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Experimental Investigation and Statistical Modeling of FRP Confined RuC Using Response Surface Methodology

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Abstract

Scrap tires that are dumped to landfill is a serious problem in China and rest of the world. The use of rubber in concrete is an effective environmental approach to reduce the amount of scrap tires around the world. However, the loss in compressive strength of concrete is a major drawback of rubberized concrete. In this paper, the fiber reinforced polymer (FRP) confinement technique is used to overcome the drawbacks of rubberized concrete (RuC). A total of sixty six RuC cylinders were tested in axial compression. The cylinders were cast using recycled rubber to replace, a) 0-50 percent fine aggregate volume, b) 0-50 percent coarse aggregate volume, and c) 40-50 percent fine and coarse aggregate volume. Twenty seven cylinders of the latter mix were then confined with one, two and three layers of CFRP jackets. Concrete suffered a substantial reduction in compressive strength up to 80 percent by fine and coarse aggregate replacement with rubber content. However, CFRP jackets recovered and further enhanced the axial compressive strength of RuC up to 600% over unconfined RuC. SEM was performed to investigate the microstructural properties of RuC. Statistical models were developed on the basis of experimental tests for FRP confined RuC cylinders using response surface method. The effect of variable factors; unconfined concrete strength, rubber replacement type and number of FRP layers on confined compressive concrete strength was investigated. The regression analysis was performed to develop the response equations based on quadratic models. The predicted and experimental test results were found in good agreement as the variation between experimental and predicted values were less than 5%. Furthermore, the difference between predicted and adjusted R^2 was found to be less than 0.2 which shows the significance of the statistical models. These proposed statistical models can provide a better understanding to design the experiments and the parameters affecting FRP-confined RuC cylinders.

Keywords: FRP; Concrete; Cylinders; Response Surface Methodology; Rubberized Concrete.

1. Introduction

Scrap tire management has become a serious issue due to the increase in tire production. Worn out tires cause serious health and environmental issues. Scrap tires contain a high percentage of volcanized rubber which is difficult to recycle. Tires can also catch fire resulting in increased cost to extinguish it. Rubber content can be partially replaced by mineral aggregates in concrete, which is one of the possible recycling approaches. Several advantages of rubber have been reported in the literature [1]. High strength, flexibility and the ability to maintain its volume under compressive loading are some of the advantages of rubber. However, the addition of rubber can cause a significant loss in mechanical properties of concrete [1-5]. The reduction in compressive strength of rubberized concrete is a major drawback of using RuC in engineering practice [1]. A lot of studies have been conducted for partial replacement of mineral aggregate by

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