



Cairo University

ANALYTICAL STUDY ON REINFORCED CONCRETE BARBELL SHEAR WALLS

By

Mahmoud Ahmed Sayed Saeed

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
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Title of Thesis: **Analytical Study on Reinforced Concrete Barbell Shear Walls**

Key Words:

Shear wall behaviour - Barbell shear wall - Confinement of shear wall - Boundary columns of shear wall

Summary:

Behavior of reinforced concrete barbell shear walls is investigated in this research. The output of the finite element program ANSYS are validated using experimental results. The shear wall specimens were analyzed for different parameters. The results from validation were used as inputs for studying the effect of enlargement ratio, confining end region of shear walls, ratio of vertical loads and the effect of increasing the thickness and width of enlargement on performance of shear wall for resisting lateral forces. It was concluded that for the optimum seismic performance, width of enlargement should not exceed the length of compression zone and vertical loads ratio should not exceed 10 % of gross area of shear walls. It was found that the thickness of enlargement has no effect if it exceeds (1/10) of the unsupported height and confining of enlargement has an important effect on strain of the compression zone.

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Dedication

To my Family, my brother, my sisters, my fiancée, eng_ Taha Hussien and all my friends

Table of contents

<u>ACKNOWLEDGMENTS</u>	i
<u>DEDICATION</u>	ii
<u>TABLE OF CONTENTS</u>	iii
<u>LIST OF TABLES</u>	vi
<u>LIST OF FIGURES</u>	vii
<u>ABSTRACT</u>	x
<u>CHAPTER 1: INTRODUCTION</u>	1
1.1 GENERAL.....	1
1.2 RESEARCH OBJECTIVES	1
1.3 SCOPE OF RESEARCH	1
1.4 CONTENTS OF THE THESIS	2
<u>CHAPTER 2: LITERATURE REVIEW</u>	3
2.1 INTRODUCTION	3
2.2 LITERATURE REVIEW	3
2.2.1 Effect of end region confinement and dimensions	3
2.2.2 Effect of end region dimensions and vertical load ratio	10
2.3 RECOMMENDATION FOR DESIGN RC SHEAR WALLS ACCORDING TO DIFFERENT BUILDING CODES.....	13
2.3.1 Shape of shear wall	13
2.3.1.1 Egyptian code [ECP-203] [1]	13
2.3.1.2 ACI code [ACI 318-14] [2]	15
2.3.1.3 CSA code [A23.3-14] [3].....	16
2.3.1.4 Euro code [pr EN 1998-1:2003E].....	17
2.3.1.5 Comparison between codes	19
2.3.2 Reinforcement details of shear wall	20
2.3.2.1 (ECP-203) and (ACI 318-14)	20
2.3.2.2 (CSA code – A23.3)	21
2.2.2.3 Eurocode (prEN 1998-1:2003 E)	21
2.3.2.4 Comparison between codes	22
<u>CHAPTER 3: FINITE ELEMENT MODELING USING ANSYS V 16 PROGRAM</u>	24
3.1 INTRODUCTION	24
3.2. TYPES OF ELEMENTS USED IN ANSYS	24
3.2.1 SOLID65: 3D Reinforced Concrete Solid	24
3.3 MATERIAL PROPERTIES	25
3.3.1 Material properties of concrete	25
3.3.1.1 Young modulus (EX)	25
3.3.1.2 Poisson ratio (PRXY)	25
3.3.1.3 Open shear transfer coefficient	25
3.3.1.4 Closed shear transfer coefficient	25
3.3.1.5 Uniaxial cracking stress	26
3.3.1.6 Uniaxial crushing stress	26
3.3.1.7 Stress – Strain curve of concrete	26

