EMC SQUARED® System

3 Decades of History

Federal Agency Road Projects

EMC SQUARED®








Advanced Stabilization Technology

The EMC SQUARED System from Soil Stabilization Products Company, Inc.

Over *20 Years* in Service for Federal Agency Road Projects

Performance, Durability And Reliability

Soil Stabilization Products Company (SSPCo) has a long relationship with the federal agencies that have expansive road construction and road maintenance responsibilities. With individual agencies managing road networks that can include several hundred thousand miles of paved and unpaved roads, there are widespread opportunities with the availability of advanced stabilization product technology and highly experienced technical support services to build better roads, reduce construction costs and reduce environmental impacts. SSPCo's EMC SQUARED® System stabilization products have been in service on federal agency projects for more than twenty years and SSPCo has been involved in hundreds of stabilization projects across the country and internationally, including arctic, desert and tropical rainforest locations. SSPCo's stabilization technology has been proven effective over decades of field service with correlating materials laboratory testing documenting the constellation of stabilization benefits provided. With the technical expertise and technical assistance of Soil Stabilization Products Company, supporting public agency road and earthwork construction projects from preliminary evaluation through construction, the EMC SQUARED System has an unequaled record of performance and reliability.

Unique Versatility

Cement and lime are the products that traditionally come to mind for most highway engineers when it comes to the subject of base stabilization and subgrade soil stabilization. These chemical stabilizing agents are expensive and limited in their range of effectiveness. Their high calcium content makes them susceptible to the adverse reaction of sulfate induced heave. Lime is normally used only for treatment of heavy clay soils and rarely used with aggregate materials. Neither cement nor lime treatments are normally used to improve the performance of unpaved dirt or gravel surfaced roads. The brittle nature of cement and lime treated aggregate and soil materials, and their susceptibility to moisture infiltration, make the resulting constructed products just not tough enough to stand up to the repetitive pounding of automobile and truck tires and direct exposure to wet weather and freezing conditions.

EMC SQUARED System treatments, on the other hand, are economical and have proven effective in stabilizing non-plastic (granular) and cohesive, highly plastic (expansive clay) soils, non-plastic and plastic aggregate materials, recycled asphalt pavement millings (RAP), and recycled pavement aggregates manufactured with pulverized asphalt and crushed concrete content. A partial list of EMC SQUARED System applications includes subgrade soil stabilization for major interstate freeway, highway, and city expressway projects; stabilized soil layers exposed directly to traffic and weather, such as military tank trails, solar array sites, construction sites, industrial sites, and landfill closures; stabilized base courses under streets and roads; and stabilized aggregate running surfaces for a wide variety of public agency and industrial applications. EMC SQUARED stabilized aggregate and stabilized soil installations continue to provide effective performance after more than twenty years of service in direct exposure to traffic and the environment. Following in this publication is a sampling of federal agency projects constructed with EMC SQUARED System products.

Layer Equivalency To Asphalt

Where EMC SQUARED System products stand head and shoulders above other stabilizing agents, such as cement and asphalt emulsion products, is in treatment of aggregate materials for road running surfaces. When matched with aggregate base course and recycled aggregate materials that have suitable gradation and adequate binder content, EMC SQUARED System stabilization treatments can facilitate the construction of bound aggregate layers that most closely resemble hot mix asphalt pavement in layer equivalency evaluations. When improved to this degree by the EMC SQUARED System stabilization treatment, a one inch layer of asphalt millings, recycled aggregate or virgin aggregate base course has equivalent load bearing capability

Layer Equivalency To Asphalt *(Continued from previous page)*

as a one inch thick layer of hot mix asphalt. Backing up field performance observations and monitoring are studies conducted by independent pavement materials testing laboratories using tests that have been applied to untreated aggregate materials and stabilized aggregate materials as well as to hot mix asphalt materials. These studies include Resilient Modulus, Marshall Stability, and Suction and Dielectric (Tube Suction) Testing. For more in depth information on the testing and implications for cost savings and more sustainable construction practice, see http://www.sspco.com/docs/EMC/8778.pdf.

While many other materials laboratory test methods and test results are addressed in other SSPCo publications, such as the EMC SQUARED overview, all of which are available at www.sspco.com, following are the three test methods most directly relevant to comparing aggregate materials treated with EMC SQUARED System applications and asphalt pavement in regards to layer equivalency factors.

