LTRC Technical Summary Report 436

LTRC Proj. No. 05-1C ~ State Proj. No. 736-99-1363

November 2008

Louisiana Transportation Research Center

4101 Gourrier Ave., Baton Rouge, LA 70808

Air Void Analyzer for Plastic Concrete

Introduction

The best protection against freeze-thaw cycles in concrete is to have a good air void system. Although microscopic, concrete is a porous material. Conventional field tests, the volumetric or pressure tests, only provide the volume of air voids in the concrete. These tests do not offer any information on the size or spacing of the air voids. Petrographic analysis does provide this missing information but only on hardened concrete well after placement. The development of the air void analyzer (AVA) offers to provide volume and size distribution of entrained air voids (< 3 mm) to allow an estimation of the spacing factor and to give the specific surface and the total amount of entrained air all within 30 min. of sampling the fresh and still plastic concrete. This development allows for changes in the mix while placement operations are still ongoing.

Objective

The objectives of this research were as follows: (1) Statistically validate the AVA results with petrographic analysis as per ASTM C 457 (Standard Test Method for Determination of the Parameters of the Air-Void System in Hardened Concrete) and (2) Evaluate the effects of different types of air entraining admixtures (AEA) and water reducing admixtures (WRA) and optimistically draw some general conclusions on their use in concrete mixes for the Louisiana Department of Transportation and Development (LADOTD).

Scope

For the first objective, to compare the AVA results with petrographic analysis, the initial strategy was to produce several trial batches of two types of concrete used for LADOTD projects. A Type B portland cement concrete pavement (PCCP) mixture and a Class AA structural mixture used for bridge decks were selected. These mixes were to serve as a baseline from which future changes and adjustments will be made. Statistical criteria for this analysis was to allow a deviation of 10 percent between the AVA results and the results established by linear traverse measurement on harden concrete as per ASTM C 457.

After successful completion of the first objective, the second objective was to use these two mix types, PCCP and structural, to establish an "what could be expected" impression of the air void system with varying types and amounts of AEA and WRA that are commonly used in these two mix types. This analysis would be based on the results from the AVA. Statistical analysis from these results would indicate the scale and confidence of "what we could expect."

Cont'd on Back

LTRC Report 436

Principal Investigator:
John Eggers, P.E.

LTRC Contact:
Chris Abadie, P.E.
Phone (225) 767-9109

Louisiana Transportation Research Center

Sponsored jointly by the Louisiana Department of Transportation and Development and Louisiana State University

4101 Gourrier Avenue
Baton Rouge, LA 70808-4443

Research Approach

Ten separate batches were proposed; five batches of the most common LADOTD (Type B) PCCP mixture design and five of the LADOTD (Class AA) structural mixture design. The (Type B) PCCP mixture design utilized 475 lb. of Type I portland cement, a maximum water-to-cement ratio (w/c) of 0.53, a moderately restrictive aggregate gradation, a total air content of 5 percent (+/- 2 percent), and a slump requirement of 1 to 2.5 in. as specified for slip-form paving.

The (Class AA) structural mix design utilized 560 lb. of Type I portland cement, a maximum w/c ratio of 0.44, traditional aggregate gradation, total air content of 5 percent (+/- 2 percent), and a slump requirement of 2 to 4 in. For the first objective, the AEA and WRA used in these mixes were kept constant in brand and type. Standard lab mixing procedures (ASTM C 192) were used for all batches produced.

Standard lab testing for these mixes included: air and concrete temperature (ASTM C 1064), slump (ASTM C 143), pressure air content (ASTM C 231), volumetric air content (ASTM C 173), and unit weight (ASTM C 138). From each of the ten batches, two samples of the plastic concrete were analyzed in the AVA and two 4 x 8 in. cylinders were made for future petrographic analysis as per ASTM C 457. The use of two samples for the AVA was deemed appropriate considering the time allocated for testing, approximately 40 min. per test, versus ongoing hydration process of the plastic concrete sample. As a measure of success for validation of the AVA, a variability of 10 percent was set as the maximum allowance. It should be noted that the second objective of this research project was never fulfilled due to the inconsistency of the AVA to provide consistent and reliable test results.

Conclusions and Recommendations

The difficulty experienced in this research and evaluation of the AVA was unanticipated. The meticulousness nature of running this test alone makes it questionable for use in a field or construction environment unless essential. The desired variation in AVA test results was only achieved for 35 percent of the mixtures tested. This performance showed that the AVA cannot help in quality control/quality assurance (QC/QA) operations or to further refine process control of PCCP production in the state of Louisiana.

Taking into consideration LADOTD's current PCCP needs, it is recommended that no action be taken with regards to implementation pertaining to the AVA. The intricate steps involved in sampling and testing using the AVA along with the questionable test results justifies this recommendation.

Figure 1
Air Void Analyzer