3.3.2 Material properties of reinforcing bars	27
3.4 SIMULATION OF REINFORCEMENT	28
3.4.1 Smeard method	28
3.4.2 Discrete method	29
3.5 STEPS OF CREATING MODEL VOLUME	29
3.6 MESHING OF WALL VOLUMES	30
3.7 ASSIGNMENT OF LOADS AND SUPPORTS	31
3.8 ANALYSIS OF MODEL	31
<u>CHAPTER 4 : VALIDATION OF ANSYS MODELS.</u>	32
4.1 INTRODUCTION	32
4.2 TEST SPECIMENS	32
4.2.1 Properties of test specimens	32
4.2.2 Test procedure by R. Taleb[5]	36
4.3 ANSYS SPECIMENS	36
4.3.1 Description of the shear wall model	36
4.3.2 The analysis results from ANSYS	36
4.3.2.1 Specimen (V1) according to (BC80)	36
4.3.2.2 Specimen (V2) according to (BC40)	39
4.3.2.3 Specimen (V3) according to (NC80)	41
4.3.2.4 Specimen (V4) according to (NC40)	43
4.3.2.5 Specimen (V5) according to (MC)	45
4.3.2.6 Specimen (V6) according to (SC)	47
<u>CHAPTER 5 : PARAMETRIC STUDY.</u>	50
5.1 INTRODUCTION	50
5.2 DESCRIPTION OF ANSYS SPECIMENS	50
5.3 DISCUSSION OF NUMERICAL RESULTS	54
5.3.1 Effect of concentrating reinforcement in end region, without boundary columns	54
5.3.1.1 Crack pattern and deflection	55
5.3.1.2 Load – deflection relation	57
5.3.2 Effect of boundary column dimensions	58
5.3.2.1 Crack patterns and deflection	61
5.3.2.2 Deflections of specimens of group two	66
5.3.2.3 Proposed equation on effect of boundary column dimensions	66
5.3.3 Effect of confinement boundary columns (Third group)	69
5.3.3.1 Third group (case one specimen (SW2- V10- S80- R1)	70
5.3.3.1.1 Crack pattern and deflection	71
5.3.3.1.2 Load – deflection relation	73
5.3.3.1.3 Comparison between limits of code and finite elements results	74
5.3.3.2 Third group - case two specimen SW4- V10- S80- R1	75
5.3.3.2.1 Crack pattern and deflection	77
5.3.3.2.2 Load – deflection relation	79
5.3.3.2.3 Proposed equation to consider the effect of confinement boundary columns	80

5.3.3.2.4 Comparison between limits of code and finite element results	80
5.3.4 Effect of uniform vertical loads (group four)	83
5.3.4.1 Group four - case one specimen SW2- V10- S80- R1	83
5.3.4.1.1 Crack patterns and deflection	84
5.3.4.1.2 Load – deflection relation	87
5.3.4.2 Group four - case two specimen SW4- V10- S80- R1	87
5.3.4.2.1 Crack pattern and deflection	86
5.3.4.2.2 Load – deflection relation	91
5.3.4.2.3 Proposed equation for the effect of the uniform applied vertical loads	91
5.3.5 Effect of increasing thickness of boundary column (group five)	92
5.3.5.1 Crack pattern and deflection	94
5.3.5.2 Load – deflection relation.....	97
5.3.5.3 Proposed equation on effect of increasing thickness of boundary column	97
5.3.5.4 Comparison between limits of code and finite elements results	99
5.3.6 Effect of increasing width of boundary column (group six)	100
5.3.6.1 Crack pattern and deflection	101
5.3.6.2 Load – deflection relation.....	104
5.3.6.3 Proposed equation to consider the effect of increasing width of boundary column.....	104
5.3.6.4 Comparison between limits of code and finite element results	106

CHAPTER 6 : SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE RESEARCHES..... 107

