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Proceedings of the 7th RILEM Workshop on High Performance Fiber Reinforced Cement Composites

Edited by H.W. Reinhardt
G.J. Parra-Montesinos
and H. Garrecht

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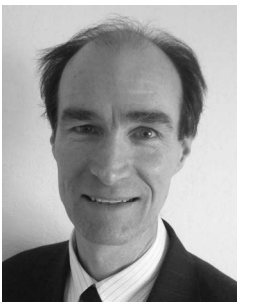
Dedication

The Seventh International RILEM Conference on High Performance Fiber Reinforced Cement Composites (HPFRCC7) and its proceedings are dedicated to three outstanding members of our international community who have made significant and lasting contributions to broaden the safe application of fiber reinforced cement and concrete composites through fundamental understanding, testing, analysis, modeling and design.

John E. Bolander



John E. Bolander (born July 1, 1958) is a professor within the Department of Civil and Environmental Engineering at the University of California, Davis. He received his Ph.D. degree in civil engineering from the University of Michigan, Ann Arbor, in 1989. He belonged to the faculty of engineering at Kyushu University, Japan, for five years prior to arriving at UC Davis in 1994. He received the Outstanding Faculty Teaching Award from the College of Engineering in 2006.

Bolander has served as the Chief Editor of the international journal Cement and Concrete Composites for the period of 2006-2012. He received fellowship awards for computational mechanics research from the Japan Society for the Promotion of Science in 1997 and 2008. Bolander's research and teaching interests involve the effective use of high-performance materials within the civil infrastructure, with emphasis on the life-cycle performance of concrete materials and structures. Over the past two decades, he has been a pioneering developer of discrete methods for the modeling fiber reinforced cement composites.

Professor John E. Bolander is being honored for his outstanding contributions to the development of modeling tools for fiber reinforced cement composites, which have provided new insights into fibre-matrix interaction and its effect on composite behavior.

Wolfgang Brameshuber

Professor Wolfgang Brameshuber was born on August 2, 1956 in Mannheim, Germany. From 1975 – 1981, he studied civil engineering at the University of Technology Karlsruhe. Following first-part finals, more detailed study of structural engineering followed, specialising in concrete structures. In February 1988, he received his degree of doctor of engineering at the faculty of Civil Engineering of University of Karlsruhe.

After that he worked at BUNG consultant in Heidelberg, Germany, for three years. He was building materials consultant for planning and execution of building projects and was responsible for supervision of construction work and the development of the department for building maintenance. From 1991 until end of 1998 he was head of the central laboratory for building materials and building maintenance at Bilfinger Berger AG in Mannheim. Since January 1999 he has been the chair of Institute of Building Materials Science at RWTH Aachen University with a period as dean of the Faculty of Civil Engineering for 2 years.

Professor Brameshuber has been part of many expert groups e.g. RILEM (Réunion Internationale des Laboratoires et Experts des Materiaux, Systèmes de Constructions et Ouvrages) where he is the delegate for Germany and member of the Bureau, CEN (Comité Européen de la Normalisation), DIBt (Expert Groups of German Institute of Building Technology), DIN NABau (German Institute for Standardization), DBV (German Society for Concrete and Construction Technology) and the German Federal Associations of Ready-mix Concrete. In 2001 he received the STUVA Award (Award of the Research Association for Underground Transportation Facilities).

His research priorities are special concretes including high-performance concrete, self-compacting concrete and textile reinforced concrete (TRC), environmental impact of building materials, constitutive models for concrete, modelling of damage processes in concrete (micro-level structural model), durability of concrete (additives, frost, sulfate), carrying capacity and durability of masonry. He was one of the leading researchers in the Sonderforschungsbereich 532 (Special research initiative of DFG). Wolfgang Brameshuber is an international consultant for concrete technology and holds two technical patents.

He has authored or co-authored more than 300 publications and delivered more than 200 presentations worldwide.

Professor Brameshuber is being honored for his numerous contributions to the development of textile reinforced concrete and hybrid HPFRCC with textiles and fibres, especially the composition and rheology of these special concretes, as well as the introduction of TRC in practice.

Pierre Rossi

Dr. Pierre Rossi was born in Paris, France, in 1956. He started his scientific education by receiving a physics master's degree from the University of Picardie Jules Verne, France, in 1980. He then obtained a second master's degree in Mechanics of Materials from the University of Technology of Compiègne, France, in 1982. In 1986, he completed his PhD degree on the application of linear fracture mechanics to concrete, reinforced concrete and fibre reinforced concrete structures at the École Nationale des Ponts et Chaussées (ENPC). In 1990, he completed his habilitation degree (HDR) allowing him to conduct research and pursue a career as a university professor.

