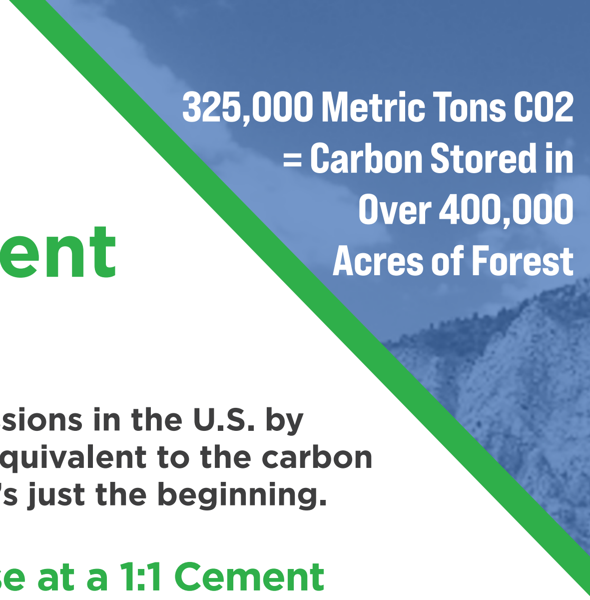
plc
portland-limestone cement




# Portland-Limestone Cement U.S. Fact Sheet

**A lower carbon cement that has already reduced CO2 emissions in the U.S. by more than 325,000 metric tons is available now, which is equivalent to the carbon stored in over 400,000 acres of forest for a year. And that's just the beginning.**

Portland-limestone cement, or PLC, is engineered with a higher limestone content than portland cement to reduce the carbon footprint of concrete by about 10%. It performs just like the cement you're used to using, resulting in the same concrete you're used to having. The same specifications, the same mix design, now with a better carbon profile.

Concrete is everywhere. In fact, other than water, it's the most-used material on the planet, representing about 50% of all manmade materials (by mass). It's a versatile, economical construction material that is the basis for everything we build. Foundations. Buildings. Roads. Water and waste storage and delivery structures. Modern society is possible thanks to the versatility and widespread availability of concrete.

Because society places so much concrete each year, even small changes to its formulation can have dramatic effects on the construction industry's annual carbon footprint. Modifying a concrete mix design to replace higher carbon materials with lower carbon ingredients is an effective strategy. Portland-limestone cement offers an easy way for concrete producers to accomplish this, much like fly ash and slag cement have done for decades. And concrete mixes designed with PLCs are compatible with all supplementary cementing materials (SCMs), so when you substitute PLC for ordinary portland cement, you can continue to use all the other materials you use to make concrete for an even greater reduction in carbon footprint.

## Applications and Uses

Almost anywhere you use ordinary portland cement, you can use PLC instead. In the U.S., PLCs have an established track record for transportation infrastructure. Many states have been placing PLC concrete pavements for more than a decade – with good results. From highways to driveways, PLC performs just as well in heavy-duty pavements as it does for residential flatwork. And it's appropriate for bridge applications, too, from top to bottom, everything from the deck down to the foundation, even including geotechnical work. For buildings, PLC concrete is a natural fit for structural members of any type or size, and it's also great for exterior finishes and hardscaping. Architects and other designers who are tasked with meeting goals put forth by green rating systems or codes will find PLC an especially useful approach to help them achieve a lower carbon footprint for any project.

## Easy to Use at a 1:1 Cement Replacement

To help with the transition to more environmentally friendly concrete, cement manufacturers understand that the switch to PLC must be simple. By optimizing PLCs, they have made it easy for specifiers, producers, and installers to use them. PLC can be swapped in for portland cement at a 1:1 replacement level. This is a big help to ready mix producers, who can continue operations using their well-established systems with a minimal amount of disruption.

In most cases, all that is needed for maintaining fresh concrete behavior is typical tweaking of proportions or admixtures, similar to changing from one source of cement to another. Anyone who knows how to work with cement and concrete knows how to work with PLC concrete.

