PENILAIAN GENTIAN KELULI KECIL UNTUK MENINGKATKAN CIRI-CIRI LENTURAN KONKRIT BERTETULANG

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ABSTRACT

Improving construction material with minimum cost is main goal of construction industry and in this regard several researches have been documented. To improvement of plain concrete quality and reducing construction cost a new simple technique has been suggested. The small steel fiber in different length directly has been used in concrete mixed design for modifying plain concrete fractural characteristics. The main objectives are evaluating length and percentage of small steel fiber in modifying plain concrete flexural characteristics. The result indicated that this method is one of the easiest and cost effective techniques and also less time is required for enhancing plain concrete flexural characteristics. It has been find that if steel fiber length of 50 mm shown better performance compare to when steel fiber length is 10 mm, 20 mm and 40 mm. The limitation was the smooth steel fiber is used and the result could be better in application of deformed steel fiber or rough surface steel fiber.

ABSTRAK

Antara matlamat utama industri pembinaan ialah meningkatkan kualiti bahan binaan disamping dapat meminimumkan kos pembinaan. Beberapa penyelidikan telah berjaya dilakukan dalam usaha tersebut. Untuk meningkatkan kualiti konkrit disamping mengurangkan kos pembinaan satu kaedah baru telah disarankan. 'Steel fiber' atau gentian keluli dengan panjang yang berlainan telah ditambah pada konkrit untuk meningkatkan keupayaan konkrit dalam mengawal keretakkan. Objektif utama adalah untuk menentukan panjang dan peratusan gentian keluli yang diperlukan untuk mengubahsuai karekteristik sesebuah konkrit. Keputusan analisis menunjukkan kaedah ini adalah yang paling mudah dan menjimatkan kos disamping memerlukan masa yang singkat untuk merubah karekteristik sesebuah konkrit. Ia terbukti apabila gentian keluli dengan panjang 50mm mampu menghasilkan kualiti yang lebih baik berbanding gentian keluli dengan panjang 10mm,20mm dan 40mm. Hanya gentian keluli yang berpemukaan licin dan halus digunakan dalam kaedah ini namun jika gentian keluli dengan permukaan yang kasar dan tidak sekata digunakan,hasil yang lebih baik boleh diperolehi.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Concrete is produce by mixing water, aggregates and with a binding agent (usually cement) and, if necessary, with addictive. This mixture is usually made on building sites and factories. Concrete is incredibly useful and flexible building material but without modern architecture and construction would not be possible. It is used in building, foundations, bridges, footings, roads and in many other infrastructures and construction activities.

The concrete characteristic is depending on type and ratio of aggregate and cement as well as addictive. The used of concrete and surface treated can also have impact on their performance and appearance. The color, chemical and physical characteristics of aggregates have a direct impact on the durability, esthetics and mechanical properties of concrete.

The mechanical properties of concrete can be improved by the addition of steel fibers. Some researchers have proved that the addition of steel fibers in concrete can enhance greatly the ductility and toughness not only after 28 days, but also at early stages.

It is well known that the addition of steel fibers in concrete significantly improved the concrete behavior such as tensile, flexural, impact, fatigue and abrasion strength, deformation capability, load bearing capacity after cracking and toughness properties. The presence of steel fibers in the concrete induces a multi-axial state of stress, results in a higher strength.

Many researcher hold the view that steel fibers do not have a significant influence on the compressive behavior of concrete due to the small volume of fibers in concrete mix.

Role of steel fibers is to impact ductility and energy absorption characteristics without any marked influence on compressive strength of concrete. Shorter fibers with a high fiber count offer superior first crack strengths and better fatigue endurance. Tensile and flexural strengths of concrete are also enhanced significantly due to the addition of steel fiber.

The uses of steel fibers in producing a high quality of concrete can offer substantial cost savings. The superior performance of steel fiber will often reduce maintenance over the installations life, thus reducing the project cost.

1.2 State of problem

Plain concrete is a brittle material. Under impact loading plain concrete exhibits extensive cracking and undergoes brittle failure. Poor toughness, a serious shortcoming of high strength concrete can be overcome by reinforcing with steel fibers. The most important effect of steel fibers used in conventional concrete is prevention of crack propagation in concrete. The addition of steel fibers at high dosages, however, has potential disadvantages in terms of poor workability and increased cost. In addition, due to the high stiffness of steel fibers, micro defects such as voids and honeycombs could form during placing as a result of improper consolidation at low workability levels.

