

ASTM Updates – Blended Cements & SCMs

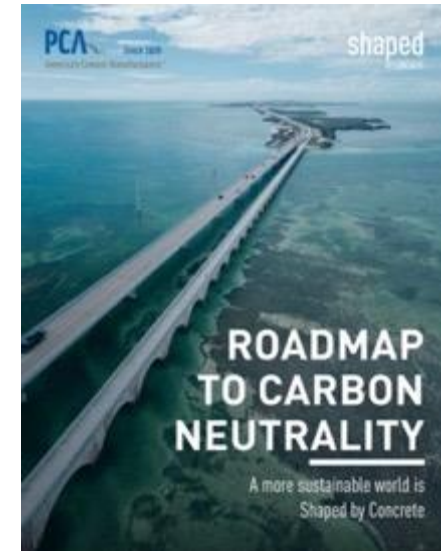
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We Still Got Roadmaps!

- The cement and concrete producers are still “committed” to being **net carbon neutral by 2050**
- Common elements - address the carbon footprint across the entire concrete value chain
- Long-term (10-30 years out) - modification of cement production including carbon capture, utilization, and storage (CCUS) – **or “other” changes**
- **Near term (next 5-10 years)** - significant progress must be achieved through **enhancements in concrete production and use.**



The Path Forward for Concrete

Less clinker in cement, less cement in concrete, less concrete in construction

- Replace clinker content in cement
 - More supplementary cementitious materials (SCMs) in blended cements (ASTM C595)
 - More SCMs at the concrete plant
- Use less cementitious materials
 - Optimized aggregate grading
 - Lower cementitious content
- Optimize designs & new mixtures
- Use “emerging materials” materials (i.e., new materials)

The Path Forward for Concrete

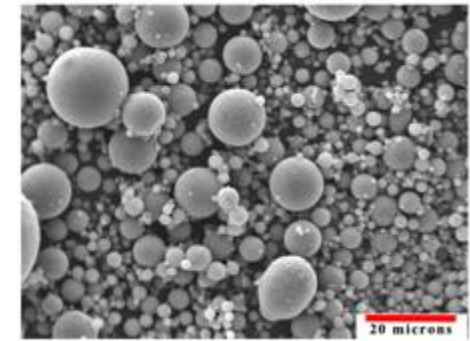
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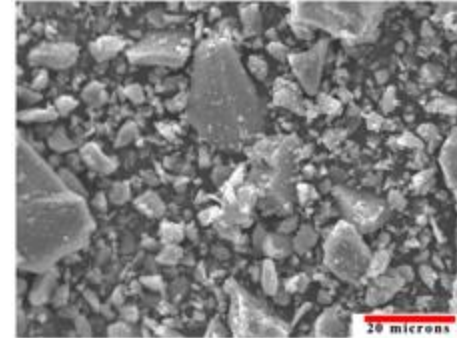
Supplementary Cementitious Materials

- Key Materials (historically)
 - Coal fly ash – **over 2/3 of total SCM use**
 - Slag cement – Ground Granulated Blast Furnace Slag
 - Silica fume
 - Natural pozzolans – raw and calcined

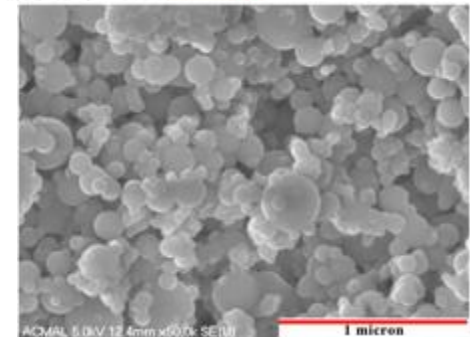
Fly Ash



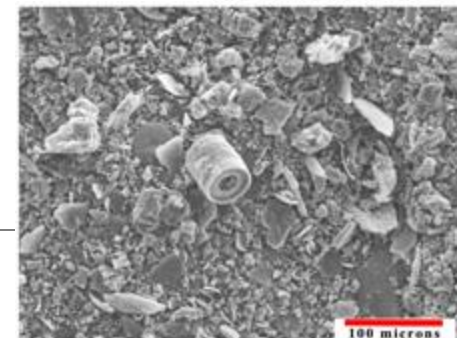
Slag Cement



Silica Fume



Natural Pozzolan



New Cements & Supplementary Cementitious Materials



- Different feedstocks
- Different production processes
- Some are manufactured new materials
- Some are modified old materials
- Some are not materials but are processes to apply to existing materials

