



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم



شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلم



MONA MAGHRABY



شبكة المعلومات الجامعية
التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغييرات



يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار



MONA MAGHRABY



COMPARISON BETWEEN FINITE ELEMENT AND DIFFERENT CODES FOR DETERMINING THE CAPACITY OF COMPOSITE BEAM COLUMN

By

Mohammed Ali Ibrahim Ali Mohammed

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

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2021

COMPARISON BETWEEN FINITE ELEMENT AND DIFFERENT CODES FOR DETERMINING THE CAPACITY OF COMPOSITE BEAM COLUMN

By
Mohammed Ali Ibrahim Ali Mohammed

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

Under the Supervision of
Prof. Dr. Shiref Ahmed Mourad, **Prof. Dr. Mohamed Massoud El
Sadaawy**
Professor of Steel Structures Professor of Steel Structures
Structural Engineering Department Structures and Metallic Constructions
Faculty of Engineering, Cairo in HBRC
University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2021

COMPARISON BETWEEN FINITE ELEMENT AND DIFFERENT CODES FOR DETERMINING THE CAPACITY OF COMPOSITE BEAM COLUMN

By
Mohammed Ali Ibrahim Ali Mohammed

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

Approved by the Examining Committee

Prof. Dr. Sherif Ahmed Mourad (Thesis main advisor)

Prof. Dr. Mohamed Massoud El Sadaawy (Thesis advisor)
Professor of Steel Structures in Building and Housing National Research
Center, Research Institute of Structures and Metallic Constructions

Prof. Dr. Hesham Sobhy khedr (Internal examiner)

Prof. Dr. Maged Tawfick Hanna (External examiner)
Professor of Steel Structures in Building and Housing National Research
Center, Research Institute of Structures and Metallic Constructions

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2021

Engineer's Name: Mohammed Ali Ibrahim Ali Mohammed
Date of Birth: 14/09/1990
Nationality: Egyptian
E-mail: eng.m.ali.nassar@gmail.com
Phone: +20 - 0112 176 9990
Address: 10 Street Al-Azhr, Haram, Giza - Egypt
Registration Date: 1/10/2016
Awarding Date:/....../2021
Degree: Master of Science
Department: Structural Engineering



Supervisors:

Prof. Dr. Shiref Ahmed Mourad
Prof. Dr. Mohamed Massoud El Sadaawy
Professor of Steel Structures in Building and Housing
National Research Center

Examiners:

Prof. Dr. Shiref Ahmed Mourad (Thesis main advisor)
Prof. Dr. Mohamed Massoud El Sadaawy (advisor)
Professor of Steel Structures in Building and Housing
National Research Center
Prof. Dr. Hesham Sobhy Khder (Internal examiner)
Prof. Dr. Maged Tawfik Hana (External examiner)
Professor of Steel Structures in Building and Housing
National Research Center

Title of Thesis:

Comparison Between Finite Element and Different Codes for Determining the Capacity of Composite Beam Column

Key Words:

Composite Column; Concrete Encased; Interaction Diagram; Steel-Core Area

Summary:

The thesis presents an analytical investigation of the flexural and compression load capacity of the composite columns from a steel section encased with reinforced concrete, by using the finite element theory that was applied to different models of the columns under study where several variables were studied such as the area of the longitudinal reinforcement bars and the area of the steel core section, and a comparison of different codes results using the reaction diagram.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Mohamed Ali Ibrahim Ali Mohamed

Date: ----/----/-----

Signature:

Dedication

To my parents and my sisters with love

Acknowledgments

I am grateful to my parents who are always behind me for the success. I would not have achieved this work without their help.

I would like to express my sincere gratitude to my advisors Prof. Dr. Shiref Ahmed Mourad and Prof. Dr. Mohamed Massoud El Sadaawy for their guidance, support, encouragement, valuable discussions, and review during the course of this work, and great efforts to accomplish the thesis objectives.

