UP acquires the largest geotechnical centrifuge in the southern hemisphere

The University recently established itself as the leader in the field of geotechnical research when it acquired the largest geotechnical centrifuge in the southern hemisphere and opened a dedicated Geotechnical Centrifuge Laboratory in the Department of Civil Engineering. This move is set to greatly expand the University's research programmes, promote collaborative research, and attract more postgraduate students to enter this important field of study.

Soil-structure interaction and its associated problems is an aspect of civil engineering that is essential to understand. Sinkholes, bursting pipes and soil analysis for construction are just some of the issues that fall under the theme of geotechnical research. One can use computer models to simulate or model soil-structure interaction problems, but without a centrifuge this is a difficult and sometimes not-so-accurate task.

The University's new state-of-the-art centrifuge, only the second geotechnical centrifuge in Africa, will therefore greatly enhance research efforts into geotechnical problems. The centrifuge was installed in a heavily reinforced concrete chamber (for safety reasons) and was officially unveiled on 13 June 2012.

A geotechnical centrifuge is used to accelerate small-scale soil models through high accelerations, thus creating a realistic stress distribution within the model that corresponds to the full-scale situation. For example, a model with a scale of 1:50 needs to be accelerated to 50 times the earth's gravity, or 50 G. This is necessary because realistic soil behaviour in the model will only occur at the correct stress level.

The instrument acquired by the University is classified as a 150 G-ton instrument, meaning that it is capable of accelerating a model weighing up to 1 ton, to 150 times the earth's gravity. The centrifuge model platform measures 0,9 m x 0,8 m with unobstructed headroom of 1,3 m. The radius, measured from the centrifuge axis to the model platform, is 3 m. This means that at an acceleration of 150 G, the model can travel in a circular track at 240 km/h.

Existing and planned research programmes

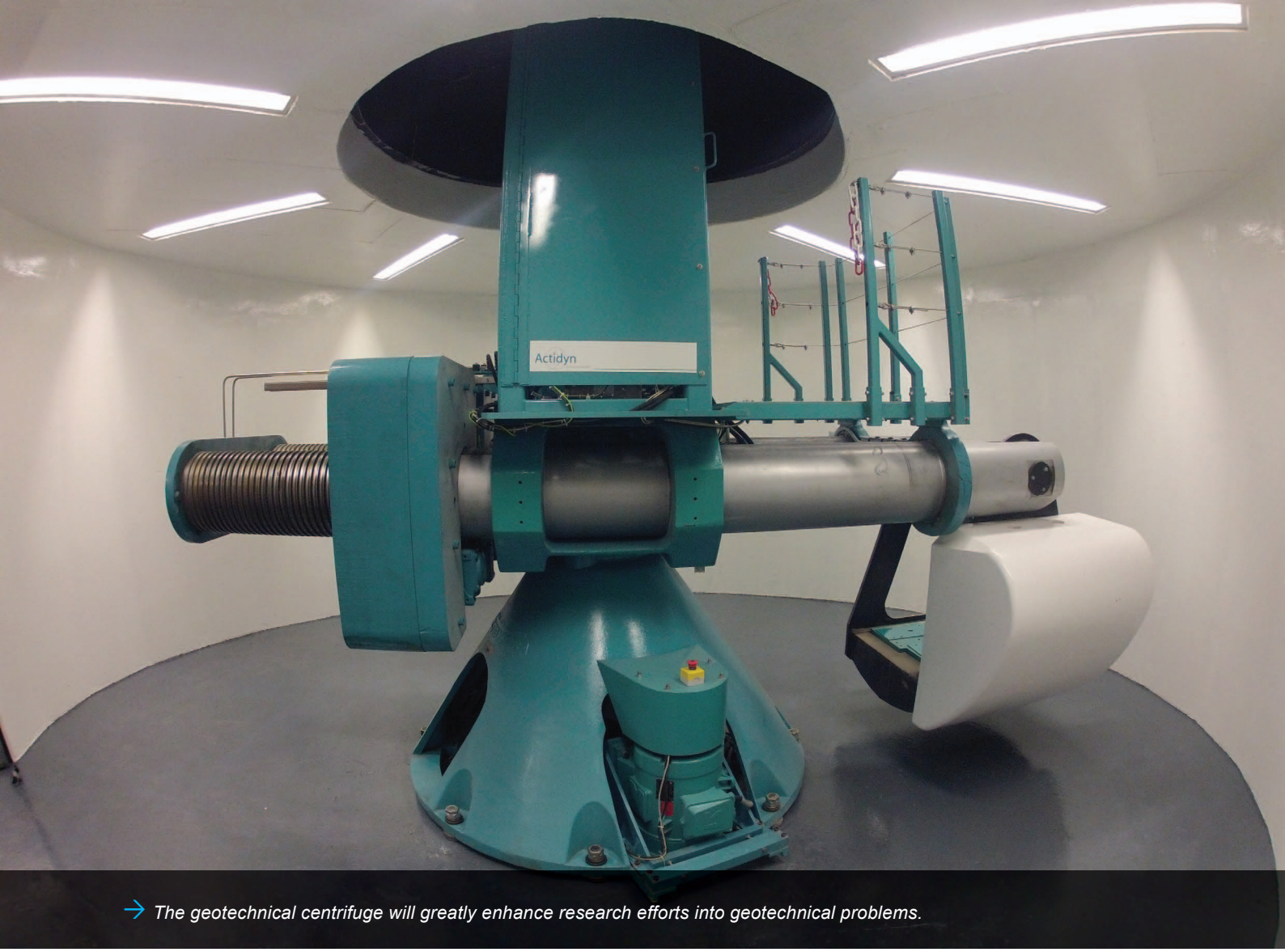
One UP research programme for which this centrifuge will be used is the study of dolomitic sinkholes, a problem often encountered south of Pretoria and on the West Rand. The University wishes to study the effects of these sinkholes on various foundation types and structures. Scope also exists to investigate sinkhole rehabilitation methods. New sinkholes open up regularly in the Centurion area and need to be closed quickly to limit danger to the public.