6.1 SUMMARY	107
6.2 CONCLUSIONS	108
6.3 RECOMMENDATIONS FOR FUTURE RESEARCHES	108
<u>REFERENCES.....109</u>	

List of Tables

Table (2.1): Properties of shear wall specimens in laboratory	5
Table (2.2): Results of experimental shear wall specimens	7
Table (2.3): Results of experimental shear wall specimens	9
Table (2.4): Specimens' properties	10
Table (2.5): Experimental results of shear wall specimens	11
Table (2.6): Comparison between codes in concrete dimensions of shear wall	20
Table (2.7): Comparison between codes in reinforcement details of shear wall	23
Table (3.1): The material of properties of concrete used in ANSYS program	26
Table (3.2): Material properties for steel bars	28
Table (3.3): Angle directions of elements	28
Table (4.1): Properties of wall specimens in laboratory	32
Table (4.2): Mechanical properties of concrete and steel materials	35
Table (4.3): Comparison between ANSYS and experimental results for specimen (V1) ..	39
Table (4.4): Comparison between ANSYS and experimental results for specimen (V2) ..	39
Table (4.5): Comparison between ANSYS and experimental results for specimen (V3) ..	41
Table (4.6): Comparison between ANSYS and experimental results for specimen (V4) ..	43
Table (4.7): Comparison between ANSYS and experimental results for specimen (V5) ..	45
Table (4.8): Comparison between ANSYS and experimental results for specimen (V6) ..	47
Table (5.1): Mechanical properties of concrete and steel materials	52
Table (5.2): Details of specimens	52
Table (5.3): Group one specimens' details	54
Table (5.4): Numerical results of specimens of group one	58
Table (5.5): Group two specimens' details	59
Table (5.6): Numerical results of specimens of group two	65
Table (5.7): Value of increase in horizontal loads and drift ratio relative to SW	67
Table (5.8): Group three case one specimens' details	70
Table (5.9): Numerical results of specimens of group three case one	71
Table (5.10): Group three case two specimens' details	75
Table (5.11): Numerical results of specimens of group three case two	79
Table (5.12): Value of increase in horizontal loads and drift ratio relative to minimum confinement of boundary column	81
Table (5.13): Details of specimens of group four case one	83
Table (5.14): Numerical results of specimens of group four case one	86
Table (5.15): Details of specimens of group four case two	87
Table (5.16): Numerical results of specimens of group four case two	90
Table (5.17): Value of increase in horizontal loads and drift ratio relative to shear wall without applied vertical loads	92
Table (5.18): Details of specimens of group five	93
Table (5.19): Numerical results of specimens of group five	96
Table (5.20): Values of increase in horizontal loads and drift ratio relative to shear wall with thickness of boundary column equal to thickness of web	94
Table (5.21): Details of specimens of group six	100
Table (5.22): Numerical results of specimens of group six	103
Table (5.23): Value of increasing in horizontal loads and drift ratio relative to SW18	100

List of Figures

Figure (2.1): Cross section of first group specimens [5]	4
Figure (2.2): Cross section of second group specimens[5].....	4
Figure (2.3): Load- drift angle % of specimens (BC40) and (BC 80) by R. Taleb [5].....	6
Figure (2.4): Load – drift angle% of specimens (NC40) and (NC80) by R. Taleb [5].....	6
Figure (2.5): Load- displacement of analytical and experimental specimens	7
Figure (2-6) : stress – strain relation for confined concrete proposed by Kappos.....	8
Figure (2.7): Load- displacement curve of specimen (SW14) with differential confinement	9
Figure (2.8): Load – displacement curve of specimen (SW22) with differential confinement.....	10
Figure (2.9): Load – displacement curve of specimens (WSH1)	11
Figure (2.10): Load- displacement curve of specimen (WSH2).....	12
Figure (2.11): Typical cross section of tested specimens	12
Figure (2.12): Simplified model for plastic deformation.....	13
Figure (2.13): Effect of confinement of concrete	13
Figure (2.14): Horizontal cross section of concrete dimensions and reinforcement details of rectangular shear wall	14
Figure (2.15): Horizontal cross section of concrete dimensions and reinforcement details of barbell shear walls according to Egyptian code	15
Figure (2.16): Horizontal cross section of concrete dimension and reinforcement details of barbell shear wall according to ACI code	16
Figure (2.17): Horizontal cross section of concrete dimensions of barbell shear wall according to CSA code inside plastic hinge region	17
Figure (2.18): Horizontal cross section of concrete dimensions of barbell shear wall according to CSA code outside plastic hinge region.....	17
Figure (2.19): Horizontal cross section of concrete dimensions of barbell shear walls according to EURO code inside plastic hinge region	18
Figure (2.20): Horizontal cross section of concrete dimensions of barbell shear walls according to EURO code outside plastic hinge region case (1).....	18
Figure (2.21): Horizontal cross section of concrete dimensions of barbell shear walls according to EURO code outside plastic hinge region case (2).....	19
Figure (2.22): Cross section in barbell shear wall	19
Figure (3.1): SOLID 65 element in ANSYS.....	24
Figure (3.2): Stress – strain of concrete showing slope of young modulus	25
Figure (3.3): Stress – Strain curve of concrete according to Desay & Krishan formula	27
Figure (3.4): Stress – Strain curve of reinforcing bars used in ANSYS program.....	27
Figure (3.5): Horizontal cross section of shear wall in ANSYS program	29
Figure (3.6): Steps of creating shear wall in ANSYS program.....	29
Figure (3.7): Isometric of shear wall volumes in ANSYS program	30
Figure (3.8): Isometric of shear wall lines.....	30
Figure (3.9): Isometric of shear elements	30
Figure (4.1): Reinforcement details and concrete dimensions of test specimens	33
Figure (4.2): Test procedure for wall specimens in laboratory	36
Figure (4.3): Load deflection curve of specimen (V1) analytical model and experimental model	37
Figure (4.4): Deformed shape of specimen V1 (BC80) Analytical model	38
Figure (4.5): Cracks patterns of specimen (V1)	38
Figure (4.6): Load deflection curve of specimen (V2) analytical model and experimental model	40

