THE EFFECT OF NATURAL FIBER USING LALANG GRASS AS AN ADDITIVE IN REINFORCED CONCRETE ON COMPRESSIVE STRENGTH AND FLEXURAL STRENGTH

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ABSTRACT

Concrete is the main material in construction industry. Concrete is the combination of Ordinary Portland Cement, fine and coarse aggregate, and water. The water and Ordinary Portland Cement will react by hydration process which will form cement paste. This cement paste will make the combination in making concrete become more solid and hard material. The concrete is low in compression but high in tensile strength. Nowadays, the researchers found new technology to improve the strength of concrete by using natural fiber as an additive or replacement material in the reinforced concrete. There are many types of natural fiber used in reinforced concrete, such as Leaf fiber, Grass fiber and reeds fiber. The natural fiber is used because of low cost and low impact to environment.In this study, the *Lalang Grass* was used as an additive in the reinforced concrete. *Lalang Grass* is a natural fiber that in the categories of Grass fiber. *Lalang Grass* is a plant that does not shows any economical value, and also gives problem to control its breeding. The *Lalang Grasses* are used for different percentage of *Lalang Grass* such as 0.1%, 0.2% and 0.3% by weight of cube and beam specimen. The cube and beam specimen are cured for different age of curing. For cube specimens are cured for 7, 14 and 35 days, while the beam specimens are cured for 35 days. The compression and flexural test were the testing for cube and beam specimen respectively. The compression and flexural test are conducted at the end of age of curing and the result of average for cube and beam specimens of the testing were the ideal result for the compressive strength and flexural strength. The result of compression test shows that an addition of *Lalang Grass* can improve the strength of compressive strength.This is because when the period of age of curing become longer, the compressive strength also increase. The 0.3% of *Lalang Grass* as an additive had the higher compressive strength compare with the other percentage of *Lalang Grass*. For the flexural strength, the 0.3% of *Lalang Grasses* an additive shows the potential to improve the flexural strength of the concrete. this is because, the flexural strength of Ordinary Portland Cement concrete with 0.3% of *Lalang Grass* had higher strength compare plain Ordinary Portland Cement concrete and Ordinary Portland Cement concrete with 0.2% of *Lalang Grass*.

ABSTRAK

Konkrit merupakan bahan utama dalam industri pembinaan. Konkrit adalah campuran dari simen Portland biasa, agregat halus dan kasar, dan air. Air dan simen Portland biasa akan bertindak balas oleh proses penghidratan yang akan membentuk pes simen. Pes simen ini akan membuat kombinasi dalam membuat konkrit menjadi bahan yang lebih kukuh dan keras. Konkrit adalah rendah dalam mampatan tetapi tinggi dalam kekuatan tegangan. Kini, para penyelidik mendapati teknologi baru untuk meningkatkan kekuatan konkrit dengan menggunakan serat semula jadi sebagai bahan tambahan atau bahan gantian dalam konkrit bertetulang. Terdapat banyak jenis serat semula jadi yang digunakan dalam konkrit, seperti serat daun, serat rumput dan serat buluh. Serat semulajadi digunakan kerana kos yang rendah dan impak yang rendah terhadap alam sekitar. Dalam kajian ini, rumput Lalang telah digunakan sebagai bahan tambahan di dalam konkrit bertetulang. Rumput Lalang adalah serat semula jadi yang berada dalam kategori serat Rumput. Rumput Lalang adalah tumbuhan yang tidak menunjukkan apa-apa nilai ekonomi, dan juga memberikan masalah untuk mengawal pembiakannya. Rumput Lalang digunakan untuk peratusan rumput Lalang yang berbeza seperti 0.1%, 0.2% dan 0.3% mengikut berat spesimen kiub dan spesimen rasuk. Spesimen untuk kiub dan rasukdi awet untuk tempoh pengawetan yang berbeza. Bagi spesimen kiub yang di awet selama 7, 14 dan 35 hari, manakala spesimen rasuk diawet selama 35 hari. Ujian untuk mampatan dan lenturan adalah ujian untuk spesimen kiub dan spesimen rasuk masing-masing. Mampatan dan ujian lenturan dijalankan di akhir tempoh pengawetan dan hasil purata bagi kiub dan rasuk spesimen ujian adalah hasil yang sesuai untuk kekuatan mampatan dan kekuatan lenturan. Keputusan ujian mampatan menunjukkan bahawa penambahan rumput Lalang boleh meningkatkan kekuatan kekuatan mampatan. Ini adalah kerana apabila tempoh pengawetan menjadi lebih lama, kekuatan mampatan juga meningkat. 0.3% daripada rumput Lalang sebagai bahan tambahan mempunyai kekuatan mampatan yang lebih tinggi berbanding dengan peratusan lain rumput Lalang. Untuk kekuatan lenturan, 0.3% daripada rumput Lalang bahan tambahan menunjukkan potensi untuk meningkatkan kekuatan lenturan konkrit. Ini adalahkerana, kekuatan lenturan konkrit simen Portland biasa dengan 0.3% daripada rumput Lalang mempunyai kekuatan lebih tinggi berbanding simen Portland Biasa konkrit dan konkrit simen dengan 0.2% daripada rumput Lalang.

