# SHEAR BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE WIDE BEAMS WITHOUT STIRRUPS

By

Ahmed Said Mohamed Abd El-Ghafar

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

SHEAR BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE WIDE BEAMS WITHOUT STIRRUPS

By
Ahmed Said Mohamed Abd El-Ghafar

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

Under the Supervision of

Prof. Dr. Mostafa Fouad El-Kafrawy

……………………………….

Professor of Concrete Structures
Structural Engineering Department
Faculty of Engineering
Cairo University

Dr. Tamer Mahmoud El-Rakib

……………………………….

Associate Professor
Reinforced concrete department
Housing and Building National Research Center, Cairo, Egypt

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

SHEAR BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE WIDE BEAMS WITHOUT STIRRUPS

By
Ahmed Said Mohamed Abd El-Ghafar

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
STRUCTURAL ENGINEERING

Approved by the
Examining Committee

_______________________________
Prof. Dr. Mostafa Fouad El-Kafrawy

_______________________________
Dr. Tamer Mahmoud Sayed El-Rakib

_______________________________
Prof. Dr. Mohamed Talaat Mostafa

_______________________________
Prof. Dr. Mounir Mohamed Kamal

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2016

**Engineer's Name:** Ahmed Said Mohamed Abd El-Ghafar…………………………

**Date of Birth:** 1 / 2 / 1988

**Nationality:** Egyptian

**E-mail:** Eng_ahmedsaid2010@yahoo.com

**Phone:** 01002928735

**Address:** 8 Mekhael Kosbar Der el Malak Hadayek el Koba, Cairo, Egypt

**Registration Date:** 1/10/2010

**Awarding Date:** / /

**Degree:** Master of Science

**Department:** Structural Engineering

**Supervisors:**

Prof. Dr. Mostafa Fouad El-Kafrawy
Dr. Tamer Mahmoud Sayed El-Rakib

**Examiners:**

Prof. Dr. Mostafa Fouad El-Kafrawy
Dr. Tamer Mahmoud Sayed El-Rakib
Prof. Dr. Mohamed Talaat Mostafa
Prof. Dr. Mounir Mohamed Kamal
(Faculty of Engineering in Shebin , Menoufia University)

**Title of Thesis:**

Shear behavior of steel fiber reinforced concrete wide beams without stirrups

**Key Words:**
Concrete ; shear ; wide beam ; steel fiber

**Summary:**

Twelve wide beams were tested in the current experimental program to investigate the effect of steel fiber on the shear behavior of wide beam without stirrups. All tested beams were simply supported with 1.00m effective length, width 450mm and thickness 200mm. Main variables were fiber volume fraction, concrete compressive strength, span-to-depth ratio and longitudinal reinforcement ratio. The results showed that the addition of steel fibers in RC wide beams without stirrups increase the shear strength, ultimate load capacity and ductility. It also decrease deflection and delay appearance of the first shear crack.

# Table of Contents

# List of Tables

# List of Figures

# Abstract

Shear failure in reinforced concrete structures is known to be catastrophic and sudden. So, it is a major concern to structural engineer. Shear cracks are developed when the principal tensile stress is exceeded. Once tensile cracking occurs, the shear strength of the beam is reduced. Design engineers control this problem by using stirrups in the reinforced concrete structures.

The addition of steel fiber in the concrete matrix enhances the structural behavior of this composite. It helps to improving shear strength, tensile strength, compressive strength, toughness and ductility. Using steel fiber in the concrete could allow reducing conventional transverse stirrups or increase spacing between them. It could eliminate the conventional stirrups.

Twelve wide beams are tested in the current experimental program to investigate the effect of steel fiber on the shear behavior of wide beam without stirrups. All tested beams were simply supported with 1.00 m effective length (1.20 m total length), width 450 mm and thickness 200 mm. Beams are divided into four groups according to the studied parameters; each group has a specific parameter influencing the shear strength. Main variable were fiber volume fraction ($V_f$= 0.00, 0.75&1.25%), concrete compressive strength ($f_{cu}$ = 27& 49 MPa), span-to-depth ratio (a/d = 1.8 & 2.4) and longitudinal reinforcement ratio (ρ = 3 & 2%). All beams were tested under four-point loading to investigate their behavior in shear, cracking, ultimate capacity and ductility. All beams failed in shear. The results of the experimental work showed that the addition of steel fibers in reinforced concrete wide beams without stirrups increases the shear strength, ultimate load capacity and ductility. It also decreases deflection and delays the appearance of the first shear crack. As with conventional reinforced concrete beams the ultimate shear strength decreases with increasing shear span depth ratio a/d increases with increasing flexural reinforcement ratio ρ, and increases with increasing concrete compressive strength $f_{cu}$.

Most of the existing models available in the literature to predict the shear strengths of SFRC members without shear stirrups, which were adopted for slender beams, gave a reasonable estimate of the shear strengths for SFRC wide beams.

# Chapter 1 : Introduction

## 1.1. General

Shear failure in reinforced concrete structures is known to be catastrophic and sudden. So, it is a major concern to structural engineer. Shear cracks are developed when the principal tensile stress is exceeded. Once tensile cracking occurs, the shear strength of the beam is reduced. Design engineers control this problem by using stirrups in the reinforced concrete structures.

The addition of steel fiber in the concrete matrix enhances the structural behavior of this composite. It helps to improving shear strength, tensile strength, compressive strength, toughness and ductility. The increased shear strength and ductility of fiber-reinforced beams stems from the post-cracking tensile strength of fiber-reinforced concrete. The use of steel fibers is particularly attractive for high-strength concrete, which can be relatively brittle without fibers. Also using steel fiber in the concrete could allow reducing conventional transverse stirrups or increase spacing between them and it may eliminate the conventional stirrups which reduces reinforcement congestion. Several researchers have studied the shear behavior of steel fiber reinforced concrete (SFRC) slender beams, however, the influence of steel fibers on shear behavior of wide beams has not been established, and a very limited work has been reported. Further study, however, is required to investigate the shear behavior of the SFRC members for the various combinations of shear span-depth ratio (a/d), fiber content $V_f$ %, grade of concrete $f_{cu}$ and percentage of longitudinal reinforcement ρ.

.

## 1.2. Main Objective

The main objective of this research is to investigate the overall shear behavior of steel fiber reinforced concrete (SFRC) wide beams without conventional stirrups. Also, to study the effect of steel fiber volume fraction, concrete compressive strength, longitudinal reinforcement ratio and span-to-depth ratio on crack pattern, failure mode, ultimate and cracking shear load and ductility of wide beams. In addition, to compare the experimental shear strength values with those predicted by the existing models corresponding to slender beams.

## 1.3. Scope of Work

Twelve wide beams are tested in the current experimental program to investigate the effect of steel fiber on the shear behavior of wide beam without stirrups. All tested SFRC beams were simply supported with 1.00 m length (1.20 m total length), width 450 mm and thickness 200 mm. All beams are tested under four –point loading. Beams are divided into four groups; each group has a specific parameter influencing the shear