A Global Force in Geotechnical Centrifuge Technology

A new exciting range of geotechnical centrifuges, supported by Cambridge University's Drum IPR is marketed under the 'Broadbent G-Max' Umbrella. Broadbent have thus created a uniquely experienced and proven resource to service the needs of the global geotechnical community.

The product range of drum centrifuges, now incorporates Broadbent's Geotechnical 'G' Series Drum Centrifuges and tilting drum centrifuge designed by Professor Andrew Schofield F.R.S, F.Eng., F.I.C.E of Cambridge University. This worldwide patent protected drum technology is now integrated into the revolutionary **Modular Centrifuge** – *the world's first single platform, multi test environment, beam and drum centrifuge,* designed specifically to offer the complete test environment to the civil engineering researcher.

A World First – the Modular Centrifuge

Broadbent have designed and developed an entirely new concept in Geotechnical Centrifuge design. The world's first combined beam and drum platform – the **Modular *Centrifuge.***

Centrifuge modelling is of prime importance worldwide in civil engineering research and education. Geotechnical modelling plays a key role in introducing students to failure mechanisms and helps them understand the crucial importance of soil self weight effects on ground behaviour. The Broadbent G-Max Modular Centrifuge is the most convenient, and cost effective way to create high acceleration fields for geotechnical modelling, by uniquely offering both beam and drum test environments to the civil engineering researcher and teacher.

Historically the researcher has had to choose a centrifuge dedicated for their immediate intended research activity, i.e. beam or drum centrifuge. Any future changes or demands for the second test environment involved a costly second purchase. Only a small handful of large research institutes could contemplate the overhead in purchase and infrastructure required to run two centrifuges.

Standalone beam and standalone drum centrifuges are limited to their particular test specialisation and modes of operation, but the Modular centrifuge offers, on a single drive platform, two interchangeable centrifuge test environments. With one machine purchase, on one floor installation, a multiple test environment is provided to encompass all geotechnical centrifuge research activities; a future proof investment for the university.

Client List

Recent centrifuge installations from **Broadbent** include:

0.5m Continuous Centrifuge	Cambridge University, UK
0.65m Mini Beam Centrifuge	IT Sligo, Ireland
1.0m Tilting Drum Centrifuge	COPPE, UFRJ, Brazil
1.0m Tilting Drum Centrifuge	MIT, USA
1.2m Drum Centrifuge	University of West Australia, Australia
1.2m Drum Centrifuge	Tokyo Institute of Technology, Japan
1.2m Drum Centrifuge	Kiso Jiban Construction, Japan
1.4m Drum Centrifuge	University of Texas at Austin, USA
1.4m Drum Centrifuge	Dalian University of Technology, PR China
1.5m Beam Centrifuge	ETH, Mineralogy, Switzerland
2.2m Drum Centrifuge	Toyo Construction, Japan
2.2m Drum Centrifuge	ETH, Geotechnics, Switzerland
1.7m Beam Centrifuge	Nottingham University, UK

Key Applications of Geotechnical Modelling

The primary scientific reason for the use of centrifuge modelling to investigate geotechnical systems is due to the dominance of material self-weight.

The fundamental mechanical behaviour of soil is highly non-linear and stress-level dependent and to simulate accurately a prototype at small scale, the in situ stresses must be reproduced correctly in the model. In order to replicate these gravity induced stresses of a prototype in a '1/nth' scale model, it is necessary to test the model in a gravitational field 'n' times larger than that of the prototype.

Thus the dimensions and many of the physical processes of the prototype can be scaled correctly if an 'nth' scale model is accelerated by N times the acceleration due to gravity.

The Geotechnical Centrifuge is the only means of creating these accelerations fields in the laboratory environment.

Centrifuge Scaling Laws	
Prototype Parameter:	**Scale model by:**
Length	1/n
Area	$1/n^2$
Volume	$1/n^3$
Stress	1
Strain	1
Force	$1/n^2$
Velocity	1
Acceleration	n
Frequency	n
Time (Dynamic)	1/n
Time (Consolidation)	$1/n^2$

Consolidation Time Acceleration				
Model Time	**Prototype Time**			
	50g	**100g**	**200g**	**400g**
1 Hour at:	2,500 Hrs	10,000 Hrs	40,000 Hrs	160,000 Hrs
	104 Days	417 Days	1667 Days	6667 Days
	0.29 Years	1.14 Years	4.57 Years	18.27 Years
24 Hours at:	7 Years	27 Years	110 Years	438 Years
48 Hours at:	14 Years	54 Years	220 Years	876 Years
72 Hours at:	21 Years	81 Years	330 Years	1314 Years

Physical modelling plays a vital role in geotechnical engineering in the following areas:

- ***Parametric studies***
- ***Investigation of new phenomena***
- ***Verification of analytical or numerical methods***

The physical modelling of soil behaviour under load has always played a pivotal role in helping design engineers acquire a better understanding of the actual behaviour under similar stress conditions of real construction projects. In particular, centrifuge modelling is currently regarded as an invaluable means of soil testing that markedly enhances the understanding of the physical behaviour of soils under complex static or dynamic situations. Examples include:

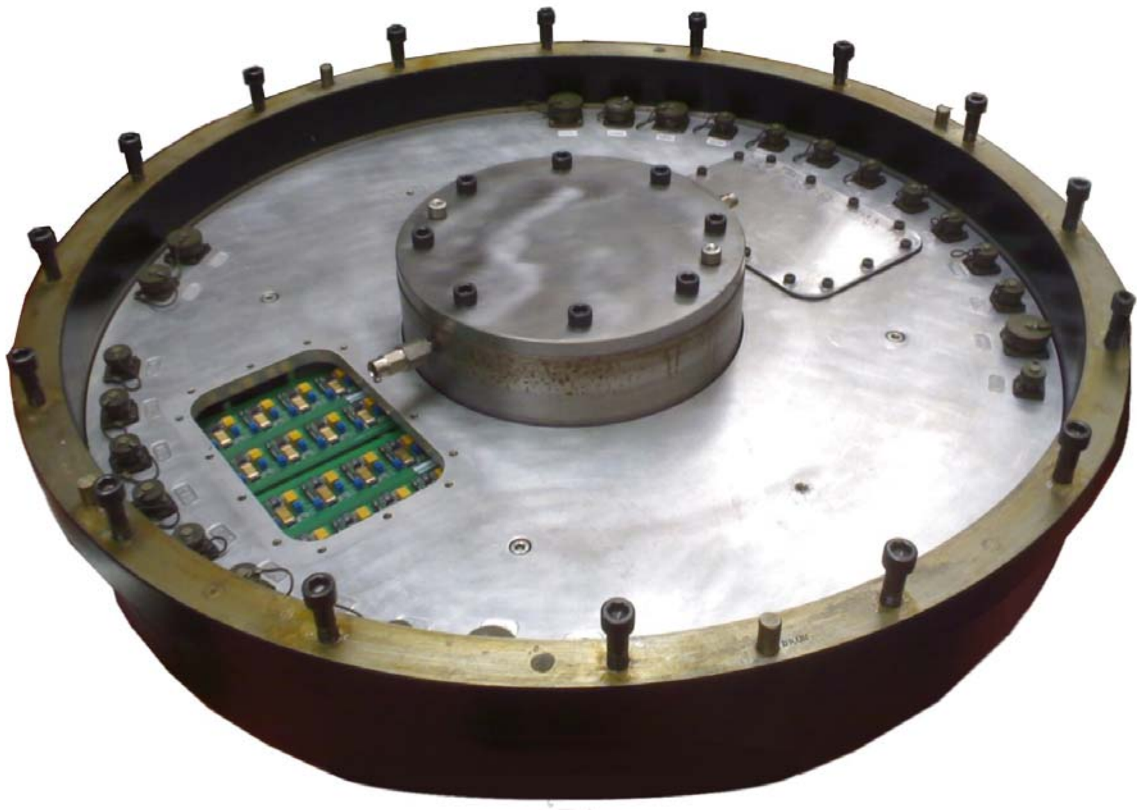
- ***slope stability***
- ***retaining structures***
- ***embankments***
- ***foundations***
- ***Pile – Soil Interaction***
- ***tunnels***
- ***heat transfer***
- ***diffusion***
- ***seepage***
- ***earthquakes***
- ***wave loading***
- ***contaminant transport***
- ***freeze/thaw***
- ***effects of deep mining***

By creating stress conditions in a small soil laboratory model, where the effects of gravity on a real structure on real ground conditions are simulated by generating a centrifugal force field throughout the soil sample, geotechnical research scientists and engineers can obtain insight into the factors affecting geotechnical risk in major and complex construction projects.

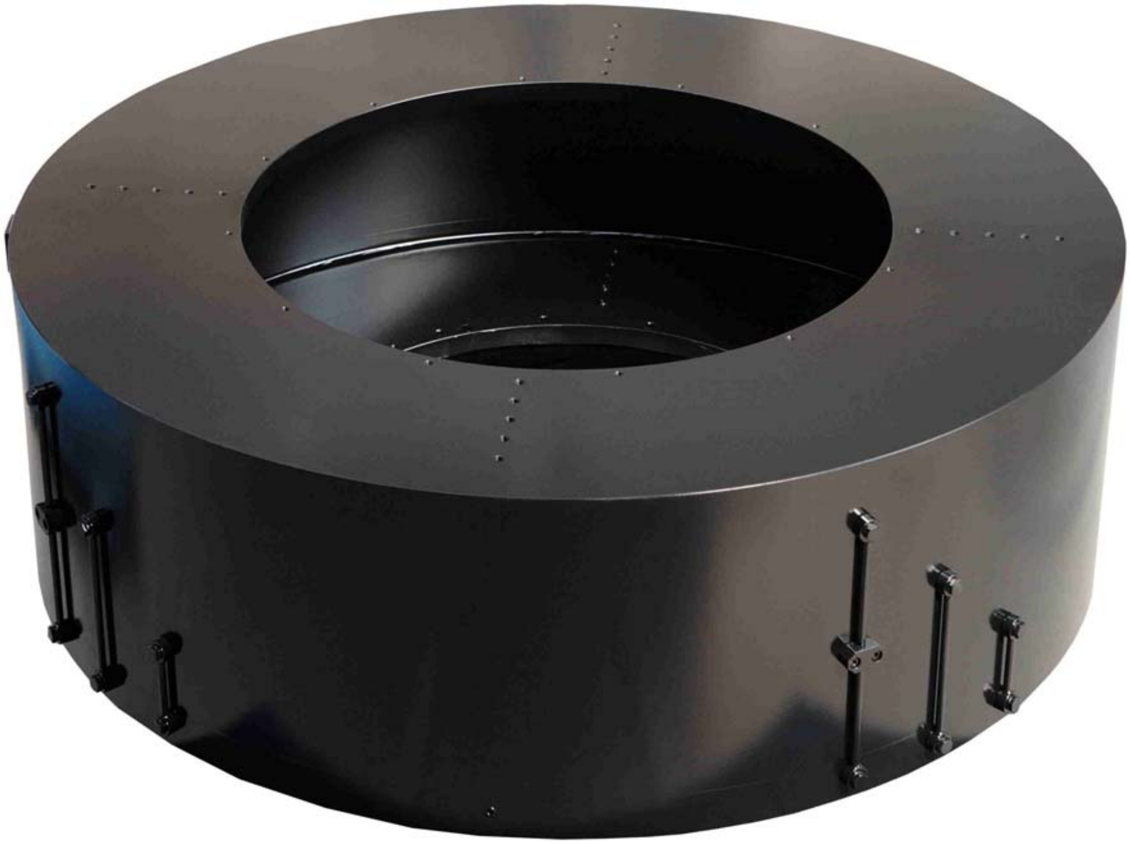
Images

Modular 50 g-tonne Beam – GMB GT50/1.7

Modular 50 g-tonne Beam – GMB GT50/1.7



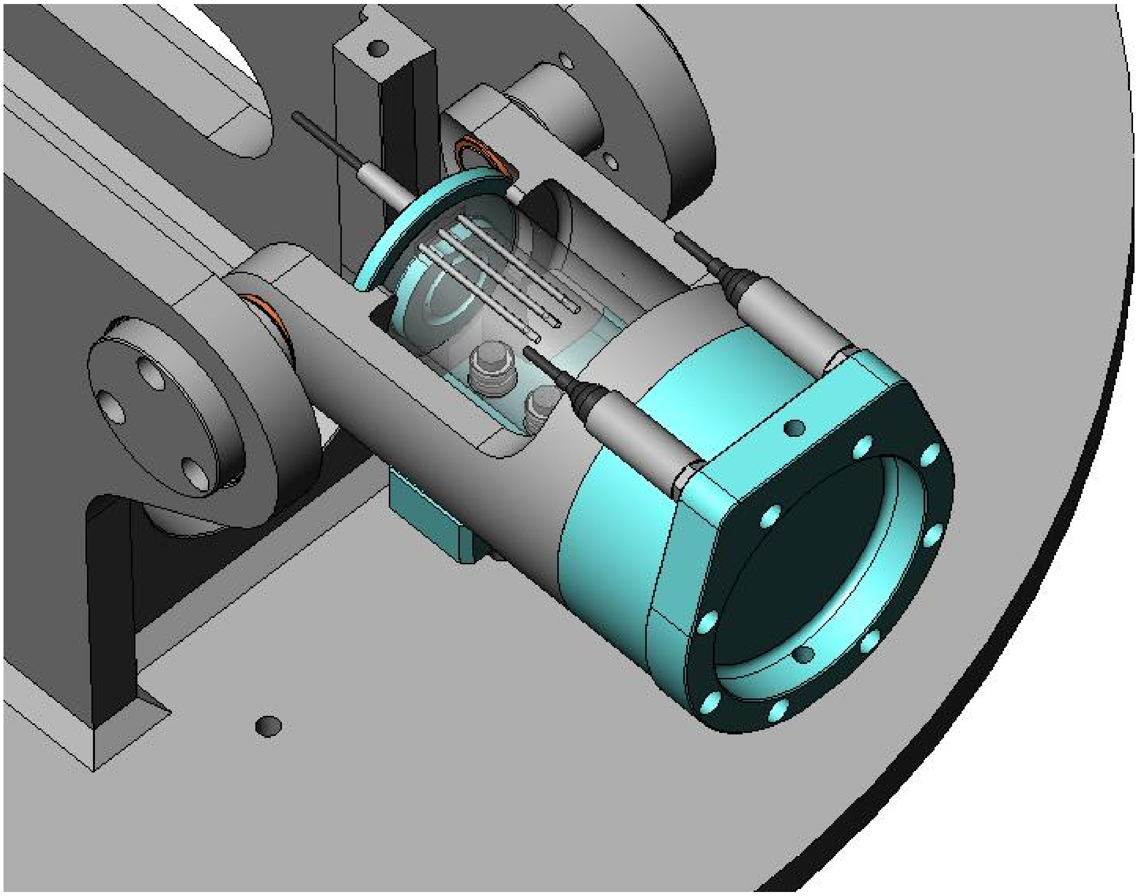
32 Channel Drum DAS – 450g rated



