

ERDC Centrifuge Research Complex

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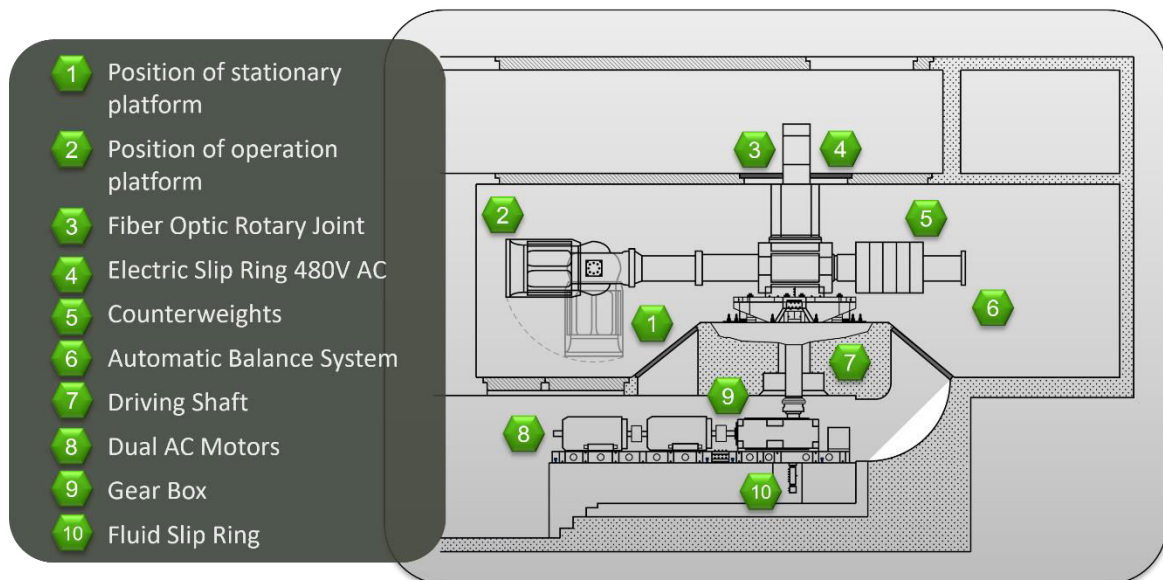
Website: <https://www.erdc.usace.army.mil/Locations/GSL/>

Owner: U.S. Army Engineer Research and Development Center (ERDC)

Location: Vicksburg, Mississippi, USA

Introduction

The ERDC Centrifuge Research Complex (CRC) supports research and model development for a 6.5 m diameter (1,200 gton capacity) geotechnical beam centrifuge, a cutting-edge earthquake simulator, and a variety of actuators and highly specialized devices and sensors in a recently upgraded secure testing facility. Our experimental infrastructure is predominantly used for civil works and military research. The CRC has a number of traditional research areas and scalable centrifuge problem sets which align with the U.S. Army Corps of Engineers research and development (R&D) priorities. In addition to traditional government partnerships, typical collaborators with the CRC include both domestic and international student researchers, faculty, academic institutions, and commercial organizations.



The centrifuge located at the U.S. Army Engineer Research and Development (ERDC).

Key Technical Specifications

| Beam Centrifuge | |
|----------------------------------|---|
| Manufacturer | Actidyn Systems |
| Year established | 1995 (refurbished in 2022) |
| Radius to base of soil container | 6.5 m |
| Capacity | 1,200 gton (8 tons @150g, max G-level: 350g) |
| Bucket area | 1.3 m x 1.3 m x 2 m |
| Major equipment | PVL ES-80 Earthquake Simulator (capacity 1.5 tons @120g) Teledyne multiple detonation and sequencer firing system S991 Phantom High-Speed Camera Automated sand raining system Downward hydraulic gradient consolidometer 2DOF Robotic loading system (under construction) |

Centrifuge

The U.S. Army Corps of Engineers (USACE) Centrifuge Research Center (CRC) was originally commissioned for operation in 1995 with a range of 10 to 350 g capability. The centrifuge was designed and built by Actidyn Systems. It can carry a maximum payload of 8.8 tons on its 1.3 m x 1.3 m platform which extends along a 6.5 m dual-beam arm from the center of rotation. The dual beam arm supports the platform via three straps on each hanger. The counterweights, opposite the platform, total 32,900kg. There is an integrated computer controlled auto balance system on-board of +/- 50kg for in-flight water or other dynamic loading eccentricities. At the maximum payload of 8 tons, the maximum gravity permitted is 150 g. At the maximum gravity of 350 g, the maximum payload is 2 tons. Its 1,200 gton capacity makes this centrifuge the most powerful in the US, and the second most powerful in the world.

