FERROCEMENT AND LAMINATED CEMENTITIOUS COMPOSITES

by Antoine E. Naaman, Ph.D.
Fellow ACI; Fellow ASCE; Fellow PCI; Fellow IFS

Professor of Civil Engineering, University of Michigan, Ann Arbor

Hardcover; 372 pages; 160 figures and illustrations; 43 pages containing 120 photographs; design aids; bibliographic references; 7.25x9.5 in.

ISBN: 0-9674939-0-0; LCCN: 99-96382; Copyright 2000

US$ 75.00

Note: This book and the 3rd Edition of the Prestressed Concrete book sell for only $ 175 for the set.

Contents
Preface
Acknowledgments

Chapter 1 Introduction to Ferrocement
Chapter 2 Mechanical Properties of Ferrocement as Observed From Tests
Chapter 3 Modeling the Tensile Response of Ferrocement and Other Brittle Matrix Composites with Continuous Fibers
Chapter 4 Analysis and Design of Ferrocement in Bending
Chapter 5 Practical Design Guidelines
Chapter 6 Construction/Fabrication of Ferrocement
Chapter 7 Testing for Reinforcement and Composite Properties
Chapter 8 Cost Estimates of Typical Ferrocement Composites
Chapter 9 Ferrocement in Housing and Other Related Applications
Chapter 10 Advanced Materials and Concepts
Chapter 11 Prospects for Ferrocement Materials, Applications and Technology

Appendix A: Notation
Appendix B: Unit Conversions
Appendix C: References
Appendix D: Standard Meshes, Wires and Bars
Appendix E: Common Formulas for Beams
Index

Chapter 1 INTRODUCTION TO FERROCEMENT
Ferrocement: Definition and Historical Background / Introduction / Definition by ACI Committee 549 / Suggested Revised Definition / Applications of Ferrocement - Marine - Terrestrial - Repair and Rehabilitation / Constituent Materials of Ferrocement - Cement Based Matrix: Composition and Compressive Strength - Skeletal Steel - Mesh Reinforcement / Distinct Characteristics of Ferrocement
versus Reinforced Concrete - Physical - Mechanical - Processing / Manufacturing - Maintenance and Repair / Similarities Between Ferrocement and Reinforced Concrete / Volume Fraction of Reinforcement - Square or Rectangular Meshes - Example: Square Mesh - Any Mesh - Example: Expanded Metal Mesh - FRP Meshes - Example: FRP Mesh / Specific Surface of Reinforcement - Example: Reinforced Concrete versus Ferrocement / Distinctive Behavior of Ferrocement in Tension - Cracking and Multiple Cracking Behavior - Maximum Elongation at Failure - Stress at First Cracking - Influence of Specific Surface of Reinforcement / Apparent Modulus of the Mesh System / Ferrocement: a Composite and a Member of the Structural Concrete Family / Ferrocement versus Fiber Reinforced Polymeric Composites / Ferrocement as a Laminated Composite / Advantages of Ferrocement as a Construction Material.

Chapter 2 MECHANICAL PROPERTIES OF FERROCEMENT AS OBSERVED FROM TESTS

Chapter 3 MODELING THE TENSILE RESPONSE OF FERROCEMENT AND OTHER BRITTLE MATRIX COMPOSITES WITH CONTINUOUS FIBERS

Chapter 4 ANALYSIS AND DESIGN OF FERROCEMENT IN BENDING
Concluding Remarks.

Chapter 5 PRACTICAL DESIGN GUIDELINES
Design Philosophy / General Design Approaches - USD, LSD, or LRFD - WSD or ASD / Design Approaches Applied to Ferrocement / Practical Design Guidelines to Insure Good Serviceability - Allowable Stresses under Maximum Service Load - Maximum Crack Width - Fatigue Life - Durability and Corrosion - Deflection Limitations / Practical Design Parameters for Ferrocement / Guidelines for Good Construction / Design Example: Tensile Element - Water Tank Wall / Design Example: Bending Element - Floor Sandwich Panel / Concluding Remarks

Chapter 6 CONSTRUCTION - FABRICATION OF FERROCEMENT

Chapter 7 TESTING FOR REINFORCEMENT AND COMPOSITE PROPERTIES
Introduction / Recommended Tests - Compressive Strength and Static Modulus of Elasticity of Mortar - Tensile Test of the Mesh Reinforcement - Tensile Test of Ferrocement - Bending Test of Ferrocement / Efficiency Factor of Reinforcement - ho from Direct Tensile Tests - ho from Bending Tests with One Layer of Mesh - ho from Bending Tests with Several Layers of Mesh - Discussion Related to sry and Er - Test Sequence / Recommended Values for ho, sry and Er / Example of Computation of Er, hL, and sru from a Tensile Test / Example of Computation of Mesh Yield Strength, sry - Using a Composite Tensile Test - Using a Composite Bending Test / Example of Computation of Mesh Elastic Modulus from a Bending Test.

