In Honor of Dr. Kenneth Hover
It's Been a Great Journey
Let's Keep it Going!

Larry Sutter Ph.D., P.E., F.ACI, F.ASTM

Principal
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Professor Emeritus and Professor of Research
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sutter engineering llc

Michigan Tech

Why Me?

- Got an email one day…

Why Me?

- Would I speak at a session honoring Ken Hover?

Why Me?

- Moi?
- What would I speak about?

Why Me?

- Never took a class from him
- We haven’ t collaborated on any research
- We never coauthored a paper…
- I have not served on an ACI committee with Dr. Hover
- ????

YES !!! I WOULD BE HONORED TO SPEAK

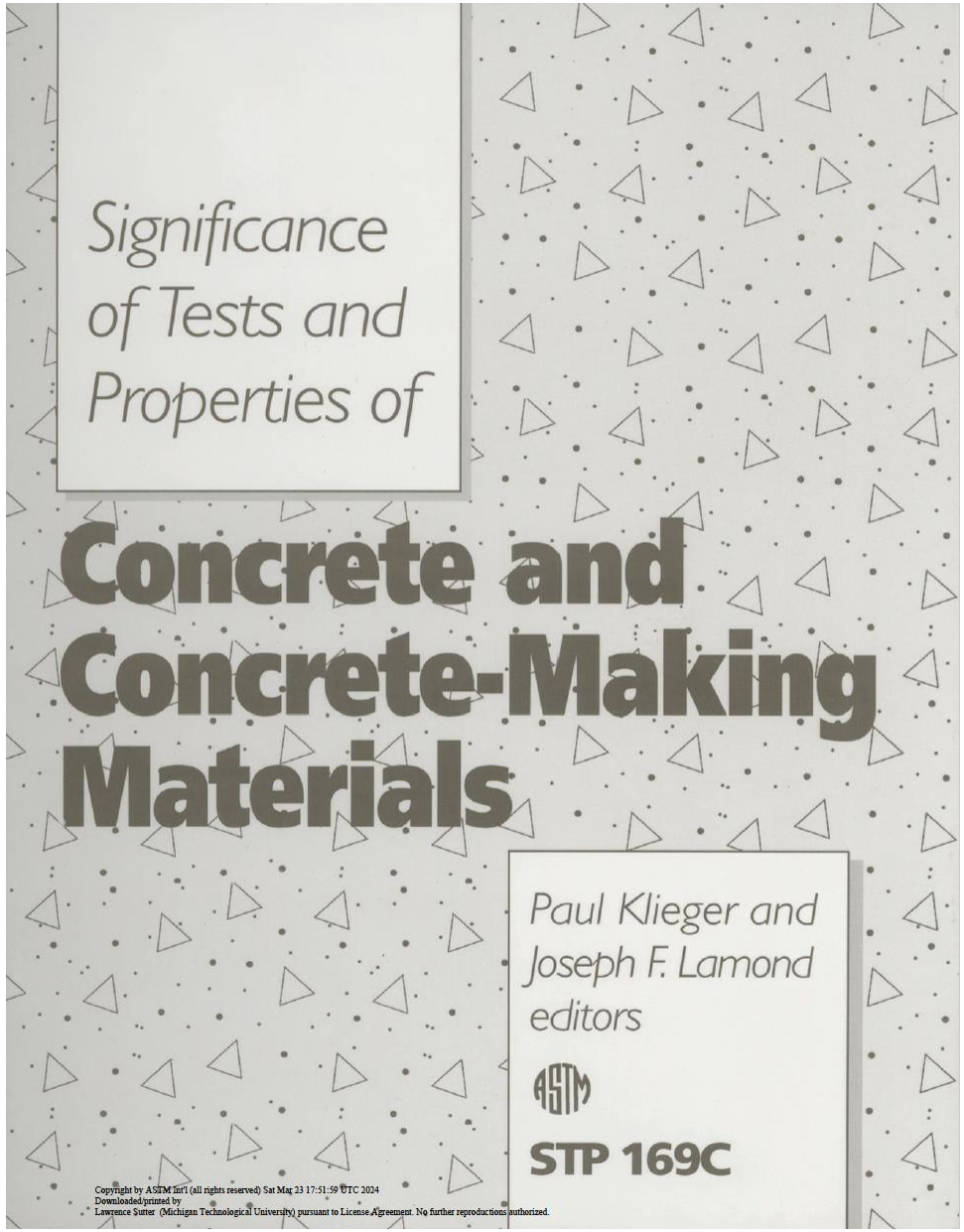
Why ?

