GRAYBOND™
A GRAYMONT™ PRODUCT

GRAYMONT

MAKING THE CASE FOR GRAYBOND™ CEMENTITIOUS BINDERS

PATENTED*, LOW CARBON BINDER SOLUTIONS

BACKGROUND

What is GRAYBOND™?

The GRAYBOND™ family of patented* cementitious binder solutions is a new product line from Graymont that helps our customers meet their greenhouse gas (GHG) emission targets while ensuring security of supply with no loss in material performance. The GRAYBOND™ binders are formulated from sustainable sources of lime, limestone, and pozzolan to meet our individual customer performance requirements. Customers can count on Graymont's extensive networks of operational facilities and logistical capabilities to get the optimal low carbon binder to meet their needs. Our goal is to achieve Graymont's core mission to contribute to a decarbonized world by providing essential calcium lime-based solutions, like GRAYBOND™ binders, to the benefit of our customers.

CHALLENGES

What are the challenges with typical alternative binders?

Traditional industrial co-products, such as fly ash and blast furnace slag, are declining in availability due to technology shifts in the energy and steel industries away from carbon intensive processes, like coal power. Unlike a co-product, GRAYBOND™ binders are an engineered, manufactured material designed to maximize performance in our customer's applications and provide consistent quality and supply.

SOLUTION

What are the advantages of GRAYBOND™?

The production of GRAYBOND™ binders leverages the use of materials that are naturally lower in GHG footprint, in part by limiting the amount of energy intensive thermal processing. Where calcining is unavoidable, such as lime production, Graymont has demonstrated year-over-year success in lowering the GHG footprint of our lime by choosing to transition to greener fuels and investing in state-of-the-art technology. Additionally, Graymont is committed to achieving net-zero GHG emissions by 2050.

*Patented in the United States under patent no.: 11,919,813 B2 and patents pending in other jurisdictions.

80%
reduction in GHG emissions

Customers can expect GRAYBOND™ binders to provide up to an 80% reduction in GHG emissions based on application and rate of cement displacement.

RESULTS

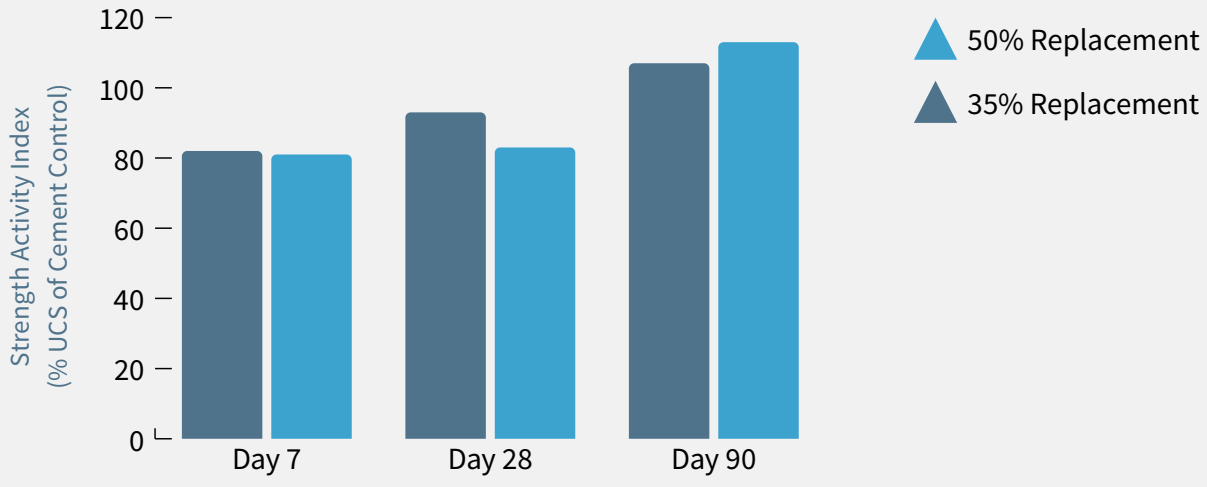
Proving the efficacy of GRAYBOND™

Graymont has researched and developed the GRAYBOND™ family of products over the last few years, partnering with third party engineering labs and independent partners to test, trial and prove GRAYBOND™ binders' efficacy as an alternative binder to cement which delivers verifiable performance and decarbonization benefits.

