STUDY OF SHEAR FOR STEEL FIBRE REINFORCED CONCRETE BEAM WITH RATIO OF 0.2%, 0.4%, 0.6%, 0.8% AND 1.0%

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ABSTRACT

Concrete is the most widely used man-made construction material in the world. It can be defined as a composite material composed of a coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the particles and glues them together. One of the applications of beam is used as a floor, such as for factories and parking lot. One layer of steel fabric mesh was introduced on top or bottom section of concrete for controlling the cracks only. But during the service life, these structures are subjected to cyclic, impact loads and loads from heavy goods and etc, causing the service life of structures become shorten. These floors need an adequate fatigue flexural strength and energy absorption capacity. The application of steel fibres as an alternative way can be introduced into the beam to overcome the problem of cracking for the structure of building. This report presents an experimental study on the steel fibre reinforced concrete beams with different ratios of steel fibre. The study is about using a steel fibre as one of the component in the concrete. In this experiment, a total of eighteen reinforced concrete beam casted and tested to fail. The beam with reinforcement bar R6 and incorporated with 0.2%, 0.4%, 0.6%, 0.8%, 1.0% of steel fiber and a normal reinforced concrete beam. All the beams have overall size of 100mm x 100mm x 500mm and tested with flexural test. Experimental results on the flexural behaviour indicated that the beam with steel fiber performed almost in a same manner with the normal reinforced concrete beam. Both ultimate load capacity and flexural behaviour of steel fibre reinforced concrete were found to be higher compared to normal concrete beam. From the research, it is found that sample incorporated with 0.6% of steel fibre possessed the high compression and flexural strength compared to the other five types of samples.

ABSTRAK

Konkrit merupakan bahan buatan manusia yang paling banyak digunakan di dunia. Ia boleh ditakrifkan sebagai suatu bahan komposit yang mengandungi butiran kasar iaitu batu-batuan dan pasir yang tertanam di dalam satu acuan khas iaitu simen, yang mana ia mengisi ruang-ruang kosong di dalamnya dan melekatkannya sekali. Salah satu aplikasi rasuk ialah digunakan sebagai lantai, sebagai contoh lantai untuk kilang dan tempat letak kereta. Satu lapisan tetulang diletakkan di bahagiaan atas lantai konkrit untuk mengawal keretakan sahaja. Sepanjang hayat penggunaan, lantai ini akan ditindaki oleh beban secara berulang-ulang, beban impak, beban dari barang berat dan sebagainya, ini akan menyebabkan jangka hayat lantai berkurangan. Struktur lantai ini perlu mempunyai kekuatan lenturan dan tenaga serapan yang mencukupi. Penggunaan gentian keluli adalah sebagai cara lain yang boleh diaplikasikan dalam lantai konkrit untuk menangani masalah keretakan struktur bangunan. Laporan ini membentangkan kajian eksperimental tentang rasuk konkrit gentian tetulang dengan peratus kandungan gentian keluli yang berbeza. Kajian ini menggunakan gentian keluli sebagai salah satu komponen di dalam pembuatan konkrit. Dalam ujikaji ini, 18 rasuk konkrit disediakan dan diuji sehingga gagal. Rasuk yang dibuat adalah dengan tetulang besi R6 ditambah dengan gentian tetulang 0.2%, 0.4%, 0.6%, 0.8%, 1.0% dan rasuk konkrit normal. Semua rasuk mempunyai saiz 100mm x 100mm x 500mm dan diuji dengan ujian lenturan. Keputusan menunjukkan sifat lenturan rasuk dengan gentian keluli hamper menyerupai rasuk konkrit bertetulang biasa. Beban muktamad dan kelakuan lenturan rasuk mempunyai gentian keluli menunjukkan prestasi lebih baik dibandingkan dengan rasuk konkrit biasa. Hasil daripada kajian ini mendapati sampel konkrit yang mengandungi 0.6% kandungan gentian keluli memiliki kekuatan mampatan dan lenturan yang paling tinggi berbanding dengan lima lagi jenis sampel yang berlainan.

