PERPUSTAKAAN UMP
0000092695

EFFECT OF PINE FIBER ON CONCRETE COMPRESSIVE AND FLEXURAL STRENGTH

MUHAMMAD SYAFIQ BIN MANSORUDDIN
AA09069

A Final Year Project Report submitted in partial fulfillment of the requirements for the award of the degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering and Earth Resources
Universiti Malaysia Pahang

JUNE 2013

ABSTRACT

There are having been many efforts made to increase the capacity and strength in concrete technology. The use of natural fibers in concrete technology is one of the techniques used to achieve these objectives. The use of natural fibers as an additive in concrete is not widespread and not yet found a place in the industry. This research was carried out to establish the effects of pine fiber addition on concrete compressive and flexural strength. In this study, a total of 36 cubes (150mm x 150mm x 150 mm) and 12 small beams (100mm x 100mm x 500 mm) were prepared according to three types of mixture proportion and all these samples were cured in water curing for 7 days, 14 days and 35 days.

The three types of concrete mixture used in this research were concrete containing 0.1% pine fiber, 0.2% pine fiber and 0.3% pine fiber and plain concrete as control sample. The test results showed that the 0.1% pine fiber content is the optimum percentage of pine fiber additional. Even though the compressive strength result does not show the satisfied result, but the flexural strength of concrete is increased for 0.1% pine fiber. However, the strength of concrete does not increase with increasing of fiber content. The results show a good sign for further investigation to increase the flexural strength of concrete in presence of pine fiber as additive.

ABSTRAK

Banyak usaha yang telah dilakukan dari segi meningkatkan keupayaan dan kekuatan dalam teknologi konkrit. Penggunaan bahan mentah semulajadi dalam teknologi konkrit adalah salah satu teknik yang digunakan untuk mencapai objektif ini. Penggunaan gentian semulajadi sebagai bahan tambahan di dalam konkrit masih tidak meluas dan masih tidak mendapat tempat dalam industri. Kajian ini dijalankan untuk menentukan kesan penambahan terhadap kekuatan mampatan dan kekuatan lenturan sesuatu konkrit setelah ditambah serat mengkuang. Dalam kajian ini, sebanyak 36 kiub yang bersaiz 150mm x 150mm x 150 mm dan 12 rasuk kecil yang bersaiz 100mm x 100mm x 500 mm telah disediakan mengikut tiga jenis nisbah campuran. Kesemua sampel ini telah direndam untuk proses pengawetan dalam tangki air selama 7 hari, 14 hari dan 35 hari.

Tiga jenis campuran konkrit yang digunakan dalam kajian ini. Campuran tersebut adalah konkrit yang mengandungi 0.1% gentian mengkuang, 0.2% gentian mengkuang dan 0.3% gentian mengkuang dan konkrit biasa sebagai sampel kawalan. Keputusan ujian yang dijalankan menunjukkan bahawa kandungan gentian mengkuang sebanyak 0.1% adalah peratusan optimum sebagai bahan tambahan didalam konkrit. Walaupun hasil kekuatan mampatan tidak menunjukkan hasil yang baik, tetapi kekuatan lenturan konkrit meningkat bagi 0.1% gentian mengkuang. Walau bagaimanapun, kekuatan konkrit adalah tidak meningkat dengan peningkatan peratusan kandungan gentian. Keputusan yang diperolehi menunjukkan satu petanda yang baik untuk siasatan selanjutnya pada masa hadapan dalam meningkatkan kekuatan lenturan konkrit oleh gentian mengkuang sebagai bahan tambahan di dalam konkrit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

UMP	-	Universiti Malaysia Pahang
FKASA	-	Fakulti Kejuruteraan Awam dan Sumber Alam
N/mm^2	-	Newton per meter cube
BS	-	British Standard
ASTM	-	American Society for Testing and Materials
mm	-	millimeter
cm	-	centimeter
m	-	meter
ft	-	feet
kg	-	kilogram
g	-	gram
^oC	-	degree Celcius
^oF	-	degree Fahrenheit
MPa	-	Mega Pascal
MR	-	Modulus of Rupture
ACI	-	American Concrete Institution
NRMCA	-	National Ready Mixed Concrete Association
pH	-	Potential of Hydrogen
SI	-	Système International
C-S-H	-	Calcium silicate hydrate
$Ca(OH)_2$	-	Calcium hydroxide
CO_2	-	Carbon dioxide

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

In the modern life era, many researches carried out to give more benefit to humans, developments and technology. Many efforts were done in order to improve the quality of the concrete. One of the innovations carried out is by using fibre as an additive in the concrete. There are two types of fibre commonly used as an additive which are synthetic fibre and natural fibre. Fibrous material can effectively increase the structural ability. Concrete is relatively strong in compression but weak in tension and brittle. Therefore, the addition of the fibrous material it will help to improve the compression and flexural strengths of the concrete. Other functions of fibrous material that used in concrete are to lower permeability rate of concrete and reduce bleeding.

