Contents

Keynote Lectures

Progress in Creep and Shrinkage Prediction Engendered by Alarming Bridge Observations and Expansion of Laboratory Database .............................................. 1
Z. P. Bažant, M. H. Hubler, R. Wendner, and Q. Yu

Structure and Small Angle Scattering of Polydisperse Granular Porous Materials: A Fingerprint for Cement Paste ................................................................. 18
P. Levitz and S. Brisard

Nanoscale Numerical Study of C-S-H Precipitation and Gelation ........................................ 30
Emanuela Del Gado and Katerina Ioannidou

Bernhard Pichler, Christian Hellmich, Josef Eberhardsteiner, Jaromír Wasserbauer, Pipat Termkhajornkit, Rémi Barbarulo, and Gilles Chanvillard

Creep Properties of Cementitious Materials from Indentation Testing: Significance, Influence of Relative Humidity, and Analogy Between C-S-H and Soils .................................................................................................................... 48
M. Vandamme, Q. Zhang, F.-J. Ulm, R. Le Roy, B. Zuber, E. Gartner, and P. Termkhajornkit

A Depinning Model for Creep and Plasticity of Disordered Materials .................................. 62
David Bouttes and Damien Vandembroucq

Molecular and Meso-Scale Simulations and Characterization

NANO-CREEP of Synthetic CSH Produced using 1.5 and 0.7 CAO/SiO₂ Mixture Ratios ............................................................................................................................... 70
Michelle L. Begaye, Sherif H. Aboubakr, Jung J. Kim, and Mahmoud M. Reda Taha

Applying Tools from Glass Science to Study Calcium-Silicate- Hydrates .......................... 78
MJ. Abdolhosseini Qomi, M. Bauchy, R. J-M. Pellenq, and F-J. Ulm

Mechanical Behaviour of Ordered and Disordered Calcium Silicate Hydrates under Shear Strain Studied by Atomic Scale Simulations ...................................................................... 86
H. Manzano, E. Masoero, I. Lopez-Arbeloa, and H. M. Jennings

Hydrothermal and Mechanical Stability of Metal-Organic Frameworks .................................. 98
François-Xavier Coudert, Aurélie Ortiz, Marta De Toni, Anne Boutin, and Alain H. Fuchs

NMR Investigations of Water Retention Mechanism by Cellulose Ethers in Cement-Based Materials ...................................................................................................................... 102
J.-P. Korb, L. Patural, A. Govin, and Ph. Grosseau
Water Sorption Hysteresis in Cement Nano Slits .......................................................... 110
Wen Hui Duan, Shu Jian Chen, and Mija Hubler

Interpretation of Full Sorption-Desorption Isotherms as a Tool for Understanding
Concrete Pore Structure ........................................................................................................ 118
Matthew B. Pinson, Hamlin M. Jennings, and Martin Z. Bazant

Multi-scale Hydric Transport in Hardened Cement Pastes and Reference Porous
Silicate Materials .................................................................................................................. 126
H. Chemmi, V. Tariel, D. Petit, J-P. Korb, R. Denoyel, and P. Levitz

Water Isotherms, Shrinkage and Creep of Cement Paste: Hypotheses, Models and
Experiments ............................................................................................................................ 134
Hamlin M. Jennings, Enrico Masoero, Matthew B. Pinson, Elena
G. Strekalova, Patrick A. Bonnaud, Hegoi Manzano, Q. Ji, Jeffrey J. Thomas,
Roland J.-M. Pellenq, Franz-Josef Ulm, Martin Z. Bazant, and Krystyn
J. Van Vliet

Diffusion Properties of Sodium and Lithium Silicates through Cement Pastes and
its Mitigating Effect on Alkali-silica Reaction ................................................................. 142
Irfan Prasetia, Soyo Asano, and Kazuyuki Torii

New Experimental Approach to Study Creep and Shrinkage Mechanisms of
Concrete on the Nano-scale Level ....................................................................................... 150
Harald S. Müller, Joerg-Detlef Eckhardt, and Michael Haist

