11 YEAR UPDATE 2011

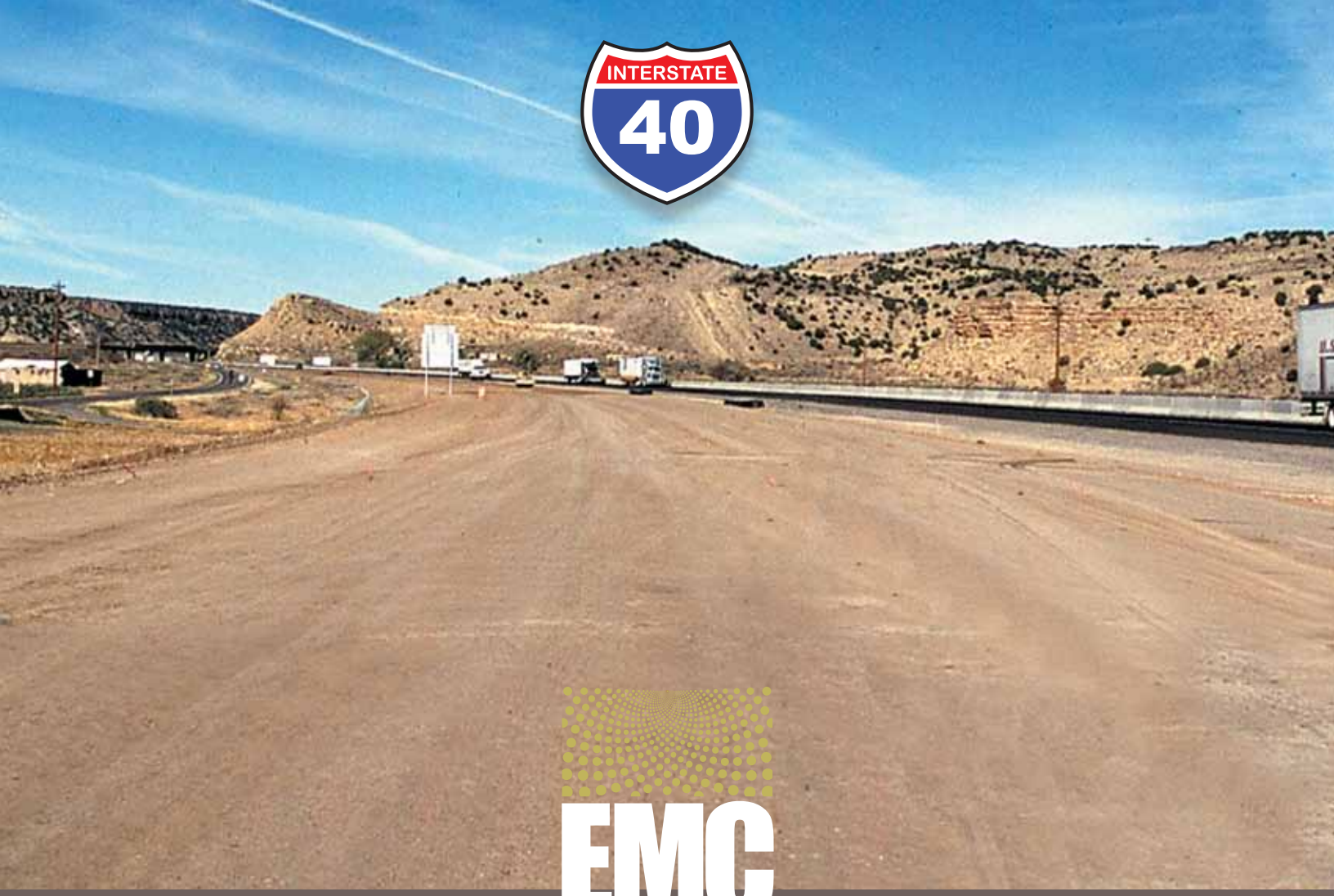
INTERSTATE 40 FREEWAY

SOIL STABILIZATION EXTENDS SERVICE LIFE

EMC SQUARED® System Outperforms Lime Treatment

EMC SQUARED

The EMC SQUARED Treatment extends project Theoretical Design Life by over 4.5 Million Truck Passes



