



Cairo University

COMPARISON BETWEEN ASD & LRFD EGYPTIAN STEEL CODES FOR BEAM-COLUMNS UNDER DIFFERENT LIVE TO DEAD LOAD RATIOS

By

Abdelrhman Mostafa Awd

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
2015

COMPARISON BETWEEN ASD & LRFD EGYPTIAN
STEEL CODES FOR BEAM-COLUMNS UNDER
DIFFERENT LIVE TO DEAD LOAD RATIOS

By
Abdelrhman Mostafa Awd

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

Dr. Fouad Fayez Aly

Associate Professor of Structural Engineering
Structural Engineering Department
Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

COMPARISON BETWEEN ASD & LRFD EGYPTIAN
STEEL CODES FOR BEAM-COLUMNS UNDER
DIFFERENT LIVE TO DEAD LOAD RATIOS

By
Abdelrhman Mostafa Awd

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. Nabeel Mahmoud, External Examiner

Prof. Dr. Ahmad Fouad Sabry, Internal Examiner

Assoc. Prof. Dr. Fouad Fayez Aly, Thesis Main Advisor

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

Engineer's Name: Abdelrhman Mostafa Awad
Date of Birth: 25/12/1980
Nationality: Egyptian
E-mail: Abdlerhman80@yahoo.com
Phone: +201114701881
Address: 19A Omarat El Obour Salah Salem
Registration Date: 1/10/2011
Awarding Date: / /
Degree: Master of Science
Department: Structural Engineering
Supervisors: Assoc. Prof. Dr. Fouad Fayez Aly



Examiners: Prof. Dr. Nabeel Mahmoud, (External examiner)
Prof. Dr. Ahmad Fouad Sabry (Internal examiner)
Assoc. Prof. Dr. Fouad Fayez Aly (Thesis main advisor).

Title of Thesis:

COMPARISON BETWEEN ASD & LRFD EGYPTIAN STEEL CODES FOR
BEAM-COLUMNS UNDER DIFFERENT LIVE TO DEAD LOAD RATIOS

Key Words:

ASD; LRFD; ECP CODE, STEEL; BEAM-COLUMN.

Summary:

This Thesis presents a study of the structural design of beam-columns in accordance with the latest Egyptian steel codes (ASD & LRFD) under the effect of different live to dead load ratios. Extracted design charts are produced to determine the relation between different Live to dead load ratios versus different unsupported member lengths. While focusing on regions where either LRFD or ASD shall give an optimum designed section based on the different design parameters. Different cross sections, member spans, steel grade and buckling lengths are introduced. It is shown clearly the significant effect of different sharing of axial compression force to the applied moment for the output results. Great influence is also observed for the unsupported length "Lu" and of course the live to dead load ratio. Generally it is concluded that, ASD" method is more reliable than "LRFD" method for beam-column section with bigger unbraced length "Lu", and for higher N ratios, while LRFD method is much optimum for smaller Lu values, smaller N ratios, smaller cross sections and smaller L/D ratios.

Acknowledgments

I would like to express my deepest gratitude and appreciation to my supervisor Prof. Dr. Fouad Fayez for his precious guidance, support and encouragement, and it makes me proud that he supervised this thesis. I would also like to express my deepest gratitude to him for his great effort and help to complete the research and his insistence on following the progress weekly till the end of the research. Grateful thanks to the staff of the steel Department of the faculty of Engineering. Finally, I cannot express my deepest appreciation to my dear mother for her support and encouragement through my entire life.

Dedication

I Dedicate This Thesis To My Dear Mother.

Table of Contents

ACKNOWLEDGMENTS	I
DEDICATION.....	II
TABLE OF CONTENTS.....	III
LIST OF TABLES	V
LIST OF FIGURES	VII
NOMENCLATURE	XV
ABSTRACT	XVIII
CHAPTER 1 : INTRODUCTION	1
1.1. GENERAL	ERROR! BOOKMARK NOT DEFINED.
1.2. RATIONALE OF DESIGN.....	2
1.3. GENERAL DESIGN IMPLICATION	5
1.4. LOAD FACTOR	7
CHAPTER 2 : LITERATURE REVIEW	8
2.1. INTRODUCTION	8
2.2. STEEL CODES.....	9
2.3. RESEARCH WORK LEADING TO CODE DEVELOPMENT	9
2.4. OBJECTIVES AND ORGANIZATION OF THE PRESENT RESEARCH.....	13
CHAPTER 3 : PROBLEM FORMATION AND STUDIED MODELS.....	14
3.1. INTRODUCTION	14
3.2. METHODS OF DESIGN.....	15
3.2.1 DESIGN OF ROLLED SECTION AS BEAM-COLUMN (ASD-ECP).....	15
3.2.1.1 DEFINING THE SECTION COMPACTNESS.....	16
3.2.1.2 ALLOWABLE BENDING STRESSES.....	16
3.2.1.3 AMPLIFICATION FACTORS A1 & A2.....	17
3.2.1.4 ALLOWABLE COMPRESSIVE STRESSES.....	18
3.2.2 DESIGN OF ROLLED SECTION SAS BEAM-COLUMN USING (LRFD-ECP).....	19
3.3. LOAD COMBINATIONS AND ASD VS LRFD	22
3.3.1 LOAD AND RESISTANCE FACTOR DESIGN (LRFD).....	22
3.3.2 ALLOWABLE STRESS DESIGN (ASD).....	23
3.3.3 RELATION BETWEEN LRFD & ASD LOAD COMBINATIONS	24
3.4. APPLYING APPROCH AND DESIGN PROCEDURE.....	25
3.5. DESIGN PARAMETERS AND STUDIED MODELS	27
CHAPTER 4 : RESULTS AND DISCUSSION.....	28
4.1. INTRODUCTION	28
4.2. ILLUSTRATED FIGURES.....	28
4.2.1 MODEL (1).....	28

