Dear Reader

We thank you for your feedback on the sequel edition of Construction and Demolition Waste.

With this edition we bring to you interesting research papers on *Sustainability of Concrete Through Blended Binders,* guest edited by Prof. Ravindra Gettu and Er. Anusha S. Basavaraj of the Indian Institute of Technology (IIT) Madras. Dr. Gettu is the Dean, Industrial Consultancy and Sponsored Research, and V. S. Raju Chair Professor in the Department of Civil Engineering, at IIT Madras. He is a Fellow of the Indian National Academy of Engineering and of the Reunion Internationale des Laboratories at Experts des Materiaux, Systems de construction et Ouvrages (RILEM) – the International union of laboratories and experts in construction materials, systems and structures. He is presently the President of RILEM (2018-21). He is a recipient of several notable awards and recognitions, has authored about 500 articles and guided several students for their doctoral and masters theses. His current research interests are in fibre reinforced concrete, sustainability assessment, the effective use of chemical admixtures, concrete technology, housing and the mechanical characterization of construction materials. Ms. Basavaraj is a Ph.D. research scholar in the Building Technology and Construction Management Division at IIT Madras. She holds an M.Tech. degree in Construction Technology from BMS College of Engineering, Bengaluru. Her work interests include Life cycle assessment of cement and concrete systems, durability of concrete systems, alternate construction materials and systems, and concrete technology.

We look forward to your valuable feedback and comments.

Production Editor
Indian Concrete Journal

Dear Colleague

It is with great pleasure that we bring you this special issue of the Indian Concrete Journal, a publication that has disseminated scientific work and new developments in the construction sector, and enabled technology transfer to the concrete industry for almost a century. This is an excellent medium for researchers to convey discoveries, new methodologies and findings to practising engineers and technologists, especially in India.

It is being debated more and more if there is sufficient impact of research on the growth and improvement of the construction sector. Further, it is increasingly evident that the paper count is not really important for a researcher but the relevance of their work for society and for the industry is (Elangovan and Hoffman, 2019). Moreover, the impact of a publication is being judged by reputed researchers by the citations and quality of impact (Czarnecki et al., 2013), rather than the impact factor of the journal or its exotic nature. It is a pity, therefore, that many Indian researchers, even those from some top public-funded institutions, publish India-relevant work in South American, East European or Middle Eastern journals (no offense intended), as international journals are valued more by the academic machinery, though some corrective measures are being taken, somewhat late (Mallapaty, 2018). Such erroneous attitudes of choosing the international tag over actual relevance has led to the proliferation of predatory journals that publish practically anything for a fee (Burdick, 2017), masquerading as peer-reviewed open access journals (Boucherie, 2018), leading to the wastage of resources, as well as some significant results that could have been of relevance if they had been peer-reviewed and published in journals accessible to the domestic industry and academics. To arrest this trend, we certainly advocate publishing in a journal such as the ICJ rather than in an obscure or spurious journal, where the results are lost or suspected, by noteworthy researchers, as dubious. We see the future of publishing research findings moving gradually towards ethical peer-reviewed open access journals, even made free for the authors by sponsoring through industry or associations, such as the RILEM Technical Letters; we hope that ICJ would soon become one such journal so that concrete research in India becomes more relevant and sustainable.

Talking about sustainability, our construction materials group at IIT Madras has been working on the efficient and rational use of supplementary cementitious materials in concrete for about two decades. Over the years, through many research endeavours, the pros and cons of using blended binders have been well understood (Gettu et al., 2018a), extending the work of stalwarts in this field since the 1990s, such as Mehta, Malhotra, Swamy, Dhir and many others (Dhir and Jones, 1994; Malhotra and Ramezanianpour, 1994; Mehta, 1994, 2001). The recent enhancement of the approach is the incorporation

of quantitative life cycle assessment with data from the field (Prakasan et al., 2019) to analyse the environmental impact of cements and concretes. This has led to the assertion that the primary approach toward more sustainable concrete usage has to be through blended binders due to the enormous potential for enhancing durability, and for reducing the carbon footprint and embodied energy (Gettu et al., 2018b). Beyond fly ash and blastfurnace slag, the new entrant on the blended binder menu is LC^3 – limestone calcined clay cement, which promises to be a game changer (Dhandapani et al., 2018; Gettu et al., 2019; Pillai et al., 2019; Dhandapani and Santhanam, 2020), as can also be seen in some of the papers in this issue.