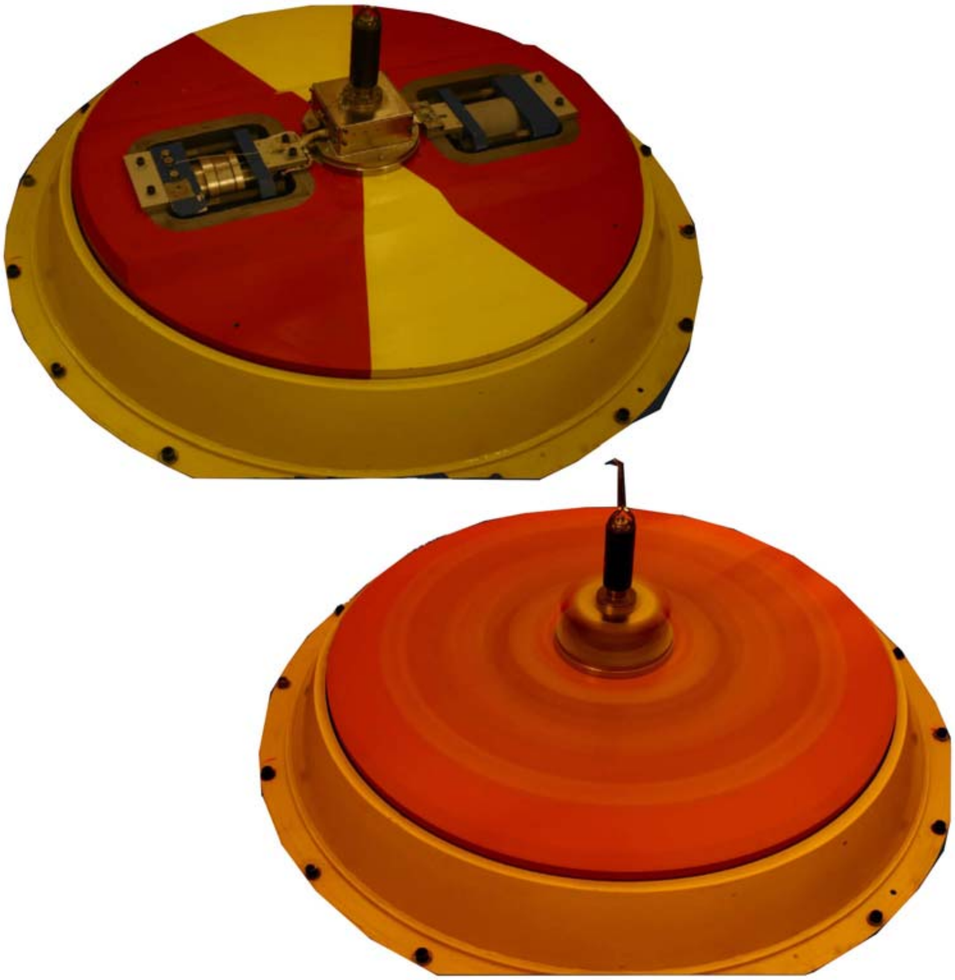
1.4m diameter, 450 g-tonne drum

Modular 450 g-tonne Drum – GMD GT450/1.4 F

600g Permeameter – GMP GT18/0.7 F



Permeameter detail



3000g Mineralogy Table – MT GT150/0.6 F