Modular Farming Project

Distribution Center and Modular Farming Units

Civil Engineering Department: Group 17

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GROWTH BLOCKS

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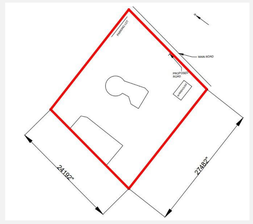
Background

The modular farming project develops an innovative model for agricultural produce and sales. Its objective is to minimize food waster during distribution and sales process by providing a transportable, alternate, easily scalable, and customizable way of growing various types of organic produce locally, as close as possible to the point of use. The targeted users are consumers who have needs for fresh agricultural produce, such as restaurants, grocery stores, schools, and individuals.

Site Selection and Environmental Assessment

The site of the distribution centre was determined by comparing two pres-selected sites in rural Great Toronto Area. A multi-criteria decision analysis method, also known as the Weighted Sum Method, was used to evaluate which site was more optimal based on the following aspects:

- Geographic details
- Zoning plans
- Historical uses of land
- Topography
- Soil conditions
- Climate and weather
- Transportation plans
- Environmental effects



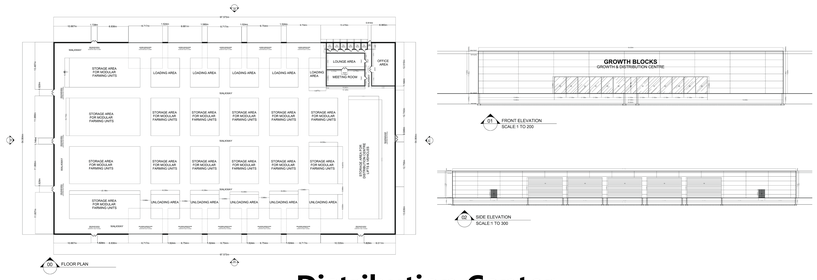
General Site Plan

Upon completion of the environmental assessments of the two pres-selected sites, the designated site for the distribution centre was determined to be 5567 Sixth Line, Milton, Ontario.

Traffic Analysis

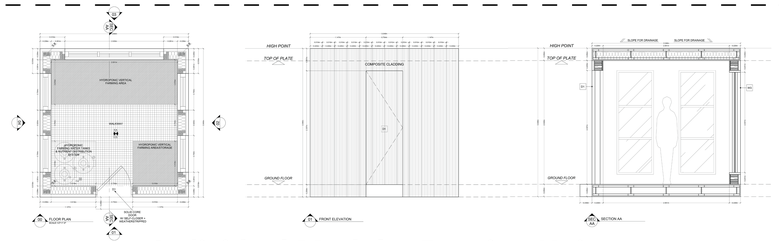
The traffic was modeled by Synchro to determine the impact of the project. A suggested 3.5% increase in traffic depicted smooth traffic flow with minimal congestion. The LOS of the intersection was found to be a C, and when considering a more extreme value of traffic, the LOS would be a D, also acceptable under the Ontario Traffic Manual. Furthermore, traffic and safety signs will be installed on the property and by the new lane into and out of the distribution centre to promote safer roads.

Architectural Design



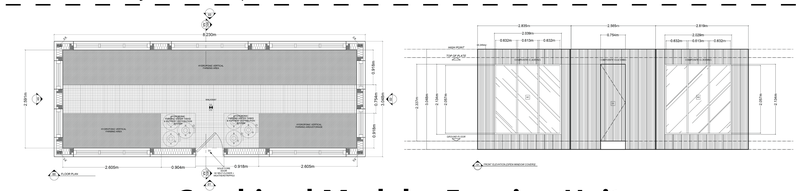
Distribution Center

It is a one-story building which has a floor area of 5334 m² and a height of 7.6 m.



Individual Modular Farming Unit

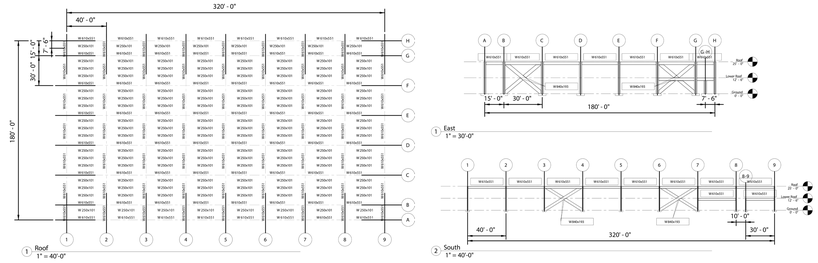
An individual unit is a cube of 3m x 3m x 3m. The modularity of each unit makes it easy to transport and assemble on-site.