Table of Contents

LIST OF TABLES.....	VI
LIST OF FIGURES.....	VII
LIST OF SYMBOLS.....	X
ABSTRACT.....	XIII
CHAPTER 1: INTRODUCTION.....	1
1.1. General.....	1
1.2. Problem statement.....	2
1.3. Objective and Scope	2
1.4. Thesis organization	2
CHAPTER 2: LITERATURE REVIEW	4
2.1. General.....	4
2.2. Design Codes.....	4
2.3. Research Works.....	8
CHAPTER 3: FINITE ELEMENT MODEL AND VERIFICATION.....	21
3.1. General.....	21
3.2. Finite Element Program.....	21
3.3. Element Type.....	22
3.3.1. concrete element	22
3.3.2. Steel plates element	23
3.3.3. Reinforcement Element	23
3.4. Non-linear Behavior in Ansys Program.....	24
3.5. Material Properties.....	24
3.5.1. Stress-Strain Curve	24
3.6. Model Geometry.....	27

3.7. Applied Loads and Failure Criteria.....	31
3.8. Non-linear Solution.....	34
3.9. Analysis type.....	35
3.10. Model Verification.....	35
3.10.1. Finite Element Verification	35
3.10.2 Spreadsheet Program Verification	36
CHAPTER 4: PARAMETRIC STUDY.....	38
4.1. General.....	38
4.2. Interaction Diagram	38
4.3. Encased Column Design Programs.....	41
4.4. Design of Encased Composite Column in The International Codes.....	44
4.4.1. Introduction.....	44
4.4.2. Effect of Limitations using interaction diagrams.....	44
4.4.2.1. Comparison of Composite Columns Using Different Codes.....	44
4.4.2.2. Behavior of composite columns with constant longitudinal steel bars (A_{sb}) using finite element curves.....	61
4.4.2.3. Behavior of composite columns with constant steel core (A_{sc}) using finite element curves.....	64
4.4.2.4. Behavior of composite columns with a fixed increase 1% in each steel area (A_{sb}) and (A_{sc}) to comparison between of reinforcement bar and steel section using finite element curves...	68
4.4.2.5. Factor of Safety.....	71
4.5. Suggest New Curve.....	73
CHAPTER 5: CONCLUSION AND RECOMMENDATIONS.....	74
5.1. Summary.....	74
5.2. Conclusion.....	74
5.3. Recommendations for Future Research.....	75
REFERENCES.....	76

List of Tables

Table 3.1: Element Materials	24
Table 3.2: Details od Models Characteristics	29
Table 3.3: Non-linear Analysis Control Commands	35
Table 4.1: Table 4.1: ratio-differ for group A	46
Table 4.2: Table 4.1: ratio-differ for group B	48
Table 4.3: Table 4.1: ratio-differ for group D	51
Table 4.4: Table 4.1: ratio-differ for group E	53
Table 4.5: Table 4.1: ratio-differ for group F	56
Table 4.6: Table 4.1: ratio-differ for group G	58
Table 4.7: Percentage increase in axial capacity and flexural difference in interaction diagram axes, with constant reinforcement longitudinal bars.....	61
Table 4.8: Percentage increase in axial capacity and flexural difference in interaction diagram axes, with constant steel core section.....	64
Table 4.9: compares between area increase in steel core and longitudinal reinforcement bars area with same area ratio +1%.....	68

