ACI-ASConference 2019

CONFERENCE TOPICS & SYNOPSIS

1. Comprehensive Corrosion Protection Strategies – Case Study of Protection to Concrete Foundations in Highly Aggressive Sub-soil

~ ACI Ambassador Dr. Ishita Manjrekar, Vice President, ACI-India Chapter

India has emerged as the 3rd largest construction industry globally. Megaprojects across all sectors and industry are underway. This rapid growth must be equality supported by due consideration to durability and sustainability do as to maximize the ROI on the nation's investment in infrastructure. Blessed with tropical climate and a significant coastline, corrosion is a major concern as well as design consideration. Further as a result of rapid industrialization, several construction sites encounter significant sulphate content in the subsoil.

Durability of reinforced concrete gets drastically affected due to highly aggressive sub-soil & water conditions in the vicinity of reinforced concrete. Sulphate attack causes loss of bond between cement paste & aggregates resulting in excessive cracking, delamination and loss of strength of concrete, whereas chloride penetration through the concrete causes corrosion in the reinforcement steel bars. Each of the two types of attack is a serious problem and is responsible for premature failure of many reinforced concrete structures in coastal areas.

Techniques for mitigating Sulphate attack or Chloride attack individually have been developed and are deployed as per requirement, but a combined attack of sulphate-chloride solution in acidic ground water in a high rainfall zone is however rare and is of more serious concern. This combined attack required a multi-pronged durability approach designed to tackle the environmental aggressors to the structure both individually and in combination.

This paper presents a case study regarding method adopted for obtaining sustainable concrete structure having protection for reinforced concrete pile & shallow foundations under such aggressive soil conditions in an industrial marine environment for an industrial plant located at the South-eastern coast of India. Besides the design parameters and strict quality control of the concrete, special attention was paid to utilizing cutting edge and proven material science, nanotechnology and galvanic technologies including galvanic corrosion protection systems of sacrificial anodes (ASTM B 418), bi-polar organic corrosion inhibiting admixtures (ASTM G 109), permeability reducing and durability enhancing admixtures (conforming to ACI 212) and supplementary cementitious compounds including GGBS and flyash in the concrete were utilized to increase the design life of the foundation making this an exciting and unique case study.

2. From 3D Printable Concrete Materials to Sustainable Construction

~ Dr. Qian Shunzhi, Asst. Professor, Nanyang Technological University

Digital fabrication, especially 3D concrete printing, has seen a rapid development in the last decade due to primary advantages including formwork-free fabrication, reduced labor cost, decreased waste material generation. Lots of academic research studies and engineering applications have been conducted, e.g. printing with recycled wastes, 3D printed concrete bridge, 3D printed villa. With rapid advancement in this field, it is critical to review the current development on 3D printable concrete materials and put it into the perspective of sustainable construction and development.

A systematical review of 3D printable concrete materials has been carried out. To guide the review work, multi-level material design (MMD) approach was proposed. Mixture design, printing process and composite structure related to 3D concrete printing were reviewed accordingly, which can provide insights for the future development of 3D printable cementitious materials for building and construction. By linking up material mixture design, printing process and composite structure performance, a holistic approach can be developed to maximize the potential of 3D printing technique in the industry.

3. Coal Bottom Ash as a Potential Supplementary Material for Sustainable Concreting Applications

~ Dr. Sudharshan N. Raman, President, ACI-Malaysia Chapter

Coal fired thermal power plants generate substantial amounts of waste materials during its operation. Bulk of the waste generated from these power plants are in the form of fly ash, while the remaining are in the form of the coarser bottom ash, as well as scrubber ash. While fly ash has found applications in cement production, soil amelioration, ceramic industry, catalysis, zeolite synthesis, etc.; coal bottom ash (CBA) is mainly being disposed of in landfills. The open disposal of CBA poses serious environmental pollution, in addition to occupying a large area of valuable land. In view of these negative implications, it is imperative to devise ways and means to reduce the growth of CBA accumulation. As CBA is listed as a scheduled waste in Malaysia, its uncontrolled disposal in landfills can be a threat to the environment.

