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THE EFFECT OF WET COCONUT FIBRE ON CONCRETE PROPERTIES (COMPRESSIVE STRENGTH AND FLEXURAL STRENGTH)

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ABSTRACT

Natural fiber is a fiber derived from plants or minerals. The use of fiber materials in the construction industry has been practiced all over the world. Ability of the engineering properties of the fiber has led to this study. This study was conducted to investigate the effect of using wet coconut fiber as an additive in concrete mix. Two types of testing were conducted in this study, compression test and flexural test. 48 samples were prepared in this study consist of 12 small beams with dimension of 100mm x 100mm x 500mm for flexural test and 36 cubes with dimension of 150mm x 150mm x 150mm for compression test. Concrete with grade 25MPa was designed. Wet coconut fiber was added based on the percentage of concrete weight. In this study three different percentage of wet coconut fiber 5cm length was added into the concrete mix. The percentages are 0.1%, 0.2% and 0.3%. A control sample was used as a reference where all the results will compare it. Experimental results show that concrete mix added with wet coconut fibers. The result obtained indicate that the concrete added with 0.2% wet coconut fibers has the highest compressive strength compare with 0.1% and 0.3% but the strength is less than the control.

ABSTRAK

Serat semula jadi adalah serat yang berasal dari tumbuh-tumbuhan atau mineral. Penggunaan bahan-bahan serat dalam industri pembinaan telah diamalkan di seluruh dunia. Keupayaan sifat kejuruteraan gentian telah membawa kepada kajian ini. Kajian ini telah dijalankan untuk mengkaji kesan penggunaan gentian kelapa basah sebagai bahan tambahan dalam campuran konkrit. Dua jenis ujian telah dijalankan dalam kajian ini, ujian mampatan dan ujian lenturan. 48 sampel telah disediakan dalam kajian ini terdiri daripada 12 rasuk kecil dengan dimensi 100mm x 100mm x 500mm untuk ujian lenturan dan 36 kiub dengan dimensi 150mm x 150mm x 150mm untuk ujian mampatan. Konkrit dengan 25MPa gred direka bentuk. Sabut kelapa basah ditambah berdasarkan peratusan berat konkrit. Dalam kajian ini tiga peratusan yang berbeza kelapa basah serat panjang 5cm telah ditambah ke dalam campuran konkrit. Peratusan adalah 0.1%, 0.2% dan 0.3%. Satu sampel kawalan telah digunakan sebagai rujukan di mana semua keputusan akan dibandingkan. Keputusan eksperimen menunjukkan bahawa campuran konkrit ditambah dengan gentian kelapa basah. Keputusan yang diperolehi menunjukkan bahawa konkrit ditambah dengan 0.2% gentian kelapa basah telah kekuatan mampatan yang paling tinggi berbanding dengan 0.1% dan 0.3% tetapi kekuatan adalah kurang daripada kawalan.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Natural fibres exist in reasonably large quantities all over the world and natural fibres are produced in most developing countries. Natural fibre have been used to reinforce inorganic materials for thousands of years for examples include straw for bricks , mud and poles ,plaster and reeds. Natural fibres such as coconut, bamboo, wood cellulose fibres, wool or chips, bast fibres, leaf fibres, seed and fruit fibres have been used in cement sd base products for centuries (Hasan et al., 2012).

In civil engineering today, coconut fibers have been widely used as reinforcement in composites for non-structural components. A considerable effort has been taken worldwide to utilize local natural, coconut fibre as a products material such as supplementary cementing materials to improve the properties of concrete. Lot of interest and benefit in developing the technology for used natural fibers in cement. Using of these materials leads to reduce the loss due to improper disposal of the waste and give the less impact on environment.

Some research have reported that the coconut fiber is the most interesting fiber as it has the lowest thermal conductivity, bulk density and reduced the thermal conductivity of the composite samples. A.Aida et al. (2011). Damke (2012) writes "Coconut fibers are reported as most ductile and energy absorbent material. It is concluded that coconut fibers have the potential to be used in composites for different purposes. Since the use of coconut fibers has given some marvelous products, there is still possibility of the invention of new products containing coconut fibers with improved results".

