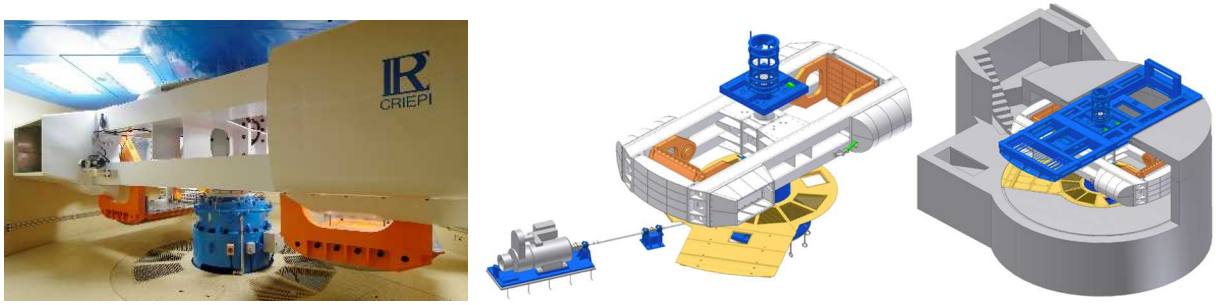
Geotechnical Centrifuge of CRIEPI

Director: Non-disclosure
Manager: Non-disclosure
Contact: https://criepi.denken.or.jp/cgi-bin/en/inquiry/inquiry_entry.cgi
Website: https://criepi.denken.or.jp/en/index.html
Owner: Sustainable System Research Laboratory, Central Research Institute of Electric Power Industry
Location: Abiko City, Chiba prefecture, Japan

Introduction

CRIEPI's geotechnical centrifuge has a maximum loading capacity of 1.5 tons, up to 100G, and can operate for a long time, up to 6 months. To take advantage of the characteristics of long-term operation, we have been evaluating the long-term coupled thermal-hydraulic-mechanical behaviour of high-level radioactive waste geological repository. In 2014, we installed a uniaxial horizontal shake table and have also been investigating seismic stability issues in the bedrock. And we are currently developing a 3D shaking table.



