# ACI 224 Virtual Meeting
# 224R Chapter 10
# October 2017 Ballot Negatives

March 20, 2019

3 PM (EDT)

# Agenda

- Roll Call
- Meeting Rules of Engagement
- Negative Vote Overview
- Proposed Non-persuasive Ballot Items
  - Ballot Item 1, 88
  - Ballot Items 36, 38, 39
- Negative Ballot Items with Proposed Resolution
- Negative Ballot Items Accepted and Revised*

*Time Permitting

# Roll Call (23 Voting Members, Quorom = 9)

| Jacob Bice | Present | Harvey Haynes | Present |
|---|---|---|---|
| Ralf Leistikow | Present | Mohammed Iqbal | Present |
| Peter Barlow | Present | Malcolm Lim | Absent |
| Florian Barth | Regrets | Edward Nawy | Present |
| Neal Berke | Present | Kamran Nemati | Absent |
| Peter Bischoff | Regrets | Keith Pashina | Regrets |
| David Darwin | Absent | Guillermo Riveros | Absent |
| John Duntemann | Present | Ernest Schrader | Absent |
| Christopher Ferraro | Present | Jeffrey West | Absent |
| Fouad Fouad | Present | | |
| David Fowler | Present | | |
| Robert Frosch | Absent | | |
| Grant Halvorsen | Present | | |
| Will Hansen | Absent | | |

# Meeting Rules of Engagement

# Ballot Item 1

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|---|---|---|---|---|---|---|
| 1 | Ferraro | | | N | Overall the document is lacking in depth and does not provide much guidance. This chapter should provide much more depth. I've provided negatives below for a number of areas which should be improved technically. | Non-persuasive in the absence of proposed revisions. |

# Ballot Item 88

Negative

Chapter 10 needs extensive work. My negative vote is the withdraw the chapter and start over. A proposed outline is given below, including a new chapter title.

Control of Cracking by Concrete Mixture Considerations

Introduction: This chapter provides an overview of factors that influence drying shrinkage and thermal behavior.

Drying Shrinkage: In general, paste volume shrinks with internal water loss while aggregate resists the shrinkage.

- Water Content
- Paste Volume
- SCM
- Aggregate
- Admixtures

Thermal Behavior: Two mechanisms are part of thermal behavior, that of heat of hydration and coefficient of thermal expansion.

- Cement
- SCM
- Water Content
- Aggregate
- Admixtures

# Ballot Item 36

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|---|---|---|---|---|---|---|
| 36 | Ferraro | 3 | 3 | N | This sentence is not defendable. A reference to 40 year old documents. This should be updates with current documents. | Non-persuasive in the absence of proposed revisions. |

increase the ~~elastic modulus~~risk of ~~elasticity~~settlement and ~~increase creep, beneficially reducing the~~the associated risk of cracking. ~~Research~~When settlement is not likely, research has not found a consistent relationship between water content and the risk of cracking~~.~~ (Horn, Stewart and Boulware 1972, 1975).

# Ballot Item 38

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|---|---|---|---|---|---|---|
| 38 | Ferraro | 3 | 4 | N | This section is lacking in content. There are an abundance of text, research papers and other documentation which discusses cracking types and w/c. I suggest this section be dramatically revised to reflect the state of the art. | Non-persuasive in the absence of proposed revisions. |

**10.6 — Water-Cementitious Ratio**

Reducing the water-cementitious ratio usually increases concrete strength and decreases <u>drying</u> shrinkage~~, beneficially reducing the risk of cracking.~~ . However, reducing the water-cementitious ratio typically increases the modulus of elasticity and decreases creep, detrimentally increasing the risk of cracking. <u>Additionally, autogenous shrinkage can develop at low water-cementitious ratios.</u>

# Ballot Item 39

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|---|---|---|---|---|---|---|
| 38 | Ferraro | 3 | 4 | N | This section is lacking in content. There are an abundance of text, research papers and other documentation which discusses cracking types and w/c. I suggest this section be dramatically revised to reflect the state of the art. | Non-persuasive in the absence of proposed revisions. |
| 39 | Ferraro | 3 | 9 | N | Same comment, but with respect to aggregate / paste content. | Non-persuasive in the absence of proposed revisions. |

**10.7 — Aggregate and Paste Content**

Using a concrete ~~mix~~mixture with a high aggregate content and low paste content is usually desirable to reduce the risk of shrinkage and thermal cracking. Decreasing the paste content typically reduces shrinkage and temperature gain, reducing related stresses. Leaner ~~mixes~~mixtures are ~~also~~ often less thermally expansive and thereby develop smaller thermal stresses, and they are also more economical.

~~However, creep is related to the proportion of paste in the mix, and leaner concrete mixes typically creep less and develop larger stresses for a given strain. Reducing the paste volume reduces shrinkage but also reduces creep, often offsetting each other as they affect the risk of cracking.~~

# Ballot Items 25 & 27

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|---|---|---|---|---|---|---|
| 25 | Darwin | 2 | 11 | N | Change "**Cementitious Content**" to "**Cementitious Material Content**". "**Cementitious**" **is an adjective, not a noun.** | Accepted. Revise as noted. |
| 27 | Ferraro | 2 | 12 | N | This is vague. Cementitious material can refer to a number of things. Slag, C ash, etc. It is not appropriate to assume portland cement is the only cementitious material in a concrete mixture. | See response to Darwin.<br>Change "**Cementitious Content**" to "**Cementitious Material Content**". |

**10.4 – Cementitious Content**

Reducing the cementitious ~~content~~material typically increases creep and reduces shrinkage and thermal stresses, thereby reducing the risk of cracking. Reducing the cementitious ~~content~~material also reduces temperatures during hydration, reducing both early and long-term thermal stresses. As a general rule, each 100 pounds of portland cement added to a cubic yard of concrete will increase the temperature rise approximately 13 to 15 °F. To reduce the risk of thermal and shrinkage cracking, the lowest permitted cementitious ~~content~~material should generally be used.