1.2 PROBLEM STATEMENT

In countries especially in Asia for countries like Thailand, Philippine and Malaysia dispose in a large amount of agricultural waste. If waste cannot be disposed of properly it will lead to environmental problems and human health. In civil engineering today, researchers about the coconut fiber have been widely. Using the additive materials from waste such as coconut fibre can reduce the cost of materials and environmentally friendly. The properties of concrete are important such as strength, workability, flexural strength and effects of additive material to concrete mix. Asasutjarit, (2009) stated in the utilization of agricultural waste products as low cost construction materials especially in developing countries. Based on previous research, it was found that dried coconut fiber is less suitable when added too much into the concrete. This is because dry coconut fiber will absorb the water which is a substance that assists in the process of cement reaction. Coconut fiber is water absorbent material is very high that is by 130 to 180 percent absorption (Balaguru and shah, 1992). However, researches for wet coconut fiber as an additive material are not widely held. Use coconut fibre as an additive material is an advanced technology today that can in applications to the real world.

1.3 SCOPE OF WORK

Research conducted involves a literature review relevant to the project title. Studies have focused on the scope of this research went well and undistorted away from anything that is required. This research is limited to the following areas:

1. Natural fibre is focused on coconut fibre as an additive material.
2. Analysis and design of the mixture is based on ASTM guidelines added with 0.1%, 0.2% and 0.3% coconut fibre by weight of concrete.
3. iii. The mixing process will be carried out in a mechanical mixer where all of raw materials will be mixed together until homogenous mixture was formed. Mechanical tests: will be conducted compression test and flexural test.
4. Total of specimen for this research is a 48, for compression test 36 specimens and flexural test 12 specimens. Cubes measuring 150mm x150 x150mm will be used for compression strength and tested at 7 days, 14 days and 35 days of curing. Flexural strength will measure under three-point loading at 35 days of curing using 100mm x 100mm x 500mm prims. For compressive and flexural testing, the specimens will loaded during the testing at a constant rate until failure. For the project used a wet coconut fibre. Table 1.1 shows list of specimen and fibre volume for the research.

Table 1.1: Number of Samples and Testing

List of Specimen and Fibre Volume												
Fibre (%)	**0**			**0.1**			**0.2**			**0.3**		
Curing (days)	7	14	35	7	14	35	7	14	35	7	14	35
Compression test	3	3	3	3	3	3	3	3	3	3	3	3
Flexural test			3			3			3			3
Total sample	**48**											

