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# Large-Scale, Radial Drainage Consolidometer with Central Drain Facility

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# LARGE-SCALE, RADIAL DRAINAGE CONSOLIDOMETER WITH CENTRAL DRAIN FACILITY

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## 1. INTRODUCTION

The large scale radial drainage consolidometer (Fig. 1) designed by the first author has now been commissioned at the Dept. of Civil and Mining Engineering, University of Wollongong at a cost of about \$35,000. This facility will be used to study the consolidation and drainage properties of saturated or "wet" materials. The potential materials to be tested include: undrained clay soils, fine mill tailings (washery wastes), wet coal with fines, water and sewage sludge and municipal (domestic) waste. The large sample size allows the testing of highly heterogeneous specimens beyond the scope of small conventional consolidation equipment. Railway ballast and rockfill specimens are typical examples. The consolidation process of wet samples will be accelerated by the provision of a central vertical drain, a unique feature of the apparatus. The central drain may consist of natural sand or synthetic fabric (geotextiles), depending on the type of tested material. A specially designed steel hoist is capable of inserting a synthetic drain along the central axis of the cell.

## 2. SUMMARY OF MAJOR COMPONENTS

The consolidometer consists of five major items, viz, the test chamber or cell, axial loading system, pore pressure measurement devices, axial and volume change measurement systems, and the hand winch system to install the central vertical drain.

(i) Cylindrical cell: The stainless steel cell (450 mm internal diameter and 950 mm in height) consists of two half sections, having the facility for installing six piezometers at pre-determined locations. The number of piezometers

can be readily increased by drilling more holes at prescribed locations on the steel cell. The friction along the cell boundary is reduced by a 1.5 mm thick teflon sheet.

(ii) Loading system: The maximum axial loading capacity is 1200 kPa, representing a maximum normal load of 190 kN which is applied by an air jack-compressor system via a steel piston.

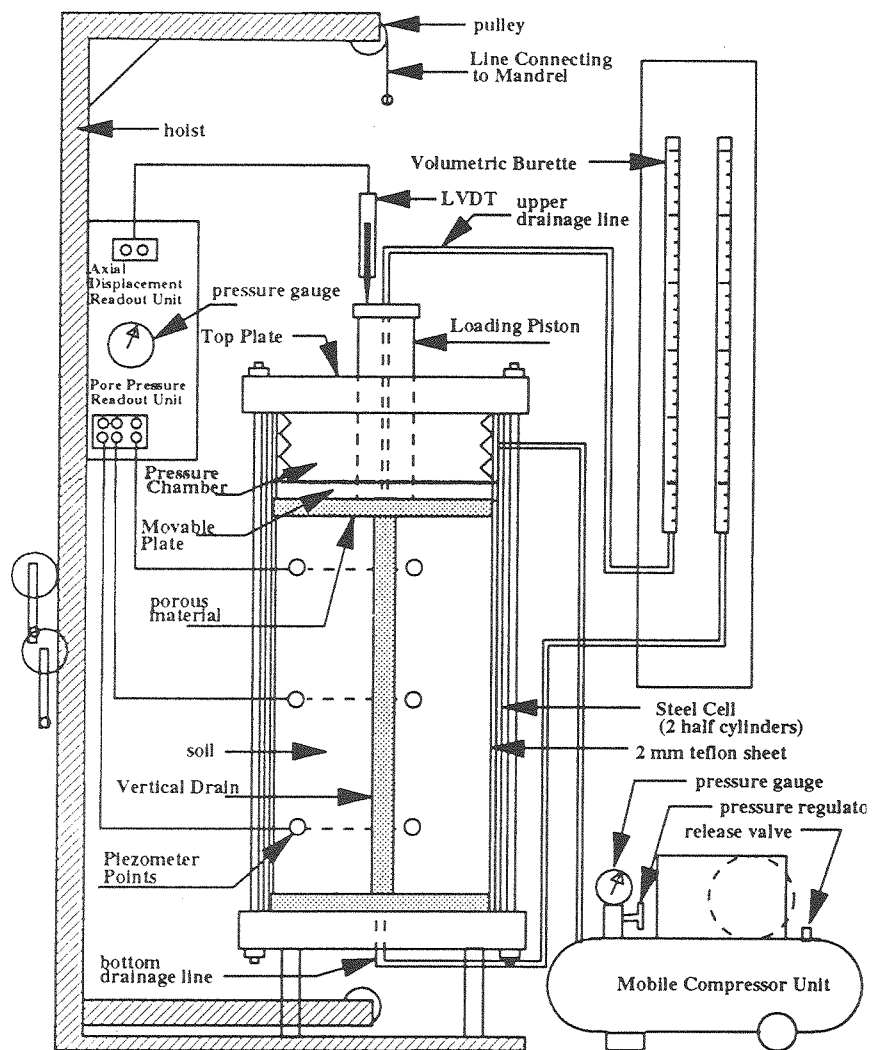


Figure 1: Radial Drainage Consolidometer with Central drain and pore pressure measurement

