



ANALYTICAL AND EXPERIMENTAL ASSESSMENT OF NONLINEAR BEHAVIOR FOR CIRCULAR STEEL HOLLOW SECTIONS UNDER BENDING

By

Eslam Yehia Mohamed El-Sayed

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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Under the Supervision of

Prof. Dr. Sherif A. Mourad
Professor of Steel Structures and
Bridges
Faculty of Engineering, Cairo
University

**Assoc. Prof. Dr. Maheeb M. E.
Abdel-Ghaffar**
Associate Professor of Steel
Structures and Bridges
Faculty of Engineering, Cairo
University

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Prof. Dr. Sherif A. Mourad

Professor of Steel Structures and Bridges
Faculty of Engineering, Cairo University

Assoc. Prof. Dr. Maheeb M. E. Abdel-Ghaffar

Associate Professor of Steel Structures and Bridges
Faculty of Engineering, Cairo University

Prof. Dr. Mokhtar M. Seddeik

Professor of Steel structures and Bridges
Faculty of Engineering, Cairo University

Prof. Dr. Abdelrahim Khalil Dessouki

Professor of Steel structures and Bridges
Faculty of Engineering, Ain-shams University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

Engineer's Name: Eslam Yehia Mohamed El-Sayed
Date of Birth: 21/03/1990
Nationality: Egyptian
E-mail: eslamyehia@eng.cu.edu.eg
Phone: +20 - 01113907020
Address: 54 El Eshrien Street, Faisal, Giza, Egypt
Registration Date: 1/10/2011
Awarding Date:/.....
Degree: Master of Science
Department: Structural Engineering



Supervisors:

Prof. Sherif A. Mourad
Assoc. Prof. Maheeb M. E. Abdel-Ghaffar

Examiners:

Prof. Sherif A. Mourad
Assoc. Prof. Maheeb M. E. Abdel-Ghaffar
Prof. Mokhtar M. Seddeik
Prof. Abdelrahim Khalil Dessouki

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Analytical and Experimental Assessment of Nonlinear Behavior for Circular Steel Hollow Sections under Bending

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Circular Steel Hollow Sections, Finite Element Analysis, Experimental Assessment, bending moment, Eigen Buckling Analysis, full nonlinear analysis, ovalisation and local buckling

Summary:

This thesis presents an analytical and experimental assessment of the behavior of circular steel hollow sections under bending. Three dimensional non-linear finite element models have been established by ANSYS11 Finite element program to assess the allowable bending strength and D/t limits which separate between the sections types (compact, non-compact, slender). Several parameters are studied; Diameter to thickness (D/t) ratio, length to diameter (L/D) ratio, load conditions, boundary conditions, and variation of steel profile. Nine full-scale circular beams were tested to verify the finite element models; seven specimens were tested in cantilever models and two specimens were tested in simple beam with two concentrated loads. An analytical equation was proposed to predict the allowable bending stress in circular steel tubes. The equation was verified by a parametric study.

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Dedication

To my parents, my dear brother and sisters with love

Table of Contents

Acknowledgment.....	i
<i>Dedication</i>	ii
Table of Contents	iii
List of Tables.....	vi
List of Figures	vii
Nomenclature	xi
Abstract	xiii
Chapter 1 : Introduction.....	1
1.1. General.....	1
1.2. Problem statement.....	1
1.3. Overview and scope of the research	4
Chapter 2 : Literature Review	6
2.1. General.....	6
2.2. Design codes	6
2.2.1. The Egyptian Code of Practice (LRFD).....	6
2.2.2. AISC Specifications	7
2.2.3. Australian Standard	8
2.2.4. British Standard	9
2.2.5. ASME Steel Stack Standard.....	10
2.2.6. ASCE Recommended Practice	10
2.3. Research Work.....	12
Chapter 3 : Finite Element Model and Verification	42
3.1. General.....	42
3.2. ANSYS11 program.....	42
3.3. Numerical Model	42
3.4. Model verification.....	44
3.4.1. First verification	44
3.4.2. Second verification.....	52
3.4.3. Third verification.....	56
Chapter 4 : Parametric study	60
4.1. General.....	60

