Kansas Department of Transportation

TECHNICAL SUMMARY

Evaluation of Cement-Modified Soil (CMS) with Microcracking

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CMS specimen after microcracking

Introduction

In an attempt to overcome the damaging effects of shrinkage cracks in subgrade, this study measured the durability of multiple cement-modified soil (CMS) specimens containing various amounts of cement that have also been subjected to a microcracking treatment.

Project Description

Cement modification of subgrade has been widely practiced for the past few decades. Recently, cement has become a more economical binder to modify in-situ subgrade soil since other binders, such as fly ash, have become less available and therefore their prices have increased significantly. In addition, a much higher percentage of fly ash needs be used, when compared with cement to achieve the same subgrade strength and stiffness. In general, cement-modified subgrade is prone to develop shrinkage cracking, which can eventually reflect through asphalt pavement layers to the surface after construction. For some subgrade soils, a high cement content is needed to meet the unconfined compressive strength requirement without jeopardizing durability. A higher cement content will result in higher shrinkage cracking potential. To overcome this problem, a microcracking technology has been developed and adopted in the field. This technology involves re-compaction of cement-modified soil (CMS) with a roller, 24 to 48 hours after initial compaction, to induce microcracks in the CMS and minimize the potential for large shrinkage cracks. Microcracking of CMS is not expected to significantly reduce the strength and stiffness of CMS, but it is expected to increase its hydraulic conductivity and reduce the potential for large shrinkage cracks. Unfortunately, the procedure to simulate microcracking of CMS in the laboratory and to evaluate its effect on properties of CMS has not been established yet. This report documents the development of such a procedure and discusses the effect of microcracking on the properties (strength and modulus) of CMS specimens. The developed procedure utilized unconfined compression (UC) tests to generate microcracks in specimens. To generate microcracks, the loading stress level was found to be equal to the unconfined compressive strength of the CMS specimen. The laboratory results showed that microcracking increased the hydraulic conductivity of the specimen and reduced its electrical resistivity when the specimen was saturated. The Light Weight Deflectometer (LWD) tests conducted in the field showed that adding cement increased the subgrade modulus. However, after applying three passes of roller compaction to generate the microcracks in the CMS in the field, the subgrade modulus dropped to approximately 40% of its original value on average.

Project Results

The following procedure is recommended to prepare and test a cement modified subgrade (CMS) specimen with microcracking:

(1.) Collect native soil from a project site.

(2.) Characterize the soil, such as gradation, soil type, maximum dry density, and optimum moisture content.

(3.) Based on the required unconfined compressive (UC) strength for the CMS for design, select a range of cement contents and prepare at least three UC specimens for each cement content to determine the desired cement content for the mix.

(4.) Using the desired cement content, prepare at least six UC specimens. Use half of the specimens for microcracking by following the procedure recommended in this study and use the rest of the specimens to determine the UC strength for uncracked CMS specimens.

(5.) To achieve a representative microcracking process in the laboratory, it is recommended that loading of the CMS specimen (cured for 48 hours) should continue past the peak compressive strength by less than 0.1% axial strain and then the load should be released to zero. The microcracked specimens should be returned to the moisture room for continuing curing.

(6.) Run UC tests on the uncracked and cracked CMS specimens after seven days of moist curing. Determine the UC strengths and moduli (E50) for both un-cracked and microcracked specimens and calculate the percentage reduction of the modulus and the modulus to strength ratio.

(7.) The estimated modulus reduction from the laboratory can be used as a reference for the light weight deflectometer (LWD) tests to evaluate the modulus reduction of the subgrade required to achieve microcracking in field.

Project Information

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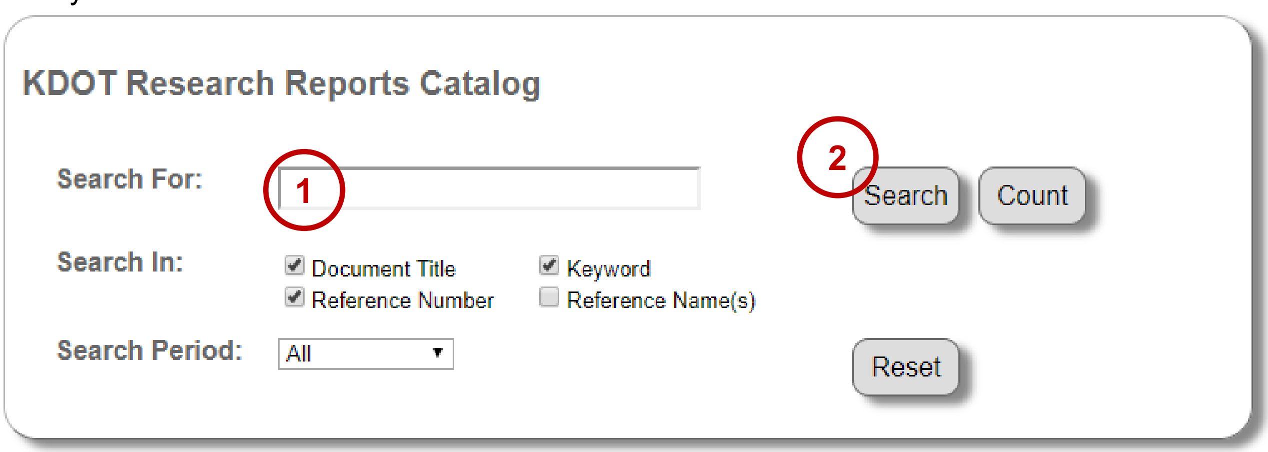

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