# Ballot Item 40

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| 40 | Neal Berke | 3 | 18-34 | N | We need a sentence noting that the maximum aggregate size will need to conform to restrictions based on form dimensions, reinforcement spacing, and concrete cover. Suggest add that at the end. | Add the following from ACI 318:<br>The nominal maximum size of coarse aggregate shall not exceed the least of:<br>1. One-fifth the narrowest dimension between sides of forms<br>2. One-third the depth of slabs<br>3. Three-fourths the minimum specified clear spacing between individual reinforcing bars or wires, bundles of bars, prestressed reinforcement, individual tendons, bundled tendons or ducts |

# Ballot Item 40

**10.8 — ~~Large~~Coarse Aggregate**

The large-size aggregate typically occupies more volume than any other individual ~~mix~~mixture component. It therefore largely affects many concrete properties.

~~Large~~Coarse aggregate ~~is typically the strongest part of the mix, it~~ does not generate heat, ~~and it~~nor does ~~not~~it shrink. ~~It is also usually the cheapest component of the mix, excluding the water. Therefore, within reasonable limits, it is typically desirable to maximize~~Increasing the amount of ~~large~~coarse aggregate decreases the amount of paste required for a given level of workability, which beneficially decreases hydration heat and drying shrinkage, reduces stiffness. Therefore, increasing the coarse aggregate content in a ~~concrete mix. This is especially true for thick concrete pours, where thermal stresses are very important.~~

properly graded mixture is almost always beneficial. **10.8.1 *Size*** — Larger aggregates permit a leaner ~~mix~~mixture while maintaining workability and reducing early temperatures and related thermal stresses. Well-graded larger aggregates also tend to reduce shrinkage and bleeding~~.~~ (Portland Cement Association 1970). To maximize the amount of ~~large~~coarse aggregate in a concrete ~~mix~~mixture, the ~~mix~~mixture should utilize the largest aggregate size possible. ~~Large aggregate~~Coarseaggregate of 38-mm (1½-inch) size is readily available and concrete made with this size aggregate can be placed by pumping or other common construction placement means. ~~Mixes~~Mixtures containing aggregates as large as 64 mm (2½ inches) have been readily pumped, although such ~~mixes~~mixtures employed river gravel and not crushed stone.

# Ballot Item 40

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|---|---|---|---|---|---|---|
| 70 | Darwin | 5 | 6 | E | Add the names of Types II, IV, and V portland cement in this and the following line. | Accepted. Revise as noted.<br><br>Type I General purpose<br>Type II Moderate sulfate resistance |
| | | | | | | Type III High early strength<br>Type IV Low heat of hydration (slow reacting) |

ACI 207.1R discusses the different types of portland cements available and related heat properties (ACI Committee 207 1990).– Reducing early temperatures can reduce the risk of cracking by reducing the thermal contribution to tensile stresses. In brief, Ttype II or V cements will typically reduce early temperatures and related cracking risks, especially in thick concrete placements (Coutinho 1959). Type IV cement is no longer readily available.

# Ballot Item 76

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|---|---|---|---|---|---|---|
| 76 | Ferraro | 5 | 22 | N | Type C fly ash does not produce more heat than Portland Cement. It usually produces less (depending on CaO content) . Gajda 2007 does a great job of explaining this. | Accepted. Revise as follows:<br>Addition of either type of fly ash will reduce the heat of hydration; the reduction associated with the addition of Class F ash is greater than that with Class C fly ash.<br>Also add Gajda 2007 reference. |

**10. 10.2** ***Fly ash*** — Fly ash is a byproduct from the fossil fuel industry, and concrete ~~mixes~~mixtures often use fly ash as a substitute for some of the portland cement. Because fly ash particles are spherical, the use of fly ash generally improves the pumping characteristics of concrete. There are two types of fly ash: Type C and Type F. Type C (high lime content) fly ash typically produces as much heat or more heat as portland cement. Type F (low lime content) fly ash generally produces less heat than portland cement, but this is not always the case.

# Ballot Item 83

| | | | | | | |
|---|---|---|---|---|---|---|
| 83 | Darwin | 6 | 13 | N | Delete this sentence. You can produce a workable low-cracking concrete with slumps lower than 3 in. | Revise as follows:<br>Concrete should generally have a slump of at least 2-4 inches to allow for proper compaction and finishing. Concrete with slumps less than 2 inches have low to very low workability. |

**10.12 — Slump**

To allow for proper compaction and finishing, concrete should generally have a slump of at least 3 inches. The risk of settlement cracking occurring typically increases with slump, although careful proportioning of the ~~mix~~mixture can significantly mitigate this risk~~.~~ ~~Research on the relationship between slump and other cracking is inconclusive.~~ (Portland Cement Association 1970; Babaei and Hawkins 1987).