Dalhousie Fitness Centre Addition

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Project Scope

Overview

Dalhousie University required a new building addition to the existing Dalplex facility in order to accommodate recreational needs for their campus. The new building houses the weightlifting and stationary workout equipment, as well as multi-purpose rooms that can be used for rhythmic activities.

Constraints

The new building must feature large spans in the open gym area to maximize space and usability. Also, vibration and noise to lower levels must be minimized, as this was an issue in the existing Dalplex facility.

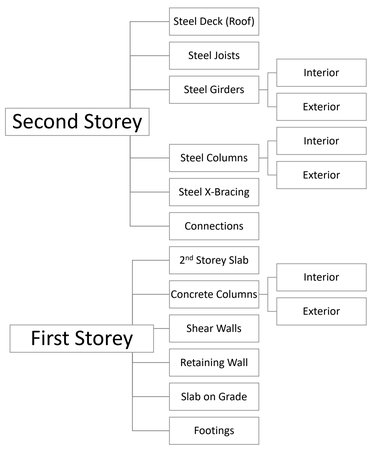
Architectural rendering of the Dalplex Addition.[1]

Design Process

Options Analysis

Three materials considered for construction were structural steel, concrete, and timber. Based on the design constraints, it was concluded that steel optimizes spans on the second storey, allowing the open spaces required for functionality; concrete was used for the slab to reduce vibration and noise, as well as for the first storey supports, allowing for a monolithic design and easy construction.

Top-Down Design Approach

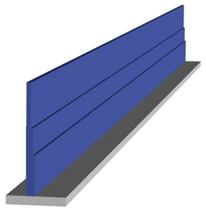


ETABS was used to complete a structural analysis, which was then checked with calculations done by hand.

Unique Features

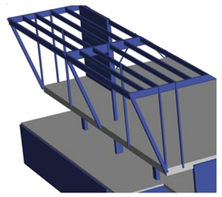
Basement Foundation Wall

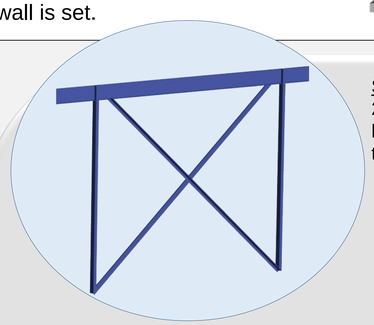
The North and East sides of the building are buried beneath soil, requiring a retaining wall that is 600 mm thick at the bottom, tapering to 300 mm at the top. This allows the soil to be backfilled as soon as the wall is set.



Cantilevered Roof Section

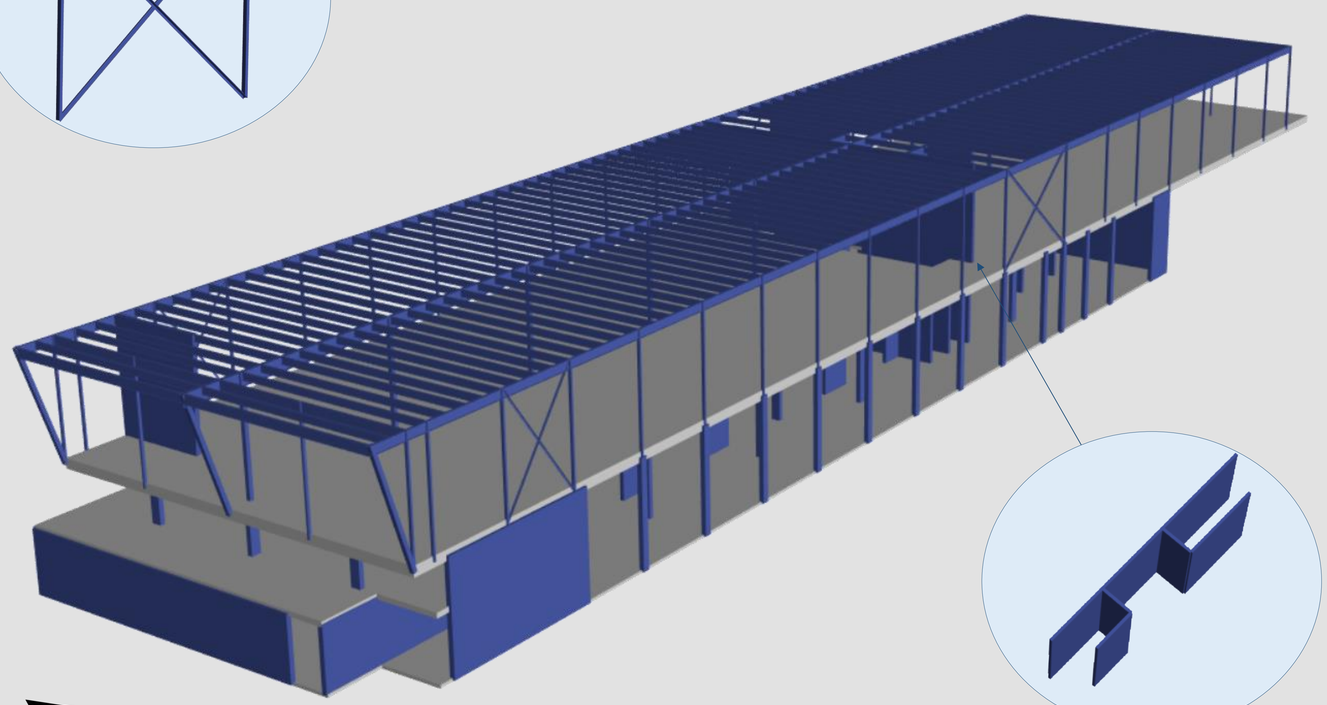
The West end of the building features a diagonal facing wall, which is supported by a cantilevered length of roof, and framed by HSS 254x254x7.9.





