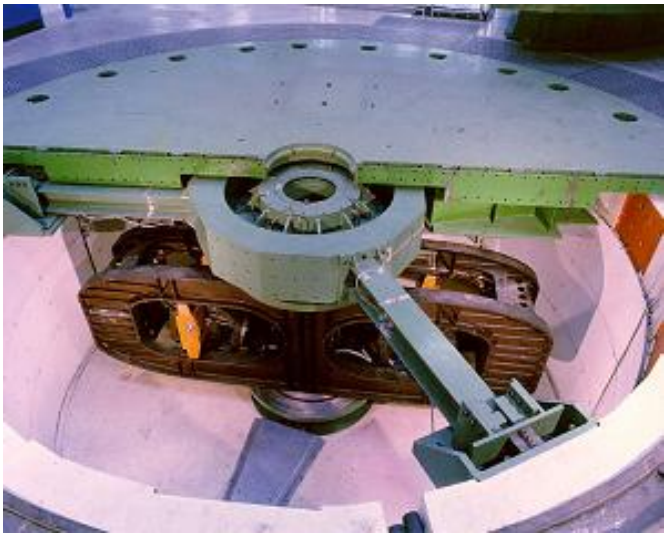
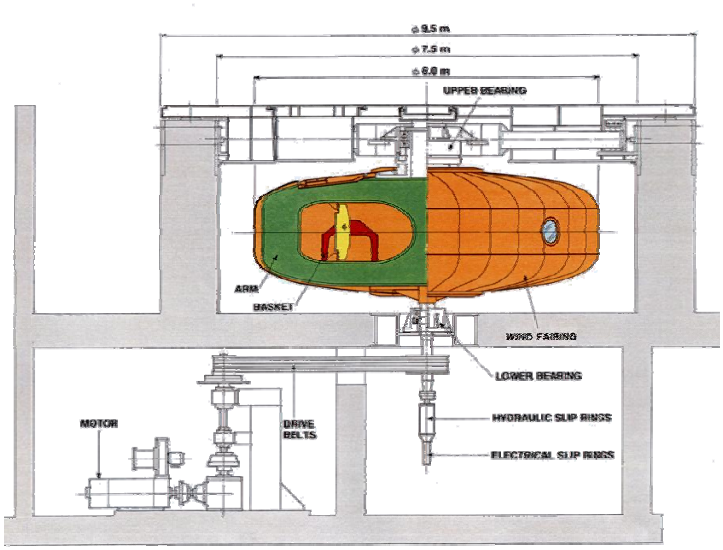
THE ISMGEO GEOTECHNICAL CENTRIFUGE (IGC)

The IGC has a symmetrical 2m high, 1m wide rotating arm with a radius of 3 m which holds two swinging platforms that house the model container and the counterweight; during the test, the platforms lock horizontally to the arm to prevent transmitting the working loads to the basket suspensions. An outer fairing covers the arm and rotate to reduce air resistance and perturbation during flight. The centrifuge has the capacity of reaching an acceleration of 600 g at a payload of 400 kg; is equipped with a set of hydraulic slip rings, for the oil at high pressure (250 MPa), water and air (20 MPa), and electrical slip rings for the power supply (7 A) and electrical signals.

The maximum dimensions of the model are: length = 1 m, height = 0.6 m, width = 0.5 m.

The unusual shape of the arm provides the following advantages:
(i) relatively small distortion of the centrifugal field in the model since its main dimension is parallel to the rotation axis; (ii) low deflection of the support plane of the swinging baskets; (iii) an easy location of instruments close to the rotation axis because of the absence of a central shaft across the arm; (iv) a dynamic excitation of the model in direction parallel to the rotation axis, so that the problem of Corioli's acceleration is removed.

