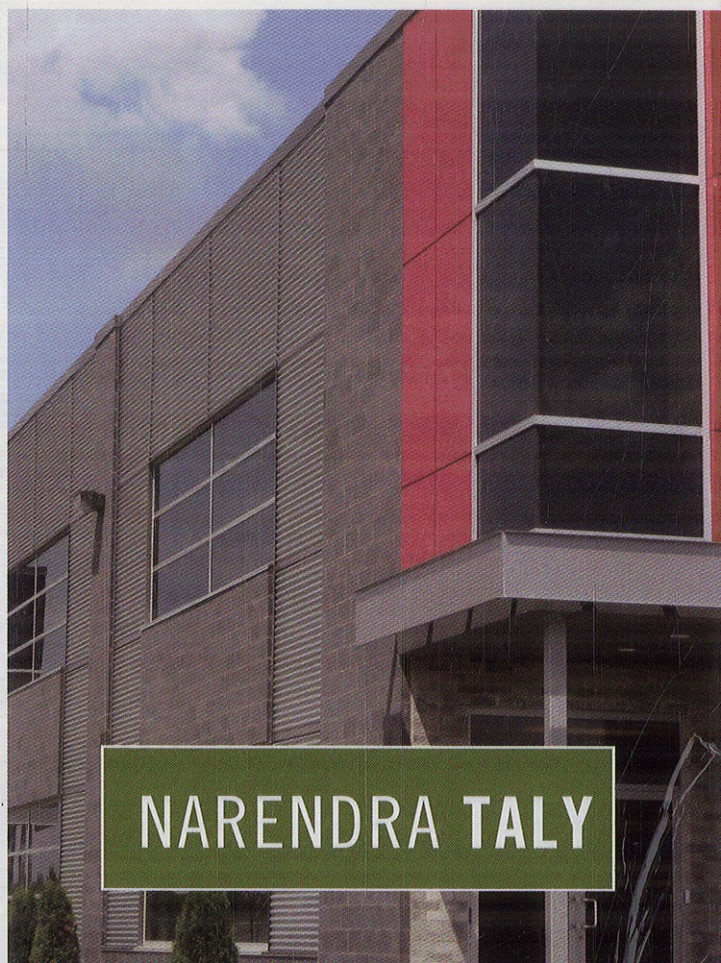




Design of
REINFORCED
MASONRY
STRUCTURES

Second Edition



NARENDRA TALY

CONTENTS

Preface to the Second Edition xiii

Preface to the First Edition xvii

Acknowledgments xix

Notation xxi

Acronyms xxvii

Chapter 1. Introduction

1.1

- 1.1 What Is Masonry? / 1.1
- 1.2 Plain and Reinforced Masonry / 1.1
- 1.3 A Brief History of Masonry Construction / 1.2
- 1.4 Evolution of Reinforced Masonry / 1.3
- 1.5 Unreinforced and Reinforced Masonry / 1.5
- 1.6 Historical Development of Building Codes and Standards for Masonry Construction / 1.6
- 1.7 Design Methods / 1.9
- 1.8 Load Combinations / 1.11
- References / 1.14

Chapter 2. Masonry Units: Applications, Types, Sizes, and Classification

2.1

- 2.1 Introduction / 2.1
- 2.2 Application of Masonry Units in Construction / 2.1
- 2.3 General Description of Masonry Units / 2.2
- 2.4 Clay Building Brick / 2.4
- 2.5 Functional Aspects / 2.15
- 2.6 Concrete Masonry Units / 2.23
- 2.7 Bonds and Patterns in Masonry Work / 2.35
- 2.8 Structural Requirements for Masonry in Stack Bond / 2.41
- 2.9 Mortar Joints / 2.42
- 2.10 Types of Wall Construction / 2.43
- 2.11 Glass Unit Masonry / 2.46
- 2.12 Mortarless Block Systems / 2.51
- 2.13 Prefabricated Masonry / 2.51
- 2.14 Autoclaved Aerated Concrete / 2.54
- References / 2.55

Chapter 3. Materials of Masonry Construction

3.1

- 3.1 Introduction / 3.1
- 3.2 Mortar / 3.1
- 3.3 Grout / 3.6
- 3.4 Differences between Mortar, Grout, and Concrete / 3.11
- 3.5 Compressive Strength of Masonry / 3.12
- 3.6 Steel Reinforcement / 3.15
- 3.7 Modulus of Elasticity of Masonry Materials / 3.22

- 3.8 Thermal Effects on Masonry / 3.23
- 3.9 Influence of Moisture on Masonry: Shrinkage / 3.25
- 3.10 Creep of Masonry / 3.27
- References / 3.28

