

Portland Limestone Cement

An Innovative Solution for Sustainable Construction

Background

Portland Limestone Cement (PLC) is an innovative cement in which finely ground limestone within the cement ranges from 5% to 15%. PLC has been designed to perform similarly to existing cements and is rigorously tested to verify its performance. PLC is currently manufactured according to both ASTM C595 & AASHTO M240 Standard Specifications for Blended Hydraulic Cements. As of December 2011, PLC has been accepted for inclusion in both ASTM C595 and AASHTO M240 Standard Specifications for Blended Hydraulic Cements.

Sustainability

Growing concerns over the environmental impact of building materials has been a driving force for the adoption of PLC to provide sustainable solutions. The production of PLC allows an increase in the amount of limestone versus Type I and Type II cement, thus resulting in less CO₂ generated per ton of cement.

In 2004, ASTM C150 was modified to allow the use of up to 5% limestone as a constituent in the manufacturing process. The result was a positive effect on the environment (based on an average of 2.5% limestone in the cement).

The data from the Portland Cement Association (PCA) in Figure 1 approximates the reduction in energy and CO₂ emissions if the industry moves to a 10% limestone replacement.

Properties

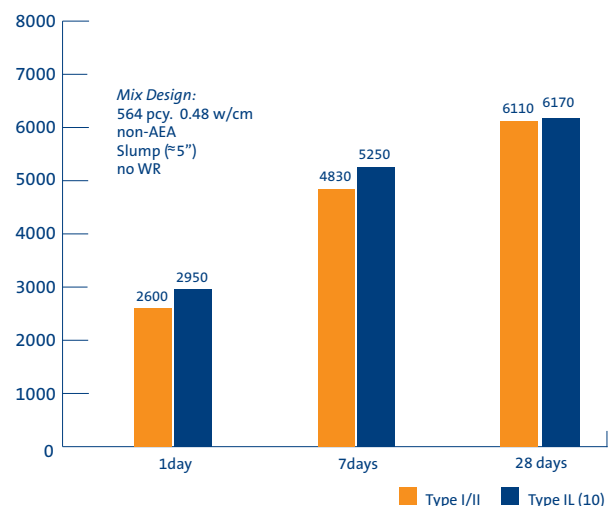
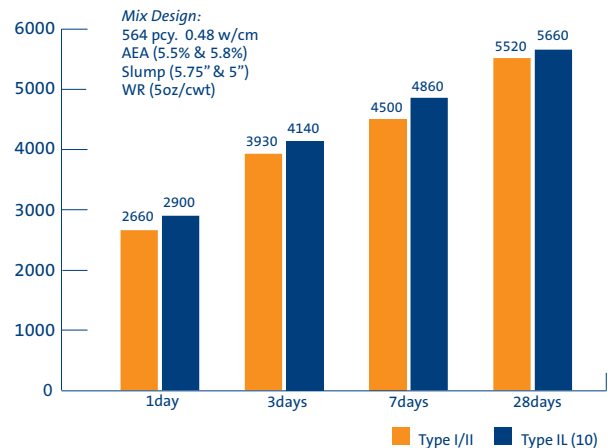
Holcim plants have targeted the performance of PLC cement to perform similar to the predominant cement produced, based on extensive testing and evaluation (Figure 2). The performance targets encompass both fresh and hardened concrete properties. These properties include durability evaluations in addition to the usual strength requirements.

Figure 1: Environmental Benefits from 10% Limestone as a Constituent in Cement

- Energy use reduction by 443,000 BTUs
 - CO₂ emissions reduction 189,000 tons
- *Per million tons cement

