

An ACI / ASCC Manual

The Contractor's Guide to Quality Concrete Construction

4th Edition



CI-5(19)



American Concrete Institute
Always advancing



AMERICAN SOCIETY OF
CONCRETE CONTRACTORS
Enhancing the Capabilities of Those Who Build with Concrete

An ACI / ASCC Manual

The Contractor's Guide to Quality Concrete Construction

4th Edition

Reported by ACI Committee E703, Concrete Construction Practice

James J. Ernzen
Chair

William D. Palmer
Secretary

Scott M. Anderson

Reynold Franklin

Katherine M. Pflieger

Paul J. Beagley

Leonard J. Gagliardi

Thomas Roth

Aron J. Csont

Beverly A. Gornat

Frank Townsend

Daniel P. Dorfmueller

John L. Kousfeld

Thomas G. Tyler

Michael G. Hernandez

Additional recognition to Anthony Lamanna, who edited the document, revised the photos, and provided content to match the intended audience and to Jeffrey W. Coleman for authoring Appendix A on legal issues. Their efforts are greatly appreciated.



American Concrete Institute
Always advancing



AMERICAN SOCIETY OF
CONCRETE CONTRACTORS
Enhancing the Capabilities of Those Who Build with Concrete

Contractor's Guide to Quality Concrete Construction
ISBN 978-1-64195-047-3
Copyright © 2018 American Concrete Institute

This document is published jointly by the American Concrete Institute (ACI) and the American Society of Concrete Contractors (ASCC). It has been reviewed in accordance with the Educational Committee Manual document review procedures of the ACI Educational Activities Committee.

ACI and ASCC reports are intended for guidance in planning, designing, executing, and inspecting construction. This document is intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. ACI and ASCC disclaim any and all responsibility for the stated principles. ACI and ASCC shall not be liable for any loss or damage arising therefrom.

Reference to this document shall not be made in contract documents. If items found in this document are desired by the Architect/Engineer to be a part of the contract documents, they shall be restated in mandatory language for incorporation by the Architect/Engineer.

Managing Editor: Michael L. Tholen, Ph.D., P.E.
Art Program: Claire A. Hiltz and Aimee M. Kahaian
Engineering Editor: Katie A. Amelio, P.E.
Manager, Publishing Services: Barry M. Bergin
Production Editors: Kelli R. Slayden, Tiesha Elam, Kaitlyn Lubben
Page Design & Composition: Kelli R. Slayden
Manufacturing: Marie Fuller

First Printing: December 2018
Printed in Ann Arbor, Michigan



American Concrete Institute
3800 Country Club Drive
Farmington Hills, MI 48331
USA

www.concrete.org
+1.248.848.3700



American Society of Concrete Contractors
2025 S. Brentwood Blvd., Suite 105
St. Louis, MO 63144
USA

www.asconline.org
+1.314.962.0210

On the cover: Front and back cover photos courtesy of Baker Concrete Construction Inc.

About

American Concrete Institute

The American Concrete Institute (ACI) is a leading authority and resource worldwide for the development and distribution of consensus-based standards and technical resources, educational programs, and certifications for individuals and organizations involved in concrete design, construction and materials. ACI has over 95 chapters, 125 student chapters, and nearly 20,000 members spanning over 120 countries.

ACI resources provide valuable information to concrete designers, contractors, and researchers, as well as students studying in various construction-related programs. Specifically for contractors, ACI publishes books that provide practical information and cutting-edge construction practices. The Institute provides free online videos, on-demand online courses, seminars, conventions, and events of interest to concrete contractors. Additionally, ACI has developed 25+ certification programs (see Appendix C for details) that provide individuals with credentials to build the best concrete structures in the world. Learn more at www.concrete.org/contractors.

American Society of Concrete Contractors

The American Society of Concrete Contractors (ASCC) is a nonprofit organization dedicated to enhancing the capabilities of those who build with concrete, and to providing them a unified voice in the construction industry. Members include concrete contracting firms, general contractors, manufacturers, suppliers, designers, educators, and others interested in the concrete industry. There are over 730 member companies in the United States and abroad.

Concrete contracting requires you to make tough technical and business decisions. The quality of a project depends on the hundreds of decisions you and your employees make every day.

Membership in ASCC provides the tools, including publications like this one, to make informed, careful decisions. It connects you to a nationwide network of peers, professionals, and experts who will support you every step of the way. And, the credibility of a national organization, made up of the country's leading concrete contractors, elevates you and your industry to a level of recognition and respect that will facilitate your growth in the years ahead.

A Decorative Concrete Council, Concrete Polishing Council, and Safety & Risk Management Council address specific issues in the market of the industry.