In 1983, he joined the Laboratoire Central des Ponts et Chaussées (LCPC – today known as IFSTTAR) in Paris as a scientist. His current research interests include the analysis of cracking in concrete structures subjected to quasi-static and dynamic loadings, nonlinear finite element modelling, normal and ultra-high performance fibre reinforced concrete, and the time-dependant behaviour of concrete. He is the author or co-author of more than 80 scientific studies published in international journals, and one book on concrete reinforced with steel fibers (1998, Presses de L'Ecole Nationale des Ponts et Chaussees). He is also holder of three patents, and has been the main instigator and chairman of the BEFIB and SSCS international conferences. He has been active in numerous international scientific, technical and standardization committees, in addition to being a reviewer for several international journals. He is also a member of the editorial board of the Fib International journal, Structural Concrete. Finally, he was the technical director of a French national project on industrial applications of steel fibre reinforced concrete between 1996 and 2000.

Dr. Pierre Rossi was awarded the international Robert L'Hermite medal from the RILEM in 1996, the French Civil Engineering Association medal from the Association française de génie civil (AFGC) in 2001, and the Chevalier National de l'Ordre du Mérite medal from the government of France in 2005 for his contributions to civil engineering research.

Dr. Rossi is being honored for his long-lasting contributions to the development of HPFRCC by experiments, material models and numerical computations. He has published pioneering ideas to the understanding of creep and shrinkage of concrete.

Preface

HPFRCC7 will be the seventh workshop in a series dealing with High Performance Fiber Reinforced Cement Composites (HPFRCC). The six prior workshops have led to a definition of HPFRCC that mostly suggests a technical challenge. That is, composites that exhibit a strain hardening tensile stress-strain response accompanied by multiple cracking (and relatively large energy absorption capacity). Besides this mechanics related definition there are other features which make a cement composite "high performing" like workability, durability and robustness. Researchers have tried to reduce fiber content to a necessary minimum. By reducing fiber content, they are simplifying the production process, helping make standard mixing procedures acceptable, and opening the way to large-scale practical applications.

The first international workshop on High Performance Fiber Reinforced Cement Composites took place in June 1991 in Mainz, Germany, under the auspices of RILEM and ACI. It was funded in part by the US National Science Foundation (NSF) and the Deutsche Forschungsgemeinschaft (the German NSF). Other co-sponsors included the center for Advanced Cement Based Materials (ACBM), the University of Michigan, and the University of Stuttgart. The second workshop took place in Ann Arbor, Michigan, in June 1995, the third in Mainz Germany, in June 1999, the fourth in Ann Arbor, Michigan, in June 2003, and the fifth in Mainz, Germany, in July 2007, the sixth in Ann Arbor, Michigan, in June 2011, all supported by the same sponsors. In each case hard-cover proceedings were published as a special RILEM publication. While the first workshop in 1991 included mostly US and German participants, subsequent workshops were opened to top researchers in the field from other countries. The last workshop in Ann Arbor 2011 assembled researchers from 20 countries. The proceedings included 66 papers grouped in 7 different sections.

Since the first workshop in 1991, continuous developments have taken place in new materials, processing, standardization, and improved products for building and other structures. Also, enhanced theory and modeling techniques for HPFRCC now allow a better description of their behavior and reinforcing mechanisms. While in the first workshop HPFRCC implied relatively high fiber volume fractions (over 4%), today HPFRCC can be designed with as little as 1% fiber volume content. While the root definition of HPFRCC is simplest (that is, fiber cement composites with strain hardening and multiple cracking behavior in tension) to clearly differentiate them from other cement composites, this is not the only description of desirable performance. Durability, fire resistance, impact resistance, diffusion resistance, imperviousness, and constructability at reasonable cost are other important attributes that need to be further investigated.

In each workshop, a broad range of technical issues, ranging from microstructure characterization to design recommendations, are typically covered; however, some selected themes are emphasized. In this seventh workshop, the organizers identified the following themes for which research information is needed:

- Production of TRC and HPFRCC
- Composite properties in the fresh and hardened states
- Testing methods
- Structural elements: design, detailing, bending, shear, tension stiffening
- Impact, cyclic and seismic loading
- Structural applications
- Durability and sustainability.

Papers addressing these themes are grouped in seven separate sections of the proceedings.

The organizers hope that this new volume will help foster the continuous development and increasing utilization of HPFRCC in both stand-alone and structural applications.

H.W. Reinhardt
G.J. Parra-Montesinos
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HPFRCC7 – Workshop

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H.W. Reinhardt
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H. Garrecht

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