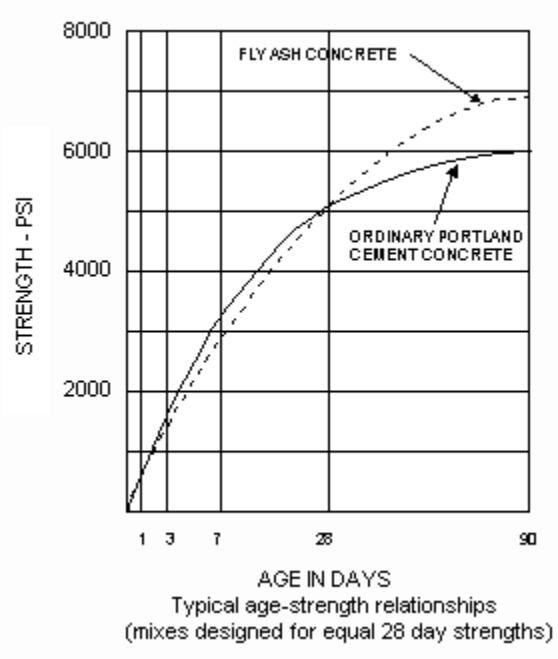
FLY ASH

Fly ash is a by-product of pulverized coal blown into a fire furnace at a power generating plant. Coal, ground to the consistency of flour ignites when blown into the furnace and a certain amount of non-burnable material residue remains as either slag or airborne particles, known as fly ash. The airborne particles are removed by mechanical collectors, electrostatic precipitators, or wet scrubbers.

Fly ash looks very similar to cement in appearance. However, when magnified, fly ash will appear as spherical particles, similar to ball bearings, whereas cement appears angular, more like crushed rock. Fly ash has cementitious qualities and, therefore, can be used as a replacement of a portion of the cement in a concrete mix.

Concrete mixes with fly ash to make for easier placement and finishing, and machinery operates easier due to the spherical shape of the fly ash, which acts somewhat like a lubricant. The compressive strength of concrete with cement and fly ash closely approximates concrete without fly ash. There may be a slight reduction in the initial compressive strength, then there is a slight increase after the first two weeks.



Typical age-strength relationships
(mixes designed for equal 28 day strengths)

Fly ash is categorized as Type F or Type C. Type F is produced when either anthracite, bituminous, or sub-bituminous coal is burned. Type C normally comes from lignite or sub-bituminous coal. Fly ash is a pozzolan substance [(1)]. Both types of fly ash have a wide range of qualities, but differ mainly as follows:

TYPE F

1. Provides sulfate resistance equal or superior to Type V cement.
2. Effectively moderates heat gain during concrete curing.

TYPE C

1. Concrete made with Type C fly ash (as opposed to Type F) has higher early strengths because it contains its own lime. This allows pozzolanic activity to begin earlier. At later ages, Type C behaves very much like Type F - yielding higher strengths than conventional concrete at 56 and 90 days.

Fly ash used in concrete pipe dates back to the 1940's and 1950's. ASTM Specifications first allowed the use of fly ash in concrete pipes in 1955.[1]

One distinct advantage of using fly ash in the manufacturing of concrete pipe is the greater density of the concrete. With a more dense concrete mix, permeability is improved, thus reducing the chances of infiltration/exfiltration. The ability to pass the Low Pressure Air Testing holding times is improved.

Other advantages of using fly ash in concrete mixes for concrete pipe are:

1. Improves workability.
2. Improved sulfate resistance.
3. Increases resistance to freezing and thawing.
4. Increases cohesiveness.
5. Improved long-term strength.
6. Reduces the water content of the mix.
7. Reduces the heat of hydration.
8. Decreases permeability.
9. Resists alkali-aggregate reaction.

Current ASTM Standards allow the use of 5% minimum and 25% maximum by weight of fly ash to be included in the total amount of cementitious materials used in manufacturing concrete pipe. There is a slight difference between ASTM C 618 physical properties and AASHTO M 295 physical properties.

A fly ash concrete mix will generally gain strength more slowly at early ages. After about seven days, the rate of strength gain of fly ash concrete exceeds that of conventional concrete, enabling equivalent strength at 28 days. This higher rate of strength gain continues over time enabling fly ash concrete to produce higher ultimate strength than can be achieved with conventional concrete.

CONCLUSION: Concrete pipe made with fly ash and Portland Cement provides added quality to concrete pipe. Concrete pipe made with fly ash and Portland Cement should be considered by Engineers and, when appropriate, should be specified.

[1] Pozzolans are siliceous or siliceous/aluminous materials which, when mixed with lime and water, form cementitious compounds. Natural pozzolans are found in many parts of the world and have been used in concrete for over 2,300 years. Fly ash is a processed pozzolan, meaning it is a derivative of coal used as fuel, and has very similar qualities as natural pozzolans.