



User's Guide to ASTM  
Specification C94/C94M on  
**Ready-Mixed  
Concrete**

2nd Edition

D. Gene Daniel  
Colin L. Lobo



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# User's Guide to ASTM Specification C94/C94M on Ready-Mixed Concrete: 2nd Edition

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ASTM Manual Series  
ASTM Stock Number: MNL49-2ND



ASTM International  
100 Barr Harbor Drive  
PO Box C700  
West Conshohocken, PA 19428-2959  
USA



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National Ready Mixed Concrete Association  
900 Spring Street  
Silver Spring, MD 20910, USA

Printed in the U.S.A.

### Library of Congress Cataloging-in-Publication Data

Daniel, D. Gene, 1934-

[User's guide to ASTM specification C94 on ready-mixed concrete]

User's guide to ASTM specification C94/C94M on ready-mixed concrete / D. Gene Daniel, Colin L. Lobo. -- 2nd edition.  
pages cm

Revised edition of: User's guide to ASTM specification C94 on ready-mixed concrete / D. Gene Daniel and Colin L. Lobo. 2005.

Includes bibliographical references and index.

ISBN 978-0-8031-7054-4 (alk. paper)

1. Ready-mixed concrete--Specifications--United States. I. Lobo, Colin L., 1961- II. Title.

TA439.D25 2013

666'.893--dc23

2013041858

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Website: [www.astm.org](http://www.astm.org)  
ISBN 0-8031-3363-4  
ASTM Stock Number: MNL 49-2ND

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Website: [www.nrmca.org](http://www.nrmca.org)  
NRMCA Order Number: 2PMNL 49

Printed in  
Mayfield, PA  
May, 2014

## Foreword

THIS PUBLICATION, *User's Guide to ASTM Specification C94/C94M on Ready-Mixed Concrete*, was co-published by ASTM International and the National Ready Mixed Concrete Association (NRMCA). It was both authored and edited by D. Gene Daniel, concrete consultant, Claremore, Oklahoma; and Colin L. Lobo, National Ready Mixed Concrete Association, Silver Spring, Maryland. This publication was sponsored by Committee C09 on Concrete and Concrete Aggregates and it is the second edition of Manual 49 of ASTM's manual series.

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## Preface

### WHAT IS ASTM?

To fully understand ASTM **C94/C94M**, *Specification on Ready-Mixed Concrete*, it is necessary to understand ASTM and the consensus process for developing standards such as ASTM **C94/C94M**. Getting a view of ASTM from its conception takes us back more than a century. The time period involved is between the American Civil War, which ended in 1865, and World War I, which began in 1914. The true beginning of ASTM coincided with the Spanish-American War fought in 1898.

The world, and more specifically the United States, was in the midst of the second phase of the Industrial Revolution. Major advances in communication and transportation were taking place in a country that in the late 1890s consisted of 45 states. The diesel engine, electrical power, and the steel industry were all coming into prominence. The United States was a growing, developing, and prosperous nation with industrial corporations, some of which have gone on to grow into giants that remain today. William McKinley was elected President in 1896, re-elected in 1900, and assassinated in 1901.

This growth period and the industrial revolution were the backdrop that fostered ASTM. The North American railroad network was expanding in all directions less than 30 years after the completion of the first transcontinental railroad. Charles Dudley, holder of a Ph.D. from Yale University, was a chemist for the Pennsylvania Railroad. Mr. Dudley's degree preceded by two years Custer's Last Stand at the Battle of the Little Big Horn in the hills of Montana. A portion of Mr. Dudley's duties included doing research to develop more durable steel for use as rails and writing a specification conveying those findings to the rail manufacturers. Mr. Dudley's ideas did not always coincide with those of the steel manufacturers or the other railroads that were buying steel rails. These problems of differing viewpoints led to the first meetings of manufacturers, chemists, engineers, and others in the steel and railroad or bridge business to develop standards everyone could tolerate. The idea that emerged was that good material standards require the input of manufacturers, designers, builders, and users. This was the idea in June of 1898 when ASTM was first formed under another name,

American Section of the International Association for Testing Materials. From the first meeting, the goal was to develop consensus standards.

