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Experimental Study on The Effect of Size, Type, and Replacement Ratio of Recycled Aggregate on The Mechanical Properties of Reactive Powder Concrete

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Abstract: This paper presents an experimental investigation of the mechanical characteristics of Reactive Powder Concrete (RPC) and Recycled Aggregate Reactive Powder Concrete (RPC-RA), utilizing two types of recycled aggregate (RA), recycled concrete aggregate (RCA), and recycled concrete brick aggregate (RCBA) as alternative aggregates. A series of sixteen RPC and RPC-RA mixes were prepared and tested. A reference RPC mix without RA was tested to determine the maximum compressive strength of 128.17 MPa, the tensile strength of 15.56 MPa, and the flexural strength of 25.90 MPa. Then, the study examines twelve different mixes of RPC-RA, each with RCA with maximum particle sizes of 0.6, 1.18, 2.36, and 4.75 mm and replacement ratios of 20%, 40%, and 60%, to study the effects of varying replacement ratios of the RCA and various maximum particle sizes. Additionally, three mixes of RPC-RA are investigated using RCBA with a maximum particle size of 0.6 mm and replacement ratios of 20%, 40%, and 60%. The use of RA resulted in various percentages of reduction in compressive, splitting, and flexural strength, as shown in the results of the study.

Keywords: Reactive Powder Concrete, Recycled Aggregate, Crushed Concrete Aggregate, Crushed Concrete with Brick Aggregate, Sustainable RPC.

1. Introduction

As concrete is one of the most important materials used in construction work around the world [1], researchers have tried for many years to produce a new type of concrete characterized by unusual specifications with very high resistance and durability and can be operated and used on work sites at a low cost. Reactive powder concrete (RPC) is one of the most significant types of concrete. It is also referred to as ultra-high-performance concrete (UHPC) due to its superior characteristics and high resistance [2]. RPC has excellent mechanical properties. It contains a silica fume-cement mixture with superplasticizer, steel of fiber, and ratio of water to cement (w/c) that is low, it is distinguished by the existence of very small particles of sand (600 μm) instead of typical aggregate [3]. The first researcher who produced this type of concrete was Pierre Richard with Marcel Cheyrezy in 1994 [4]. The construction industry is one of the most responsible economic sectors for working with natural resources and producing waste. Construction and demolition processes involving the use of concrete contribute significantly to recycling accumulation. Each year, thousands of tons of concrete are produced worldwide [5]. Masood et al. (2012) [6] estimated that every year, the amount of concrete demolition waste in the United States and the European Union reaches 100 million tons. Given the high costs of transportation and disposal and a lack of suitable sites for receiving these materials. These huge quantities of waste are presently one of the greatest challenges and concerns in the construction industry. The recycling of concrete waste by pulverizing and grinding it to a classification similar to that of regular sand and producing an alternative aggregate for RPC is an option for responding to these problems. Recycled reactive powder concrete (RRPC) containing this recycled concrete aggregate is accepted internationally. Chkheiwer and Kadim (2019) [7] The availability of the proposed materials in the local market helps to conclude a better cost and higher economic concrete. To assess their effects on concrete compressive strength, the study examined curing processes, sand particle size distribution, binder type and ratio, and steel fiber content. The curing technique, which required 5 days