ISMGEO Geotechnical Centrifuge Centre, Italy

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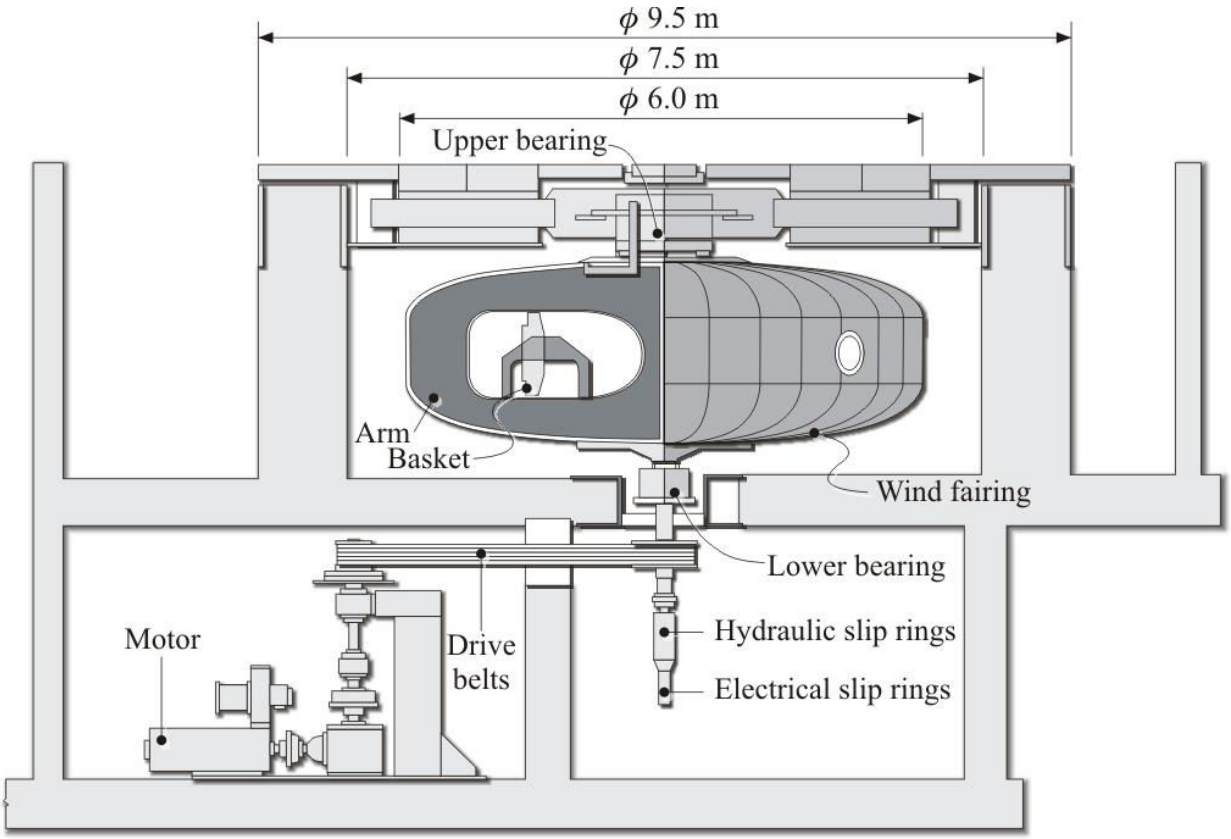
Introduction

The ISMGEO seismic geotechnical centrifuge (ISGC) is a beam centrifuge made up of a symmetrical rotating arm with a diameter of 6 m, a height of 2 m, a width of 1 m and a nominal radius of about 2.2 m to the model base. An outer fairing covers the arm and they concurrently rotate to reduce air resistance and perturbation during flight. The centrifuge has a 240 g-ton capacity, i.e. the machine has the potential of reaching an acceleration of 600g holding a payload of 400 kg.