Another common problem in civil engineering is one that relates to urban water distribution systems. Such systems often rely on large diameter, thin-walled, buried pipelines. The stability of such pipes, when buried in trenches or under fill embankments, requires further research. The University is investigating to what extent the load imposed on these pipes by the ground can cause deformations on the pipes, and how this pressure influences the stability of the soil-pipe system.

The machine will also enhance the Department of Civil Engineering's seismic investigation techniques, which were developed at the University to measure the small-strain stiffness of soil by means of seismic methods. These techniques are now used routinely by many consulting engineers in the design of foundations. However, the correct compressibility that should be used in the calculation of foundation settlement is yet to be researched.

To answer this question, a project has just commenced at the University to model the placement and loading of a foundation in the centrifuge. During this process, small-strain stiffness and model foundation settlement will be measured.

During the construction of the Gautrain viaduct through Centurion, large-scale surcharge trials were carried out to measure the compressibility of the dolomitic soils on which the viaduct had to be founded.



The geotechnical centrifuge will greatly enhance research efforts into geotechnical problems.

The back analysis of the settlement that was measured during these trials was a complex undertaking that required many assumptions to be made. The behaviour of the surcharge loads will now be modelled in the geotechnical centrifuge, which will entail settlement and soil compressibilities being measured and compared. This may have important applications for future projects when construction has to be carried out on dolomitic soils.

In addition to these examples of how the geotechnical centrifuge will be used in the field of civil engineering, the centrifuge can also be used for research in mining engineering, geology, mechanical engineering and other fields where large accelerations have to be applied to models or components. It therefore has the potential for great collaboration across various departments and disciplines.

Although the primary purpose of the centrifuge will be for research, the University will also make the equipment available to companies who would like to carry out the testing of physical models for commercial purposes.

Funding

The new Geotechnical Centrifuge Laboratory and procurement of the machine were co-funded by the National Research Foundation (NRF) through the Research Infrastructure Support Programme (RISP), and the University of Pretoria, thanks to the hard work and dedication of Prof Elsabe Kearsley and Prof SW Jacobsz of the Department of Civil Engineering.

In addition to the support received from the NRF to acquire the centrifuge, the University has received remarkable support from industry to create the infrastructure necessary to safely house the instrument in a heavily reinforced concrete chamber.

The Department of Civil Engineering would like to express its gratitude to the following companies for their tremendous support:

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