International Workshop (Online Zoom)

Recycling in construction sector – from material characterisation to contribution in the circular economy

30 December 2020

Hold by **Ton Duc Thang University (TDTU), Ho Chi Minh City, Vietnam**

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Workshop Agenda

(*following Vietnam time, UTC+7*)

15:00-15:10	Introduction
15:10-15:40	Presentation 1: **On the Reactivity Mechanism of Supplementary Cementitious Materials by Alkali Activation** Yu Jin, Shenzhen Institute of Information Technology, China
15:40-16:10	Presentation 2: **Utilization of Fine RCA together with MSWI Bottom Ashes** TANG Luping, Chalmers University of Technology, Sweden
16:10-16:40	Presentation 3: **Why rammed earth is designed to fulfil the circular economy principles in the construction sector?** Jean-Claude Morel, Coventry University, United Kingdom
16:40-17:10	Presentation 4: **Properties of Self- Consolidating Concrete with Rice Husk Ash and Calcium Carbonate Powder** Natt Makul, Phranakhon Rajabhat University, Thailand
17:10-17:40	Presentation 5: **Recycling in construction material: case studies** Quoc-Bao Bui, Ton Duc Thang University, Vietnam
17:40-18:10	Presentation 6: **Research on Green Concrete by utilizing FA and Slags** Aissa Bouaissi, University of Plymouth, United Kingdom
18:10-18:20	Presentation 7: **Royal Academy of Engineering Frontiers Champion project on Recycled Aggregate Concrete in South East Asia** Boksun Kim, University of Plymouth, United Kingdom
18:20-18:30	Conclusion

Contact Person: Dr. Quoc-Bao Bui, **Email:** buiquocbao@tdtu.edu.vn, Tel: (0084)909 358 935

Summary:

This workshop is a deliverable of TRAC project which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº777823.

Concrete, owing to its availability, easy preparation and fabrication, is the most popular construction material. Today, concrete is the second most used material after water, with nearly three tonnes used annually for each person on earth. Due to the vast amount of concrete being produced and the huge amount of demolition waste from old concrete structures, the reuse of concrete waste by the construction industry is becoming increasingly important. This is motivated not only by the environmental protection, but also by the conservation of natural aggregate resources, the shortage of waste disposal land, and the increasing cost of waste treatment prior to disposal. The aim of this project is to develop tailor-made concretes by using recycled concrete aggregate (RCA) for structural applications to promote the increased use of RCA in civil infrastructure projects, particularly in marine environment which is currently restricted. This workshop is a deliverable in WP3 of the TRAC project, which is to test and analyse the material characterisation of recycled aggregate concretes with SCMs.

Partners of TRAC project

1. UoP (University of Plymouth, UK) – Coordinator, Leader of WP1, 5 & 6
2. CHALMERS (CHALMERS TEKNISKA HÖGSKOLA AB, Sweden) – Leader of WP2, 3 & 4
3. PNRU (Phranakhon Rajabhat University, Thailand) – Co-leader of WP6
4. TDTU (TRUONG DAI HOC TON DUC THANG, Vietnam) – Co-leader of WP3
5. SZU (Shenzhen University, China) – Co-leader of WP2

Project Website: www.h2020-trac.eu

On the Reactivity Mechanism of Supplementary Cementitious Materials by Alkali Activation

Yu Jin
Shenzhen Institute of Information Technology, China

Abstract

Industrial by-products or solid waste, such as blast furnace slag, coal-combustion fly ash et al., have long been used as supplementary cementitious materials (SCM) in Portland cement and concrete. Utilization of SCM can mitigate the problems caused by cement production, including high energy and natural resources consumption, massive carbon dioxide emission.

To reach the desired high replacement levels (beyond 30 wt.%) of Portland cement without significant performance loss, triggering SCM reactivity is the key. However, from the point of view of material science, the empirical testing approach concerning macroscopic properties led to a quite fragmented understanding of SCM reactivity. In addition to their specific surface area, the hydraulic reactivity of SCM is highly dependent on the dissolution-precipitation reaction of the glass phase within the minerals.

The glass structure of SCM can be simply expressed as the molar ratio between network modifer (e.g. Ca, Na) and network former (e.g. Si, Al), such as depolymerization degree in glass chemistry. Recent studies on CaO-SiO2-Al2O3 glass enhance the understanding of the structure in terms of Si(Qn(mAl)) polymerization units. The polymerization degree of the glass, saturation index in the solution, cation/anion species and their concentration and pH determine the dissolution rate of the glass structure. Besides, formation of precipitates changes the dissolution kinetics as well.

This research investigate the glass structures in terms of depolymerization degree and Si(Qn(mAl)). The reactivity of the glass structure under different activation conditions is also elaborated. Therefore, it lays a foundation for the development of the building materials with low-carbon footprint, while stable quality and good durability of the building materials are maintained.

