K-water Center for Centrifuge Modeling

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Introduction

K-water Center for Centrifuge Modelling, established in 2013, has been operating and managing one of the largest geotechnical centrifuge facility and carrying out physical modelling research programs. It is developing various physical modelling technology to promote number of experimental projects using the centrifuge and has been conducting research projects for safety evaluation of large water management systems and general geotechnical engineering problems. It also supports experimental research and development projects in construction engineering in the world using its own equipment and expertise.

Key Technical Specifications

Beam Centrifuge	
Manufacturer	ACTIDYN SYSTEMES (France)
Year established	2013
Radius to base of soil container	8.0 m
Capacity	800 gton (8 tons @100g, max G-level: 150g)
Bucket area	2.0 m x 2.0 m
Major equipment	Earthquake simulator (capacity 1.5 tons @ 100 g) Vertical 1D loading equipment (capacity 100 kN) Automated sand rainer, vaccum clay mixer

Centrifuge

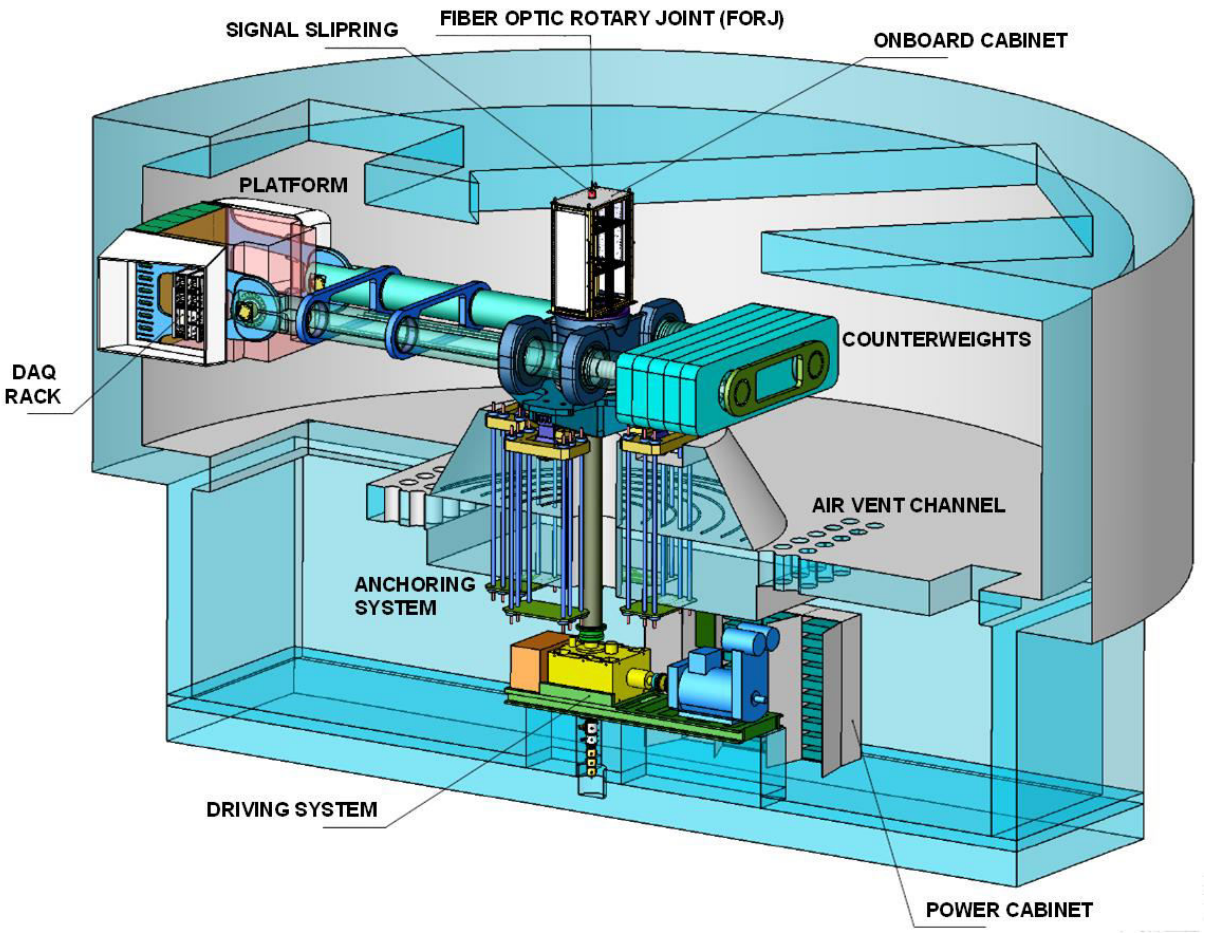
The centrifuge at K-water Research Institute was manufactured by ACTIDYN SYSTEMES, Elancourt, France, and its installation was completed in December 2012. The centrifuge was designed as asymmetric type, and this type of design has advantages of users' convenience on balancing and reduces aerodynamic drag force during operation. Therefore, it can also minimize the electrical power consumption for high g operation.

