# Geotechnical Centrifuge Experimental Facility (GeoCERF)

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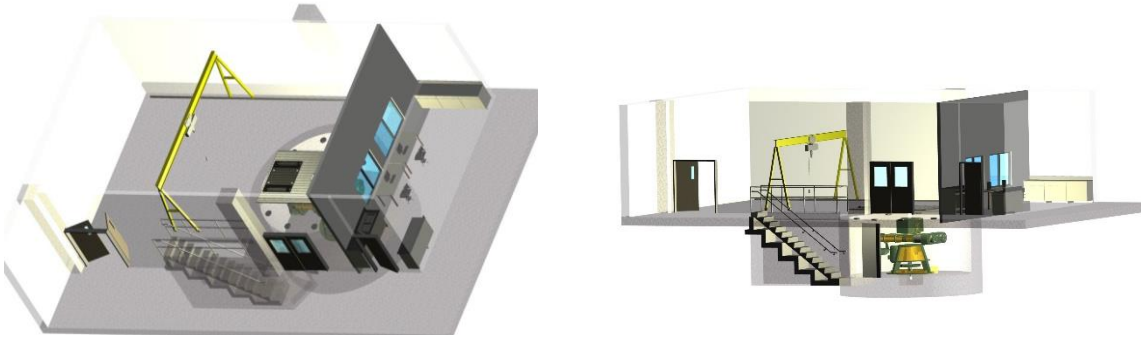
## Introduction

The Geotechnical Centrifuge Experimental Research Facility (GeoCERF) currently operates the only geotechnical beam centrifuge in western Canada. Located at the University of Alberta in Edmonton, Canada and operated by members of the Reservoir Geomechanics Research Group, the team in GeoCERF carries out research as well as commercial testing services for Canadian and international academics and industrial clients. Our Geotechnical Centrifuge offers researchers a time machine, allowing them the ability to peer into the future by condensing vertical stress data collection from decades to days. Research carried out in GeoCERF advances knowledge in areas as diverse as the energy sector (mining tailings and cold heavy oil production with sand), structural engineering (helical pile testing), and other tests requiring long-term data from vertical stress. The team in GeoCERF was named a finalist in the 2019 ASTech Awards in recognition of their ability to deliver decades of data in a matter of days.



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## Key Technical Specifications

| **Beam Centrifuge** | |
|---|---|
| Manufacturer | Broadbent |
| Year established | 2012 |
| Radius to base of soil container | 2 m |
| Capacity | 50 gton (500 kg @100g, 335 kg@150g, max G-level: 150g) |
| Bucket area | 0.6 m x 0.6 m |
| Major equipment | Consolidation cell/tub with miniaturized T-bar and CPT<br>Strongbox with dual-axis actuator platform<br>Cold Heavy Oil Production with Sand (CHOPS) vessel<br>Earthquake simulation shaking table (under construction) |

## Beam Centrifuge

A geotechnical beam centrifuge is a type of centrifuge used to simulate the effect of gravity on soil and soil bearing structures. The centrifuge works by spinning at high speeds, generating a centrifugal force that mimics the gravitational forces present in the field. This enables researchers to study the behaviour of soils and structures under simulated field conditions, including their response to earthquakes, landslides, and other natural disasters.

The beam centrifuge at GeoCERF consists of a large, cylindrical rotor that is driven by an electric motor. The rotor is suspended on a horizontal beam and rotates about a vertical axis. With an effective diameter of 4 m, the centrifuge can be accelerated up to 100g carrying a payload of 50 kg (or equivalently 5tons at 1g). The test platform has a working area of 0.6 x 0.6 m, where the model is placed.

The beam centrifuge at GeoCERF is equipped with a number of sensors and instruments that enable researchers to measure the response of the soil sample and structure models to the centrifugal forces. These include strain gauges, accelerometers, pressure transducers, load cells, lasers/LVDTs, high-frequency high-resolution imaging, miniaturized T-bar/CPT probe, dual axis actuator, etc. Data collected from the beam centrifuge experiments can be used to develop models and design criteria for soil structures such as foundations, embankments, and retaining walls.

GeoCERF geotechnical beam centrifuge

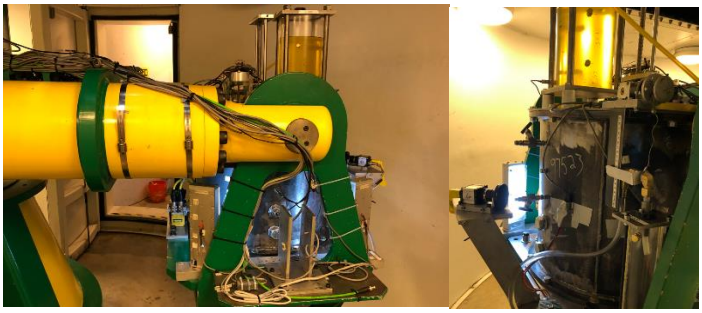
### Tailings Consolidation

GeoCERF has designed and commissioned multiple iterations of consolidation cells suitable for variable prototype size and boundary conditions, allowing them to complete more than 80 studies on consolidation of mine tailings for both Alberta and international mine tailings operators. State-of-the-art instruments and sensors employed in the modelling package include T-bars, miniature CPTu, miniature pressure transducers, and load cells with the capacity to perform both single-lift and multi-lift deposition scenarios under different drainage conditions.

Simulating the self-weight consolidation of multi-lift tailings

## Innovative Prototyping and Engineering

In addition to our own research, GeoCERF has collaborated with academic partners within the University of Alberta as well as across Canada on a wide range of geotechnical and geomechanical experiments including miniaturized centrifuge models of SAGD cap rock, helical piles in foundations, 3D printed fractures, and prototyping of oil production, wormhole foundation, and sand displacement in CHOPS (Cold Heavy Oil Production with Sand). The GeoCERF team also had the pleasure of testing the University of Alberta's 10cm x 10cm x 30cm QB50 mission Ex-Alta 1 CubeSat satellite prior to its launch on May 26, 2017.



Simulating the sand production in CHOPS