ARDOT TRC TRANSPORTATION RESEARCH COMMITTEE

PROBLEM STATEMENT
No. 17

RESEARCH PROBLEM STATEMENT

DATE: 09/06/2019	**PROJECT AREA:** Materials

TITLE: Re-examining air content testing for pumped concrete

PROBLEM STATEMENT:

Concrete durability is a foremost consideration in bridge construction because the bridge deck is where the most maintenance is required. Premature deterioration of the bridge deck is common and results in high costs to highway departments and the public. Entraining about 6% air in the fresh concrete prior to placement is a well accepted method to improve durability. This entrained air mainly protects the concrete from freeze-thaw deterioration, but can also protect against other forms of expansive concrete deterioration. Most of the time, bridge deck concrete is placed by using a pump truck. According to ARDOT Specifications, the fresh air content of the concrete must be measured at the discharge end of the pipe. Previous lab and field research has shown that measuring the air content after pumping does not reflect the air that will be found in the hardened concrete. The pressures from pumping seem to cause air to dissolve. This air then returns to the concrete over time. This can cause the concrete producer to introduce air contents that are much higher than needed. This causes a loss of strength and an increase in porosity. Concrete may also be wrongly rejected.

OBJECTIVES:

1. Sample concrete before and after the pump at bridge deck pours around Arkansas (including taking hardened samples for laboratory studies). Measure the fresh and hardened air void contents and perform freeze-thaw testing.
2. Perform laboratory studies on the effects of pumping on the air void system and on freeze-thaw resistance using a full scale concrete pump and pipe network at Oklahoma State University.
3. Combine results of objectives 1 and 2 with past data to help determine which factors most influence changes in the air content.
4. Draft updated ARDOT Specifications to reflect best practices based on objective 3 with special emphasis on the proper sampling and testing requirements for fresh concrete air content.

FORM OF RESEARCH IMPLEMENTATION AND RETURN ON INVESTMENT:

Updated specifications which reflect the most effective way to measure the air void system in pumped concrete will save ARDOT money by preventing concrete with bad air void systems from being placed in the first place. Since air content is an acceptance test for concrete, the revised specifications will result in fewer rejected lots while still resulting in a high quality end product. If Arkansas bridge decks have better freeze-thaw durability, early maintenance can be avoided and costly repairs delayed until later in the design life.

Estimated Project Duration: **Months**

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Standing Subcommittee Ranking	Advisory Council Ranking	Statement Combined with Statement Number(s)