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LIST OF ABBREVATIONS

ASTM	American Society for Testing and Materials
NaOH	Sodium Hydroxide
NRMCA	National Ready Mixed Concrete Associations
OPC	Ordinary Portland Cemen
PPC	Portland Pozzolana Cement

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Nowadays, concrete is the major material in construction industries due to the inexpensive materials, not complex and available over the world. Concrete is a solid and hard material produced by the combination of cement, fine and coarse aggregate, and water. Concrete is easy to formed in any shape and size regarding to the need from the construction industry. The architectural structures, foundation, walls, bridge and roads are examples of construction industry that had used concrete as the main material. Concrete classified as a material which is good in compression strength but low in tensile strength and this action will definitely produce cracks in tension zone.

High compressive strength, high flexural strength, low permeability, high durability and dimensional variations are the properties for high quality hardened concrete. Many researchers found new solutions to improve the properties of concrete by using fiber as an additive in concrete mix. The fiber that had recently used as an additive in concrete is natural fiber due to the low cost and also lowers the impact to environment.

1.2 PROBLEM STATEMENT

The concrete industry conduct a research on green concepts by using natural fiber as an additive or replacement in concrete to give low impact to environment and at the same time will increase the strength of concrete. *Lalang Grass* usually does not have any economical value and become one of major problem in agriculture industry. This is because planters need to shed a lot of effort especially allocation of money, energy and time to control its population. Therefore, the breeding of *Lalang Grass* can be reduced by use it as an additive or replacement in concrete.

1.3 OBJECTIVES

Natural fiber used in this study was *Lalang Grass*. It is use as an additive in concrete mix. There are two objectives in this study:

1. To determine the flexural strength of the concrete by adding *Lalang Grass* into concrete mix as an additive.
2. To determine the compressive strength of the concrete by adding *Lalang Grass* into concrete mix as an additive.

1.4 SCOPE OF WORKS

This study covered two laboratory tests, compression test and flexural strength test of an Ordinary Portland Cement (OPC) concrete mix added with different percentage of *Lalang Grass*. The concrete mix was designed for grade concrete 25MPa. Two sizes of specimen used in this study according to two different tests. The standard specimen size for compression test is a cube with dimension of 150 mm x 150 mm x 150 mm is, while the standard specimen size for flexural test is a small beam with dimension of 100 mm x 100 mm x 500 mm. The total number of specimen used in this study is 48 specimens, 36 cubes and 12 small beams.

The *Lalang Grass* was cut 1.0 cm length and added into concrete mix with three different percentage of quantity which is 0.1%, 0.2% and 0.3% of the specimen weight. In this study water curing was used for all specimens and for compression test it set for 7 days, 14 days and 35 days while for flexural test it set only for 35 days.