Figure (4.7): Deformed shape of specimen V2 (BC40) Analytical model	40
Figure (4.8): Cracks patterns of specimen (V2)	41
Figure (4.9): Load deflection curve of specimen (V3) analytical model and experimental model	42
Figure (4.10): Deformed shape of specimen V3 (NC80) Analytical model.....	42
Figure (4.11): Cracks patterns of specimen (V3)	43
Figure (4.12): Load deflection curve of specimen (V4) analytical model and experimental model	44
Figure (4.13): Deformed shape of specimen V4 (NC40) Analytical model.....	44
Figure (4.14): Cracks patterns of specimen (V4)	45
Figure (4.15): Load deflection curve of specimen (V5) analytical model and experimental model	46
Figure (4.16): Deformed shape of specimen V5 (MC) Analytical model	46
Figure (4.17): Cracks patterns of specimen (V5)	47
Figure (4.18): Load deflection curve of specimen (V6) analytical model and experimental model	48
Figure (4.19): Deformed shape of specimen V6 (SC) Analytical model	48
Figure (4.20): Cracks patterns of specimen (V6)	49
Figure (5.1): Behavior of shear wall under lateral force.....	50
Figure (5.2): Cross section in barbell shear wall	51
Figure (5.3): Group one specimens details and concrete dimensions	54
Figure (5.4): Cracks of group one specimens	56
Figure (5.5): Deformed shape of group one specimens	56
Figure (5.6): Comparison between load – drift ratio (%) group one specimens.....	57
Figure (5.7): reinforcement details and concrete dimensions of group two specimens.....	61
Figure (5.8): Cracks and crushing of group two specimens	63
Figure (5.9): Deformed shape of group two specimens	64
Figure (5.10): Comparison between load – drift ratio (%) group two specimens	66
Figure (5.11): Trend line equation between ANSYS results of group two specimens relative to specimen (SW) datum.....	67
Figure (5.12): Comparison between limits of thickness of boundary columns due to codes and ANSYS results of group two specimens in partial for ultimate horizontal forces	68
Figure (5.13): Comparison between limits of thickness of boundary columns due to codes and ANSYS results of group two specimens in partial for Drift ratio (%)	69
Figure (5.14): reinforcement details and concrete dimensions of group three case one specimens	71
Figure (5.15): Cracks and crushing of group three case one specimens	72
Figure (5.16): Deformed shape of group three case one specimens	72
Figure (5.17): Comparison between load – drift ratio (%) group three case one specimens	74
Figure (5.18): Comparison between limits of spacing between stirrups in boundary columns due to codes and ANSYS results of group three case one specimens in partial for ultimate horizontal forces	74
Figure (5.19): Comparison between limits of spacing between stirrups in boundary columns due to codes and ANSYS results of group three case one specimens in partial for Drift ratio (%)	75
Figure (5.20): reinforcement details and concrete dimensions of group three case two specimens	77
Figure (5.21): Cracks and crushing of group three case two specimens	78
Figure (5.22): Deformed shape of group three case two specimens	78
Figure (5.23): Comparison between load – drift ratio (%) group three case two specimens	80