Natural fibres have been the subject of the extensive research. In construction industry, natural fibres provide many advantages such as light weight and reduce the material costs. Moreover, fibres also offer specific benefits such as low density, low pollutant emissions, biodegradability and high specific properties.

Nowadays, research have been carried out to develop different concrete manufacturing processes and to study the mechanical properties of natural fibres. The use of natural fibres as additives in concrete is an alternative way to increase the strength and the quality of the concrete. In this research, pine fibres were used as an additive in concrete. Pine fibre is the Pandanales, a group of economically important monocotyledons, consisting of trees, shrubs and vines of a single family, the Pandanaceae, are confined to the old world tropics. These plants have a remarkable diversity of pollinators, which yield insights to the relationships between pollination and the evolution of plant-breeding systems.

1.2 PROBLEM STATEMENT

Many researches have been done in order to upgrade and increase the plain concrete strength and characteristic. Additives are much needed for plain concrete as the concrete produce is low cost, more durable, less in weight and low pollutant emissions. The best additive for concrete is silica fume. Silica fume can react with calcium hydroxide ($Ca\ (OH)_2$) from the hydration process and producing calcium silicate hydrate (C-S-H). As the result, the process contributes to produce stronger and denser concrete. But the use of chemical additive such as silica fume is very costly beside it is not environmental friendly. Therefore, pine fibre is introduced in this research to find out whether it also can contribute to produce stronger concrete. So in this research the strength of plain concrete and pine fiber concrete will be compare.

1.3 OBJECTIVES

The main objectives for this research are listed as:

i. To study the strength of pine fiber concrete added with 0.1%, 0.2% and 0.3% pine fiber.
ii. To study the optimum percentage of pine fiber added as an additive in concrete mix for 0.1%, 0.2% and 0.3% pine fiber.

1.4 SCOPE OF WORK

In this study, the pine fibre was added into the concrete to observe the effect of the pine fibre on the concrete's flexural strength and compressive strength. 36 cubes and 12 small beams need as sample. The cube size for compression test is 150 mm x 150 mm x 150 mm as illustrated in Figure 1.1. Beams with dimension of 100 mm x 100 mm x 500 mm used for flexural test are shown in Figure 1.2. Others materials need in this project are aggregates, sand, cement, water and pine fibres as an additive. All tests were conducted in heavy concrete lab at Faculty of Civil Engineering and Earth Resources (FKASA), Universiti Malaysia Pahang (UMP). The reference standard used in this project is BS 1881:Part116:1983 and BS 1881:Part118. The additional of pine fibres is 0.1%, 0.2% and 0.3% of the concrete weight. For the pine fibre specimens length it will be 5 cm each. After the testing, the experimental result obtained were analyzed and discussed accordingly. Table 1.1 shows the sample quantity and the testing to take place. 48 samples will be test for 7, 14 and 35 days curing. Three samples will be test for each curing day.