LABORATORY TESTING

Resilient Modulus and Layer Equivalency

Resilient Modulus testing is the method now standardized by the U.S. Department of Transportation's Federal Highway Administration (FHWA) for the evaluation of pavement materials performance, and regarded by AASHTO (American Association of State Highway and Transportation Officials) as the primary factor in characterizing materials for highway pavement applications. Resilient Modulus testing is recognized internationally as a state of the art test method. Replicating the dynamic loading conditions that pavement and base course layers experience under automobile and truck traffic, Resilient Modulus testing evaluates the elasticity of the material and its ability to be resilient and return to its original shape and size without any permanent deformation, or damage, after repetitive loading cycles are applied. The comparative resiliency of a pavement material allows pavement design engineers to determine the load bearing capacity of a certain layer thickness of a specific material and to evaluate layer equivalency. Pictured here are the Resilient Modulus and Layer Equivalency Factors of an EMC SQUARED System stabilized aggregate mixture installed for several miles of access roads in downtown Las Vegas, Nevada.

As indicated in the test data, the stabilized aggregate is similar in layer equivalency to hot mix asphalt, and based upon the Layer Equivalency Factor, equal to a far thicker layer of untreated aggregate base material. In addition to improving the performance of unpaved roads, subgrade and base course materials made stronger and more resilient by EMC SQUARED System treatments can lower construction costs by allowing design engineers to reduce layer thickness for both base course and pavement layers.

Resilient Modulus Results and Layer Equivalency Factors

Sample ID	Average Resilient Modulus (psi)*	Layer Equivalency Factor**
Aggregate Base with EMC SQUARED	**272,500**	**0.35*** **
Untreated Aggregate Base	**51,000**	**0.10**

*Resilient Modulus results reported by UNR
**Professional Service Industries, Inc.
*** Standard practice in Southern Nevada is to assign a layer coefficient of 0.35 for dense graded hot mix asphalt.

LABORATORY TESTING

Marshall Stability Testing

The Marshall Stability Test Method (ASTM D 1559) has long been a standard procedure used by materials testing laboratories for evaluation of hot mix asphalt pavement mixtures and modern flexible pavement mixtures. The Marshall Design Criteria from the Asphalt Institute are provided below. A higher stability measure indicates greater bonding strength and resistance to rutting. As part of the Marshall Stability test, a Flow measurement is also taken to evaluate the relative flexibility of different pavement mixtures, with the higher Flow measurements indicating more flexibility. As indicated in the test results reported below, materials treated with EMC SQUARED® System applications compare favorably with hot mix asphalt pavement materials.

Asphalt Institute Marshall Design Criteria

Marshall Method Criteria	Light Traffic Surface & Base		Medium Traffic Surface & Base		Heavy Traffic Surface & Base	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Stability (lbs)	750		1200		1800	
Flow (0.25mm)	8	18	8	16	8	14

1992

Stabilized Aggregate Base Course Materials

Marshall Method Criteria	Average Stability	Average Flow
EMC SQUARED Stabilizer (1000) Aggregate Base Rock, Cemex, AZ	11,920	12
EMC SQUARED Stabilizer (1000) Asphalt Aggregate Base Rock, Cloud Mining, NM	8,740	10

Stabilized Recycled Aggregate Materials

Marshall Method Criteria	Average Stability	Average Flow
EMC SQUARED Stabilizer (1000) Recycled Aggregate, CVT, CA	13,230	11
EMC SQUARED Stabilizer (1000) Recycled Aggregate, Vulcan, CA	10,520	7

Stabilized Recycled Asphalt Millings

Marshall Method Criteria	Average Stability	Average Flow
EMC SQUARED Stabilizer Only Asphalt Millings - Mojave County, AZ	1,863	9
2% CSS-1h Asphalt Emulsion Only Asphalt Millings - Mojave County, AZ	906	13

All Marshall Stability Testing done by Kleinfelder, Inc.

