Soil Stabilization Methods: Chemical vs. Geogrid

Tensar®

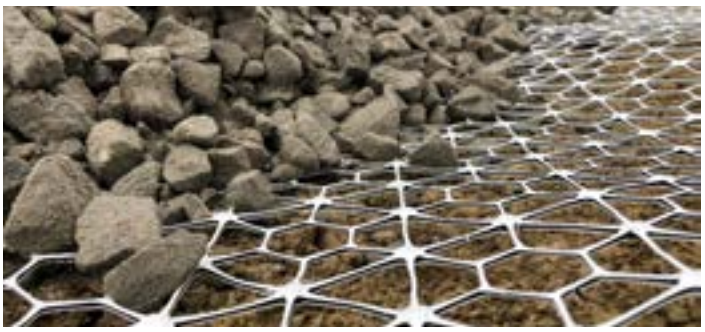
Comparing Soil Stabilization Methods

Soils with low shear strength, high compressibility, and shrink/swell behavior are common problems for roadway construction and for long term project performance. When choosing a soil stabilization method for solving these problems, upfront construction costs, time and feasibility of installation, and durability of the solution are key considerations to keep in mind. Chemical and geosynthetic soil stabilization are often used in these situations: **how do they match up in a head-to-head comparison?**

University of Kansas's geotechnical engineering professor, Dr. Jie Han, recently published an article in Geostrata magazine that summarized the benefits for using chemical stabilization and geosynthetic stabilization for in-situ soils and the practicality of implementing each method on a job site. Based on his comparison, geosynthetics seem to have an advantage in multiple situations, because they could speed up construction and reduce material costs. Geosynthetics as a category include many different products to enhance the engineering properties of soil, so seeking guidance for your specific stabilization needs is highly recommended. In this publication, we compiled available data to summarize the pros and cons of using chemical stabilization methods compared with Tensar geogrids, the most advanced geosynthetic for soil stabilization. Before we dive in, let's first define chemical and geogrid stabilization for those who are unfamiliar:

CHEMICAL STABILIZATION refers to the method by which cementitious materials such as lime, Portland cement, or fly ash are used to chemically alter the composition of the in-situ soil to improve its mechanical properties. When this process takes place, soil particles are bound together, which ultimately increases their shear strength and load distribution ability.

GEOGRID MECHANICAL STABILIZATION refers to the method by which multiaxial geogrids are used in conjunction with well-graded angular fill material to create a stable working surface over soft and unsuitable in-situ soils. A multiaxial geogrid used for stabilization has openings called apertures which allow the particles of the granular material to strike through and interlock. As particles interlock with the geogrid, they become laterally restrained and obtain a higher degree of confinement. The composite system created by combining compacted well-graded granular fill materials and multiaxial geogrid for stabilization is known as a Mechanically Stabilized Layer (MSL). The MSL is significantly stiffer than an unbound aggregate layer because soil particle movement under applied loads is restricted. This improvement in stiffness can be quantified with performance validation testing and later applied to the design. Roads, both paved and unpaved, are primary applications for stabilization geogrids.



Now that we have a clear definition of each method, let's see what happens when they go head-to-head during various phases of a project.

Soil Types

It's important to know the composition of the soil since that will determine the type of treatment that can be applied. Chemical stabilization can be used for most types of soils, except for organic or sulfate-rich soils. Of course, soils are often variable across your job sites, so the first challenge with chemical treatment is making sure you have a full understanding of what types of soils are present. Soils will require lab testing to determine compatibility prior to construction, and based on the results, the mix design for chemical stabilization would be developed.

Geogrid stabilization can be used over any type of in-situ subgrade soil and with any type of granular fill materials, with the exception of a few fill materials that are very rounded or that exceed a fines content of 10% by weight. The MSL design provides a stable working surface based on the strength of the subgrade, the strength of the granular material, and the expected trafficking loads that it will carry. Tensar geogrids are backed by decades of experience and extensive, full-scale performance testing, so determining the right solution is clear and straightforward.

Cost

The factors that determine the costs include:

- Unit costs of the materials used
- Quantities of the materials used
- Cost of QA & QC by an external laboratory to assess successful chemical stabilization
- Cost of the labor and equipment needed for installation

These factors are all site and product specific so it's difficult to make a generalized comparison regarding the two methods. Beyond upfront material expense, with chemical stabilization there is also potential uncertainty in the quantities of chemicals required. What would happen if the expected application rate of the chemical stabilization agent doesn't achieve the required results? There are also several installation costs mentioned in the next section to consider.

With geogrid stabilization, uncertainty related to soil chemistry is eliminated. Stabilization with Tensar geogrids uses established design methods and performance testing making quantities virtually certain, so you know up front what your total cost will be. Our higher-performing geogrids also allow you to use less aggregate to achieve the same results, translating to lower material costs and less dependence on raw material suppliers.

PRE-CONSTRUCTION

Getting the highest performing solution for the budget and minimizing risks are top priorities when choosing between these stabilization methods.

