

## Fly ash: the “poor man’s portland cement”

*Editor’s note: Kenneth Bergeson, professor of civil and construction engineering, will retire from Iowa State University in December 2000. Ken is not only an award-winning teacher but an active member of many research groups, including the Iowa Fly Ash Affiliates.*

*Ken has been a valuable research affiliate of CTRE, and we will miss his important contributions to transportation research in Iowa.*

Kenneth Bergeson has dedicated the past 15 years of his research career to an important material in highway construction—fly ash. Researching fly ash has led him throughout Iowa as he works to discover new ways to use this product.

Fly ash is a waste product generated when a power plant burns coal. It has been shown to be effective in many transportation-related applications because of its unique strength-gain properties.

Fly ash historically had been relegated to landfills. By the 1980s, however, the US Department of Energy realized that the country’s landfills rapidly were filling with the material and searched for alternative disposal methods. Bergeson’s work has developed some of those alternatives since

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referencing, and inventory infrastructure data.

For more information about Iowa State’s role in the consortium, contact Reg Souleyrette, CTRE’s associate director of transportation planning and information systems, 515-294-8103, [reg@iastate.edu](mailto:reg@iastate.edu); Shauna Hallmark, CTRE’s program manager for the consortium, 515-294-8103, [shallmar@iastate.edu](mailto:shallmar@iastate.edu); or the consortium’s website, [www.ncgia.ucsb.edu/ncrst/](http://www.ncgia.ucsb.edu/ncrst/). •

1985. “We were looking for high-volume applications for fly ash, primarily to keep it out of the landfills and utilize it in construction,” he explains. “Why should we waste it when meanwhile our mineral resources are being depleted?”

The unique physical properties of fly ash from subbituminous coal make it useful in a variety of transportation construction applications. When moisture contacts the calcium-rich crystalline material, calcium silica hydrates form, which in turn bond the glass particles in the ash. This reaction is similar to portland cement hydration.

“That’s why it’s often referred to as the ‘poor man’s portland cement,’” Bergeson says.

Since 1990 researchers have been investigating the potential of reclaimed hydrated Class C fly ash. This material is typically produced at a utility sluice pond site by dumping raw ash into the pond and allowing it to hydrate and harden into a working platform. Additional raw ash is placed on top of the platform in thin lifts, watered, compacted, and allowed to hydrate and harden. This process continues until 10 to 20 feet of hardened ash has been placed. Reclaiming the material for use as an aggregate is accomplished when recycling/reclaiming equipment scarify the ash.

When the reclaimed, hardened ash is watered and recompact, it exhibits the unique property of resuming its strength-gain characteristics. The continued strengthening of the reclaimed fly ash is attributed to the gradual dissolution of its reactive glass components, which release additional calcium, silica, and aluminum. These then continue to hydrate and harden.

Researchers now are working to determine the full extent of fly ash’s hardening

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Ken Bergeson

Hydrated glass components in reclaimed fly ash will continue to form calcium, silica, and aluminum.



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Reclaimed fly ash has been used (top to bottom) in building borrow pit haul roads, as select fill in some road projects, and as railroad track subballast.



propensities and the amount of time necessary to reach this maximum strength. Recent core samples taken from a fly ash-based access road at the Sutherland Power Plant in Marshalltown, Iowa, averaged 2,600 psi. Such strengthening properties of a fly ash subbase can contribute to the endurance and durability of the roadway it supports.

An additional benefit of reclaimed fly ash for transportation construction is the potential applicability of traditional testing methods. Bergeson reveals that the dynamic cone penetrometer appears to be one reliable method for testing fly ash-based roadways “because it has such an extensive research background. There’s been so much work done with this test by the Corps of Engineers. It’s a quick, economical method.”

Other testing procedures, including the Clegg hammer and nuclear densometer, are being studied for their ability to transfer to reclaimed fly ash testing situations.

Of the many uses for fly ash that Bergeson has studied during the past 15 years, a few are chronicled below:

*As highway base material.* In a 1991 study, fly ash from a Council Bluffs, Iowa, power plant, reclaimed with a single pass of a scarifier, was determined to nearly meet Iowa Department of Transportation specifications for low quality Class B crushed stone. The fly ash demonstrated high absorption and low specific gravities, and when activated by portland cement kiln dust, revealed significant gains in strength and resistance to freeze-thaw conditions. The study consequently suggested that the fly ash had potential as highway base material.

*As construction working platforms.* Also during the 1991 study, it was noted how

the unloading trucks at the Council Bluffs plant end-dumped fly ash into the sluice pond, where it would quickly self-harden. Continuous, subsequent dumps resulted in a six- to eight-foot hardened ash platform, on which the trucks drove their ash loads increasingly farther into the pond. Consequently, the potential value of fly ash for construction platforms built on soft soils was implied during this study.

*As access roads.* In 1994, an access road was constructed near the Sutherland Power Plant in Marshalltown, Iowa, the base of which included reclaimed fly ash and was activated with cement kiln dust and combustion ash. Five years later, the 1999 Iowa Fly Ash Affiliate Research Program *Annual Research Report* stated that “the road is performing very well” and continues to demonstrate significant strength gains.

*As structural fill.* In 1998, a haul road between Chillicothe and the Monroe-Wapello county line was constructed using 10 inches of reclaimed fly ash as select fill under portland cement concrete (the fill was necessary because of the Class 10 soil in the area). Subsequent testing revealed that those areas of the road with fly ash select fill showed greater stability than areas supported only with soil fill.

*As railroad subballast.* Given the ever-increasing strength and weather endurance of a reclaimed fly ash subbase, in 1997 the material was used to build a foot-thick railroad track subballast over the soft soil of the Missouri River’s flood plain near Council Bluffs, Iowa. Not only does the reclaimed fly ash provide a uniform, high-strength support for the rail system, it also minimizes loss of ballast into the subgrade soil.

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