
Real Air Testing
In Real Time
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Centerline deterioration in Illinois on I-55 northbound, just south of Springfield, July 2000. The pavement is about 20 years old.

On the left, another view of I-55 in Illinois

On the right, I-70 in Kansas City, KS, March 2000, after about 10 years in service.

Note that there is no spalling at the transverse joints, only the centerline joint.

Both centerline and transverse joints in Kansas were sealed with silicone over a tightly fitting backer rod. The centerline joint is tied with deformed bars that do not allow for movement and therefore the backer rod retains the water when the sealant fails, saturating the concrete.

The transverse joints close up in the heat of the summer and the backer rod take a set. In the winter the joint opens so even when the sealant fails water can drain and not be retained at the top of the joint. This has been the most common occurrence. Some pavements have shown deterioration in the transverse joints along with the centerline distress.

The centerline joint under the bridge is not spalled. Under winter freezing and thawing conditions the sun does not reach this area to thaw the concrete. Hence no freeze-thaw cycles from sunlight and no deterioration of the joint.

The beginning of spalling at the centerline

The spalled centerline joint showing failure in the paste. No broken aggregate is showing

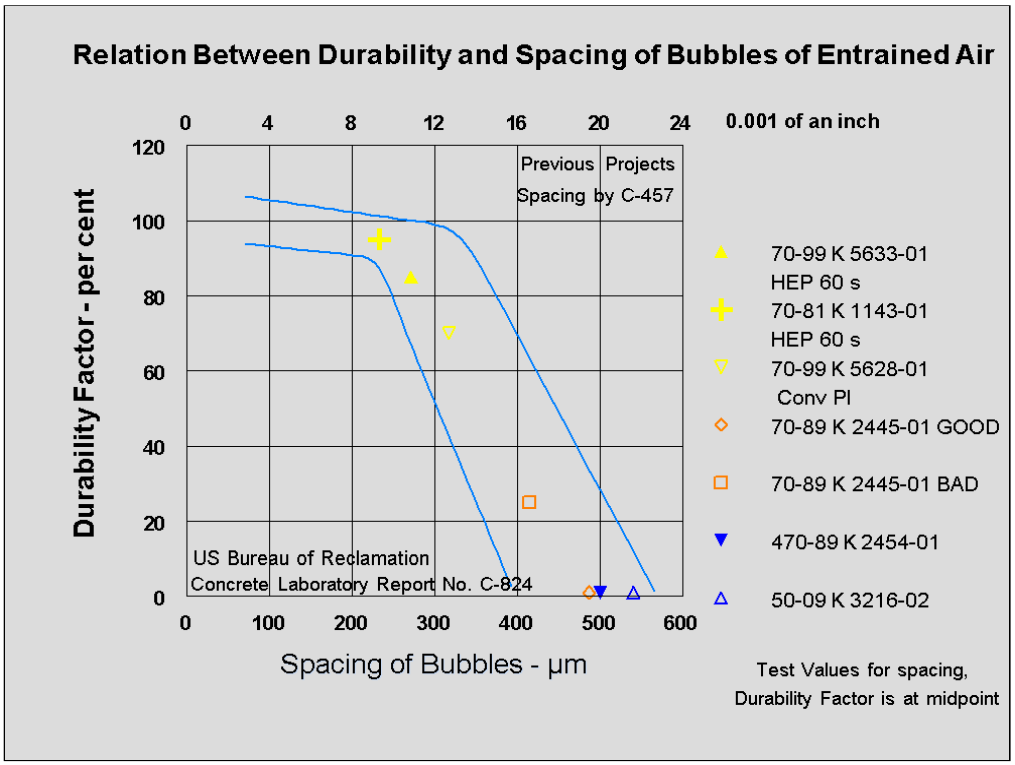
A slightly closer view of the centerline spall

