Material Characteristics and Structural Applications of Engineered Cementitious Composites

S. B. Singh
Senior Professor, Birla Institute of Technology & Science, Pilani, Rajasthan -333031, India

Abstract:

Engineered Cementitious Composite (ECC) is a cement based composite material containing discontinuous short polymeric fibers performing strain hardening behavior and high ductility based upon its micromechanics. Micro-mechanics mean that a micro-mechanical model is developed for the mechanical interaction between fiber, matrix, and interface which relates these constituent properties to composite response. ECC has high ductile properties after the first crack and due to this property, it is also known as Ductile Fiber Reinforced Composite (DFRCC). ECC exhibits strain-hardening performance with multiple micro-cracking during the inelastic deformation unlike the conventional fiber reinforced composite. This study reviews the properties of ECC and differentiate its behavior with High Performance Fiber Reinforced Cementitious Composites (HPFRCC) and other Fiber Reinforced Concrete (FRC). Moreover, this study provides an insight on application of ECC in the structural engineering so far around the world. Furthermore, an experimental study has been performed to determine the efficiency of precast ECC sheets for strengthening of masonry walls. The precast ECC sheets are pasted to masonry walls by use of epoxy as adhesive. The out-of-plane response of the unstrengthened and strengthened masonry walls are determined. The present study shows that the application of precast ECC sheet increases the load bearing capacity and ductility of the masonry walls and hence demonstrates its performance as strengthening element for brick masonry structures. The concluding remarks of the study are summarized as follows:

i. ECC has the properties of tensile strain-hardening behavior and excellent crack dispersion capacity which make it better than the conventional concrete and FRC. Also, the material could be used in fabrication of plastic hinges as mechanism of ductility enhancements in Reinforced Concrete Structures.

ii. The failure load of ECC strengthened masonry walls are observed 5.47 times higher than the unstrengthened specimens.

iii. It is observed that ECC is very promising material for strengthening purpose. The precast ECC sheet is recommended for strengthening purpose.

iv. The ECC has high potential to enhance the strength and ductility of both the concrete and masonry structures leading to reduction in the amount of steel reinforcements at critical sections.

Bio-sketch: Prof. (Dr.) Shamsher Bahadur Singh

Prof. (Dr.) Shamsher Bahadur Singh is a licensed Professional Engineers [P.E. (Civil) in the state of Michigan, USA and have Post-doctorate from the Lawrence Technological University (LTU), USA. Prof. Singh is elected fellow from six prominent International Organizations such as (i) Fellow of American Society of Civil Engineers (F. ASCE), (ii) Fellow of Structural Engineering Institute (F.SEI) of ASCE, (iii) Fellow of Coalition Disaster Resilience Infrastructure (F. CDRI) (iv) Fellow of Institution of Civil Engineers (FICE) of U.K. (v) Fellow of Indian Association of Structural Engineers (FIAStructE), and (vi) Fellow of Institution of Engineers (F.IE). He is designated Chartered Engineer (INDIA), and currently working as Senior Professor of Department of Civil Engineering at Birla Institute of Technology and Science (BITS), Pilani. Prof. Singh is recipient of several fellowships such as Post-doctorate from the Lawrence Technological University (LTU), USA, Quality Improvement Program Fellowship at Indian Institute of Technology Kanpur, Junior Research Fellowship at Motilal Nehru National Institute of Technology (MNNIT), Allahabad, and National Merit Scholarships at NIT Warangal. He has about 36 years of teaching, research, and administrative experience at International level. He has 262 publications to his credit which include more than 200 research papers (104 Journals plus 97 conference papers), 12 books [Three printed text books, one online text book, and eight edited books], 14 research reports and 30 book chapters, 02 theses, and 3 Patents in addition to being Who is Who of various organizations. Prof. Singh is active member of various Technical Committees such as ACI 440, ACI 423, ASCE/SEI 7-Minimum Design Loads, CED 54 Committee of BIS, ISO/ TC 71/ SC 6/ WG 6. The current areas of research of Prof. Singh are development of design guidelines for Functionally Graded Composite materials and Fiber Reinforced Polymer (FRP) reinforced prestressed concrete structures in particular and composite materials and structures in general including nonlinear finite element modeling. Prof. Singh has executed a total of 45 research and consultancy projects funded by the International and National funding agencies.