

Purpose

The **RapidAir** is an image analysis system for **automatic determination** of the air void structure parameters in hardened concrete according to the linear traverse method (procedure A) or the point count method (procedure B) as described in ASTM C457, "Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete," or in EN 480-11, "Admixtures for concrete, mortar and grout - Test methods - Part 11: Determination of air void characteristics in hardened concrete."

RapidAir is used to:

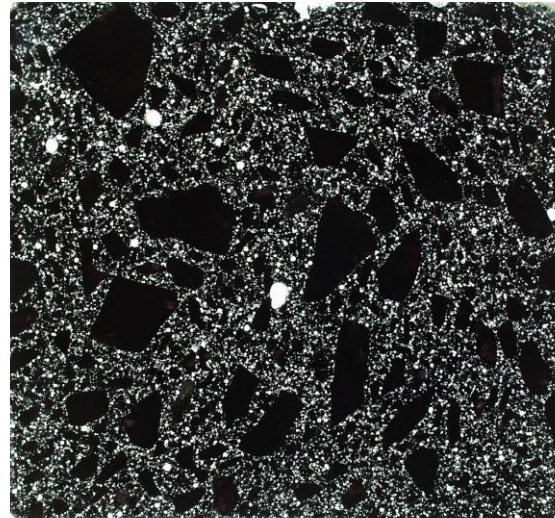
- Determine the total air content, spacing factor, and specific surface in hardened concrete.
- Effectively and rapidly study and quantify the air void system: volume, spacing, and size distribution of the air bubbles.

Principle

A core is taken from the structure, and then sliced, ground, and lapped in the laboratory. The resulting surface is plane, smooth, and with sharp edges along the perimeter of air voids. Before final specimen preparation, the lapping quality is checked under a stereomicroscope.

The lapped surface is colored black with a black ink marker pen and a white barium sulphate powder is worked into the air voids using a rubber stopper. The quality of the black-white contrast is checked under a stereomicroscope. The voids should be filled totally with white powder and no white regions should be visible on the surface. Finally, voids in aggregates and obvious cracks are also colored black under the stereomicroscope.

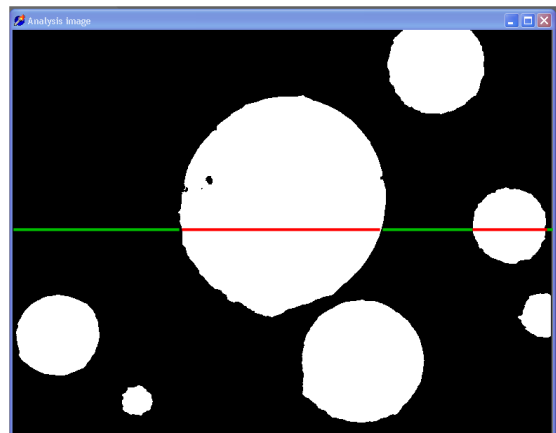
The photo on the right shows a properly prepared specimen. The preparation of a well-lapped specimen surface for analysis takes about 30 minutes. The **RapidAir** measurement is done within 12 min for linear traverse analysis and within 30 min for modified point count. This should be compared with a time of 4 to 6 hours normally required for manual analysis in accordance with ASTM C457 or EN 480-11.

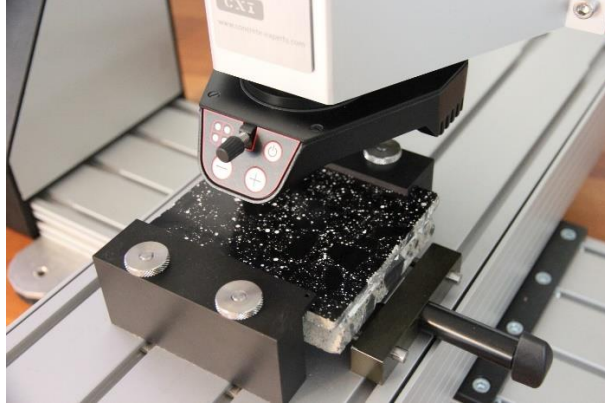


Operation

Following contrast enhancement, the prepared specimen is mounted on a moving X-Y-Z stage positioned below a video camera. The **RapidAir** control unit automatically moves the stage, and the software determines the portion of the total traverse length that passes through the white air voids, as shown in the magnified view to the right. After the scan is completed, the air-void parameters are calculated as per ASTM C457 or EN 480-11.

The specimen scan is saved automatically in a report file documenting the air content, spacing factor, and specific surface. In addition, graphical presentation of the air-void distribution and the raw data are available.





Prepared specimen positioned on the moveable stage ready for image analysis.

