



**Indian Institute of Technology Bhubaneswar**

in association with

**Indian Concrete Institute (ICI)**

**Present**

**3-Day Summer School**

On

## **Low Clinker High Performance Cement Composites (HPCC)**

*June 13-15, 2018*

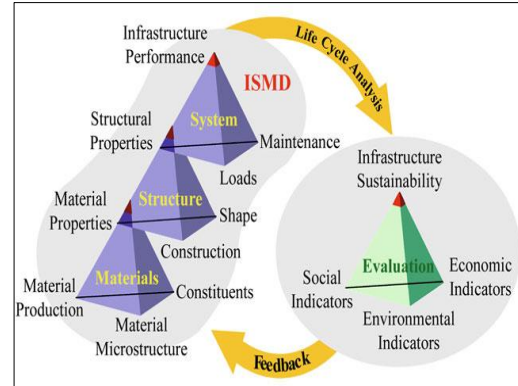
*School of Infrastructure*

*Indian Institute of Technology, Bhubaneswar*

*Jatni, Arugul*

### **Introduction**

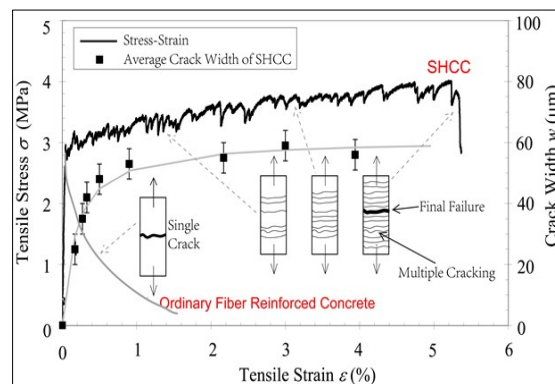
High Performance Cement Composites (HPCC) are a class of new generation construction materials combining short random fibres and cement-based matrix materials. Making such materials with low clinker binders is the latest in the historical efforts to improve the brittle tendency of cement-based materials under tensile stress and impart other functionalities, with emphasis on sustainability. Although high performance could be about a range of properties, for the purpose of the proposed course and workshop, composite strain hardening or pseudo-ductile behaviour and low clinker binder systems will be the key areas of focus along with relevant recent 'low clinker binders such as high volume fly ash and slag cements, limestone calcined clay cement (LC3), and alkali activated fly ash or slag systems known as geopolymer or alkali activated binders will be covered'. Special focus in the workshop would be on possible practical applications in India for these emerging material technologies.



### **Objectives of the summer school**

The objective is two-fold:

1. The summer course will aim to provide an opportunity for prospective researchers in the promising and fast emerging fields of research areas such as low clinker binders and HPCC, to learn from leading researchers in the field.
2. The workshop is designed to bring together active and prospective researchers from institutions, laboratories and industry from around India to help create a national network for collaboration in order to accelerate the pace of research, development and application of these novel classes of materials.





### **Expected participants**

1. For the summer course, it is expected that up to 50 postgraduate students, young faculty, research scholars and others would participate from backgrounds such as cement chemistry, material science, civil engineering and concrete technology.
2. For the workshop, it is expected that active and aspiring researchers from educational institutes, research laboratories, industry and funding bodies will participate. It will be restricted to a maximum 50 participants, by invitation only.

### **Summer School Focus**

The workshop will focus on the issues identified below:

#### **Day 1: Pseudo strain-hardening multiple-cracking cement composites**

- a. Performance Driven Design Approach (PDDA) to HPCC
  1. Linkage between structural performance requirement, material properties and micro-mechanics of composite design
  2. Requirement specification - strength vs. serviceability/durability
  3. Material properties - fracture behaviour of brittle matrix material (LEFM)
- b. Fundamentals of micro-mechanics of composite design
  1. Crack opening vs. fibre bridging stress relationship
  2. Modelling of composite tensile behaviour
  3. Critical fibre volume fraction and criteria for saturated strain hardening
- c. Tailoring of fibre, matrix and fibre-matrix interface
  1. Single fibre pull-out to determine interfacial bond
  2. Example of PVA fibre and interface oiling to reduce chemical bond
- d. Latest developments in modelling, linking micro-mechanics to structural performance

