Experimental investigation of eco-friendly high strength fiber-reinforced concrete developed with combined incorporation of tyre-steel fiber and fly ash

Tauqueer Akhtar\textsuperscript{a,b}, Babar Ali\textsuperscript{a}, Nabil Ben Kahla\textsuperscript{c,d}, Rawaz Kurda\textsuperscript{e,f,g,*}, Muhammad Rizwan\textsuperscript{a}, Mohammad Mohsin Javed\textsuperscript{a}, Ali Raza\textsuperscript{h}

\textsuperscript{a} Department of Civil Engineering (CVE), COMSATS University Islamabad (CUI)-Sahiwal Campus, Sahiwal 57000, Pakistan
\textsuperscript{b} Department of Civil Engineering, University of Engineering & Technology, Lahore 54000, Pakistan
\textsuperscript{c} Department of Civil Engineering, College of Engineering, King Khalid University, PO Box 394, Abha 61411, Saudi Arabia
\textsuperscript{d} Applied Mechanics and Systems Research Laboratory, Tunisia Polytechnic School, University of Carthage, Le Marsa, Tunisia 2078, Tunisia
\textsuperscript{e} Department of Highway and Bridge Engineering, Technical Engineering College, Erbil Polytechnic University, Erbil 44001, Iraq
\textsuperscript{f} Scientific Research and Development Center, Nawras University, Duhok 42001, Iraq
\textsuperscript{g} CERIS, Civil Engineering, Architecture and Georesources Department, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001 Lisboa, Portugal
\textsuperscript{h} Department of Civil Engineering, University of Engineering and Technology, Taxila, Pakistan

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A B S T R A C T

Simultaneous addition of waste fibers and supplementary cementitious materials is a novel and eco-friendly approach to resolve the issues related to brittleness and environmental impact of plain-concrete (PC). This study examines the concrete mixes incorporating different levels of recycled-tyre steel fiber (RTSF) (0, 0.25, 0.5 and 1% by volume fraction) and low-calcium fly ash (FA) (0, 10, 15, 25, and 35% by volume replacement of cement). The studied properties include compressive strength, tensile strength, modulus of rupture, water absorption, and electrical resistivity. The experimental results showed that the simultaneous addition of 10−15% FA and 0.25%−0.5% RTSF can enhance the ductility and imperviousness of concrete. The maximum efficiency of RTSF in suppressing the reference concrete mix containing 10% FA. Whereas rise in FA content beyond 15% decreased the overall mechanical strength and efficiency of RTSF. The high strength concrete mix containing 10%FA and 0.5%RTSF showed 83%, 49% and 19% higher MOR, f_{sp}, and f_{as}, respectively than the reference concrete mix. FA at all levels and RTSF at 0.25−0.5% volume was beneficial to the imperviousness of high strength concrete. All FA levels (i.e., 10−35%) can minimize the electrical conductivity of RTSF-reinforced concrete mixes with respect to the reference mix.

1. Introduction

Due to massive demands for concrete, cement industry single-handedly contributes 7% to the total global warming gases produced [1]. The production of one kilogram of cement produces about 0.75−1 kg of green-house gas emissions [2]. Therefore, about 88% carbon footprint of concrete is dependent on the cement [3,4]. In order to lower the carbon footprint of concrete, it is essential to minimize the consumption of cement for concrete production. The most common method to bring down the environmental impact of concrete is to replace the cement with some suitable waste supplementary cementitious material (SCM). Commonly found SCM like FA when used as the cement-replacement materials yield multiple benefits. SCMs incorporation not only lessen the energy footprint of concrete but it also helps in managing huge

\textsuperscript{*} Corresponding author.

E-mail addresses: engr.tauqueer@cui.islamabad.edu.pk (T. Akhtar), babar.ali@cui.islamabad.edu.pk (B. Ali), nbohlal@kk.edu.sa (N. Ben Kahla), rawaz.kurda@tecnico.ulisboa.pt (R. Kurda), fa17-cve-015@students.cuisihiwal.edu.pk (M. Rizwan), fa17-cve-008@students.cuisihiwal.edu.pk (M. Mohsin Javed), ali.raza@uettaxila.edu.pk (A. Raza).

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