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Punching Shear Behavior of UHPC Flat Slabs

Al-Quraishi Hussein and Ekkehard Fehling

***Abstract*— At the Institute of Structural Engineering of the Faculty of Civil Engineering, Kassel University, series tests of slab-column connection were carried out, subjected to concentrated punching load. The effects of steel fiber content,**

**concrete compressive strength, tension reinforcement ratio, size effect, and yield stress of tension reinforcement were studied by testing a total of six UHPC slabs and one normal strength concrete slab. Based on experimental results; all the tested slabs failed in punching shear as a type of failure, except the UHPC slab without steel fiber which failed due to splitting of concrete cover.**

**The post ultimate load-deformation behavior of UHPC slabs subjected to punching load shows harmonic behavior of three stages; first, drop of load-deflection curve after reaching maximum load, second, resistance of both steel fibers and tension reinforcement, and third, pure tension reinforcement resistance. The first shear crack of UHPC slabs starts to open at a load higher than that of normal strength concrete slabs. Typically, the diameter of the punching cone for UHPC slabs on the tension surface is larger than that of NSC slabs and the location of critical shear crack is far away from the face of the column. The angle of punching cone for NSC slabs is larger than that of UHPC slabs. For UHPC slabs, the critical perimeter is proposed and located at 2.5d from the face of the column. The final shape of the punching cone is completed after the tension reinforcement starts to yield and the column stub starts to penetrate through the**

**slab. Numerical model using Finite Element Analysis (FEA) for UHPC slabs is presented. Also some variables effect on punching shear is demonstrated by a parametric study. A design equation for UHPC slabs under punching load is**

**presented and shown to be applicable for a wide range of parametric variations; in the ranges between 40 mm to 300 mm**

**in slab thickness, 0.1 % to 2.9 % in tension reinforcement ratio, 150 MPa to 250 MPa in compressive strength of concrete and 0.1 % to 2 % steel fiber content.**

***Keywords—*flat slab, ultra high performance concrete,**

**punching shear, critical shear perimeter, proposed design**

**equation.**

Al-Quraishi Hussein

Faculty of civil and Environmental Engineering

M.Sc University of Technology /Iraq

Ph.D student / University of Kassel /Germany

Ekkehard Fehling

Faculty of civil and Environmental Engineering/ University of Kassel

Germa