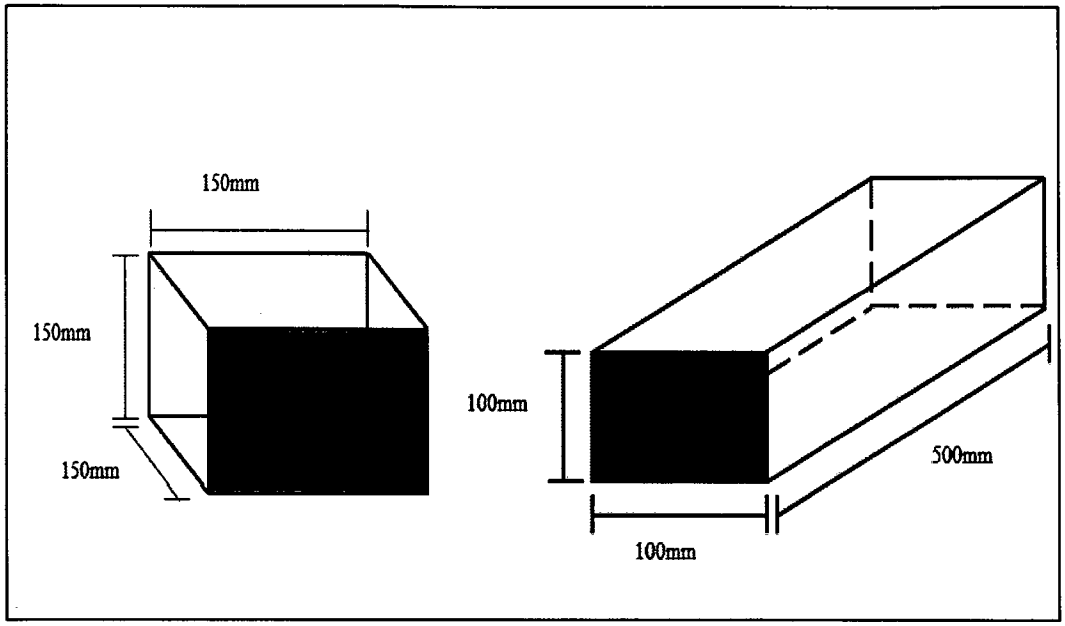

Figure 1.1: Dimension of Prims

The Figure 1.1 above shows the dimension of the cube and beam. Cube size is used in this research was 150 mm x 150 mm x150mm whereas for the flexural strength the use size was 100mm x 100mm x 500mm.

1.4 OBJECTIVE

This research covered two objectives as listed below:

1. To determine the compressive strength of the concrete using 0.1%, 0.2% and 0.3% of wet coconut fibre as an additive materials.
2. To determine the tensile strength of the concrete using 0.1%, 0.2% and 0.3% of wet coconut fibre as an additive materials.

1.5 SIGNIFICANT OF STUDY

This research was conducted to research the advantages and strengths of using additive material (wet coconut fibre) as to the concrete mixture composition. Quantity of water in the concrete mix composition may be absorbed by coconut fiber if using dry coconut fiber. This will affect the quality of the concrete. The previous studies dry coconut fiber is used as an additive material. In this case, to differentiate between concrete strength using a wet coconut fiber research was conducted. This research also used to distinguish using compression strengths wet with the dry coconut fiber.

Furthermore, to determine the compressive strength and the different behaviors of different proportion additive material and to determine the compressive strength of different proportion which was the strength development for 7 days, 14 days and 35 days of curing for the all mixing proportion of the concrete.

1.6 EXPECTED OUTCOMES

The expected outcome will be obtained is:

i) To identify the optimum percentage of wet coconut fibers added into the concrete mix.
ii) To identify the tensile strength of the concrete using wet coconut fibre as an additive material.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The construction industry in western countries has been using waste recycling technology to produce high quality concrete. Many researches about the concrete have been made to reduce the cost of manufacturing concrete and reduce the material to make concrete. Construction sector is an important sector of developed countries. So, to reduce the manufacturing the cost of concrete, a lot of research has been conducted to find ways to reduce the use of concrete using waste materials to be added in the concrete.

Fiber is materials that have been used by humans for centuries whether in natural or modified form until the high-tech such as synthetic fiber. Developments in fiber technology is consistent with the development of human knowledge, not surprised the natural fibre that is making headway for discovery of new and the creation of innovative. Use of natural fibers in the construction industry is growing every year. Because of lack of resources and rising prices of building materials based on mineral resources of non-renewable such as steel, aluminum and timber. Mazlee at el,(2011) state the development of coconut fibre based green composites by conventional method of mixing and curing process.

This research discussed the theoretical about definition of concrete, materials that is used to produce concrete and tests the carried out on concrete. Besides that, this chapter also discussed the previous research on the effect of coconut fiber in the wet concrete. This chapter reviews the strength of concrete based on previous studies.

2.2 CONCRETE MATERIALS

Concrete is a major materials of construction used all over the world, the raw materials needed are available in most parts of the world. Concrete consists of cement, sand and aggregates are mixed thoroughly with water in accordance with a predetermined ratio. This mixture will harden according to required grade. The active ingredient in concrete is cement and water. Whereas, function of aggregate as filler spaces and provide durability and resistance force of a shrink. Though other types exist, Portland cement is the most abundant and popular. Portland cement is used more widely as the cost of manufacturing more economical and are easily available.

