International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

Analysis of Reinforced Road Embankment with applied load using PLAXIS 2D

Siddharth Tiwari[1] and Prof. Mohit Verma[1]
[1]Department of Civil Engineering, Jabalpur Engineering College, Jabalpur (M.P.)

ABSTRACT- Geotextiles are increasingly being used as a stabilizer on road sides in soft soils. The objective of this study was to determine the total geotextile capacity as road edge reinforcement considering the safety and permissive aspects of migration. Road edge hardness analysis was performed using PLAXIS 2D in a limited manner. Simple modeling was performed in this study. When constructing roads in soft soils, a certain amount of foundation is required to prevent unnecessary splitting of the road structure. Even with insufficient capacity with subsoil, stability is required. Geotextiles are increasingly being used as reinforcement for road walls in soft surfaces. It analyzes effective stress, total stress, total displacement and total strain. Suitable construction practices and sophisticated methods of design should be adopted on such soils. Considering the site conditions and poor soil properties, we suggested a composite that would help provide the necessary design strength for the road pavement construction required for this project. The solution included proper drainage with a high-strength geogrid, which provided improved ground conditions and uniform stress transfer to the sub-soil. The product and solution were carefully selected to alleviate the current problem of the coastal road.

KEYWORDS - Geotextile; Road embankment; Draw strength; PLAXIS 2D.

1 INTRODUCTION

Three types of sequence modeling were conducted in this study. Firstly, the stability of the road embankment without any reinforcement was analyzed. The second modeling was to determine the length of the geotextile reinforcement considering the stability of the model road embankment. The final sequence was to investigate the stability of the model reinforced embankment with different tensile strength of geotextile reinforcement. The result of this study showed that the optimum tensile strength of the geotextile was significantly influenced by the factor of safety. In this study, 4 m embankments with a slope of 2H:1V were investigated. The water level was at 0.00 level. A nominal overload of 6.13kN/m' has been used for modeling the traffic load. A layer of PET woven geotextile is placed between the base of the embankment and the sand mat. The tensile strength of geotextile reinforcement varies from 100 to 1000 kN/m. In recent years, due to the increase in the amount of road traffic in Indonesia, many roads have been constructed on soft soil. In this case, geotechnical engineers are faced with a common problem such as large settlements and slope instability. Several studies have shown the use of geosynthetics as wall reinforcement in soft soils. Geotextiles are increasingly being used as reinforcement on road sides in soft soils. Geotextiles are synthetic textile materials used to improve soil characteristics. The functions of geotextiles when applied to the ground are to separate, filter, stabilize, conserve and drain water. Typically geotextiles are made from polymers such as polyester or polypropylene.

Various types of geotextiles are used in road reinforcement systems which include woven and non woven. Woven geotextiles are made of interlocking fabric strands that reinforce and reinforce the project where geotextiles are needed. Woven geotextiles are made from polypropylene fibers that can withstand a large amount of thickness and are suitable for separation and reinforcement purposes. Non woven geotextiles are made from continuous filament yarns or short fibers. The fibers are usually fused together using hot, chemical or mechanical techniques, or a combination of the two or all methods. The primary function of non woven geotextile is for separation, protection and filtering purposes for road, railway, landfill, or community and environmental projects.

The reinforced geotextile design should have suitable protection and migration characteristics. Some research has been done on the use of geotextile reinforcement in soft soils. Qasim et al. Determine the safe height of a wall built on a soft surface using various geotextile gaps such as soil reinforcement. Siavoshnia et al. Investigates the effect of the number of geotextile layers, geotextile durability, and active geotextile length. Vashi et al. Learned about horizontal and vertical pressures as well as horizontal displacement and shear acting on the wall surface by geotextile reinforcement on backfill. The objective of this study was to determine the total geotextile capacity as road edge reinforcement considering the safety and permissive aspects of migration. Road edge stiffness analysis was performed using PLAXIS version 8.2 [1] as a standard characterization. The foundation is the part of the building on which the building stands. The foundation transfers and distributes its own weight and loads in such a way that the load capacity of the "foundation bed" is not exceeded. If the soil at a shallow depth cannot support the structure, a deeper foundation is required to transfer the load to a deeper surface. If a firm bed is so deep that it cannot be reached by open excavation, a deeper foundation will be accepted. The most common types of deep foundations are piles, piers and caissons. The method of transferring the load to the ground is the same for these types of foundations. If both piles and rafters cost the same, then piles are better than piles because pile settlement is much less than the wear [2].

