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## WHAT IS SOIL CEMENT?

Soils vary widely in engineering properties, and often local soils are not adequate to meet the support requirements for a construction project. Soils can be improved by adding portland or slag cements to the soil, mixing thoroughly with a measured amount of water, and densely compacting the mixture. The resulting blend is called “**soil cement.**”

## WHERE IS SOIL CEMENT USED?

Soil cement is most often used as a pavement base material for flexible (asphalt or bituminous) pavements or as a subbase for rigid (concrete) pavements. Marginal quality aggregates can also be improved with cement to produce “cement-treated base.” A related application is recycling of failed bituminous pavements by pulverizing the surface/base and stabilizing this material with cement to produce a new pavement base. Subgrade soils (the material below the base) can be modified with cement, though normally with lower strength/performance requirements. This produces a weather-resistant work platform. Additional applications of soil cement include slope and bank protection, low-permeability liners, and stabilized fill material.

Slag cement can be used alone or in conjunction with portland cement or other cementitious materials (such as fly ash or lime) to improve soil properties and performance.

## HOW DOES SOIL CEMENT IMPROVE SOIL?

Hydraulic cement, such as portland or slag cement, binds soil particles together, improves compaction, and decreases void spacing. Usually cementitious material is combined in quantities from 2 to 20 percent by weight of the soil or aggregate material. Benefits include:

- Improved unconfined compressive and shear strengths
- Improved soil properties under saturated conditions
- Greater durability in wet/dry and freeze/thaw conditions
- Higher resilient modulus, reducing fatigue cracking and rutting in asphalt pavements
- Reduced plasticity and moisture retention in fine-grained clay soils

## HOW CAN SLAG-CEMENT HELP?

Soil cement provides a cost-effective alternative to removing and replacing poor soils, building thicker pavement sections, or using geotextile fabrics or grids.

Slag cement generally produces soil cement with lower early age strength and higher strength at later ages. Slower strength development can decrease the cracking potential of the soil cement base which reduces reflective cracking in flexible pavements. Higher later age strength ensures long term durability and fatigue resistance. Additionally, slag cement can improve performance under high moisture conditions.

# USE OF SLAG CEMENT IN SOIL CEMENT

**Figure 1: Compressive Strength of a Stabilized Soil**

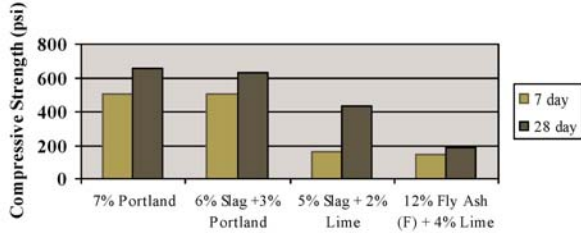
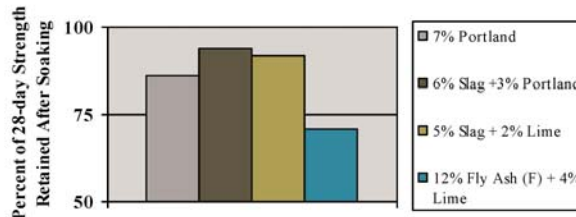


Figure 1 compares, for a specific soil, several mixtures with different types of cementitious materials. The portland-only and the slag-portland mixtures produced similar 7-day and 28-day strengths. The slag-lime mixture produced twice the 28-day strength of the lime-fly ash mixture, using less than half the amount of cementitious material.<sup>1</sup>

Figure 2 indicates, for a specific soil, the moisture susceptibility of several mixtures by showing the percentage of 28-day strength retained

after soaking in water. The slag cement mixtures (portland-slag and slag-lime) retained moderately higher percentages of strength than the portland-only mixture. When compared with the lime-fly ash mixture, the slag-lime combination provided almost 25% higher strength retention when soaked (with less cementitious material).<sup>1</sup>

**Figure 2: Strength Retention under Soaked Conditions for a Stabilized Soil**



Slag cement can also help decrease cracking in soil-cement. A slag-lime test section constructed in Mississippi resulted in 20 percent lower crack density than the portland-only soil cement, with superior strength when compared with the lime-fly ash mix.<sup>2-3</sup> Finally, for sulfate-bearing soils, slag can help mitigate sulfate heave often found with lime stabilization.<sup>4-6</sup>

## PROPORTIONING WITH SLAG CEMENT

Slag cement is normally proportioned in quantities from 25 to 80 percent of the cementitious material. Job mixes are developed by proportioning trial batches with actual field materials combined with proposed percentages of cementitious binders. Final binder composition and percentage is made based on meeting specification requirements. Slag should be used with an activator (portland cement or lime) for best results.

Soil cement produced with a combination of slag and portland cement (or other cementitious materials) is mixed and compacted in a similar manner to portland-only soil cement. The cementitious materials are incorporated in the soil by using either mixed-in-place or central plant (pug mill) methods. Slag can be incorporated separately, or as a component of blended cement. American Concrete Institute's State of the Art Report on Soil Cement, 230.1R,<sup>3</sup> provides guidance in design, proportioning, testing, and construction of soil cement for a variety of applications.

Stabilization of sulfate-bearing soils is an emerging technology, so standard expansion test methods do not exist; however reference 6 provides guidelines used by the Louisiana Department of Transportation and Development in its research.

As with all soil cement mixtures, trial batches should be produced and tested to verify soil cement properties. Results may vary due to a variety of circumstances, including temperature and mixture components, among other things. you should consult your slag cement professional for assistance. Nothing contained herein shall be considered or construed as a warranty or guarantee, either expressed or implied, including any warranty of fitness for a particular purpose.

### References

1. Cost, T. and Ahlrich, R. "Use of Slag Cement (GGBFS) in Soil Stabilization," 2003 (draft report)
2. George, K.P., "Soil Stabilization Field Trial - Interim Report III", University of Mississippi/Mississippi DOT, Jackson, MS, 2003.
3. "Reflective Cracking in Cement Stabilized Pavements", IS537, Portland Cement Association, Skokie, IL, 2003
4. Higgins, Kinuthia, and Wild, "Soil Stabilization using Lime-Activated Ground Granulated Blast Furnace Slag", proceedings of the Sixth CANMET/ACI International Conference, Bangkok, Thailand, 1998.
5. Higgins and Kennedy, "Lime + Ground Granulated Blast Furnace Slag Stabilisation of Boulder Clay on the 'A421' Tingewick Bypass", 3rd European Symposium on the Performance and Durability of Bituminous Materials and Hydraulic Stabilised Composites, 1999.
6. Roy, A., Wang, L., Seals, R.K. and Metcalf, J.B., "Stabilization Techniques for Reactive Aggregate in Soil-Cement Base Course," Louisiana State University and Louisiana DOTD, Baton Rouge, 2003
7. ACI 230.1R-90 (Reapproved 1997) State of the Art Report on Soil Cement, American Concrete Institute, Farmington Hills, Michigan, 1997



*Slower strength development with slag cement can decrease the cracking potential of the soil cement base which reduces reflective cracking in flexible pavements.*



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The Slag Cement Association is the leading source of knowledge on blast-furnace slag-based cementitious products. We promote the increased use and acceptance of these products by coordinating the resources of member companies. We educate customers, specifiers and other end-users on the varied attributes, benefits and uses of these products.

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