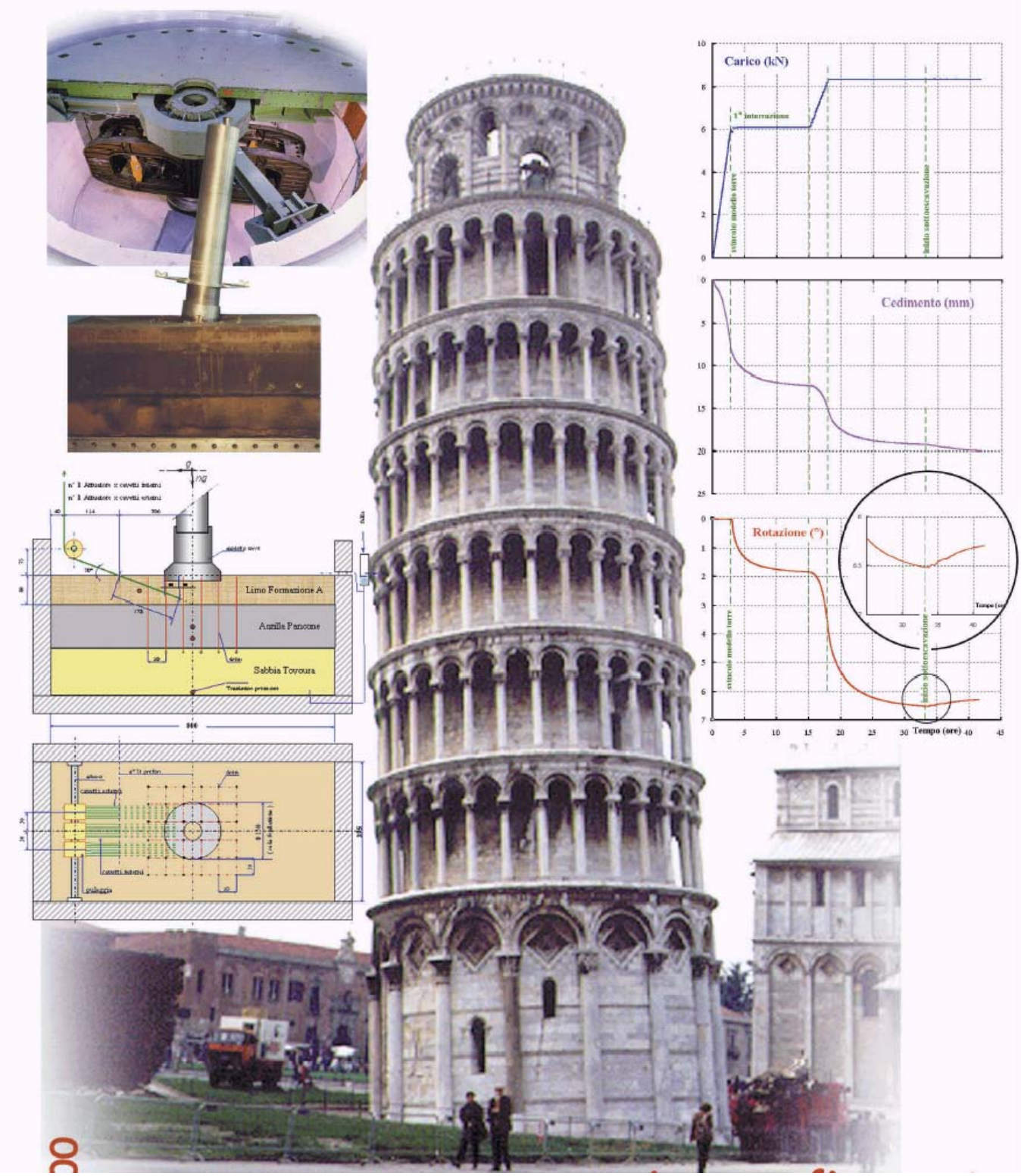




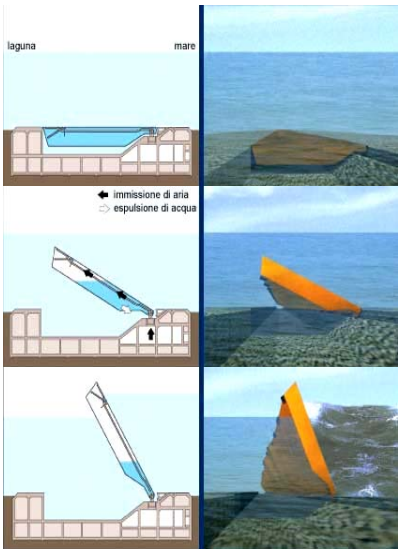
MAIN PROJECTS UNDERTAKEN

- ✓ Tower of Pisa – Modelling the leaning instability and the stabilisation techniques
- ✓ MOSE project – piled foundations of the Venice lagoon tidewater barriers
- ✓ Behaviour of piles axially loaded in compression and in tension
- ✓ Behaviour of shallow foundations
- ✓ Rigid piled raft foundation – piles used as settlement reducers
- ✓ Landslide stabilisation methods in over-consolidated clay
- ✓ Contribution of geo-grid materials on the stability of a dam founded on fine soils