Brief biography of Yu Jin

Dr. Yu Jin obtained his Ph.D from Techische Universität Berlin and works currently as an associate researcher at Shenzhen Institute of Information Technology. He is now the member of GDCh Bauchemie (German Chemical Society Construction Chemistry Branch) and reviewer for some prestigious journals like Journal of the American Ceramics Society, Journal of Cleaner Production. He has published 19 journal papers, including those in Cement and Concrete Research, Journal of Cleaner Production. His research interest covers the ultlization of solid waste, alkali activated materials, latex modified cement based materials.

Utilization of Fine RCA together with MSWI Bottom Ashes

Luping Tang, Liming Huang, Emma Zhang and Arezou Ahmadi
Chalmers University of Technology, Gothenburg, Sweden
(to be presented by Luping Tang)

Abstract

For the globe development of sustainability, it is important to reuse or recycle the solid materials. There exists a big problem in use of fine recycled concrete aggregate (FRCA) due to its high water-absorption and poor shape which dramatically impairs the workability of fresh concrete. On the other hand, there is a need for value-added use of the more and more amount of bottom ashes (BA) from the municipal solid waste incineration (MSWI). Through the EU-project TRAC and the Swedish EnergiForsk-project we found a new way to utilize both the FRCA and the MSWI-BA, with the help of alkali-activation techniques. The preliminary results show that both the FRCA and the MSWI-BA can be used for production of "green" aggregate with various particle sizes, which in turn can be easily used in concrete production without impairing the basic properties of concrete.

Brief biography of TANG Luping

Prof Tang received his PhD in 1996 at Chalmers University of Technology, Gothenburg, Sweden. Since then he has worked at SP Technical Research Institute of Sweden for 12 years and rejoined Chalmers since 2008 as professor and leader of research group for building materials. His main research interest is new types of cementitious materials and durability of concrete, especially chloride transport mechanisms and chloride induced corrosion of steel in concrete. In the past years he has been involved in several research projects dealing with greener cementitious materials including nano-technology and chemical activations.

Why rammed earth is designed to fulfil the circular economy principles in the construction sector?

Jean-Claude Morel
Coventry University

Abstract

To provide buildings with low embodied energy within a circular economy, it is possible to use rammed earth mixed with crushed concrete waste for the construction of load-bearing and non-structural walls. These components will be entirely formed from local waste taken from excavation, from ground works, construction, earthen building demolitions and/or locally sourced Recycled Crushed Concrete. The presentation gives an overview of the potential for earthen architecture to deliver sustainable and circular buildings. We will expatiate the limitations of rammed earth as an engineering construction material. Those limits imply a change of paradigm in the construction process approach. We will see how the circular economy adoption can help to overcome the current obstacles to the development of modern earthen architecture.

Brief biography of Jean-Claude Morel

Prof. Jean-Claude Morel studied at the University of Grenoble (PhD Soil Mechanics), France. He was researcher for the French Ministry of Sustainability at Ecole Nationale des Travaux Publics de l'Etat of Lyon from 1996 to 2015, before joining Coventry University as Professor Low Impact Buildings. His current research activites include sustainable building with earth and stone. He has more than 50 articles in peer review international Journals, co-writer of 7 books in French and English covering the range of design guideline for architects and engineers to continuum mechanics. He is Editorial panel member for the journal Engineering Sustainability of ICE.

Properties of Self- Consolidating Concrete with Rice Husk Ash and Calcium Carbonate Powder

Natt Makul
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Abstract

Self-consolidating concrete (SCC) incorporating alternative materials has been remarkably popular to enhance high-performance workability. This research aimed to investigate the impact of using finely ground calcium carbonate powder (CaCO3, CC) on the workability and strength development of SCC containing residual-unprocessed rice husk ash (RuRHA). Three different particle sizes of CC were replaced in Portland cement (PC) at 20 wt% and 40 wt%, while RuRHA replaced fine aggregate at 20 wt%. The results indicate that the CC content is higher than the water-powder materials (PC+CC) ratio of control SCC. The fresh unit weight of SCC with and without RuRHA decreased relative to that of the nominal 100% control SCC. The workability of SCC prepared using CC and RuRHA fell within an acceptable range as specified by EFNARC for most of the mixtures. SCC mixed with CC and RuRHA had a lower compressive strength and acid attack resistance than the control SCC

Brief biography of Dr. Natt Makul

Dr. Natt Makul is a senior lecturer in the Department of Building Technology under the Faculty of Industrial Technology at Phranakhon Rajabhat University. His research interests include microwave heating of cement-based materials, utilization of waste materials as concrete materials, behaviors of Portland cement-based materials, microstructural characteristics of concretes, and special testing and analysis of concretes.