- Because Dr. Hover is a special person in our industry
- We are fortunate to have him along on our journey we call… *concrete*
- *But what to talk about…?*

Knowledge

The beginning of my journey…1994

- Started my journey in concrete
- Learned quickly how little I knew
- First exposure to Dr. Hover



STP169C-EB/Aug. 1994

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Air Content and Unit Weight of Hardened Concrete

Kenneth C. Hover[1]

PREFACE

Samuel Helms discussed the unit weight and air content of hardened concrete in each of the three preceding editions of this ASTM Special Technical Publication. This present edition makes much use of Helms' clear and concise work, particularly in the area of unit weight. The discussion of air content is more extensive here, however, largely in response to the great deal of new research since the last major update. It has also become evident that the further in time that the industry has come from the landmark contributions of the early workers in air-void systems and frost resistance in concrete, the less understood are the fundamental principles laid down in the late 1940s and early 1950s. Following the pattern set by Helms, the present edition therefore reviews much of this key literature to explain the origins of today's state of the art. Finally, this edition appears when there is a proliferation of the use of the ASTM Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete (C 457) microscopical analysis procedure, which was once exclusively performed by a small cadre of experts. While expansion of the use of the test has produced more data, it has in some cases

of the concrete influences the workability, consistency, bleeding tendency and yield of the fresh concrete, and the density, strength, and frost resistance of the hardened concrete. The most significant of these effects is the influence of air voids in mitigating the damaging effects of freezing and thawing of absorbed water. The magnitude and utility of these effects depends on not only the total volume of these air voids, but on the entire size-distribution of voids and on their dispersion throughout the concrete. The beneficial consequences of air voids are obtained by using air-entraining admixtures and appropriate concrete production and construction procedures to encourage the retention of the smallest voids, and, by using effective placing and consolidation procedures to reduce the number and volume of the largest voids.

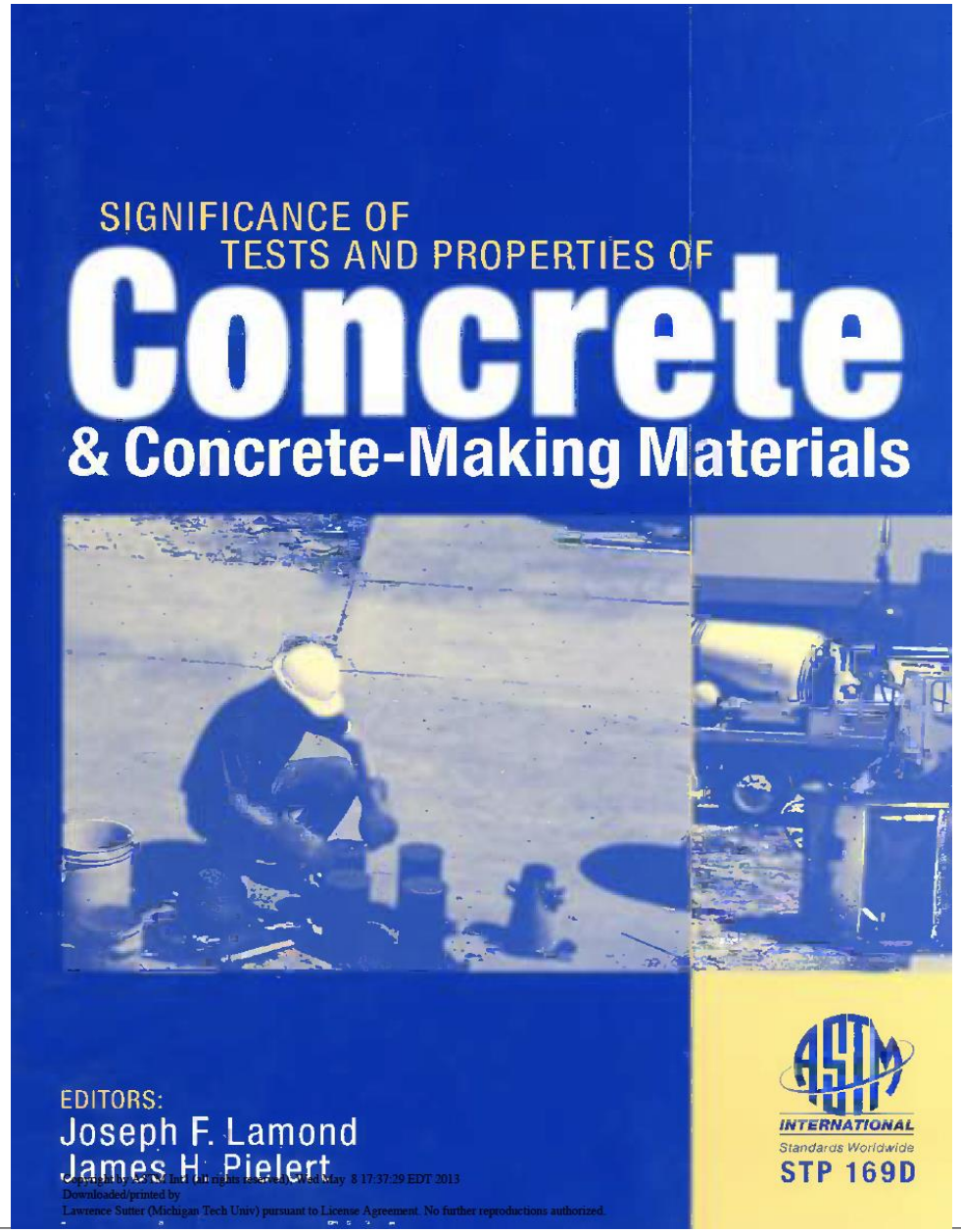
While the concrete is still plastic, however, the air voids have an opportunity to move, become larger or smaller, coalesce, or change shape. Some voids can be removed from the concrete entirely. The total air content and other air-void characteristics therefore depend on the stage in the mixing, transport, placement, and consolidation processes at which the measurement was taken. Once the concrete has hardened, however, permanent void spaces remain, preserving the size and shape of those air voids