2.2.1 Cement

Cement is a grey powder and hardens by the action of water only. Portland cement is produced by heating a finely divided mixture of a fine, pulverized materials consisting of compound of lime, iron, silica, and alumina with a high temperature around 1500OC. Concrete strength is influenced by the chemical composition of the different cement. The properties of portland cements, its chemical composition is consists of the four compounds, Tricalcium silicate (C_3S) with 50%, Dicalcium silicate (C_2S) with 20%, Tricalcium aluminate (C_3A) with 12% and Tetracalcium aluminoferrite (C_4AF) with 8%. The main contributor to the strength of the cement is C_3S and C_2S which consists of 75% of the cement composition (Taylor, 2000).

2.2.2 Aggregates

Aggregate content is approximately 60 percent to 80 percent of the total volume concrete and strongly influence the concrete's freshly mixed and hardened properties, mixture proportions, and economy (A.Wahab, 2011). With the presence of dust the bond between the cementing gel and the aggregates get weakened. Therefore, for a strong and durable concrete, aggregates used should be strong, hard, and free from harmful effects. Therefore, the selection of a suitable aggregate is very important to ensure the strength and quality of concrete. Aggregates that have texture angular or harsh surfaces will produce concrete that is stronger than the round-shaped aggregates and has a smooth surface. This is because cornered and rough surface has a strong adhesion in concrete compared to round and smooth surface.

2.2.3 Water

Water is the chemical means by which cement is converted from a powder into hardened materials with strength and durability. Water used in making concrete should be clear and free from the impurities such as sulfates, acids, alkalis, and humans (A.Wahab,2011). Water which is in contents with organic materials such as vegetation can be contaminated by organic acids. These can reduce the rate of hydration by increasing the pH value (acidity) of the wet water (Taylor, 2000). In general, the lower concrete mix water / cement ratio, getting higher and lower the compressive strength of concrete porosity.

2.3 PROPERTIES OF CONCRETE

2.3.1 Mechanical

2.3.1.1 Compressive Strength

In determining whether the concrete is good quality or not, compressive strength is one of the important criteria. The materials should be used are good quality and the method of mixing is done carefully and procedure to achieve this criterion. Normally, compressive strength of tested at the age 7 days and 28 days because at the 28 days attain the damping peak. The compressive strength and thermal conductivity decreased when the quantity of fibre increased (Mazlee at el, 2011). The compressive strength are slightly increase in value with low fibre content in range (0.3-1.5%) as compared with the ordinary concrete (Ismail,2007).

2.3.1.2 Flexural Strength

One measure of the tensile strength of concrete is flexural strength. Tensile strength was carried out to determine the strength of materials and to estimate the load where the concrete members maybe crack. Flexural strength it is the ability of a beam or slab to resist failure in bending. Flexural strength was a special importance in spite of its low magnitude as compared to compressive strength. Flexural modulus rupture is about 12 to 20 percent of compressive strength. It is most commonly utilized in beams and slabs (Gambhir 1995).

2.4 HARDENED CONCRETE

2.4.1 Creep of concrete

Creep is defined as increased of the strain in the concrete with the time-dependent deformation under a constant load. Creeping of concrete occurs due to the movement under stress likewise with shrinkage. 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.

2.4.2 Durability of concrete

Durability in the concrete is its ability to resist deterioration resulting from external and internal causes. The external causes are to resist weathering action, chemical attack, abrasion, or any other process of deterioration, and hence to retain its original shape, dimension, quality and serviceability. While, the internal causes are the effects of interaction between the constituent materials, such as alkali-aggregate reaction, volumes change absorption and permeability.

