وزارة التعليـــم العـــالي
والبحث العلمي
جامعـــة ديـــالى
كليـــة الهندسة

تصرف القص للعتبات الخرسانية المسلحة بأستخدام تقنيات تسليح قص مختلفة

الرسالة مقدمة الى
مجلس كلية الهندسة / جامعة ديالى
وهي جزء من متطلبات نيل درجة الماجستير في علوم الهندسة المدنية/ انشاءات

من قبل
اسماء شاكر محمود
(بكالوريوس هندسة مدنية 2013) - الجامعة ديالى

بأشراف
أ.م.د .سهاد محمد عبد

1444هـ العراق 2023م

Ministry of Higher Education
and Scientific Research
University of Diyala
College of Engineering

Shear Behavior of Reinforced Concrete Beams Using Alternative Shear Reinforcement Technique

A Thesis Submitted to Council of College of Engineering, the University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Structural Engineering

By

Asmaa Shaker Mahmood

(B.Sc. in civil Engineering, 2013)-University of Diyala

Supervised by:

Assist. Prof Dr. Suhad Mohammad Abd

2023 A.D **IRAQ** **1444 A.H**

Chapter One

Introduction

1.1 General

Shear and flexural failure modes both exist in beams. Due to the complexity and rapidity with which shear failure can occur in reinforced concrete beams, this type of failure should be avoided whenever possible. In general, safety factors for shear designs are higher than those for flexural designs due to the brittleness of shear compared to the flexibility of flexure (Amaireha et. al, 2020).

Failure due to shear stresses manifests as diagonal cracks close to the supports. To increase the shear strength, the stirrups are placed between the support and the point where the load is being applied. Flexural and shear loading are the most common causes of failure in reinforced concrete beams. Forces in excess of the beam's flexural strength cause the first change to occur(Al-Rousan, Rajai Z 2021). Inadequate shear resistance between the beam's materials leads to the second type of failure. One can anticipate a different kind of breakdown from each of these potential causes. Tension failure, compression failure, and balancing failure are the three main types of stress-related failure. Many different causes contribute to the wide variety of failure mechanisms that exist.. It is the concrete on the compression side of the beam that is crushed after the steel reinforcement fails under flexural stress. According to ACI 318-19, this problem manifests itself when the reinforcement ratio of the beam is lower than the balanced reinforced ratio. There also needs to be a look backwards to find options that will help strengthen the shear and strike a good balance between the concrete beam's various functions. shown plate (1-1)

Plate (1-1) Beam Breakage Due to Flexure (**Madeh Izat 2020)**

In the event of a breakdown of flexural compression failure, the concrete on the compression side of the beam will give way before the steel on the tension side of the beam does. Beams have this issue when their reinforcement ratio is greater than the balanced reinforcement ratio, as specified by ACI 318-19. A brittle failure describes this type of sudden breakdown. Therefore, from the perspective of reinforced concrete, it is not suitable,as shown in Plate (1-2).

Plate (1-2) Cracking Due to Flexural Compression (Izat 2020)

When both the steel and the concrete fail at the same time, it is called a balanced failure. That's when the steel content of the beam matches the balanced reinforcement ratio, as defined by ACI 318-19.

1.2 Type of crack on reinforce concrete beams

Different types of cracks in concrete sills are identified according to the component failure that brought about the destruction .

1- Flexural cracks at the beam's base are the first sign of impending failure due to diagonal tension. If one increases force exerted on the beam, the crack will get longer and wider as it moves toward the loading point, and it will also curve diagonally. After that point, the concrete begins to fail suddenly due to shear. This is a common mode of failure for beams with inadequate or nonexistent web reinforcement. Beams with an a/d ratio greater than 2 fail in diagonal tension, but this also occurs for smaller values as shown figure (1-1).

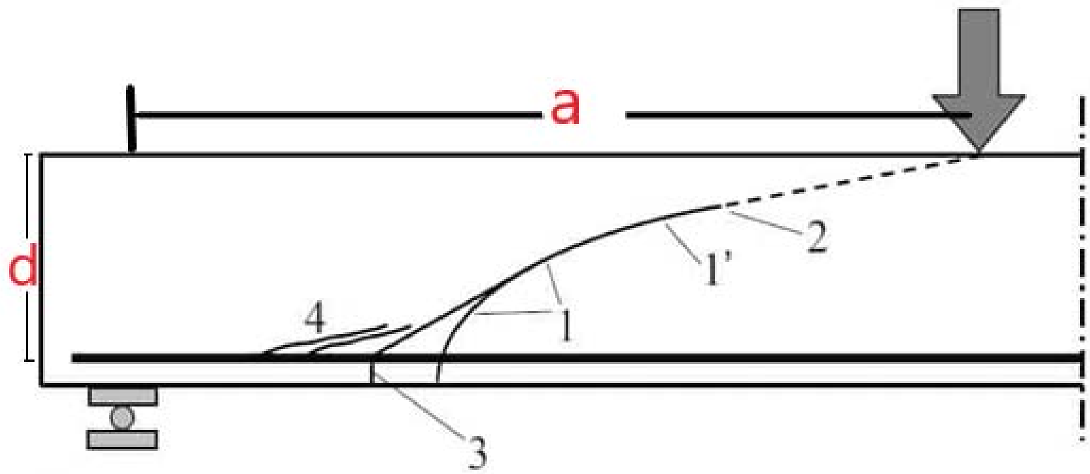

Figure (1-1) Diagonal Tension Crack Development

2- Beam cracking is the first step in shear compression failure. To put it simply, a concrete structure will fail if its compressive strength is surpassed. The point of the fracture nearest the source of the load undergoes crushing first. Cracks form in a beam as a result of shear compression failure. High shear reinforcement leads to a failure mode known as shear compression. Last but not least, beams with a span-to-depth ratio of less than four are susceptible to shear compression , as shown figure (1-2).