There are many research works are going on for improving quality and performance of concrete without increasing the cost of construction. The main objective of this research work is to enhancement concrete tensile strength. And at final the a reinforced concrete has been introduced and time for construction of reinforced concrete has been reduced as well as economically increased concrete tensile strength.

1.3 Objectives

The objectives this research work is as following:

a) Assessment of small steel fibers length in reinforced concrete characteristics.

b) Evaluation of small steel fibers proportion in reinforced concrete strength enhancement.

c) Analyzing stress-steel fiber length behavior in this new reinforced concrete.

1.4 Scope of study

The scope of this research work is as following:

a) Introducing new reinforced concrete.

b) Time reducing for construction of reinforced concrete.

c) Increasing concrete flexural strength.

The author made an investigation for introducing new reinforced concrete for reducing construction time as well as improving concrete flexural strength quality by using small steel fiber during concrete mixed design.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

2.1.1 Concrete

Concrete is the most widely used as a construction material in the world. The use of concrete is so widespread, especially in construction industry. Concrete can be considered very important in everyday life. It was used as long ago as the Greek and Roman Civilizations (Neville, 1981). Concrete such a good construction material where it has a high compressive strength. However, the concrete also has it weakness. The weakness of concrete in tension has been identified since the early1800. Under impact loading plain concrete exhibits extensive cracking and undergoes brittle failure. Concrete requires some form of tensile reinforcement to make up for its brittleness and improve its tensile strength and strain capacity for it to be used in structural applications.

2.1.2 Steel Fibers

Steel fibers are prominent in early literature to improve the mechanical properties of concrete. Early steel fibers used as concrete reinforcement were round and smooth. Today, smooth, straight fibers have largely been replaced by fibers that have either rough surfaces, hooked ends, or are crimped throughout their length. Most steel fibers are manufactured from steel wire. However, steel fibers also can be made from steel sheet material (slit sheet method) and by the melt-extraction process. The presence of steel fibers in concrete can enhance many of the engineering properties materials, such as fracture toughness, flexural strength, and resistance to fatigue, impact, thermal shock and spalling.

The replacement of traditional reinforcing bars with steel fibers has the following advantages:

a) Steel fibers increase the tensile strength of the matrix, thereby improving the flexural and shear strength of concrete.

b) The bridging mechanism of fibers and its tendency to redistribute stress evenly throughout the matrix contribute to post-cracking resistance, restrain crack.

c) Growth and impart ductility to concrete.

d) Producing and placing traditional rebar requires costly labor and time. Thus, use of fibers in concrete saves labor costs and time.

2.1.3 Classification of Steel Fibers

There are two typical methods generally used for fibers classification. First, fibers can be group by the low modulus or high modulus compared with the modulus of the concrete. The second method is according to their origin as either metallic, mineral or organic or this method widely had been used. Figure 2.1shows the classification of fibers.

In metallic fibers, steel, carbon steel, and stainless steel is the most popular types of fiber. Asbestos and glass fibers are two normal fibers in the group of mineral fibers.

Organic fibers can be further divided into natural and man-made fibers. Natural fibers can be separated into vegetable origin or sisal and animal origin. For example, wood fibers and leaf fibers are vegetable origin, while hair fibers and silk are from animal origin fibers. Man-made fibers can also be divided into two groups; there are natural polymer and synthetic fibers. For instance, cellulose and protein fibers are from natural polymer, while nylon and polypropylene are synthetic fibers (James Patrick Maina Mwangi, 1985).