Chapter 8 COST ESTIMATES OF TYPICAL FERROCEMENT COMPOSITES
Introduction / Description of Cost Survey / Comparative Cost Results / Building and Construction Cost Indexes - Definition - Cost Correlation to the Present - Relative Importance of Labor and Materials Costs / Examples of Gross Cost Estimates Based on Past Experience / Remarks on Cost Reduction Measures

Chapter 9 FERROCEMENT IN HOUSING AND RELATED APPLICATIONS
Introduction / Background: Ferrocement Housing Systems / Example of Ferrocement Panelized Housing System / System Criteria - Basis of Study- Panel System Developed - Types of Joints or Connections - Shear Type Joint - Moment Type Joint / Ferrocement Sandwich Panels / Manufactured Housing: Engineering Vision and Consumer’s Dream / Monolithic Ferrocement Auditorium / Ferrocement Water Tanks / Sunscreens / Concluding Remarks

Chapter 10 ADVANCED MATERIALS AND CONCEPTS
Chapter 11 PROSPECTS FOR FERROCEMENT MATERIALS, APPLICATIONS, AND TECHNOLOGY

Research Trends in Construction Materials / Prospects for Ferrocement Materials, Applications and Technology

APPENDIX A: NOTATION
Notation: English Letters / Notation: Greek Letters / Abbreviations / Abbreviations for Professional Organizations

APPENDIX B: UNIT CONVERSIONS

APPENDIX C: REFERENCES
General References - Symposia Proceedings on Ferrocement - Books - Background References - Sources of Information / References by Chapter // Close to 400 references in all.

APPENDIX D: STANDARD MESHES, WIRES AND BARS

APPENDIX E: COMMON FORMULAS FOR BEAMS

INDEX

REVIEWS:

"I have read almost everything written about ferrocement in the English language and can truthfully say: this book is the most comprehensive and authoritative treatment of ferrocement in existence."

Martin E. Iorns, Industrial Engineer, Member Editorial Board of the Journal of Ferrocement.

"Ferrocement and Laminated Cementitious Composites is a comprehensive source of information. The author has used his considerable expertise in giving a modern treatment to ferrocement. His emphasis on understanding the relationship between behavior, analysis and design is unique....The book offers perspectives and insights unparalleled in the existing literature on thin reinforced concrete products, and is an invaluable addition to the library of any professional involved in structural concrete."

Surendra P. Shah, Water P. Murphy Professor of Civil Engineering, Northwestern University, and Director NSF Center for Advanced Cement Based Materials.

"Indispensable book for engineers, architects, researchers, students and contractors interested in ferrocement and thin reinforced concrete products. The author has provided a much needed single source textbook that consolidates a broad coverage of information, whether on state-of-the-art, design, construction, cost, applications or future potential of ferrocement and hybrid composites."

Gordon B. Batson, Emeritus Professor of Civil Engineering, Clarkson University, former Chairman ACI Committee on Ferrocement.

"A unique and comprehensive treatise of laminated cement composites covering materials, fabrication techniques, analysis and design of structural components and systems, and including the
latest developments on high performance composites."

**P.N. Balaguru, Professor of Civil Engineering, Rutgers University, Former Chairman of ACI Committee 549 on Ferrocement.**

"It must certainly be the most comprehensive work in its field. Even sculptors, who may not understand the mathematics, can derive sculptural applications from the many excellent illustrations and verbal explanations and can learn the basics about how and where to place the steel."

**Lynn Olson, Sculptor, Clausen Lane, Valparaiso, Indiana.**

"This detailed and comprehensive book enables an appreciation to be made of ferrocement from theoretical and practical considerations. The many good examples of ferrocement are brought together indicating the undeniable range and breadth of the material and its potential uses which good design and implementation can bring about. It is an indispensable ferrocement companion."

**Patrick J. Jennings, Director of Engineering, NCL Stewart Scott Ltd., London, U.K.**

"This book is indeed the finest and most comprehensive book on the subject that I know of. Professor Naaman has pulled together his 25+ years of experience and research in the ferrocement field and come up with a textbook of ferrocement. This book will most likely become the standard textbook for the teaching field when it comes to ferrocement.

**Paul Sarnstrom, Host, www.ferrocement.net, Montrose, Colorado.**

"I have been collecting books on ferrocement for five years. I recently bought "Ferrocement and Laminated Cementitious Composites. I'm certain design of many new products and structures. In my opinion, it is definitely the "ferrocement bible"."

**David B. Smith, Spartanburg, S.C.**

"This book is the first to bring together the wealth of information and presents it in a digestible format. Written in an extremely readable style, it guides the reader through the historical and early technical background to a method with abundant worked examples. More practical information and construction is then presented with further detail on the specific costing and housing. A final section on advanced materials and a sneak preview into a possible future.

**Paul Nedwell, University of Manchester Institute of Science and Technology, Manchester, U.K.**