EMC SQUARED

The section of the Interstate 40 freeway just east of Grants, New Mexico, identified as Milepost 93 to 97 (MP 93-97), has in past years been a nightmare for the New Mexico Department of Transportation (NMDOT). Grants is at an elevation of approximately 6,500 feet, close to where Interstate 40 crosses the Continental Divide at the southern end of the Rocky Mountains. This section of freeway is impacted by a high frequency of heavy truck traffic and severe cold climate conditions in winter. Groundwater problems are extreme under the freeway alignment. The silty clay subgrade soils were regularly found to be in a highly saturated state when excavated during full depth repair and reconstruction efforts. This section of freeway prior to year 2000 had required full depth removal and replacement of the entire pavement structural section on a three to five year cycle. The eastbound lanes of this section of freeway were particularly problematic, experiencing significantly more differential settlement (more rolls and dips, or roughness in the running surface) and higher frequency of repair. NMDOT maintenance staff reported that the entire annual budget of the local maintenance station was exhausted taking care of this one segment of freeway in the year prior to the full depth reconstruction in 2000. NMDOT and the Federal Highway Administration (FHWA) determined that the EMC SQUARED® System could really be put to the test if it were evaluated in this severe service environment, one that featured four of the worst enemies of pavement performance; heavy loads, high frequency traffic, saturated subgrade soils and extremely cold winter conditions.

Out of the four mile length of the Interstate 40 eastbound lanes reconstructed in 2000, two miles were constructed above subgrade soils stabilized with the EMC SQUARED System treatment. The EMC SQUARED System treatment was highly effective in bridging over saturated native soils below the subgrade layer, maintaining a working platform for the haul trucks and construction equipment involved in the base course placement and paving operations with only minimal repair requirements. The remaining two miles were constructed without application of any soil stabilization treatment. This unstabilized section consisted of two different subgrade conditions, one being areas of solid Malpais lava flows, the other saturated silty clay soils that had to be extensively reinforced with geosynthetic products. Geogrids were placed over geotextile fabric (mechanical stabilization) to provide the contractor with a functional working platform during construction. The base course construction and asphalt

EMC SQUARED

paving work were then completed and the eastbound lanes returned to service in early summer 2000. The westbound lanes were also completely reconstructed to full depth as part of the same construction contract. The silty clay subgrade soils for three of the four mile length were treated with lime. The rest of the westbound subgrade was either solid Malpais lava flow, or areas of saturated silty clay soils that were extensively reinforced with geosynthetic products. The thickness of the aggregate base course layers and the hot mix asphalt pavement layers were similar for both the reconstructed eastbound and westbound lanes, so this project provided an opportunity to compare the performance of the EMC SQUARED System subgrade treatment with the performance of the lime treatment, as well as with the sections of pavement constructed above the lava flows and geosynthetic reinforcement which are identified in the Performance Data chart on page 4 as "Unstabilized & Reinforced Subgrade". The four mile long MP 93 - 97 Project was reconstructed as part of a program that included eleven more miles of adjacent sections of Interstate 40 Freeway. Since these sections adjacent to the MP 93 - 97 Project were built with the same pavement structural section design, incorporating base course and hot mix asphalt layers of similar thickness, but without stabilized or reinforced subgrade treatments, the project also provided the opportunity to compare the benefits of the stabilization and reinforcement treatments in prolonging the service life of the pavements.

In response to the FHWA mandate to state highway agencies for annual reports on pavement smoothness, NMDOT conducts yearly profilometer testing of its highway system. Since the ultimate goal of subgrade stabilization is to maintain pavement smoothness, the profilometer testing therefore is the best examination of the effectiveness of a stabilizer treatment in highway system applications. Profilometer testing results are now available for the stabilized and unstabilized subgrade segments of the Interstate 40 Freeway project over a ten year period of monitoring. Ray Pederson, the FHWA Area Engineer for the project (now Area Engineer for the Bureau of Indian Affairs in New Mexico) has continued to monitor project performance through visual observation and review of the annual IRI or profilometer data collected by NMDOT. In addition to FHWA's use of the data for its International Roughness Index (IRI) monitoring, the data is also useful for performance comparison of different subgrade treatments. NMDOT developed a formula to predict the percent of

