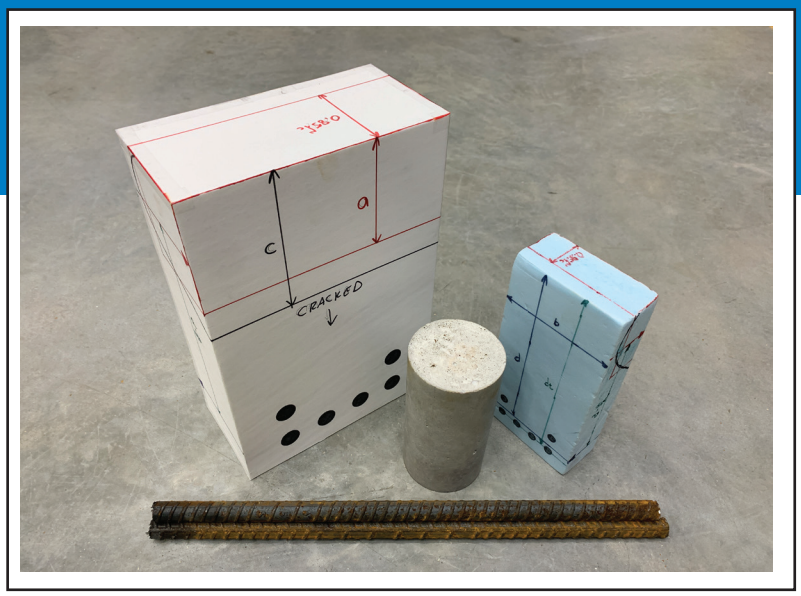
An ACI Technical Publication

SYMPOSIUM VOLUME



Best Practices and Lessons Learned for Teaching Concrete Materials and Reinforced Concrete

SP-359

Editors:
Benjamin Z. Dymond and J. Chris Carroll

American Concrete Institute
Always advancing

Best Practices and Lessons Learned for Teaching Concrete Materials and Reinforced Concrete

Sponsored by
ACI Committee S802

ACI Virtual Convention
October 17-21, 2021

Editors:
Benjamin Z. Dymond
and J. Chris Carroll

American Concrete Institute
Always advancing

SP-359

First printing, November 2023

Printed in the United States of America

Editorial production: Ryan M Jay

ISBN-13: 978-1-64195-236-1

Best Practices and Lessons Learned for Teaching Concrete Materials and Reinforced Concrete

The manuscripts included herein introduce common learning theories and methods in engineering education that can be specifically applied to the topics of reinforced concrete and concrete materials. The papers focus on the application of these theories to specific concrete-related topics and suggest ways to implement these methods in university classrooms. The primary goal of this Special Publication is to provide pedagogical resources, ideas, and techniques that can be implemented by anyone that accepts the challenge of teaching reinforced concrete and concrete materials, from a new instructor to an experienced professor.

To disseminate effective teaching methods among a global group of educators and learners, ACI Committee S802 organized two sessions entitled “Best Practices and Lessons Learned for Teaching Concrete Materials and Reinforced Concrete” at the Spring 2021 ACI Virtual Convention. The first session was focused on best practices teaching concrete materials and the second session was focused on best practices teaching introductory reinforced concrete. The manuscripts in this Special Publication are organized in the order in which they were presented at the ACI Convention.

The co-editors, Dr. Benjamin Dymond and Dr. J. Chris Carroll, are grateful for the contributions from the Special Publication authors and sincerely value the time and effort of the authors in preparing the papers in this volume. Furthermore, the Special Publication would not have been possible without the effort expended by the experts who peer reviewed the papers in this volume.

