CONCREEP-9@MIT

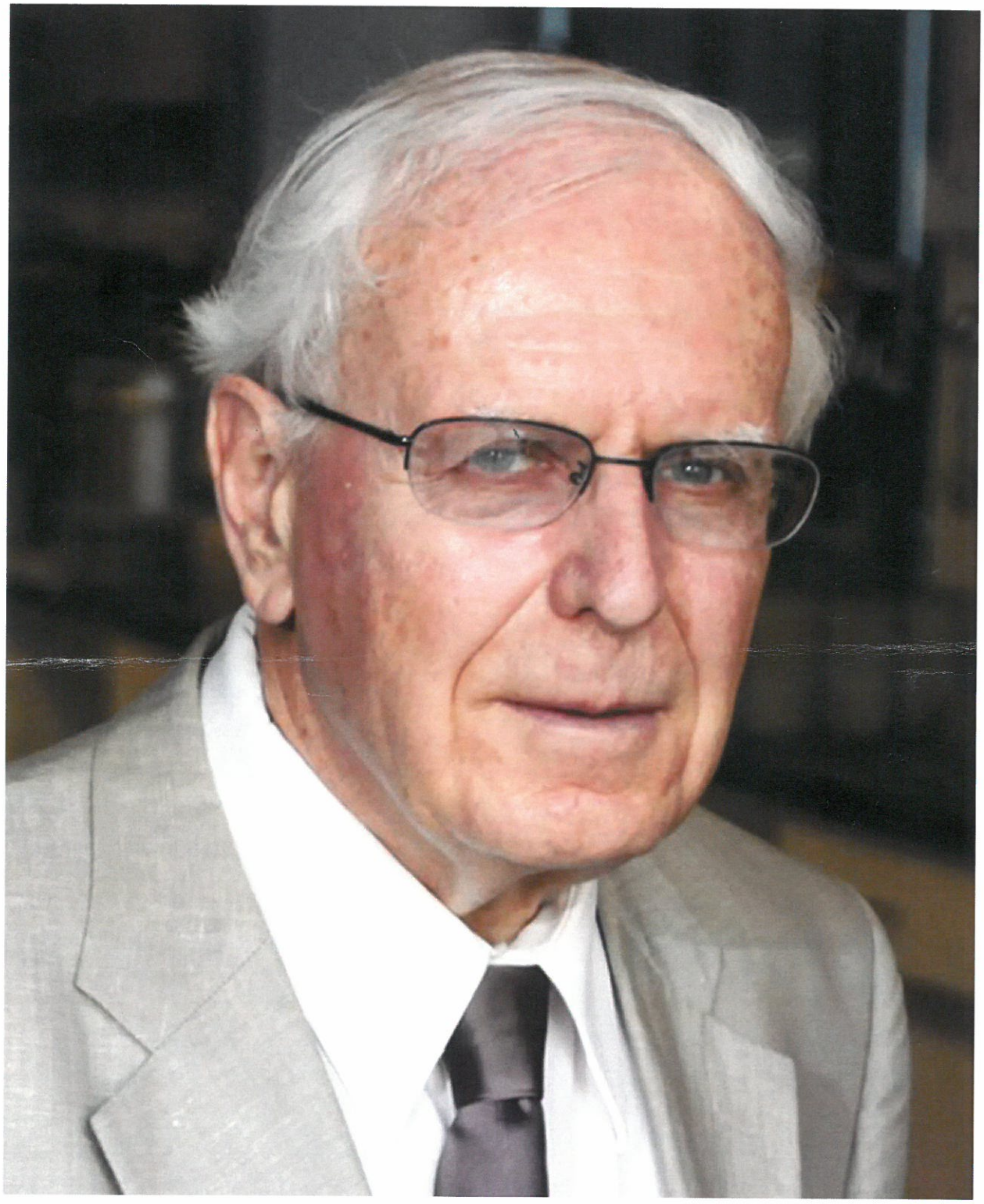
September 22-25, 2013
Organized under the auspices of Ia-Concreep
Hosted by the Concrete Sustainability Hub at MIT (CSHub@MIT),
with the support of the Groupement de Recherche International "Multi-scale Materials Under the Nanoscope (GDRI, M2UN)"
and the sponsorship of the Engineering Mechanics Institute (EMI),
American Society of Civil Engineers (ASCE).

Chaired by:
Franz-Josef Ulm, Hamlin M. Jennings, Roland Pellenq

A TRIBUTE TO ZDENEK P. BAZANT

PROGRAM

9th International Conference of Creep, Shrinkage and Durability Mechanics of Concrete and Concrete Structures. Massachusetts Institute of Technology, Cambridge MA 02139. September 22-25, 2013.



Dedicated to
Zdeněk P. Bažant
at the occasion of his 75th birthday.