Recycling in construction material: case studies

Le Hoai-Bao, Bui Quoc-Bao, Le Duc-Hien, Tran Minh-Tung, Phan To-Anh-Vu

Sustainable Developments in Civil Engineering Research Group, Faculty of Civil Engineering, Ton Duc Thang University, Ho Chi Minh City, Vietnam
(to be presented by Quoc-Bao Bui, E-mail: buiquocbao@tdtu.edu.vn)

Abstract

The ordinary cement concrete is today the most current construction material but it contributes also to the consumption of natural resources and CO2 emission which is related to the cement manufacture. In the context of sustainable development and circular economy, the recycling of materials and the use of alternative binders having less environmental impacts than cement are the challenges for the construction sector. This study presents some case studies of the recycling in construction materials. First, investigations on concrete using recycled aggregates and alkali-activated binder are presented. The specimens were prepared from low calcium fly ash (an industrial by-product), sodium silicate solution, sodium hydroxide solution, fine aggregate from river sand, and recycled coarse aggregate. Influences of different factors were investigated: treatment of recycled aggregates, ratio between alkaline activated solution and fly ash, the curing temperature and the LignoSulfonate superplasticizer. The interfacial transition zone of geopolymer recycled aggregate concrete (GRAC) was evaluated by using microscopic analyses. The models for the prediction of GRAC compressive strength were also investigated. Then, investigations on geopolymer adobes (soil-based material) were also presented and discussed.

Brief biography of Dr. Quoc-Bao Bui

Dr. Quoc-Bao Bui received his PhD in 2008 at ENTPE (Ecole Nationale des Travaux Publics de l'Etat) Lyon, France. From 2008 to 2011, he continued at ENTPE as Postdoc researcher funded by Filiaterre company. From 2011 to 2016, he worked as Associate Professor at Polytech Annecy-Chambery, University Savoie Mont-Blanc, France. Since 2016, he has joined Ton Duc Thang University (Vietnam) as Associate Professor. His research interests cover non-conventional materials (soil-based materials, recycled materials) and structural analyses (RC structures, dynamic behaviour). He has recently been involved in research activities related to chemical activations, especially alkaline-activated materials. He has published about 60 articles in international journals.

Research on Green Concrete by utilizing FA and Slags

Aissa Bouaissi

University of Plymouth, United Kingdom

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Abstract

This research is an investigation study which supports the concept of eco-friendly materials and sustainable development. Potential studies have been conducted on cementitious materials with low-carbon emissions. In recent years, many efforts have been attempted to utilize fly ash and other abundant aluminasilicate wastes from various industrial sectors as alternative cementitious binders which could partially replace Portland cement. Most of these by-product wastes, such as fly ash and furnace slag are currently landfilled and dumped undersoil, which in turn contaminate and generate a substantial threat to the environment. This research project has the aim of investigating the capability of producing a sustainable concrete mainly based on the combination of various by-product materials at ambient temperature.

Brief biography of Dr Aissa Bouaissi

Dr. Aissa Bouaissi holds an MSc Cert in Chemical Engineering and PhD in Civil Engineering, Material from the University of Plymouth, UK. His research interests cover the fields of OPC-free cement and concrete and eco-friendly materials, applications of chemical and physical processes in industrial wastes and by-products. Previously he worked as a senior process engineer in national and multinational companies in Algeria, where he built his expertise in well-cementing services and the Oil and Gas industry. Dr Bouaissi is a member of the editorial board of Journal of Knowledge-based engineering and sciences (KBES) and a guest reviewer with several journals including Construction and Building Materials (CBM), Hazardous Materials, Journal of Building and Engineering, Engineering with Computers. Dr Bouaissi's last publication was a chapter in a book titled: "Zero-Energy Buildings - New Approaches and Technologies".

Royal Academy of Engineering Frontiers Champion project on Recycled Aggregate Concrete in South East Asia

Boksun Kim
University of Plymouth, United Kingdom
(to be presented by Boksun Kim, Email: Boksun.kim@plymouth.ac.uk, recycledaggregateconcrete@plymouth.ac.uk)

Abstract

Funded by the Royal Academy of Engineering, this Frontiers Champion project aims to bring together global research communities, policy makers, practitioners, innovators and social scientists to establish an interdisciplinary consortium to investigate the development of sustainable, durable, cost-effective, green concrete by utilising recycled aggregates in Southeast Asia. Due to the increase of population and urbanisation in Southeast Asia, the concrete industry faces two major challenges: the supply of the natural resources needed for new construction, and dealing with waste from the demolition of existing buildings. One elegant solution would be to recycle the waste from the demolitions for the new constructions, hence using fewer natural aggregates and reducing construction waste. However, currently there are many challenges, including the lack of standardisation of recycled aggregates and the inconsistent quality of the derived recycle aggregate concrete. Via two different types of community building activities, we aim to tackle these challenges. First, we will host monthly webinars to explore the knowledge, skills and experience of the network in the development of recycled aggregate concrete. Second, we will organise an in-person networking event to tackle the challenges in a regional context in Southeast Asia.

Brief biography of KIM Boksun

As Associate Professor of Structural Engineering at the University of Plymouth in the UK, Dr Kim has been working on projects involving steel and concrete structures, graphene oxide concrete, recycled aggregates concrete and plastic bottle houses, which have led to over 37 research publications. As a Fellow of the Institution of Civil Engineers, Chartered Structural Engineer and the Chair of the Institution of Structural Engineers Devon and Cornwall Regional Group, she has been promoting structural engineering to raise the profile of engineering.

Websites

Project website: https://www.plymouth.ac.uk/research/materials-and-structures-research-group/recycled-aggregate-concrete-in-south-east-asia

Consortium for Recycled Aggregates in Concrete (CRAC): https://www.linkedin.com/groups/8992966/