The CRC consists of the centrifuge itself, the structurally hardened containment building, adjoining control building, and numerous ancillary systems and components which are all interconnected. Systems critical for operation include the safety interlocks, high-volume air circulation and cooling system, onboard air and water delivery systems, high pressure fluid rotary joint, on board data acquisition and transmission networks, lighting, heating - ventilation and air conditioning, video systems, dual drive motors, auto balance, master and slave variable frequency drives, controller, and remote-control computer. Each of these systems are linked through a 40 GB/sec fiber-optic network located across the two buildings and were fully refurbished or replaced between 2020 and 2022.



ERDC's geotechnical beam centrifuge recently refurbished (in 2022) and installed in Vicksburg, MS.

Earthquake Simulator

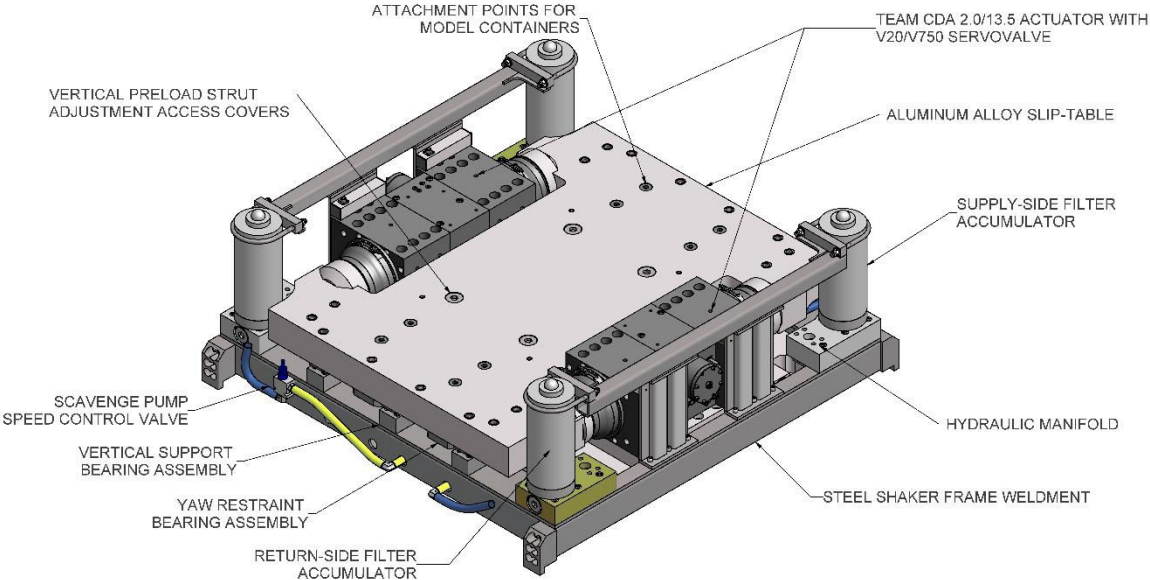
Custom-designed for the ERDC centrifuge, the Paul Van Laak (PVL) Technologies ES-80 earthquake simulator can deliver horizontal seismic ground motions of any target waveform (including recorded and artificial motions) on packages of up to 1,000 kg over a wide frequency band, at a maximum centrifugal acceleration of 150g. The shaker is integrated within a single structural frame, and is designed to be installed or removed from the centrifuge in a few hours using a forklift. Quick-

connects are provided on all hydraulic hoses to facilitate rapid installation and removal, and all electrical connections to the centrifuge are made using Mil-spec connectors for high reliability.

Twenty gallons of accumulator storage has been installed on the centrifuge for the supply circuit, which is sufficient to permit shaking for up to 1 second at maximum velocity with only a 33% drop in supply pressure; shaking at lower velocities can be carried out for proportionately longer durations. The system is controlled with a controller from Data Physics Corp.

Key performance specifications for the ES-80 shaker:

- Method: Servo-hydraulic multi-actuator system
- Shaking Type: Periodic or random, determined by input signal
- Shaking Direction: One direction
- Nominal Shaking Force: 5,515 Bar
- Maximum Table Displacement: 12.7 mm
- Maximum Table Velocity: 1,270 mm/sec
- Maximum Payload Dimensions: 63.5 cm W x 124.5 cm L x 58 cm H (laminar box)
- Maximum Centrifugal Acceleration: 150g



Schematic of the PVL ES-80 on-board earthquake simulator.