remaining pavement design life as related to the surface roughness of the pavement determined by the IRI data. A review by the Area Engineer monitoring the project indicates that the pavement constructed above the EMC SQUARED® System subgrade treatment has retained its smoothness better than the pavement above the adjacent unstabilized and reinforced sections of the eastbound lanes and better than the pavements in the westbound lanes constructed above the lime treated subgrade. Using the calculation formulas furnished by NMDOT and the FHWA, the IRI test results indicate that the EMC SQUARED System has done the best job retaining pavement smoothness and extending the Theoretical Design Life of this heavily trafficked section of Interstate 40. This degree of improvement during the monitoring period translates into a gain in load carrying capacity over the lime treated section of **5,155,966 ESALs, or 4,687,242 truck passes***, according to the NMDOT Materials Bureau model. **For sake of perspective, at one truck pass per minute, twenty-four hours per day, the EMC SQUARED® System stabilization treatment would extend service life by approximately 9 years beyond the results achieved with the lime treatment.**

NMDOT's District Engineer responsible for this section of Interstate 40 Freeway provided additional perspective important to the evaluation of benefits of the soil stabilization applications under the Interstate 40 pavement structural section. He commented in December 2005 that NMDOT had reconstructed approximately fifteen miles of the I-40 freeway through this area, including the EMC SQUARED System project. While all of the projects from 1999 forward utilized NMDOT's newer design with thickened layers of asphalt pavement and aggregate base course materials, only the MP 93 - 97 Project constructed with a stabilized and reinforced subgrade remain smooth running and free of pavement damage. While the costly addition of thickened layers of hot mix asphalt pavement has clearly contributed some incremental improvement, the soil stabilization treatments are providing a completely new level of pavement performance and service life in the face of these highly problematic freeway service conditions.

As detailed earlier, the EMC SQUARED System treatment was effective as a construction work platform. It was less expensive and less time-consuming to install in comparison to the conventional design, which called for subgrade excavation and replacement of the silty clay soils with more suitable road base materials. The EMC SQUARED System was also less expensive and less time-consuming to install than reinforcement with geosynthetic products. Finally, the IRI data on the Interstate 40 project is clearly demonstrating the effective performance of the EMC SQUARED System in extending pavement surface life over worst case native subgrade conditions.

Eleven Year Summary.

The four mile long section of the MP 93 - 97 Project is clearly outperforming eleven miles of adjacent sections of Interstate 40 freeway that were constructed with the same pavement structural section but without subgrade stabilization or subgrade reinforcement. The service life of the entire fifteen mile section of Interstate 40 freeway has been improved by NMDOT's expensive new pavement structural section design that incorporated a thicker aggregate base course layer and a far thicker layer of hot mix asphalt pavement (eleven inches thick) than had ever been used for previous Interstate 40 freeway construction projects. Of greater note, the relatively inexpensive stabilization of subgrade soils under the MP 93 - 97 Project has demonstrated outstanding cost-effectiveness in prolonging the service life of the pavement structure. Finally, the EMC SQUARED System, the only sustainable product used in construction of the MP 93 - 97 Project, and the least expensive, has been shown to be significantly more effective in prolonging the smooth running maintenance-free performance of the freeway pavement installation.

** using an estimated ESAL Factor of 1.1 ESALS (Equivalent Single Axle Loads) per truck (WSDOT)*

Additional Notes from Area Engineer (May 2010):

1. There is a dip that has been forming for some years near MP 96 eastbound in the transition area between the subgrade stabilized with the EMC SQUARED System treatment and a section of unstabilized subgrade. This section of subgrade was constructed just prior to starting the EMC SQUARED System treatment program and its consists of silty clay soils that were not treated with a stabilizer or reinforced with geosynthetic products.
2. Ultra-thin hot mix surface treatments (NovaChip®) have been applied as a preventative maintenance measure to both the eastbound and westbound pavements of the MP 93 - 97 project. Some sections of the westbound pavement above the lime treated subgrade were exhibiting longitudinal cracking prior to the application of the surface treatment. The quality of the surface treatment installation work was inconsistent and some sections of the surface treatment installation were rougher than others. From this point forward, the results of the annual pavement smoothness testing (International Roughness Index) may be significantly influenced by the variability in the quality of the surface treatments as increased roughness accelerates the rate of deterioration of the pavement structure under the dynamic loading of truck and car traffic.

