Research Article / Civil Engineering - Sanitary Engineering http://dx.doi.org/10.15446/ing.investig.v40n2.83120

Resilient Module Soil-Cement Prediction based on Setting Temperature

Predicción del Módulo Resiliente del Suelo Cemento en función de la Temperatura de Fraguado

Liliana Carolina Hernández García[1] and Nelson Fernando Lizarazo Salamanca[2]

ABSTRACT

This research correlates the setting temperature of the Soil Cement (SC) with its resilient modulus, based on the maturity index of three mixtures made with different types of cements: general use, High Early Resistance, and Moderate Heat of Hydration. Each mix design has a compressive strength of 4,5 MPa at 7 days of age and durability measured with the 10% wetting and drying test. The method consisted of curing the samples of the three mix designs at three different temperatures -11, 30, and 40 °C- and then monitoring the development of the temperature within the samples during the first thirty hours. At 28 days of age, the resistance modulus of the samples was measured with cyclic triaxial equipment. After analyzing the results, a linear equation was deduced which would facilitate quality control during the construction process. This prevents microcracking of the compacted layers, since their fracturing is not necessary during the extraction of nuclei and field density tests.

Keywords: soil cement, setting temperature, resilient module, heat of hydration, resilience

RESUMEN

Esta investigación correlaciona la temperatura de fraguado del Suelo Cemento (SC) con su módulo resiliente, a partír del índice de madurez de tres mezclas fabricadas con diferentes tipos de cementos: uso general, Altas Resistencias Tempranas y Moderado calor de Hidratación. Cada diseño de mezcla cuenta con una resistencia a la compresión de 4,5 MPa a los 7 días de edad y una durabilidad medida con la prueba de humedecimiento y secado del 10 %. El método consistió en curar las muestras de los tres diseños de mezcla en tres temperaturas diferentes -11, 30 y 40 °C- para luego monitorear el desarrollo de la temperatura al interior de las muestras durante las primeras treinta horas. A los 28 días de edad, se midió el módulo resiliente de las muestras con equipo triaxial cíclico. Tras analizar los resultados, se dedujo una ecuación lineal que facilitaría un control de calidad durante el proceso constructivo. Esto evita la micro fisuración de las capas compactadas, ya que no es necesario fracturarlas durante la extracción de núcleos y las pruebas de densidad en campo.

Palabras clave: suelo cemento, temperatura de fraguado, módulo resiliente, calor de hidratación, resiliencia

Received: October 24th, 2020
Accepted: May 19th, 2020

Introduction

The ASTM D6236-11 (ASTM International, 2011) guide states that control of the final resistance of Soil Cement (SC) must be carried out by extracting nuclei in the field after its maturation stage, and that its results must be compared with a mixture design validated in a laboratory (Emmert et al. 2017). However, the resistance of Soil Cement (SC) is influenced by multiple factors, such as the type of cement and its quantity in the mix, the water content, the degree of compaction, the uniformity of the compacted layer, the curing conditions, and the age of maturity (Ghanizadeh, Rahrovan, and Bafghi, 2018; Linares-Unamunzaga, Pérez-Acebo, Rojo, and Gonzalo-Orden, 2019; Estarbragh and Ranjbari, 2017). That is why waiting for the mixture to reach 28 days of age is a method that delays the construction process of any infrastructure project.

In order to speed up the construction procedure, the ACI 230 Committee (2009), recommends carrying out a density control on site as soon as the compaction process is completed, either by the ASTM D2922 nuclear method (ASTM International, 2005), the ASTM D1556 sand cone method (ASTM International, 2015a) or the ASTM D2167 rubber ball method (ASTM International, 2015b). However, for any of the above, the test requires fracturing of the compacted layer to open a hole in the surface, causing the bonds that form between the cement and the ground to break during the first adjustment. This results in early microcracking.

[1]Civil Engineer, M. Sc. Road Infrastructure, Universidad Santo Tomás, Colombia. Specialist in Design and Construction of Roads and Airways, School of Military Engineers, Colombia. Professor of the Civil Engineering Program, Universidad Piloto de Colombia. Email: liliana-hernandez@unipiloto.edu.co
[2]Civil Engineer, M. Sc. Road Infrastructure, Santo Tomás University, Colombia. Specialist in Design and Construction of Roads and Airways, School of Military Engineers, Colombia. Email: espinglizarazo@gmail.com

How to cite: Hernández G., L. C. and Lizarazo S., N. F. (2020). Resilient Module Soil-Cement Prediction based on Setting Temperature. *Ingeniería e Investigación*, *40*(2), 7-13. 10.15446/ing.investig.v40n2.83120