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# CONCRETE FROM AN ENGINEER'S PERSPECTIVE

***To better understand how concrete specifications are created, we interviewed Mr. Cary Kopczynski, PE, SE, FACI, FPTI of CKC Structural Engineers in Bellevue, Washington.***

- CKC has won over eighty regional, national and international awards for engineering excellence, and has been selected several times by Zweig White and Structural Engineer magazine as a top structural engineering firm to work for.
- Mr Kopczynski is the current President of the American Concrete Institute (ACI). ACI has over 30,000 members in more than 100 countries.
- Mr. Kopczynski is an ACI Fellow and was honored with ACI's Charles S. Whitney medal in 2015 and Alfred E. Lindan Award in 2017.
- ENR magazine has twice selected Mr. Kopczynski as one of their "Top 25 Newsmakers" for CKC's pioneering work in the fields of high strength reinforcing bar and Steel Fibrous Reinforced Concrete (SFRC).
- Mr. Kopczynski is a past President of the Seattle Chapter of the Structural Engineers Association of Washington (SEAW) and past President of the ACI Washington State Chapter.

**CalPortland:** Let's begin by talking about your overall philosophy for specifying concrete. What is your opinion on performance versus prescriptive specifications?

**Cary Kopczynski:** We at CKC are believers in performance specifications whenever possible. We specify the critical performance requirements for each mix and leave the means and methods necessary to achieve those performance requirements to the supplier. For example, we stopped specifying slump years ago since we do not believe it is a critical performance requirement.

**CalPortland:** We are intrigued about your comments concerning slump. Please elaborate.

**CK:** Slump was once a good indicator of water content. Since it was easy to measure, it became a standard method of concrete quality control. With modern mixes containing water reducing admixtures, however, slump is no longer correlated to water content. Hence, from an engineering perspective, slump measures nothing meaningful except relative consistency from batch to batch.

CKC's policy is to request that the contractor and concrete supplier propose slumps that are appropriate for each mix, based on field requirements. Once we agree on the slumps to be used, CKC specifies that the slump tolerance from batch to batch be held to the requirements of ASTM C94. We use slump as a measure of relative consistency only.

**CalPortland:** Let's talk about water/cementitious ratio (w/cm). Controversies sometimes arise about the importance of w/cm ratio and whether it should be specified for all concrete. We often see conflicts between strength specifications and w/cm ratio specifications. Give us your thoughts.

**CK:** We at CKC specify water/cementitious ratio when we are concerned about permeability, but seldom specify it when we are not. For example, if

we are designing a parking slab exposed to weather where low permeability is important to reduce the absorption of water, chlorides and other harmful chemicals, we typically specify that the w/cm ratio not exceed 0.40. This results in low permeability concrete, which is important in a parking slab.

The strength requirement for that same mix might be only 4,000 psi. Since w/cm ratio is closely correlated to strength and since a w/cm ratio of 0.40 results in concrete strength much higher than 4,000 psi, this may appear to be a conflict. It isn't, because compressive strength and w/cm ratio for a parking slab are specified for unrelated reasons. The strength is specified for structural integrity and the w/cm ratio is for reasons of long-term durability.

Getting back to our philosophy on performance specifications, for many mixes—perhaps most—we don't specify w/cm ratio. It's unnecessary and can create conflicts. For example, the porosity of hardened concrete in an enclosed building column is generally unimportant. The key requirement for column concrete is strength, and perhaps modulus of elasticity  if the building is very tall or it is part of a seismic frame. Thus for column mixes we typically specify only strength and leave the w/cm ratio to the mix designer to avoid the conflicts mentioned in your question.

**CalPortland:** What is your opinion on specifying compressive strength at a delayed age? We often see high-strength concrete specified at 28 days when the service loads won't be applied for many months. Why is this done?

**CK:** With rare exceptions, there is no good reason. Concrete needs its specified strength only when required to carry its specified load. No load, no strength requirement; it's as simple as that.

There are occasional situations when strength is specified as a roundabout way of achieving high stiffness (modulus of elasticity), and the stiffness is needed early, regardless of other factors. An example might be a heavily loaded slab, with the

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loads expected to be applied immediately after stripping the forms. In most cases, however, high strength concrete is used for columns and shear walls in tall buildings and there is no need for strength targets set at 28 days. For mixes exceeding 8,000 psi, CKC typically specifies column and shear wall concrete at 90 days to allow use of high percentages of SCM's, which also reduce heat generation and lower the embodied carbon. A win-win all around.

**CalPortland:** You mentioned Supplementary Cementitious Materials (SCM's). We sometimes see customers who are reluctant to use them. What is your opinion?

**CK:** Everything has its place. If you are looking for rapid strength gain, SCM's can create problems, since mixes with high SCM percentages typically require more time to gain strength. If you want to reduce permeability or heat gain, however, SCM's are useful. They can reduce the porosity of hardened concrete and the heat gain during hydration.

In recent years, SCM's have received significant attention because of their potential to reduce concrete's carbon footprint. This is an ongoing and very important effort, and I applaud all of those working hard to make progress.

**CalPortland:** Thank you, Cary, for sharing your perspectives on concrete specifications.

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