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FINITE ELEMENT ANALYSIS OF 28M HIGH GRAVITY RETAINING WALL AT QALANDAR ABAD, ABBOTTABAD BY USING FINITE ELEMENT SOFTWARE

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Abstract: *Retaining wall is an important engineering structure to resist lateral forces for a mass of earth. Design of retaining wall is complex because it depends on the shape as well as the condition of mass retained. Most of the time its design is done with more factor safety which makes it uneconomical. In this study a 28-meter-high gravity retaining wall which was already constructed, was analyzed with Finite element software PLAXIS 3D and GeoStudio. The parameters compared are vertical settlement, deflection of wall and stability of slope. It was concluded that factor of safety more than three was adopted which makes it uneconomical.*

Keywords: *Retaining wall; FEM; PLAXIS 3D; GeoStudio; Analysis*

INTRODUCTION

Retaining wall is an engineering structure that is used to provide the resistance to lateral forces for a mass of earth or other material to accommodate a transportation facility. The Earth behind the back of a retaining wall can be natural embankment or backfill adjacent to retaining wall. These retaining walls can be used for variety of applications including new Highways embankment construction, road widening specially in hilly areas, slope stabilization and to provide the support in underwater construction [1]. Hence a retaining wall needs to be designed very carefully. Several types of earth retaining structures are available to retain the earth depending on soil condition and distribution of the lateral earth pressure. Design of the retaining wall is based on fundamental principal of soil Mechanics as retaining the soil is one of the oldest and important problem in Geotechnical engineering [2]. Number of Geotechnical earth retaining structures has been developed with time but Gravity and Cantilever Retaining walls are the oldest of the retaining wall types.

Gravity Retaining wall is the simplest and oldest of all gravity retaining wall types. A typical gravity retaining wall is use to hold the soil by its own weight. While designing a gravity retaining wall it is important to know the failure Mechanism that could be sliding, tilting or bearing capacity failure [3]. The design philosophy for a gravity retaining wall deals with the determination of magnitude and distribution of lateral earth pressure acting on it by using the old classical theories [4].

Real problem these days while designing a gravity retaining wall is the type of assumption made without realization of their significance using these old classical theories which ultimately results into the complete or partial failure of these earth retaining structures. In this paper a numerical study is done of a Gravity retaining wall as a case study using finite element analysis PLAXIS 3D [] and GeoStudio [5]. A 28m high Gravity is analyzed to get the more realistic results using finite element analysis.

A. Qalandarabad, Abbottabad Slope Failure:

The site is located in Qalandarabad, Abbottabad. The Coordinates of the site were found to be 34° 15.861'N ,73°15.153'E. The area is located in seismic zone-3 according to the Building Code of Pakistan seismic provision 2007. Pakistan is divided into five seismic zone [6] shown in
Table 1-***Error! No text of specified style in document.****-1*

Table 1-**Error! No text of specified style in document.**-1: Seismic zones of Pakistan

Zone	Peak Horizontal Ground Acceleration
1	0.05 to 0.08
2A	0.08 to 0.16
2B	0.16 to 0.24
3	0.24 to 0.32
4	>0.32

According to the locals of the area, slope of the hill was mild before 2002. But due to a landslide after 2002 the slope was left utmost vertical. As a remedial measure a 10 to 15 feet high stone masonry retaining wall was constructed with RC foundation. During rain of March 2016 which continued for few days, the slope failed on March 18, 2016.However a crack was developed at the crest of the slope and parallel to the road was developed allowing the rain water to seep through the crack, according to the locals of the area. Total Depth of the sliding Area from depth of the stream to the top

of the hill was found to be 128 feet High. Top 80 Feet High of the sloping surface was found to be very steep. As per visual inspection the soil was found to be clayey Gravel.

Figure 1-1: Slope Failure View

On the complaints of the locals the works and services department approached the University of Engineering and Technology, Peshawar and after extensive soil investigation a 128 feet High gravity retaining wall was proposed.

B. GeoStudio Analysis:

GeoStudio is an integrated software suite for modeling slope stability, ground deformation, and heat and mass transfer in soil and rock. Its products are SLOPE/W, SIGMA/W, SEEP/W, QUAKE/W, etc.

C. SLOPE/W:

SLOPE/W is the leading slope stability software for soil and rock slopes. SLOPE/W can effectively analyze both simple and complex problems for a variety of slip surface shapes, pore-water pressure conditions, soil properties, and loading conditions.

With this comprehensive range of features, SLOPE/W can be used to analyze almost any slope stability problem you will encounter in your geotechnical, civil, and mining engineering projects.

D. SLOPE/W Stability Analysis before Construction of Retaining Wall:

A bear

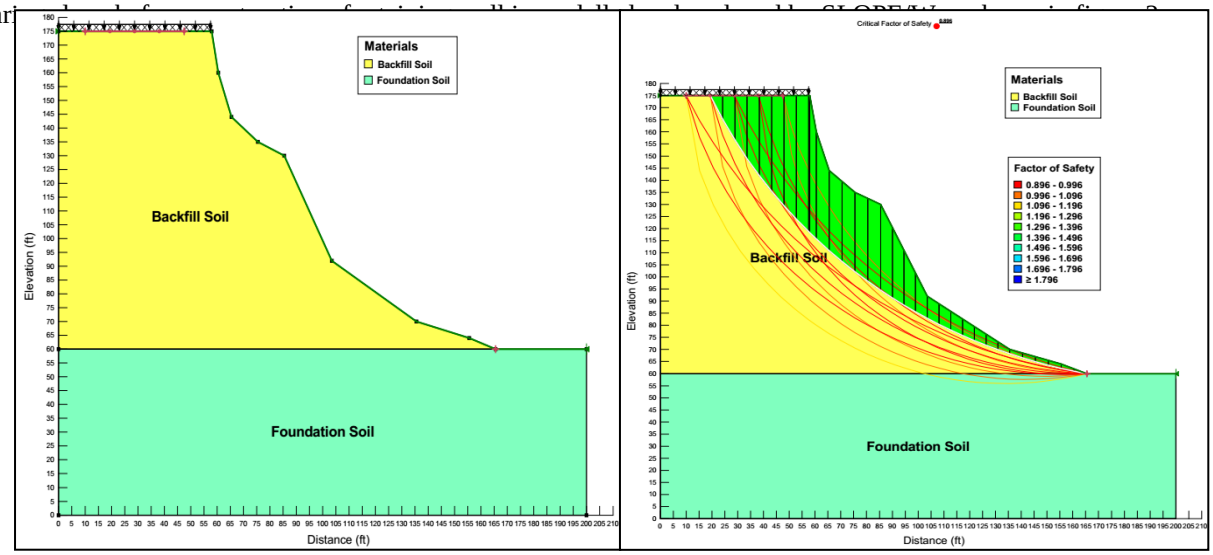

Figure 1-2: Bearing Slope Model and Analysis

From the Analysis the calculated critical Factor of Safety is 0.896. This analysis shows the need for construction of retaining wall.

E. SLOPE/W Stability Analysis after Construction of Retaining Wall:

A retaining wall along with the mass retained is modelled and analyzed by SLOPE/W as shown in figure 3.