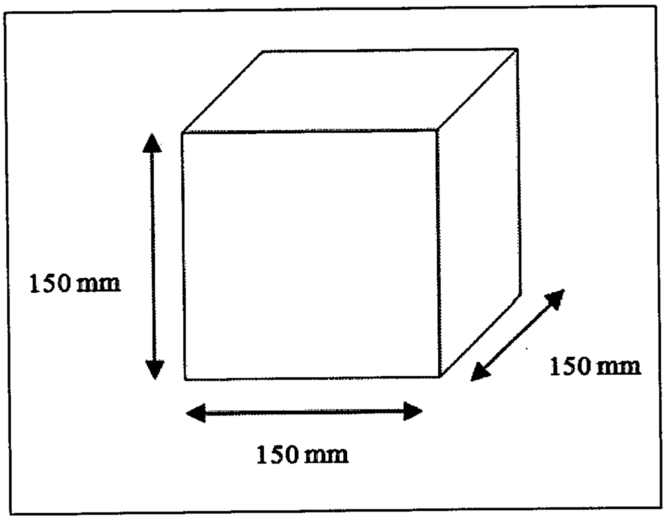

Figure 1.1: Cube Sample Dimension

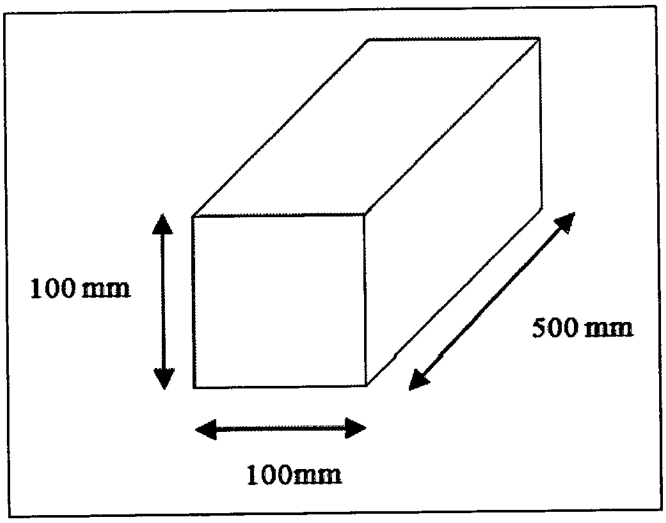

Figure 1.2: Small Beam Sample Dimension

Table 1.1: Number of Samples and Tests

Percentage	**Testing**	**Water Curing (Days)**	**Number**
Control (0%)	Compression	7	3
		14	3
		35	3
	Flexural	35	3
0.1% Pine Fiber	Compression	7	3
		14	3
		35	3
	Flexural	35	3
0.2% Pine Fiber	Compression	7	3
		14	3
		35	3
	Flexural	35	3
0.3% Pine Fiber	Compression	7	3
		14	3
		35	3
	Flexural	35	3
Total Samples			48

1.5 EXPECTED OUTCOMES

This study will determine the effect of adding pine fibre to the concrete mixed. The additional of pine fibre into the concrete will increase the strength of the concrete and also increase the concrete resistance towards tensile force. At the end of the research, the result can be observed by comparing between pine fiber concrete and the control concrete. Furthermore, the optimum percentage of pine fibre as additive on concrete also can be obtained.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The previous study or research which related to the effect of the natural fiber will be discussed in term of its engineering properties. There are two types of strength of concrete which is compressive strength and flexural strength that will be discussed in this research. This chapter also will review some characteristic of the natural fiber and review the performance of the natural fiber in the certain application. The testing use in this research also will be review in order to find out the best and suitable testing method can be use.

The use of natural fibres in construction materials and the interest of natural fibres composite materials are in rapid growth. This situation refers to the industrial applications and the fundamental research. The growing rapidly is due to the high performance of natural fibres in mechanical properties, significant processing advantages and low density. Natural fibres also provide good material performance at a low cost and making the economics attractive for applying these green solutions more globally.

2.2 NATURAL FIBERS

Natural fibres have many benefits such as abundantly available, low weight, biodegradable, low cost, low abrasive nature, renewable source, interesting specific properties and exhibit good mechanical properties (Mahsa G, 2006).

Natural fibre-based composites have been intensively studied in the last few years due to their specific properties and their clearly positive environmental impact. Other advantages of using natural fibres are related to their economical production and processing, their safe handling and working conditions (D. Puglia et al., 2008)

However, using natural fibres in construction materials has some disadvantages for examples low modulus elasticity, high moisture absorption, decomposition in alkaline environment and low thermal stability (Mahsa G, 2006).

Natural fibers can be classified according to their origin and grouped into leaf type as abaca, cantala, curaua, date palm, henequen, pineapple, sisal and banana. The seed fibre type is cotton and for bast type are flax, hemp, jute and ramie. For fruit type, commonly fiber use is coir, kapok and oil palm while for grass type is alfa, bagasse and bamboo. For stalk type fibers is straw (cereal). The bast and leaf (the hard fibers) types are the most commonly used in composite applications (Kalia S. et al., 2009)

2.2.1 Properties of Natural Fibers

In the Figure 2.1 shows there are two types of natural fibers which are animal fibers and plants fibers. Plants fiber can be divided into 2 classes which is wood and non wood. Example of wood is soft and hard wood. For the non wood, there is another five classes such as straw, bast, leaf, seed/fruit and grass. The example of straw fibers is corn, wheat and rice. For the bast class is Kenaf, Flax, Jute and Hemp. Sisal and pineapple leaf are the example for leaf class while cotton and coir is an example for ssd/fruit class. Lastly, for the non wood is a grass class where the example is bamboo, switch grass and elephant grass.