- ✓ Slope stabilisation with reinforcing materials
- ✓ Stability of excavation fronts of tunnels in over-consolidated clay
- ✓ Skirt pile off-shore foundations
- ✓ Fissured state of concrete gravity works.

MODELLING THE LEANING INSTABILITY AND THE STABILISATION TECHNIQUES OF THE PISA TOWER

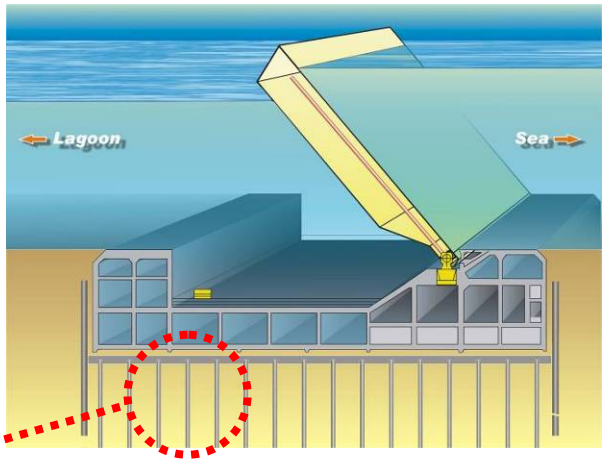


MOSE PROJECT
ON THE BEHAVIOUR OF PILE-REINFORCED SOIL



Mobile barriers

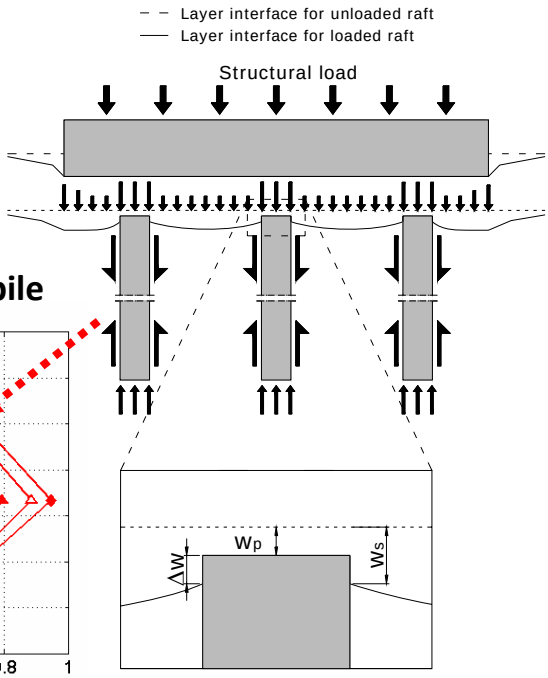
- ✓ Piles as soil reinforcement
- ✓ Pile efficiency as settlement reducers
- ✓ Pile foundation load transfer mechanisms



