PCI Plant Quality Talk
Quality Enhancement Committee

SERIES 4, ISSUE 4 – REDUCING EMBODIED CARBON

Embodied carbon in a construction project is the amount of carbon dioxide equivalent (CO_2e) associated with the extraction, processing, manufacturing, transportation, and installation of building products. Embodied carbon is also referred to as global warming potential (GWP).

For concrete, embodied carbon includes the CO_2e associated with the extraction, handling, and processing of the concrete materials, and the CO_2e involved in batching the concrete and operating the production facility. In an environmental product declaration (EPD), embodied carbon is qualified as the mass of CO_2e per unit mass of concrete. Although portland cement production is a relatively energy-efficient process, more than 80% of the embodied carbon in concrete is typically from cement. Using supplementary cementitious materials such as fly ash to replace a portion of the cement content can reduce embodied carbon.

A maximum GWP limit for each concrete mixture may be specified. These GWP values may be derived from benchmark values for varying strength levels of typical mixtures. Factors that affect baseline embodied carbon, such as design strength, low water-cementitious materials ratios, and high reinforcing steel ratios should be considered, and adjustments made to stay below the specified maximum GWP.

Optimizing Concrete Mixtures for Lower Embodied Carbon

When concrete mixtures are optimized for performance and economy, their embodied carbon content will generally be lowered. The GWPs of individual materials and concrete production practices will affect the embodied carbon content of the concrete mixture. Consider local sources to reduce GWPs when optimizing mixture proportions.

Reducing the Paste Volume of Mixtures

Because of the high percentage of embodied carbon associated with cement, reduction of paste volume can be considered. Reducing paste volume involves reducing the content of mixing water and cementitious materials while maintaining the same water-cement ratio. The paste volume can be reduced by implementing some or all the following options:

- Use a larger-size coarse aggregate.
- Use low-water-demand fine aggregate, such as gravel, and rounded, clean, or very well graded sand.
- Combine the aggregate in appropriate percentages to increase packing density.
- Use cementitious materials that reduce water demand.
- Use high-range water-reducing admixtures.
- Use cement hydration–enhancing admixtures.

Using fly ash or slag cement as a portion of the cementitious materials will reduce the required mixing water content for the target slump. Replacing portland cement with an equal weight of fly ash or slag cement will increase the volume of cementitious materials, but the lower mixing water content will have a net effect of a reduced paste volume.

Structure design

The design of a structure can affect its carbon footprint. The use of higher-strength concrete can reduce component size and the amount of required reinforcement, and the reduced quantity of materials thereby reduces the structure's embodied carbon. Higher-strength concrete can be designed with reasonably low quantities of cementitious materials.

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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 foreman anything out of the ordinary on a project. See something, say something.

NOTES	ATTENDEE SIGNATURES
DATE PRESENTER	