

An ACI Technical Publication

SYMPOSIUM VOLUME



Durability, Service Life, and Long-Term
Integrity of Concrete Materials, Bridges,
and Structures

SP-351

Editors:

Yail J. Kim, Chris P. Pantelides, and Xianming Shi



American Concrete Institute
Always advancing

Durability, Service Life, and Long-Term Integrity of Concrete Materials, Bridges, and Structures

Sponsored by
ACI Committee 345

ACI Virtual Concrete Convention
October 17-21, 2021

Editors:
Yail J. Kim,
Chris P. Pantelides,
and Xianming Shi



American Concrete Institute
Always advancing

SP-351

First printing, April 2022

Discussion is welcomed for all materials published in this issue and will appear ten months from this journal's date if the discussion is received within four months of the paper's print publication. Discussion of material received after specified dates will be considered individually for publication or private response. ACI Standards published in ACI Journals for public comment have discussion due dates printed with the Standard.

The Institute is not responsible for the statements or opinions expressed in its publications. Institute publications are not able to, nor intended to, supplant individual training, responsibility, or judgment of the user, or the supplier, of the information presented.

The papers in this volume have been reviewed under Institute publication procedures by individuals expert in the subject areas of the papers.

Copyright © 2022
AMERICAN CONCRETE INSTITUTE
38800 Country Club Dr.
Farmington Hills, Michigan 48331

All rights reserved, including rights of reproduction and use in any form or by any means, including the making of copies by any photo process, or by any electronic or mechanical device, printed or written or oral, or recording for sound or visual reproduction or for use in any knowledge or retrieval system or device, unless permission in writing is obtained from the copyright proprietors.

Printed in the United States of America

Editorial production: Gail L. Tatum

ISBN-13: 978-1-64195-174-6

Durability, Service Life, and Long-Term Integrity of Concrete Materials, Bridges, and Structures

Durability is one of the most important requirements for built-environments. Federal, state, and local agencies expend significant effort to maintain the quality and condition of aging civil infrastructure, especially in aggressive service environments. Among many factors, durability influences the service life, integrity, and reliability of concrete materials and structures. Extensive research has been conducted to understand the deterioration mechanisms of concrete in an effort to extend the longevity of concrete members. This Special Publication (SP) contains nine papers selected from three technical sessions held during the virtual ACI Fall Convention in October 2021. Emphasis is placed on durable reinforcing schemes, service life prediction, structural integrity, repair and retrofit, corrosion mitigation, inspection techniques, and the application of state-of-the-art construction materials. All manuscripts were reviewed by at least two experts in accordance with the ACI publication policy. The Editors wish to thank all contributing authors and anonymous reviewers for their rigorous efforts. The Editors also gratefully acknowledge Ms. Barbara Coleman at ACI for her knowledgeable guidance.

Yail J. Kim, Chris P. Pantelides, and Xianming Shi

Editors

University of Colorado Denver

University of Utah

Washington State University

TABLE OF CONTENTS

SP-351-1:

Axial Compression Capacity of Concrete Columns Reinforced with GFRP and Stainless Reinforcement 1-18
Authors: J.W. Wright and C.P. Pantelides

SP-351-2:

Remaining Service Life Assessment of Bridge Abutments Using Different Models: Comparative Study..... 19-37
Authors: Abeer Al-Shammari and Mojtaba Afzali

SP-351-3:

A Consideration of the Structural Integrity of Time-Varying Mass Systems 38-53
Authors: Vanissorn Vimonsatit, Phung Tu, and Jack Fletcher

SP-351-4:

A Case Study on the Durability of Fiber-Reinforced Concrete Fireproofing in Aggressive Industrial Environments54-69
Authors: Nicholas Triandafilou, Mark Guirguis, Ephraim Dissen, Olu Awomolo, and Mustafa Mahamid

SP-351-5:

Durability of a Bridge Column under Marine Environments..... 70-82
Authors: Jun Wang and Yail J. Kim

SP-351-6:

Visual Inspection of Precast Concrete Bridge Using UAS Technologies.....83-96
Authors: Junwon Seo, Euseok Jeong, and James P. Wacker

SP-351-7:

Modeling the Service Life Performance of Bridge Deck Overlays.....97-109
Authors: Neal S. Berke and Ali N. Inceefe

SP-351-8:

Research Needs for Fiber Reinforced (FR) Composite Retrofit Systems in Buildings and Infrastructure..... 110-128
Authors: Jazalyn Dukes, David Goodwin, Siamak Sattar, and Lipiin Sung

SP-351-9:

Ductility of Ultra-High Performance Concrete Beams Reinforced with Ordinary, High-Strength and Stainless Steel Bars 129-150
Authors: Yang Li and Hassan Aoude

Axial Compression Capacity of Concrete Columns Reinforced with GFRP and Stainless Reinforcement

J.W. Wright and C.P. Pantelides

Synopsis: Axial compression performance of concrete columns reinforced with GFRP bars and spiral, 2304 duplex stainless bars and spiral, and 316L stainless clad bars, in varying combinations is examined after exposure to accelerated corrosion. The hybrid columns were reinforced with a combination of metallic and GFRP reinforcement. After corrosion exposure the columns were tested under axial compression to failure. Columns with GFRP vertical bars and stainless steel spiral were less corrosion resistant and had smaller axial load capacity than hybrid columns with stainless clad or stainless steel vertical bars and GFRP spiral. Columns reinforced with stainless steel spiral achieving two to three times the maximum axial displacement of columns with GFRP spiral. Axial compression capacity of hybrid columns in both corroded and uncorroded conditions was modeled using concrete confinement models for metallic and GFRP reinforcement with good agreement.

Keywords: carbon steel, columns, concrete, corrosion, glass fiber reinforced polymer, stainless clad, stainless steel.