LABORATORY TESTING

Suction and Dielectric Testing

Along with test methods such as Resilient Modulus and Marshall Stability, laboratory test methods that measure the affinity of aggregate materials for water (moisture affinity) are essential to the evaluation of the ability of a particular material to retain its strength over time. The Suction and Dielectric Testing (or Tube Suction) methodology uses two electrical properties, dielectric value and electrical conductivity, to classify aggregate materials in regards to strength and deformation properties as well as moisture and frost susceptibility. Suction and Dieletric Testing has been incorporated in the National Cooperative Highway Research Program (NCHRP) for classification of aggregate materials. The use of Suction and Dielectric testing has also proven out in evaluating the effectiveness of EMC SQUARED System treatments. The test method accurately measured the performances of aggregate materials in the materials testing laboratory following their field evaluation in both unstabilized and stabilized conditions while serving as running surfaces for three unpaved roads in cold climate locations. On each of the three road construction projects, the stabilized aggregates provided running surfaces for vehicles and trucks. Two of these stabilized aggregate running surfaces were subjected to very heavy truck traffic. During this time, months in one case and years in the others, the stabilized aggregates provided excellent running surfaces requiring little to no maintenance and with no evidence of moisture penetration or frost damage. The stabilized aggregate surface courses, having first proven effective while directly subjected to the full range of environmental conditions, to heavy truck traffic and to winter snow plowing, were eventually used as stabilized or bound base courses for asphalt pavements and bituminous surface treatments. The laboratory test results, summarized below from a research study conducted at the Texas Transportation Institute[1], correlate well with observed field performance. The untreated aggregate materials were highly unstable as road running surfaces in the presence of moisture. Following treatment with EMC SQUARED System applications, the stabilized aggregate road surfaces acted similarly to asphalt pavement in their ability to retain strength in the presence of moisture while providing flexible running for surfaces servicing heavy truck and vehicular traffic.

Suction and Dielectric Testing

Aggregate Samples	Untreated	EMC SQUARED Stabilizer (1000)
Alaska	17.5	8.0
New Mexico	35.0	7.1
Nevada	17.3	7.7

References for Dielectric Constant Values of Highway Materials

MATERIAL	DIELECTRIC VALUE
Dry Aggregates	4 - 6
Asphaltic Concrete	5 - 7
Portland Cement Concrete	7 - 9

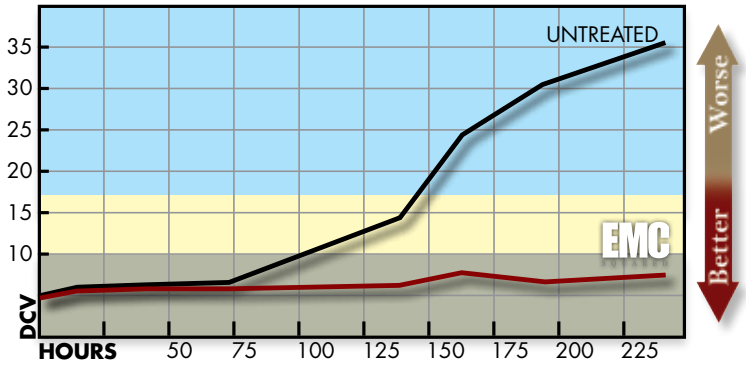
A Dielectric Value of greater than 15 indicates that the aggregate is wet or water saturated and extremely moisture and frost susceptible

A Dielectric Value of 10 to 15 indicates that a significant amount of free water has accumulated within the aggregate during the testing period and is a warning signal that the material is moisture sensitive and frost susceptible

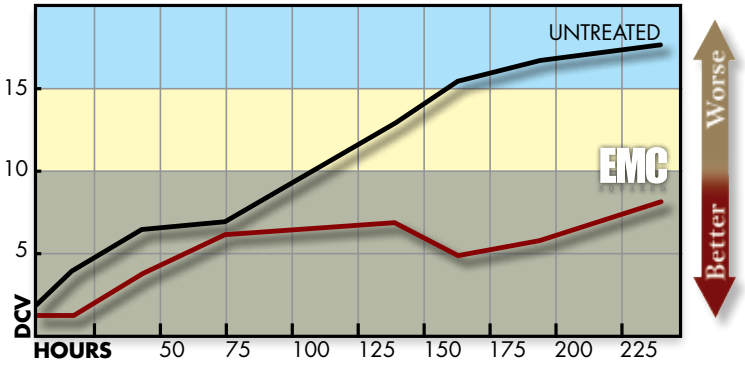
Aggregate materials with a Dielectric Value of less than 10 are considered non-moisture sensitive and non-frost susceptible in service for road and highway base applications

Notice in the test results above for the three stabilized aggregate surface course materials that they were improved by the EMC SQUARED System application from a condition of being extremely moisture and frost susceptible to a performance level closely equivalent to asphalt and concrete pavement. The graphed test results for the Alaska project are presented in the Alaska case study in this publication.

