CEMENTS FOR CONTAINMENT STRUCTURE REPAIR

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CTS Cement Manufacturing

Containment Structures Concrete Repairs

Containment Structures

- Containment
  - Water
  - Wastewater
  - Chemical
  - Fuel
  - Nuclear
- Tunnels and Concrete Pipes
- Manholes

Containment

Primary Causes of Concrete Failure

- Erosion
- Alkali Silica Reaction
- Sulfate Attack
- Reinforcing Corrosion
- Shrinkage and Cracks
- Chemical

Repair Correctly – Not Always Cheap!

Repairs-Why Not Traditional PCC Mixes

- Limited Abrasion Resistance
- Limited ASR Mitigation
- Limited in Sulfate Resistance
- Limited Chemical Resistance
- Very Porous
- Shrinkage Cracks
- Coatings – 30 plus days to apply

Cements That Address the Primary Concrete Failures

- **ASTM C-1600 Rapid Hardening Hydraulic Cements**
  - **Calcium Sulfoaluminate Cement**
  - Specific Blended Cements
- Potential Portland Cement with Specific Supplementary Cementitious Materials (SCMs)
  - Fly Ash
  - Slag
  - Metakailan
- Calcium Aluminate
- ASTM C-845 Type K Shrinkage Compensating

Vision 2020 – ASTM C-1600

ASTM C-1600 Cements

- Can be Most Any Natural or Blended Rapid Strength Hydraulic Cement System
- Intention is to Create a Cement Solution That All End User Has to do is Add Water and Aggregates
- Admixture Friendly
- Bulk or Packaged Products

ASTM C-1600 Rapid Hardening Hydraulic Cement

- Performance Specification
- Clearly Defines the Cement by Speed of Strength Development
- Tests Include

Strength Development	Set
Shrinkage	Expansion
Sulfate Resistance	Heat Hydration
Alkali Silica Reactivity	

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Client:		CTL Project No.:	059154
Project:	ASTM C 1600-07 Testing Rapid Hardening Cement	CTL Proj. Mgr.:	Jerzy Zemajtis
		Analyst:	Celestin/Hernandez
Contact:		Approved:	Xiuping Feng
Submitter:		Date Analysed:	November 14
Date Received:	November 14, 2008	Date Reported:	May 12, 2010

ASTM C 1600-07 STANDARD PHYSICAL REQUIREMENTS

	Cement Type				Client ID:	Rapid Set nt (0810-478)
	URH	VRH	MRH	GRH	CTL ID:	2256701
Strength, compression, min, Mpa (psi)						
1-11/2 h	21 (3000)	12 (1770)	---	---		22 (3200)
3 h	28 (4000)	15 (2280)	10 (1500)	7 (1000)		24 (3510)
6 h	---	---	14 (2000)	10 (1500)		31 (4430)
1 day	35 (5000)	24 (3480)	17 (2500)	14 (2000)		33 (4770)
7 days	41 (6000)	28 (4000)	24 (4000)	24 (3500)		34 (4900)
28 days	57 (8300)	35 (5000)	31 (4500)	28 (4000)		41 (5910)
Drying Shrinkage, (ASTM C 596) max %						
7 days	0.06	0.06	0.08	0.10		0.02
28 days, air storage	0.07	0.07	0.09	0.12		0.03
Time of Setting, (ASTM C 191) Vicat test[A], minutes						
Initial setting	---	---	---	---		10
Final setting[B], min	10	10	10	10		12
Autoclave, max expansion %	0.8	0.8	0.8	0.8		-0.01

ASTM C 1600-07 OPTIONAL REQUIREMENTS

Sulfate expansion[C] (ASTM C 1012)					
6 months, max %	0.05	0.05	0.05	0.05	0.02
1 year, max %	0.10	0.10	0.10	0.10	0.02
ASR expansion[D] (ASTM C 441)					
14 days, max %	0.020	0.020	0.020	0.020	-0.002
56 days, max %	0.060	0.060	0.060	0.060	-0.004
Heat of Hydration (ASTM C 186)					
7 days, max, kJ/kg (kcal/kg)	250 (60)	250 (60)	250 (60)	250 (60)	257 (61.5)
28 days, max, kJ/kg (kcal/kg)	290 (70)	290 (70)	290 (70)	290 (70)	279 (66.7)
Expansion in water (ASTM C 1038)					
14 days, max %	0.10	0.10	0.10	0.10	0.001

A: Test conducted using method A of ASTM C 191-04b.
B: The initial setting time typically ranges from 10 to 45 min for rapid hardening cements of various types and compositions.
C: In the testing of these cements, testing at one year shall not be required when the cement meets the 6-month limit. Cement failing the 6-month limit shall not be rejected unless it also fails the one-year limit.
D: The test for mortar expansion is an optional requirement to be applied only at the purchaser's request and is not required unless the cement will be used with alkali-reactive aggregate.

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Calcium Sulfoaluminate Cement

- Very Rapid Hardening – 3000 psi 1 to 3 hours
- Very Low Shrinkage – Volume Stability
- Limited Expansion
- No Carbonization
- No C_3A in Chemistry – Sulfate Resistant
- Very Low Alkali – Addresses ASR Issues
- Low Heat of Hydration
- Low Porosity
- High Abrasion Resistance
- Coatings Can Be Applied Within Hours

Calcium Sulfoaluminate Cement

- User Friendly – Requires .45 to .50 water Cement Ratio – 4” slump without WRs
- Most Traditional Admixtures Work Well with CSA – Including Corrosion Inhibitors
- Reduce Permeability Using New Gen Polymers or Mod A Latex
- Can Be Used With Cathodic Devices and Impressed Systems
- LEED Points

Blended Cements

- Portland and SCMs
  - Limited Reduction in ASR and Sulfate
  - Slow Strength Development without Adds
  - Moderate to High Shrinkage
- Mineral Based Cements
  - Specific End Results Differ with Each Product

Packaged Concrete Product

Packaged Cement Materials

- Portland Cement Based Products w/ Adds Dominate Market
- Portland Blends
- CSA Cement
- Mineral Admixtures
- Mineral Based
- Chemical – i.e. Mag Phosphate

Package Products

- Each Has Specific Characteristics
- Each Has a Specific Application
- Each Has Specific Mixing Instruction
- Each Have Differing Content
- READ DATA SHEET BEFORE SPECIFYING and USE

ASTM C-845 Type K Cement

James River Paper Mill

This 280’ diameter tank is 10 years old and has 20' of hydrostatic head. It was poured in 100’ sections with no waterstop and it has no leaks.

Type K Grout

- Many Repairs in Containment Require Large Quantity of Grout as Some Type of Fill
- Type K Grout Can be Delivered to Job Site in Conventional Ready Mix Trucks at 50% the Cost of Bagged Non-Shrink Grouts (material cost)

Cement Repair Materials

- Utilize ICRI Guidelines to Determine the Cause and Appropriate Repair
- Use ICRI Surface Prep Profile Guidelines
- Select Cement Based Concrete That Meets the Owners Requirements