The first committee dealing with cement, C01, was formed in 1902, and the concrete and concrete aggregates committee, C09, formed in 1914.

The scope of ASTM has continued to expand, and its name has continued to change. The name today is ASTM International, reflecting both its wide use and a broad international membership. From the original 70 members, ASTM International (ASTM) has grown to more than 30,000 members. For the 100 plus years of its existence, the committee work has remained in the hands of volunteers.

### WHAT IS SUBCOMMITTEE C09.40?

At the bottom of the first page of the document ASTM Standard Specification for Ready-Mixed Concrete (**C94/C94M**) is a notation: "This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.40 on Ready-Mixed Concrete." Very simply, Subcommittee C09.40 is the group of people who do the actual writing of ASTM **C94/C94M**. This subcommittee is typically composed of approximately 100 people, including manufacturers of ready-mixed concrete, private engineers from design firms and material testing firms, state highway department engineers, representatives of federal agencies, representatives of trade organizations, professors from foreign and domestic universities, contractors, and representatives from concrete material producers, such as cement and chemical admixtures, as well as others who have a relationship to the industry. Most of these people are engineers or scientists whose daily activities involve them with the concrete industry. Most, but not all, live in the United States.

Subcommittee C09.40 is only one of many subcommittees that function as a part of the Committee C09 on Concrete and Concrete Aggregates. The main body of Committee C09 divides into approximately 29 subcommittees to develop consensus standards for the concrete and concrete aggregates industry.

### ASTM STANDARDS DEVELOPMENT PROCESS

ASTM standards development follows a consensus process consistent with requirements of the American National Standards Institute (ANSI). ANSI facilitates the development of American National Standards (ANS) by accrediting the procedures of standards developing organizations (SDOs) like ASTM International. SDOs work cooperatively to develop voluntary national consensus standards. An important requirement is to ensure the voting producer representation on the committee is balanced between voting representation by users and by general interest members. Each company or entity is assigned one vote, and additional representatives from that entity are provided a nonvoting status. This ensures that the interests of one particular group do not bias the development of the standard and that all viewpoints are addressed. The development of standards through consensus requires time and compromise but ensures, for the most part, that the standards developed satisfy all affected groups. American National Standards development process is usually referred to as “open” standards development. In this sense, “open” refers to a process used by a recognized body for developing and approving a standard. This ensures a collaborative, balanced, and consensus-based approval process. The content of these standards may relate to products, processes, services, systems, or personnel.

New standards or revisions to existing standards within ASTM usually begin within a task group of a subcommittee. The task group develops a written ballot that is submitted for letter ballot to the subcommittee. Reviewing subcommittee ballots and voting is both a privilege and a responsibility of committee membership. When a subcommittee member casts a negative vote on a ballot item, an explanation of what the voter objects to and what changes could be made to satisfy the concerns of the negative voter is required.

For a ballot to become valid, at least 60 % of the voting subcommittee members must have voted. For a ballot item to be successful, two thirds of the eligible voting members must vote affirmatively on a ballot item. To advance to the next level, the subcommittee vote must be positive for two thirds or more of those voting. In reality, each negative vote of a member, voting or nonvoting, is vetted, or the ballot item withdrawn and revised, if possible, into a new subcommittee ballot.

The item is then either re-balloted at the subcommittee level, or with the approval of the committee chairman the revised item may be balloted concurrently at both the subcommittee and committee levels. The committee level involves all the members of the various subcommittees. In the case of the Committee C09 this involves approximately 29 subcommittees and 700 members. Committee C09 meets in June and December each year with a usual attendance of 150 to 200 members. It is at these semiannual meetings that each negative ballot is vetted and voted on.

At the committee level a ballot item must receive affirmative votes on at least 90 % of the votes cast for approval.

If approved at the committee level, the balloted item is approaching ASTM membership approval.

