portland-limestone cement

How do I specify PLC?

Specifying PLC for use in concrete is not complicated. PLC is a direct replacement for ordinary portland cement (OPC), so it only requires one change to project specifications: Refer to **ASTM C595 Type IL** instead of ASTM C150 Type I portland cement. **It's that simple.** If the concrete requires special properties, such as sulfate resistance, see "What if I my concrete requires special properties?" below.

DOT Construction using AASHTO Specifications

For some state DOT construction, specifications developed by the American Association of State Highway Transportation Officials (AASHTO) are used instead of ASTM. AASHTO M 85 is the specification for portland cements; AASHTO M 240 is specification for blended cements. The technical provisions of AASHTO M 85 and M 240 are the same as those of ASTM C150 and C595 respectively, so switching to PLC just requires reference to an M 240 Type IL cement instead of M 85 Type I. Just as with C150/C595, similar special cement types are available— see "What if I my concrete requires special properties?" below.

American Institute of Architects (AIA) MasterSpec

AIA MasterSpec includes PLC as an option under the Blended Hydraulic Cement entry. MasterSpec Section 0330000 on Cast-in-Place Concrete includes the following options in Section 2.5D on Cementitious Materials:

> Portland Cement: ASTM C 150/C150M, **[Type I] [Type II] [Type I/II] [Type III] [Type V], [gray] [white]**
>
> Blended Hydraulic Cement: ASTM C 595/C595M, **[Type IS, portland blast-furnace slag] [Type IP, portland-pozzolan] [Type IL, portland-limestone] [Type IT, ternary blended]** cement.

Federal Aviation Administration (FAA) Specification

For airport construction, PLC is permitted under FAA Advisory Circular AC 150AC No: 150/5370-10H, Standard Specifications for Construction of Airports. Item P-501, Cement Concrete Pavements, includes the following text with the option to use Type IL cements:

> **501-2.2 Cement.** Cement shall conform to the requirements of ASTM **[ ]** Type **[ ]**.
> **********
> **The Engineer shall specify all of the following that are acceptable for use on the project:**
> **ASTM C150 - Type I, II, or V.**
> **ASTM C595 - Type IP, IS, IL.**
> **ASTM C1157 – Types GU, HS, MH.**

Other cements may be specified with concurrence of the FAA.

Canadian Specifications

Canada has two categories for portland-limestone cements, and both are specified under CSA A3000, Cementitious Materials Compendium. This is a bit different than how the U.S. handles PLCs. Under CSA A3000, Type GUL, meaning "General Use-Limestone" is a portland-limestone cement and that standard has another category for portland-limestone *blended* cements, which include SCMs in addition to the ground limestone. These are specified, for example, as Type GULb, with the designation meaning "General Use-Limestone blended" cement. In Canada, for other portland-limestone cements and their blended counterparts that are used for concrete with special properties, refer to the CSA Group.

Testing Requirements and Cement Qualifiers for PLCs and PLC Mixes

If I add PLC to my specifications, is any testing required?

It is recommended that trial batching be performed to confirm expected fresh and hardened performance, just as if a new source of portland cement was being used. Because PLCs are optimized to provide the same type of performance in concrete, your mix designs are likely to remain unchanged. Some minor adjustments may be needed, like dialing in admixture dosages or tweaking aggregate content.

What if I my concrete requires special properties?

If special properties such as moderate sulfate resistance are required, a qualifier is added to the IL designation. The table below shows a comparison of OPC vs. PLC to meet special properties for cements specified by either ASTM C150 or C595, or their counterparts from AASHTO, M 85 or M 240.

Cement type	**OPC C150 (M 85)**	**PLC C595 (M 240)**
General use	I	IL
moderate sulfate resistance*	II, II(MS)	IL(MS)
moderate heat of hydration	II(MH)	IL(MH)
high sulfate resistance*	V	IL(HS)
low heat of hydration	IV	IL(LH)

*For additional sulfate resistance, SCMs can be used in the concrete mix.

Sulfate resistance. Cements with moderate and high sulfate resistance are only required when exposures warrant that. Although some Type IL cements can meet sulfate resistance requirements without SCMs, in general, the same techniques that protect Type I cement

mixtures against sulfate exposure are used to protect Type IL mixtures: use additional supplementary cementitious materials (SCMs) and low water-to-cementitious materials ratios to improve sulfate resistance. Guidance on this is provided in ACI 318, *Building Code Requirements for Structural Concrete and Commentary*. If there is no sulfate exposure, the (MS) or (HS) designations are not needed.

Heat of hydration (HOH). Moderate and low HOH designations (MH) and (LH) are generally only needed for mass placements, when the concrete member is greater than about a meter (yard) thick. If heat is not rapidly dissipated in massive members, a significant rise in concrete temperature can occur, *potentially* leading to non-uniform cooling of the concrete and creating excessive tensile stresses. Elevated concrete temperatures during curing (more than 70°C (about 158°F)) may also trigger a distress mechanism known as “DEF” (delayed ettringite formation). DEF has been associated with reduced service life for concrete. On the other hand, a rise in concrete temperature caused by HOH is often beneficial in cold weather, if it helps maintain favorable curing temperatures.

Heat of hydration characteristics of OPC and PLC are assessed using the same test (ASTM C1702) and the same limits apply. As cements with special properties may not be routinely produced in all areas, it is recommended that their availability be verified when needed.