NEW MEXICO
CITY OF GALLUP



NEVADA
MOUNTAIN ROAD



1) Syed and T. Scullion, Texas Transportation Institute, Texas A&M University, College Station, TX 77843-3135. R.B. Randolph, Soil Stabilization Products Company, Inc., Merced, CA 95344 "Tube Section Test for Evlauating Aggregate Base Materials in Frost and Moisture Susceptible Environments" Transportation Research Record 1709, January 2000, 78-90

Arkansas Success Story

USDA National Forest Service Project

SUCCESSFUL TREATMENT OF FROST AND MOISTURE SUSCEPTIBLE AGGREGATE IN ARKANSAS

EMC SQUARED

24 Years of Service

Before Stabilization Treatment

"During the winter months, freezing and thawing, shrinking and swelling of the clay soils and the steep grade would make the road almost impassible."

After Stabilization Treatment

"The freezing and thawing of the clay soils are no longer a problemwith the road."

"...the stabilized aggregate remains solid, providing a safe and stable running surface on a winding road running through steep terrain."

A forest road improvement project was completed in 1988, upgrading a heavily traveled surfaced road with a new aggregate surface course material which was treated at the time of placement with EMC SQUARED® Stabilizer. A copy of the letter from Gary McElroy, Road Engineer for the Ozark-St. Francis National Forest, summarizes the construction and performance of the stabilized road is provided on the following page. In review of this EMC SQUARED case study, the permanency of this stabilization treatment throughout a monitoring period of more than twenty years has been obvious and impressive. Moisture and frost susceptibility have been effectively addressed and the shale/aggregate blend has been strengthened to provide an all-weather running surface for truck and vehicular traffic. These service conditions are far more severe than would be appropriate for conventional stabilization treatments such as cement and lime; products which are rarely, if ever, used for stabilization of unpaved roads (much less a gravel surfaced road with grades in excess of 12%). Given the challenging conditions, as Road Engineer Gary McElroy commented during a review of the project, it is not likely that a six inch thick asphalt pavement would have survived a similar length of time with so few repair requirements on this winding road running through steep terrain.

According to a January, 2010, update from Gary McElroy, the original stabilized aggregate running surface was still intact more than twenty years after installation, with only a few localized repairs needed. Significant surface wear began only after twenty years following a major flood event in spring of 2008, and then an abnormally wet 2009 year when the area received approximately 32 inches of rainfall above normal annual rainfall. Other than accumulated surface wear and minor localized repairs, the stabilized road continues to support traffic loadings after 24 years.

These improvements have been achieved as the result of a single treatment with the economical and environmentally friendly EMC SQUARED Stabilizer product. The investment in application of stabilization treatment has been repaid many times over, just by the reduction in grading maintenance. The savings to road users in auto and truck operating costs and the safety benefits of the smooth running surface have been significant. The initial investment in construction costs and in gravel surfacing materials has been preserved. Nearby streams have been protected from road generated sedimentation. This well designed and well constructed Forest Service project certainly deserves the title the USFS engineer gave it in his summary letter on the following page: Arkansas Success Story.

Letter from USDA Forest Service Road Engineer

September, 2005

Soil Stabilization Products Company
P. O. Box 2779
Merced, CA 95344

Re: Arkansas Success Story
Ozark-St. Francis National Forests - Mount Magazine Ranger District, Paris, Arkansas

This is an update on the reconstruction of the 2.0 miles of New Blaine Road No. 1600, which was completed in spring of 1988. This road was reconstructed by constructing a 6-inch compacted base using shale material. The surface course was created by mixing 6 inches of shale plus a 6-inch depth of 1" minus aggregate with the fines within the 12% range. EMC Squared was incorporated with the surface course materials, mixed, brought to optimum moisture, and compacted with a steel wheel drum roller.

In 2001, we had some minor rutting and erosion due to poor maintenance practices. We addressed this problem by adding additional aggregate and scarifying the existing damaged area to a depth of 12 inches. Again, we added the EMC Squared soil stabilizer, mixed, and compacted the surface course.

This road receives maintenance only twice a year. At this time, the road continues to service the forests with outstanding performance. The original surfacing is still intact. The 12% plus grades remain free of corrugations and we continue to maintain a smooth running surface to support an arterial transportation system, which supports management of national forest resources. Since seeing the early success with the New Blaine Road, we have continued to use these products with the same results. At this time, we have approximately 20 miles of roads in our inventory with soil-stabilized surfaces.

I do wonder why more folks are not on board with these products. The savings in surface replacement and reduced maintenance in addition to increased road strength far exceed the additional cost incurred during reconstruction.

