Research Summary

Topic: Evaluation of using TriAx geogrids for below Rigid Pavements
Caltrans Contract No.: 07-252624
Location: Interstate 5, Santa Clarita, California

Application:

Rigid Pavements

Type:

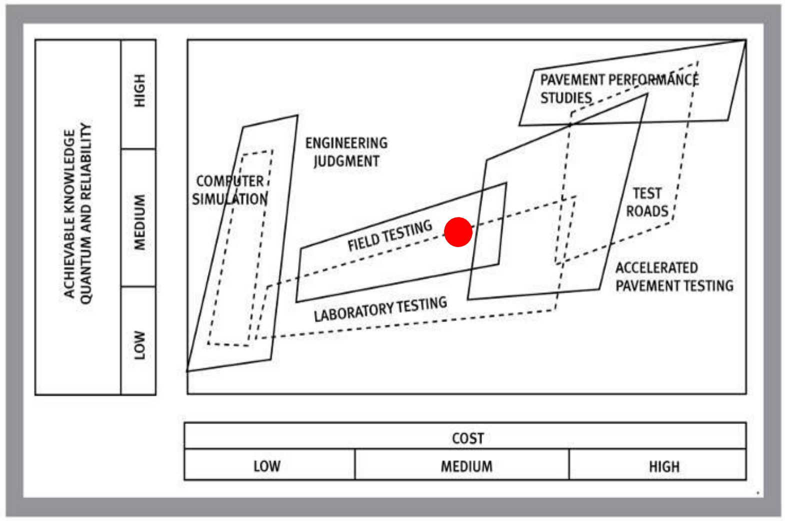
Field Structural Performance Study

Geogrid Products Tested:

- Tensar TriAx TX130s Geogrid Caltrans Non-Standard Special Provision (NSSP)

Section Profiles:

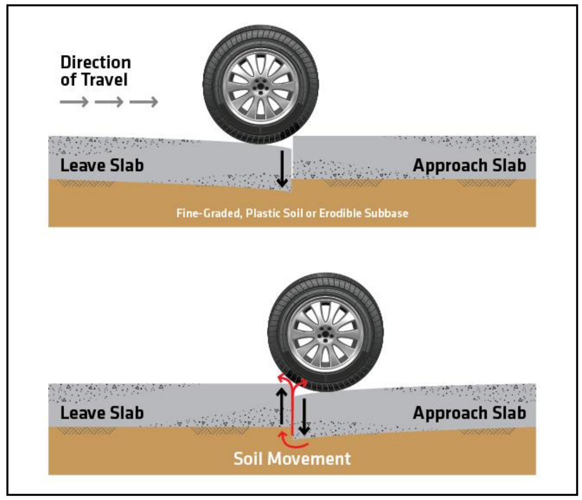
- Enhanced Section: 4 – 5 inches (0.35 feet) thick Class 3 AB stabilized with TriAx Geogrid
- Control Section: 8 – 9 inches (0.70 feet) Class 3 AB
- Control Section: 10 – 10½ inches (0.85 feet) Class 3 AB
- All sections constructed over a subgrade with Type II Soils (Subgrade R-Value between 10 and 40)



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:

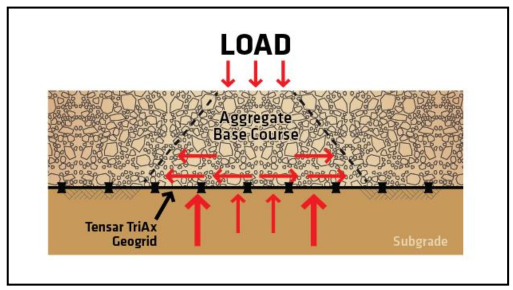
- Uniform support
- Additional load distribution; and
- Drainage



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.