4.2.	Elastic-plastic analysis.....	60
4.2.1.	Pure bending model.....	60
4.2.1.1.	Steel ST37	60
4.2.1.2.	Steel ST52	69
4.2.2.	Two concentrated loads model.....	77
4.2.3.	Cantilever model	79
4.2.4.	Comparison between the results of three models.....	81
4.3.	Elastic analysis.....	82
Chapter 5 : Experimental Testing and Comparison		93
5.1.	General.....	93
5.2.	Cantilever models	93
5.2.1.	Specimens geometry.....	93
5.2.2.	Specimen construction.....	94
5.2.3.	Material properties.....	96
5.2.4.	Test setup.....	96
5.2.5.	Test loading	99
5.2.6.	Instrumentation.....	99
5.2.7.	Observed behavior.....	99
5.2.7.1.	Specimen (CB1)	100
5.2.7.2.	Specimen (CB2)	101
5.2.7.3.	Specimen (CB3) and (CB4).....	103
5.3.	Two concentrated load models	107
5.3.1.	Specimen geometry	107
5.3.2.	Specimen construction.....	107
5.3.3.	Material properties.....	107
5.3.4.	Test setup.....	108
5.3.5.	Test loading	108
5.3.6.	Instrumentation.....	109
5.3.7.	Observed behavior.....	110
5.4.	Comparison between the results of FE analysis and experiments.....	113
5.4.1.	Cantilever models.....	113
5.4.1.1.	Specimen CB1	113
5.4.1.2.	Specimen CB2	113
5.4.1.3.	Specimens CB3 and CB4	114

5.4.2. Two concentrated loads model	118
5.4.2.1. Specimen SB1	118
5.4.2.2. Specimen SB2	119
5.5. Comparison between the results of experiments	120
Chapter 6 : Conclusions and Recommendations	123
6.1. Summary	123
6.2. Conclusions.....	124
6.3. Recommendations for future research	125
References	126
Appendix A: Calculation of the curvature from end rotations	128

List of Tables

Table 2.1: Egyptian Code Slenderness Limits	6
Table 2.2: Compression of width to thickness ratios: elements subject to flexure	7
Table 2.3: Values of Plate Element Slenderness Limits.....	8
Table 2.4: Diameter to wall thickness ratio limits for CHS	9
Table 2.5: Slenderness limits for HSS Sections	10
Table 2.6: Summery of simply supported test results. [9].....	13
Table 2.7: Summery of cantilever test results. [10].....	14
Table 2.8: Total results of the ten specimens. [11].....	14
Table 2.9: The results of the four specimens. [12]	15
Table 2.10: The results of the eight specimens. [13].....	15
Table 2.11: Measured and nominal mechanical properties of samples. [14]	17
Table 2.12: Measured and nominal material properties of samples. [14]	17
Table 2.13: Results of pure bending tests. [14]	18
Table 2.14: Predicted vs. experimental ultimate moment capacity. [14]	19
Table 2.15: Measured mechanical properties of specimens. [17]	20
Table 2.16: Measured dimensions of specimens. [17]	21
Table 2.17: Mechanical properties of specimens. [17].....	21
Table 2.18: Results of pure bending test. [17]	22
Table 2.19: Geometry and material properties. [19]	25
Table 2.20: Summary of total test results. [19]	25
Table 2.21: Comparison between experiments and FE ultimate moments. [20].....	26
Table 2.22: Samples dimensions and symbols. [23]	34
Table 2.23 : Samples initial geometrical imperfection (mm). [23]	34
Table 2.24: Samples bending capacities. [23]	39
Table 4.1: Summery of $L/D = 1$ results.....	83
Table 4.2: Summery of $L/D = 7$ results.....	83
Table 4.3: Summery of $L/D = 15$ results.....	83
Table 4.4: Summery of $L/D = 20$ results.....	83
Table 5.1: Dimensions cantilever of specimens.	94
Table 5.2: Slenderness limits of cantilever specimens.....	100
Table 5.3: Comparison between the results of cantilever models.	106
Table 5.4: Dimensions of specimen.	107
Table 5.5: Slenderness limits of two concentrated loads specimens.....	110
Table 5.6: Comparison between the results of two concentrated loads models.....	113
Table 5.7: Proposed slenderness limits.	120
Table 5.8: Comparison between experiments and proposed bending tubes capacities.	122

