

An ACI Technical Publication

SYMPOSIUM VOLUME



Durability and Sustainability of Concrete Structures – Workshop Proceedings

SP-305

Editors:

Mario Alberto Chiorino, Luigi Coppola, Claudio Mazzotti,
Roberto Realfonzo, and Paolo Riva



American Concrete Institute
Always advancing

This is a preview. [Click here to purchase the full publication.](#)

Durability and Sustainability of Concrete Structures – Workshop Proceedings

Editors:
Mario Alberto Chiorino
Luigi Coppola
Claudio Mazzotti
Roberto Realfonzo
Paolo Riva



American Concrete Institute
Always advancing

SP-305

First printing, September 2015

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 © 2015
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.

Cover photo: Interior of the concrete dome of Small Sports Palace in Rome, Italy, 1957, by Pier Luigi Nervi with Annibale Vitellozzi. Courtesy of PLN Project Association

Editorial production: Ryan Jay

ISBN-13: 978-1-942727-44-6

This is a preview. [Click here to purchase the full publication.](#)

Preface

With the dawn of twenty-first century, the world has entered into an era of sustainable development. The main challenge for concrete industry is to serve the two major needs of human society, the protection of the environment, on one hand, and - on the other hand - meeting the infrastructural requirements of the world growing population as a consequence of increase in both industrialization and urbanization. In the past, concrete industry has satisfied these needs well. Concrete is an environmentally friendly material useful for the construction of vast infrastructures. Skyscrapers, highway bridges, roads, water retaining structures and residential buildings are all testimonials to concrete's use and versatility. However, for a variety of reasons the situation has changed dramatically in the last years. First of all, the concrete industry is the largest consumer of natural resources. Secondly, portland cement, the binder of modern concrete mixtures, is not as environmentally friendly. The world's portland cement production, in fact, contributes to the earth's atmosphere about 7% of the total CO₂ emissions, CO₂ being one of the primary greenhouse gases responsible for global warming and climate change. As a consequence, concrete industry in the future has to face two antithetically needs. In other words how the concrete industry can feed the growing population needs being – at the same time - sustainable?

ACI Italy Chapter has been playing a significant role in the last years in the broad area of concrete technology in Italy and, in particular, in the field of concrete durability and sustainability. ACI Italy Chapter has become increasingly involved in research and development dealing with durability and sustainability issues such as reduction in CO₂ emissions, use of recycled materials and innovative products, design of durable structures and maintenance, repair and refurbishment of concrete infrastructures.

In October 2015, the American Concrete Institute Italy Chapter (ACI IC) and the Department of Civil, Chemical, Environmental, and Material Engineering (DICAM) of the University of Bologna sponsored the First International Workshop on “Durability & Sustainability of Concrete Structures” in Bologna (Italy). The workshop was co-sponsored by the American Concrete Institute and ACI Committee 201. The proceedings of the workshop were published by ACI IC as SP305. The proceedings consist of forty-eight refereed papers concerning reduction in green house gases in cement and concrete industry, recycled materials, innovative binders and geopolymers, Life Cycle Cost Assessment in concrete construction, reuse and functional resilience of reinforced concrete structures, repair and maintenance, testing, inspection and monitoring.

Many thanks are extended to the members of the technical paper review panel. Without their dedicated efforts it would not have been possible to publish the proceedings. The cooperation of the authors in accepting reviewers' comments and suggestions and in revising the manuscripts accordingly is greatly appreciated.

Editors

Mario Alberto Chiorino
Luigi Coppola
Claudio Mazzotti
Roberto Realfonzo
Paolo Riva



Organizing Committee

The organizing committee is composed by:

Luigi Coppola (University of Bergamo);	Paolo Riva (University of Bergamo -
Claudio Mazzotti (University of	ACI IC Vice President);
Bologna);	Marco Savoia (University of Bologna)
Roberto Realfonzo (University of	
Salerno - ACI IC President);	

Honor Committee

The Honor Committee is composed by:

Mario Alberto Chiorino (Italy)	Koji Sakai (Japan)
Mario Collepardi (Italy)	Surendra P. Shah (USA)
Tarun Naik (USA)	

International Scientific Committee

The international Scientific Committee is composed by:

