The Future of Concrete Is Green

by Michael J. Ramerth, PE

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STRUCTURAL DESIGN + ENGINEERING

Mike Ramerth is a structural engineer and specialist in the uses of concrete in buildings. He is a principal of Meyer Borgman Johnson, as well as a member and past president of the Minnesota Concrete Council (MCC), where he recently helped lead a study on optimum durability of concrete. Mike is an advocate for the use of "green" concrete and has been specifying it on his own projects for years.

Concrete is a time-tested, wonderful building material. As far back as 3000 BC, the Egyptians were using gypsum and lime mortars. The Romans made concrete from Quicklime, pozzolanic ash/pozzolana, and an aggregate made from pumice. The Roman Coliseum (72-80 AD), the Pantheon, and the Pont du Gard aqueduct in France all were built with concrete – and all are still standing today!

What makes concrete such a great building material? Concrete is durable and flexible. Because of its mass and density, it resists fire, reduces sound transmission, and minimizes floor vibration. It is readily available and affordable. For these reasons, concrete plays a part in nearly every significant structure built in the world today. Yet, for all its positive qualities, there is room for significant improvement in the concrete batched on a daily basis in the United States and around the world. Because of a growing consciousness about sustainability in the building industry – and everywhere – it is essential to look at how this common material can be brought up to "greener" standards.

The fundamental ingredients of concrete are Portland cement, large and small aggregate, and water. Sounds pretty simple, but as with most things in life, batching (mixing) concrete for a multitude of different applications and climates is anything but simple. Portland cements and aggregates vary greatly, and to complicate the recipe even more, most concrete mixes contain at least one chemical admixture, such as water reducing admixture (WRA) or air entraining admixture, two of many possibilities. The most consistent ingredient in concrete is the solvent, good old H2O.

How can we "green up" today's concrete mixtures? By replacing up to 50% of the Portland cement with recycled pozzolans such as slag cement, fly ash, and microsilica, we can create a much more sustainable design material with the following qualities:

- Lower permeability and higher durability
- More resistance to alkali silica reactivity
- More resistance to sulfate attack
- Easier to place and finish
- Greater economy, because slag and fly ash both cost less than Portland cement

Today, the Portland cement industry is working to reduce emissions, because every pound of Portland cement produced releases nearly a pound of CO2 into the atmosphere. Regardless of where one comes down on the debate about global warming, it seems clear that good stewardship of our planet requires that we minimize green-house gas emissions as much as possible. Specifying the partial replacement of Portland cement with recycled pozzolans is the right thing to do for our future.

In addition to using recycled pozzolans, another way to cut back on the amount of Portland cement consumed is simply to reduce the total amount of cementitious material in our mixes. A prime example is the concrete batched on a daily basis for slabs-on-grade and slabs-on-metal deck. The vast majority of these applications only require concrete with a compressive strength

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of 3000 psi. Yet the concrete supplied for slabs-on-grade and slabs-on-metal deck routinely tests out in excess of 5,000 psi. The real travesty is that this higher strength (higher paste volume) concrete does not perform as well as the lower strength (lower paste volume) concrete for these applications. Shrinkage and curling increase in severity at the higher strength, because the only part of the concrete matrix that shrinks is the cementitious paste; therefore, less paste, less shrinkage and curling. Once again, "less is more."

A number of additional recycled pozzolans, such as metakaolyn, calcined paper sludge, and metro waste burner ash, are currently being tested and considered as possible partial replacements for Portland cement. We will see what improvements these materials yield.

In the meantime, the future of concrete as a premiere building material is extremely bright. However, we must look for ways to preserve our natural resources and reduce our green-house gas emissions. It is clearly the right thing to do.