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Investigation Usage of Interface Elements on Optimum Design GRS Walls

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ABSTRACT

Here, the performance of geosynthetic reinforced soil walls (GRS walls) using finite element method and Plaxis software are studied. Therefore, a geosynthetic reinforced soil wall is selected that the instrumentation results for it are available. Modelling of reinforcement layers without interface element and with interface element are investigated. Charts including deformed mesh, total displacement, shear strains, horizontal stress and vertical stress have been reviewed. The results show that the use of stronger and taller reinforcement, in above reinforcement layers than bottom reinforcement layers is optimum and economical.

KEYWORDS: Optimum design, Geosynthetic reinforced soil wall, Interface elements.

1. INTRODUCTION

Recently, geosynthetics in geotechnical engineering have found wide use. Technology geosynthetic walls is based on the idea reinforced soil technology. These walls are designed in different shapes and are made using different kinds of geosynthetics. Most of reinforced soil structures are consist of three main components namely soil, reinforcement and face. Normally grainy soils used as embankment, although cohesive soils can also be used as embankment. Geosynthetic walls are more flexible in structural system. In front of inequality subsidences and earthquake forces are resistant. Earthworks and excavation volume is lower on the back wall. In geosynthetic walls is not seen corrosion of concrete and steel. For their durability and reliability issues must had sufficient attention [1]. Here, some of the studies that have been done by researchers on reinforced soil walls, is presented.

Juran and Christopher (1989) [2] have studied laboratory models to evaluate performance, behavior and failure mechanisms of reinforced soil walls, using reinforcement elements made of different materials.

Leshchinsky et al (2004) [3] a study have done on reinforced retaining walls with limited space. Similar work by Zornberg and Leshchinsky (2001) [4] is performed.

Hattamleha and Muhunthan (2005) [5] have studied behavior of reinforced soil walls. Conditions of loading and support conditions during construction were investigated.

Bathurst et al (2000) [6] have evaluated the performance and design of reinforced soil structures using the same type of geosynthetic reinforcement made in the laboratory.

2. Model specification and properties of materials

In this research, geosynthetic reinforced soil wall has been studied by Abioghli (2013) [1]. The wall height of 20 feet (6 meters) and 9 layer reinforcement are each 14 feet (2.4 meter) long. Figure 1 shows wall of modeled by the Plaxis software. Table 1 shows properties of Reinforced soil and properties of foundation soil. Young's modulus face of wall is 7220000 kN/m^2. The normal stiffness of Geogrid is 38850 kN/m. The load strip in near the wall face is 75 KN/m^2 and length of 1.5 meters.

Table 1. Properties of Reinforced soil and properties of foundation soil

Type of parameter	Reinforced soil	foundation soil
Type of model	Mohr–Coulomb model	Mohr–Coulomb model
Type of material	Drained behavior	Drained behavior
Unit weight of dry soil	21 KN/m^3	21 KN/m^3
Saturated unit weight of soil	21 KN/m^3	21 KN/m^3
Poisson's ratio of soil	0.3	0.3
Amount of Cohesion	0.005 KN/m^2	2.5 KN/m^2
Internal friction angle of soil	40 ˚	36 ˚
Soil dilation angle	0 ˚	0 ˚
Horizontal permeability of soil	1 m/day	1 m/day
Vertical permeability of soil	1 m/day	1 m/day
Strength reduction factor	0.7	0.7

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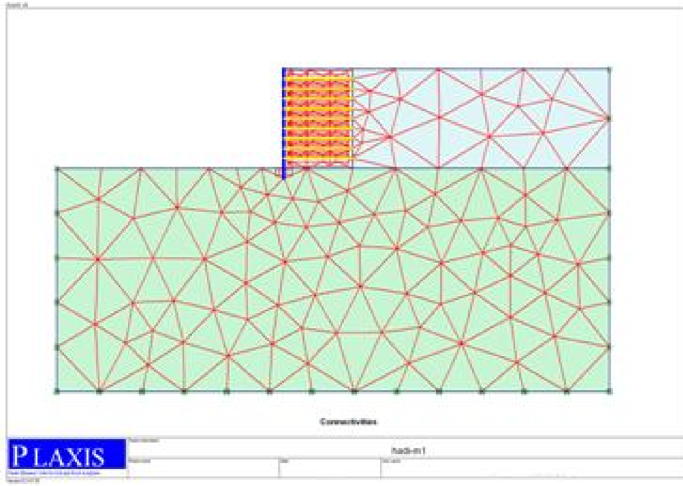

Fig. 1. Wall of modeled by the Plaxis software

3. Analysis of results

Figure 2 shows the deformed mesh without interface element and with interface element.