Carmen Andrade Perdrix (Spain)	Doug Hooton (Canada)
Chen Baochun (China)	Eduard Koenders (Germany)
Luca Bertolini (Italy)	Giuseppe Mancini (Italy)
Julie Buffenbarger (USA)	Herbert Mang (Austria)
Jan Cervenka (Czech Republic)	Alberto Meda (Italy)
Edoardo Cosenza (Italy)	Guenther Meschke (Germany)
Laura De Lorenzis (Germany)	Giorgio Monti (Italy)
Carolina Di Biase (Italy)	Giacomo Moriconi (Italy)
Marco Di Prisco (Italy)	Antonio Nanni (USA)
Josè Guillermo Etse (Argentina)	Nicola Nisticò (Italy)
Ciro Faella (Italy)	Giovanni Plizzari (Italy)
Vyatcheslav Falikman (Russian	Anna Saetta (Italy)
Federation)	Romildo Toledo Filho (Brazil)
Liberato Ferrara (Italy)	Tom Van Dam (USA)
Pietro Gambarova (Italy)	Ruan Xin (China)
Ravindra Gettu (India)	

Workshop Secretary

Nicola Buratty (University of Bologna)
Maddalena Cimmino (University of Naples)



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
DEPARTMENT OF CIVIL, CHEMICAL, ENVIRONMENTAL
AND MATERIALS ENGINEERING

Main Sponsors



Sponsors

ACI Committee 201 Durability and Sustainability



TABLE OF CONTENTS

DURABILITY

SP-305—1

Analysis And Rehabilitation Of A R.C. High-Rise Strategic Building In Milan 1.1
Author(s): M. Acito, F. Cavagnera, C. Chesi, V. Lavermicocca, V. Sumini

SP-305—2

Natural Carbonation Of Concrete 2.1
Author(s): F. Aguayo, T. Drimalas, K. Folliard

SP-305—3

The Durability Of Restoration Of Exposed Concrete. Case Histories Compared....3.1
Author: F. Albani

SP-305—4

Prediction Of Service Life Of Reinforced Concrete By Considering The Initiation
And The Propagation Periods.....4.1
Author: C. Andrade

SP-305—5

Coupled Damage Model For RC Elements Assessment Under Environmental
Degradation 5.1
Author(s): L. Berto, H. Budelmann, I. B. N. Finozzi, A. Saetta, D. A. Talledo

SP-305—6

Chloride Diffusivity Of Hardened Cement Paste From Multiscale Modeling 6.1
Author(s): P. Carrara, L. De Lorenzis, T. Wu

SP-305—7

Durability And Conservation Of Twentieth-Century Concrete..... 7.1
Author: C. Di Biase

SP-305—8

FRCM Mechanical Properties Using Carbon Fabrics With Different Coating
Treatments 8.1
Author(s): J. Donnini, V. Corinaldesi, A. Nanni

SP-305—9

Strength And Durability Of Concrete Subjected To High Temperature: Continuous
And Discrete Constitutive Approaches..... 9.1
Author(s): G. Etse, M. Ripani, A. Caggiano, D. Said Schicchi

SP-305—10

Strength And Durability Of Sustainable Concrete: An Experimental Study 10.1
Author(s): C. Faella, C. Lima, E. Martinelli, M. Pepe, R. Realfonzo

SP-305—11

Natural Fibres As Promoters Of Autogeneous Healing In HPFRCCS: Results From On-Going Brazil-Italy Cooperation..... 11.1
Author(s): L. Ferrara, S. R. Ferreira, V. Krelani, M. Della Torre, F. Silva, R. D. Toledo Filho

SP-305—12

Internal Curing Of Concrete With Presaturated LWA:
A Preliminary Investigation 12.1
Author(s): L. Ferrara, L. Cortesi, O. Ligabue

SP-305—13

Self Healing Of Cement Based Materials Engineered Through Crystalline Admixtures: Experimental Results From A Multinational University Network 13.1
Author(s): L. Ferrara, I. Albertini, R. Gettu, V. Krelani, S. Moscato, F. Pirritano, M. Roig Flores, P. Serna Ros, S. M. Theeda

SP-305—14

Extruded Cementitious Hollow Tubes For Healing Agent Delivery 14.1
Author(s): A. Formia, P. Antonaci, S. Irico, F. Canonico, J.-M. Tulliani

SP-305—15

Indirectly-Supported One-Way R/C Slabs: Durability And Safety Issues..... 15.1
Author(s): P. G. Gambarova, F. Lo Monte

SP-305—16

Action Mechanisms And Performances Of Hydrophobizing Additives
In Mortars..... 16.1
Author(s): A. Lagazzo, S. Vicini, A. Nora, R. Botter