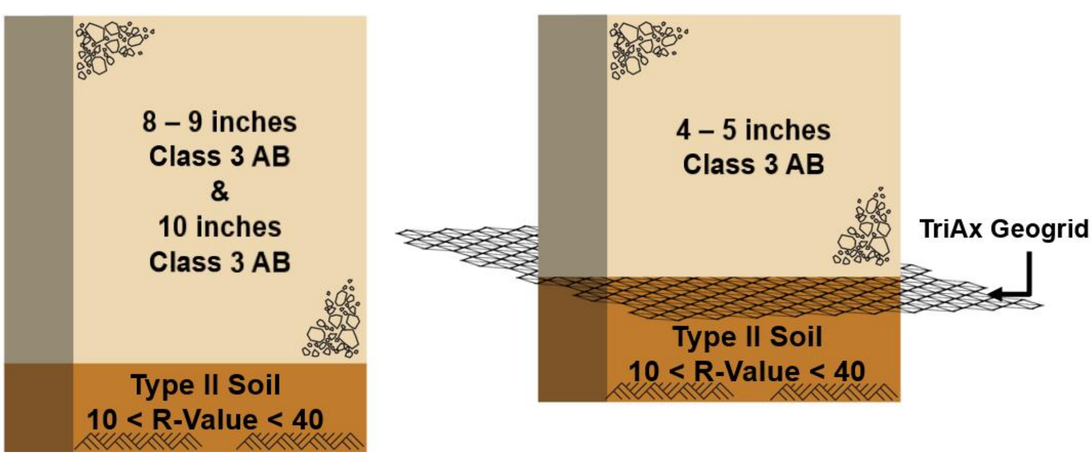
Benefits of the Geogrid Mechanically Stabilized Layer (MSL)



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 Interstate 5 in Santa Clarita, California. A contractor constructed the test section within the limits of project area. The diagrams below present the three test sections:



Purpose/Objective:

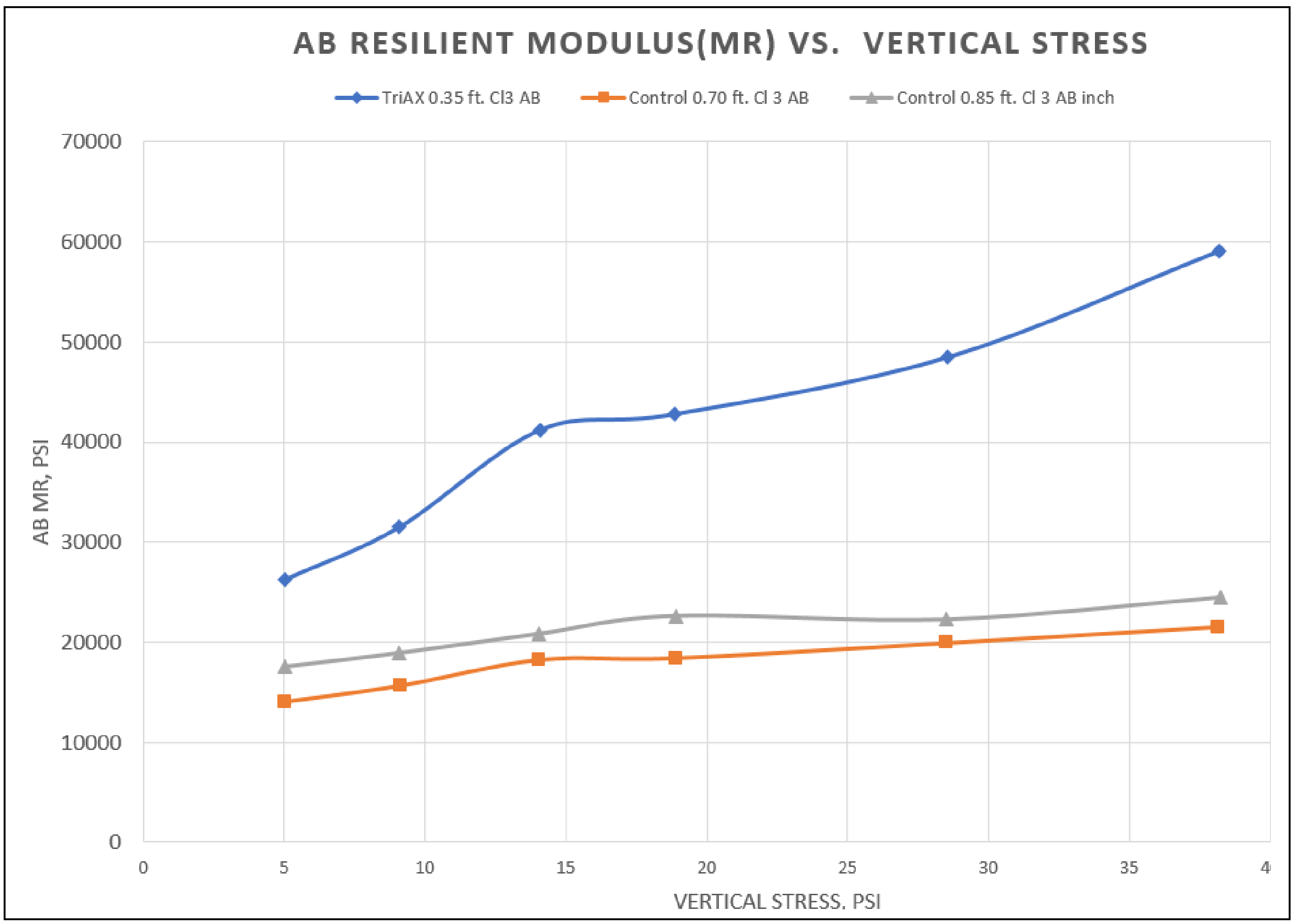
The purpose of the testing was to demonstrate that an MSL below a rigid pavement will reduce deformation better than a thicker aggregate base section creating more uniform support. Additionally, the MSL will create a more resilient foundation section and not lose strength over time.

