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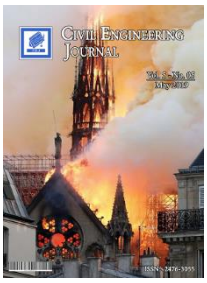

A Comparative Study on the Flexural Behaviour of Rubberized and Hybrid Rubberized Reinforced Concrete Beams

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Abstract

This paper aims to investigate the flexural behaviour of the rubberized and hybrid rubberized reinforced concrete beams. A total of fourteen beams, 150×200 mm in cross-section with 1000 mm in length, were subject to a laboratory test over an effective span of 900 mm. The sand river aggregate was replaced by 10%, 12.5%, and 15% of crumb rubber (volume). The hybrid structure contained two double layers: 1) rubberized reinforcement concrete at the top layer of the beam and 2) reinforcement concrete at the bottom layer of the concrete beam. The static responses by the flexural test of all the beams were evaluated in terms of their fresh properties, failure patterns, total energy, flexural strength, stiffness, and ultimate deflection, modulus of rupture, strain capacity, and ductility index. The results showed that there were improvements when the hybrid beams were used in most cases such as failure pattern, ultimate load, stiffness, modulus of rupture, and stress. The rubberized concrete beams showed improvements in the strain capacity as illustrated in strain gauges and stress-strain curves, toughness, ultimate deflection, and ductility index. The findings of the study revealed an improved performance with the use of the hybrid beams. This has resulted in the implementation of innovative civil engineering applications in the engineering sustainable structures.

Keywords: Rubberized Concrete; Hybrid-Rubberized Concrete; Crumb Rubber; Double Layers.

1. Introduction

There exist billions of scrap car tires per annum, which represents a significant environmental issue around the globe [1]. Significant benefits can, therefore, be achieved when these expired tires are reused in different civil engineering applications such as concrete. Sustainable concrete can be obtained and the dangerous substances of tires in the environment can be reduced [2]. Regarding such a critical environmental issue, studies (small-scale specimens) were published during the last twenty years. These studies focused on the use of crumb rubber particles as an alternative to using sand aggregates replacement at different ratios. The findings showed a decrease in the mechanical properties of concrete and low workability, which were increased when the percentage of rubber replacement increased [3]. However, different findings revealed that toughness, strain capacity, ductility, and cracking resistance and reduction of self-weight have improved [4, 5]. Ismail et al. [6] Conducted flexural testing in large-scale of structural beams made of rubberized concrete ranged from 5 to15% of fine aggregate replacement. They pointed out that, with the increase of crumb rubber it will lead to the reduction of crack widths and increased the number, reduce self-weight of concrete, decrease in toughness when exceeded 15% of crumb rubber contents. Another study on large scale beams was carried out by Mendis et al. [7] to evaluate the efficacy of different ratio of crumbed rubber on beams with and without shear reinforcements.

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