Additional Notes from Area Engineer (March 2011);

1. During the past year NMDOT has had both eastbound and westbound lanes of a ten mile length of Interstate 40, including the MP 93 - 97 project, treated with a 5/6" open graded friction course. This is a standard preventative maintenance procedure, which as one of its benefits improves the smoothness of the pavement.

International Roughness Index (IRI)

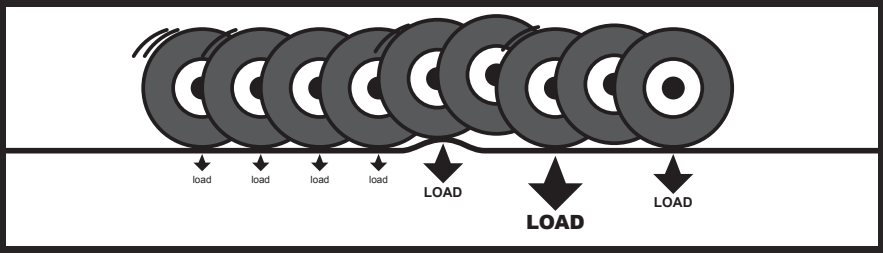
Losses Of Pavement Smoothness, Theoretical Design Life, And Theoretical Design ESALS

Pavement smoothness has become the most recognized international index for the evaluation of pavement performance. IRI measurement has been in nationwide use since 1990 when the Federal Highway Administration (FHWA) mandated implementation by all state highway agencies. The ultimate goal of subgrade stabilization, beyond providing an effective working platform, is to maintain pavement smoothness. IRI testing evaluates this fundamental performance criteria more directly than any other field test or test method in the materials laboratory.

The rate at which a pavement develops roughness is a generally accepted index for predicting the limits of the remaining service life of a specific section of highway pavement. The development of roughness between successive IRI measurements is translated into the percent of Theoretical Design Life that is lost and the decrease in load carrying capacity, or ESALs (Equivalent Single Axle Loads). Finally, these relationships can be converted into the number of truck passes, something more simple to visualize in regards to lost carrying capacity.

How Pavement Roughness Generates **Dynamic Load**

Pavement roughness leads to higher dynamic loads on localized pavement sections which increases pavement deterioration at those locations. This not only lowers ride quality, but also leads to a cycle of increasing deterioration rates with increasing roughness severity.



The load is relatively constant on smooth roads, while on rough roads the pavement receives higher loads *at and after the point of roughness*

Interstate 40 Freeway Performance Data

	Monitoring Dates*				
	February 19, 2001	February 26, 2008	March 18, 2009	March 25, 2010	
Average IRI Measurement					**Smoothness Lost**
Lime Stabilized Subgrade	38.9	51.6	53.0	56.9	31.59%
Unstabilized & Reinforced Subgrade	41.0	52.3	55.6	59.0	30.41%
EMC2 Stabilized Subgrade	41.4	47.8	49.6	52.8	21.65%
Percent of Theoretical					**Design Life Lost**
Lime Stabilized Subgrade	109.6	81.4	78.7	71.4	38.2%
Unstabilized & Reinforced Subgrade	104.5	80.3	73.7	67.6	36.9%
EMC2 Stabilized Subgrade	103.6	89.2	85.5	79.0	24.6%
Number of Theoretical					**Design ESALs Lost**
Lime Stabilized Subgrade	41,545,099	30,867,798	29,826,403	27,058,832	14,486,268
Unstabilized & Reinforced Subgrade	39,453,798	32,880,788	28,298,269	28,289,425	13,164,373
EMC2 Stabilized Subgrade	39,275,357	33,814,686	32,416,488	29,945,054	9,330,302

*Testing conducted by New Mexico Department of Transportation on an annual basis starting in 2001.

The first monitoring of this project took place on February 19, 2001 and the results at that time largely reflected the smoothness quality of the initial road construction work, as defined by the International Roughness Index testing (from which the initial Theoretical Design Life and the Theoretical Design ESALs are calculated), rather that a measurement of the influence of the various types of subgrades over time. As the annual monitoring of pavement smoothness progressed over subsequent years, the influence of the different subgrade treatments on pavement smoothness becomes apparent.