Mine backfill verification studies

Third party verification studies conducted on samples from a mine backfill site show how up to 50% replacement of cement with GRAYBOND CRF™ binder, purpose designed for cemented rockfill processes, provides excellent performance, maintaining at least 80% of the cement strength after seven (7) days and demonstrating performance better than cement after 90 days.

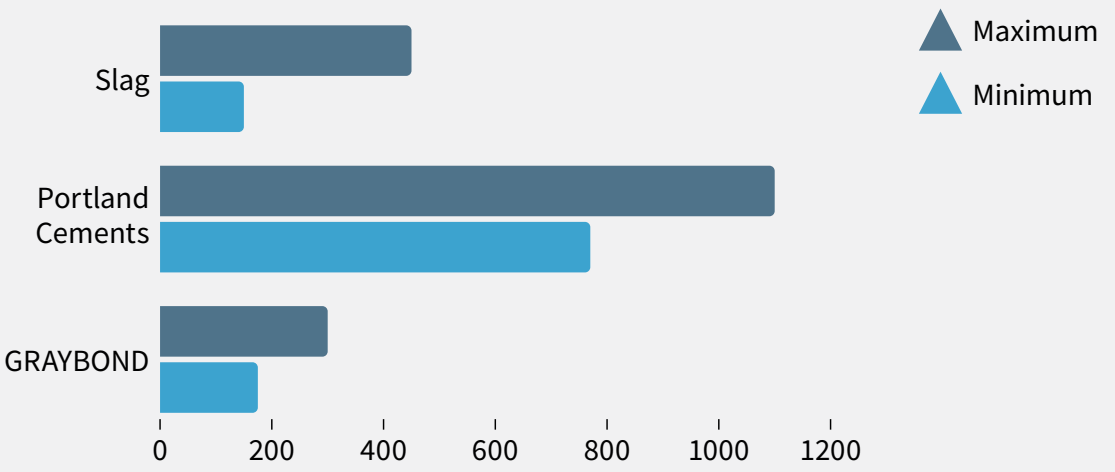
Table 1: Strength Activity of Cement Replacement With GRAYBOND CRF™



GRAYBOND™ vs. alternatives

The calculated decarbonization potential of GRAYBOND™ binders is significant compared to typical cements with performance comparable to slag co-products used in the market today. Graymont continues to verify GRAYBOND™ binders' performance and decarbonization potential in coordination with our industry and academia partners with the goal of delivering an alternative cement binder which meets their performance and low carbon needs of various mining and construction applications.

Table 2: Comparing the GHG Emissions of GRAYBOND™ and Alternatives



ADDITIONAL USE CASES

What are the uses for GRAYBOND™ binders?

Customers can use GRAYBOND™ binders in any applications that use cement. The replacement rate of cement with GRAYBOND™ varies between 20% to a full 100% replacement depending on the application. Graymont has worked with industry leaders to develop specific formulations of GRAYBOND™ binders for the following applications:

- Mine backfilling
- Soil stabilization
- General construction

Mine backfilling

Graymont has made significant progress in the development and field testing of GRAYBOND™ binders. A commercial scale cemented rockfill pilot trial, targeting 35% replacement of cement with GRAYBOND CRF™, is underway with a mining partner in the Western US, with a target of starting commercial supply in 2025. Initial laboratory and preliminary field trials with this cemented rockfill application have shown that GRAYBOND CRF™ is an excellent alternative to cement at the 35% substitution rate.

Additionally, Graymont is making significant progress towards the development of a high-sulphate resistant GRAYBOND PASTE™ binder, which can act as a replacement for at least 50% of the blast furnace slag in paste backfill and are targeting a pilot demonstration of this product in 2025. There is significant customer interest in these high-sulphur resistant GRAYBOND™ binders, as slag is the main binder used for high sulphate conditions and the supply of the correct slag (GGBFS) is dwindling and represents a potential supply crisis for mine operators.