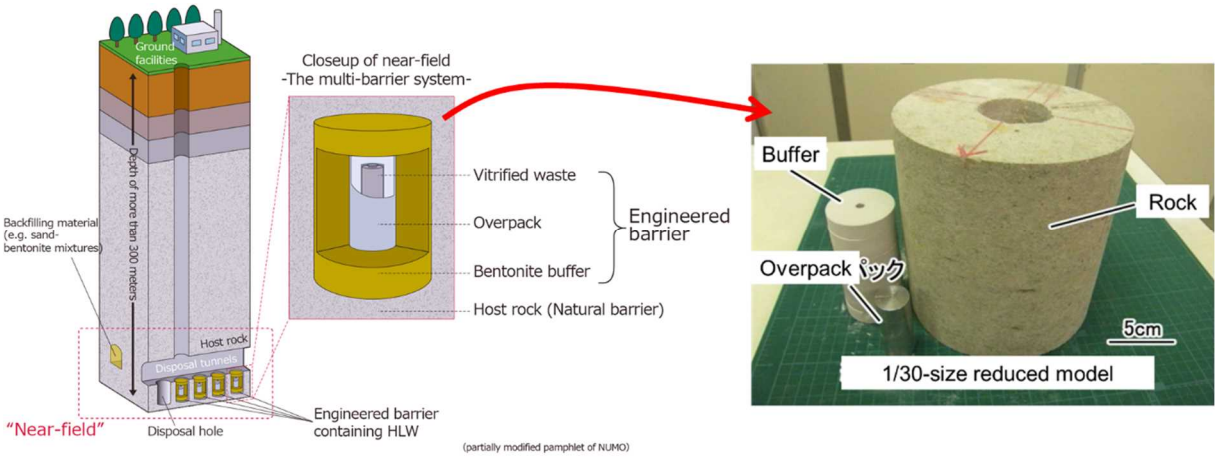
Geotechnical Centrifuge of CRIEPI

Key Technical Specifications

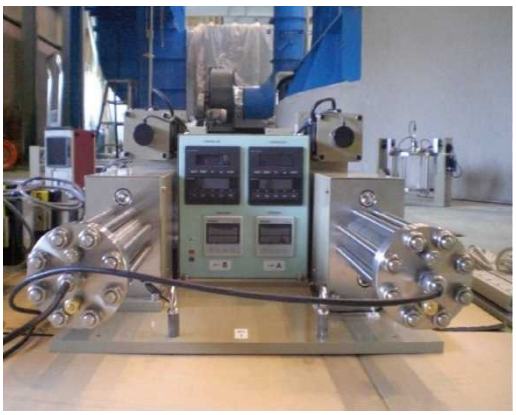
Beam Centrifuge	
Manufacturer	Sumikin Kansai Industries (currently, Nippon Steel Railway Technology)
Year established	2008
Radius to base of platform	3.2 m
Capacity	150 G ton (1.5 ton @ 100 G, max G-level: 100 G (static), 50 G (dynamic))
Bucket area	1.6 m x 1.65 m
Major equipment	(Static test) ・Water injection pressure pump (up to 20 MPa, 490 ml) ・Temperature control equipment (up to 100°C) ・Pressure vessel (300 mm-cube and 180 mm-cube and 180 mm-cylinder specimen. Confining pressure: up to 20 MPa, injection pore pressure: up to 10 MPa) (Dynamic test) ・Uniaxial horizontal shaking table ・Three-dimensional shaking table ・Soil container

Static test

In the static test, we use our centrifuge to evaluate the long-term behaviour of high-level radioactive waste geological disposal. Based on the similarity law of time acceleration, we estimate the behaviour of coupled thermal-hydrological-mechanical phenomena occurring in a repository over several hundred years by centrifuge model test. Since it is difficult to construct a scaled model of the entire repository, a model of the area around the disposal hole is used, and overburden pressure is applied by a pressure vessel and a water injection pump. The heat generated by the waste (overpack) is controlled by a temperature control equipment. Long-term equivalent data on the strain of the rock mass, the stress of the buffer material, and the displacement of the waste are obtained in the centrifuge test.



