



## Experimental and Numerical Investigation of Octagonal Partially Encased Composite Columns Subject to Axial and Torsion Moment Loading

Mehdi Ebadi Jamkhaneh <sup>a\*</sup>, Mohammad Ali Kafi <sup>b</sup>

<sup>a</sup> Ph.D. Candidate, Civil Engineering Faculty, Semnan University, Semnan, Iran.

<sup>b</sup> Associate Professor, Civil Engineering Faculty, Semnan University, Semnan, Iran.

Received 13 September 2017; Accepted 23 October 2017

### Abstract

This paper includes experimental and numerical study of the octagonal partially encased composite (PEC) columns specimens under axial and torsion loading. The major difference between them was the concrete reinforcement details. The parameters investigated in the experimental and numerical study were the type of reinforcement details, the failure mode, width-to-thickness ratio of flange, transverse links spacing and diameter. The results were presented as load-deformation curves. Numerical model was validated using finite element method and the results indicated acceptable accuracy with tests results in the form of capacity and ductility. In the analytical phase, the experimental results in the compressive loading were compared with those obtained from CSA S16-14 and EN 1994-1-1 equations. Also, the new concrete confinement factor in proportion to the web width to thickness ratio was presented to octagonal PEC columns under pure compressive load. Furthermore, different types of retrofit of cross-shaped steel column including concrete encasement, use of stiffener plates and transverse links were investigated in this research. Results revealed that concrete confinement and use of transverse links had respectively the most and the least effect on increasing torsional capacity of the specimens.

*Keywords:* Octagonal Partially Encased Composite Column; Failure Mode; Experimental Model; Finite Element Method; Load Bearing Capacity; Torsional Stiffness.

### 1. Introduction

Steel-concrete structures improve the seismic performance of structures and stiffness of high-rise buildings [1, 2]. Taking benefit from composite sections is of high importance in construction and tall buildings industry [3]. On the other hand, using of two material properties lead to increase the energy absorption [4]. The Partially Encased Composite (PEC) column is one of the recent achievements in the field of composite columns. Usually, PEC columns are made out of three plates filling the gap between the flange and web is filled using concrete. In the common samples in European countries and Canada, web and flange thicknesses are considered as equal. Meanwhile, in order to prevent flanges local buckling strength from increasing, transverse links are welded to the flange tip between the flanges on equal intervals. In Europe, hot-rolled compressed standard sections are used which are inherently resistant against local buckling. The concrete casted between the flanges both provide a certain part of the column axial compressing strength and prevent column web from local buckling. Moreover, flanges deformation towards the column internal part is prevented. On the

\* Corresponding author: mehdi.ebadi@semnan.ac.ir

 <http://dx.doi.org/10.28991/cej-030927>

➤ This is an open access article under the CC-BY license (<https://creativecommons.org/licenses/by/4.0/>).

© Authors retain all copyrights.