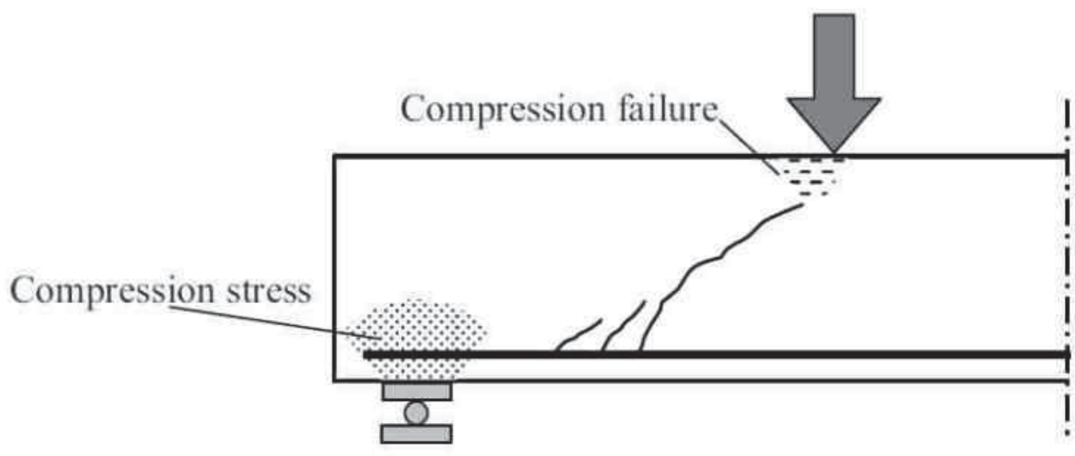

Figure (1-2) A Beam Breaks Due to Shear and Compression (Izat, 2020

3- Beams fail when the ratio of their shear span to their depth is less than 1. Deep beams offer greater shear strength than regular flexural beams and transfer stresses directly to supports. Compression failure, rather than shear collapse, can sometimes occur close to the supports see figure (1-3) .

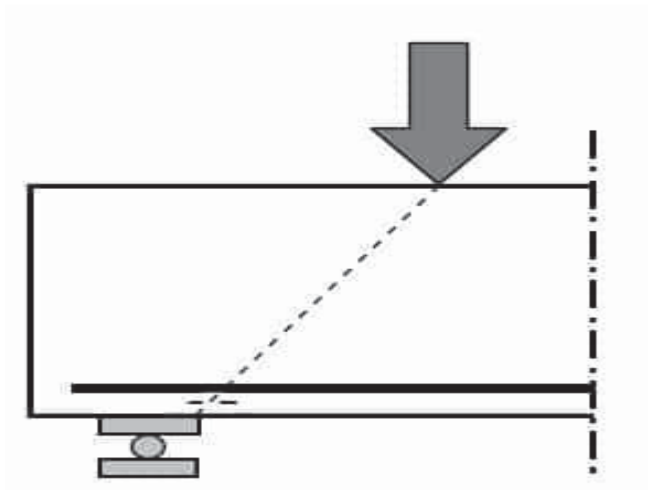

Figure (1-3) Real shear failure or shear splitting

4- Anchorage failure is concrete splitting along longitudinal reinforcement due to small diagonal cracks. The main reinforcement isn't anchored beyond the crack. The yield strength of longitudinal reinforcement (the yield strength of transverse reinforcement the cylinder compressive strength of concrete ,the width of the beam and the effective depth of the beam are the variables that need to be considered .It is generally accepted that the shear capacity of reinforced concrete beams is affected by the shear span in regards to the effective depth of the beam (a/d)(shear span is the ratio of the distance from the load to the support to the effective depth) , the longitudinal reinforcement ratio (ρl), and the transverse reinforcement ratio (Reineck, Karl-Heinz 2020),as shown in Figure(1-3).