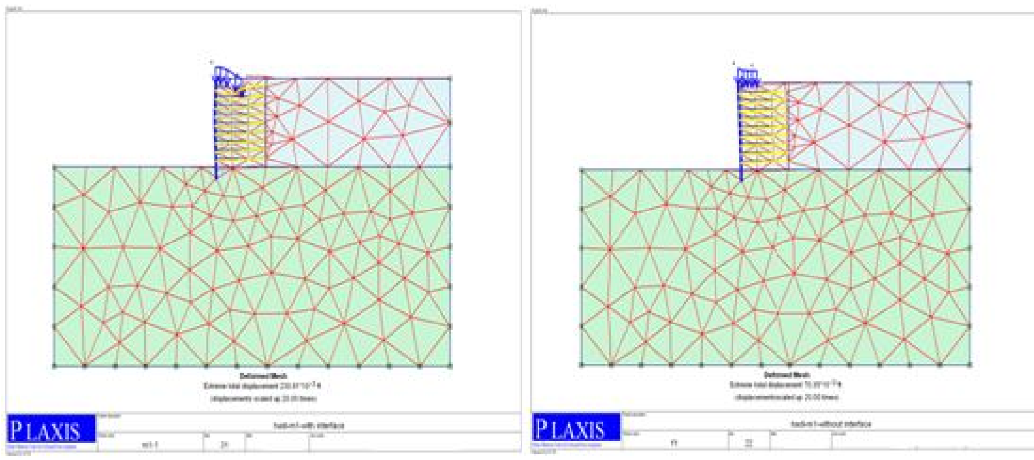

Fig. 2. Chart of deformed mesh (right: without interface element, left: with interface element)

As is clear from figure 2 in without interface element mode than with interface element mode occurred little deformation under load strip, that is sign of sufficient freedom for deformation with interface element mode. The maximum displacement of the wall is in without interface element mode 0.07 ft (21 mm), which is about 0.23 ft (69 mm) in with interface element.

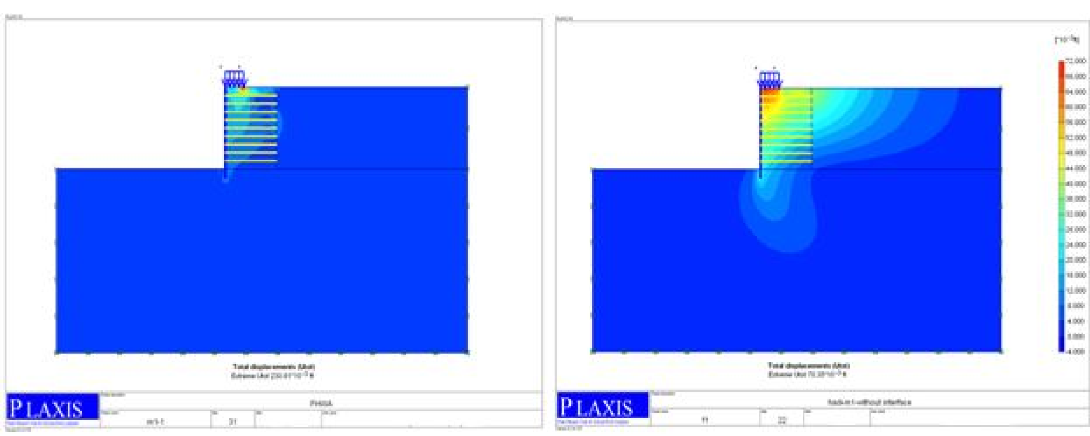

Fig. 3. Chart of total displacement (right: without interface element, left: with interface element)

Figure 3 shows the total displacement without interface element and with interface element. Chart of total displacement in Figure 3 indicate that displacement without interface element on the back embankment has been developed. While in without interface element mode have been developed under load strip and move away from the area declined. Considering that the failure wedge of reinforced soil wall within surface with a slope of 45 degrees plus half the angle of internal friction occurs, Therefore modeling with interface element a logical form provides of the failure the wall.