1.5 EXPECTED OUTCOMES

The compressive strength at day 7, day 14 and day 35 of the Ordinary Portland Cement (OPC) concrete mix added with 0.1%, 0.2% and 0.3% *Lalang Grass* will be determined. In line with the result, the potential of *Lalang Grass* either it can increase or reduce the strength of concrete will disclosed. The flexural strength at day 35 of the OPC concrete mix added with of 0.2% and 0.3% *Lalang Grass* will be determined.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of studying a literature review was to find, read, and analyze the body of literature which been published by books, journal article, conference articles, research papers and thesis. The previous reviews on engineering properties of concrete and its performance in the existing applications will be studied in order to analyze more valuable information associated to the construction activity. In this chapter, the review on natural fiber such as *Lalang Grass* also will be analyzed.

2.2 CONCRETE STRENGTH

Concrete are the main material in construction industry. Concrete is the combination of cement, water, fine and coarse aggregate. Hasan (2008) stated that there are two state of concrete which is fresh or plastic concrete, and hardened concrete. The fresh or plastic concrete is placed to produce a large variety of structural elements, while the hardened concrete shows the concrete is high in compression but low in tensile strength and give the result of concrete was cracks easily under tension (Hasan, 2008). The strength which is compressive strength and tensile strength was one of the properties of concrete in hardened stages (Hasan, 2008). Other than that, cement content, density, and curing time was one of factors that can improve the concrete strength, and quantity of water are decrease (A. Wahab et al, 2011). According to A. Wahab et al, (2011), the specimen for fresh concrete test must follow the specification in ASTM C 172, while the specimen for hardened concrete test should follow ASTM C31 in the field, and ASTM C192 in the laboratory.

2.2.1 Compressive Strength of Concrete

The compressive strength is important in concrete. The importance of the compressive strength in concrete is to use as qualitative measures the properties of hardened concrete (Hasan, 2008). The cross-sectional area resisting the load and failure load were important to calculate the compressive strength (NRMCA, 2003). The concrete can be determined either in cubes, cylinders or prisms. The requirements of specified strength of concrete mixture are determined from the compressive strength test results with average of at least two standard strength specimens (NRMCA, 2003). This is because average strength should produce higher strength than the specified strength (NRMCA, 2003).

According to A. Wahab et al, (2011), the ASTM C31 is used for the compressive strength test. Seven to twenty-eight days are commonly used for curing times, although there are specifications requirements before tests are made (A. Wahab et al, 2011). According to NRMCA (2003), the concrete strength is required at an age of 28 days. The apparent of compressive strength concrete had increased because of the presence of friction (Hasan, 2008). An increase in modulus of elasticity, strain at maximum stress and toughness of stress-strain curve are due to the compressive strength improvement (Naaman & Harajli, 1990). The curing age also the factors can affect the compressive strength of the specimen. According to Rao et al, (2010), when the age of curing is increase, the compressive strength also increases.

2.2.2 Flexural Strength of Concrete

As we know that the concrete is low in tensile strength, but high in compressive strength. Hasan (2008) stated that the concrete low in tensile strength due to the offset by steel reinforcement. Other than that, the tensile stresses form due to the drying shrinkage, rusting of steel reinforcement, temperature variations and other reasons (Hasan, 2008). Flexural strength is one measure of the tensile strength of concrete. According NRMCA (2000), ASTM C 78 for third-point loading or ASTM C 293 for center-point loading are methods that used to determine the flexural strength. The flexural Modulus of Rupture for center-point loading is higher than the Modulus of Rupture determine by the third-point loading (NRMCA, 2000).

The standard beam for the tensile strength should be 100 mm x 100 mm x 500 mm or 150 mm x 150 mm x 700 mm if the nominal sizes of aggregates not exceed 20 mm. the specimens are tested by breaking the specimen by pressure applied to midpoint and support on each end (A. Wahab et al, 2011). According to Hasan (2008), the load will be increasingly applied until the specimen fails and the data given for the maximum load applied must be recorded, and the specimen appearances of fractures faces and any failure type should be noted.

