PCI Plant Quality Talk
Quality Enhancement Committee

SERIES 4, ISSUE 3 – WATER-CEMENTITIOUS MATERIAL RATIO

The water-cementitious material ratio (*w/cm*) is the ratio of the mass of water to the mass of the cementitious material in a concrete mixture, expressed as a decimal. It is a key factor affecting the properties of concrete, such as strength, workability, durability, and consistency.

The water-cementitious material ratio is calculated as follows:

w/cm = Mass of water / Total Mass of cementitious materials

The mass of the water used in the calculation includes the mass of the water directly added to the mixture as well as that added indirectly, such as in the aggregates. The total mass of the cementitious materials includes the mass of the cement as well as the mass of any supplementary cementitious materials such as fly ash, silica fume, and slag.

Instructions for a concrete mix design will specify the *w/cm*. The *w/cm* is used to determine the maximum amount of water to add to the mix including free water in excess of the saturated surface dry (SSD) condition of aggregates. If too much water is added to the concrete, the actual *w/cm* will be higher than the specified *w/cm*. That is a problem because adding too much water can weaken concrete: The excess water creates a diluted paste that separates cement particles. Then, when the cement and water chemically react to form crystals, the crystals are too far apart to form a strong bond. Concrete with a higher *w/cm* ratio is more susceptible to dry shrinkage cracking.

The water content requirements for a concrete mixture can be influenced by any or all of the following:

- Cementitious material types and content
- Aggregate size and shape
- Air content
- Admixtures
- Environmental conditions

Water demand can be lowered by the following:

- Increased air content
- Increased aggregate size
- Use of a rounded or cubical aggregate
- Use of a high-range water-reducing admixture

On the other hand, water demand is increased by the following:

- Increased concrete temperatures
- Increased cementitious material content
- Increased aggregate angularity
- An increase in the ratio of fine aggregate to coarse aggregate
- Use of lightweight aggregates

Per MNL 116 and MNL 117, the maximum allowable *w/cm* ratio for normal weight concrete is 0.45. During production, the *w/cm* is not allowed to vary from the ratio specified in the mixture design by more than 0.02.

Example:

Assume a batch with 30 gallons of water, 550 lb of cement, and 150 lb of fly ash. Each gallon of water weighs 8.33 lb. Aggregates are at SSD condition.

30 gallons × 8.33 lb/gallon = 250 lb of water

w/cm = 250 lb water / (550 lb cement + 150 lb fly ash) = 0.36

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Note: Please complete this form and return to the Quality Control Manager. All crew members should be observant and report to their supervisor anything out of the ordinary on a project. See something, say something.

NOTES	ATTENDEE SIGNATURES
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