White Paper Report

EMC® SQUARED

Advanced Stabilization Technology

Build Better Roads

Lower Construction Costs

Reduce Environmental Impacts

presented by

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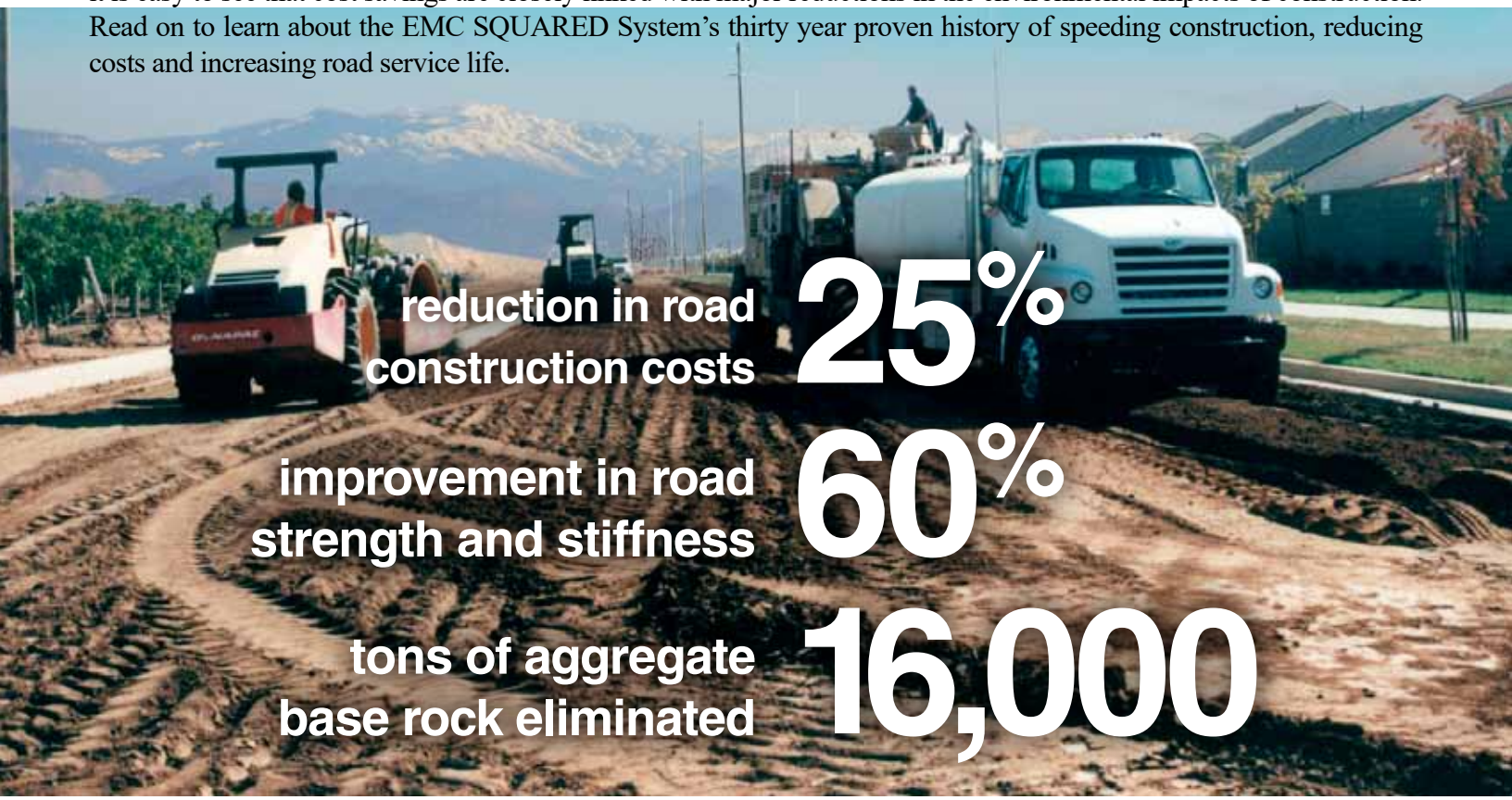
Big Cost Savings

The cost-savings realized by application of EMC SQUARED System stabilizer products are easy to measure. Among the thirty year history of applications are two California projects, the first being the reconstruction and widening of a one mile long city expressway project where the city reported that costs were reduced by 25%, saving $250,000.00 by stabilizing the soil subgrade and constructing a stabilized base course using recycled asphalt millings from the original pavement. Falling Weight Deflectometer (FWD) field tests following construction proved that the stabilized materials provided a 60% improvement in strength and stiffness in comparison to an adjacent section of road that was constructed according to conventional design using many thousands of tons of imported aggregate materials. For all these projects, it is easy to see that cost savings are closely linked with major reductions in the environmental impacts of construction. Read on to learn about the EMC SQUARED System's thirty year proven history of speeding construction, reducing costs and increasing road service life.



