

Centrifuge modelling centre of Zhejiang University

Director: Prof. Dr. Yunmin Chen

Manager: Prof. Dr. Bin Zhu, Prof. Dr. Yu Zhao

Contact: Yu Zhao

Website: <http://ccealab.zju.edu.cn/>

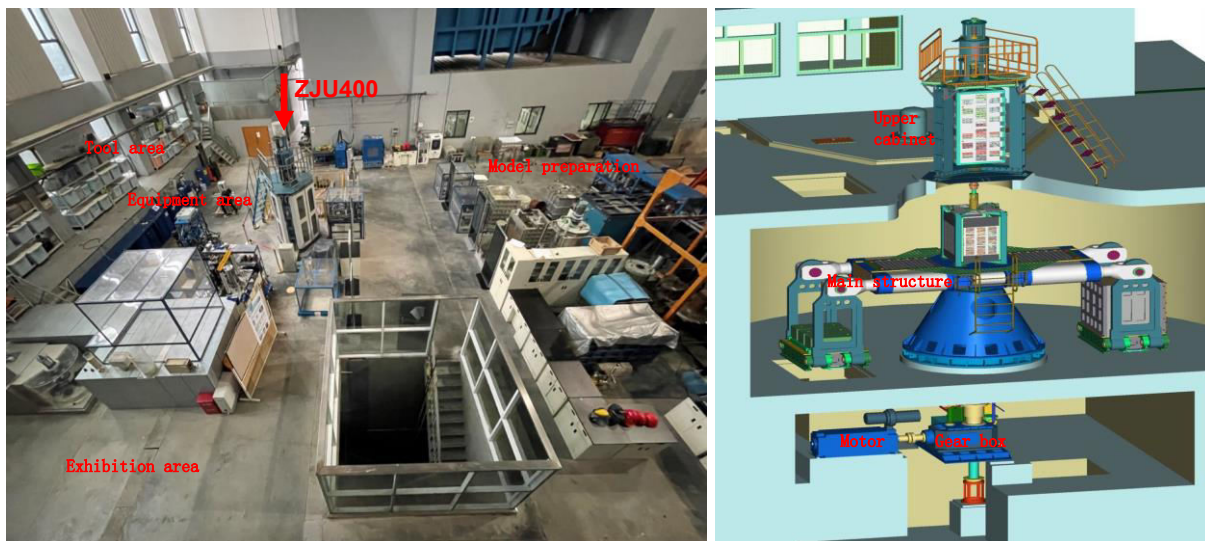
Owner: Zhejiang University

Location: Hangzhou, China

Introduction

The centrifuge modelling centre of Zhejiang University is located at the Zijingang campus, Hangzhou, China.

The centre is equipped with a beam centrifuge named ZJU-400 and its cooling system, hydraulic and pneumatic power sources, inflight devices and sensors. The ZJU-400 centrifuge has a 400 gton capacity with two 4.5m swings. The inflight devices built to work in it include an 1D shaking table, a 3DOF loading apparatus, a wave loading device, a shield tunneling's excavation surface failure simulation system and etc. Measuring techniques such as CPTu and T-bar testing, piezoceramic bender element and micro time domain reflectometry testing as well as particle image velocimetry are also implemented. Research interests of this centre include slope and high-dam engineering, geotechnical earthquake engineering, offshore geotechnical engineering, geo-environmental engineering, geological processes, etc. The centre space contains model preparation area, equipment area, tool area and exhibition area. We can only see the upper cabinet at the ground level. If we made cross-section, we can see spatial layout at three floors. The main structure is at the -1 floor while the motor room at the -2 floor.



