Research Summary

Evaluation of using geogrids for
Permanent Pavement underlain by soft subgrades
Higley Road between Elliot and Higley Trail Crossing
Gilbert, Arizona

Application:

Reducing Risk with
Enhanced Pavement Design using
Tensar TriAx Geogrid

Type:

Field Pavement Structural
Performance Study

Geogrid Products Tested:

- Tensar TX8

Section Profile:

- 5 inches Asphalt Concrete
  10 inches Aggregate Base
  Tensar TX8
- Clayey Subgrade
  Assumed Mr of 12,000 psi
- 95% Relative Compaction

Background:

The Town of Gilbert is in the Phoenix metropolitan area. Geologically this area is known to be underlain by clayey material with medium to high plasticity that is highly moisture sensitive. The construction consisted of removal of the existing pavement section and construction of a new section. Figure 1 presents the planned pavement section.

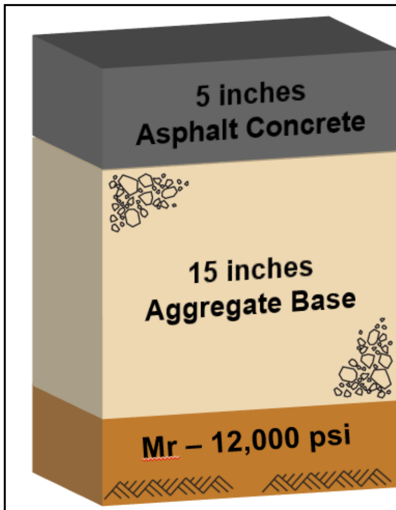


Figure 1

The Tensar design optimized the amount of subgrade export and import of aggregate base by reducing the aggregate base section to 10 inches with the use of TriAx TX8 Geogrid. Additionally, the geogrid was utilized to reduce the potential for problematic soils to delay construction. To provide the Town of Gilbert with additional data from the construction, Tensar agreed to contract with Ingios® to perform a series of Automated Plate Load Test's (APLT) at the project site. APLT is a testing system that was developed to perform fully automated static and repetitive/cyclic plate load tests, per AASHTO and ASTM test methods to measure the performance of the aggregate base.

Construction:

As part of the evaluation process a Tensar representatives performed Dynamic Cone Penetrometer (DCP) Testing of the subgrade at the site as well obtained samples of the subgrade for laboratory testing. The tests indicated the subgrade at the site was highly variable. Table 1 presents a summary of the test results.

Table 1 - Summary of Measured Subgrade Strengths

Type of Test	Depth	Resulting Mr
DCP[1,2]	0-12 inches	1,300 psi
	12-24 inches	2,000 psi
	24-36 inches	5,400 psi
CBR[2]	Grab Sample 0-36 inches	5,550 psi
R-Value[3]	Grab Sample 0-36 inches	6,200 psi

1.DCP-US Army Corp Correlation
2. Mr=1,500 X CBR
3. R-Value correlation based on ADOT

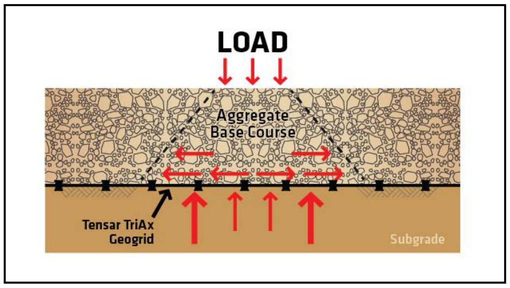
As shown in Table 1, the in-situ subgrade strengths were identified to be less than what was originally assumed to be on site from laboratory testing. Additionally, the subgrade strength was less than what was developed from the Arizona Department of Transportation (ADOT) Table 2-3 Correlation Chart. This is most likely the result of adjacent surface irrigation water and rains during construction saturating the subgrade. From a constructability perspective this required a modification to the placement of aggregate base. The modification consisted of placing a thickened base section on the geogrid and then cutting the aggregate base to grade for the planned final thickness of 10 inches. This method reduces the potential for additional stresses on the subgrade that cause the subgrade to pump.