For comparison, I am attaching an updated picture taken near the area of your original photo.

Sincerely,
/s/Gary Mc Elroy

Road Engineer
Ozark-St. Francis National Forests
Supervisors Office
Russellville, AR 72801

Alaska Road Stabilization

Federal Highway Administration
FHWA Experimental Feature Project

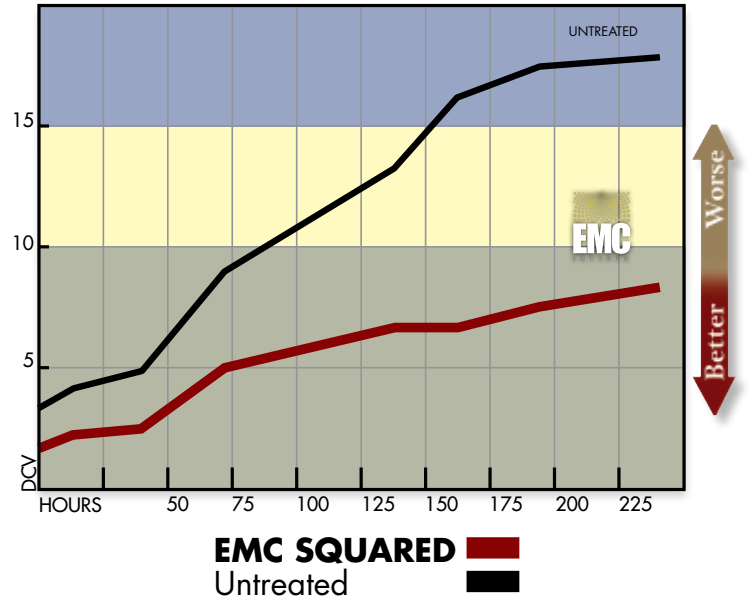
The "Pipeline Haul Road," known today as the Elliott Highway and the Dalton Highway, was built to service the Prudhoe Bay oil fields and the Trans-Alaska Pipeline. It presents a maintenance challenge for Alaska Department of Transportation & Public Facilities (ADOT&PF) staff with 450 miles of gravel-surfaced road servicing year-round heavy truck traffic in severe conditions common to cold regions. In late spring of 1991, approximately 2.5 miles of new aggregate surface course material was treated with an EMC SQUARED® System application to a depth of six inches on the Elliott Highway beginning at the transition from asphalt to gravel surfaces. This section of road was selected both because of its proximity to Fairbanks (for convenient monitoring) and its assortment of severe superelevated curves, reportedly the worst on the entire length of gravel road. The project was funded by the Federal Highway Administration (FHWA) as an Experimental Feature Project. State quality-control technicians provided tight moisture and compaction control inspection and grade controls were carefully observed to ensure alignment as a running surface for the expected high-speed traffic.

Late 1992, after two summers of service with only minor touch-up in the superelevated curves, the section stabilized with the EMC SQUARED System treatment was described as being essentially maintenance free. Involved ADOT&PF staff unanimously gave the stabilized road section an excellent performance rating. The supervisor of an independent materials testing laboratory involved in monitoring the project made two site visits during late September 1993. He reported only a few small potholes on the stabilized section, located in the worst stress area of the superelevated curves, no larger than "half a grapefruit." After five summers of service without protection of pavement or a surface treatment, state maintenance crews applied an experimental bituminous surface treatment to the stabilized test section in late summer 1995 after reworking the top 2 inches of the treated aggregate to prepare the surface. An October 1995 inspection after application of the bituminous surface treatment verified that the stabilized section of highway continued to provide excellent alignment, easily supporting driving speeds of 70 mph, whereas much of the adjacent 3-year-old asphalt pavement was unsafe to drive at 55 mph due to the development of "roller-coasters" resulting from serious differential settlement problems. This was an interesting and dramatic example of the unique moisture barrier performance of the EMC SQUARED System treatment retaining the smooth running alignment of the newly constructed road. The adjacent section of asphalt pavement developed severe roughness within the first year after full depth reconstruction. The roughness in the asphalt pavement developed in spite of the six-inch thickness of the pavement layer and the fact that the six-inch thick aggregate base course underneath was constructed with an asphalt emulsion treatment, which itself was many times the cost of the adjacent EMC SQUARED System treatment.

Pictured below are the Suction and Dielectric Testing results for this road construction project, documenting the highly moisture and frost susceptible nature of the untreated aggregate prior application of the EMC SQUARED System stabilizer treatment, and then the pavement-like performance of the stabilized aggregate material.

