BEYOND THE BASICS:

Fly Ash: Putting Waste to Work

Written by Bret Rooks, Taylor & Syfan Consulting Engineers

What is fly ash?

Fly ash is a fine, powdery residue which is a byproduct of burning coal. In the past, it was released into the atmosphere from coal-fired power plants, but with current pollution controls in place, it is captured and kept for recycling or disposal.

High-quality fly ash is often used as a concrete additive since it has self-cementing and pozzolanic properties. A pozzolan is a material that acts like a cement when combined with calcium hydroxide, also known as “lime.” Fly ash has been used as a concrete additive since the early 1900's, although pozzolan use in concrete goes back at least to the ancient Romans, who used volcanic ash in their aqueducts and in the Pantheon.

Fly ash from a coal plant

What are the benefits of using fly ash?

Incorporating fly ash as a concrete additive provides environmental benefits on several fronts:

- Fly ash replaces a portion of the Portland cement in a concrete mix, commonly around 25%. Portland cement is highly energy intensive to produce, so this lowers the overall carbon footprint of the concrete.
- When fly ash is recycled, it doesn't need to be disposed of as a waste product. Most discarded fly ash ends up in landfills or impounds (“ash ponds”), some of which have had high-profile failures in recent years. According to the American Coal Ash Association, the US recycles about 70 million tons of fly ash per year, over 40% of our national output.
- For those of you counting points, the LEED system recognizes fly ash as a “postindustrial recycled material.” If using the Build It Green Checklist, 20% fly ash earns 2 points.

On top of that, there are benefits when looking at the physical properties of the concrete itself:

- Fly ash's fine particles contribute to better concrete flow with lower water use and a smoother, more durable finished surface.
- The fine particles also fill small voids within the concrete better, allowing for both a higher final strength and better resistance to salts and sulfates than a similar mix with no fly ash.
- Concrete made with fly ash tends to have less efflorescence (white salts left on the surface by water evaporation from within the concrete).

What else should I know?

Not all of fly ash's physical effects on concrete are necessarily beneficial:

- The use of fly ash delays the curing and development of strength in concrete, which has the potential to stretch out construction schedules.
- While fly ash concrete has better resistance to salts and sulfates than normal concrete, its resistance to freeze-thaw cycles is not as good.
- It does not work well with air-entrained concrete (often used in more extreme climates).

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In recent years, concretes with higher volumes of fly ash (35% to 70%) have been used in some projects, but it is still a relatively new approach and there is more to be learned. As fly ash proportions increase, more-particular mix designs and greater installation control are required to achieve a required strength at a given time.

It should also be mentioned that there is a measure of environmental controversy about the use of fly ash in construction materials, due to the measurable presence of some toxic components in the ash itself (arsenic, heavy metals, lead, etc.). However, studies by the EPA and others generally show that the concentrations of these components are very small (on the same order as generic soil or other building materials) and that the cementitious matrix of concrete is effective at sequestering these elements.

Concrete wall made with fly ash

To take advantage of the benefits of fly ash as a building material, evaluate your project based with regard to the above information. Working with your subcontractors, make sure that the project specifications reflect current best practices and standards (e.g. ASTM C618 for fly ash, ACI 232.2R & PCA IS531 for recommended uses in concrete, etc.).

For more information, you can read more about fly ash at the following sites (last accessed 08/04/2010):

American Coal Ash Association:
http://www.acaa-usa.org/

EPA :
http://www.epa.gov/osw/nonhaz/industrial/special/fossil/