ASTM C10 CONFORMANCE – WHY DOES IT MATTER?

Are You Certain the Natural Cement on Your Project Meets the Requirements?

What Do You Risk if it Doesn't?

Background

When Edison Coatings began the commercial reintroduction of natural cement, 17 years ago, a wise engineer told us that if we wanted serious design professionals to specify it, we would need to have an ASTM Standard in place. That made sense to us – conscientious professionals understand the potential liabilities of specifying structural materials for which there exists no industry consensus regarding essential minimum qualities and performance. Standards, enforcement of standards and testing for conformance to standards help protect both the specifier and the client against products for which quality and performance may otherwise be undefined, or for which Quality Control procedures may be inconsistent or arbitrary.

The current Standard Specification for Natural Cement is designated ASTM C10/10M-19.

The original ASTM **Standard Specification for Natural Cement** was one of ASTM's oldest standards, dating back to 1904. It was later designated ASTM C10. The last 20th Century revision of the C10 standard was withdrawn in 1976, as Natural Cement was no longer a commercially-available product at that time. In 2005, shortly after resuming production of Natural Cement, Michael Edison approached ASTM Technical Subcommittee C1.10 on Hydraulic Cement to ask permission to form a Task Group for the purpose of reinstating ASTM C10. He was appointed to chair the Task Group, designated as C1.10.04. With a great deal of unexpected and welcome assistance from cement experts on Technical Committee C1 on Cement, most of them employed in the portland cement industry, the standard was updated, successfully reinstated and published in 2006.

Today, ASTM C10 is frequently referenced in historic masonry restoration work. Adherence to the standard assures that the agreed-upon minimum requirements for performance and composition will be met. Why is that important? What essential parameters does the standard address and how were the actual critical numbers determined?

Composition: Chemical Requirements

The chemical requirements of the standard are intended to assure that several key objectives are met. These include maintaining the connection between the natural cements produced today and those produced in the 19th Century and confirming that the cements were properly produced.

The most basic requirement is not an obvious one – it is the **2% minimum insoluble residue** requirement. This requirement assures that the cement rock was not heated to excessive temperatures in-process, as that would result in formation of Alite and other, more rigid constituents typically associated with portland cement. In short, it assures that the material produced is the intended low-fired Natural Cement and not a higher-fired portland.

There is also a **3% limit on maximum SO_3 content**. This restricts the amount of gypsum that can be added to the cement for the purpose of set time regulation.

Finally, there is a **Loss On Ignition requirement of 12% maximum**. This limit assures that the cement rock was not significantly "under-cooked", leaving an excessive amount of uncalcined material.

Physical Requirements

The standard requires **minimum compressive strengths at 7 and 28 days of 510 psi and 1020 psi respectively.** It is further stipulated that if the cement fails the 7-day test but passes the 28-day test it is acceptable. This testing assures basic minimum performance requirements are met.

Beyond compressive strength, an important requirement involves the **minimum Time of Setting**. For *Natural Cement*, the **minimum time of setting is 30 minutes**. For *Quick-Setting Natural Cement* the minimum Time of Setting is **10 minutes** and the maximum is 30 minutes. When these requirements were discussed within the ASTM Technical Committee, there was a consensus that faster setting times would be impractical for many users and applications.

Other requirements in the standard are included to assure volume stability of the cement.

ASTM C10 and Edison Coatings' Rosendale Natural Cement Products®

When Edison Coatings began natural cement production in 2004, all raw material was sourced from mines in Rosendale, NY. While the cement we produced from rock mined in Rosendale narrowly met the ASTM C10 requirements, we found reasons for serious concerns regarding both the raw material and the people providing it. Generally, the resulting cement had difficulty meeting the 7-day minimum strength requirements, but did pass the 28-day tests. It had a fairly rapid setting time but very slow development of strength.

Insoluble residue was also exceptionally high. The latter observation appeared to correspond with an observed "grittiness" to the cement, which was also difficult to grind to a very fine powder. Although there is no specific fineness requirement in the C10 Standard, Edison routinely reports the fineness data in its C10 test reports.

These observations and test data were not consistent with the historical data for cements produced in the Rosendale region, and we concluded that some of the mined rock was inappropriate for making the highest quality natural cement, in our opinion.

