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Abstract

Mechanical Properties and Structural Requirements of Recycled Aggregate Concrete for Pavements

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In recent years, the recycling of waste materials has attracted considerable attention due to the scarcity of natural resources on earth. For instance, researchers have been working on various techniques to utilize construction and demolition wastes as substitutes for natural materials in the construction industry, which is one of the major consumers of natural resources. From this point of view, concrete roads, as one of the frequently used infrastructural facilities [1] of the construction industry, have significant environmental impacts during their construction period and service life in different aspects. Therefore, great importance should be given to the construction of concrete roads to minimize their environmental impacts considering their dependence on the high volume of concrete production. Using recycled materials to produce the concrete roads is one of the methods implemented in this respect, as their usage provides benefits through natural resources and landfill conservation [2].

The use of recycled aggregates to reduce the environmental impact of concrete is one of the well-known methods, and their impacts on performance have been studied in various respects up to now. However, the number of studies on structural requirements of concrete pavements produced with recycled aggregates is very limited. This study aimed to investigate the structural performance of concrete pavements produced with recycled coarse aggregates as total (100%) and partial (50%) replacement of natural coarse aggregates.

To this end, three different concrete pavement mixtures (Control, RAC-50, and RAC-100) were designed and tested for compressive strength, modulus of elasticity, flexural strength, and density. Then, material parameters obtained from the applied tests were used to determine the required thickness values for a sample pavement (based on IRC 58 [3]), and the results were compared.

According to the test results, percent reduction compared to control mixture in average compressive strength, modulus of elasticity, flexural strength, and density values were 12.7, 7.7, 16.5, and 2.5 for RAC-50, and 18.9, 14.0, 24.9, and 4.5 for RAC-100, respectively. Test results indicate that the reduction in all the measured parameters increased with an increase in the replacement ratio of natural coarse aggregates with recycled coarse aggregates. The required concrete pavement thickness values for Control, RAC-50, and RAC-100 mixtures were determined to be 18, 20, and 23 cm, respectively (for the sample road and traffic data considered). The required thickness increased with an increase in the amount of recycled aggregate utilized (11% and 25% increase for RCA-50 and RCA-100,

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respectively). Besides, concrete pavement thickness values were well-correlated with the flexural strength values obtained for the corresponding concrete mixtures.

To summarize, this study numerically presented the change in the mechanical performance of concrete due to the replacement of natural coarse aggregate with recycled aggregate and the effect of obtained performance on the thickness requirement of a sample pavement. It should be noted that the test results are dependent on the properties of recycled aggregate used in this study, and various aggregate sources may yield different results.

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