Purpose/Objective:

At the request of the Town of Gilbert, Ingios Geotechnics performed Automated Plate Load Test's (APLT) at the subject site. The purpose of the testing was to help validate the Tensar pavement section design as well as provide the City insight into providing pavement section designs on upcoming pavement projects.

Benefits of the TriAx Mechanically Stabilized Layer (MSL)

Incorporating TriAx into the pavement section, below the aggregate base materials, is an effective method of creating a stiffer and more uniform pavement foundation that will maintain its integrity. This composite section of TriAx and aggregate base creates a mechanically stabilized layer (MSL). The TriAx enhancement results in less deformation during construction, and more importantly, through the pavement's life. This is accomplished by TriAx interlocking with and confining the aggregate base. The confinement reduces the potential for contamination of the aggregate base with the subgrade soil. The MSL provides a resilient layer that minimizes the potential for differential movements of the pavement surface that initiate structural distress.



Field Verification

TIC contracted with Ingios Geotechnics to conduct Automated Plate Load Tests to measure the performance of the flexible pavement foundation with TriAx geogrid.

Test Procedure:

Ingios® performed a series of Automated Plate Load Test's (APLTs) at the project site. APLT is a system developed to perform fully automated static and repetitive/cyclic plate load tests, per AASHTO and ASTM test methods. For performance validation the resilient modulus of the composite foundation section, aggregate base and subgrade was measured.

Results / Key Findings:

Figure 2 shows the results of the Stress Dependent Resilient Modulus APLT measurements. Each point on the graph represents 100 cycles at the given stress along the "X" axis. The graph demonstrates the stress dependency of the Mr as well the nominal deformation of a TriAx enhanced section. Also note the increase in the measured subgrade Mr. This is the result of less stress on the subgrade from the addition of the TriAx.