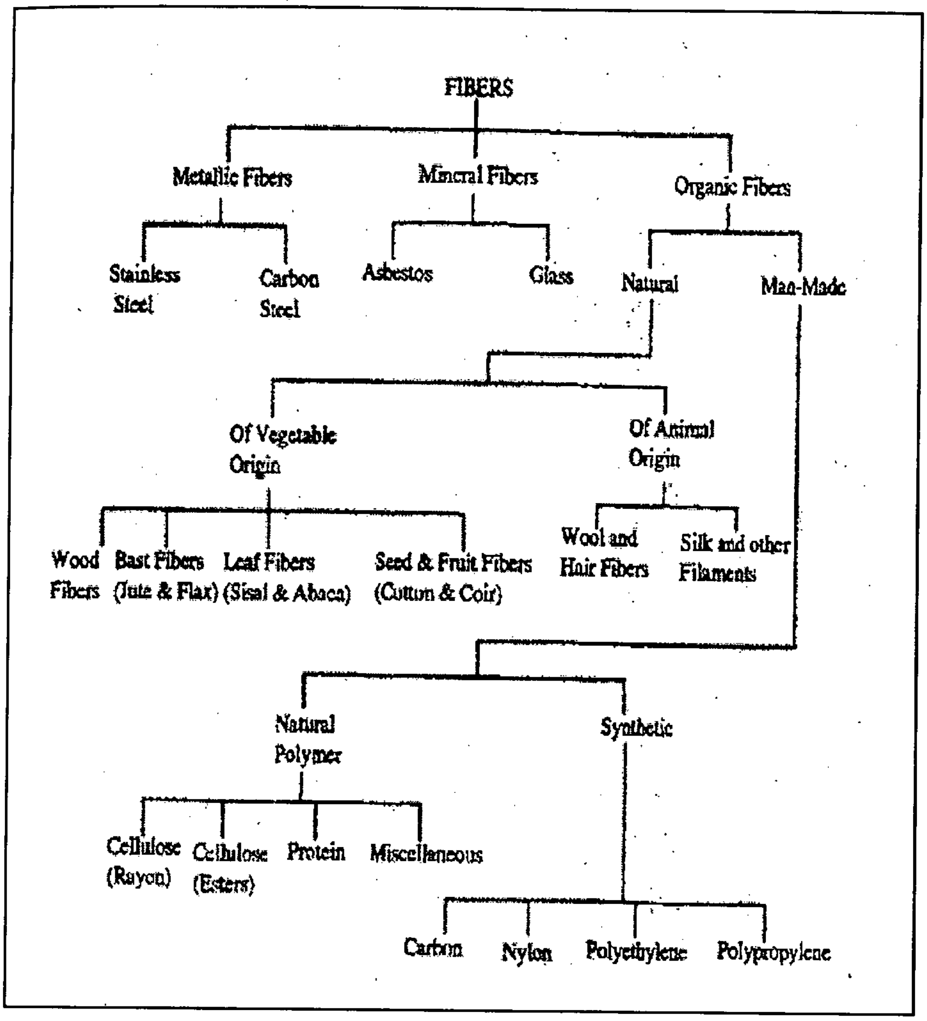

Figure 2.1: Fiber Classification [James Patrick Maina Mwangi, 1985]

There are several types of fibers have been used in the civil engineering fields. Table 2.1 shows the properties for the typical types of fibers.

Table 2.1: Typical Properties of Fibers [Johnson, Colin D. , 1985]

Fibers	Diameter (μm)	Specific Gravity	Modulus of elasticity	Tensile Strength (GPa)	Elongation to Failure (%)
Chrysotile Asbestos	0.02-20	2.55	164	3.1	2-3
Crocidolite Asbestos	0.02-20	2.55	196	3.5	2-3
E-Glass	9-15	2.56	77	2-3.5	2-3.5
AR-Glass	9-15	2.71	80	2-2.8	2-3
Fibrillated Polpropylene	20-200	0.91	5	0.5	20
Steel	5-500	7.84	200	1-3	3-4
Stainless Steel	5-500	7.84	160	2.1	3
Carbon Type I	3	1.90	380	1.8	0.5
Carbon Type II	9	1.90	230	2.6	1.0
Aramid (Kevlar)	10	1.45	65-133	3.6	2.1-4.0
Cellulose	-	1.2	10	0.4	-
Wood	-	1.5	71.0	0.9	-
Nylon (Type 242)	>4	1.14	4	0.9	1.5

2.1.4 Fiber Reinforced Concrete

With the improvement in concrete technology, concrete strength over 100MPa can be easily produced to fulfill the current construction requirement. However, the main concern with high strength concrete is the increasing brittleness with the increasing of strength.

Therefore, a new trend has emerged in the concrete industry over the past few decades. Fibers of varying material, size, and geometry have been added to the concrete mixture to produce a construction material generally known as Fiber Reinforced Concrete (FRC). Fibers which added to the concrete are generally measured as a portion of the total volume of the concrete. Generally, there are three categories with regards to the fiber portion introduced into the matrix, for example low volume, moderate and high volume (John Mackay, 2002).

Low volume of fibers composites are typically being used for applications which involving large volumes of concrete. The matrix is usually proportioned following the procedures used for plain concrete, with slight modification done on the mix. Volume fractions of fibers range from 0.4 to 2 percent for steel fibers, while 0.06 to 0.5 percent for polymeric fibers. The design of the fiber concrete mixture should consider the concrete's workability and good fibers distribution as well.

Moderate fibers volume composites are usually being used for special applications. These composites normally only contain cement and fine aggregate leading with fiber volume fractions usually range from 1 to 5 percent.

