

MARKET INTELLIGENCE

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Increased Adoption of Portland-Limestone Cement

Overview

In the context of global climate change, industry is being challenged to reduce its carbon footprint. To this end, the United States cement industry is engaged in an aggressive, multifaceted approach to reach carbon neutrality by 2050 ([PCA's Roadmap to Carbon Neutrality](#)). Lowering the clinker-to-cement ratio is an important ingredient of this initiative. To this end, the industry has dramatically increased its use of portland-limestone cement (PLC).

This report provides insight into the adoption of PLC and recent volume trends within the United States. Additionally, PCA identifies the carbon benefits associated with the increased adoption of portland-limestone cement and highlights long-term industry goals in order to reach carbon neutrality by 2050.

What is PLC

Portland-limestone cement (PLC) is a modified formulation of portland cement that contains up to 15% of added uncalcined limestone by mass. The same clinker is used to make both ordinary portland cement (OPC) and PLC, but the amount of clinker is reduced in PLC. To ensure the same quality as OPC concrete, manufacturers grind PLC clinker finer than OPC. The finer limestone particles allow for a slightly more reactive grind with a tighter concrete matrix to control strength. Limestone directly contributes to particle packing effects which can reduce water-to-cement ratios and subsequently increase strength. Furthermore, finer grinds produce limestone chemical reactions which reduce porosity. The increased limestone content allows for the same durability, same resilience, and up to 10% reduction in carbon footprint. PLC is extensively tested; research shows that the performance of PLC concrete is comparable to OPC. Similarly, ready mix concrete producers find that concrete proportions do not change significantly if PLC is substituted for OPC at 1:1 replacement rate.

Recent Volume Trends

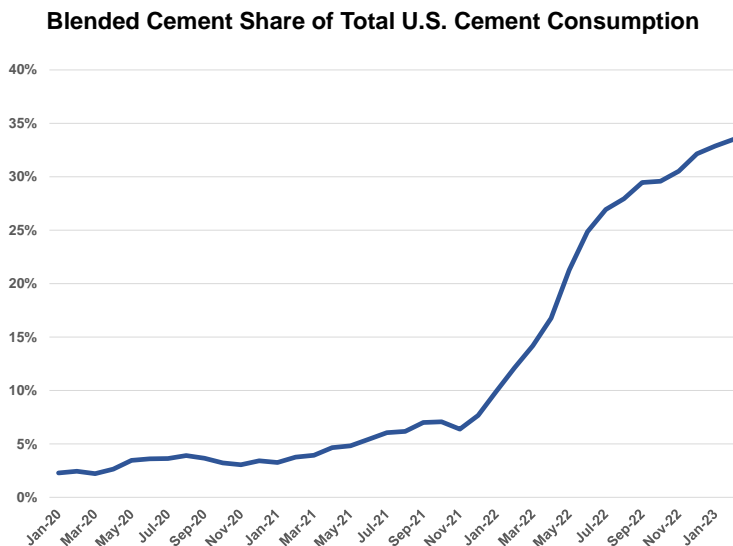
Ground limestone additions in cement date back to the 1960's in Europe. In the U.S., slow changing codes and misconceptions regarding PLC performance have inhibited its growth in the marketplace. In 2012, requirements for PLC (Type IL) with up to 15% limestone were defined in blended cement specifications ASTM C595 and AASHTO M 240. With educational and advocacy efforts, there has been an increased adoption of PLC. From 2012 to 2019, blended cements averaged 1.8% of the total cement market.

Over the past several years, technical research has resulted in the acceptance of PLC by numerous states and federal agencies as well as other decision makers. PLC is readily available through the same supply chain that already successfully serves developers, builders, and contractors. PLC is currently accepted by Departments of Transportation (DOT's) in 45 states, with the remaining five states planning its acceptance.

Similarly, the production of PLC has grown significantly in recent years. Currently there are 34 states in the United States that house cement plants. PLC is produced in at least 24 of these states. A large share of the industry has already announced plans to shift to 100% production of PLC in cement manufacturing plants. Based on public announcements, PCA has determined that at least 35% of the domestic cement industry, measured by clinker capacity, has announced the transition from OPC production to full PLC production. This translates to roughly 34 million metric tons (MMT).