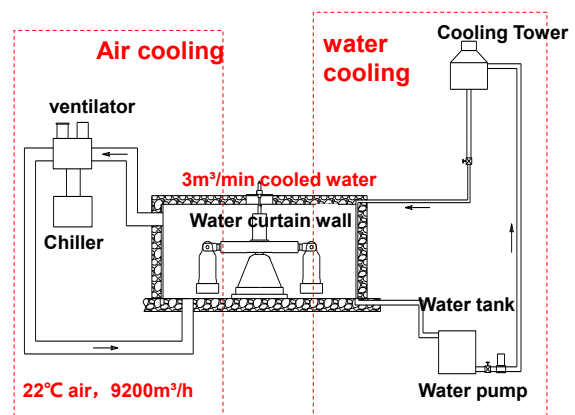
The centrifuge modelling centre of Zhejiang University

Key Technical Specifications

<i>ZJU-400 Centrifuge</i>	
Year established	2009
Radius to bucket base	4.5 m
Capacity	400 gton (4 tons @100g, max G-level: 150g)
Bucket volume	1.5 m x 1.2 m x 1.5 m
Data acquisition	80 channels (dynamic) 40 channels (static)
Major equipment	1D shaking table (capacity 0.5 tons @75g) 3DOF loading apparatus Wave loading device

Beam Centrifuge

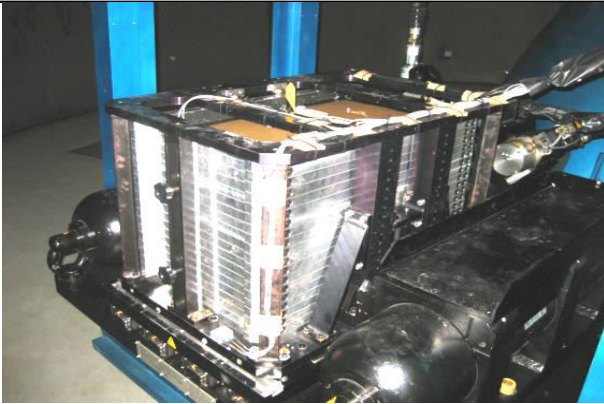
ZJU-400 was custom-designed for Zhejiang University and originally installed at Zijingang campus. With an effective diameter of 4.5 m, the centrifuge can be accelerated up to 150g carrying a payload of 2.6 tons (or equivalently 4tons at 100g). Its 400gton capacity is one of the largest in China. The effective volume of the bucket is 1.5m×1.2m×1.5m. The control system of ZJU-400 centrifuge mainly adopts Siemens drive control technology. Through the double closed-loop speed regulation control mode, the centrifugal acceleration can be accurately controlled with the acceleration precision up to 0.001g. The dynamic balance detection device is adopted to real-time monitor the unbalanced force. The combined air-cooled and water-cooled system is used to control the temperature of the experimental chamber. With the assistant of this system, the temperature rise of the chamber does not exceed 10°C in an experiment up to 72 hours. The data acquisition system have 80 dynamic and 40 static channels. Sensors in a model box is connected to data acquisition panel at the end of the rotating arm, and then the data are transmitted to the control room through slip ring.



ZJU-400 centrifuge and its cooling system

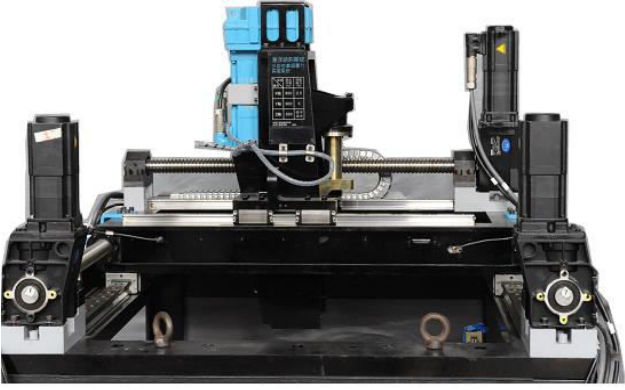
1D Shaking Table

The shaking table was custom-designed for ZJU-400 and developed by Zhejiang University in cooperation with Solution (Japan), composed of accumulator, electro-hydraulic actuation system, pipeline system, control, test system and so on. The specifications of the shaking table are listed below.