High fibers volume composites are similar to fiber reinforced cement mortar except that they contain very little or no fine aggregate. Fiber volume fractions ranging from 3 to 6 percent have been used in the past (John Mackay, 2002).

Besides, the fibers can be divided into micro-fibers and macro-fibers. Micro-fibers usually been used at relatively low dosages (0.08 to 0.2% by volume) to reduce the plastic shrinkage by providing the concrete with early tensile strength and arresting micro cracks. Micro-fibers are usually less than 40 microns in diameter and from 1 to 50mm in length made from steel, carbon and polypropylene. It has also been suggested to define micro-fibers as with the specific surface area less than 20m2/kg. Figure 2.2 shows the typical micro-fiber used in the construction.

However, macro-fibers are added to concrete at relatively high dosages ranging from 0.3 to 2.0% by volume, which normally 0.3 to 1.0mm in diameter and 15 to 60mm in length. This is normally referred for steel or synthetic material such as polyethylene fibers which shown in Figure 2.3.

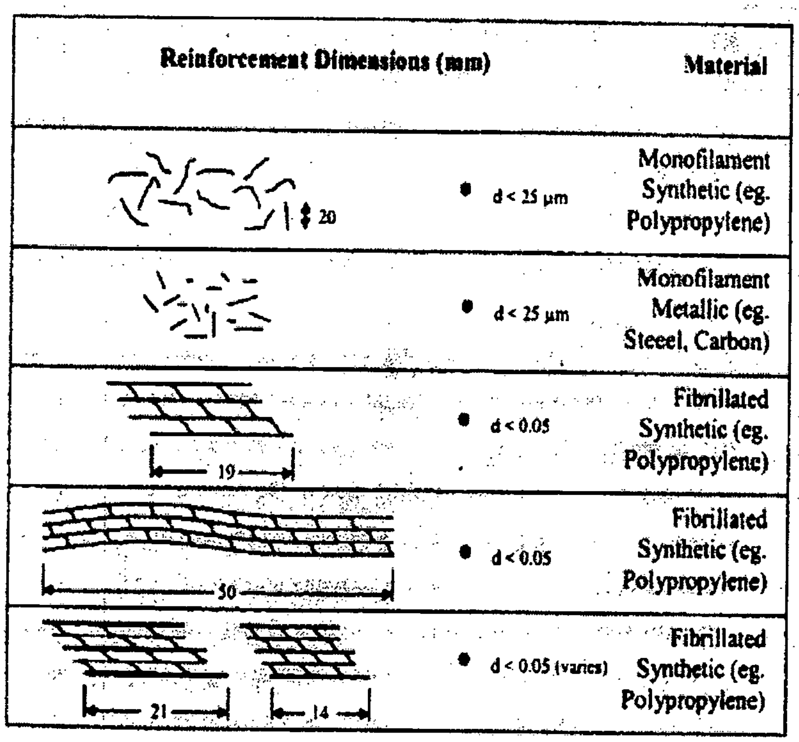

Figure 2.2: Typical Micro-Fiber Used in Construction [John Mackay, 2002]

