Introduction and Overview

Understanding ASTM International Test Procedures for Cement and Concrete - Staying Up to Standard

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CTLGROUP

Personal Background

Anthony Bentivegna, PhD, PE

Laboratory Manager and CTLGroup-Qatar Liaison

- Manager of Testing Laboratories in Chicago, IL, USA
- Liaison for CTLGroup-Qatar Laboratory in Doha, Qatar
- PhD, University of Texas at Austin, Civil Engineering
- Professional Engineer, Multiple States in USA

Technical Expertise

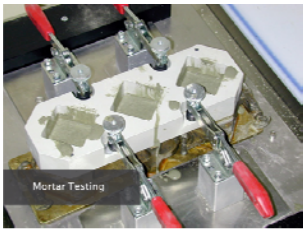
- Concrete and Concrete Durability Related Testing
  - Alkali-silica Reaction, Delayed Ettringite Formation, Freeze/Thaw, and Shrinkage
- Diagnosis and Repair of Structures which Suffer Premature Deterioration due to Concrete Durability Issues.
- Project Oversight for Numerous Global Projects
- Facilitate Laboratory Services and Testing to Engineering Application

CTLGroup: Company Overview

- History
  - 1916 - R&D lab for Portland Cement Association
  - 1987 - Incorporated as a wholly owned subsidiary, Construction Technology Laboratories, Inc.
  - 2005 - Diversified services and became internationally known as CTLGroup
- 110 employees
  - Engineers, architects, petrographers, and chemist
  - 25% have Ph.D. Degrees

Company Overview – Laboratory Services

- 5,500 m^2 of laboratory facilities



CTL GROUP QATAR

Presentation Outline (1/2)

- Monday May 9, 2016:
  - (Introduction and Mixing)
    - Introduction, Overview and Related Standards
    - ASTM C305 – Practice for Mixing Pastes and Mortars
  - (Paste and Mortar Testing)
    - ASTM C204 - Fineness
    - ASTM C1437 – Flow
    - ASTM C187 – Normal Consistency
    - ASTM C191 – Time of Set
    - ASTM C109 – Compressive Strength of Cubes
    - ASTM C185 – Air Content of Cement Mortar
    - Discussion

Presentation Outline (2/2)

- Monday May 9, 2016 (Continued):
  - (Requirements of Standards)
    - ASTM C150 – Standard Specification for Portland Cement
    - ASTM C989 – Standard Specification for Slag Cement

Learning Objectives

- Understand the reasons for conducting each test,
- Define terminology pertinent,
- Identify necessary equipment,
- Understand the sampling procedures,
- Understand limitations, and
- Witness demonstrations (videos).

How Reliable is Laboratory Testing? (and How Realistic is the Testing?)

- Lot's of tests don't resemble reality.
  - Some tests are too aggressive,
  - Some tests are not aggressive enough,
  - Some tests don't have any practical value, and
  - Some test have inherent flaws.

So, Why Do We Perform Standardized Tests?

Why Do We Perform Standardized Tests?

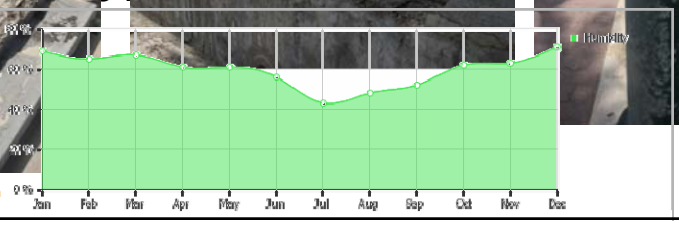
- The ultimate goal is to…..build buildings, bridges, roadways, and all concrete structures that are safe and durable.
- So, why do we run these tests…
  - To ensure uniformity of materials,
  - To check for potential material related failures prior to placing concrete,
  - Documentation for government representatives,
  - Documentation for future problems, and
  - Life Safety.

Concrete in Kuwait

Beautiful Concrete of Kuwait but, it's longevity is challenged by….

Many Durability Concerns

- Weather – high temperatures can lead to cracking and potential for delayed ettringite formation in mass concretes.
- Salt exposure – Corrosion



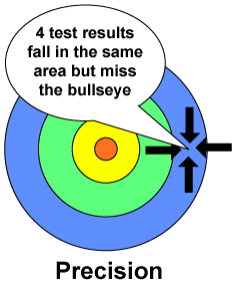
Why Do We Perform Standardized Tests?

- The goal is to make build buildings, bridges, roadways, and all concrete structures that are safe and durable.

How Reliable is Laboratory Testing?

