

University of New Hampshire Geotechnical Centrifuge Facility

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Introduction

Geotechnical Centrifuge is a convenient equipment for scaled physical modelling. A 5 g-ton Genisco centrifuge at UNH is suitable for seismic soil models, slope stability evaluation, seepage mechanisms and contaminant transport study, soil-structure interaction problems, miniature field testing, and fluid-sediment-structure interaction. An inflight hydraulic shake table enables the researcher to study the response of geotechnical systems under earthquake loads. Various types of container are available serving different research projects including several rigid containers and a laminar container. This lab is equipped with advanced measurement sensors including LVDTs, accelerometers, pore water pressure sensors, moisture content probes, laser transducers, and cameras, all being monitored and controlled through remote DAQ. The machine also equipped with four hydraulic slip rings to supply hydraulic oil to the shake table accumulators and also to provide fluid for potential infiltration tests. State-of-the-art miniature piezocones and also electric actuators are designed for in-flight penetration and in-flight static and dynamic loading scenarios. An electric actuator is available for pile lateral loading. Also, a wave simulation system is available to simulate fluid-sediment-structure interaction.



UNH Geotechnical Centrifuge Centre.

Key Technical Specifications

Beam Centrifuge	
Manufacturer	Model A1030 Genisco
Year established	2013 renovated at UNH (1985 RUHR University Bochum)
Radius to base of soil container	1 m
Capacity	5 g-ton (100 kg @50g, max G-level: 175g)
Bucket area	0.46-m by 0.59-m
Major equipment	Earthquake Simulator Infiltration System Load Actuator Miniature Wave Generator Miniature Cone

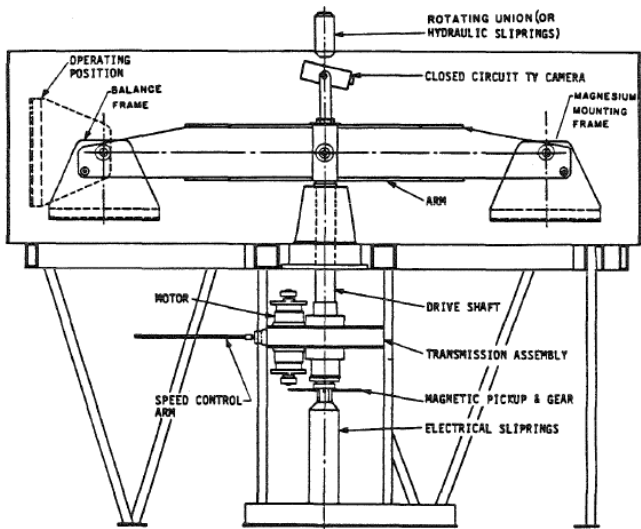
Beam Centrifuge

The beam centrifuge consists of an arm supporting two swings, in which the model and the counterweight are installed. Geotechnical Engineering Group in the Department of Civil and Environmental Engineering at the University of New Hampshire (UNH) maintains and operates the geotechnical centrifuge. This centrifuge is one of the oldest centrifuges in the US originated from the California Institute of Technology, which was later moved to the University of Southern California. In 2013, the centrifuge was moved to UNH and has been installed and re-operated. Since then, it is fully refurbished, modernized, and a new controller and Data Acquisition systems and testing capacities have been added.

The centrifuge is a Model A1030 Genisco g-accelerator with a 2-m diameter aluminum-alloy arm rotating in a horizontal plane. It is rated at 5 g-ton payload capacity. The 0.46 by 0.59-m magnesium mounting frames at both end of the arm can carry 100 kg or 30 kg payload up to 50g or 30g respectively. The absolute acceleration capacity of the basket is 175g. A schematic of the centrifuge arrangement and a picture of the inside of the centrifuge are shown in Figures below.



Geotechnical beam centrifuge refurbished and installed at UNH.



Centrifuge schematic.

Earthquake Simulator

A 1-D in-flight hydraulic shake table is mounted on one side of the arm for dynamic modelling of geotechnical systems. A special smart mounting frame shown in the Figure below was used. On each side of it, there is a row of four vertical cylindrical rods to support the test container. A hydraulic double chamber piston with a servo-valve is located at the center. Four horizontal bars are used to guide the test container. The electro-hydraulic system controlling the shake table includes the following parts. A HPS-6A Team Vibration Testing system hydraulic pump, the servo-valve, accumulators, the controller and signal analyzer, and a LVDT. Shake table servo valve control is a G-122-829-001 P-I servo-amplifier with compact DIN rail housing. The pump includes a 20 gallon reservoir with 5 HP motor and can supply up to 3000 psi pressure. To control the flow capacity of the hydraulic pump, two small accumulators (ZEMARC standard bladder accumulators) (1 gallon each) were fixed underneath the centrifuge arm. They can deliver extra flow of hydraulic oil very quickly during dynamic tests. A 5 gallon accumulator outside the centrifuge delivers oil to the inside ones. A second line returns the oil to the hydraulic pump. A LVDT was used to provide a feedback mechanism. This enables the controller to assess the performance of the valve and correct the movement if necessary.



Shake Table and Laminar Container.

A laminar container is used to control the boundary effects on the soil response. It was found to be an optimal solution because it simulates shear beam conditions in which the shear waves propagate uniformly through the soil specimen while minimizing the end effects. The centrifuge facility at UNH includes a laminar container with an inside dimensions of 355.6-mm long, 177.8-mm wide, and 254-mm height. It is composed of 19 rectangular aluminum rings, each 12.7-mm thick, and separated by a 0.6-mm gap between them. Linear bearings between the rings reduce friction during differential movement of the rings. A picture of the laminar container is shown in the Figure above.

Other Geotechnical Testing Modules

- The centrifuge is equipped with two separate slip-ring lines for simulating water infiltration, rainfall modelling, and unsaturated soil testing. In addition, water collection tanks are installed on the sides of the container for free water collection.
- A miniature, electrical load actuator is available for pushing miniature cones or applying lateral load to piles and foundations.
- A wave generator box is built to simulate fluid-sediment-structure interaction capable of simultaneous wave and physical loading.