Necessary and Sufficient Conditions for Freeze-Thaw Damage to Concrete Paste

Wet (Saturated) Concrete

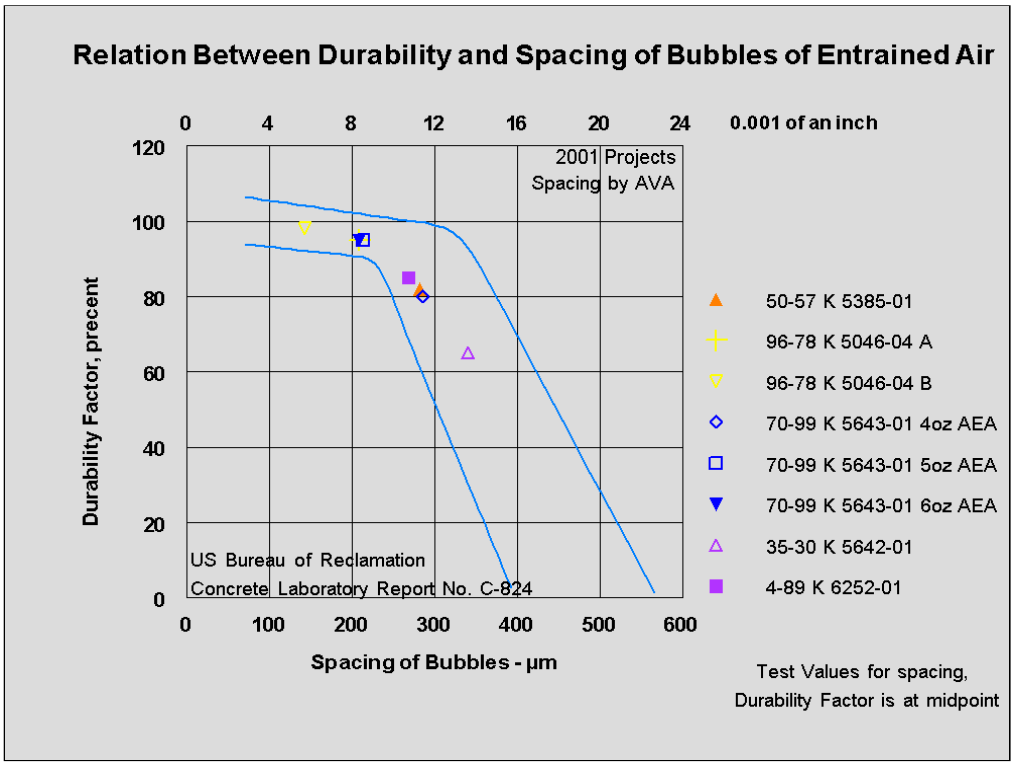
Freeze-Thaw Cycles

Improper Air-Void System

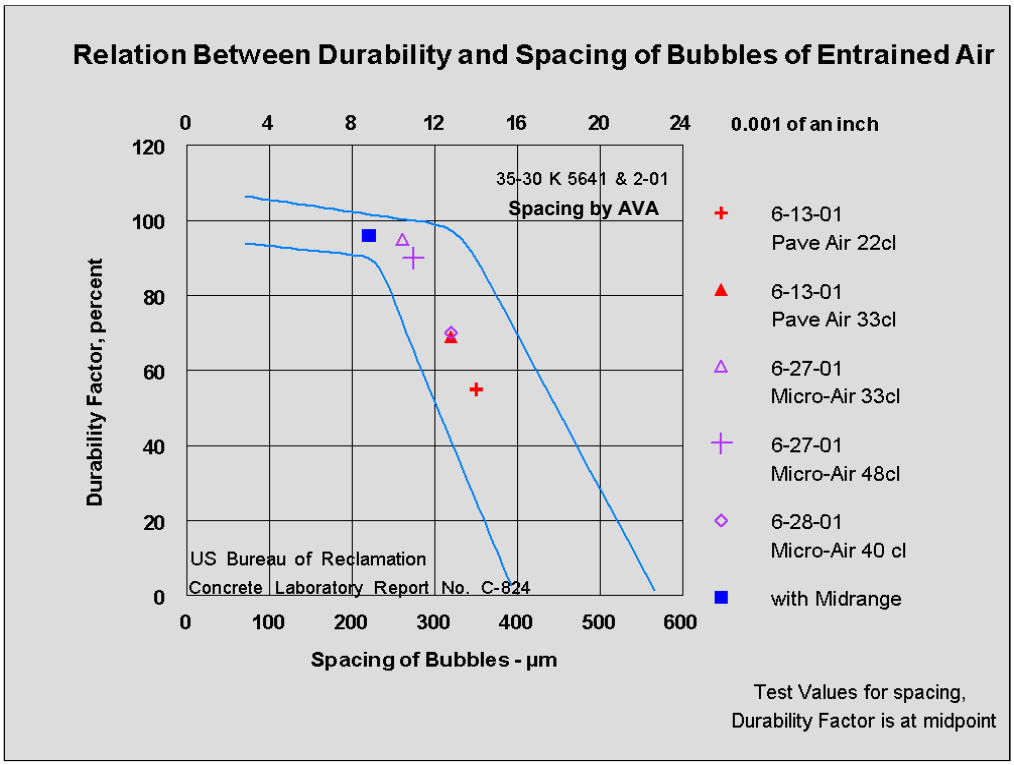


This graph was developed by the Bureau of Reclamation. The spacing factor is the most important parameter of the air-void system.

