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Punching shear behaviour of edge column connections in continuous flat slabs

Jürgen Einpaul, Robert L Vollum

Department of Civil and Environmental Engineering, Imperial College London, London, UK

Antonio Pinho Ramos

Faculty of Sciences and Technology, Universidade Nova de Lisboa, Lisbon, Portugal

Contact: jyrgen.einpaul@gmail.com

Abstract

This paper deals with the behaviour of reinforced concrete flat slabs around their connections to edge columns. Using a non-linear finite element model with shell elements and simple assumptions regarding flexural and shear response, this study investigates the magnitude of unbalanced moments transferred between the slab and the column as well as the distribution of shear forces in the slab around the connection. The influence of distribution of reinforcement between hogging (around the columns) and sagging (in the mid-span) areas as well as in the directions parallel and perpendicular to the slab edge are analysed. The behaviour of continuous slabs is compared to that of typical test specimens. It is shown that the distribution of shear stresses in test specimens may be significantly less uniform which can lead to lower punching capacities in the tests than in actual continuous slabs.

Keywords: Reinforced concrete; slabs; punching shear; edge columns; non-axisymmetric conditions; non-linear finite element analysis.

1 Introduction

Reinforced concrete flat slabs on small supports, which are commonly found in various types of structures, are easy and fast to construct, have flat soffits and low depths of structure while offering architectural liberty in placing the supports. The critical point in their design is often the connections between the slab and columns where both flexural moments and shear forces reach their peak values. The brittle failures that can occur in these regions are referred to as punching shear failures.

Experimental and theoretical research on punching shear has been conducted for decades. The majority of studies have focused on punching around symmetrically loaded interior columns where simple conditions make the interpretation of test results relatively straightforward. In such connections, no bending moment is transferred between the slab and the column and the distribution of internal forces can be assumed to be axisymmetric. Shear stresses in the slab around the connection can thus be considered uniform along a control perimeter located at some distance from the column edge.

However, most slab-column connections in practice are not axisymmetric. The majority of slab-column connections in many practical slabs are located at the edge of the slab. In such connections, bending moments can be transferred

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