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Micro structure analysis and digital image processing of monofilament and fibrillated fiber reinforced recycled aggregate concrete

Ramalingam Vijayalakshmi, Aswin G. Sriram, Ramaiah Prakash, Nagarajan Divyah, Ramalingam Geetha

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Abstract

The rising demolition rate of old infrastructure has led to a substantial increase in the accumulation of recycled aggregate, posing a significant threat to environmental

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compared to conventional natural aggregate, making it necessary to enhance its mechanical properties for practical application. This study investigates the effectiveness of incorporating plastic (PF) and polypropylene (PP) fibers in hybrid configurations to enhance the mechanical and microstructural behaviour of hybrid fiber-reinforced recycled aggregate concrete (HFRAC). The influence of recycled aggregate replacement, hybrid fiber combination and fiber dosage on the mechanical properties, failure mechanism and stress-strain behaviour were studied. Three plastic fibers dosages (i.e., 0.5%, 1% and 2%), and three hybrid fibers combination was (0.5% PF+0.5% PP; 0.75% PF+0.25% PP; 1.5% PF+0.5% PP) tested. Totally 10 different cases of recycled aggregate concrete without fiber, with single fibers and with hybrid fibers were tested. The RAC25-PF0.75-PP0.25 mix achieved a maximum compressive strength of 43.56 MPa, marking a 7% increase over plain RAC. Flexural strength improved by approximately 4%, and splitting tensile strength by 5.5%. Stress-strain behaviour showed a transition from brittle to ductile failure with hybrid fiber addition. SEM and digital image processing confirmed enhanced ITZ density, reduced porosity, and effective crack-bridging. These results validate HFRAC as a sustainable and high-performance alternative for structural applications.

Keywords

digital image processing hybrid fiber micro fiber micro structural analysis plastic fiber recycled aggregate

Affiliations

Ramalingam Vijayalakshmi — Department of Civil Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, India

Aswin G. Sriram — Department of Civil Engineering, Sri Sivasubramaniya Nadar College of Engineering, Chennai, India

Ramaiah Prakash — Department of Civil Engineering, Alagappa Chettiar Government College of Engineering and Technology, Karaikudi, India

Nagarajan Divyah — Department of Civil Engineering, PSG Institute of Technology and Applied

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