Infinitesimal Shrinkage as Determined by Inverse Analysis Based on Drying and
Shrinkage Tests ...................................................................................................................... 158
B. Villmann, V. Slowik, F. Wang, and F. H. Wittmann

Kinetic Simulation of the Logarithmic Creep of Cement ................................................. 166
E. Masoero, H. Manzano, E. Del Gado, R. J.-M. Pellenq, F.-J. Ulm, and
S. Yip

Recent Developments in Durability Mesomechanics of Concrete, Including
Cracking via Interface Elements ......................................................................................... 174
Joaquin Liaudat, Mariana Rodriguez, Carlos Lopez, and Ignacio Carol

Finite Element Based Characterization of the Creep Properties of the Cement
Paste Phases by Coupling Nanoindentation Technique and SEM-EDS ......................... 182
L. Sorelli, D.-T. Pham, D. Vallée, J. Chen, and M. Fafard

In-situ Chemo-Mechanical Characterization of Cementitious Microstructures
with Coupled X-Ray Microanalysis and Indentation Technique ..................................... 190
Konrad J. Krakowiak, William Wilson, Simon James, and Franz.-J. Ulm

Micromechanics of Creep and Shrinkage

Efficient Homogenization of Ageing Creep of Random Media: Application to
Solidifying Cementitious Materials .................................................................................... 201
J. Sanahuja

Multi-scales Characterization of the Early-age Creep of Concrete ................................ 211
M. Farah, F. Grondin, M. Matallah, A. Loukili, and J. Saliba

Coupled Damage and Multiscale Creep Model Applied to Cementitious Materials .... 219
B. Bary, Q.-C. He, and M.-Q. Thai
Micromechanical Model of Concrete Creep ........................................ 227
Lev Khazanovich and Kairat Tuleubekov

Experimental Analysis of Drying Shrinkage Cracking in Coating Mortars by
Digital Image Correlation ............................................................... 235
F. Benboudjema, T. Maouroux, P. Turcry, A. Ait-Mokhtar, and O. Deves

Numerical Analysis of Cracking Induced by Drying Shrinkage in Concrete using a
Mesoscopic Approach: Influence of Aggregates Restraint and Skin Effect .......... 243
M. Briffaut and F. Benboudjema

Delayed Strains of Cementitious Materials – Impact of Heterogeneities and Creep
on Cracking Induced by Drying .................................................... 251
C. De Sa, C. Benboudjema, and A. Michou

Influence of the Initial Water Saturation of Aggregates on Concrete Shrinkage .... 261
E. Roziere, R. Cortas, A. Loukili, A. Hamami, and S. Staquet

Multiscale Creep, Shrinkage, Fracture and Durability Properties

Freeze-Thaw Resistance of Fiber Reinforced Composites with Superhydrophobic
Admixtures .......................................................... 269
Scott Muzenski, Ismael Flores-Vivian, and Konstantin Sobolev

Experimental Study on Effect of Internal Cracking on Corrosion Rate of
Reinforcement in Concrete ......................................................... 277
Isao Ujike, Shinichiro Okazaki, and Ryoichi Sato

Mechanical Properties of Deteriorated Hardened Cement Paste ................ 285
K. Kurumisawa, H. Owada, and M. Shibata

Microstructure Improvement of Cementitious Systems using Nanomaterials: A
Key for Enhancing the Durability of Concrete .................................. 293

The use of Superabsorbent Polymers to Mitigate Shrinkage of Concrete .......... 301
A. Assmann and H.W. Reinhardt

Measuring the Chemical Shrinkage of Alkali-Activated Slag Cements Using the
Buoyancy Method .................................................................... 308
Christopher P. Cartwright, Farshad Rajabipour, and Aleksandra Radlińska

An Apparatus for Dissecting Volumetric Changes in Hydrating Cement Paste .... 316
M. Abuhaikal, S. Musso, J. Thomas, and F.-J. Ulm