The platform radius of the centrifuge is 8.0 m, and the maximum capacity is 800 g-tonne so that the earthquake simulator with payload which weighs about 8.0 ton can be accelerated up to 100 g. The centrifuge is one of the largest in the world in terms of both platform radius and capacity. A model payload with maximum weight can be accelerated up to 100 g, and the maximum centrifugal acceleration of the system at a nominal radius of 7.5 m is restricted to 150 g with 3800 kg payload, which is enough to simulate most large dams appropriately.

The centrifuge is equipped with two different balancing mechanisms. Before running the machine, users move the primary counterweights which consist of three 18 ton metal plates to a certain location automatically calculated considering the weight and the center of mass of payload using a motor and gear system attached to the counterweight itself. Fine adjustment for unbalanced load during operation can be reached using an in-flight automatic balancing system. The unbalanced load is measured using strain gages at two blade shape metal springs among four anchoring systems. Two additional counterweights, which are cylindrical metal weights, are installed inside the arm tubes and they move by hydraulic actuators attached to the back end plate, so this mechanism adjusts the unbalanced load.

The centrifuge driving system consists of 3 major parts; the power drive, an AC brushless variable speed induction motor, and a gear reducer in the room below the centrifuge chamber. The motor and gear system operates according to users' command and rotates the vertical drive shaft which connects the entire system of the centrifuge.

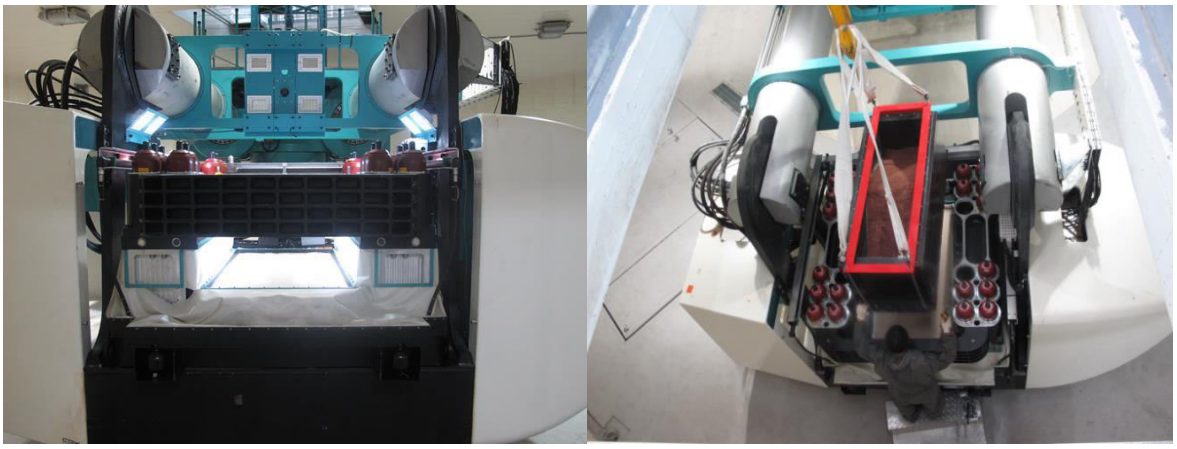
K-water geotechnical centrifuge


SIGNAL SLIPRING
FIBER OPTIC ROTARY JOINT (FORJ)
ONBOARD CABINET
PLATFORM
DAQ
RACK
COUNTERWEIGHTS
AIR VENT CHANNEL
ANCHORING
SYSTEM
DRIVING SYSTEM
POWER CABINET

Earthquake Simulator

The earthquake simulator of K-water is a self-balanced uniaxial shaking table. This system is basically designed for operation in 100 g centrifugal acceleration and the maximum shaking acceleration level is 60 g without any payload mass. Maximum 1500 kg payload can be installed at 1.8 m(L) × 0.8 m(W) platform, and maximum 22 g sinusoidal waveform motion from 20 to 350 Hz frequency range can be applied. Experiments using this system must be designed according to proper scaling principles considering the frequency response and allowable simulating acceleration capacity, because the response of this system depends on both payload and frequency of input motion.

The earthquake simulator has been designed and operated based on the dynamic balancing principle. There are counterweights with similar mass of the experimental model at the table, and dynamic balancing is achieved by reciprocal actuation of the model and the balancing counterweight. In this system, the dynamically balanced motion is obtained by close loop control of its parallel pairs of actuators. It is known that this offers better performance than any known type of mechanical bearing guidance associated with symmetry of construction. The dynamic balancing is important not only for simulating accurate input motion but for reducing the risk of damaging mechanical parts of the centrifuge itself.



In-flight uniaxial earthquake simulator at K-water Research Institute