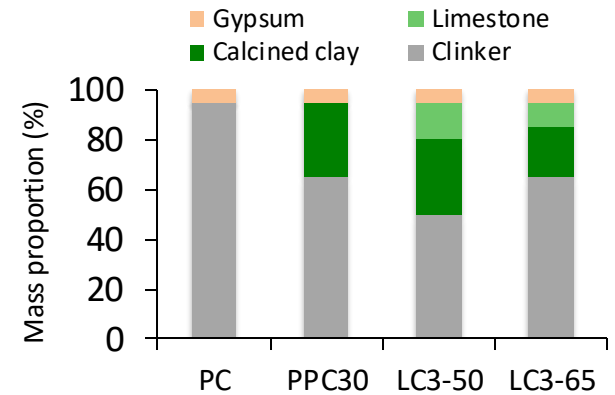


New Binder Systems

- Old materials used differently
- Significant clinker reductions
- Specify under ASTM C1157 but no AASHTO equivalent of ASTM C1157

Calcined clay,
~45% kaolinite

Limestone
Calcined
Clay
Cement **LC³**



High-Filler Low-Water (HFLW)

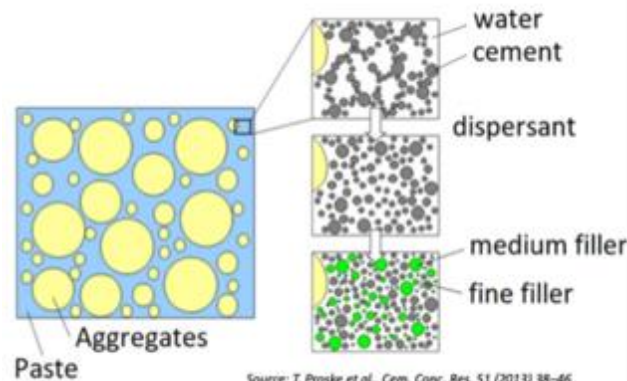
HFLW

30% cement

20% – 30% slag

40% – 50% limestone

Proprietary admixtures



Current initiatives for new specifications

- **New Standards from ASTM**
 - Performance-oriented specification for SCMs
 - Changes to blended SCM specification
 - Performance-oriented specification for alkali activated cements
 - Changes to the blended cement specification to accommodate new binder systems

#1 - SCM Performance-Oriented Specification

- ASTM has passed a performance-oriented specification for SCMs – **ASTM C1912** – *to be published in September 2025*
- A new pathway to specify emerging materials and off-spec conventional materials
- No limit on composition or origin of the material
- Measure and report properties, do not prescribe limits unless necessary
- Uses newly developed standard tests for assessing reactivity and for foam index
- New bulk resistivity test to be added soon – **ASTM C1952**

New Tests



Designation: C1897 – 20

Standard Test Methods for
Measuring the Reactivity of Supplementary Cementitious
Materials by Isothermal Calorimetry and Bound Water
Measurements¹

R3 Tests



Designation: C1827 – 20

Standard Test Method for
Determination of the Air-Entraining Admixture Demand of a
Cementitious Mixture¹

Foam Index



New Tests – R3 – ASTM C1897

- R3 Tests – *Rapid, Reliable and Reproducible*
 - *Developed by RILEM, an international research consortium*
- **Method A - Isothermal Calorimetry** – determine the heat of hydration of hydrating pastes comprising the SCM, calcium hydroxide, calcium carbonate, potassium sulfate, and potassium hydroxide
- **Method B - Bound Water Test** – Determine the chemically bound water of pastes comprising the SCM, calcium hydroxide, calcium carbonate, potassium sulfate, and potassium hydroxide
- The heat of hydration value (in joules per gram of SCM), or the total bound water (in grams of water per 100 grams of dry paste) is used as a measure of the chemical reactivity of the SCM

This is a new direction

- **Big Picture**
 - We need to move from empiricism to testing and specifying individual material properties that affect performance in concrete
- **Material Specifications vs Concrete Specifications**
 - Component material specifications need to focus on uniformity of key properties of the component material (e.g., strength development, heat evolution, setting time) – limit where necessary – report the rest
 - Concrete specifications need to address the assemblage of materials

The Change

- **Performance-Oriented Specifications**
 - We cannot prescribe specification limits for every individual material
 - Too many materials, too diverse
 - We need to measure and report fundamental properties (e.g., reactivity) that determines a materials performance in concrete, and learn how to use that information to design mixtures

Implementation

- Specifiers have relied on prescription for materials... because they could... (false security IMHO)
- *Example: Fly ashes of the same type are assumed to be similar enough, normally*
 - *Often this is not true – but we lived with it*
- Experience with new materials will come with time
- Develop performance-oriented specifications, new tests, design tools and guide documents will be needed