2.3 CONCRETE MATERIALS

2.3.1 Cement

Cement is the combination of different compounds with proper proportion which are Lime, Iron, Silica, Alumina, Magnesia and Sulphur Trioxide under the controlled condition (A. Wahab et al, 2011). The wet or dry process is the process that used in the manufacture of cement. Hasan (2006) stated that clinker will be produced when the compounds in cement is subjected to temperature of 1400°C. Besides that, the clinker also can be produced when it is subjected to temperature of 1600-1780°C (A. Wahab et al, 2011). The cement or known as Ordinary Portland Cement produced when a small amount of gypsum added to the clinker when it is cooled down. The cement will become harden and rigid when there are chemical reaction between compounds on cement with water.

Cement is very sensitive to moisture because of the chemical reaction. This is called the process of hydration. In the manufacture storage, they provide a storage that is very watertight due to the reaction with moisture.

The cement properties will change when the amount of the compounds changed (Hasan, 2006). This will give result of different types of cement in the cement industry such as Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), Low Heat Cement, Rapid Hardening Portland Cement, Portland Slag Cement, Quick Setting Cement, High Alumina Cement, Sulphate Resisting Cement, Super Sulphated Cement, Hydrophobic Cement, White Portland Cement, and Masonry Cement which follow the ASTM specifications. Besides that, there are also types of cement that not stated in ASTM specifications such as Waterproof Portland Cement, Plastic Cement, Expensive Cement, Oil-Well Cement, and Regulated Set Cement (A.Wahab et al, 2011). There two testing method to get the high quality of cement, which are Field Testing such as Visual Test for colour and presence of lumps, Adulteration Test for physical properties, and Strength Test, and Laboratory Testing such as Chemical Composition, Fineness, Normal Consistency, Setting Time, Soundness, and Strength (Hasan, 2006).

In Visual Test, the colour of the Ordinary Portland Cement must be in grey with greenish shade, must uniform, and cement must free from any type of lumps either in soft or hard which shows either the cement absorbed moisture from the atmosphere or not (Hasan, 2006). The adulteration test is about physical properties test of the cement which to make sure the cement in smooth condition, cool, warm and also float on surface of water (Hasan, 2006). If the cement paste soaked in water for 24 hours does not show any sign of crack, the sample of cement satisfies the strength test and the quality of the cement is acceptable (Hasan, 2006). The Fineness test is shows when the cement in fineness increase, the rate of hydration also will increase (A.Wahab et al, 2011). The Consistency is other testing method for laboratory testing. The Consistency test is related with the quantity of water that should be able to flow in fresh mixture by follow the ASTM C191 (A.Wahab et al, 2011).

The plasticity of cement and capacity of mortar to flow will increases if there are excess in water added, while cement will grow harsh and stiff if there are small quantity of water are added (Hasan, 2006). The Setting Time test is to determine chemical reaction called hydration to take place to undergo setting and hardening of the cement paste (Hasan, 2006). There are two sets that must be identified during the chemical reaction to takes place which are the initial set and the final set. Hasan (2006) stated that the initial set stage when the plasticity of cement paste start to decreases, while the final set stage is occur when the cement paste achieved its sufficient strength and hardness.

Other than that, the Soundness tests also one of the laboratory tests to determine the properties of cement. If the volume of the cement paste can be maintained its volume after it's is achieved sufficient strength and hardness in Setting Time test, this called Soundness test (A. Wahab et al, 2011). The Compressive Strength test is also one of the testing methods of cement properties. The Compressive Strength is the major physical properties. Type of cement such as compound composition and fineness will affect the compressive strength. According to A. Wahab et al, (2011), since there are many additives and variances in concrete mixture, therefore the compressive strength of concrete cannot be determine using the compressive strength of cement. The compressive strength can be determined by using the actual concrete mixture without any additives.

2.3.2 Aggregates

The aggregate also one of the important materials used in construction including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregated. According to Hasan (2008), three-quarters of the volume and composed from well-graded gravel or crushed stone is aggregate. It similarly the concrete contain 60 to 80 percent of aggregate (A. Wahab et al, 2011).The aggregates should be clean, hard, strong, free of absorbed chemicals, and free of coating of clay, humus, and other fine materials to get the strong and durable concrete but still need to follow the ASTM specifications (A. Wahab et al, 2011). Although aggregates are more cheaper than cement, but aggregate give more higher volume stability and better durability than the cement paste alone (Hasan, 2008).