1D Shaking Table		
	Max. centrifugal acceleration	100 g
	Max. shaking acceleration	40 g
	Max. velocity	188 cm/s
	Max. displacement	± 6 mm
	Frequency range	10~200Hz
	Max. payload	500 kg
	Shaking duration	3 s

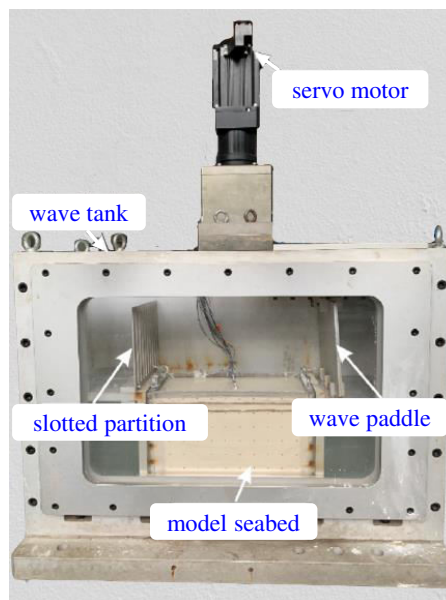
3DOF loading system

The center owns a number of loading devices, which were built to investigate the monotonic and cyclic loading behaviors of offshore foundations. The 3DOF Robotic loading system is capable of applying combined monotonic and cyclic loads in three directions at a maximum load magnitude of 15 kN. The key specifications are listed below.

3DOF loading system		
	Loading capacity	X-axis 2.5 kN
		Y-axis 5.0 kN
		Z-axis 15 kN
Max. distance of moving	X-axis 0.9 m	
	Y-axis 0.6 m	
	Z-axis 0.5 m	

Wave loading device

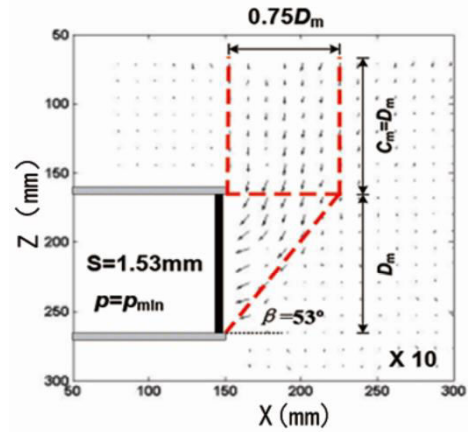
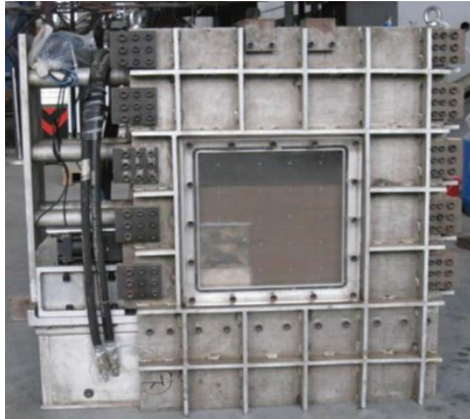
An in-flight wave loading device was built to mimic the wave-soil interaction. The maximum acceleration level of this device is 25g and the highest frequency is 10Hz. The maximum prototype water depth and wave height it can simulate are 7.5m and 2m respectively.



Wave loading device

Shield tunneling's excavation surface failure simulation system

Support pressure is a key parameter in shield tunneling for ground settlement and construction safety control. Insufficient and excess support pressure may cause surface subsidence and heaving respectively. Shield tunneling's excavation surface failure simulation system is the world-first inflight centrifuge apparatus for revealing the development of support pressure and failure pattern under steady state seepage. The device is comprised of a model tunnel and servo loading system. A semi-circular face plate is developed as the face support in the model tunnel. By moving backward of the face plate, the support pressure and corresponding failure mechanism can be obtained. The maximum acceleration level and height of water head are 50g and 20 meter respectively. This experimenting device is capable of simulating tunnel face instability at 200kPa of maximum water pressure and 100kPa of maximum effective overburden earth pressure.



Shield tunneling's excavation surface failure simulation system