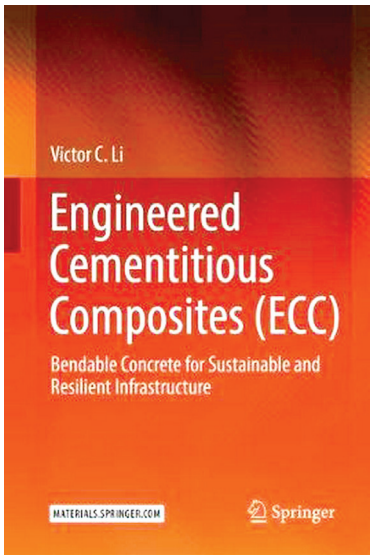
ENGINEERED CEMENTITIOUS COMPOSITES (ECC): BENDABLE CONCRETE FOR SUSTAINABLE AND RESILIENT INFRASTRUCTURE



SHAMSHER BAHADUR SINGH*

At the onset, I express my deep sense of gratitude to the ICJ team for giving me an opportunity to review the book by Prof. Victor C. Li. I had an opportunity to meet him in 2008 at Dundee during UKIERI Concrete Congress held at University of Dundee and had very interesting technical interaction with him related to the processing of Engineered Cementitious Composite (ECC). That interaction has been very helpful both for me and my research team at BITS Pilani, leading to the effective execution of my projects on ECC. This book has been very nicely written and is divided into 10 chapters, sharing my comments and feedback on this.

Chapter 1 deals with the introduction and is found to be very instructive for all category of readers be it graduate students, researchers, and/or practitioners. Difference between the ECC, Ultra-High Performance Concrete, and Fiber Reinforced Concrete has been well described and the importance of ECC for making of structures and infrastructures with appropriate resilience, durability and sustainability has been demonstrated. Likewise, Chapter 2 describes the micromechanics concepts as the design basis for developing ECC as strain hardening materials like metals suitably choosing the fiber, matrix, and fiber-matrix interfacial properties. Chapter 3 describes the significance of effective processing of ECC for achieving the desirable strain-hardening characteristics along with processing requirements for self-consolidating casting, shotcreting, and extrusion. The important factors governing the fresh properties of the ECC have been described in a very simple way. It has been shown that the fiber dispersion uniformity is of critical importance to the robustness of composite hardened properties. In Chapter 4, mechanical characterization along with test methods have been described. It has been highlighted that additional research is needed to understand and control the behaviour of structures under sustained tension and low amplitude fatigue loading. Chapter 5 provides the details of constitutive modelling of ECC which can be helpful in the deployment of Integrated Structural and Materials Design (ISMD) approach. In this approach, targeted structural performance is downlinked to the composite properties and material composition and microstructures which in turn provides the basis for ECC material design for optimal structural performance. This chapter is really important for computer simulation of structural response using commercial software packages. This chapter also highlights for further research on extention of the current multi-scale approach to complex loading cases such as impact or cyclic loading.

Chapter 6 deals with the improving structural resilience using ECC. It has been shown that under reversed or reverse cyclic loading, the hysteresis envelop tends to be more stable in R/ECC elements even at relatively high drifts. This mechanism could be used for exploiting R/ECC as coupling beams or structural dampers. Thus this chapter has great relevance as far as ductility of structures is concerned. Chapter 7 is about durability aspects of R/ECC. ECC made structures are having high durability due to its intrinsically tight crack width in ECC. It has been shown that the ECC offers great resistance to permeation, diffusion, and sorption of aggressive agents through micro-crack width and hence make it more durable with respect to normal and high strength concrete

*Corresponding author : Shamsher Bahadur Singh, email : sbsinghbits@gmail.com

especially under mechanically loaded states. Thus details presented in this chapter will be useful for durability based design of structures using ECC. Chapter 8 shows how ECC as a new construction material can be developed to make sustainable structures by reducing the embodied energy and carbon intensity with judicious choice of material ingredients by incorporating as much materials from industrial waste as possible or incorporating the renewable material. Definition of sustainability of structures and/ or infrastructures has been outlined very nicely. It has been shown that ECC infrastructure derives its sustainability mainly from its durability under a variety of exposure conditions. It has been shown that the combination of enhanced material greenness and durability in ECC provides a strong platform for the development of sustainable civil infrastructure. In Chapter 9, applications of ECC for building, transportation, and water infrastructure domains are described based on the performance requirements of structures and use of specific characteristics of ECC material. A very good summary of applications has been presented in Table 9.2 of this chapter. In Chapter 10, which happens to be the last chapter of the book, potential of the ECC as multi-functional material has been presented. This demonstrates that the ECC could be used as thermal adaptive ECC, self-healing ECC, Photo-catalytic ECC, and self-sensing ECC. Thus, while offering enhancements in infrastructure resilience, durability, and sustainability, ECC can also offer multi-functionalities and could be useful for developing future smart cities and infrastructures.

Thus, based on the review of the all the 10 chapters of this book, the reviewer is highly appreciative of the hard, rigorous, and intelligent work of Prof. Victor C. Li for publishing such a nice, informative, and most importantly, educative book for graduate students, researchers, and practitioners. The reviewer feels that the last chapter could be very useful for innovative research works where potential of the ECC could be investigated for its multi-functionalities for making future sustainable infrastructures for smart cities. It could have been better for the author to introduce some design examples to demonstrate the effectiveness of ECC as material to enhance ductility, durability, and sustainability. In more specific terms, a sustainability based design example for ECC based structures could have been useful to the students and practitioners. Overall, the book has excellent information and has been well-written in lucid English language.

SHAMSHER BAHADUR SINGH is an ICI member and Professor of Civil Engineering Department at Birla Institute of Technology and Science (BITS), Pilani. His current areas of research are development of design guidelines for Fiber Reinforced Polymer (FRP) reinforced prestressed concrete structures in particular and composite structures in general including nonlinear finite element modeling. He has over 32 years of teaching and research experience. He is a member of various committees and serves as an editorial board member of various Journals. Currently, he is representing BITS Pilani on committee of Ireland-India Concrete Research Initiatives (IICRI). Prof. Singh has been awarded Professinal Engineer (Civil) License from State of Michigan, USA and Chartered Engineer (India) as fellow of Institution of Engineers. He has authored more than 175 research papers, 13 research reports and text books. Prof. Singh has had an opportunity to teach in some of the best universities, both in India and in USA.

Cite this article: Singh, S.B. (2020), "Engineered Cementitious Composites (ECC): Bendable Concrete for Sustainable and Resilient Infrastructure." *The Indian Concrete Journal,* Vol. 94, No. 6, pp. 74-75.