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Structural behaviour of Ultra-High Performance Fibre Reinforced Concrete Columns subjected to eccentric loading

Manpreet Singh, M.S. Mohamed Ali, A.H. Sheikh

The University of Adelaide, Adelaide, SA, Australia

Contact: manpreet.singh@adelaide.edu.au

Abstract

An experimental investigation conducted on ultra-high performance fibre reinforced concrete (UHPFRC) columns is presented in this paper. The columns consisted of longitudinal and transverse reinforcement, tested under concentric and eccentric compressive loads with varying load eccentricities. The UHPFRC manufactured with locally available raw materials attained compressive strengths of 140 to 160MPa. The experimental data of axial load with lateral and axial deformations, mode of failure was obtained for each test. The cover spalling was not observed for all the columns. The interaction diagram of axial load-bending moment is established for compression members and is in good agreement with the test results.

Keywords: ultra-high performance concrete; columns; beams; reactive powder concrete.

1 Introduction

With the development of Ultra high performance fibre reinforced concrete (UHPFRC), it is now possible to build highly loaded columns with reduced cross sections to cater the demands of high-rise structures, elevated transit structures and bridge piers. UHPFRC is developed in recent years and is generally characterized as a concrete with compressive strength greater than 150MPa with sufficient inclusion of fibres to achieve ductility in tension and compression (AFGC [1], Graybeal [2]). Many studies have investigated the flexural behaviour of UHPFRC, whereas very few investigations were done to study its behaviour under axial compression. The scarcity of experimental results on UHPFRC columns limits its adaptation in the industry.

It is well understood that detailed transverse reinforcement provides sufficient confinement and improves the ductility of the reinforced concrete column (Saatcioglu et al.[3], Cusson et al.[4]). Malik et al. [5] shown that inclusion of high volume of steel fibres can considerably reduce the transverse reinforcement in UHPFRC columns. Furthermore, the steel fibres effectively prevented the spalling of concrete cover and buckling of longitudinal reinforcement [5].

Shin et al. [6] studied the effect of transverse reinforcement and fibre content on the ductility of UHPFRC columns. The inclusion of fibres was found to be effective to control the spalling of cover whereas the post peak ductility was not improved in poorly confined UHPFRC columns. It was shown that large amount of transverse reinforcement is still required to achieve the post peak ductility in UHPFRC columns. Empelmann et al. [7] investigated the influence of longitudinal reinforcement on the post peak ductility of UHPFRC column. The high strength steel reinforcement with moderately spaced transverse reinforcement was found favourable for UHPFRC columns to achieve the same ductility as that of normal strength concrete columns.

In practice, columns are always subjected to bending moments and axial compressive loads [8]. Bending moments are introduced due to several factors such as unintentional load eccentricities due to out of straightness of column, horizontal loads of earthquake and wind, moment transfer from beam and slabs. The

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