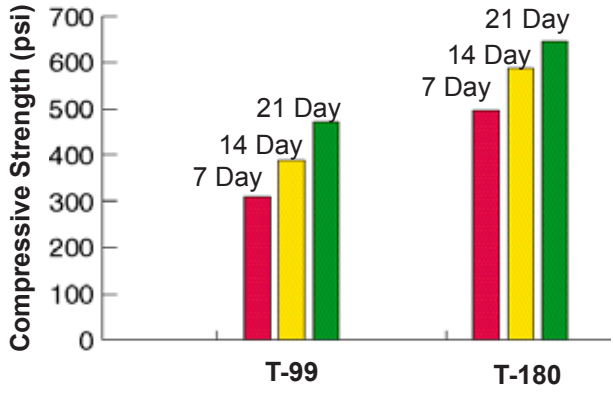
Compressive Strength Testing Device

Compressive Tests

EMC SQUARED System

Dual Component Treatment

	T-99	T-180
7 Day	310	496
14 Day	388	589
21 Day	472	646



Date: 13-Jul-00 Project Number: IM-040-2(56)93

Prior to approval of EMC SQUARED® System, the NMDOT Materials Bureau testing laboratory in Santa Fe conducted compaction control testing and standard Unconfined Compressive Strength (UCS) tests. Tests were also conducted by the district materials testing laboratory. The EMC SQUARED System easily passed the Materials Bureau's laboratory index requirements of 200 psi after 7 days of curing with a 310 psi result (AASHTO T-99 ASTM D 698 Compaction Energy), as well as testing at 496 psi after 7 days using the compaction energy specified for EMC SQUARED System field application (AASHTO T-180 ASTM D 1557).

The EMC SQUARED® System product technology is very much focused on treatment of subgrade moisture susceptibility. The goal of the treatment is to create an effective moisture barrier layer that protects the native subgrade below from rainwater and that resists saturation by the upward flow of capillary water from groundwater sources. The laboratory study conducted under the direction of Dr. Robert Lytton at the Texas Transportation Institute (TTI), clearly addressed this aspect of moisture barrier performance of the EMC SQUARED System treatment.

EMC SQUARED SYSTEM
STABILIZED SUBGRADE

barrier to rain water
barrier to atmospheric effects

impermeable non-moisture susceptible subgrade

barrier to upward migration of water
barrier to evaporation

MOISTURE BARRIER

The moisture barrier approach is not a new concept for construction over saturated clay subgrades. It has long been understood that there are two very different routes to stabilizing clay soils. Cement and lime are used in attempts to overwhelm volume change problems with cementation and reduction of plasticity. The moisture barrier approach instead controls volume change by maintaining the moisture content of the clay within the treated subgrade layer in a state of "near-optimum" condition.

Cement and lime treatment have been successful in providing rigid construction platforms, but less successful in addressing the development of roughness in highway pavements over time. The interest in application of moisture barrier technology has in large part been driven by the desire to construct pavement structural sections that would retain smoothness better over time in comparison to results with lime and cement treated subgrades. The limitation until recent years with the moisture barrier approach is that flexible membrane liners (also known as FML's or plastic liners) were the only technology available. Unfortunately, flexible membrane liners are expensive and a nightmare for contractors to install. The availability of the EMC SQUARED® System technology, which is low cost and relatively simple to install, has changed this picture. Moisture barriers have an additional advantage over cement and lime treatment as they effectively stop the upward flow of capillary water from the groundwater sources by sealing off the underlying native subgrade soils from atmospheric contact. The native subgrade is then far less influenced by seasonal weather fluctuations ranging from arid to monsoon conditions, as soil volume change is controlled by limiting fluctuations in soil moisture content. The net effect of the moisture barrier layer is improvement of the stability of the native subgrade as well as the treated subgrade.

OTHER HIGHWAY PROJECTS CONSTRUCTED ON SUBGRADES STABILIZED WITH EMC SQUARED SYSTEM TREATMENTS

SSPCo's EMC SQUARED® System products are used in combination with natural earth materials such as aggregates and 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.

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