A CASE STUDY OF A GRAVITY WALL LOCATED IN THE FISHING PORT AREA

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Abstract: In a technical sense, a gravity wall is defined as any structure that resists soil pressure. The gravity wall is typically a permanent structure constructed in the form of a retaining element for the slope. The advantages of this wall type are that the excavation materials can be used in the walls of these walls, the evaluation of the waste materials and the integrity of nature by adapting to the ground conditions of the weight wall. The gravity wall, which is built between the service road of fishing port and the highway, is about 340 meters in length and varies in height and has a maximum height H = 10.50 meters. During the construction of the road, some parts of the gravity wall which had been built, were collapsed in the form of breakage in the wall as a result of the surcharge load effect caused by mass transfer from the road embankment. Damaged parts of the wall were repaired. In this study, bearing capacity and stability analysis were carried out on the failure cross section (Section-A) which has the height of 5.16 meter along the wall route. GEO5 package program are used in the analyses. The parameters used in analyses were obtained from the laboratory studies and literature. The port area is located in the second degree earthquake zone and the seismic effect was considered in the analysis.
Keywords: Gravity Wall, Retaining Structure, Bearing Capacity

Introduction

Gravity walls are widely used as earth retaining systems supporting fill slopes adjacent to roads and residential areas built on reclaimed land (Trandafir, Kamai & Sidle, 2009).

Gravity walls are the most common type of construction for docks because of their durability, ease of construction and capacity to reach deep seabed levels. The design of gravity walls requires sufficient capacity for three design criteria; sliding, overturning and allowable bearing stress under the base of the wall. Although the design of gravity quay walls is reasonably well understood for static loads, analysis under seismic loads is still in being developed (Alyami et. al., 2007)

One of the advantages of gravity walls is that the waste material can be used during the construction process and this ensures that the gravity wall is fully integrated into the nature.

In this study, bearing capacity and stability analysis were carried out on the failure cross section (Section-A) which has the height of 5.16 meter along the wall route.

GEO5 package program is used in the analyses. The parameters used in the analysis were obtained from the laboratory studies and literature.

Gravity Walls

Gravity walls are the earliest known retaining structures. These walls construct from solid concrete or rock roble mortared together. The lateral forces from backfill is resisted by the weight of wall itself and due to their massive nature, they develop little or no tension.

The difficulty with retaining walls is that they are often concrete or a similar material which, compared to soil, are extremely strong. It is not advisable to include the actual strength of the retaining wall in the analysis, due to potential convergence difficulties. Consider also that failure of retaining walls is usually a result of undercutting of the retaining wall, not shearing of the concrete itself. For this mode of failure, the strength of the retaining wall itself becomes inconsequential, but the weight of the wall acting as a stabilizing force is critical.

Site Conditions

The gravity wall, which is built between the service road of the fishing port and the highway, is about 340 meters in length and varies in height and has a maximum height H = 10.50 meters. The gravity wall has been shown in Figure 1 and Figure 2.

Figure 1. Right Side of Gravity Wall

Figure 2. Left Side of Gravity Wall

The soil parameters to be used in numerical analysis are given in Table 1.

Table 1. Soil Parameters Used in Analysis

Soil	**γ (kN/m³)**	**ϕ (°)**	**c (kPa)**
Soil-I (Behind the Wall)	20.0	37	10
Lime Stone	22.0	35	25

Analysis were carried out under effective stress conditions, assuming that groundwater was not encountered and necessary drainage precautions are taken.

Highway traffic load is considered as a surcharge pressure of 15 kPa (15 kN/m²) which is effective on embankment. In analysis of bearing capacity, the bearing capacity value for limestone was taken as 500 kPa.

