Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7083

SUBSTITUTION OF THE TRANSVERSE REINFORCEMENT WITH ENGINEERED CEMENTITIOUS COMPOSITE IN RC EXTERIOR BEAM-COLUMN JOINTS SUBJECTED TO CYCLIC LOADING

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ABSTRACT

This paper presents a comparative study to investigate the seismic behavior of RC exterior beam-column joints subjected to cyclic loading. Two specimens of full-scale RC beam-column joint were cast and prepared for testing. The first specimen was cast with conventional concrete (CC) and seismically designed according to ACI 352R-02 structural connection Type 2. For second specimen, the CC and the transverse reinforcement in the joint region were substituted by engineered cementitious composite (ECC) using synthetic polyethylene (PE) fibers. The specimens subjected to a reversed cyclic loading at the end of the beam under controlled deformation until failure.

Keywords: normal concrete (CC)**,** engineered cementitious composite (ECC), polyethylene fibers (PE).

INTRODUCTION

Beam-column joints undergo high shear forces and moments in the joint zone under seismic excitations. Two main modes of failure at the beam-column joint zone were observed during the earthquake disasters are (i) shear failure on the diagonals of joint and (ii) failure due to insufficient anchorage of reinforcement penetrating into the joint core (Sharma, 2010). As a result, the design codes (ACI-ASCE Committee 352R-02; NZS 3101, 1995; IS 13920, 2002) prescribed a procedure to estimate the shear reinforcement (steel hoops) required within the joint core in addition to anchorage length of steel bars needed to penetrate inside the joint core.

Engineered cementitious composite (ECC) is a class of improved high performance fiber reinforced cementitious composite (HPFRCC), which was introduced in the early 90's (Li, 2008). It is characterized with a tensile strain-hardening and multiple-cracking behavior (Lepech, 2008). ECC has a tensile strain capacity which ranges from 3 to 7% compared to a value of 0.01% for normal concrete, with a tensile strength around 4-6MPa.

EXPERIMENTAL RESULTS AND DISCUSSION

In this experimental study, two full-scale exterior beam-column joint specimens were cast and prepared for testing under cyclic loading, Figures 1 and 2. The study highlights the comparison between the behavior of CC specimen and ECC-PE specimen in the joint zone in terms of flexural capacity, shear capacity, joint rotation, and energy dissipation capacity of the joint.

For the first specimen cast with CC and Transverse reinforcement in the joint region, the average ultimate load capacity of the specimen is 59 kN at drift ratio 4% and an ultimate moment and shear capacity of the joint of 72 kN.m and 346 kN, respectively. The joint zone was almost intact indicating a shear failure with moderate ductility in the joint. Load amount at failure stage shows a decrease of about 20% of the ultimate load capacity at 5% of drift ratio.

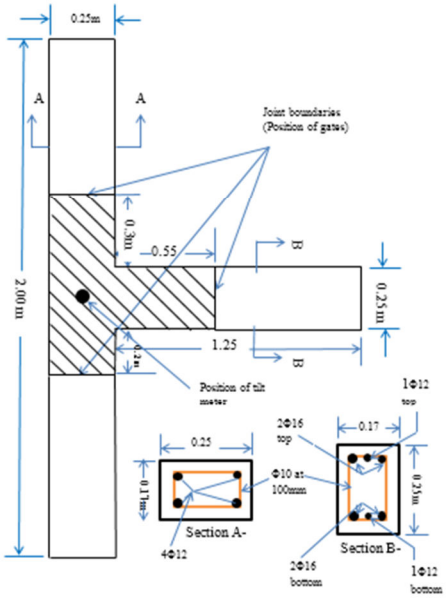

Fig. 1 - Details and dimensions for beam-column specimen

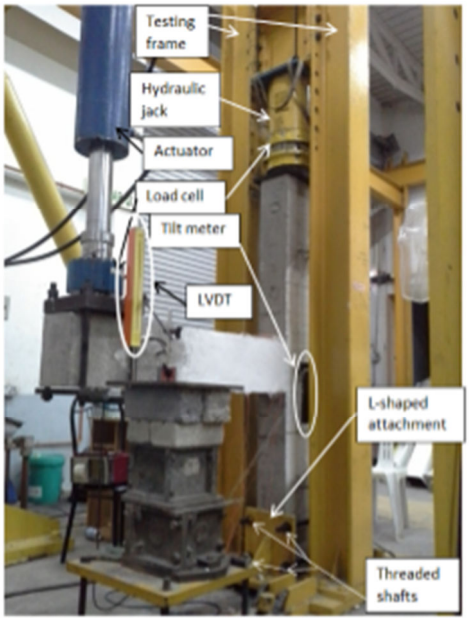

Fig. 2 - Testing process of beam-column joint

For the second specimen cast with ECC in the joint region, the specimen sustained an average ultimate load of 67.4 kN at drift ratio of 6% with a moment at the joint of 82.5 kN.m and shear force capacity of 395 kN. The drop in the load initiated after 6% drift ratio and the load value decreased about 15.8% of the ultimate load capacity at 8% drift ratio. The beam-column joint failed owing to the localization of the two main cracks on both diagonals commencing from the meeting points of beam boundaries and inner column boundary.

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