- Accuracy and Precision
  - Tell us how well the test method performs day to day in the laboratory, and
  - are the cornerstone for reliability of your test results.

Accuracy



Precision

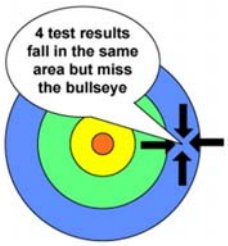
Ideally…

- We want test that are accurate and precise.
  - Accurate meaning they tell us the future of the concrete in the field, but
  - This is outside the scope of this presentation.

Accuracy

So, We Will Focus on Precision.

- We will discuss the standards in detail, from the equipment to the nuisances of the testing procedures.
- So, that you can get precise results that are repeatable in your laboratory and amongst other laboratories.



Precision

How Do We Improve Precision?

NQA-1 Compliant

ACCREDITED
17025

Quality management systems help meet the most demanding requirements for engineering consulting and testing of materials and structural components.

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Other Ways to Improve Precision

- Address These Common Sources of Error
  - Follow the Procedures
  - Timing is Everything
  - User Dependency
  - Equipment
  - Laboratory Conditions
  - Reading Standards

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How Do We Prevent Mistakes?

- Quality Training
- Reading Standards and Practices
- Bad Habits are Passed Down
- Internal and External Audits
- Yearly Performance Evaluations
- Reading All Related Standards and Practices

Related ASTM Standards

- Commonly Overlooked, but VERY Important!
- ASTM C511 - Mixing Room, Cabinets, Moist Rooms, and Water Storage Tanks
- ASTM C778 - Standard Sand
- ASTM C1005 - Reference Masses and Devices for Determining Mass and Volume
- ASTM D1193 – Reagent Water

ASTM C511 – Mixing Room, Cabinets, Moist Rooms, and Water Storage Tanks (1/3)

- ***Scope:*** This specification includes requirements for mixing rooms where paste and mortar specimens are prepared; and for moist cabinets, moist rooms, and water storage tanks where paste, mortar, and concrete specimens are stored.
- ***Requirement of Cement Mixing Rooms:***
  - Air in the vicinity of the mixing, molds, and base plates shall be maintained at 23.0 ± 4.0°C and at a relative humidity of not less than 50 %.

ASTM C511 – Mixing Room, Cabinets, Moist Rooms, and Water Storage Tanks (2/3)

- ***Requirements for Moist Cabinets and Moist Rooms:***
  - Specimens maintained at 23.0 ± 4.0°C and RH > 95%
  - **Moist Cabinets:** Relative humidity maintained by the use of fog sprays or curtains of water.
  - **Moist Rooms for Cement Testing:** prevent droplets of water from falling on the surfaces of freshly molded specimens.
  - **Moist Rooms for Concrete Testing:** specimens in storage both look moist and feel moist.

ASTM C511 – Mixing Room, Cabinets, Moist Rooms, and Water Storage Tanks (3/3)

- ***Requirements for Water Storage Tanks:***
  - Maintain storage water temperature at 23.0 ± 2.0°C
  - Saturated with calcium hydroxide to prevent leaching of calcium hydroxide from the specimens.
  - Tanks shall be cleaned and refilled with water containing 3 g/L of calcium hydroxide at intervals not to exceed 24 months.

ASTM C778 – Standard Sand

- ***Scope:*** This specification covers standard sand for use in the testing of hydraulic cements.
- 20–30 sand: standard sand, predominantly graded to pass a 850-µm (No. 20) sieve and be retained on a 600-µm (No. 30) sieve.
- Graded sand: standard sand, predominantly graded between the 600-µm (No. 30) sieve and the 150-µm (No. 100) sieve.

Characteristics	20-30 Sand	Graded Sand
Grading, percent passing sieve:		
1.18 mm (No. 16)	100	100
850 µm (No. 20)	85 to 100	
600 µm (No. 30)	0 to 5	96 to 100
425 µm (No. 40)		65 to 75
300 µm (No. 50)		20 to 30
150 µm (No. 100)		0 to 4
Difference in air content of mortars made with washed and unwashed sand, max, % air[A]	2.0	1.5
Source of sand	Ottawa, IL or LeSuer, MN	Ottawa, IL

ASTM C778 – Standard Sand (2/2)

- Sample: sample sand and check for air entrainment requirements and sieve analysis.

Total No. of Consecutive Bags in Shipment	No. of Bags to Test	Test in Consecutive No., the Following Bags
Sampling:		
less than 5	1	random
5 to 19	1	5th
20 to 34	2	5th and 20th
35 to 49	3	5th, 20th, and 35th
50 to 64	4	5th, 20th, 35th, and 50th
Resampling:		
less than 5	none	reject shipment
5 to 19	1	10th
20 to 34	2	10th and 25th
35 to 49	3	10th, 25th, and 40th
50 to 64	4	10th, 25th, 40th, and 55th

- Reject sands not meeting the requirements.