4.2.2	MODEL (2).....	37
4.2.3	MODEL (3).....	45
4.2.4	MODEL (4).....	53
4.2.5	MODEL (5).....	61
4.2.6	MODEL (6).....	70
4.2.7	MODEL (7).....	79
4.2.8	MODEL (8).....	88
4.2.9	MODEL (9).....	97
4.2.10	MODEL (10).....	106
4.2.11	MODEL (11).....	115
4.2.12	MODEL (12).....	123
4.2.13	MODEL (13).....	132
4.2.14	MODEL (14).....	141
4.2.15	MODEL (15).....	150
4.2.16	MODEL (16).....	159
CHAPTER 5 : SUMMARY & CONCLUSION		169
REFERENCES		171

List of Tables

Table 3.1: Models Studied With Variable Parameters	20
Table 4.1: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (1)	36
Table 4.2: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (2)	44
Table 4.3: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (3)	52
Table 4.4: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (4)	60
Table 4.5: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (5)	69
Table 4.6: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (6)	78
Table 4.7: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (7)	87
Table 4.8: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (8)	96
Table 4.9: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (9)	105
Table 4.10: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (10)	114
Table 4.11: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (11)	122
Table 4.12: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (12)	131
Table 4.13: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (13)	140

Table 4.14: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (14)	149
---	-----

Table 4.15: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (15)	158
---	-----

Table 4.16: “L/D” Ratio of the balanced curve for different regions with variation of N ratio for Model (16)	167
---	-----

List of Figures

Figure 3.1: Schematic configuration of balancing line curve with different significant regions	25
Figure 4.1.1: Model (1) N ratio=0	29
Figure 4.1.2: Model (1) N ratio=0.1	29
Figure 4.1.3: Model (1) N ratio=0.2	30
Figure 4.1.4: Model (1) N ratio=0.3	30
Figure 4.1.5: Model (1) N ratio=0.4	31
Figure 4.1.6: Model (1) N ratio=0.5	31
Figure 4.1.7: Model (1) N ratio=0.6	32
Figure 4.1.8: Model (1) N ratio=0.7	32
Figure 4.1.9: Model (1) N ratio=0.8	33
Figure 4.1.10: Model (1) N ratio=0.9	33
Figure 4.1.11: Model (1) N ratio=1.0	34
Figure 4.2.1: Model (2) N ratio=0	37
Figure 4.2.2: Model (2) N ratio=0.1	38
Figure 4.2.3: Model (2) N ratio=0.2	38
Figure 4.2.4: Model (2) N ratio=0.3	39
Figure 4.2.5: Model (2) N ratio=0.4	39
Figure 4.2.6: Model (2) N ratio=0.5	40
Figure 4.2.7: Model (2) N ratio=0.6	40
Figure 4.2.8: Model (2) N ratio=0.7	41
Figure 4.2.9: Model (2) N ratio=0.8	41
Figure 4.2.10: Model (2) N ratio=0.9	42

Figure 4.2.11: Model (2) N ratio=1.0	42
Figure 4.3.1: Model (3) N ratio=0	45
Figure 4.3.2: Model (3) N ratio=0.1	46
Figure 4.3.3: Model (3) N ratio=0.2	46
Figure 4.3.4: Model (3) N ratio=0.3	47
Figure 4.3.5: Model (3) N ratio=0.4	47
Figure 4.3.6: Model (3) N ratio=0.5	48
Figure 4.3.7: Model (3) N ratio=0.6	48
Figure 4.3.8: Model (3) N ratio=0.7	49
Figure 4.3.9: Model (3) N ratio=0.8	49
Figure 4.3.10: Model (3) N ratio=0.9	50
Figure 4.3.11: Model (3) N ratio=1.0	50
Figure 4.4.1: Model (4) N ratio=0	53
Figure 4.4.2: Model (4) N ratio=0.1	54
Figure 4.4.3: Model (4) N ratio=0.2	54
Figure 4.4.4: Model (4) N ratio=0.3	55
Figure 4.4.5: Model (4) N ratio=0.4	55
Figure 4.4.6: Model (4) N ratio=0.5	56
Figure 4.4.7: Model (4) N ratio=0.6	56
Figure 4.4.8: Model (4) N ratio=0.7	57
Figure 4.4.9: Model (4) N ratio=0.8	57
Figure 4.4.10: Model (4) N ratio=0.9	58
Figure 4.4.11: Model (4) N ratio=1.0	58
Figure 4.5.1: Model (5) N ratio=0	61
Figure 4.5.2: Model (5) N ratio=0.1	62

