Design of Cantilever and Gabion Retaining Walls for Slope Failure Caused by Hurricane Maria in Lares, PR

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Abstract

Due to the rain caused by Hurricane Maria there were various slope failures around Puerto Rico (PR). This project evaluates a failure in Lares, PR, road PR-124. The evaluation consists in mitigate that failure with two designs for retaining walls (Cantilever and Gabions).

Introduction

It is our 3rd anniversary of Hurricane Maria's passing thru the island of Puerto Rico (PR), and even though time has passed, the struggle at the island persists. This project is going to focus on the designs of cantilever and gabion retaining walls for slope failure due to Hurricane Maria, in Lares, PR (PR-124). To design these types of walls, an engineer must know the parameters of both the soil that is going to be retained behind the wall and the soil under the base slab, which are: the unit weight (γ), the angle of friction (Φ), and the cohesion (c). Both cantilever and gabion walls are under the category of Gravity Walls, which depend on their own weight to achieve stability (resist failure from overturning, sliding, and bearing capacity); they can be made of concrete, bricks, or stone.

Problem

Hurricane Maria caused various slope failures around the island, which means that those areas were affected and need a design to prevent slope failure.

Objective

- On this project we will create a design for both cantilever and gabion walls for the soil at Lares, PR.
- Provide a design that is easy to apply to other types of soil in the island.

Contributions

Some contributions made with this project are:

- Minimizing slope failures in PR by using this design for retaining walls.
- Preventing the high costs that involve the repair of such failures.

Methodology

The soil properties for both retaining wall designs are:

- Cohesion (c) = 0
- Unit Weight (γ) = 130 pcf
- Angle of Friction (Φ) = 32°
- The report gave various heights along the road, in this case we took the worst-case scenario which are the following:
  - Cantilever Wall – H = 20 ft
  - Gabion Wall – H = 21 ft

Figure 1.
Shows PR-124

Figure 2.
Shows the Slope Failure on PR-124

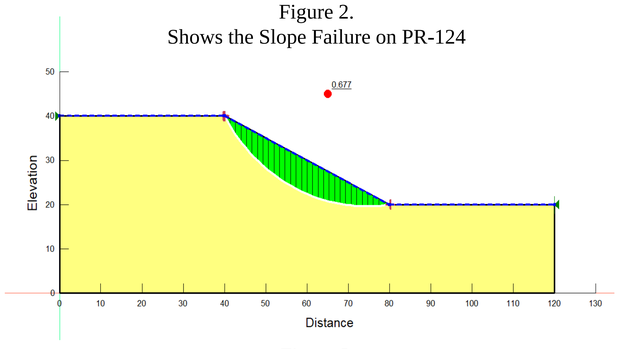

Figure 3.
Illustrates GeoSlope using the Piezometric Line

Results

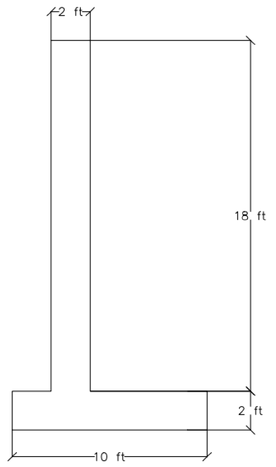

Figure 4.
Final Dimensions for Cantilever Wall

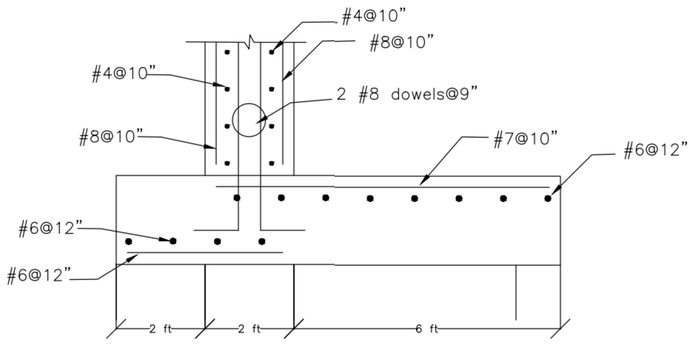

Figure 5.
Reinforcement Detail of the Cantilever Wall

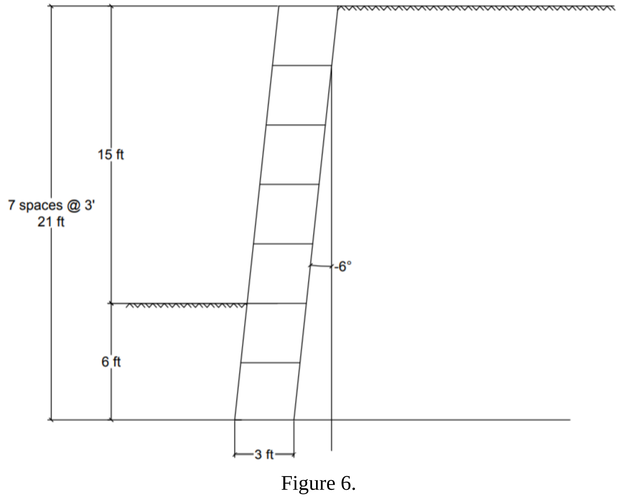

Figure 6.
Cross Section of Gabion Wall Design

Conclusions

Although Hurricane Maria caused devastation on the island, it gave people an impulse to innovate new ideas. While simulating the slope in GeoSlope with both conditions, saturated and dry, as expected, the most critical safety factor was the saturated, 0.677. The designs presented in this project came to be because of that devastation. Although this project takes place in Lares, PR, both designs can be used around the island.

Future Work

For future work it is recommended to:

- Evaluate and design the drainage for these walls, to avoid the premature failure caused by the increase in water pressure.
- Create other types of retaining walls and evaluate the costs.
- Use these designs at other cities of PR that had slope failures, and compare the soil types, type of failure, and how is most effective to mitigate the failure.

Acknowledgements

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