

2.5 INDUSTRIAL BY PRODUCT:

2.5.1 Fly ash:

Fly ash is a fine powder that is a by product of burning pulverized coal in electric generation power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water. When mixed with lime and water, fly ash forms a compound similar to Portland cement. This makes fly ash suitable as a prime material in blended cement, mosaic tiles, and hollow blocks, among other building materials. When used in concrete mixes, fly ash improves the strength and segregation of the concrete and makes it easier to pump.

2.5.2 Applications for Fly Ash

Fly ash can be used as prime material in many cement-based products, such as poured concrete, concrete block, and brick. One of the most common uses of fly ash is in Portland cement concrete pavement or PCC pavement. Road construction projects using PCC can use a great deal of concrete, and substituting fly ash provides significant economic benefits. Fly ash has also been used as embankment and mine fill, and it has increasingly gained acceptance by the Federal Highway Administration.

The rate of substitution—of fly ash for Portland cement—typically specified is 1 to 1 1/2 pounds of fly ash for 1 pound of cement.¹ Accordingly, the amount of fine aggregate in the concrete mix must be reduced to accommodate the additional volume of the fly ash.

There are two common types of fly ash:

- Class F
- Class C.

1)Class F: Class F fly ash contain particles covered in a kind of melted glass. This greatly reduces the risk of expansion due to sulfate attack, which may occur in fertilized soils or near coastal areas. Class F is generally low-calcium and has a carbon content less than 5 percent but sometimes as high as 10 percent.

2)Class C:

Class C fly ash is also resistant to expansion from chemical attack. It has a higher percentage of calcium oxide than Class F and is more commonly used for structural

concrete. Class C fly ash is typically composed of high-calcium fly ashes with a carbon content of less than 2 percent.

Currently, more than 50 percent of the concrete placed in the U.S. contains fly ash.² Dosage rates vary depending on the type of fly ash and its reactivity level. Typically, Class F fly ash is used at dosages of 15 to 25 percent by mass of cementitious material, while Class C fly ash is used at dosages of 15 to 40 percent.³

2.5.3 Benefits:

Fly ash can be a cost-effective substitute for Portland cement in many markets. Fly ash is also recognized as an environmentally friendly material because it is a byproduct and has low embodied energy, the measure of how much energy is consumed in producing and shipping a building material. By contrast, Portland cement has a very high embodied energy because its production requires a great deal of heat. Fly ash requires less water than Portland cement and is easier to use in cold weather.

Other benefits include:

- Produces various set times
- Cold weather resistance
- High strength gains, depending on use
- Can be used as an admixture
- Considered a non-shrink material
- Produces dense concrete with a smooth surface and sharp detail
- Great workability
- Reduces crack problems, permeability, and bleeding
- Reduces heat of hydration
- Allows for a lower water-cement ratio for similar slumps when compared to no-fly-ash mixes
- Reduces CO₂ emissions

2.5.4 Disadvantages

Smaller builders and housing contractors may not be familiar with fly ash products, which can have different properties depending on where and how it was obtained. Additionally, fly ash applications may face resistance from traditional builders due to

its tendency to effloresce along with concerns about freeze/thaw performance. Other concerns about using fly ash in concrete include:

- Slower strength gain
- Seasonal limitation
- Increased need for air-entraining admixtures
- Increase of salt scaling produced by higher proportions of fly ash