Steel X-Bracing

2-L102x76x7.9 act as lateral load resisting elements along the exterior of the building.

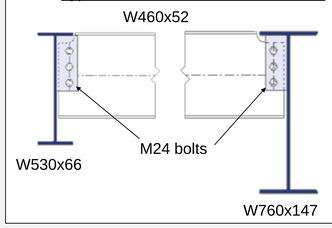


Concrete Shear Walls

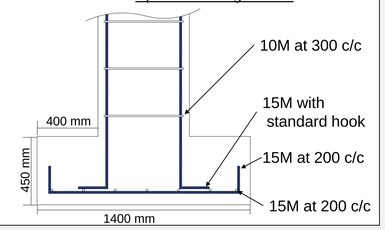
300 mm concrete walls in the centre of the building resist the majority of lateral loads.

Connections and Details

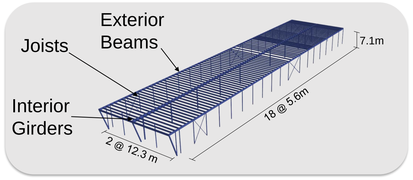
Typical Steel Joist Bolted Connections



Spread Footing Details



Steel Elements



Joists
Span: 12.3 m
W460x52

Exterior Beams
Span: 5.65 m
W530x66

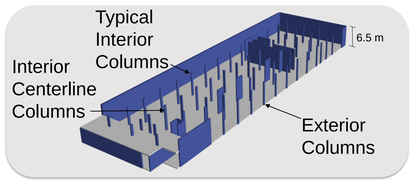
Interior Girders
Span: 11.3 m
W760x147

Interior & Corner Columns
HSS 254x254x7.9

Exterior Columns
HSS 254x152x7.9

Steel Deck
38 mm, 18 gauge

Concrete Elements



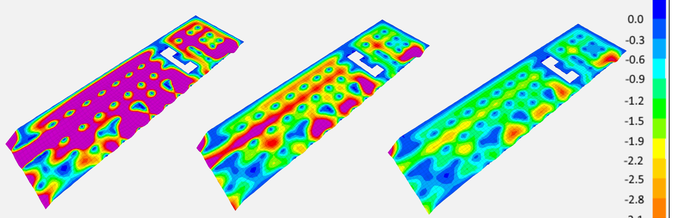
Interior Centerline Columns
600x300, 12-25M bars

Typical Interior Columns
600x300, 12-15M bars

Exterior Columns
450x300, 8-15M bars

300 mm Slab
15M at 300 mm c/c typ. with spacing reduced where required for strength.

Deflection Analysis of the Concrete Slab



200 mm
Δ = 7.9 mm
Inadequate

250 mm
Δ = 4.9 mm
Inadequate

300 mm
Δ = 3.4 mm
Adequate

SAFE software was used to complete a deflections analysis to determine the size of the second storey concrete slab.[2] For linear elastic analysis, 4.0 mm is the suggested maximum acceptable deflection in order to minimize vibrations.[3] To achieve this, a 300 mm slab is required.

Cost Estimate

Using historical data, a "Class A" cost estimate was performed for the Dalplex Addition.[4] This class of estimate is accurate to within 5-10% of the actual cost to construct the building.

The Class A cost estimate for the Dalhousie Fitness Center Addition is $18,900,000.

References

1 Webber M. J. (2016). New fitness facilities set for completion in 2018.
2 Computer & Structures, Inc. (2019). ETABS, SAFE.
3 Allen D.E., Pernica G. (1998). Control of Floor Vibration.
4 Plotner, S.C. (2018). Building Construction Costs with RSMeans Data.