The second California project experienced a similar reduction in construction costs during the construction of a new access road into a federal penitentiary. The native clay soils were stabilized in place, eliminating the requirement for importing aggregate base rock materials from a source thirty miles distant.

Road Project Under Construction
Trimming and Final Compaction of Stabilized Subgrade

A North Dakota County located in the center of the Bakken Field oil and gas boom, with roads impacted by heavy oilfield service truck traffic, reduced construction costs by well over a million dollars by stabilizing native subgrade soils in place and eliminating the need to import fourteen inches of aggregate subbase material for two roads that totaled fifteen miles in length. In fact, FWD testing conducted during the construction process demonstrated that the subgrade treated with the EMC SQUARED Stabilizer provided a higher strength (modulus) than the state specification aggregate base course material that was placed on top of the stabilized subgrade.

Road Project Under Construction
Trimming and Final Compaction of Stabilized Subgrade

Completed Road Project
Constructed on Top of EMC SQUARED® Stabilized Subgrade

Stabilized Soil Subgrade Eliminates Need for Over 1 Million Tons of Aggregate

Subgrade Stabilization with Disc Mixing of EMC SQUARED Stabilizer Treatment

Fort Bliss is a huge U.S. Army base that stretches across the state border into New Mexico and Texas. Troops conduct training exercises and operate caravans of military tactical equipment, including tracked Abrams M1A2 Battle Tanks weighing approximately 70 tons and Heavy Equipment Transporter trucks weighing as much as 122 tons fully loaded, on their unpaved Main Supply Routes (MSR), or Tank Trails. Two U.S. Army Corps of Engineers projects reduced costs by approximately twenty million dollars by speeding construction and eliminating the need for importing over one million tons of crushed aggregate subbase material by providing the road construction contractors with the option to stabilize native soils in place with the EMC SQUARED Stabilizer product. Savings of almost 40% were reinvested in using the same stabilizer product to stabilize the aggregate surface course materials as a pavement layer and to extend the amount of road that could be constructed from 70 miles to a total of 116 miles, or 187 kilometers. The stabilized aggregate material performed as a smooth-running and more wear-resistant surface for caravans of tactical equipment and heavy transport trucks.

Visit stabilizationproducts.net and review these case studies and associated material testing reports for yourself.

Placement of EMC SQUARED Stabilized Aggregate Mix by Asphalt Paving Machine

Building More Resilient Infrastructure

Using the San Francisco Bay Area and the Sacramento Delta Area in California as examples of two regions where mega-sized construction projects must be undertaken in anticipation of the effects of Climate Change, we can start with the problems of Sea Level Rise and the more recent extreme weather patterns with frequent flooding events that put the more antiquated California highway and levee systems at a high level of risk. These very real threats need to be addressed with massive earthwork projects. Earthen dikes must be constructed to protect existing infrastructure and planned new shoreline developments around the perimeter of San Francisco Bay. Hundreds of miles of existing levees in the Delta must be reconstructed, reinforced and enlarged. While in past years cement and lime (quicklime and hydrated lime) might have been added to soils to further strengthen soil structures to function as protective dikes and levees, the extremely high cost and negative environmental impacts of these calcium-based stabilizers and the huge amounts of carbon emissions related to their manufacturing processes make it apparent that more appropriate technology must be utilized. Dike and levee structures must be more resilient and less expensive to build and maintain. For such applications, the EMC SQUARED System products are uniquely appropriate. They are created with a clean cold manufacturing process that does not require the use of fossil fuel for heating or release of carbon emissions. The concentrated liquid stabilizers can be applied at much lower cost than cement or lime. They are environmentally friendly in composition and documented in a U.S. EPA funded study as being appropriate for use in the vicinity of sensitive estuary and riparian areas. EMC SQUARED System products are formulated to reduce the permeability, or hydraulic conductivity (rate of moisture flow) of soil materials, as well as increase their strength and resistance to erosion.