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LIST OF SYMBOL

%	= Percentage
mm	= Millimeter
□mm	= Phi Millimeter
cu yd	= cubic yard
Mpa	= Mega Pascal
N/mm^2	= Newton per millimeter square
Cr	= Chromium
Ni	= Nickel
ZrO_2	= Zirconium Dioxide

LIST OF ABBREVIATIONS

ASTM	= American Society Testing and Material
Asv	= Cross sectional area of the two legs of link
b	= Width of the sample
d	= Thickness or depth of the sample
F	= Load (force) at the fracture point
FRC	= Fiber Reinforced Concrete
fyv	= Characteristic strength of the reinforcement, ($\leq$500 N/mm^2)
GRC	= Glass Reinforced Concrete
L	= Length of the support span
M	= Design moment force values at the section due to the particular ultimate load condition
V	= Design shear force values at the section due to the particular ultimate load condition
W/C	= Water Cement Ratio

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Construction Industry is one of the most booming industries in the whole world. The construction industry is generating wealth and improving the quality of life for the world and also Malaysian through the translation of government's sosio-economic policies. Concrete is the mostly used materials in the world. According to the Portland Cement Association, it is estimated that annual production of cement is expected to excess 5 billion cubic yard.

According to Theodore (2002)[1], basically concrete is 60 to 80 percent inert ingredients of aggregates which comprising sand, stone and others whereby it is considered inert ingredients, and 20 to 40 percent active ingredients of paste which comprising water, Portland cement and others, whereby it is considered as the active ingredients. These materials are combined, or mixed, and cured to develop the hardened properties of concrete.

Concrete is chosen as construction materials because of its advantages. One of the advantages of concrete is it possesses a high compressive strength. Concrete when properly prepared its strength is equal to that of a hard stone. This characteristic has made concrete popular materials in construction industry. There are many experimental and researched has been done by researcher in upgrading the quality of the concrete that already exist nowadays.

Having additional materials in concrete is part of the technology invention made by researcher to improve quality properties required in concrete itself. Examples of common admixtures used in mixing concrete are divided into two which is chemical admixtures and mineral admixtures. Usually these admixtures are function to increased workability of fresh concrete, to improve the durability of the concrete, to accelerate setting and hardening and thus to produced high early strength of the concrete, to reduced evolution of heat, and others function that is required and necessary for the concreting work.

Today they are many incorporated concrete with addition materials to improve the quality of the concrete. This study is focusing on usage of the fibre admixtures to be incorporated in the concrete mixtures. It has been successfully used in construction with its excellent flexural-tensile strength, resisting to splitting, impact resistance and excellent permeability, and frost resistance. It is an effective way to increase toughness, shock resistance, and resistance to plastic shrinkage cracking of the mortar.

Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these different fibres that character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and densities.

1.2 Problem Statement

Concrete is the most widely used man-made construction material in the world. It can be defined as a composite material composed of a coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the particles and glues them together. One of the applications of beam is used as a floor, such as for factories and parking lot. One layer of steel fabric mesh was introduced on top or bottom section of concrete for controlling the cracks only. But during the service life, these structures are subjected to cyclic, impact loads and loads from heavy goods and etc, causing the service life of structures become shorten. These floors need an adequate fatigue flexural strength and energy absorption capacity. The application of steel fibres as an alternative way can be introduced into the beam to overcome the problem of cracking for the structure of building. This report presents an experimental study on the steel fibre reinforced concrete beams with different ratios of steel fibre. The study is about using a steel fibre as one of the component in the concrete. In this experiment, a total of eighteen reinforced concrete beam casted and tested to fail.

This study is about using a steel fibre with no end hook as one of the component in the concrete mixtures generally in concrete composition. This study is conducted to determine the optimum percentage of steel fibre contents in concrete structure respects to its shear strength and also to find out the value of compressive and flexural strength of the specimen with different ratios of steel fibre. In this study, the compressive strength for cube test and the flexural strength for beam test are tested and comparison is made between normal concrete and concrete incorporated with steel fibre.

1.3 Objective of the study

The objectives of the study are:

i. To find the significant of shear strength due to a variation of steel fibre ratios in beam design.

ii. To find out the value of compressive and bending stress of the specimen with different ratio of steel fibre.

iii. To compare and choose the optimum percentage of steel fibre contents in concrete structure respects to its shear strength.

1.4 Scope of the study

In order to achieve the objective of this study, a compression test and flexural test was implemented which was accordance to the ASTM C-39 and ASTM C-78 respectively for standard section beams with appropriate loading bearers.

The concrete grade 30 was used during the preparation of the concrete mixture for the usage of normal concrete as the control sample, 0% and sample with 0.2%, 0.4%, 0.6%, 0.8% and 1.0% of steel fibre.

In this study, the steel fibre with no end hook was used in incorporated with the normal concrete that contain normal composition and proportion of concrete materials which are cement, aggregates, and water.