SP-305—17

Self-Compacting Concrete With C&DW: Microstructure And Long-Term Behavior..... 17.1
Author(s): S. Manzi, C. Mazzotti, M. C. Bignozzi

SP-305—18

Geopolymeric And Cementitious Mortars With The Same Mechanical Strength Class: Performances And Corrosion Behaviour Of Black And Galvanized Steel Bars..... 18.1
Author(s): A. Mobili, C. Giosuè, A. Belli, T. Bellezze, F. Tittarelli

SP-305—19

Time-Variant Structural Reliability Of R.C. Structures Affected By Chloride-Induced Deterioration..... 19.1
Author(s): B. Palazzo, P. Castaldo, A. Mariniello

SP-305—20

Durability And Sustainability Of Fly Ash Hpc Exposed To
Freeze-Thaw Cycles.....20.1
Author(s): A. Pasqualini, M. Bressan, F. M. Liberatore

SP-305—21

Safety-Shaped Concrete Bridge Railings And Traffic Barriers Using GFRP
Reinforcement.....21.1
Author(s): V. Rinaldi, M. Savoia, A. Nanni

SP-305—22

Multi-Ionic Models Of Chloride Diffusion And Migration In Concrete22.1
Author(s): Z. Song, L. Jiang, J. Xu, C. Xiong, H. Chu, Y. Zhang

SP-305—23

Upgrading Mortar Durability By Surface Coating Layer Formation And
Densification Using Electrodeposition Method.....23.1
Author(s): J. Xu, Y. Cao, H. Shan, L. Tang, Y. Xu

SP-305—24

Effect Of Fly Ash And Polypropylene Fiber On Early Shrinkage And Cracking Of
Alkali-Activated Slag Cement24.1
Author(s): Y. Wan, Y. Fang

SUSTAINABILITY**SP-305—25**

A Sustainable And Innovative Construction System25.1
Author(s): G. Bregoli, A. Madini Moretti, M. Parolari, P. Riva, M. Santicoli.

SP-305—26

Building Toward a Sustainable and Resilient Future26.1
Author: Julie K. Buffenbarger

SP-305—27

Alternative Cementitious Materials: Challenges And Opportunities.....27.1
Author(s): L. E. Burris, P. Alapati, K. E. Kurtis

SP-305—28

Fly Ash Geopolymers: Effect Of Admixtures On Fresh
And Hardened Properties28.1
Author(s): L. Carabba, S. Manzi, M. C. Bignozzi

SP-305—29

Self Compacting Light-Weight Concretes With Ground Bottom
Ash From Municipal Solid Waste Incinerators (MSWI).....29.1
Author(s): S. Collepardi, A. Borsoi, M. Collepardi, A. Quadrio Curzio

SP-305—30

TRC Precast Façade SANDWICH Panel For Energy Retrofitting Of Existing Buildings 30.1
Author(s): G. Colombo, M. Colombo, M. Di Prisco

SP-305—31

Lightweight Cementitious Mortar Made With Foamed Plastic Waste Aggregates 31.1
Author(s): B. Coppola, L. Di Maio, L. Courard, P. Scarfato, L. Incarnato

SP-305—32

Rheological And Mechanical Performances Of Concrete Manufactured By Using Washing Water Of Concrete Mixing Transport Trucks..... 32.1
Author(s): L. Coppola, S. Lorenzi, S. Pellegrini

SP-305—33

Use Of Recycled Aggregate And Expanded Clay For Self-Compacting Lightweight Aggregate Concretes..... 33.1
Author(s): V. Corinaldesi, G. Moriconi

SP-305—34

Green Concrete: Optimization Of High-Strength Concrete Based On LCA 34.1
Author(s): C. Dossche, V. Boel, W. De Corte, N. De Belie

SP-305—35

Use Of Recycled Glass As Partial Replacement Of Natural Sand In Tile Adhesive Mortars 35.1
Author(s): L. Fagandini, G. Mailli, L. Barbieri

SP-305—36

Structural Concrete In The Age Of Sustainable Development 36.1
Author(s): V. R. Falikman, B. V. Gusev

SP-305—37

Analyzing Factors Of Variability In Energy-Use In Concrete Production..... 37.1
Author: S. Fujimoto

SP-305—38

Effect Of Waste Fibers On The Mechanical Properties Of Concrete 38.1
Author(s): D. Hamzacebi, O. Sengul

SP-305—39

Design Of High Performance Concrete With Environmental Benefits..... 39.1
Author(s): P. Kara, G. Moriconi