PROJECT
SPOTLIGHT

State Route 2

Lake County, Ohio

Cement stabilization was initially used on this project, however, heaving failure was observed immediately after paving in areas with high sulfate soils. Tensar geogrid was selected to stabilize these areas where cement stabilization had failed. It was also selected to stabilize ramps to avoid risking consequences of encountering more high sulfate soils.

Climate/Weather

Hours and days lost to bad weather are a serious concern. Certain weather conditions must be met for chemical stabilization since wet or cold weather can affect performance. A temperature of 40° F or higher is required for the chemical reactions to take place. Also, chemical treatments can't be applied during wet weather.

Installation of Tensar geogrid is not dependent on temperature and can be deployed even when a worksite is saturated. In fact, contractors often find that installing Tensar geogrids is one of the few tasks which can continue when the weather turns rainy.

Equipment, Installation and Site Access

Chemical stabilization requires specialized equipment to apply the chemicals to the soil and mix them to the desired depth. Once applied, time is required for the chemical reaction to take place, during which the area must be left undisturbed. Lime, for example, undergoes a mellowing period from one to seven days, then the soil is remixed, graded, and compacted in place. OSHA requires that workers take safety precautions when working with lime to avoid severe irritation of the skin, lungs, eyes and mouth. Chemicals can have a negative impact on the nearby environment so it's important to prevent migration from the treated areas into air or water.

Specialized equipment and labor are not required to install geogrid although workers should wear gloves and basic eye protection. The geogrid is rolled out directly onto the subgrade followed by placing granular fill and then compaction. The site is immediately accessible to construction traffic, so projects keep moving.

CONSTRUCTION

Construction delays and unexpected costs are problems on any project site. What are some of the considerations to keep in mind when choosing between chemical and geosynthetic stabilization?

CONSTRUCTION

PROJECT
SPOTLIGHT

Northpointe Subdivision

Plainfield, IL

A contractor encountered soft soils during excavation of a subdivision. Due to cold weather, the Village of Plainfield did not allow lime stabilization after October 15th. A solution using Tensar geogrid required no undercut to stabilize the subgrade and allowed construction of the pavement section to continue despite the cold weather.

PROJECT
SPOTLIGHT

Roadway Interchange

Oklahoma City, Oklahoma

After heavy rain, a project in Oklahoma City saw Tensar geogrid reduce overall construction time in addition to increasing pavement life. Switching to geogrid shaved off several days of construction time which would have been spent waiting for chemical stabilization treatment to cure. Instead, the contractor was able to place the aggregate and test for compaction in the same day, which meant less time waiting around to install asphalt, and less inconvenience for motorists. For a high-traffic intersection in Oklahoma's most populous city, this was precious time saved without compromising on design life.

Darlington Road three years post-construction

POST-CONSTRUCTION

Long-term Performance

Improved long-term performance for roads lowers life-cycle costs, and minimizes the frequency of closures for repairs. Proper design and construction are required to account for freeze-thaw cycles, moisture variations, and shrinkage cracking effects on long- term performance. Chemical stabilization deteriorates over time as precipitation and groundwater gradually leach the chemicals out of the soil. Some studies have shown that premature failures of chemically treated subgrades happened for one of two reasons: either the chemical additive lost its effectiveness over time, or it was ineffective for that specific soil.

Take for example the Darlington Road project in Cranberry Township, Pennsylvania. In 2018, a full depth reclamation of the road was done using cement stabilization. Just three years later, the road is already in desperate need of repair. The photo above was taken in 2021 and shows asphalt cracking, base failure and premature rutting.

Geogrid-stabilized soils are less susceptible to freeze-thaw damage, shrink/swell effects, and strength reduction due to excess moisture. Decades of in-ground full-scale performance testing, and extensive research from the US Army Corps of Engineers and other reputable universities and engineering institutions, have proven that Tensar geogrid significantly extends the life of paved and unpaved roads and reduces maintenance costs.

PROJECT
SPOTLIGHT

Lake Avenue

Buffalo, NY

The Erie County Department of Public Works (DPW) had to completely reconstruct nearly 2 miles of Lake Avenue located just outside Buffalo. This road, originally constructed in the 1970s, had poor subbase materials and subgrade drainage that led to degraded asphalt. Erie County has very thick standard pavement sections and they wanted to avoid deep undercuts for this project. A Tensar geogrid design was proposed to address the issues of soft subgrades and optimize the pavement design. The base layer of geogrid was used to stabilize these very soft soils and helped the county avoid expensive and time-consuming excavation and removal costs. The upper layer of geogrid helped reduce the overall pavement section thickness and provided an extended life expectancy of the road. Costs were reduced by approximately $1 million compared to traditional construction methods. The Erie County DPW won the 2015 Transportation Project of the Year award given by the American Public Works Association.

COSTS REDUCED APPROX. $1 MILLION

As of February of 2022, the asphalt still looks like new after nearly six years of extremely harsh winters and it hasn't been resurfaced once. The Lake Avenue project in Orchard Park, New York is a great example of both the cost savings and resiliency pavement designers can expect with geogrid stabilization.

