Kansas Department of Transportation

TECHNICAL SUMMARY

Evaluation of Low-Quality Recycled Concrete Pavement Aggregates for Subgrade Soil Stabilization

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Introduction

Natural aggregate resources, although vast, are finite. The cost of using natural aggregates in construction projects is rising due to the scarcity of economic sources, especially near urban areas, and increasing haul distances. In addition, the depletion of natural resources has undesirable environmental impacts; thus, environmental regulations further limit the opening of new quarries or the expansion of existing aggregate quarries. Unfortunately, construction waste produced in the United States and around the world continues to increase each year. The massive production of construction waste raises economic and environmental concerns, particularly related to landfilling. However, the use of recycled concrete aggregate (RCA) as a substitute for virgin aggregates helps conserve natural aggregates and reduces the amount of waste entering landfills while conserving significant amounts of energy used to process and transport virgin aggregates and remove construction waste.

Although many state Departments of Transportation (DOTs) have used recycled concrete as aggregates in pavement construction, the acceptance of RCA usage in pavement applications has varied. The properties of RCA differ from those of natural aggregates primarily due to the recycled mortar in RCA, which consequently alters pavement layer performance. As such, many highway agencies are reluctant to use RCA in the surface layer, choosing instead to primarily utilize these materials in unbound bases. Although experience using RCA for subgrade soil stabilization is limited, especially RCA from low-quality sources such as D-cracked pavements, RCA usage offers the potential for pavement performance improvement, elimination of ever-increasing waste stream, and reduction of costs associated with subgrade soil stabilization. D-cracking is a form of concrete pavement deterioration that appears on the pavement surface as a series of closely spaced cracks generally parallel to transverse and longitudinal joints. Coarse aggregates are susceptible to D-cracking. Freeze-thaw (F-T) cycles and moisture are the primary contributors to D-cracking. To date, no known work has evaluated the effectiveness of a combination of RCA and chemical stabilizers for subgrade soil stabilization.

Project Description

The primary objective of this study was to investigate the suitability of D-cracked RCA for subgrade stabilization for hot-mix asphalt (HMA) pavements. This research also evaluated the strength, stiffness, and shrinkage potential of clay subgrade beneath HMA pavements stabilized using D-cracked RCA and various stabilizers. The selected stabilizers were lime, Class C fly ash, and a combination of portland cement and Class C fly ash. Potential soil improvement was assessed via compaction, unconfined compressive strength (UCS), California Bearing Ratio (CBR), and linear shrinkage tests. In addition, this study used scanning electron microscopy (SEM) and energy dispersive X-ray (EDX) analysis to investigate the RCA-clay interaction to identify the effects of RCA on the microstructure of stabilized mixtures. Finally, this research sought to predict the long-term performance of stabilized mixtures using the AASHTOWare Pavement ME Design software and assess the potential cost savings of using RCA via life-cycle cost analysis (LCCA).

Project Results

The two sources of RCA used in this study, Topeka and KC, performed satisfactorily, although Topeka mixtures outperformed KC mixtures in strength and stiffness. Topeka had higher qualities of absorption capacity, specific gravity, toughness, soundness, and aggregate stiffness. However, KC showed superior shrinkage performance, which correlated with the higher porosity of KC aggregate. Overall results of this research showed that, although RCA properties vary widely, they can be mechanically and economically effective for stabilizing clay soils when used with fly ash and portland cement.

Project Information

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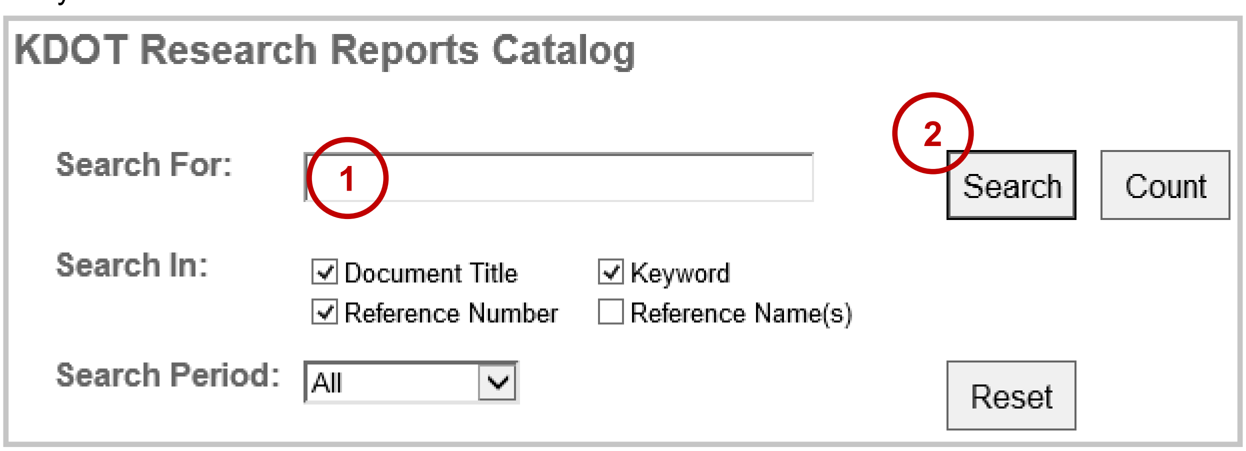

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