List of Figures

Figure 1.1: (a) Traffic sign, (b) Water or Petroleum pipelines, (c) Special frames, (d) Advertising boards, and (e) Wind turbine towers.	2
Figure 1.2: Tubes failure modes (a) Ovalisation, (b) Smooth kink, (c) Wall wrinkles and (d) Local buckling.	3
Figure 2.1: Comparison between bending design strength values in codes.	11
Figure 2.2: Brazier assumption. (a) The moment-curvature curves (b) the deformed shape at ultimate moment (point A).	12
Figure 2.3: Pure bending test schematic with bending moment and shear force diagrams. [14]	16
Figure 2.4: Normalized moment-curvature curve for 9 samples. [14]	18
Figure 2.5: Failure mode shapes. (a) Compact specimen TB11 (Ovalisation), (b) Non-compact specimen TB5 (non-symmetric mode), (c) Slender specimen TB2 (non-symmetric mode). [17]	23
Figure 2.6: The test schematic view. [19]	24
Figure 2.7: Stress-strain curve. [19]	25
Figure 2.8: FE model (a) Typical FE model, and (b) Failure modes of experiment and FE models. [20]	26
Figure 2.9: The numerical model for both shell and solid elements. [22]	27
Figure 2.10: Assumed engineering stress-strain curve. [22]	28
Figure 2.11: Normalized moment-curvature curves for $D/t = 20$. [22]	28
Figure 2.12: Buckling modes for both solid and shell elements for $D/t = 20$. [22]	29
Figure 2.13: Normalized moment curvature curves for $D/t = 50$. [22]	30
Figure 2.14: Buckling modes for both solid and shell elements for $D/t = 50$. [22]	30
Figure 2.15: Normalized moment curvature curves for $D/t = 50$. [22]	31
Figure 2.16: Buckling modes for both solid and shell elements for $D/t = 100$. [22]	32
Figure 2.17: Dimensions of four points bending tests. [23]	33
Figure 2.18: Dimensions of cantilever bending tests (a) Dimensions of cantilever beam (b) cross section for CHS with stiffeners. [23]	33
Figure 2.19: Sample DT75 failure shape. [23]	35
Figure 2.20: Sample DT100-2 failure shape. [23]	35
Figure 2.21: Sample DT100-1 failure shape. [23]	35
Figure 2.22: Failure shapes of cantilever beams (a) Sample DT100-3 (b) Sample DT100-4. [23]	36
Figure 2.23: Sample DT125 failure shape. [23]	36
Figure 2.24: Sample DT150 failure shape. [23]	36
Figure 2.25: Failure shape of cantilever samples (a) Sample DT200-1 (b) Sample DT200-2 (c) Sample DT300-1 (d) Sample DT300-2. [23]	37
Figure 2.26: Load-deformation curve for four points tests. [23]	38
Figure 2.27: Load-deformation curve for cantilever beams. [23]	38
Figure 2.28: Tested tower (a) Test setup, and (b) Tower dimensions. [24]	40
Figure 2.29: Load-displacement curve of both specimens. [24]	41
Figure 2.30: Failure modes (a) Test failure mode, and (b) FE failure modes. [24]	41
Figure 3.1: ANSYS 3-D shell element representation [25]	43

