Can a petrographer determine slump?

The experienced petrographer can use many pieces of information to arrive at a slump estimate. —Richard Stehly

By examining hardened concrete cores, petrographers can provide information regarding the concrete's composition and serviceability. ASTM C 856, "Standard Practice for Petrographic Examination of Hardened Concrete," outlines procedures for the petrographic examination of hardened concrete samples. But sometimes petrographers report information that's not specifically covered by the ASTM standard procedures, such as an estimate of the slump of the concrete when it was plastic.

Concrete Construction asked Richard Stehly of American Engineering Testing Inc., St. Paul, Minn., and Bernard Erlin of The Erlin Company, Latrobe, Pa., some questions regarding the determination of concrete slump by petrographic examination.

CC: Can a petrographer determine slump? If yes, how? If not, why not?

Stehly: Yes. The experienced petrographer can use many pieces of information to arrive at a slump estimate. Examining a polished section offers the following data:

- The paste color. It is light when the water-cement ratio is high and dark when it's low.
- Aggregate shape. Angular particles have a higher water demand than rounded particles.
- Air entrainment. Air entrained concrete lowers water demand.
- The orientation of aggregate particles. Bleedwater channels are sometimes evident.
- Aggregate distribution. Segregation may indicate a fluid consistency.

Thin sections observed in a petrographic microscope also offer good data, such as the water-cement ratio and the presence of fly ash, which often lowers water demand.

Given that the description of slump is an estimate, it may be more appropriate to describe it as low, medium, or high rather than trying to assign a single value.

Erlin: Estimating the slump of fresh concrete from the petrographic examination of hardened concrete is a pure guess, whatever the basis for the guess. Perhaps it's better to express it as an estimate of concrete consistency and workability when the concrete was placed. What the petrographer really sees in hardened concrete is the result of the compactive effort used to consolidate the concrete. The textural features of hardened concrete that can be visually examined are a result of a combination of factors, including slump, consistency, workability, and rheological characteristics of the plastic concrete.

Estimating the slump of fresh concrete from the petrographic examination of hardened concrete is a pure guess, whatever the basis for the guess.—Bernard Erlin

Water-cement or water-cementitious materials ratios may be a part of someone's basis for estimating slump but are irrelevant if the concrete underwent early slump loss, had been tempered, or had a rubbery consistency because of the influence of admixtures. Mid- and high-range water-reducing admixtures allow use of low or very low water-cement ratios that dramatically change the workability, consistency, and rheological properties of concrete. These admixtures create high-slump concrete from low-slump concrete at essentially the same water-cement ratios, and can permit consolidation without much, if any, compactive effort. So slump is not necessarily related to water-cement ratio. There also are concrete and mortar mixtures designed to have slumps so low that they can't be, and aren't intended to be, well consolidated.

What can the petrographer see that will assist in estimating the consistency of concrete when it was plastic? Sometimes the presence and shape of entrained and entrapped air voids can help petrographers interpret something about the nature of the plastic concrete when it was placed and consolidated. However, honeycombing can reflect concrete that had good slump when it left the truck mixer but underwent rapid slump loss—for whatever reason—after it was placed and before it was consolidated. The magnitude of distortion of entrained-air voids reflects the degree of concrete movement when the concrete underwent slump loss (stiffening) during

placement, consolidation, or finishing. That degree of distortion is variable and depends on the degree of concrete rigidity when those events happened, not particularly on the slump of the plastic concrete when it was field-tested using the slump cone or when it was placed into the forms.

So a petrographer has to be very wary when estimating slump, whatever the basis for that estimation is, because there is a greater chance of being wrong than right. Perhaps a better way of interpreting what is seen is to say that the compactive effort was or was not sufficient to produce the desired degree of concrete consolidation or compaction.

CC: What's the accuracy or precision of a slump estimate reported in a petrographic examination?

Stehly: The probable accuracy of a slump estimate is ±1 inch, although I am aware of no studies that determined this value.

Erlin: There is no accuracy or precision.

CC: Since ASTM C 856 doesn't cover a procedure for determining slump, should petrographers describe their basis for reporting slump?

Stehly: Because petrographers usually work on hardened concrete samples, any reference to slump must come from indirect sources of information. ASTM C 856 advises the petrographer to include in the report:

- Descriptions of the samples and a report on mix proportions (if available or if estimated), workmanship, construction practice, and original quality of the concrete insofar as such information is available. (Section 13.1.4)
- Interpretation, insofar as possible, of the nature of the materials and the chemical and physical events that have led to the success or distress of the concrete. (Section 13.1.5)

I believe slump to be an important concrete characteristic impacting quality, and a reference to slump in a report to be an estimate.

Erlin: Although ASTM C 856 does not comment on the estimation of slump from petrographic observations, that does not mean such estimates should not be done. C 856 is a guide to the petrographer and thus is not all-inclusive.

My question in the past to petrographers who have interpreted petrographic data about concrete they have examined has been, "What is the basis for your interpretation, and are you comfortable with it?" Anyone can estimate or interpret the meaning of data, however little or much, without qualifying the basis for that estimate. But usually necessity dictates there be a solid, substantial basis for an estimation or interpretation, as petrographers and others involved in forensic matters soon discover. ■

Publication #C00G058