Re-examining air content testing for pumped concrete

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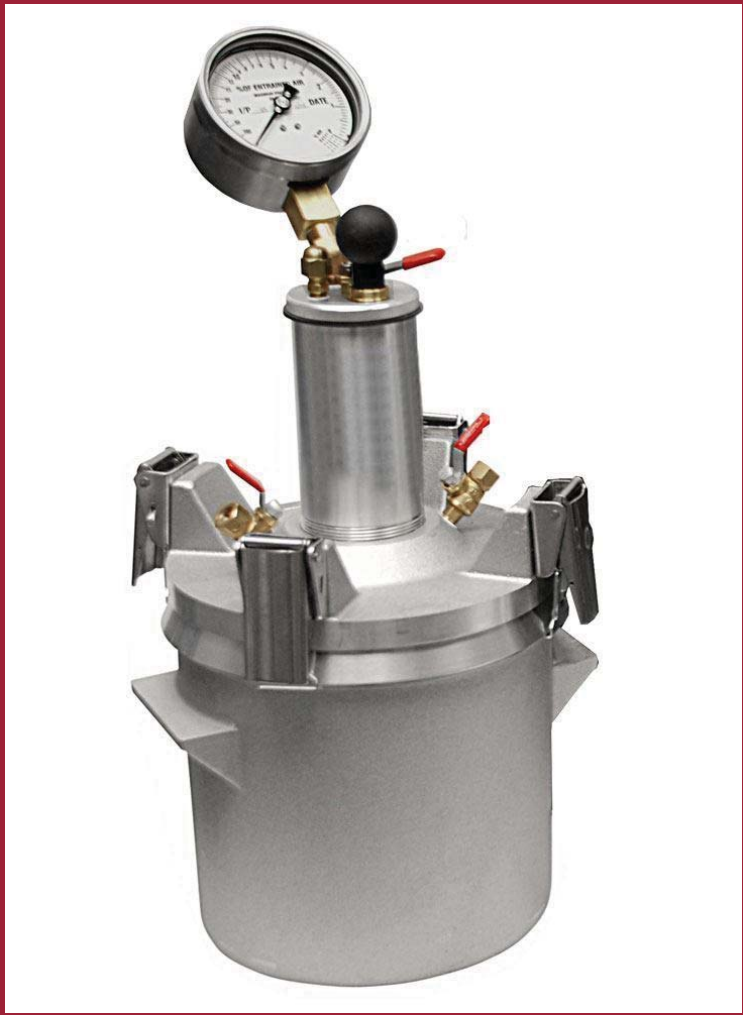
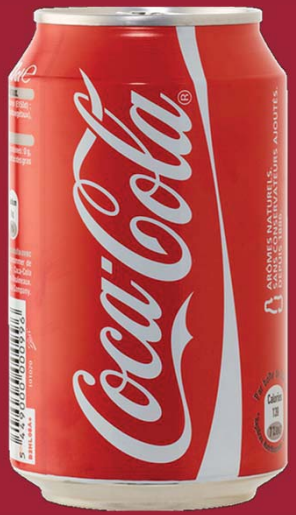
Concrete air entrainment

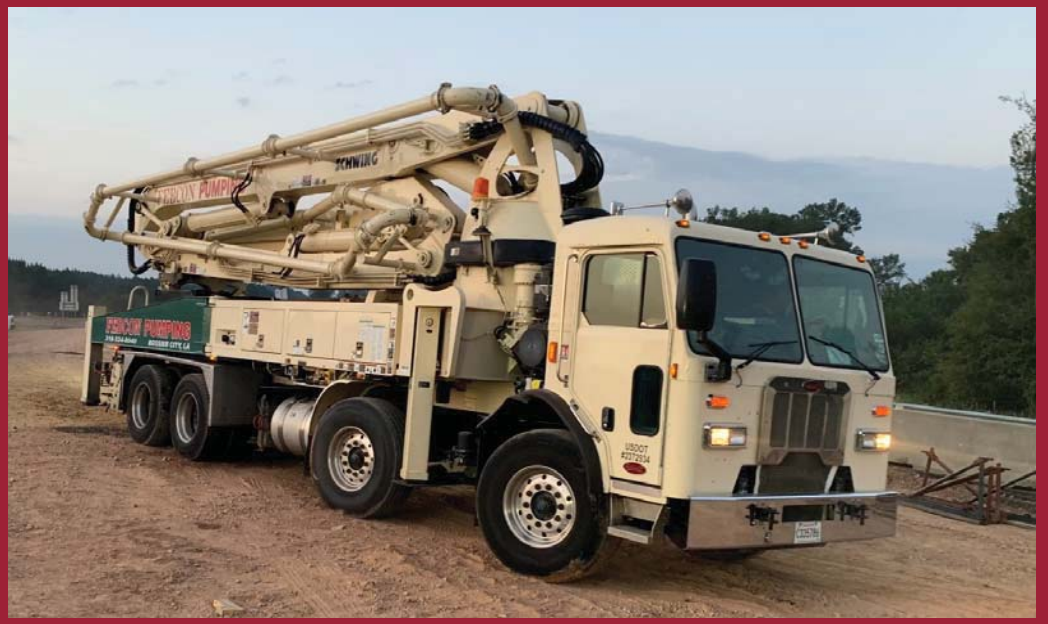
- Good F-T concrete has good air void system
- 4 – 8% entrained air standard
  - Shown to improve F-T durability
  - “Magic” number may differ
  - Spacing factor a better measure (<0.008 in.)
- Air content measured for fresh concrete only
- What happens if pumped?