According to Hasan (2008), there are four categories of aggregates which are coarse aggregate, fine aggregate, all-in aggregate, and single-size aggregate that been classified depend on their origin, size, shape and weight. The coarse aggregate is commonly obtained from stream deposits, glacial deposits and alluvial fans that will be retained on 4.7 mm sieve after passing through 80 mm sieve. There are few types of coarse aggregate such as crushed gravels due to crushing of gravels of hard stones, the uncrushed gravel that form from weathering and abrasion of large parent rocks, and also partially crushed form from crushed and uncrushed gravels (Hasan, 2008). For the fine aggregate, the aggregate should pass through 4.75 mm and is retained on 75 micron sieve.

There are three types of fine aggregate, which are natural sands, crushed stone sands, and crushed gravel sands (Hasan, 2008). The natural sands are from pits, lakes, rivers, or seashore which the size is about 0.07 mm or lower (Hasan, 2008). The crushed stones sands are form crushing hard stone while the crushed gravel sands are from crushing the natural gravel (Hasan, 2008). For the all-in aggregates, it contain all size range of natural aggregate and has poor gradation that make this type of aggregate not used in high quality of concrete but it only can be used after the proper gradation (Hasan, 2011).

Nowadays, many researches were done to replace the aggregate that usually used in construction with various type of aggregate follow ASTM specifications. There are three types of rock and material constituent in aggregates such as minerals rock, igneous rock, and metamorphic rock. From this types of aggregates, it will produced various type of concrete such as normal weight concrete, structural lightweight concrete, insulating concrete, and heavyweight concrete. Each types of concrete have its own weight and specified in the ASTM. The lightweight structural concrete were made from lightweight aggregates such as shale, slate, clay and slag and will produce density from 90 to 115 lb./ft^3 (A. Wahab et al, 2011). The heavyweight concretes are form from heavyweight aggregates such as ferrophosphorus, barite, goethite, hematite, ilmenite, limonite, magnetite, and steel shot and punching and the heavyweight concrete usually used for radiation shielding and other great weight desired (A. Wahab et al, 2011).

2.3.3 Water

Water that used in making concrete should be clear and free of sulphates, acids, alkalis, and humus. The types of water that suitable for used in making concrete is municipal water systems and potable water from wells (A. Wahab et al, 2011). the other types of water should be checked for the suitability before use such as water from lakes, ponds, and river (A. Wahab et al, 2011). These types of water are test according ASTM C109 to determine the seven-day and twenty eight-day strength that should equal to 90 percent of samples made with drinkable water (A. Wahab et al, 2011).

Nowadays, many researches are done by replace the material for making concrete, and of the examples is by replace the suitable water with seawater. The seawater has higher strength at the early age of curing than the normal concrete, but the strength will become lower after twenty-eight days (A. Wahab et al, 2011). The seawater suitable to use in making the reinforcement concrete, but the reinforcement should be protect to avoid the corrosion. Water is important to hydration process for making the cement paste. Other than that, water-cement ratio can give effect to the properties of concrete.

2.4 INTRODUCTION OF NATURAL FIBER

For these recent years, the natural fiber was utilized to produce the low cost construction materials. The increasingly in using the non-renewable and sustainable resources such as natural fiber have been discovered this century (O. Faruk et al, 2012).The natural fiber was used because of the factors of economy and other related factors (M.A.Aziz et al, 1981). The natural fibers become the main ingredient in each study for the construction industry because the natural fiber is readily available, high demand in construction and manufacturing industry, and can be more effectively and economic due to the technology applied to the natural fiber (M.A.Aziz et al, 1981).

