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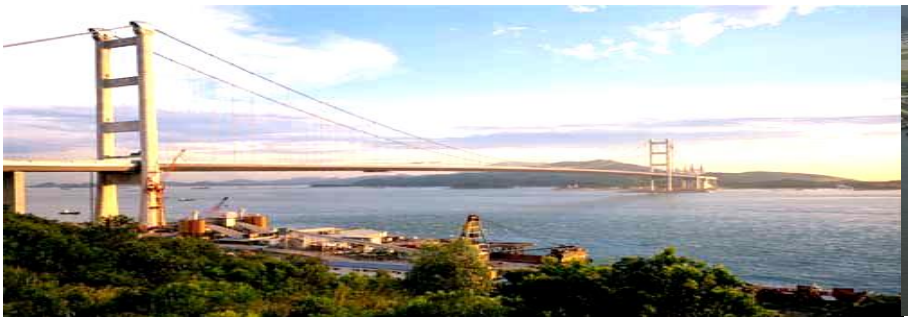

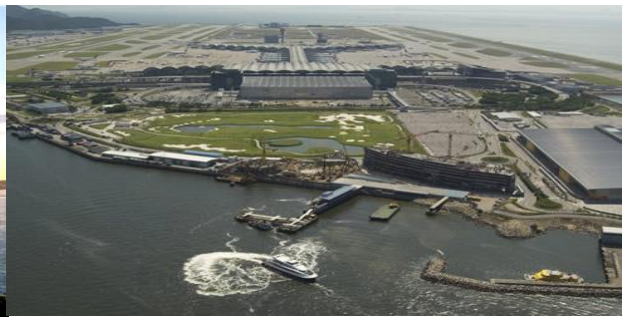

From Thixotropy of Self-Consolidating Concrete to SmartCast and 3D Printing

Dr. Ye Qian

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Nanyang Technological University

ABSTRACT

Concrete is the most widely used infrastructural material, where 3 billion tons were consumed globally in 2010. Modern concrete is a complex material consisting not only cement, aggregates and water, but also chemical admixtures and supplementary cementitious materials (SCMs) for concrete sustainability.

Compared with conventional vibrating concrete, self-consolidating concrete (SCC) is more flowable and can consolidate under its own weight. Therefore, it introduces many advantages in construction applications. These include decreasing labor work for casting, better quality control and enhancing hardened properties. However, challenges still remain, such as issues relating to formwork pressure and multi-layer casting. Each of these issues is closely related to the property of thixotropy. For SCC, as well as other concrete systems, it is about balancing sufficient flowability during casting and rate of structural buildup after placement. For instance, relating to the issue of SCC formwork, it is ideal for the material to be highly flowable to achieve rapid casting, but then exhibiting high rate of structural buildup to reduce formwork pressure. This can reduce the cost of formwork and reduce the risk of formwork failure. It is apparent that accurately quantifying the two aspects of thixotropy, i.e. structuration and destructuration, is key to tackling these challenges in field application.

During my Ph.D. program at Columbia University, and postodoctoral research at Ghent University in Belgium, I have been extensively working on defining and quantifying thixotropy. Firstly, I applied creep recovery test to accurately measure the static yield stress and probe tack test to quantify cohesion. Nanoclay addition increases both static yield stress and cohesion and thus decreases SCC formwork pressure, as well as improve static segregation and stability. Secondly, after accurately measuring both aspects of thixotropy, I tied thixotropy to the discrepancy between static and dynamic yield stress. The higher the thixotropy, the higher the discrepancy. I also define an index I_{thix} to effectively quantify thixotropy. Thirdly, results of thixotropic index I_{thix} indicate that water reducing agents decrease thixotropy while nanoclay increases it. Finally, with a good balance of water reducing agents and nanoclay, I have developed mixtures with high flowabiltiy yet high stability after placement. It is an ideal mixture for 3D printing cementitous materials. Highly thixotropic cementitious materials are found to be suitable for concrete 3D printing applications, where the materials should be flowable to be pumped, then quickly build up strength and stiffness after being extruded.

Date: **25 March 2019**

Time: **2:30 p.m. – 3:30 p.m.**

Venue: **Room ZS970, 9th floor, Block Z, The Hong Kong Polytechnic University, Hung Hom, Kowloon**

SPEAKER'S BIOGRAPHY

Dr. Qian is working as Research Fellow at Singapore Centre for 3D Printing.

Before coming to Singapore, he also worked as postdoctoral researcher at Ghent University in Belgium. He has obtained his Ph.D. at Columbia University in the City of New York, his M.S. at Hokkaido University in Japan, and his B.S. at Huazhong University of Science and Technology in China. He specializes in cement and concrete rheology, particularly in the development of innovative measurement techniques to further the understanding of the structural and temporal evolution of the fresh-state microstructure of cementitious systems. He is also interested in sustainable infrastructural materials and durability especially freeze-thaw damage of cementitious materials.

***** All Interested Are Welcome *****

For further information, please contact Prof. J.G. Dai at Tel. 27666026

Free Admission. Please reserve your seat with Dr. Y.S. Wang by email: yswang@polyu.edu.hk

Certificates of attendance will be provided to participants if they attend the whole lecture.