Prescriptive versus Performance Specifications for Cements

A description of the differences between performance specifications and prescriptive specifications outlines some of the potential benefits and drawbacks of each.

Specifications, or standards, are the basis to verify quality and maintain product uniformity. Conformance to standards can be determined using either prescriptive or performance specifications. A prescriptive specification gives chemical or physical requirements that are indirectly related to performance. A performance specification sets limits for physical test results only.

In the U.S., specifications for cement have had both prescriptive and performance features. Performance features have included requirements for setting time, strength, and durability. Prescriptive features have included limits on chemical composition, some physical properties, and restrictions on ingredients. Both ASTM C 150 (for portland cement) and ASTM C 595 (for blended hydraulic cement) have prescriptive and performance elements. In 1992, the first performance-only specification for cements, ASTM C 1157, was issued.

As an example of the difference between prescriptive and performance requirements, ASTM C 150 limits the tricalcium aluminate (C_3A) level in portland cement to provide sulfate resistance for concrete (or mortar). The C_3A level is obtained from results of chemical analyses of the cement. In ASTM C 1157, sulfate resistance of concrete (or mortar) is controlled by evaluating laboratory tests of mortar prisms made with the cement. The laboratory test is intended as a predictor of field performance of concrete.

Prescriptive specifications provide a well-defined means for the manufacturer to demonstrate compliance with chemical composition, but may limit the options of cement manufacturers (by restricting the use of constituent materials) and thus pose somewhat of a barrier to innovation. Compliance with performance specifications, on the other hand, allows the use of different constituent materials but is more sensitive to the test methods used to predict performance.

Blended cements offer attractive methods of manufacturing a material to minimize environmental impact and result in very efficient use of raw, recycled, and by-product materials. Currently, the ASTM C 595 specification would not allow the most innovative and potentially efficient combination of materials. That is where C 1157 can fill in the current gaps. Users potentially can choose these cements to address particular durability or construction needs. A comparison of some features of the three cement specifications is given below.

Comparison of ASTM Cement Specifications

Feature	ASTM C 150	ASTM C 595	ASTM C 1157
Specification limits on:			
Minimum compressive strength?	Yes	Yes	Yes
Autoclave expansion?	Yes	Yes	Yes
Time of setting?	Yes	Yes	Yes
Alkalies?	Optional	No	No
Chemical composition?	Yes	Yes	No
Fineness?	Yes	No	No
Mortar air content?	Yes	Yes	No
Number of basic types	5	6	6
Total number of types	8	16	6
Type designation for:			
General concrete construction	I	IS, IP, I(PM), I(SM), P	GU
High early strength	III	—	HE
Moderate sulfate resistance	II	IP(MS), IS(MS)	MS
High sulfate resistance	V	—	HS
Low heat of hydration	IV	P(LH)	LH
Moderate heat of hydration	II	IS(MH), IP(MH), I (PM)(MH),I(SM)(MH)	MH
Accepted by:			
ASTM C 55 (Concrete brick)?	Yes	Yes	Yes
ASTM C 90 (Concrete block)?	Yes	Yes	Yes
ASTM C 94 (Ready mix specification)?	Yes	Yes	No
ACI 301 (Structural concrete specification)?	Yes	Yes	No
ACI 318 (Building Code)?	Yes	Yes	No
Uniform Building Code?	Yes	Yes	Yes

ASTM C 150: Standard Specification for Portland Cement
ASTM C 595: Standard Specification for Blended Hydraulic Cements
ASTM C 1157: Standard Performance Specification for Blended Hydraulic Cement

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