Figure 4.5.3: Model (5) N ratio=0.2	62
Figure 4.5.4: Model (5) N ratio=0.3	63
Figure 4.5.5: Model (5) N ratio=0.4	63
Figure 4.5.6: Model (5) N ratio=0.5	64
Figure 4.5.7: Model (5) N ratio=0.6	64
Figure 4.5.8: Model (5) N ratio=0.7	65
Figure 4.5.9: Model (5) N ratio=0.8	65
Figure 4.5.10: Model (5) N ratio=0.9	66
Figure 4.5.11: Model (5) N ratio=1.0	66
Figure 4.6.1: Model (6) N ratio=0	70
Figure 4.6.2: Model (6) N ratio=0.1	71
Figure 4.6.3: Model (6) N ratio=0.2	71
Figure 4.6.4: Model (6) N ratio=0.3	72
Figure 4.6.5: Model (6) N ratio=0.4	72
Figure 4.6.6: Model (6) N ratio=0.5	73
Figure 4.6.7: Model (6) N ratio=0.6	73
Figure 4.6.8: Model (6) N ratio=0.7	74
Figure 4.6.9: Model (6) N ratio=0.8	74
Figure 4.6.10: Model (6) N ratio=0.9	75
Figure 4.6.11: Model (6) N ratio=1.0	75
Figure 4.7.1: Model (7) N ratio=0	79
Figure 4.7.2: Model (7) N ratio=0.1	80
Figure 4.7.3: Model (7) N ratio=0.2	80
Figure 4.7.4: Model (7) N ratio=0.3	81
Figure 4.7.5: Model (7) N ratio=0.4	81

Figure 4.7.6: Model (7) N ratio=0.5	82
Figure 4.7.7: Model (7) N ratio=0.6	82
Figure 4.7.8: Model (7) N ratio=0.7	83
Figure 4.7.9: Model (7) N ratio=0.8	83
Figure 4.7.10: Model (7) N ratio=0.9	84
Figure 4.7.11: Model (7) N ratio=1.0	84
Figure 4.8.1: Model (8) N ratio=0	88
Figure 4.8.2: Model (8) N ratio=0.1	89
Figure 4.8.3: Model (8) N ratio=0.2	89
Figure 4.8.4: Model (8) N ratio=0.3	90
Figure 4.8.5: Model (8) N ratio=0.4	90
Figure 4.8.6: Model (8) N ratio=0.5	91
Figure 4.8.7: Model (8) N ratio=0.6	91
Figure 4.8.8: Model (8) N ratio=0.7	92
Figure 4.8.9: Model (8) N ratio=0.8	92
Figure 4.8.10: Model (8) N ratio=0.9	93
Figure 4.8.11: Model (8) N ratio=1.0	93
Figure 4.9.1: Model (9) N ratio=0	97
Figure 4.9.2: Model (9) N ratio=0.1	98
Figure 4.9.3: Model (9) N ratio=0.2	98
Figure 4.9.4: Model (9) N ratio=0.3	99
Figure 4.9.5: Model (9) N ratio=0.4	99
Figure 4.9.6: Model (9) N ratio=0.5	100
Figure 4.9.7: Model (9) N ratio=0.6	100
Figure 4.9.8: Model (9) N ratio=0.7	101

Figure 4.9.9: Model (9) N ratio=0.8	101
Figure 4.9.10: Model (9) N ratio=0.9	102
Figure 4.9.11: Model (9) N ratio=1.0	102
Figure 4.10.1: Model (10) N ratio=0	106
Figure 4.10.2: Model (10) N ratio=0.1	107
Figure 4.10.3: Model (10) N ratio=0.2	107
Figure 4.10.4: Model (10) N ratio=0.3	108
Figure 4.10.5: Model (10) N ratio=0.4	108
Figure 4.10.6: Model (10) N ratio=0.5	109
Figure 4.10.7: Model (10) N ratio=0.6	109
Figure 4.10.8: Model (10) N ratio=0.7	110
Figure 4.10.9: Model (10) N ratio=0.8	110
Figure 4.10.10: Model (10) N ratio=0.9	111
Figure 4.10.11: Model (10) N ratio=1.0	111
Figure 4.11.1: Model (11) N ratio=0	115
Figure 4.11.2: Model (11) N ratio=0.1	116
Figure 4.11.3: Model (11) N ratio=0.2	116
Figure 4.11.4: Model (11) N ratio=0.3	117
Figure 4.11.5: Model (11) N ratio=0.4	117
Figure 4.11.6: Model (11) N ratio=0.5	118
Figure 4.11.7: Model (11) N ratio=0.6	118
Figure 4.11.8: Model (11) N ratio=0.7	119
Figure 4.11.9: Model (11) N ratio=0.8	119
Figure 4.11.10: Model (11) N ratio=0.9	120
Figure 4.11.11: Model (11) N ratio=1.0	120