Table 1 Physical Requirements

<i>Fineness</i>		
Amount retained when wet-sieved on 45 µm (No. 325) sieve		report only
Amount retained on 150-µm (No. 100) sieve, max, % ^A		10
<i>Relative density</i> ^B		
		report only
<i>Strength activity index</i>		
Option 1		
At 7 days, percent of reference mixture, min, %		80
and		
At 28 days, percent of reference mixture, min, %		80
Option 2		
At 56 days, percent of reference mixture, min, %		80
<i>Water requirement</i>		
Water requirement, percent of reference mixture		report only
<i>Reactivity</i>		
Bound water content, at 7 days, min, g/100 g dry paste		3.6
<i>Time of initial setting</i> ^D		
Setting time, minutes		report only
<i>Uniformity</i>		
Test results of individual samples shall not vary from the average established by the ten preceding tests, or by all preceding tests if the number is less than ten, by more than:		
Relative density, max variation from average, percentage points from average		5
Percent retained on 45-µm (No. 325), max variation, percentage points from average		5

TABLE 2 Optional Physical Requirements

<i>Foam index</i> ^A		
Relative absolute volume of AEA, %		report only
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Expansion of reference mixture at 14 days, %		report only
Expansion of test mixture, at 14 days, %		report only
<i>Uniformity requirements</i>		
The quantity of air-entraining admixture required to produce an air content of 18.0 vol % of mortar shall not vary from the average established by the ten preceding tests or by all preceding tests if less than ten, by more than, %		20

^A Determine the foam index in accordance with Test Method C1827. The purchaser shall identify the air-entraining admixture (AEA) to be used. Report the type and brand of AEA used in the test and report the type, brand, and source of portland or portland limestone cement used in the test.

^B Prepare a reference mixture in accordance with Test Method C1260 and a test mixture in accordance with Test Method ASTM C1567. Use a reactive aggregate source with a 14-day expansion greater than or equal to 0.20 % and less than or equal to 0.45 % when tested in accordance with Test Method ASTM C1260. The producer shall determine the mass replacement of the SCM in the test mortar mixture. Use no SCM replacement in the reference mortar mixture. Report the mass replacement of the SCM in the test mortar mixture and the expansion results for the test mixture and the reference mixture.

9.2.1 If the SCM meets the scope of one of the alternative specifications referenced in 9.2, the supplier shall: a) perform all required testing to establish compliance with the applicable specification identified in 9.2; b) report all test results required by the applicable specification identified in 9.2; and c) specifically identify the requirements or limits of the applicable specification identified in 9.2 that the SCM does not comply with.

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9.2 The supplier's report shall include certification of whether the SCM meets the scope of Specification C618, C989/C989M, C1240, C1866/C1866M, or C1945.

9.2.1 If the SCM meets the scope of one of the alternative specifications referenced in 9.2, the supplier shall: a) perform all required testing to establish compliance with the applicable specification identified in 9.2; b) report all test results required by the applicable specification identified in 9.2; and c) specifically identify the requirements or limits of the applicable specification identified in 9.2 that the SCM does not comply with.

ANNEX
(Mandatory Information)

A1. Evaluation of Alternative Supplementary Cementitious Materials

A1.1 The provisions of this Annex apply only to SCMs that do not meet the scope of Specification C618, C989, C1240, C1866, or C1945. See Note 12.

A1.2 The supplier shall provide one of the following if requested by the purchaser:

- a) the results of a comprehensive evaluation of the material following Guide C1709 Stage I through Stage IV;
- b) the results from evaluation by field trials and long-term performance and durability testing obtained following Guide C1709 Stage V; or
- c) other laboratory or field testing, or both, evaluating the material performance in concrete approved by the purchaser.

#2 - Blended SCM Specification (ASTM C1697)

- Historically could only blend fly ash, natural pozzolan, slag, or silica fume
 - *Each must meet their respective specification*
- Changed fly ash to coal ash
 - Coal ash is fly ash or bottom ash, or both, fresh or harvested
- Added ground glass pozzolan (ASTM C1866)
- Adding ground limestone – less than 50% (in ballot)

#2 - Blended SCM Specification (ASTM C1697)

Ground **L**imestone



Portland **C**ement



Calcined **C**lay



LC³

#2 - Blended SCM Specification (ASTM C1697)

Ground **L**imestone



Calcined **C**lay



LC²

#2 - Blended SCM Specification (ASTM C1697)