Pile foundation full scale prototype

Small-scale model

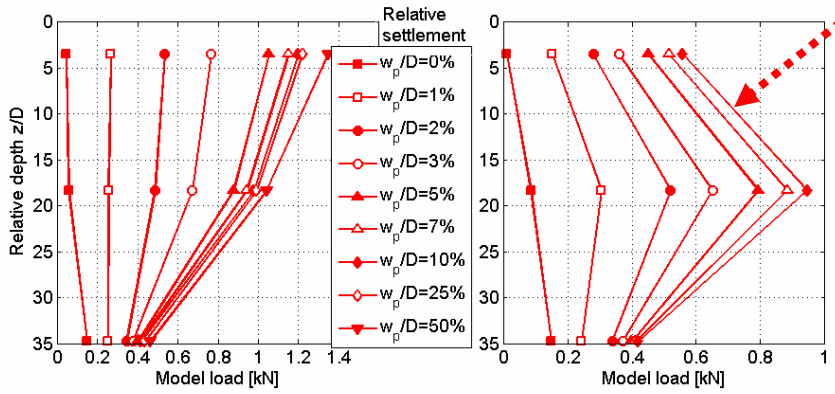
LOAD TRANSFER MECHANISMS



LOAD DISTRIBUTION IN PILES

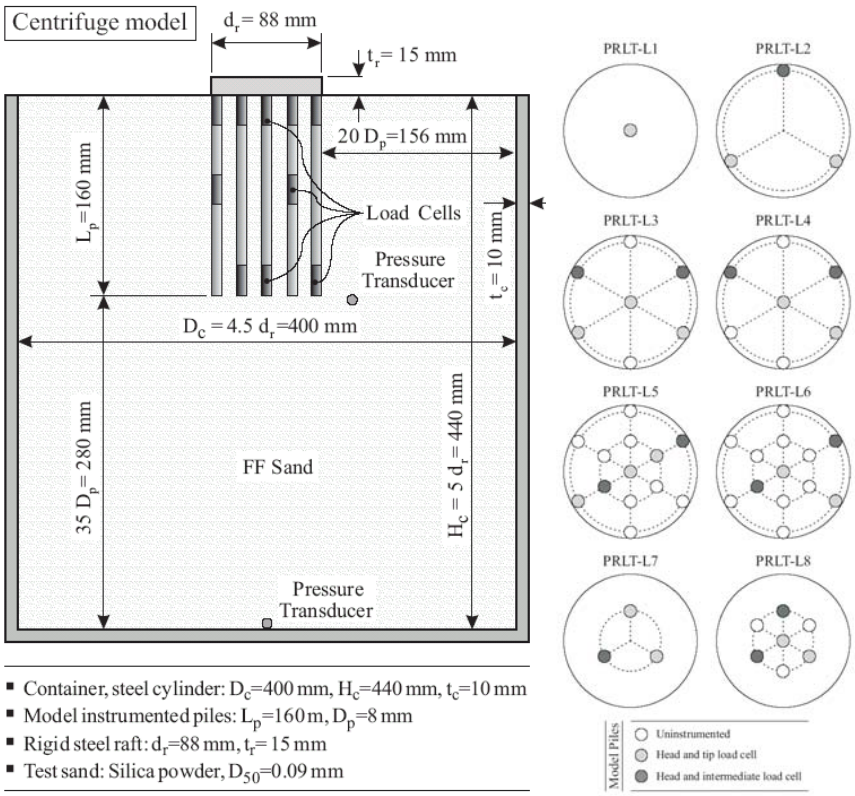
Contact pile

Non-contact pile

