FLEXURAL BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE BEAMS

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ABSTARCT

Concrete is good in compression but week in tension that is, concrete is a brittle material. So, in order to improve the tensile properties, short fibers are used. Effects of steel fibers on flexural performance of reinforced concrete (RC) beams are the main objectives of this study. The hooked-end steel fibers with the dimensions of 0.75 mm in diameter, 50 mm in length and with the aspect ratio of 67 were used in this study. Initially the optimum percentage addition of steel fibers in concrete was determined. In order to accomplish this task, several concrete prisms and cubes with the same mix proportioning of concrete and different volume fractions of steel fiber (0.5 %, 1%, 1.5 %, and 2 %) were prepared. Then, by determining the flexural and compressive strength of samples, it was concluded that the optimum volume fraction was 1 % ($78.5 kg/m^3$). In the next step,the flexural behavior of RC beams with the addition of steel fibers with lower and higher compressive strength of concrete was considered. The study was conducted on two types of concrete with different grades of 30 and 50. For each grade of concrete, two beams were cast which steel fiber was included in one of the beams, with the addition of 1% volume fraction, and the other beam was considered as control beam. The overall dimensions of the beams were 170 mm in height, 120 mm in width, and 2400 mm in length. The beams were tested under four-point loading test. The results showed that addition of steel fibers in concrete increases the first crackingload, ultimate load, stiffness and ductility of the concrete beams. Furthermore, the addition of steel fibers has more effect on the properties of RC beams with higher concrete grade compared to lower grade.

ABSTRAK

Konkrit merupakan bahan yang kuat dalam mampatan tetapi lemah dalam tegangan iaitu ia adalah bahan yang rapuh. Oleh itu untuk meningkatkan sifat tegangan konkrit gentian pendek digunakan. Kesan gentian keluli terhadap prestasi lenturan rasuk konkrit bertetulang adalah objektif utama kajian ini. Gentian keluli yang mempunyai hujung bengkok berdiameter 0.75 mm, panjang 50 mm dan nisbah aspek bernilai 67 digunakan dalam kajian ini. Pada peringkat permulaan kadar optima penambahan gentian ditentukan. Bagi mencapai tujuan ini beberapa prisma dan kiub konkrit dengan kadar bahan campuran konkrit yang sama dan peratus gentian yang berbeza (0.5%, 1%, 1.5% dan 2%) telah disediakan. Hasil daripada penentuan kekuatan tegangan dan mampatan sampel telah diperolehi kadar optima gentian keluli ialah 1% (78.5kg/m^3).Seterusnya kelakunan lenturan rasuk konkrit bertetulang dengan penambahan gentian keluli menggunakan dua kekuatan konkrit yang rendah dan tinggi telah dibuat. Kajian dilakukan menggunakan dua gred konkrit berbeza iaitu gred 30 dan 50. Bagi setiap gred konkrit dua rasuk dibuat dengan satu rasuk ditambah 1% gentian keluli dan rasuk kawalan. Ukuran keseluruhan rasuk ialah 170 mm tinggi, 120 mm lebar, dan 2400 mm panjang. Rasuk telah diuji di bawah pembebanan empat titik. Keputusan menunjukkan penambahan gentian keluli meningkatkan beban retakan, beban maksimum, kekukuhan dan kemuluran rasuk konkrit. Selain daripada itu, penambahan gentian keluli mempunyai kesan yang lebih terhadap sifat-sifat rasuk konkrit yang bergred lebih tinggi berbanding konkrit gred rendah.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Concrete is by far one of the most important building materials and its consumption is increasing in all countries and regions around the globe. The reasons are many such as: its components are available everywhere and relatively inexpensive, its production may be relatively simple, and its application covers large variety of building and civil infrastructure works. In addition, it has the lowest cost to strength ratio compared to other available materials.

One of the characteristics of the plain concrete is low tensile strength, and low tensile strain capacities; that is, concrete is a brittle material. Thus concrete require reinforcement before it can be used extensively as construction material. Historically this reinforcement has been in the form of continuous reinforcing bars which could be placed in the structure at the appropriate locations to withstand the imposed tensile and shear stresses. Fibers, on the other hand, are generally, short discontinuous, and are randomly distributed throughout the concrete to produce a

new construction material, known as Fiber Reinforced Concrete (FRC). Fibers used in cement-based materials are primarily made of steel, glass, and polymer or derived from natural materials. Since fibers tend to be more closely spaced than conventional reinforcing bars, they are better at controlling cracking. It is important to recognize that, in general, fiber reinforcement is not a substitute for conventional reinforcement. Fibers and steel bars have different roles to play in modern concrete technology, and there are many applications in which both fibers and continuous reinforcing bars should be used.

Initially, fibers are used to prevent and control plastic and drying shrinkage in the concrete. After some research and improvement, the addition of fibers material in the concrete can also improve the other concrete properties such as flexural toughness, flexural strength fatigue resistance, impact resistance, and post-crack strength. The behavior of FRC can be classified in to three groups according to application, fiber volume fraction and fiber effectiveness. Such classification leads to :1) very low volume fraction of fiber (<1%), which has been used for many years now such as age plastic shrinkage control or pavement reinforcement, 2) moderate volume fraction of fiber (l%-2%) for improvement of modulus of rupture (MOR), fracture toughness, impact resistance and other desirable mechanical properties, and 3) high volume fractions of fibers (more than 2%) for special applications such as impact and blast resistance structure.s

The type of fibers which will be used in this study is Steel Fibre. Steel fibers are the most popular material for the reinforced concrete. The performance of the Steel Fiber Reinforced Concrete (SFRC) has shown a significant improvement in flexural strength and overall toughness if compared to plain reinforced concrete.

1.2 Problem Statement

As it is mentioned, concrete is good in compression but week in tension that is, concrete is a brittle material. So, in order to improve the tensile properties, short fibers are used. Effects of steel fibers on flexural performance of RC beams are what will be investigated in this study.

1.3 Thesis Objectives

The objectives of this study are as follows:

i. To determine the optimum percentage of steel fibers in SFRC.
ii. To study the flexural behavior of SFRC beams compared with conventional reinforced concrete beams.
iii. To study the flexural performance of SFRC beams with lower and higher concrete strength and compared with conventional reinforced concrete beams.

1.4 Scope of study

The scope of study is established to achieve the objectives and this study will be mainly concentrated on experimental works. Experiments regarding to the flexural strength test on the SFRC beams will be carried out in order to study the flexural behavior of the beams. The shape and characteristics of steel fibers which are used in this study are explained in Chapter 3. All testing methods and procedures are specified according to British Standard or American Society Testing Method.

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