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Date: 10/11/2020

Subject: Individual Analysis Memo

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1 Introduction

This document revisits the first semester analytical task assignment based on the base support structure of the vertical farming design. The vertical farming design is composed of an aquaponics setup combined with a small-scale vertical farming system. This design will target everyday homes interested in farming their own vegetables. The design will include troughs that guide water under the roots of chosen plants. The water coming from the aquarium below, using nutrients from the fish to feed the plants. Over the span of five months, the design changed to better suit the resources available to the team. One such design change was the material of the base support. During the initial phases of design, it was decided that Unistrut would be the best choice for overall structure of the vertical farming system. However, after an analysis of the cost per unit, the design team chose to split the structure between Unistrut and wood.

During the first analytical analysis, the Unistrut was calculated to withstand all estimated 1500 pounds of equipment stored above the stand. The analysis consisted of a force balance combined with the known properties taken from a Unistrut site. A similar analysis will be conducted for the now wooden base stand. This change is due to a smaller than anticipated budget and therefore certain design changes occurred to better suit the design budget.

2 Analysis

For the analysis, it was assumed that water within the aquarium weighs ~8.33lbs per gallon [1]. This was the same assumption during the first assignment. For the 125-gallon fish tank that will be used, 1,042lbs of force will be uniformly distributed on top of the wooden stand. The values for wood had to be averaged instead of having a specific table of load limits that were provided for the Unistrut. To calculate whether the wood stand will handle the expected loading, calculations were made to make a relation of expected load to handling load of the wood. With a tank of dimensions 6x2x2 ft, the square footage of the system is estimated to be 12sqft. Looking online for strength values of wood, the compressive strength for Douglas Fir wood is 7230psi [2]. To make the comparison, the following equations were used:

$$A = L * W \qquad \text{Equation 1}$$

$$S_{est} = F/A \qquad \text{Equation 2}$$

Here, area was calculated using Equation (1) and then the estimated strength was calculated using Equation (2). The force is the anticipated force load from the tank as well as the equipment which is currently estimated to be 1500 lbs. This includes the tank weight, fish tank equipment, and the vertical farming supplies to include the troughs. The estimated compressive strength was, after a unit conversion to psi, 2.08psi. In comparison to the rating of the wood, the anticipated load falls well within the range of a safe and reliable base. The only thing to take into consideration past this point is the construction.

The frame construction has varied slightly in comparison to the Unistrut frame. More material has to be used in order to have a dependable structure. One example of the wooden base is shown in Figure (1). The base would have thicker support beams at the corners and at the center.

Figure 1: Aquarium Stand

3 Conclusion

In conclusion, the project has undergone numerous iterations in design. The final iteration now includes a wooden support structure instead of the Unistrut. The primary reason for this change was a smaller budget which required a cut in cost for the overall project. Despite the changes, the new support system will still withstand the anticipated weight force of the vertical farming system and the aquarium.

4 References

[1] Engineeringtoolbox.com. 2020. *Convert Gallons Of Water To Pounds*. [online] Available at: <https://www.engineeringtoolbox.com/water-gallons-pounds-d_1710.html> [Accessed 11 October 2020].

[2] Workshopcompanion.com. 2020. *Wood Strength*. [online] Available at: <http://workshopcompanion.com/KnowHow/Design/Nature_of_Wood/3_Wood_Strength/3_Wood_Strength.htm> [Accessed 11 October 2020].