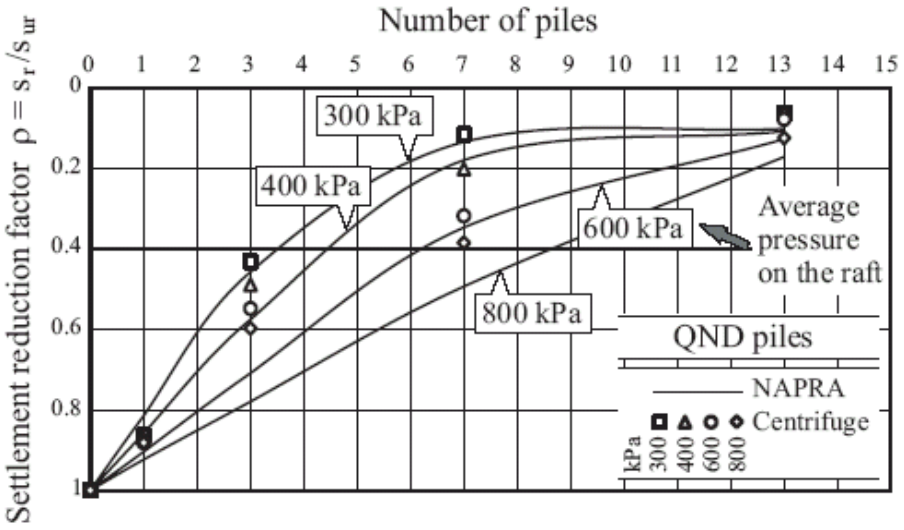


PILED RAFT FOUNDATIONS
PILES AS SETTLEMENT REDUCERS

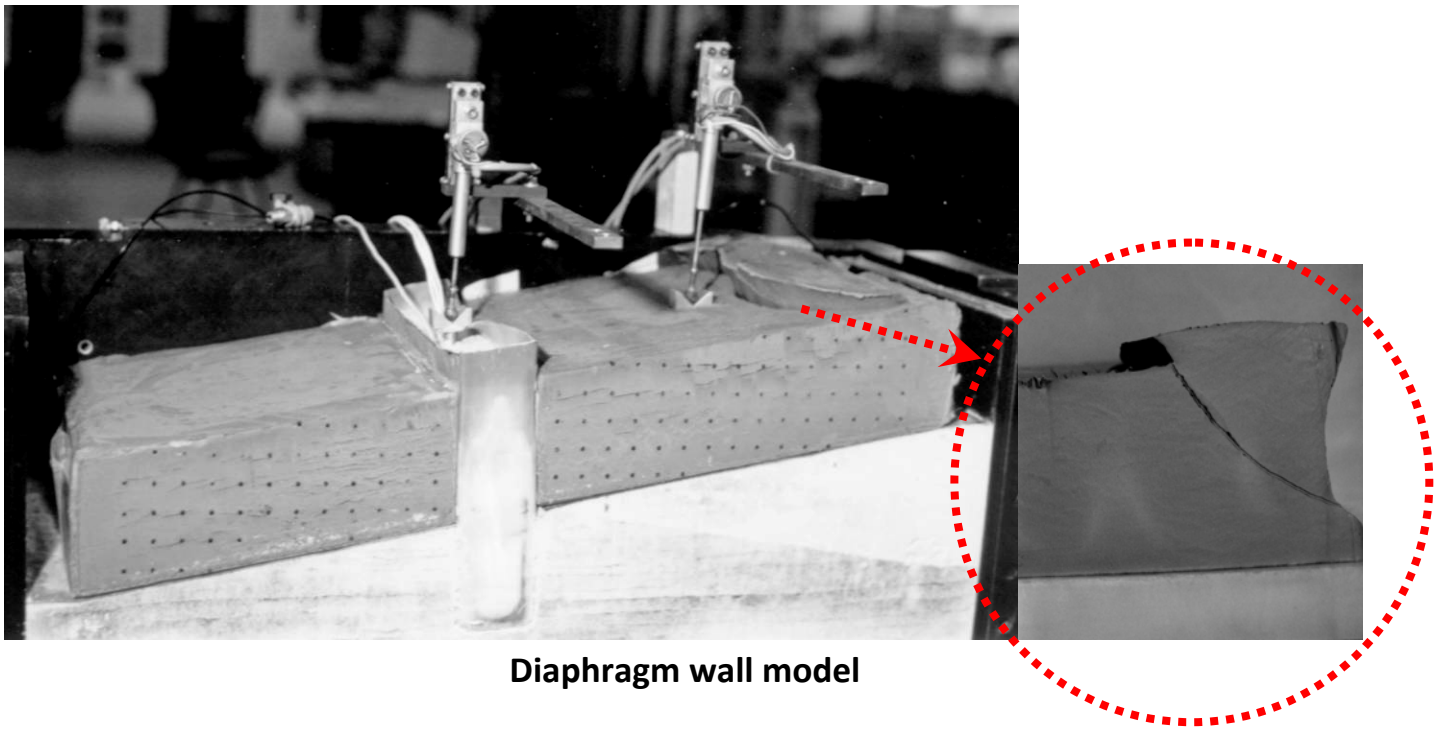
- ✓ **Pile efficiency as settlement reducers**
- ✓ **Load transfer mechanisms**
- ✓ **Validation of numerical model (NAPRA)**