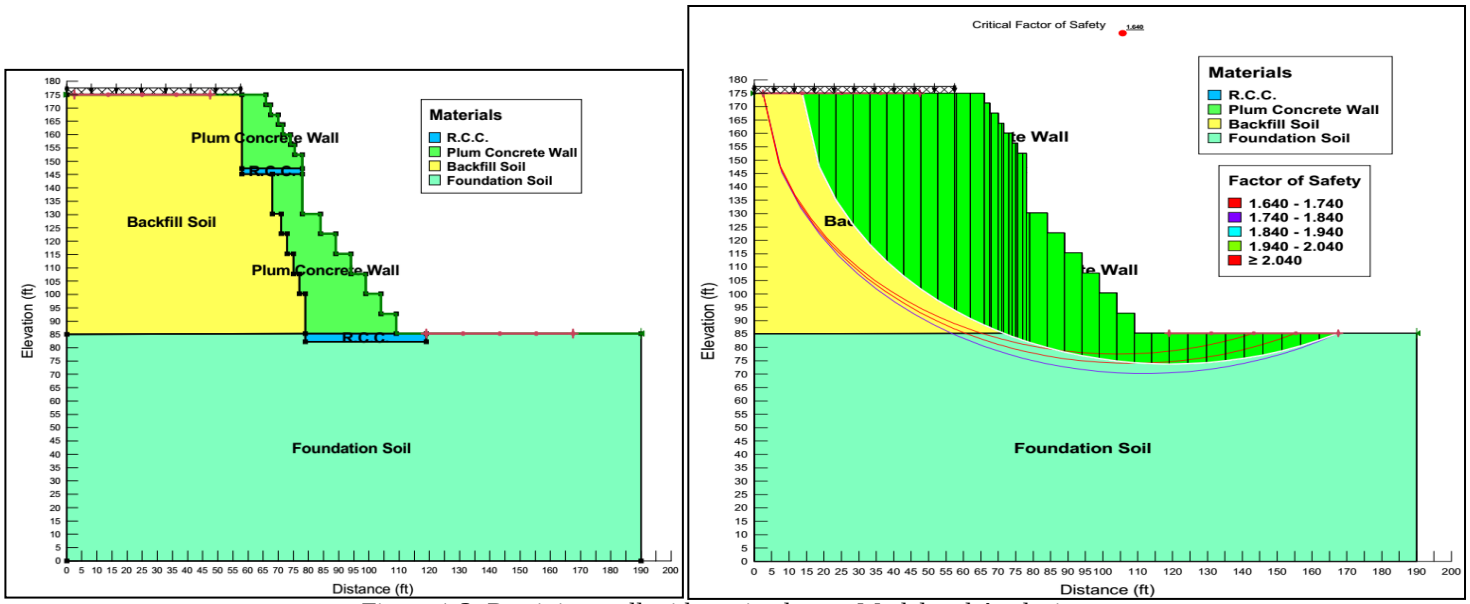

Figure 1-3: Retaining wall with retained mass Model and Analysis

From the Analysis the calculated critical Factor of Safety is 1.640.

F. PLAXIS 3D Analysis:

PLAXIS 3D is finite element software use for solving Geotechnical problem. It can do nonlinear, static and many types of analysis for a large spectrum of engineering problems. Plate element option can be use to model raft, basement and retaining walls. Beam elements can be use to model piles and columns.

For this analysis the soil properties used are shown in below table. For modelling volume under retaining wall, a volume with properties same as that of the material use for retaining wall was modelled.

Table 1-2: Soil Properties

Properties	Value
Soil modulus, Es	80 [MPa]
Cohesion of Soil, Cu	32 [KPa]
Poison's ratio of Soil, □s	0.3
Angle of internal friction, □	30
Unit Weight	19 [KN/m^3]

After analyzing the model in PLAXIS 3D, the settlement calculated as 8.1 mm in vertical direction. In lateral direction, the deflection was 3.8 mm. Both calculations are within safe limit. PLAXIS 3D models are shown in Figure 4.

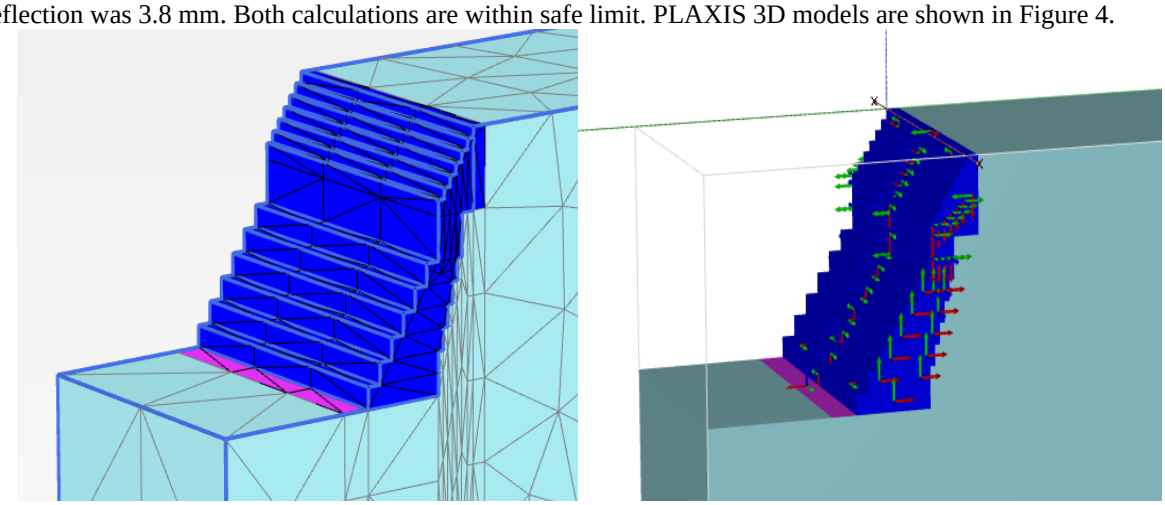

Figure 1-4: Figure. 4 PLAXIS 3D models

I. Conclusion

Based on the Finite element analysis in both software, it can be concluded that 28 m high retaining wall is safe. The analysis shows the need for construction of retaining wall as the FOS for slope stability before the construction of wall was less than 1. For future design and analysis, it is recommended to use manual calculation along with Finite element analysis for these complex problems which will make design economical as well as more safety can be achieved.

III. References

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