

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL DESIGN, CONSTRUCTION & SOIL MECHANICS CENTER (NDCSMC)
DESIGN & CONSTRUCTION STAFF
Fort Worth, Texas
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REPORT

Job: Considerations for use of Type IL Portland Cement
Location: Nationwide

Purpose: The Conservation Engineering Division asked the NDCSMC office to research the use of Type IL Portland Cement. These findings and recommendations will be available to all state offices.

Scope: This report uses existing NRCS and industry-accepted guidance for its development.

- Assistance Request (9-14-2021)

Basis: This review primarily draws on the experience and judgment of the reviewers following NRCS references and guidelines. Documents referenced while performing this review include:

- National Engineering Manual, Part 536, "Structural Engineering"
- National Engineering Handbook (NEH), Part 642, Chapter 3, National Material Specification 531, "Portland Cement"
- NEH, Section 6, Chapter 4, "Concrete"
- American Society for Testing Materials (ASTM) C150, "Standard Specification for Portland Cement"
- ASTM C595, "Standard Specification for Blended Hydraulic Cements"
- ASTM C1012, "Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution"
- American Concrete Institute (ACI) 318, "Building Code Requirements for Structural Concrete"
- Portland Cement Association (PCA), "Design and Control of Concrete Mixtures- 16th Edition"

Findings:

Portland cement is the most common type of cement in use as a basic ingredient of concrete. Its name is derived from its similarity to Portland stone, which was quarried on the Isle of Portland in England during early 19th century.

ASTM has standardized five types of Portland cement in the United States.

- 1) Ordinary (Type I)

- 2) Modified (Type II)
- 3) High-early-strength (Type III)
- 4) Low-heat (Type IV)
- 5) Sulfate-resistant (Type V)

ASTM uses the following nomenclature for blended cements.

- Portland blast-furnace slag cement (Type IS)
- Portland-pozzolan cement (Type IP)
- Portland-limestone cement (Type IL)
- Ternary blended cement (Type IT)

Type IL is a Portland-limestone blended cement that contains limestone in contents greater than 5 percent and less than 15 percent. Type IL is a more sustainable cement product because the limestone content is not calcined (heated) but instead ground and incorporated into the Portland cement. ASTM C595, “Standard Specification for Blended Hydraulic Cements,” covers the material requirements for Type IL in addition to other blended cements and should be used as the basis for NRCS acceptance when reviewing a mix design.

Type I Portland cements are considered general purpose and are suitable for applications where other Type II-V cement properties are not needed. However, if a Type I blended cement needs Type II-V cement properties such as sulfate resistance or early/late hydration, the product should be labeled according to ASTM C595. Additionally, the percent of limestone included in the blended cement should be stated in parentheses immediately following the classification Type IL. For example, a Portland-limestone blended cement with 10 percent limestone and moderate sulfate resistance would be labeled as “Type IL(10)(MS).”

The cement could also be labeled as “Type IL(10)” if passing test results for ASTM C1012 are also submitted. If the documentation submitted to the engineer supports these findings, the uses should be consistent with ACI 318, Table 601-2, Sulfate Exposure Class 1.

Several studies evaluating Type IL concrete mix designs have observed a correlation between a drop in compressive strength with limestone amounts above 10 percent. Adjusting the mix design could compensate for this loss of compressive strength. However, until there is more research on this correlation, it is recommended for mix designs to include limestone amounts of only 10 percent or less. This includes all products meeting the definition of ASTM C595 Type IL(10).

The primary benefit of using Type IL (ASTM C595) cement for concrete is that it performs similarly to a Type I (ASTM C150) but can be produced with a lower carbon footprint. Although this class of cement is relatively new to the ASTM C595 standard, cement manufacturers across the U.S. appear to recognize this benefit and the cement will likely have widespread availability throughout the U.S. in the near future. If this is the case, the NRCS will need to adopt this product, which already has been adopted by several State and Federal Agencies, to maintain sustainable and cost-effective construction, which already has been adopted by several State and Federal Agencies. Therefore, Type IL(10) has been added to MS 531 with the understanding that this will require the designers to verify the optional features that apply to the specific properties used for each engineering application.