Simultaneously with the committee level vote, the proposed change is also subject to a vote by the entire ASTM Society, which includes all the ASTM members in various committees. No voting percentages are required at this level, but negative votes must again be considered.

The consensus system also provides for an appeal by a negative voter. The appeals system varies depending upon the grounds stated for the appeal. A Committee on Standards assures that due process is followed.

The primary point of the entire process is that each negative voter's voice and arguments are heard, and the subcommittee or committee is then afforded the opportunity to vote on an issue based on the thoughts and reasoning of one member of the group. A single objection often influences others and alters the content of a proposal or kills the proposal completely. ASTM firmly believes in the old adage that two heads are better than one and has set up a system to ensure that each member's voice is heard.

### ORIGINAL ASTM SPECIFICATION FOR READY-MIXED CONCRETE

The original C-9 (now C09) committee required six years (1914–1920) to issue its first standard. The first standard addressed the proper means of molding and storing concrete cylinders in the field and described methods still in use today.

The first product specification was issued in 1933 as a tentative specification for ready-mixed concrete. The topics covered did not vary much from today's standard, over 75 years later.

The specification has been revised many times since approved in 1935 and continues to undergo revisions to remain in step with technological advances, such as load-cell weighing, and environmental issues, such as limiting plant runoff water by the use of non-potable water in the batching process.

The roots of a successful specification go back to the abilities of the committee who prior to 1933 published a comprehensive document prescribing the materials, proportioning, mixing, delivery, quality, inspection, testing, and acceptance of ready-mixed concrete for delivery to the job site ready for use.

An equivalent specification to ASTM C94/C94M is published by the American Association of State Highway and Transportation Officials (AASHTO) M 157 Standard Specification for Ready-Mixed Concrete. As the association name implies, this organization includes representatives from each state and some other entities involved in construction of transportation infrastructure. Development of AASHTO standards does not follow the typical consensus process because AASHTO limits voting interests to designers and users (state departments of transportation) and excludes industry representation. AASHTO Subcommittee on Materials reviews changes to ASTM standards and chooses to ballot these changes to the AASHTO standards. Some AASHTO standards are

essentially very similar to ASTM standards. AASHTO M 157 is structured slightly differently than ASTM C94/C94M, but the technical differences are relatively minor. There are several sections of ASTM C94/C94M that are not covered in AASHTO M 157. The greatest difference between the two specifications is in the category of ordering information. ASTM C94/C94M has three options, providing more latitude to the purchaser. AASHTO M 157 does not provide a section on ordering. Instead AASHTO M 157 has a quality of concrete section that concerns submittals to the engineer by the contractor or the proportioning prescribed by the engineer and directed to the contractor. Another difference between the two sets of standards is in the reference to the use of mixing water in concrete. ASTM C94/C94M references ASTM C1602. A note at the end of AASHTO M 157 recognizes these differences and suggests, “users other than specifying agencies should consider ASTM C94.” State highway agencies vary in their reference to ASTM or AASHTO standards.

#### HOW TO USE ASTM C94/C94M

The most common usage of ASTM C94/C94M is as a reference document within a design professional’s specification for cast-in-place concrete. A statement such as “**Unless otherwise specified, use materials, measure, batch, and mix concrete materials and concrete and deliver concrete in approved equipment, all in conformance with ASTM C94/C94M**” within the concrete specifications for a project specify the strength,

slump, air content, aggregate size, and other variable factors named in Section 6, Ordering Information, will be provided.

Other methods are suitable if the questions in Ordering Information are answered. A purchase order with a ready-mix concrete manufacturer may simply state “**Produce and deliver concrete as per C94.**”

An important violation that can cause trouble is using excerpts from ASTM C94/C94M or any other specification without a careful reading of the entire document for related segments. Unfortunately some design professionals follow this cut and paste style. It is best to use the complete document by reference.

