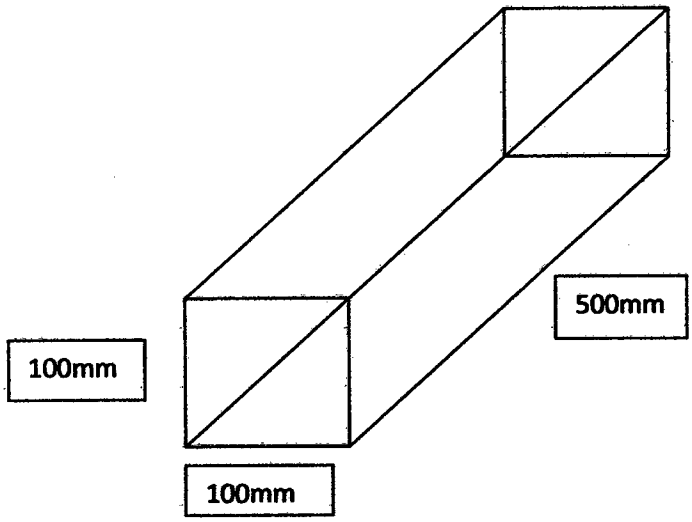

Figure 1.2: Dimension of the Prism

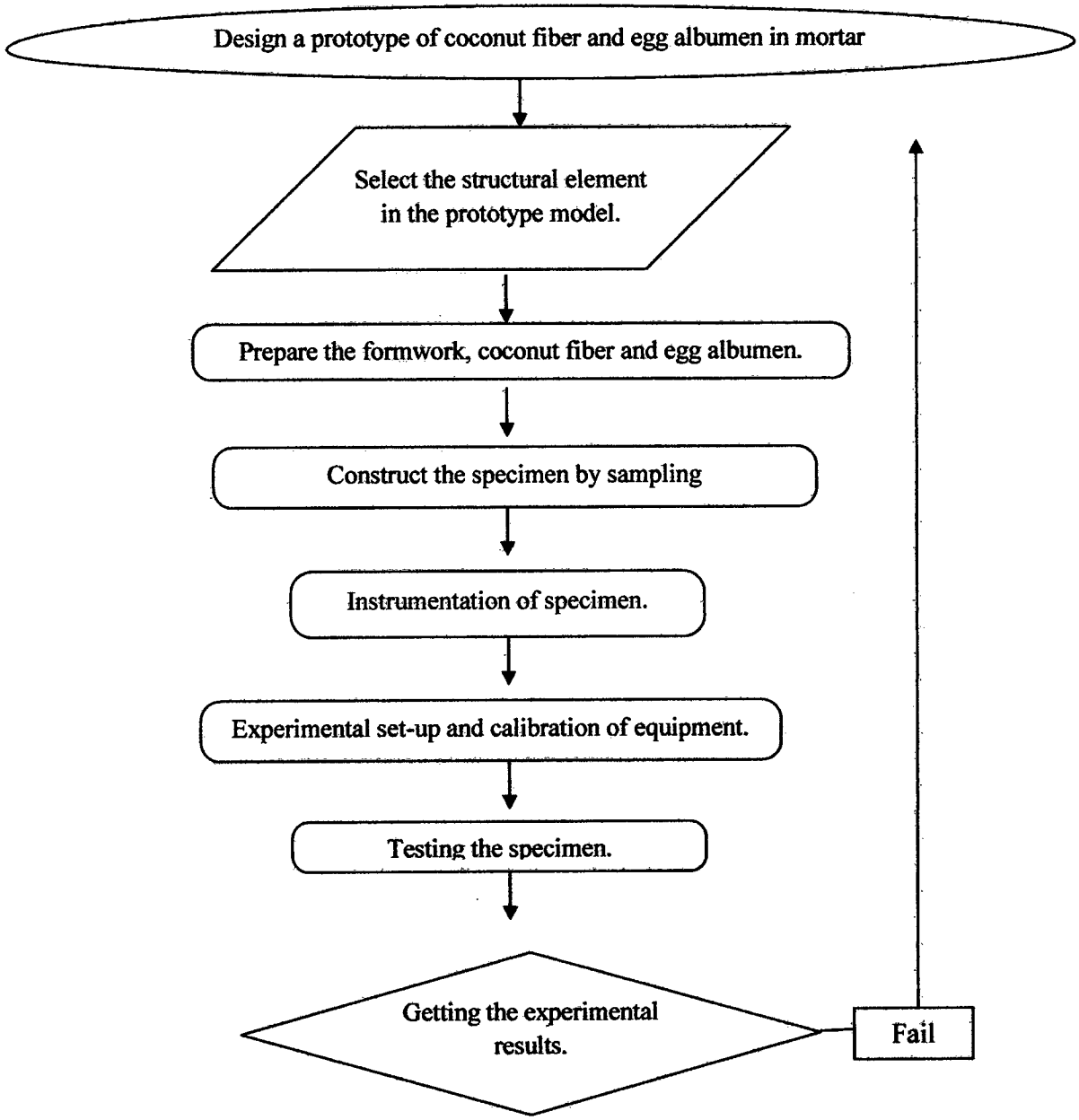

Figure 1.3: Flow Chart of Study

1.5 Significant of Study

The coconut fiber and egg albumen can increase the strength of mortar compared with the normal mortar cube without adding the coconut fiber and egg albumen. The coconut fiber added into the mortar was to help control the cracking. The coconut fiber added in mortar can reduce the cost of construction and bring the saving in materials. The egg albumen added into mortar was to increase its strength and decreased the density of mortar. In this research, the mortar provides a good workability and durability. The bond strength of mortar added with additive increase rather than the normal mortar.

1.6 Summary

This study reported the experimental works which was to investigate the effect of 0.1% coconut fiber + 1% egg albumen and 0.5% coconut fiber + 5% egg albumen on mortar flexural and compressive strength. Moreover, the effectiveness of the mortar can be identified by using the additive into the mortar. By using the coconut fiber and egg albumen as an additive into the mortar might increase the strength, workability, and durability. Most important was to utilize the waste materials which from waste to wealth by reusing them into the construction work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter was to review the properties of plastic mortar and hardened mortar from some journals and books. The effect of coconut fiber on mortar was reviewed. Besides that, the properties of egg albumen protein foam were basically evaluated.

2.2 Mortar

2.2.1 Historical of Mortar

According to William P. Spence (1998), mortar was the bonding agent used to join masonry unit into an integral structure in order to bonding the units together. To prevent the masonry unit penetrated by air or moisture, the spaces between the units must be seal by mortar. Mortar was composed by cementitious materials such as fine sand, Portland cement, and water.

