HISER International Conference

Advances in recycling and management of construction and demolition waste

21, 22 & 23 June 2017

Delft, The Netherlands

Editors:

Francesco Di Maio

Somayeh Lotfi

Maarten Bakker

Mingming Hu

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Conference Proceedings

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Preface

Dear Colleagues,

We are pleased to organize the first International conference on Advances in Recycling and Management of Construction and Demolition Waste, from June 21-23, 2017, in Delft, The Netherlands. This conference intends to provide researchers, practitioners and industry experts with the opportunity to exchange the latest knowledge and tools in advanced/innovative technologies and methodologies to process and valorize C&DW in the context of circular economy.

Production of waste materials, via industrial and human activities, creates big environmental and economic problems but also opportunities to recover valuable resources. EU28 currently generates 461 million tons per year of ever more complex Construction and Demolition Waste (CDW) with average recycling rates of around 46%. There is still a significant loss of potential valuable minerals, metals and organic materials all over Europe.

Considering the fact that public and private sectors have become aware of the urgency and importance of CDW recycling, the European Commission has taken initiatives towards sustainable treatment and recycling of CDW. In 2014, the European Commission announced a call for proposals with the subject of “Recycling of raw materials from products and buildings”. The aim was to develop solutions for a better recovery of CDW, particularly in the most promising targets, such as deconstruction of non-residential buildings, showing the feasibility of increasing the recovery rate of CDW (e.g. metals, aggregates, concrete, bricks, plasterboard, glass and wood), and the economic and environmental advantages associated with CDW treatment, thereby closing the current gap between reality and the overall 70% recycling target for CDW as set in the Waste Framework Directive. This call resulted in a successful project with the full title of “Holistic innovative solutions for an efficient recycling and recovery of valuable raw materials from complex construction and demolition waste” with acronym of HISER. The main goal of HISER project is to develop and demonstrate novel cost-effective technological and non-technological holistic solutions for a higher recovery of raw materials from ever more complex CDW, by considering circular economy approaches throughout the building value chain (from the End-of-Life Buildings to new Buildings).

Following the success achieved in the HISER and its earlier EU projects such as C2CA and IRCOW, Technical University of Delft, took an initiative to organize an

international conference on construction and demolition waste management and recycling together with the project coordinator Tecnalia.

The response on the call for papers was encouraging and convincingly illustrated the importance of the subject. Finally around 80 papers were submitted, coming from more than 20 countries. The contributions cover the wide, coherent field of construction and demolition waste recycling and management and make this conference a meeting point to exchange technology and engineering best practices.

We hope you will find the conference and your stay in Delft both valuable and enjoyable.

Dr. Ir. Francesco Di Maio,
Dr. Ir. Somayeh Lotfi,

Organizing Committee

I

Keynote Lectures

The future of concrete

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Abstract

After a decade of intensive research into the recycling of End-of-Life (EOL) concrete into high-grade new concrete, largely supported by funding from the European Commission, it appears that a circular economy for concrete is techno-economically feasible. A collection of advanced technologies, in particular smart demolition for clean mono-flows of EOL concrete, new attrition and classification processes for removing the fine, moist-, lights- and cement-rich fraction from coarser aggregates, sensor sorters for removing larger pieces of wood, plastics and metals from recycle aggregate, green thermal treatment for concentrating and purifying the EOL cement paste and Laser-Induced Breakdown Spectroscopy tools for verifying the quality of input materials for the mortar facilities, have been put into place to make recycled concrete in some technical aspects even superior to concrete made from river gravel. And at competitive costs. Is this enough to make the transition to circular concrete into a success? Not necessarily. The integration of circular concrete into the routine of construction requires new procedures and agreements between stakeholders to avoid risks in producing an extremely cheap but at the same time strongly quality-guaranteed concrete commodity from a new and variable feedstock. It is argued that extremely tight quality checks should be installed in combination with a commitment of the entire chain to gently increase the fraction of recycled materials into new concrete as the EOL concrete flow grows as a consequence of phasing out buildings from the post-war boom.

Use of accelerated carbonation technique to enhance the properties of recycled aggregate concrete

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Abstract

In Hong Kong, huge quantities of construction and demolition (C&D) wastes (57,000 ton-per-day) are produced representing the largest fraction of the total solid waste stream. The disposal of the wastes has become a severe social and environmental problem in the territory. Government sources have indicated that there are acute shortages of both public filling areas (reclamation sites) and landfill space in Hong Kong. Hong Kong's three mega landfills are expected to be full within 5-6 years' time. The possibility of reducing and recycling these wastes is thus of prime importance.

The Hong Kong Polytechnic University has been conducting research on methods to recycle construction waste. The potential applications of the recycled materials are in road pavements, concrete, concrete blocks and mortars. Some of the developed techniques have been commercially utilized in industry. This presentation summarizes the major findings of the research conducted, and introduces some case studies on utilizing accelerated carbonation technique to enhance the properties of recycled aggregate concrete

In recent years, adopting the accelerated carbonation technique to improve the quality of recycled concrete wastes as well as to capture and store CO_2 has been investigated by a number of researchers including our group at PolyU. The potential CO_2 capture ability of recycled concrete aggregates (RCAs) was related to the carbonation conditions and the characteristics of RCAs. It was found that a moderate relative humidity, a CO_2 concentration higher than 10%, a slight positive pressure or a gas flow rate of > 5 L/min were optimal to accelerate the RCAs carbonation. The properties of RCAs were improved after the carbonation treatment. The reduction of water absorption was up to 16.7%. There was about 4.0% increase of 10% fine value and a 26% reduction of crushing value.