Our results for spacing factor by ASTM C 457 of old prescription concrete (in blue and orange) and newer optimized mixes (in yellow) are plotted. The durability is assumed to be at the midpoint for the measured spacing factor.



Results of the spacing factor by Air Void Analyzer of this past year (2001) for optimized mixes



Improvements of the spacing factor can come from increasing the dosage of air entraining agent, by using a different air entraining agent, and by changing from an ordinary water reducer to a midrange water reducer.

Air Void Analyzer Evaluation
FHWA-SA-96-062

The DBT work showed that their AVA data and that obtained using ASTM C 457 had acceptable correlation except for the air content.

This evaluation showed that the spacing factor was about the same with either the AVA or ASTM C 457.

Air Void Analyzer Evaluation
FHWA-SA-96-062

Conclusions: The AVA has demonstrated that it can provide information that characterizes the air void system. …the system can be applicable in quality control and assessment of concrete mixes.

DBT Data, FHWA Appendix, Figure 16

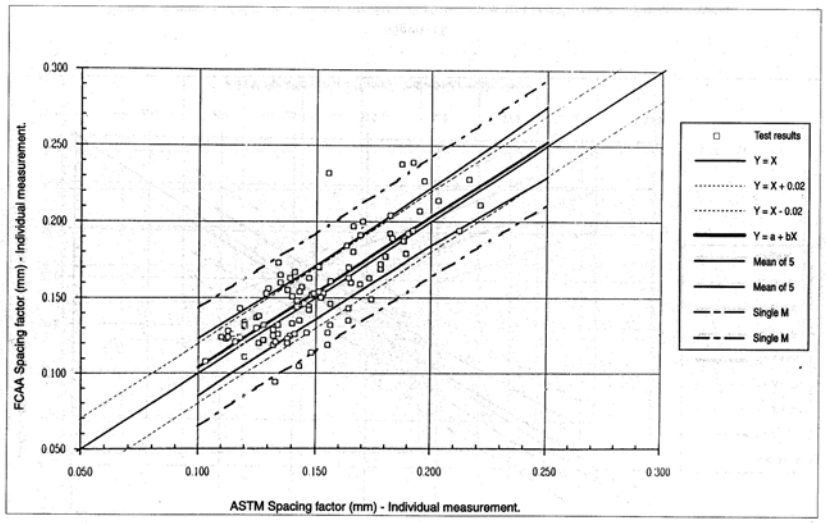
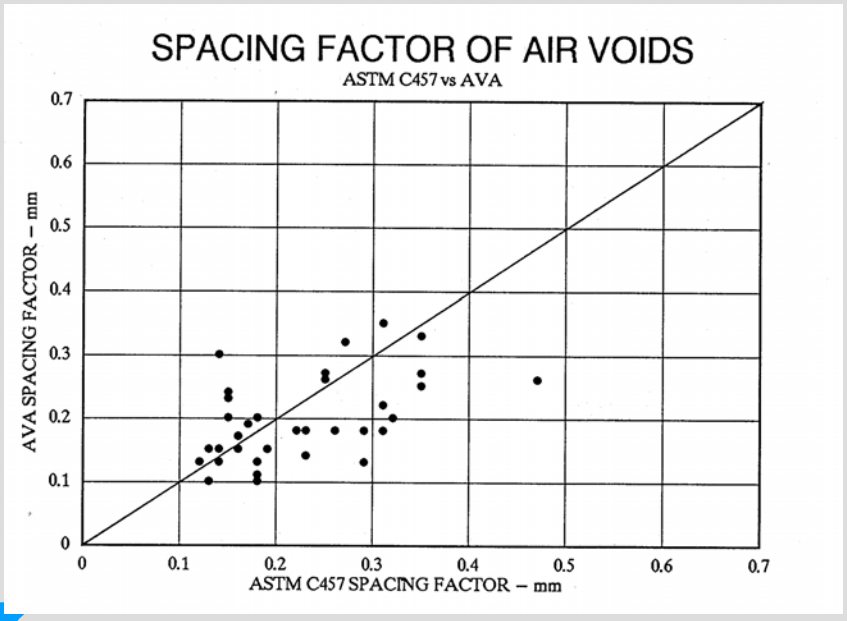


Figure 16.
Regression curve and 95% confidence limits for a single measurement and the mean of 5 measurements

This is the graph showing the DBT (manufacturer) data from the report, FHWA-SA- 96-062, May 1996.