For many years geosynthetics have been used to stabilize the underlying foundations of unpaved roads such as rural roads or access roads. To date the use of geosynthetic reinforcement on paved roads has not been discussed due to very few landslides and the long-term instability of geosynthetics used in roads. Geosynthetics with excellent stress behavior and good long-term behavior should be used on paved roads. In general, black cotton soil fields are fertile and ideal for agriculture, agriculture, sericulture and aquaculture. Good irrigation systems are available, rainfall is high and people are prosperous in these areas. Although black cotton soil is very good for agriculture, it is not suitable for making roads. A good road network is a basic requirement for universal development. Unfortunately, poor road network is hindering the overall development of even the most developed areas. To develop a good and strong road network in black cotton soil, the quality of the soil has to be well understood. Black cotton soil absorbs most of the water, swells and becomes soft and weak [3-4].

Geosynthetics is involved in the consolidation of global activities. Ground slopes, retaining walls, roads and beams are some of the applications that often require mechanical reinforcement for geotextile installations. To investigate the effect of numerical stabilization, various modeling techniques include general methods found in the analysis of boundary measurements for continuous modeling and geosynthetics-reinforced earth structures based on established relationships. The static element method is more advantageous than traditional analytical techniques in that ground motion and pressure are combined and the actual soil behavior can be represented based on the original model. Numerical methods such as the fixed-element method (FEM) have the ability to model the membrane using a structure similar to a certain level of structure of the shell material; Obviously without degrees of freedom rotation. Many engineering problems resulted in mass desertion and disability. If these problems are modeled in a Lagrangian finite element way, the mesh can become very distorted and need to be rewired. Soil can withstand shear pressure and force very well, but it cannot tolerate strong forces. Reinforced soil is a composite of compounds that can easily withstand strong forces. Today reinforcement materials are widely used to overcome technical problems. Reinforced soil is used for slope stabilization (slope), fill dams, retaining walls, foundations and in-situ slope to increase the stress of soil surface tension in various land structures [5-6].

Geosynthetics, viewed as synthetic, are used in soil. Typical families of geosynthetics are: geotextiles, geogrids, geomembranes and geocomposites. When synthetic fibers are made with simple weaving machines into flexible, perforated fabrics or sewn together into woven and non-woven fabrics, the product is referred to as a "geotextile". Soil is known to withstand compression and shear loads but is not stable in the presence of solid loads. Soil consolidation is one of the most effective and reliable methods for improving and treating soil structure. Soil consolidation by composite materials includes elements that can carry solid loads. Soil consolidation is used for a variety of purposes including earth dams, slopes or retaining walls, and even to stabilize soil layers under shallow foundations or pavements. The concept of firm soil was introduced in 1968 by Henri Vidal, a French engineer. He used metal strips between interlocking layers of soil to increase the strength and stability of the soil. Ten years later the use of geosynthetics as stabilizers has increased dramatically. They are widely used for economic reasons and easy access to strong structures such as beams, dams and slopes. Until recently, the Malaysian Public Works Department (PWD) was involved in highway projects on soft soils. Soft soils are often viewed as having low strength, low compressibility, and easily penetrable. However soft soil is part of soft soil and any structure built on fragile soft soil formations will contribute to a significant problem during construction. High pressure compression factors are among the most important factors that can lead to high resolution. Soft soil formations have very fine particles and are highly dense, especially in water [7–8].

Slope stability is an important consideration in the design and construction of geotechnical structures such as highways and railway embankments because the consequences of slope failures are often catastrophic with loss of large property and significant lives. Important factors contributing to slope instability leading to gravity failure are force due to water flow, erosion of slopes due to running water, sudden fall of water near slope, earthquake strength. In addition, if slopes or estates are to be built in soft and weak surfaces that are frequently compacted, the low load capacity and high pressure may result in failure of the flat sliding seat. Several methods of soil development have been successfully adopted to prevent deep slope failures, such as sand compaction piles, rock pillars and deep mixed pillars. Areas of the Earth are filled with soft soil. Global population growth requires setting up of more projects. Infrastructure projects like roads and railways, large storage tanks, factories etc require the implementation of wide areas even if the areas have soft soils. Therefore, various strategies are developed for the improvement of soft soil areas such as: drainage management, replacement of upper soil layers, use of small piles, used additives, use of stone pillars with or without reinforcement, etc. There has been a lot of progress in this. , This process has since been developed by various researchers (laboratory and embedded works). Due to limited code availability and increased computing power, geotechnical designers prefer numerical analysis. Thus, a number of statistical analyzes were carried out, such as: The researchers investigated the effect of column diameter and geosynthetics covering varying lengths during loading. Studies have shown that increasing the width of the sand column will increase their performance [9–10].