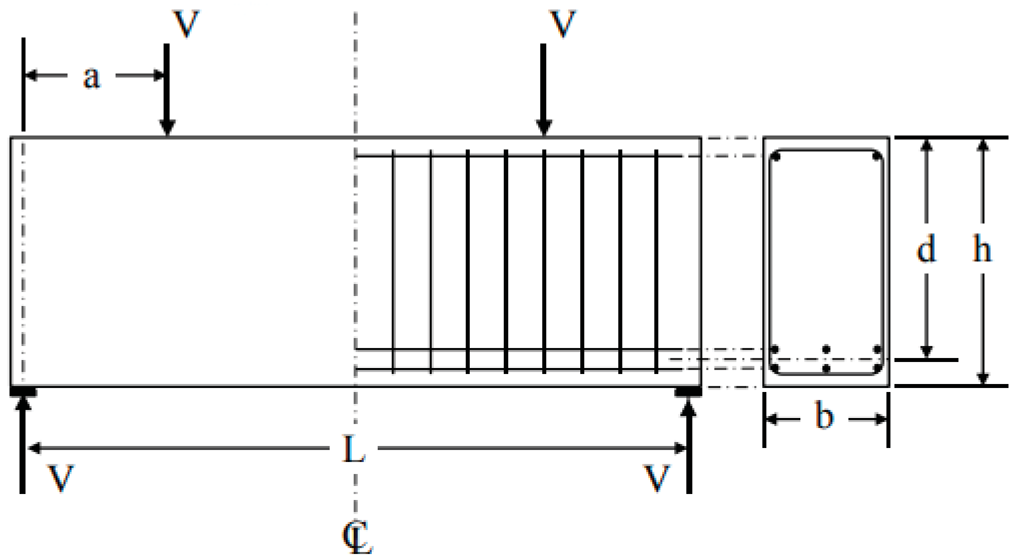

Figure (1-4) Shearing concrete beam (Reineck, Karl-Heinz 2020)

1.3 Statement of problem

Finding alternatives or techniques that improve the behavior of shear resistance and are prefabricated so that it is easier for workers to deal with and thus facilitate work for them. In terms of sustainability, unstressed iron residues can be used in its manufacture.

1.4 Aim and objectives of the study

The main aim of this study is to replace the traditional steel stirrups with alternative reinforcement techniques as shear reinforcement stirrups. The specific objectives taken into account in this study are as follows:

- ❖ The proposed techniques include steel plate and flamingo steel reinforcement, which are being investigated as shear reinforcing methods for reinforced concrete beams.
- ❖ Compareing the proposed methods of structural behavior to that of stirrup-based shear reinforcement and to that of beams without shear reinforcement.

- ❖ Find the most efficient way to increase or improve the shear capacity.

1.5 Scope of the study

Fourteen beams will be made and tested as part of the experimental program for this investigation. Results are examined in terms of ultimate load, the load-deflection relationship, the load-concrete compressive strength, the crack pattern, and the manner of failure.

1.6 Layout of the study

- ➢ Chapter 1 provides an overview of shear failure in beams as opposed to other forms of reinforcement. It also outlines the study's objectives.
- ➢ The literature review of earlier work relating to shear techniques in beams is presented in Chapter Two.
- ➢ The experimental work and the properties of the materials used are explained in Chapter 3.
- ➢ The experimental results of all the tests that are conducted for this study are presented in Chapter 4 along with a detailed discussion of them.
- ➢ Chapter 5 summarizes the study's findings as well as presenting recommendation and suggestion for further studies.

Abstract

Reinforced concrete beams usually carry the load ,Therefore, , excessive load may cause unexpected beams shearing failure, which is an unsafe beam failure situation, and overcoming shear failure uses stirrups or any technique providing an improvement of shear strength.

This experimental study focuses on the shear behavior using two proposed, the Flamingo technique and Folded steel plate technique. Fourteen reinforcement concrete beams with dimensions of (1800 mm, 200 mm, and 300 mm) were cast, treatment, and subjected to point load testing. Two of them are reference beams, one is with standard shear reinforcement and the other without it, and eight reinforcement concrete beams with Flamingo technique. Three of them have a variable diameter of bar steel @ (6 mm, 8 mm, and 10 mm), two of them have different length of the free ends inclined by a percentage of the effective depth (d), two have angles variable for the free ends, and one using a hook at the ends. Folded steel plate was used with four , with the reinforcement concrete beams, it was roughly similar to a N shape with legs ,length of legs was 60% from effective depth of beam and three beams included two shear connecter and two holes were on inclined plate while vertical plate different with number holes having circular (3,4,and 5)with diameter (30cm), on the last beam shear connecter was used only where put two shear connecter on inclined steel plate while in vertical plate was put five shear connecter.

The use of reinforcing bars for the Flamingo Technique led to an increase in the final load, and this increase was increased with the increase in the change in the diameter of the reinforcement used, On the other hand, it was found that the best results were for the model with diameter of 8 mm and the length of the ends 50% of the effective depth and at an angle of 45, as it gave the

highest load increase over the reference without shear reinforcement by 153% and by 52.5% over the reference with standard shear reinforcement,

The application of the Folded Steel Plate Technique on the steel plate enhanced the shear strength properties of the beam when the folded steel plate was used, but the five-hole beam in the vertical plate was better than the other beams, as it increased the shearing capacity ratio by 32.1%, while the final crack of the beam with three holes in the vertical steel plate decreased by 43.9% compared with the reference beam, while the crack load of all beams was improved compared to the crack load of the reference beam, as well as the crack width decreased. On the other hand, it was found that a steel plate folded with a shear connecter gives a narrower crack width than a steel plate folded with holes.