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High Performance Fiber Reinforced Cement Composites 6

HPFRCC 6



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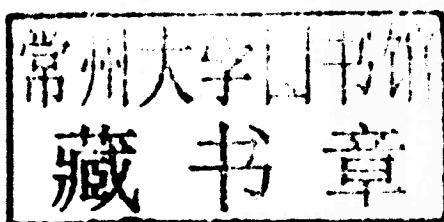
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A.E. Naaman

Editors

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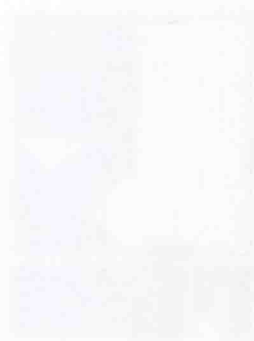
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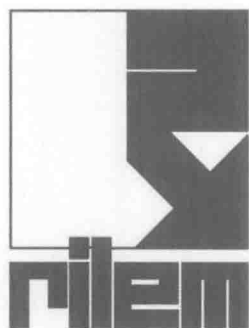
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High Performance Fiber Reinforced Cement Composites 6



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Dedication

The Sixth International RILEM Conference on High Performance Fiber Reinforced Cement Composites (HPFRCC6) 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.

Andrzej M. Brandt

Professor Andrzej Marek Brandt was born on November 15, 1930 in Bydgoszcz, Poland. He graduated from the Warsaw University of Technology, Faculty of Civil Engineering, in 1955, then joined the Institute of Fundamental Technological Research (IFTR) of the Polish Academy of Sciences in Warsaw, where he has been employed ever since. In 1958-1959, he completed advanced studies at the Centre de Hautes Etudes de la Construction in Paris, France. Professor Brandt holds two doctoral degrees, one in 1962, and one, a DSc, in 1967, both from IFTR. He was promoted Associate Professor in 1967 and Full Professor in 1979. His positions included Chairman of the Committee for Civil Engineering of the Polish Academy of Sciences, and Head of the Section on Strain Fields.



Professor Brandt's main interests have been focused on structural mechanics and bridge design, optimization of structures and materials, strain measurements and analysis, fracture mechanics and mechanics of brittle matrix composites. He is the author or co-author of more than 100 technical papers and 20 books among them a classic titled "Cement Based Composites - Materials, Mechanical Properties and Performance" published in 2009. He has been the main instigator and co-organizer of the continuous series of International Symposia on Brittle Matrix Composites (BMC) in Poland since 1985, a topic that encompasses fiber reinforced cement and concrete composites.

Professor Brandt received an Honorary Doctorate from the University of Paisley, Scotland, in 1997. He was a Visiting Professor at University of Poitiers in France, Delft University of Technology in The Netherlands, Koriyama and Tohoku Universities in Japan, and Drexel and North Carolina State Universities in the USA.

Professor Brandt has been active on numerous scientific committees and technical organizations in Poland and abroad, among them, the Polish Standardization Committee, the Euro-International Concrete Committee (CEB), the International Organization for Standardization (ISO), the American Concrete Institute (ACI) and RILEM. He also served as member of the editorial board of a number of national and international journals.

Professor Brandt is being honored for his contributions to the in-depth understanding of the mechanics of brittle matrix composites and optimization of their properties including high performance fiber reinforced cement composites.

Wei Sun

As a distinguished scholar, Professor Wei Sun has been engaged in teaching and scientific research at Southeast University, China, since her graduation from Nanjing Institute of Technology (previous name of Southeast University) in 1958. During her 53 years of teaching and research, she has supervised more than 60 master students and over 40 doctoral students. Professor Sun is currently director of the institute of fiber reinforced concrete and also director of the Jiangsu Key laboratory for Construction Materials. During her career she also was Head of the Department of Materials Science and Engineering, Southeast University, and deputy editor-in-chief of "Journal of the Chinese Ceramic Society". Due to her significant contributions to the theory and application of cementitious composites (including preparation, mechanical behavior, microstructure and modeling of ultra high performance fiber reinforced cementitious composites; service life prediction under the coupled action of load and environmental factors), she was selected to be a member of the Chinese Academy of Engineering in 2005. Together with over 20 of her team members, Professor Sun is still very active in research and teaching. With her team, she has successfully carried out over 50 important national or international projects and co-authored more than 400 technical publications.



