بسم الله الرحمن الرحيم

∞∞∞∞

تم رفع هذه الرسالة بواسطة /صفاء محمود عبد الشافى

بقسم التوثيق الإلكتروني بمركز الشبكات وتكنولوجيا المعلومات دون أدنى مسئولية عن محتوى هذه الرسالة.

ملاحظات: لايوجد

Ain Shams University
Faculty of Engineering
Structural Engineering Department

BEHAVIOR OF HOLLOW STEEL SECTIONS FILLED WITH SAND AND EPOXY RESIN MIXES

By

Mahmoud Mohamed Elsayed Marzouk
M.Sc. 2016, Structural Engineering Department
Ain Shams University

A Thesis

Submitted in Partial Fulfillment for the Requirements
of the Degree of Doctor of Philosophy
in Civil Engineering (Structural)

Supervised by

Prof. Dr.
Abdelrahim Khalil Dessouki
Professor of steel structures
Structural Engineering Department
Ain Shams University

Dr.
Mohamed Kohail Fayez
Associate Professor
Structural Engineering Department
Ain Shams University

Dr.
Tamer Hanafy Radwan
Assistant professor
Structural Engineering Department
Ain Shams University

Dr.
Nady Mohamed Morsy
Assistant professor
Civil Engineering Department
MTI University

Cairo - Egypt
2022

Ain Shams University
Faculty of Engineering
Structural Engineering Department

Approval Sheet

Name **:** Mahmoud Mohamed Elsayed Marzouk

Title of thesis **: Behavior of Hollow Steel Sections Filled with Sand and Epoxy Resin Mixes**

Degree **:** Doctor of Philosophy in Civil Engineering (Structural)

Examining Committee	**Signature**
Prof Dr. Fouad Helmy Fouad Professor of steel structures Alabama University – United States	……
Prof Dr. Shrief Mohamed Ibrahim Professor of steel structures Ain Shams University	……
Prof. Dr. Abdelrahim Khalil Dessouki Professor of steel structures Ain Shams University	……

Date: **August 2022**

STATEMENT

This thesis is submitted to Ain shams University, Cairo, Egypt, for the Doctor of Philosophy in Civil Engineering (Structural Engineering).

The work included in this thesis was carried out by the author in the Department of Structural Engineering, Faculty of Engineering, Ain Shams University, from 2016 to 2021

No part of this thesis has been submitted for a degree or a qualification to any other University or Institution.

Name : Mahmoud Mohamed Elsayed Marzouk

Date : / / 2022

Signature

INFORMATION ABOUT THE RESEARCHER

Name : Mahmoud Mohamed Elsayed Marzouk

Date of Birth : March 19th, 1987

Place of Birth : Minia, Egypt

Qualifications : M.Sc. 2016, Structural Engineering Department
Ain Shams University

Present Job:

Signature:

ACKNOWLEDGMENTS

First and foremost, praise and thanks to Almighty Allah, the Most Gracious, the Most Merciful, and peace be upon His Prophet.

I would like to express my deepest thanks and appreciation to **Professor Dr. Abdelrahim Khalil Dessouki**, for his continuous advice, keen interest, and valuable supervision and for his reviewing of the manuscript.

Profound gratitude and sincere appreciation to **Dr. Mohammed Kohail Fayez** for his direct supervision, valuable criticism, usual and continuous support, and reviewing the manuscript.

Greatly appreciate the help, guidance, and support provided by **Dr. Tamer Hanafy Radwan** throughout all stages of research. Appreciate the help by **Dr. Nady Mohamed Morsy**.

Finally, I would like to thank deeply my family for their continuous encouragement, overwhelming support, fruitful care, and patience, especially in the difficult times.

Mahmoud Mohamed Elsayed Marzouk

ABSTRACT

The behavior of the composite sections has been examined, particularly for the composite columns. Some previous research used concrete to fill in steel tube columns to improve the different buckling modes of steel tubes and increase the strength of the columns. Other researchers used the sand to fill in steel tube columns to improve the different buckling modes of steel tube columns.

This research aim is to improve the behavior of hollow steel sections to resist different buckling modes. In this context, the study is presently being conducted on hollow steel sections filled with materials having lighter weight, more ductility, high tensile strength, and easy to operate. The aim of mixing sand with epoxy resin is to improve the shear strength of the filling material. Properties of epoxy materials are better than properties of cement as better adhesion, low shrinkage, lower weight, higher tensile strength, high ductility, better workability, and better resistance to physical and chemical attacks.

This research focuses on the behavior of hollow steel sections filled with sand and epoxy resin mixes under concentric loads. A total of 16 specimens of square hollow and composite columns have been examined to test the behavior of slender hollow steel sections filled with sand and epoxy resin mix. In this process the experimental program considers two groups of test specimens, the first group has 7 models of Hollow Steel columns (Group-H). The second group has 9 models of composite steel columns (Group-C). Different parameters were considered in this study which are epoxy to sand ratios mixes, steel tube width-to-thickness ratio (b/t), and the height-to-with ratios of steel tubes (h/b).

A nonlinear finite element model (FEM) using the multi-purpose FE program ANSYS has been developed. The validity of the developed model was examined by comparing with the experimental data of the current experiments. The comparison indicated that the results of the FEM well agree with the experimental results. Upon completing the FE model verification, it was used to extend the range of investigated parameters. Results from a wide range parametric study were utilized to propose design formulae and design charts to be used for calculating the capacity of hollow steel tubes filled with sand and epoxy resin mixes.

Based on test results obtained, it became clear the enhancement in the behavior of steel hollow section filled with sand and epoxy resin mix also, it is confirmed that tube length has a considerable effect on the carrying capacity and the failure mode. In all test tubes, fracture occurred by the convex local buckling of the steel section due to the outward thrust of the filling material.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES