Vivo Expansion Project

Monica Doerksen, Quintin Lee, Mahima Maheshwari, Ryanne Nasser, Kathleen Rombano, Calem Schalm, Momal Tahira
ENCI 570 - Capstone Project S4

Figure 1: Conceptual Design [1]

Introduction

Objective

The objective of our design was to meet the structural requirements in an efficient and sustainable way without undermining the utility of the indoor park.

Project Purpose

The indoor park will allow for a wide-open green space during the winter months. This is especially important at a time when seasonal depression sets in. By designing for a large span, the community will gain access to a large uninterrupted green space.

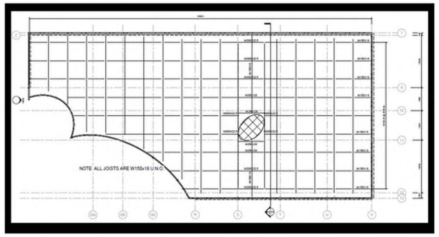


Figure 2: Floor Plan

Scope

In depth designs of various components of the indoor park including:

- Roof framing
- Interior and perimeter columns
- Lateral load resistance system
- Concrete foundation design, primarily considering foundation piles, pile caps, and grade beams
- Connections between structural members

Challenges Faced

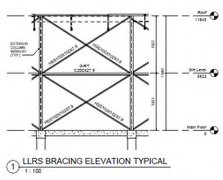
- **Unsupported span**
- The indoor park did not allow for intermediate supports, so the roof had to span 70 m x 33 m
- **Skylight**
- The Skylight disrupted uniform distribution of members
- The raised skylight creates a potential for increased snow load due to drifting

Design Methodology

We began by developing four preliminary roof designs (two wood & two steel) to use as a basis for comparison. Analyzing the preliminary designs based on the criteria below, a steel framing system was selected to be developed further. Using an iterative approach to limit material consumption, the final design saved roughly 70 tonnes of steel when compared to the preliminary design. Continuing with a collaborative approach to the design, we moved 'top-down' by then designing the LLRS, columns, connections, and foundations.

Design Criteria			
Cost	Sustainability	Structural Efficiency	Constructability

Final Design



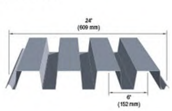


Figure 3: Roof Decking Used [2]

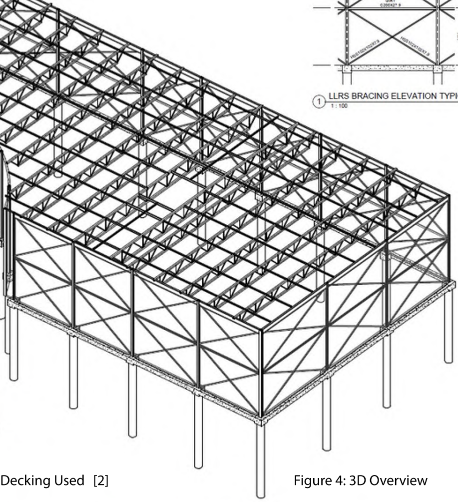
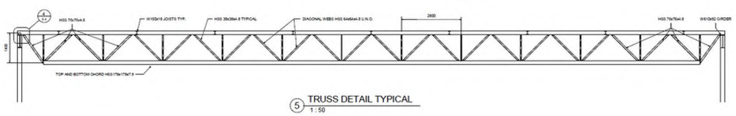
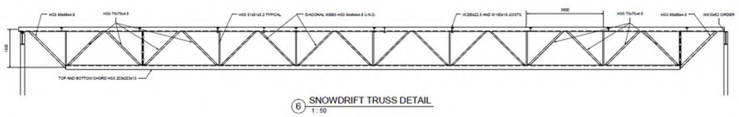


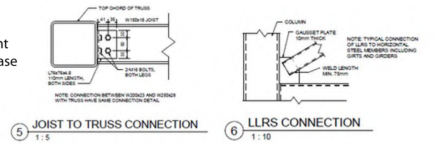
Figure 4: 3D Overview

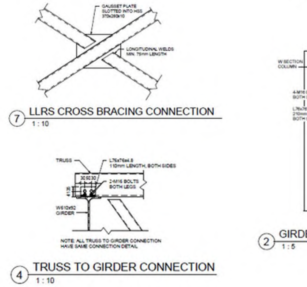


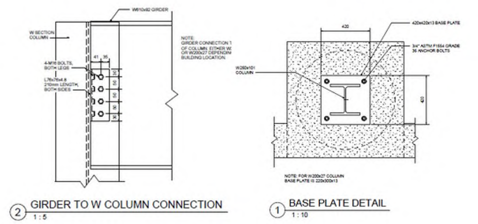


Foundation and Connection Design

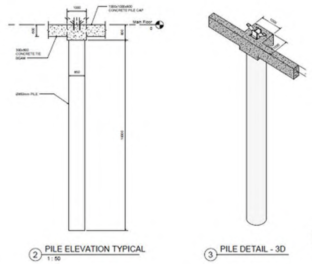
The main connections are detailed to the right and below. They were designed in a way to ease construction while still maintaining structural integrity.

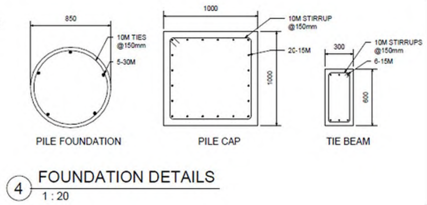






CFA Piles offer an environmentally friendly and sustainable solution in urban and sensitive locations because it eliminates vibrations to the adjacent structures. Limiting noise and vibration were primary design criteria, as there's an ongoing school, swimming pool, and a public library adjacent to the construction. expansion site.





Conclusion

Table 13 – Steel Design Cost Comparison								
Option	Roof deck Area (m^2)	Roof deck Cost ($/$m^2$)	Total Mass due to Joists (t)	Total Mass due to Beams (t)	Total Mass due to Girders (t)	Total Mass not including decking (t)	Installation Cost ($/kg)	Total Cost ($)
Original	1100	100	8.7	134.2	27.1	170.0	4	$789,800
Revised	1100	100	5.0	115.0	15.8	135.8	4	$653,200
Truss	1100	100	5.0	45.4	15.8	66.2	8	$547,800

LLRS Element	$178,617
TRUSS SYSTEM	$547,759
Interior Columns	$70,315
Total Cost	$796,691

Figure 5: Total Material Project Cost

The final design cost is shown in Figure 5 (left) and was minimized from the original design cost of $789,800 + LLRSS and column costs. There were also additional costs added to the final design with snow load and skylight reinforcements. The minimized cost will allow for a lower cost of admission and less environmental impacts.

References: [1] DIALOG Design. (2020). Vivo expansion drawing package [PDF].
[2] Products, V. B. (2021, December 9). Roof Deck RDS938 / RD306. Vicwest. Retrieved April 2, 2022, from https://vicwest.com/products/roof-deck-rd938-rds938-rd306/
[3] Further references for design calculations and numbers can be found within the Vivo Expansion Project Final Report

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