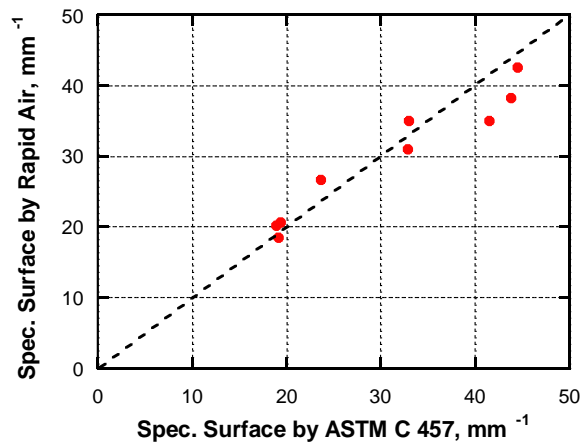
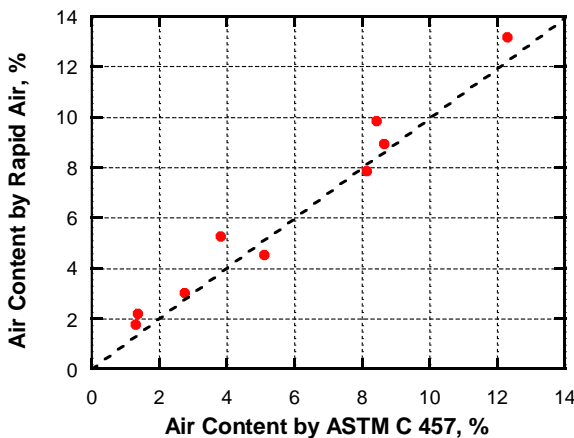


RapidAir system in operation.

Correlation with ASTM C457 and Precision

As reported by Pade, C. et al.⁽¹⁾, very good agreement was found between the air-void system parameters measured by the RapidAir system and by the ASTM C457 standard method. The study involved thirteen European laboratories and concluded that the repeatability of the automatic analysis system not only conforms to the precision statement of ASTM C 457 but is better than when the tests are performed manually. The standard deviations of the air-void parameters determined by RapidAir were as follows:

- Air content: 0.37 %
- Specific surface: 1.57 mm⁻¹
- Spacing factor: 0.011 mm

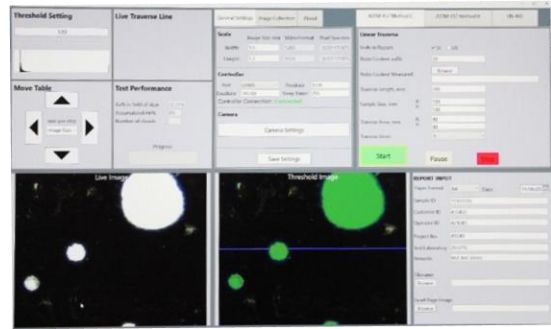


Comparison between RapidAir and ASTM C457 measurements of air content and specific surface

The very good results for reproducibility and repeatability of the RapidAir system were also validated in an international Round Robin study where seven laboratories participated ⁽²⁾. The results are better than those obtained from traditional manual analysis of air-entrained concrete because these ones have been shown to be significantly operator-dependent since the person that observes the specimen defines the air void edges subjectively ⁽³⁾. In contrast, the automatic programmed procedure performed by the Rapid Air importantly reduces this sensitivity to bias errors.

RapidAir Specifications

- X,Y,Z-stage with electronic stepper motor for accurate X-Y displacement, 230/120 VAC, equipped with emergency switch
- LED ring lightening system
- Color digital camera, 2 μm resolution
- Microscope objective for op to 100x magnification
- Windows based software with user friendly interface
- Self-calibration with a reference sample
- Exporting of data to MS Excel
- Print out reports for ASTM C 457 and EN 480-11



RapidAir Ordering Numbers

Item	Order #
RapidAir System Delivered with computer and software, pre-configured, aligned, tested, and ready for Plug-and-Play use.	RAP-3000



References

1. Pade, C., Jakobsen, U.H. and Elsen, J., "A New Automatic Analysis System for Analyzing the Air Void System in Hardened Concrete," International Cement Microscopy Association Conference, San Diego, CA, USA, April 2002.
2. U.H. Jakobsen, C. Pade, N. Thaulow, D. Brown, S. Sahu, O. Magnusson, S. De Buck, and G. De Schutter, "Automated air void analysis of hardened concrete — a Round Robin Study", Cement and Concrete Research Vol. 36 – 8, Pages 1444-1452, August 2006
3. Schlorholtz, S. Image Analysis for Evaluating Air Void Parameters of Concrete. Iowa DOT Project HR-396; Final Report; Iowa Department of Transportation: Ames, IA, USA, 1998.