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. To evaluate the stress dependent resilient modulus a 12-inch diameter plate was cycled 100 times at stress increments between about 5 pounds per square inch and 40 pounds per square inch. Additionally, 10,000 cycle tests with a 12-inch diameter plate on the 8-inch control section and the enhanced TriAx section at a stress of about 15 pounds per square inch.

Results / Key Findings:

The chart below shows the resilient modulus of the aggregate base versus the applied stress using the 12-inch diameter plate. The results demonstrate how the resilient modulus of the 0.35 feet Class 3 AB section underlain by TriAx geogrid is more resilient as the stress and loading increments increase as compared to the control sections with 0.70 feet Class 3 AB and 0.85 feet Class 3 AB.



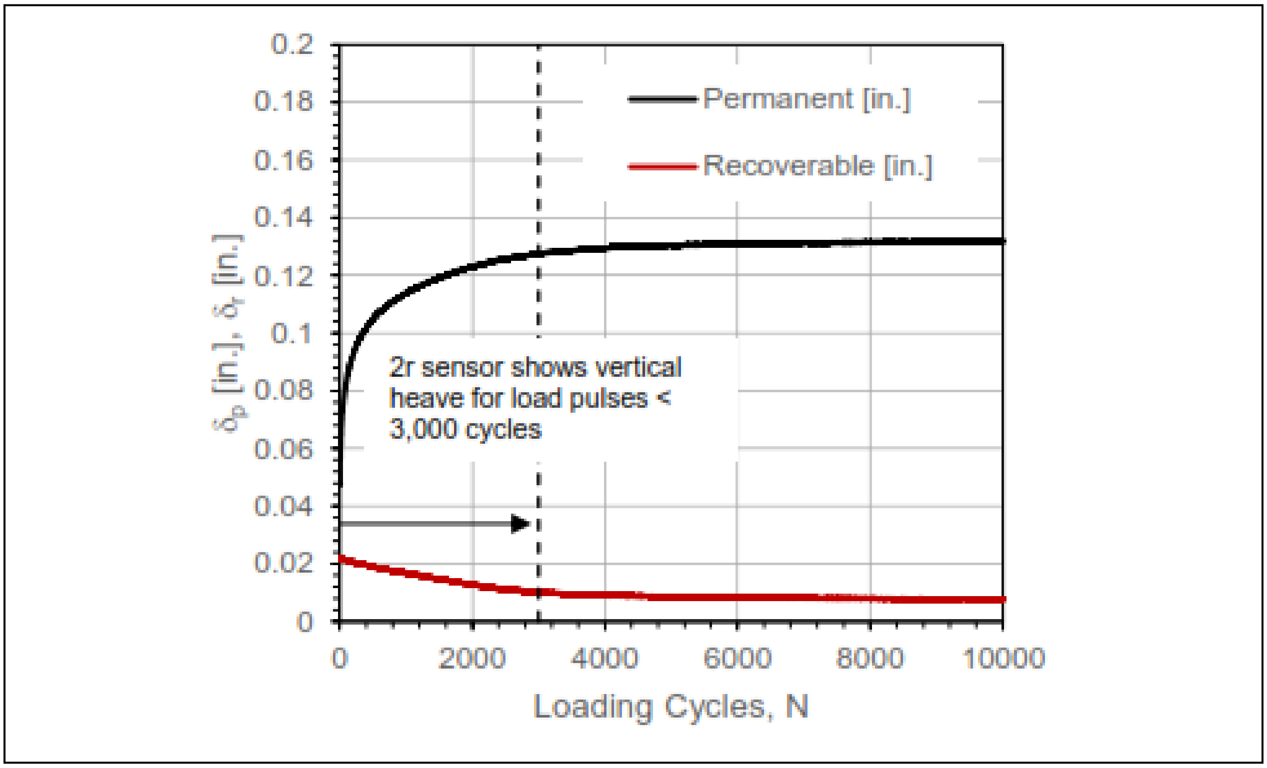
Note: Average aggregate base resilient modulus

<u>Why is this concept significant to the rigid pavement design?</u>

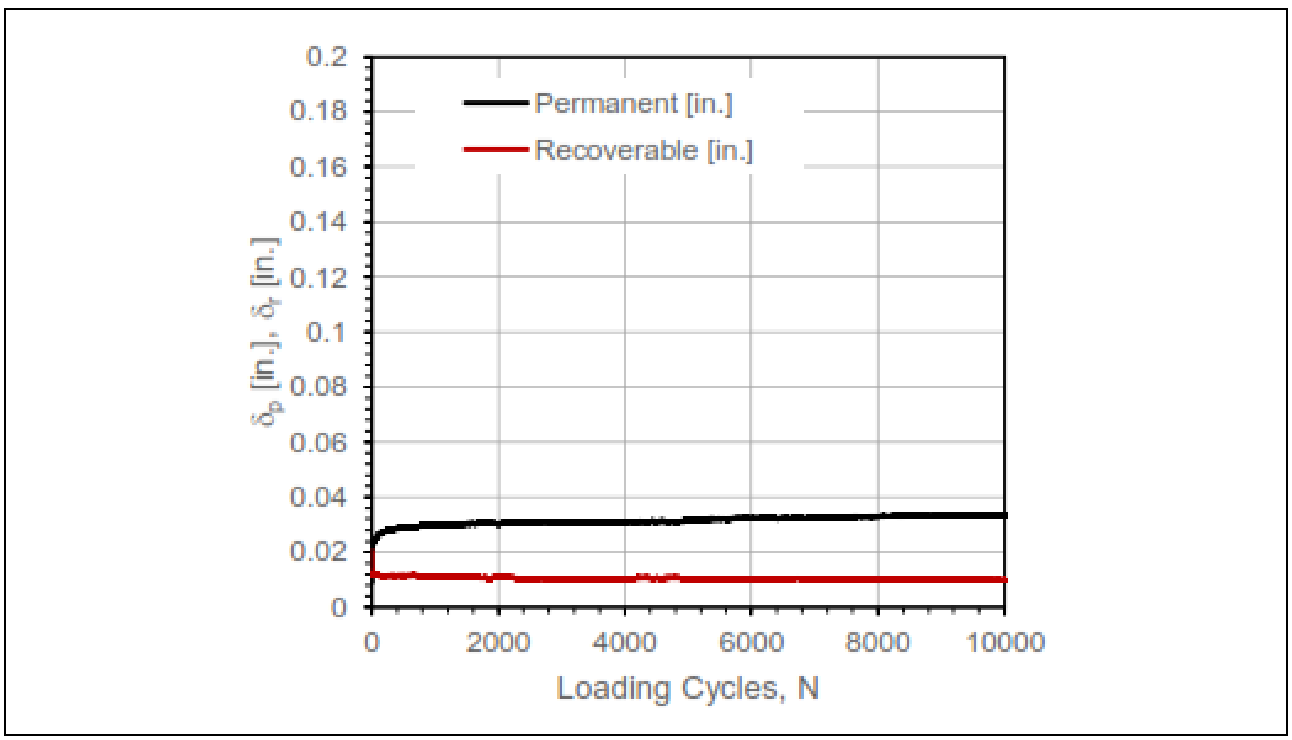
The aggregate base within a rigid pavement section is a construction platform. The purpose of the construction platform is to provide an acceptable working surface for placement of the wearing surfaces consisting of asphalt concrete or Portland cement concrete above the aggregate base. During construction the aggregate base layer will be trafficked by typical construction equipment. Without geogrid the aggregate base layer will become intermixed with the underlying subgrade. This intermixing results in non-uniform support characteristics and additional maintenance during construction to maintain a surface that can be paved on. Additionally, the aggregate base will sometimes move and rut under the traffic loading. The intermixing is demonstrated with the results of the stress dependent resilient modulus testing with the APLT shown above. As the stress is increased there is only a slight increase in the resilient modulus test of the aggregate base. By placing a geogrid on the subgrade an MSL is created. The MSL acts as a composite system where the aggregate base is confined and the unable to become intermixed with the subgrade material or move. This is demonstrated with the results of the stress dependent resilient modulus testing with the APLT shown above. As the stress is increased the resilient modulus of the aggregate base increases. This occurs because the aggregate base is prevented from intermixing with the subgrade material and the aggregate base is confined.

Another test performed at the site to demonstrate the benefit of the MSL was a 10,000 cycle plate load test with an applied pressure of about 15 pounds per square inch on a 12-inch diameter plate. The purpose of this tests is another measurement of the performance of the MSL with multiple cycles of loading, like traffic. The applied load is more than double what the aggregate will experience during the life of the pavement. The critical measurement parameter with this test is the deformation of each system. The charts below show the results.

Control Section with 8.25 inches of Class 3 AB



Ennhanced TriAx Section with 4.5 inches of Class 3 AB



The plots above show the permanent and recoverable deformation measured. The control section showed about 3 times more permanent deformation than the TriAX section over the 10,000 cycles.

Why is the deformation significant?

With less deformation a more uniform surface is created. This uniform surface creates a non-yielding surface for paving and ultimately provides a better foundation for the rigid pavement. Additionally, 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 the design life. This test shows the reduced potential for deformation with an MSL.

Conclusions

The testing here demonstrates that 0.35 feet Class 3 AB placed on TriAx Geogrid provides superior performance compared to the control sections of 0.70 feet Class 3 AB and 0.85 feet of Class 3 AB within a pavements foundation by:

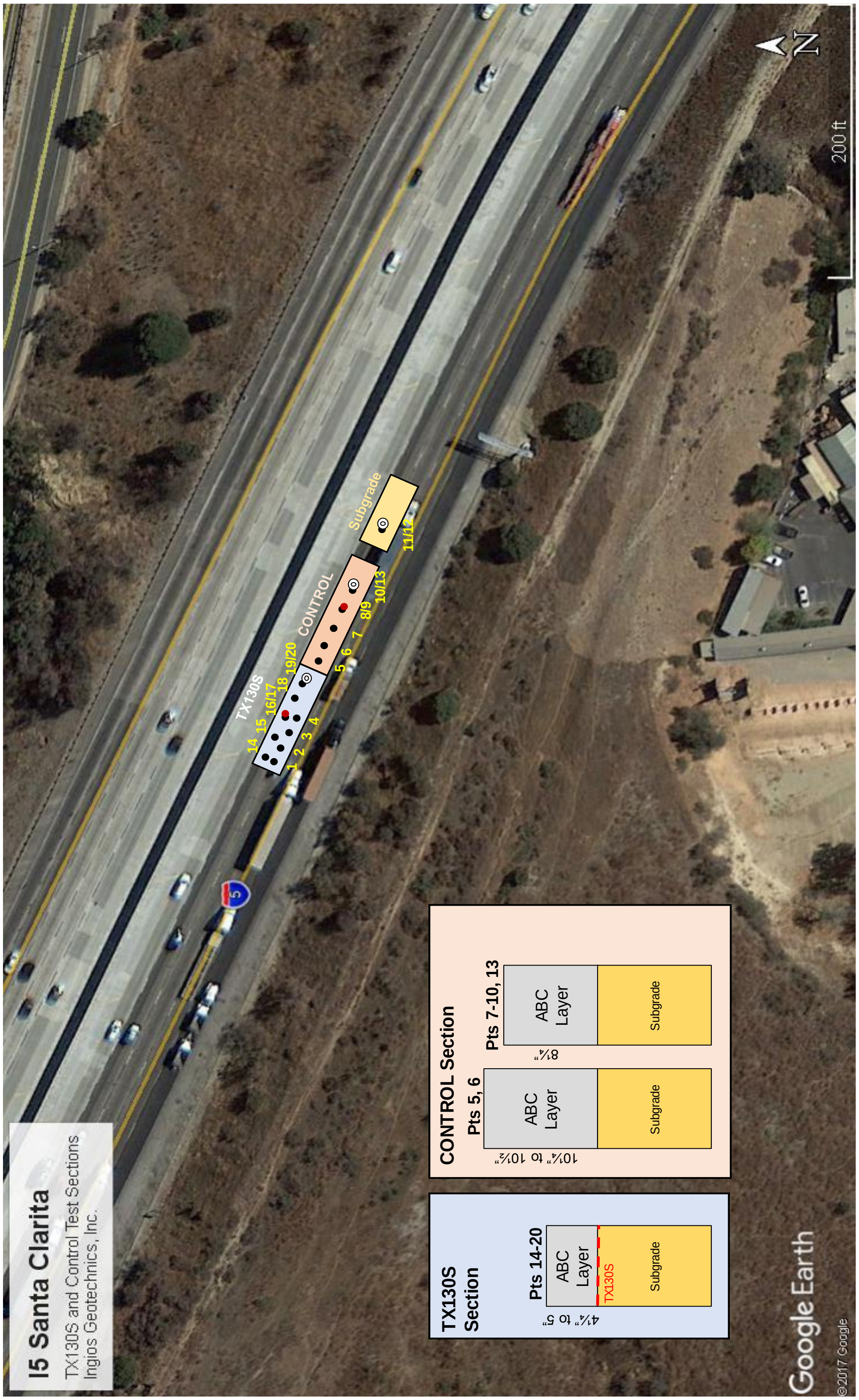
- Reducing deformation as compared to thicker aggregate base sections
- Providing more uniform support characteristics improving rigid pavement performance
- Improving the performance of the aggregate base through confinement and less subgrade soil contamination. This will maintain drainage properties of the aggregate base over time.

