EDITORIAL

Dear Reader

We are pleased to share with you that Dr. Sivakumar Kandasami has edited this special edition on construction and demolition waste. Dr. Sivakumar Kandasami is a trained concrete technologist with the Construction Division of Larsen & Toubro. His Ph.D. work at the University of Dundee, UK was on concrete durability and his expertise is frequently sought for mega projects designed to last an intended service life. He takes keen interest in developing robust solutions for concreting challenges at site, involves in R&D efforts within Larsen & Toubro and regularly reviews manuscripts for scholarly journals.

The Institution of Civil Engineers (ICE), UK awarded him the MCR PRIZE 2012 for the best paper published in the Magazine of Concrete Research. He is an Editorial Board member of Construction Materials (ICE, UK) and Journal of Testing and Evaluation (ASTM, USA). He is a Fellow of the Institute of Concrete Technology (UK) and the Institution of Engineers (India).

Production Editor
Indian Concrete Journal

Dear Colleagues,

It gives me immense pleasure to write this Editorial for the *Indian Concrete Journal* (ICJ) issue slated for the month of September 2019 - a special month during which the *Indian Concrete Institute* celebrates 'Concrete Day' across India by presenting awards to achievers in concrete technology, recognises excellence in projects and organises numerous talks of eminent practitioners. The September issue is dedicated to the cause of recycled Construction and Demolition (C&D) Waste in construction, an area that is fast catching the attention of various Government authorities in India. This issue of ICJ is a compilation of invited contributions on a variety of topics within the broad theme viz. a) the role of specifications, case studies and potential applications - all from Europe; b) emerging applications from Australia; and c) the present status of recycling in India. As a champion promoting the use of recycled C&D Waste in the Indian industry, there cannot be a better driver for me to get this high quality issue produced sooner. I thank all the authors for agreeing to contribute a paper and the reviewers for their invaluable time in ensuring that all loose ends are tied properly.

The leader point of view article by Potier (2019) has an important contribution on a French National Project on Complete Recycling of Concretes "RECYBETON" which was initiated in 2012 by the 'Ministry in charge of Public Works'. The author stresses the need for recycling of concrete for four major reasons viz. a) avoid exploitation of natural resources; b) prevent waste ending in landfill; c) limit CO_2 emissions from haulage over long distances; and d) match recycling rates and systems comparable to other materials like steel. Apart from the core research work in RECYBETON, five demonstration projects were constructed to prove the suitability of recycled C&D Waste material either in the production of concrete or cement. The outcome of the project is presented in the form of a book with the individual chapters structured in the format of a journal paper.

The opening technical paper by Harrison (2019) deals with development of the provisions for coarse recycled concrete aggregate (RCA) and recycled aggregate (RA) in British Standards (BS8500-2). Coming from someone who had chaired the concrete committee of the British Standards Institution for nearly two decades and has significantly contributed to several Technical Committees of the European Committee for Standardization (CEN), this paper authoritatively demolishes the very notion of looking at recycled material as "second class". It argues for treating RCA as a resource and points to the importance of developing quality protocols and standards (BS EN12620) as done in the UK, for taking things forward in India. By using RCA it is certainly possible to design concretes having adequate durability resistance in select exposure classes. The case for revising IS383:2016 is subtly put forward, as standards are meant to facilitate uptake of RCA and RA in appropriate applications and thereby help promote sustainability. The research initiated by the author at the University of Dundee is robust enough that very little changes were made to the provisions for RCA and RA in BS8500-2 since it was first introduced in 2002, though subsequently it has undergone three revisions with the recent one in 2019. BS8500-1 is popular in India as a guidance for service life design of major infrastructure projects and there is no harm in adopting certain provisions of BS8500-2 as an interim measure to enable widespread use of recycled C&D Waste material in India.

The following paper by Bravo et. al. (2019) studied the variation in the properties of concrete produced using fine and coarse RA from six different C&D Waste recycling plants in Portugal by an extensive experimental work. Significant variation is observed with fine RA from three different C&D Waste recycling plants, which was detected by a marked decrease of performance in durability tests in comparison to the mechanical properties. This is attributed to the contamination of clay with C&D Waste feedstock and the requirement for proper processing cannot be over emphasised. The clay content has pushed the water-cement ratio up resulting in decrease of compressive strength. Further the clay content is neither uniform nor similar between the fine and coarse RA sourced from the same C&D Waste recycling plant(s). When it comes to durability the variability in resistance to carbonation is much higher relative to chlorides. The authors however are of the opinion that not allowing RA in IS383:2016 for manufacturing plain concrete is too conservative. Moreover, preferring the coarser fraction of RA over the finer fraction seems to be the better option for producing structural concrete with durability requirements.