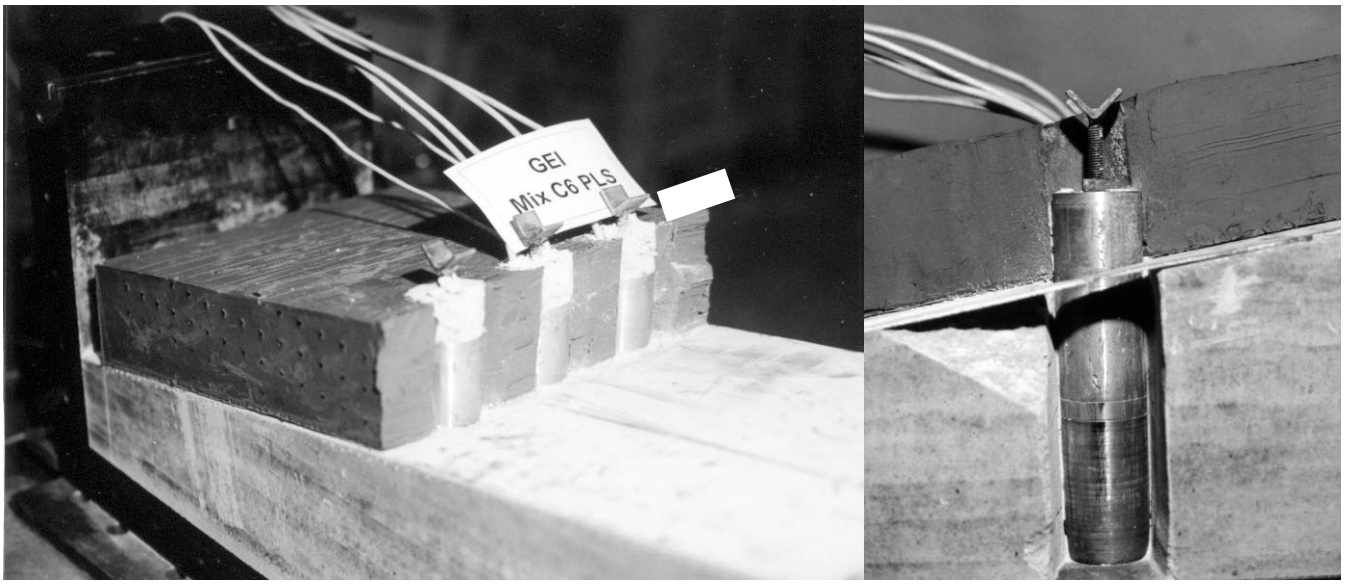
- Container, steel cylinder: D_c=400 mm, H_c=440 mm, t_c=10 mm
- Model instrumented piles: L_p=160 m, D_p=8 mm
- Rigid steel raft: d_r=88 mm, t_r= 15 mm
- Test sand: Silica powder, D_{50}=0.09 mm



LANDSLIDE STABILISATION METHODS IN OVER-CONSOLIDATED CLAY



Diaphragm wall model

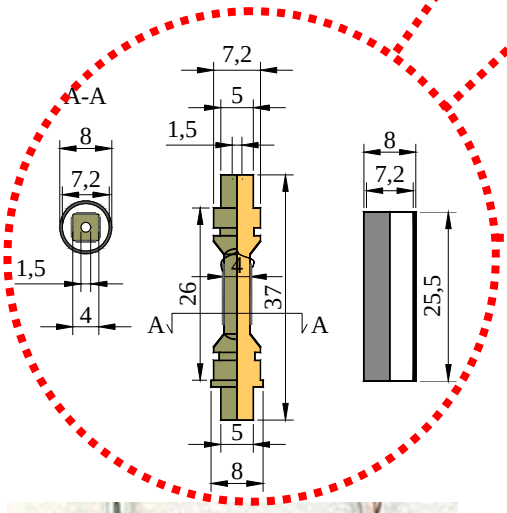


Piers model

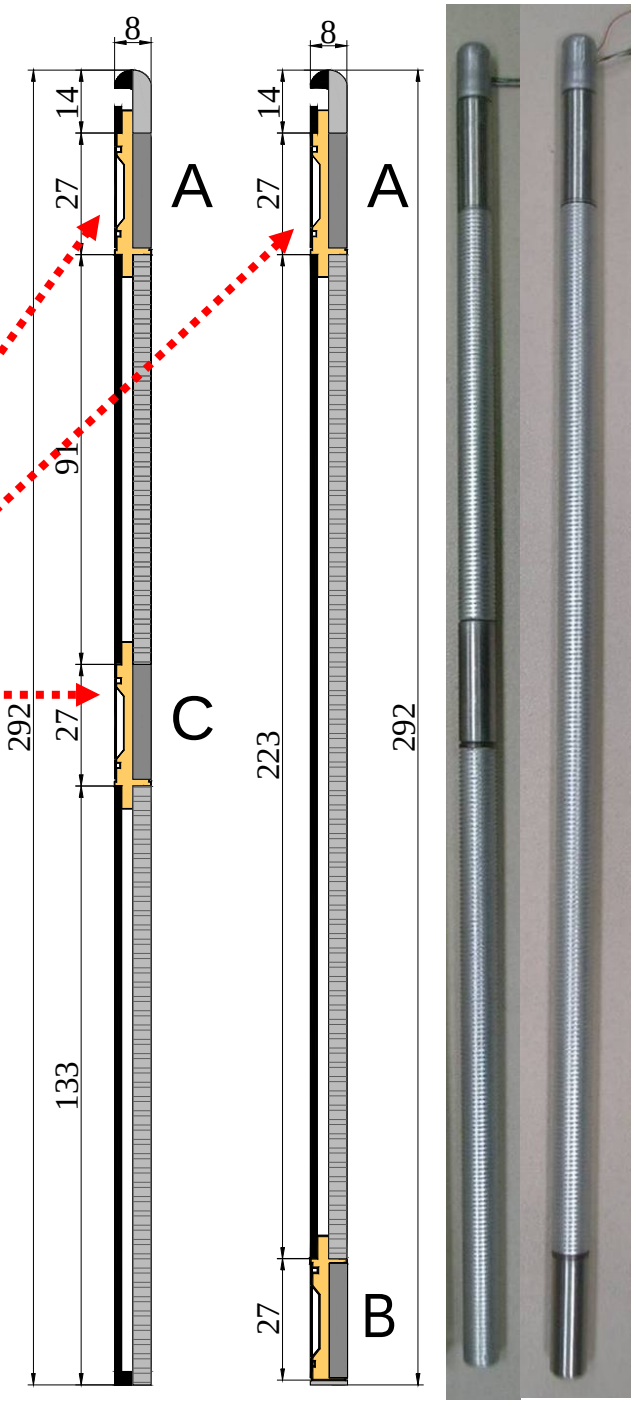
IN-HOUSE DEVELOPED MODEL INSTRUMENTATION

To monitor the load distribution with depth along model piles, miniaturised load cells were developed in-house. Depending on the model pile diameter, two or four load cells were inserted per pile.