The centrifuge is used both for research, teaching and consulting services. Recent experimentations covered the following topics:

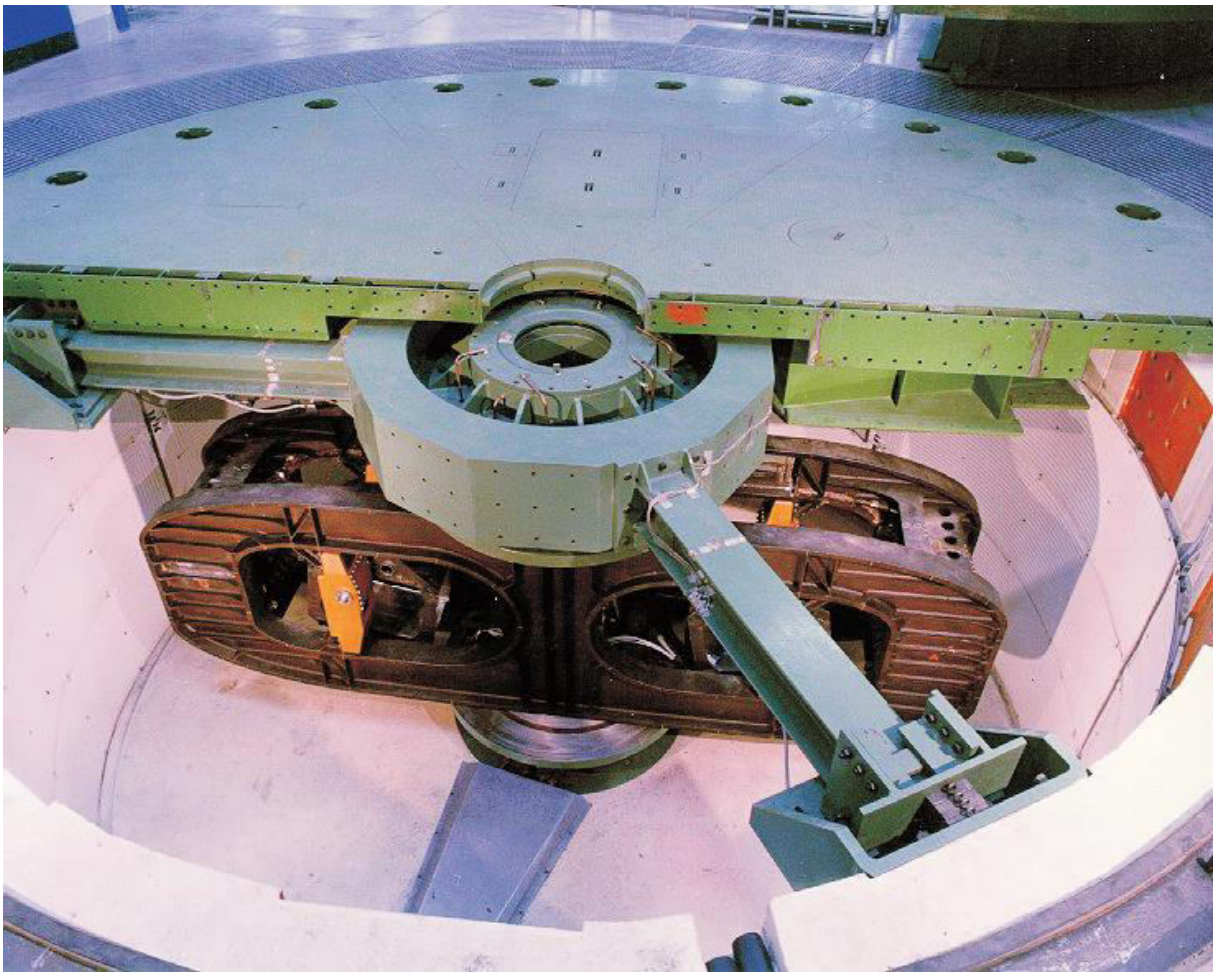
- Calibration CPTUS in silty soils and carbonate sands
- Liquefaction triggering and liquefaction mitigation techniques
- River embankment under transient seepage condition
- Zoned dams under seismic conditions



The ISMGEO Geotechnical Centrifuge Centre (GCC).

