ECOMATERIAL TECHNOLOGIES

TECHNICAL BULLETIN

Fly Ash

for Pipe Manufacturing

Concrete pipe is made by essentially two different processes, one using extremely dry concrete mixtures and the other using plastic concrete mixtures.

Dry cast concrete pipe is produced utilizing mechanical and/or vibratory compaction to consolidate dry concrete into a form. The form is removed from the pipe as soon as the casting is finished. With removal of the form, the green pipe is carefully transported to its place of curing. Atmospheric pressure curing at elevated temperature is typically used to obtain early age performance.

Wet cast pipe uses plastic concrete placed and compacted in a form, which remains around the pipe until certain levels of performance are achieved. Although declining in popularity, wet cast pipe may be manufactured by the spinning process (centrifugal) to remove excess water and air to produce great density and low permeability.

Fly ash has found widespread use as a cementitious material and as an aggregate mineral filler to enhance quality and economy in the manufacturing of concrete pipe.

Class F fly ash has been used successfully in the manufacturing of concrete pipe for more than 30 years. It has become an almost indispensable ingredient in the dry, harsh mixes typically used in modern pipe manufacturing.

The major reasons for the use of fly ash in concrete pipe are:

HOSTILE CONDITIONS

Pipe is inevitably subject to hostile conditions. It is most often used to convey sewage to and through sewage treatment plants where hydrogen sulfide gas attack may reduce portland cement concrete to rubble. Sulfate attack from soluble sulfates is also of concern. Fly ash makes concrete less permeable, and pipe containing it may be more resistant to weak acids and sulfates (Davis 1954; K. Mather 1982). Factors pertaining to the life of concrete pipe exposed to sulfate attack include the type of cement, chemistry of fly ash, quality of concrete, bedding and backfill used, groundwater, sulfate concentration and severity of exposure.

REDUCED CEMENT

Dry cast concrete pipe mixes without fly ash typically use more cement than necessary for strength to obtain the required workability. In a "packerhead" pipe casting operation, concrete with a very dry consistency is compacted into a vertical pipe form using a revolving compaction tool. Vibratory pipe casting uses mechanical vibration to compact dry mix concrete into a form. Fly ash allows the producer to remove excess cement from the concrete without sacrificing strength, while at the same time reducing the amount of water in the mix. Fly ash is

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used as cementitious material and aggregate mineral filler to provide strength and added workability and plasticity.

WORKABILITY

Pipe manufacturers throughout the world recognize that the spherical shape of fly ash makes dry harsh mixes, as used in packerhead and vibratory machines, extremely workable. This added workability reduces cycle time, wear on moving parts and forms, and makes a denser, less permeable and more airtight pipe. Increased workability translates into more complete form filling in less time, with less effort and at lower cost. Equipment used in pipe production may last longer due to the lubricating effect of the fly ash. Fly ash increases the cohesiveness of the no-slump, freshly placed concrete, facilitating early form stripping and movement of the product for curing.

FEWER REJECTS

Dry cast concrete pipe benefits from fly ash by obtaining more complete form filling with fewer voids and reduced collapse. Wet cast and centrifugal pipe also benefit from the workability and densification that fly ash contributes to each mix. Most manufacturers using fly ash in their mix have less pipe rejected because of voids and crazing.

Other benefits attributed to the use of fly ash include a reduction in the heat of hydration of concrete mixtures containing fly ash, which can reduce the number of hairline cracks on the inside surface of stored pipe sections (Cain 1979). Concrete mixtures containing fly ash also tend to bleed less, which is particularly beneficial in wet cast pipe.

The combined benefits, fewer rejects, lower cement requirements, reduced wear on machinery and lowered cycle times add up to reduced manufacturing costs.

ASTM SPECIFICATIONS

Current ASTM specifications for the production of concrete pipe address the use of fly ash meeting the conditions of ASTM C618 Class F or C in concrete pipe. These specifications allow for the use of portland-pozzolan cement per ASTM C595 containing a maximum of 25% fly ash by weight. Where fly ash is used separately, it is limited to between 5% and 25% of total cementitious material. The cementitious materials content for concrete for pipe production shall not be less than 470 pounds per cubic yard. The concrete mixture shall also have a maximum water/cementitious materials ratio of 0.53.

SUGGESTED ADDITIONAL READING

- "How Fly Ash Improves Concrete Block, Ready-Mixed Concrete, Concrete Pipe", Concrete Industries Year Book 1976-1977, pp. 1-6.
- Cain, Craig J., "Fly Ash in Concrete Pipe", Concrete Pipe News, Vol. 31, No. 6, Dec., pp. 116-119.
- Davis, Raymond E. "Pozzolanic Materials - With Special Reference to Their Use in Concrete Pipe", Technical Memorandum, American Concrete Pipe Association, Vienna, pp. 14-15, 1954.
- Mather, Katherine, 1982 "Current Research in Sulfate Resistance at the Waterways Experiment Station", George Verbeck Symposium on Sulfate Resistance of Concrete, SP-77, ACI, Detroit, pp. 63-74.

For more information or answers to questions about the use of fly ash in specific applications, contact your nearest Eco Material Technical Sales Representative or call 801-984-9400.