This resulted in performance enhancement of the new concrete prepared with the carbonated RCAs, especially an obvious increase of the mechanical strengths and an even more significant improvement of durability properties. In addition, the replacement percentage of natural aggregates by the carbonated RCAs can be increased to 60% with an insignificant reduction in the mechanical properties of the new concrete.

Additionally, the potential utilization of fresh concrete slurry waste (CSW), which is sourced from dewatered solid cement residues after washing out over-ordered/rejected fresh concrete and concrete trucks in concrete batching plants, has been investigated. Due to its rich calcium-silicate content and cementitious feature, it was considered as a cementitious paste as well as a CO_2 capture medium to produce new products. Subjecting to accelerated carbonation, rapid initial strength development and lower drying shrinkage for the prepared concrete mixture were achieved. Moreover, the production of the concrete mixtures for partition wall blocks using the developed technique can be considered as carbon neutral.

Advances in studying of recycled aggregate concrete in China

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Abstract

This report firstly presents the current state of construction and demolition (C&D) waste generation in PR China. It is found that the composition of C&D waste in mainland China is much different from other countries, leading to some difficult on the aspect of waste concrete recycling. As a result, in China, some reclamation chains have been well-established, which are suitable for local conditions. Secondly, the research work on recycled aggregate concrete (RAC) in mainland China is introduced, including mechanical property of RAC material, structural behavior of RAC load-bearing elements, and seismic performance of RAC frame structures. The experimental study results prove that it is feasible to apply RAC as a structure material in building structures. Lastly, this report presents an outline of Chinese technical codes for RAC organized and edited by the speaker. It also puts forward some successful applications of RAC in building structures in the mainland of China which will be helpful to promote and popularize RAC as one kind of ecological structural materials.

Keywords: Recycled aggregate concrete (RAC), Reclamation, Material property, Structural behaviour, Technical code, Application.

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Accelerating circular city development

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Abstract

In Circular Cities, resources that drive human activities are by definition regenerative rather than linear or degenerative: be it energy, water, materials, nutrients or air. Meaning the focus shifts from gradual destruction of resource-value – "take, make, waste" – to value-creation through models based on cascades and cycles. In order to establish such regenerative resource flows that retain or increase value in cities' subsystems there is dire need for new concepts as well as rigorous and critical testing of existing ones: both at an academic and practical level. This relates for example to aligning & connecting flows, exploring shared value models, implementing smart sensing technologies, identifying negative external effects etc. The impact on how cities are conceived, materialized and operationalized in a circular framework can hardly be overstated. Some impacts can be imagined, based on current knowledge, but others can at best be anticipated. This is due to cities being complex, adaptive systems in which "an increasing number of independent variables begin interacting in interdependent and unpredictable ways" [Sanders 2008]. The implications of a circular agenda are thus significant, and we only just begin to fathom the magnitude. Moreover, there is a proliferation of different interpretations concerning the meaning of 'circular'. Some interpretations are essentially linear processes made more efficient, whereas other interpretations may seem 'too holistic to succeed'. Accommodating circular processes in all their diversity means that potential contradictions in the actions we take need careful consideration. The abovementioned notions resonate in the Circular City research program through three, strongly interrelated subthemes: 1) materials & buildings, 2) nutrients recovery, and 3) urban energy systems. Each subtheme has its own research priorities, informed by the interplay between society, science and business, rooted in the definition that circular cities understand, establish, monitor and control circular economy principles in an urban context, whilst realizing the vision of a resilient, future-proof city.
An important focus within the 1st theme is on materials that are temporarily stored in built constructions for diverging periods of time. Including the question how to streamline supply, demand and conversion processes of those materials, components and buildings on different time- and scale levels. The 2nd theme concerns nutrient recovery from (waste) water streams. At stake are methods and systems to better reutilize nutrients, materials and energy in water flows, as well as the integration of wastewater treatment systems on various scales in urban regions. The 3rd theme centres on the transition to renewable energy sources and its spatial and infrastructural implications, dealing with increased variability in consumption, storage and production, and concerning multiple energy products and services. This theme accentuates innovation in systems engineering & integration, energy storage, and ICT, adopting a citizen perspective.

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The use of renewable materials in reversible building design: a literature study

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Abstract

Today we are getting more and more confronted with the finiteness of mineral and fossil deposits of organic material. Extraction costs are rising and the availability of resources is decreasing. Together with an increased demand -as world population expands and developing nations are becoming wealthier- the situation will become unbearable, even if resources are recycled in perpetuity. Instead of using finite resources, such as concrete and steel, renewable materials, such as flax and hemp, can be used in the building sector. Renewable materials are sourced from living plants and animals and do not disadvantage future generations. They do not only take pressure off finite resources, they can be composted at the end of their useful life if no undegradable materials are added, beside other advantages.
Furthermore, the use of reversible building design is recommended to reduce the extraction of resources. For example, a building can be more easily maintained and can anticipate changing needs during its useful life, such as a changing family composition, without generating additional waste by using reversible building components.
By combining both strategies, the use of renewable building materials and the use of reversible building design, the advantages of both strategies can be combined too. The use of renewable materials in reversible building components enables the closure of the loop at both scale levels: material and component level. In this way, a building component can be reused, but can be composted when a component is damaged.
Therefore, in this paper additional advantages, opportunities, barriers and threats are identified of using renewable resources in reversible building design. In addition, current application is examined.

Keywords: circular product design, reuse, renewable materials.


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