I read this chapter and more…

- A wealth of publications on air entrainment and other subjects
- Led us to work of many others like Ken Snyder
- Measuring air content – especially hardened air – and the effect of air entrainment became a focus of much of our research at Michigan Tech – my journey turned towards *durability*

2006

- Fast forward…



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Air Content and Density of Hardened Concrete

Kenneth C. Hover[1]

Preface

IN PREPARATION OF THIS CHAPTER THE CONTENTS of the 4th edition were drawn upon, as the 4th edition had drawn upon Samuel Helms's clear and concise work in the previous three editions of this ASTM Special Technical Publication. The discussion of air content is more extensive here, however, largely in response to the continuing interest and research in air-entrained concrete and freeze-thaw durability. It has also become evident that the further in time that the industry has come from the landmark contributions of the early workers in air-void systems and frost resistance in concrete, the less well understood are the fundamental principles laid down in the late 1940s and early 1950s. Following the pattern set by Helms, the present edition therefore reviews much of this key literature to explain the origins of today's state of the art. Finally, this edition appears when there is a proliferation of the use of the ASTM Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete (C 457) microscopical analysis procedure, which was once exclusively performed by a small cadre of experts. While expansion of the use of the test has produced more data, it has in some

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Another intersection

- The Foam Index Test
  - It's interesting… even in the furthest northern reaches of the frozen tundra of the Upper Peninsula of Michigan… we have libraries
  - Through ours we found over 20 different methodologies in the literature for the foam index test
  - *Standardization was required for the test to gain use*

Another intersection

- We sallied forth to develop the

<u>One Foam Index Test to Rule Them All</u>

- About three steps down that path we found…
- Dr. Hover and his students had already been there

Let me save you some time…

- If you want to learn about the foam index test - read these

Harris, N. J., K. C. Hover, K. J. Folliard, and M. T. Ley. The Use of the Foam Index Test to Predict AEA Dosage in Concrete Containing Fly Ash: Part I-Evaluation of the State of Practice. Journal of ASTM International, Vol. 5, No. 7, 2008.

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Knowledge

- For a standard foam index test, 90% of what we needed to know/do was in these papers.
- Fortunately, research sponsors rarely read the literature so what they didn't know didn't hurt us.
- We just had to avoid plagiarism… ☺ I hope we did…
- We did add some changes, mainly addressing kinetics

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: C1827 – 20

Standard Test Method for Determination of the Air-Entraining Admixture Demand of a Cementitious Mixture[1]

This standard is issued under the fixed designation C1827; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is for the determination of the air-entraining admixture (AEA) demand of a mixture of cementitious materials, AEA, and water.

3.1.1 For definitions of terms used in this test method, refer to Terminology C125.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *absolute volume of AEA, n*—the air-entraining admixture demand expressed as volume of un-diluted air-entraining

than 10 drops will be required to achieve a stable foam and test sensitivity is reduced.

X1.2.2 For a given test material-AEA combination, the choice of AEA solution concentration typically remains unchanged, unless there is a change in test material, AEA, or both.

X1.3 Ambient temperature fluctuations may influence AEA adsorption. If separate tests are performed under different temperature conditions, a solution concentration used at one ambient temperature may not produce a stable foam at a different ambient temperature with the same number of drops. To ensure consistency, it is necessary to perform the test at 23.0 ± 3.0 °C as described in the test method.

