Research Project*: SP109B4G-2*
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RESEARCH SUMMARY

ENVIRONMENTAL SUITABILITY OF RECYCLED CONCRETE AGGREGATE IN HIGHWAYS

Problem

Natural highway aggregate is a finite resource that with continued use in construction activities but some good quality aggregates used in existing concrete structures may be re-used to replace with the natural aggregate. Due to the repair or replacement of aging infrastructure, the increasing quantity of construction demolition waste generated, such as concrete aggregates, cannot be wasted in landfills. Using recycled concrete aggregate to replace with the natural graded aggregate base (GAB) or as Foamed Asphalt in highway construction can contribute to a reduction in of greenhouse gas emission and energy consumption but other environmental concerns need to be addressed.

Therefore, the Maryland State Highway Administration (SHA) initiated a study to evaluate the environmental sustainability of the use of recycled concrete aggregate (RCA) as base material in for pavement construction.

Objective

The primary objective was to evaluate the geomechanical and environmental suitability of RCA in highway systems. The deliverables include a set of guidelines for testing methods and modulus-stress models for RCA and RCA-GAB mixtures, and a discussion of influencing factors on stiffness and metal leaching from the RCAs.

Description

The study was conducted to evaluate the mechanical properties of two different types of materials used in highway base layer constructions (GAB and RCA) and the environmental suitability of RCA. These properties were defined through a set of laboratory geotechnical tests on GAB, RCA, as well as RCA-GAB mixtures. The mechanical tests included California bearing ratio (CBR), resilient modulus, and permanent deformation tests. The effects of curing and winter conditions were also evaluated by performing resilient modulus tests on the RCA specimens after curing and a series of freeze-thaw cycles. The environmental suitability (metal leaching) of RCA and RCA-GAB mixtures was studied through laboratory batch water leach tests (WLTs, Figure 1). The laboratory leaching tests investigated the effects of freeze/thaw cycles, curing time, liquid-to-solid ratio, pH, and particle sizes on the leaching behavior of metals.

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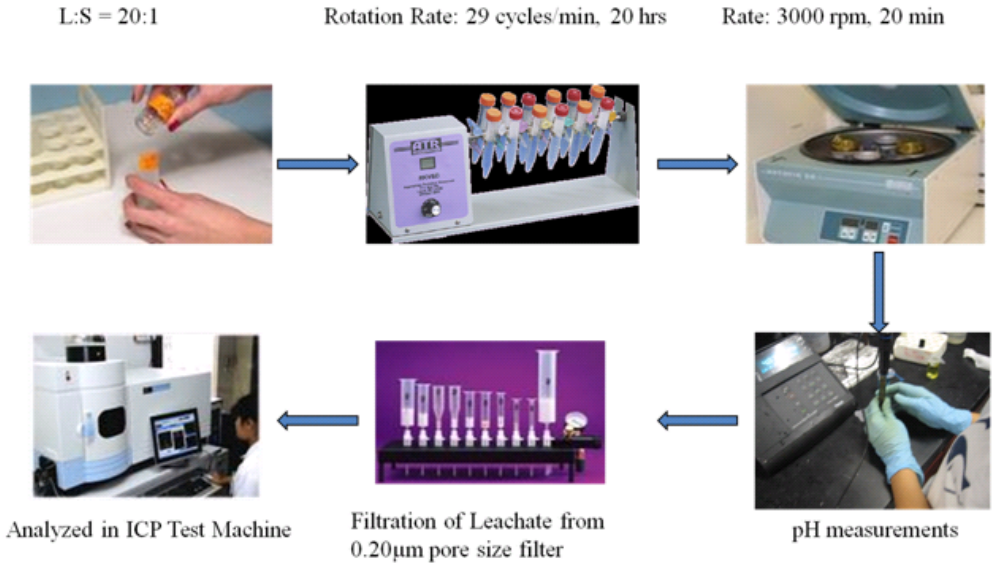

Figure 1

Results

The RCA materials had higher CBR and resilient moduli than the regular GAB materials due to presence of higher CaO content. The RCA materials experienced a 0.98-2.1 times increase in SM_R with increasing freeze-thaw cycles due to the ongoing hydration process during freezing and thawing. Curing of RCA materials decreased the effluent pH and leached Ca, Cu, and Cr concentrations due to the rehydration of cement particles in the RCA aggregate matrix. The GAB materials showed lower permanent deformation (plastic strain) than both RCA materials indicating that regular GAB tended to provide better resistance under constant loads.

Based on these test results, RCA has satisfactory mechanical properties and can be a valuable alternative material for use in highway base/sub-base construction. Additional laboratory and field studies involving a variety of GAB and RCA materials are necessary to optimize the use of RCA in highway applications while safeguarding the environment.

Report Information

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Link to Report: http://www.roads.maryland.gov/OPR_Research/MD-15-SP109B4G-2_RCA-GAB_Report.pdf