Ultrasonic In-situ Monitoring of Stiffening Process of Concrete for Predicting Saw-Cutting Windows of Concrete Pavements

Xuhao Wang¹, Peter Taylor², and Kejin Wang³

Abstract

Concrete stiffness and strength development strongly influence scheduling of pavement construction operations, such as surfacing or trowelling and joining or saw-cutting. Saw cutting at the proper time is a delicate balance between the prevention of raveling (too early) and random cracking (too late). At present, the saw-cutting window is determined by arbitrary approaches, such as scratching the surface with a knife. In order to accurately assess the saw cutting time for pavements, the present study investigates another approach to monitor concrete microstructure, stiffness, and early strength development using ultrasonic compressional (P) wave transmission technique and to relate the P-wave test results to the saw-cutting window.

This paper presents the results from the first part of this study-monitoring stiffening process of concrete using P-wave. The P-wave transmission technique was used for both conventional concrete (CC) and self-consolidating concrete (SCC). The CC includes eight mixes with two slag types (grade 100 and 120) at 20%, 35%, and 50% replacement levels and eight patching mixtures with a Class F fly ash at 20% of fly ash replacement level for cement. The patching mixes also contain lightweight fine aggregate, integral waterproofer, and shrinkage reducing admixture. The SCC mixes, designed for bridge construction applications, are made with different aggregate sizes (¼”, ½”, and 3/8”) and different cementitious materials and filler (fly ashes, slag, and limestone dust). Setting time, semi-adiabatic calorimetry, and 1-day compressive strengths of these concretes were measured.

The results revealed that the P-wave test used can properly monitor the stiffening process of various concrete mixtures. Both P-wave and calorimetric measurements are clearly related to set time test results. These relationships can serve a strong support of predicting saw-cutting windows of concrete pavements in the forthcoming study.

Keywords: ultrasonic pulse velocity; concrete stiffening; saw-cutting windows; setting time

¹ Research Assistant, Department of Civil, Construction and Environmental Engineering, Iowa State University, 136 Town Engineering, Ames, Iowa 50011, Tel: 515-294-2252, Email: wangxh@iastate.edu
² Associate Director, National Concrete Pavement Technology Center, Iowa State University, Ames, Iowa 50011, Tel: 515-294-9333, Email: ptaylor@iastate.edu
³ Professor, Department of Civil, Construction and Environmental Engineering, Iowa State University, 492 Town Engineering, Ames, Iowa 50011, Tel: 515-294-2152, Email: kejinw@iastate.edu