Technology in Practice

What, Why & How?

TIP 14 - Time of Setting of Concrete Mixtures

This TIP facilitates the understanding of factors impacting the setting characteristics of concrete and the method to measure it (ASTM C403)

WHAT is the Time of Setting of Concrete Mixtures?

ASTM C125 defines the time of setting as the *elapsed time from the addition of mixing water to a cementitious mixture until the mixture reaches a specified degree of rigidity as measured by a specific procedure*. The development of rigidity in cementitious mixtures is a gradual and continuous process. For cementitious mixtures development of rigidity is measured as the elapsed time to attain a specified level of resistance to penetration by a probe.

The time of setting of hydraulic cement paste is determined based on the penetration resistance using a Vicat needle (ASTM C191) or Gillmore needle (ASTM C266). These methods are used to measure the time of setting of hydraulic cement in pastes at a standard (normal) consistency. The time of setting of hydraulic cement is primarily measured to ensure compliance with cement specifications – ASTM C150, C595 and C1157. A modified Vicat needle (ASTM C807) is used to measure the time of setting of hydraulic cement mortar. This method is referenced in the specification for expansive cement ASTM C845. The setting time reported on a cement mill test report does not have a very good correlation to the time of setting of concrete mixtures.

The time of setting of concrete is measured by ASTM C403. A mortar portion is extracted by wet-sieving the concrete sample. The elapsed time after initial contact of cement and water required for the mortar to reach a penetration resistance of 500 psi is defined as initial setting time and the elapsed time to reach a penetration resistance of 4000 psi is defined as final setting time. Penetration resistance of the concrete surface should not be confused with compressive strength of concrete. A penetration resistance of 4000 psi (final setting time) approximately corresponds to a compressive strength of 100 psi.

In the field a concrete slab is considered stiff enough to begin final finishing such as bull-floating, troweling, and brooming when the finisher produces a ¼ in. deep footprint on the concrete slab (ACI 302.1R). Various researchers (Bury et al. 1994; Abel and Hover 2000; Suprenant and Malisch 1998) have correlated this to a penetration resistance of less than 50 psi, which is much earlier than the initial time of setting measured by ASTM C403.

Concrete should set gradually, since concrete contractors need some time to discharge a fresh load of concrete and work it into the forms before the mixture becomes too stiff. At the same time concrete should not set too slowly as a delay in finishing will increase costs and potential for plastic shrinkage cracking. An ASTM C403 initial time or setting of 3 to 5 hours for a concrete mixture in the laboratory is considered reasonable. It is important for the time of setting to be consistent from load to load.

WHY is it Important to Measure the Time of Setting?

Specifications for concrete typically do not specify requirements for time of setting measured by ASTM C403. Most contractors however prefer consistent setting times between loads. This is especially important for slab and floor construction to schedule finishing operations. Changes in types or brands and even shipments of concrete materials, quantities, and concrete temperatures strongly influence the time of setting of the concrete mixture. The rate of reaction of cementitious materials increases with an increase in concrete