Richard T. Kreh, Sr. (2003) described that besides binding the masonry materials into permanent structure, the mortar also acts as a bond for various parts of the structure such as anchor bolts, metal ties, and reinforcement rods so they may become an integral part of the wall. For engineered construction and load bearing applications, mortar strength and performance were as critical as unit strength and workmanship.

Based on the McKee and Harley J (1973), the first mortars were made from clay or mud. In addition, the natural cements had higher clay contents compare to the hydraulic lime products, and allowed for better strength development. When masonry was subjected to moisture and high levels of strength, the natural cement mortar was used in construction. These materials were used for the construction at that time was because of its low cost and availability. The Egyptians utilized gypsum mortars to lubricate the beds that were made by large stones when they were being moved into position.

According to Richard T. Kreh, Sr, (2003) in 2690B.C. the Great Pyramid of Giza was built in Egypt which was made of the huge blocks and this structure were cemented together with mortar made from burned gypsum and sand. However, in 1824, Portland cement was developed and it was much stronger material than had been used before.

2.2.2 Application of Mortar

Mortar was used in construction that it was a binding agent in masonry work. It was used to join bricks, concrete blocks, or stones and keep them set firmly in place over time. Moreover, mortar also used to repair or restore the existing structures. For some old building, the old mortar was chiseled out and this old mortar needs to replace with fresh material in a process known as "tuck-pointing" or "pointing-up".

2.3 Properties of Plastic Mortar

2.3.1 Workablility

William P. Spence (1998) describes the workability was the condition of a mortar that will spread easily, holds the weight, cling to vertical surfaces, easily extrudes from joints without dropping or swearing, and permit easy positioning of masonry units. By observing how the mortar slides or adheres to their trowel, the workability was judged by masons. The other properties like consistency, water retention, setting time, weight, adhesion, and permeability will affect a mortar's workability.