Suction and Dielectric Testing
References for Dielectric Constant Values of Highway Materials

Material	Dielectric Value
Dry Aggregates	4-6
Asphaltic Concrete	5-7
Portland Cement Concrete	7-9




Livengood 44
Yukon River 101
Minto 94

Stabilized All Weather Roads
Utah and Arizona

The USDI Bureau of Land Management (BLM), has thousands of miles of dirt and gravel roads to maintain in remote areas far from road maintenance crews. BLM crews and road contractors in the southwest have been using EMC SQUARED® System treatments to stabilize soil and aggregate materials for dirt and gravel roads, remote landing strips and to armor newly placed aggregate surfacing for roads that run through arroyos where seasonal overtopping with flood waters cannot be avoided. These stabilized road surfaces undergo overtopping, for a period of days in some cases, without significant loss of aggregate surfacing.

Pictured here is a section of stabilized all-weather gravel surfaced road, connecting St. George, Utah, with the north rim of the Grand Canyon. Starting with this section in 1996, the BLM road maintenance crew hauled in new aggregate surfacing for six miles of road, mixed in the EMC SQUARED System stabilizer treatment and then applied an emulsion armor coat to the compacted surface. This section included over a mile of road with a ten percent grade. Fourteen years after construction, the BLM engineer in charge reports that the stabilized road still provides safe all-weather support on the steep grades even during the wettest weather conditions. Additional sections of this road have been sequentially upgraded with stabilized aggregate surfacing and treated soil surfacing as funding has permitted. These are severe service conditions, far beyond the capabilty of lime and cement treatments which must be protected by asphalt or concrete pavement surfaces. Continuing utilization of the EMC SQUARED System on unpaved BLM road systems is testimony to the broad spectrum effectiveness and durability of EMC SQUARED System treatments.

Border Road Stabilization
Arizona and California

Pictured below is a section of border fence and road along the border with Mexico, located just south of San Diego, California, and another section of border road in southeastern Arizona. Both are examples of EMC SQUARED System all-weather roads constructed by National Guard troops during their annual training rotations. The California road construction project involved a section of border road running through an area of seasonally flooded wetlands that provide duck habitat (pictured in inset photo below while a border fence installation was in progress). Historically, the road embankment would become saturated with water and require constant road maintenance. To solve the moisture infiltration problems that led to the continuing road failures, National Guard troops, during successive rotations in 1999, placed two layers of highly compacted stabilized aggregate material to elevate the road embankment by one foot and create a moisture resistant causeway through the low lying wetland area. Eleven years later, reports indicate the EMC SQUARED System stabilized causeway continues to provide solid load support through this wetland area for the additional gravel surfacing that has been placed on the border road system as part of the ongoing area-wide road maintenance program.

Wetlands adjacent to road

Haul Road Stabilization For Environmental Restoration Project

Fort Ord, California

Cost saving military base closures have been accompanied by significant environmental remediation requirements as these facilities are prepared for conversion to private sector utilization. The US Army Corps of Engineers managed a Total Environmental Restoration Contract (TERC) at Fort Ord, California, adjacent to Monterey Bay. In one phase of the project old landfills were excavated and consolidated within a single newly constructed landfill cell. The access and haul roads traversed sand dunes as they connected various work sites and the road alignment was a constant series of hills and curves. With an extended construction schedule and haul of 600 daily trips by dump trucks, the contractor knew that something nearly equivalent to a paved road would be required. An innovative road building program was implemented incorporating products that would stabilize the aggregate base rock surfacing materials and leave them clean of contaminants so that aggregate materials would be reusable for other road requirements once the access roads and haul roads were ripped up and removed at the completion of their use.

The roads were constructed with an aggregate base rock incorporating some crushed concrete material. This aggregate mixture was treated upon placement with EMC SQUARED® System stabilization treatment to strengthen the structural section and harden the running surface. The compacted surfaces were then treated with a light armor coat spray application of an environmentally friendly emulsion treatment to further bind the surface and provide dust control. The contractor maintained the haul roads with light sprays of the emulsion treatment applied as needed with their water truck from a bulk storage tank located on site. The haul road functioned as an efficient production platform and the contractor was able to operate their access and haul roads for over a year without a single dust complaint from the nearby housing complex. Haul trucks operated at nearly 100 percent availability, clearly demonstrating the cost-effectiveness of the stabilized aggregate surfacing for haul equipment efficiency.

