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EFFECT OF REINFORCING SUBGRADE SOIL BY GEOGRID

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Abstract. *Because of the number of vehicles increasingly important and weight, problems may occur on the road. The good soil bearing support is essential for the successful completion of pavements. The application of geogrid in a flat road shape, can effectively improve the behavior of deformation roadways. A geogrid provide a simple, reliable and cost for carriers soil reinforcement to have a stable foundation on which to build a causeway. The main role of geogrid is strengthening, but other functions can be there as associated drainage and waterproofing. Technical and economic interest of the use of geogrid in these applications is well established. This work deals with the numerical simulation using PLAXIS software for improving the soil bearing support of a floor resting on a platform of low bearing. The stress analysis on soil-structure interface allows analyzing the effect of reinforcing in improving the lift. The study also shows the effect the anchorage length of the geogrid on strengthening the platform.*

1 INTRODUCTION

The considerable need for the use of geosynthetics in civil engineering and geotechnical engineering field has spawned several design methodologies and countless studies on the impact of geosynthetics on the constructions. The geogrids have high tensile modulus (20 kN / m and 1000 kN / m), and have low creep. For special applications, we can achieve tensile strengths of more than 1000kN / m.

In addition, reinforced soils are often treated as composite materials in with reinforcement resisting tensile stresses and interacting with soil through friction.

Geosynthetics are now widely used for strengthening and mechanical improvement of pavement layers from the sub- base up to the asphalt wearing course, explained through three main mechanisms:

- Containment mechanism (self-locking) side of the base layer;
- Failure surface modified by shearing mechanism;
- Tensioned membrane mechanism.

The geosynthetic membrane causes the effect and the increase of the foundation module resulting from the lateral confinement which gives a high resistance to rutting [1].

Reinforcement with geogrid improves the subgrade such that when the normal pavement structure of sub-base and base course are placed, the entire structure will have a very high structural number or strength. The findings are consistent with the study made by Barksdale et al. (1989) when they compared the performance of geogrids with different strength properties. This generally informs us that geogrid reinforcement would be very helpful in dealing with relatively poor lateritic subgrade materials by improving the strength. [2]

Burd and Houlsby (1986) developed a large strain finite element model that was used to analyze experimental results from reinforced unpaved road test sections but could be extended to include material elements representing an asphalt layer. The large strain formulation was included to account for the large rut depths that can develop in unpaved roads. Interface elements were not included in the model, which implies perfect fixity between the soil layers and the geosynthetic.

The model was used to predict the response of a footing resting on a base layer with a geosynthetic placed between the base and the underlying subgrade. The model predictions were compared to experimental results and a reasonable correspondence was achieved. The experimental results showed a slight improvement in the load-displacement curve for the reinforced footing for footing penetrations less than 4mm, the improvement exhibited by the reinforced base became significant for both the model and the experimental results; the model over predicted the experimental results at larger displacements, [3].

The stiffness of the geosynthetic is proportional to the shear stress at the interface, by the effect of lateral containment provided by the geosynthetic. Under static loading and using a geosynthetic excessively rigid, a little advantage can be gained for small deflections while high shear stresses are developed at the soil / base interface [4]. The friction behavior of geosynthetic / soil interface follows an elastoplastic Mohr-Coulomb model. Increasing Stiffness of geosynthetics in paved roads structures reduces vertical deflection and shear stresses in the foundation [5].
The deflection depends inversely on the stiffness of the geosynthetic. Similarly, the plastic deflections remaining after removal of the load are smaller when the stiffer geosynthetic will produce a smaller deflection [6]. Additionally, the elastic analysis could not capture the plastic displacements remaining after the load was removed. For these reasons an elastoplastic analysis should be conducted.
The results of the purely elastic analyses were found not to accurately represent the behaviour of the road. This conclusion was drawn from the result that the elastic solutions predicted a tensile stress at the bottom of the base layer of a purely granular material crushed limestone that cannot withstand stress. For these reasons an elastoplastic analysis should be conducted [7].

2 FINITE ELEMENT ANALYSIS

Our problem can be posed as determining the pressure-displacement behaviour of a pavement composed of a bilayer consisting of a base layer in serious selected based on a low-resistance soil with or without reinforcement geogrid interposed between the soil and the base layer. The study will also address the strains and stresses in the soil and the tension force in the geogrid.
The pavement is loaded with a wheel with equal static weight to 65 KN (corresponding to a half axle 130 KN) and the contact pressure generally accepted in Algerian recommendations is 660 kPa, the value of the side (a) contact surface which we deduce is 31.8 cm, which corresponds to a contact pressure Pc such that:

$$Pc = \frac{P}{a^2} = \frac{65}{0.318^2} = 642.8Kpa$$

Using the longitudinal symmetry, we consider a half side B:

$$B = ½.\ a = 15.9 \text{ cm}$$

The boundary conditions for this model are the standard blocking in computer code Plaxis of external borders, and the displacement imposed a -0,127m value in both ends in the direction of it under the loaded structure of dimension B = 0,159m (Figure 1).
A planar analysis was performed using the Mohr-Coulomb model. The geometrical and mechanical characteristics of the model are depicted in Table 1.

Parameter	**Symbole**	**Subgrade**	**base layer**	**units**
Model material	-	Mohr-Coulomb	Mohr-Coulomb	-
Type of material	-	Not draind	Not draind	-
saturated unit weight	γsat	19,000	22,00	kN/m3
specific gravity unsaturated	γunsat	17,000	18,000	kN/m3
Elasticity module	E'ref	10	50	Mpa
Poisson coefficient	ν '	0.33	0.25	-
density Module	K'	9.804	33.33	MPa
Cohesion	Cu	30	0	kPa
friction angle	φu	0	40°	o
Dilatancy angle	Ψ	0	20°	o
Depth	D	2.544≈2.55	0.212≈0.20	m
width	W	3.18≈3.20	3.18≈3.20	m

Table 1: Data model and material properties

3 Properties of reinforcement (geogrid)

Geogrid used in this study is the Tensar BX1200 of rigidities with the following:

- EMD A= 481kN/m ; longitudinally.
- EXMD A =25,9kN/m ; crosswise.

From where:

- E average A=[EMD A + EXMD A]/2= 253,45 kN/m = EA.

In most analysis the geosynthetic reinforcement membrane is considered as an isotropic elastic material. Interface elements were used at the interface of the geogrid; this will allow the relative deformation between the geogrid and pavement layers.

4 MODEL GEOMETRY

Figure 1 shows the geometry model

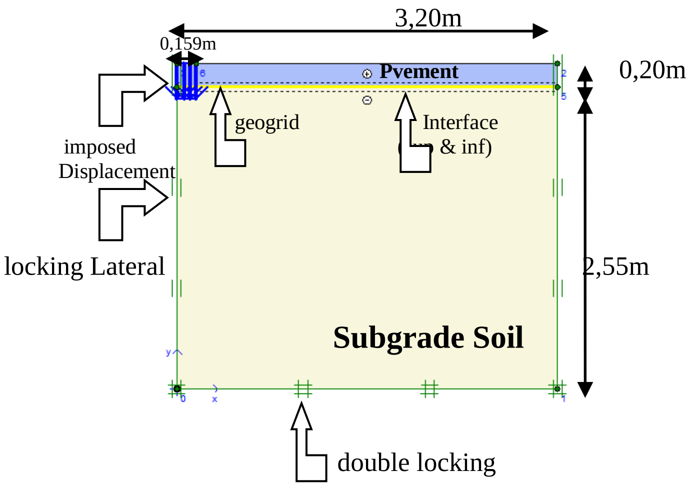

Figure.1 Problem Geometry for Reinforced Soil

For better finesse local and more triangular elements, we choose 15 noded triangular elements, and we adopt local mesh refinement with a coefficient of 0.1 at the base soil-layer interface and along the axis of symmetry. Therefore, a 1671 mesh elements was adopted.[2]

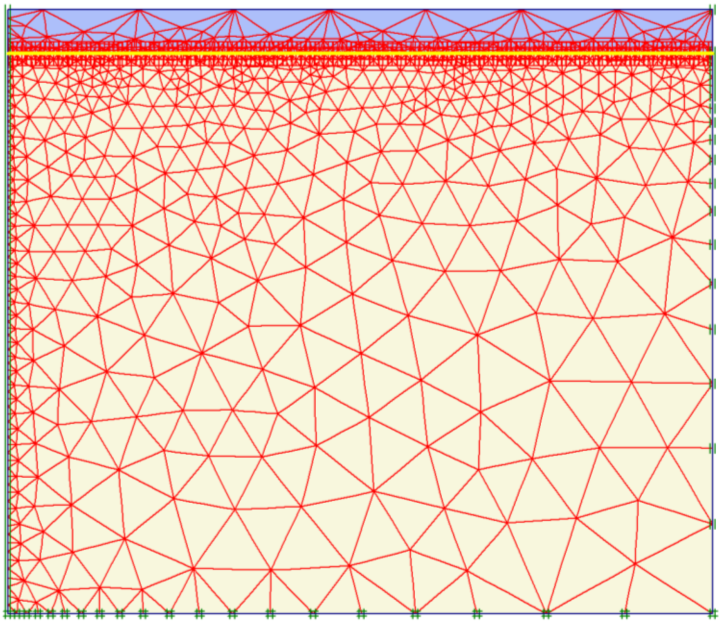

Figure.2 coarse mesh Finesse refined locally with a coefficient 0.1

5 RESULTS AND DISCUSSION

The results of modelling presented in the following figures

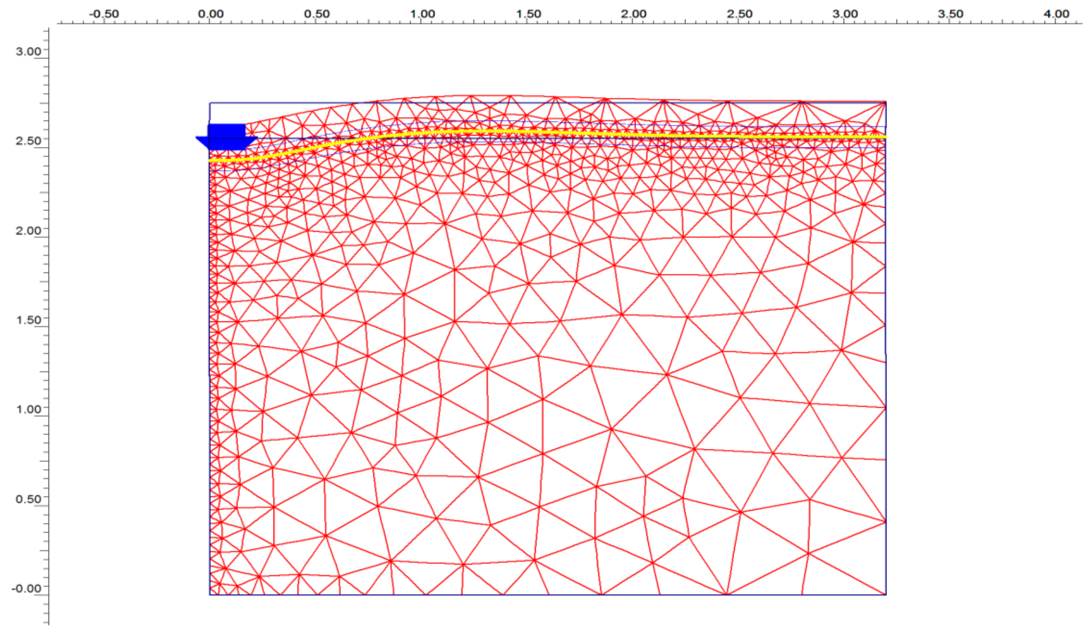

Figure.3 deformed Mesh

The shear stresses on the interface reinforced and non-reinforced soil, shown in Figure 4, are low under the soil. The maximum stress for the road platform reinforced τxy= = 78.32 kPa centrifugal shear is reached at a distance x = 0.38m of the axis of the load and that for the non-reinforced platform τxy= = 15,61kPa is reached at the same distance. Geogrid increases the maximum shear stress of 20%.

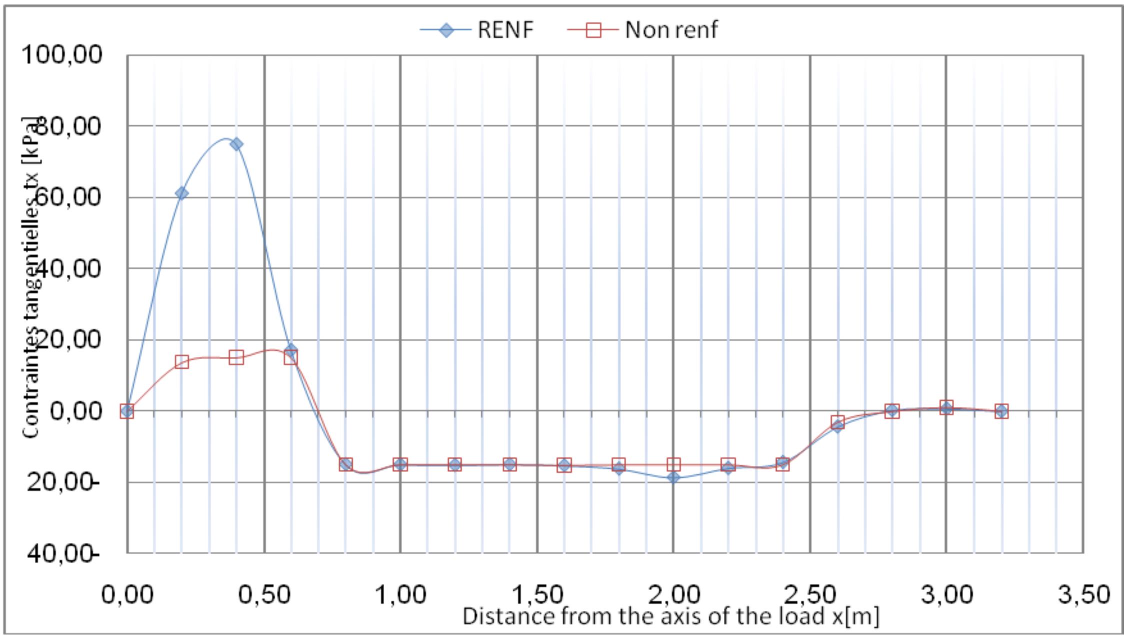

Figure 4 tangential stresses at the interface

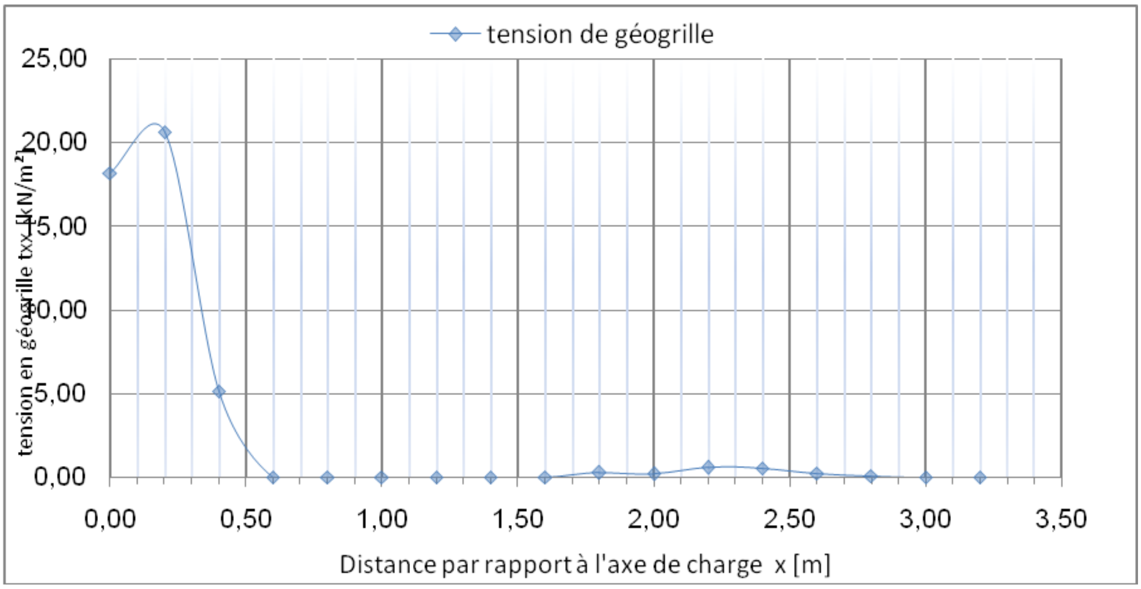

Figure 5 Tension in the geogrid

Figure 5 shows the distribution of tension in the geogrid in the entire length anchoring. The tension is maximum for a distance equal to 0.158m that is to say towards the edge of the carriageway. This maximum tension is 21,93kN / m².

It is noted from both figures a correspondence between the tangential stress at the interface and tension in the geogrid, which reflects that the shear stresses at the interface are transferred to the geogrid as a tension, and the tensioned membrane mechanism, is produced.

CONCLUSIONS

Because of their contribution in reinforcing, the geogrids provide very effective solutions. Generally, a soil is reinforced for two main reasons, or to limit its deformations fixed loading; either to increase the capacity of soil to support high deformations.

Geosynthetic reinforcement techniques allowed meeting the requirements and desired goals by offering alternative solutions with many benefits. Indeed, they are simple to implement, the structures are flexible in their operation and contribute to the preservation of the natural resource. The reinforcing elements or inclusions can work in tension, compression or flexure - shear.

The results showed the effect of geogrid in the pavement system of two layers. To improve the rigidity of the pavement by improving the bearing capacity of the subgrade, we include the geogrid as tension reinforcement. The tensile stress acting in the pavement is thus transferred to the geogrid as tensile strength.

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