## Extensively Tested for Similar Production, Handling, and Durability

Portland-limestone cement and concrete mixes containing PLC have been used around the world for decades. However, PLC has also been subjected to extensive research and testing by industry, both in the U.S. and elsewhere. Researchers have studied fresh properties related to placing and finishing, as well as hardened properties that relate to durability.

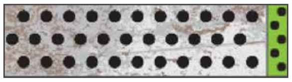
As noted, cement producers optimize PLC products so that they perform in the same way as portland cement because that's what their customers expect: fresh properties that enable similar handling and placing characteristics and hardened properties to assure good long-term performance in any type of exposure.

Durability is usually first demonstrated by accelerated laboratory testing and backed up by observation of field performance over time. Areas studied include resistance to scaling and freeze-thaw, chlorides, sulfates, and alkali-silica reaction. Each type of exposure has been thoroughly investigated to confirm that PLC produces strong, durable concrete.

## Manufactured with Lower CO2

Cement is made by grinding clinker—the main energy intensive ingredient—to a fine powder. Cement producers know that replacing some of the clinker in portland cement with ground limestone offers benefits, the most important being that it reduces the embodied CO2 of the cement. Whereas the U.S. standard for portland cement allows for up to 5% of clinker to be replaced by limestone, the standard for blended cement allows for 5% to 15% limestone replacement in PLC. Either way, the same clinker is used to make portland cement and portland-limestone cement. There's just less of it in PLC.

Portland cement can contain up to 5% limestone along with the clinker.



Portland-limestone cement can contain from 5% to 15% limestone along with the clinker.

To assure similar performance in concrete, manufacturers optimize PLCs by grinding them a bit finer than portland cement. The limestone particles can pack closer together to tighten the concrete matrix and their finer grind makes them slightly more reactive. And with the particles distributed throughout the mix, they can provide additional "nucleation" sites for chemical reactions to take place. All of this helps control strength development, ultimate strength, and is beneficial to concrete performance in other ways, too, such as helping to reduce permeability.

## Adoption in U.S. Building Codes... And More

The cement industry has made great strides with other agencies toward the acceptance of PLC, allowing the U.S. to transition to environmentally friendlier concrete. ACI 318, Building Code Requirements for Structural Concrete, includes PLCs in the same way as portland and other blended cements. Along with code recognition, PLCs were similarly included in ACI 301, Specification for Structural Concrete. In addition to inclusion in ACI standards, PLCs are in recognized by the International Code Council, the Federal Aviation Authority, and the American Institute of Architects Master Spec.

Reference standards for ready mixed concrete, ASTM C94, Specification for Ready Mixed Concrete, treat PLCs in the same way as other blended cements that have been used for decades. Cement standards in the U.S. (ASTM C595, AASHTO M 240) and Canada (CSA A3001) have recognized portland-limestone cements for about a decade. And even before that, some manufacturers were producing PLCs under the performance specification for cement (C1157). Though these are innovative, PLCs are not new products.

## Doing More to Reduce Carbon Emissions (or GHGs)

By simply specifying PLC instead of ordinary portland cement, you can typically achieve a reduction of about 10% of the CO2 footprint for concrete. (The exact amount depends on each cement manufacturer's formulations.) For the best understanding of your CO2 savings with PLC, ask your cement provider.

Since the 1970s, improvements to U.S. cement manufacturing have resulted in a more than 40% decrease in production energy while also reducing CO2. The innovation of PLC can be viewed as yet another improvement in a long line of developments introduced by the cement industry to lower its energy and carbon footprints: converting wet kilns to dry kilns to reduce the energy for combustion, adding preheaters and precalciners to cement kilns to improve energy efficiency, and using waste for energy to reduce the burden on landfills.

As society looks to the future, cement manufacturers can offer a major contribution on the part of the construction industry to help address global climate change. PLC offers specifiers, architects, engineers and designers a new way to think about concrete while still offering the resilience and sustainability they've come to expect from it. ■