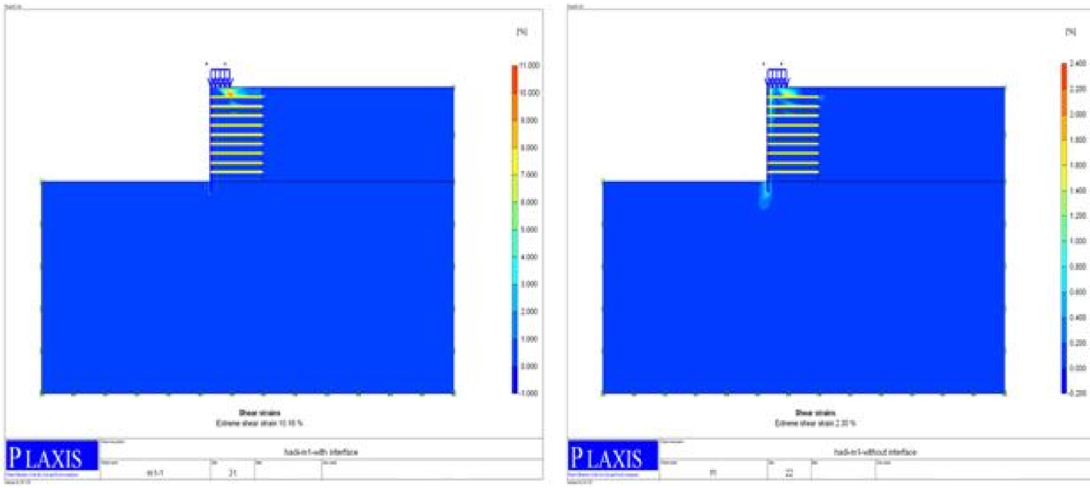

Fig. 4. Chart of shear strains (right: without interface element, left: with interface element)

As is clear from figure 4, maximum shear strain near the face without interface element mode is about 2.3 percent. While the maximum shear strain with interface element mode is 10 percent under load strip. Considering that in reinforced soil wall, the greater part of reinforcement layers are placed inside the wedge failure, Therefore in this area we can expect more of the strain. Again, modeling with interface element mode provide as well. Also in this case, modeling with interface element mode provides good results.

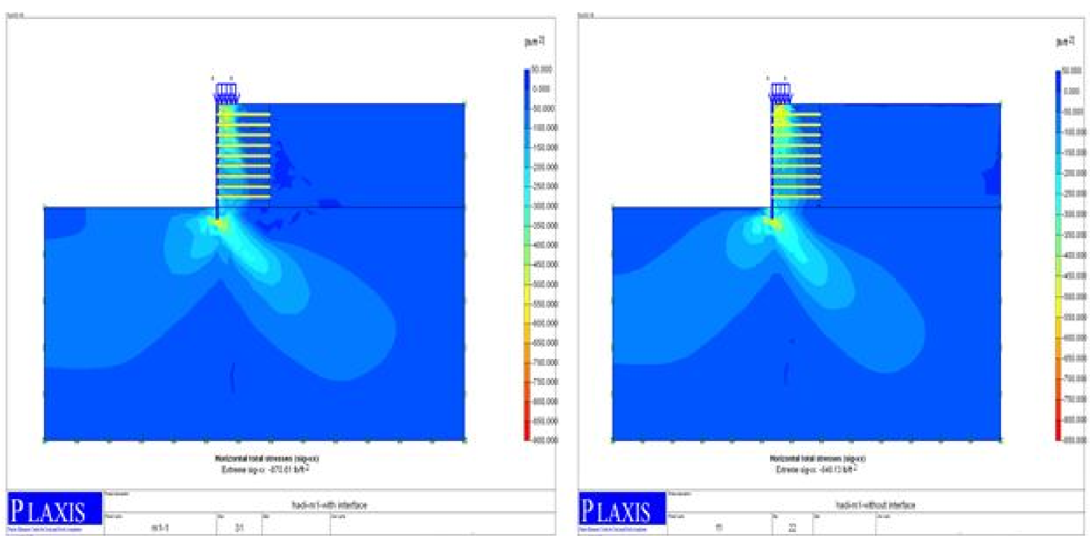

Fig. 5. Chart of horizontal stress (right: without interface element, left: with interface element)

Horizontal stress reveals stress levels in the behind embankment. Figure 5 shows the horizontal stress without interface element and with interface element. As is clear from figure 5, the maximum horizontal stress of the wall in case of without interface element mode 42.5 KN/m^2, which is about 43.5 KN/m^2 in with interface element.

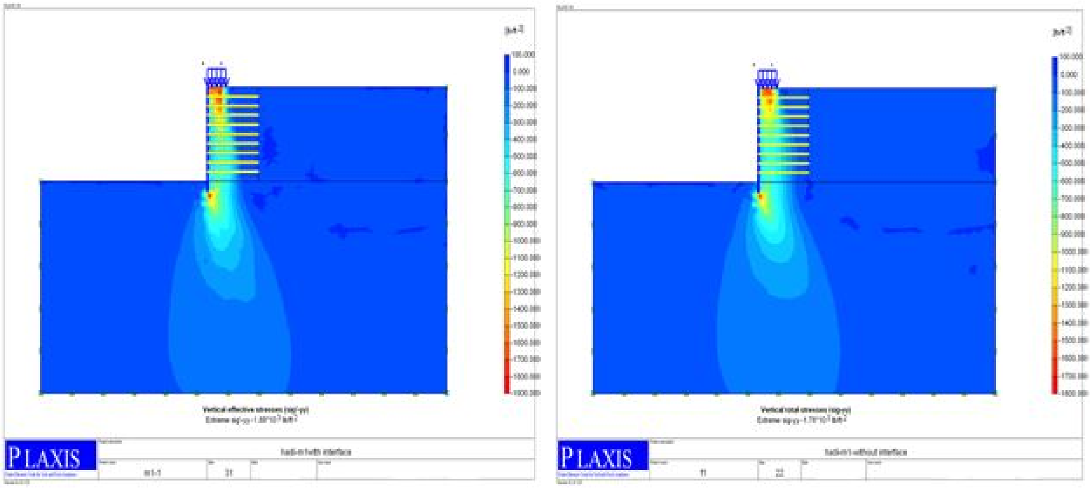

Fig. 6. Chart of vertical stress (right: without interface element, left: with interface element)

Figure 6 shows the vertical stress without interface element and with interface element. As is clear from figure 6, the maximum vertical stress of the wall in case of without interface element mode 88 KN/m^2, which is about 94.5 KN/m^2 in with interface element. Stress concentration in under load strip in Figure 6 shows the maximum stresses, which are located inside the wedge failure. For this reason from reinforcements that are stronger and longer in the upper layers than the bottom layers used.

4. Conclusion

The following results of the research on geosynthetic reinforced soil wall are obtained.

Modeling results reinforcement layers and wall face with interface elements are well consistent than modeling results without interface elements. The use of these elements in the around structures, sufficient freedom to deformation and accurate distribution can be found.

Displacement of reinforcement layers from bottom to top increases. Because of load strip near the wall face is located, displacement of reinforcement layers near the wall face is greater.

Tension force of reinforcement layers near the wall face is greater. The most amount of tension force endures in the highest reinforcement layer than other reinforcement layers.

According to the charts can be concluded that the stresses and strains within surface with a slope of 45 degrees plus half the angle of internal friction are in the highest level of their own. For this reason, use of stronger and taller reinforcement, in above reinforcement layers than bottom reinforcement layers is optimum and economical.

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