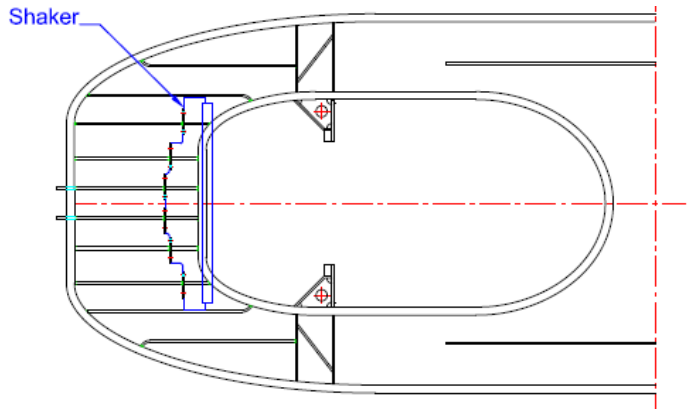
The centrifuge consists of a symmetric rotating arm. At each side, the symmetric arm holds a swinging platform which carries the model container, for static test at one side, for dynamic test at the other. At one side of the arm is fixed a single degree of freedom shaking table. The swinging platform which holds the model for dynamic tests is moved in contact with the table in flight and released before starting the dynamic excitation.
The unusual shape of the arm offers the following advantages:

- small distortion of the centrifugal field in the model, since its main dimension is parallel to the rotation axis;
- low deflection of the support plane of the swinging basket;
- easy location of instruments close to the rotation axis because of the absence of a central shaft across the arm.



Symmetric rotating beam beam.

The shaking table can work under an artificial acceleration field up to 100g and can provide excitations at frequencies up to 500 Hz and seismic accelerations up to 50g. The shaker can reproduce real strong motions at the model scale. The axis of motion of the shaker is parallel to the centrifuge rotational axis, thus problems related to Corioli's acceleration are avoided. The shaker is not integrated into the swinging platform, but is directly connected to the rigid arm: the model container is moved into contact with the table in flight and released before dynamic excitation of the model starts; the shaker forces are entirely transferred from the slip table to the model container by mechanical coupling.
The shaker was designed by TEAM corporation to fit on the centrifuge. The symmetric arm is of a particularly rigid construction, which makes it suited as reaction base for the shaker.



Lateral view of the centrifuge arm with shaker installed.

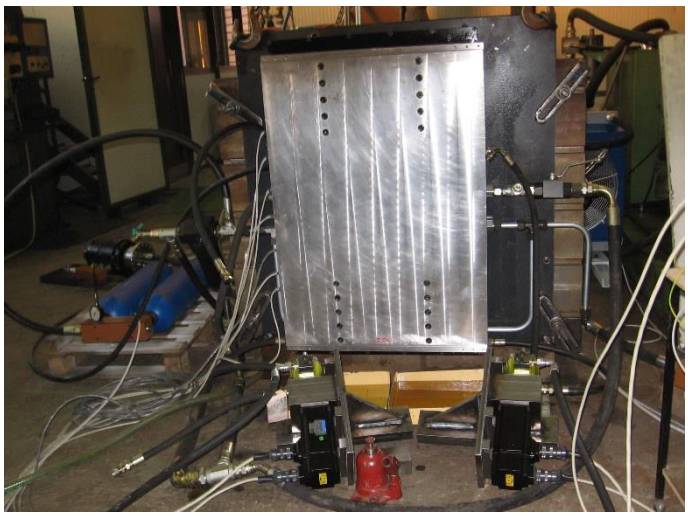
Two dynamically matched back-to-back mounted integrated shakers drive the slip table. These consist in an actuator driven by a two-stage V-100 servo-valve, and pressure and return side accumulators that improve frequency response. The actuator pistons are coupled, through hydrostatic pad bearings that allow rotation and lateral sliding between contact surfaces, to sliding beams fixed to the slip table. This configuration was chosen to maximize load capacity and actuator force in a compact construction that can fit into the available space. Hydrostatic T-film bearings support the slip table vertically by an oil film on the top surface of the T-film bearing housings and actuator bodies and restrains it axially with sliding beams running in hydrostatic bearing T-slots. This bearing system gives very low friction and high dynamic stiffness. All bearings are unsealed to improve reliability and reduce maintenance, which creates a major leakage flow collected in the shaker moat.