Contents

Chapter 1—Safety	4		
Most Accidents Are Not Accidents	5	Groundwater Control	48
The Need for a Company Safety Program	5	Footing Forms	49
Concrete Construction Hazards	5	Moisture Control	51
Daily Safety Meeting	7	Backfilling	51
Experience Modification Rate and Incident Rate	7		
Chapter 2—The Concrete Mixture	10	Chapter 5—Formwork	54
Control Tests	10	Safety Precautions	55
Cement	14	Formwork Affects Concrete Quality	56
Other Cementitious Materials	15	Types of Forms	57
Mixing Water	16	Form Material and Hardware	64
Water–Cementitious Materials Ratio	17	Design of Forms	68
Aggregates	17	Placing Concrete in Forms	73
Admixtures	19	Cost of Formwork	78
Concrete Mixture Design	21	Form Removal	81
Water Addition at the Jobsite	24	Shoring and Reshoring	82
Set Time	25	Formwork for Slabs-on-Ground and Continuous Footings	84
Chapter 3—The Concrete Specification	28	Chapter 6—Reinforcement in Structures	88
Specification Formats	29	Why Use Steel Reinforcement?	88
Sources for Concrete Specifications References	30	Engineering and Placing Drawings	90
Reference Specifications	31	Types of Reinforcement	91
Specification Categories	32	Reinforcing Bar Fabrication	97
Acceptance Criteria	32	Storing and Handling Reinforcing Bars on the Job	99
Assignment of Risk	33	Concrete Cover	100
Strength	33	Tolerances in Placing Steel Reinforcement	100
Acceptance Testing	33	Placing of Reinforcement	101
Early Strength Requirements	35	Bar Supports and Spacers	103
Flexural Strength	35	Splicing Reinforcing Steel	104
Water–Cement Ratio (w/c) and Water–Cementitious Materials Ratio (w/cm)	36	Coordination	105
Minimum Cement Content	36	Chapter 7—Joints and Embedments in Structures	108
Slump	36	Types of Joints in Structural Elements	109
Air Entrainment	37	Construction Joints for Supported Beams and Slabs	110
Chemical Admixtures	38	Contraction Joints for Walls	110
Delivery Time for Ready Mixed Concrete	38	Isolation Joints for Walls	111
Hot Weather Concrete	39	Construction Joints in Walls	112
Mass Concrete Placements	39	Waterstops	113
Cold Weather Concrete	39	Embedments	114
Flatwork Finish Acceptance Criteria	40	Anchors	117
		Points to Remember	119
Chapter 4—Foundations	42	Chapter 8—Joints and Reinforcement for Slabs-on-Ground	120
The Ground Below	43	Volume Changes	121
Bearing Capacity	43	Contraction (Control) Joints	121
Geotechnical Investigations	43	Construction Joints	124
Compaction	44	Isolation Joints (Expansion Joints)	125
Basic Foundation Types	45	Reinforcement in a Slab	126

Chapter 9—Planning for Quality	132		
Elements of Quality Management	132	Controlling Placement	179
Management Responsibility	133	Hot Weather Placement	179
Quality Management System	133	Cold Weather Placement	181
The Site-Specific Quality Plan	134	Vibratory Screeds	182
Contract Review	135	Finishing a Slab-on-Ground	182
Design Control	136	Floor Surface Finish Tolerances	184
Document and Data Control	136	Curing to Maintain Proper Moisture Content	186
Purchasing	137		
Process Control	138	Chapter 12—Common Field Problems—	190
Inspection and Testing	139	Cause and Prevention	
Control of Nonconforming Product, Corrective Action,		Fresh Concrete	190
and Preventive Action	140	Hardened Concrete	196
Control of Quality Records	140		
Training and Certification	140	Appendix A—Legal Issues	204
Chapter 10—Preparing for Concreting	144	Responsibility for the Concrete Mixture	204
Contractor/Ready Mixed Concrete Producer		Concrete Defects	205
Cooperation	145	Cracking of Concrete	206
Preconstruction Conference	147	Standards of Care	209
Jobsite Preparation	150	Substantial Performance	209
A Checklist for Major Projects	151	Delivery Tickets and Acceptance	210
		Spearin Doctrine	210
Chapter 11—Concrete Placement and Finishing	174	Unforeseen Conditions	210
Depositing Concrete from the Concrete Truck	174	Inspection/Observation/Supervision	211
Bugging Concrete	175	Dispute Resolution	211
Belt Conveyors	175	Personal Injury	212
Bucket Placement	176		
Pumping Concrete	176	Appendix B—ASCC Position Statements	214
Pumping Lightweight Concrete	177		
Consolidation during Placement	178	Appendix C—ACI Certification Programs	258
		Testing Programs	258
		Inspection Programs	259
		Construction/Specialist Programs	260