2 PLAXIS 2D AND SIMULATION

PLAXIS 2D is a powerful and easy-to-use feature package designed to analyze the two sides of aging and stability in geotechnical engineering and rock equipment. It is used worldwide by top engineering companies and institutions in the civil engineering and geotechnical engineering industries. Applications range from mining, fencing and foundations to tunneling, mining and reservoir geomechanics. PLAXIS is equipped with a wide range of advanced features covering a wide range of geotechnical problems within one integrated software package. PLAXIS uses predefined structural elements and types of loading in a CAD-like environment. It empowers the user by creating a faster and more efficient model, allowing more time to translate results. An easy-to-use visual interface guides the user through a model to create an efficient and logical continuous geotechnical workflow. In addition to the flexible output system, PLAXIS provides several methods for copying force, displacement, pressure and flow data into contours, vectors and tables, or to display them by Python based scripting, for additional processing purposes.

PLAXIS is a limited-edition package designed to perform resilience and stability analysis in geotechnical engineering projects. Simple graphical input procedures enable rapid generation of complex boundary models, and advanced output fields provide detailed presentation of computational results. The calculation itself is fully automatic and is based on solid numerical procedures.

3 METHODOLOGIES

The sample geometry is merged into PLAXIS, an open source software for finite element mesh generators. Joint flow analysis produces the mesh with respect to a second-order shape function. One factor is the model of all experimental simulations. The generated match file is included in PALXIS as a geometric input file. Lateral motion is limited to these limits due to axial symmetry on the left edge and the closed ring on the right edge (cell compression in the case of triangulated examination). Friction effects from the closing ring are not considered in the simulation due to the limited scope of this software. The hydraulic pressure at the upper limit is set to zero to allow direct water flow. Vertical removal is limited to the bottom edge.

Road edge hardness analysis was performed using PLAXIS 2D in a limited manner. The Mohr–Coulomb model was used as a simple preliminary analysis of the hypothetical problem. Edge Analysis & Sand Mat is formulated to be water absorbent and non-abrasive for all foundation clay soils. Three types of sequential modeling were performed in this study. First, the stability of the road surface was stabilized without reinforcement. The second modeling was to determine the geotextile reinforcement length taking into account the stability of the modeled roadbed. The final sequence was to investigate the stability of the reinforced model of the wall with different strengths of reinforcing geotextiles.

4 GEOMETRY

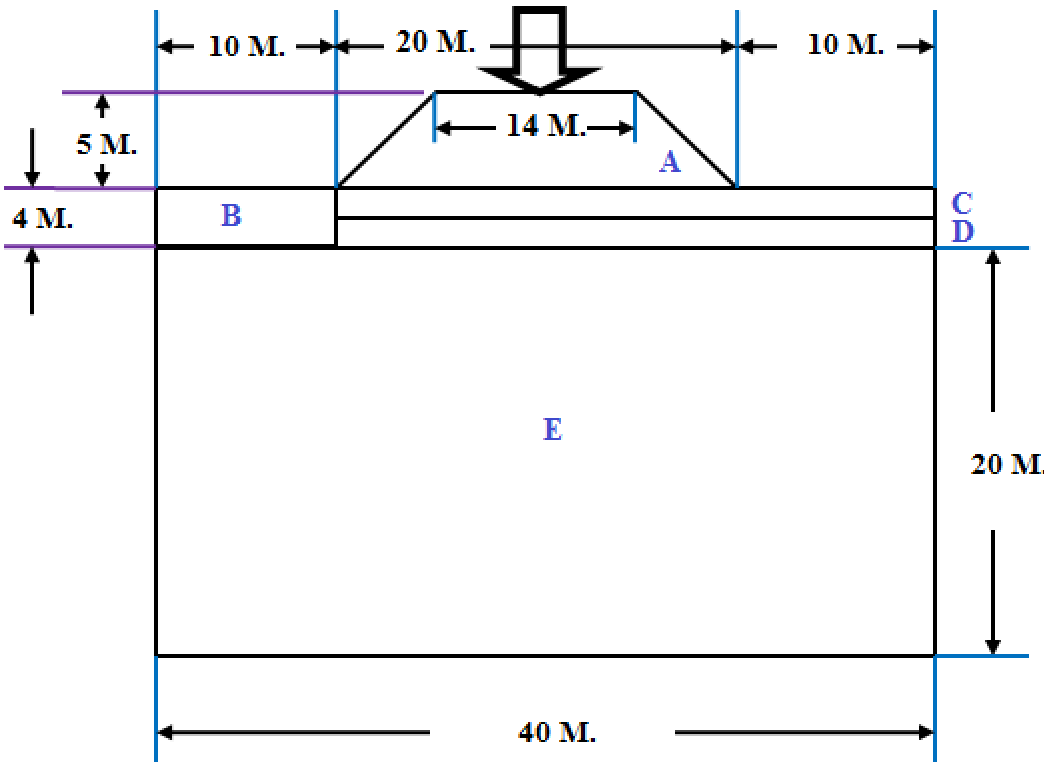

Figure 1 Geometry

To determine the appropriate geotextile strength such as reinforcing walls, the geotextile reinforcement should have a strength of 4000 kN/m and a stiffness of (0.33). The strength of the road has been analyzed using PLAXIS 2D on the embankment in Finite Element. The Mohr–Coulomb model was used as a simple preliminary analysis of the hypothetical problem. The fence and sand mat have been analyzed as having wet conditions, while the clay soils of the entire foundation have been described as unproductive. The modeling was to determine the length of the geotextile reinforcement taking into account the stability of the dress model.

Table 1 Soil Parameter

Sl. No.	Material	γunsat (kN/m^3)	γsat (kN/m^3)	*Eref* (kN/m^2)	*c* (kN/m^2)	Φ (°)	*Ψ* (°)
1	Fill	25	25	70000	1	45	5
2	Sand Mat	20	25	30000	1	35	4
3	Clay	17	20	2500	160	1	0
4	RETANING BLOCK	14	14	2000	5	20	0

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

5 RESULT AND DISCUSSION

5.1 Applied load of 8 KN/m^2

Figure 2 to 5 shows the Deformation mesh, Total Displacement (569 X 10^{-3}), Effective mean Stress (-1.07 X 10^3 kN/m^2) and Mean Stress (-1.07 X 10^3 kN/m^2). using Material Isotropic elastic and Axial stiffness EA (122670 kN/m) with applied load of 8 KN/m^2.

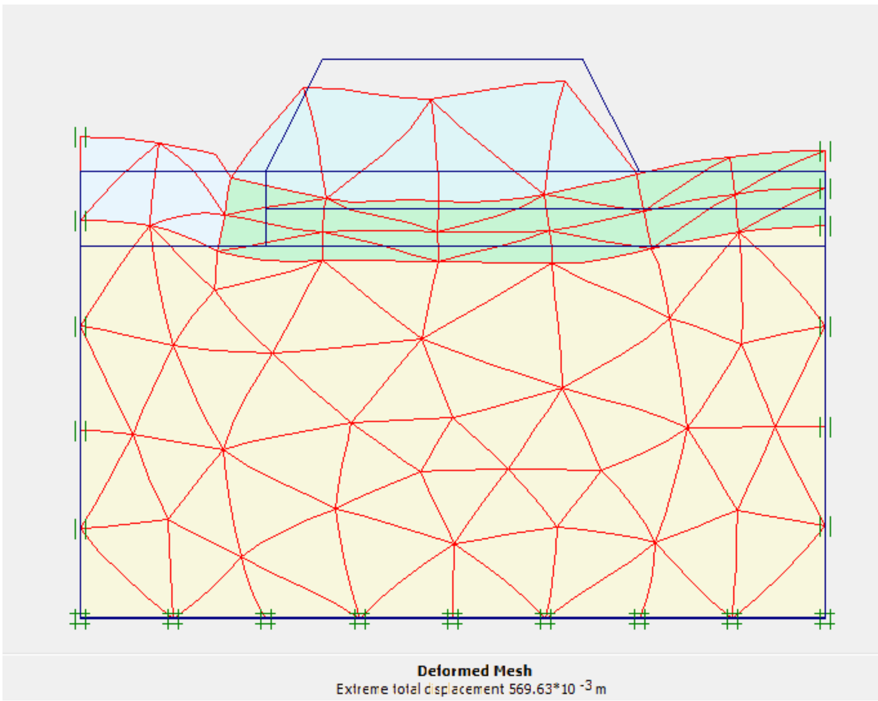

Figure 2 Deformation mesh

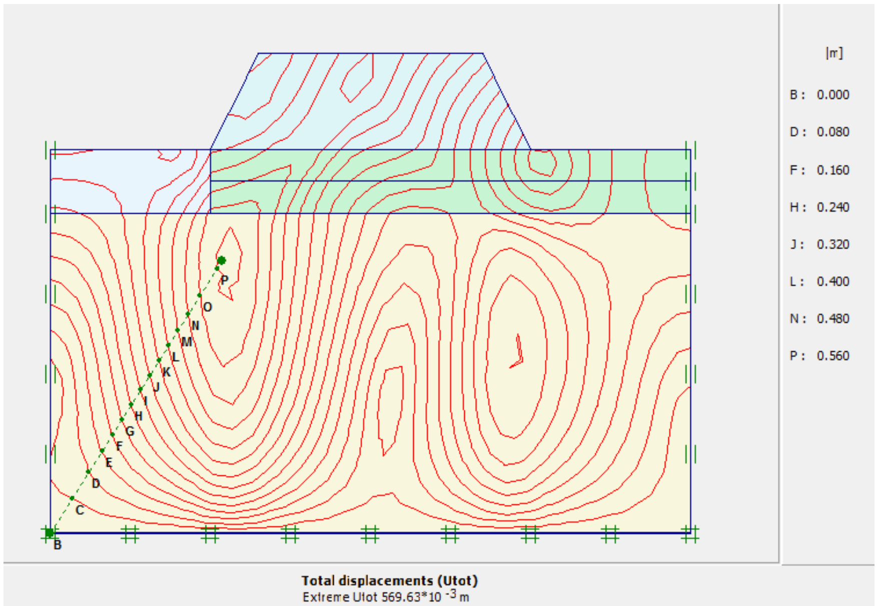

Figure 3 Total displacement 569 X 10^{-3} m

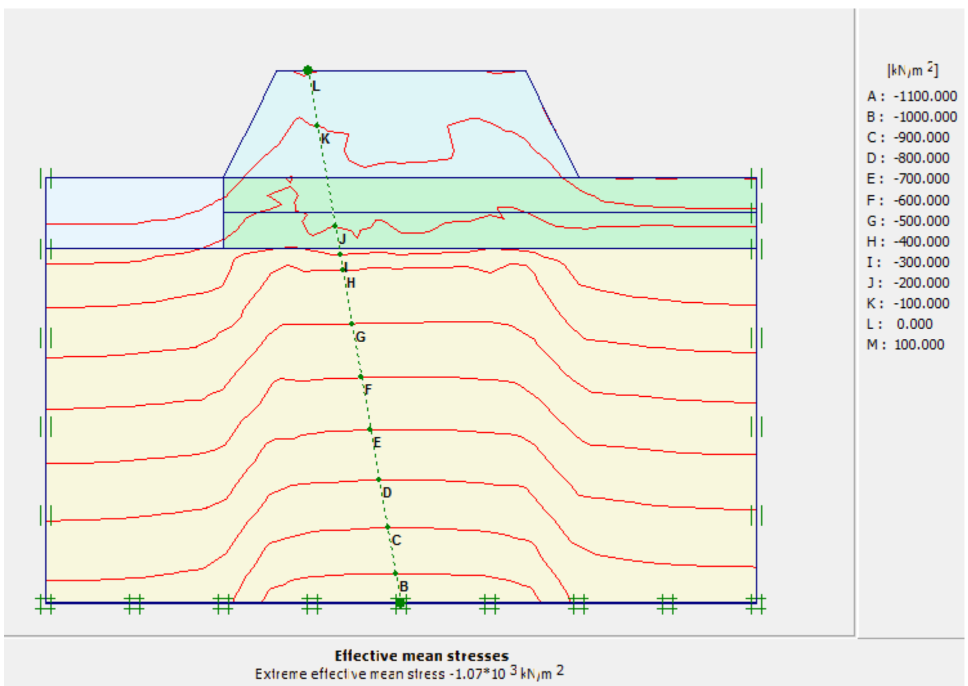

Figure 4 Effective mean stresses -1.07 X 10^3 kN/m^2

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

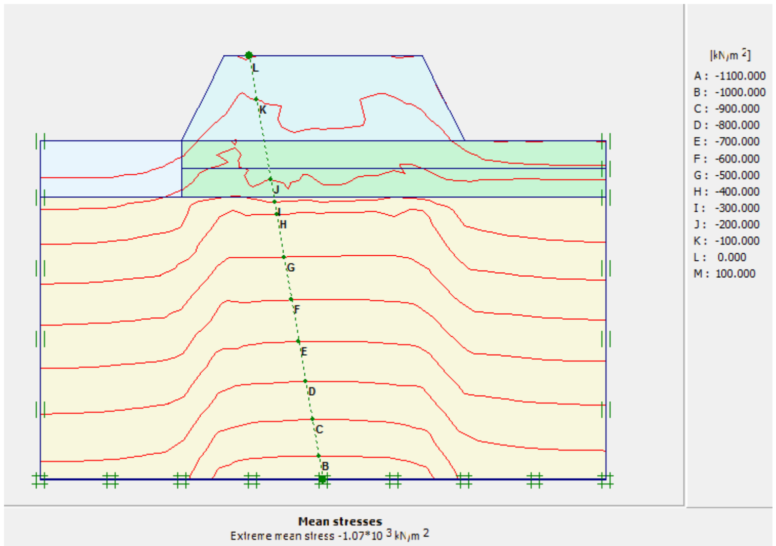

Figure 5 Mean stresses -1.07 X 10^3 kN/m^2

5.2 Applied load of 8 KN/m^2 using geotextile

Material Isotropic elastic

Axial stiffness EA- 122670 kN/m

Figure 6 to 9 shows the Deformation mesh, Total Displacement (381.58 X 10^{-3} m), Effective mean Stress (-804.46 kN/m^2) and Mean Stress (-804.46 kN/m^2) using Material Isotropic elastic and Axial stiffness EA (122670 kN/m) with applied load of 8 KN/m^2. Effective mean stress was analyzed near the base of the edge to obtain the total strength of the geotextile. Increasing the strength of the geotextile reduces migration near the base of the boundary.

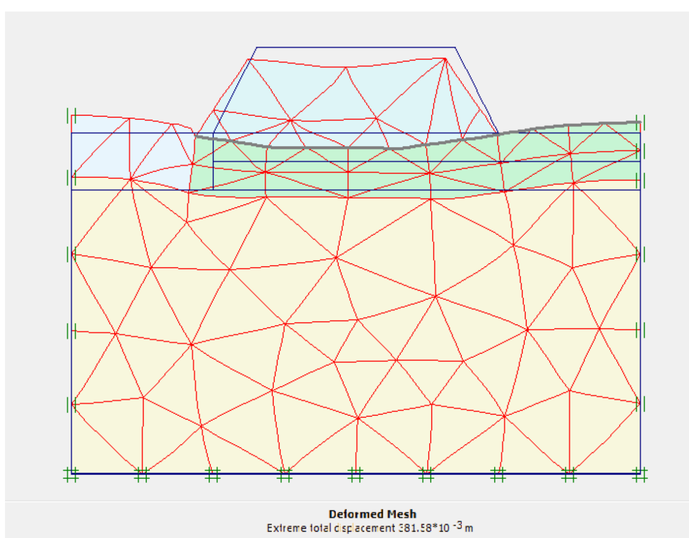

Figure 6 Deformation mesh

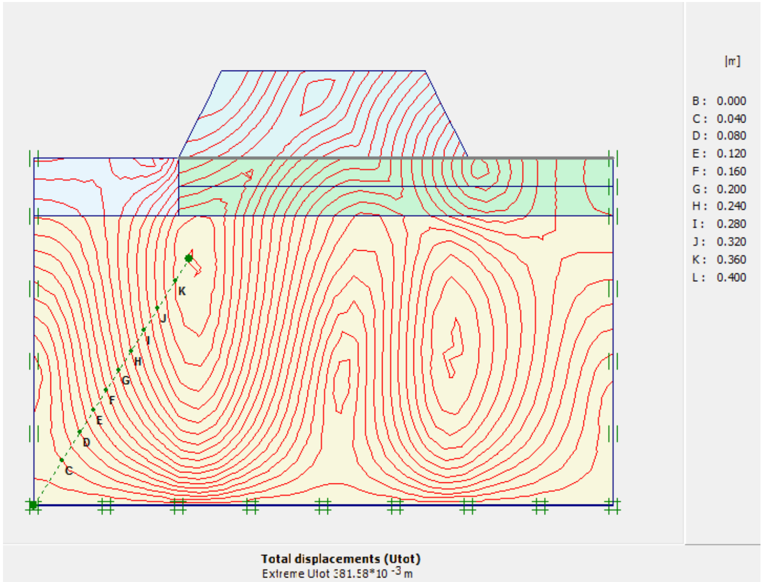

Figure 7 Total displacement 381.58 X 10^{-3} m

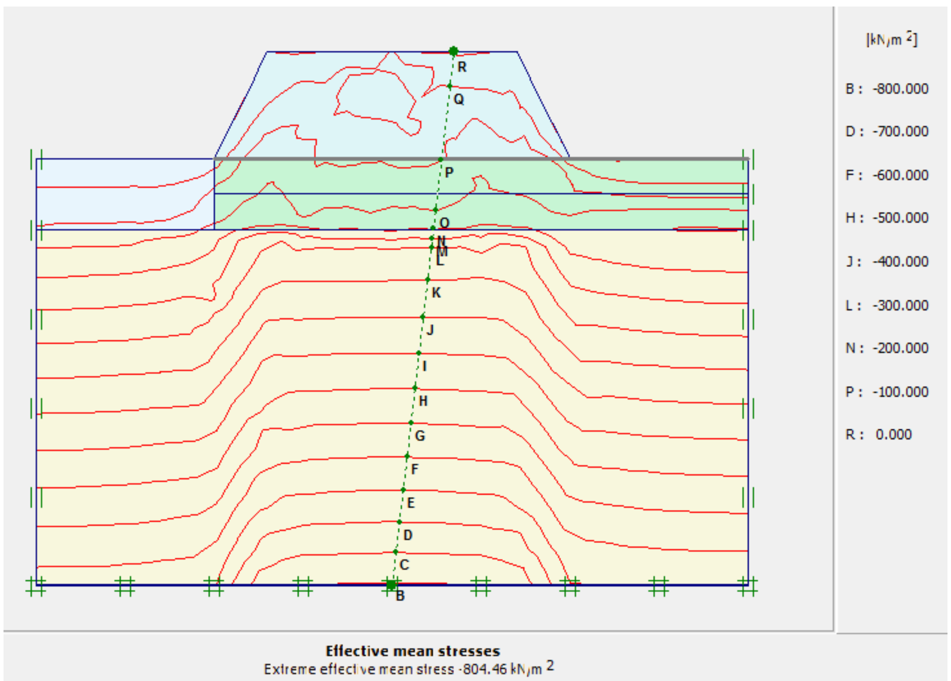

Figure 8 Effective mean stresses -804.46 kN/m^2

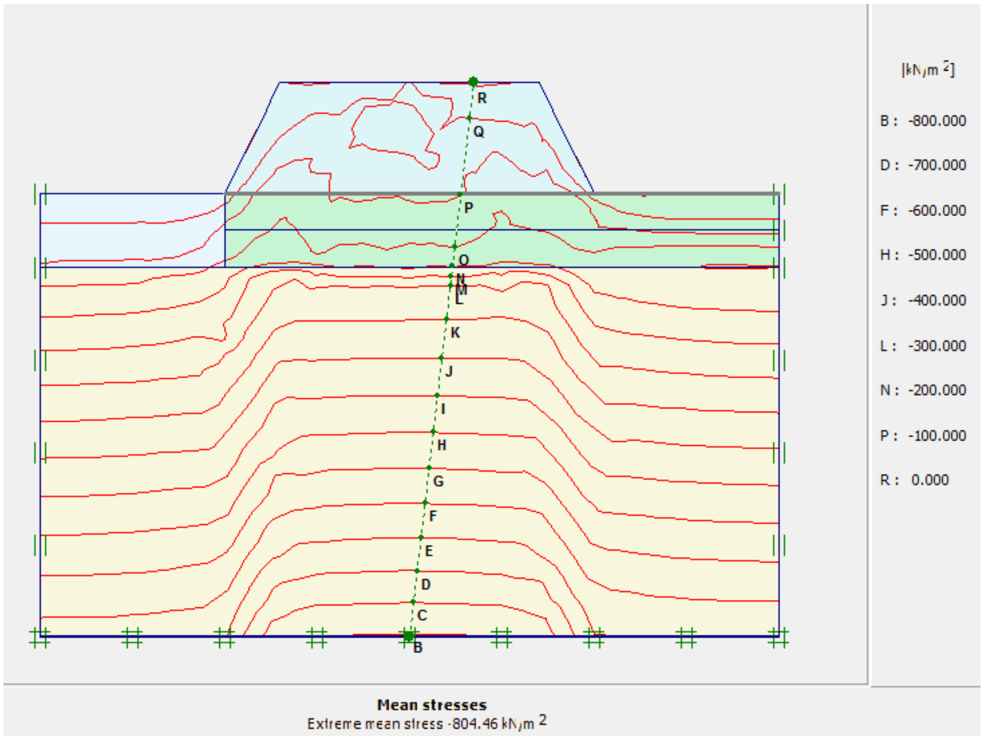

Figure 9 Mean stresses -804.46 kN/m^2

6 CONCLUSIONS

The strength of geotextile reinforcement was increased in this study. Since transportation does not have a significant effect on the increase in geotextile capacity, this parameter can be neglected in determining the maximum geotextile capacity in this study. Therefore, it can be concluded that the maximum strength of the layer-reinforced geotextile is strongly affected in this study. In this current research project it is proposed to analyze the performance of a reinforced road surface. Figure 2 to 5 shows the Deformation mesh, Total Displacement (569 X 10^{-3}), Effective mean Stress (-1.07 X 103 kN/m2) and Mean Stress (-1.07 X 103 kN/m2). using Material Isotropic elastic and Axial stiffness EA (122670 kN/m) with applied load of 8 KN/m^2. Figure 6 to 9 shows the Deformation mesh, Total Displacement (381.58 X 10^{-3} m), Effective mean Stress (-804.46 kN/m^2) and Mean Stress (-804.46 kN/m^2) using Material Isotropic elastic and Axial stiffness EA (122670 kN/m) with applied load of 8 KN/m^2. Effective mean stress was analyzed near the base of the edge to obtain the total strength of the geotextile. Increasing the strength of the geotextile reduces migration near the base of the boundary.

