National Concrete Pavement Technology Center

Improving Precision and Variability of Air-Void Analyzer Test Results

tech transfer summary

AVA is a useful tool for determining the air-void parameters in fresh concrete, and it has significant advantages over conventional air-void test methods.

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RESEARCH PROJECT TITLE
Improving Variability and Precision of Air-Void Analyzer (AVA) Test Results and Developing Rational Specification Limits

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The mission of the National Concrete Pavement Technology Center is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

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Objective

The goals of the present research project are to reduce variability and improve precision of air-void analyzer (AVA) test results and to develop rational specification limits for controlling concrete freezing and thawing (F-T) damage using the AVA test parameters.

The specific objectives of this research include the following:

- Identify problems related to use of the AVA device and causes of the variations in AVA test results (such as variability due to the test equipment, materials, weather, and construction conditions)
- Standardize the AVA test procedure and improve precision of AVA test results
- Examine the relationships between the parameters obtained from AVA tests and those from commonly used hardened air tests and durability tests
- Develop rational specification limits for controlling concrete F-T damage using the AVA test parameters

Problem Statement

The measurements of the air voids in hardened concrete are unable to provide on-time information for field concrete quality control. It is too late to correct any air-entraining problems after the concrete is hardened.

The test methods for assessing the spacing factor and surface area of the air voids in fresh concrete were not available until the 1990s when an air-void analyzer was developed. AVA tests are different from all existing test methods, which measure only air content of fresh concrete. The AVA device offers the ability to measure the air content, specific surface, and

Devices for air content measurement of fresh concrete

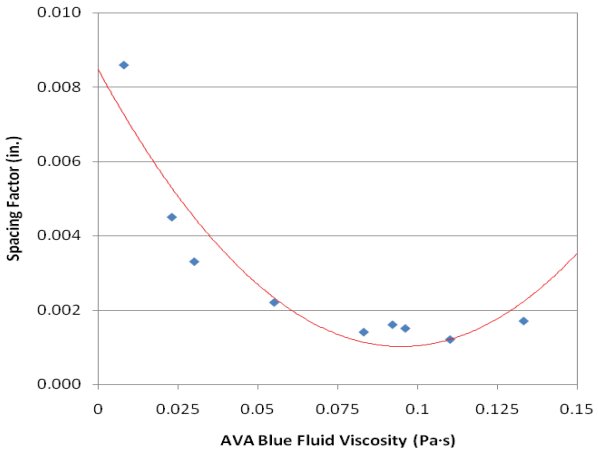
spacing factor in fresh concrete within 25–30 minutes. With this information, adjustments can be made in the concrete batching process to ensure that proper air-void structure is achieved in the concrete.

Research Description

This research project consists of three phases. The report is based on findings from Phase 1. Phase 1 includes a literature search and existing data analysis. The first phase was designed to review and synthesize the existing AVA test data from literature and the National Concrete Pavement Technology Center's (CP Tech Center's) "Material and Construction Optimization for Prevention of Premature Pavement Distress in PCC Pavements" (MCO) project. Data were also collected from the TAC members. It was designed to identify the factors that affect AVA test procedures, variation and repeatability of AVA measurements, existing specification limits, and the relationship between AVA and other hardened or durability test results.

The Phase 1 study started with a kickoff meeting at Kansas City on June 11–12, 2007. At the meeting, the project Technical Advisory Committee (TAC) members shared their experience in working with AVA tests. They discussed the problems associated with AVA tests, variables contributing to inconsistency of AVA test results, and potential research topics. Specific issues on the AVA equipment and test procedures were also addressed.

A literature review was conducted in the Phase 1 study on the use of AVA in concrete labs and construction sites. This work was focused on examining the critical factors that affect AVA test results (such as mixture properties, time of sampling/testing, and testing conditions), specification limits, and results of the comparative tests (such as hardened air-void properties or F-T results).



Effect of blue fluid viscosity on AVA measurements

In addition, four sets of AVA test data were collected from Missouri, Kansas, Michigan, and Iowa through the TAC members of this project. These data were compiled, and statistical analysis was applied. Based on these available data, relationships between the air-void parameters measured by AVA tests and other tests (such as ASTM C231 and C457) were examined. The agreement in the acceptance/rejection criteria provided by existing AVA and C457 specifications was investigated.

Finally, the research team also conducted some AVA trial tests in lab to study the repeatability of the commonly used AVA test method, effect of flowability of mixtures, and effect of viscosity of AVA blue fluid on AVA test results.

Key Findings

The Phase 1 study has indicated that AVA is a useful tool for determining the air-void parameters in fresh concrete, and it has significant advantages over conventional air-void test methods, providing not only air content as ASTM C231 and C173 do, but also air-void spacing factor and specific surface as ASTM C457 does. AVA is also a time- and cost-effective tool for field concrete quality control compared with ASTM C457. However, AVA equipment and test methods need further improvement for proper implementation in concrete practice.

Implementation Benefits

The Phase 2 study of the project was designed to modify the AVA test procedure and specifications through a series of systematic experiments in laboratory. The experimental results of Phase 1 will be used to modify, calibrate, and/or validate the test procedures.

Implementation Recommendations

Based on the results of the Phase 1 study, the following major tasks are recommended for the Phase 2 study so as to reach the goal of this project:

- Investigate and improve robustness of the AVA device
- Systematically evaluate the underdeveloped American Association of State Highway and Transportation Officials (AASHTO) AVA test procedure
- Further study the relationship between AVA measurements and F-T durability factors and develop rational acceptance criteria (AVA indexes) for AVA measurements
- Conduct a well-designed round-robin test to verify the findings obtained from the above-described tasks