

Supplementary Cementitious Materials: Fly Ash

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Supplementary cementitious materials (SCMs) used in concrete generally consist of fly ash, slag cement, silica fume, and pozzolans. These materials are used separately or in various combinations with portland cement or blended cements to enhance the properties of the fresh and hardened concrete. They are also used as a component in blended cements. This article is part of a series - that provides brief descriptions of each material and resources for more information.

Fly Ash

Fly ash is the most widely used SCM in concrete. Fly ashes are divided into two classes according to AASHTO M 295: Class F fly ash has pozzolanic properties; Class C fly ash has some cementitious properties in addition to pozzolanic properties. Some fly ashes meet both Class F and Class C criteria.

The use of fly ash in concrete reduces water demand, increases cohesiveness, reduces permeability, reduces segregation, and improves finishability of the fresh concrete. The use of fly ash as a cement replacement reduces the heat of hydration, thereby reducing peak temperatures

and the potential for thermal cracking.


Fly ash improves the properties of hardened concrete through its pozzolanic reaction. This results in concrete with a lower permeability, higher resistivity, increased resistance to alkali-silica reactivity, and increased long-term compressive strength.

According to a 2012 survey by the American Coal Ash Association, all state department of transportation specifications permit the use of fly ash. Twelve states, however, specify only one type of fly ash, Class F. Most state specifications have an upper limit on the amount of fly ash that may be included in the concrete. The upper limit is usually in the range of 15% to 30% of the total cementitious materials, with some as low as 10% or as high as 35%. Some states require the use of a high percentage of fly ash to control alkali-aggregate reactivity.

Additional Information

1. AASHTO (American Association of State Highway and Transportation Officials). 2015.

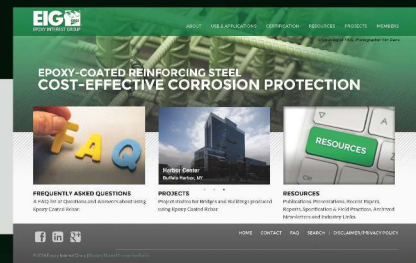
Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete. AASHTO M 295-11. Washington, DC: AASHTO.

2. ACI (American Concrete Institute) Committee 232. 2003. *Use of Fly Ash in Concrete (ACI 232.2R-03)*. Farmington Hills, MI: ACI.
3. American Coal Ash Association, <https://www.acaa-usa.org/>.
4. Kosmatka, S. H., and M. L. Wilson. 2016. *Design and Control of Concrete Mixtures.* Engineering Bulletin 001. Skokie, IL: Portland Cement Association.
5. Russell, H. G. 2013. *NCHRP Synthesis of Highway Practice 441: High Performance Concrete Specifications and Practices for Bridges.* Washington, DC: Transportation Research Board. 

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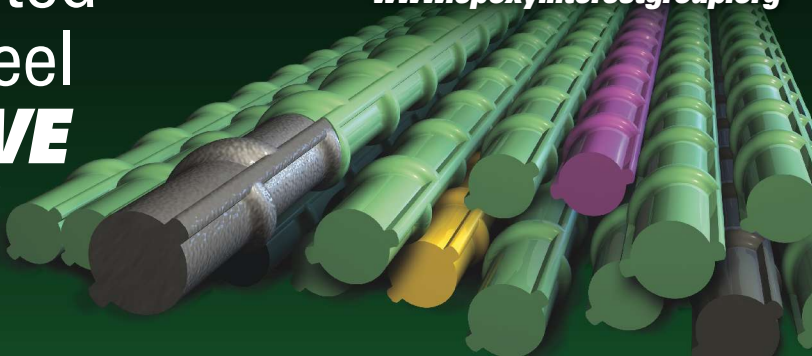


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