We subsequently visited other locations where natural cement had been produced in large volumes during the 19th and early 20th Centuries and found sources of high-quality natural cement rock material. We were able to secure reliable materials that corresponded very well with the historic cement produced in the 19th Century from a trustworthy supplier. Since that time, we have been receiving consistent raw materials that result in cements of high quality, easily meeting or exceeding the requirements of ASTM C10.

One of the most important properties for high-quality natural cement is **Time of Setting**. Edison Coatings routinely performs set time adjustments on its cement, within the parameters stated in the ASTM C10 Standard, and in a manner consistent with late 19th Century Natural Cement industry practices. Our Natural Cement is regulated to provide a minimum of 30 minutes of working time before

initial set, and actual times are typically 40 minutes, more or less. Our Quick-Setting Natural Cement provides the minimum 10 minutes of working time, typically setting in 12-20 minutes.

Edison Coatings also produces a Natural Cement with Retarder, as permitted under ASTM C10 as long as there is full disclosure on the package. While having no effect on final cured properties, the retarder provides up to 1½ hours of working time and allows work to proceed efficiently during hot weather conditions.

Other products marketed as Natural Cement have set times faster than 10 minutes. European natural cements, for example, may set in as little as 2-3 minutes. In hot weather, all cements set even more rapidly. Anecdotally, we were recently told by one masonry crew that when working with another manufacturer's natural cement they "barely had time to lay one brick" before the cement would begin setting. They are currently using Edison Coatings' Rosendale 10C and have said they are very satisfied with the Edison material and its superior workability.

Natural cements with set times less than 30 minutes cannot claim to conform to the requirements of ASTM C10. Cements with set times of less than 10 minutes cannot claim to conform to the requirements of ASTM C10 for Quick-Setting Natural Cement.

What is the danger of excessively rapid set times?

Particularly in larger-scale uses in warmer weather there is concern that workers will become frustrated with very short working times, the necessity to mix in very small batches and the need to discard materials which have begun to set. The temptation is to retemper the mortar, adding more water after initial set to make the material workable again. When additional water is added to mortar that is stiffening due to initial setting of the cement, rather than just losing workability due to evaporation of water from the mix, it is no longer properly called "retempering". What is occurring, in fact, is disruption of partially-set cement. **This causes low strength, high shrinkage, poor weather resistance and likely premature failure.**

Product Stewardship

From the very beginning of our natural cement re-introduction efforts, we understood that good product stewardship meant more than just producing high-quality natural cement. Accordingly:

- We invested the time and resources to produce, test and publish strength development data for a wide range of natural cement mix designs to help specifiers and users determine the optimal mix for their particular project.
- We invested years of effort in testing and improving freeze-thaw and salt scaling resistance for a wide range of masonry mortars, including mortars based on natural cement.
- We maintain a full-time staff of degreed chemical engineers who are able to undertake project-specific formulation and development, and offer knowledgeable, comprehensive technical support. As a result we have been able to engineer an extensive line of natural cement-based mortars, renders, concretes and micro-injection grouts and the guidance to use them effectively.

Table 1 –Natural Cement Test Results

Chemical Analysis			Rosendale 10C	ASTM C10/C10M - 14 Specification Requirements
				Natural Cement
Sulfur Trioxide (SO_3)			2.97	3.0 % max
Loss on Ignition @ 1000˚C			6.56	12 % max
Insoluble Residue			5.82	2 % min
Physical Analysis				
Normal Consistency (% of cement)			42.31	---
Compressive Strength (psi) Moist Cure				
At 7 Days:	9-10-19	Test Average	1,200	510 min
At 28 Days:	10-1-19	Test Average	2,390	1,020 min
Compressive Strength (psi) Air Cured				
At 7 Days:	9-10-19	Test Average	1,670	---
At 28 Days:	10-1-19	Test Average	3,550	---
Autoclave Expansion (%)			0.70	0.80 max
Air content of mortar (%)			7	12 % max
Time of setting (Vicat test) (min)		Initial set	38	30 min
		Final set	120	---
Blaine Fineness (Air permeability test) (m2/kg)			412	---