Chapter 4. Design of Reinforced Masonry Beams

4.1

- 4.1 Introduction / 4.1
- 4.2 Historical Development / 4.2
- 4.3 Strength Design Philosophy / 4.2
- 4.4 Assumptions in Strength Design Philosophy / 4.5
- 4.5 Analysis of Rectangular Sections in Flexure / 4.7
- 4.6 Modulus of Rupture and Nominal Cracking Moment of a Masonry Beam / 4.26
- 4.7 Design of Masonry Beams / 4.31
- 4.8 Procedure for Flexural Design of Beams / 4.41
- 4.9 Overreinforced Beams / 4.53
- 4.10 Design for Shear in Reinforced Masonry Beams / 4.56
- 4.11 Lateral Support of Masonry Beams / 4.69
- 4.12 Analysis of Doubly Reinforced Masonry Beams / 4.69
- 4.13 Lintels / 4.74
- 4.14 Masonry Wall Beams (Deep Wall Beams) / 4.101
- 4.15 Bond Beams / 4.109
- 4.16 Diaphragm Action / 4.111
- 4.17 Flexural Strength of a Wall due to In-Plane Loads / 4.115
- 4.18 Development Lengths for Reinforcing Bars / 4.117
- 4.19 Serviceability Criteria for Beams / 4.119
- 4.20 Service Load Analysis of Reinforced Masonry Beams / 4.120
- 4.21 Deflections of Reinforced Masonry Beams / 4.126
- References / 4.139

Chapter 5. Columns

5.1

- 5.1 Introduction / 5.1
- 5.2 Behavior of Axially Loaded Columns / 5.4
- 5.3 Axial Strength of Reinforced Masonry Columns / 5.7
- 5.4 MSJC Code Provisions for Reinforced Masonry Columns / 5.10
- 5.5 Analysis of Reinforced Masonry Columns / 5.16
- 5.6 Design Procedure for Reinforced Masonry Columns / 5.21
- 5.7 Columns under Combined Axial Load and Bending / 5.28
- 5.8 Discussion and Interpretation of the Axial Load-Bending Moment Interaction Diagrams / 5.57
- 5.9 Interaction Diagram for a Wall under Combined Loading (Axial Load and Bending) / 5.58
- 5.10 Shear Strength of Masonry Columns / 5.60
- 5.11 Masonry Piers / 5.64
- References / 5.68

Chapter 6. Walls under Gravity and Transverse Loads

6.1

- 6.1 Introduction / 6.1
- 6.2 Types of Masonry Walls / 6.1
- 6.3 Bond Patterns in Masonry Walls / 6.16
- 6.4 Analysis of Walls under Gravity and Transverse Loads / 6.23
- 6.5 Out-of-Plane Loads on Walls / 6.25

- 6.6 Analysis of Masonry Walls for Out-of-Plane Loads / 6.38
- 6.7 Design of Walls for Gravity and Transverse Loads / 6.44
- 6.8 Axial Loads on Walls Subjected to Out-of-Plane Loads / 6.69
- 6.9 Pilasters / 6.69
- 6.10 Nonload-Bearing Walls / 6.77
- References / 6.86

Chapter 7. Shear Walls

7.1

- 7.1 Introduction / 7.1
- 7.2 Fundamental Concepts / 7.2
- 7.3 Types of Shear Walls / 7.6
- 7.4 Rigidity and Relative Rigidity of a Shear Wall / 7.10
- 7.5 Rigidity of a Shear Wall with Openings / 7.17
- 7.6 Determination of Seismic Lateral Forces in Shear Walls / 7.39
- 7.7 Horizontal Diaphragms / 7.50
- 7.8 Influence of Building Configuration on Lateral Force Distribution in Shear Walls / 7.57
- 7.9 Analysis of Shear Walls and Diaphragms under Direct Shear and Torsional Moments / 7.69
- 7.10 Design Considerations for Shear Walls / 7.81
- 7.11 Analysis of Shear Walls under Flexure and Axial Loads / 7.95
- 7.12 Design of Multistory Shear Walls / 7.108
- 7.13 Failure Modes of Shear Walls / 7.110
- References / 7.121

Chapter 8. Retaining and Subterranean Walls

8.1

- 8.1 Introduction / 8.1
- 8.2 Principal Types of Retaining Walls / 8.2
- 8.3 Lateral Pressures on Retaining Walls / 8.9
- 8.4 External Stability of a Retaining Wall / 8.25
- 8.5 Design Procedure for Masonry Retaining Walls / 8.29
- 8.6 Subterranean or Basement Walls / 8.35
- 8.7 Construction Considerations / 8.42
- References / 8.48

Chapter 9. Construction Aspects

9.1

- 9.1 Introduction / 9.1
- 9.2 Placement of Steel Reinforcement / 9.2
- 9.3 Grouting / 9.7
- 9.4 Movements of Construction Materials, Their Causes and Effects / 9.23
- 9.5 Control of Cracking and Movement Joints / 9.33
- 9.6 Quality Assurance / 9.42
- 9.7 Flashing for Masonry Construction / 9.43
- References / 9.46

Chapter 10. Anchorage to Masonry

10.1

- 10.1 Introduction / 10.1
- 10.2 Types of Anchor Bolts / 10.1
- 10.3 Placement and Embedment of Anchor Bolts in Masonry Grout / 10.2
- 10.4 Nominal Strength of Anchor Bolts / 10.3

- 10.5 Nominal Axial Strength of Anchor Bolts Loaded in Tension and in Combined Tension and Shear / 10.5
- 10.6 Nominal Shear Strength of Headed and Bent-Bar Anchor Bolts in Shear / 10.14
- 10.7 Headed and Bent-Bar Anchor Bolts in Combined Axial Tension and Shear / 10.15
- 10.8 Structural Walls and Their Anchorage Requirements / 10.16
- References / 10.27

Appendix Design Aids: Tables A.1

Glossary G.1

Index I.1