Moving on Engelsen and Mehus (2019) have detailed a successful full scale demonstration in the construction of Sørumsand High School in Norway which finds its place as the cover page image of this issue. I had visited this building in October 2018 as a guest of Norway's 'The Foundation for Industrial and Technical Research' (SINTEF). Completed in 2003 it is a remarkable demonstration project where the RCA replacement is 37% and the building is in a very good condition. Owing to the high heterogeneity of the waste source, wet processing technology was adopted to process C&D Waste and all the physical and chemical properties of the RCA produced were meticulously documented. Though the RCA was mainly from crushed concrete, some contamination of brick (4.6%) and asphalt (<1%) was also detected. Despite the minor contamination, having 40% RCA in concrete did not have any detrimental consequences. The pioneering effort was made possible by the joint efforts of the urban local body, the C&D Waste recycling plant, the ready mixed concrete producer and the contractor under the technical guidance of SINTEF. For operations in India, the authors have suggested a methodology to implement quality control during production of RCA based on CEN standards and a list of the important physical properties to care for.

Can we classify marble dust as a C&D Waste material? The next paper by Papatzani (2019) says yes and stresses the need to treat marble dust as a C&D Waste on equal footing along with other waste materials. Marble dust is generated from crushing of architectural panels while renovating heritage structures and during shaping of marble in industrial units. By reviewing an extensive collection of 83 papers, the author has done a commendable work for this paper. The review findings are summarised in an easy to comprehend format, supported by raw photos from the author's private collection. An important conclusion is the recommendation of replacing cement clinker by 10-15% of marble dust, though it is neither pozzolanic nor a fully inert material. Significantly, the claim of enhanced concrete durability in terms of migration of chloride ions and oxygen permeability is an important pointer for researchers. Various possibilities of using marble dust can be looked at with a fresh perspective.

Nanomaterials in the range 1-100 nm are finding immense use in construction for applications in concrete, glass and coatings. However, there are many myths and misunderstandings around them such as their effectiveness and defined particle size. Considering the fact that the range of particle size is large and some materials like nano titanium could have a particle size of 150 nm, the connotation of the term nano need not be the same in all situations. In this scenario, the paper by Ahmed (2019) shows how a judicious blend of the cementitious materials with 50% RCA concrete can offset the carbon footprint without significant reduction in engineering properties. The experimental work was carried out with a range of cementitious material compositions i.e. 50% ggbs, 50% fly ash, 5-15% silica fume, 2% nano silica, and 10% ultra fine fly ash. Special dispersion techniques of the nanosilica material was achieved by suitable equipment. The main findings are supported by a life cycle analysis. It is a refreshing approach to reduce the carbon footprint of RCA concrete by use of nanoscale materials and the need for further research remains. By this novel paper, we learn there are better pathways to enable switch over to a Circular Driven Economy by reducing embodied carbon dioxide along the way.

An application that is gaining worldwide acceptance in construction is the use of 3D printing and it has great potential to consume the finer fraction of recycled C&D Waste material. The penultimate paper by Shakor et. al. (2019) details pathbreaking experiments to explore heat curing as a method for enhancing the mechanical properties of 3D printed mortar specimens. Using inkjet printing, 3D printed mortar specimens were subjected to different curing temperatures and tested for their bending and compressive strengths. Calcium aluminate cement has been used as a cementitious material for this printing work. In the longer term, the authors are looking at using the finer fraction of RCA in large scale 3D printing applications using powder jet technology, which if successful would help increase consumption of recycled C&D Waste.

The final paper of this issue by Ram et.al. (2019) is an eye opener to the current status on use of recycled C&D Waste in the Indian construction industry. Being a highly cost conscious industry, new technologies face tremendous resistance, like in the rest of the world. As the authors have observed, use of recycled C&D

Waste material is seen as something that is unpredictable and of inferior quality. No doubt, there is huge reticence on the ground to use recycled C&D Waste in any form of new construction. Given this background, the authors have conducted structured interviews with key stakeholders to ascertain their views. Based on those interactions, the authors have identified paver blocks as the right market segment to target use of recycled C&D Waste. In this regard, the Central Public Works Department (CPWD) should be applauded for including in the 2018 'Delhi Schedule of Rates', concrete paver blocks of M30 grade and precast concrete blocks of M10 grade manufactured using recycled C&D Waste. CPWD in Delhi is proactively working on redevelopment projects by identifying applications such as kerb stones, filling applications, manufactured sand for plaster, and road sub-base. The other aspect the authors have ascribed to is the strong supply chain for natural aggregates. In contrast, it is difficult to get consistent supply of RCA and RA even in major Indian cities. High taxation on recycled C&D Waste products is also a deterrent. Meanwhile, mountains of C&D Waste continue to accumulate across the country. Natural aggregates should be selectively used for making concrete of only M40 grade and above. For all other low strength concretes, use of RCA and RA in some proportion should be made mandatory to take pressure off pristine natural reserves.

A review of the book on BUILDING MATERIALS (Subramanian, 2019) authored by a practising structural engineer is also included in this edition.

The use of recycled C&D Waste material in construction is something we cannot neglect for long. While the technical expertise and proven exemplar projects are readily available, what is in short supply is the will to act. Like in the United Kingdom, a leader in recycling, where introduction of "Aggregate Levy" and "Landfill Tax" finally made use of recycled products commercially viable, India needs proper legislation to make things happen on the ground. Sustainability of the environment demands immediate adoption of recycled materials in the manufacture of concrete. I believe you would enjoy reading this themed issue, find the information presented really useful and also frequently refer back to this issue for continual guidance.

Sivakumar Kandasami
Guest Editor for the Special Issue, ICJ.

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