Benjamin Dymond and J. Chris Carroll
Co-Editors

TABLE OF CONTENTS

SP-359—1

Effective Teaching Methods in Concrete Education

Matthew K. Swenty, Benjamin Z. Dymond, J. Chris Carroll

Synopsis: Teaching engineering students reinforced concrete and concrete materials topics is not a trivial task. Students learn in a variety of different ways and many professors rely on only a few methods of presenting the material and directing learning. The disconnect can create a struggle in the learning process for all parties involved. This paper introduces several different common teaching styles and methods that have been used in engineering education. The methods are compared and contrasted based on complexity, resources required, and preparation time. Various levels of change are discussed from small incremental adjustments to completely redesigning the course. A series of examples are described to demonstrate a few ways of implementing new teaching ideas into a classroom. Companion papers expand upon this introductory paper and provide in-depth and specific applications to topics common in concrete education. The goal of this special publication is to provide a venue to share teaching ideas and make concrete education more effective, efficient, and enjoyable for everyone.

Keywords: Engineering education, civil engineering, learning styles, teaching methods, active learning, reinforced concrete, concrete materials, teaching examples

INTRODUCTION

Educating engineering students is a challenging proposition for a professor. The material is based on difficult subjects that commonly build upon one another requiring the students to thoroughly understand one topic before proceeding to the next. Many times, students desire to learn simple "plug and chug" style equations, but the reality is they must understand the basis for the methods they use as a design engineer. Ultimately, they will be responsible for the safety of the public. Teaching engineering topics has always been challenging since the inception of engineering programs at the turn of the 20th century (McDaniel 1917).

Professors are very well educated and have a thorough understanding of their subject matter. However, most professors do not have any formal training in education, so they must find ways to convey knowledge and help students learn (Welch & Estes 2005). Some in the profession have noted the importance of transforming the engineering education experience by placing more emphasis on quality teaching (TUEE 2013). Many professors revert to a default, comfortable teaching method or technique that their favorite professors used or a method that is easy to implement. One major issue is making useful and updated material easily accessible for a professor to use in their quest to educate effectively.

Students come from different backgrounds and acquire and remember knowledge, commonly called learning, in a variety of ways. Competing educational theories state that either the approach to learning or the learning style affects student learning. Some believe a student's approach to learning is influenced by their motivation and their stimulations to learn by outside influences. Others believe that learning styles are attributed to the psychological attributes the student has for processing information. Learning styles tend to remain static for an individual (Cuthbert 2005). Criticism of each theory continues, but many in engineering education, particularly in the United States, rely on the learning styles approach (Cuthbert 2005, Popescu 2009). From the perspective of the learning style, there is a strong likelihood that some students in a class struggle to understand a teacher because of the teaching methods or style, not because of the technical difficulty of the material. Professors must identify this dilemma and target the variety of learning styles and motivations used by their students (Dunn & Griggs 2000; Felder & Silverman 1988).

There are many different methods of presenting information to students and guiding the learning process (Wankat & Oreovicz 2015). It is important that all professors maintain a flexible attitude when practicing the art of teaching. The teaching process changes with time and with students. Even those who have taught for many years must be patient and assess their own teaching methods regularly to help their students learn effectively (Stronge et al. 2004).

OVERVIEW OF THIS SPECIAL PUBLICATION SERIES

This paper is the first in a special publication (SP) series that contains nine additional manuscripts designed to introduce common learning theories and methods in engineering education that can be specifically applied to the topics of reinforced concrete and concrete materials. The companion papers focus on the application of these theories to specific topics, which include:

2. Approaches to Teaching Cement Hydration Processes to Undergraduates
3. Pedagogical Techniques used to Teach Fresh and Hardened Concrete Properties
4. Teaching Additive Manufacturing with Consideration for Cementitious Materials
5. Effective Teaching Methods for Non-destructive Testing Techniques
6. Pedagogical Techniques used to Teach Detailing of Reinforced Concrete Structures
7. Teaching the Equivalent Rectangular Stress Block
8. Teaching Flexural Strength Failure Modes in Reinforced Concrete I
9. Active and Visual Methods for Teaching Nonrectangular Reinforced Concrete Beams
10. Approaches for Teaching Shear Analysis and Design of Reinforced Concrete

Included herein are suggested ways to implement these methods, a list of time commitments for each method, and a description of their complexity. The primary goal of this special publication is to provide pedagogical resources, ideas, and techniques that can be implemented by anyone that accepts the challenge of teaching reinforced concrete and concrete materials, from a new instructor to an experienced professor.