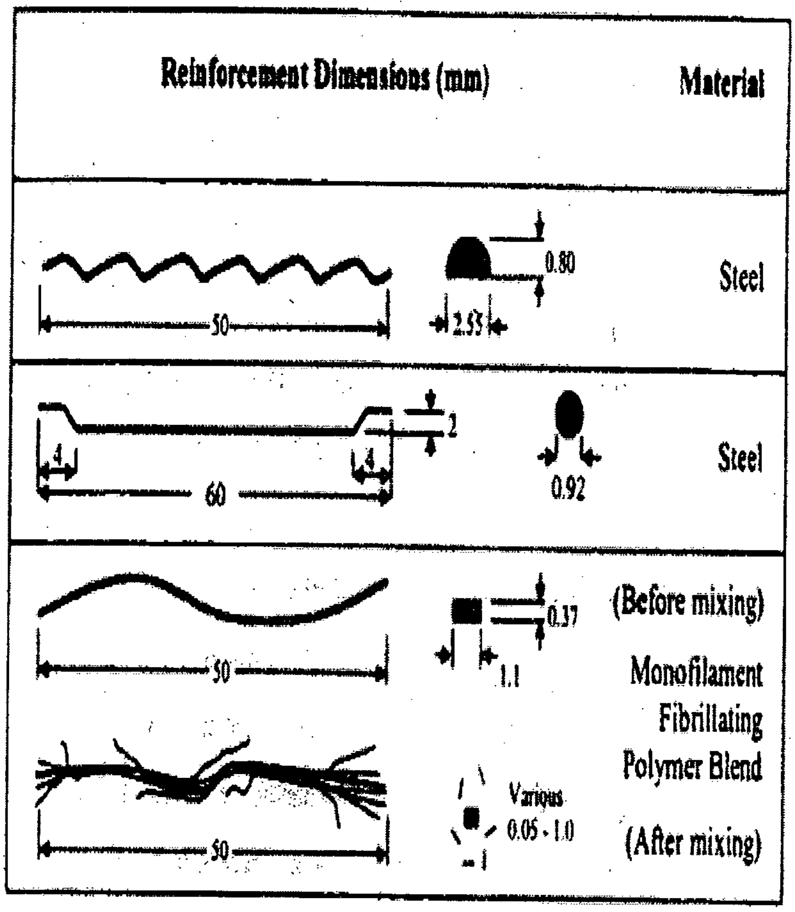

Figure 2.3: Typical Macro-Fiber Used in Construction [John Mackay, 2002]

2.1.5 Steel Fiber Reinforced Concrete (SFRC)

Steel fibers are the most popular material for the reinforced concrete. In general, steel fiber length is around 12.7mm to 63.5mm. The most common steel fibers diameters are in the range of 0.45mm to 1.0mm. The steel fibers have several shapes which include round, oval, rectangular, and crescent cross sections, depending on the raw material used and the method of manufacture. Figure 2.5 shows various shapes of steel fibers (A. Sivakumar, Manu Santhanam, 2007).

Hydraulic cements, fine and coarse aggregate and short steel fibers are the material to produce steel fiber reinforced concrete. It may contain chemical or organic admixture. The steel fibers usually range from 0.25 percent to 2 percent by volume (Hannant, 1978). The aspect ratio, (*l/d*), can be varied from 30 to 250. The major problem for SFRC is the difficulty in mixing and workability because the fiber will bundle or balling if the fibers volume is high or the fibers are too long.

Mechanical and engineering properties of steel fibers reinforced concrete are significantly improved if compared to plain concrete, notably flexural strength, fatigue strength, impact strength, toughness and the ability to resists cracking and spalling. Normally, the efficiency of steel fibers will increase by increasing the matrix strength. The improvement of the SFRC properties is affected by the steel fibers shape, size, type, volume percentage, distribution, properties and quantity (James Patrick MainaMwangi, 1985).

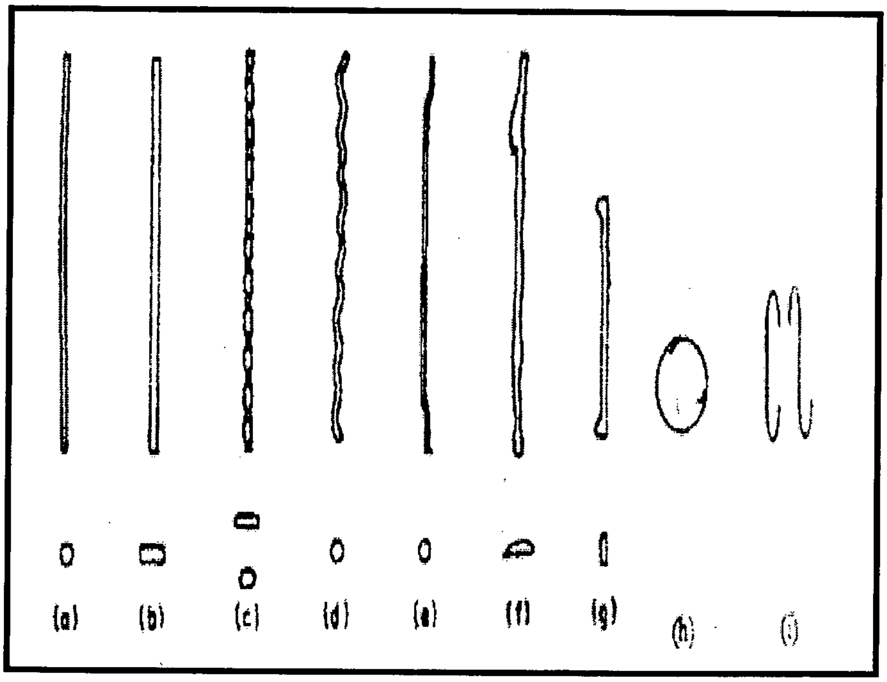

Figure 2.4: Types of Steel Fibers [James Patrick Maina Mwangi, 1985]