Effectiveness of Various Superabsorbent Polymers (SAP) in Mitigating
Autogenous Shrinkage of Cement-based Materials ................................ 324
V. Mechtemerine, C. Schroefl, and M. Gorges

Macrorack Propagation in a Concrete Specimen Subjected to a Sustained
Loading: Influence of Tensile Creep ............................................ 332
Pierre Rossi and Jean-Louis Tailhan

Experimental Research and Numerical Simulation of Post-Crack Creep Behavior
of SFRC Loaded in Tension ......................................................... 340
Guanyu Zhao, Marco di Prisco, and Lucie Vandewalle
Analysis of Concrete Creep in Compression, Tension and Bending: Numerical Modeling ................................................................. 348
A. Hilaire, F. Benboudjema, A. Darquennes, Y. Berthaud, and G. Nahas

Improvement of Crack Resistance of Slag Concrete by Utilizing High Alite Cement ................................................................. 356
Huynh Phuong Nam and Akira Hosoda

Experimental Determination of Early Age Fracture Toughness and Fracture Process Zone Size in Cement Pastes ................................. 364
C. Hoover

The Significance of Nanosilica on Degradation of Oil Well Cement in Carbonated Brine Environments .............................................. 372
Andrew S. Griffin, Muhammad K. Rahman, Jung J. Kim, and Mahmoud Reda Taha

Optimization of Anti-creep Admixtures for Plasterboards .................................................. 380
J. Colombani and M. Bellotto

Role of Recycled Concrete Aggregates on the Long-term Behavior of Structural Concrete ..................................................................... 388
C. Mazzotti, S. Manzi, and M.C. Bignozzi

Effects of Poly Vinyl Alcohol Fibers in Fracture Energy of Concrete ........................................ 396
H. R. Ahmadian and M. Ganji

From Material Creep and Shrinkage to Structural Design

Desiccation Shrinkage of Large Structures: Is there a Size Effect? ........................................... 404
J. M. Torrenti and F. Benboudjema

Development of Comprehensive Platform for the Estimation of Volume Change and Damage in Cementitious Material .................... 412
T. Tanabe, S. Ono, H. Morimoto, H. Nakamura, and Y. Ishikawa

Simulation of Time-dependent Tensile Behavior of Concrete under Various Loading and Drying Path ............................................. 421
T. Shimomura, Y. Aoki, and H. Obata

The B4 Model for Multi-decade Creep and Shrinkage Prediction .......................................... 429
R. Wendner, M. H. Hubler, and Z. P. Bažant

Improved Estimation of Long-Term Relaxation Function of Aging Concrete from Its Compliance Function ........................................ 437
Z. P. Bažant, M. H. Hubler, and M. Jirásek

Overall Stiffness Reduction of Cracked Reinforced Concrete Beams Due to Long Term Effects ........................................................................ 443
Arnaud Castel, Raymond Ian Gilbert, and Gianluca Ranzi

An Effective Flexural Stiffness Equation for Long Term Deflection of Prestressed Concrete with and without Cracks ............................ 451
R. Sato, K. Nakarai, Y. Ogawa, and K. Kawai
Viscoplastic Constitutive Relation for Relaxation of Prestressing Steel at Varying Strain and Temperature .................................................. 459
Qiang Yu and Zdeněk P. Bažant

Material Law on the Time-dependent Stress-strain Behavior of Young Concretes ...... 467
Isabel Anders and Harald S. Müller

Inverse Estimation of Thermal Properties of Concrete During Hydrating Process ..... 475
Osvaldo D. Quintana, Antonio Aquino, Rubén López, Jean Marie Désir, and Eduardo M. B. Campello

Effect of Heat Elimination by Pipe Cooling System for Temperature Rise with Heat of Cement Hydration in Beam Using High Strength Engineered Cementitious Composites ...................................................... 483
T. Mizobuchi, T. Kanda, and M. Kunieda

Development of FEM Thermal Analysis for Concrete Structures with Pipe Cooling System .................................................................................................................. 491
Yasuaki Ishikawa, Toshiaki Mizobuchi, and Tada-aki Tanabe