# Air-Void Analyzer

*By Tine Aarre, Ph. D.*
*Dansk Beton Teknik A/S*

*A new test determines the air-void system of fresh concrete.*

It is generally accepted that entraining air in concrete improves its frost resistance. It is also recognized that it is the number of very small closely spaced air voids and not the volume of air that determines the efficiency of the (entrained) air-void system.

Most conventional methods for analyzing air in fresh concrete, such as the pressure-meter method, measure the total air content only, and consequently provide no information about the parameters that determine the quality of the air-void system.

These parameters–the size and number of voids and spacing between them–can be measured on polished samples of hardened concrete (ASTM C 457) but the result of such analysis will only be available several days after the concrete has hardened.

## A New Test Method

This problem has now been overcome by new test equipment called the air-void analyzer (AVA) or commonly referred to in North America as the Danish air test (see Fig. 1 and Ref. 2).

The AVA was developed to determine the standard ASTM C 457 air-void parameters in fresh samples of air-entrained concrete. The test apparatus determines the volume and size distributions of entrained air voids and thus allows an estimation of the spacing factor, the specific surface, and the total amount of entrained air.

Fresh concrete samples can be taken at the ready mix plant and on site. Testing concrete before and after placement into forms can verify how the applied methods of transporting, placing, and consolidation affect the air-void system. Since the samples are taken on fresh concrete, the air content and air-void system can be adjusted during production.

## Principle of the Method

In this test method, air bubbles from a sample of fresh concrete rise through a viscous liquid, enter a column of water above it, then rise through the water and collect under a submerged buoyancy recorder. The viscous liquid retains the original bubble sizes. Large bubbles rise faster than small ones through the liquids. The change in buoyancy is recorded as a function of time and can be related to the number of bubbles of different size.

*Figure 1. Equipment for the air-void analyzer. (67961)*

## Test Procedure

- A 20 $cm^3$ mortar sample is extracted from the concrete.
- The sample is injected into the bottom of a column filled with the viscous liquid and water (see Fig. 2). The mortar is stirred for 30 seconds to release the air bubbles into the viscous liquid.
- The bubbles rise through the liquid and enter the column of water above it. Bubbles collect under a submerged buoyancy recorder that is attached to a balance.
- The computer calculates voids less than 3.0 mm, spacing factor, and specific surface.

These parameters correspond to those that would be obtained from linear traverse measurements (ASTM C 457) on a hardened concrete sample. Comparison with that method yields an accuracy of ±10% for a data collection period of 25 minutes. A curve, similar to particle size distribution, shows voids versus void diameter, and a bar chart shows actual void volume in different ranges of void diameter.

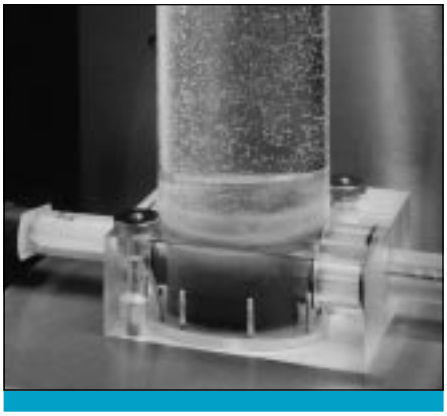

*Figure 2. Air bubbles rising through liquids in column. (67962)*

## Documentation and Use

Extensive testing and documentation of the accuracy of the AVA have been carried out. Currently no standard exists for the method. The AVA was not developed for measuring the total air content of concrete, and because of the small sample size, may not give accurate results for this quantity. However, this does not impact the use of the method for assessing the quality of the air-void system.

The AVA is used in Europe, North America, and Japan, and it was used on the Great Belt Project in Denmark. The method is used in conjunction with traditional methods for measuring air content.

## References

1. *Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete*, ASTM C 457, ASTM, West Conshohocken, Pennsylvania, 1990.
2. *Quality Assurance of Concrete Based on Testing of the Fresh, Still Plastic Material*, EC-Contract No. BRE-CT90-0.58, 1991-1995.
3. Henrichsen, A., and Vyncke. J., "Quality Assurance of Air-Void Structures in Concrete," *International Symposium on Non-Destructive Testing in Civil Engineering (NDT-CE)*, German Society for Non-Destructive Testing (DGZfP), Berlin, September 1995.

## Editor's Note

Further information can be obtained by contacting Dansk Beton Teknik A/S, Helleruplund Alle 21, DK-2900 Hellerup, Denmark, Telephone: 011-45-39-61-23-66, Fax: 011-45-39-62-28-33, e-mail: taa@dbt.dk.



Return To Index