ASTM C1005 – Reference Masses and Devices for Determining Mass and Volume (1/2)

- ***Scope:*** This specification cover the minimum requirements for scales, balances, reference masses, and glass graduates used in the physical testing of hydraulic cements.
- ***Requirement of Reference Masses:***
  - Reference masses shall be used to verify balances daily.

ASTM C1005 – Reference Masses and Devices for Determining Mass and Volume (2/2)

- ***Requirements for Scales and Balances:***
  - Capacity shall be at least equal to the maximum load
  - Precision and Accuracy
    - Allowable tolerance 0.05% for balances with capacity greater than 3000g from 300 to 3000g
    - For balances with capacity less than 3000g, the tolerance shall be tested from 10% up to the capacity of the balance.
- ***Requirements for Glass Graduates:***
  - Suitable capacity for measuring paste and mortar water
  - Permissible variation 100-150 mL allowed ± 1.0 mL
  - Permissible variation 200-300 mL allowed ± 2.0 mL
  - Divided at 5 mL increments

ASTM D1193 – Reagent Water

- ***Scope:*** This specification describes the required characteristics of waters deemed suitable for use with the Standards under the jurisdiction of ASTM.
- Four types of water specified with three different grades (i.e. IA, IB, IC, 2A, etc.)
- Production Process: Purified, Distilled, Deionized, Electrodeionization (EDI), and Reverse Osmosis
- Limits: Electrical Conductivity, Electrical Resistivity, pH, Total Organic Carbon, Sodium Content, Chloride Content, and Hetertophic Bacteria Count
- Recommendations for Monitoring Water and Storage and Distribution of Water

ASTM D1193 – Reagent Water

Type	Grade	Production Process[A,B,C,D]	µS/cm[E] (max)	MΩ-cm[F] (min)	pH[G]	TOC µg/L[H] (max)	Sodium µg/L[I] (max)	Chloride µg/L[J] (max)	Total Silica µg/L (max)	HBC[K] cfu/mL (max)	Endotoxin, EU/mL[L] (max)
I		Purity to 20 µS/cm by dist. or equiv., followed by mixed bed DI, 0.2 µm filtration[A]	0.0555	18		50	1	1	3		
I	A	Purity to 20 µS/cm by dist. or equiv., followed by mixed bed DI, 0.2 µm filtration[A]	0.0555	18		50	1	1	3	10/1000	0.03
I	B	Purity to 20 µS/cm by dist. or equiv., followed by mixed bed DI, 0.2 µm filtration[A]	0.0555	18		50	1	1	3	10/100	0.25
I	C	Purity to 20 µS/cm by dist. or equiv., followed by mixed bed DI, 0.2 µm filtration[A]	0.0555	18		50	1	1	3	100/10	
II		Distillation[B]	1.0	1.0		50	5	5	3		
II	A	Distillation[B]	1.0	1.0		50	5	5	3	10/1000	0.03
II	B	Distillation[B]	1.0	1.0		50	5	5	3	10/100	0.25
II	C	Distillation[B]	1.0	1.0		50	5	5	3	100/10	
III		Distillation, DI, EDI, and/or RO, followed by 0.45 µm filtration.[C]	0.25	4.0		200	10	10	500		
III	A	Distillation, DI, EDI, and/or RO, followed by 0.45 µm filtration.[C]	0.25	4.0		200	10	10	500	10/1000	0.03
III	B	Distillation, DI, EDI, and/or RO, followed by 0.45 µm filtration.[C]	0.25	4.0		200	10	10	500	10/100	0.25
III	C	Distillation, DI, EDI, and/or RO, followed by 0.45 µm filtration.[C]	0.25	4.0		200	10	10	500	1000/100	
IV		Distillation, DI, EDI, and/or RO.[D]	5.0	0.2	5.0 to 8.0		50	50			
IV	A	Distillation, DI, EDI, and/or RO.[D]	5.0	0.2	5.0 to 8.0		50	50		10/1000	0.03
IV	B	Distillation, DI, EDI, and/or RO.[D]	5.0	0.2	5.0 to 8.0		50	50		10/100	0.25
IV	C	Distillation, DI, EDI, and/or RO.[D]	5.0	0.2	5.0 to 8.0		50	50		100/10	

Summary

- Understanding Why We Perform Standardized Testing
- The Importance of the Testing
- Common Areas for Mistakes
- Related Technical Standards That Are Overlooked

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Questions & Answers