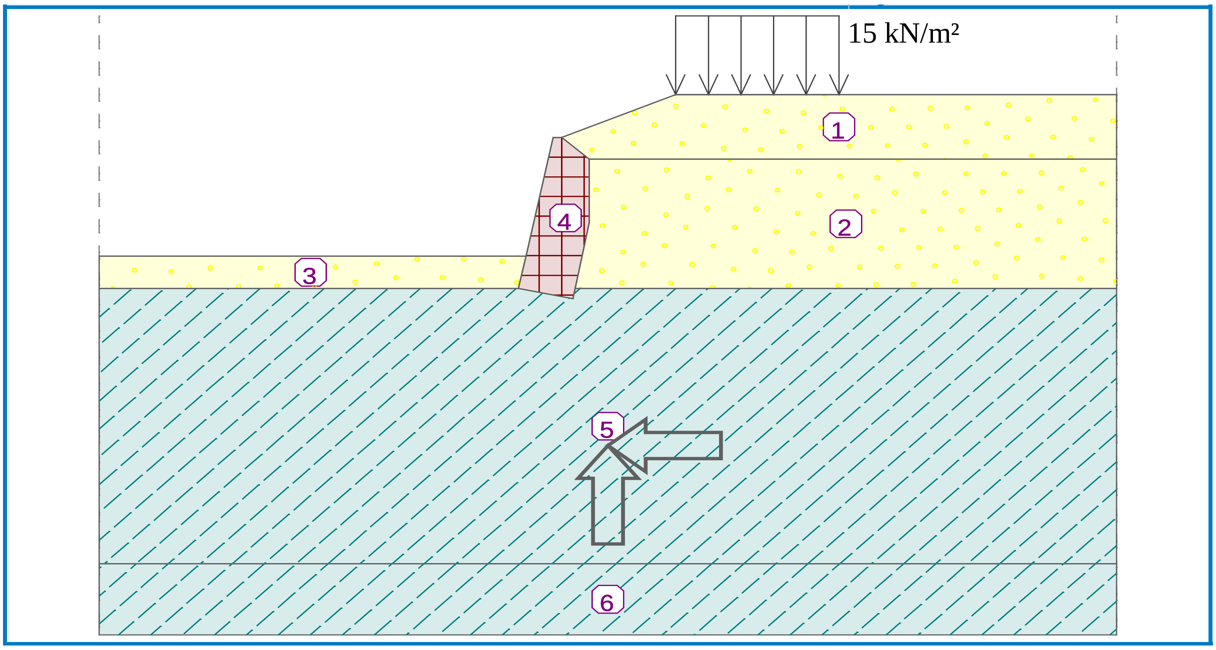

Figure 3. Section A Used Geo5 Program

Some points (1 to 6) shown in Figure 3.

- Point 1-2 : Soils behind the wall
- Point 3 : Fishing port area service road
- Point 4 : Gravity wall
- Point 5-6 : Limestone

Model Analysis

The simplified Bishop method neglects the interslices shear forces (Bishop, 1955). The factor of safety equations is derived by taking moments about the center of rotation. In the other words, the simplified Bishop method corresponds to the moment equilibrium factor of safety equation. In general, the difference between the simplified Bishop factor of safety satisfying both force and moment equilibrium, decreases as a particular slip surface has an increasing planar portion (Fredlund, Krahn & Pufahl, 1981).

As a result of numerical analysis studies made, the factor of safety obtained for overturning and sliding, bearing capacity and stability are given in Table 2.

When the result of the analysis is evaluated, the factor of safety for section A is greater than the value of 1.50 according to Bishop method. (FS>1.50)

Table 2. Factor of Safety in Numerical Analysis

Analysis Type		**Factor of Safety**
Wall Analysis	*Overturning Analysis*	1.88 > 1.50
	Sliding Analysis	1000 > 1.50
Bearing Capacity		1.57 > 1.50
Stability *(Bishop-Optimization)*		2.19 > 1.50

The most critical slip circle obtained with the optimization on the section and according to the Bishop method is also shown in Figure 4.

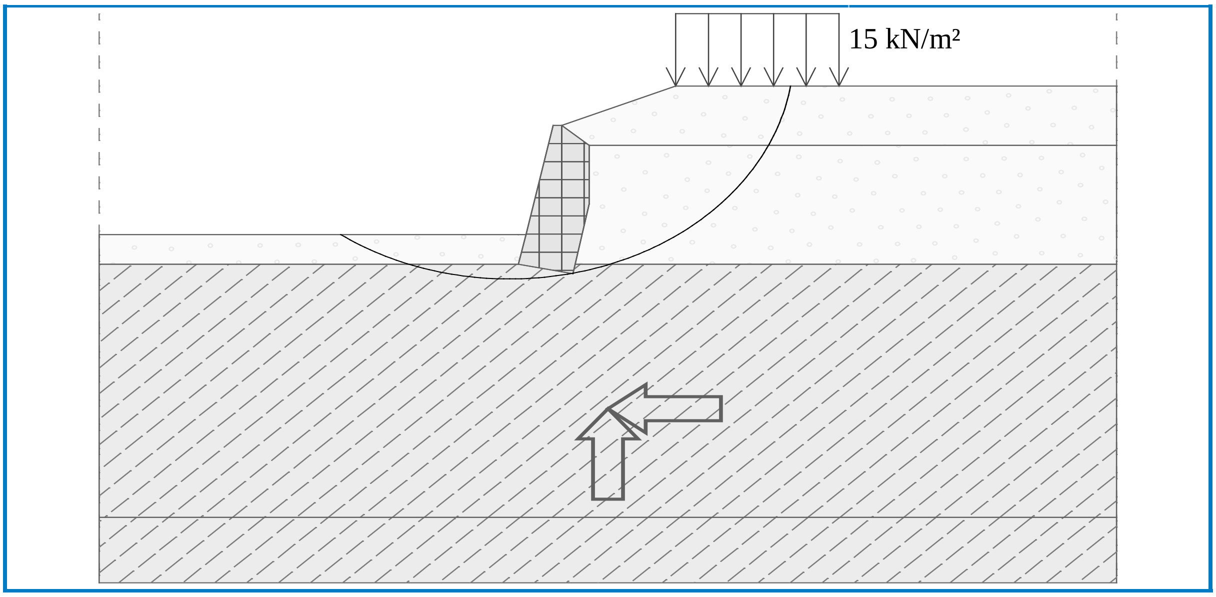

Figure 4. Most Critical Slip Circle

Conclusion

In this study, the factor of safety of the gravity wall were evaluated according to the Bishop method and the critical slip circle was determined according to numerical analysis. Site conditions and soil profiles were considered in this study based on literature and site studies.

It has been understood that there are no bearing capacity and settlement problems in the calculations made on the gravity wall located in the fishing port area. As a result of the numerical analysis, the factor of safety of sufficient magnitude were obtained in the wall investigations (overturning and sliding), bearing capacity and stability related to the gravity wall and no problems were observed.

References

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