Structures

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Structures

Structures is a new sub-team of Cornell AguaClara. The goal of the group is to introduce structural analysis into the AguaClara design process. In the past, AguaClara has not been responsible for the structural design of the treatment plants.

We are evaluating the structural design of the plant and providing guidance to improve seismic protection. We are also assessing the merits of rectangular vs. circular tanks when considering the Stacked Rapid Sand Filters. Clay brick, re-bar, mortar, and plaster are used to created waterproof tank walls, while poured reinforced concrete is used for the columns adding structural support to the tanks.

The Structure team is new to the AguaClara project. Professor Weber-Shirk created the team this semester to provide structural analysis for the growing number of Aguaclara water treatment plants. Currently, the automated design tool does not provide structural designs for the tanks. Our ultimate goal is to automate the design of the tanks including column spacing, column sizing, and rebar use when given the required tank height, width, and length.

The team focused on organizing data and resources in the form of e-mail correspondences and meetings with Cornell University professors to decide on the first problem to address. Following the meetings, the team decided to analyze the structural capabilities for the columns and walls using the specifications from the Alauca plant. We have been working in conjunction with Dan Smith and Santiago Garcia to obtain relevant information about the AguaClara plants.

Overview of our Work

Our main objective we wished to accomplish this semester was to create a means of automating the design of the columns and walls for the design tool. We began this work by analyzing the structural capabilities of the columns and walls for the Alauca plant.
There are three different load cases that guide the design of the columns and walls of the tank. The first case assumed that the tank walls were supported by the surrounding backfill. The second case assumed no support from this backfill. The third case analyzed the structural importance of the rubble which lies at the base of the sedimentation tank.

For our analysis of the walls, we modeled them as closely spaced columns. The plans for the Alauca plant show vertical rebar that runs through these walls will add flexural support. By modeling the walls as columns we accounted for this vertical rebar. Modeling the walls as a combination of individual columns also allowed us to use the same tools and procedures that we used for the analysis of the columns. We set the moment at initial cracking as our first failure moment. We determined this moment by using the Transformed Moment of Inertia method. We also wanted to know the moment that would render the walls and columns to no longer be structurally intact. This would be the largest moment that these walls and columns could experience before ultimate failure. We believed that this value would be of importance for future analyses which would incorporate earthquake conditions. For this ultimate failure analysis, we used the Column Interaction Diagram. This method plots the area of all axial load and moment cases that a column would be able to support safely. A full report with calculations and conclusions can be found in our Structures Team Final Report Spring 2011 document.

We also explored how changing key variables such as cover depth, rebar size, and strength properties of the materials used affected the moment capacity of the walls and columns.

All the documents used in our analysis this semester are found under the "Documents" section.

Members

Kester Wilkening

Documents

	Challenges	Tasks	Teach-In	Presentation
Summer '11	? Unknown Attachment			
Spring '11	? Unknown Attachment	? Unknown Attachment	? Unknown Attachment	? Unknown Atta

Column Design Spreadsheet
Flexural Analysis Spreadsheet

MathCAD Files

Moment Due to Water Pressure MathCAD
Column Interaction Diagram MathCAD
Transformed Moment Method MathCAD

Moment Capacity vs. Column Variables Documents

Cover Effects
Beta1 Values
Rebar Effects
Column Dimension Effects

Past Research

This is a new team with no past research.