This trend is expected to grow further. At least 50 plants are producing or have announced plans to produce PLC in the US. Overall, this accounts for over 60% of U.S. clinker capacity. Approximately 70% of PCA member companies have publicly announced plans to produce PLC. PLC is currently produced at different rates across the country. The Midwest region leads PLC production with an impressive 80% of the region's clinker capacity producing at least some PLC.

Using annual cement consumption data from the U.S. Geological Survey (USGS), PCA estimates that over the past three years, the US cement industry has consumed a total of approximately 31.8 MMT of PLC. In 2020, PCA estimates that 2.2 MMT of PLC was consumed. As acceptance of PLC became more widespread, consumption of PLC increased by 126% in 2021. Consumption of PLC experienced massive growth in 2022 as adoption grew rapidly. The industry consumed an estimated 24.8 MMT of PLC – over four times as much compared to the previous year.



Within the United States, USGS operates as the authority of cement data tracking. USGS publishes monthly reports regarding U.S. cement production and shipments. Prior to 2023, reporting of PLC was aggregated with other blended cements. However, cement producers now have the ability to specify PLC volumes on the monthly survey forms. This will allow for more accurate tracking of PLC market penetration. Currently, the USGS is working with OMB to update survey forms so that they include PLC volume collection in a more comprehensive manner.

Carbon Benefits of PLC

While 100% adoption of PLC at some U.S. cement plants is relatively recent, PCA members have already made progress toward reducing carbon emissions through blended cements in recent years. Because PLC has a lower clinker content than OPC, it also carries a lower carbon intensity. The estimates in the table below represent the carbon savings accrued from conversion to PLC. It is important to note that these carbon savings are relative to the most recent industry average blend rate. At a given plant, the conversion to PLC could yield even higher carbon savings depending on its blend rate.

The carbon saving benefits of increased reliance on PLC are already extensive. In 2020 PCA estimates these savings were 126,871 metric tons of CO₂. The US cement industry consumed an estimated 4.9 MMT of PLC in 2021, which resulted in 286,148 metric tons of carbon savings. In 2022, a 409% increase in PLC consumption materialized, which resulted in carbon savings totaling 1.5 MMT in 2022 alone. Altogether, the industry has saved approximately 1.87 MMT of carbon since 2020, simply by utilizing PLC as a replacement for OPC.

Year	Estimated PLC Consumption	Carbon Savings (MT)
2020	2,159,385	126,871
2021	4,870,331	286,148
2022	24,783,805	1,456,132
Total		1,869,151

PCA estimates that 31.8 MMT of cement were placed toward road construction in 2022. If the entirety of this market was converted to PLC, the result would be an estimated 1.87 MMT of carbon saved. Similarly, cement consumed in housing construction in 2022 was roughly 29.4 MMT. If every house constructed in 2022 had used PLC this would have resulted in 1.73 MMT of carbon saved. If every ton of cement consumed in 2022 were PLC, industry carbon savings would be approximately 6.4 MMT. However, significant carbon savings are still possible by replacing a portion of OPC with PLC. Every incremental step toward PCA's Roadmap to Carbon Neutrality represents carbon savings along the way.

The Infrastructure Investment and Jobs Act was signed into law during the 117th Congress in 2021. The bill invests approximately \$1.2 trillion in the nation's infrastructure, including \$550 billion in new spending for transportation, broadband, water, and power systems. While inflation and sterilization will erode some of the infrastructure package's full impact, if all the tonnage implied by the bill were taken at face value and a 100% replacement with PLC were assumed, the carbon savings would be very consequential. In this case, PCA estimates that 2.8 MMT of carbon would be saved – the equivalent of the carbon stored in 3.44 million acres of forest.

Future Industry Blended Cement Goals

To achieve the goals highlighted in PCA's Roadmap to Carbon Neutrality, it is imperative to continue lowering clinker-to-cement ratios. The carbon intensity of concrete construction can be reduced further by increasing the amount of PLC utilized. In addition, the carbon intensity of cement can be further reduced by increasing use of other blended cements, including ternary blended cements, with even lower clinker contents.

Likewise, US specifications for cements with higher than the currently permitted 15% limestone could be developed: EU specifications for more than 20 years have included classes of cement with between 6% and 20% limestone, as well as classes with between 21% and 35% limestone. In the US, portland cement includes less than 5% limestone while PLC allows for between 5% and 15% of limestone additions. PCA's Roadmap is targeting lower clinker-to-cement ratios of 0.85 by 2030, 0.8 by 2040, and 0.75 by 2050.