

Case Study

Calcium Carbonate for Stronger and More Sustainable Concrete.

2024



Case Study Overview

Industry

Construction and Engineering

Challenge

Formulate concrete with the necessary strength and durability requirements, while also using sustainable materials and processes.

Solution

Calcium carbonate can be used to produce concrete with enhanced properties, while making use of cost effective and sustainable materials.

Outcome

Production of one of the most used construction materials with a lower environmental impact and improved properties.

Summary

Concrete is among the most widely used construction materials in the world. Concrete is a mixture of water, aggregate, and cement.

Aggregates include materials such as sand, stone, and gravel, and constitute most of the composition of concrete. Cement is the binder that holds the aggregate together and provides the strength of the concrete.

One ingredient that may be found in cement formulations is calcium carbonate (CaCO_3), which is a naturally occurring mineral found in many places across the world. Calcium carbonate has been used in concrete production for millennia and is still widely used today due to its numerous benefits, which has been further elucidated with recent research.



Background

One of the earliest known instances of calcium carbonate in concrete was by the ancient Romans. The Romans used a type of concrete made from a mixture of volcanic ash, lime, and seawater, which contained high levels of calcium carbonate. This concrete was used to construct a wide range of structures, including some of Rome's most famous buildings such as the Colosseum, Pantheon, and many of their aqueducts. The testament to the strength of their concrete is that many of these buildings still stand today, and much of their damage comes from war and scavenging, rather than natural weathering and degradation.

Recent and closer examinations of Roman concrete revealed that there is a ubiquitous presence of small white mineral features, which originate from lime, the key component of all concrete formulations. While previously considered evidence of poor-quality raw materials, this new research suggests an entirely different perception. It appears that a combination of the choice of materials and the processes used in manufacture, produce "lime clasts" that provide a self-healing capability to the concrete. These inclusions were determined to be made of calcium carbonate at high temperatures with quicklime.

There remains ongoing research into how calcium carbonate has been used to make some of the most durable concrete in history, and better understand how it can be used to further improve modern concrete formulations. Calcium carbonate's properties are complemented by its low cost, wide availability, and sustainable nature, making it a near ideal material for concrete.



"Calcium Carbonate" has been used to make some of the most durable concrete in history, and its properties are complimented by its low cost, wide availability, and sustainable nature, making it a near ideal material for concrete.

Noah Chemicals, Chief Chemist

Evaluation

Calcium carbonate offers several advantages as a component of concrete, the first of which being its increased strength. This is achieved by reducing the permeability of the concrete, making it more durable and resistant to weathering, cracking, and other forms of damage. Furthermore, recent research suggests that calcium carbonate also offers improved strength through its self-healing abilities. During the hot mixing process, lime clasts develop a characteristically brittle nanoparticle architecture, producing a reactive source of calcium, and potentially providing self-healing functionality. When tiny fractures appear in the concrete, they can preferentially travel through the high-surface-area lime clasts. Subsequently, there may then be a reaction with water, creating a calcium-saturated solution that can recrystallize as calcium carbonate to fill the crack, or alternatively react with other materials to form even stronger composite materials. These processes take place spontaneously, “healing” the fractures before they can spread to the broader structure.

While offering enormous benefits to the properties of concrete, it is also a highly sustainable material. Calcium carbonate is a naturally occurring mineral, making it a more sustainable alternative to synthetic materials. Furthermore, due to its geographic abundance, it can often be produced locally, reducing the carbon footprint associated with transportation. Calcium carbonate is a relatively inexpensive material, making it an attractive option for concrete production. On top of this, calcium carbonate can reduce the total amount of cement required, further reducing the cost of concrete production. Calcium carbonate also improves the workability of concrete, making it easier to mix and pour. This can save time and costs by increasing the efficiency during construction.



Use Of Calcium Carbonate in the Manufacture of GRC (glass fiber reinforced concrete).

We use Calcium Carbonate in the manufacture of GRC (glass fiber reinforced concrete) as a main ingredient that is with acrylic emulsion resin and glass fibers to form a strong and water-resistant composite.

What is GRC (Glass Fiber Reinforced Concrete)

Glass fiber reinforced concrete (GRC) is a composite material that combines the strength of concrete with the flexibility of fiberglass.

We make GRC is by embedding filaments or fiberglass into a concrete matrix. The fiberglass strands provide tensile strength, while the concrete matrix provides compressive strength.

GRC is a lightweight, durable material that is resistant to fire, water and chemicals. It is also easy to shape, making it a versatile material for a variety of applications, such as making panels, pipes, and architectural elements.

Advantages of using GRC (Glass Fiber Reinforced Concrete)

GRC is a promising material with a wide range of potential applications. As technology continues to develop, it is likely to become an even more important material in the future. Among the advantages of this material are:

Light weight: GRC is much lighter than traditional concrete, which makes it easier to transport and install.

Durability: GRC is resistant to fire, water and chemicals, making it a long-lasting material.

Strength: GRC is stronger than conventional concrete, especially in tension.

Flexibility: GRC is more flexible than traditional concrete, making it less susceptible to cracking.

Versatility: It is easily to shape GRC making it a versatile material for a variety of applications, such as:

Construction:

GRC is commonly in construction to make wall panels, floors, pipes, architectural elements such as formwork, decorative elements and structural structures.

Marine:

GRC is in marine applications to make boats, hulls and other components.

Industrial:

GRC is in industrial applications to make tanks, pipes and other equipment.

Transportation:

GRC is in transportation applications to make components for cars, trucks, and other vehicles.

Consumer Goods:

GRC is to make a variety of consumer goods, such as bathtubs, sinks, and countertops.

The importance of using calcium carbonate in the GRC industry

The use of calcium carbonate in the manufacture of GRC is an efficient process and produces a high-quality composite material that can be used to create a variety of products. It is in GRC industry for the following reasons:

Calcium carbonate is an abundant and natural substance.

Calcium carbonate is strong and resistant to breakage, which makes GRC a strong material.

Calcium carbonate is a water-resistant substance. This makes GRC a suitable material for exterior applications, such as wall panels and pipes.

Calcium carbonate is a chemical resistant material. This makes GRC a suitable material for applications that are to chemicals, such as water tanks and septic tanks.

Calcium carbonate is a moldable material, allowing the creation of GRC products with complex shapes.

How to use calcium carbonate in GRC industry

It is available in a variety of forms, including limestone, chalk, and lime. In the manufacture of GRC, we use it in powder form, which is by grinding limestone, chalk, or lime into a fine powder that we add acrylic emulsion resin to form a homogeneous paste.

Here are some details about how we use calcium carbonate in GRC industry:

We grind calcium carbonate into a fine powder.

We add calcium carbonate powder with Acrylic Emulsion resin to form a homogeneous paste.

We add glass fibers to the paste, which acts as a strengthening agent.

DISCLAIMER:

This case study is for informational purposes only. While it highlights the use of calcium carbonate as a primary component in manufactured stone veneer and its potential benefits as a strong building material, the findings are based on specific conditions and may not apply universally. Always consult with a qualified professional for product suitability and performance in your specific application.