Meanwhile, Table 2.1 shows the comparison mechanical and physical properties of natural fibers. Each fiber has different value in term of density, moisture content, elongation to break, fracture stress and young's modulus. The table showed the properties of several natural fiber which is cotton, jute, flax, hemp, sisal, coir, bamboo, pineapple and ramie.

In Table 2.2 lists the advantages and the disadvantages of natural fiber. The advantages of natural fiber is low cost investment to produce, possible for thermal recycling, low specific weight and natural fiber is one of the renewable resources. However the disadvantages of natural fiber are the price can be fluctuate, has lower durability, moisture absorption and have lower strength properties.

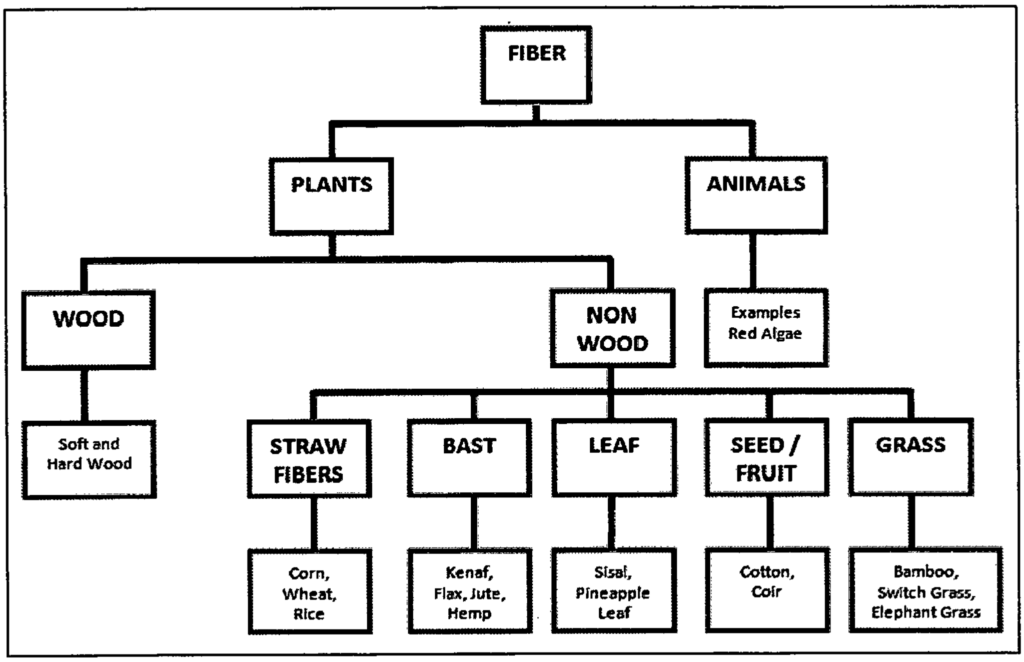

Figure 2.1: Type of Natural Fibers (Mohanty AK et al., 2002)

Table 2.1: Properties Comparison of Natural Fibers (F.T. Wallenberger, 2003)

Fiber	Density (g/cm^3)	Moisture content (wt%)	Elongation to break (%)	Fracture stress (MPa)	Young's modulus (GPa)
Cotton	1.5	-	7.0-8.0	287-597	5.5-12.6
Jute	1.3	12.6	1.5-1.8	393-773	26.5
Flax	1.5	10.8	2.7-3.2	345-1035	27.6
Hemp	-	11.0	1.6	690	-
Sisal	1.5	8.0	2.0-2.5	511-635	9.4-22.0
Coir	1.2	-	30.0	175	4.0-6.0
Bamboo	0.8	11.8	-	391-1000	48-89
Pineapple	-	10.0	1.6	413-1627	34.5-82.5
Ramie	1.5	8.0	3.6-3.8	400-938	61.4-128

Table 2.2: Advantages and Disadvantages of Natural Fiber (Nurulhuda, 2008)

Advantages	**Disadvantages**
• Low cost investment to produce which makes the material an interesting product for low-wage countries.	• The price can fluctuate by harvest results or agricultural politics.
• Possible for thermal recycling where glass causes problems in combustion furnaces.	• Lower durability, fiber treatments can improve this considerably.
• Low specific weight which resulting in a higher specific strength and stiffness than glass. Give the benefit especially in parts designed for bending stiffness.	• Moisture absorption, which causes swelling of the fibers.
• One of the renewable resources, the production requires little energy; CO_2 is used while oxygen is given back to the environment.	• Have lower strength properties, particularly its impact strength.

