# Evaluation of mechanical behavior of a reinforced soil with geosynthetics through scale tests

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ABSTRACT
In this study, the behavior of two biaxial geogrids and a reinforcing geotextile located at different depths in a subbase layer of a pavement, composed of light tezontle, is evaluated through a standard static load test.
The load tests were carried out inside a test box of dimensions 2.0 x 2.0 x 1.50m. The sensors used for the study included linear transducers of variable displacement, pressure and load cells, and strain gauges attached to the geosynthetics.
Additionally, numerical modeling with finite elements was carried out using PLAXIS 3D Software in order to compare the results with those obtained experimentally and to identify their prediction capacity.

## 1. INTRODUCTION AND OBJECTIVES

### 1.1 Introduction

The use of geosynthetics in different countries of the world has increased due to the need, which is becoming increasingly critical in different fields of engineering, to seek an economic balance and reduce the environmental impact with products or systems that promote protection of the environment.
Although there is unquestionable evidence of the advantages of using geosynthetic reinforcements, the specific conditions or mechanisms that govern the reinforcement of pavements are, at least, unclear and have remained practically without quantification. Under this concept, geosynthetics have been a successful solution on many occasions, but there have been cases in which their application has not been satisfactory, they can even be considered as failures to put it in the clearest way. However, it was not due to the bad behavior of the materials, nor to a bad installation, these failures can be attributed to an inadequate planning of the correct use of geosynthetics, as well as to the quality of the product. For this reason, one must act with great criteria and solid bases for the correct functionality of geosynthetics.

### 3.0 1.2 Objectives

- Evaluate in an experimental way and numerically model the mechanical behavior of a soil reinforced with geosynthetics by means of scale tests.
- Evaluate the benefit of using biaxial geogrids and geotextiles as reinforcement of the granular layers of a pavement through laboratory scale tests.
- Perform numerical modeling using the finite element method using PLAXIS 3D software to calibrate the behavior models used to predict the performance of reinforcing elements in granular layers.

## 2. DEVELOPMENT

### 2.1 Scope and limitations

The scope of this study will include the descriptive study whose purpose will be to describe the behavior of a material reinforced with geosynthetics by means of scale tests in the laboratory.
Scale laboratory tests will be carried out to measure the efficiency of two types of biaxial geogrid and a geotextile as a reinforcing element in granular layers.
The results of these tests will be analyzed and interpreted and a finite element model will be fed with them in order to determine how accurate they are in predicting the behavior of reinforced granular layers.

### 2.2 Justification

This investigation will allow to study in detail and understand the response of a granular soil instrumented and reinforced with biaxial geogrids and woven and non-woven geotextiles subjected to loads similar to those experienced by a pavement base layer

### 2.3 Materials

*Granular subbase layer*

A granular basalt-type material will be used that meets the mechanical and physical requirements defined by the Secretariat of Communications and Transportation of the Mexican Republic for sub-base layers in asphalt pavements.

*Subgrade*

A support soil will be used for the base layer that meets the mechanical and physical requirements defined by the Secretariat of Communications and Transportation of the Mexican Republic for subgrade layers in asphalt pavements. The detail of the layer thickness is shown in Figures 1-3.

*Geosynthetics*

Four types of geosynthetics will be used, a woven geotextile, a non-woven geotextile and two types of biaxial geogrids. As the Table 1 indicates.

Table 1. Physical-mechanical properties of geogrids

| Geosynthetic | Type | T, kN/m | Opening size, mm |
|---|---|---|---|
| **Biaxial Geogrid** | P-BX11 | 12.40 | (27/37) |
| **Biaxial Geogrid** | P-BX12 | 19.20 | (28/38) |
| **Woven geotextile** | TR2400 | 72.00 | - |
| **No-woven geotextile** | NT5600P | 1.58 | - |

*Intrumentation*

Next, the instruments that will be used during the development of the scale tests are described, the location of which is illustrated in Figure 1-3.

- Load cell: to measure and control load application.
- Displacement sensors type LVDT: to measure the displacement on the surface of the granular layer (base).
- Pressure cells: two plate-type pressure cells will be used to measure the forces transmitted to the interior of the base layer.
- Deformation Sensors: to measure the axial deformations of the geogrids. Due to the symmetry of the experiment, they will only be installed in one of the axes of the geogrid.