The use of CBA in concrete production, especially for infrastructural applications, is one of the effective ways to circumvent the direct disposal of CBA, as this material can be a feasible supplementary material for cement and aggregates in concrete. The focus of this lecture is directed towards assessing the feasibility of application of CBA for concreting applications and the work that have been undertaken in that direction to date. The points that will be covered during this discussion include the utilization of coal ash especially CBA, present scenario in Malaysia and the region, characteristics of CBA, motivation and benefits of using CBA for concreting applications, demonstrating strategies, and test methods for sustainable infrastructural applications. The lecture will also cover some recent work undertaken by the authors on the microstructure, mechanical and leaching characteristics of concrete incorporating CBA.

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4. Effective Utilizations of Coal Fly Ash in Concrete : Low Heat Fly Ash Concrete
~ Dr. Somnuk Tangtermsirikul, Professor, Thammasat University, Thailand

Coal fly ash is a by-product from coal power generating industry which in general encounters large variation in properties and qualities depending on coal types, coal processing and burning, boiler types, and ash collecting process. Properties of fly ash affect properties of concrete, therefore standards and specifications for use in concrete have been prepared and used as references for quality control. However, as characteristics of fly ashes in different countries/sources are different, standards and specifications vary depending on their properties as well as concepts of their utilizations and nature of practices. The most effective use by considering both volume and value aspects at present is to use as a cement replacing material. Although a few properties of fly ash concrete are inferior to the concrete without fly ash, fly ash improves many properties especially durability. A proper use of fly ash based on types of construction work and service environments is considered to be most rational. Though there have been worldwide studies, indicating the benefit of fly ash, it still has not been effectively utilized in most countries. In Thailand, the use of fly ash in concrete started in early 1990's. Fly ash produced in Thailand has been used as a partial cement substitution material for both quality improvement and cost reduction of concrete.

As generally known, fly ash has many advantages over cement-only system such as better workability and pumpability, lower heat of hydration, lower autogenous and drying shrinkage, higher long-term strength, lower permeability, higher chloride penetration and sodium sulfate resistance, lower alkali aggregate reaction potential, while on the contrary, worsens some properties like delayed setting and early strength, lower carbonation and magnesium sulfate resistance.

In normal concrete, fly ash is normally used to replace cement in the ranges of 20 to 30% by weight of binder. Many special concrete products with higher replacement of fly ash such as marine concrete, sulfate-resisting concrete, self-compacting concrete, low-heat concrete, etc. had been launched since late 1990's. High volume fly ash concrete has been practiced in Thailand with the maximum fly ash contents up to 55% of the total binders for self-compacting concrete (SCC), 60% for low-heat concrete and 68% for roller-compacted concrete for dams, etc. Ready-mixed concrete is the major consumer of fly ash in Thailand. In Precast and Concrete Products, fly ash is normally used in the works that does not require early strength such as non-prestressed concrete. For prestressed concrete, fly ash is used up to 10% replacement except for SCC.

Recently, studies have been conducted to effectively utilized off-standard fly ashes by the authors' research group. This presentation emphasizes on the application of fly ash in mass concrete as it is one of the most beneficial and successful applications. Simulation modeling as well as analysis and examples of real mass concrete construction projects using fly ash mass concrete in Thailand will be delivered in this presentation.

5. Effect of nano-materials on microstructure and properties of UHPC
~ Dr. Shi Caijun, Professor, Hunan University, China

The mechanical properties of a fiber-reinforced concrete are closely related with the properties of the matrix, fiber, and fiber-matrix interface. The fiber-matrix bond properties is mainly governed by the adhesion between the fiber and surrounding cement materials, as well as the strength of materials at the interfacial transition zone. In this study, the effects of different nano-$CaCO_3$ and nano-SiO_2 contents on flowability, heat of hydration, mechanical properties, calcium hydroxide content, and pore structure of ultra-high performance concrete (UHPC) matrix were investigated. The dosages of nano-$CaCO_3$ were 0, 1.6%, 3.2%, 4.8%, and 6.4%, by the mass of cementitious materials, while the dosages of nano-SiO_2 were 0, 0.5%, 1.0%, 1.5%, and 2%. The influence of nano-$CaCO_3$ and nano-SiO_2 contents on mechanical properties of UHPC reinforced with 2% steel fibers was then evaluated. Test results indicated that the incorporation of 1% nano-SiO_2 or 3.2% nano-$CaCO_3$ significantly improved the fiber-matrix bond properties and the flexural properties of UHPC. This was attributed to densification and strength enhancement of ITZ as observed from micro-structural analyses. Beyond these critical values, the fiber bond and mechanical properties of UHPC decreased due to increased porosity associated with agglomeration of the nano-particles.