A simple Google search for "sustainable concrete" throws up close to 150,000 results reflecting the breadth and continued interest, obviously occasioned by the ubiquitous and versatile nature of concrete as a construction material. It is, therefore, ideal that sustainability be made quantifiable for better assessment of the potential of different concretes, or building materials, in general. In this context, the first paper in this special issue, written by Daman Panesar and co-authors, from the University of Toronto, presents a rational approach for the comparison of different concretes based on life cycle assessment. They propose the concept of environmental disturbance indicators that can be used to optimize concrete mixture proportions to get the best environmental performance. The approach is illustrated by them, with a set of concretes having granulated blast furnace slag, fly ash and silica fume.

The review paper of Piyush Chaunsali of IIT Madras discusses calcium sulfoaluminate-belite cements as a possible alternative to portland cement systems for furthering the cause of sustainability. The advantages, in this respect, are the lower kiln temperature, reduced limestone requirement and less grinding energy. Though the cost of these cements is higher due to the need for bauxite or other alumina-rich raw materials, there is the possibility of shrinkage compensation that can lead to the use of lower element thickness and less steel reinforcement, in certain types of applications.

There are three papers in this issue on LC^3, written by the principal academic teams, other than EPFL (Switzerland) and TARA (India), working on this topic for about six years, some of them more, within a large research project headed by Karen Scrivener and funded by the Swiss Agency for Development and Cooperation. Cuba has been the pioneering setting for the industrial production of LC^3 – the story of how this came about is told by its main protagonist, Fernando Martirena-Hernandez of the Universidad Central de las Villas, Cuba. The assessment of the clays suitable for the production, the challenges in making the new cement and the durability studies on concrete blocks maintained on the seashore for many years are succinctly explained. The next paper from the IIT Madras team, headed by Manu Santhanam, explains the synergistic interactions between limestone and calcined kaolinitic clay in the cementitious system that lead to quick setting, early strength gain, and lower water absorption and chloride ingress, when compared with portland cement-fly ash systems. The enhanced performance is attributed mainly to the early refinement of pore structure due to the lower capillary pore space in the microstructure. The authors led by Yuvaraj Dhandapani also conclude that calcined clay-limestone binders can accommodate up to 15% - 20% finely ground limestone without any loss of mechanical and durability performance. The final paper of the LC^3 trilogy is by Shashank Bishnoi and co-authors, from IIT Delhi, who have been working closely with the industry to standardize and to facilitate large-scale manufacturing. Along with emphasizing the merits of LC^3 as a binder, they discuss potential show-stoppers, such as the higher water demand, sensitivity to curing temperature and carbonation rates, so that the users are aware of the issues and suitable mitigation measures can be adopted.

The next two papers are on alkali-activated binder systems, which have received tremendous research attention in India over the past decade or so. The paper, by Sonal Thakkar and co-workers, reports the results of collaborative research between Nirma University (India) and University of Victoria (Canada). They address one of the main impediments of alkali-activated binders, namely the need for heat curing, by combining fly ash and bottom ash with appropriately proportioned superplasticizer and activators to yield ambient cured concretes. The other paper on such concretes is by Salmabanu, associated with National Taipei University of Technology, and Ismail Luhar, who activate processed and unprocessed fly ashes to provide binders that can yield reasonable strength with short-term high-temperature curing. The resultant materials could be of interest for precast elements and the like.

The final paper of this issue is that of Zhenbo Wang and Jun Zhang, who report on research at Tsinghua University, China, on low-shrinkage high-strength concrete reinforced with polyvinyl alcohol and micro steel fibres. The use of these materials in large-scale applications such as jointless pavements, insulation walls for buildings and irrigation channels is explained in detail, highlighting the possibility and advantages of making thin elements of sufficient mechanical integrity and durability.

We hope that this issue and the papers presented herein provide an impetus to rational and increased usage of blended binders in concrete to help reduce the negative impacts of construction, especially in emerging economies all over the world. We have to make concrete with less raw materials, lower energy consumption and minimum carbon footprint. More importantly, we should use the least amount of concrete possible and ensure that it is as durable as required.

"It is time to get out of our comfort zones" said Vanessa Nakate, a young climate activist from Uganda, at Davos 2020. Let us pay attention, and act! Now!

Ravindra Gettu and Anusha S. Basavaraj
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