The results of the testing are consistent with the findings of the Accelerated Pavement Testing and over 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, Interstate 5 Test Sections, Santa Clarita, California" prepared by David J. White, Ph.D., P. E. dated January 12, 2018.*
2. *AASHTO, MEPDG, 2015*
3. *Concrete Pavement Joints, Technical Advisory T 5040.30. Federal Highway Administration. Washington, D.C. http://www.fhwa.dot.gov/legsregs/directives/techadvs/t504030.htm.*
4. *Concrete Pavement Design Details & Construction Practices. Course No. 131060. CD-ROM course companion including technical digest, instructor's guide, participant's workbook and visual aids. Federal Highway Administration. Washington, D.C.*
5. *Concrete Types. Web page on the American Concrete Pavement Association's web site. http://www.pavement.com/PavTech/Tech/Fundamentals/fundtypes.html. Accessed 18 January 2002.*
6. *Load Transfer Design on the Pavement Interactive web site.* http://www.pavementinteractive.org/article/joint-design/
7. *"State of California, Department of Transportation, Concrete Pavement Guide" prepared by Division of Maintenance Pavement Program, 5900 Folsom Boulevard, MS-5, Sacramento, California 95819, dated January 2015.*
8. *"Full-Scale Evaluation of Geogrid Reinforced Thin Flexible Pavements"* prepared by U.S Army Engineer Research and Development Center, dated August 2, 2011.
9. *"Performance of Geogrid-Stabilized Flexible Pavements"* prepared by U.S Army Engineer Research and Development Center, dated July 2014.
10. *"Full-scale accelerated testing of multi-axial geogrid stabilized flexible pavements," Geotechnical and structures laboratory, Engineering research and development center, June 2017,report can be obtained at https://erdc-library.erdc.dren.mil/xmlui/handle/11681/22653*

Project Location and Test Locations



Test Locations	
Project Name:	I-5, Santa Clarita, CA
Project ID:	TIC-00031
Location:	Santa Clarita, CA

Site Conditions and Pictures

Pictures	
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