National Lime Association
LIME
The Versatile Chemical

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CONSTRUCTION AND BUILDING MATERIALS

Lime is an important commodity for construction activities and for building materials, with an increasing use in innovative construction materials.

Soil Modification & Stabilization

Lime can be used to treat soils in order to improve their workability and load-bearing characteristics in a number of situations. Quicklime is frequently used to dry wet soils at construction sites and elsewhere, reducing downtime and providing an improved working surface. An even more significant use of lime is in the modification and stabilization of soil beneath road and similar construction projects. Use of lime can substantially increase the stability, impermeability, and load-bearing capacity of the subgrade. Both quicklime and hydrated lime may be used for this purpose.

Application of lime to subgrades can provide significantly improved engineering properties. There are essentially two forms of improvement: modification and stabilization. The use of lime can modify almost all fine-grained soils to some extent, but the most dramatic improvement occurs in clay soils of moderate to high plasticity. Modification occurs primarily due to exchange of calcium cations supplied by the hydrated lime for the normally present cation adsorbed on the surface of the clay mineral. Modification is also caused as the hydrated lime reacts with the clay mineral surface in the high pH environment promoted by the lime-water system. In this high pH environment, the clay surface mineralogy is altered, as it reacts with the calcium ions to form cementitious products. The results are plasticity reduction, reduction in moisture-holding capacity (drying), swell reduction, improved stability and the ability to construct a solid working platform.

Stabilization occurs when the proper amount of lime is added to a reactive soil. Stabilization differs from modification in that a significant level of long-term strength gain is developed through a long-term pozzolanic reaction. This pozzolanic reaction is the formation of calcium silicate hydrates and calcium silicate aluminates as the calcium from the lime reacts with the aluminates and silicates solubilized from the clay mineral surface. This reaction can begin quickly and is responsible for some of the effects of modification. However, the full-term pozzolanic reaction can continue for a very long period of time, even many years-as long as enough lime is present and the pH remains high (above 10). As a result of long-term pozzzolanic reaction, some soils can produce very high strength gains when treated with lime. The key to pozzolanic reactivity and stabilization is a reactive soil and a good mix design protocol. The results of stabilization can be very substantial increases in resilient modulus values (by a factor of 10 or more in many cases), very substantial improvements in shear strength (by a factor of 20 or more in some cases), continued strength gain with time, even after periods of environmental or load damage (autogenous healing) and long-term durability over decades of service even under severe environmental conditions.

In addition to stabilization of new materials, lime plays an increasing role in the reclamation of road-bases. Lime has been effectively used to upgrade or reclame not only clay soils, but also clay contaminated aggregate bases and even calcareous bases which have little or no appreciable clay. . Work in the U.S., South Africa and France has established benefits of lime stabilization of calcareous bases which results in significant strength improvements, moisture resistance improvement and resilient modulus improvements without transforming the calcareous bases into rigid systems which could be susceptible to cracking and shrinkage.

Asphalt

Lime has been used in hot mix asphalt (HMA) to reduce moisture sensitivity and stripping since 1910 in the United States. Stripping is commonly defined as "Loss of adhesion between the aggregate Surface and asphalt cement binder in the presence of moisture." Lime is a superior antistripping agent in asphalt.

Lime also acts as a mineral filler to provide structural integrity to the asphalt binder and HMA. It reduces age hardening and brittleness of the asphalt binder and hot mix asphalt. Lime is also useful to upgrade marginal aggregates. In addition to the chemical effects that reduce stripping potential and the aging impact resulting from oxidative hardening, the filler effect improves resistance to high temperature rutting and adds fracture toughness at low temperatures. Thus, when these multi-functional benefits are considered, lime has been shown to be a superior additive for HMA.

A new and growing use for lime is in cold in-place recycling for the rehabilitation of distressed asphalt pavements. Existing asphalt pavement is pulverized using a milling machine, and a hot lime slurry is added along with asphalt emulsion. The cold recycled mix is placed and compacted using conventional asphalt paving equipment, and produces a smooth base course for the new asphalt surface. The addition of lime results in superior cold recycled mixtures, with much greater early strength and resistance to moisture damage.

Building Uses - **Masonry Mortars, Stuccos, and Plasters** - Lime has been used as a primary ingredient in masonry mortars for centuries, and this important use continues to the present day. Mortars compounded with lime and portland cement exhibit superior workability balanced with appropriate compressive strength, as well as low water permeability and superior bond strength. Lime is also used as an ingredient in stuccos and plasters, enhancing the strength durability and workability of these materials.

Autoclaved Aerated Concrete and Other Construction Materials - Lime is employed with pozzolans or portland cement in the manufacture of innovative lightweight cellular concrete products, which can be formed into block as well as large masonry units or insulation slabs. These materials have been widely used in Europe, and are beginning to gain acceptance in the United States as well. In autoclaved aerated concrete, also called “aircrete”, the light way cellular effect is achieved through a reaction between calcium hydroxide and aluminium powder. The ingredients of this material are mixed and placed into a mold to set, After which they are shaped before autoclaving. This process can be used to produce both block and reinforced products, and it demonstrates a beneficial combination of strength, energy efficiency, workability, density, and sound and thermal insulation.

Concrete products – Some manufacturers add hydrated lime to the concrete mix in making concrete block and other concrete products, in order to produce a denser, more water resistant concrete product. By adding greater plasticity to the mix, lime produces concrete products with more precise edges and corners, improves reflectivity in the product, and reduces loss through breakage.

Calcium silicate brick – Calcium silicate (sand-lime) brick is employed in standard masonry construction in the same manner as common clay brick. Clean, high-grade sand is mixed with 5-10 percent high calcium lime (quick or hydrated) in a wet state, with or without silica flour. The mixture is molded into brick and then autoclaved. Under these conditions, lime reacts with silicates that act as the cementing material and provide high dimensional stability. Improved modern production techniques can develop strengths exceeding Portland cement-based products. In similar processes hollow sand-lime building block, tile, slabs, and pipe are also made. Masonry units are also manufactured with lime-slag-aggregate mixtures and lime-pozzolan combinations with similar processes.

Insulation materials – Some insulating materials, molded as units, contain lime and diatomaceous earth or lime and silica. In these products lime serves as a binding agent, reacting chemically with the available silica present in the mix, forming calcium silicates. The lime-silica reaction is employed in making microporite insulation.