2.4.3 Workability of concrete

Workability is to describe the properties of fresh concrete. Workability normally influenced by the degree of compaction. Insufficient compactions give the effect in strength with small increase in void content. Characteristic of workability are consistency and cohesiveness. Workability of concrete is important to make sure that the concrete easy to pour. Workability of concrete the mixed will determine whether achieve or not according to control specimens. Workability can be measured using slump test to obtain the required Workability for the specific condition and method of placement American concrete Institute (ACI) standard (ACI 1990b).

2.5 ADDITIVE MATERIALS

The additive is materials are added into the concrete during mixing. Additives used to modify the properties and characteristics of a particular concrete. These additives are also used to improve the workability of concrete without increasing the quantity of material in concrete. Furthermore, use the additive materials in the concrete mix to reduce the cost of concrete.

2.5.1 Natural fiber

Natural fibres are referred to as vegetable, biomass, photomass, phytomass, agromass, solarmass or photosynthetic fibres. Natural fibre could also include hair, feather, wool and silk fibres and mineral fibre. Natural fiber has been used very broad and varied functions today. Natural fibers were used long ago as a form of reinforcement such as mud bricks reinforced with straw. Fiber usually used for fiber reinforced concrete is unprocessed natural fibers (UNF). The properties of unprocessed natural fiber reinforced concrete are affected by a large number of factors. According report by (Journal ACI commitee 544 Reapproved, 2002), the type and length of fibers, as well as the volume fraction, are the most significant factors. Natural fibres can be classified into several categories as shown below:

Table 2.1: Categories of Natural Fibre (K.L.Pickering,n.d)

Categories of natural fibres	Types of natural fibres
Bast fibre	Jute, kenaf, ramie, flax and hemp
Leaf fibre	Banana, sisal, agave and pineapple
Seed fibre	Coir, cotton and kapok
Core fibre	Kenaf, hemp and jute
Grass fibre	Wheat, corn and rice
Wood fibre	Soft and hard woods (many spices)

Table 2.1 gives a more complete list of fibre types. Natural fibres can be classification into six types of natural fibre. Natural fiber can be subdivided into two parts, unprocessed natural fiber and wood fiber (Processed Natural Fibers). Unprocessed Natural fibre consists of coconut coir, sisal, bamboo, jute, wood, and vegetables fibre. According William C,(1992) the concrete made with unprocessed natural fibres show good mechanical properties. However, they have some deficiencies in durability and many of natural fibre are highly susceptible to volume changes due to variations in fibre moisture content. All categories highlighted are can be classified as natural fibers unprocessed except wood fibers that are in categories processed natural fibers.

Bast fibres come from the inner bark or phloem of dicotyledonous plants and provide structural strength and rigidity to the plant stem. Bast strands vary in length but can be up to 100cm with widths approximately 1mm. The strands exist of smaller units called ultimate fibres. An ultimate fibre is like flax, ramie hemp, kenaf and jute. While the, Core fibre or stick fibres exist on the inside of the bast fibres in the center of plants such as kenaf, jute, and hemp. All categories have a disadvantages and advantages for additive mateials.

Table 2.2: Typical Properties of Natural Fibres (Balaguru and shah, 1992)

Fibre type	Coconut	Sisal	Sugar cane bagasse	Bamboo	Jute	Flax	Elephant grass	Water reed	Plantain	Musamba	Wood fibre (Kaft pulp)
Fibre length, mm	50-100	N/A	N/A	N/A	175-300	500	N/A	N/A	N/A	N/A	2.5-5.0
Fibre diameter, mm	0.1-0.4	N/A	0.2-0.4	0.05-0.4	0.1-0.2	N/A	N/A	N/A	N/A	N/A	0.025-0.075
Relative density	1.12-1.15	N/A	1.2-1.3	1.5	1.02-1.04	N/A	N/A	N/A	N/A	N/A	1.5
Modulus of elasticity, Gpa	19-26	13-26	15-19	33-40	26-32	100	5	5	1.5	1.0	N/A
Ultimate tensile strength, MPa	120-200	275-570	180-290	350-500	250-350	1000	180	70	90	80	700
Elongation at break, %	10-25	3-5	N/A	N/A	1.5-1.9	1.5-1.9	3.6	1.2	5.9	9.7	N/A
Water absorption, %	130-180	60-70	70-75	40-45	N/A	N/A	N/A	N/A	N/A	N/A	50-75