2.3 PINE FIBERS (PANDANUS ATROCARPUS)

Pine which the scientific name is Pandanus Atrocarpus is a type of plant in family pandanaceae monocotyledons. This tree thrives in the sides of the groove, swamps, rivers and freshwater swamp areas throughout the archipelago. Pine has a larger leaf size and length compared with pandan leaves (Zainura, 2010).

Pines vary in size from small shrubs less than 1 m tall and up to medium-sized trees 20 m tall. A pine is typically with a broad canopy and moderate growth rate. The trunk is stout, wide-branching, and ringed with many leaf scars. Pines commonly have many thick prop roots near the base, which provide support as the tree grows top-heavy with leaves, fruit, and branches. The leaves are strap-shaped, varying between species from 30 cm up to 2 m or more long, and from 1.5 cm up to 10 cm broad (Wagner, Herbst, & Sohmer 1990).

Moreover pines are dioecious, with male and female flowers produced on different plants. The flowers of the male tree are 2-3 cm long and fragrant, surrounded by narrow, white bracts. While the female tree produces flowers with round fruits that are also bract-surrounded. The fruits are globose, 10 to 20 cm in diameter, and have many prism-like sections, resembling the fruit of the pineapple. Typically, the fruit changes from green to bright orange or red as it matures. The fruit is edible (Wagner, Herbst, & Sohmer 1990).

In the Table 2.3 show the general characteristics of Pandanus Atrocarpus such as the distribution, size, habitat vegetation, soils, growth rate and many more. Pandanus Atrocarpus can be found in native throughout the Pacific islands and parts of Southeast Asia and northern Australia. It can reaches 4 m until 14 m in height and the habitat usually at elevation of sea level to 20 m and can grow at elevations of 600 m or higher. Pandanus Atrocarpus also associated with species of coastal forests and it is adapted to a very wide range of light to heavy soil types. This plant growth rate is slow to moderate about 2-80 cm per year. The yield for this plant is around 10 to 300 leaves per tree per year or about 8 to 12 fruits. For the intercropping, it is often planted in and around mixed agro forests in the pacific.

Meanwhile in the Table 2.4 show the environmental preferences of Pandanus Atrocarpus. The suitable climate for this plant is in its native habitat, the temperatures are warm to hot throughout the year and show little variation, both seasonally and diurnally. The elevation range is about 0 m to 20 m and it may be cultivated at higher elevations. This plant mean annual rainfall preferences is about 1500 mm to 4000 mm and the pandanus is adapted to climate with summer, bimodal and uniform rainfall patterns. The dry season duration is long-time average rainfall data suggested that across its range these is a short or no dry season. However, there may be a dry season up to 6 months or longer in some years especially in central or equatorial Pacific. The mean annual temperature suitable for the pandanus is 24°C to 28°C while the mean maximum temperature of hottest month is 28°C to 36°C. For the mean minimum temperature of coldest month is 17°C to 25°C and the pandanus minimum temperature tolerated is 12°C. Other environmental preferences are about the soil. The pandanus occurs on various coastal soils especially sandy and rocky beaches including raised coralline terraces and recent basalt. The soil texture is in light to heavy soils such as sands, sandy loams, clays and many more. This plant grows in soils that are impeded drainage including seasonally waterlogged soils. The suitable soil acidity for pandanus plant is in soils of acid to alkaline around pH 6 to 10. Lastly, the pandanus special soil tolerances are it can be grows in shallow, saline, sodic and poor nutrient soils. In the Figure 2.2 show the pine plant.

Table 2.3: Pandanus Atrocarpus characteristics (Lex A.J Thomson et al., 2006)

Characteristics	**Description**
Distribution	Native throughout the Pacific islands and parts of Southeast Asia and northern Australia.
Size	Reaches 4-14 m (13-46 ft) in height, with about the same canopy diameter.
Habitat	Usually elevations of sea level to 20 m (66 ft), but can grow at elevations of 600 m (1970 ft) or higher.
Vegetation	Associated with species of coastal forests.
Soils	Adapted to a very wide range of light to heavy soil types.
Growth rate	Stem growth is slow to moderate, 2-80 cm (0.8-3 ft) per year.
Main agro forestry uses	Coastal protection, windbreak, home gardens.
Main uses	Food, thatch, weaving.
Yields	10-300 leaves per tree per year or 8-12 fruits.
Intercropping	Often planted in and around mixed agro forests in the Pacific.
Invasive potential	Naturally spreads into coastal plant communities. Since it is native to Pacific islands, the tree is not considered to be invasive.