

Off-White Biosilica from Rice Hulls– A Renewable and Low-Carbon Supplementary Cementitious Material for Concrete Industry

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Supplementary Cementitious Materials (SCMs) are an integral part of modern-day concrete formulations. While SCMs have historically been used in concrete to achieve different objectives such as improving the fresh and hardened properties of concrete and lowering the economic impact, there is a growing realization that SCMs can play a vital role in lowering the carbon footprint of concrete. The shortage of traditional SCMs such as fly ash is increasingly being felt as the fossil-fuel based power plants are being replaced by renewable and nuclear energy plants. As a result, there is a need to develop sustainable sources of SCMs for concrete industry. Mineral ash residues from selected agricultural by-products can be processed to produce potentially pozzolanic materials. Biosilica is a pozzolanic material obtained from controlled combustion of rice hulls from the paddy crop, a widely grown and consumed source of food across the world. Depending on the amount of carbon content and the amorphous silica content, Biosilica is produced in four different compositions and primarily identified by their color - black, grey, off-white, and white. The off-white Biosilica with less than 5% amorphous carbon and greater than 92% amorphous silica is suitable for use as an SCM in conventional Portland cement concrete, whereas white Biosilica with zero percent carbon content and predominantly amorphous silica is more appropriate as an SCM for architectural concrete applications where white cement is typically used.

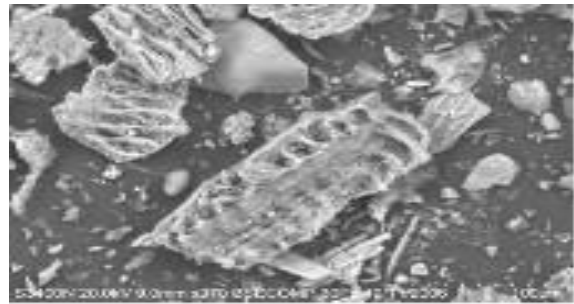


Figure 1. Cellular Structure of Rice Hull Ash

Past work on rice hulls had typically yielded ash residues that had high-carbon content (high LOI), typically graphitic carbon, making this material undesirable for its use as an SCM due to its high water-demand, difficulty in entraining air in concrete, among others negative attributes.

Off-white Biosilica, a form of rice hull ash, is carefully processed to remove carbon content of hulls is produced to not only have superior characteristics of an effective pozzolan, but also with minimal amounts of residual carbon in the material, making it an SCM with highly desirable properties. Off-white Biosilica contains highly amorphous material with high silica content and a high specific surface area, provided the rice hulls are properly processed, making it an effective pozzolan.

Off-white Biosilica, being a material produced from a short-carbon cycle, i.e., the carbon uptake into the plant and release from the rice hulls in a few months, its production has very little carbon footprint, and is a renewable material with little impact on the environment and the natural resources. Therefore, the use of off-white Biosilica as an SCM in concrete can make a significant impact on lowering the carbon-footprint of concrete. This presentation will elaborate on the production and performance of off-white Biosilica as an SCM and its role in reducing the carbon footprint of concrete.

Keywords: Rice Hull Ash, Supplementary Cementitious Materials, Low-Carbon Material, Pozzolan, Amorphous SiO₂, Amorphous Carbon

Biography: Dr. Prasad Rangaraju is a Professor at the Glenn Department of Civil Engineering in Clemson University. He received his Ph.D. from Purdue University in Civil Engineering. He is a Registered Professional Engineer and a Fellow of American Concrete Institute and a member of ASTM. His research interests include Material Science and Engineering of Cementitious and Supplementary Cementitious Materials, Aggregates and Concrete, Microscopy of Cement based Composites, Repair Materials, Durability of Cementitious Systems, and Design, Construction and Rehabilitation of Concrete Pavements. Dr. Rangaraju is the Director of Sustainable Materials Research and Technology (SMART) Lab at Clemson University, with a mission to develop and promote sustainable technologies related to the production and use of green construction materials and practices.