Access Road and Parking Lot Stabilization

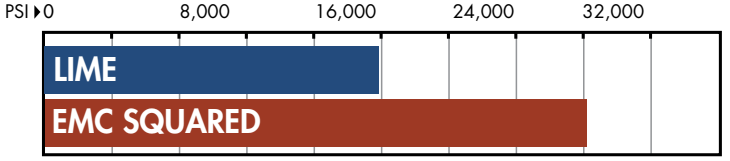
Mendota Federal Penetentiary, California

In order to develop the most economical road design for the first phase of a large federal penitentiary project in California, engineers used the AASHTO 2002 Mechanistic - Emperical (M-E) Pavement Design methodology promoted by the Federal Highway Administration (FHWA). With over fifteen acres of paved road and parking lots to be constructed on top of highly expansive clay soils, older design methods would have required thick layers of aggregate base rock hauled from the nearest source that was over thirty miles away. Design engineers utilized Resilient Modulus testing to carefully evaluate an alternative base layer design constructed of stabilized soil. Interestingly, while design engineers assigned aggregate base rock a resilient modulus value of 25,000 psi, test results for the clay soil stabilized with the EMC SQUARED System treatment were 32,000 psi.

The high performance stabilized layer remained in service for over two years without protection by the planned asphalt pavement. Federal budget problems delayed funding for the second phase of the project, which included the asphalt paving work. The building contractor operated heavy truck and construction equipment for this $100 million first construction phase through wet winter and spring conditions without need for repair of the stabilized roads and parking lots while the rest of the construction site remained impassible due to the saturated heavy clay soils. The stabilized surfaces retained their stability and bearing strength with nothing more than two inches of aggregate spread on top as an all-weather traction layer.

Lime treatment was also considered as it offered large savings over importing aggregate base rock, but the EMC SQUARED System stabilization treatment was selected as it far outperformed lime in testing and provided additional savings of approximately $250,000.00 over lime treatment. With costs for imported aggregate running approximately eight times as much per cubic yard as the EMC SQUARED System stabilization product used with the native soils, there were major cost savings over the original aggregate base road design. Use of the EMC SQUARED System stabilization treatment replaced approximately 30,000 tons of aggregate base rock and about 1,200 diesel truck trips of sixty miles roundtrip. In addition to cutting project construction costs, this advanced soil stabilization treatment also reduced the traffic safety hazard and the road damage associated with the heavy truck haul, and eliminated the air pollution related to 1,200 truck trips through California's San Joaquin Valley, an air basin already contending with extreme air pollution problems.

Resilient Modulus



MENDOTA FEDERAL PENITENTIARY
Expansive Clay Soil
Kleinfelder, Inc., Fresno, California
(Terracon Consulting Engineers & Scientists)

Tank Trail and Heavy Haul Road Stabilization

Fort Carson, Colorado

Fort Carson is located near Colorado Springs, Colorado, and shares the view of nearby Pikes Peak and the adjacent Rocky Mountain peaks. Dirt roads on base are subject to year round traffic by equipment with gross vehicle weights well in excess of those permitted on the nearby interstate freeway. The combination of severe Rocky Mountain weather and heavy equipment traffic (such as M1 Abrams Battle Tanks and heavy trucks, including giant lowbed haulers which can transport tanks, bulldozers and other large equipment) leaves untreated roads subject to rutting in wet weather conditions and requiring constant grading maintenance. The fine particle silty clay soils create a constant dust control problem in dry weather.

In summer of 1994, the tank trail running parallel to the Fort Carson motor pool area was treated with EMC SQUARED® stabilizer to a thirty foot width and a minimum depth of six inches. Soil testing reports classified the materials to be treated as moderate expansive clay, AASHTO A-7-6, with a Liquid Limit of 47 and a Plasticity Index of 25, with 100 percent passing a #100 sieve and 95.5 percent passing a #200 sieve. While some sections of the haul road had some rock content in the clay soil, the overall road project was notable for its extremely high percentage of minus #200 sieve fine particle soil. In the AASHTO Soil Classification System for Highway Subgrade Materials, this soil is classified as an extremely poor subgrade.

A crew from the base O&M Contractor, PAE, Inc., utilized a water truck to apply the stabilizer solution, a motor grader for mixing and grading and a vibratory smooth drum roller for compaction. Heavy rains set in the day after construction and the stabilized section was already able to support traffic while tanks rutted an adjacent control section to a six inch depth.

