

SUPPLEMENTARY CEMENTITIOUS MATERIALS

WHAT are Supplementary Cementitious Materials?

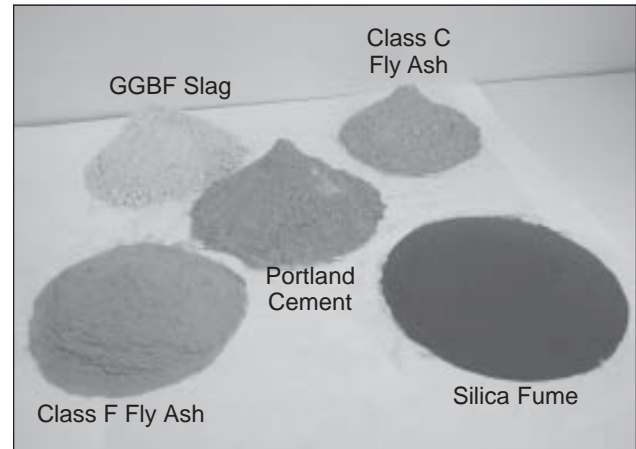
In its most basic form, concrete is a mixture of portland cement, sand, coarse aggregate and water. The principal cementitious material in concrete is Portland cement. Today, most concrete mixtures contain supplementary cementitious materials that make up a portion of the cementitious component in concrete. These materials are generally byproducts from other processes or natural materials. They may or may not be further processed for use in concrete. Some of these materials are called pozzolans, which by themselves do not have any cementitious properties, but when used with portland cement, react to form cementitious compounds. Other materials, such as, slag do exhibit cementitious properties.

For use in concrete, supplementary cementitious materials, sometimes referred to as mineral admixtures, need to meet requirements of established standards. They may be used individually or in combination in concrete. They may be added to the concrete mixture as a blended cement or as a separately batched ingredient at the ready mixed concrete plant.

Some examples of these materials are listed below.

Fly Ash is a byproduct of coal-fired furnaces at power generation facilities and is the non-combustible particulates removed from the flue gases. Fly ash used in concrete should conform to the standard specification.

ASTM C 618. The amount of fly ash in concrete can vary from 5% to 65% by mass of the cementitious materials, depending on the source and composition of the fly ash and the performance requirements of the concrete. Characteristics of fly ash can vary significantly depending on the source of the coal being burnt. Class F fly ash is normally produced by burning anthracite or bituminous coal and generally has a low calcium content. Class C fly ash is produced when sub-bituminous coal is burned and typically has cementitious and pozzolanic properties.



Ground Granulated Blast Furnace Slag (GGBFS) is a non-metallic manufactured byproduct from a blast furnace when iron ore is reduced to pig iron. The liquid slag is rapidly cooled to form granules, which are then ground to a fineness similar to portland cement. Ground granulated blast furnace slag used as a cementitious material should conform to the standard specification, ASTM C 989. Three grades - 80, 100, and 120 are defined in C 989, with the higher grade contributing more to strength potential. GGBFS has cementitious properties by itself but these are enhanced when it is used with portland cement. Slag is used at 20% to 70% by mass of the cementitious materials.

Silica Fume is a highly reactive pozzolanic material and is a byproduct from the manufacture of silicon or ferro-silicon metal. It is collected from the flue gases from electric arc furnaces. Silica fume is an extremely fine powder, with particles about 100 times smaller than an average cement grain. Silica fume is available as a densified powder or in a water-slurry form. The standard specification for silica fume is ASTM C 1240. It is generally used at 5 to 12% by mass of cementitious materials for concrete structures that need high strength or significantly reduced permeability to water. Due to its extreme fineness special procedures are warranted when handling, placing and curing silica fume concrete.

Natural Pozzolans. Various naturally occurring materials possess, or can be processed to possess pozzolanic properties. These materials are also covered under the standard specification, ASTM C 618. Natural pozzolans are generally derived from volcanic origins as these siliceous materials tend to be reactive if they are cooled rapidly. In the US, commercially available natural pozzolans include, metakaolin and calcined shale or clay.