Professor Sun is being honored for her long-term and numerous contributions to the investigation of HPFRCC materials, specifically their physical, mechanical, and impact properties, as well as their durability modeling.

Pietro G. Gambarova

Pietro G. Gambarova was born in Milan, on September 1st, 1941. He received his MS Degree in Aeronautical Engineering in March 1966 from the Politecnico di Milano. After two periods spent as an officer in the Corps of Engineers of the Italian Air Force (1966-67 and 1971), he joined the Department of Structural Engineering at the Politecnico di Milano, where he held the position of Assistant Professor from 1968 to 1974, Associate Professor from 1975 to 1980, and Full Professor since 1980. He teaches courses on Structural Analysis and Design, Reinforced Concrete Plates and Shells, and Fire Safety of Materials and Structures. He has been visiting professor (1976) at the National Somali University in Mogadisho, visiting scholar (1978 and 1982) at Northwestern University (Evanston, USA) and at EPFL-Ecole Polytechnique Fédérale de Lausanne (2006).



Pietro Gambarova has conducted research on non-destructive analysis of structures and materials, shear and punching shear in R/C, bond mechanics in R/C, high-performance and fiber-reinforced concrete, non-linear analysis of R/C structures, and lately high-temperature degradation of high-performance concrete and R/C structures. He is the author or coauthor of two books on structural analysis and R/C plates, and of more than 180 technical papers. In 2009, he coauthored the translation into Italian of the book "Structural Design for Fire Safety" by Andy Buchanan.

Pietro Gambarova is an active member of several Italian and international technical committees. He chaired the subcommittee for the preparation of the introductory chapter of fib Bulletin No.10 "Bond of Reinforcement in Concrete" (August 2000). He co-organized the workshop "Fire Design of Concrete Structures: What now? What next?" (Milan, December 2004) and the International Conference FraMCoS-6 (Catania, Italy, June 2007). He is one of the authors of fib Bulletin No.46 "Fire Design of Concrete Structures: Structural Behavior and Assessment" (2008).

Professor Gambarova is being honored for his outstanding contributions to the identification of the physical mechanisms that govern the behavior of high performance and fiber reinforced concrete subjected to high temperature, including fire.

Preface

HPFRCC6 will be the sixth workshop in a series dealing with High Performance Fiber Reinforced Cement Composites (HPFRCC). The five 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). 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, 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 Mainz 2007 assembled researchers from 22 countries. The proceedings included 56 papers grouped in 6 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 sixth workshop, the organizers identified the following themes for which research information is needed:

- Composite properties in the fresh and hardened states
- bond and pull-out mechanisms
- durability
- structural elements: design, detailing, shear, tension stiffening
- impact, cyclic and seismic loading
- ultra high performance fiber reinforced concrete
- textile reinforced concrete and hybrid composites.

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.

G.J. Parra-Montesinos
H.W. Reinhardt
A.E. Naaman

HPFRCC6 - Workshop

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The organizers would like to thank all members of the Scientific and International Committees for enthusiastically supporting the organization of this sixth workshop, and all the authors who have contributed with the valuable papers that make these proceedings. Special thanks are due to Ms. Simone Stumpp for preparing with great care and efficiency the camera-ready material for printing. Once more, H.W. Reinhardt and A.E. Naaman would like to express their deep gratitude to the Alexander von Humboldt Foundation for giving them the opportunity to initiate, in 1990, a long-term continually productive cooperation.

G.J. Parra-Montesinos
H.W. Reinhardt
A.E. Naaman

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