University of California San Diego Geotechnical Centrifuge Centre

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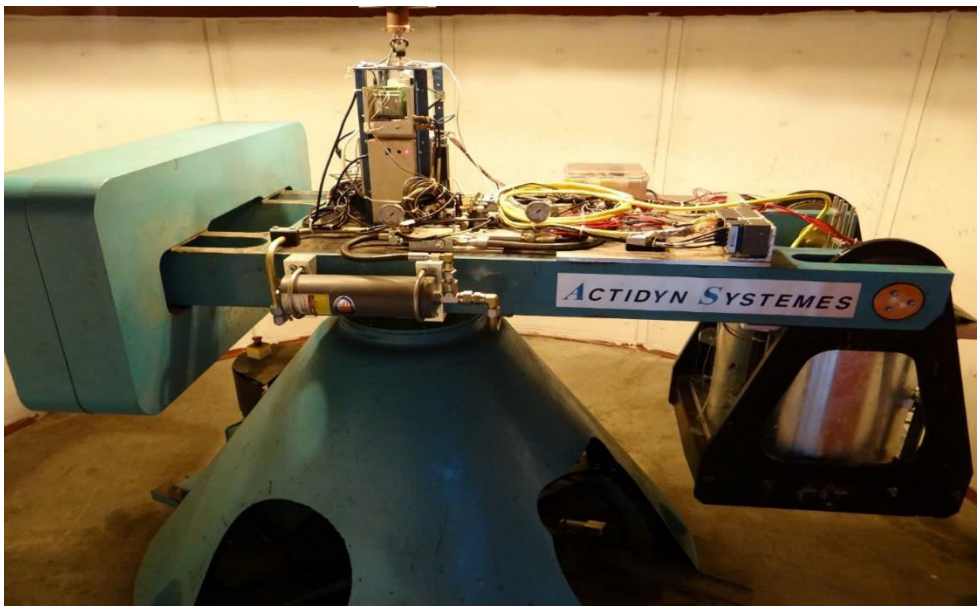
Location: La Jolla, California, USA