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“Need-to-Know” information… *(Burt Gummer, Tremors)*

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Other Impacts

Performance Specifications for Durable Concrete," Concrete International, ACI, Vol. 28, No. 9, September 2006, pp 51-57.]

Other Impacts

- Ever wonder where 318 exposure classes came from?

- If I have that story right, there was some serendipity involved…

TABLE 5:
PROPOSED REFORMAT OF ACI 318-05 DURABILITY REQUIREMENTS BY EXPOSURE CLASS

Exposure class	Exposure conditions	Air content	Maximum w/cm*	Minimum f'_c, psi*	Cement type	Maximum SCM, %	Maximum Cl^-, %
F1	Moderate freezing-and-thawing cycles	Refer to Table 4.2.1	0.45	4500	—	—	—
F2	Severe freezing-and-thawing cycles	Refer to Table 4.2.1	0.45	4500	—	—	—
S1	Negligible sulfate exposure (SO_4 < 0.10% by weight in soil or SO_4 < 150 ppm in water)	—	—	—	—	—	—
S2	Moderate sulfate exposure† (0.10% ≤ SO_4 < 0.20% by weight in soil or 150 ≤ SO_4 < 1500 ppm in water)	—	0.50	4000	II, IP(MS), IS(MS), P(MS), I(PM)(MS), I(SM)(MS)	—	—
S3	Severe sulfate exposure (0.2% ≤ SO_4 ≤ 2.0% by weight in soil or 1500 ≤ SO_4 ≤ 10,000 ppm in water)	—	0.45	4500	V	—	—
S4	Very severe sulfate exposure (SO_4 > 2.0% by weight in soil or SO_4 > 10,000 ppm in water)	—	0.45	4500	V plus pozzolan‡	—	—
C1	Concrete intended to have low permeability when exposed to water	—	0.50	4000	—	—	—
C2	Exposed to deicing chemicals	Refer to Table 4.2.1	0.45	4500	—	Refer to Table 4.2.3	—
C3	For corrosion protection of reinforcement in concrete exposed to chlorides from deicing chemicals, salt, salt water, brackish water, seawater, or spray from these sources	Refer to Table 4.2.1	0.40	5000	—	Refer to Table 4.2.3	Refer to Table 4.4.1

* When more than one exposure class is considered, the lowest applicable maximum w/cm and highest applicable minimum f'_c shall be used.
† Seawater.
‡ Pozzolan that has been determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement.

TEACHER

Inspirational and Revered

- Everyone that teaches would love to have their students speak of them as a teacher in such glowing terms as Dr. Hover's students
- Not one bad word form any student ever – in fact it's the opposite – high praise
- Most students speak of Dr. Hover as a teacher in the context of the experience being life changing

Inspirational and Revered

- He has changed the lives of so many and have placed many materials-knowledgeable engineers in our industry
- *He explains things in ways that normal people can understand*
- Why use a partial differential equation to explain something that can be explained by an analogy to a piece of candy – Atomic Fireball?

HUMOR & WIT

Part of His Success as a Communicator

- Dr. Hover adds his unique wit and humor to any conversation – my kind of humor – and it has a purpose
- *It reinforces the broader technical point in an enjoyable approach*
- One I remember – “Mining Fly Ash”

TIME

Dr. Hover is approachable

- He's a busy guy…
- He always makes the time for a chat with a colleague – student or another gray hair like me
- And it doesn't need to be about concrete…
- Are you looking for a good cup of coffee in Salamanca NY? I know Ken has a recommendation

Sidebar: Our industry is special

- *In our industry those that have led like Dr. Hover make time for those of us (including me) that come behind.*
- They relish the opportunity to share knowledge
- This is a very special aspect of our industry, and ACI
- Dr. Hover more than anyone personifies that quality

CLASS & CHARACTER

Class & Character

- Class – Treats people with respect
- Character – what you do when nobody is watching – That's true
- It's also what you do when people ARE watching
- It's what you do when people depend on you it's how you lead.

Closing

- Our industry is unique.
- The people in our industry share a common bond over something that most people take for granted but we know it is very complex and not always easy to predict or describe.
- Concrete is our collective journey

For All of Us on the Journey

- Dr. Hover has provided us technical information to guide us on that journey
- Dr. Hover has developed that information through his amazing body of research
- Dr. Hover has communicated that information through his inspirational teaching and started many on the journey

For All of Us on the Journey

- Dr. Hover gives his time to talk with colleagues - especially students and young members
- Dr. Hover's humor and wit make the journey more fun for all of us
- He has provided needed leadership for our industry as we all take the journey

And for all of this, the knowledge, the teaching, the time he invests and his leadership over many years I just want to say…

Thanks Ken and don't think were letting you ride off in sunset just yet!