Response of air to pressure

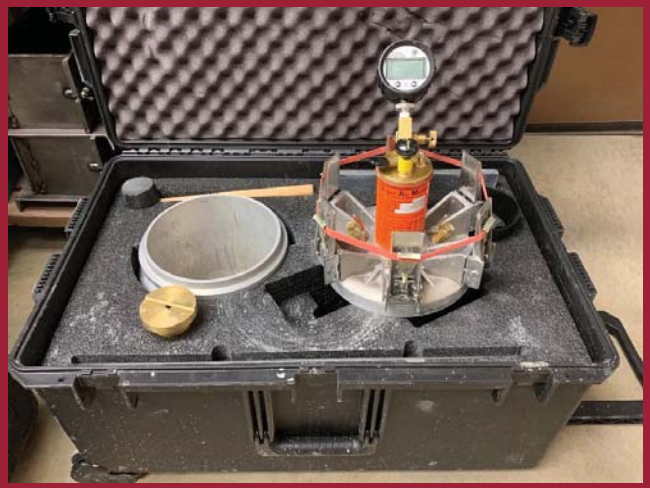
- Pressure causes air voids (especially small ones) to go into solution
- As pressure goes back down, bubbles come back over ≈ 1 h

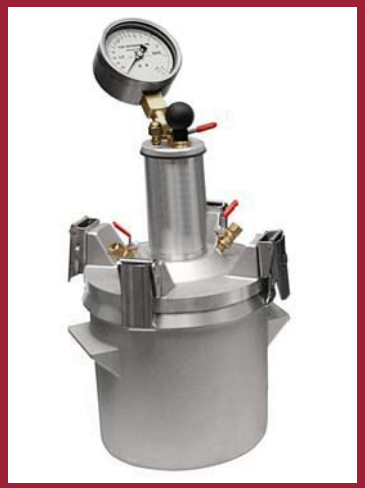


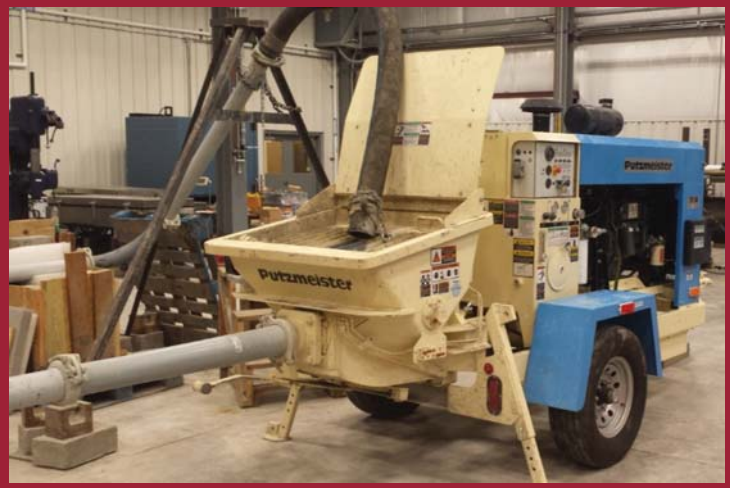


Current standard of practice

- ARDOT Specifications Section 802.10: Pumping "*Samples of concrete for slump and air content tests will be obtained at the discharge end of the pipe.*"
- Air content pre-pumping ≠ air content post-pumping
- What is the best way to ensure F-T durability in fresh concrete?







Objectives

- Lab and field studies of effects of pumping on air void system and F-T durability
- Some work has been done on this topic, but much more data is needed!
- Revise ARDOT Specifications to ensure durable concrete