Figure 3.2: Beam Load Cases: (a) Pure bending, (b) Two concentrated loads, and (c) Cantilever model.	43
Figure 3.3: Simple beam with two concentrated load finite element model.	44
Figure 3.4: Comparison of load-displacement curves of specimen DT75. [23]	45
Figure 3.5: Comparison between failure mode shapes of specimen DT75. [23].	45
Figure 3.6: Comparison of load-displacement curves of specimen DT100. [23]	46
Figure 3.7: Comparison between failure mode shapes of specimen DT100. [23]	46
Figure 3.8: Comparison of load-displacement curves of specimen DT125. [23]	47
Figure 3.9: Comparison between failure mode shapes of specimen DT125. [23]	47
Figure 3.10: Comparison of load-displacement curves of specimen DT150. [23]	48
Figure 3.11: Comparison between failure mode shapes of specimen DT150. [23]	48
Figure 3.12: Cantilever finite element model.....	49
Figure 3.13: Comparison of load-displacement curves of specimen DT100 (cant.). [23] ..	50
Figure 3.14: Comparison between failure mode shapes of specimen DT100 (cant.) [23] ..	50
Figure 3.15: Comparison of load-displacement curves of specimen DT200. [23]	50
Figure 3.16: Comparison between failure mode shapes of specimen DT200. [23]	51
Figure 3.17: Comparison of load-displacement curves of specimen DT300. [23]	51
Figure 3.18: Comparison between failure mode shapes of specimen DT300. [23]	51
Figure 3.19: Pure bending finite element model with elements meshing.	52
Figure 3.20: Normalized moment-curvature curves for $D/t = 20$. [22]	53
Figure 3.21: Buckling mode shapes for $D/t = 20$. [22].....	53
Figure 3.22: Normalized moment-curvature curves for $D/t = 50$. [22]	54
Figure 3.23: Buckling mode shapes for $D/t = 50$. [22].....	54
Figure 3.24: Normalized moment-curvature curves for $D/t = 100$. [22]	55
Figure 3.25: Buckling mode shapes for $D/t = 100$. [22].....	55
Figure 3.26: ANSYS wind turbine model.	56
Figure 3.27: Specimen 1 load-displacement curves. [24]	57
Figure 3.28: Failure mode shapes of specimen 1. [24].....	58
Figure 3.29: Specimen 2 load-displacement curve. [24]	58
Figure 3.30: Failure mode shapes of specimen 2. [24].....	59
Figure 4.1: Stress-strain curve of used steel material.....	60
Figure 4.2: Normalized moment-curvature curves of $L/D = 3.5$ model.....	61
Figure 4.3: Failure mode shapes of $L/D = 3.5$ model for all D/t ratios.	62
Figure 4.4: Normalized moment-curvature curves of $L/D = 5$ model.....	63
Figure 4.5: Normalized moment-curvature curves of $L/D = 7$ model.....	63
Figure 4.6: Failure mode shapes of $L/D = 5$ model for all D/t ratios.	64
Figure 4.7: Failure mode shapes of $L/D = 7$ model for all D/t ratios.	65
Figure 4.8: Normalized moment-curvature curves of $L/D = 10$ model.....	66
Figure 4.9: Failure mode shapes of $L/D = 10$ model for all D/t ratios.	67
Figure 4.10: Normalized moment vs. D/t for all ST37 models.	68
Figure 4.11: Normalized curvature vs. D/t for all ST37 models.	68
Figure 4.12: Normalized moment-curvature curves of $L/D = 3.5$ model.....	69
Figure 4.13: Failure mode shapes of $L/D = 3.5$ model for all D/t ratios.	70
Figure 4.14: Normalized moment-curvature curves of $L/D = 5$ model.....	71
Figure 4.15: Normalized moment-curvature curves of $L/D = 7$ model.....	71
Figure 4.16: Failure mode shapes of $L/D = 5$ model for all D/t ratios.	72