While cement and lime products can be added to soils to increase strength values and reduce expansive characteristics, these calcium-based products are not economical answers when it comes to making earthen structures more impermeable and effective as barriers to water infiltration. This is a category where the EMC SQUARED System products clearly have a performance advantage in addition to the economic and environmental advantages. Add highway and railroad embankments to the long list of earthwork structures that need to be upgraded with more erosion-resistant measures in preparation for extreme weather events. As demonstrated by damaged infrastructures throughout the United States, unstabilized earthen embankments and aggregate base course materials under highway pavements and railways offer little resistance to the erosive forces of water when hit by major flooding events. Some crippled or collapsed transportation systems may take up to a decade to be fully restored after just one flooding event. The need to armor constructed earthworks is widespread, extending far beyond transportation infrastructure and protective dike and levee structures. The EMC SQUARED System products again can be of service at the lowest cost and least environmental impact.

Compaction of EMC SQUARED System Stabilized Soils for New Railway

Necessity is the Mother of Invention

Soil Stabilization Products Company Inc. (SSPCo) was headquartered in the Central Valley of California, where highly expansive clay soils are prevalent. The destructive influence of these problem soils on the built infrastructure is a costly problem for public agencies and private parties with extensive paved areas or road systems. Counteracting the cyclical shrinking and swelling behavior, or volume changes, of expansive clay soils has traditionally required thick road structural sections using far more aggregate and hot mix asphalt or concrete pavement materials than roads constructed on top of less problematic native soils. Building less robust pavement structural sections on top of expansive clay soils, newly constructed roads can rapidly deteriorate and require frequent reconstruction. According to a study published by the American Society of Civil Engineers (ASCE), the cumulative deleterious effects that expansive clay soils have on constructed facilities in the United States alone total billions of dollars.

With previous career backgrounds in the production of aggregate, asphalt, and concrete materials, and the use of these road building products as general engineering contractors in an area where expansive clays are the predominate native soils, the founders of SSPCo had first hand knowledge that these costly problems were not cost effectively addressed by any of the conventional chemical stabilizers or geosynthetic products available on the national or international market. Based upon the belief that a better solution could be developed, they focused on solving the problem with a new approach. Soil stability, at its essence, has water as the common denominator. The engineering properties of all soil materials are governed by variations in their water content. Starting with the knowledge that the volume change of expansive clay soils is driven by fluctuations in the moisture content of the soil, the most cost-effective solution was to develop a product technology that could maintain the moisture content of soil materials in a "near optimum" or equilibrium state, shedding rain water and not soaking moisture up from below. The same holds true for aggregate base course materials. When subgrade soils and aggregate base course materials are maintained in an equilibrium state near what is known as their optimum moisture content, they retain their highest strength values and provide the most consistent support for the pavement. By directly addressing the moisture fluctuation problems of soil and aggregate materials, the EMC SQUARED System technology lowers the cost of soil stabilization and reduces the use of nonrenewable resources as well as the environmental impacts of construction. When locally available native soils can be stabilized in place, it eliminates the need to use aggregate materials that have to be mined, crushed, screened, hauled and placed. The reduction in the environmental impacts of the overall construction project are obvious.

While cement and lime were originally developed for other higher value applications, it was found that they could also be used to improve the strength of some types of soils. But significantly, the improvements these products offered did not include stabilization of moisture content. The benefits of cement and lime applications typically do not reduce the permeability, or slow the rate of moisture flow through a soil. In fact, exactly the opposite is the case. Because they take an indirect path to counteracting the problems that are driven by fluctuations in the moisture content of soil and aggregate materials, cement and lime must be applied in massive quantities to be effective. The ability to directly address the moisture fluctuation problem is what makes the EMC SQUARED System products so unique and cost effective. It helps explain why it can take 50 to 100 times more cement or lime product than the concentrated EMC SQUARED System product to effectively treat the same volume of material. **This is truly a classic sustainability success story — finding a way to do more with less, and replacing very dirty conventional products with more cost-effective clean product technology.**

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Engineering Field Evaluation of Stabilized Road in Progress

Smoother Roads Increase Fuel Efficiency and Reduce Carbon Emissions

Federally mandated highway monitoring programs have shown that the application of the EMC SQUARED System stabilizer products improved and extended the smooth-running performance of roads, highways, and interstate freeways. This has been evidenced by ongoing monitoring of interstate freeway projects constructed above soils treated with EMC SQUARED System products in New Mexico and Texas. Based upon research completed at the Massachusetts Institute of Technology (MIT) on pavement-vehicle interaction (PVI), reducing pavement deflection by improving the stiffness factor of pavement structural sections lessens fuel consumption of the cars and trucks driven on the roads, thereby reducing the amount of carbon emissions related to their operation. No costly modifications of cars and trucks, or driver behavior are required to reap these environmental benefits. These smoother running, more fuel efficient roads can be constructed at lower cost than conventional roads using engineering designs based upon the unique improvements in materials performance provided by application of the EMC SQUARED System products.

