Density and Stability
+ EMC SQUARED® System CLS

"We know that as the density of a soil increases, its strength increases. Also, as its density increases, both its compressibility and permeability decrease."[1] To say the same thing from another perspective: "As porosity and void ratio decrease, the engineering properties of a given soil become more dependable with decreases in permeability and compressibility and an increase in strength."[2] The attainment of high density is obviously the most fundamental necessity for achieving stability in a compacted soil or aggregate material.

When a soil is disturbed for construction purposes, its natural stability and void ratio is changed. The void area is greatly increased and the inherent structural relationships are destroyed. Putting the soil back together better than mother nature takes considerable effort to wet, mix, and compact it into its new alignment. Putting it all back together to achieve long-term stability with the dynamic forces of traffic and the environment at work often requires more than effort alone.

Moisture is the most influential factor affecting the properties of a soil. Maintenance of the optimum moisture content during compaction operations is basic to the achievement of high density. Yet water alone often fails to thoroughly and homogeneously wet a soil or an aggregate material, so construction manipulations consequently fight against less than optimum moisture conditions and against natural forces that are still at work when a material has not been properly conditioned for compaction and maximum densification. Moisture tolerances for compaction are typically strict, and for good reason. A variation of only one percent from optimum may reduce density by over two pounds per cubic foot (thirty-two kilograms per cubic meter) and consequently increase the void space by a far greater percentage. Increasing the void ratio reduces structural strength while tremendously increasing the susceptibility of the material to moisture intrusion, saturation, and loss of bearing strength. For this reason, achieving the highest possible density during construction can make a tremendous difference in long-term stability.

"The objective of a compaction operation is to bring the soil to the highest percentage of density that can be attained within the limits of available equipment and cost."[3] Obtaining 90 to 95 percent compaction in the field may be the currently accepted standard for public agencies, but by no means is this an indication that we have attained the best possible densification for the material. These compaction standards were established to be within the past limitations of construction technology, prior to the availability of the EMC SQUARED System Concentrated Liquid Stabilizer (CLS) product technology.

"There is no other single treatment that produces so marked a change in physical properties at so low a cost as does properly controlled compaction."[4] Clearly there is still significant potential for improved compaction and densification beyond application of mechanical effort alone, yet relatively little attention is focused in this area. This is unfortunate, because the most economical improvements in stability can be achieved by compaction. Small percentage improvements above the maximum density determined by laboratory tests achieve even greater benefits. This is where the EMC SQUARED Stabilizer begins to go to work improving soil structure to enhance strength and resistance to water infiltration.

When soil stabilization is mentioned, cement and lime come to mind as the conventional chemical additives. These two calcium-based stabilizers improve stability by cementation reactions and major chemical changes of the soil material. They are relatively expensive to use as large bulk quantities are required to achieve stability in this manner. Costs are further increased because additional construction operations are required to incorporate these products. The calcium-based stabilizers do not help to increase the density of a compacted soil, and in fact, do exactly the opposite when they flocculate the soil structure. The EMC SQUARED System is an alternative approach to improving stability: conditioning soil and aggregate materials so that they can be compacted to their highest

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potential density, then curing to a stronger, more stable structure with improved bearing strength and reduced moisture susceptibility. Effective treatment of moisture susceptibility provides a very important bonus in cold regions – the elimination of the potential for damage by frost heave.

EMC SQUARED System products are formulated specifically for the treatment of earth materials (aggregates and soils) and recycled pavement aggregates. Applied as compaction water additives, the treatments condition the soil or aggregate materials for optimum densification and are then incorporated and interlocked into the compacted materials. EMC SQUARED treatments are like molecular rebars, reinforcing density by increasing cohesive forces within a compacted earth material and protecting the stabilized structure against damage by moisture infiltration. This environmentally friendly product technology significantly improves soil structure as an additive to the compaction water applied as part of the conventional construction process.

To again emphasize the basic advantages gained by densification, closer proximity of soil particles and agglomerates is achieved by reducing pore and void space and improving soil structure. Increased proximity strengthens interparticle forces and internal cohesion. Reduced pore and void space decreases permeability and susceptibility to damaging moisture fluctuations. Once you address these valuable changes in stability that occur by increasing density, then the ability of the highly concentrated EMC SQUARED System products to achieve meaningful improvements in stability with a wide variety of earth materials should be easier to understand. EMC SQUARED treatments facilitate attainment and maintenance of high density and high strength. For many applications, the economics of utilizing EMC SQUARED System treatments are outstanding. Performance and effectiveness for a particular service environment can be determined by preliminary field and laboratory tests.

Soil and aggregates are among man's oldest building materials. Next time you set up a laboratory or field test with some of these ancient earth materials, consider improving their performance for construction applications with modern stabilization technology. Paralleling the natural processes of consolidation and lithification, preconditioned aggregate materials behave more like conglomerate rock, clays like claystone, sands like sandstone, and silts like siltstone. The EMC SQUARED System products are cost-effective tools for the transformation of aggregate and soil into high stability construction materials.

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