

Specifications: Are They *Clear, Correct, and Current?*

BY WILLIAM S. PHELAN

Concrete specifications should be a clear guide to project requirements. The scope, products, and execution phases must be accurately defined. Preparing a clear, correct, and current specification requires the specifier to have technical expertise and the ability to write clearly. If a master specification is used, it should be updated annually.

KEY ELEMENTS

When writing a new concrete specification or updating a master, ask the following questions related to key specification elements:

- Are the references up-to-date?
- Are the scope and quality assurance requirements clear?
- Is the product selection thorough? When several approved products are named, are they truly equivalent?
- Are the concrete systems composed of compatible products? (For example, high-performance concrete often contains fly ash or slag, corrosion inhibitor, silica fume, and a high-range water-reducing admixture. These must be compatible.)
- Is a vapor barrier/retarder needed for floors? What is the vapor barrier/retarder type and location? Does the

chosen vapor-retarder type conform to requirements in ASTM E 1745, "Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs," and do the properties and location conform to recommendations in ACI 302.1R, "Guide for Concrete Floor and Slab Construction"? Is "quick-dry" concrete required?

- What are the required concrete properties (w/cm , air content, compressive strength, flexural strength)?
- Does the compressive strength or the maximum w/cm control the mixture proportions? A low w/cm may be required to provide the needed durability, which means that strength will be higher than the specified value.
- Does the specification conform to current ACI standards and specifications?
- Is there proper usage of liquid surface treatments? If more than one such product is specified, such as strippable curing compounds and penetrating liquid sealers, are the products compatible?
- Is the specified w/cm in accordance with ACI requirements (depending on usage)?
 - w/cm of 0.40 (maximum) for reinforced concrete subjected to deicers, brackish water, and salt spray;
 - w/cm of 0.45 (maximum) for concrete required to be watertight and nonreinforced concrete subject to deicers;

This point of view article is presented for reader interest by the editors. However, the opinions expressed are not necessarily those of the American Concrete Institute. Reader comment is invited.

TABLE 1:

BASIC ELEMENTS OF A SPECIFICATION FOR A PARKING-STRUCTURE DECK, WITH TYPICAL VALUES FOR THE RECOMMENDED ELEMENTS

Parking structure slabs	
Compressive strength	5000 psi (34 MPa) @ 28 days
<i>w/cm</i>	0.40 maximum
Air content	4.5 to 7.5%
Silica fume	5% by weight of cementitious materials
Corrosion inhibitor	3 gal./yd ³ (15 L/m ³)
HRWR required	8 in. (200 mm) slump maximum
Curing method	7-day continuous moist curing as approved by the Engineer. Under rapid drying conditions, additional curing with a curing and sealing compound may be required by the Engineer.

Note: The above mixture proportions are controlled by the maximum *w/cm* allowed.

- *w/cm* of 0.50 (maximum) for concrete exposed to freezing and thawing in service; and
 - *w/cm* between 0.48 and 0.53 for trowel-finished floors subjected to vehicular traffic.
- Does the specification put limits on combined aggregate grading for slabs and other designated concrete? (For example, 8 to 18% retained on each sieve below the top size and above the No. 100 sieve for a 1-1/2-in. [38 mm] top size aggregate).
 - Is the use of supplementary cementitious materials (fly ash, ground-granulated blast-furnace slag, silica fume) allowed or specified? Some specifications prohibit the use of these beneficial materials, and other specifications make no mention of them.
 - Is a concrete preconstruction conference required? Is there a proper agenda? Are complete and promptly distributed meeting minutes required?
 - Are there proper floor flatness/levelness tolerances, including F_L for elevated slabs only where appropriate?
 - Is self-consolidating concrete (SCC) required or recommended? If so, successful on-site test placements should be required to confirm proper flow, workability, and setting time.

The specifier must also be sure that concrete specifications are in agreement with concrete notes on the plans.

SPECIFY MORE THAN SLUMP AND STRENGTH

Many times a concrete specification is simply reused from project to project and includes reference only to compressive strength, slump, and possibly air entrainment if the concrete will be exposed in a cold climate. Tests to verify other concrete properties aren't required. Such specifications commonly require that four test cylinders be taken for every 100 yd³ (76 m³) of each class of concrete placed each day. Air content requirements for exterior concrete are often not clearly outlined and air meters are often not on the job site.

Water content in concrete is generally not known, although specifications may limit *w/cm*. Slump tests are used "to control water" in these cases. Because all high-performance concrete contains a high-range or mid-range water-reducing admixture, however, a slump test measures only slump, *not* water content. The microwave test is easily used on the job site to verify water content. Specifications should require use of the microwave test method and an air meter if proper air content, water content, and *w/cm* are important. These tests, along with those for compressive strength and flexural strength, are required on the job site to ensure that such specified qualities as high durability, low permeability, and low shrinkage are being achieved.

TABLE 2:

BASIC ELEMENTS OF A SPECIFICATION FOR CONCRETE TO BE USED FOR INDUSTRIAL FLOORS, WITH TYPICAL VALUES FOR THE RECOMMENDED ELEMENTS

Industrial floor (F_F50/F_L35)	
Flexural strength	700 psi (5 MPa) @ 28 days
<i>w/cm</i>	0.53 maximum
Air content	3% maximum
Combined aggregate grading	Percent retained on each sieve below the top size and above the No. 100 sieve: 8 to 18% for 1-1/2 in. (38 mm) top size or 8 to 22% for 3/4 or 1 in. (19 or 25 mm) top size
Coarse aggregate content	12 ft ³ minimum per yd ³ (0.44 m ³ /m ³)
Initial slump (water)	2 to 3 in. (50 to 74 mm)
Enhanced slump (HRWR or mid-range water-reducing admixture)	5 to 7 in. (125 to 175 mm)

Note: This concrete should achieve properties described in "Admixtures and Aggregates: Key Elements of Athletic Concrete," *Concrete International*, V. 22, No. 4, Apr. 2000, pp. 35-39.

TWO EXAMPLES

Specifiers must clearly understand, from the owner's perspective, the concrete qualities required in the hardened state. They must then write a specification that achieves the desired qualities without specifying means and methods that limit the contractor's ability to do the job efficiently. For example, parking-structure concrete that will be durable for many years requires far more than satisfactory cylinder-test results for compressive strength. Table 1 shows the criteria that I believe should be measured during the construction of parking structures. I've also given typical values for concrete properties, dosage rates for admixtures and supplementary cementitious materials, and recommended curing methods.

Another example is the required elements of a specification for a high-performance industrial floor subjected to vehicular traffic. The goal is a burnished steel-troweled surface with minimal cracking and curling. Table 2 shows some of the criteria that I recommend for use in specifying concrete for industrial floors.

GOOD SPECIFICATIONS HELP CONTRACTORS

Concrete contractors fulfill their contracts by executing the work in accordance with the plans and specifications. But the contractor's function shouldn't have to include a

specification update. When the specification is clear, correct, and current, the contractor needs only to follow it. All members of the concrete team—owner, design professional, concrete producer, materials supplier, and contractor—can then share the great satisfaction of a successful project.

Selected for reader interest by the editors.



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