A 117 mile long system of stabilized Main Supply Routes, or Tank Trails, stretching across the border between the States of Texas and New Mexico, further illustrates the cost-savings and reduced environmental impacts when this sustainable product technology is employed.

How Stabilization of Soil and Aggregate Materials Counteracts Climate Change at Net Zero Cost

Aggregate materials for road and highway construction projects are typically mined from nearby quarries and riverbed deposits. These sources are rapidly being exhausted and are often increasingly distant from the job sites. When you factor in the maintenance costs for the adjacent roads systems that are subjected to hundreds or even thousands of truck trips just to build one mile of new roadway or highway, it is obvious that the city, county, and state taxpayers are subsidizing the construction of new roads with their paved road networks that are being rapidly deteriorated by the aggregate hauls. This is a terrible waste of public resources. As the transportation costs, the air pollution, and road wear associated with these long hauls mount up, the built-in demand for proven stabilization treatment becomes apparent. The replacement of imported aggregate base rock materials by in-place stabilization of native soils or reuse of asphalt millings as stabilized base course materials can lower project expenses.

Through the past thirty years, the EMC SQUARED System stabilization technology has shown it can not only reduce initial costs, but also counter climate change by saving fuel and lowering the greenhouse gas emissions of the construction process. Most importantly, use of this stabilization technology can build roads and highways that last longer than traditional pavement systems. The

community committed to counteracting climate change should actively consider the widespread use of this generation's innovative stabilization products.

The innovative product technology covered in this White Paper Report is a family of highly concentrated liquid stabilizers identified as the EMC SQUARED System. These liquid concentrates are applied as dilute solutions using locally available water at the construction site. The stabilizer solutions are mixed with soil and aggregate materials during the moisture adjustment processes preliminary to the compaction operations that are the standard construction procedures for any earthwork or road building project. The EMC SQUARED System stabilizer product technology has a profound potential for a global role in counteracting climate change. These green stabilizer products provide a unique package of valuable performance benefits not previously available from bulk applications of cement and lime products, the most widely used conventional chemical stabilizers.

EMC SQUARED System liquid concentrates can be applied at far lower installed cost than the traditional bulk cement and lime chemical products that often require applications of 50 to 100 times more product by weight in order to be of any benefit. In addition to the basic cost, performance and environmental advantages, the highly concentrated nature of the liquid EMC SQUARED System products means they can be economically shipped worldwide, expanding opportunities for use in the global market. All nations can now take advantage of the economies of stabilization to reduce the costs and environmental impacts of construction activities.

As illustrated in the case studies available by visiting stabilizationproducts.net, there are many situations where use of the EMC SQUARED System stabilizer products can lessen or exclude the requirement for the mining, manufacturing, and transport of millions of tons of crushed aggregate materials. Far more expensive cement, lime, and asphalt products generate significant amounts of carbon emissions during their manufacture. These sources of greenhouse gas (GHG) emissions would be eliminated by use of this clean product technology. Equally important, it has been demonstrated that application of the economical EMC SQUARED System products to subgrade soils and aggregate base layers during initial construction significantly extends the service life of roads and highways surfaced with gravel, asphalt, and concrete pavements. Placing costly asphalt and concrete pavements on top of more stable road foundations reduces the frequent need for reconstructing roads and highways built according to dated and unsustainable practices. Thicker layers of aggregate, asphalt, and concrete, or applications of cement and lime to subgrade soils, are expensive measures. They consume nonrenewable resources, and they contribute vast amounts of carbon and toxic air emissions during the related mining and heated manufacturing processes. A change to more sustainable construction practice is now within reach, made possible through the development of innovative cold-manufactured stabilization technology that is more cost-effective than the conventional products.

What's to be excited about?

What's most exciting about the combination of benefits and reduced environmental impacts described above is that they can be achieved with modern green product technology that provides significant overall cost savings for project owners. **As addressed in referenced case studies that illustrate the success of the EMC SQUARED System product technology in reducing both construction costs and environmental impacts, this is a unique case where cost-saving product technology can be used to significantly reduce carbon emissions at Net Zero Cost.**

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