Project Scope

Retaining Wall Redesign

Grand Canyon High School
Grand Canyon Village, AZ

CENE 476
Due: 2/27/2018

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Table of Contents

List of Figures

N/A

List of Tables

N/A

1.0 Introduction

The scope of the project reviews all tasks and subtasks that are associated with the design of the project. This includes fieldwork, analysis methods, reports, drawings, deliverables, and methods of data collection. The main tasks of the scope will be surveying, geotechnical analysis, structural analysis, final plans, project limitations, and deliverables.

2.0 Surveying

Surveying will be done to understand the topography of the region. Measurements are done for reference points which determine the location of the planned structure, vertical and horizontal positioning, dimensions, configuration, and the determination of elevation of the proposed structure.

Research, reconnaissance, control, and mapping of the project area are the tasks in the initial phase of the engineering project. The result of this work is used for design, detailing of plans, and estimation of the project costs.

2.1 Surveying Fieldwork

Fieldwork will consist of shooting various points around the retaining wall in order to create a topography of the area. This will ensure if the site of the retaining wall will hold moisture. Points will also be taken of the existing retaining wall to gather information on the length and the height so that the redesigned retaining wall is designed to the geographic constraints of the site.

Fieldwork includes recovery of existing vertical and horizontal controls points, augmentation and replacement of control stations that are necessary to control the project and performing random checks of the vertical and horizontal control network. It also includes checking vertical controls as necessary, comparison of resultant coordinates to the original, collection of confidence points to check and validate the terrain model and condition documentation.

2.2 Equipment

Surveying equipment, such as, Electronic Distance Measurement (EDM) and total stations are the main forms of survey data collection equipment and are the most readily accessible options.

Equipment that will be used for surveying the retaining wall site are as follows in the list below:

- Topcon/recon total station equipped with tripod.
- Prism and rod
- Data collector
- AutoCAD

2.3 Analysis

To reduce the survey data the use of AutoCAD will be applied. AutoCAD is useful in the sense that it can adjust a traverse loop using the standard compass rule method or other adjustment methods. The Civil 3D program within AutoCAD will provide an adequate way to plot the data collected in the data collector from the field survey [2].

Civil 3D reduces the costs of the client due to the less amount of time needed to create a model and increasing efficiency.

3.0 Geotechnical Analysis

The geotechnical analysis will determine whether the soil at the site of the proposed retaining wall will be sufficient for the wall design. This includes whether the retaining wall will be supported by the existing soil and how much pressure is exerted on the wall. The components of the geotechnical analysis are contained in the following sections.

3.1 Geotechnical Fieldwork

For the geotechnical analysis, soil samples need to be taken from the area of the proposed wall to test for the desired properties. Soil samples will need to be taken from the base of the wall, top of the wall, and middle of the wall if possible. In addition to this, soil samples will be taken along the entire length of the wall to see if the soil has generally the same composition for the entire length. If there are significant differences, the analysis will need to be broken up into different segments for the retaining wall. The only samples needed are general samples that will be taken in soil bags from each location on the wall. Collecting the samples will be done using a shovel or other digging device.

3.2 Soil Lab Testing

Once the soil samples are taken from the field, they will need to be tested in the soils lab for the necessary properties needed for the retaining wall analysis. For the analysis, the unit weight of the soil, cohesion, friction angle, and moisture content will need to be tested for. In addition to these properties, the soil will need to be classified to better understand how it will react to water and stress being applied. To test for the unit weight of the soil samples, a known quantity of each sample will be taken and weighed, the

weight per quantity of soil is taken as the unit weight. Finding the cohesion, or cohesive strength, helps determine what percentage of each soil sample is clay. Cohesion also depends on much water is present in the soil. The lab test needed to find cohesion is the direct shear test, which is done using a direct shear machine [3]. The friction angle of a soil is used to analyze the friction strength of soil based on the minerals, particle shape, gradation, and void ratio. The direct shear test is also used to find the friction angle of the collected soil samples [3]. The moisture content of each soil samples will be tested using the moisture content test, which weighs soil samples as they sit and after being dried in an oven [3]. Pore water pressure is related to the moisture content, but is simply the unit weight of water multiplied by the depth of the point where pore water pressure is being analyzed. Other soil tests that will need to be done are a sieve analysis to classify the soil based on particle size and a triaxial test.

3.3 Retaining Wall Stability Checks

Once the soil properties of existing soils are found, the geotechnical stability of the retaining wall will be analyzed based on these found properties. Depending on what the soil properties are, an engineered fill might be needed. The stability of the wall is determined by three tests that check for overturning, sliding, and soil bearing capacity. The overturning check ensures the retained soil pressure does not cause the wall to overturn about the toe of the wall foundation [4]. An overturning failure would result in the wall being tilted outward, pivoting about the foundation toe [4]. The sliding check makes sure the retaining wall will not slide along the soil interface due to the lateral pressure imposed by the retained soil. A sliding failure can also happen from the passive force of the soil at the front of the wall not provided enough of a resisting horizontal force. A sliding failure could result in the retaining wall being pushed out by the soil being retained with no moment failure [4]. The last stability check is the bearing capacity check, which makes sure the soil under the retaining wall can support the weight of the wall and soil above it [4]. A bearing capacity failure would result in the retaining wall sinking down into the soil below the foundation.