In addition, in Masonry design and detailing book, Christine Beall (2003) expresses that the workability of a mortar was recognized as a complex rheological property including adhesion, cohesion, density, flowability, plasticity, and viscosity, and thus no single test method can measure it. Air entrainment act as lubricants in promoting flow of the mortar particles, but to minimize the reduction of bond strength in mortar, maximum air content was limited. Compare to concrete, mortar needs a maximum

amount of water for workability, and permit retempering to replace moisture lost to evaporation.

The optimum mortar consistency and workability might be affected by the variations in unit materials and in environment conditions. Heavy unit mortars were denser and thus it was effectively to prevent uneven settling after unit placement or excessive squeezing of mortar from the joints. For hot temperature like warmer summer, mortar requires a softer, wetter mix to compensate for evaporation.

2.3.2 Water Retention

Refer to the H. Leslie Simmons (2007) , the water retention in a mortar was to prevents rapid loss of the mixing water to the air when the mortar contacts a masonry unit with a high absorption rate. Added by Christine Beall (2003), water retention was the mortar's ability to retain its plasticity so that the mason can carefully align and level the units without affect the bond between mortar and unit. Mortar must have a good or high degree water retention in order to resists a mortar from bleeding when it contact with a masonry unit that has a low absorption rate. If low-absorption masonry units were used with a highly retentive mortar, they may "float" and less retentive mortar may "bleed" moisture.

Christine Beall (2003) mentioned that a mortar made with only Portland cement and sand, without any lime, would have high compressive strength but low water retention. In contrast, a mortar made with only lime and sand, without Portland cement, would have low compressive strength but high water retention.

Water retention was important, not only to enhance workability (plasticity), but also to extend board life and assure that adequate water was available to hydrate cementitious components of the mortar. According to Palmer et al 1934, water retention of the mortar becomes more important as the absorption rate of the masonry increases or the temperature during installation process. If the high-suction units laid in hot or dry weather, mortar that has high water retention was required and for the low-suction units laid in cold or wet weather, mortar that has low water retention was required. In addition, Levin et al 1956 states that the plasticity was a good predictor of water retention through some research, water retention by itself was not a predictor of plasticity.

In addition, William P. Spence (1998) expresses that by entrained air, very fine aggregate or cementitious materials, the water retentivity of mortar might increased. There were two types of flow test to measure the water retention limit of mortar that was initial flow and after suction tests made in a laboratory as described in ASTM C91 (Standard Specification for Masonry Cements). The allowable initial flow should be in a range of 100% to 115% and the flow after suction should be in a range of 70% to 75%. The flow test was similar with the concrete slump test, but flow test was performed on a "flow table" that was rapidly vibrated up and down for several seconds.

2.4 Properties of Hardened Mortar

2.4.1 Bond Strength

Bond strength was the degree of contact between the mortar and the masonry units or in other words was the tensile bond strength available for resisting forces that tend to pull the masonry units apart, according to William P. Spence (1998). Tensile

bond strength was required to withstand forces such as wind, structural movement, expansion of clay masonry units, shrinkage of mortar or concrete masonry units, and temperature changes.

William P. Spence (1998) indicates that the major factors affect the bond strength of mortar were the characteristic (strength) of the masonry units, quality of the mortar, workmanship of the mason and curing conditions. Bond was low on smooth surfaces and high on textured surfaces. Bond of masonry units was influence by the suction rates and it tend to retain moisture after they were cured and have relatively low suction rates. Some clay bricks have very high suction rates, they will pull water from the mortar, establish a bond between them. If the bricks were wetted before using, it will result a poor bond and thus the surface of bricks should be permitted to dry before use.

Furthermore, the tensile bond strength also influence by mortar flow. As the water content inside mortar increases, the bond strength also increases. Relatively, as the water content increases, the compressive strength of mortar decreases. This can be conclude that using higher water content of mortar was better and yet retain a workable mortar.

A good workmanship can spread the mortar and placing the masonry units in a minimum time elapse. Once the mortar was placed, some of the water of mortar will evaporate and some will absorbed by the masonry units, leaving insufficient water to form a good bond on the next masonry units. The masonry units should not be moved, tapped or slid after placed on a bricks and getting its initial alignment to prevent breaking the initial bond.

Lastly, the maximum amount of water possible in the mortar results a good curing conditions, because it was needed for hydration. To retain moisture while curing, the laid units should be covered with plastic. For the wall under dry conditions, it must be wet with a fine mist spray for several days to keep the wall always in wet conditions.