



## Punching Shear Strength Characteristics of Flat Plate Panels Reinforced with Shearhead Collars: Experimental Investigation

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### Abstract

This paper presents an experimental investigation on the punching shear strength of reinforced concrete flat plate slabs with shearhead collars. Eight reinforced concrete slab specimens were casted and tested under static load test, the load was applied at the center of slab by 100x100 mm steel column. The effect of the shapes, diameter and number of stiffeners has been discovered for shearheads through studying its effect on the load-deflection behavior, ultimate capacity, cracking load, failure mode, stiffness, ductility and energy absorption of tested specimens. The experimental results indicates that using square shearhead had achieved a slight increase in punching shear strength about 3% over that circular shearhead using the same surface area. Also, utilize 550 mm shearhead diameter will contribute to increase the punching shear strength about 14.5%. The increase in the number of stiffeners in specimen (CS4) had reduced the ultimate punching shear capacity by 20.3% over reference specimen. The first crack was decreased from 12.5kN to 7.5kN, when increases the number of stiffeners from one to two. The cracking load was increased with the increase of the diameter of circular shearhead from 10kN to 15Kn in specimens of 336mm and 550mm respectively. The specimen with 336mm diameter and 30mm height circular shearhead achieved 427 kN.m energy absorption, it is higher than the energy absorption of reference specimen by 2.6%. Also, using two stiffeners improved the energy absorption by 110.2% higher than the specimen with one stiffener.

*Keywords:* Punching Shear; Shearhead; Flat Plate; Stiffeners; Stiffness and Ductility.

### 1. Introduction

Slabs are two-dimensional structural elements that can be defined as a flat pieces of concrete supported by beams, columns or walls, and these are made of reinforced concrete, steel or building stones. One-way action of slabs obtains when the bending occurs in direction perpendicular to the supported edges. Two-way action of slabs obtains when the bending occurs in two directions [1].

In slab-column system, there are two main types of shear failures: the first type is one-way type and referred to “beam type”; the crack in this type of shear failure is often appear along whole width of the concrete slab. The second type is two-way shear failure and commonly known as “punching”; its common pattern. The occurrence of punching is generally either as a result of applying concentrated loads or due to the presence of columns. In flat plate slabs, punching shear at slab-column connection is the govern design criterion, which is a complex three dimension stress state [2].

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