Lake Ave. before construction in 2015

Lake Ave. seven years post-construction

RESEARCH
SPOTLIGHT

Ingios Geotechnics completed testing of three pavement sections along Cabeza Road in 2014 and then again in 2015. Two Tensar geogrid stabilized sections and a control section were tested. The subgrade for all sections consisted of a cement treated subgrade (6% nominal by dry weight).

Immediately after construction, no additional benefit was observed in the TriAx stabilized sections. However, in 2015, after a year of weather cycles (i.e. rain, temperature changes), the sections were again tested and the TriAx stabilized sections were providing 2-5 times the support compared to the control section.

In 2018, the University of Texas at Austin conducted a pavement condition survey, which indicated that the TriAx stabilized sections had reduced environmental cracking in the road surface compared to the chemically stabilized control section.

A SUMMARY OF THE PROS AND CONS

The benefits of choosing Tensar geogrid over chemical methods for soil stabilization have been well demonstrated for all phases of construction. This chart gives a convenient side-by-side comparison of the pros and cons we've just discussed.

	CHEMICAL STABILIZATION	TENSAR GEOGRID
Mechanisms	Alter chemical compositions and soil structures to improve soil properties	Restricts particle movement to improve soil mechanical properties and behavior
Soil Types	Applicable to most types of soils, except for organic soils and sulfate-rich soils	Applicable to all soil types
Benefits	Increase bearing capacity and stiffness, reduce rutting, mitigate moisture-related distresses, and prolong road life	Increase bearing capacity and stiffness, reduce rutting and cracking, mitigate moisture-related distresses, and prolong road life
Design	Soil tested in a lab for compatibility. Mix design required based on testing and validation for given soil types and applications	Backed by decades of extensive, full-scale testing and third-party validation to design geogrid mechanical stabilization. Site-specific validation is not required
Equipment Required	Specialized equipment needed to place and mix chemicals	Standard equipment
Construction Process	Blend chemicals with in-place or with fill soils, grading, compaction, and mellowing	Roll geogrid out directly on native subgrade. Place and compact granular fill.
Climate/Site Concerns	Temperature must exceed 40-50 F and no rain. High water table in silts and very fine subgrades may cause compaction operations to pump water to the surface. Environmental safeguards limit applicability.	No restriction
Post-Construction Traffic	Must wait 3 - 7 days before the site can be accessed, to allow curing to occur.	Site can be accessed immediately
Cause for Road Distress	May induce shrinkage cracks and cause reflective cracks in asphalt pavements	None
Durability	Proper design and construction required to mitigate or consider freeze-thaw, wet-dry cycle, and shrinkage cracking effects on long- term performance	Unaffected by freeze-thaw, geogrid and granular fill are not soluble and offer a permanent and resilient solution. No negative effect on permeability of granular base.
Tolerable to Differential Movement	No	Yes
Recycling	Difficult to recycle treated granular base material	Relatively easy to recycle granular base material, but not geosynthetic
Environmental	Possible leaching	No environmental concern
Safety	Safety protection required during construction	Gloves and eye protection recommended
Cost	Site- and product-specific	Site- and product-specific

Tensar+

AVOID UNNECESSARY EXPENSE AND UNCERTAIN DESIGN LIFE WITH TENSAR+ SOFTWARE

Using Tensar geogrid for soil stabilization offers clear advantages for total installed cost savings, ease and speed of installation and long-term performance. Tensar's investment in research has not only led to InterAx geogrid, the most advanced geogrid for soil stabilization, but also to the development of our award-winning Tensar+ design software. Tensar+ allows engineers, contractors, and owners to design with geogrid in a variety of applications, including pavements, crane pads, soft soil stabilization, unpaved roads and marine scour protection. You can calculate the total value of each design alternative, including chemical stabilization and other conventional methods. We've incorporated the benefits of Tensar geogrids into accepted design methods, based on rigorous full-scale testing and validated by third-party experts.

Click here to access Tensar+ software and start designing and building with more confidence.

WITH TENSAR+, YOU CAN:

- ☑ Evaluate and optimize performance of roadways and other site works over a variety of subgrade conditions
- ☑ Easily compare design alternatives, including geogrids and conventional construction
- ☑ Determine initial and life cycle cost savings, time savings, and sustainability metrics
- ☑ Generate custom specifications and reports for your design
- ☑ Access product data, research reports and training resources
- ☑ Connect through any major mobile platform or browser and work online or offline with a single workspace
- ☑ Print high quality visuals of your design and expected savings to share with colleagues or clients
- ☑ Share your design with colleagues directly from the software platform for improved collaboration

Have a question about a specific project? Schedule a virtual or in-person session and we can walk you through design scenarios.

Visit TensarCorp.com/support to get started.

About Tensar

With Tensar, you can design and build with confidence because we empower you to achieve cost-effective, engineered solutions. Our industry-leading geogrid technology and other innovative products solves the toughest soil stabilization, earth reinforcement, and site development challenges. Through these innovations, you can create a more resilient future because our technology is backed by decades of research and proven performance.

From project start to project completion, we're not afraid to get our boots dirty. No matter where you are, you can depend on the international Tensar team and network of distribution partners to provide support and advice. Whether you're building roadways, retaining walls, railways, or foundations, we are the partner you can depend on.