Pressure transducers located in the actuator chambers give pressure feedback and an LVDT mounted on the actuator body and connected to the sliding beam gives position feedback.

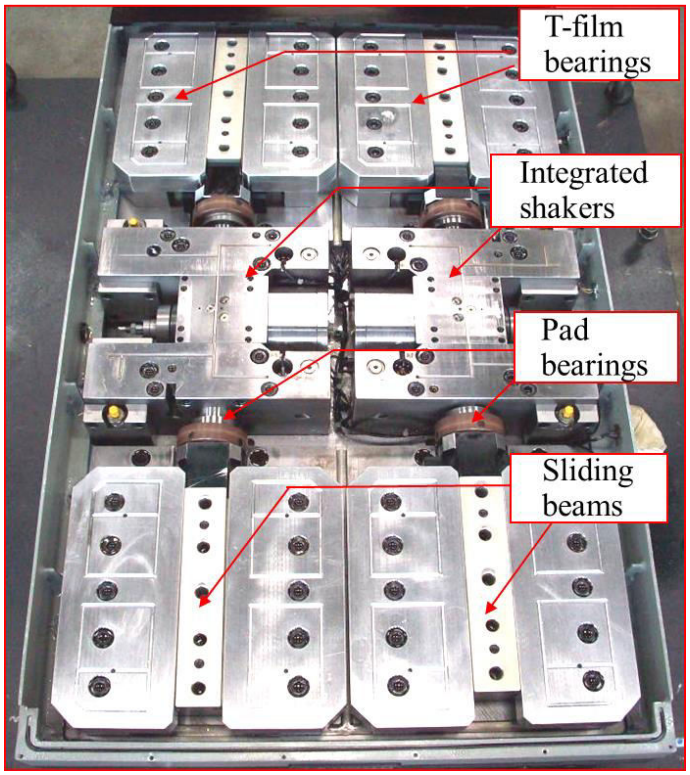
The external view of the table is shown in Figure 5. The table without the slip plate is shown in Figure 6: the T-Film bearings are located at the four corners, the Integrated Shakers are located between the bearings.

Driving a slip table with more than one actuator with separate lines of action requires that the actuators operates at the same force and in phase throughout the frequency band, to avoid the generation of a moment. The T-film bearings to which the slip plate is mounted have a very high dynamic load capacity. The bearings prevent large dynamic cross axis mo-tions and their presence eases the requirement for precise phase and amplitude control.

In the ISGC, the two actuators are driven by a two-stage servo-valves, the first is master, controlled by a T-2200 servo-controller, and the second is slave. The actuators need to be closely synchronized to avoid application of static moments to the sensitive hydrostatic T-film bearings. This is accomplished by force control. By monitoring the difference of pressure, the actuators can be dynamically matched. To this end four pressure transducers are installed, one for each actuator chamber, that give feedback to the servo-controllers.



Picture of the shaking table.



Slip Plate removed, view along the axis of motion

Key Technical Spefications

Beam Centrifuge	
Manufacturer	ISMES
Year established	1985
Radius to base of soil container	2.153 m
Capacity	600 gton (240kg @600g, max G-level: 600g)
Bucket area	length = 1 m, height = 0.8 m, with = 0.5 m
Major equipment	1 DOF Earthquake simulator
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Shaking table	
Manufacturer	Team
Year established	2010
peak operational g level	100 g
max frequency	1000Hz
Max payload at 100g	3.50kN
peak velocity	0.9 m/s
peak displacement	+/- 6.35 mm
max acceleration	50 g
full load acceleration	16 g