Ground **L**imestone



Bring
Your
Own
Cement

Calcined **C**lay



LC³

#2 - Blended SCM Specification (ASTM C1697)

- Historically could only blend fly ash, natural pozzolan, slag, or silica fume
 - *Each must meet their respective specification*
- Changed fly ash to coal ash
 - Coal ash is fly ash or bottom ash, or both, fresh or harvested
- Added ground glass pozzolan (ASTM C1866)
- Adding ground limestone – less than 50% (in ballot) – **Supports LC³ implementation**

#3 - Performance specification for alkali-activated cements

- New standard for alkali-activated cements – **ASTM C1948**
- Based largely on ASTM C1157
- Defines two (2) types based on curing requirements
- Incorporates the newly developed **ASTM C1928** test method for compressive strength of AAC cubes



Designation: C1948/C1948M – 24

**Standard Specification for
Alkali-Activated Cementitious Materials**



Designation: C1928/C1928M – 23

**Standard Test Method for
Compressive Strength of Alkali Activated Cementitious
Material Mortars (Using 2-in. [50 mm] Cube Specimens)**

Alternative Cementitious Materials (ACMs)

- **Alkali-Activated**



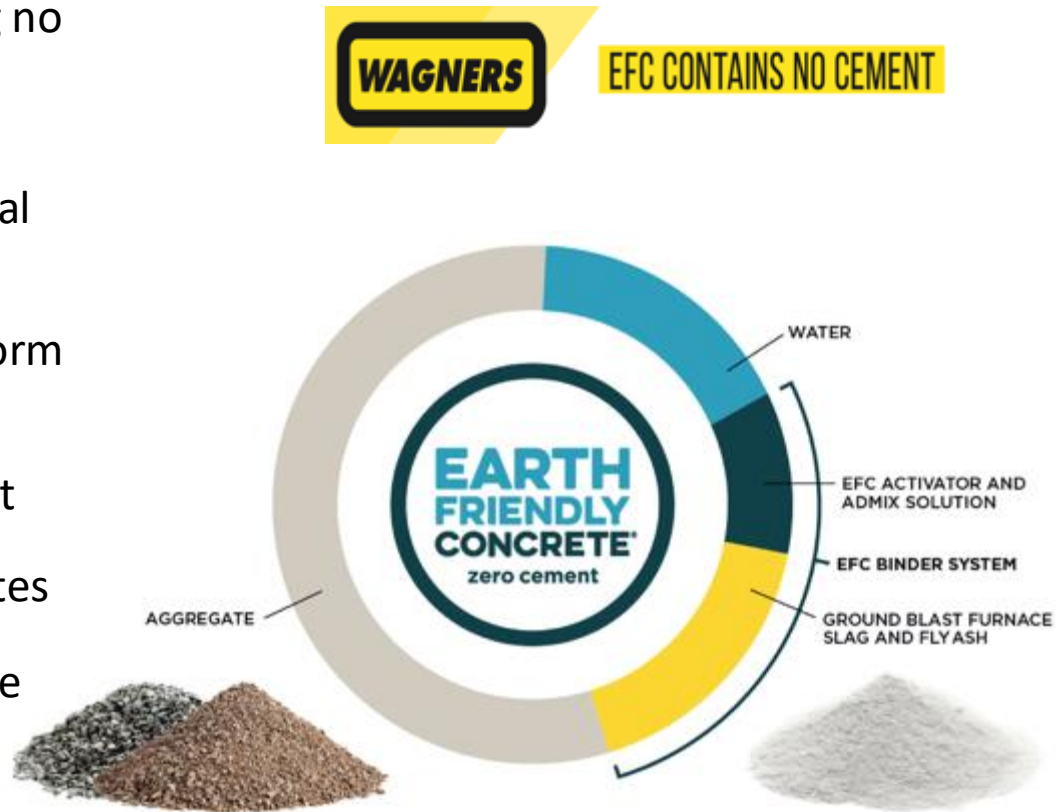
- **Non- or partially-hydraulic**
- **Different curing**
- **Different feedstocks**
- **Different production processes**



Alkali Activated - Example

- ***Company: Wagners EFC***

- Use “no cement” meaning no portland cement
- Highly alkaline solution dissolves precursor material e.g., slag
- Ca, Al, Si ions in solution form C-S-H and C-A-S-H
- “True” geopolymer will not have adequate calcium to form calcium-based hydrates
- Many successful large-scale projects



