QUANTIFYING EARLY-AGE CONCRETE MECHANICAL PROPERTIES AND CURING CONDITIONS UTILIZING AN AUTOMATED SYSTEM

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Dedication

I would love to dedicate my work to my beautiful mother, Guadalupe Arras, through her continuous support helping me finish this milestone of my career. Also, to my beloved grandparents whose love during their life gave me the strength to further my education.

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Abstract

The validation of concrete quality based on the 28-day strength is a lengthy process. Predicting concrete mechanical properties through early-age methods can streamline the construction process. Early-age concrete behavior consists of assessing the concrete curing as-related to setting stages, the hydration process, strength and stiffness development, while considering various environmental system parameters. This paper reports on a nondestructive method for observing the early-age strength and modulus development of concrete mixes over seven days in a controlled, laboratory setting. An apparatus was designed and built for continuous acquisition of seismic modulus data (using free-free resonant column) and heat of hydration/maturity information (derived from ambient air temperature and specimen internal temperature).

The experimental design, carried out with the apparatus, represented curing conditions at controlled temperatures (50°F, 70°F, 90°F) and humidity levels (40% and 80%). Two different sources of aggregates, dolomite and gravel, were also considered. An alternative method for quantifying maturity is presented. Concrete samples also underwent compression testing at 1-day, 3-days, and 7-days. The developed apparatus and ensuing analysis method exhibited promising results for predicting the strength from the seismic modulus and maturity over a 7-day period. The heat of hydration, the curing process and the resulting impact on the concrete mechanical properties was also assessed.

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