Figure 4.17: Failure mode shapes of $L/D = 7$ model for all D/t ratios.	73
Figure 4.18: Normalized moment-curvature curves of $L/D = 10$ model.	74
Figure 4.19: Failure mode shapes of $L/D = 10$ model for all D/t ratios.	75
Figure 4.20: Normalized moment vs. D/t for all ST52 models.	76
Figure 4.21: Normalized curvature vs. D/t for all ST52 models.	76
Figure 4.22: Normalized moment-curvature curves of $L/D = 5$ of two loaded points model.	77
Figure 4.23: Failure mode shapes of $L/D = 5$ of two loaded points model for all D/t ratios.	78
Figure 4.24: Normalized moment-curvature curves of $L/D = 5$ of cantilever model.	79
Figure 4.25: Failure mode shapes of $L/D = 5$ of cantilever model for all D/t ratios.	80
Figure 4.26: comparison between the three models in bending capacity.	81
Figure 4.27: Eigen buckling failure modes for $L/D = 1$	84
Figure 4.28: Nonlinear Geometry analyses for $L/D = 1$	85
Figure 4.29: Eigen buckling failure modes for $L/D = 7$	86
Figure 4.30: Nonlinear Geometry analyses for $L/D = 7$	87
Figure 4.31: Eigen buckling failure modes for $L/D = 15$	88
Figure 4.32: Nonlinear Geometry analyses for $L/D = 15$	89
Figure 4.33: Eigen buckling failure modes for $L/D = 2$	90
Figure 4.34: Nonlinear Geometry analyses for $L/D = 20$	91
Figure 4.35: The M_{NGA}/M_{Tim} and D/t ratio curves.	92
Figure 4.36: The M_{NGA}/M_{Bra} and L/D ratio curves.	92
Figure 5.1: The final shape of four cantilever specimens	95
Figure 5.2: Tested dog bone slice (a) before the test (b) after the test.	96
Figure 5.3: Tension test results of CB1 and CB2 specimens.	97
Figure 5.4: Tension test results of CB3 and CB4 specimens.	97
Figure 5.5: Cantilever hollow circular steel beam subjected to one concentrated load at the free end: (a) Schematic view of the test, (b) Test set-up and (c) LVDTs arrangement.	98
Figure 5.6: Test instruments: (a) Load cell and (b) Configuration of LVDT.	99
Figure 5.7: Load-displacement of specimen (CB1)	100
Figure 5.8: Failure mode of specimen (CB1).	101
Figure 5.9: Load-displacement curve of specimen (CB2).	102
Figure 5.10: Failure mode shape of specimen (CB2).	103
Figure 5.11: Load-displacement curve of specimen (CB3).	104
Figure 5.12: Load-displacement curve of specimen (CB4).	105
Figure 5.13: Failure mode shape of Specimen (CB3).	106
Figure 5.14: Failure mode shape of Specimen (CB4).	106
Figure 5.15: Stress strain curve of SB1 and SB2.	108
Figure 5.16: Test setup of two concentrated loads models: (a) Schematic view of the test, (b) Test setup and (c) LVDTs arrangement.	109
Figure 5.17: Load-displacement of specimen (SB1).	110
Figure 5.18: Load-displacement curve of specimen (SB2).	111
Figure 5.19: Specimen SB1 failure mode.	111
Figure 5.20: Specimen SB2 failure mode.	112
Figure 5.21: Load-displacement curves of specimen CB1.	114
Figure 5.22: Failure mode shapes of CB1.	114

Figure 5.23: Load-displacement curves of specimen CB2.....	115
Figure 5.24: Failure mode shapes of CB2.....	115
Figure 5.25: Load-displacement curves of specimen CB3.....	116
Figure 5.26: Failure mode shapes of CB3.....	116
Figure 5.27: Load-displacement curves of specimen CB4.....	117
Figure 5.28: Failure mode shapes of CB4.....	117
Figure 5.29: Load-displacement curves of specimen SB1.....	118
Figure 5.30: Failure mode shapes of SB1.....	118
Figure 5.31: Load-displacement curves of specimen SB2.....	119
Figure 5.32: Failure mode shapes of SB2.....	119
Figure 5.33: M_u/M_p -section slenderness relationship.....	122

Nomenclature

D	Outside diameter of tubes
D_i	Inside diameter of tubes
E	Modulus of elasticity of steel
E_t	Tangent modulus
F_y	Steel yield stress
F_u	Ultimate tension strength of steel
L	Length of sample
M	Bending moment
M_p	Plastic bending moment
M_{pt}	Plastic bending moment according to measured dimensions
M_y	Yield bending moment
M_r	Moment when the relative angle of rotation is 60 degrees
M_{theory}	Predicted ultimate moment capacity
M_u	Ultimate bending moment
S	Elastic section modulus
SF	Shape factor
t	Thickness of steel pipe
Z	Plastic section modulus
$Z_{ovalized}$	Plastic section modulus of an ovalised tube.
α	Slenderness parameter
β	End rotation
β_y	Yield end rotation
κ	Curvature
κ_p	Curvature corresponding to M_p
ε	Constant $(275/F_y)^{0.5}$
λ_s	Generalized section slenderness