List of Figures

Figure 1.1: Cross-Sectional of composite column.....	1
Figure 2.1: Calculate the plastic capacities encased shapes about strong axis.....	6
Figure 2.2: Cross section of composite column	9
Figure 2.3: Rectangular and circular cross sections and properties	10
Figure 2.4: Interaction curve for circular column diameter 230 mm	11
Figure 2.5: Interaction curve about the strong axis at different moments of fire exposure for partially & totally encased steel sections	12
Figure 2.6: The new cross-section studied	13
Figure 2.7: Cross section for (FCSCs) & (FCCCs)	16
Figure 2.8: Parts for unconfined, partially confined, and highly confined concrete in several composite cross sections	17
Figure 2.9: Cross section for composite polygonal tubular columns with reference to loading	18
Figure 2.10: Variation of load versus moment interaction curves.....	19
Figure 2.11: Comparison of three different design codes for composite columns....	20
Figure 3.1: Finite element of composite column	21
Figure 3.2: Finite element of cross section of composite column	22
Figure 3.3: Solid 65 3-D reinforced concrete solid ansys 19	22
Figure 3.4: Solid 45 3-D solid ansys 19	23
Figure 3.5: Link 180 ansys 19	23
Figure 3.6: Stress-strain curve for steel material	25
Figure 3.7: Stress-strain curve for concrete material	25
Figure 3.8: Multi-linear isotropic stress-strain curve for the concrete	26
Figure 3.9: The geometrical characteristics of specimens.....	27
Figure 3.10: The geometrical & buckling mode of studies cases.....	28
Figure 3.11: Element connectivity: (a) Concrete solid and link elements (b) Concrete solid and steel solid elements.....	30
Figure 3.12: Loading system and Dimensions (mm).....	31
Figure 3.13: Point at interaction diagram	31
Figure 3.14: Applied Load case one at point A.....	32
Figure 3.15: Applied Load case one at point B.....	32
Figure 3.16: Applied Load case one at point C.....	33
Figure 3.17: Applied Load case one at point D.....	33
Figure 3.18: Deformed shape finite element.....	34
Figure 3.19: Cross section for specimen of M. Magdy Abdel Wahab	35
Figure 3.20: Comparison between interaction diagram of our F.E model and M. Magdy experimental model	36
Figure 3.21: Comparison of interaction diagram Aisc-2010 & Aisc-2016 between the Spreadsheet Program (Ultimate Length)	37
Figure 3.22: Comparison of interaction diagram Aisc-2010 & Aisc-2016 between the Spreadsheet Program (Length Effect).....	31
Figure 4.1: Simplified determination of the interaction curve and stress distributions	39

Figure 4.2: Stress Distribution for max. capacity of cross section for point A, B, D, & B.....	40
Figure 4.3: Example cross section for composite column G-6.99-1.93.....	41
Figure 4.4: Spreadsheet program for composite column name G-6.99-1.93 (1/2)...	42
Figure 4.5: Spreadsheet program for composite column name G-6.99-1.93 (2/2)...	43
Figure 4.6: Comparison between expected interaction diagram for column A-2.05-0.97 and interaction diagram by codes.....	46
Figure 4.7: Comparison between expected interaction diagram for column A-2.06-1.23 and interaction diagram by codes.....	47
Figure 4.8: Comparison between expected interaction diagram for column A-2.06-1.52 and interaction diagram by codes.....	47
Figure 4.9: Comparison between expected interaction diagram for column A-2.07-1.84 and interaction diagram by codes.....	48
Figure 4.10: Comparison between expected interaction diagram for column B-2.97-0.98 and interaction diagram by codes.....	49
Figure 4.11: Comparison between expected interaction diagram for column B-2.98-1.24 and interaction diagram by codes.....	49
Figure 4.12: Comparison between expected interaction diagram for column B-2.99-1.53 and interaction diagram by codes.....	50
Figure 4.13: Comparison between expected interaction diagram for column B-3.99-1.88 and interaction diagram by codes.....	50
Figure 4.14: Comparison between expected interaction diagram for column D-3.94-0.98 and interaction diagram by codes.....	51
Figure 4.15: Comparison between expected interaction diagram for column D-3.97-1.25 and interaction diagram by codes.....	52
Figure 4.16: Comparison between expected interaction diagram for column D-3.98-1.55 and interaction diagram by codes.....	52
Figure 4.17: Comparison between expected interaction diagram for column D-3.99-1.88 and interaction diagram by codes.....	53
Figure 4.18: Comparison between expected interaction diagram for column E-5.03-0.99 and interaction diagram by codes.....	54
Figure 4.19: Comparison between expected interaction diagram for column E-5.04-1.26 and interaction diagram by codes.....	54
Figure 4.20: Comparison between expected interaction diagram for column E-5.05-1.56 and interaction diagram by codes.....	55
Figure 4.21: Comparison between expected interaction diagram for column E-5.07-1.90 and interaction diagram by codes.....	55
Figure 4.22: Comparison between expected interaction diagram for column F-6.12-1.01 and interaction diagram by codes.....	56
Figure 4.23: Comparison between expected interaction diagram for column F-6.14-1.28 and interaction diagram by codes.....	57
Figure 4.24: Comparison between expected interaction diagram for column F-6.16-1.58 and interaction diagram by codes.....	57
Figure 4.25: Comparison between expected interaction diagram for column F-6.18-1.92 and interaction diagram by codes.....	58
Figure 4.26: Comparison between expected interaction diagram for column G-6.93-1.01 and interaction diagram by codes.....	59