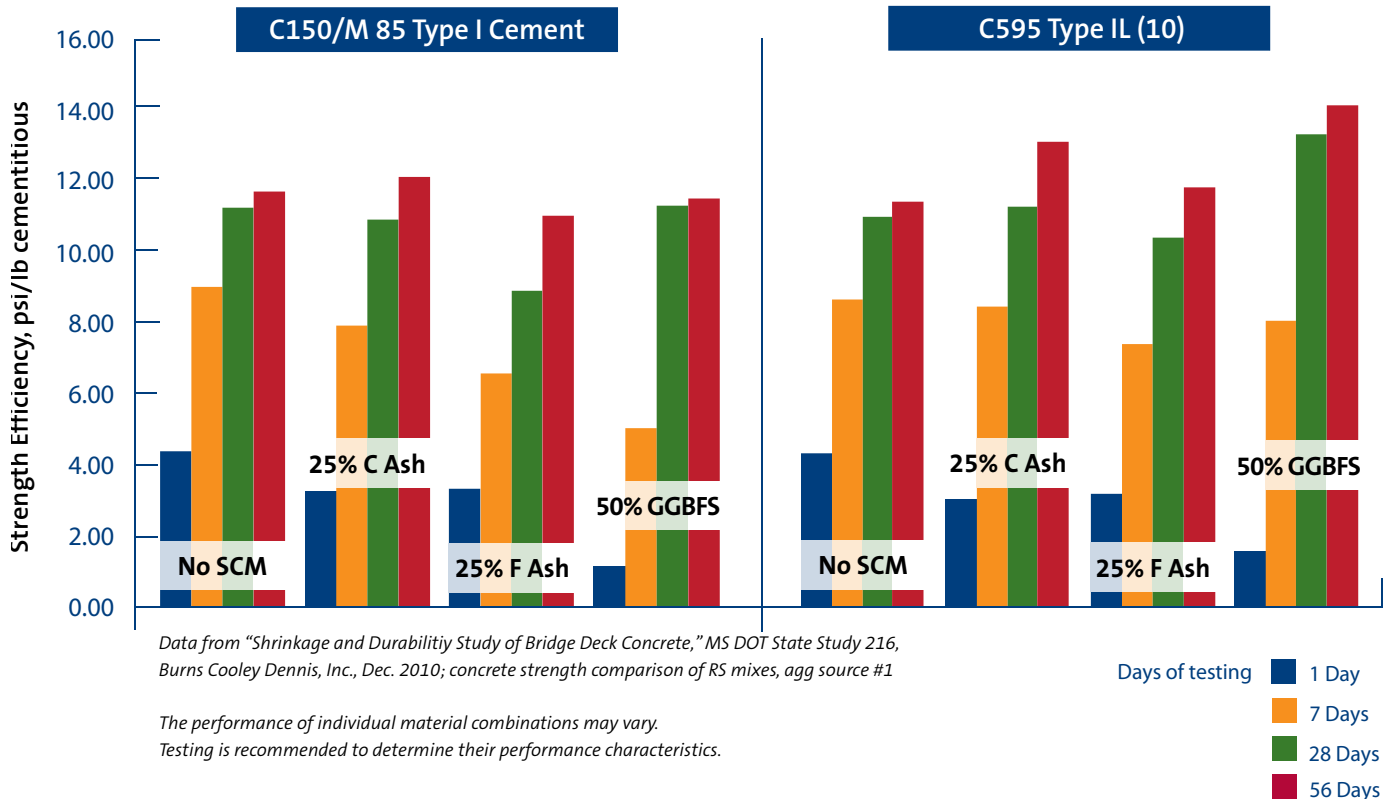
Source: State-of-the-Art Report on Use of Limestone in Cements at Levels of up to 15%, PCA SN3148, 2011

Figure 2: Ste. Genevieve Type I/II versus Type IL (10) Concrete Strength (psi)



It has been found in many studies within Holcim and by 3rd parties and academia that a positive interaction may exist between PLC and supplementary cementitious materials (SCM) such as fly ash and slag cement (ground granulated blast-furnace slag, GGBFS) when compared with Type I cements (Figure 3).

Figure 3: Mississippi DOT (MSDOT) Study – Type I vs. 10% LS with 3 SCMs



Experience

The cement industry has experience in the use of PLC as it has been utilized in Europe since the 1970s and in Canada since 2008. At Holcim US, we have produced PLC under existing performance standards (ASTM C1157 Standard Performance Specifications for Hydraulic Cement) since 2004. To date, Holcim has produced over 1 million tons of PLC.

This innovative product has been utilized in a variety of applications including precast, structures and pavements. Since its introduction in Colorado, PLC has been used to construct over 100 miles of pavement in that state. These projects have been very successful and are well documented. An article describing these experiences, whose authors included Tom Van Dam, was published in Road&Bridges Magazine in November of 2010.

References

Roads&Bridges, November 2010 Performance-enhancing by Thomas VanDam, PH.D., P.E., LEED AP, Brooke W. Smartz, LEED AP, and Todd Laker LEED AP contributing authors

The Construction Specifier, June 2012 Sustainable Construction By Todd S. Laker, LEED AP and Brooke W. Smartz, LEED AP

Concrete International, September 2013 Performance and Sustainability - Applications of portland-limestone cements in concrete paving by Brooke W. Smarts, Todd S. Laker and Thomas Van Dam.

Use of Portland-Limestone Performance Cements in Colorado and Utah: Laboratory Durability Testing and Field Case Studies by T. Laker and B. Smartz - Transportation Research Board 2012



Roads&Bridges

The Construction Specifier