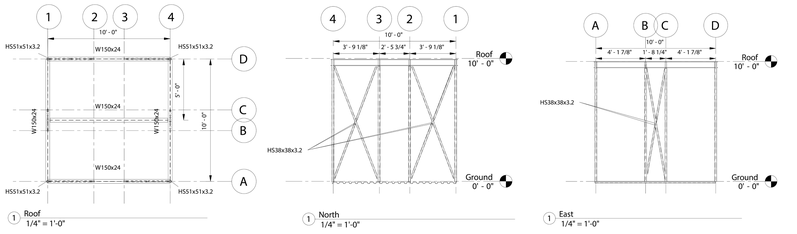
Combined Modular Farming Units

The users can customize the placement and orientation of the units by stacking them vertically and/or horizontally depending on their objectives and amount of available space.

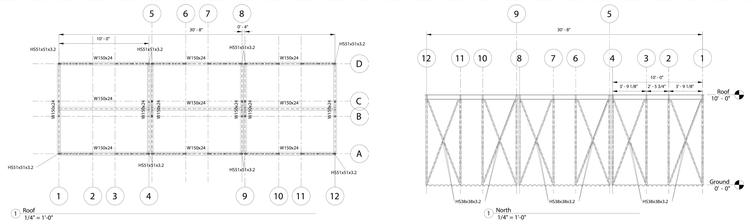
Structural Analysis



W Sections were mainly used to withstand the different kinds of loads applied to them.

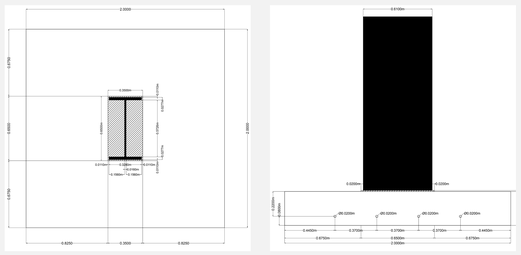


Hollow Structural Sections (HSS) were mainly used in order to save more spaces for doors and windows and to reduce the total weight of the unit.



All structural design were determined based on CISC handbook after multiple iterations.

Foundation Design



Square Footing

Size:	2.0m x 2.0m x 0.15m
Structural Reinforcement:	4 x 20M @370mm
Depth of Embedment:	0.6m
Bearing Capacity:	212.5 kPa
Settlement:	15.5 mm

Comparing to a rectangular combined footing, the square footing is more favorable for the project in terms of the economical benefits. The square footing was designed to meet the CFEM requirements of a 2.5 factor of safety and a maximum settlement of 25.4mm.

Building Science and Sustainability

In order to make the building more energy efficient, building science and sustainable measures have been taken into accounts. Specifically, the heat loss and cooling loads of the distribution center were calculated based on ASHRAE handbook. It was determined that the maximum cooling load is approximately 100.8 kW at 17:00 and the maximum heat loss is 1,889 kW.

The team will also implement the **hydroponic vertical farming system** in the modular units. In comparison of transitional farming models, the hydroponic system has a smaller water footprint due to its closed loop system that recycled water.

Another sustainable measure the team will use is the **tubular lighting system** in the distribution center, which maximizes the use of the natural light, and therefore reducing the needs for electrical light.

Cost Estimation

The cost estimation was preformed for both the distribution center and the modular unit, considering the construction cost, utility costs, and transportation cost. The construction was calculated using RSMEANS, while the others were calculated based on research. The overhead is assumed to be 10% of subtotal, profit margin for sub-contractors is 7%, 8.5% AE fee and 10% contingency.

The total cost for the distribution center and modular unit is just over $8,100,000 and $39,000 Canadian Dollars respectively. Transportation Expenses would be a total of $107,000 for each driver per year. Utilities would cost around $52,000 per year and Maintenance cost would be $6000 per year for modular units and $17,000 per year for distribution center.