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Use of calibration chamber as a large triaxial apparatus

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A segment of a gravel column, 1 m high and 0.53 m in diameter, was modelled in a calibration chamber. The reconstituted sample was consolidated at a given confining pressure and then subjected to axial load exerted by the upper and lower membranes. Volumetric changes in both membranes and in internal chamber were measured. Up to 2% vertical strain was reached and internal friction angle was evaluated. Secant modulus of deformation was determined at considerable strains and at intermediate strain level in the unloading–reloading cycle. For the latter several times higher modulus was found.

Keywords: *calibration chamber, triaxial test, friction angle, deformation modulus, gravel*

1. Introduction

In laboratory determination of the shear strength and deformation characteristics of the gravelly soils or composite materials, a large-scale apparatus is indispensable since it allows grain size. To be accommodated large-size direct shear box was constructed to study the shear strength of railway ballast (Bolt [2]) or of gravelly surface layers in slope stability analysis (Fannin et al. [6]). The tests performed at small vertical stress applied to the box give an internal friction angle of gravelly soils even higher than 50 degrees. A new in-situ direct shear test was devised and applied to study the resistance of the block samples of coarse grained material to translation forces (Matsuoka et al. [12] and Fannin et al. [6]). Here, the shear strength of an undisturbed material in its natural state can be determined.

In order to evaluate the deformation characteristics of gravels at small strain, a large triaxial cell equipped with local strain gauge was used (Flora et al. [9]). The need for local strain measurements in gravel specimen is even more important than for the tests on sand. Here, some LDT-based systems are used (Flavigny et al. [8], Tatsuoka et al. [13], Da Re et al. [5]) or seismic wave propagation methods with bender elements (Brignoli et al. [3]), Fioravante et al. [7]), within a small-strain elastic region. The stiffness of gravelly soils subjected to small strains was also studied in calibration chamber using compression and shear wave propagation (Brignoli et al. [4]).

Gravel columns are often used to reinforce soft subsoil and to improve its drainage characteristics (Gryczmański [11]). A one-meter segment of a gravel column was modelled in the calibration chamber at Gdańsk University of Technology (GUT). Laboratory determination of the shear strength and deformation characteristics of gravel columns at considerable and intermediate strains is the objective of this study.

2. Test description

2.1. Calibration chamber device

The calibration chamber built at GUT enables large-size soil samples (Figure 1) to be tested in well defined boundary conditions. It is double-wall chamber with independent pressure control in internal and external chambers, which permits complex boundary conditions to be applied. The mass of the soil is confined by a rubber membrane. Vertical stress is applied to the specimen by the top and the bottom membranes filled with water. The water pressure in internal chamber is transmitted to the sample as a lateral stress. In this way, some kind of triaxial system is realised. Due to a substantial size of the specimen the vertical pressures in the upper and lower membranes are different and the lateral stress changes along its height. While at high confining stress this increase can be considered negligible, it is quite important in the case of the physical modelling of gravel column executed at small depths. The section of a gravel column with a length of 1.0 m and 0.53 m in diameter is modelled in the calibration chamber. The behaviour of the column section at a given depth can be analysed using different horizontal stress and increasing vertical stress applied in the chamber.

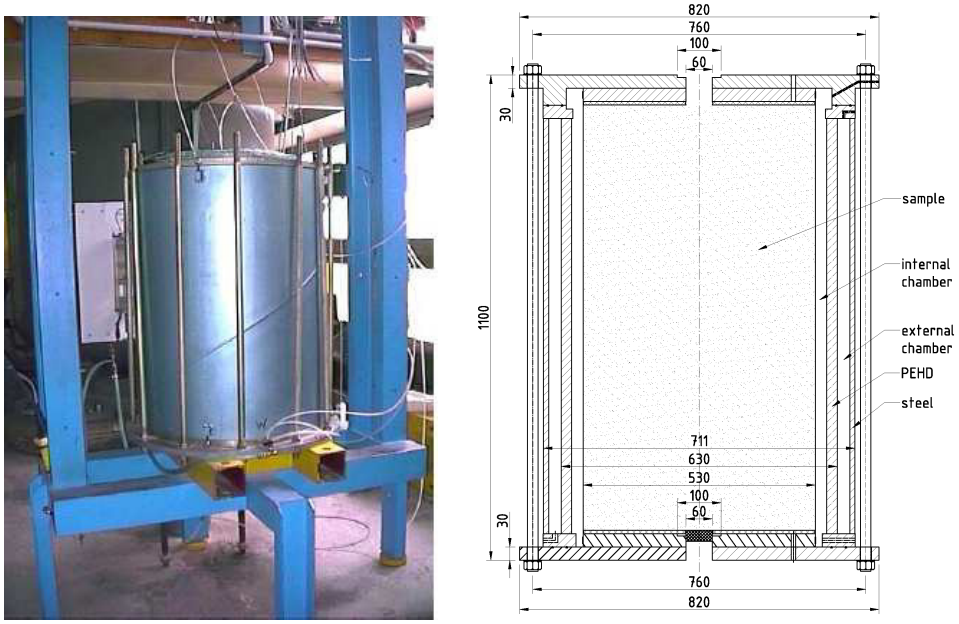

Fig. 1. View and cross-section of the calibration chamber at Gdańsk UT, Bałachowski and Dembicki

Volumetric changes of the specimen are measured in air–water columns mounted on the control panel (Figure 2) and equipped with micropulse transducers BTL2. The