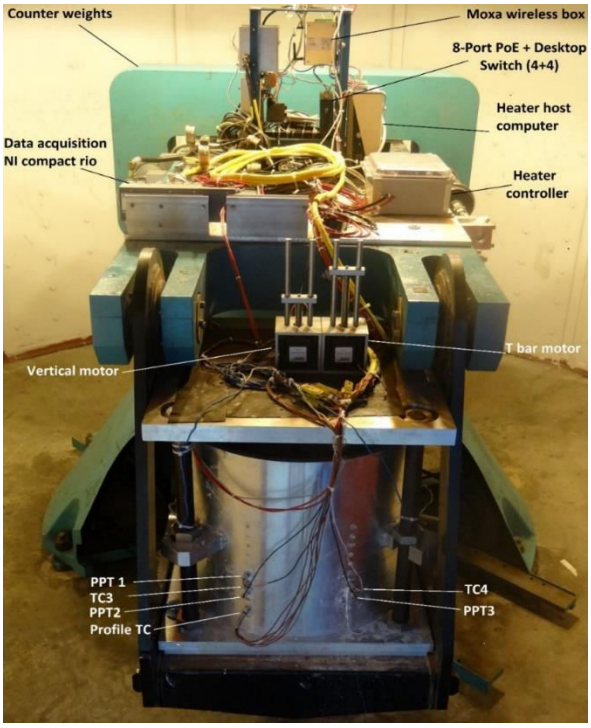
Introduction

The UCSD geotechnical engineering facilities include a 50 g-ton geotechnical centrifuge used for research, industry design, and instructional purposes. The swinging-basket type centrifuge platform can support a container with a maximum payload mass of 500 kg and footprint of 0.6 m by 0.7 m. This platform can accommodate boxes with a height of 0.6 m, with a maximum headroom of 0.75 m for offset actuators and loading devices. The centrifuge has been recently upgraded, with a new control room, power supply, a data acquisition system. The centrifuge was recently equipped with a servo-hydraulic shaking table and high-pressure pump for evaluation of the seismic performance of level ground, slopes, and retaining structures. A laminar container has been fabricated for use with the shaking table. Three cylindrical containers with integrated load frames are available that are suitable for testing thermal drains, energy piles, and offshore foundation structures in soft clay layers or compacted soil layers. One of these containers can also be used as a centrifuge permeameter for evaluation of the hydraulic properties of unsaturated soils. The data acquisition system for the 50 g-ton centrifuge was recently upgraded and includes a suite of NI CompaqDaq and CompaqRio chasses with modules suitable for signal conditioning of LVDTs, strain-gauge-type sensors (load cells, pressure sensors), accelerometers, capacitance-type differential pressure transducers, thermocouples, and cameras for image analysis. Motor control capabilities are also possible to operate brushed electric servomotors, solenoids, and electronic flow valves. Camera acquisition software can be used to track deformation of points or planes. The centrifuge includes a hydraulic rotary union with 2 lines to supply hydraulic fluid at pressures up to 200 MPa, and 2 lines to supply air or water under pressures up to 1 MPa. The laboratory has devices for mixing large batches of clay slurry and for consolidating clay specimens outside of the centrifuge. The centrifuge has recently been used to perform a series of pullout tests on offshore thermal energy piles (Ghaaowd and McCartney 2020; Ghaaowd et al. 2022) and a series of shake table tests on shallow rocking footings installed in sand layers with different ground improvement strategies (Newgard et al. 2022, 2023). The shake table tests were performed on a shake table designed and installed by Paul van Laak, within a laminar container custom designed and fabricated at UCSD and characterized by Zayed et al. (2017).

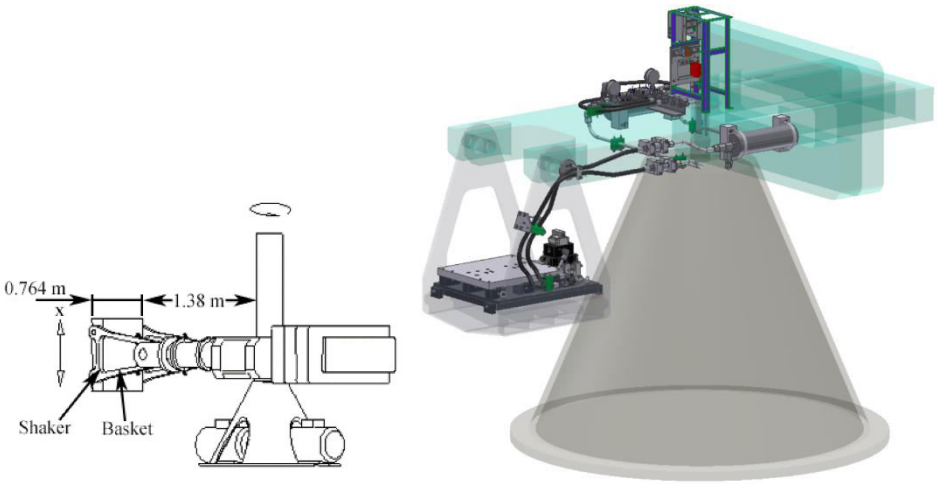
Key Technical Specifications

Beam Centrifuge	
Manufacturer	Actidyne
Year established	1999
Radius to base of soil container	2.144 m
Capacity	50 gton (500 kg @100g, max G-level: 130g)
Basket area	0.6 m by 0.7 m
Major equipment	• Soil containers with integrated quasi-static loading systems • Shaking table developed by Paul van Laak • Laminar container

