VIDEO ARTICLE

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Multiphase Transport Processes of the Near-surface Concrete under Combined Carbonation-Chloride Exposures

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Abstract

In numerous service environments for concrete structures, there is a high probability for the occurrence of cyclic exposures to chloride ingress and carbonation. The design of reinforced concrete structures by considering single exposure environment may or may not be suitable for the cyclic exposure conditions. Therefore, the objective of this paper is to present results of a detailed investigation on the carbonation and chloride ingress under typical individual and combined exposures. The effect of the exposures was investigated by comparing the air permeability, chloride profiles as well as the consumption of hydroxyl ions (OH^-). The latter was used to assess the change in concrete alkalinity during the different exposures.

The results indicated that when chloride contaminated concrete is exposed to carbonation, both the peak value of the chloride content and the extent (depth of penetration) of the redistribution of chlorides were related to the degree of carbonation and the type of binder. Similarly, when carbonated concretes were exposed to chlorides, there was the increased penetration of chlorides much deeper into the concrete, due to the possible presence of carbonation induced microcracking in the near-surface region. There existed complex interactions between carbonation profile and chloride profile for the combined exposure regimes, and these depended on the type of binder and the exposure combinations. It is recommended that these effects are taken into service life models for improving the service life prediction of concrete structures exposed to combined exposures to chlorides and carbonation. Further, it was found that the resistance alone is not sensitive enough to assess both the carbonation process and the chloride ingress in concretes exposed to combined exposure regimes.

Keywords: Air permeability, carbonation, chloride profile, chloride ingress, pH Profile, concrete alkalinity, combined exposures.

Biography of Presenting Author

Muhammed Basheer, Chair in Structural Engineering at University of Leeds, Leeds, United Kingdom, has been an educationalist and researcher in the field of civil (structural) engineering for more than 30 years. He has been a lecturer on analysis, design and durability of concrete structures at UG and PG levels and his research interests are primarily on the Science, Technology and Performance of Structural Materials, including non-destructive evaluation and structural health monitoring. Since graduating from the University of Kerala in 1981, Prof. Basheer worked in construction industry/government departments for a period of two years and then he joined Calicut Regional Engineering College (now known as National Institute of Technology), Kerala, India, as a lecturer. He took his masters degree in structural engineering from University of Calicut in 1986. From 1987 to 2014, he was at Queen's University Belfast, U.K. as a PhD student, post-doctoral research fellow (1990-'92), lecturer (1993-'96), senior lecturer (1996-'98), reader (1998-'99) and professor of structural materials (1999-2014). In September 2014, he jointed University of Leeds to take up the prestigious chair in structural engineering.

He has been an external examiner for candidates for the degree of DSc in Heriot-Watt University Edinburgh and University of Liverpool, PhD in Heriot-Watt University Edinburgh, Aston University Birmingham, Leeds University, University of Liverpool, University of Cardiff, Indian Institute of Technology Madras, Imperial College London, University of Loughborough, National Institute of Technology Calicut, India, National Institute of Technology Suratkal, India, University fo Nantes, France and Monash University, Australia. He is a member of the Engineering and Physical Sciences Research Council College and an assessor for the Technology Strategy Board and European Commission FP7 NMP programme. He is also an assessor for grant applications in USA, Finland, Poland, and Saudi Arabia.

Prof. Basheer is a member of the Concrete Society, U.K., RILEM and American Concrete Institute. He is a Member of the following Technical Committees: ACI 130, 211, 235, 236 and 365 and RILEM TC-ITZ, TC-IDC, TC-TMC, TC-NEC, TC-CTC and TC-PSC. Within the European Union, he was a member of COST Actions 509, 521, 530 and 534, and he is currently a member of COST Action TU1404, all dealing with materials used in Civil Engineering. He is an elected Fellow of the Institution of Civil Engineers since 2003, the American Concrete Institute since 2005, the Irish Academy of Engineering since February 2012, Royal Academy of Engineering since November 2014, Institute of Concrete Technology since March 2015 and Institution of Structural Engineers since 2015. He was also a member of the UK Research Excellence Framework sub-panel B-14 on Civil Engineering and Construction.

He is an editor of the international journal of Construction and Building Materials from January 2012 and was an associate editor of the International Journal of Civil Structural Health Monitoring from 2012 to 2015. He is a member of the editorial board of the International journal of Structural Engineering (IJStructE) since 2009. He has been a reviewer for more than 20 other international journals, which include ACI Journal of Structural Materials, ASCE Journal of Materials, ACI Concrete International, RILEM journal of Materials and Structures, Journal of Cement and Concrete Research, Journal of Cement and Concrete Composites and Journal of Measurements. He has been

a member of organising committee, scientific committee and paper review panels of 18 international conferences, including those of the CANMET/ACI conferences on Durability of Concrete.

Prof Basheer's research work includes the development of new test techniques for measuring transport properties of concrete, assessment of the effect of new materials and methods for improving the durability of concrete, prediction of service life of reinforced concrete structures by non-destructive testing and structural health monitoring, relationships between micro-structural properties and the durability of concrete and the use of industrial by-products and waste materials in concrete.

To support these areas of research, he has received funding in excess of £10million from Engineering and Physical Sciences Research Council, UK, Department of Trade and Industry, Technology Strategy Board, and various industries and other government agencies, including those from the EU. In these areas he has successfully supervised 15 postdoctoral researchers, 26 PhDs and 29 MSc projects. His research has resulted in over 400 refereed publications, which include several invited contributions at international conferences and special issues of international journals.

He has received the ACI/James Instruments Award for the best non-destructive test method for the development of the Autoclam permeability system in 1991 and the in-situ chloride migration test in 1999. He also received the Young Scientist Award from the Department of Science and Technology, Kerala, in the year 1991 for his research work on permeability of concrete, a special award from the Committee of International Conferences (formerly CANMET/ACI) for his contributions to concrete technology research in October 2012 at Prague and a lifetime achievement award for his contributions to education, research and technology transfer in the field of concrete and concrete structures from Civil Engineering Research Association of Ireland in August 2014. In addition, an International symposium was held in his name on "Advances in Science and Technology of Concrete" on 18th and 19th December 2015 at Mumbai, India.

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