FHWA Data, Figure 15



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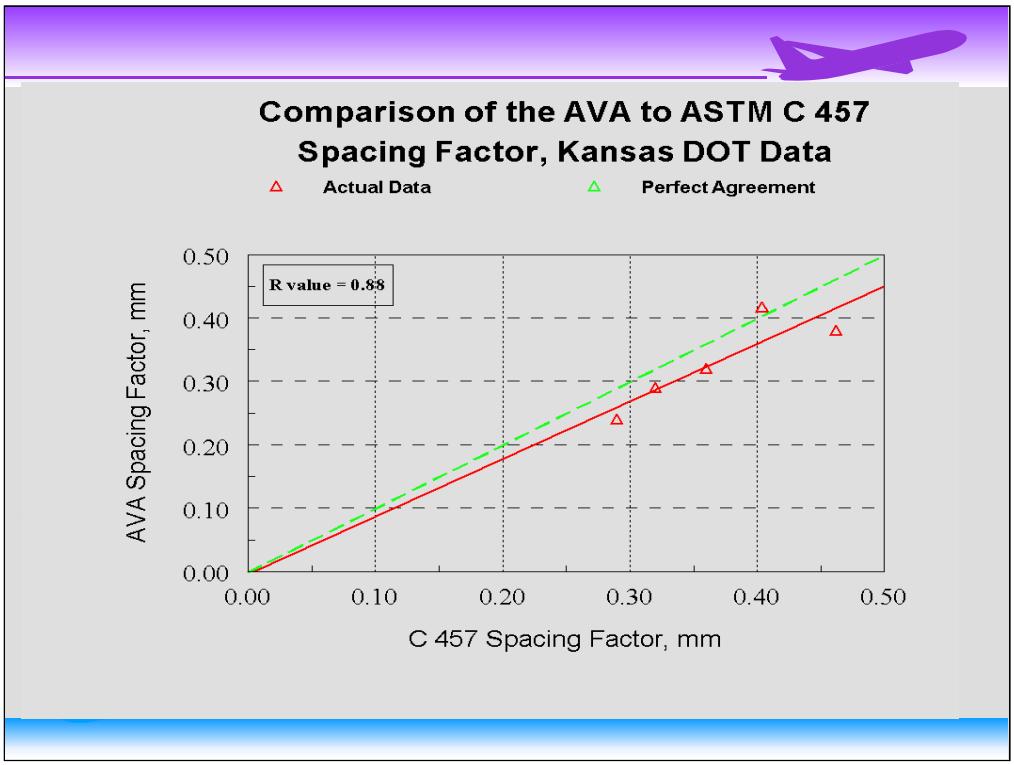
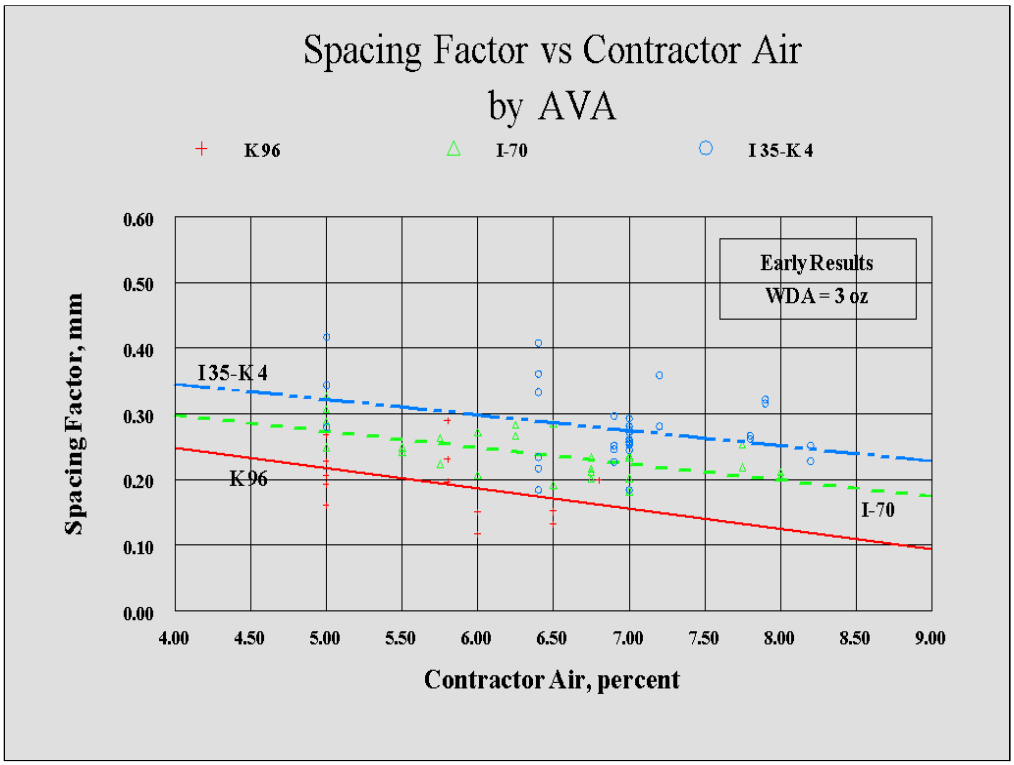
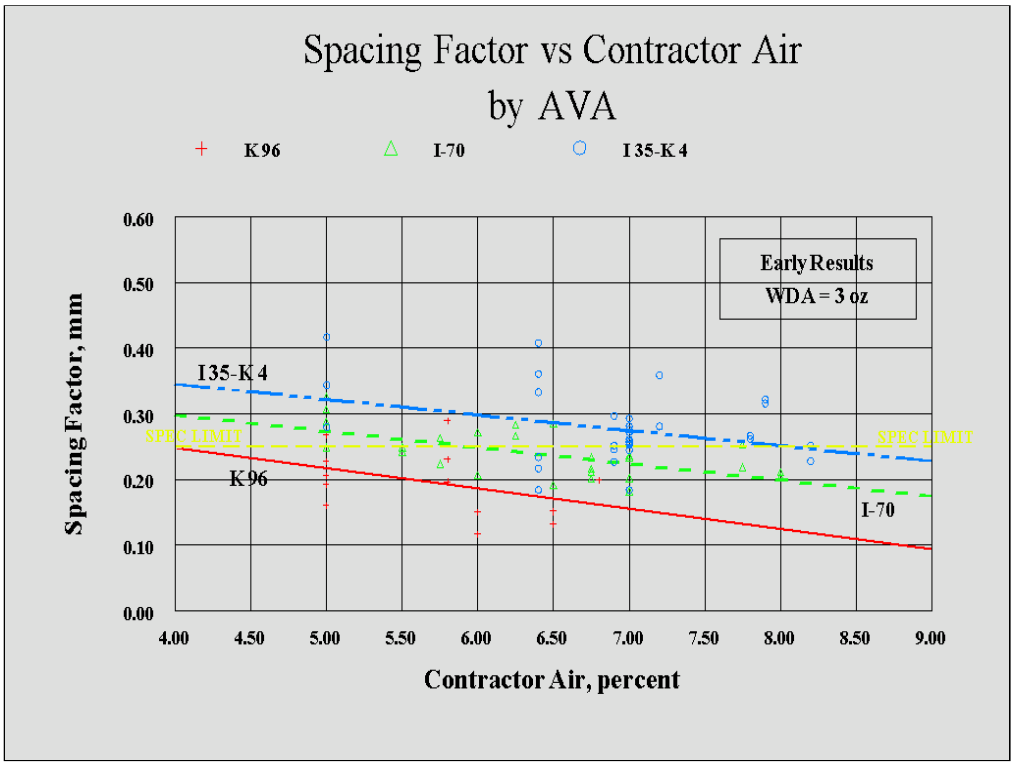


Good agreement of AVA results and C 457 for the spacing factor was obtained on comparative samples in Kansas.



The relationship between air content and spacing factor seemed to fall along three lines in 2001, mainly based on the fine aggregate, coarser being better. The top line (with the finest fine aggregate) can be moved down below the middle line by using a midrange water reducer



A higher total air content is needed for mixes that produce a higher spacing factor. The best mix would need only 4 percent air to meet the specification limit of 0.25 mm while the worst mix would have to have 8 percent air to meet the specification limit.

Applications for the AVA

- Short Mixing Times for the Concrete, especially for sandy mixtures (< 55% Rock) and low slump
- Very Low Slump Mixtures
- Mixtures with Fly Ash, Slag, or Natural Pozzolans
- Effects of Construction Variables

Applications for the AVA

- Warranty Projects
- Late Season Placements
- Extreme Exposure Environments
- Pumped Concrete
- Research on new Materials, Admixtures, Equipment, Procedures, etc

Kansas DOT Specification

Establish a minimum air content based on a max spacing factor of 0.25 mm (5.0% min)

Prequalification of the mixture in the laboratory

Verification of the mixture in the field

Monitoring of the project concrete


KDOT
Working for Kansas