The miniaturised load cells, made from stainless steel, had a square cross section as outlined in Figures; a couple of active strain gauges was coated with an acrylic moisture barrier on each of the four flat surfaces. The instrumented cross-section was covered by a protective stainless steel jacket to avoid soil radial stress acting on the gauges, and it was sealed with O-rings as a second moisture barrier.



MODEL PILE LOAD CELLS



INSTRUMENTED MODEL PILES

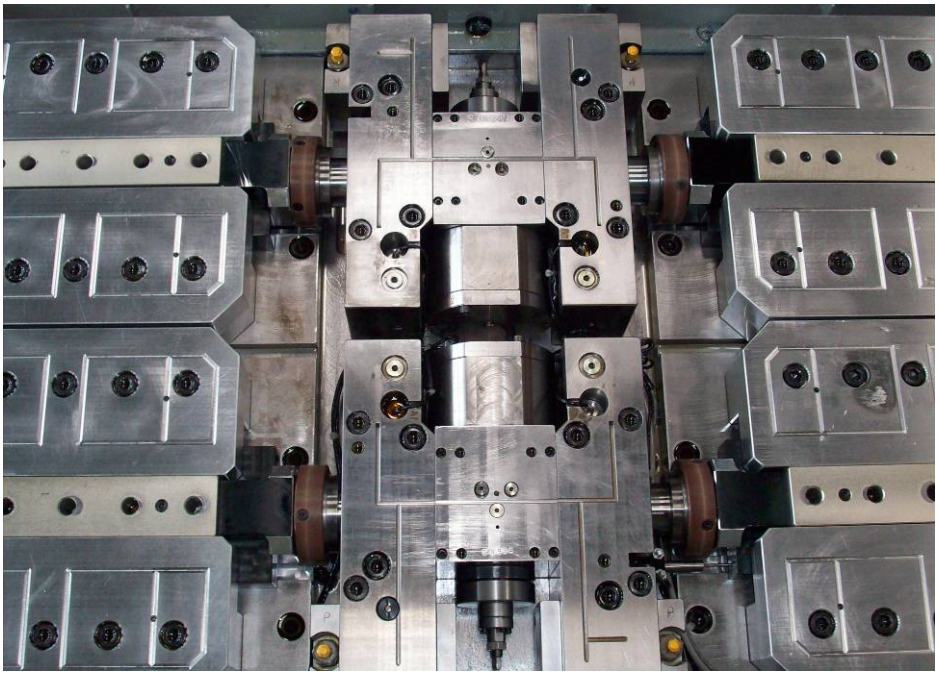
THE CENTRIFUGE EARTHQUAKE SIMULATOR

A recent upgrade of the centrifuge foresees the installation of a shaking table for dynamic modelling of seismic events. The installation includes a complete upgrade of the data acquisition and control system.

1 DEGREE-OF-FREEDOM SHAKING TABLE

(Specifically designed by Team for the ISMGEO centrifuge)

- Operating frequency up to 500 Hz
- 100 g centrifuge acceleration
- Two 50 kN integrated actuators
- Peak velocity: 0.9 m/s
- 60 g's no load acceleration
- 15 g's full load acceleration
- Fixed to the rigid centrifuge arm
- System designed to operate several times during the same flight
- New Data Acquisition System and Controls



INTERIOR VIEW OF SHAKING TABLE