REFERENCES

1. ASTM D4439-00, Standard terminology for geosynthetics, ASTM International, PA, 2000.
2. D.Tjandra, Determination of optimum tensile strength of geogrid reinforced embankment, International Civil Engineering Conference "Towards Sustainable Civil Engineering Practice", Surabaya (2006) 187-193.
3. Bakar, M. F. Othman, Simulation of safe height embankment on soft ground using Plaxis, APCBEE Proceedia 5 (2013) 152–156.
4. M. Siaovashnia, F. Kalantari, A. Shakiba, Assessment of geotextile reinforced embankment on soft clay soil, The 1st International Applied Geological Congress, Iran (2010) 1779–1784.
5. NCMA Design Manual for Segmental Retaining Walls, 3rd Edition (2009).
6. PLAXIS 8.2 design manuals a “finite element code for rock and soil analysis”.
7. R. gourves and M. grediac, blaise Pascal University, “mechanical behavior of soil reinforced by geocells”.
8. S. Lambert, O. Jenck,Erizal,M. Widyarti. An Original Testing Apparatus for Rapid Pull-Out Test, Civil Engineering Dimension Vol 16 No 2 (2014) 61–67.
9. Solanki, Analysis of geotextile reinforced embankment on difficult subsoil condition, International Journal of Scientific & Engineering Research Volume 4 Issue 5 (2013) 41–44
10. X. Yang. Numerical modeling of geosynthetic-reinforced earth structures and geosynthetic-soil interactions. Geotechnical Engineering, 42(1): 43, 2011.