Soil stabilization

For soil treatment, the development of GRAYBOND™ binders utilizes well-established principles of modifying clayey soils using lime and integrates a synergistic blend of naturally sourced pozzolanic materials along with lime and limestone fines which can be combined with cement or used on its own depending on the type of soils to achieve the desired mechanical and environmental performance. By optimizing the composition and dosing of GRAYBOND™ based on the soil type and mineralogy, we have an opportunity to lower the greenhouse gas footprint associated with binder use by up to 65% compared to cement.

Laboratory-scale experiments conducted on sandy clay soils from a case-study project site in California have demonstrated that GRAYBOND™ was effective in both lowering the plasticity of the soils and exceeded the 28-day unconfined compressive strength benchmarks set by conventional cement at the same binder application rate. Trends observed so far in the above project and in similar soil mixing projects in Canada have indicated potential to replace at least 50% of the cement using GRAYBOND™ while offering opportunities to cut back the overall binder consumption by up to 30%. Further work is underway to test the effectiveness of GRAYBOND™ on various soil types and to establish the field performance of GRAYBOND™ with the support of industry partners.

General construction

In addition to soil treatment applications, GRAYBOND™ also has shown promise to find a place within low-carbon concrete mix designs as a value added low-carbon cementitious binder alternative to traditional supplementary cementitious materials such as fly ash and GGBFS. Graymont's in-house testing has demonstrated the potential to replace up to 15% cement with GRAYBOND™ binders in general use concrete mixes while meeting all required performance requirements. Work is underway to qualify GRAYBOND™ per relevant ASTM specifications.

Future applications

We also have active R&D efforts underway in partnership with other technologies to develop a 2nd generation of GRAYBOND™ products tailored to replace higher quantities of cement and further lower the GHG footprint associated with binder use in concrete products. The Graymont team is ready to assist our partners in the development of low carbon, cementitious solutions with our GRAYBOND™ low carbon, calcium lime-based binder solution designed to meet the specific project needs and decarbonization goals of our customers.

WORK WITH GRAYMONT

Can Graymont make a custom GRAYBOND™ for my process?

Yes, GRAYBOND™ is a customizable product that can be optimized for a customer's specific process. Graymont supports the optimization of GRAYBOND™ binders through a combination of internal development by our own technical team at our state-of-the-art laboratory in Sandy, UT and with trusted third-party consultants and external laboratories. We are proud to actively collaborate with market partners to develop the right GRAYBOND™ binders and help lower their Scope 3 GHG emissions.

Graymont has current pilot production capabilities of GRAYBOND™ to support field trials throughout North America with commercial production targeted for early 2025. Technical papers will be presented detailing technical aspects of GRAYBOND™'s performance at the 2024 Paste (Melbourne, April 15-18, 2024) and Minefill (Vancouver, May 13-15, 2024) conferences.

Graymont is actively exploring applications for GRAYBOND™ binders to assist our partner customers with robust, cost-effective solutions for geotechnical tailings management, alternative cementitious binders and other potential applications with the goal of displacing traditional cement binder systems, thereby making a meaningful contribution to a decarbonized world.

Why partner with Graymont?

Graymont is a global, world class leader in lime and limestone production and market solutions serving markets throughout North America and Asia Pacific. In the 75+ years since our founding in 1948, Graymont has grown both organically and through acquisitions to become the third largest lime producer in the world.

Graymont is a private company, professionally managed and family owned with HQ in Canada and a global presence in North America, Asia Pacific and Latin America via our strategic partner Grupo Calidra, the largest lime and limestone company in Latin America. Graymont is committed to sustainability leadership and developing lime and limestone solutions for healthy modern societies and a decarbonized world.

GRAYMONT

Mission: Contributing to a decarbonized world by providing essential lime and limestone solutions.

HOW TO WORK WITH GRAYMONT ON YOUR NEXT PROJECT

Contact us to learn how high-performance, low-carbon alternative cement binder solutions can enhance your next mining or construction project.

Email: GRAYBOND@graymont.com