

Superplasticizers and Other Chemical Admixtures in Concrete

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July 2022

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American Concrete Institute

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Denny Coffetti,
Luigi Coppola, and
Terence Holland



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Preface

In May 1978, the Canada Centre for Mineral and Energy Technology (CANMET), in association with the American Concrete Institute (ACI) sponsored a 3-day conference in Ottawa, ON, Canada, on the use of superplasticizers in concrete. Selected papers from the conference were published as ACI SP-62.

In 1981, CANMET, again in association with ACI, sponsored a second 3-day international conference in Ottawa on the use of the superplasticizers in concrete. Proceedings of the conference were published as ACI SP-68.

The purpose of the third international conference in Ottawa in 1989 was to review the progress made since the meetings in 1978 and 1981, and to bring together representatives of the chemical admixtures, cement, and concrete industries to exchange information and delineate new areas of needed research. The scope of this conference was expanded to include chemical admixtures other than superplasticizers. Proceedings of the conference were published as ACI SP-119.

In October 1994, CANMET in association with ACI and several other organizations sponsored the fourth conference in Montreal, QC, Canada. The objective of this conference was to bring attention to new developments in chemical admixture since the last conference in 1989. The proceedings of the conference were published as ACI SP-148.

In October 1997, the Committee for the Organization of CANMET/ACI International Conference, (ACI Council), in association with ACI and several cement and concrete organizations in Italy, sponsored the fifth conference in Rome, Italy. The conference was aimed at transferring technology in the fast-moving field of chemical admixtures. The proceedings of the conference were published as ACI SP-173.

In October 2000, Committee for the Organization of CANMET/ACI International Conferences, (ACI Council), in association with several organizations in Canada and France, sponsored the sixth conference in Nice, France. More than 50 papers from more than 20 countries were received and reviewed by an ACI review panel, and 37 were accepted for publication in the proceedings of the conference. The proceedings were published as ACI SP-195.

In October 2003, the Committee for the Organization of CANMET/ACI International Conferences (ACI Council) in association with several organizations in Canada and Germany, sponsored the seventh conference in Berlin, Germany. The conference attracted more than 275 delegates and proceedings of the conference consisting of 39 papers, were published as ACI SP-217.

In October 2006, the Committee for the Organization of CANMET/ACI International Conferences, (ACI Council), sponsored the eighth conference in Sorrento, Italy. More than 60 papers from more than 25 countries were received, and peer reviewed by the CANMET/ACI review panel in Budapest, and 36 were accepted for publication as ACI SP-239.

In October 2009, the Committee for the Organization of International Conferences (COIC) (formerly CANMET/ACI International Conferences) sponsored the ninth ACI International Conference in Seville, Spain. More than 50 papers from more than 20 countries were

received and peer reviewed, and 35 were accepted for publication in the proceedings of the conference. The proceedings were published as ACI SP-262.

In October 2012, COIC sponsored the Tenth International Conference on Superplasticizers and Other Chemical Admixtures in Concrete in Prague, Czech Republic. More than 70 papers from all over the world were peer reviewed, and 33 were accepted for publication in the proceedings of the conference. The proceedings were published as ACI SP-288.

In July, 2015, the COIC in association with ACI sponsored the Eleventh International Conference on Superplasticizers and Other Chemical Admixtures in concrete in Ottawa, ON, Canada. More than 60 papers from the world over were peer reviewed, and 28 were accepted for publication in the proceedings of the conference. Also, additional papers were presented at the conference that were published in the Supplementary Papers Volume.

In October 2018, the Chinese Ceramic Society and the China Academy of Building Research (CABR), Beijing China, in association with ACI, sponsored the Twelfth International Conference on Superplasticizers and other Chemical Admixtures in Concrete in Beijing China. More than 80 papers from all over the world were received and peer reviewed. A total of 36 refereed papers were accepted for publication in the proceedings of the conference. The proceedings were published by as ACI SP-329. The proceedings were published as ACI SP-302. Also, 54 additional papers were presented at the conference, and were published in the Supplementary Papers Volume.

In July, 2022, after a postponement for the COVID-19 pandemic, the ACI Italy Chapter and the University of Bergamo, Italy, sponsored the Thirteenth International Conference on Superplasticizers and Other Chemical Admixtures in Concrete in Milan, Italy. The proceedings of the conference consisting of 35 refereed papers were published by ACI as SP-354. In addition to the refereed papers, about 20 other papers were presented at the conference, and were published in a supplementary papers volume.

The main topics of the papers presented at the conference are related to superplasticizers, accelerating admixtures, retarding admixtures, air-entraining agents, shrinkage-reducing agents, superabsorbent polymers, and self-healing admixtures, and their influence on the properties of the concrete in fresh and hardened state. These properties include: workability, slump-loss, time of setting, heat of hydration, strength, durability, shrinkage, and creep of the concrete mixtures.

Thanks are extended to the reviewers for the valuable efforts in reviewing all the manuscripts published in the conference proceedings and in the supplementary volume.

