Triangle Tech Tips
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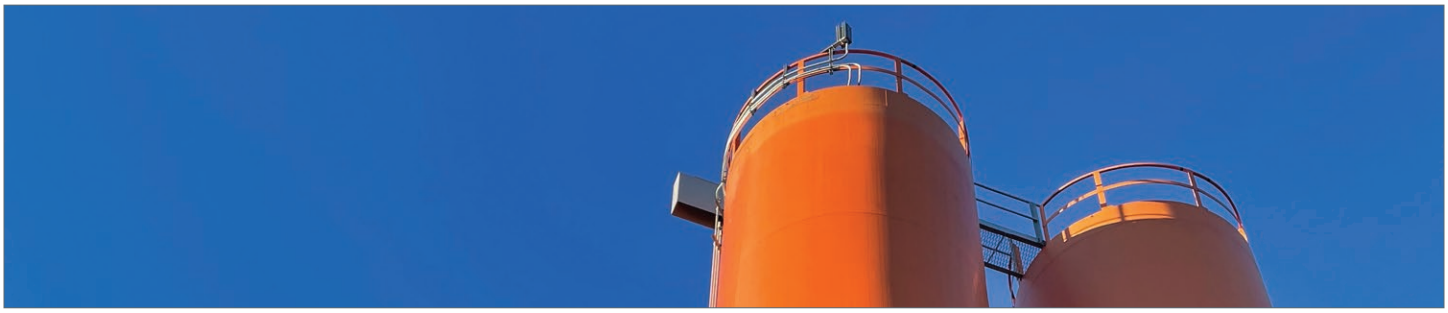
Understanding Pozzolanic & Cementitious Materials



What is the difference between "Pozzolanic" and "Cementitious?"

The terms *"Pozzolanic"* and *"Cementitious"* refer to different types of chemical reactions that materials undergo in the presence of water and other compounds, particularly in the context of concrete production. The primary pozzolan involved in concrete production is fly ash. The primary cementitious material is, naturally, Portland cement. Typically, as shown in the photo above, ready-mixed concrete plants will have 2 or more silos for storage of both of these materials to use in concrete production.

Pozzolanic:

Definition: Pozzolanic materials are not cementitious by themselves, but they can react chemically with calcium hydroxide ($Ca(OH)_2$) in the presence of water to form cementitious compounds, primarily calcium silicate hydrate (C-S-H), which is responsible for the strength and durability of concrete.

Reaction: The pozzolanic reaction occurs when a pozzolan combines with calcium hydroxide (a byproduct of the hydration of Portland cement) to form additional binder materials.

Examples: Fly ash (Class F), silica fume, natural pozzolans (such as volcanic ash), and metakaolin.

Characteristics:

Pozzolans require an external source of calcium (usually from Portland cement) to activate and contribute to strength development.

They enhance the long-term strength and durability of concrete by consuming excess calcium hydroxide, which can reduce the concrete's vulnerability to chemical attack (such as sulfate attack) and increase resistance to alkali-silica reactions (ASR).

Cementitious:

Definition: Cementitious materials can independently react with water (a process called hydration) to form solid, binding compounds without the need for additional chemicals or activation. These materials possess intrinsic cementing properties.

Reaction: Cementitious materials undergo a direct hydration reaction, where the primary compounds in cement (like tricalcium silicate and dicalcium silicate) react with water to produce calcium silicate hydrate (C-S-H) and calcium hydroxide ($Ca(OH)_2$), providing the initial and ongoing strength in concrete.

Examples: Portland cement, ground granulated blast-furnace slag (GGBFS), and Class C fly ash (which has both cementitious and pozzolanic properties).

Characteristics:

Cementitious materials do not require calcium hydroxide or other compounds to activate; they hydrate with water and begin to harden on their own.

These materials contribute to both early strength gain and long-term performance.

Key Differences:

1. Chemical Activity:

- **Pozzolanic:** Requires calcium hydroxide to react and form cementitious compounds.
- **Cementitious:** Reacts directly with water and hardens independently.

2. Role in Concrete:

- **Pozzolanic materials** enhance long-term durability by consuming calcium hydroxide and forming additional C-S-H, improving the concrete's chemical resistance and strength over time.
- **Cementitious materials** are responsible for the primary strength development in concrete, especially in the early stages.

3. Usage:

- **Pozzolans** are often used to replace a portion of Portland cement in concrete mixes to improve performance and reduce costs or environmental impact.
- **Cementitious materials**, like Portland cement, are the primary binding agents in concrete and are responsible for its initial setting and strength development.

Summary

Cementitious materials can form a solid mass on their own when mixed with water, while pozzolanic materials need an additional source of calcium (like Portland cement) to form similar compounds that contribute to concrete strength and durability.

Pozzolanic – vs – Cementitious

Pozzolanic materials are not cementitious by themselves. But, they can react chemically with calcium hydroxide ($Ca(OH)_2$) in the presence of water to form cementitious compounds — primarily calcium silicate hydrate (C-S-H), which is responsible for the strength and durability of concrete.

Class F Fly Ash | Silica Fume | Volcanic Ash

Types of pozzolanic materials include: Fly ash (Class F), silica fume, natural pozzolans (such as volcanic ash), and metakaolin.

Cementitious materials can independently react with water (a process called hydration) to form solid, binding compounds without the need for additional chemicals or activation. These materials possess intrinsic cementing properties.

Portland Cement | GGBFS | Class C Fly Ash

Types of cementitious materials include: Portland cement, ground granulated blast-furnace slag (GGBFS), and Class C fly ash (which has both cementitious and pozzolanic properties).