EXPERIMENTAL POST BUCKLING BEHAVIOR OF COMPOSITE BATTENED STEEL COLUMNS USING EPS CONCRETE SUBJECTED TO AXIAL LOADING

By

Eng. Mostafa Samy Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Structural Engineering

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Title of Thesis:

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Key Words:
Battened columns, Built-up columns, Light weight concrete, Non-linear analysis, Buckling of steel columns.

Summary:

This research work is based on strengthening the battened steel columns using light weight concrete as a filling material, and making a comparison between failure load for battened steel columns as a steel only and as a composite columns, to detect the effect of using the light weight filling material in enhancing the columns resistance. Experimental tests for nine steel battened columns with full scale test (3.0 m height) have been carried out, three of these columns were tested as a steel only, and the other six columns were tested after filling them using Expanded polystyrene concrete (EPS concrete), design load for steel columns was calculated according to Egyptian code of practice for steel construction and bridges. It was found that expected failure load for columns according to design load multiplied by safety factor 1.70 is so close to test results, and the failure load for columns filled with EPS concrete is much more than failure load for columns as a steel only, and in some cases it reaches twice of that for steel only case load, and this considered a satisfactory result.

Acknowledgment

First of all, great thanks to ALLAH for his grace and mercy, and for giving me the effort to complete this work.

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This work is dedicated to my children, Yousof and Razan. You have made me stronger, better and more fulfilled than I could have ever imagined.

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ABSTRACT

In this study, experimental work is performed to compare battened steel columns capacities with versus without filling material. Lightweight concrete mixes are used and compared to choose a suitable mix for filling such columns.

This research work is based on strengthening the battened steel columns using light weight concrete as a filling material. Comparison is made between failure loads for battened steel columns as steel only vs. composite to detect the effect of using the light weight concrete in enhancing the column resistance. Experimental tests for nine columns with full scale (3.0 m height) have been carried out. Three of these columns were tested as steel only, and the other six columns were tested after filling them using Expanded polystyrene concrete (EPS concrete or foam concrete). Design load for steel columns was calculated according to the Egyptian Code of Practice for Steel Construction and Bridges. It was found that expected failure load for columns according to design load multiplied by safety factor 1.60 is smaller than test results and the code is considered conservative in calculating design load for battened bare columns. Moreover the failure load for filled columns is bigger than failure load for bare columns.

In general, filled columns are stronger than bare columns by 143% to 225%. The bigger the slenderness ratio of the column, the bigger the gain we get in column capacity due to composite action. The minimum gain of 43% in column capacity is satisfactory enough as we focused on the other main target of having light portable column using EPS. The increase in column capacity is mainly due to prevention of the inward buckling mode of column components.

CHAPTER (1)

INTRODUCTION

1-1 Introduction

In low rise and temporary buildings, time and cost are very important. So using battened columns of small sections could save on cost of materials and decrease cost of labor because the lightweight of the columns makes construction easier and faster.

Due to local buckling of column components, it needs to be improved. To enhance columns capacity we could use filling material to prevent local buckling of members and make the failure mode overall buckling, but to keep lightweight of columns we should use light-weight material that has enough strength to achieve max column capacity.

In this study, there is experimental work to check columns capacities with and without filling material and study for lightweight concrete mixes to choose a suitable mix for filling columns.

1-2 Literature review

In this chapter a brief summary of analytical and experimental research work previously carried out on battened columns, and opened-built up sections is presented. Research work on composite battened columns was rarely found.

1-2-1 Buckling of battened columns composed of slender angles

M.A. El Aghoury and A.H. Salem [4,5] tested twenty specimens of battened beam-columns composed of four slender angles, these specimens have variable width-thickness ratios for their plate elements, and member slenderness varied from short to medium slenderness. The batten plates were connected to the angles using bolts Fig. (1-1), residual stresses were measured as well as geometric imperfections.

On the other hand, finite element models were done simulating these specimens using ANSYS taking into consideration geometric non-linearity, material non-linearity, residual stresses and geometric imperfections. Comparing tests results with finite element model results, it was found that:

- Difference between two results for all columns is less than 8%, and results of finite element are higher.

