NATIONAL PLASTERERS COUNCIL

Limestone Cement

Current Status

Limestone cement is a combination of portland cement and limestone that is produced by grinding the two materials to a fine powder in a ball mill at the cement plant. While limestone cement has surged into the construction industry in recent years, it actually entered the plastering market in late 2011 to early 2012, when Lehigh White Cement released the first ASTM C1157 Type GU limestone cement. Since then, limestone cement has slowly increased in presence, before saturating the market over the last few years. Limestone cement is now one of the dominant cement types in the U.S., with an estimated 40% of the market. In fact, there are regions of the country where ASTM C 150 Type I portland gray cement, the once dominant cement, is no longer available.

The reason for the rapid move to limestone cement by the producers is due to a push to reduce greenhouse gases (see Chart #1), and especially the overall carbon footprint. The production of cement is the third largest single contributor of greenhouse gases. The push to increase the amount of limestone in cement is an attempt to lower the energy needed to produce cement. The thinking is, the greater the amount of raw uncalcined limestone that can be ground in with the cement, the lower the overall emissions to produce the cement, since the limestone portion is not calcined.

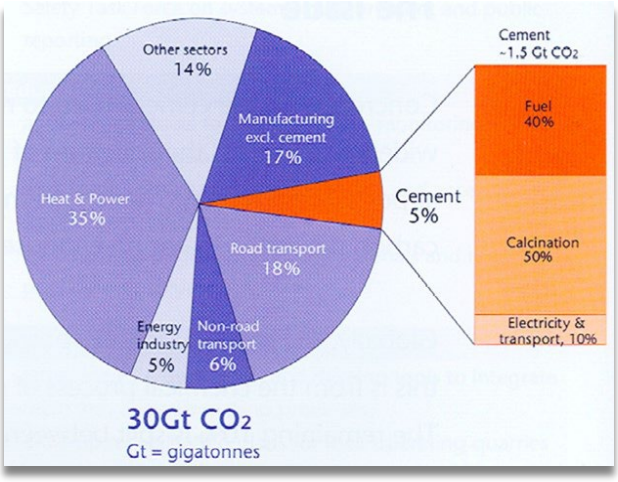

Chart #1: CO2 emissions. Graphic courtesy of civildigital.com "CO2 Emissions from Cement Production" by Anand Paul, May 12, 2013.

But there is a limitation to the amount of limestone that can be added. As the proportion of limestone to cement increases, the cement and limestone must be ground finer to achieve the equivalent 'parent'* cement performance. At some point, higher levels of limestone would require such an extended amount of ball mill grinding time and would need such a high fineness, that the additional energy output would result in little to no energy reduction, and greatly affect the workability and finishing characteristics. Also, limestone is not a cementitious material. While some performance benefits are shown with limestone cement at lower levels of limestone addition, there appears to be a proportional decrease in most workability and performance characteristics as the limestone addition increases above 15%. To offset this, it is anticipated that as limestone levels increase above 15%, either the limestone cement or the field mix design will require the addition of performance enhancers such as pozzolan, slag, or polymer modification to achieve similar performance characteristics of the 'parent' cement.

Limestone cement is available under ASTM C 595 Type IL (Limestone Cement) when the limestone content is below 15%, and ASTM C 1157 GU ('General Use' Cement) when the limestone content is between 15% - 35%. There are other cement types available that contain limestone and some percentage of pozzolan or slag. Currently in the United States, the majority of white limestone cement meeting ASTM C 595 Type IL, contains approximately 8% to 12% limestone addition. But this may increase over the next two or three years as cement plants increase their grinding mill capacities, or as government regulations continue to place restrictions on cement producers. While ASTM C 1157 limestone cement does not have a restriction on the amount of limestone that can be in the cement, the prevailing thought is, that the cement cannot pass the performance requirements of the Specification over approximately 35% limestone content.

Regarding the likely future of limestone cement, the Portland Cement Association recently released the following industry statement:

"PCA member companies are committed to achieving carbon neutrality across the cement and concrete value chain by 2050. The PCA Roadmap involves the entire value chain starting at the cement plant and extending through the entire life cycle of the built environment to incorporate the circular economy." [1]

Given the current technology of cement producers, overall carbon emissions can be reduced through the usage of clean energy alternatives, carbon sequestering, carbon capturing, and other methods. The current pathway to achieve the 2050 goal must include increasing the amount of limestone in gray cement to approximately 35%. In fact, some countries currently allow these levels of limestone for general construction usage. The current projection by white cement producers selling into the U.S. is for the limestone content in ASTM C 595 Type IL limestone cement to remain between 8% and 15% limestone, and become the dominant cement (over the current ASTM C 150 portland cement) in the marketplace by 2025. However, further government restrictions could drive limestone levels higher.

* the 'parent' cement is the calcined and ground source cement without the addition of limestone.