An onsite inspection in May of the following year by local civil and geotechnical engineering firm, Entech Engineering, Inc., observed that both tank and armored troop transport equipment were utilizing the treated road and reported that the tank trail was in extremely good condition and had performed without maintenance since treatment the previous year and that, in fact, its condition was superior to that of adjacent sections which were being "maintained" by monthly grading. Grading crews reported that the treated section of road was so highly cemented that they were unable to cut into it with their grader blades. In testing for the tank trail project that was conducted by Entech Engineering, Inc., in their materials laboratory, the Unconfined Compression Test results for the stabilized soil material averaged 566 psi

The performance of the EMC SQUARED treatment was even more impressive considering the area had been subjected to record rainfall in months prior to the inspection. The engineering firm additionally noted that tanks were clearly turning on top of the treated material and then creating ruts as deep as two feet in the untreated shoulder areas as they maneuvered off the tank trail. Maintenance crews at Fort Carson at last report in March 1996, confirmed that this low cost EMC SQUARED treatment continued to support all forms of heavy traffic without damage to the road structure.

ENTECH
ENGINEERING, INC.
4720 FORGE ROAD, SUITE 100
COLORADO SPRINGS, CO 80907
(719) 531-5599
FAX (719) 531-5238

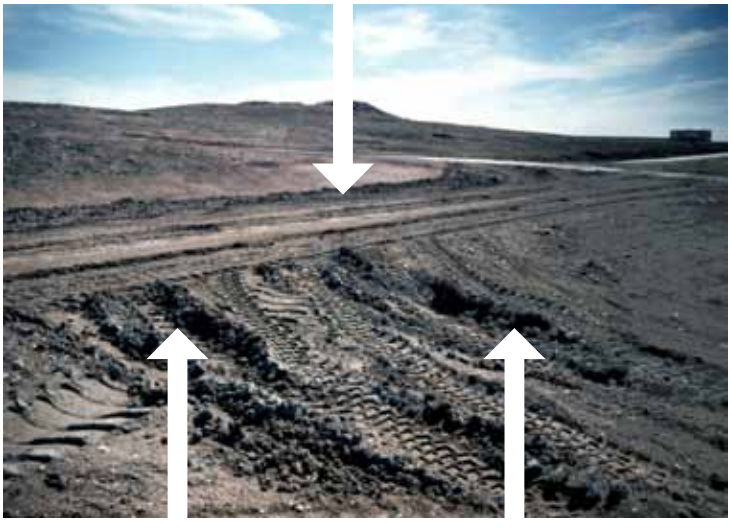
FIELD OBSERVATIONS TANK TRAIL

Fort Carson

Met with Sandy Whyte, site inspection on May 16, 1995. Tank and Bradley Transport Traffic observed on the road.

- Test section has not had any road maintenance since installed in July 1994. Other sections required monthly maintenance.
- The treated section with no maintenance appeared to be in superior condition than the areas that have been "maintained".
- Severe ruts were noted in the shoulders which were not treated where the tanks turn. Some rutting 2 feet deep was observed.
- Treated areas adjacent to the rutted areas which experienced the same tank maneuvers were in good condition with not ruts.
- Treated soil was field cored with a concrete coring machine.
- Test section was noted to be in extremely good condition, especially in consideration of the lack of any maintenance on the test section.

STABILIZED ROAD SURFACE



Ruts Left In Unstabilized Shoulder By Tanks Turning Off Of The Stabilized Road Surface

FIELD CORES

For additional information, go to www.stabilizationproducts.net

EMC SQUARED System products are used in combination with natural earth materials such as aggregates, soils and mixtures of reclaimed asphalt and concrete pavements. The products are components in the construction of a final product. Engineering and construction controls are vital to the selection of all the ingredients and construction processes which will deliver the final product, and the excellence of that end result is, in large measure, dependent upon engineering judgements and construction quality control measures.

This publication is solely for use by professional personnel who are competent to evaluate the significance and limitations of the information provided. It was reviewed carefully prior to publication. Stabilization Products LLC and Milieu Road Technologies, Ltd., assume no liability for its accuracy or completeness. Final determination of the suitability of any information or material for the use contemplated, or for its manner of use, is the sole responsibility of the user.

Stabilization Products LLC

www.stabilizationproducts.net

Email: Info@stabilizationproducts.net

(800) 523-9992 or (209)383-3296

Canadian Sales: Milieu Road Technologies, Ltd. (780) 875-9159

NDX 18664