Notes

N/A properties not readily available or not applicable

From the other research, the typical properties of natural fibres are present in Table 2.2 that are mentioned by Balaguru and Shah, (1992). Jute, grown solely for its fibre content, easily found in Bangladesh, India, Thailand and China. Normally, diameter of jute is 0.1 to 0.2. The fibre are then removed manually and dried. Jute fibre is relatively strong in tension as show in Table 2.2. Jute fibre is a fiber that has a relatively high ultimate strength and strong. Different with the Bamboo Fibre, bamboo is a member of the grass family, grows in tropical and subtropical regions. Bamboo plants can grow up to height of 15m. Bamboos have a relatively high modulus of elasticity from 33-40MPa. Flax extracted from other plants such as elephant grass, water reed and musamba have also been tried as reinforcement for concrete. Flax fibers are the longest in the category of natural fiber and strong under tension and also possess a high modulus of elasticity. Akwara is very attractive natural fibre derived from a plant stem grown in large quantities in Nigeria. According to Balaguru and Shah(1992), akwara fibre is not durable in alkaline environment of cement matrix, and also dimensionally stable under wetting and dry condition. Akware fibre has a low elastic modulus and brittleness.

Wood fibre is the major portion of natural fibre use in concrete worldwide. Usually, wood fibre uses in Portland cement as a replacement for asbestos fibre. These fibres have a high tensile strength, high modulus of electricity and the well developed technology to extract the fibre. Component of wood is cellulose, hemicelluloses and lignin. Strength of the wood fibre can effect from the liginin. Whereas tensile strength for dignified cellulose fibre recorded is high as 2000MPa. Sugarcane bagasse fibre from a 50 percent of content after the extraction of juice from sugarcane.

2.5.1.1 Coconut fibre

Coconut palms are mainly easily found in the tropical regions and the coconut fibre commonly used applied in food and non-food products. Coconut fiber is one of the natural fibers which are widely used over the years. Coconut tree thrives on sandy soils and wetlands; it can reach a height 6 to 30m. The overall coconut tree can be used for multipurpose. Coconut fiber is obtained from coconut husk. A mature coconut fibre has an outer fibrous husk. The coconut palm comprises of a white meat which has total percent by weight of 28 surrounded by a protective shell and husk which has a total percent by weight of 12 and 35 respectively. These fibers are known as an ideal material and biodegradable and be a solution to the problem of ecology. Coconut fibre, called coir, can be extracted simply by soaking the husk in water or alternatively, by using mechanical process. Balaguru and Shah (1992) coir has low elastic modulus and is also sensitive to moisture changes.

Coconut fiber consists of two types, white fiber and brown fibre. The white fibre is produced from immature coconuts and is a finer, more flexible fibre than brown fibre. Coconut fibre is obtained from mature coconut and has a higher content of lignin K.L.Pickering(n.d). Brown fibres are thick, strong, high abrasion resistance and have a high degree of retaining water and also rich in micronutrients. Coconut fibres were selected because has a many advantages, its highest ductility. According to Munawar et al.(2007), stress-strain curves for different natural fibres. They had proved that the coconut fibre had the higher ductility compared to other natural fibre.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes about the materials used, the mix proportions, the sample preparation and the test procedures. To achieve the objectives of the research a lot procedures to be followed such as access information, conducting research, collect the data, analyze data and concluded. Laboratory work should be planned to make sure our work more regulated nicely and systematic.

These steps must be done properly to ensure that the research is done properly to support of this research. On the initial stages, all the materials and equipment that needed will be gathered or checked for availability. Finally, the results obtained will analyze to draw out the conclusion.