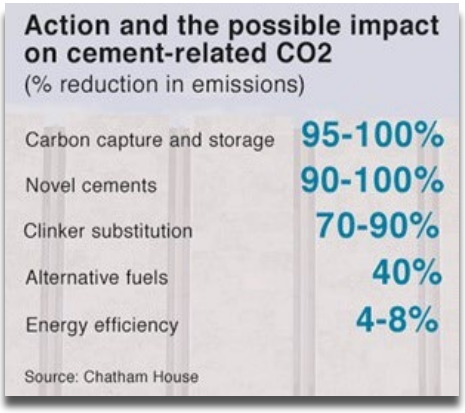

Chart #2: Graphic by Chatham House, in BBC News, "Climate Change: The massive CO2 emitter you may not know about", December 17, 2018.

In the future, ASTM C 150 portland cement may be phased out completely in some regions of the country. Some cement producers are designed to produce one dominant or 'primary' cement type. While cement producers can make and store smaller volumes of "specialty cements" in large silos; ultimately, the vast majority of the cement produced must be quickly sent into the marketplace, as the massive kilns that produce the cement never stop production. Many producers do not have storage capacity to accommodate two dominant cement types. Therefore, they must decide on one cement type to be their primary (large volume) cement. That decision is quickly becoming ASTM C 595 Type IL limestone cement instead of ASTM C 150 portland cement.

Comparing Workability and Performance Characteristics

Cement Fineness & Color **-** The Blaine or fineness of the cement can be different. Limestone is much softer and grinds finer than cement clinker. This can contribute to an increase of the Blaine of the cement. The cement coloration can often change depending upon the Blaine fineness. The change in coloration is generally subtle, but some variation is possible. It is recommended to conduct small scale testing when using pigments to verify that the pigment loading is adjusted, if necessary, to achieve the desired interior finish color.

Water Demand **-** Water demand can be different. Water demand in general is higher when using PLC. The water content can alter the pigment intensity. In general, more water results in a lighter color, and less water results in a darker color. The strength and durability can also be influenced by the water content.

Set Time & Strength - The setting time and strength can vary from cement supplier to cement supplier. As with the other cement characteristics, it is recommended to conduct small scale tests to understanding the differences between OPC and PLC, or when changing to a PLC from a different cement producer.

Admixtures - Admixtures can and do play a vital role in your finished product. While most admixtures will not need to be replaced, the dosage may need to be adjusted. The manufacturer of the admixture should be consulted for compatibility and usage with PLC. The manufacturer may have alternative products available where necessary.

What You Should Do

When working with a different cement type, or a different producer's cement for the first time, it is always recommended to test and verify that the properties and characteristics are adequate for your specific usage. It is advisable to initially test the cement in samples, test panels, or small projects, and monitor the cement for the desired workability characteristics necessary to properly pump, place, work, and finish the material. It may be necessary to incorporate additives or modifiers into the batch mix design to offset or regain certain performance characteristics. More drastic measures would include slowing the set time or increasing the manpower on certain projects to facilitate placement and finishing.

It is also recommended that you develop a good working relationship and frequent line of communication with the producer/supplier, asking them to inform you of any changes to the limestone cement. According to ASTM Standard Specifications, for much of the chemistry of the cement, the cement producer is not required to inform the purchaser **unless requested** by the purchaser.

Therefore, it is recommended to ask for and retain periodic mill certificates that disclose the following:

- The amount (percentage) of limestone
- The cement fineness
- The equivalent alkali content
- The magnesium content
- Any recent significant changes to the cement or processing of the cement

The following are general characteristics to monitor when using limestone cement:

- Limestone is not cement. It doesn't react significantly with water; therefore, it does not bind together with pigment. When incorporating pigments, colors may be somewhat muted (less intense) depending on the limestone content.
- During application and exposure of the aggregate, monitor for increased white dusting in the coves and floors with exposed aggregate finishes.
- After filling the pool there may be an increase in white dusting ('plaster dust').
- Monitor for any increase in the amount, or the size, of surface shrinkage cracking.
- There may be a significantly greater reaction (foaming) when applying acid solutions to the surface of a new interior finish, especially on a same-day or next-day acid wash.
- Monitor long-term durability. Periodically, visit past work and make an evaluation as to whether the limestone cement is performing similarly to a portland cement in a swimming pool environment.
- Other potential differences may include a slower set time, a stiff or doughy rheology, and less bleed water at the surface.
- **TEST… TEST… TEST… BEFORE USING…** Unfortunately, limestone cement characteristics such as set time, workability, slump (rheology), and shrinkage vary greatly depending on the producer. For each of these characteristics, there are some limestone cements that are reported to perform equal to, or better than portland cement. And there are some limestone cements that are reported to perform much worse than portland cement.
- Report any suspected changes or concerns to your cement producer immediately.
- Report suspected changes or concerns to the NPC Technical Department, as we are maintaining a database, documenting all issues and concerns relating to limestone cement usage across the country.

References:

1. Portland Cement Association, Roadmap to Carbon Neutrality, 5420 Old Orchard Road Skokie, IL. 60077, www.cement.org.

National Plasterers Council
1000 N Rand Road, Suite 214
Wauconda, IL 60084
Phone: 847.416.7272
mail@npconline.org
www.nationalplastererscouncil.com