

Performance-Based Specifications for Concrete

Traditional prescriptive specifications treat concrete as a commodity, assuming a prescribed mix of components produces virtually identical performance, when in fact concrete—like most products—varies widely. Two batches of concrete with identical mix proportions may exhibit very different properties, depending on variations in the ingredients. When a producer is essentially bidding on a mix 'recipe,' there are few opportunities to add value or compete on any aspect other than price.

Performance-based specifications, on the other hand, focus on properties such as consistency, strength, durability, and aesthetics, rewarding quality, innovation, and technical knowledge, in addition to promoting better use of materials. For example, a producer may be able to use a higher-quality portland cement in different proportions, or supplementary cementitious materials (SCMs), to deliver high strength while improving concrete workability and reducing overall costs.

While industry is theoretically moving toward performance-based specifications, the reality is few purely performance-based specs are actually written for concrete. Most of them tend to be hybrids, combining some elements of both performance and prescriptive specifications.

While a 'blended,' hybrid approach seems prudent, it may actually cause a variety of problems. A prescriptive spec may be followed only to result in performance requirements not being met. It may also preclude a producer from offering a mix design superior to the one contemplated in the specification, and may stifle the producer's and/or concrete contractor's own expertise. Should something go wrong with the job, project participants could have a

hard time figuring out who is responsible under a prescriptive spec scenario. After all, should a producer and/or contractor be held responsible for a mix design for which they had little or no control?

A purely performance-based specification gives all parties a better understanding of what is required from whom, and offers more ways to achieve a good result.

Writing for performance

Slump and specific strength are the simplest types of performance-based specification. However, strength may not be the best measure of how well the concrete fits the required purpose. For example, resistance to chloride ion penetration or alkali-silica reactivity (ASR) may be more important, depending on intended use, exposure conditions, etc. For a warehouse floor, perhaps flatness and abrasion resistance are the most important performance characteristics required by the owner.

The following steps can help specifiers create comprehensive performance-based specifications delivering the greatest value for owners:

Understand the project

Performance-based specs demand focus on how a material will be used rather than what it contains. The first step, then, is to thoroughly research the broad goals of the project. In the case of concrete, what is its purpose? How will it be used, and by whom? What construction issues must be considered? How important are environmental and sustainability issues, and why?

While specifications may exist for 'typical' applications, they are only a starting point, and should be tailored to the specific conditions and needs of the project at hand. For example, the specifier should consider reviewing existing projects/structures with



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similar applications to understand long-term performance issues. He should solicit input from contractors, suppliers, and other specifiers—their practical experience with similar projects can be useful in identifying key performance issues, and their technical expertise can also be useful in understanding what is achievable with modern materials.

The specifier should also consider cost-performance tradeoffs, and prioritize expectations according to “must-have” and “nice-to-have.”

Develop measurable criteria

Using this information, the specifier translates the owner’s expectations into measurable performance criteria (see Specification Elements).

Review and resolve inconsistencies

This oft-overlooked step is critical. When performance criteria are taken from multiple sources—or developed to meet different expectations—they can create mutually exclusive requirements. This is especially prone to happening in hybrid specifications, where, for example, a higher cement content prescribed to increase strength conflicts directly with shrinkage requirements specified elsewhere.

Some of these inconsistencies may be obvious, but others may be apparent only to someone with an extensive knowledge of concrete mix design. The input of the contractor and concrete producer is useful at this stage, and the specifier may further consider retaining a consultant to review the proposed specification.

Incorporate quality control (QC) measures

The specifications should include QC criteria and notes on how they are to be measured and monitored, both for pre-qualifying suppliers and mix designs (acceptance level), and for monitoring during and after material placement. This way, the specification doubles as the quality control plan.

Specification elements

The specifier should consider the following elements when drafting a performance-based specification for concrete:

Intended application

Define the specific application for the concrete.

This information provides the framework and context for detailed performance criteria, and facilitates the specification’s review and fulfillment by the contractor and concrete producer. In addition, a well-defined application allows the specification to be referenced for similar, future projects.

Responsibilities

Define the owner’s, contractor’s, and supplier’s responsibilities:

- The owner is responsible for specifying performance criteria, the QC plan, and supplier certification (when required). Do not just consider industry certifications, but other relevant items, such as International Organization for Standardization (ISO) standards.
- The contractor is responsible for: working with the supplier to establish concrete mix properties; submitting documentation demonstrating the owner’s pre-qualification

requirements have been met (when required); preparing and implementing the QC plan, and; documenting performance requirements have been met.

- The supplier is responsible for: certifying the plant, equipment, and materials comply with requirements; meeting production and delivery requirements; ensuring the concrete complies with performance criteria; quality control testing in accordance with the plan, and; meeting certification requirements (when specified).

Durability

Consider the following elements (not an exhaustive list):

- Types of exposure conditions
- Resistance to alkali-silica reactivity (ASR)
- Abrasion and chemical resistance
- Permeability

Structural criteria

The usual method for specifying concrete is by compressive strength. This may or may not be the most appropriate performance measure. For example, flexural tensile strength may be a more relevant measure in some applications. Consider the following criteria:

- Minimum compressive and/or flexural strength at specified age
- Air content
- Volume stability
- Heat of hydration
- Required slump at discharge

Additional criteria

Also consider:

- Aggregate properties (*i.e.*, size, reactivity, etc.)
- Architectural properties (*i.e.*, color, finish, appearance, flatness, etc.)
- Sustainable development/environmental criteria

Quality control criteria

The QC criteria should be directly related to performance criteria. Elements include:

- Test method
- Acceptance criteria
- Level of testing

Rewarding quality and innovation

Performance-based specifications deliver benefits not just for owners, contractors, and producers, but the construction industry as a whole. By focusing on results, these specs create incentives for quality and innovation, and encourage the use of higher-performing portland, blended, and slag cements. Furthermore, performance specifications encourage the proper use of fly ash, taking into consideration the ash’s quality and consistency profile.

Specs based on a final product’s performance help create a stronger market for new technologies, thereby encouraging research and development. They also reward producers and contractors for technical expertise, and promote concrete that works better and lasts longer. ♡