The natural fibers are used to increase the compressive and tensile strength, post cracking resistance, high energy absorbing characteristics and fatigue strength (M.A.Aziz et al, 1981).Other than that, the natural fiber had advantages and disadvantages. According to Prasad et al, (2011), the natural fibers are also good thermal, high resistance, and high strength and stiffness other than low density, cheaper and renewable. The natural fiber need to use compatibilizers or coupling agents to improve the adhesion between fiber and matrix due to the disadvantages of the compatibility between hydrophilic natural fiber and hydrophobic matrix (Prasad et al, 2011).

2.4.1 Natural Fiber Classification

The natural fiber can be classified into two classifications which are the primary and secondary (Rowell, 2008). The primary plants are the plants that grown for the fiber content such as jute, hemp, kenaf and sisal (Rowell, 2008). For the secondary plants such as pineapple, oil palm and coir are the plants that a product from some other of the primary utilization (O. Faruk et al, 2012). (Rowell, 2008) stated that there are six basic types of natural fiber which are bast fiber, leaf fiber, seed fiber, core fiber, grass and reed, and all other types.

Table 2.1: Six General Types of Natural Fibers (Rowell, 2008)

<table>
<tr><th colspan="2">Group</th><th>Examples</th></tr>
<tr><td colspan="2">Bast</td><td>Hemp, Ramie, Flax, Kenaf, Jute, Mesta, Urena, Roselle</td></tr>
<tr><td colspan="2">Leaf</td><td>Pineapple, Sisal, Agava, Henequen, Curaua, Banana, Abaca, Palm, Cabuja, Albardine, Raphia, Curauá</td></tr>
<tr><td rowspan="5">Seed</td><td>Fibers</td><td>Cotton</td></tr>
<tr><td>Pod</td><td>Kapok, Loofah, Milk weeed</td></tr>
<tr><td>Husk</td><td>Coir</td></tr>
<tr><td>Fruit</td><td>Oil palm</td></tr>
<tr><td>Hulls</td><td>Rice, Oat, Wheat, Rye</td></tr>
<tr><td colspan="2">Core</td><td>Kenaf, Jute, Hemp, Flax</td></tr>
<tr><td colspan="2">Grass/reeds</td><td>Wheat, Oat, Barley, Rice, Bamboo, Bagasse, Corn, Rape, Rye, Esparto, Sabai, Canary, grass</td></tr>
<tr><td colspan="2">Other</td><td>Wood, Roots, Galmpi</td></tr>
</table>

The bast fibers are from the inner bark or phloem of dicotyledonous plants and provide structural strength and rigidity to the plant stem. This type of fiber lay under a thin bark and exist as fiber bundles or strands and run parallel to the length of the stem. One of the examples for bast fiber is Kenaf. According to O. Faruk et al, (2012), the kenaf are the genus Hibiscus and an annual plant that grows in temperate climates.

A long, multiple-celled fiber extracted from the leaves of many plants is the definition for leaf fiber. One of the examples of Leaf fiber is Pineapple (Rowell, 2008). The Pineapple leaf fiber has potential for polymer reinforcement because it is rich in cellulose, relatively inexpensive and abundantly available (O. Faruk et al., 2012). Other than that, it has long leaves with long fiber bundles running the length of leaves, hard and stiff (Rowell, 2008).

Coir husk fiber is one of the examples of seed fiber. The coir husk fibers are located between husk and the outer shell of the coconut. According Rowell (2008), there are two types of coir husk fiber which are white fiber and brown fiber. The white fiber of coir husk fiber contains less lignin and more flexible, while the brown coir content of high lignin (Rowell, 2008).

Bamboo is one of the examples of Grass and reed fiber. Bamboo is a perennial plant, which grows up to 40 m in height in mansoon climates. According to O. Faruk et al.(2012), the bamboo fiber are less harmful to human body since the bundle of bamboo fiber can absorb ultraviolet radiation in various wavelengths. The bamboo fiber also stiff and brittle which can be characterized by small rectangular thick-walled cells with blunt to pointed ends and long narrow fibers (Rowell, 2008).