Performance specification for alkali-activated cements

- Defines two (2) types of alkali-activated cementitious materials
 - Those tested with curing at standard laboratory temperatures (i.e., 20 °C), “Type AACM RTC”
 - Those tested with curing at elevated temperatures (i.e., 60 °C, “Type AACM ETC”
 - Each Type can be designated GU, HE, MS, HS, MH, LH
 - Physical requirements follow the requirements in ASTM C1157; slightly more stringent



Designation: C595/C595M – 24

#4 - Changes to ASTM C595

Standard Specification for
Blended Hydraulic Cements

- Approved changes to Types IT, IP, and IS
- Allow up to 15% limestone plus the pozzolan or slag
- In Type IT limestone IS NOT counted as one of the blending ingredients
- Example IT(L10)(S30)(P15)
 - Portland cement plus 10% limestone + 30% slag + 15% pozzolan
 - i.e., 45% portland or ~ 42% clinker



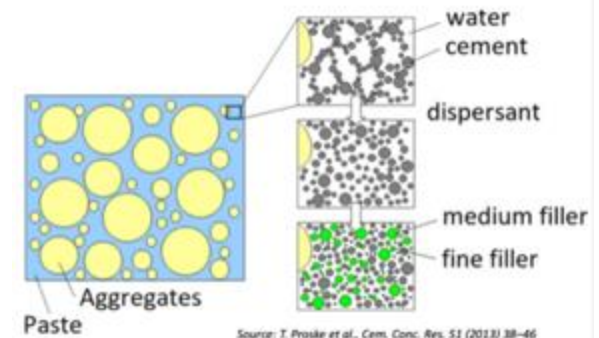
Designation: C595/C595M – 24

#4 - Changes to ASTM C595

- For the blended hydraulic cement specification, **a new Type IC has been approved**
- Minimum 30% portland cement
- Limestone, pozzolan (e.g., coal ash, natural pozzolan, silica fume) or slag cement combined must be 70% or less, any combination
- Example: (L5)(S24)(P20)(P8)

Standard Specification for Blended Hydraulic Cements

High-Filler Low-Water (HFLW)



Limestone
Calcined
Clay
Cement

LC³



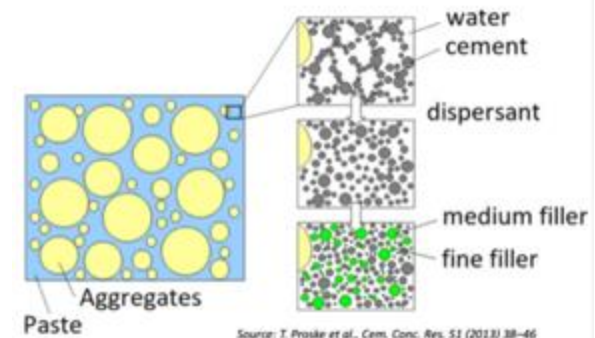
Designation: C595/C595M – 24

#4 - Changes to ASTM C595

- Must meet all applicable requirements of the specification e.g., strength, LOI
- Will directly support development of LC³ or HFLW blends as part of an existing specification
- AASHTO balloting the same changes for AASHTO M 240

Standard Specification for Blended Hydraulic Cements

High-Filler Low-Water (HFLW)



Limestone
Calcined
Clay
Cement



AASHTO-ASTM Harmonization

Material	Specifications	Harmonized
Portland Cement	AASHTO M 85, ASTM C150	YES
Blended Cement	AASHTO M 240, ASTM C595	YES
Coal Ash	AASHTO M 295, ASTM C618	YES
Slag Cement	AASHTO M 302, ASTM C989	YES
Natural Pozzolans	<i>AASHTO M xxxx, ASTM C1945</i>	in progress
Silica Fume	AASHTO M 307, ASTM C1240	in progress

New Harmonization Activities

- At the August 2025 AASHTO COMP meeting, AASHTO representatives announced they will enter a pilot program to share standards between AASHTO & ASTM
 - Develop AASHTO versions of selected ASTM standards and ASTM versions of selected AASHTO standards
- ~ 7 years in the making - Hopefully just the beginning...
- First test cases:
 - ASTM C1912 to AASHTO (new SCM spec)
 - AASHTO T 395 to ASTM (SAM meter)

Summary

- Changes to specifications to support emerging materials and new blends
 - ASTM C1912 – SCMs
 - ASTM C1697 – Support LC³ with addition of limestone
 - ASTM C1948 – Alkali Activated Cements
 - ASTM C595/AASHTO M 240
 - Up to 15% limestone in Types IT, IP, and IS
 - New Type IC to support lower clinker content blends

We are doomed

Questions?

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periculosum est tempus indoctus