MECHANICS AND PHYSICS OF CREEP, SHRINKAGE, AND DURABILITY OF CONCRETE

A Tribute to Zdeněk P. Bažant

PROCEEDINGS OF THE NINTH INTERNATIONAL CONFERENCE ON CREEP, SHRINKAGE, AND DURABILITY MECHANICS (CONCREEP-9)

September 22–25, 2013
Cambridge, Massachusetts

SPONSORED BY
IA-CONCREEP
Engineering Mechanics Institute of ASCE
American Concrete Institute
Concrete Sustainability Hub at MIT
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EDITED BY
Franz-Josef Ulm
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Preface

Concrete, the solid that forms at room temperature from mixing Portland cement with water, sand, and aggregates, is the backbone material of our society's legitimate need for housing, shelter, hospitals, energy, and transport. But concrete suffers from time-dependent deformation under load. This creep occurs at a rate that deteriorates the durability and truncates the lifespan of concrete structures. However, the fundamental causes of concrete creep are still an enigma and have deceived many decoding attempts from both experimental and theoretical sides. In the United States alone, concrete creep is partly responsible for an estimated 78.8 billion dollars required annually for highway and bridge maintenance. In some applications, concrete creep and shrinkage is considered a serious threat to longevity and safety of our built concrete infrastructure, including bridges, containment structures, oil and gas well cement seals, and so on.

The contributions assembled in this book all aim at contributing to dissecting the very physical origin of creep and shrinkage of concrete, and to propel this knowledge from the scale of a few atoms to the scale of day-to-day engineering applications. They comprise both the invited and contributed papers presented at the Ninth International Conference on Creep, Shrinkage, and Durability Mechanics (ConCreep-9@MIT), held at the Massachusetts Institute of Technology, Cambridge, MA, U.S.A., from September 22–25, 2013. Now in its 9th edition, ConCreep-9@MIT continues a highly successful conference series on Creep, Shrinkage, and Durability Mechanics of Concrete and other Quasi-Brittle Materials, that started more than a half a century ago in Munich (1958,1968), Leeds (1978), Evanston (1986), Barcelona (1993), Cambridge (2001), Nantes (2005), and Ise-Shima (2008).

Hosted by the Concrete Sustainability Hub at MIT (http://web.mit.edu/cshub/), ConCreep-9@MIT brings together scientists and engineers at the leading edge of research and implementation of innovation related to creep, shrinkage, and durability mechanics of concrete and concrete structures. While the main objective of Concreep-9@MIT remains true to the original objectives of this conference series, to review and discuss novel efforts in both research and engineering practice on physical origin, prediction, and structural effects of time-dependent deformation, we recognize that the development of the next generation of science-enabled engineering solutions requires an outreach to fields that have classically not been associated with the ConCreep community. Specifically, through the co-sponsorship of this conference by the Groupement de Recherche International Multi-scale Materials Under the Nanoscope (GDRI, M2UN), we extend the outreach to the community of soft matter scientists, glasses physicists, and computational materials scientists. The results of this synergy can be traced throughout this book, from molecular and mesoscale scale

simulations and measurements to loss of prestress assessment due to creep and shrinkage using the latest advances in engineering design creep models.

We dedicate this collective work of the state-of-the-art of the science and engineering of creep and shrinkage of concrete to Zdeněk P. Bažant, the McCormick Institute Professor, Walter P. Murphy Professor of Civil and Environmental Engineering, Mechanical Engineering and Material Science and Engineering at Northwestern University, Evanston, Illinois, at the occasion of his 75th birthday. Zdeněk P. Bažant epitomizes like no other the theme of this conference series at the cross-road of fundamental physics and engineering. A native of Prague, Zdeněk P. Bažant's first encounter with creep and shrinkage was during his early practice as a Structural Bridge Engineer in the early 1960s in the former communist Czechoslovakia, which culminated in his 1963 doctoral dissertation on creep effects in concrete structures (subsequently published as a book). His postdoctoral studies in Paris and Toronto, during the short-lived period of liberalization in communist Czechoslovakia that preceded the Prague Spring in 1968, brought him to the West and to the forefront of research on creep and shrinkage of concrete. It culminated in his early fundamental contribution to the surface thermodynamics of volume change, hindered adsorbed water and disjoining pressure, which laid the foundation for the modern theory of creep and shrinkage mechanisms and its application in constitutive modeling and engineering design codes. After more than 45 years, this topic continues to be focus of cutting edge research. In the fall of 1969, he joined the faculty at Northwestern University. For more than four decades, Zdeněk P. Bažant continues to shape and redefine the engineering sciences in civil and mechanical engineering in general and of creep, shrinkage, and fracture of concrete and other quasi-brittle materials in particular. He is member of the National Academy of Engineers and the National Academy of Sciences of the United States of America and the founding president of IA-Concreep, the international association organizing the ConCreep conference series.

As the future of sustainable concrete engineering solutions is at stake, we trust that the conference papers in the ConCreep-9@MIT Proceedings will significantly contribute to Concrete Science and Engineering in the 21st Century and be a permanent tribute to the groundbreaking work of a scientist and engineer, educator, mentor, and friend, Zdeněk P. Bažant.

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Roland Pellenq

Cambridge, MA, June 2013

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