GRAYBOND™
A GRAYMONT™ PRODUCT

GRAYMONT

MAKING THE CASE FOR GRAYBOND™ CEMENTITIOUS BINDERS

FOR SOIL STABILIZATION

BACKGROUND

To prove the soil stabilization capabilities of GRAYBOND™ binders, Graymont partnered with ENGEO to conduct an in-depth study using different soil-binder mixtures and soil type/properties.

For soil treatment, GRAYBOND™ binder 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.

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.

CHALLENGE

What are the strength characteristics of various soil-binder mixtures, including the low-carbon GRAYBOND™ binder?

SOLUTION

Unconfined compressive strength testing was performed on untreated soil and 4 different soil-binder mixtures at 7 and 28 days to determine the strength characteristics of each soil-binder mixture. Atterberg Limits testing and Percent pH lime was performed on the target soil (untreated) and the soil-lime mixtures to aid in the soil description/determination, as well as to determine the subsequent soil plasticity reduction post binder addition.

TYPES OF BINDERS

The types and dosing of binders used in the testing program are listed below.

1. Untreated-Control

2. 4% Hi-Cal Quicklime

3. 4% Cement

4. 4% GRAYBOND™

SOIL TYPE/PROPERTIES

The target soil was determined to be clayey sand based on visual description (ASTM D2488) and Atterberg Limits testing (ASTM D4318). The binder application rate was chosen as 4% by weight of dry soil for all binders used in the study based on the Atterberg limits and pH test data obtained after treating the soils with 3%, 4%, and 5% Hi-Cal Quicklime.

The Atterberg limits and pH test results of the soil-lime mixtures are shown in the tables below. The 4% Hi-Cal Quicklime resulted in maximum reduction in soil PI while also achieving the target soil pH of 12.4 to initiate pozzolanic reactions.

Table 1: Atterberg Limit Test Results

MATERIAL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
Untreated clayey SAND	27	16	12
3% Hi-Cal Quicklime treated sandy SILT	28	23	5
4% Hi-Cal Quicklime treated sandy SILT	25	23	2
5% Hi-Cal Quicklime treated sandy SILT	31	24	7

Table 2: Percent Lime pH Results

SAMPLE ID	PERCENT LIME	pH IN DISTILLED WATER	pH IN CALCIUM CHLORIDE SOLUTION
1	3%	12.2	12.2
2	4%	12.4	12.4
3	5%	12.4	12.4

Mix Designs

To determine the appropriate amount of water to add to the soil-binder mixtures, compaction testing was performed on all binder mixes using method ASTM D1557. Based on the compaction test results, the amount of water added to the soil-binder mixtures was determined to be a specified percentage greater than the optimum moisture content. After the addition of water, the soil-binder mixtures were allowed to cure for complete hydration of the binders with the soil.

Table 3: Mix Designs

MIX DESIGNS	OPTIMUM MOISTURE CONTENT (OMC), IN %	WATER ADDITION ABOVE OMC (%)
Untreated-Control	10.6	0
4% Hi-Cal Quicklime	12.1	2
4% Cement	11.1	2
4% GRAYBOND™	11.8	2

RESULTS

The unconfined compressive strength of the molded soil-binder mixtures was determined based on the average of 3 specimens at time intervals of 7 and 28 days.

Table 4: Unconfirmed Compressive Strength

MIXES	7-DAY (AVG. PSI)	28-DAY (AVG. PSI)
Untreated-Control	211	355
4% Hi-Cal Quicklime	500	913
4% Cement	447	594
4% GRAYBOND™	614	805

Superior strength

Based on the test results, the GRAYBOND™ family of binders developed by Graymont produced superior strength performance to cement and could be used as an alternative binder to cement and lime for treatment of certain soil types.

Sustainability

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.

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.

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™ binder and help lower their Scope 3 GHG emissions.

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 soil stabilization project.

Email: GRAYBOND@graymont.com