#### HOW TO USE THIS GUIDE

The chapters in this book reflect the sections of C94/C94M. Text from C94/C94M is reproduced in italicized text followed by a discussion of the section. Sentences in the specification are cross-referenced and discussed in the text with identifications S1, S2, etc. Tables, figures, and numerical examples are numbered sequentially by chapter number, except for tables excerpted from C94/C94M, which retain the actual table number from C94/C94M.

#### DISCLAIMER

This book represents the interpretation of the authors concerning ASTM C94/C94M and does not represent the views of ASTM International or Subcommittee C09.40.



## Introduction

### **ASTM DESIGNATION: C94/C94M-13 STANDARD SPECIFICATION FOR READY-MIXED CONCRETE**

This is the official number and title for the ASTM specification for ready-mixed concrete. Portions of the designation remain constant, and other parts are always subject to change. An analysis of the parts of the alphanumeric identification for the “Specification for Ready-Mixed Concrete” entails four segments:

**C94** includes the group designation “C” (which comes from the 19 ASTM committees currently grouped under the “C” designation, of which committee C09 is one).

ASTM Committee C09 is responsible for this ready-mixed concrete specification. The permanent number 94 was assigned

in numerical sequence from all of the C committee standards when first developed.

“**C94M**” means this specification is a combined standard that includes metric (SI) values as well as inch-pound values.

The hyphenated numerals following the serial designation represent the last two digits of the year the standard originated or was last revised. An e1 superscript (e1) following the year designation would indicate that an editorial change has been made later than the substantive changes of 2013.

Footnotes on the title page are self-explanatory.<sup>1</sup>

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<sup>1</sup> This specification is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.40 on Ready-Mixed Concrete.



D. Gene Daniel holds the degree of Bachelor of Architectural Engineering from Oklahoma State University and an MSCE from the University of Arkansas. Following a period as an instructor at the University of Arkansas, he entered private practice as a civil engineer in Fort Smith, Arkansas. He also owned and acted as principle engineer for a geotechnical and construction materials testing laboratory. He later became technical director and president of a ready-mixed concrete company before becoming consulting director of technical services for a group of ready-mixed concrete operations. Recently, he has served as the concrete and aggregate monitor for a five-year federally mandated program of a multidisciplinary material supplier. Work with NRMCA includes preparation of an instructor guide for certification of batch plants.

He is a past president of the American Consulting Engineer's Council of Arkansas and a member of the Arkansas Academy of Civil Engineers. Mr. Daniel has held the title of fellow in the National Academy of Forensic Engineers and served on the NRMCA Research, Engineering, and Standards Committee. As a 50-plus year member of the American Concrete Institute he was elected as an ACI Fellow in 1998. Also a 50-year plus member of ASTM, he has chaired several technical committees and remains a member of several, including C09.40, Ready Mixed Concrete; C09.60, Testing Fresh Concrete; C09.98, Evaluation of Laboratories; and C09.50, Risk Management for Alkali Aggregate Reaction.



Dr. Colin L. Lobo is senior vice president of the engineering division at the National Ready Mixed Concrete Association in Silver Spring, Maryland. He has been with the NRMCA for 23 years and is an active member of ASTM Committees C09 on Concrete and Aggregates and C01 on Cement. He is an active member on committees of the American Concrete Institute responsible for the Building Code for Structural Concrete, Specifications for Structural Concrete, and other technical committees. He has published several papers on concrete technology, performance-based specifications, and practical use of concrete as a construction material. He has developed and administered education and certification programs for ready-mixed concrete industry personnel and its customers. He manages the NRMCA Certification Program for Ready Mixed Concrete Production Facilities and the NRMCA Quality Certification Program. Dr. Lobo has responsibilities for the education, research, and technical programs at the NRMCA.

Dr. Lobo is a Fellow of the American Concrete Institute. He is a recipient of the ASTM International Katherine and Bryant Mather Member Contribution Award, the ACI Henry C. Turner Medal, and the NRMCA Richard D. Gaynor Award.

He holds a Ph.D. from Purdue University, an MS from Northeastern University, and a B.E. in civil engineering from Mysore University in India. He is a registered professional engineer in the state of Maryland.