There are 36 cubes and 18 beams of concretes will be prepared for this study. The proposed size for the cube is 150mm x 150mm x 150mm, while size for beam is 500mm x 100mm x 100mm.

For the cube specimen, compression test for 7 days and 28 days are conducted. Besides for the beam specimen, flexural test are conducted only for 28 days.

1.5 Limitation of the study

This study is only to find the significant of shear strength due to a variation of steel fibre ratios in the beam design. This study also to know the value of compressive and bending stress of the specimen of beam respects to it shear strength.

1.6 Expected outcome

It is expected that the concrete which mix with the steel fibre for the reinforced concrete beams give higher shear strength and can control crack of the concrete.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Concrete is very variable material, having a wide range of strength. It is literally forms the basis our modern life, for example roadways or transportation systems, airstrips, infrastructure for example bridges, dams and buildings, harbor protection for example break walls, and water distribution for example pipes and conduit. According to Neville, A.M. (1995) [2], concrete have the ability to cast the desired shapes, for example into archers, piers, columns and shells. Properties can be tailored according to need in term of strength, durability and lots more. Concrete have the ability to resist high temperatures, it will maintain structural integrity far longer than structural steel and it does not require protective coatings. It also can be an architectural and structural member at the same time for example is the concrete structure in the City of Arts and Sciences, Valencia Spain.

Chemrouk and Attari (2006) [3] mentioned that concrete is a material that have the most versatile characteristic. This is because concrete which being a fluid at start, can be poured into any mould in order to obtain any shape after hardening,

architecturally aesthetic or ugly, it is all up to the designer and also a question of economy. The properties of concrete is workability, concrete are easy to work with and not hard to prepare it. Next is it has durability to withstand wind load, dead load and live load. The strength of concrete as stated before, it have the ability to resist high temperatures, it will maintain structural integrity far longer than structural steel and it does not require protective coatings, concrete also have chloride penetration resistance and resistance of abrasion.

2.2 Reinforced Concrete

Reinforced concrete is a combination of concrete and steel reinforcement. Concrete is strong in compression but weak in tension, thus with adding reinforcement, it will increase the strength in tension. In addition the failure strains of concrete in tension with low that the reinforcement has to hold the cracked section together. For a strong, ductile and durability of construction, the reinforcement shall have the following properties:

i. High tensile strain
ii. High strength
iii. Good bond to the concrete
iv. Thermal compatibility
v. Durability in the concrete environment

It is strong durable building material that can be formed into many varied shapes and ranging from a simple rectangular column, to a slander curved dome or shell. Its utility and versatility are achieved by combining the best features of concrete and steel. (According to the book of Reinforced Concrete Design, Fifth Edition, by W.H. Mosley, J.H. Bungey and R. Hulse) [4].

As Moir, G. (2003) [5], stated that concrete has been widely known to be reinforced with steel reinforcement in order to gain substantial tensile strength. Many researchers have been conducted to investigate the ability of other construction material to sustain adequate tensile capacity in concrete structure.

2.3 Fibre Reinforced Concrete

Fibre Reinforced Concrete (FRC) is concrete containing a fibrous material which is increase its structural strength. It contains short discrete fibres that are uniformly distributed and randomly oriented.

Fibre is a class of materials that are continuous filaments or are in discrete elongated pieces, similar to lengths of thread. According to Mehta and Monteiro (2006) [6], fibres can be from several of shapes and sizes produces from steel, plastic, glass and natural materials like bamboo.

Fibre reinforced normal concrete are mostly used for on-ground floors and pavements but can be considered for a wide range of construction parts such as beams, pillars, foundation, etc.

Fibres are usually used in concrete to control plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability of concrete and thus reduce bleeding of water.

2.4 Types of Fibre Reinforced Concrete (FRC)

Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these different fibres that character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation and densities.

2.4.1 Steel Fibre

Steel is the strongest commonly available fibre, and come in different length (30mm to 80mm in Europe) and varying shapes (end hook and no end hook). Steel fibres can only be used on surfaces that can tolerate or avoid corrosion and rust strains. In some cases, a steel fibre surface is faced with other materials.

This steel fibre can be dividing into three types:

i. Carbon Steel Fibre
ii. Stainless Steel Fibre
iii. Melt Extract Stainless Steel Fibre

2.4.1.1 Carbon Steel Fibre

Steel fibre is produced from high strength cold drawn steel wire; conform to ASTM 820, widely used for reinforced concrete with excellent performances, anti crack, pressure resistance, anti abrasion, and bending toughness.