The overturning, sliding, and bearing capacity checks all have a specified factor of safety that must be met. Typically, the overturning factor of safety is 2, the sliding factor of safety is 1.5, and the bearing capacity factor of safety is 3 [4]. If all three factors of safety are met from each of the analysis checks, then the retaining wall is geotechnically stable and will not fail due to soil conditions.

4.0 Structural Analysis

Structural Analysis will govern the final design of the wall. The analysis will consider data from the soil reports determined from soil analysis, topographic maps from survey

data, and any constraints related to the governing building codes. From the geotechnical analysis, structural calculations will be conducted to ensure the retaining wall will not fail from sliding, overturning, and bearing capacity. The material of the wall will also be chosen depending on the constraints of the wall and structural capacity. Structural calculations will govern thickness of the wall, height of the wall, and size of the footing. Depending on the type of wall and material used, the connections and reinforcement of the wall will also be designed. This information will be used to create structural drawings to be used solely for the proposed design of the wall.

5.0 Drainage Analysis

Drainage systems will be considered during the structural analysis of the proposed retaining wall, however, they will also depend on the final design. Hydrologic data will be analyzed for the quantity of flow expected around the proposed retaining wall. This will impact the type and method of drainage system used. The topography will be analyzed to determine paths of flow and layout of the drainage system. Depending upon the final design of the wall, drainage systems on, around, and through the wall will be considered and chosen depending upon the complete analysis.

6.0 Final Site and Wall Constructions Plans

Final plans will be built based on the information collected from fieldwork and analysis. Plans will include a site map which will show the location of the wall and the topography associated with the site, details section commenting on specifics for the design of the wall, and structural details for different sections of the walls.

6.1 Structural Plans and Details

For the completed set of plans there will be a details section entailing for whom ever is constructing it, what must be done. This includes and is not limited to the materials used in construction, standards that must be followed based on governing codes and regulations, and drainage. Construction materials will be the largest part of the details section as it will call out for the size of the material, the strength of the material, and where it is to be placed. The details are specifically for the construction of the retaining wall and does not include any analysis.

This section of the plans will include section cuts of the wall. Section cuts will vary depending on the height of the wall and the amount of soil in which the wall is retaining. The section cuts of the wall will show the footings of the wall, the height of the wall, the thickness of the walls, where drainage features will be located, and all dimensions associated with the wall. No analysis will be in these plans as that will be done prior.

7.0 Project Limitations

Limitations of redesigning the retaining wall will be based on the codes, regulations, and standards that regulate how a retaining wall is to be built. Coconino county's codes and regulations will guide in the building of the retaining wall. Coconino county adopts the International Building Codes from 2012 [5]. The Arizona State Historic Preservation Office limits the amount of fieldwork activity based on the archaeological and historical surroundings of the retaining wall [6].

7.1 Project Challenges

Traveling will be considered a challenge to this project as the location of Northern Arizona University is approximately an hour and a half away from the Grand Canyon High School. Also, weather conditions can hinder traveling since snow conditions can be hazardous and potentially delay travels. Vehicle considerations will also be of a challenge as a large enough vehicle will be required to carry the capstone group and equipment needed for fieldwork.

7.2 Exclusions

Exclusions are any work not noted above and specifically the following: building permits or costs/fees that pertain to getting the retaining wall approved and the construction of the wall which includes all tasks associated with actually building the wall.

8.0 Project Deliverables

Project deliverables include everything that will be completed in CENE 486C such as design aspects, meeting memos, peer evaluations culminating with the final report, website and presentation.

8.1 30% Design Report

A 30% design report deliverable that will be completed in 486 will include the first rough draft of the initial design of the retaining wall. It should comply with all codes and regulations and provide the best option for the client.

8.2 60% Design Report

The 30% will be followed up with a 60% design report which will use the feedback from the first rough draft to complete a report of a much higher caliber. The second draft will attempt to correct any mistakes in the first and build on it in the addition of anything that might have been left out.

8.3 Meeting Memos

Meeting memos will provide the graders and instructors with the details of each team meeting and the agreed upon course of action following the meetings.

8.4 Peer Evaluations

Peer evaluations will allow each member of the team to honestly report the amount of work each other member has provided to the capstone project.

8.5 Final Report

The final report will include all of the design and analysis done throughout CENE 476 and 486C. The plans, designs, analysis, data, and references will all be included with this deliverable.

8.5.1 Website

The website will be used as a means to present the project to the general public should they be interested in the topic.

8.5.2 Presentation

To conclude the project the team will present all design and analysis at UGRAD presentations for those that are interested in the topic.

References

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