PERFORMANCE EVALUATION AND POTENTIAL UPGRADE OF THE CALGARY INTERNATIONAL AIRPORT GEO-EXCHANGE SYSTEM
Project 10

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Abstract

- Exploration of challenges and improvements in the geothermal exchange system at Calgary International Airport for achieving net-zero emissions by 2050.
- Initial ideas generated to reduce ground temperature for dual-mode operation, including resizing system, water treatment, energy load redirection, or resizing mechanical equipment. Decision matrix led to prioritizing optimization of load profile.
- The proposed solution entails redesigning the system to correct loading and restore ideal operation, by reintroducing heating to rebalance the system within five years through a planned simulation using ANSYS Fluent to analyze U-loop heat transfer characteristics.
- **Goal:** Propose design solutions to aim for a balanced system with reduced ground temperatures for optimal operations.

Introduction

- Performance evaluation and potential upgrade of the Calgary International Airport Geo-Exchange system.
- Commissioned in 2016, the geo-exchange system at the Calgary International Airport serves the International Terminal Building for space heating and cooling.
- Consists of 580 boreholes each drilled to a depth of 130-150 meters spanning the gross-floor area of 167,225 m^2.
- Current overloading has led to ground overheating, hindering thermal system's ability to provide effective cooling and heating. Resulting in the system working only in one mode.

Engineering Design Goal

- **Generate a long-term thermal load profile** to convert the saturated state in the ground heat exchanger into a steady state operation.

Methodology

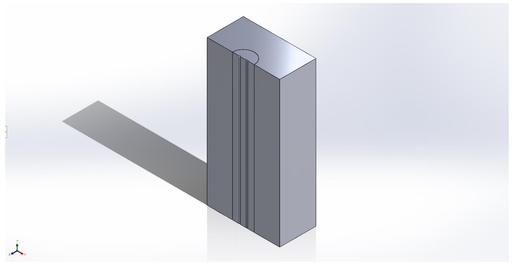
SolidWorks Design

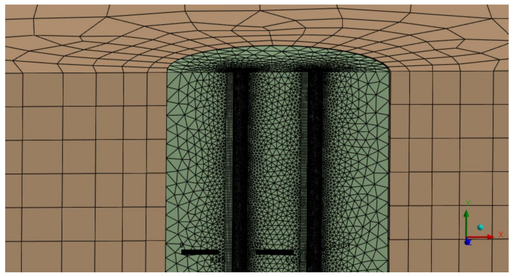
- Develop a single U-loop model in SolidWorks.

ANSYS Fluent

- Utilize Fluent solver to evaluate the current performance of the Calgary International Airport's geothermal exchange system by simulating a normalized load profile (heating/cooling) spanning a 5-year period.
- Based on simulation results, modify the pre-existing load profile to optimize the performance of the Calgary International Airport's geothermal heat exchanger system
- Perform a second simulation using the optimized load profile
- Validate results using experimental data

Note: Original Load Profile Provided by Calgary International Airport.





Challenges

- **Knowledge:** Understanding the system and its lack of performance with prior knowledge.
- **Complexity:** Design the borehole model as a digital twin to imitate the real-life behaviour of the ground heat exchanger.
- **Time:** Resource intensive computation to simulate the borehole model through an iterative process.
- **Execution:** Execute user defined code to generate the load profile, wind speed, and ambient temperature.

Demonstration and Application

- Implementing the load profile requires precise control.
- **Intent**: To match designed thermal load profile from the simulation.
- Measuring equipment (temperature sensors) are required to control the return temperatures of the heat exchanger via BMS monitoring and the sequence of operations.
- Class 3 Cost Estimate to Implement Solution: **$16, 781.38**

Load Profile Comparator Software

- Tabulates data and generates graphs between the designed load profile and the current load profile recorded in the system.

QR Code to GitHub Repository

References

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