CASE STUDY: INTERFACE SHEAR TESTER

www.gdsinstruments.com

USERS: MR ANDREAS ZIOGOS, DR MICHAEL BROWN, GEOTECHNICAL ENGINEERING RESEARCH GROUP, CIVIL ENGINEERING, UNIVERSITY OF DUNDEE.

The geotechnical engineering research laboratories at the ***University of Dundee*** *were established in 1997 and have grown significantly since that time. In addition to its undergraduate and postgraduate teaching and research activities, the group offers services to industry across a broad range of geotechnical engineering. The group is equipped with advanced facilities for geotechnical modelling and characterisation including a 7m diameter geotechnical centrifuge and the Scottish Marine Renewables Test Centre (SMART). These are supported with large 1g soil test beds and physical modelling facilities. These have been used to study offshore foundations (deep and shallow), pipelines, onshore vegetation-supported slopes, earthquake faulting and liquefaction. The applicability of the facilities at UoD for industry are recognised by their inclusion in the Scottish Enterprise Energy Lab (SEL facility 45). The REF 2014 ranked Civil Engineering research at the UoD top in Scotland and third in the UK for its quality and impact.*

THE PROBLEM

Dr Michael Brown and doctoral researcher Mr Andreas Ziogos, are interested in the development and enhancement of gravity based foundations for marine or tidal stream energy generators (Small et al. 2014 & Ziogos et al. 2015). Tidal currents may impose significant horizontal forces on submerged energy generators making horizontal sliding capacity more critical than bearing. The seabed in areas of high tidal volume may be rocky and free of sediment and consequently an understanding of the unbonded rock-steel (or rock-concrete) interface frictional properties is crucial in order to achieve efficient foundation design, since friction is the horizontal stabilising resistance of gravity based foundations. Element interface testing of foundation materials is essential and should be conducted for a wide range of materials and normal stress levels in order to allow in depth investigation of the interface shearing behaviour. The conventional direct shearbox is often used for interface testing but due to the arrangement of the equipment it does not lend itself to the testing of two rigid samples against each other. There are also limitations on the amount of normal stress that can be safely applied which is typically limited to 315 kPa for hanging weight systems.

THE SOLUTION

In order to tackle some of the issues mentioned above, an interface shear tester from GDS was specified and ordered. The apparatus was based upon the standard GDSIST but designed with torque and normal stress capacities to suit the specific needs of the project. The apparatus applies normal stress and continuous rotation to the interface under test and both load and strain controlled tests can be conducted. The frame is equipped with a 5kN/200Nm combined load/torque cell at the top,

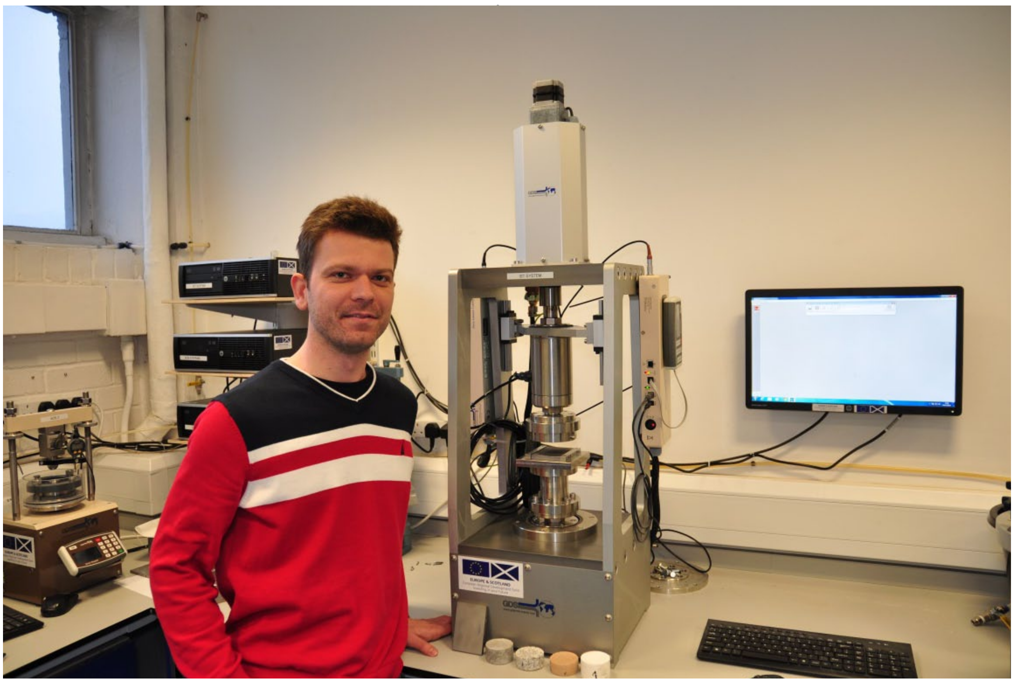

Figure 1. Member of the research team with the GDSIST

GDS Instruments
Unit 32 Murrell Green Business Park
London Road
Hook
Hampshire RG27 9GR
UK