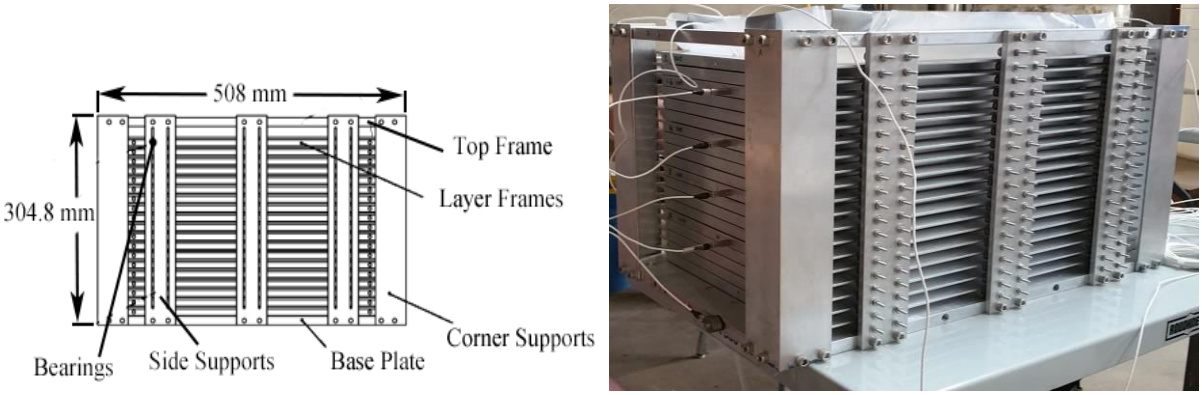




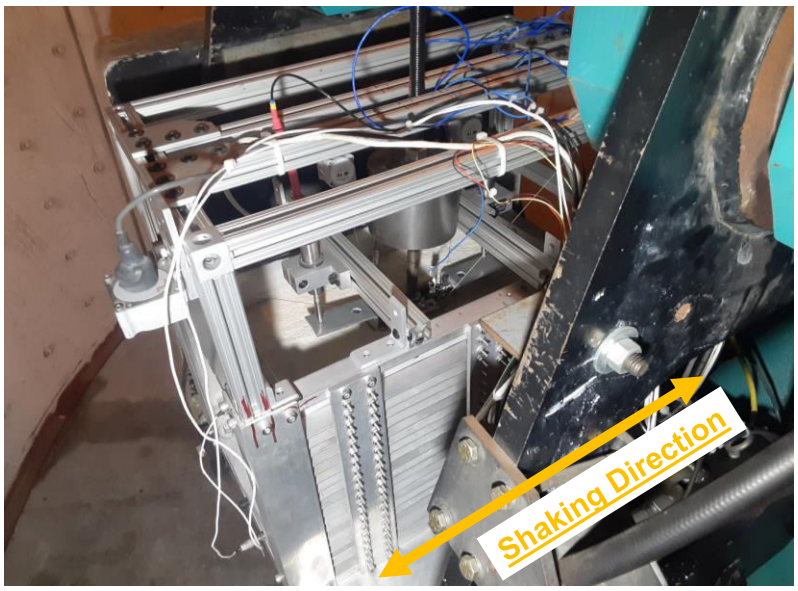
Pictures of the UCSD 50 g-ton centrifuge



Schematics of the centrifuge dimensions and layout of hydraulic system for the shake table



Laminar container (Zayed et al. 2017)



Laminar container mounted on centrifuge arm (Newgard et al. 2022, 2023)

References:

Ghaaowd, I., McCartney, J.S., and Saboya, Jr., F. (2022). “Centrifuge modeling of temperature effects on the pullout capacity of torpedo piles in soft clay.” Soils and Rocks. 45(1), e2022000822. Special Issue on Thermal Applications in Geotechnical Engineering. DOI: 10.28927/SR.2022.000822.

Ghaaowd, I. and McCartney, J.S. (2021). “Centrifuge modeling methodology for energy pile pullout from saturated soft clay.” ASTM Geotechnical Testing Journal. 45(2), 332-354. DOI: 10.1520/GTJ20210062.

Zayed, M., Luo, L., Kim, K., Elgamal, A., and McCartney, J.S. (2017). “Development and performance of a laminar container for seismic centrifuge modeling.” 3rd International Conference on Performance Based Design in Earthquake Geotechnical Engineering. Vancouver. Jun. 16-19. 1-8.

Newgard, J.T., Hutchinson, T.A., and McCartney, J.S. (2023). “Dynamic performance of model rocking footings on sand reinforced by soil-cement columns.” GeoCongress 2023. Los Angeles, CA. Mar. 26-29. GSP 338. ASCE, Reston, VA. 178-186.

Newgard, J.T., Hutchinson, T., and McCartney, J.S. (2022). “Centrifuge shake table tests on rocking footings on sand.” Proc. GeoCongress 2022. Charlotte. Mar. 20-23. GSP 334, ASCE, Reston, VA. 629-637.