2.4.2 Properties of natural fiber reinforced concretes

Until nowadays, the research and literature on the mechanical and physical properties of natural fiber become more attractive among the researcher and in the construction industry due to the factor of economy and improving the strength of the construction. The different in categories of natural fiber reinforced concretes exhibit the same behaviour and create the new and distinct group of building materials by become the conventional fiber reinforced concrete that produced from steel and other organic or synthetic fibers (M. A. Aziz et al, 1981). The enlarging in the growth of flaws in the concrete matrix into visible cracks which ultimately cause failure make these fiber act as the crack-arresters to restrict the enlargement (M. A. Aziz et al, 1981). The distribution of fiber in fiber matrix offers the suitable and practically improving the mechanical properties such as the tensile and flexural strength, fracture, toughness, fatigue and impact resistance (M. A. Aziz et al, 1981).

2.4.3 Factors Affecting the Properties of Natural Fiber

M. A. Aziz et al, 1981 stated that there are many factors can affect the natural fiber reinforced concrete. The most significant effect to the properties of natural fiber is fiber type, length and volume concentration (M. A. Aziz et al, 1981).

Table 2.2: Factors Affecting Properties of Natural Fiber Reinforced Concretes

Factors	**Constituents**
Fiber type	Coconut, sisal, sugarcane bagasse, wood, bamboo, jute, akwara, elephant grass, water-reed, plantain, musamba, cellulose, etc.
Fiber geometry	Length, diameter, cross-section, rings and hooked ends, etc.
Fiber form	Mono-filament, strands, crimped, single-knotted, etc
Fiber surface	Smoothness, coatings, etc
Matrix properties	Cement type, aggregate type and grading, additive types, etc
Mix design	Water content, workability aids, defoaming agents, fiber content, etc
Mixing method	Type of mixer, sequence of adding constituents, method of adding fibers, duration and speed of mixing, etc
Placing method	Conventional vibration, vacuum dewatering a sprayed-up concrete member, extrusion, guniting, etc
Casting method	Casting pressure, etc
Curing method	Conventional, special method, etc

According to M. A. Aziz et al, (1981), the fiber type is the examples of factors that affecting the propertied of natural fiber reinforced concretes due to different properties in each types of natural fiber. The Cotton fiber content high density with 1.21 g/m³ compare with Sisal fiber that had the density of 1.20 g/m³ (Rowell, 2008). Other than that, the cellulose content in each natural fiber also can be the factors affecting the properties of natural fiber in reinforced concrete. The Rice straw has high content of cellulose compare the Bamboo (Rowell, 2008).

2.5 INTRODUCTION OF *LALANG GRASS*

The natural fiber become big attention due to the ability each type of natural fiber to promote advantages such as renewability, sustainability, non-toxicity, biodegradability, excellent mechanical properties and low cost (Sharil Fadli et al, 20012). *Lalang Grass* also one of the natural fiber under the categories grass and reed fibers. *Lalang Grass* also known as *Imperata Arundinacea* or long-bladed grass. The *Lalang Grass* is the abundant green plant which grows wildly in the rain forests of tropical countries including Malaysia. This plant does not shows any economical value, and also give problems to agriculture industries because the planters need to get rid of *Lalang Grass* that cause allocation of money, energy and time to control the population due to the competition for nutrients, water and light with the agro-economical plant (Sharil Fadli et al, 20012).

2.5.1 Properties of *Lalang Grass*

The natural fiber from any types consists of several components such as cellulose, hemicelluloses, lignin, pectins and extractives. *Lalang Grass* is alsocontent these components because it is also a natural fiber (Sharil Fadli et al, 20012). The cellulose of natural fiber gives a low compatibility with non-polar structure of polymer composites and also contains polar groups in its structure (Sharil Fadli et al, 20012). The mechanical properties will be decrease but can be treated by using fiber surface treatment (Sharil Fadli et al, 20012).

According to Sharil Fadli et al (20012), the *Lalang Grass* has the low compatibility between the fiber and matrix which cause a non-homogeneous dispersion of fiber in their matrix and decrease the mechanical properties. By using the chemical treatment using NaOH hydroxide can give advantage by breaking down the bundle fibers into individual filament fibers and increase the contact area with the their matrix (Sharil Fadli et al, 20012).