GULUSTAN BLACK SEA SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH
ISSN: 1987-6521; E-ISSN:2346-7541
NOVEMBER –DECEMBER 2017 VOLUME 38, ISSUE 06

Performance of Composite Columns – Concrete Filled Steel Columns

Tahir Kibriya, PhD Civil Engineering

Senior Consulting Engineer, Black & Veatch, Toronto, Canada
(ex Head of Civil Engineering / Faculty, NUST, Pakistan)
t_kibriya@yahoo.com

ABSTRACT

This paper presents an experimental study on the behavior of short, concrete filled steel tubular columns axially loaded in compression to failure. A total of eight series were prepared, each series comprising of hollow steel tubes, hollow steel tubes filled with concrete and hollow steel tubes cross braced internally with #3 deformed bars welded in transverse direction, alternately at a distance of 150mm centre to centre and filled with concrete. Ultimate strengths achieved experimentally were thereafter compared with the analytical values obtained. Three-dimensional confinement effect of concrete along with support provided by concrete to the thin walls of steel tube to prevent local buckling had a composite effect on the strength of the composite column increasing the compressive strengths by almost 300 to 400%. In addition to the concrete core, the parameters for the testing were shape of the steel tube and its diameter-to-thickness ratio. An equation to estimate the ultimate axial compressive load capacities is proposed for square CFT columns based on this study.

It has been observed that ultimate strength of concrete filled steel tubes under concentric compression behavior is considerably affected by the thickness of the steel tube, as well as by the shape of it's cross section. Although a confining effect in circular CFT columns improves their strength, in square columns only a small increase in axial strength is observed. The axial load-deformation behavior of columns is remarkably affected by the cross-sectional shape, diameter/width-to-thickness ratio of the steel tube, and the strength of the filled concrete. The load deformation relationship for circular columns showed strain-hardening or elastic perfectly plastic behavior after yielding.

RESEARCH SIGNIFICANCE

This study carries significance due to recent advancements in the availability of higher strength steels, better coating materials for protection and high strengths/performance concretes which have expanded the scope of concrete filled steel composite columns with wide ranging applications in various structural systems with ease of construction, highly increased strengths and better performance.

INTRODUCTION

The steel tube in a concrete filled steel tube column acts as longitudinal and lateral reinforcement, and is thus subjected to biaxial stresses, longitudinal compression and hoop tension, whilst the concrete is stressed tri-axially. Due to their excellent structural performance

including high strength and ductility, concrete filled steel tubular columns are suitable as structural members for buildings, bridges, trussed structures and deep foundations. The advantages of the concrete filled steel tube columns over other composite systems are that the steel tube provides formwork for concrete, prevents concrete spalling, environmental damage and from offensive agencies whilst concrete in the steel tube supports thin walls and prolongs/prevents local buckling of the steel tubing. The composite column adds significant stiffness to the structure as compared to more traditional steel frame. The advent of higher strength steels, better coating materials for protection and high strengths/performance concretes have expanded the scope of this composite with wide ranging applications in various structural systems with highly increased strengths and better performance.

References

1. Georgios Giakoumelis and Dennis Lam "Axial capacity of circular concrete-filled tube columns Journal of Constructional Steel Research 60 (2004) 1049–1068

2. Lin Hai Han, Zhong Tao and Wei Liu in "Effects of Sustained Load on Concrete-Filled Hollow Structural Steel Columns" Journal of Structural Engineering, ASCE, September 2004)

3. C.S. Huang, Y.K. Yeh, G.Y. Liu, H.T.Hu, K.C. Tsai, Y.T.Weng, S.H. Wang and M.H.Wu "Axial load behavior of stiffened concrete-filled steel columns. Journal of Structural Engineering, ASCE, September 2002.

4. Martin D. O' Shea, "Design of Circular Thin-Walled Concrete Filled Steel Tubes". Journal of Structural Engineering, ASCE, November 2000.

5. Kenji Sakino, Hiroyuki Nakahara, Shosuke Morino and Isao Nishiyama, "Behavior of Centrally Loaded Concrete-Filled Steel Tube Short Columns". Journal of Structural Engineering, ASCE, February 2004.

6. Eurocode 4: Design of composite steel and concrete structures.

7. LRFD Manual of Steel Construction third edition 2001.

8. Mathias Johansson and Kent Gylltofl "Mechanical behavior of circular steel-concrete composite stub columns" Journal of Structural Engineering, ASCE, August 2002.

9. Lin-Hai Han and You-Fu Yang "Cyclic performance of concrete-filled steel CHS columns under flexural loading" Journal of Constructional Steel Research 61 (2005) 423–452