Figure (5.24): Trend line equation between ANSYS results of group three case two specimens relative to specimen SW(12).....	81
Figure (5.25): Comparison between limits of spacing between stirrups in boundary columns due to codes and ANSYS results of group three case one specimens in partial for ultimate horizontal forces	82
Figure (5.26): Comparison between limits of spacing between stirrups in boundary columns due to codes and ANSYS results of group three case one specimens in partial for Drift ratio (%)	82
Figure (5.27): reinforcement details and concrete dimensions of group four case one specimens	83
Figure (5.28): Cracks and crushing of group four case one specimens	85
Figure (5.29): Deformed shape of group four case one specimens	85
Figure (5.30): Comparison between load – drift ratio (%) group four case one specimens	87
Figure (5.31): reinforcement details and concrete dimensions of group four case two specimens	88
Figure (5.32): Cracks and crushing of group four case two specimens	89
Figure (5.33): Deformed shape of group four case two specimens	89
Figure (5.34): Comparison between load – drift ratio (%) group four case two specimens	91
Figure (5.35): Trend line equation between ANSYS results of group four case two specimens relative to specimen SW(12).....	92
Figure (5.36): reinforcement details and concrete dimensions of group five specimens ...	94
Figure (5.37): Cracks and crushing of group five specimens	94
Figure (5.38): Deformed shape of group five specimens	95
Figure (5.39): Comparison between load – drift ratio (%) group five specimens	97
Figure (5.40): Trend line equation between ANSYS results of group five specimens relative to specimen (SW1).....	98
Figure (5.41): Comparison between limits of thickness of boundary columns due to codes and ANSYS results of group five specimens in partial for ultimate horizontal forces	99
Figure (5.42): Comparison between limits of thickness of boundary columns due to codes and ANSYS results of group five specimens in partial for Drift ratio (%)	99
Figure (5.43): reinforcement details and concrete dimensions of group six specimens	101
Figure (5.44): Cracks and crushing of group six specimens	102
Figure (5.45): Deformed shape of group six specimens	102
Figure (5.46): Comparison between load – drift ratio (%) group six specimens.....	104
Figure (5.47): Trend line equation between ANSYS results of group six specimens relative to specimen (SW18).....	105
Figure (5.48): Comparison between limits of width of boundary columns due to codes and ANSYS results of group six specimens in partial for ultimate horizontal forces	106
Figure (5.49): Comparison between limits of width of boundary columns due to codes and ANSYS results of group six specimens in partial for Drift ratio (%)	106

Abstract

Shear walls are major members in tall concrete buildings for resisting lateral loads. Most failure patterns of shear walls are concrete crushing in compression zone although they are designed to collapse in tension zone. The behavior of most walls does not achieve the required ductility because of an additional stain due to lateral forces. Barbell shear wall has two enlargements and has better ductility than rectangular shear wall. This thesis evaluates the effect of monotonic lateral loads on shear walls.

A computation analytical finite element model FEM has been applied using ANSYS program version 16. Various codes provisions are used for comparison with FEM results. These include the Egyptian Code for Design and Construction of Concrete Structures, Building Code Requirements for Reinforced Concrete (ACI 318 – 14) and CSA Committee A23.3. Many parameters considered; enlargement ratio, confining of end region of shear walls, ratio of vertical loads, increase of the thickness of enlargement and increase of width of enlargement. It was concluded that for the optimum seismic performance, width of enlargement should not exceed the length of compression zone, vertical loads ratio should not exceed 10 % of gross area of shear walls, thickness of enlargement has no effect if it exceeds (1/10) of the unsupported height and confining of enlargement has an important effect on strain of compression zone. The results of the FEM and codes provisions are illustrated in Tables, figures and charts to explain the effect of each parameter on shear wall.

CHAPTER 1: INTRODUCTION

1.1 GENERAL

In the 19th century, high rise concrete buildings appeared. These buildings were most likely to collapse due to lateral loads. Rectangular shear walls were the first solution used to resist lateral loads. Rectangular shear wall is the most important element in high - rise reinforced concrete structures. Recently, many RC shear walls were collapsed and cracked because of earthquakes, so researchers searched how to improve ductility of shear walls. Laboratory tests have been done to investigate their behavior. They concluded that the behavior of shear walls did not achieve the required ductility. Although the design was considered to be flexural failure not shear failure, most failures pattern of shear walls were concrete crushing in compression zone. Compression failure occurred due to buckling of compression zone as a result of an additional compression force. It was proved that many factors affect the behavior of shear wall such as reinforcement ratio, shape of shear wall, compressive strength, vertical loads ratio and confinement.

In this thesis, main requirements for improving ductility of shear walls can be summarized as follows:

- 1- Concentrating reinforcement in end region
- 2- Boundary column dimensions
- 3- Confinement of end region
- 4- Uniform vertical loads ratio

1.2 RESEARCH OBJECTIVES

The two main objectives of this research are:

- 1- Investigate the behavior of barbell shear walls subjected to lateral force using finite element method. The finite element results are compared to those of laboratory tests from the literature.
- 2- Study the effect of concentrating reinforcement in end region, boundary columns dimensions, confinement of boundary column and uniform vertical loads ratio.

1.3 SCOPE OF RESEARCH

Thirty specimens of shear walls subjected to both vertical and lateral loads are modeled by ANSYS. Six of them were used for verification of finite elements results against available laboratory results. The rest of specimens were used to study the effect of shear wall shape, reinforcement concentration in end region, confinement of end region, vertical loads ratio and boundary column dimension.