T: +44 (0)1256 382450
F: +44 (0)1256 382451
E: info@gdsinstruments.com
W: www.gdsinstruments.com

and a stepper motor that applies rotation at the base. The equipment was specified with simple top and bottom connections such that sample mounting arrangements could be fabricated by the University of Dundee to suit the foundation material mounted at the base of the rig (sample size 65 mm diameter x 90 mm high) and the 54mm diameter rock samples mounted below the torque head. The GDSIST allows infinite shear deformation (large displacement or residual behaviour) to be applied as well as cyclic loading (cyclic degradation studies for example in offshore applications or during pile driving).

THE RESULTS

The interface shear tester (GDSIST) is currently being used to investigate the material behaviour of rock-steel and rock-concrete interfaces as part of wider research project which aims to develop cost efficient design of gravity based foundations for marine energy generators.

An extensive testing programme allows the generation of a database with friction properties of various foundation/ seabed combinations allowing the initiation of a "more realistic" design process based on lab data instead of very conservative friction coefficients that may be found in the literature. Testing to date has shown very good correlation with simple tilt table testing (simple determination of friction angle) and previously undertaken simple shear testing on a specially modified direct shear box.

CONCLUSION / TESTIMONIAL

"Dealing with GDS during specification and supply of the equipment was a very pleasant experience with GDS happy to incorporate the bespoke demands of our application. It is always re-assuring to deal with people that fully understand the capabilities and function of equipment they have designed. This makes it easy to assess the capabilities of a device and understand what modification to standard equipment can easily be accommodated. Operation of the equipment is straight forward and easy for somebody familiar with GDSLAB. During testing we are finding the equipment is more versatile than we first anticipated and are able to use it for work outside of our original equipment needs. GDS will be our first port of call for any future lab equipment."

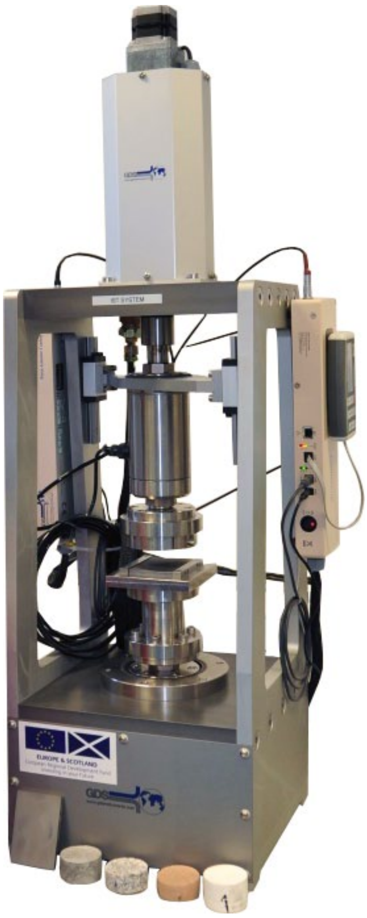

Figure 2. Interface Shear Tester

The GDSIST was supplied as part of a larger laboratory upgrade for the new Marine Renewables Test Centre at the University of Dundee. Additional equipment supplied included a Large Automated Direct Shear System, Force Actuators, Variable Direction Dynamic Cyclic Simple Shear System, an Automatic Oedometer System and a Back Pressured Shear Box.

REFERENCES

SMALL, A.A., COOK, G.A., BROWN, M.J. (2014) The geotechnical challenges of tidal turbine projects. Proc. of the ASME 2014 33rd Int. Conf. on Ocean, Offshore and Arctic Engineering (OMAE2014) 8-13 June, 2014, San Francisco, USA. DOI:10.1115/OMAE2014-23892, ISBN: 978-0-7918-4553-0.

ZIOGOS, A., BROWN, M.J., IVANOVIC, A. & MORGAN, N. (2015) Interface shear characteristics of Scottish rock samples from sites with tidal energy potential. XVI European Conference on Soil Mechanics and Geotechnical Engineering. 13 - 17 September 2015, Edinburgh, UK. ICE Publishing, London. pp. 1357-1362, ISBN: 978-0-7277-6067-8.