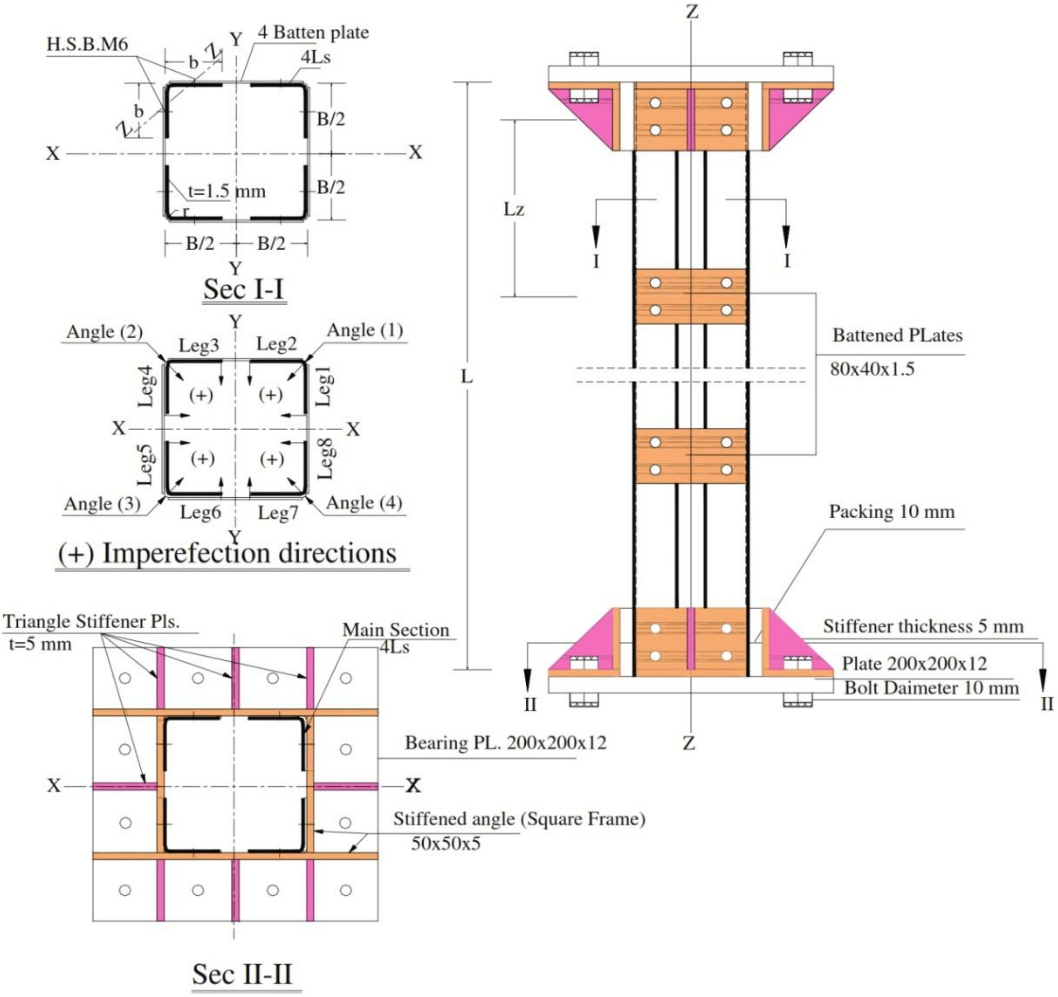

Figure (1-1): Shape of specimen

- For column sections that have short slenderness, test and finite element results are near to AISI-LRFD and EC3 specs.
- Battened columns combined of four slender angles are sensitively affected by geometric imperfections.
- Effect of bolt holes should be taken into consideration in finite element model.

1-2-2 Buckling of battened columns axially compressed

J. Chen and Long-yuan Li [3] presented an analytical solution for hinged end battened columns subjected to axial loading for case of linear elastic buckling. Classical energy method used to obtain the critical buckling load Eqn. (2-1) taking into consideration shear effect and discrete effect of battens on global buckling of columns.