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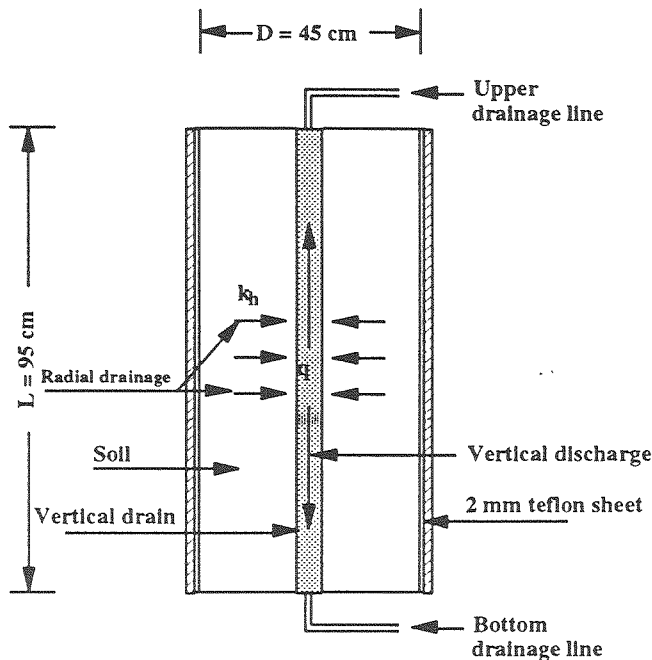


Figure 2: Enlarged view of vertical sand drain with radial and vertical flow

(iii) Pore pressure measurement: Currently, six diaphragm type piezometers complete with wiring are connected to a ten-channel switch box for signal conditioning. The readings are taken via a digital voltmeter.

(iv) Axial and volumetric strain measurement: LVDTs mounted to the top moving platen and the specially designed burette-drainage tube system are capable of determining the axial displacement and the volume change of the test specimen, respectively.

(v) Hand winch system: This is used to install and remove a geofabric drain along the axis of the cell. Installation of the drain is carried out from the top of the cell, whereas removal is facilitated through the bottom platen.

The details of the above components are shown in Figures 1 & 2.

### 3. APPLICATIONS

It is anticipated that the approaches will be particularly

useful for practical design studies of:

- vertical drainage to enhance the rate of consolidation of wet fills (Indraratna et al 1992),
- preloading of tailings deposits,
- stabilisation of colluvial slopes such as those in the Wollongong area (Indraratna et al, 1994 and Griffiths, 1995),
- simulation of the deposition and consolidation of mine backfill,
- crushed coal consolidation and drainage in stock piles and during transport, and
- the strength and stiffness of heterogeneous materials.

Current research projects which are committed to utilize this apparatus are summarised below:

(a) Evaluation of engineering behaviour of railway ballast: This project has already been funded as an APA(I) doctoral award for 3 years, in collaboration with State Rail Authority of NSW. The consolidometer will be used to study the effect of applied stress on the degradation characteristics of various types of ballast used in NSW, under dry and wet conditions. Settlement characteristics of various rockfill materials can be evaluated in the same manner at high stress levels, up to 1 MPa.

(b) Investigation of pre-compressed foundations composed of "wet" fills: The effect of vertical drains on the dissipation of excess pore pressures, hence accelerated radial consolidation will be given special attention. The effect of smeared zone and well-resistance will be investigated. It is hoped that this project will be carried out in collaboration with the Wollongong City Council.

(c) Monitoring of consolidation and drainage characteristics of mine backfills and wet coal containing fines: This is a joint project conducted in collaboration with the Centre for Geo-environmental and Mining Engineering and Key Centre for Mines with support from local coal processing plants.

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(d) Study of optimum volume reduction of consolidated municipal waste, water and sewage sludge for effective and economical disposal: Much encouragement and support for this project has been rendered by the Wollongong City Council, the Water Board and Boral, amongst other industries.

(e) Feasibility of stabilising saturated soil slopes with vertical drains in view of mitigating mass movement in soft soil deposits: A doctoral program is already underway with AIDAB support.

Griffiths, J. (1995). *Use of geosynthetics to improve the settlement and load bearing characteristics of Woonona Clay*. M.Eng Dissertation, Dept. of Civil & Mining Engineering, University of Wollongong.

## 4. CONCLUSIONS

To the knowledge of the authors, only a few institutions in this region have similar large-scale consolidometers with the facility for measuring pore water pressures during consolidation. The ability to install a central vertical drain is a unique feature of the equipment, which will be of immense benefit for a variety of geotechnical projects. The multi-purpose, radial drainage consolidometer will be useful for postgraduate training, as well as for carrying out industry sponsored laboratory projects and selected consultancy assignments.

## 5. ACKNOWLEDGMENTS

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