The guidance from Dr. V. M. Malhotra and Prof. M. Collepardi, the Honorary Chairpersons of the conference, is sincerely appreciated.

Also, acknowledged is the support of ACI International for the publication of the proceedings (ACI SP 354).

The Editors

Dr. Denny Coffetti

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TABLE OF CONTENTS

SP-354-1:

Experimental and Theoretical Investigation on the Adsorbed Layer Thickness of
PCE Comb Polymers1-12
Authors: Johann Plank, Johannes Stecher, and Constantin Tiemeyer

SP-354-2:

Tixotropic and Chemical Structural Build-Up of Cement Pastes with Superplasticizer
under Different Storage Conditions 13-24
Authors: Kun Zhang, Alexander Mezhev, and Wolfram Schmidt

SP-354-3:

Effect of the PCE Side Chain Length and Grafting Density on the Plastic Viscosity
of Cement Paste..... 25-34
Authors: David Nicia and Dirk Lowke

SP-354-4:

Novel Hybrid Additive for Low-Carbon Concrete..... 35-48
Authors: Gilberto Artioli, Anna Bravo, Alberto Brocchi, Fabio Castiglioni,
Maria Chiara Dalconi, Mikaela Decio, Giorgio Ferrari, Marco Mazzetti, Davide Salvioni,
Luca Torelli, and Luca Valentini

SP-354-5:

Novel Perspective to Explain the Retarding Effect of Organic Admixtures
in Silicate-Activated Slag.....49-60
Authors: Vlastimil Bílek Jr., Martin Kadlec, Radoslav Novotný, Lukáš Kalina, and Petr Hrubý

SP-354-6:

Meta-Analysis of PCE Structures as Dispersants in Cementitious Materials..... 61-74
Authors: Thomas Wagner, Tobias Lange, and Torben Gädt

SP-354-7:

Effect of Calcium Ions on Bio-based Polymers for Rheology Control..... 75-86
Author: Wolfram Schmidt

SP-354-8:

The Influence of the Molecular Structure of PCEs on the Interaction with Expandable Clays..... 87-98
Authors: Fabio Castiglioni, Giorgio Ferrari, Mariele Gamba, Paolo Clemente,
Giuseppe Alampi, Gianmarco Galliani, Anthony Biancardi, Gilberto Artioli, Luca Valentini,
and Maria Chiara Dalconi

SP-354-9:

Molecular Design of an Allylether PCE with Enhanced Clay Tolerance 99-112
Authors: Yue Zhang and Lei Lei

SP-354-10:

Study on the Structural Characteristics and Copolymerization Activity of Polyether
Macromonomers for Polycarboxylate Superplasticizer 113-124
Authors: Zhao Meili, Zhang Lin, Liu Xiao, and Wang Ziming

SP-354-11:

A Novel Polycarboxylate Superplasticizer Using Polyvinyl Alcohol as Side Chains:
Design, Synthesis and Characterization 125-142
Authors: Xiao Liu, Qifeng Luo, Ziming Wang, Chunlei Xia, Ming Zhao, Wu Zhou,
Mi Zhou, and Jianan Guan

SP-354-12:

Effect of Different Retarders and their Combination with Superplasticizer on the
Properties of CSA 143-156
Authors: A. Govin, G. Quintero, R. Belhadi, and P. Grosseau

SP-354-13:

Effect of Solution Chemistry on Superplasticizers in Alkali-Activated Slag..... 157-164
Authors: C. Paillard, N. Sanson, J.-B. d'Espinose de Lacaillerie, G. Ducouret,
P. Boustingorry, M. Jachiet, C. Giraudeau, and V. Kocaba.

SP-354-14:

Phosphated Superplasticizers as Effective Water Reducing Agent for a Calcium
Sulfate Hemihydrate Systems..... 165-176
Authors: My Linh Vo and Johann Plank

SP-354-15:

Impact of a Novel Slow Absorption Superabsorbent Polymer on Compressive Strength
and Autogenous Shrinkage of Concrete 177-186
Author: Yuya Akao

SP-354-16:

Self-Compacting Concrete for the Durable Reinforced Foundations of the Calatrava
Bridge in Venice 187-192
Authors: Mario Collepari, Silvia Collepari, Ettore Menegaldo, and Roberto Troli

SP-354-17:

Long Term Performance of Corrosion Inhibitors in Concrete..... 193-208
Authors: F. Bolzoni, A. Brenna, S. Beretta, M. V. Diamanti, M. Ormellese, and MP. Pedferri

SP-354-18:

Influence of the Hydroxypropylation of Starch on its Performance as Viscosity
Modifying Agent 209-218
Authors: Kun Zhang, Wolfram Schmidt, and Alexander Mezhev

SP-354-19:

The Effect of Alkanolamine Admixtures in the Hydration of Limestone Calcined
Clay Cements (LC³) 219-224
Authors: Franco Zunino and Karen L. Scrivener

SP-354-20:

PCEs Molecular Structure Formation for Gypsum and Cement-Gypsum Binders 225-232
Author: Anatoly I. Vovk

SP-354-21:

Feasibility Study on PCE Based Superplasticizers in Calcined Clay Blended Cements
with Focus on the Type of Phyllosilicate 233-246
Authors: Ricarda Sposito, Matthias Maier, Nancy Beuntner, and Karl-Christian Thienel

SP-354-22:

Combined Use of Calcium Nitrate and Fly Ash to Build ASR-Free Concrete Industrial Floors..... 247-254
Authors: Mario Collepardi, Jean Jacob Ogoumah Olagot, and Roberto Troli

SP-354-23:

The Effect of the Charge Density of a Comb Polyphosphate Superplasticizer on the
Structural Build-Up of Cement Paste 255-262
Authors: Alexander Mezhev, Wolfram Schmidt, Hang Zhang, and Charles E. Diesendruck

SP-354-24:

Thermal Stability of HPEG-Type Polycarboxylate Superplasticizers 263-272
Authors: Vyacheslav R. Falikman, Valery L. Ugolkov, Pavel N. Vasilyev,
and Ivan V. Bondarenko

SP-354-25:

Mixing Procedure Parameters Affecting Air Entrainment in Concrete..... 273-286
Authors: Marina Licht, Ida Ros, and Roberta Magarotto

SP-354-26:

Effect of Hydroxycarboxylate on the Hydration and Properties of High-Belite Calcium
Sulphoaluminate Cement..... 287-296
Authors: Ruifeng Tang, Ziming Wang, and Mingzhang Lan

SP-354-27:

Influence of HPEG-Based Polycarboxylate on the Flow Properties of Alkali-Activated Slag:
Sodium Hydroxide and Sodium Carbonate Activated Systems 297-308
Authors: Hsien-Keng Chan and Lei Lei

SP-354-28:

Research and Analysis of a Novel Waterproofing Agent with Strength Enhancing Ability..... 309-328
Authors: Yufeng Li, Serina Ng, Gan Wang, Lei Liu, and Long Wang

SP-354-29:

The MAXXI Building in Rome with the Long, Inclined and Curvilinear Reinforced Concrete
Walls after 18 Years from their Construction 329-338
Authors: Mario Collepardi, Silvia Collepardi, Giuseppe Marchese, and Roberto Troli

SP-354-30:

Mechanism Study on the Slow-Release Effects of Polycarboxylate Superplasticizers with Different Functional Groups in Cement Pastes 339-346
Authors: Sun Zhenping, Pang Min, Yang Haijing, Wu Lelin, Ge Haosheng, Shu Xuejun, Shu Doudou, Zhu Weigang, and Luo Qiong

SP-354-31:

Synthesis and Analysis of an Anti-Segregation Admixture Based on Acrylamide Copolymer 347-356
Authors: Tao Ni, Serina Ng, Zhaoyang Liu, Yongmei Wang, Xin Song, and Ke Fengi

SP-354-32:

Effect of Setting Regulator on the Properties of Cement Paste with Alkali-Free Liquid Accelerator 357-364
Authors: Yao Geng, Zhenping Sun, and Chao Chen

SP-354-33:

Use of Innovative Admixtures in Precast/Prestressed Concrete 365-378
Authors: Charles Nmai, Lesley S-C Ko, Thomas Vickers, Jeffrey Bury, and Suzanne Lianopoulos

SP-354-34:

Methylsiliconate as Set-Retarding Admixture 379-386
Authors: Kalina Materak and Marcin Koniorczyk

SP-354-35:

Nonionic Surfactants as Bubble Stabilizer in Concrete 387-394
Authors: Min Qiao, Guangcheng Shan, Jian Chen, Navnxiao Gao, and Qianping Ran

Experimental and theoretical investigation on the adsorbed layer thickness of PCE comb polymers

Johann Plank, Johannes Stecher, Constantin Tiemeyer

Synopsis: The dosage-dependent development of the adsorbed layer thickness (ALT) of two polycondensates (BNS, AFS), four polycarboxylates (23MPEG6, 45MPEG6, 52IPEG2, 52IPEG6) and one phosphate comb polymer (45MPEG-P3) was investigated via dynamic light scattering technique using cationic polystyrene nanoparticles as substrate. It was found that polycondensates develop very thin adsorbed layers [0.3 - 0.6 nm ($1.2 - 2.4 \times 10^{-8}$ in)] whereas PCEs produce layers of $\sim 2.5 - 8$ nm ($9.8 - 31 \times 10^{-8}$ in). These values are larger than those reported previously from AFM and XPS measurements, but correlate well with results from molecular dynamics simulations. For PCE molecules, the side chain length exercises the most significant effect on the adsorbed layer thickness while the grafting density has less impact. Furthermore, stronger anchor groups such as the phosphate copolymer produce more dense polymer layers and hence higher ALT values which explain their excellent dispersing effectiveness. Spread flow tests using cement paste revealed a relatively close relationship between paste fluidity and ALT.

Keywords: Polycarboxylate; Superplasticizer; Adsorption; Cement; Steric hindrance; Adsorbed conformation; Molecular dynamics (MD) simulation; Dynamic light scattering (DLS); Nanoparticles