#### **Day 2: Low Clinker Cement Based Binders**

1. Basics of cement chemistry
2. Alternative cements (LC3 and geopolymeric binders)
3. Basics of pozzolanic materials
4. Durability of cementitious binders
5. Latest developments in HVFAC and geopolymeric binders (marine concrete)
6. Environmental issues
  - a. Impact on climate change
  - b. Energy content and carbon footprint

#### **Day 3: High performance cement composites/matrix design principles**

1. Different types of HPCCs
  1. Self-healing HPCCs
  2. Self-sensing HPCCs
  3. Green HPCCs
  4. Geopolymeric HPCCs
2. Latest developments in high volume fly ash and geopolymeric binders
3. Alternative fiber options
4. Real life case studies and lessons learnt
5. Life cycle costing
6. Demonstration of HPCC material preparation and testing
  - i. Material mixing
  - ii. Direct tension / flexure test
  - iii. Measurement of matrix fracture toughness  $K_{IC}$

#### **Resource Persons**

The resource persons will include the following as teaching faculty and participants.

- Prof Nilanjan Mitra, IIT Kharagpur
- Prof Ravindra Gettu, IIT Madras
- Prof Dinakar Pasala, IIT Bhubaneswar
- Prof Durgesh Rai, IIT Kanpur
- Prof K Subramaniam, IIT, Hyderabad
- Dr Dhanada K Mishra, KMBB CET, Khurda
- Prof Radhakrishna G. Pillai, IIT Madras
- Prof Prakash N, IIT Bombay
- Prof B Hanumantha Rao, IIT Bhubaneswar
- Dr. Behzad Nematollahi, Swinburne University, Melbourne, Australia
- Dr Jing Yu, HKUST, Hong Kong



### **Advisory Group**

#### *Oversees*

- Prof Christopher Leung, Professor, Hong Kong University of Science and Technology
- Prof Victor C Li, E. Benjamin Wylie Collegiate Professor, University of Michigan
- Prof S. P. Shah, Walter P. Murphy Emeritus Professor of Civil and Environmental Engineering, North Western University
- Professor B. Vijaya Rangan, Emeritus Professor of Civil Engineering, Curtin University, Perth, Australia
- Dr Karthik Obla, PE, FACI Vice President, Technical Services (NRMCA),

#### *India*

- Prof Shamsheer Singh, BITS Pilani
- Prof Shashank Bishnoi, IIT Delhi
- Shri V R Kulkarni, RMC India Ltd
- Dr. Manmohan Kalgil, ICI President
- Chairman, Sambad Ama Odisha Trust
- Shri S K Dash, ED, NALCO
- Prof R. K. Panda, Dean – R &D, IIT Bhubaneswar
- Prof R. V. Rajakumar, Director – IIT Bhubaneswar

### **Participation Fee for Summer School**

- Participants from academic institutions - Rs 3000/- per person.
- Participant from corporate and other organizations - Rs 5000/- per person.

Participation fee includes course material as well as lunch & snacks. It does not include accommodation. However, accommodation can be provided in the institute guest house on payment basis.

### **Application Deadline**

Kindly send an e-mail regarding your participation, latest by **April 30, 2018**. In the subject of your e-mail – please mention ‘Summer School 2018 @ IIT Bhubaneswar’.

### **Contact**

Prof Dinakar Pasala - [pdinakar@iitbbs.ac.in](mailto:pdinakar@iitbbs.ac.in)  
Prof Dhanada K Mishra - [dhanadam@ust.hk](mailto:dhanadam@ust.hk)  
Prof Hanumantha Rao – [bh Rao@iitbbs.ac.in](mailto:bh Rao@iitbbs.ac.in)



**REGISTRATION FORM**

**3-Day Summer School**

On

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Name: \_\_\_\_\_

Designation: \_\_\_\_\_

Organization/Institution: \_\_\_\_\_

Postal address: \_\_\_\_\_

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Tel. (Off.): \_\_\_\_\_

Mobile: \_\_\_\_\_

Email: \_\_\_\_\_

ICI Membership No: \_\_\_\_\_

Cheque/ DD No.: \_\_\_\_\_

Dated: \_\_\_\_\_

Amount (INR): \_\_\_\_\_

Place: \_\_\_\_\_

Signature