Schematic of the repository and its model

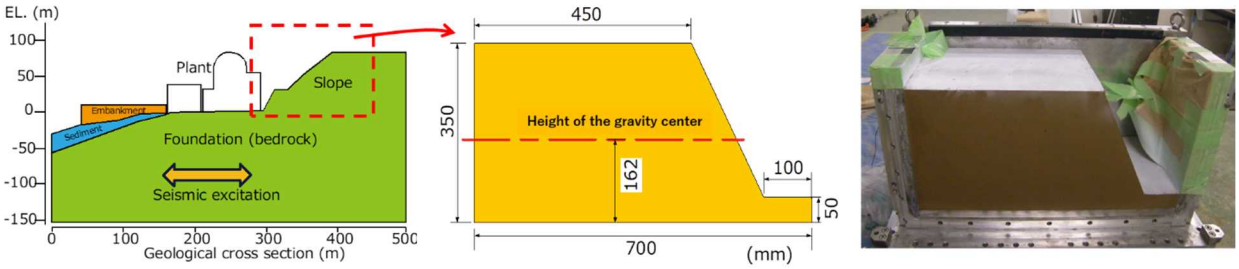


Water injection pressure pump

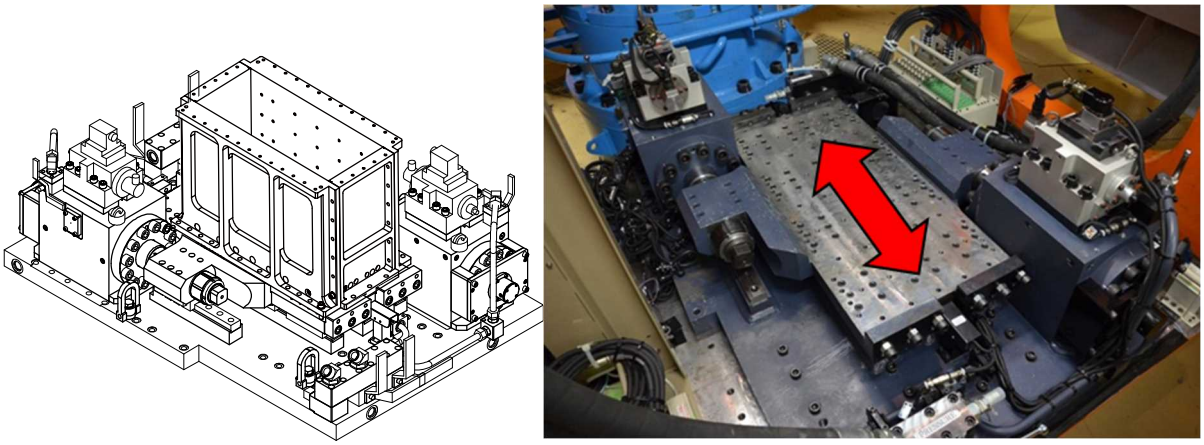
Pressure vessel (for 180 mm-cube specimen)

Dynamic test

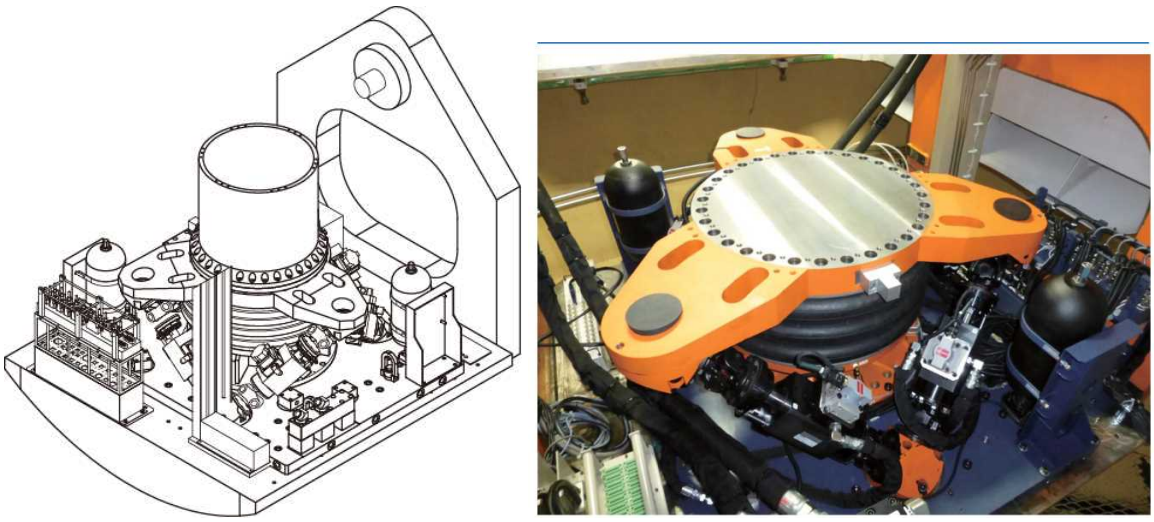
In the dynamic test, we use our centrifuge to reproduce failure behavior of foundations and slopes when an earthquake occurs based on actual conditions. Quantitative assessment of seismic resistance of critical facilities to earthquake-induced failure of rock foundations and surrounding slopes has become important for large-magnitude earthquakes. So, we are developing a nonlinear analysis method that considers progressive failure, and we are investigating the applicability of the nonlinear analysis method to the dynamic centrifugal model tests. Currently, we are mainly using uniaxial shaking table test, but we are planning to obtain data from the test using 3D shaking table in the future.



Schematic of foundation and slopes, example of the model and photo



Schematic of uniaxial horizontal shaking table and photo



Schematic of 3D shaking table and photo

Shaking direction	Uniaxial (1-D) shaking table	3-D shaking table
Max. shaking acceleration	±35G	±20G（x, y）, ±10G（z）
Max. shaking velocity	±80cm/s	±50cm/s
Frequency range	10～250Hz	10～250Hz
Dimension of shaking table	30×70cm	ϕ50cm
Wave shape	seismic wave, sine wave	

Specifications of our shaking tables