Research Summary

Evaluation of Enhancing Rigid Pavement Foundations with TriAX Geogrids
Weld County Road 47, Greeley, Colorado

Application:

Rigid Pavements

Type:

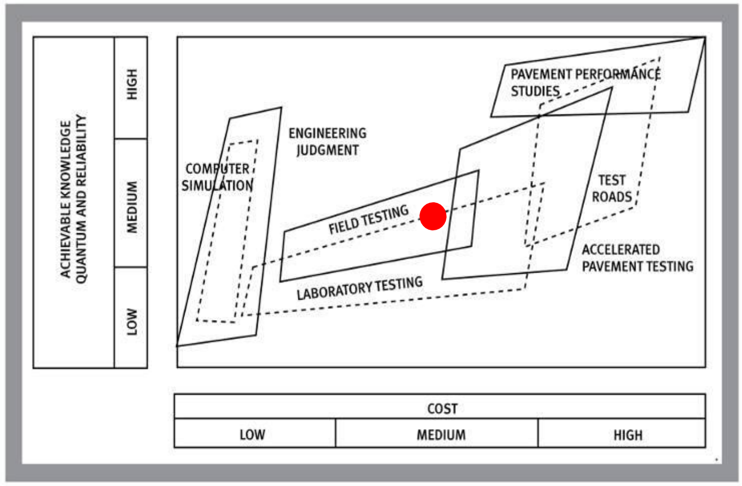
Field Structural Performance Study

Geogrid Products Tested:

- Caltrans TriAx Geogrid Non-standard special provision (NSSP) Type 1

Section Profiles:

- 0.35 feet thick Aggregate Base placed on TriAx (NSSP) Type 1
- 0.70 feet thick Aggregate Base
- Subgrade support consisted of Caltrans Type II Soils

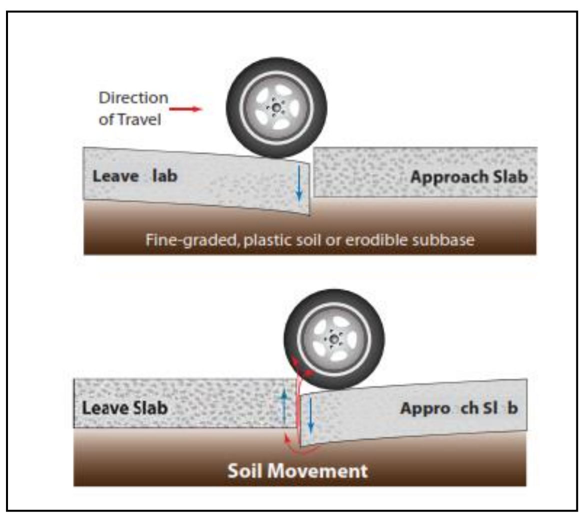


Background:

A concrete pavement structure distributes load stresses through multiple layers. The concrete layer provides most of the support for the traffic loading and the concrete's strength minimizes the stresses on the foundation structure below the rigid wearing surface. However, the performance is dependent on the foundation structure below the rigid pavement to provide:

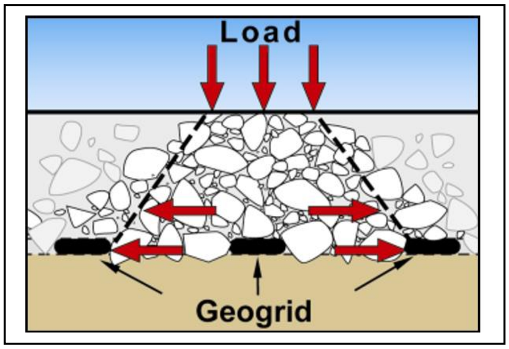
- Uniform support
- Additional load distribution; and
- Drainage

Most performance problems with concrete pavement are a result of poorly performing joints (ACPA, 2001). Poor load transfer creates high slab stresses, which contribute heavily to distresses such as faulting, pumping and corner breaks.



"Load transfer" is a term used to describe the transfer (or distribution) load across discontinuities such as joints or cracks (AASHTO, 1993). When a wheel load is applied at a joint or crack, both the loaded slab and adjacent unloaded slab deflect. The amount the unloaded slab deflects is directly related to joint performance. If a joint is performing perfectly, both the loaded and unloaded slabs deflect equally.

Benefits of the Geogrid Mechanically Stabilized Layer (MSL)



Incorporating geogrids into the roadway section is an effective method of creating a stiffer and more uniform foundation that will maintain integrity over time improving the Load Transfer. The geogrid enhancement results in less deformation during construction, and during the pavement's life. This is accomplished by the geogrid interlocking with, and confining the aggregate base. The confinement reduces the potential for contamination of the aggregate base with the subgrade soil. The geogrid and aggregate base together create a mechanically stabilized layer (MSL). The MSL provides a resilient layer that minimizes the potential for differential movements of the concrete surface that initiate faulting and corner breaks.

Field Test

The test was located along Weld County Road 47 in the Greeley, Colorado. A contractor constructed the test section within the limits of an intersection improvement project. The diagrams below present the test sections:

TriAX Test Section

0.35 Feet Caltrans Class 3 AB	
Tensar TriAX geogrid	TriAX
Caltrans Type II Soil E= 7,883 pounds per square inch[1]	

Control Test Section

0.70 Feet Caltrans Class 3 AB	
Caltrans Type II Soil E= 10,680 pounds per square inch[1]	

1. Average Elastic Modulus Determined using Dynamic Cone Penetrometer Results, Powell et al. (1986)

Purpose/Objective:

The purpose of the testing is to demonstrate that an MSL below a rigid pavement will deform less than a thicker aggregate base section creating more uniform support. Reduced deformation or equal deformation across loaded and unloaded slabs creates better load transfer and decreases the potential for distress.

Test Procedure:

Ingios® performed a series of Automated Plate Load Test's (APLTs) at the subject site. APLT is a system developed to perform fully automated static and repetitive/cyclic plate load tests, per AASHTO and ASTM test methods. For evaluating permanent and recoverable deformations tests were performed immediately adjacent to each other along the test sections to measure performance. The plate was 30 inches in diameter and a stress of approximately 14 pounds per square inch(psi) was applied. Dynamic Cone Penetrometer tests were also performed along the alignment to measure the in-situ support characteristics of the subgrade. Additionally, 12-inch diameter APLT's were performed to measure the stress dependent resilient modulus values on each section.

Results / Key Findings:

Table 1 presents the data collected from multiple APLT's at the site.

Table 1

	Units	Tensar TriAx Section						
Station		**T6**	**T5**	**T4**	**T3**	**T2**	**T1**	
Permanent Deformation [1,2]	inches	0.015	0.005	0.029	0.016	0.017	0.019	
Average Permanent Deformation	inches	0.017						
Deformation Standard Deviation		0.007						
Aggregate Base Thickness	feet	0.35						
Average Elastic Modulus of Subgrade[3]	psi	7883						
Average Stress Dependent Resilient Modulus of the Subgrade[4]	psi	11245						
Average Resilient Modulus of Aggregate Base	psi	41605						
	Units	Control Section						
Station		**CP7**	**CP6**	**CP5**	**CP4**	**CP3**	**CP2**	**CP1**
Permanent Deformation [1,2]	inches	0.029	0.042	0.043	0.042	0.031	0.013	0.021
Average Permanent Deformation	inches	0.032						
Deformation Standard Deviation		0.0108						
Aggregate Base Thickness	feet	0.70						
Average Elastic Modulus of Subgrade[3]	psi	10680						
Average Stress Dependent Resilient Modulus of the Subgrade[4]	psi	12435						
Average Resilient Modulus of Aggregate Base	psi	28108						

1. Permanent Deformation measured minus the initial plastic deformation after the first cycle
2. Permanent Deformation measured after 500 cycles
3. Determined using DCP, Powell et al.(1986)
4. Stress dependent resilient modulus measured at 14 psi using APLT

The testing compared 8 inches of aggregate base on subgrade to 4 inches of aggregate base underlain by TriAX geogrid. The subgrade material below each section consisted of A-7-6/CH clay soil but the control section was 35% stiffer (10,680 psi for the control section and 7,883 psi for the geogrid section), based on DCP testing as well as APLT measurements. Table 2 summarizes key findings from the test results.