6. Use of Recycled Aggregates and Crushed Rock Fines for Sustainable Construction
~ Dr. Tan Jun Yew, Senior Technical Manager, Samwoh Innovation Centre Pte Ltd

As a country with limited resources, Singapore relies on imported natural resources for its construction activities. Stones and sand, known as coarse and fine aggregates respectively, are the most used natural resources in concrete construction. Many countries including Indonesia and China are taking steps to reduce or even stop the export of aggregates to other countries due to environmental concerns. This has a significant impact on the construction industry in Singapore. This presentation explores and discusses the use of recycled concrete aggregates and crushed rock fines to replace natural stones and sand used in concrete production.

7. Can You 3D-Print a Bathroom in 12 Hours
~ Dr. Wong Teck Neng, Associate Professor, Nanyang Technological University

3D concrete printing is a process of joining cementitious materials in a layer by layer manner to make physical objects from a digital 3D model. Due to its potential to decrease labor costs, reduce material waste, and create customized complex geometries that are difficult to achieve using conventional construction techniques, 3D concrete printing is gaining wide attention from both academy and industry. Researchers from Nanyang Technological University (NTU), in partnership with Sembcorp Industries subsidiaries, have developed the capability to 3D print concrete structures like prefabricated bathroom units (PBU) with 30% less material and time. Other artistic elements, such as modular façade wall and spiral vase, can also be printed using various available construction materials.

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8. Sustainable Shield Against Water-Associated Deterioration Processes in Construction Materials
~ Dr. Cai Wei, Industry Manager, Wacker Chemicals (South Asia) Pte Ltd

More durable construction materials, thus enabling longer service life, can help reduce their impact on the environment and significantly contribute to a more sustainable society. This presentation will briefly review the technical aspects of cementitious systems involving transport processes of various substances, and focus on the potential issues towards durability. The main existing technical solutions towards some of the most commonly observed adverse effects on durability will be introduced. More specifically, the latest observations on the behaviors of silicone-based materials in cementitious systems will be shared and discussed. The basic functional characteristics of silicone-based materials and the relevant working mechanisms will also be introduced.

9. Using Technology for Green and Sustainable Buildings
~ Dr. Ang Zi Yang Adrian, Manager, TP School of Engineering

Green technology makes buildings more energy-efficient and sustainable. They thus have a lower carbon footprint and a reduced impact on the environment. In new buildings, green building construction plays a role in every phase of development. Every aspect of the structure, including siting, design, construction materials, and the systems used to run and maintain operations are chosen to be as sustainable and energy-efficient as possible. In existing buildings, there are obvious challenges. Nevertheless, with the right approach and employing the right technology, there are no lack of opportunities to complete the puzzle in a sustainable urban city.

10. Sustainable Ecosystem for Research, Innovation, Enterprise (RIE) & Education
~ Dr. Leong Meng Fatt, Course Chair, TP School of Applied Science

Sustainable development is critical for Singapore as we are a nation with limited natural resources. It is essential that we make full use of these resources so that we can fulfil the needs of current generation, without adversely affecting the ability of future generations to meet their needs. Education plays an important role to equip our students with the skills and knowledge to utilize these resources in a sustainable way. In this talk, we will share how sustainability is integrated into the learning and teaching activities in the School of Applied Science. These activities are not limited to classroom teachings, but extended to skills-based training in research projects and industry internships and collaborations. This approach of incorporating education, research and industry to enhance students' learning in turn provides a sustainable education model to impart our students with the relevant skills and knowledge for today and tomorrow.

11. Design for Safety on Rooftop Greenery - A Sustainable Micro-Learning for CET Short Course
~ Ms. Noor Faridah A. Rahim, Deputy Manager, TP Temasek SkillsFuture Academy

The micro-learning course entitled "Design for Safety on Rooftop Greenery" aims to impart knowledge and encourage feasible and manageable rooftop greenery designs and related matters.

This session aspires to promote a realistic view on the many needs of trees and palms when planted on the rooftop environment. Architecture design, loading requirements, suitability of placement and safe inspection are issues to be considered during the project's design phase. Through interactive teaching using questions to foster reflection, discussions and sharing of experiences, participants will be able to apply these newly-gained insights into real-life contexts.