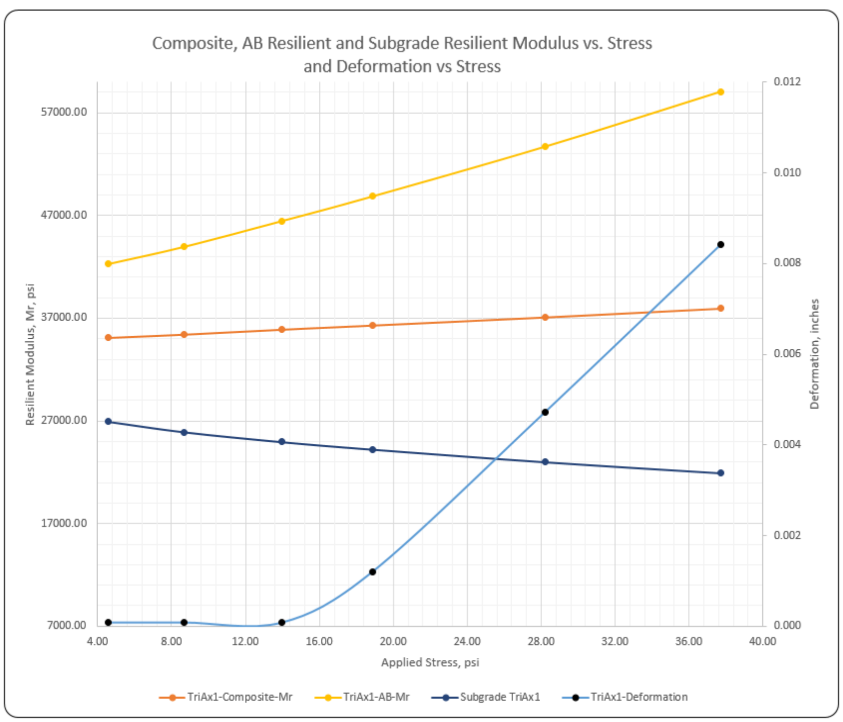


Figure 2

The other type of APLT performed at the site was a long-term test to measure the anticipated performance of the aggregate base section over 20 plus years. This test consists of cycling the plate for at least 5,000 cycles at a constant stress. Typically, the stress applied is equivalent to the stress that the pavement section will experience at the top of the aggregate base below the asphalt concrete. For this project a 5,000 cycles test was performed at a stress of about 13 pounds per square inch(psi). The results indicated that it would take about 40,000,000 million cycles until ½-inch of deflection is experienced. This is considered failure. Additionally, the Mr of the aggregate base is measured throughout. Using the results from this test the layer coefficient for the 10 inches of aggregate base underlain by TriAx geogrid would be about 0.29 using AASHTO 93 methods. Table 2 compares the planned pavement sections and the constructed section based on actual field data.

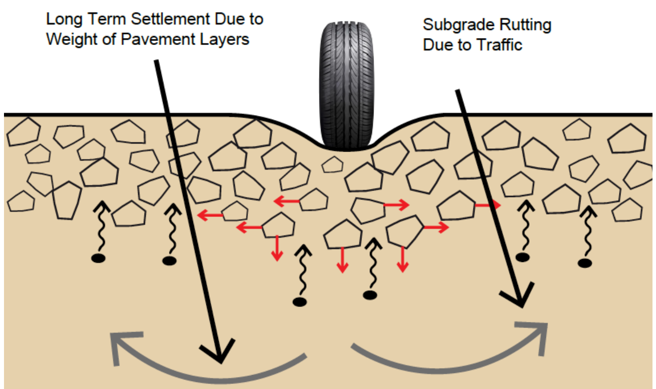
Table 2

	Planned Un-stabilized	**Planned Stabilized**	**Tensar Stabilized**	**Actual Un-stabilized**	**Actual Stabilized**	**Tensar Stabilized**
AC(inches)	5 inches					
AB(inches)	15	15	10	15	15	10
AB Layer Coefficient	0.120	0.128[1]	0.194[1]	0.120	0.128[1]	0.290[2]
Geogrid	-	Type 1	Tensar TX8		Type 1	Tensar TX8
Subgrade Mr (psi)	12,299			6,000		
Expected ESAL	5,372,000	6,022,000	6,641,000	1,016,000	1,219,000	5,478,000

1. Determined From SpectraPave® Analysis
2. Back calculated from measured from APLT testing

Why is the resilient modulus (Mr) of the TriAx section improved?

The first benefit is the improved Mr of the aggregate base. This is the result of the TriAx interlocking with and confining the aggregate base. The confinement results in increased vertical stiffness of the aggregate base. The second benefit is the reduced potential for Mr degradation over multiple cycles. Typically, the Mr of an aggregate base will degrade over multiple cycles as the aggregate particles migrate downward into the subgrade. The unique shape and configuration of TriAx geogrid allow for excellent interlock and confinement.



Conclusions

The testing here demonstrates that using TriAx Geogrid reduces the potential for structural failure. Benefits of including TriAx within the planned pavement section include:

- Reducing deformation
- Creating more uniform support characteristics
- Improving aggregate base performance through confinement and less potential for subgrade soil contamination.
- Reduced risk in differing site conditions

This project proved to be challenging due to rain, difficult site conditions and schedule. By using the Tensar design the project was able to be completed without significant changes to the initial design. This is a benefit of Tensar design solutions and geogrid being part of the planned design.

The results of the testing are consistent with the findings of the Accelerated Pavement Testing and of over 150 APLT's performed on sections enhanced with TriAx geogrid. Results can vary depending on the quality of the aggregate, type of geogrid and subgrade strength.

References:

1. *"In Situ Performance Verification of Geogrid-Stabilized Aggregate Layer Using Automated Plate Load Testing, ST176 S. Higley Road, Town of Gilbert, Arizona",* prepared by David J. White, Ph.D., P. E. dated November 7, 2018.
2. *"Arizona Department of Transportation (ADOT) Pavement Design Manual",* dated September 29, 2017.
3. *"Geotechnical Engineering Report, Higley Road Improvements, Elliot Road to the North Side of Higley Trail Crossing, Gilbert Arizona, RAAM Project No. ST176",* dated December 6, 2017