Table 2

	Control	TriAX	Key Finding
Permanent Deformation	0.032 inches	0.017 inches	47% less deformation with TriAX
Improved Subgrade Mr[1]	16%	42%	Less stress being placed on the subgrade results in higher resilient moduli values
Improved AB Mr	28,108 psi	41,606 psi	48% Improvement in AB Stiffness

As compared to the Elastic Modulus determined from insitu DCP test

Conclusions:

The California Department of Transportation (Caltrans) considers the planned aggregate base below the rigid section as a working platform and not a structural component. When the underlying subgrade consists of R-Values < 40, the aggregate base section is recommended to provide:

- Uniform support
- Additional load distribution; and
- Drainage

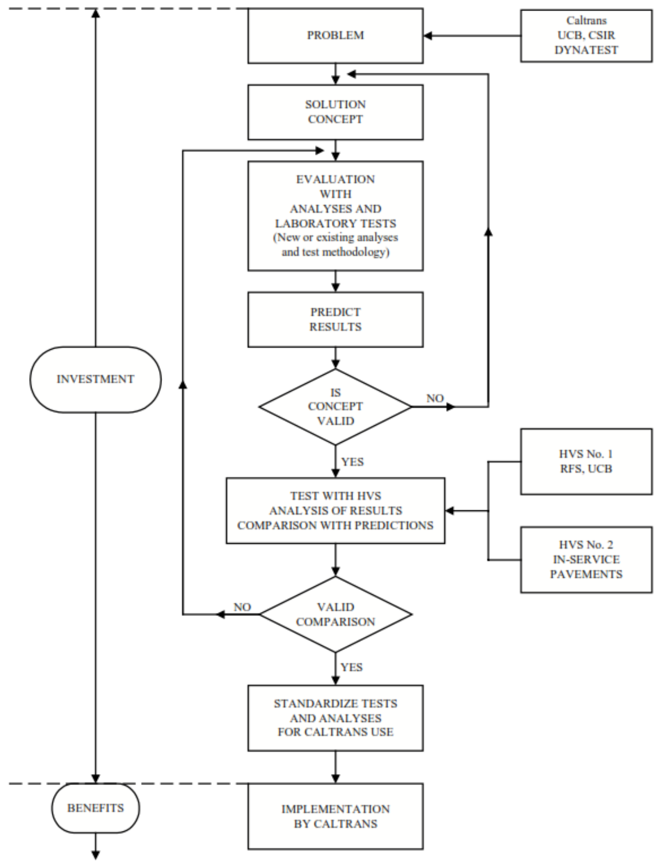
Rigid pavement distress typically occurs when the foundation supporting the concrete loses strength and deforms. This is referred to as erosion. This is more critical in rigid pavements where faulting of 0.15 inches can be the threshold at the end of a design life. The testing here demonstrates that using a TriAx geogrid MSL with 4 inches of aggregate base compared to a non-stabilized 8-inch aggregate base layer within a pavements foundation:

- Reduces deformation as compared to thicker aggregate base sections
- Provides more uniform support characteristics improving rigid pavement performance
- Distributes the stresses placed on the subgrade, relying less on subgrade performance. This distribution of stresses creates an increase in the resilient modulus measurement of the subgrade.
- Improves the performance of the aggregate base through confinement and less subgrade soil contamination. This will maintain drainage properties of the aggregate base over time.

The results of the testing are consistent with the findings of the Accelerated Pavement Testing and over 100 APLT's performed on sections enhanced with TriAX geogrid. However, results can vary depending on the quality of the aggregate, type of geogrid and subgrade strength.

In accordance with the CAL/APT Program validation process, Figure 1,, Tensar's enhanced pavements have been compared to traditional control sections to quantify the benefit of the geogrids through:

- Calibration: Full-Scale Accelerated Pavement Testing(APT) in accordance with NCHRP standards and at a listed NCHRP APT Facility
- Validation: Local California Research
- Verification: Independent 3rd Party Review



References:

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