*Test configuration*

Four scale tests will be conducted as shown below:

- Case 1: granular base material (30cm thickness) on a subgrade + non-woven geotextile
- Case 2: case 1 + type 1 geogrid
- Case 3: case 1 + type 2 geogrid
- Case 4: same thickness of case 1 + TR woven geotextile (without non-woven geotextile)

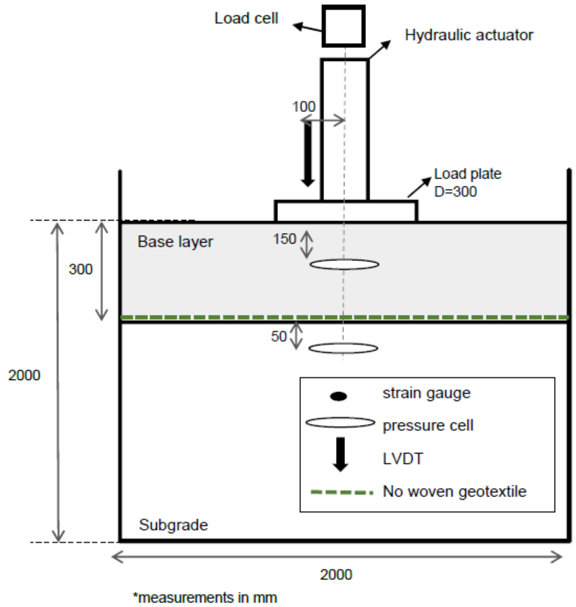


Figure 1. Test configuration, Case 1: base layer over a subgrade + no woven geotextile

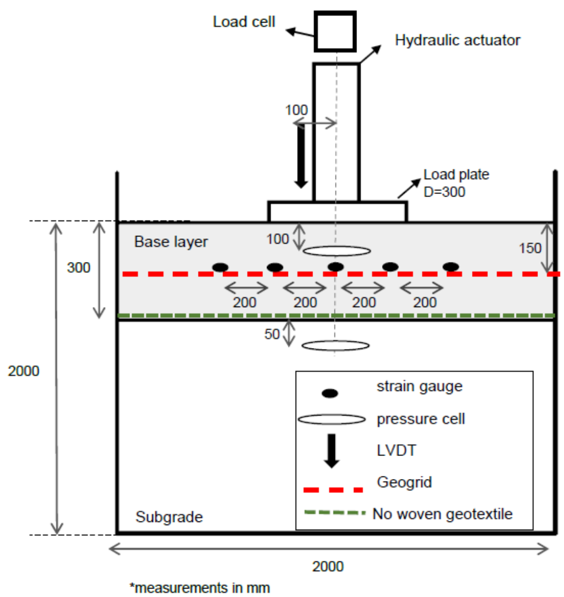


Figure 2. Test configuration, Case 2 and Case 3: case 1 configuration + geogrid 1 and geogrid 2

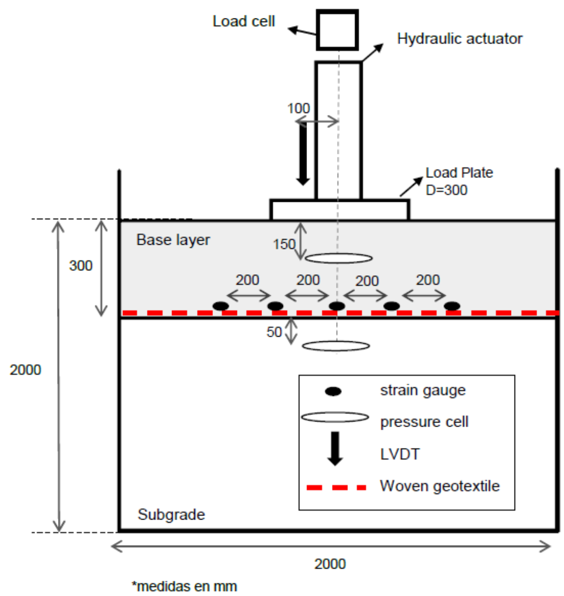


Figure 3. Test configuration, Case 3: case 1 configuration + woven geotextile

According to ASTM D1194: Plate Load Test, a static load will be applied to the ground in equal and cumulative increments. Starting at 5kPa, with 50 kPa increments, every 10 minutes until a fault is observed in the system (approximately 600kPa).

## 3. WORK PROGRESS

Currently, the research is in the initial stage, where the subbase and subgrade materials were qualitatively qualified by soil mechanics tests. The sensors to be used in the scale laboratory tests were also chosen, according to the required characteristics.